FINAL

Omnibus Essential Fish Habitat Amendment 2

Volume 5:
Environmental impacts of spatial management alternatives on managed resources and fisheries

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 Large mesh multispecies

2.1 Approach to analysis

The methods used for evaluating impacts on the large mesh groundfish resource are detailed below. Impacts to the large mesh groundfish were analyzed primarily using the hotspot analysis, which is described in detail in Volume 1, section 4.4, and in Appendix E. This anlaysis was developed by an ad-hoc technical working group convened to support the development of this amendment and chaired by Council staff. Briefly, the hotspot analysis uses fishery-independent survey data to quantify the abundance and distribution of large-mesh groundfish and emphasizes areas of unusually high abundance. Hotspots generated for juvenile groundfish were "weighted" to determine which areas are most in need of habitat protection. The weighted hotspot analysis emphasized: (1) species at low biomass levels; (2) species with sub-populations; (3) species with a high degree of residency; and (4) species with affinity for coarse substrates. In practice, for depleted stocks, biomass had the largest influence on the analysis, because the biomass weighting factor was calculated as the ratio of B_{MSY} to B, and therefore could be a relatively large number (up to 28.82 for Atlantic halibut, for example, with a mean value of 5.21). The sub-populations, residency, and substrate affinity weights had values ranging between 1 and 3. In addition to considerations for juvenile groundfish, the hotspot analysis also identified areas where larger spawning adults were highly abundant. Other sources of data, such as habitat vulnerability and the relative abundance of fish species, including older juveniles, were used to support the conclusions in addition to the hotspot analysis results.

2.1.1 Juvenile groundfish habitat analyses

Two specific objectives of this amendment that are intended to enhance groundfish fishery productivity (a goal of the amendment) are to: (1) improve protection of critical groundfish habitats, and (2) improve refuge for critical life history stages. To accomplish these objectives, habitat management measures in this amendment focus on habitats that are used by age 0/1 groundfish and are vulnerable to the adverse effects of fishing.

Following standard practices for conducting a GIS hotspot analysis, trawl and dredge survey data from 2002-2012 were used to identify concentrations juvenile groundfish. Methods, assumptions, and parameter choices are given in Volume 1, section 4.4, and Appendix E. Several choices were intentionally made that weighed the results in favor of critical life stages of groundfish species most associated with bottom habitat. These factors included affinity for hard substrates, degree of residency, evidence of formation of sub-populations, and stock status (expressed as the ratio of biomass at maximum sustainable yield, B_{MSY}, to current biomass). Groundfish stocks that are associated with mud or sand substrates, stocks that are migratory, stocks that are not known to form distinct sub-populations, and stocks that are near or above B_{MSY} were downweighted relative to other stocks. Overall, the analysis was restricted to fish estimated to be age 0 (i.e. spawned in the year observed by the survey) or up to age 1. Smaller juveniles are more likely to be associated with and dependent on habitat structure for survival and growth. While many species do not mature until a larger size, the older juvenile groundfish, in many cases, are thought to assume different diets and survival strategies that are often less associated with structured bottom habitat. Volume 1, section 4.1 provides details on the linkages between fishes and their habitats.

After the analysis identified hotspots for age 0/1 groundfish, the hotspots were weighted as noted above and binned into 10 km^2 grids, compatible with other information including estimates of vulnerability of bottom substrates to fishing. Contiguous areas of grids that had high weighted hotspot scores were further evaluated as potential candidates for groundfish habitat management areas. The number of weighted hotspots and the species composition of the total number of hotspots in various Habitat Management Areas were used to evaluate the relative positive or negative impacts that the proposed alternatives would have on the groundfish resources. Proposed habitat management alternatives with a greater number of age 0/1 groundfish weighted hotspots were generally considered to have a greater potential to generate positive impacts on groundfish habitat and groundfish stocks via regulations that prohibit the use of mobile, bottom-tending gear.

If juvenile groundfish hotspots do not overlap with a proposed habitat management area or suite of areas, the spatial patterns of fishing effort that result from adoption of these areas could have neutral or negative impacts on the groundfish resource. If habitat management areas (existing or proposed) cause effort to shift to locations with relatively high numbers of juvenile groundfish, as indicated by the hotspot analysis, this could constitute a negative impact on age 0/1 juvenile groundfish. However, if effort shifts into areas with little age 0/1 juvenile groundfish habitat, then impacts might be neutral. The same logic can be applied to spawner hotspots and shifts in fishing effort; if effort shifts from areas and seasons with few large groundfish to areas and seasons with substantial biomass of large groundfish, this could constitute a negative impact. However, if effort shifts to other areas with relatively fewer large groundfish, impacts on spawning might be neutral. It is important to note that the absence of hotspots does not necessarily indicate an absence of juvenile or spawning groundfish; this could be due to a lack of survey tows in the area and season, or indicative of somewhat lower biomass that did not reach hotspot levels of abundance. In summary, in terms of evaluating management alternatives, the characteristics of the area under consideration are important, but it is also important to consider the characteristics of nearby areas occupied by species of interest that do not fall under management in the alternative.

Juvenile groundfish rely on both highly vulnerable habitat types and lower vulnerability habitat types. Not all high vulnerability habitats may be as directly important for all groundfish species due to less than optimal conditions, such as temperature, prey availability, and predator abundance. Conversely, habitats that are less vulnerable to the impacts of fishing may be very important to certain groundfish species. Habitat conservation measures intended to reduce impacts on habitats used by juvenile groundfish should focus on the spatial intersection of vulnerable habitat types and groundfish stocks, particularly those species known to rely on complex structured habitats that provide shelter from predators and a source of food. Using the SASI and hotspot analysis criteria in combination, the greatest positive impacts for critical life stages of groundfish will be realized by protecting habitats that are both highly vulnerable to fishing and that encompass high weighted hotspot values. As noted above, stocks with low biomass values are weighted more heavily in the analysis and larger multipliers were applied to their hotspots.

Distribution of young juveniles (age 0/1)

When evaluating the impacts of the habitat management alternatives on groundfish, it is important to consider the size and age of fish targeted for conservation. Size ranges included in the hotspot analysis were selected to encompass juveniles in their first and second year of life (ages 0 and 1), and management areas that are based around the results of the hotspot analyses, therefore, are designed to protect the habitats used by these smaller juveniles. Often, the maximum sizes of age 0 and 1 juveniles (which vary by stock) are less than both the maximum size of juvenile fish as defined in the EFH designations (see Volume 2) and also the sub-legal fish caught by commercial and recreational fishing vessels. These young fish were identified as most reliant on structured bottom habitat for survival and growth. Older, sub-legal, juvenile fish may not derive as much benefit from a habitat management area closure or gear restriction because they are generally less associated with the bottom, are better swimmers and more capable of escaping predators, and are more likely to consume a greater variety of prey organisms, including other fish.

In the case of cod in the western Gulf of Maine, the age 0/1 fish tend to be more associated with inshore (and generally) shallower areas, particularly in the spring (Map 1). Specifically, there is a notable difference in distribution of age 0/1 cod (≤25 cm in spring and ≤ 35 cm in fall) compared to older, but still sub-legal cod ≤ 55 cm[1]. The age 0/1 cod are distributed more inshore and the older juveniles appear to be more abundant further offshore during both the spring and fall surveys (Map 1). This does not mean that cod older than age 1 are not inshore; however, there are relatively fewer in number. This also does not mean that there are not age 0/1 cod further offshore; however, they are fewer in number than older, sub-legal fish.

This inshore/offshore difference in distribution is not entirely due to depth or temperature (i.e. generally warmer inshore during the summer and falland colder during the winter and spring). There are significant differences in the distribution of younger versus older juveniles by depth, but they are more subtle than it might appear in Map 1. In the spring (Figure 1), abundance of age 0/1 cod appears to be significantly greater than abundance of older, sub-legal cod at depths up to 20 m. The opposite appears to be true at depths greater than 90 m, where the abundance of older sub-legal cod is greater than that of age 0/1 cod. Abundance of 0-25 (age 0/1) and 25-55 (older juveniles) cm cod are not significantly different at 20-90 m, depths often found in the offshore portions of the western Gulf of Maine (Map 1). In the spring (Figure 1), there appear to be significantly more 0-25 cm cod only at 7ºC, but not at any other temperature[2]. At temperatures above 9ºC, only sub-legal cod smaller than 25 cm were caught. In the fall (Figure 2), the relative abundance for these two size categories does not appear to be significantly different, except for depth less than 20 m, where there were very few older sub-legal cod in the survey catches. In the fall, there appear to be significantly more 35-55 cm sub-legal cod when the bottom temperature was 6ºC and more 0-35 cm cod when the bottom temperature was above 11ºC.

[1] The legal minimum size cod for commercial vessels was 22 inches (55.9 cm) from August 1, 2002 [Interim Action; 67 FR 50292] to August 29, 2013 [Framework Adjustment 48; 78 FR 53363]. Other minimum sizes as large as 24 inches applied to recreational fishing vessels.

[2] These results should be interpreted with caution, however, due to influences of larger year classes during years when temperature was abnormally high or low.

Offshore habitat management areas, such as the Western Gulf of Maine Habitat Closure Area, the Jeffreys Ledge Habitat Management Area, or the Stellwagen Habitat Management Areas (large and small) may benefit older, sub-legal cod, but they may also condense effort inshore where the smaller, younger cod are most abundant. If mobile bottom-tending gear use reduces habitat quality inshore, this could reduce survival and growth of the youngest cod, which are believed to be more dependent on bottom habitat quality, and thus may reduce recruitment to the stock.

Figure 1 – Juvenile cod per tow by size category and depth (left) and bottom temperature (right) in Gulf of Maine strata, 2002-2011 spring surveys (NMFS, MADMF, ME-NH, IBS cod). Notches in bars represent the 95th percent confidence interval for the mean.

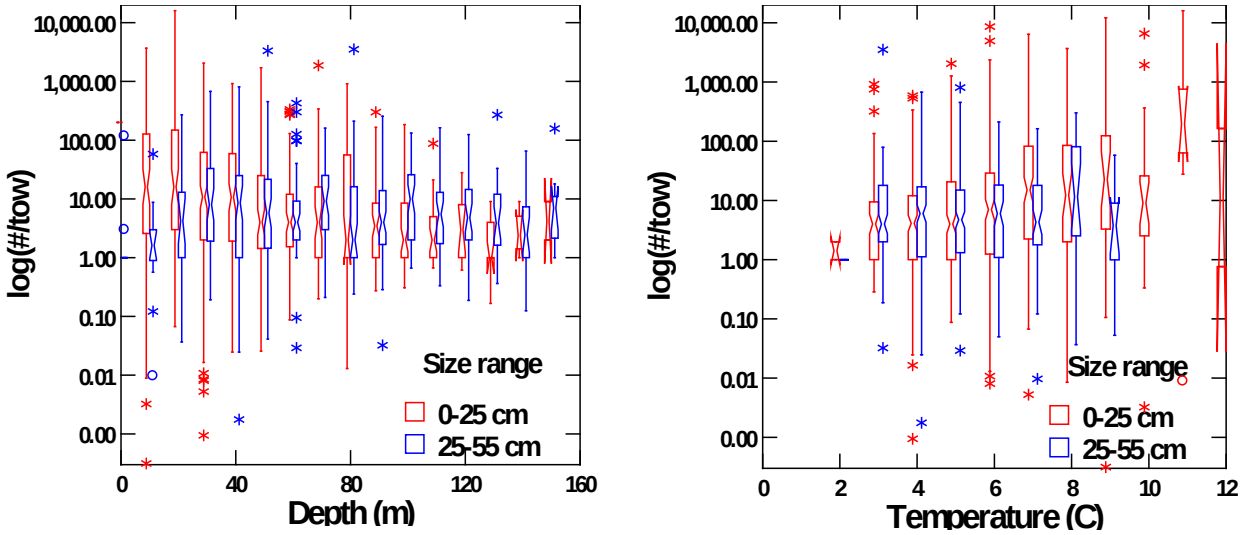
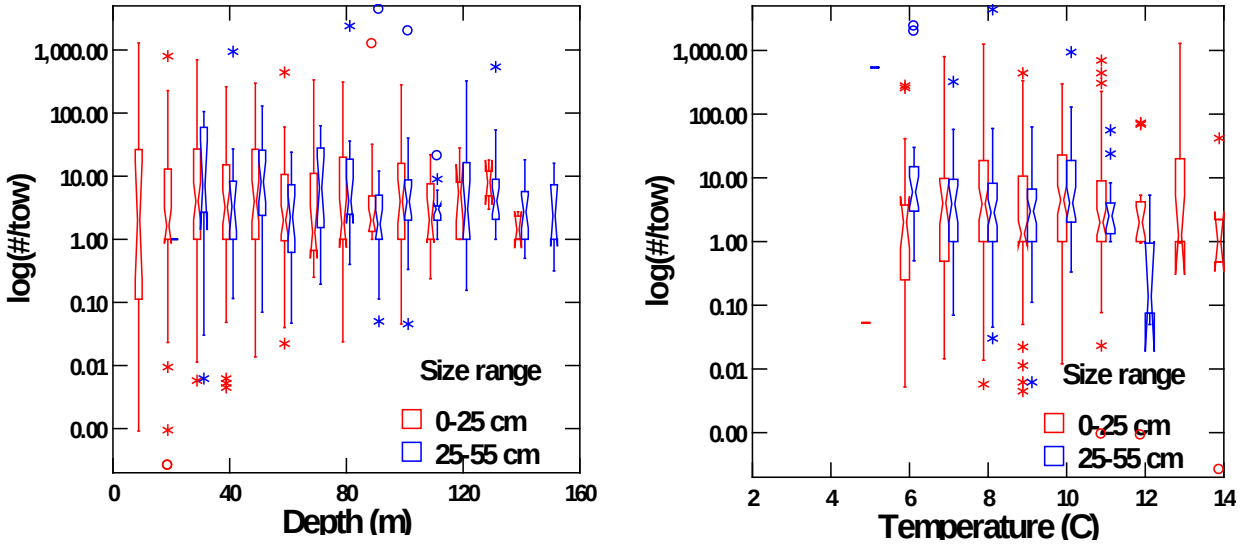
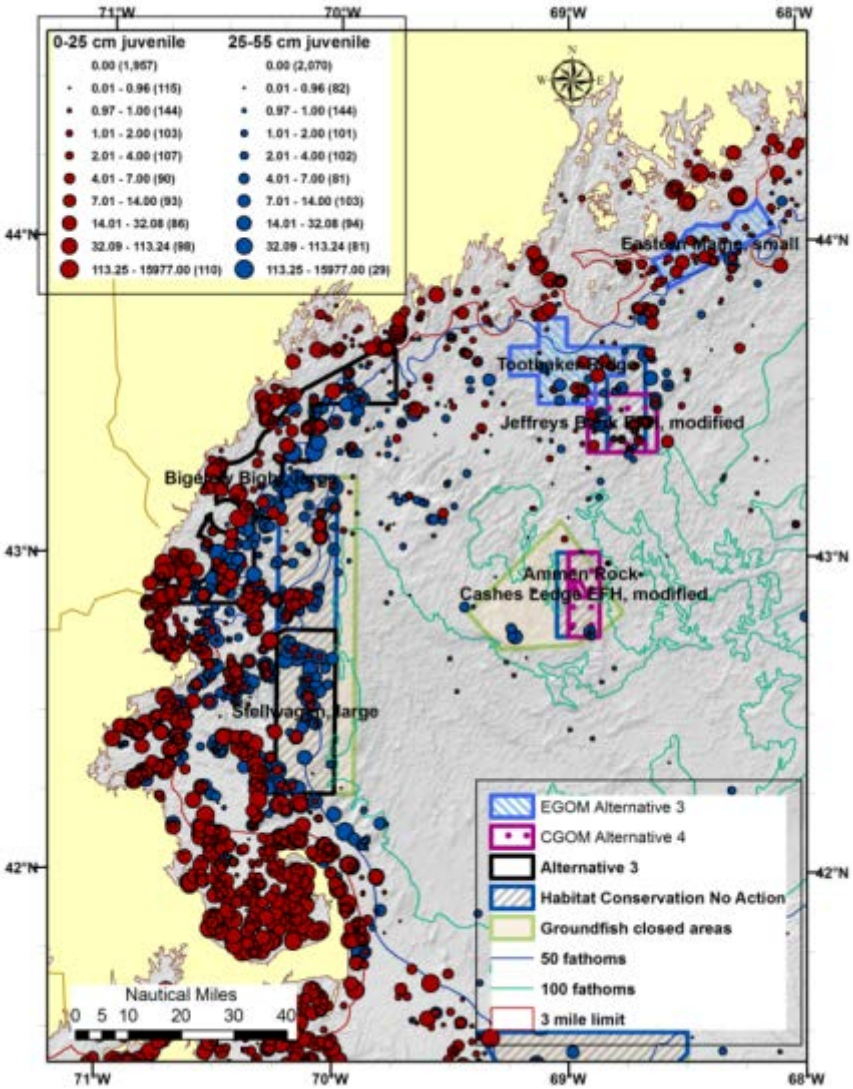


Figure 2 – Juvenile cod per tow by size category and depth (left) and bottom temperature (right) in Gulf of Maine strata, 2002-2011 fall surveys (NMFS, MADMF, ME-NH, IBS cod). Notches in bars represent the 95th percent confidence interval for the mean.

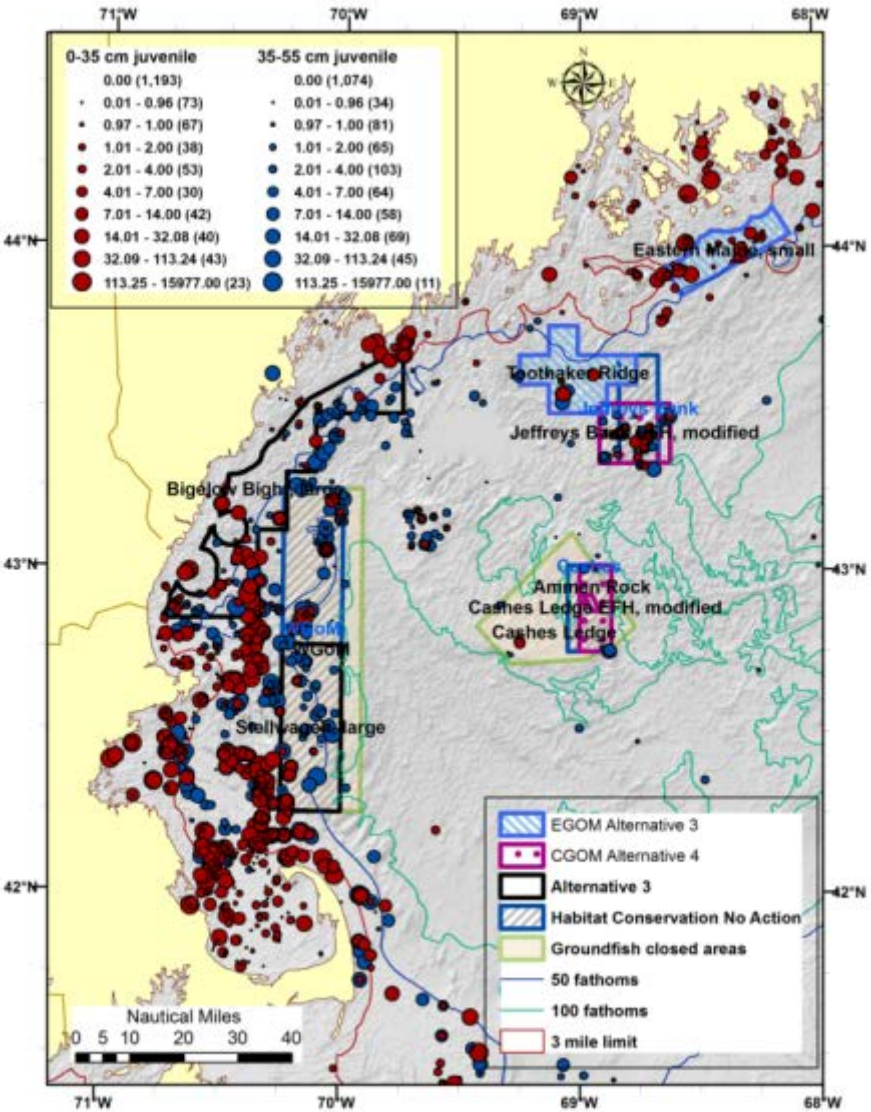


Map 1 – Distribution and overlap of WGOM Alternative 3, EGOM Alternative 3, and CGOM Alternative 4 with sub-legal cod number per tow for age 0/1 and age 2+ size classes in 2002-2012 NMFS, MADMF, ME-NH, and IBS cod surveys.

Spring and summer



Fall and winter



Local, regional, and stock level effects

Local, regional, and stock-level habitat impacts are evaluated (Table 1). These local and sub-regional effects could change the quality of habitat with which age 0/1 groundfish stocks are associated. The positive impacts of habitat management alternatives are expected to be evident at the stock level, enhancing productivity and improving sustainable yield. The alternative-by-alternative analyses focus most closely on characterization of local habitat impacts and on relevant stock-level groundfish impacts.

Table 1 – Classification of possible impacts on groundfish habitat and stocks.

Classification of effects	Local impacts on groundfish habitat in the proposed habitat management areas, without considering the effects of potential effort displacement	Regional impacts on groundfish habitat in the Gulf of Maine or Georges Bank/Southern New England region, considering the effects of effort displacement and intensified fishing in adjacent areas	Stock-level effects: Impacts on groundfish population and productivity
Positive or beneficial	Quality and quantity of groundfish habitat is expected to improve.	Quality and quantity of groundfish habitat is expected to improve.	Habitat changes are expected to increase stock productivity.
Uncertain	It is unclear how the quality or quantity of groundfish habitat will change.	It is unclear how the quality or quantity of groundfish habitat will change.	It is unclear how habitat change will affect stock productivity
Neutral	Groundfish habitat quality or quantity is not expected to improve or worsen.	Groundfish habitat quality or quantity is not expected to improve or worsen.	Expected effect is not positive or negative
Negative or detrimental	Groundfish habitat quality or quantity is expected to worsen.	Groundfish habitat quality or quantity is expected to worsen.	Habitat changes are expected to decrease stock productivity.

On a local level, a reduction in adverse gear effects within a habitat management area would promote habitat recovery in previously fished areas, or continue habitat recovery in currently unfished or closed areas. The greatest benefits are expected to accrue to species that are known to associate with coarse substrates at very young ages. Negative or detrimental local groundfish habitat impacts are not expected to result from the habitat management alternatives, except in existing year-round groundfish and habitat closures that are currently off-limits to mobile bottom-tending gear fishing and could re-open to fishing with these gear types.

On a regional level, the direction and magnitude of the impacts relates to the effects of the alternatives on habitats inside the proposed habitat management areas as well impacts on neighboring habitats. The impacts to neighboring habitats relate to the potential for fishing effort to shift into adjacent areas or for fishermen to begin using other gears to target groundfish and other species. It is very difficult to evaluate regional impacts without considering the total suite of potential alternatives in the Gulf of Maine or Georges Bank/Southern New England region.

Alternatives that close some areas but leave neighboring areas with vulnerable habitat open to fishing might actually be detrimental to regional habitat quality, depending on the relative size and importance of habitats open to fishing vs. areas where fishing is restricted.

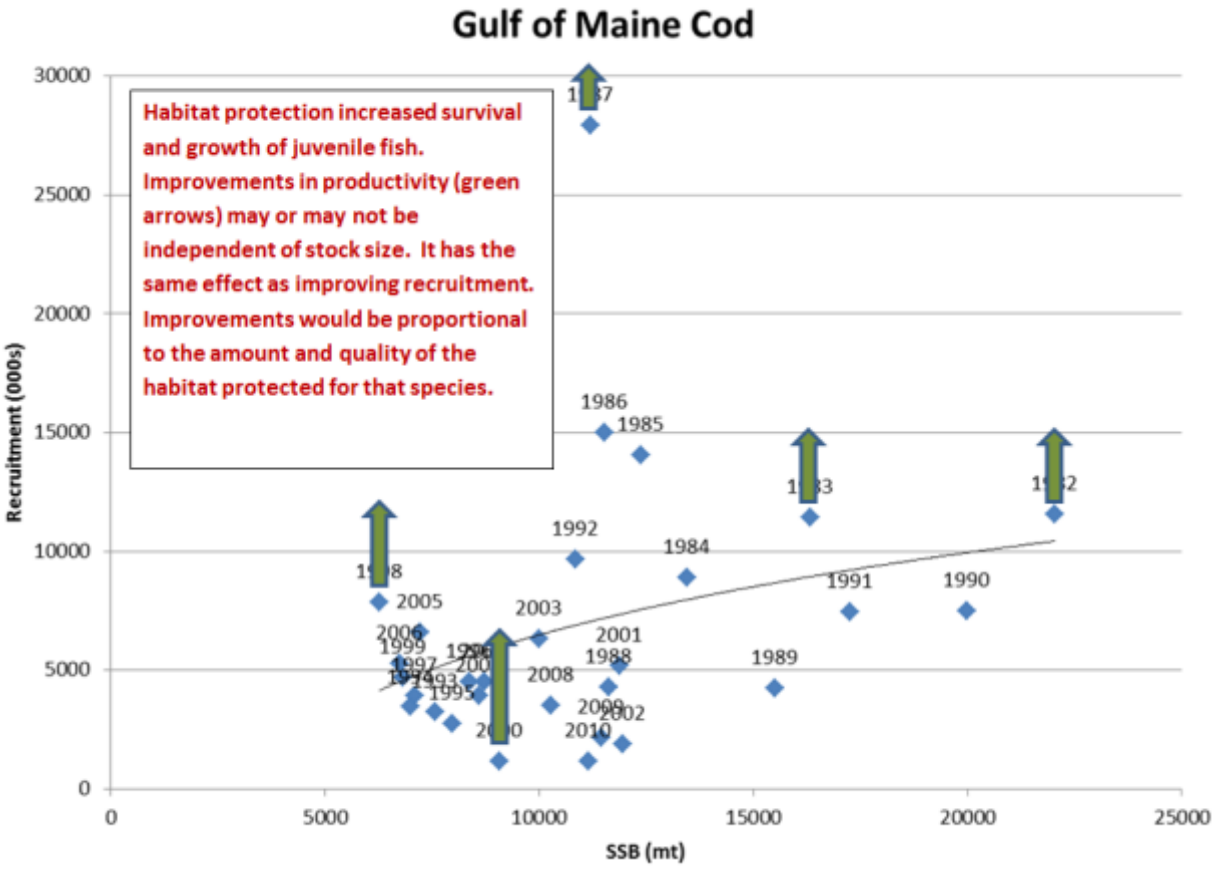
At a stock level, there are many ways to improve the productivity of a stock and increase sustainable yield, including improving survival and growth of young fish, through improved habitat quality, increasing the population of primary prey species, reducing population levels of predators, and reducing fishing mortality from discards. The discussion of impacts in this section focuses on the first of these effects, operating at a population level. When a particular alternative is expected to have a positive or beneficial effect for groundfish, the statement is made with respect to species with age 0/1 fish that are associated with coarse substrates and associated epifauna that are vulnerable to the effects of fishing with mobile bottom-tending gears. A positive or beneficial effect on juvenile groundfish habitats is expected to have a positive or beneficial effect on associated groundfish stocks.

Specifically, improvements in habitat quality are expected to translate into improvements in survival and growth of young groundfish. These stock-level effects can be explained using a recruitment/spawning stock biomass (R/SSB) conceptual framework. One mechanism by which improved habitat quality may translate into improved stock productivity would be to increase the amount of young fish, or recruits. On a stock/recruit curve, this would be represented as an increase in the R/SSB slope at the origin. Depending on the degree of density dependence and how the species occupies marginal habitats at higher abundance, the greatest effect should be when spawning stock biomass and recruitment are low. Another alternate or complementary mechanism would be that a reduction in gear effects could improve the quality of marginal habitats, allowing young recruits to spread out into improved habitats. This latter response could allow recruitment to increase proportionally to the degree to which relevant habitat improvements are realized.

An example of these potential effects using actual recruitment and spawning stock biomass estimates is illustrated in the figure below. Generally, habitat improvements would increase survival of recruits at all population levels (green arrows shown for four example years). The greatest positive effect (represented by larger green arrows) would be expected when the population (and recruitment) is low, as it has been lately for Gulf of Maine cod. Recruitment in 2010 was the fourth lowest on record. In such a situation, a large amount of better quality essential habitat would allow for better survival and growth.

As a percent change, the expected benefit is more muted at higher population and recruitment levels (represented by smaller green arrows like the 1987 year class, for example). The essential habitat in this case may be fully saturated by the larger number of recruits. Improved habitat in this case may not significantly affect survival. On the other hand, more marginal habitats may become better suited for a given species to expand its range in years when recruitment is good.

Figure 3 – Illustration of potential impacts of habitat improvement on recruitment using actual spawning stock biomass and recruitment estimates for Gulf of Maine cod. Data are from NEFSC 2013; http://nefsc.noaa.gov/publications/crd/crd1311/.



Option 1 – restrictions on mobile bottom-tending gears

Generally, prohibiting mobile bottom-tending gear fishing (Option 1) in habitat management areas that have weighted groundfish hotspots (and to some extent in areas without hotspots that host age 0/1 groundfish and encompass vulnerable substrates) is expected to have a positive local effect on age 0/1 groundfish that are associated with coarse and hard substrates, presuming that those areas have previously been altered by fishing. Areas that overlap existing year-round groundfish closed areas would experience a smaller marginal increase in benefits than areas that are now intensively fished. Areas that are currently open but have had no or little fishing are expected to have a neutral or no effect if closed to these gears.

On a regional scale, prohibiting mobile bottom-tending gear fishing may produce positive, neutral, or negative impacts, depending on where and how effort is displaced. Shifts towards the use of non-mobile bottom-tending gears would be expected to reduce regional habitat impacts and have positive impacts on groundfish habitat. Negative regional habitat impacts may occur if more sensitive areas where fishing with mobile bottom tending gear is currently prohibited are opened to fishing and are not replaced by areas with equivalent or better groundfish habitat characteristics, represented by the number of hotspots and habitat vulnerability.

Option 2 – Hydraulic clam dredge exemption

In many areas in the Gulf of Maine, Options 1 and 2 are expected to have equivalent impacts because little or no hydraulic clam dredging currently occurs currently or is likely based on the distribution of clams. The exceptions would be areas in eastern Maine which have clam resource, and areas in the western Gulf of Maine with sand and gravel habitats that provide suitable habitat for Stimson's surfclam, and different species from that typically targeted by the fishery but that could be harvested with hydraulic dredges. This assumption is likely still valid despite possible reopening the Northern Temporary PSP Closure; see discussion in clam resource/fishery section 10 about this issue. In Georges Bank management areas, the local and regional impacts on groundfish habitat would be less positive under Option 2 than if clam dredges were prohibited (i.e. Option 1) from fishing in a habitat management area.

Options 3 and 4 – Ground cable modifications

There are three ways that gear modification areas may directly affect groundfish habitat, influenced by changes in fishing behavior and/or relative catchability.

- Direct reduction of habitat alteration by trawl gear, by reducing area physical interaction with substrates and bottom habitat.
- Changes in fishing time, i.e. area swept. Area swept may increase if the gear is less efficient in catching the target species, or it could decrease if the modified gear is more efficient.
- Changes in fishing behavior or location fished due to changes in fishing costs or the inability of the fishermen to use the modified gear.

Catchability is a measure of the proportion of fish in the path of a net and ground cables that are actually caught by the net. Less than 100% of these fish are caught because fish may escape capture by avoiding or out-swimming the oncoming net, by escaping the net through unintentional or designed 'loopholes' (i.e., escape panels, raised footrope), and by passing through the trawl mesh. If there is a reduction in catchability due to required gear modifications, then vessels might fish longer to catch the target species, which mitigates the direct reduction of habitat alteration. It may also cause a negative impact if the vessel fishes substantially longer with modified gear to catch the target species.

A gear modification may also lead to changes in fishing behavior. If the modified gear cannot be fished in more rugged bottom dominated by coarse and hard substrates, fishing effort could be redistributed into other habitat types within a proposed gear modification area. This effect is expected to be positive for groundfish habitat. Other fishermen that would normally fish in the proposed area may simply choose not to use the modified gear and fish in other open fishing areas where such gear is not required. This effect could be positive, neutral, or negative depending on the quality of age 0/1 groundfish habitat that exists in the open fishing area.

Due to the potential for fishing time to increase when catchability declines compared to unmodified nets and allowance of other mobile bottom-tending gear (i.e. dredge gear) that

impacts habitat, this management measure applied to any of the proposed habitat management measures is unlikely to have positive impacts on groundfish habitat, unless it substantially reduces the amount of fishing or its location through changes in fishing behavior. Regional impacts on groundfish habitat and on groundfish stocks are either unknown or possibly negative compared to Alternative 1 (No Action).

Option 5 – Restrictions on gears capable of catching groundfish

Eastern Gulf of Maine Alternative 2 and some of the Alternative 1 (No Action) management areas would prohibit fishing with gears capable of catching groundfish. Impacts on groundfish stocks could be either positive or negative depending on the relative qualities of groundfish inside the proposed area and in adjacent areas where fishing would otherwise occur.

The purpose of this added restriction is to increase the potential for groundfish stock recovery in and around the area, complementing habitat protection measures and other recent conservation activities in the surrounding area. Closure to all gears capable of catching groundfish would reduce catch of (sub-legal and legal size) juvenile and adult groundfish. If the area has above average amounts of juvenile fish that would be retained by the fishing gear, the closure could decrease discard mortality and raise sustainable yield[3] from the stock; a positive impact on the groundfish resource. If the proposed area has fewer sub-legal fish as compared to a nearby area where fishing is displaced to, then the opposite would be true and impacts would be negative due to displacement of fishing effort.

In areas where localized spawning subpopulations exist and particularly where these subpopulations have been depleted, a localized reduction in groundfish mortality could increase the potential for recovery and rebuilding, particularly if non-fishing factors that affect growth and survival of groundfish have improved. Coupled with a reduction in effects on vulnerable habitat, this mortality reduction on localized subpopulations would be a positive impact, regardless of how and where fishing is redistributed.

2.1.2 Groundfish spawning analyses

The impacts analysis focuses on the expected direct effects of the groundfish spawning alternatives on the 20 large-mesh groundfish stocks. In general, the proposed areas are expected to reduce the negative effects of fishing on groundfish spawning success. With the exception of the Massachusetts Bay Spawning Protection Area, the proposed alternatives (Alternatives 2 and 3) to the current closed areas (Alternative 1), reduce the spatial and/or seasonal scope of the current closed areas and rolling closures. Therefore, by themselves, the action alternatives do not reduce the effects of fishing on spawning populations in relation to the no action alternative. While positive impacts are primarily focused on cod and haddock, the areas may also have benefits for other groundfish stocks.

Fishing can interfere with spawning success and productivity in a number of ways including:

[3] By increasing yield-per-recruit.

1. Removal of spawning fish before they have had the opportunity to spawn;
2. Dispersal of spawning fish;
3. Sub-lethal impacts on spawning condition fish that interact with the gear but are not brought on board the vessel, or are captured but discarded alive; and
4. Disruption of spawning behavior, including negative effects on auditory and visual communication.

These effects may be more significant if they disproportionately impact a particular sub-population.

The first effect is simple – catching developing and ripe fish before they have had the opportunity to spawn reduces spawning biomass. These removals (i.e. catch of mature fish) have the same effect whether the fish were removed well before or during spawning season. Even though groundfish catches and fishing mortality are limited by annual catch limits, fish concentrations associated with spawning tend to increase the availability of fish to the gear and increase catch per unit effort (CPUE).There is an incentive to target spawning fish to reduce fishing costs and thus preferentially remove larger mature fish from the population. While potentially reducing bycatch of sub-legal immature fish (a positive effect), targeting large spawning fish would have a negative effect on groundfish productivity by removing mature spawners, which could have more viable eggs. Selective removal of the largest and oldest fish could also truncate the age structure.

Dispersal of spawning fish, i.e. fish avoiding or leaving areas where fishing activity is concentrated, may have negative impacts if dispersed fish do not find mates elsewhere, if they move to other less-preferred spawning locations, or if they do not return to the spawning ground after fishing activity has declined. Any of these responses by spawning fish has the potential to reduce spawning success, negatively affecting productivity.

Some groundfish, particularly cod, have been observed to exhibit specific spawning behaviors (see discussion in the Affected Environment section of Volume 1). This behavior is sometimes manifested in diel separation and re-aggregation by sex, and has been observed in acoustic cod tagging by Massachusetts Division of Marine Fisheries in the Saturday Night Ledge area of the western Gulf of Maine, and in other areas (Dean et al 2014). Deployment of gillnet fishing gear appears to disrupt this behavior and it is possible that mobile fishing gear may have similar effects. In this case, spawning success and fertilization may be less successful as long as the fishing activity remains in preferred spawning locations.

Zemeckis et al. (2014) provides a timely and thorough discussion of what is known about the spatial dynamics of cod spawning and its implications for management. It appears that cod spawning is much more complicated than had been known, and the species exhibits a lekking mating system, where males are separated from females and comingle during nightly bouts of courtship and actual spawning activity. Some of these observations were made in laboratory settings, but recently have been confirmed with *in situ* observations using acoustic tags (Dean et al. 2014).

Zemeckis et al. (2014) discusses the potential for serial depletion of distinct spawning units in a population and the potential effects that fishing can have on spawning behavior. While reducing catches of large fish (by reducing total fishing mortality or with slot size limits) can address this need, Zemeckis et al. (2014) argues for spatially explicit management to protect complexes of spawning components that exhibit persistent spawning locations and seasons.

The paper recognizes the existence and potential effect on cod spawning from the Gulf of Maine Cod Spawning Protection Area (Whaleback) and the Massachusetts Winter and Spring Cod Conservation Zones. It also discusses the coincidental relationship between spring cod spawning over a broader area and the groundfish fishery rolling closures from March to June.

On one hand, small closures that protect well-defined spawning components should be very effective to reduce the impacts on spawning codfish. On the other hand, small closures of relatively short duration (to focus conservation on specific spawning components) carry a higher risk of missing annual spawning events when, for example, meteorological events in an abnormal year delay, advance, or cause spawning activity to develop elsewhere. Climate change may also play a role in changing spatial and temporal spawning characteristics. Smaller closures may place more fishing pressure on other unobserved spawning components than larger closers with longer durations, mitigating the intended benefit to spawning potential.

While specific cod spawning behavior has been observed in select locations, these informative but difficult to collect data are not available broadly where cod spawn. The extent and timing of cod spawning is generally only known for a few specific areas. Timing, location, and characteristics of spawning are also generally not well known for non-cod stocks, including other related gadid species like haddock, pollock, and hakes.

Looking at groundfish spawning from a broad, multispecies perspective over all areas of the Gulf of Maine and Georges Bank/Southern New England regions, the Closed Area Technical Team relied on groundfish size and maturity data to identify potential hotspots where large mature fish are concentrated. These results from spring, summer, fall, and winter survey data are used below to evaluate potential impacts on groundfish productivity.

A similar approach was used to identify hotspots of large, older, spawner groundfish, using survey weight per tow of the largest fish contributing to 20% of total biomass for each species during 2002-2012[4]. The hotspot totals were summed into grids and weighted in favor of more critical stocks, i.e. stocks that were at low biomass relative to B_{msy}, exhibit a higher degree of residency, and/or stocks that form sub-populations. All large-mesh groundfish stocks were included in the analysis, but some were given lower weight than others because either they are near or above the target biomass or are not characterized as forming distinct sub-populations that would be vulnerable. This ranking gave species like cod (both stocks) and Gulf of Maine haddock, as well as Atlantic halibut and ocean pout more influence on the analysis than other species like white hake and pollock.

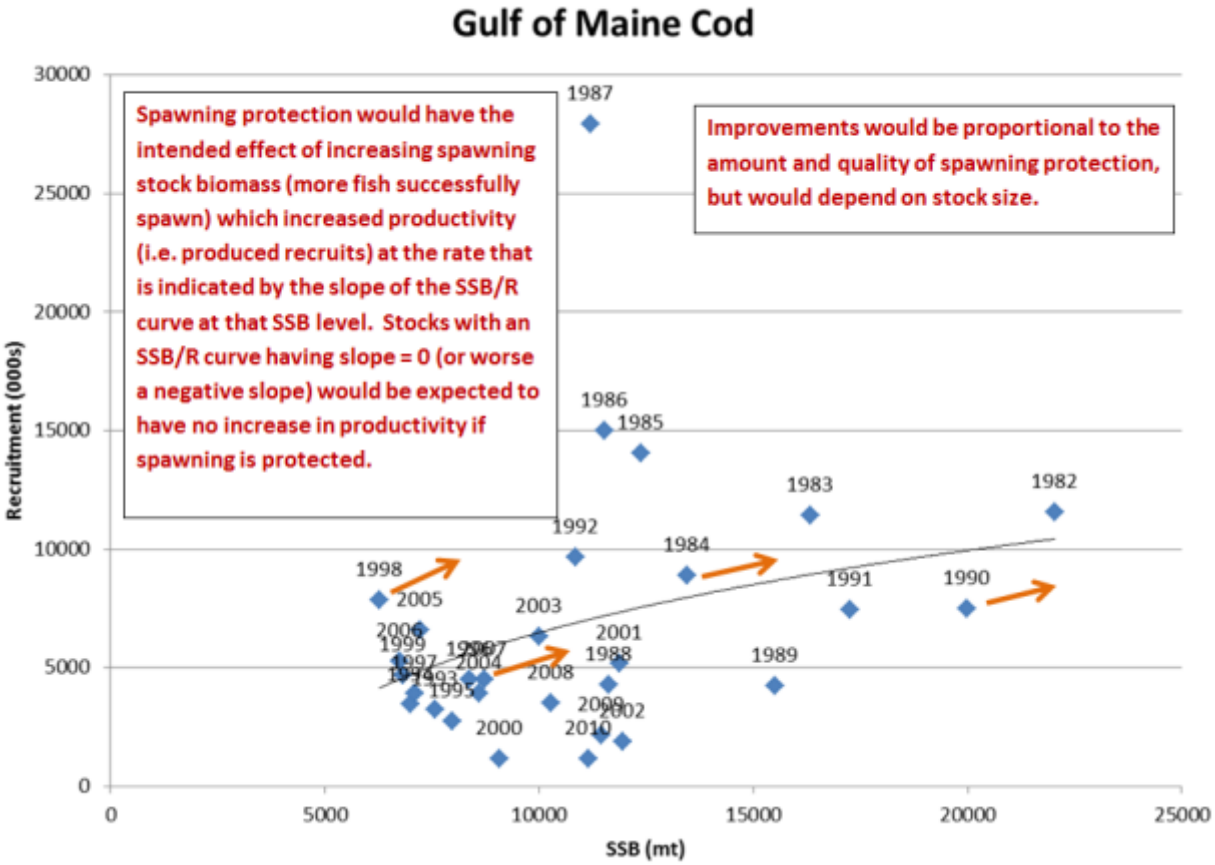
[4] The size at which larger fish contributes to 20% of total biomass changes over time due to variations in recruitment and trends in fishing mortality.

Contiguous areas of grids that had high weighted hotspot scores were further evaluated as potential candidates for groundfish spawning management areas. The number of weighted hotspots and the species composition of the total number of hotspots in various Spawning Management Areas were used to evaluate the relative positive or negative impacts that the proposed alternatives would have on the groundfish resources. Proposed spawning management alternatives with a greater amount of weighted hotspots of large spawner groundfish were considered to have more favorable characteristics and have a more positive impact on spawning and groundfish stocks.

Where relevant, additional information about the distribution of developing or ripe fish was evaluated. While these data are sometimes informative, the results are influenced by the match (or mismatch) of spawning activity and the timing of the seasonal surveys. Many times, the surveys will catch high amounts of large, mature groundfish, but they are not yet in a ripe condition or have already been spent (i.e. post-spawning). This temporal mismatch is why hotspots were identified based on numbers of large fish, rather than using numbers of fish in spawning condition.

The illustration below shows how increases in spawning success could affect productivity, using estimated Gulf of Maine cod spawning stock biomass (SSB) and recruitment. A positive stock recruitment relationship indicates that improving spawning success should improve recruitment. If a reduction in fishing in spawning locations and seasons improves spawning success, it is as if there were more spawning fish in the population. Generally, unless there is a high degree of density dependence (such as in a cannibalistic species), recruitment will be higher and would produce a larger stock size (assuming that density dependent effects on growth and survival of recruits does not negate the effect). The actual amount of increased recruitment one would expect to see will vary according to the strength of the relationship between SSB and recruitment in a given stock.

Figure 4 – Illustration of potential effects of increasing spawning success and its effect on recruitment produced by that increase.



Because fishing with mobile bottom-tending gear tends to have lasting effects on vulnerable bottom habitat, seasonal restrictions to protect spawning are unlikely to have positive impacts on local habitat condition, since damage to such habitat could occur during times when an area is otherwise open to fishing. However, some prey and fast-recovering benthic species may be important to why large mature fish congregate, such that temporary reduction of fishing by mobile bottom-tending gear during a spawning closure could reduce impacts on these species. Thus, seasonal implementation of spawning areas could provide some level of protection for prey and fast-recovering benthic species that might translate into benefits for spawning groundfish.

While the habitat alternatives were not explicitly designed to improve spawning protection, they could provide spawning protection benefits; therefore, potential impacts of the habitat alternatives on spawning groundfishare also evaluated. The mechanisms noted above for negative fishing impacts on spawning success apply to these alternatives as well: (1) removal of spawning fish before they have the opportunity to spawn, (2) dispersal of spawning fish, (3) sub-lethal effects on fish caught as bycatch, and (4) disruption of spawning behavior. The seasonality, locations, and proposed fishing restrictions associated with the various habitat management areas all influence the potential for these areas to provide positive spawning benefits.

Regarding seasonality, all of the habitat management areas would be implemented on a year-round basis. This means that habitat management measures will be in effect regardless of the season during which groundfish are spawning.

Regarding location, habitat management areas would need to overlap spatially with spawning groundfish in order to protect them before or during spawning activities. Habitat management alternatives that have limited to no overlap with spawning groundfish are expected to have neutral to negative impacts, because these areas will not actively protect spawning activity, and could displace fishing effort onto nearby spawning aggregations. If none of the alternative areas in a sub-region overlap with groundfish spawning activity, then each of the sub-regional alternatives are likely to have similar, and probably neutral, impacts. This is the case in the eastern Gulf of Maine and Great South Channel/southern New England sub-regions. If only a subset of a sub-region's habitat management areas overlap with spawning groundfish, then displacement of effort could cause negative impacts. The large spawner hotspot analysis is used to qualitatively estimate the overlap between habitat management areas and spawning groundfish. Map 2, Map 3, Map 4, Map 5, and Map 6 indicate the overlap between the weighted spawning groundfish hotspots and the habitat management areas in each sub-region.

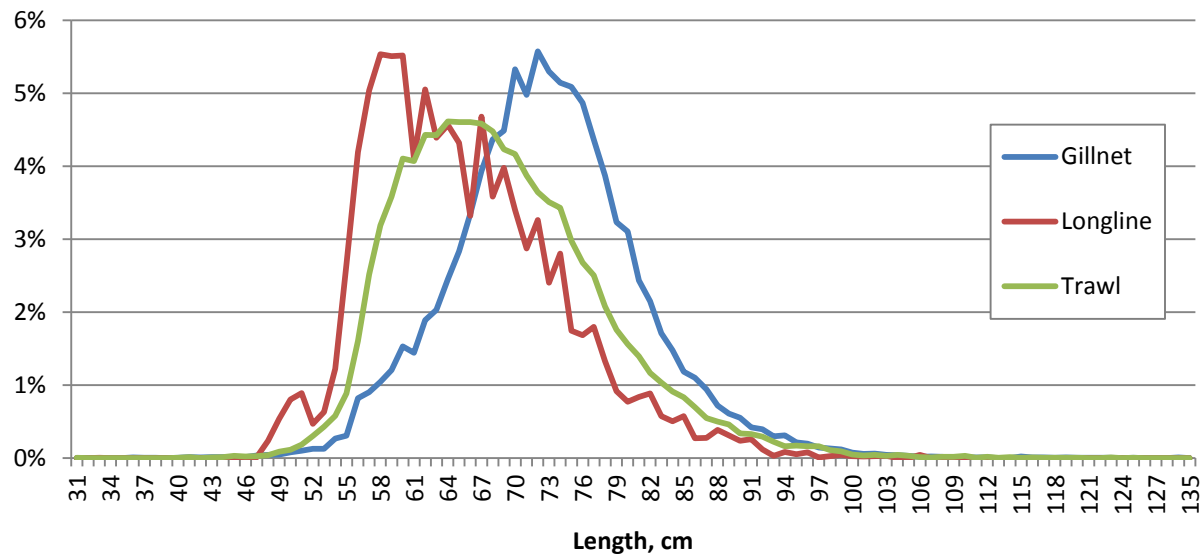
Potential fishing restrictions in habitat management areas are critically important to determining their spawning impacts. In general, the spawning protection alternatives in this amendment restrict most or all gears capable of catching groundfish, with potential exemptions for recreational gears and, on Georges Bank, scallop dredges. These more comprehensive restrictions on all gears that catch groundfish help to avoid all three of the mechanisms noted above (removal of fish, dispersal of fish, and disruption of behavior), and would provide a high positive benefit to spawning groundfish overlapping the spawning management areas spatially and seasonally. By contrast, the habitat management alternatives generally restrict mobile bottom-tending gears, but allow fixed gears and recreational gears capable of catching groundfish, including sink gillnets, demersal longlines, and demersal hook and line. Allowing gears that target groundfish to be used in habitat management areas limits the potential for positive spawning benefits of the habitat management alternatives. Further, habitat management areas that require modified trawl ground cables (Options 3 and 4) but allow use of trawl, dredges, and fixed gears that catch groundfish are assumed to have few to no spawning protection benefits. In contrast, more comprehensive restrictions on gears that catch groundfish (Option 5) would provide fairly comprehensive spawning protection; however these are only proposed in the areas included in eastern Gulf of Maine Habitat Alternative 2.

As noted above, there is specific evidence from the western Gulf of Maine that gillnet use disrupts cod spawning behavior (Dean et al 2014). In addition, gillnet gear selects for larger individuals (see below), which are assumed to contribute disproportionately to spawning production given their generally higher fecundity relative to smaller, younger, individuals. Although longlines select for smaller animals (again, see below), this gear type will also remove spawning animals from the population and could have a disruptive effect on behavior.

Fishery observer and at sea monitoring data were investigated to confirm the general selectivity patterns of various types of gear capable of catching groundfish. The figures below compare the

length of cod caught in bottom trawls (including Ruhle and separator trawls), demersal longlines, and sink gillnets from 2009 to the present. While all gears catch a wide range of lengths, trawls and longlines catch relatively smaller individuals than gillnets do. Standardizing the catches as percentages of total catch for a particular gear type shows these patterns most readily (Figure 5). The same patterns are evident across all areas (shown below), or taking the Gulf of Maine and Georges Bank statistical areas separately (not shown). As noted in the hotspot analysis section of Volume 1, the length at 80% female maturity for both stocks of cod was re-estimated by the Closed Area Technical Team to be 52 centimeters, and the "large" spawner size threshold used in the hotspot analysis was 75 centimeters. The catch rate of cod larger than 75 cm is relatively low in longline and trawl gears, but these large animals constitute a much more sizeable fraction of gillnet catch.

Figure 5 – Cod length frequency in fishery catches (2009-present), all areas



Thus, a consideration in determining the potential spawning impacts of habitat management areas is the extent to which these areas allow for the continued use of fixed gears capable of catching groundfish, particularly gillnets. Although mobile bottom-tending gears are responsible for a significant fraction of overall groundfish removals, the use of fixed gears in the habitat areas will limit their spawning protection benefits. Furthermore, it is at least possible that new mobile bottom-tending gear closures would lead to local increases in the use of fixed gears capable of catching groundfish, which could mitigate any benefits achieved through the mobile bottom-tending gear restriction.

Many factors contribute to the potential for effort shifts by gear type and projecting such changes in fishing behavior is not possible. Unfortunately, comparing fixed vs. mobile gear usage in current management areas does not provide much guidance in this regard. Because the existing (no action) habitat management areas tend to overlap existing year round groundfish closures, there are few examples of locations where mobile bottom-tending gears are currently prohibited while fixed gears that catch groundfish are allowed. Two examples of habitat closures that do not

overlap groundfish closures are the northern part of the Nantucket Lightship Habitat Closure Area and the Jeffreys Bank Habitat Closure Area. In most cases, including in Closed Areas I and II, the Western Gulf of Maine Closure Area, and the Cashes Ledge Closure Area, both mobile bottom-tending gears and fixed gears that catch groundfish are prohibited. The exception is the longline haddock special access program in the northern part of Closed Area I. Presently, the newly developed habitat management areas that are not subsets of existing closures tend to be open to both mobile bottom-tending gears and fixed gears capable of catching groundfish.

The analyses of individual habitat management alternatives include a brief assessment of their potential spawning impacts. In brief, the following factors contribute to determinations of positive, neutral, or negative impacts. In all cases, these determinations are fairly uncertain given that spawning locations remain imprecisely known, and the final patterns of fixed vs. mobile gear usage in habitat management areas are difficult to predict.

Factors contributing to potential positive impacts:

- Elimination of mobile bottom-tending gear use in the area removes one source of groundfish mortality and spawning disturbance
- Year round restrictions certain to overlap with spawning seasons
- Comprehensive restrictions on gears capable of catching groundfish (EGOM Alt 2)

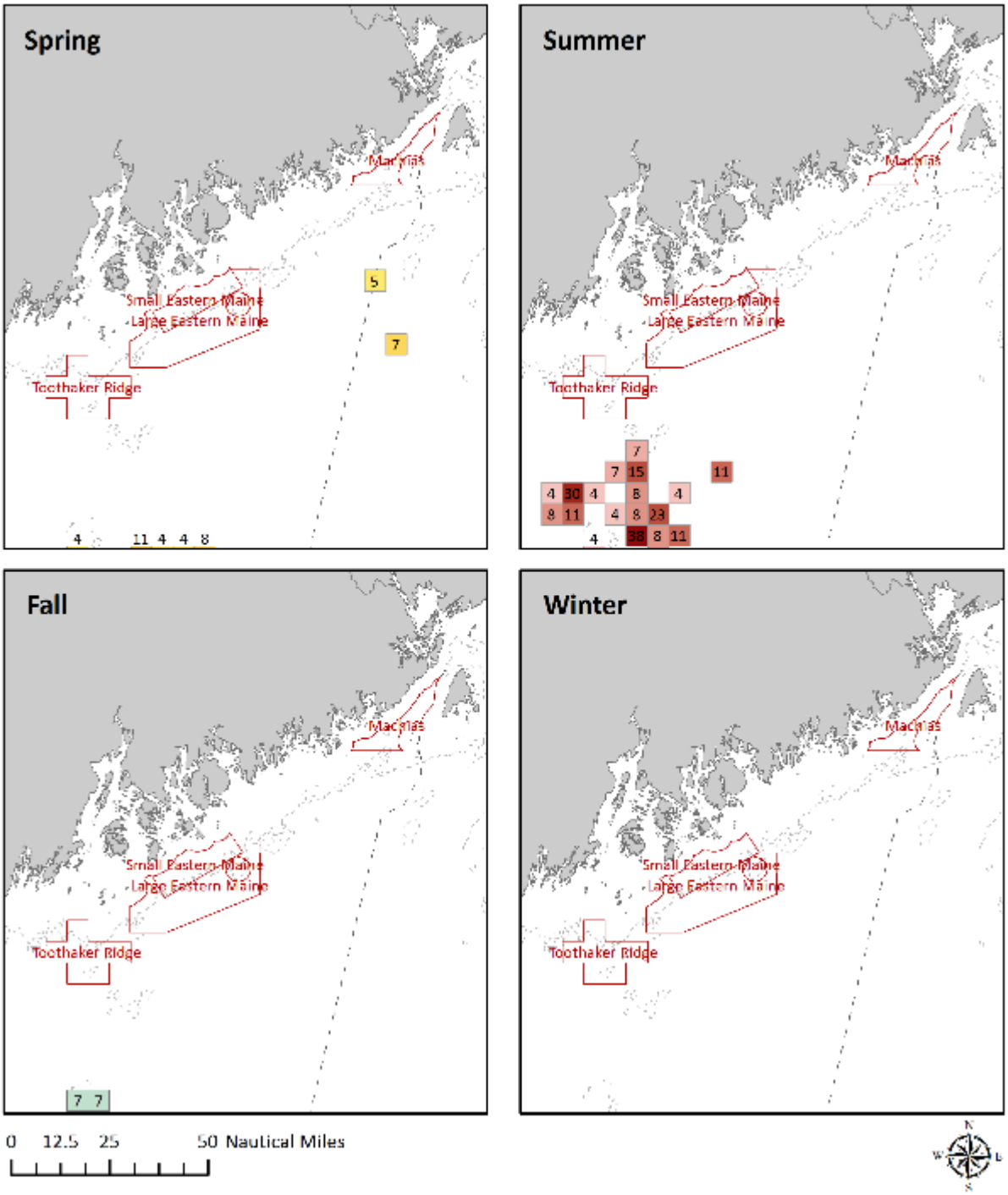
Factors contributing to potential neutral impacts:

- Little to no spawning activity in area
- Decrease in use of some gears that catch groundfish counterbalanced by increase in use of other gears that catch groundfish, particularly gillnets which catch larger animals
- In currently open areas, implementing gear modifications only
- Limited groundfishing opportunities in area such that habitat management area has small impact on groundfish catch

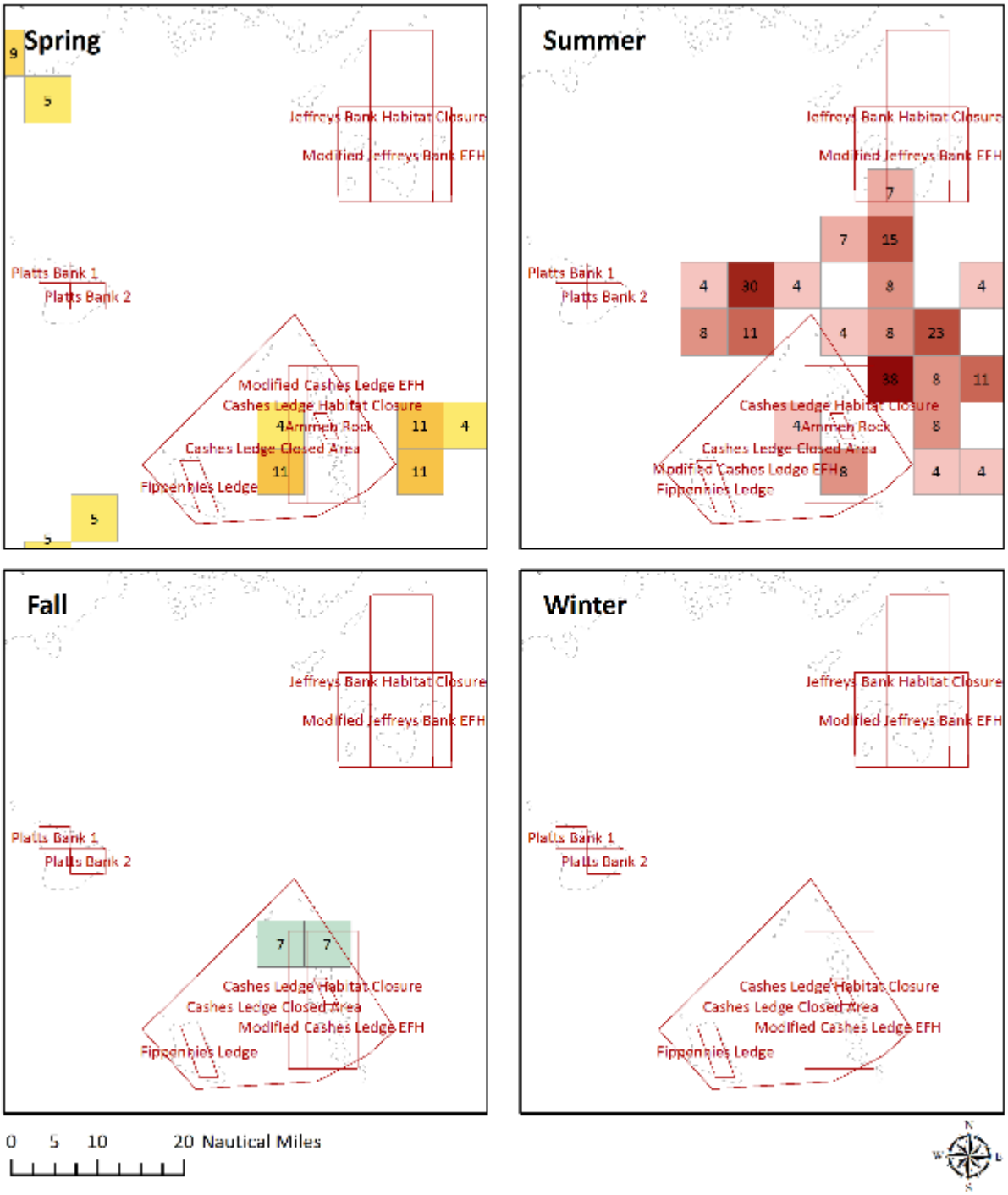
Factors contributing to potential negative impacts:

- Areas displace fishing effort onto spawning activity
- Alternative removes existing protections that benefit spawning groundfish (i.e. no habitat management area alternatives in each sub-region)

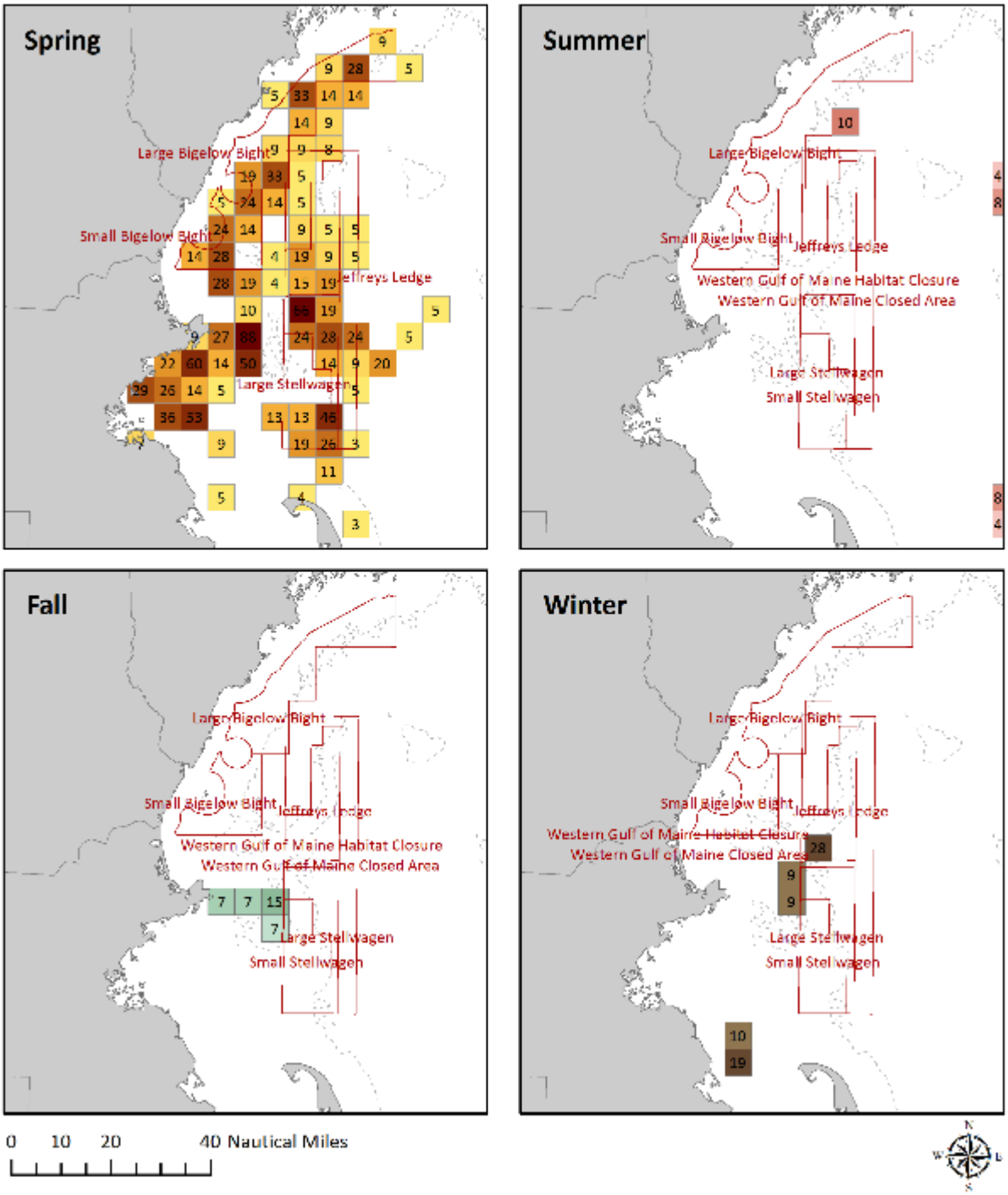
Map 2 – Weighted spawner hotspot overlap with eastern Gulf of Maine habitat management areas by season. Weighted values (numeric labels in each grid) combine the number of hotspots and the multiplier for each stock, such that higher numbers (and associated darker shading) indicates more hotspots and/or hotspots for more highly weighted stocks. The color scheme simply indicates the season.



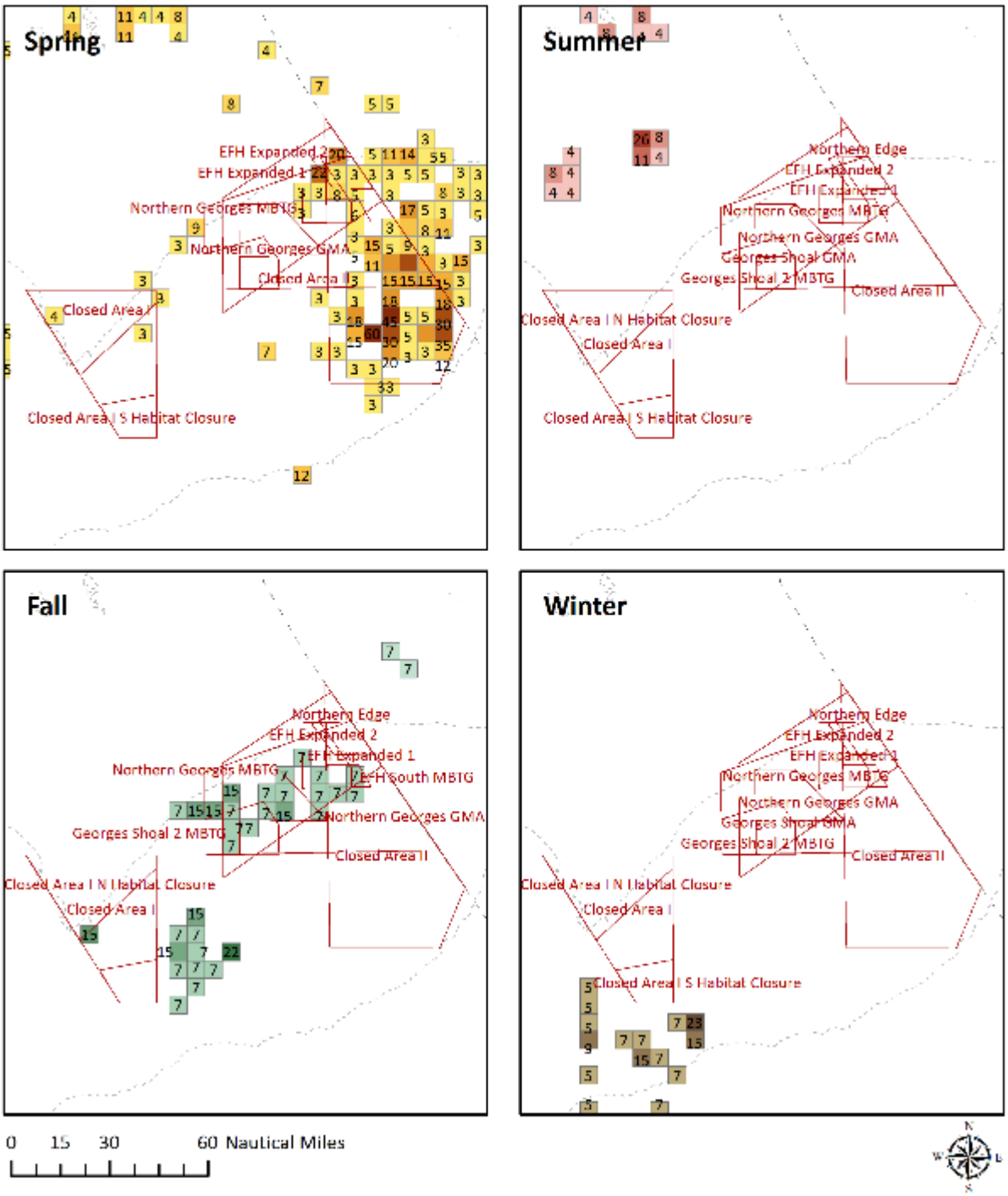
Map 3 – Weighted spawner hotspot overlap with central Gulf of Maine habitat management areas by season. Weighted values (numeric labels in each grid) combine the number of hotspots and the multiplier for each stock, such that higher numbers (and associated darker shading) indicates more hotspots and/or hotspots for more highly weighted stocks. The color scheme simply indicates the season.



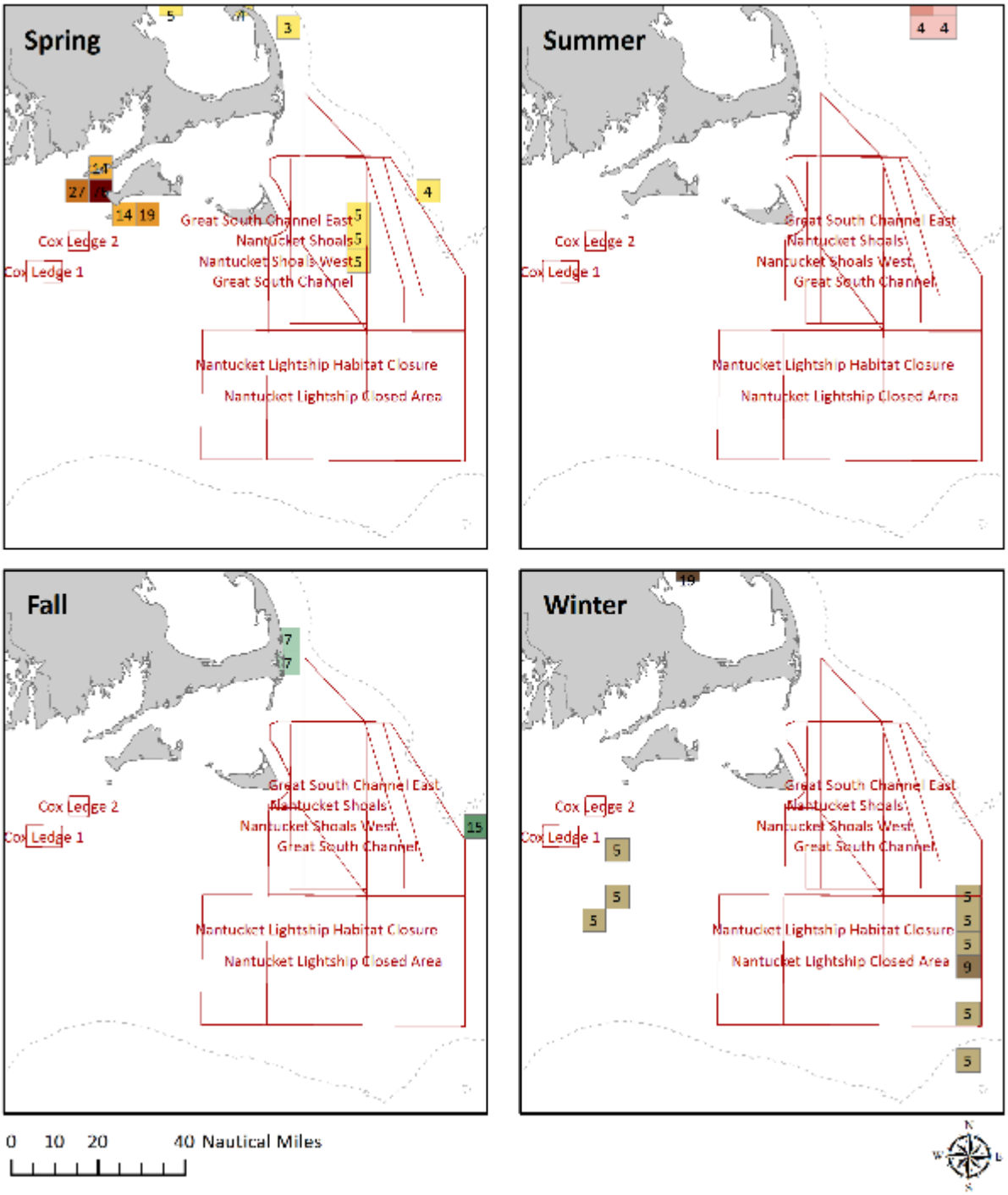
Map 4 – Weighted spawner hotspot overlap with western Gulf of Maine habitat management areas by season. Weighted values (numeric labels in each grid) combine the number of hotspots and the multiplier for each stock, such that higher numbers (and associated darker shading) indicates more hotspots and/or hotspots for more highly weighted stocks. The color scheme simply indicates the season.



Map 5 – Weighted spawner hotspot overlap with Georges Bank habitat management areas by season. Weighted values (numeric labels in each grid) combine the number of hotspots and the multiplier for each stock, such that higher numbers (and associated darker shading) indicates more hotspots and/or hotspots for more highly weighted stocks. The color scheme simply indicates the season.



Map 6 – Weighted spawner hotspot overlap with Great South Channel/Southern New England habitat management areas by season. Weighted values (numeric labels in each grid) combine the number of hotspots and the multiplier for each stock, such that higher numbers (and associated darker shading) indicates more hotspots and/or hotspots for more highly weighted stocks. The color scheme simply indicates the season.



2.2 Habitat management alternatives

This section describes the impacts of the habitat management alternatives on the large mesh groundfish resource. Although they are small mesh stocks, with impacts more fully described in section 3, red and silver hake were also included in the hotspot analysis and are included in the discussion below. Impacts of all habitat management alternatives are summarized in Table 2.

Table 2 – Summary of impacts of habitat management alternatives on the large mesh groundfish resource. No Action and preferred alternatives are identified below.

Sub-region	Alternative	Impacts
EGOM	Alt. 1 (No action)	Slightly negative to neutral
EGOM	Alt. 2 Options 1, 2, 5	Slightly positive to positive
EGOM	Alt. 2 Options 3 and 4	Slightly negative
EGOM	Alt. 3 Options 1 and 2	Slightly positive to positive
EGOM	Alt. 3 Options 3 and 4	Slightly negative
EGOM	Sm. Eastern Maine (preferred)	Slightly positive
CGOM	Alt. 1 (No action)	Slightly positive to positive
CGOM	Alt. 2 (No area)	Negative
CGOM	Alt. 3 Options 1 and 2	Slightly positive
CGOM	Alt. 3 Options 3 and 4	Negative
CGOM	Alt. 4 Options 1 and 2	Slightly positive
CGOM	Alt. 4 Options 3 and 4	Negative
CGOM	CL GF, CL HMA, JB HMA, FL HMA, AR HMA (preferred)	Slightly positive to positive
WGOM	Alt. 1 (No action)	Positive
WGOM	Alt. 1 with modified boundary (preferred)	Positive
WGOM	Alt. 2 (No area)	Highly negative
WGOM	Alt. 3 Options 1 and 2	Highly positive
WGOM	Alt. 3 Options 3 and 4	Highly negative
WGOM	Alt. 4 Options 1 and 2	Highly positive
WGOM	Alt. 4 Options 3 and 4	Highly negative
WGOM	Alt. 5 Options 1 and 2	Positive
WGOM	Alt. 5 Options 3 and 4	Highly negative
WGOM	Alt. 6 Options 1 and 2	Slightly positive
WGOM	Alt. 6 Options 3 and 4	Highly negative
WGOM	Alt. 7A (preferred)	Neutral
WGOM	Alt. 7B	Slightly positive
WGOM	Alt. 8 (preferred)	Slightly positive
GB	Alt. 1 (No action)	Highly positive
GB	Alt. 2 (No area)	Highly negative
GB	Alt. 3 Option 1	Positive
GB	Alt. 3 Option 2	Positive
GB	Alt. 3 Options 3 and 4	Highly negative
GB	Alt. 4 Option 1	Positive
GB	Alt. 4 Option 2	Positive
GB	Alt. 4 Options 3 and 4	Highly negative
GB	Alt. 5	Highly negative
GB	Alt. 6A Option 1	Positive to highly positive
GB	Alt. 6A Option 2	Positive
GB	Alt. 6A Options 3 and 4	Highly negative
GB	Alt. 6B Option 1	Slightly positive
GB	Alt. 6B Option 2	Slightly positive
GB	Alt. 6B Options 3 and 4	Highly negative
GB	Alt. 7 Option 1	Highly negative
GB	Alt. 7 Option 2	Highly negative
GB	Alt. 8 Option 1	Highly positive
GB	Alt. 8 Option 2	Positive to highly positive
GB	Alt. 9 Option 1	Positive
GB	Alt. 9 Option 2	Slightly positive to positive
GB	Alt. 10 (preferred)	Positive

Sub-region	Alternative	Impacts
GSC-SNE	Alt. 1 (No action)	Slightly positive
GSC-SNE	Alt. 2 (No area)	Slightly negative
GSC-SNE	Alt. 3 Option 1	Slightly positive to positive
GSC-SNE	Alt. 3 Option 2	Slightly positive
GSC-SNE	Alt. 3 Options 3 and 4	Slightly negative
GSC-SNE	Alt. 4 Option 1	Slightly positive
GSC-SNE	Alt. 4 Option 2	Neutral to slightly positive
GSC-SNE	Alt. 4 Options 3 and 4	Slightly negative
GSC-SNE	Alt. 4 with temporary clam dredge exemption (preferred)	Slightly positive
GSC-SNE	Alt. 5 Option 1	Neutral to slightly positive
GSC-SNE	Alt. 5 Option 2	Slightly negative
GSC-SNE	Alt. 5 Options 3 and 4	Slightly negative
GSC-SNE	Alt. 6 Option 1	Neutral to slightly positive
GSC-SNE	Alt. 6 Option 2	Slightly negative

2.2.1 Eastern Gulf of Maine

Tables and maps for the eastern Gulf of Maine sub-region are provided below. In the tables, any spatial overlaps between management areas were accounted for so that there was no double counting of hotspots for the combined alternatives. Red and silver hake are not large mesh species and were not included in the weighted hotspot analysis, but their unweighted hotspots are listed in the table of hotspots by species. Note that because hydraulic dredges are not used in this sub-region, Options 1 and 2 would have the same magnitude of impacts.

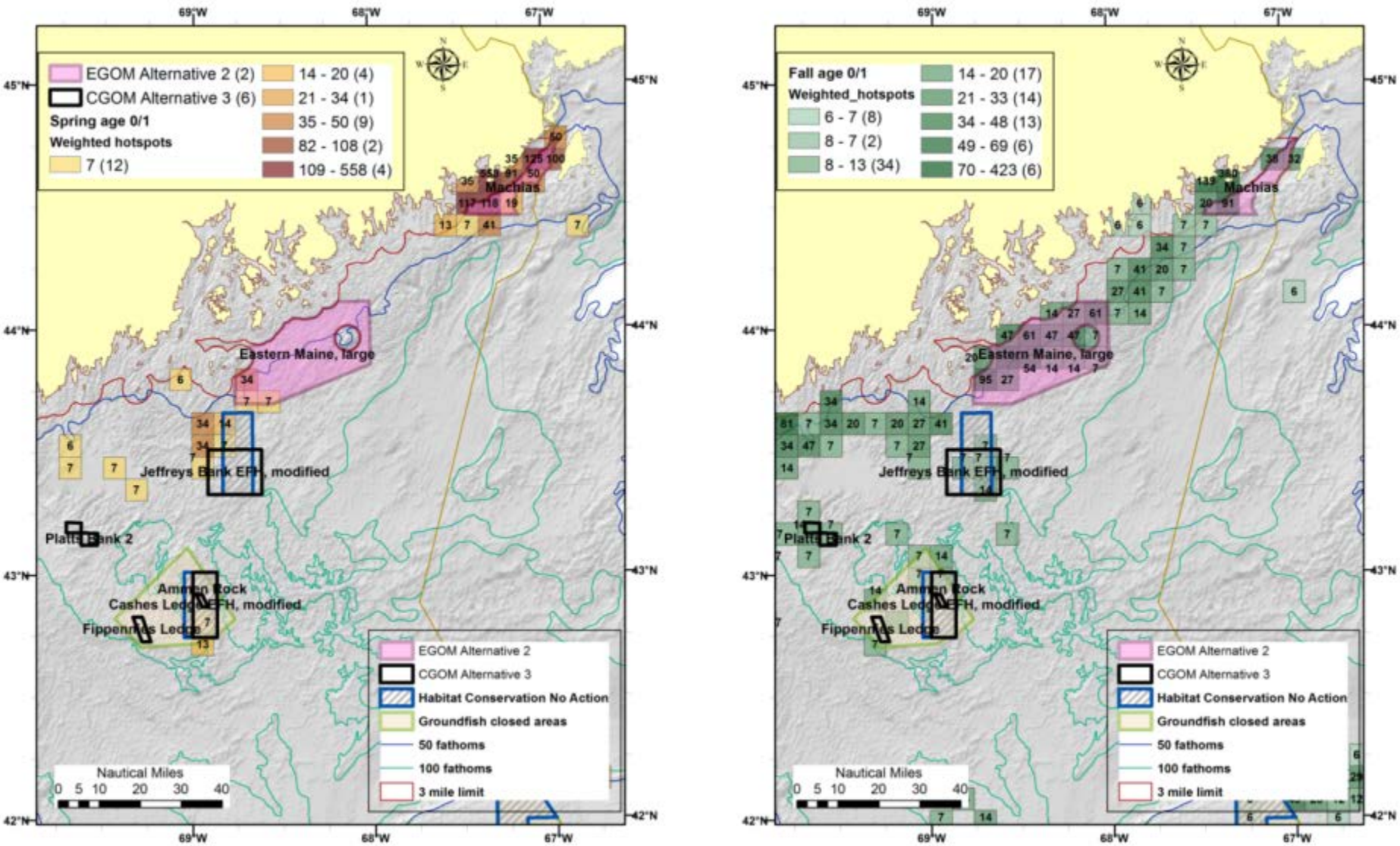
Table 3 – EGOM: Total unweighted and weighted age 0/1 juvenile large mesh groundfish hotspots, by season. Individual areas are listed first, followed by combined alternatives.

	Spring		Summer		Fall		Winter	
Area name (Alternative)	Number	Weighted	Number	Weighted	Number	Weighted	Number	Weighted
Large Eastern Maine (2)	115	47.32	4	0	263	500.24	0	0.00
Machias (2, 3)	35	187.69	0	0	11	91.49	0	0.00
Small Eastern Maine (3)	41	0	0	0	110	229.84	0	0.00
Toothaker Ridge (3)	43	81.12	33	0	69	128.44	0	0.00
Alternative 2	150	235.01	4	0	274	591.73	0	0.00
Alternative 3	119	268.81	33	0	190	449.77	0	0.00
Alt 3 preferred	41	0	0	0	110	229.84	0	0.00

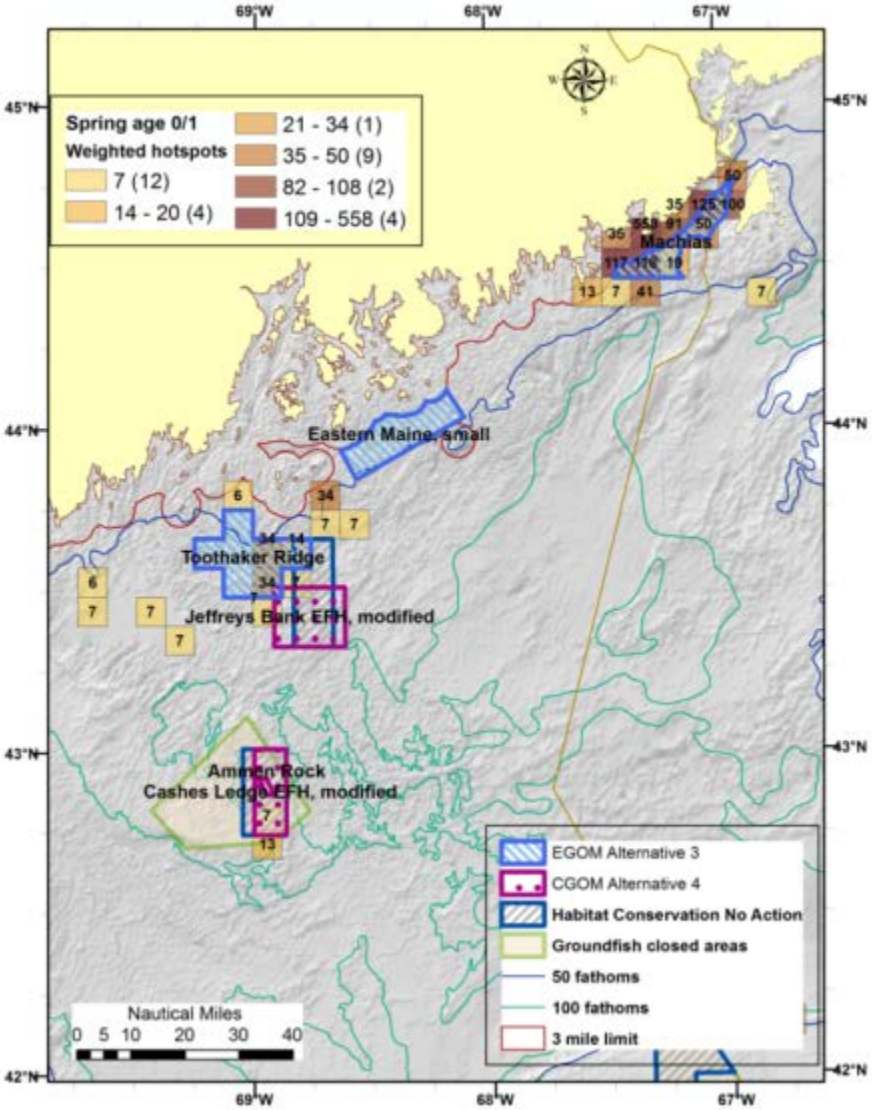
Table 4 – EGOM: Age 0/1 juvenile large mesh groundfish hotspots by species. All seasons are combined. There were no hotspots for ocean pout, pollock, or yellowtail flounder in any of the EGOM HMAs. Individual areas are listed first, followed by combined alternatives.

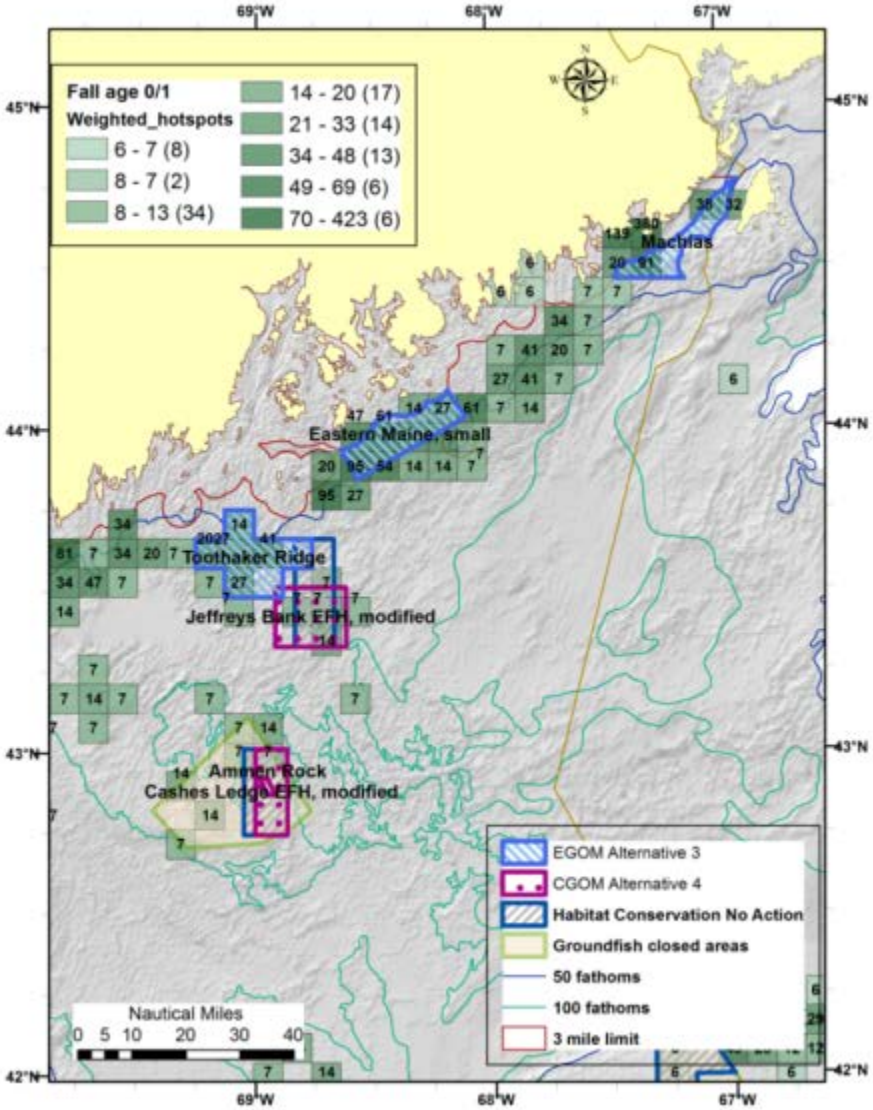
Area name (Alternative)	Redfish	Cod	Halibut	Haddock	W. hake	Windowpane	Winter Fl.	Witch Fl.	Silver hake	Red hake
Large Eastern Maine (2)	81	0	0	0	94	13	5	44	143	2
Machias (2, 3)	0	13	2	7	4	0	15	0	0	5
Small Eastern Maine (3)	34	0	0	0	36	13	3	3	62	0
Toothaker Ridge (3)	31	0	0	0	17	0	0	24	47	25
Alt 2	81	13	2	7	98	13	20	44	7	143
Alt 3	65	13	2	7	57	13	18	27	30	109
Alt 3 pref	34	0	0	0	36	13	3	3	0	62

Map 7 – EGOM Alternative 2 (red shading with red outline) and CGOM Alternative 3 (black outline) overlap with spring (left), and fall (right) weighted age 0/1 groundfish hotspots from 2002-2012 NEFSC and ME-NH survey data. There are no summer or winter weighted hotspots in this sub-region.



Map 8 – Eastern Gulf of Maine Alternative 3 (hatching with blue outline) and central Gulf of Maine Alternative 4 (dots with red outline) overlap with spring (left) and fall (right) total weighted age 0/1 groundfish hotspots from 2002-2012 NEFSC, MADMF, ME-NH, and IBS survey data. There are no summer or winter weighted hotspots in this sub-region.





2.2.1.1 ***Alternative 1 (No Action)***

There are currently no habitat management areas in the eastern Gulf of Maine sub-region, which would continue under Alternative 1/No Action. The distribution of unweighted and weighted hotspots in each survey season is shown on Map 7. Only the spring and fall figures are shown in this section as the summer and winter surveys do not cover the eastern Gulf of Maine sub-region. Given the positive presence of weighted juvenile groundfish hotspots in this sub-region, continuing Alternative 1/No Action is unlikely to substantially improve habitat quality associated with age 0/1 large mesh groundfish species because no special protection would be afforded for these juvenile groundfish populations. However, fishing activities that would be expected to negatively impact groundfish habitats are relatively limited in magnitude in the eastern Gulf of Maine (see discussion in habitat impacts section of Volume 4). Despite the presence of groundfish hotspots in the eastern Gulf of Maine, because the current magnitude of fishing impacts is low, this limits the negative opportunity costs associated with a lack of habitat management area designation. Therefore, continuing with no HMAs under Alternative 1/No Action is expected to have neutral or at worst slightly negative impacts on the groundfish resource. Alternative 1/No Action has negative impacts relative to Alternative 2, Alternative 3, and the preferred subset of Alternative 3, because these alternatives would actively conserve groundfish habitats via designation of habitat management areas. Positive impacts associated with the action alternatives are slight, however, as they are not expected to displace substantial amounts of adverse impacts from the management areas, because trawl and dredge fishing is limited in the proposed HMAs.

2.2.1.2 ***Alternative 2***

This alternative would designate the Machias and Large Eastern Maine HMAs. Total unweighted and weighted hotspots in the areas proposed for habitat management in eastern Gulf of Maine Alternatives 2 and 3 are summarized in Table 3. Only spring and fall surveys are conducted in this sub-region, a NEFSC trawl survey and a coastal Maine/New Hampshire trawl survey. The spatial distribution of the hotspots changes seasonally; in the spring, more groundfish hotspots overlap the Machias HMA and in the fall more hotspots overlap the Large Eastern Maine HMA (Map 7). The areas combined have a weighted hotspot total of 235 in the spring and 591.7 in the fall (the weighted totals are similar to those for Alternative 3). All of the cod, haddock, and Atlantic halibut hotspots were in the Machias area. The number of redfish and witch flounder hotspots was somewhat higher in Alternative 2 than Alternative 3 (Table 4). The number of hotspots in the Alternative 2 areas was also higher for species given a zero weight, such as silver hake and white hake. The higher number of hotspots for these hakes suggests that the Large Eastern Maine HMA in Alternative 2 has, on average, softer substrates than the Small Eastern Maine HMA in Alternative 3. Although there is uncertainty in the substrate characterizations in this region (see Volume 4, section 3.2.1), this would make sense given that the Large Eastern Maine HMA extends further offshore into deeper waters.

Habitat protection in the Large Eastern Maine HMA could be important to cod and other species when coupled with restoration activities in the area. There were no age 0/1 cod hotspots in the Large Eastern Maine HMA, but age 0/1 cod and herring hotspots were identified inshore of this area within Maine state waters. The Penobscot River Restoration Project is intended to restore the river to more natural conditions for diadromous migratory fish, including herring and shad.

Dam removal and fish passage construction has begun and will continue into 2014 (NOAA Fisheries Navigator, Commercial Fisheries News, Nov 2013 p4)[5]. It is thought that restoration of these forage fish around Penobscot Bay will promote restoration of important coastal fish stocks, including cod. Additional protection of cod habitat in this region could act synergistically to boost cod recovery in areas that had historic cod populations (Ames 2004). The Large Eastern Maine HMA could provide more protection to cod habitats in this region than the smaller overlapping Small Eastern Maine HMA proposed in Alternative 3.

Alternative 2 is expected to improve habitat benefits for age 0/1 groundfish, relative to Alternative 1/No Action (which contains no areas or hotspots), by preventing fishermen from refocusing fishing effort into these habitats if and when groundfish populations recover. The weighted hotspots in particular indicate use of these areas by juvenile groundfish that are vulnerable and prefer hard and coarse substrates. Although there is a relatively small amount of groundfish fishing area in the proposed Alternative 2 closures, application of Option 5, which would restrict additional gear types beyond mobile bottom tending gears, would prevent vessels from targeting groundfish subpopulations if and when they recover. Evidence suggests that in this area distinct populations of cod and possibly other groundfish species exist (or once existed). A localized reduction in juvenile and adult groundfish mortality could work synergistically with efforts to restore the forage base, and make the groundfish stocks more robust, diverse, and resilient, having a positive impact compared to both Alternative 1/No Action and Alternative 3 on the groundfish resources as a whole, even though the proposed closure would not change the overall fishing mortality rate.

Overall, Alternative 2 with Option 1 or 2 is expected to have low positive impacts on juvenile groundfish and groundfish habitats, with the potential for greater positive impacts over the long term, as discussed above. Option 5 would have somewhat higher positive impacts on groundfish resources relative to Options 1 and 2. If implemented with the gear modification options, 3 or 4, Alternative 2 would likely have neutral impacts relative to No Action (i.e. slightly negative to neutral impacts on the resource), as these gears do not have proven positive benefits, and can still be used to target groundfish, with negative impacts relative to Options 1, 2, and 5. Comparing the same gear restriction options, it is not possible to discriminate between Alternatives 2 and 3 in terms of the magnitude of positive benefits. The next section on Alternative 3 provides additional discussion of this comparison. Alternative 2 is expected to have positive impacts relative to Alternative 3 as preferred, which would include just the Small Eastern Maine HMA and is therefore a subset of either Alternative 2 or Alternative 3 as described in the draft EIS.

This alternative is expected to have neutral to low positive impacts on groundfish spawning. There are no large spawner groundfish hotspots overlapping the areas in any season, and very few large spawner groundfish hotspots in the sub-region generally (see sub-regional map in Volume 5, section 2.1.2). Currently, there is little revenue from gillnet and longline fishing in these areas (see pie charts in economic impacts section and fishing effort maps in the affected environment section of Volume 1). Given the low magnitude of current fishing effort and lack of

[5] See additional background here: http://www.greateratlantic.fisheries.noaa.gov/stories/2015/april/29_penobscot_river_restoration_trust_update__un-build_it__and_they_will_come.html.

overlap with hotspots, any positive impacts associated with fishing restrictions in this sub-region would be slight, but the highest positive impacts would be associated with Option 5, followed by Options 1 and 2, with likely neutral impacts associated with Options 3 and 4 because all gears capable of catching groundfish would still be permitted under the gear modification options.

2.2.1.3 ***Alternative 3 (Preferred Alternative, Small Eastern Maine Only)***

Alternative 3 includes the Small Eastern Maine, Machias, and Toothaker Ridge HMAs. As preferred, it would include the Small Eastern Maine HMA only. As noted above, only spring and fall surveys overlap the areas. The areas combined have a weighted hotspot total of 268.8 in the spring and 449.8 in the fall (Table 3). The spatial distribution of the hotspots changes seasonally: in the spring, more groundfish hotspots overlap the Machias HMA and in the fall more hotspots overlap the Small Eastern Maine HMA and Toothaker Ridge HMA (Map 8). Compared to Alternative 2, for species associated with hard and coarse substrates, the total number of hotspots was lower for redfish and witch flounder but the same for cod (Table 4).

There were no age 0/1 cod hotspots in the proposed Small Eastern Maine HMA, but age 0/1 cod and herring hotspots were identified inshore within Maine state waters. As noted under Alternative 2, habitat protection in the Small Eastern Maine HMA could be important to cod and other species when coupled with the synergistic effects of the Penobscot River Restoration Project. The smaller HMA may provide benefits that are similar to the larger one because the hotspots are concentrated inshore and are well captured by the smaller Eastern Maine area. Existing survey data for groundfish catches do not provide a level of precision to distinguish between the Large and Small Eastern Maine HMAs.

Alternative 2 has higher hotspot scores for hard-bottom associated species and a higher hotspot score overall compared to Alternative 3. However, part of the score is driven by a higher prevalence of hakes which are associated with softer bottoms less vulnerable to the adverse effects of fishing. Therefore, existing groundfish data do not provide a level of precision to clearly distinguish which Alternative (2 or 3) is expected to have more habitat protection value for juvenile groundfish. Based on the available data, because the number of weighted hotspots are about the same for Alternative 2 and Alternative 3, they would be expected to have similar conservation benefits for age 0/1 juvenile groundfish that are vulnerable and/or are associated with coarse and hard substrates. Like Alternative 2, Alternative 3 is expected to have positive benefits for these species relative to Alternative 1/No Action.

Overall, Alternative 3 with Option 1 or 2 is expected to have low positive impacts on juvenile groundfish and groundfish habitats, with the potential for greater positive impacts over the long term, if groundfish resources recover due to inshore habitat restoration efforts and other factors such as rebuilding plans. If implemented with the gear modification options, 3 or 4, Alternative 3 would likely have neutral impacts relative to No Action (i.e. slightly negative to neutral impacts on the resource), as these gears do not have proven positive benefits, and can still be used to target groundfish, with negative impacts relative to Options 1 and 2. Comparing the same gear restriction options, it is not possible to discriminate between Alternatives 2 and 3 in terms of the magnitude of positive benefits. Alternative 3 with all three areas is expected to have positive impacts relative to Alternative 3 as preferred, which would include just the Small Eastern Maine HMA and is therefore a subset of either Alternative 2 or Alternative 3 as described in the draft

EIS. The preferred alternative is still expected to have low positive impacts, and would have positive impacts relative to Alternative 1/No Action.

This alternative is expected to have neutral to low positive impacts on groundfish spawning. There are no large spawner groundfish hotspots overlapping the areas in any season, and very few large spawner groundfish hotspots in the sub-region generally (see sub-regional map in Volume 5, section 2.1.2). Currently, there is little revenue from gillnet and longline fishing in these areas (see pie charts in economic impacts section and fishing effort maps in the affected environment section of Volume 1). Given the low magnitude of current fishing effort and lack of overlap with hotspots, any positive impacts associated with fishing restrictions in this sub-region would be slight and would occur with restrictions on mobile bottom-tending gears (Options 1 and 2), with likely no positive benefits (neutral impacts) associated with Options 3 and 4.

2.2.2 Central Gulf of Maine

Tables and maps are provided below. Additional maps are provided in the eastern Gulf of Maine section above. In the tables, any spatial overlaps between management areas were accounted for so that there was no double counting of hotspots for the combined alternatives. Red and silver hake are not large mesh species and were not included in the weighted hotspot analysis, but their unweighted hotspots are listed in the table of hotspots by species. Note that because hydraulic dredges are not used or expected to be used in the future in this sub-region, Options 1 and 2 are expected to have equivalent impacts.

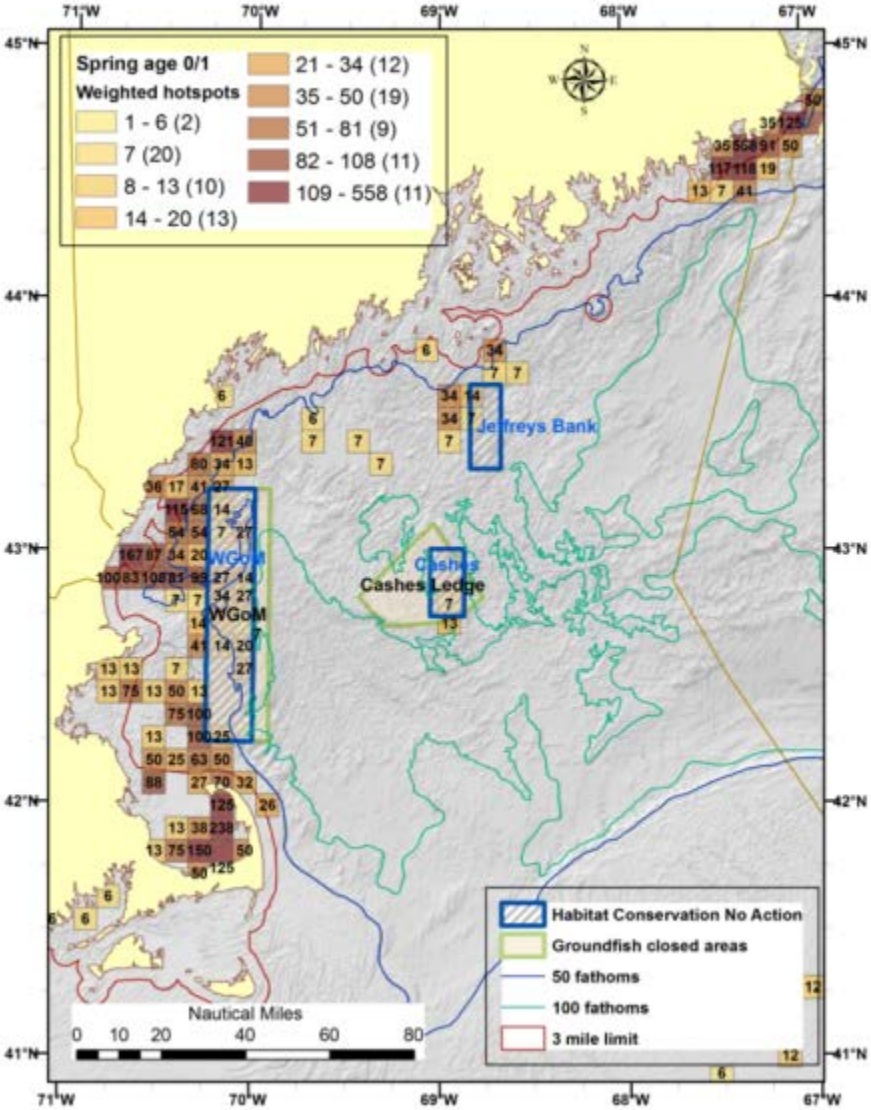
Table 5 – CGOM: Total unweighted and weighted age 0/1 juvenile large mesh groundfish hotspots, by season. Individual areas are listed first, followed by combined alternatives.

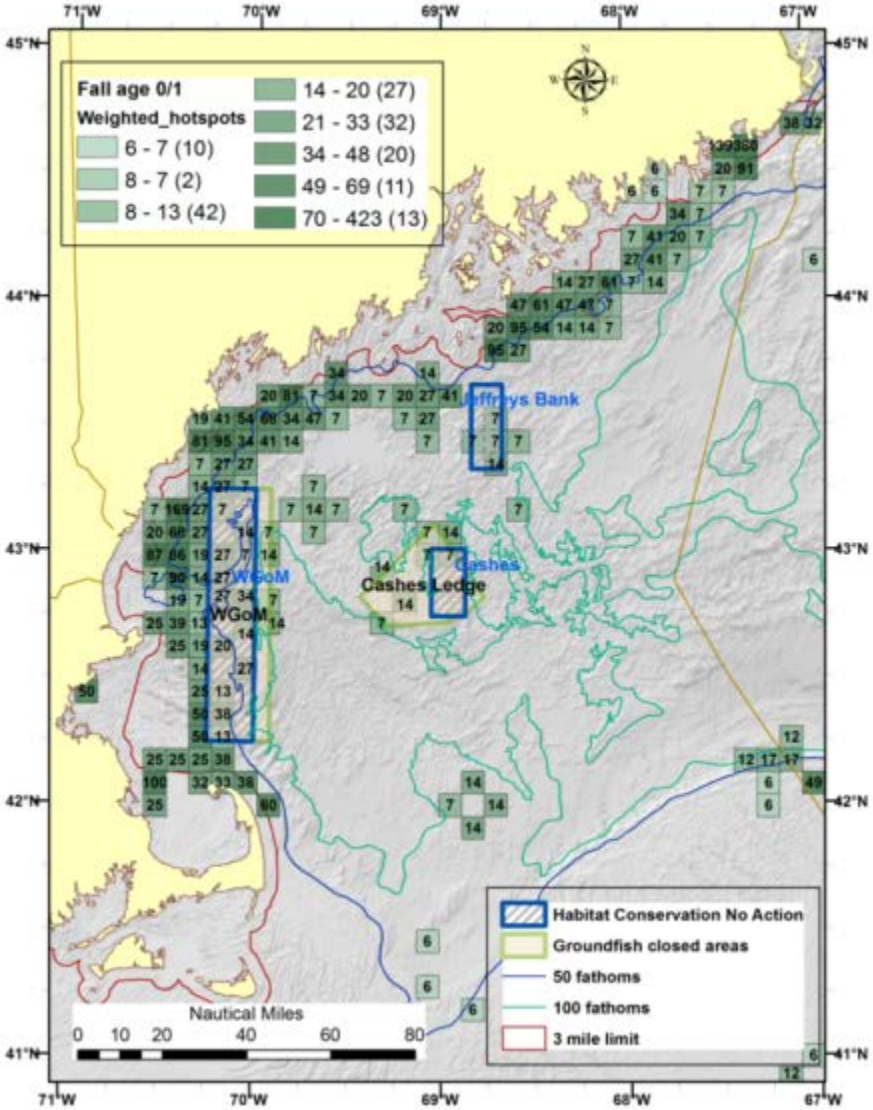
Area name (Alternative)	Spring		Summer		Fall		Winter	
	Number	Weighted	Number	Weighted	Number	Weighted	Number	Weighted
Cashes Ledge Closed Area (1)	1	6.71	16	13.52	12	47.32	4	26.84
Cashes Ledge Habitat Closure (1)	1	6.71	2	0.00	2	6.76	0	0.00
Jeffreys Bank Habitat Closure (1)	7	20.28	39	0.00	22	33.80	0	0.00
Modified Cashes Ledge EFH (3, 4)	1	6.71	2	0.00	2	6.76	0	0.00
Modified Jeffreys Bank EFH (3, 4)	0	0.00	5	0.00	15	27.04	0	0.00
Ammen Rock (3, 4)	0	0.00	1	0.00	0	0.00	0	0.00
Fippennies Ledge (3)	0	0.00	0	0.00	0	0.00	2	13.42
Platts Bank (3)	0	0.00	0	0.00	1	6.76	0	0.00
Alternative 1	8	26.99	55	13.52	34	81.12	4	26.84
Alternative 3	1	6.71	7	0.00	18	40.56	2	13.42
Alternative 4	1	6.71	7	0.00	17	33.80	0	0.00
Preferred alternative	1	6.71	21	13.52	27	74.36	4	26.84

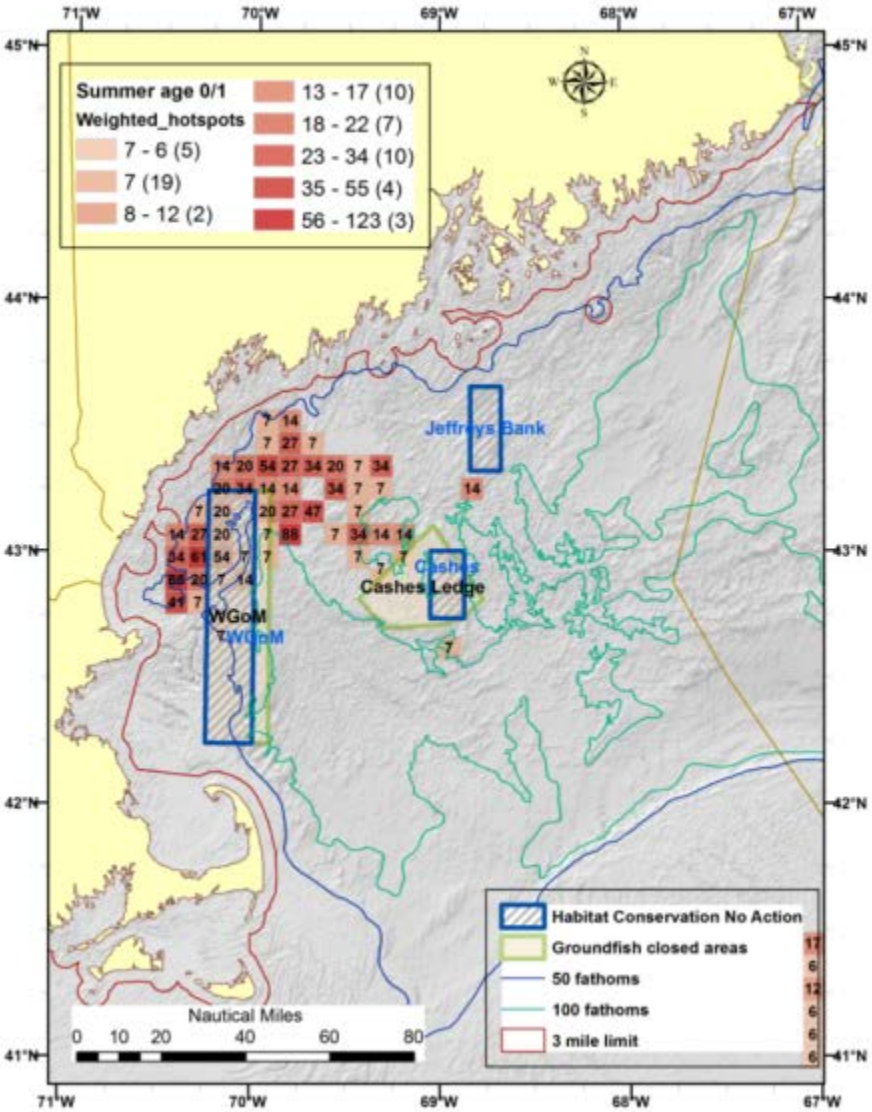
Table 6 – CGOM: Age 0/1 juvenile large mesh groundfish hotspots by species. All seasons are combined. There were no hotspots for cod, ocean pout, pollock, windowpane, winter flounder, or yellowtail flounder in any of the CGOM HMAs. Individual areas are listed first, followed by combined alternatives.

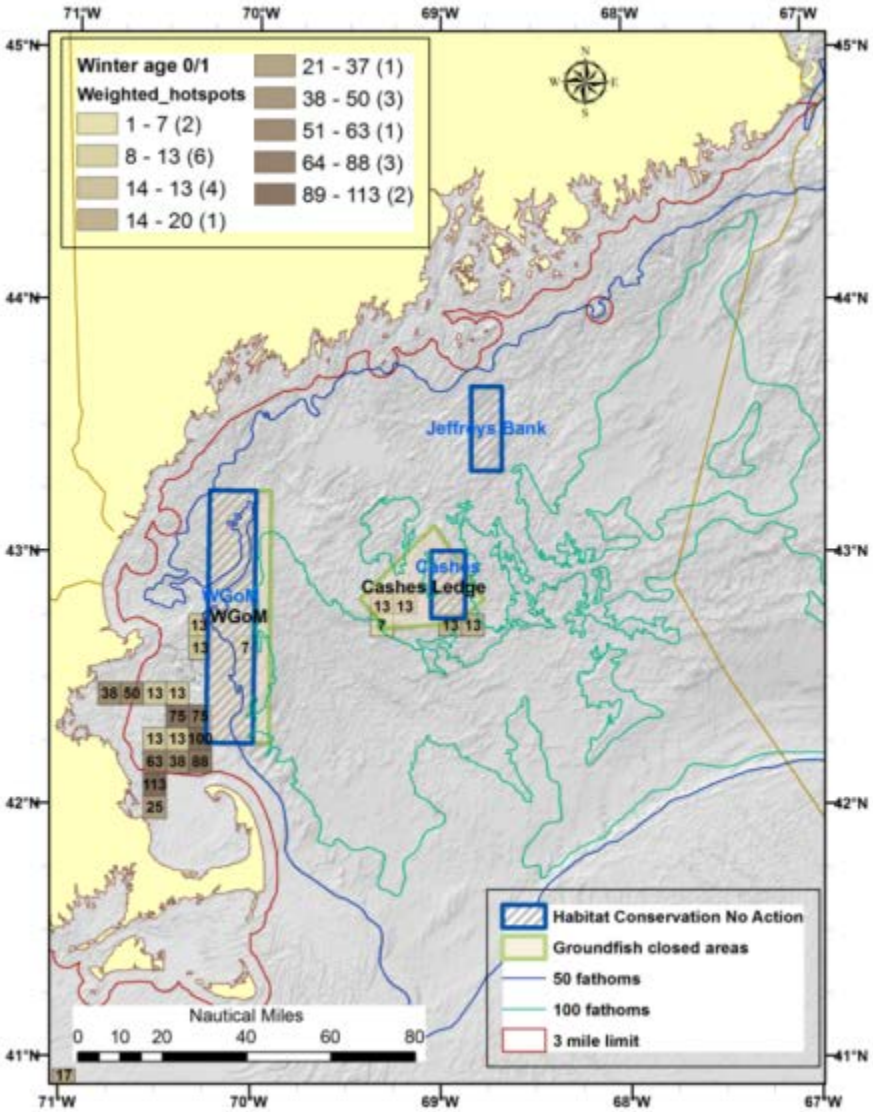
Area name (Alternative)	Redfish	Am. Plaice	Haddock	W. hake	Witch Fl.	Red hake	Silver hake
Cashes Ledge Closure Area (1)	9	13	5	0	0	1	4
Cashes Ledge Habitat Closure (1)	1	2	1	0	0	0	1
Jeffreys Bank Habitat (1)	8	0	0	20	1	8	31
Mod. Cashes Ledge EFH (3, 4)	1	2	1	0	0	0	1
Mod. Jeffreys Bank EFH (3, 4)	4	0	0	5	0	4	7
Ammen Rock (3, 4)	0	1	0	0	0	0	0
Fippennies Ledge (3)	0	0	2	0	0	0	0
Platts Bank (3)	1	0	0	0	0	0	0
Alternative 1	17	13	5	20	1	9	35
Alternative 3	6	3	3	5	0	4	8
Alternative 4	5	2	1	5	0	4	8
Preferred alternative	13	13	5	5	0	5	11

Map 9 – GOM Alternative 1 overlap with spring (left), fall (right), summer (left on next page), and summer (right on next page) total weighted age 0/1 groundfish hotspots from 2002-2012 NMFS, MADMF, ME-NH, and IBS survey data.






Summer age 0/1
Weighted_hotspots
7 - 6 (5)
7 (19)
8 - 12 (2)
13 - 17 (10)
18 - 22 (7)
23 - 34 (10)
35 - 55 (4)
56 - 123 (3)
Jeffreys Bank
Cashes Ledge
WGoM
Habitat Conservation No Action
Groundfish closed areas
50 fathoms
100 fathoms
3 mile limit
Nautical Miles
0 10 20 40 60 80
71°W 70°W 69°W 68°W 67°W
45°N 44°N 43°N 42°N 41°N


Winter age 0/1
Weighted_hotspots
1 - 7 (2)
8 - 13 (6)
14 - 13 (4)
14 - 20 (1)
21 - 37 (1)
38 - 50 (3)
51 - 63 (1)
64 - 88 (3)
89 - 113 (2)
Jeffreys Bank
Cashes Ledge
WGoM
Habitat Conservation No Action
Groundfish closed areas
50 fathoms
100 fathoms
3 mile limit
Nautical Miles
0 10 20 40 60 80
71°W 70°W 69°W 68°W 67°W
45°N 44°N 43°N 42°N 41°N

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

Alternative 1/No Action would continue mobile bottom-tending gear prohibitions in the Cashes Ledge and Jeffreys Bank Habitat Closure Areas. In addition, fishing with gears capable of catching groundfish (including large-mesh trawls, sink gillnets, and bottom longlines) would continue to be prohibited in the Cashes Ledge Closure Area. The preferred alternative maintains the groundfish closure as-is, but the habitat closure boundaries would be modified (see Alternatives 3 and 4).

The amount of unweighted and weighted hotspots in each survey season is summarized in Table 5, with the distribution of weighted hotspot shown in Map 3. Summer and winter hotspots in the Gulf of Maine are few, reflecting the limited amount of survey samples during these seasons (see the summer and winter survey distribution maps in Volume 1, section 4.4). The total weighted hotspots in the Alternative 1/No Action habitat closures were 26.99 in the spring, 13.52 in the summer, 81.12 in the fall, and 26.84 in the winter. In the Jeffreys Bank Habitat Closure Area, hotspots were identified for redfish, white hake, witch flounder, red hake, and silver hake, although only redfish were positively weighted. In the Cashes Ledge Closure Area, hotspots were identified for redfish, American plaice, haddock, red hake, and silver hake, which redfish and haddock positively weighted. The Cashes Ledge Habitat Closure contains a small subset of the groundfish closure hotspots. In the case of Cashes Ledge, this low amount of hotspots may reflect low sampling intensity.

Alternative 1 protects vulnerable bottom habitats within the existing closures that may be used by juvenile groundfish, including those species highlighted in the hotspot analysis, as well as other stocks of concern, including Gulf of Maine cod. This alternative could continue to improve habitat quality over time if the existing habitat closures and groundfish closed area are still recovering from impacts that occurred prior to year round closure in 2002 (Cashes Ledge) and 2003 (Jeffreys Bank). In addition, the prohibition on fishing with gears capable of catching groundfish in the Cashes Ledge Closure Area could improve the potential for local groundfish stock recovery (e.g., localized sub-populations where they exist) as a complement to seabed habitat conservation measures. An example of this synergy between habitat and groundfish closures is where habitat protection improves the chances for survival especially at young ages, and restrictions on groundfishing allow these animals to survive to large sizes. As larger animals generally have higher reproductive output, and considering that some of the cod occupying Cashes Ledge appear to be resident types (see below), protection of both juveniles and larger animals could locally increase productivity of the system.

There is evidence that the Cashes Ledge Closure Area has a positive effect on cod. Sherwood and Grabowski (2015) sampled cod within and to the northwest of the closure, and compared age, length and asymptotic length, body shape, and fish condition between fish captured inside vs. outside. Fish sampled inside Cashes Ledge were older (although not significantly so) and longer on average than those captured outside, and the sample population inside the closure attained longer lengths. Fish inside the closure also exhibited higher stomach fullness, smaller prey size, higher trophic position (based $\delta^{15}N$ isotope analysis), and lower fullness index. While lower fullness index is generally related to larger prey sizes, the stable isotope results indicate

that cod inside the closures have a broader range of feeding opportunities, which may lead to better condition and growth. Cod inside Cashes Ledge exhibited higher Fulton's condition factor index values, indicating better protein reserves (muscle mass), although lipid stores (as indicated by liver somatic index values) were lower inside. Cod inside Cashes Ledge were found to be deeper-bodied, indicating a more sedentary vs. migratory lifestyle relative to cod caught in the adjacent open area. The authors note that only some areas within the closures were sampled, and additional studies would be needed to confirm whether the results are representative of fish occupying other areas within the closure. Also, they acknowledged that it remains unclear how the spatial scale of the Cashes Ledge Closure Area influences these differences. Would the positive effects on size and age still be detectable with a smaller closure? Would even larger closed areas generate a greater difference between fish captured inside vs. outside?

Although the above study focused solely on cod, there have been other efforts to evaluate the impacts of the Cashes Ledge closure on groundfish stocks. Framework 48 to the Northeast Multispecies fishery management plan considered the potential impacts of allowing access to fishing grounds within the Cashes Ledge Closure Area outside of the habitat closure. These analyses were based on (1) biological characteristics, such as length at age inside vs. outside, (2) area swept biomass within and outside closures, and (3) published literature related to large mesh groundfish and the effects of area closures. Impacts of fishery access to the non-habitat closure portions of Cashes Ledge were estimated to be low for haddock, winter flounder, yellowtail flounder, redfish, monkfish, and wolffish. High negative impacts were noted for Gulf of Maine cod, given observations of larger cod inside the closed areas, and known aspects of cod population biology including fish residency in particular areas and localized spawning contingents. Possible moderate negative impacts of fishing access were noted for pollock, given potential negative effects on age structure and spawning. In short, although low negative impacts of opening the area were expected for most groundfish stocks, the closure was estimated to have positive impacts on the groundfish resource, particularly with respect to cod.

Impacts analysis should consider impacts associated with continued fishing effort redistribution to the surrounding areas outside the current closures. If the juvenile groundfish habitat quality is better outside the existing closures than within them, then higher fishing activity in the surrounding area would increase adverse impacts on age 0/1 juvenile groundfish habitat. In the case of the central Gulf of Maine, the major hard bottom features, Cashes Ledge, Fippennies Ledge, Jeffreys Bank, and Platts Bank, are largely captured within this alternative, with the exception of Platts Bank and portions of Jeffreys Bank. Thus, there are relatively few areas of hard bottom vulnerable seafloor habitat outside of this alternative. (This is in contrast with the western Gulf of Maine, where substantial areas of hard bottom vulnerable seabed habitat used by juvenile groundfish exist outside the existing closures.) Thus, effort displacement associated with this alternative is not likely having large negative consequences on groundfish habitats and groundfish resource.

With respect to spawning groundfish, the Cashes Ledge Closure Area, which includes broad restrictions on gears capable of catching groundfish, is expected to have positive impacts. However, redfish and some witch flounder hotspots were identified outside the closure area in the summer (Map 3, also see Maps 135 and 146 in Volume 1), and it is possible that the closure could be displacing effort onto these hotspots. Given that the existing Cashes Ledge habitat

closure is mostly within the boundaries of the groundfish closure, the habitat closure elements of this alternative do not really afford any additional groundfish spawning benefits beyond those provided by the groundfish. The Jeffreys Bank Habitat Closure Area is outside the groundfish closure, but this area has limited overlap with large spawner hotspots (Map 3). The spawning benefits associated with the groundfish closure area are discussed more fully in section 2.3.1.

In summary, the impacts of Alternative 1/No Action on groundfish stocks in the Gulf of Maine are slightly to moderately positive, and may benefit cod especially, but continuing the existing areas alone is unlikely to substantially improve habitat quality associated with age 0/1 large mesh groundfish species, as habitat recovery is likely well underway given the long-term nature of these areas. Given the areas included in this alternative, and the more comprehensive measures associated with the groundfish closure that restrict fixed gear groundfishing, Alternative 1/No Action is expected to have positive impacts on groundfish resoures relative to other alternatives considered in this subregion, including Alternatives 2, 3, and 4, particularly if gear modification options are adopted for Alternatives 3 and 4 in lieu of area closures. Compared to the preferred alterantive for this sub-region, i.e. the Cashes Ledge Groundfish Closure Area, combined with the four habitat management areas, modified Cashes Ledge and Jeffreys Bank, Fippennies Ledge, and Ammen Rock, Alternative 1/No Action likely has neutral impacts, as the areas and fishing restrictions are very similar between the two alternatives.

2.2.2.2 ***Alternative 2***

Alternative 2 proposes no habitat management areas for the central Gulf of Maine sub-region. To achieve positive impacts, a no closure alternative relies on increases in CPUE that lead to less fishing time and therefore reduced gear contact with the seabed. However, if particular habitats or fish populations are expected to be especially susceptible to impact, even limited amounts of fishing could be detrimental. Complex kelp habitats on the pinnacle of Cashes Ledge and localized populations of resident cod are examples of resources protected by area closures proposed under other alternatives in this sub-region that would be vulnerable to fishing under a no closure scenario. In addition, there do not appear to be significant aggregations of large fish within the closures that would improve CPUE in the central Gulf of Maine in general. For details see Volume 4, economic impacts section 4.2.2, which assesses patterns fishing activity near the closures and summarizes related analyses prepared for Framework Adjustment 48 to the Multispecies FMP. Combining these unique resources with limited potential for CPUE increases, this alternative is expected to have negative impacts on groundfish habitat conservation and groundfish stocks compared to Alternative 1/No Action, or compared to Alternatives 3 and 4.

Overall, this alternative is expected to have slightly negative impacts on groundfish spawning. There are some large spawner groundfish hotspots overlapping the Alternative 1/No Action areas in the spring, summer, and fall, and removal of these areas and their associated restrictions on gears capable of catching groundfish would eliminate some current spawning benefits. Because trawl survey sampling effort is relatively limited around Cashes Ledge, the hotspot analysis may have missed aggregations of spawning fish. Thus, the low number of observed hotpots may be under-representative of the importance of the area as a spawning ground. Removal of the existing Jeffreys Bank Habitat Closure Area would have a slight negative impact, if any, given limited overlap of this area with hotspots and the fact that it is currently managed as a mobile

bottom-tending gear closure, which limits the potential for spawning benefits given that fixed and recreational gears capable of catching groundfish are currently allowed.

2.2.2.3 ***Alternative 3 (Preferred alternative, without Platts Bank HMA)***

Alternative 3 proposes Modified Jeffreys Bank and Cashes Ledge HMAs, the Ammen Rock HMA (Map 7) which would be closed to all fishing gears except lobster traps, and the Platts Bank and Fippennies Ledge HMAs (Platts Bank contains two sub-areas). As preferred, this alternative does not include the Platts Bank HMA, but would be combined with the Cashes Ledge Groundfish Closure Area.

Total weighted and unweighted groundfish hotspots are summarized in Table 5. In addition to spring and fall trawl surveys, the summer shrimp trawl survey and the winter industry based cod surveys partially overlap the areas proposed for habitat management in the central Gulf of Maine. As noted previously, the hotspots in this sub-region are likely to be underestimated because of the reduced survey tows in the immediate vicinity of Cashes Ledge, Fippennies Ledge, and Platts Bank. The small sizes of these proposed habitat management areas would be less effective than larger areas for protecting groundfish stocks that generally have much larger ranges of movement. Additionally, detection of any potential effect on stock productivity would be very difficult.

Differences between total hotspots for Alternative 3 and Alternative 4 are unremarkable, but both are generally lower than those for Alternative 1/No Action. There are no age 0/1 cod hotspots for any alternative (Table 6), but this is probably due to the undersampling of the areas noted above. Both Platts Bank and Fippennies Ledge have some catches of age 0/1 cod surrounding them, and these additional HMAs, particularly Platts Bank which is not currently part of the Council's spatial management system, could convey some additional habitat conservation benefits for cod and other groundfish species, despite the presence of age 0/1 hotspots.

Based on the number and distribution of hotspots, Alternative 3 has fewer conservation benefits than Alternative 1/No Action and impacts on age 0/1 juvenile groundfish habitat and on the groundfish resource are therefore expected to be slightly negative compared to No Action, i.e. the alternative would have slight positive impacts on the resource. However, Alternative 1/No Action does not include any habitat closures around Platts Bank and Fippennies Ledge, which have some survey catches of age 0/1 cod and other groundfish. While Fippennies Ledge is protected by the Cashes Ledge Groundfish Closure Area, Platts Bank is not. As noted above, since differences between total hotspots for Alternative 3 and Alternative 4 are unremarkable, the impacts of Alternative 3 on age 0/1 groundfish habitat and the groundfish resource are most likekly neutral or perhaps slight positive compared to Alternative 4. Without Platts Bank, which was excluded from the final preferred alternative, the differences between Alternatives 3 and 4 are further diminished.

Overall, this alternative is expected to have neutral to slightly negative impacts on groundfish spawning relative to Alternative 1/No Action. There are some groundfish hotspots overlapping and adjacent to the modified Cashes Ledge HMA during the spring, summer, and fall, and overlapping the modified Jeffreys Bank HMA during the summer, but given that these areas would be closed to mobile bottom-tending gears only under this alternative, Options 1 and 2,

positive benefits would be somewhat limited. It is not possible to predict whether the use of fixed gears such as longlines and gillnets would increase in areas currently managed that would remain as habitat closures only (i.e. Fippennies Ledge, Cashes Ledge) if the Cashes Ledge Groundfish Closure Area were lifted. If fixed gears capable of catching groundfish are used in the groundfish closure as a result of this alternative lifting that closure, then negative impacts to spawning groundfish could result. The magnitude of these impacts would relate to the magnitude of fishing activity in the area, which is uncertain. There is currently gillnet use on Platts Bank, which would become a mobile bottom-tending gear closure under this alternative, Options 1 and 2, so any spawning protection benefits of the Platts Bank areas would be mitigated by gillnet use in the area, which would presumably continue under this alternative. Whether is has the updated or existing boundaries, the measures for the Jeffreys Bank area would remain the same under Option 1, would be functionally equivalent under Option 2 as clam resources are not known to occur around Jeffreys Bank. Because current restrictions limit mobile bottom-tending gears only, and not all gears that catch groundfish, shifting the boundaries of this area would be expected to have neutral impacts on groundfish spawning. In any event, the overlaps between either the no action Jeffreys Bank area or the preferred Jeffreys Bank area and spawner groundfish hotspots are limited. Alternative 3 implemented with Options 3 and 4 are not expected to produce any positive benefits for spawning groundfish. This, coupled with the potential negative impacts of removing the existing groundfish closure, could lead to negative impacts overall if this alternative is adopted with Option 3 or Option 4. The Ammen Rock area would offer fairly comprehensive protection to groundfish stocks year round, but the small size of this area reduces the magnitude of positive benefits to spawning.

2.2.2.4 ***Alternative 4***

Alternative 3 proposes Modified Jeffreys Bank and Cashes Ledge HMAs, and the Ammen Rock HMA, which would be closed to all fishing gears except lobster traps. Unlike Alternative 3, HMAs around Platts Bank and Fippennies Ledge are not included. This is not a preferred alternative.

Differences between total hotspots for Alternative 3 and Alternative 4 are unremarkable (Table 5), but both are generally lower than those for Alternative 1/No Action. Based on the number and distribution (Map 8) of hotspots, Alternative 4 has fewer conservation benefits than Alternative 1/No Action. Compared to Alternative 1/No Action, or to the preferred combination of the Cashes Ledge Groundfish Closure Area and Alternative 3 as preferred without Platts Bank, impacts on the habitat used by age 0/1 groundfish and on the groundfish resource are slightly negative, i.e. impacts of the alternative on the resource would be slightly positive, whereas impacts of Alternative 1/No Action are slightly to moderately positive. Primarily, habitat protections around Fippennies Ledge would be eliminated. Alternative 4 would have positive impacts relative to no closures under Alternative 2 and slightly negative to neutral impacts relative to Alternative 3, which does include Fippennies Ledge.

This alternative is expected to have neutral to slightly negative impacts on groundfish spawning relative to Alternative 1/No Action, and would have similar impacts as those discussed above for Alternative 3. This alternative would not include the Platts Bank HMA, but this area likely has neutral impacts on spawning groundfish as discussed above because it would be closed only to mobile gears that catch groundfish, not fixed gears. Under this alternative, spawning fish

occupying Fippennies Ledge would be vulnerable to fishing, via removal of the Cashes Ledge Groundfish Closure Area. Should it reopen, the potential for groundfishing activity on Fippennies Ledge is uncertain.

2.2.3 Western Gulf of Maine

Tables and maps for the western Gulf of Maine provided below. In the tables, any spatial overlaps between management areas were accounted for so that there was no double counting of hotspots for the combined alternatives. Red and silver hake are not large mesh species and were not included in the weighted hotspot analysis, but their unweighted hotspots are listed in the table of hotspots by species.

Table 7 – WGOM: Total unweighted and weighted age 0/1 juvenile large mesh groundfish hotspots, by season. Individual areas are listed first, followed by combined alternatives.

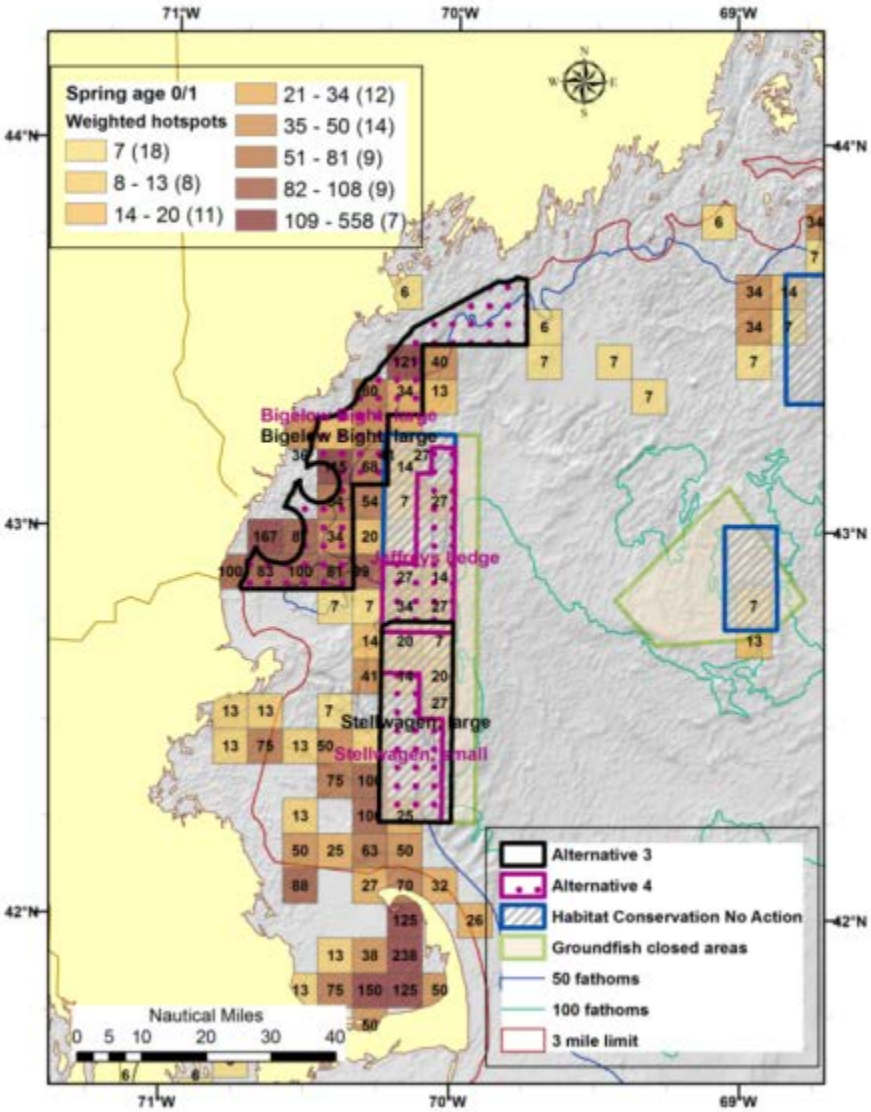
Area name (Alternative)	Spring		Summer		Fall		Winter	
	Number	Weighted	Number	Weighted	Number	Weighted	Number	Weighted
WGOM Closed Area (1)	84	261.06	49	162.24	67	305.71	1	6.71
WGOM Habitat Closure (1)	70	261.06	32	128.44	56	265.15	1	6.71
Large Bigelow Bight (3, 4)	462	826.31	77	155.48	483	844.60	11	0.00
Small Bigelow Bight (5)	150	351.68	51	114.92	153	270.13	6	0.00
Large Stellwagen (3, 6)	24	112.94	6	6.76	17	123.49	1	6.71
Small Stellwagen (4, 5)	5	38.58	1	0.00	9	82.93	0	0.00
Jeffreys Ledge (4, 5)	26	127.84	5	27.04	28	107.86	0	0.00
Inshore Roller Gear Area (7A)	1,050	2,686.88	213	500.24	1,018	1,886.75	133	720.92
Alternate Roller Gear Area (7B)	549	1,518.17	90	189.28	562	1,263.90	67	357.55
Shrimp Trawl Area (8)	20	20.28	21	94.64	11	33.80	0	0.00
Alternative 1	84	261.06	49	162.24	67	305.71	1	6.71
Alternative 1 preferred	70	261.06	32	128.44	56	265.15	1	6.71
Alternative 3	486	939.25	83	162.24	500	968.09	12	6.71
Alternative 4	493	992.73	83	182.52	520	1,035.39	11	0.00
Alternative 5	181	518.1	57	141.96	190	460.92	6	0.00
Alternative 6	24	112.94	6	6.76	17	123.49	1	6.71

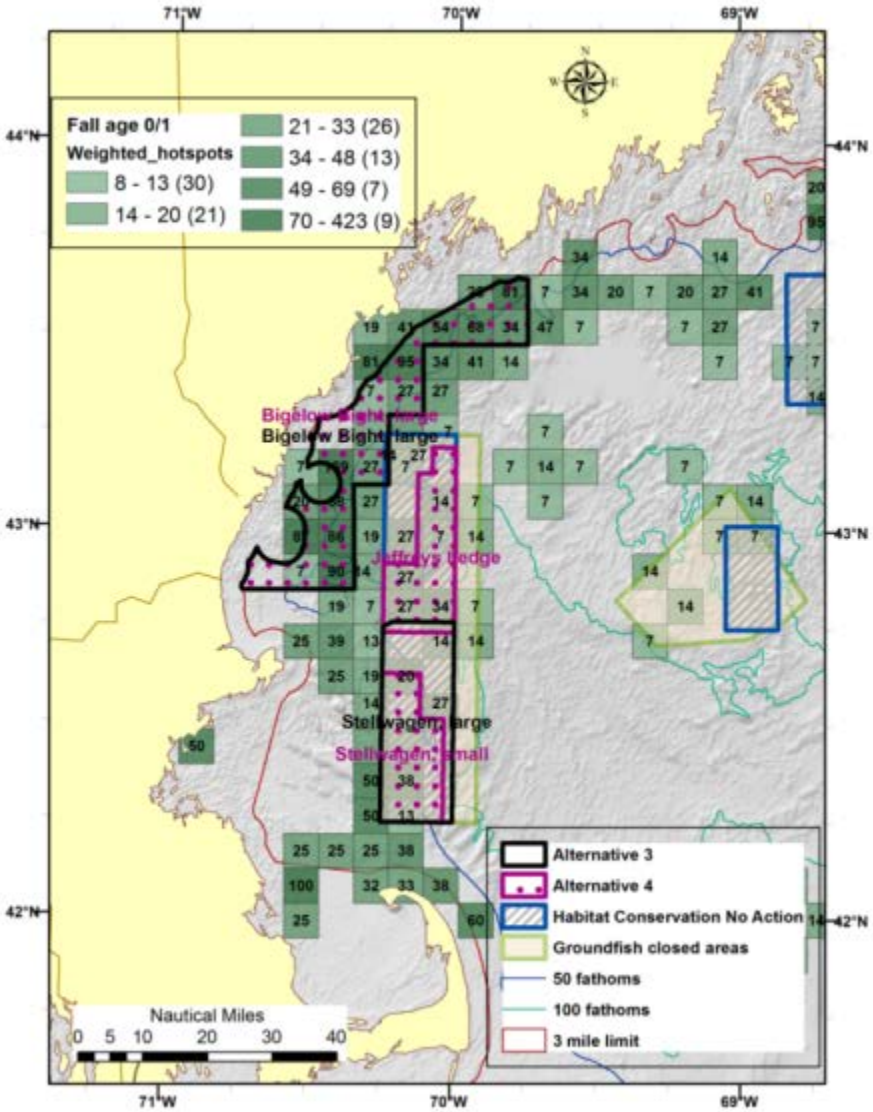
Table 8 – WGOM: Age 0/1 juvenile large mesh groundfish hotspots by species. All seasons are combined. There were no hotspots for halibut or windowpane in any of the western GOM HMAs. Individual areas are listed first, followed by combined alternatives.

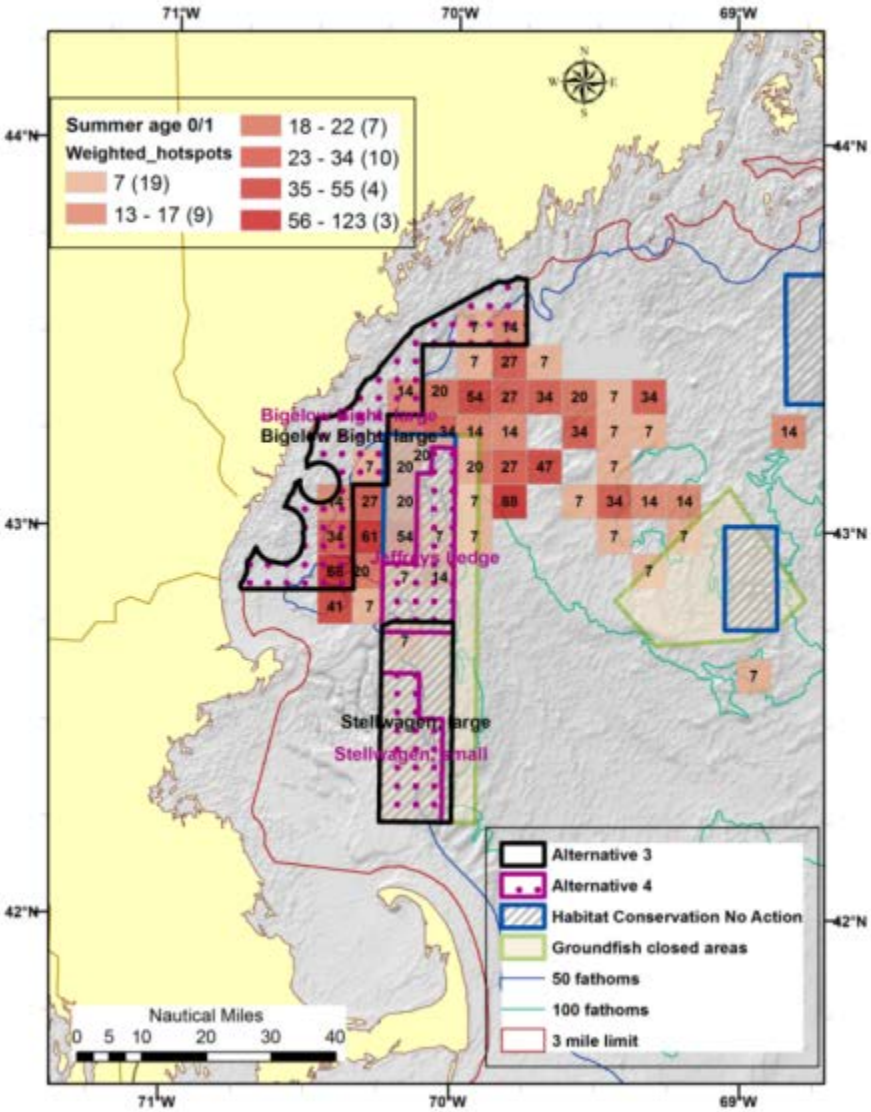
Area name (Alternative)	Redfish	Am. Plaice	Cod	Haddock	Ocean pout	Pollock	W. hake	Winter Fl.	Witch Fl.	Yellowtail fl.	Red hake	Silver hake
W. Gulf of Maine Closure Area (1)	77	35	8	19	0	0	1	1	2	0	24	30
W. Gulf of Maine Habitat Closure (1)	66	33	8	19	0	0	1	1	2	0	9	20
Large Bigelow Bight (3, 4)	198	353	12	19	9	9	40	20	17	1	106	191
Small Bigelow Bight (5)	72	137	12	11	0	4	10	20	7	1	23	62
Large Stellwagen (3, 6)	23	4	7	1	0	0	1	1	0	0	6	5
Small Stellwagen (4, 5)	5	1	7	0	0	0	1	1	0	0		
Jeffreys Ledge (4, 5)	21	10	0	18	0	0	0	0	0	0		10

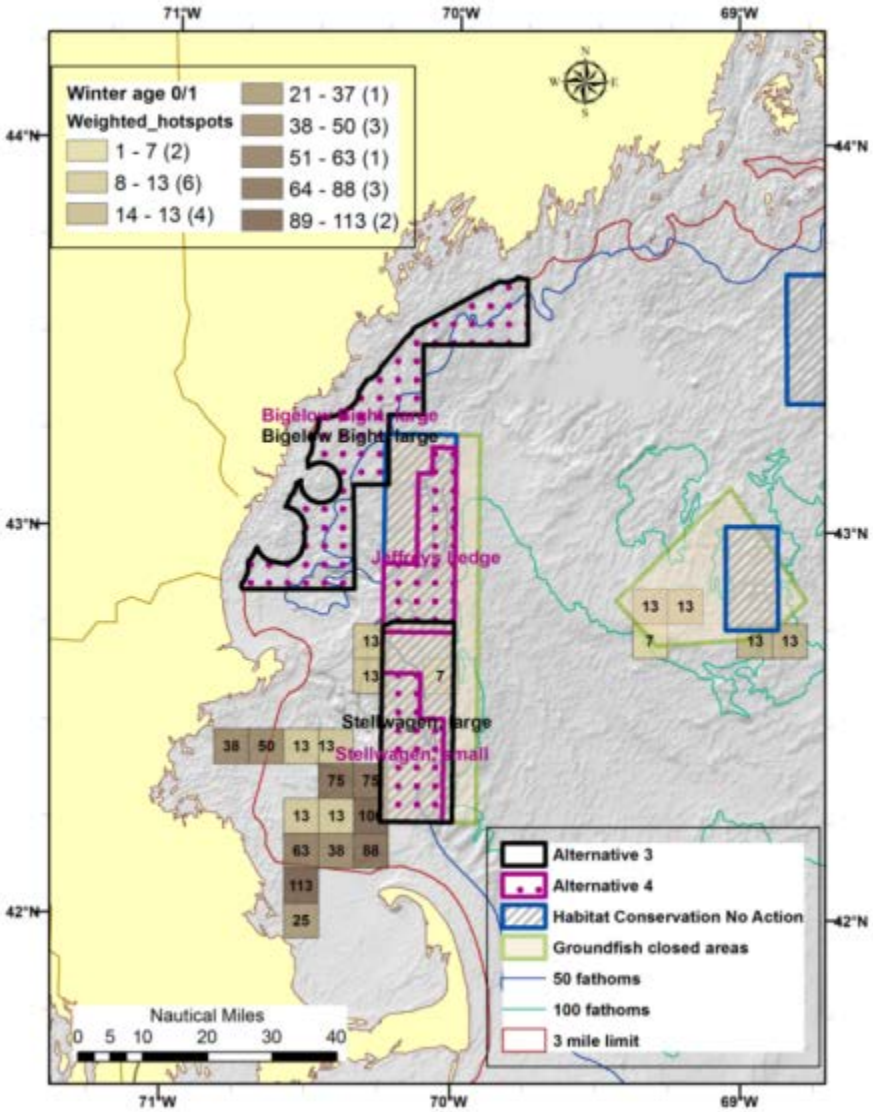
Area name (Alternative)	Redfish	Am. Plaice	Cod	Haddock	Ocean pout	Pollock	W. hake	Winter Fl.	Witch Fl.	Yellowtail fl.	Red hake	Silver hake
Inshore roller gear area (7A)	354	706	214	64	13	13	39	350	24	20	226	348
Alt. roller gear area (7B)	242	371	98	38	9	9	41	63	17	3	113	206
Shrimp Trawl Exemption Area (8)	22	19	1	0	0	0	0	0	2	0	3	5
Alternative 1	77	35	8	19	0	0	1	1	2	0	0	0
Alternative 1 preferred	66	33	8	19	0	0	1	1	2	0	0	0
Alternative 3	221	357	19	20	9	9	41	21	17	1	112	196
Alternative 4	224	364	19	37	9	9	41	21	17	1	106	201
Alternative 5	98	148	19	29	0	4	11	21	7	1	23	72
Alternative 6	5	1	7	0	0	0	1	1	0	0	0	0
Alternative 7A	354	706	214	64	13	13	39	350	24	20	20	20
Alternative 7B	242	371	98	38	9	9	41	63	17	3	3	3
Alternative 8	22	19	1	0	0	0	0	0	2	0	0	0

Map 10 – WGOM Alternatives 1, 3 and 4 overlap with spring (left), fall (right), summer (left on next page), and summer (right on next page) total weighted age 0/1 groundfish hotspots from 2002-2012 NMFS, MADMF, ME-NH, and IBS survey data.

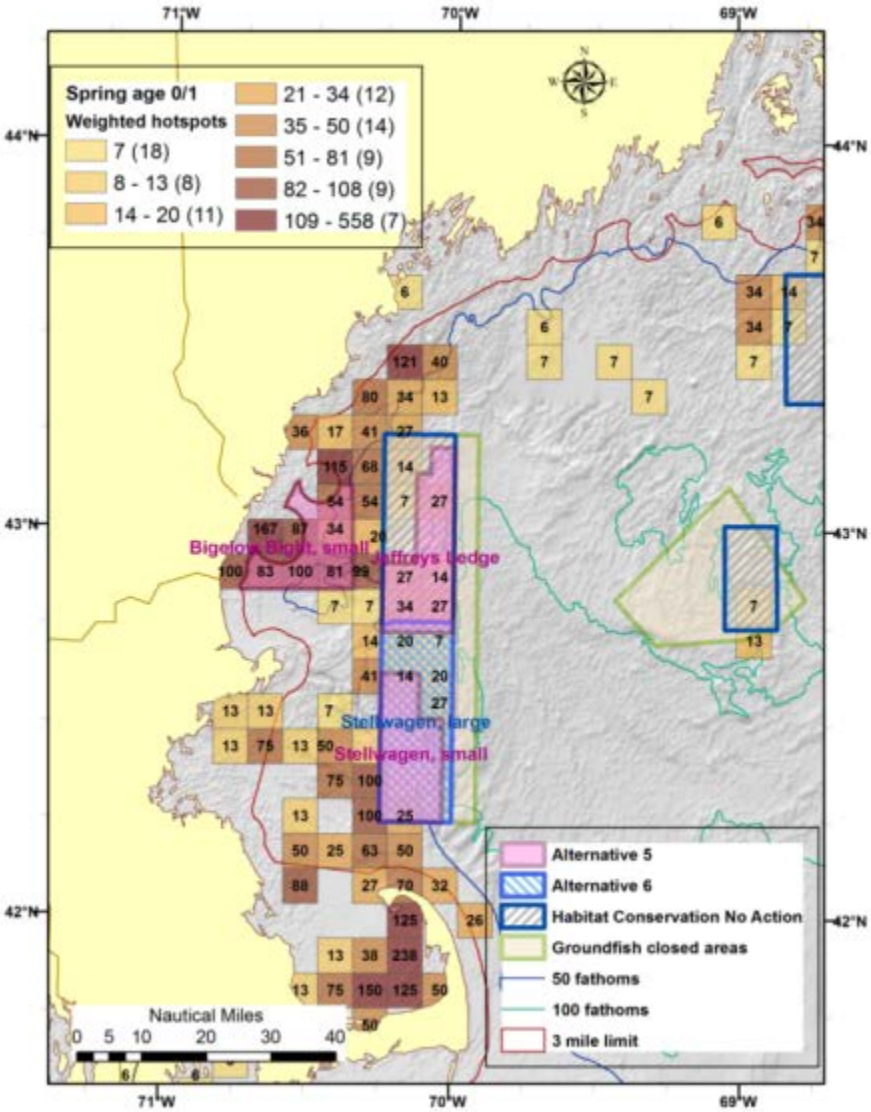


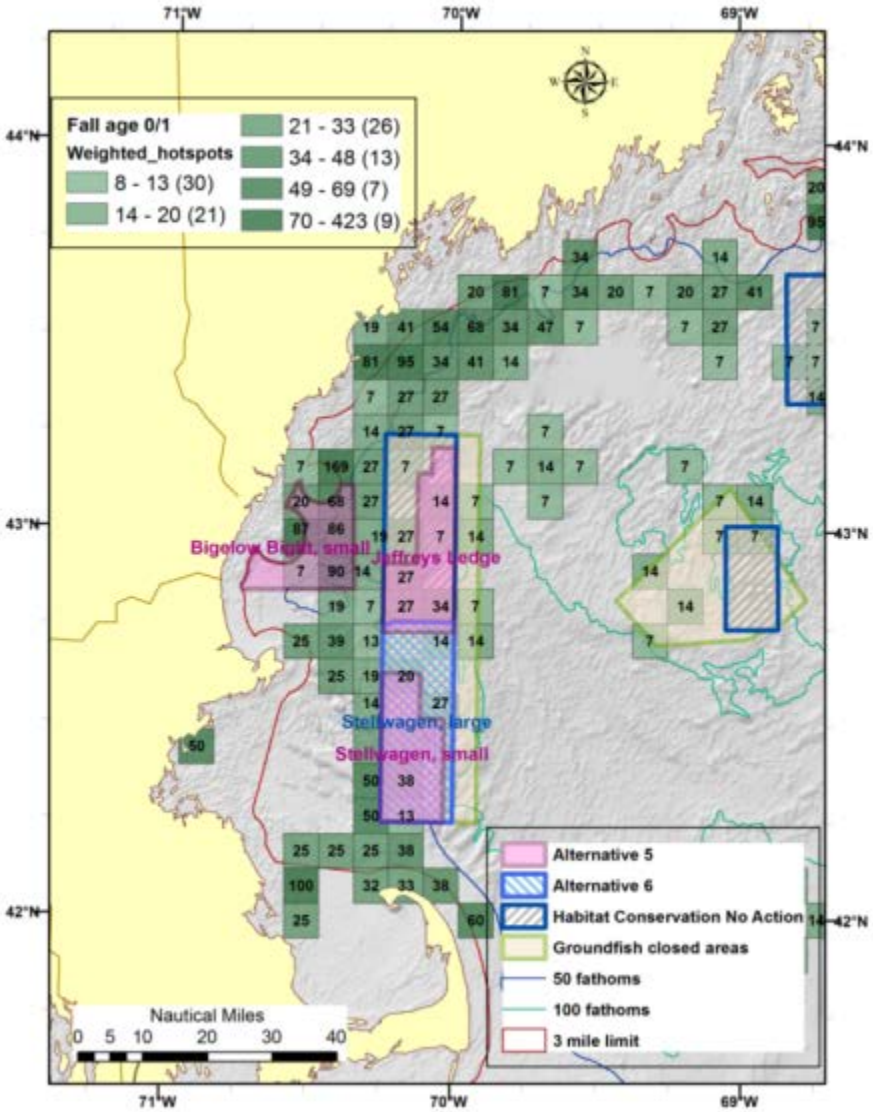


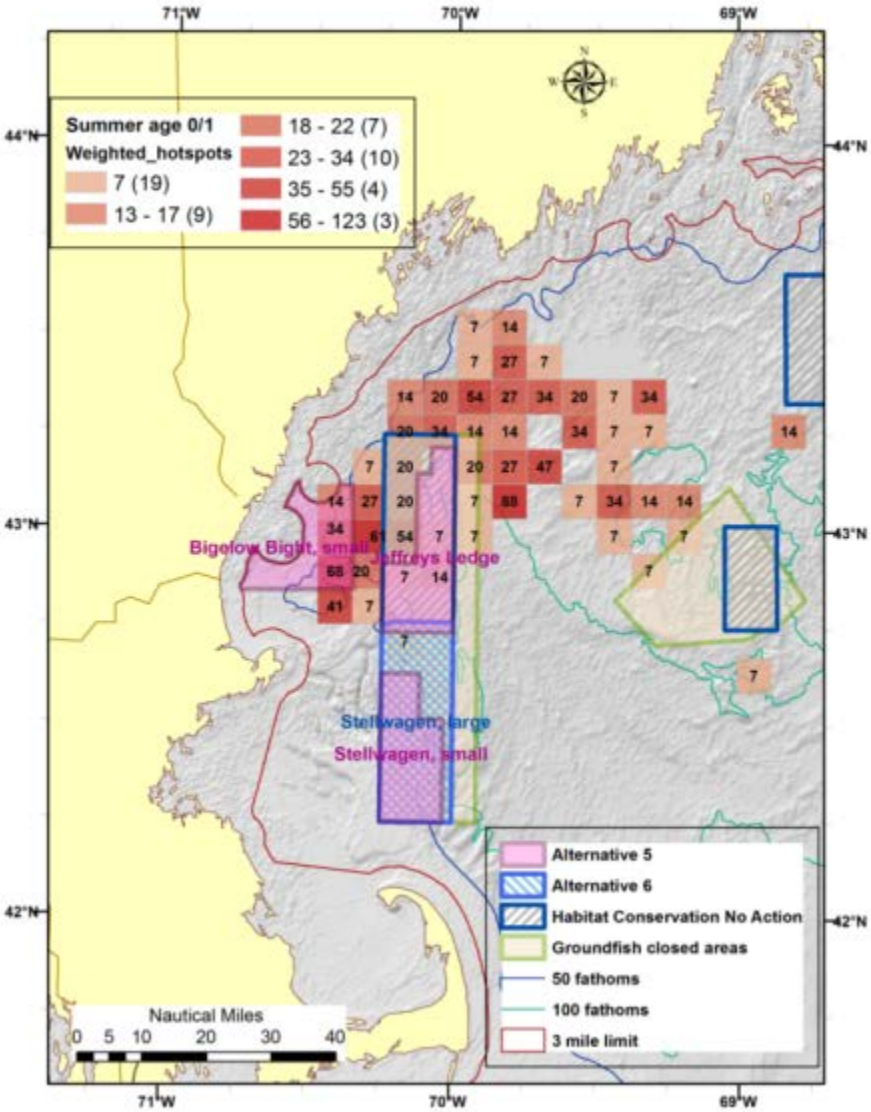

Summer age 0/1
Weighted_hotspots
7 (19)
13 - 17 (9)
18 - 22 (7)
23 - 34 (10)
35 - 55 (4)
56 - 123 (3)
Bigelow Bight large
Jeffreys Ledge
Stellwagen large
Stellwagen small
Alternative 3
Alternative 4
Habitat Conservation No Action
Groundfish closed areas
50 fathoms
100 fathoms
3 mile limit
Nautical Miles
0 5 10 20 30 40
71°W
70°W
69°W
44°N
43°N
42°N

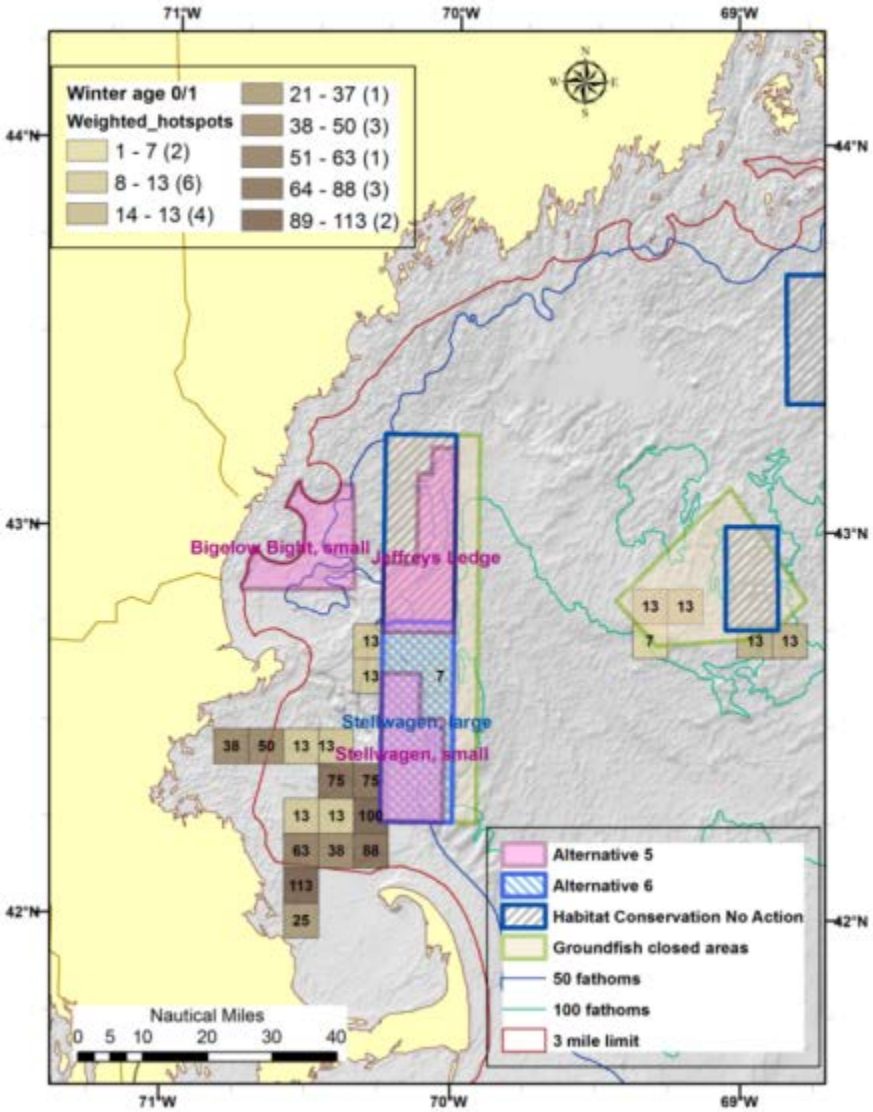

Winter age 0/1
Weighted_hotspots
1 - 7 (2)
8 - 13 (6)
14 - 13 (4)
21 - 37 (1)
38 - 50 (3)
51 - 63 (1)
64 - 88 (3)
89 - 113 (2)
Bigelow Bight large
Jeffreys Ledge
Stellwagen large
Stellwagen small
Alternative 3
Alternative 4
Habitat Conservation No Action
Groundfish closed areas
50 fathoms
100 fathoms
3 mile limit
Nautical Miles
0 5 10 20 30 40
71°W
70°W
69°W
44°N
43°N
42°N

Map 11 – WGOM Alternatives 1, 5 and 6 overlap with spring (left), fall (right), summer (left on next page), and summer (right on next page) total weighted age 0/1 groundfish hotspots from 2002-2012 NEFSC, MADMF, ME-NH, and IBS survey data.

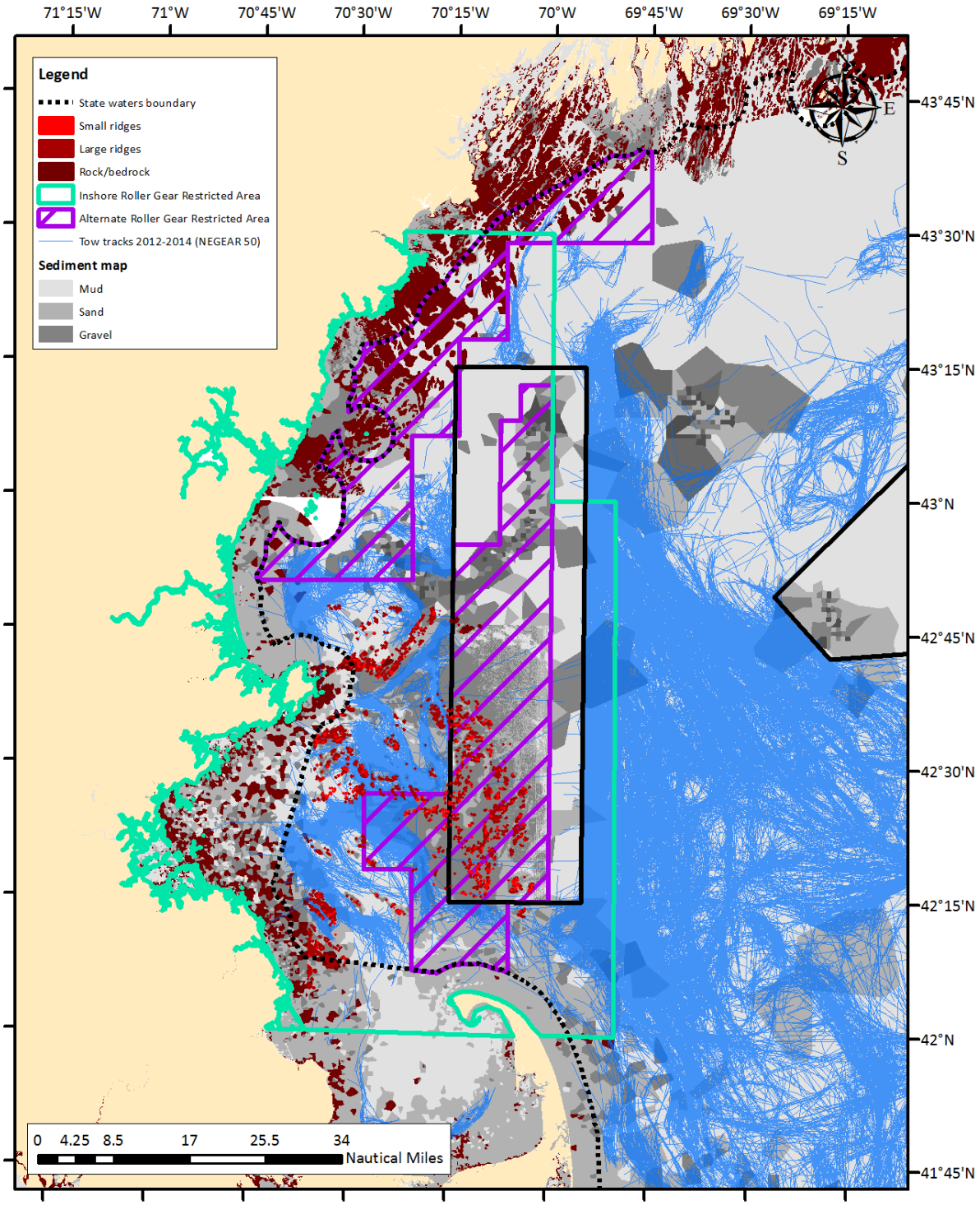




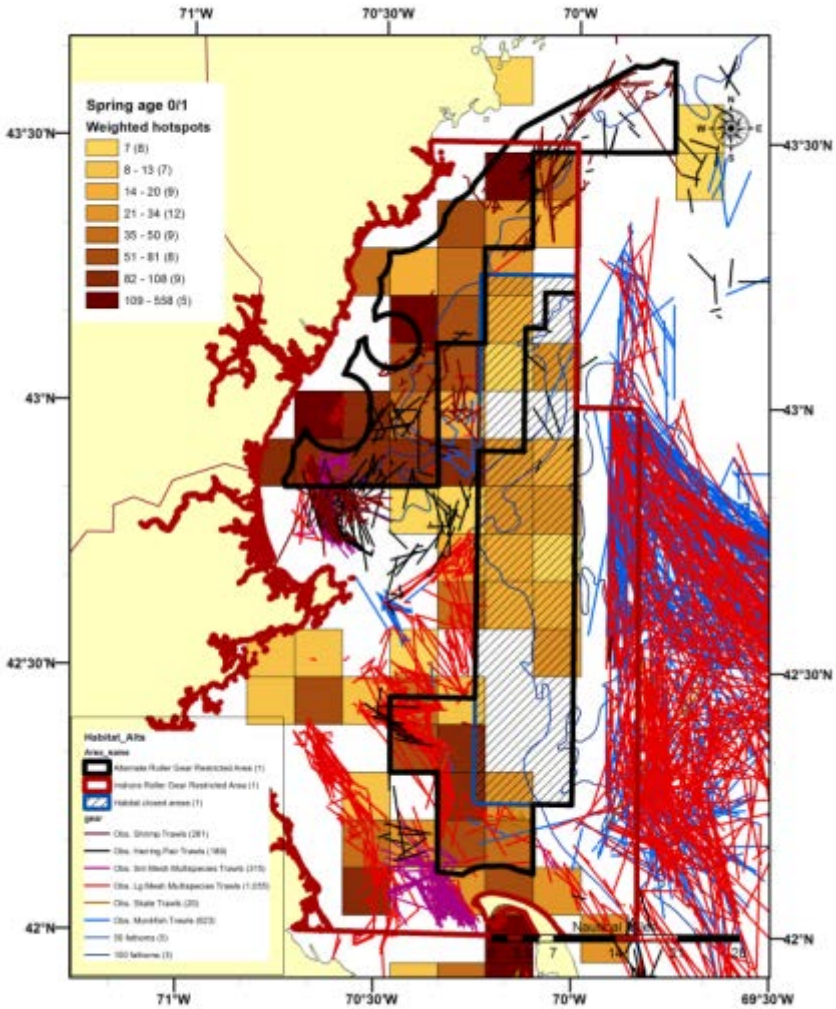

Summer age 0/1
Weighted_hotspots
7 (19)
13 - 17 (9)
18 - 22 (7)
23 - 34 (10)
35 - 55 (4)
56 - 123 (3)
Bigelow Bight, small
Jeffreys Ledge
Stellwagen, large
Stellwagen, small
Alternative 5
Alternative 6
Habitat Conservation No Action
Groundfish closed areas
50 fathoms
100 fathoms
3 mile limit
Nautical Miles
0 5 10 20 30 40
71°W
70°W
69°W
44°N
43°N
42°N

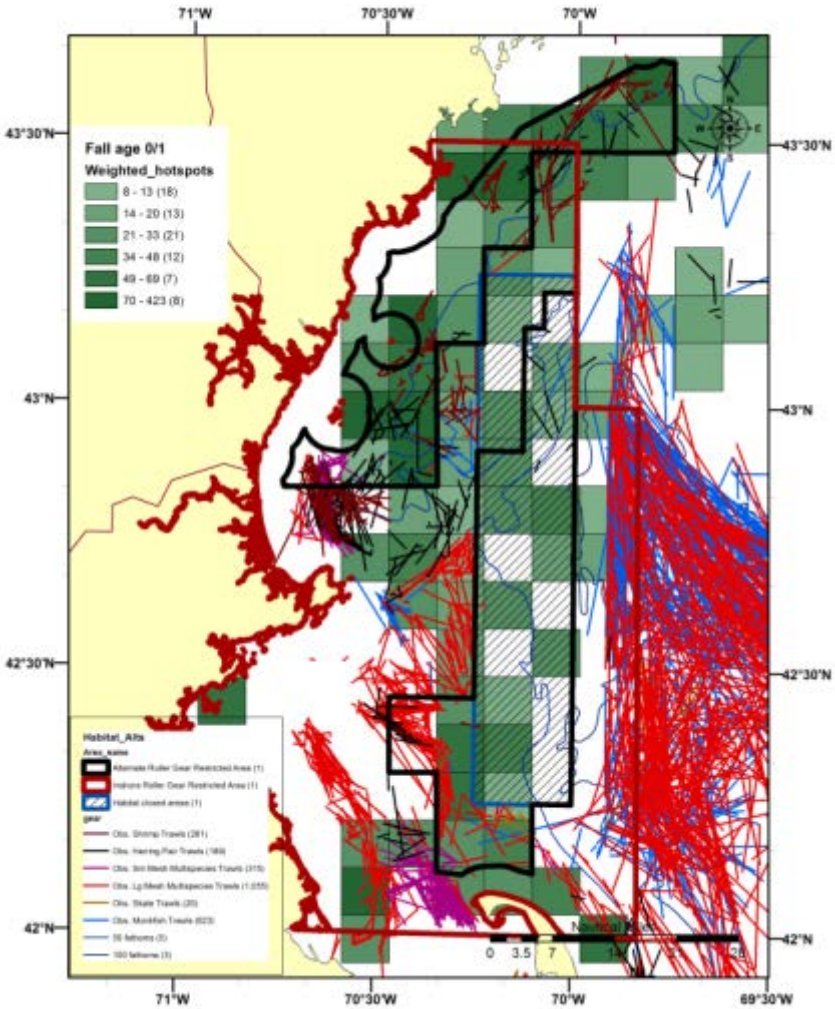

Winter age 0/1
Weighted_hotspots
1 - 7 (2)
8 - 13 (6)
14 - 13 (4)
21 - 37 (1)
38 - 50 (3)
51 - 63 (1)
64 - 88 (3)
89 - 113 (2)
Bigelow Bight, small
Jeffreys Ledge
Stellwagen, large
Stellwagen, small
Alternative 5
Alternative 6
Habitat Conservation No Action
Groundfish closed areas
50 fathoms
100 fathoms
3 mile limit
Nautical Miles
0 5 10 20 30 40
71°W
70°W
69°W
44°N
43°N
42°N

Map 12 – Location of observed hauls (fish trawl gear code 050, 2012-2014) compared to substrate types in the Western Gulf of Maine sub-region. Substrate map is a composite of SASI, ME Bottom Type, MA CZM, and USGS (Stellwagen) data shown in consistent color scales, with higher resolution data overlapping lower resolution (SASI) data. See section 4.2.1 of Volume 1 for details on these data sets.

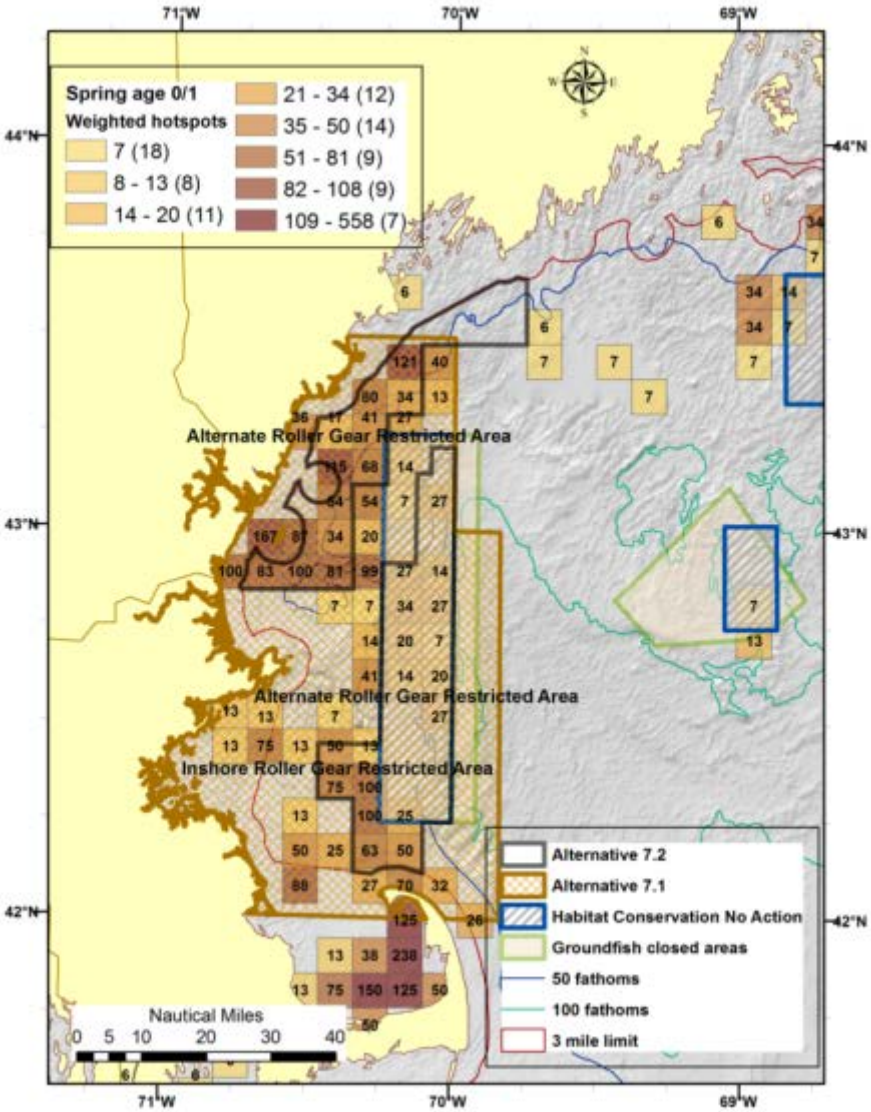


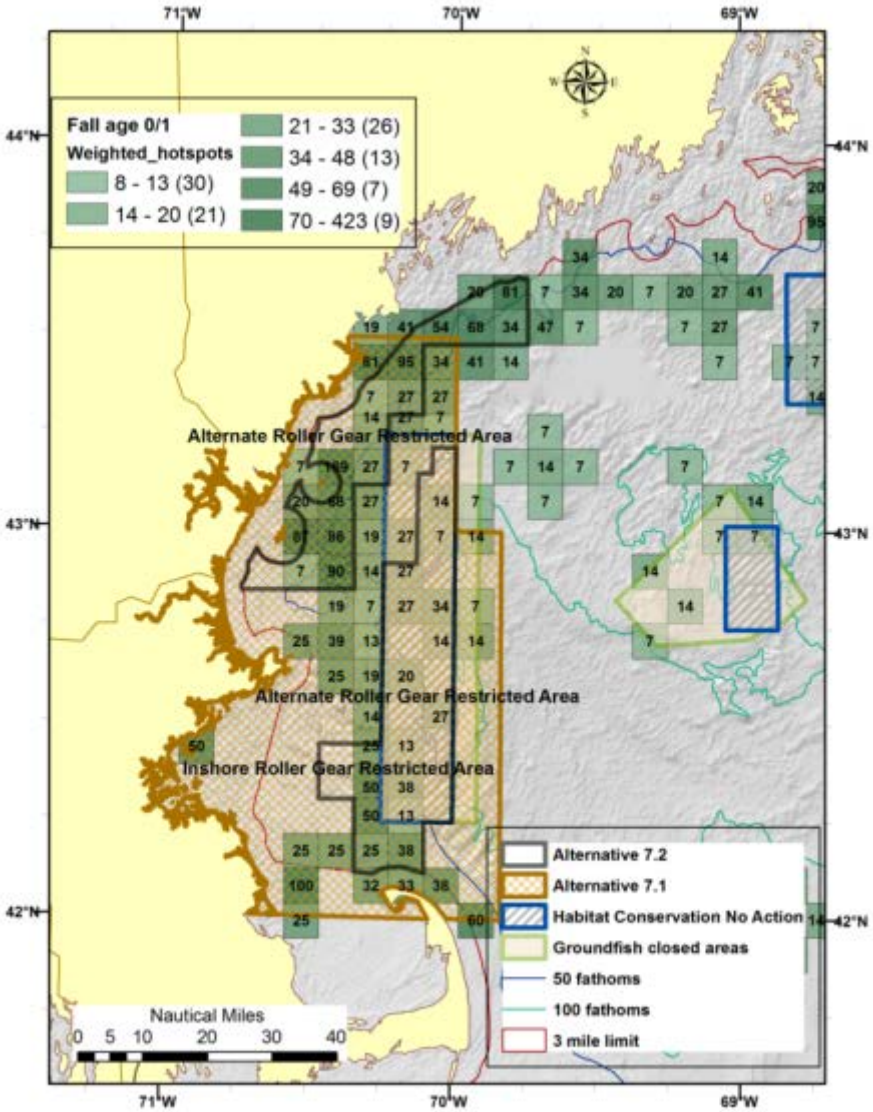
Map 13 – Location of observes hauls since 2008 by vessels targeting shrimp, herring, whiting, large-mesh multispecies, skates, and monkfish compared spring (left) and fall (right) age 0/1 groundfish hotspots heavily weighted in favor of stocks that are at low biomass and/or associated with coarse and hard substrates.

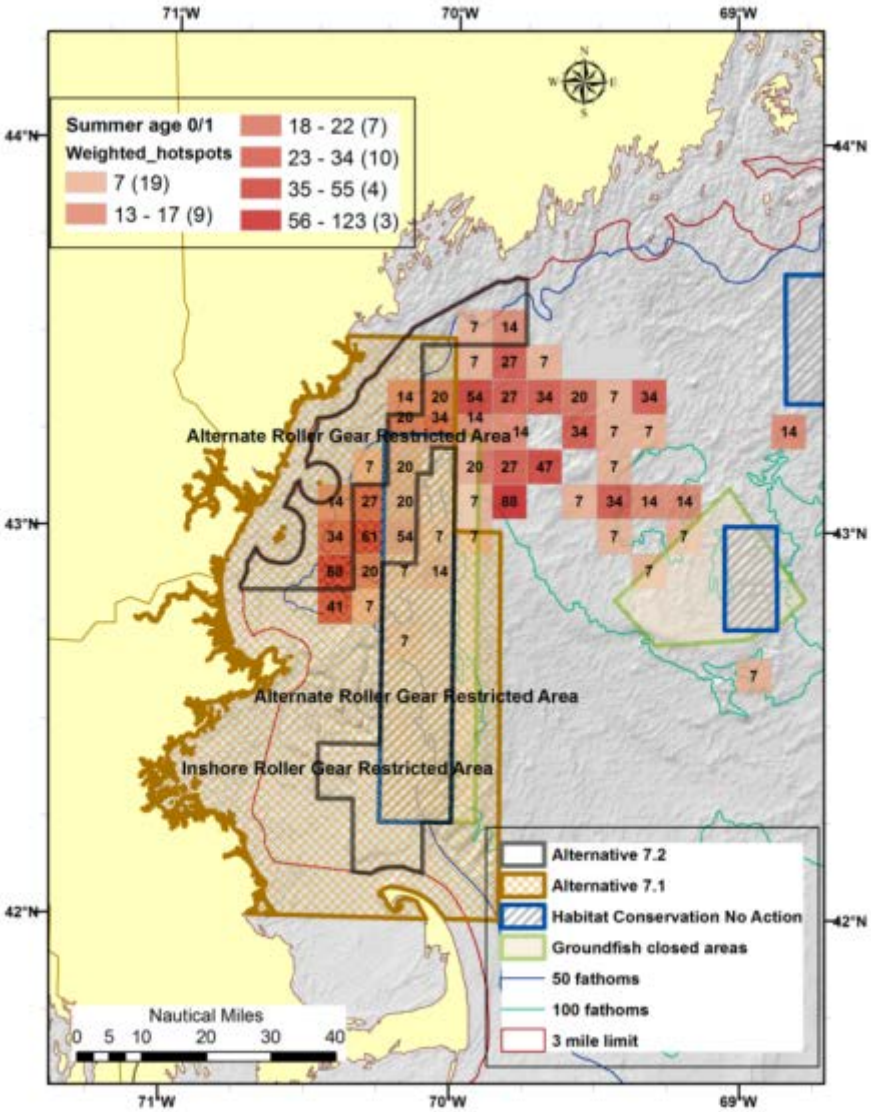


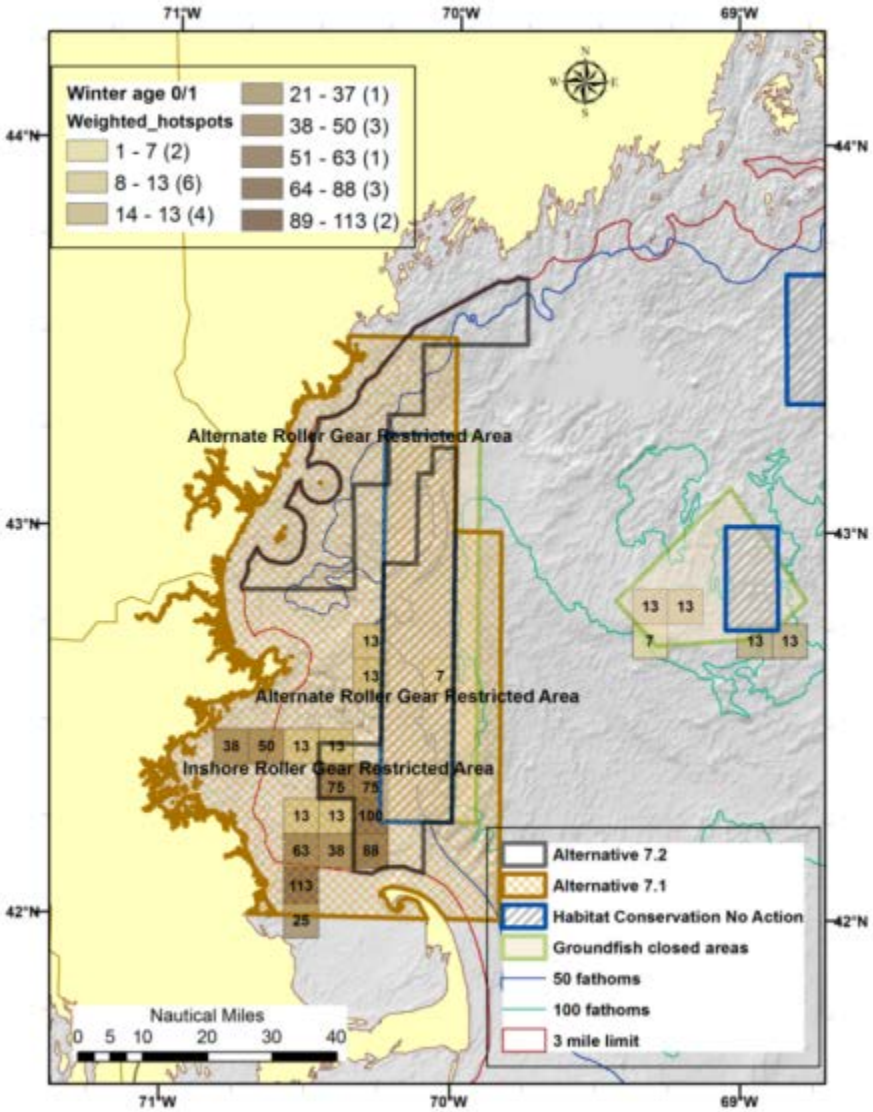


Map 14 – WGOM Alternatives 1, 7A and 7B overlap with spring (left), fall (right), summer (left on next page), and summer (right on next page) total weighted age 0/1 groundfish hotspots from 2002-2012 NMFS, MADMF, ME-NH, and IBS survey data.






Summer age 0/1
Weighted_hotspots
7 (19)
13 - 17 (9)
18 - 22 (7)
23 - 34 (10)
35 - 55 (4)
56 - 123 (3)
Alternate Roller Gear Restricted Area
Alternate Roller Gear Restricted Area
Inshore Roller Gear Restricted Area
Alternative 7.2
Alternative 7.1
Habitat Conservation No Action
Groundfish closed areas
50 fathoms
100 fathoms
3 mile limit
Nautical Miles
0 5 10 20 30 40
71°W
70°W
69°W
44°N
43°N
42°N


Winter age 0/1
Weighted_hotspots
1 - 7 (2)
8 - 13 (6)
14 - 13 (4)
21 - 37 (1)
38 - 50 (3)
51 - 63 (1)
64 - 88 (3)
89 - 113 (2)
Alternate Roller Gear Restricted Area
Alternate Roller Gear Restricted Area
Inshore Roller Gear Restricted Area
Alternative 7.2
Alternative 7.1
Habitat Conservation No Action
Groundfish closed areas
50 fathoms
100 fathoms
3 mile limit
Nautical Miles
0 5 10 20 30 40
71°W
70°W
69°W
44°N
43°N
42°N

2.2.3.1 ***Alternative 1 (No Action; Preferred alternative with modified boundaries for the Western Gulf of Maine Closure Area)***

Alternative 1/No Action would maintain the existing year-round closed areas in the western Gulf of Maine, specifically the Western Gulf of Maine Habitat Closure Area and the Western Gulf of Maine Closure Area. As preferred, the eastern boundary of the Western Gulf of Maine Closure Area would be shifted west by five minutes (approximately five nautical miles) to match the habitat closure, reducing the size of the groundfish closure. Within this single boundary, existing prohibitions on mobile bottom-tending gears and fishing gears capable of catching groundfish (including large-mesh trawls, sink gillnets, and bottom longlines) would be maintained, and recreational groundfishing would continue to be permitted. This section considers the impacts of status quo management and compares these impacts to the preferred, modified boundary.

The amount of unweighted and weighted juvenile groundfish hotspots in each survey season is summarized in Table 7, with the distribution of weighted hotspot shown in Map 9. Summer and winter hotspots in the Gulf of Maine are few, reflecting the limited amount of survey samples during these seasons (see the summer and winter survey distribution maps in Volume 1, Section 4.4). The total weighted hotspots in the Alternative 1/No Action habitat closures were 261.1 in the spring, 162.2 in the summer, 305.7 in the fall, and 6.7 in the winter (Table 7). Lower spring and summer values (128.4 and 265.2) are associated with the preferred approach, which modifies the Western Gulf of Maine Closure Area boundary (Table 7). During the spring, most of the weighted hotspots occur inshore of and partially overlapping the Western Gulf of Maine Habitat Closure. Most of the hotspots inshore of the management areas in Massachusetts, Cape Cod, and Ipswich Bays occur due to the presence of heavily weighted age 0/1 cod. Most of the hotspots inshore and southwest of the Western Gulf of Maine Habitat Closure during the winter are from cod and winter flounder, although only cod were positively weighted.

Alternative 1/No Action protects vulnerable bottom habitats within the existing closures that may be used by juvenile groundfish, including those species highlighted in the hotspot analysis. This alternative could continue to improve habitat quality over time if the existing habitat closures and groundfish closed area are still recovering from impacts that occurred prior to year round closure in 1998. Combined with restrictions on mobile bottom-tending gears, the prohibition on fishing with gears capable of catching groundfish in the closed areas could improve the potential for local groundfish stock recovery (e.g., localized sub-populations where they exist). An example of this synergy between habitat and groundfish closures is where habitat protection improves the survival and growth of forage fish which would support a larger population of juvenile and adult groundfish, locally increasing productivity of the system. As discussed in the habitat impacts analysis in Volume 4, most of the complex, hard bottom habitats on Jeffreys Ledge and the eastern portion of Stellwagen Bank are included within the habitat closure, and would remain protected under the preferred alternative. The eastern edge of the groundfish closure transitions into Wilkinson Basin and is relatively deeper and muddier. A shallow feature known as Wildcat Knoll is an exception to this pattern. Overall, the No Action alternative as well as the preferred variation are similar in terms of the amount of protection they afford to groundfish habitats, with slight reduced benefits associated with the preferred alternative.

Continuation of Alternative 1/No Action in the western Gulf of Maine is likely to have positive impacts on the groundfish resource. This is true of both the No Action and preferred versions of this alternative. However, population level impacts have proven difficult to assess. A before-after-control-impact analysis (Kerr et al 2012) showed that the Western Gulf of Maine Closed Area had positive effects on biomass of winter flounder in the closed area, but not for other species, including cod and haddock. In Northeast Multispecies Framework Adjustment 48, differences in survey CPUE of groundfish species inside and immediately adjacent to closed areas were difficult to detect, although more concentrated fishing activity particularly around the Western Gulf of Maine Closed Area is evident from the fishery data (see maps in Volume 1, Section 4.3). The positive effects on the Cashes Ledge Closure Area on cod noted by Sherwood and Grabowski (2015) were not duplicated within and outside the Western Gulf of Maine Closure Area. Cod captured outside the Western Gulf of Maine Closure Area were on average older and larger, and exhibited higher trophic position and body condition (higher protein reserves). However, cod inside the closure did exhibit the deeper and less streamlined body shape, which was characteristic of the cod captured in all four closure areas in the study. The authors speculated that recreational fishing effort and associated fishing mortality inside the Western Gulf of Maine Closure Area could be affecting the life history traits exhibited in this area, as compared to other closed areas. If recreational fishing does explain the differences in life history parameters, this means that such removals may be locally limiting stock production, despite the fact that recreational hook and line gears do not have a negative impact on cod habitats. It follows then that combining habitat protection measures with limits on removals of groundfish may be an important conservation strategy, at least for some areas and species.

Impacts analysis should consider impacts associated with continued fishing effort redistribution to the surrounding areas outside the current closures. If the juvenile groundfish habitat quality is better outside the existing closures than within them, then higher fishing activity in the surrounding area would increase adverse impacts on age 0/1 juvenile groundfish habitat. Similarly, if catches of juvenile and sub-legal groundfish are higher outside the closed areas than within them, then higher groundfish fishing effort in the surrounding area would increase adverse impacts on groundfish stocks. Increasing effort on small fish would reduce yield-per-recruit and sustainable yield. It is possible that some of the positive effects of this alternative on groundfish may be accruing to the fishery operating outside the boundary of the closed areas. Fishing on the border of the closed area may render undetectable biomass changes within the area, even over long periods. Given the substantial number of juvenile groundfish hotspots inshore of the existing closures, displacement of effort onto inshore areas may be an important contributor to the overall impacts associated with No Action management, moreso than in the central Gulf of Maine, where there is less fishing effort overall and less of a contrast between the existing closures and other areas in terms of hotspot distributions.

Alternative 1/No Action is expected to have positive impacts on spawning groundfish via the Western Gulf of Maine Closure Area as compared to not having this management area in effect. The closure includes broad restrictions on gears capable of catching groundfish in areas with numerous spawner hotspots in the spring. The preferred modification to the Western Gulf of Maine Closure Area overlaps somewhat fewer spawner hotspots, and is therefore assumed to have slightly negative impacts relative to the area as currently designated. The action alternatives 2-6 do not restrict gears such as gillnets which could interfere with spawning activity, so the

impacts of Alternative 1 as currently configured or as preferred are expected to be positive relative to any other alternatives in this sub-region. The habitat closure does not afford any additional groundfish spawning benefits beyond those provided by the groundfish closure because it is spatially overlapping and does not restrict additional groundfish gears. The spawning benefits associated with the groundfish closure area are discussed more fully in section 2.3.1. Numerous additional spring hotspots are found inshore of the Alternative 1 areas, but to some extent, these are encompassed by seasonal closure areas.

In summary, the impacts of Alternative 1/No Action on groundfish stocks in the Gulf of Maine are slightly positive, but is unlikely to improve habitat quality associated with age 0/1 large mesh groundfish species. Impacts on juvenile groundfish habitats are likely negative relative to Alternatives 3, 4, and 5, which include either the Large or Small Bigelow Bight Areas, but positive relative to Alternative 6 and especially relative to Alternative 2. Because the measures associated with the Western Gulf of Maine Closure Area are explicitly intended to limit groundfishing activity, Alternative 1/No Action, including the preferred variation, will best protect groundfish spawning activity as compared to any other alternatives in this sub-region.

2.2.3.2 ***Alternative 2***

Alternative 2 proposes no habitat management areas for the Western Gulf of Maine sub-region. This alternative is therefore expected to have negative impacts for groundfish stocks as compared to Alternative 1/No Action, or any of the other alternatives for this sub-region. Groundfish conservation benefits would derive from other management measures such as catch limits and mesh size, and not from area closures. Under this alternative it is assumed that the existing Inshore Roller Gear Restricted Area (Alternative 7A) would continue, although it might not be explicitly recognized as a habitat protection measure and would only apply to Northeast Multispecies sector or DAS vessels. Thus, Alternative 2 and Alternative 7A would provide very similar conservation benefits. This alternative would eliminate direct protection for vulnerable groundfish habitats in the existing habitat management area, and would remove year-round limits on groundfishing in the Western Gulf of Maine Closure Area. As the existing areas overlap both juvenile and spanwer hotspots, eliminating these conservation measures could have highly negative impacts on managed large mesh groundfish relative to Alternative 1/No Action. The action alternatives 3-6 also overlap juvenile and spawner hotspots and include habitats vulnerable to fishing, such that Alternative 2 would have highly negative impacts relative to these alternatives as well.

The extent to which this alternative would negatively impact on groundfish spawning is highly dependent on the spawning management alternatives selected in the Gulf of Maine. At a minimum, Gulf of Maine Spawning Alternative 2 would maintain restrictions on gears capable of catching groundfish in the sector rolling closures, which overlap various parts of the western Gulf of Maine during April, May, and June, such that the negative impacts of year-round groundfish closure removal would be restricted to species that spawn outside the spatial and temporal windows covered by the sector rolling closures. For further discussion of this issue, see the spawning alternatives section of this section on groundfish resource impacts.

2.2.3.3 ***Alternative 3***

Alternative 3 proposes the Large Bigelow Bight HMA coupled with the Large Stellwagen HMA, the latter overlapping the southern half of the existing Western Gulf of Maine Habitat Closure Area. This is not a preferred alternative.

These two areas contain considerably more age 0/1 groundfish hotspots than areas included in Alternative 1/No Action, weighted more heavily for stocks that have low biomass and have a high affinity for coarse and hard substrates. The total weighted hotspots (Table 7) are similar to Alternative 4, but higher than Alternatives 5 and 6. (Comparison to the number of hotspots in the much larger existing or alternative roller gear management areas in Alternative 7A/7B is not appropriate because the Alternative 3 HMAs would have different and more restrictive management measures, possibly including prohibition on the use of all mobile bottom-tending gears).

Most of the age 0/1 groundfish hotspots in the Alternative 3 areas include redfish, plaice, red hake, and silver hake (Table 8). There are 19 age 0/1 cod hotspots, which is nearly the same as 16 hotspots for Alternative 1/No Action, but the 20 age 0/1 haddock hotspots is about half the Alternative 1 number (38). The number of cod hotspots is nearly the same for all of the action alternatives, except for the much larger existing (Alternative 7A) or modified (Alternative 7B) roller gear restricted areas, which encompass the large number of cod hotspots in Massachusetts Bay and west of the Western Gulf of Maine Closure Area but as noted above are not directly comparable as their management measures are very different.

Based on the number and prevalence of weighted hotspots being nearly two to three times those for Alternative 1/No Action in the spring and fall surveys, this alternative is expected to have greater conservation benefits for groundfish stocks that are at low biomass and are strongly associated with coarse and hard substrates. Therefore, the overall impact of Alternative 3 on managed large mesh groundfish is expected to be highly positive. Impacts of Alternative 3 would be positive compared to Alternative 1/No Action and most other alternatives in this sub-region. Because Alternative 4 also includes the Large Bigelow Bight HMA, impacts are likely to be similar between Alternatives 3 and 4.

It is difficult to assess the impacts of this alternative on groundfish spawning activity. On the one hand, the area would restrict trawl gears that catch groundfish in the Large Bigelow Bight HMA, but, on the other hand, restrictions on these gears would be lifted on Jeffreys Ledge, and fixed gear use could continue in the Large Bigelow Bight HMA. As discussed elsewhere in this document, Jeffreys Ledge historically had a relatively high amount of gillnet activity, which could have negative impacts on groundfish spawning in the area. Gillnet and other fixed gear fishing for groundfish could expand in the Large Stellwagen HMA as well, given that this area would be managed as a mobile bottom-tending gear closure only under Alternative 3 Options 1 and 2. Any effects would likely accrue to spring spawning stocks, as most of the large spawner hotspots in this sub-region are found in the spring. Adopting the Large Bigelow Bight and Large Stellwagen HMAs with Options 3 or 4 would lead to negative impacts on groundfish spawning, as this would allow gears capable of catching groundfish to be used throughout the sub-region. As for Alternative 2 above, any negative effects would be mitigated by the spawning management alternative selected.

2.2.3.4 ***Alternative 4***

Alternative 4 includes the Large Bigelow Bight HMA from Alternative 3, but proposes two areas (Jeffreys Ledge and Small Stellwagen) instead of one within the existing Western Gulf of Maine Habitat Closure Area. This is not a preferred alternative.

Alternative 4 areas also contain considerably more age 0/1 groundfish hotspots than areas included in Alternative 1/No Action, weighted more heavily for stocks that have low biomass and/or have a high affinity for coarse and hard substrates. The total weighted hotspots (Table 7) are similar to the totals for Alternative 3, but higher than those for Alternatives 5 and 6. As noted above, comparison to the number of hotspots in the Alternative 7A and 7B areas is not appropriate.

The hotspot species composition for Alternative 4 is similar to Alternative 3, with high numbers of hotspots for redfish, plaice, red hake, and silver hake (Table 8). The number of age 0/1 cod hotspots (19) is identical to that for Alternative 3, and similar to Alternative 1/No Action (16). There are more age 0/1 haddock hotspots in the Jeffreys Ledge area, so the number of haddock hotspots is nearly the same as Alternative 1/No Action and double that for Alternative 3.

Based on the number and prevalence of weighted hotspots being nearly 2 to 3 times those for Alternative 1/No Action in the spring and fall surveys, this alternative is expected to have greater conservation benefits for groundfish stocks that are at low biomass and/or associated with coarse and hard substrates. Therefore, the overall impact of Alternative 4 on managed large mesh groundfish is expected to be highly positive. Impacts would be positive compared to Alternative 1/No Action and other alternatives in this sub-region. Positive impacts would be similar in magnitude to Alternative 3, but could be distributed across groundfish species differently. For example, Gulf of Maine haddock appear to be more prevalent in the Jeffreys Ledge area protected by Alternative 4.

The impacts of Alternative 4 on groundfish spawning would likely be similar to those associated with Alternative 3. Mobile bottom-tending gear restrictions would be maintained on Jeffreys Ledge, but gillnet usage in this area could limit any positive impacts of this HMA on spawning groundfish.

2.2.3.5 ***Alternative 5***

The proposed HMAs in Alternative 5 (not preferred) are similar to Alternative 4 except that Alternative 5 includes a much smaller Bigelow Bight area. Alternative 5 contains fewer age 0/1 groundfish hotspots than Alternatives 3 and 4, but nearly double the total weighted hotspots for Alternative 1/No Action in the spring and fall surveys (Table 7).

Compared to Alternatives 3 and 4, Alternative 5 contains fewer age 0/1 hotspots for redfish, American plaice, red hake, silver hake, and white hake (Table 8). It has fewer redfish and haddock hotspots than Alternative 1/No Action, but more plaice hotspots. As noted above, the number of cod hotspots are nearly the same as in other alternatives. The notable exception are Alternatives 7A and 7B, where cod hotspots occur inshore of Stellwagen Bank in the spring and

on the offshore side of the Bank in the fall, but as noted previously these alternatives have different gear restrictions and are therefore not directly comparable.

Based on the number and prevalence of weighted hotspots being nearly double those for Alternative 1/No Action in the spring and fall surveys, this alternative is expected to have greater conservation benefits for groundfish stocks that are at low biomass and/or associated with coarse and hard substrates as compared to Alternative 1/No Action. However, Alternative 5 includes roughly one-fourth of the weighted hotspots identified in areas associated with Alternatives 3 and 4. Thus, Alternative 5 is likely to have negative impacts on age 0/1 juvenile groundfish habitat and on the groundfish resource relative to Alternatives 3 and 4.

The impacts of Alternative 5 on groundfish spawning would likely be similar to those associated with Alternatives 3 and 4. Mobile bottom-tending gear restrictions would be maintained on Jeffreys Ledge, but gillnet usage in this area could limit any positive impacts of this HMA on spawning groundfish. Although recreational gears are not prohibited under Alternative 1/No Action, restrictions on other gears capable of catching groundfish associated with the Western Gulf of Maine Closure Area are better suited towards protecting spawning activities.

2.2.3.6 ***Alternative 6***

This alternative, which is not preferred, proposes only one area, the Large Stellwagen HMA, which is a subset of the existing Western Gulf of Maine Habitat Closure Area. It is similar to Alternative 3, but does not include either of the Small or Large Bigelow Bight HMA, both of which contain many weighted hotspots. This alternative has the lowest amount of total weighted hotspots as any alternative in the western Gulf of Maine (Table 7), including Alternative 1/No Action. This alternative has fewer age 0/1 hotspots than any other alternative, including Alternative 1/No Action, for redfish, plaice, cod, haddock, red hake, silver hake, white hake, and winter flounder (Table 8).

Based on the number and prevalence of weighted hotspots being a third to a half of those for Alternative 1/No Action in the spring and fall surveys, this alternative is expected to have considerably fewer conservation benefits for groundfish stocks that are at low biomass and/or associated with coarse and hard substrates, i.e. impacts on the resource would be slightly positive. Therefore, compared to Alternative 1 (No Action) and other alternatives in this sub-region, the overall impact of Alternative 6 on managed large mesh groundfish is expected to be negative.

It should be noted however that the analysis in Section 0 shows that age 2+ sub-legal juvenile cod are present further offshore than for age 0/1 cod. The distribution of these older codfish has substantial overlap with the Large Stellwagen Bank HMA. To the extent that cod between 25 and 55 cm (about 10 to 22 inches)[6] rely on coarse and hard substrates for survival and growth, this alternative would likely maintain important conservation benefits for Gulf of Maine cod.

[6] The minimum legal limit for cod was 22 inches from Aug 1, 2002 to Aug 29, 2013.

Similar to alternatives 2, 3, 4, and 5, this alternative would likely have negative impacts on spawning groundfish as the Western Gulf of Maine Closure Area protections would be eliminated. Compared to Alternatives 4, and 5, there would not be closures in the Jeffreys Ledge area that would protect groundfish spawning through restrictions on mobile bottom-tending gear, and fixed gears could be fished on Jeffreys Ledge area due to removal of the year-round groundfish closure. In addition, any spawning protection benefits afforded by the Large or Small Bigelow Bight restrictions on mobile bottom-tending gears would not be realized under Alternative 6.

2.2.3.7 ***Alternative 7A and 7B (Preferred alternative, Option A)***

This alternative adapts the Inshore Roller Gear Restricted Area to recognize its potential habitat conservation benefits. As a preferred alternative it is considered to be a management measure integrated with Alternative 1 which retains the Western Gulf of Maine Habitat Closure and the Western Gulf of Maine Groundfish Closure Area. Under either alternative 7A or 7B, all vessels using trawls to target any species would be required to use rollers no larger than a 12” diameter. This measure differs from No Action, because the existing roller gear restriction applies only to sector vessels and vessels on a day-at-sea (including vessels using a day-at-sea to target skates and monkfish). However, adopting this measure for all trawl vessels will probably not represent a substantial change in roller gear configuration, since the non-groundfish trawl fishing in this region is dominated by shrimp and other small-mesh trawlers, who generally already use rollers smaller than 12”.

According to fishermen, vessels with low to moderate horsepower are restricted to areas with softer bottoms and sand when they use nets with smaller roller gear than used outside of the 12” roller gear restriction area. Fishermen also report that high horsepower vessels are able to fish the harder bottoms within the 12” roller gear restricted area, despite the restriction. Vessels with higher horsepower are more able to pull through the harder bottom and are therefore not as constrained by the roller gear restriction.

Although not summarized by vessel horsepower, there is some indication in the observer data that vessels using certain types of trawls in the restricted roller gear area fish in areas having fewer coarse and hard substrates. Map 12 shows the geographic distribution of observed trawl hauls between 2012 and 2014 compared to the existing restricted roller gear area, outlined by a green border, and the Alternative 7B area, which is hatched. These tows are overlaid on the SASI dominant sediment map, which mud and sand shown in lighter shading and gravels shown in darker shading. Boulder ridges and areas identified as rock or bedrock are mapped in reds.

It appears from the map that there are fewer tows overlapping boulder ridge habitats on and around Stellwagen Bank, and the rocky inshore habitats have limited trawl fishing activity overall, likely oweing the restrictions on fishing in state waters. However, inferring effort according to habitat type is challenging because both fishing effort and substrate maps are not finely resolved spatially. Observed hauls are plotted using beginning and ending haul locations, which could miss the fine scale changes in tow direction to avoid these harder substrates. Also, the local spatial accuracy of the substrate map is relatively uncertain in the western Gulf of Maine region, given the underlying data (see the physical environment description in Volume 1 for details).

Because Alternative 7A encompasses a much bigger area, which overlaps Massachusetts and Cape Cod Bays where the IBS cod and winter trawl surveys have taken place, the total number of age 0/1 weighted groundfish hotspots is considerably higher than any other alternative (Table 7), including five to ten times the number for Alternative 1/No Action. It includes far more age 0/1 hotspots than Alternative 1 and most other alternatives for redfish, alewife, plaice, cod, haddock, ocean pout, pollock, red hake, silver hake, winter flounder, witch flounder, and yellowtail flounder (Table 8).

Because it covers a larger area containing more juvenile groundfish habitat as compared to the other alternatives in this sub-region, if this measure were as effective as a mobile bottom-tending gear closure area in reducing the use of mobile bottom-tending gears on vulnerable substrates, it could be more effective than the other alternatives at reducing adverse impacts to age 0/1 juvenile groundfish habitat associated with vulnerable substrates. While there is some evidence for avoidance of hard substrates within the roller gear area, it is unlikely to prevent fishing on vulnerable seafloor types. Identifying this roller gear requirement as a habitat measure is unlikely to change their fishing behavior to avoid areas of harder substrates, and therefore will not improve groundfish habitat. Thus, relying solely on an expanded roller gear restriction in the area is likely have highly negative impacts on groundfish habitat, compared to Alternative 1/No Action, which closes a large area of vulnerable substrates to mobile bottom-tending gear fishing. As a complementary measure to mobile bottom-tending gear closure area, this alternative is likely to have slightly positive benefits as compared to the existing implementation of the roller gear restricted area because additional gears would be included

Alternative 7B proposes a smaller area than Alternative 7A as a restricted gear area to protect vulnerable habitat. The existing roller gear area would remain in place and apply to Northeast Multispecies vessels, so the difference is that Alternative 7B would extend the roller gear restriction to the northeast off the central Maine coastline in Federal waters and apply the restriction to all trawl vessels. Implementing both areas simultaneously but applying them to different gears could be somewhat confusing.

The area encompassed by this alternative contains fewer age 0/1 weighted groundfish hotspots (Table 7) than Alternative 7A, but more than Alternative 1/No Action. This is true for redfish, plaice, cod, haddock, red hake, silver hake, winter flounder, and yellowtail flounder (Table 8). Compared to Alternative 7A, there are more hotspots for alewife and monkfish due to the proposed northeast extension of the existing restricted roller gear area (Table 8).

Similar to Alternative 7A, it does not appear that requiring 12” or less diameter roller gear in a smaller area of the western Gulf of Maine will change fishing behavior to avoid areas with vulnerable habitat. Compared to Alternative 1/No Action which prohibits fishing with mobile bottom-tending gear in an area that has vulnerable groundfish habitat, this alternative is likely to have a highly negative impact on groundfish habitat if it were implemented as a stand-alone measure. As a complementary measure to mobile bottom-tending gear closure area, this alternative is likely to have slightly positive benefits as compared to the existing implementation of the roller gear restricted area because it would extend the 12” restriction into the northernmost portions of the Large Bigelow Bight area.

Either of these alternatives is expected to have neutral impacts on spawning groundfish, as these alternatives maintain or modify a trawl gear restriction only.

2.2.3.8 ***Alternative 8 (Preferred alternative)***

Alternative 8 would allow shrimp trawl vessels to fish within the northwest corner of the Western Gulf of Maine Habitat Closure Area. Shrimp trawls are estimated to have an equivalent impact per unit area swept on vulnerable substrates to groundfish and other trawls (see seabed vulnerability section of Volume 1 and Appendix D). However, the fishery is conducted during a short winter season, often four to six weeks depending on how long it takes to catch the annual quota, and effort tends to occur on softer substrates given the distribution of northern shrimp. Although shrimp fishing may cause some damage to these soft sediment habitats, the short season allows for some recovery during the remainder of the year.

Furthermore, during the spring and fall, the exemption area accounts for a very small number of age 0/1 juvenile groundfish hotspots. There were 20.3 total weighted hotspots in the exemption area in the spring vs. 261.1 in the Western Gulf of Maine Habitat Closure. In the fall, the area accounted for 33.8 weighted hotspots vs. 265.2 for the larger habitat closure. The shrimp exemption area in the summer accounted for a high fraction of total weighted age 0/1 groundfish hotspots, 94.6 vs. 128.4, although most of this hotspots value arises from presence of age 0/1 redfish and American plaice. The summer shrimp survey tows do appear to cover areas of harder substrates.

Thus the impacts of the shrimp fishery on age 0/1 juvenile groundfish habitat in the proposed exemption area are likely to be minimal and temporary. Also, allowing shrimp fishing in this exemption area may also spread some fishing effort out away from adjacent areas where age 0/1 groundfish hotspots and hard and coarse substrates are more prevalent. The distribution of effort in the shrimp fishery is also influenced by timing within the season, as the shrimp move from inshore to offshore from winter to summer.

In summary, the fraction of age 0/1 juvenile groundfish habitat affected by this alternative (low in the spring and fall, high in the summer for redfish and American plaice) coupled with the potential for spreading out shrimp fishing effort away from areas inshore along coastal New Hampshire and Maine suggests that the impacts on age 0/1 juvenile groundfish habitat and on the groundfish stock by Alternative 8 would be slightly positive.

This alternative likely has a neutral or very slightly negative impact on groundfish spawning relative to Alternative 1/No Action. While shrimp trawl gears have low groundfish bycatch rates, the use of these trawls could disrupt spawning activity, and the exemption area does contain large spawner hotspots in the spring. However, the magnitude of shrimp trawling in the exemption areas is likely to be low, especially in the short term, which mitigates any negative effects.

2.2.4 Georges Bank

Tables and maps for the Georges Bank sub-region are provided below. In the tables, any spatial overlaps between management areas were accounted for so that there was no double counting of

hotspots for the combined alternatives. Red and silver hake are not large mesh species and were not included in the weighted hotspot analysis, but their unweighted hotspots are listed in the table of hotspots by species.

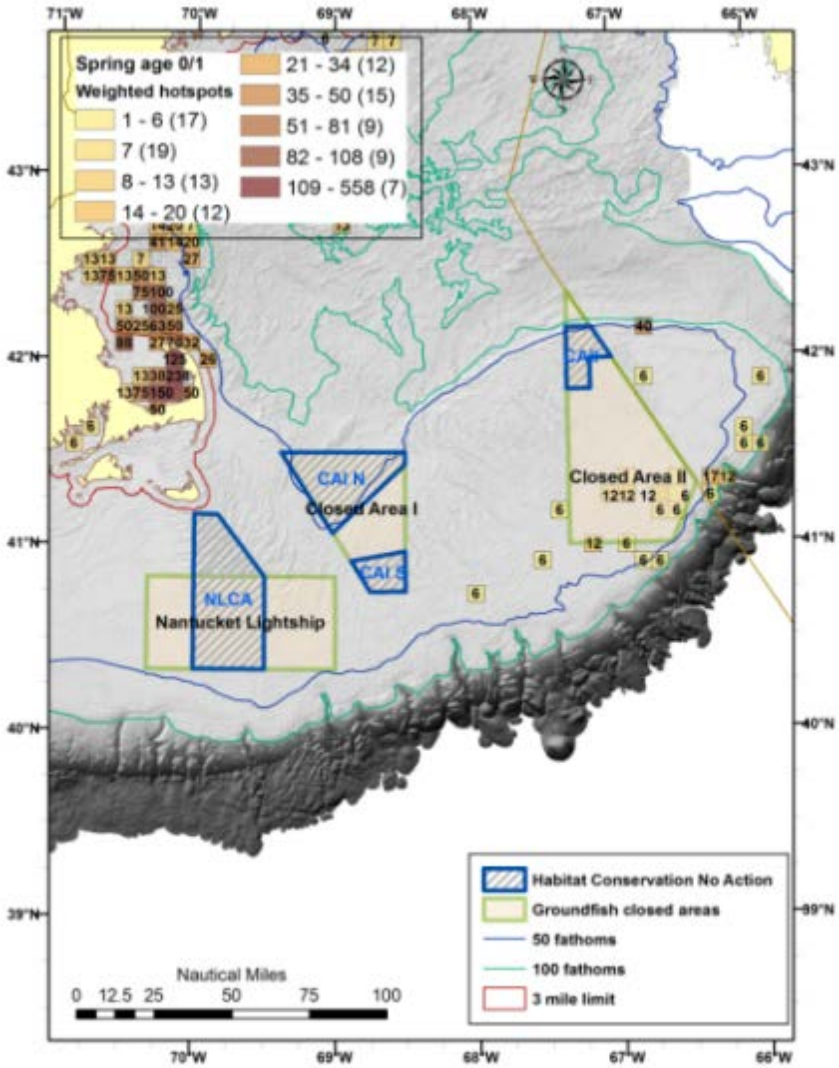
Table 9 – GB: Total unweighted and weighted age 0/1 juvenile large mesh groundfish hotspots, by season. Individual areas are listed first, followed by combined alternatives.

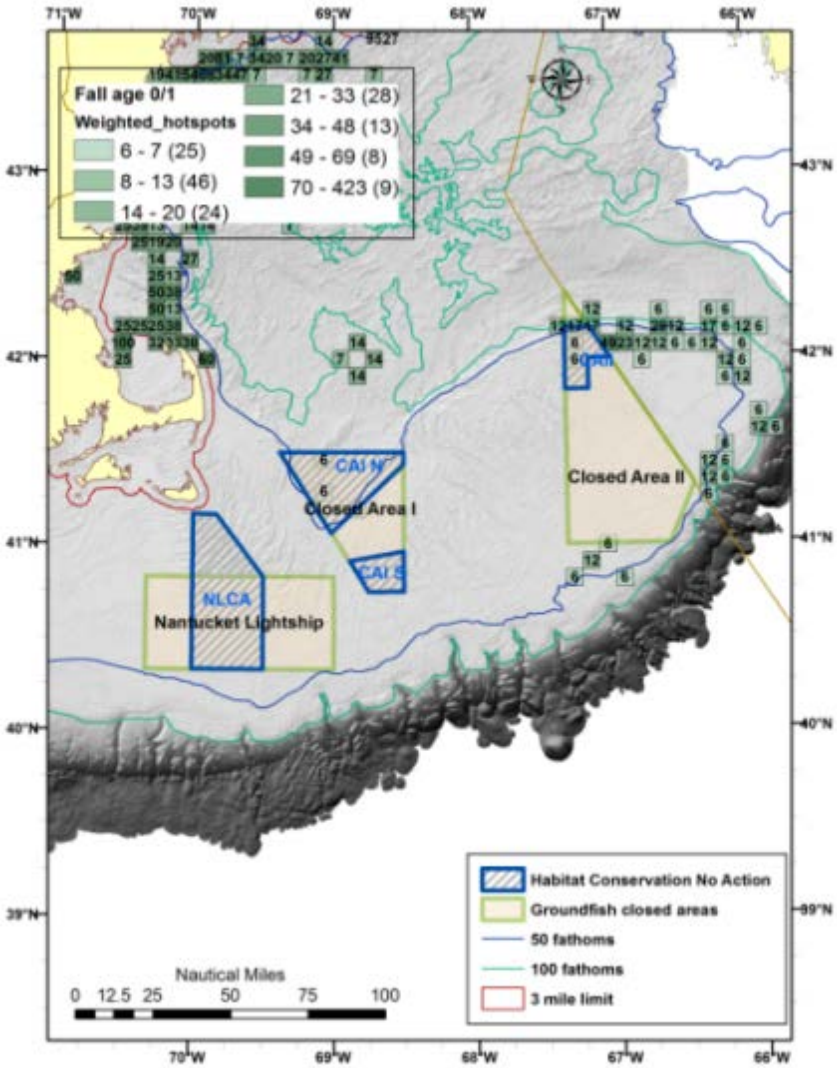
Area name (Alternative)	Spring		Summer		Fall		Winter	
	Number	Weighted	Number	Weighted	Number	Weighted	Number	Weighted
CAI (1)	0	0.00	0	0.00	35	17.25	0	0.00
CAI N Habitat Closure (1)	0	0.00	0	0.00	10	11.50	0	0.00
CAI S Habitat Closure (1)	0	0.00	0	0.00	0	0.00	0	0.00
CAII (1)	11	63.25	39	195.50	16	28.75	0	0.00
CAII Habitat Closure (1)	0	0.00	5	0.00	4	11.50	0	0.00
Northern Edge (3. 4)	0	0.00	0	0.00	8	34.50	0	0.00
Georges Shoal GMA (4)	0	0.00	1	0.00	4	0.00	0	0.00
Northern Georges GMA (5)	6	0.00	15	0.00	33	11.50	0	0.00
Georges Shoal 1 MBTG (5)	0	0.00	0	0.00	0	0.00	0	0.00
EFH Expanded 1 (6A)	0	0.00	13	0.00	12	11.50	0	0.00
EFH Expanded 2 (6B)	0	0.00	13	0.00	10	5.75	0	0.00
Georges Shoal 2 MBTG (7, 10)	0	0.00	0	0.00	1	0.00	0	0.00
EFH South MBTG (7)	0	0.00	1	0.00	0	0.00	0	0.00
Northern Georges MBTG (8)	6	0.00	15	0.00	35	40.25	0	0.00
Western (9)	0	0.00	1	0.00	7	0.00	0	0.00
Eastern (9)	0	0.00	5	0.00	2	5.75	0	0.00
Mortality (9)	0	0.00	2	0.00	3	5.75	0	0.00
N. Edge MBTG (10)	0	0.00	5	0.00	2	5.75	0	0.00
N. Edge Reduced Impact (10)	0	0.00	2	0.00	3	5.75	0	0.00
Alternative 1	11	63.25	39	195.50	51	46.00	0	0.00
Alternative 3	0	0.00	0	0.00	8	34.50	0	0.00
Alternative 4	0	0.00	1	0.00	12	34.50	0	0.00
Alternative 5	6	0.00	15	0.00	33	11.50	0	0.00
Alternative 6A	0	0.00	13	0.00	12	11.50	0	0.00
Alternative 6B	0	0.00	13	0.00	10	5.75	0	0.00
Alternative 7	0	0.00	1	0.00	1	0.00	0	0.00
Alternative 8	6	0.00	15	0.00	35	40.25	0	0.00
Alternative 9	0	0.00	8	0.00	12	11.50	0	0.00
Alternative 10 (preferred)	0	0.00	7	0.00	6	11.50	0	0.00

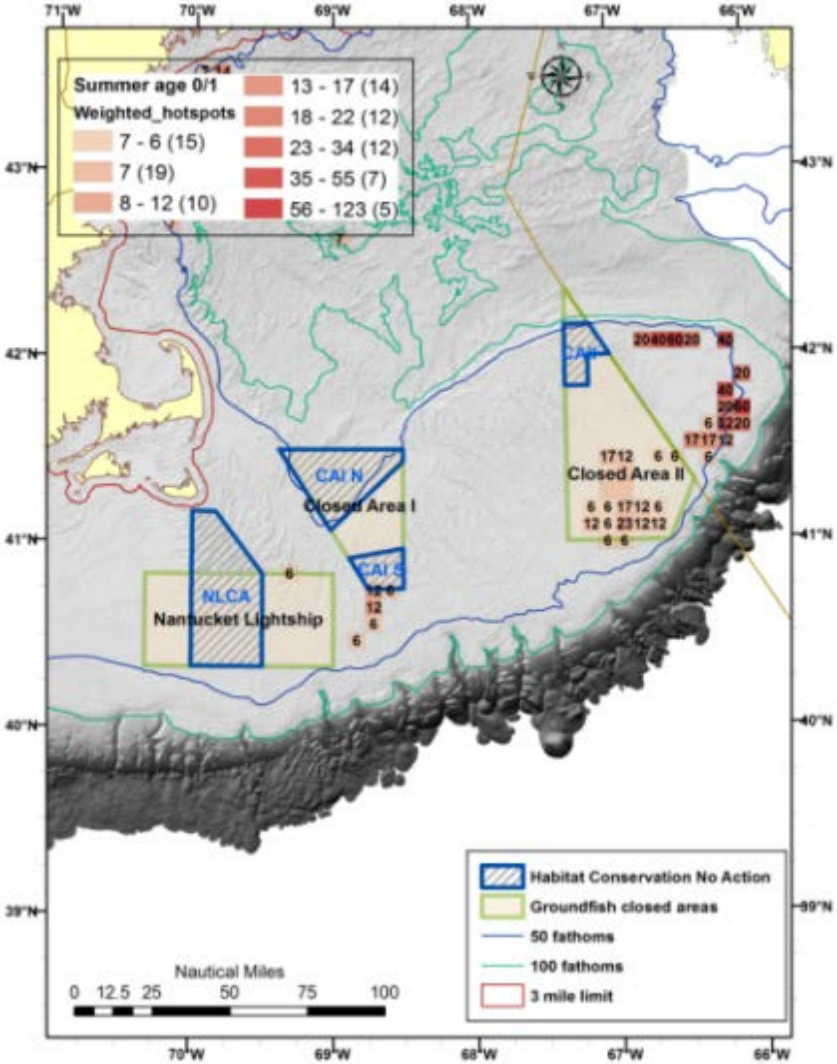
Table 10 – GB: Age 0/1 juvenile large mesh groundfish hotspots by species. All seasons are combined. There were no hotspots for redfish, cod, halibut, ocean pout, pollock, white hake, or witch flounder in any of the Georges Bank HMAs. Individual areas are listed first, followed by combined alternatives.

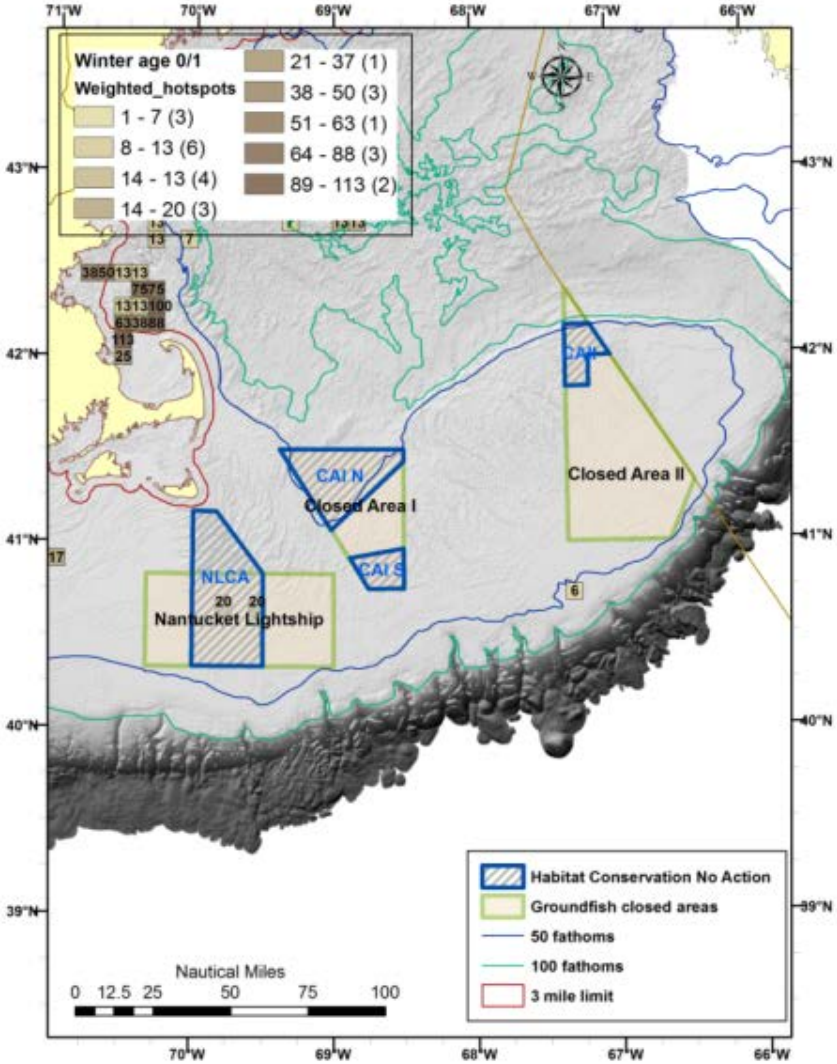
Area name (Alternative)	Am. Plaice	Haddock	Windowpane	Winter Fl.	Yellowtail fl.	Red hake	Silver hake
CAI (1)	1	3	0	0	0	23	8
CAI N Habitat (1)	1	2	0	0	0	7	
CAI S Habitat (1)	0	0	0	0	0		
CAII (1)	0	50	1	5	0	10	
CAII Habitat (1)	0	2	0	5	0	2	
Northern Edge (3, 4)	0	6	0	0	0	2	
Georges Shoal GMA (4)	0	0	0	0	1	4	
Georges Shoal 1 MBTG (5)	0	0	0	0	0		
Northern Georges GMA (5)	0	2	2	14	1	34	1
EFH Expanded 1 (6A)	0	2	1	13	0	9	
EFH Expanded 2 (6B)	0	1	1	13	0	8	
Georges Shoal 2 MBTG (7, 10)	0	0	0	0	0	1	
EFH South MBTG (7)	0	0	0	1	0		
Northern Georges MBTG (8)	0	7	2	14	1	32	
Western MBTG (9)	0	0	0	0	1	7	
Eastern MBTG (Alt 9)	0	1	0	5	0	1	
Mortality closure (9)	0	1	0	2	0	2	
N. Edge MBTG (Alt 10)	0	1	0	5	0	1	
N. Edge Reduced Impact (10)	0	1	0	2	0	2	
Alternative 1	1	53	1	5	0	33	8
Alternative 3	0	6	0	0	0	2	
Alternative 4	0	6	0	0	1	2	
Alternative 5	0	2	2	14	1		1
Alternative 6A	0	2	1	13	0	9	
Alternative 6B	0	1	1	13	0	8	
Alternative 7	0	0	0	1	0	1	
Alternative 8	0	7	2	14	1	32	
Alternative 9	0	2	0	7	1	10	
Alternative 10	0	2	0	7	0	4	

Map 15 – Georges Bank Alternative 1 overlap with spring (left), fall (right), summer (left on next page), and winter (right on next page) total weighted age 0/1 groundfish hotspots from 2002-2012 NEFSC trawl and summer dredge survey data.

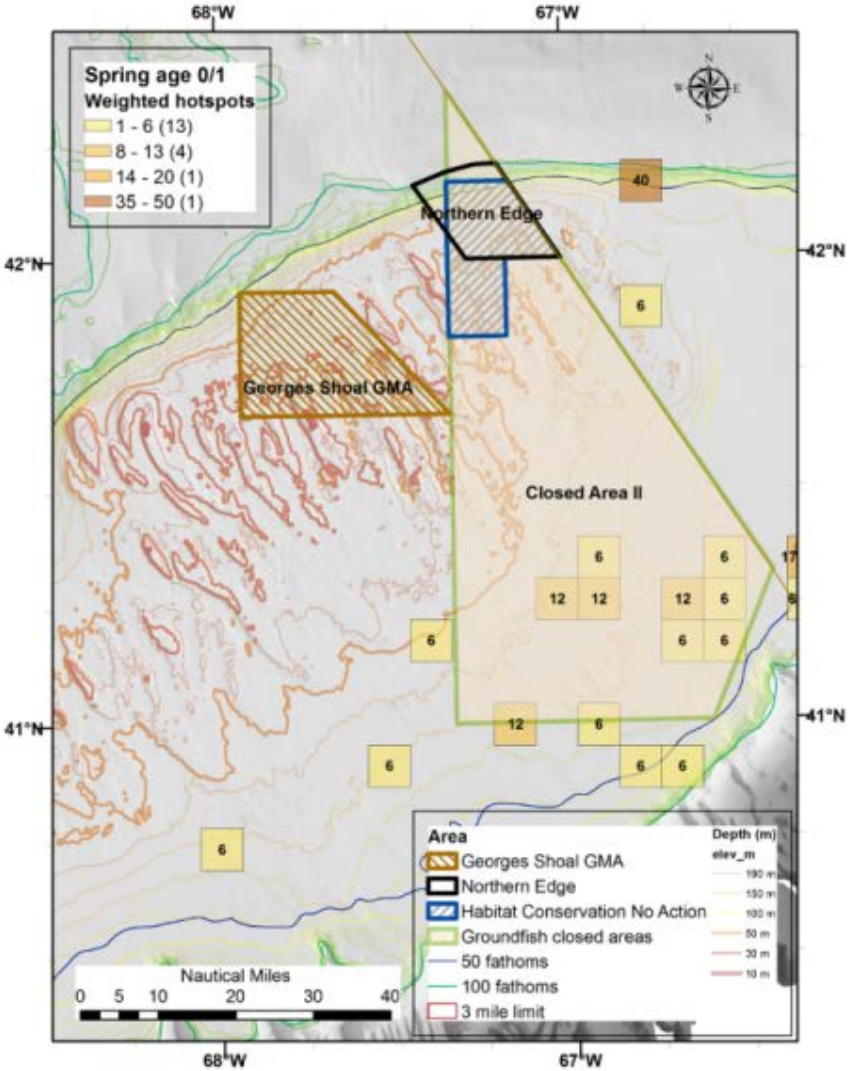


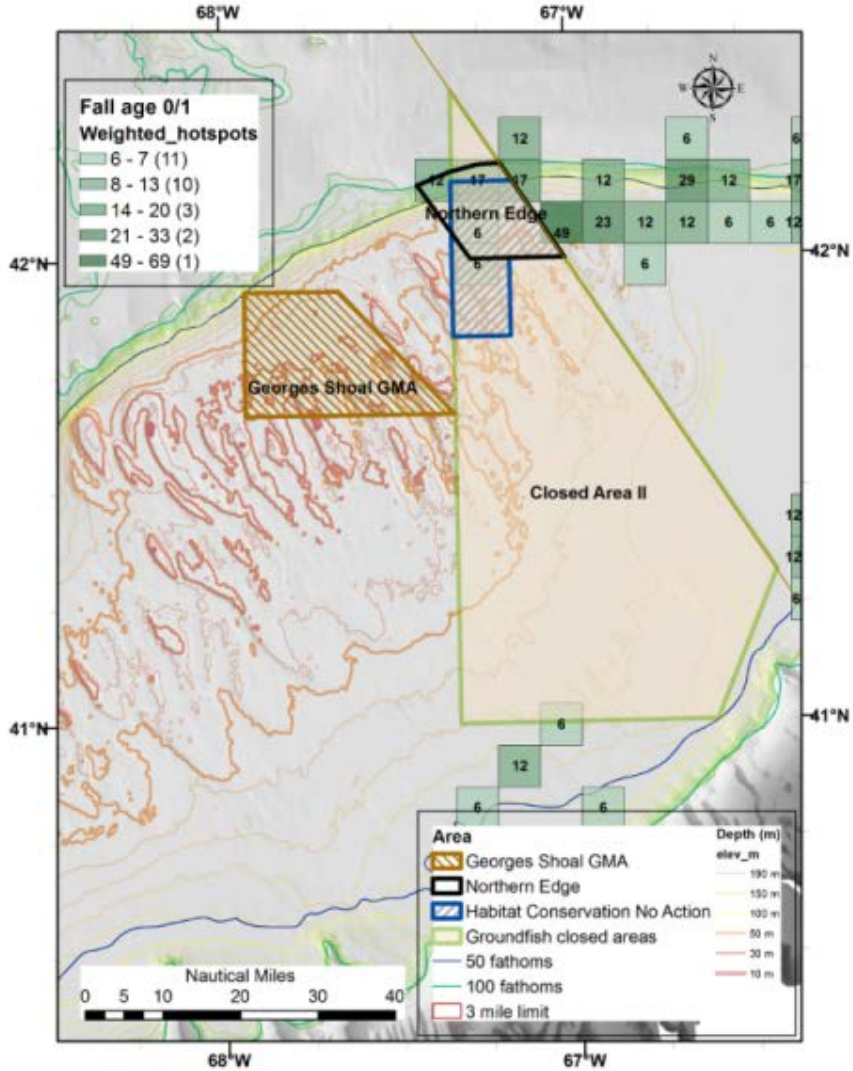


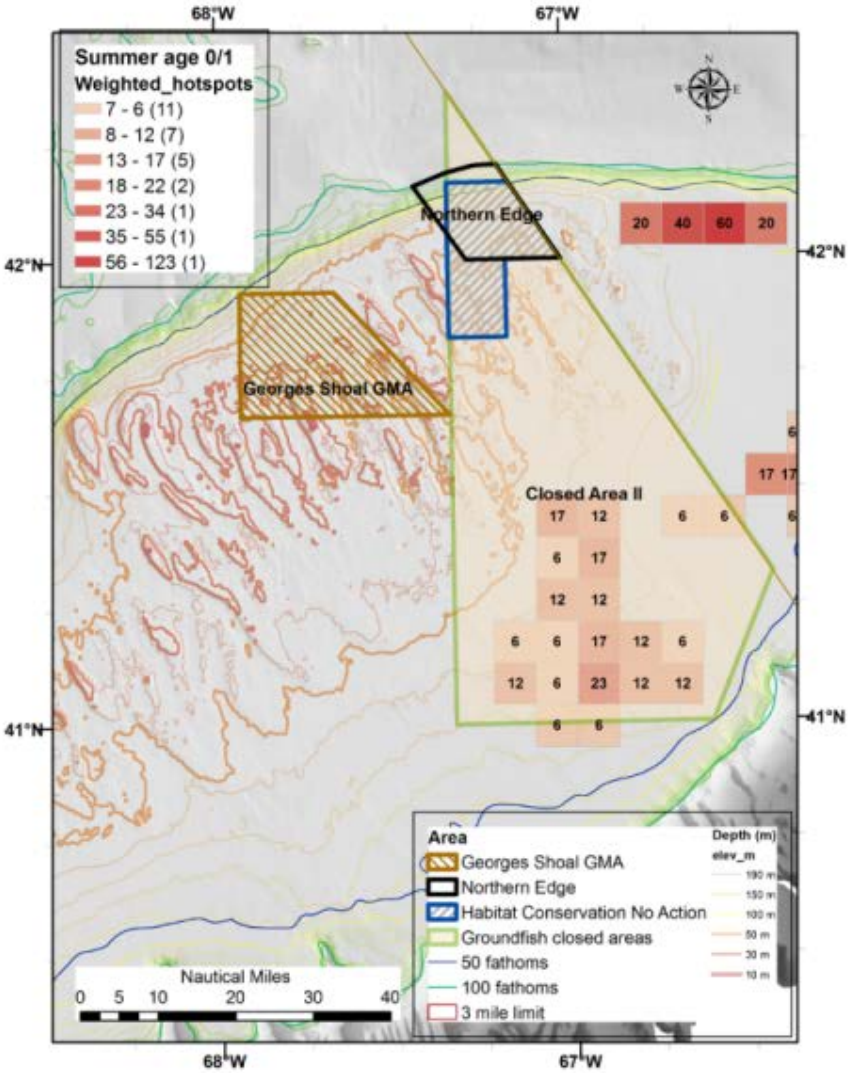

Summer age 0/1
Weighted_hotspots
7 - 6 (15)
7 (19)
8 - 12 (10)
13 - 17 (14)
18 - 22 (12)
23 - 34 (12)
35 - 55 (7)
56 - 123 (5)
CAI N
Closed Area I
CAI S
Closed Area II
NLCA
Nantucket Lightship
Habitat Conservation No Action
Groundfish closed areas
50 fathoms
100 fathoms
3 mile limit
Nautical Miles
0 12.5 25 50 75 100

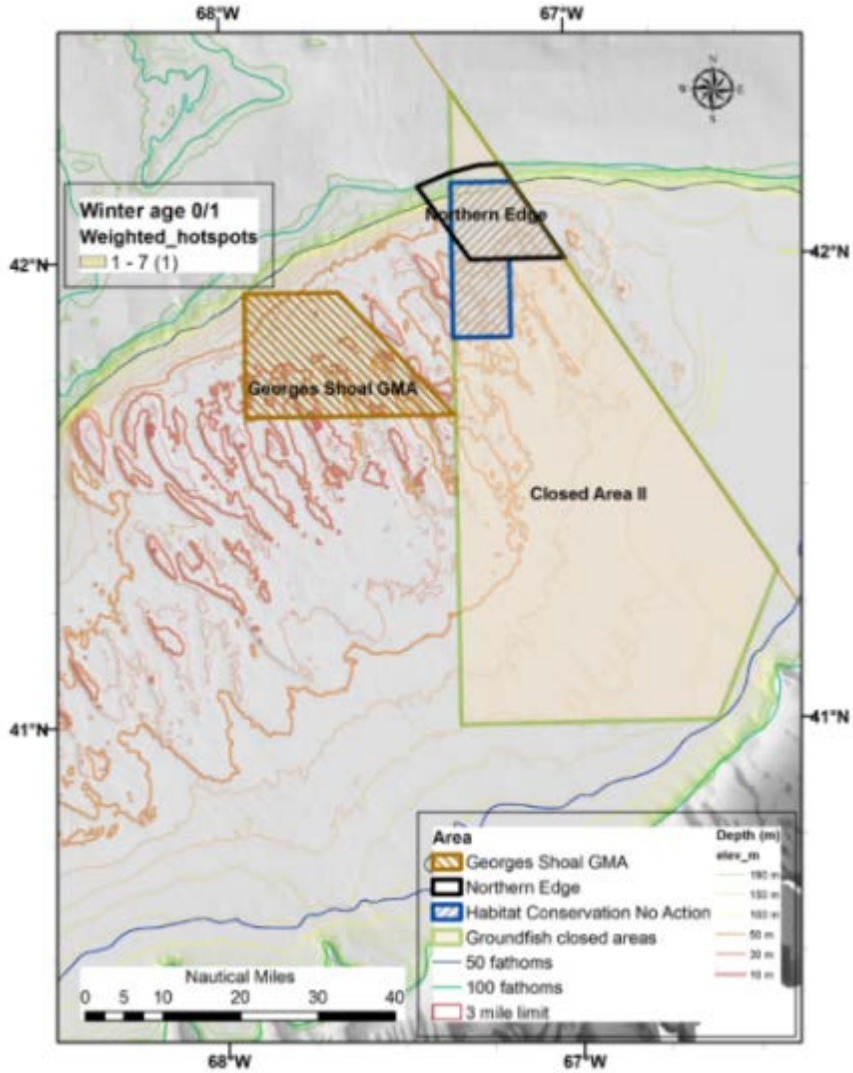

Winter age 0/1
Weighted_hotspots
1 - 7 (3)
8 - 13 (6)
14 - 13 (4)
14 - 20 (3)
21 - 37 (1)
38 - 50 (3)
51 - 63 (1)
64 - 88 (3)
89 - 113 (2)
CAI N
Closed Area I
CAI S
Closed Area II
NLCA
Nantucket Lightship
Habitat Conservation No Action
Groundfish closed areas
50 fathoms
100 fathoms
3 mile limit
Nautical Miles
0 12.5 25 50 75 100

Map 16 – Georges Bank Alternatives 3 and 4 overlap with spring (left), fall (right), summer (left on next page), and winter (right on next page) total weighted age 0/1 groundfish hotspots from 2002-2012 NEFSC trawl and summer dredge survey data. Alternative 3 includes the Northern Edge only, while Alternative 4 includes both the Northern Edge and the Georges Shoal GMA.

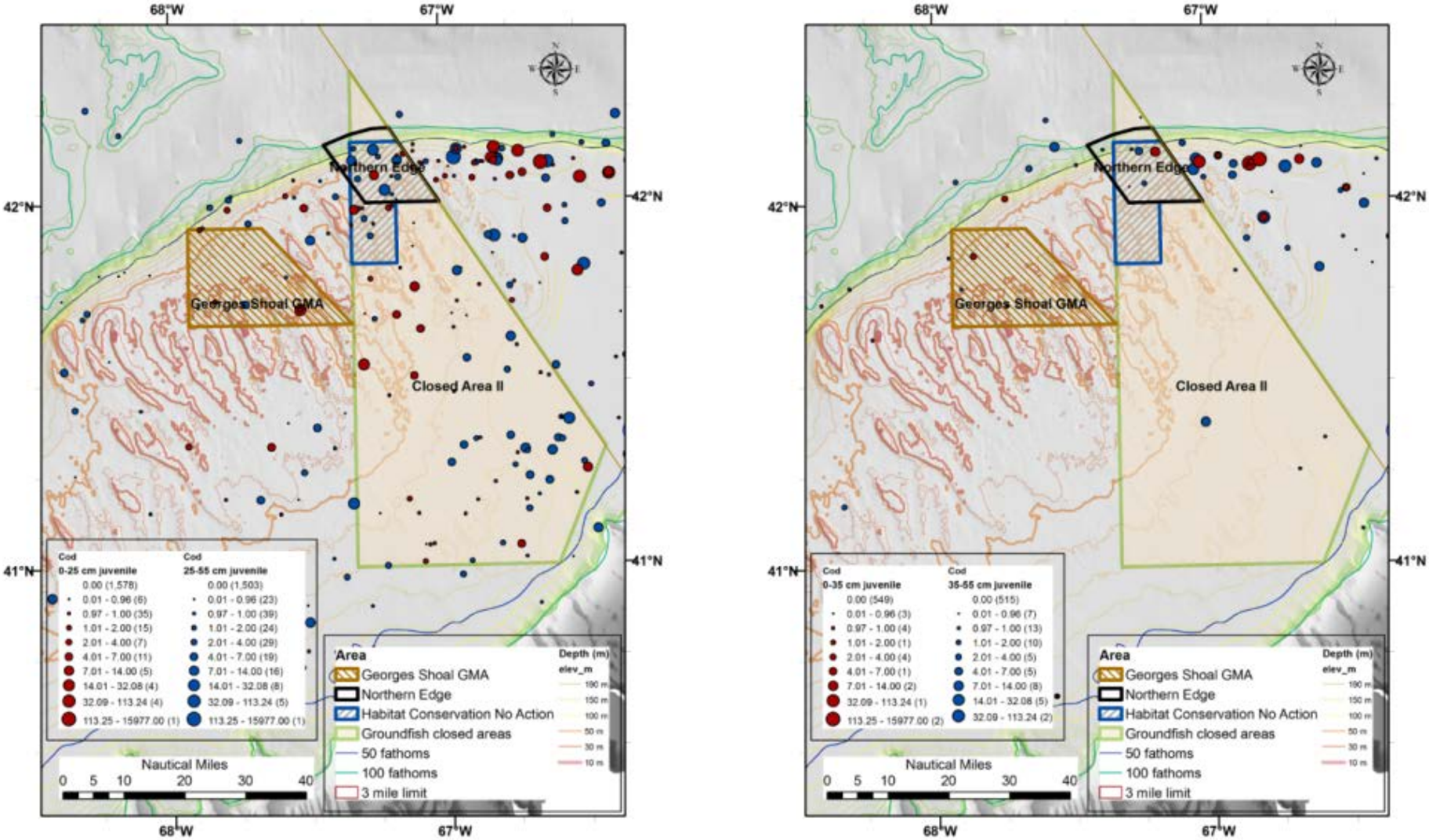




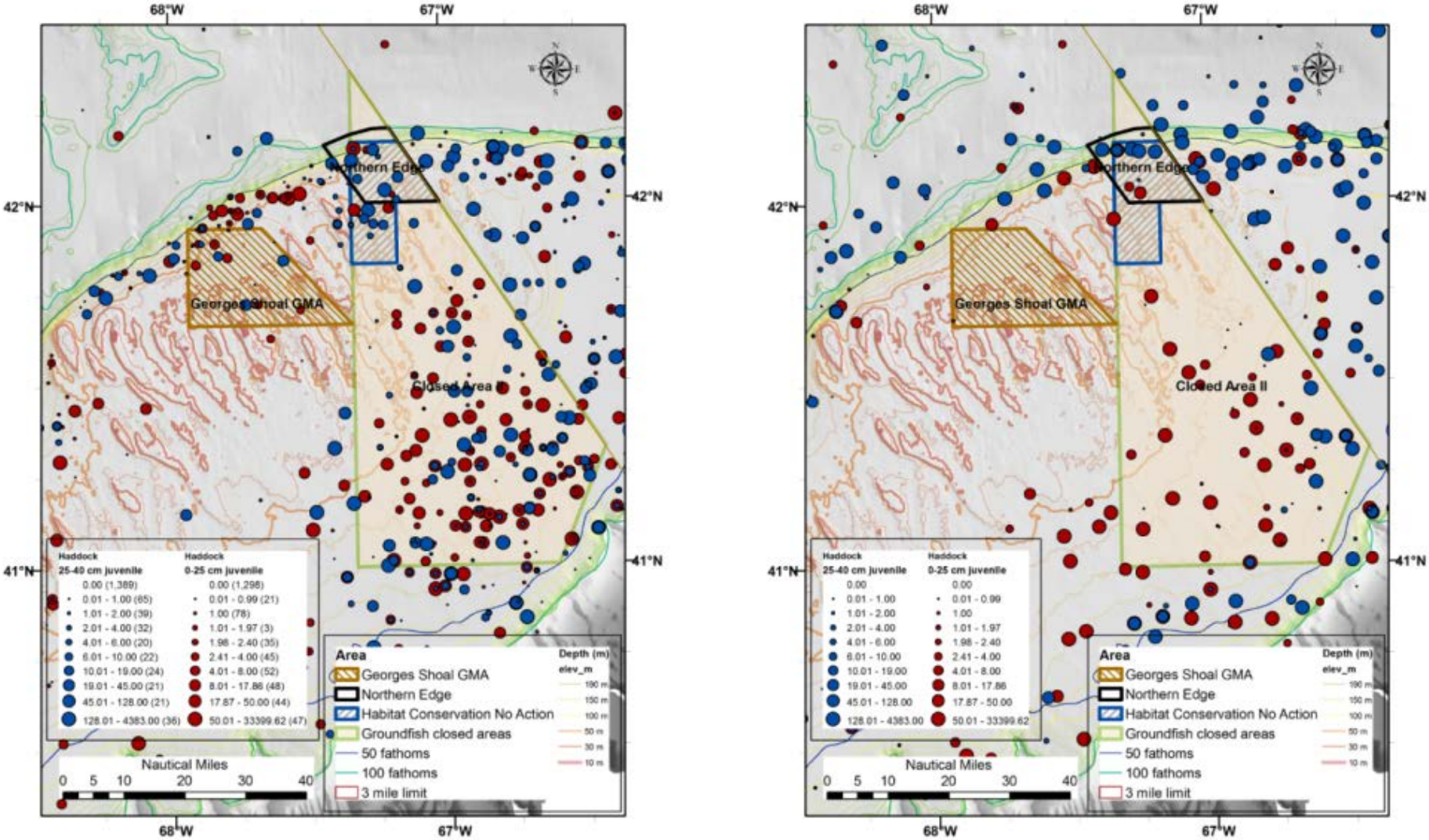

Summer age 0/1
Weighted_hotspots
7 - 6 (11)
8 - 12 (7)
13 - 17 (5)
18 - 22 (2)
23 - 34 (1)
35 - 55 (1)
56 - 123 (1)
Northern Edge
Georges Shoal GMA
Closed Area II
68°W
67°W
42°N
41°N
Area
Georges Shoal GMA
Northern Edge
Habitat Conservation No Action
Groundfish closed areas
50 fathoms
100 fathoms
3 mile limit
Depth (m)
Nautical Miles
0 5 10 20 30 40


Winter age 0/1
Weighted_hotspots
1 - 7 (1)
Northern Edge
Georges Shoal GMA
Closed Area II
68°W
67°W
42°N
41°N
Area
Georges Shoal GMA
Northern Edge
Habitat Conservation No Action
Groundfish closed areas
50 fathoms
100 fathoms
3 mile limit
Depth (m)
Nautical Miles
0 5 10 20 30 40

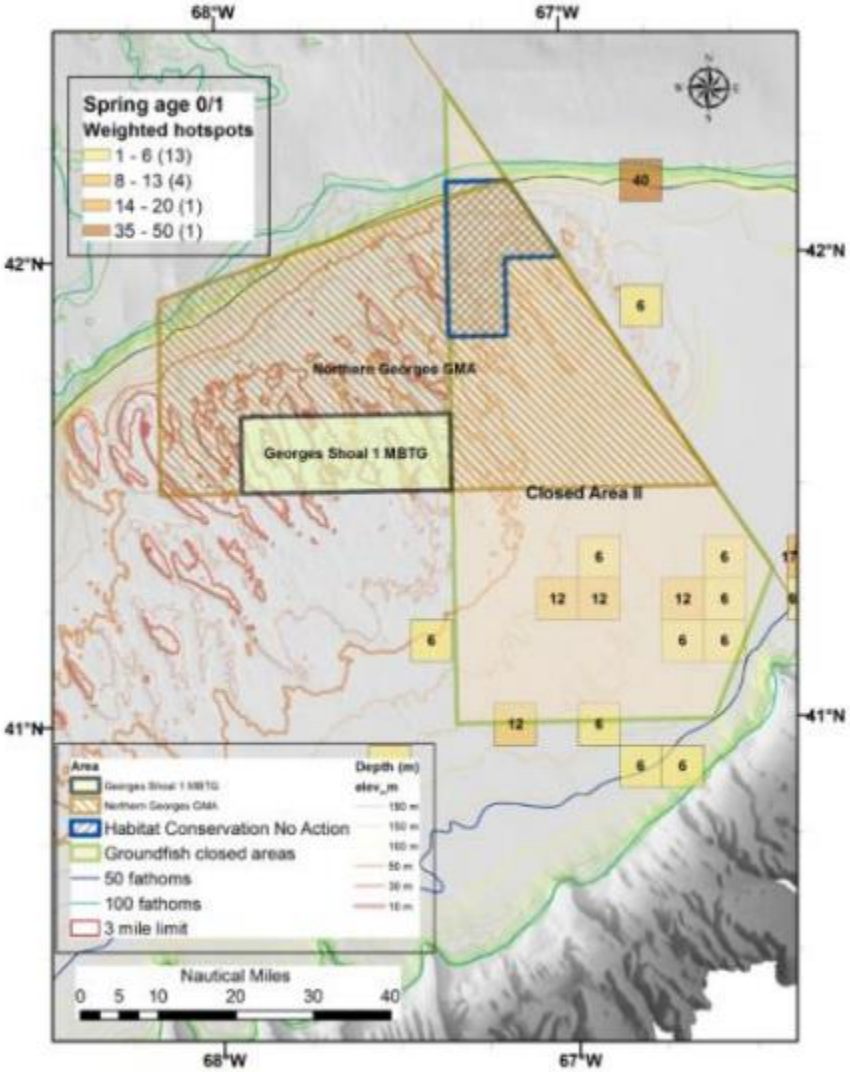
Map 17 – Overlap of GB Alternatives 3 and 4 with distributions of sub-legal cod number per tow for age 0/1 and age 2+ size classes in 2002-2012 NMFS surveys. Left panel – spring and summer. Right panel – fall and winter.

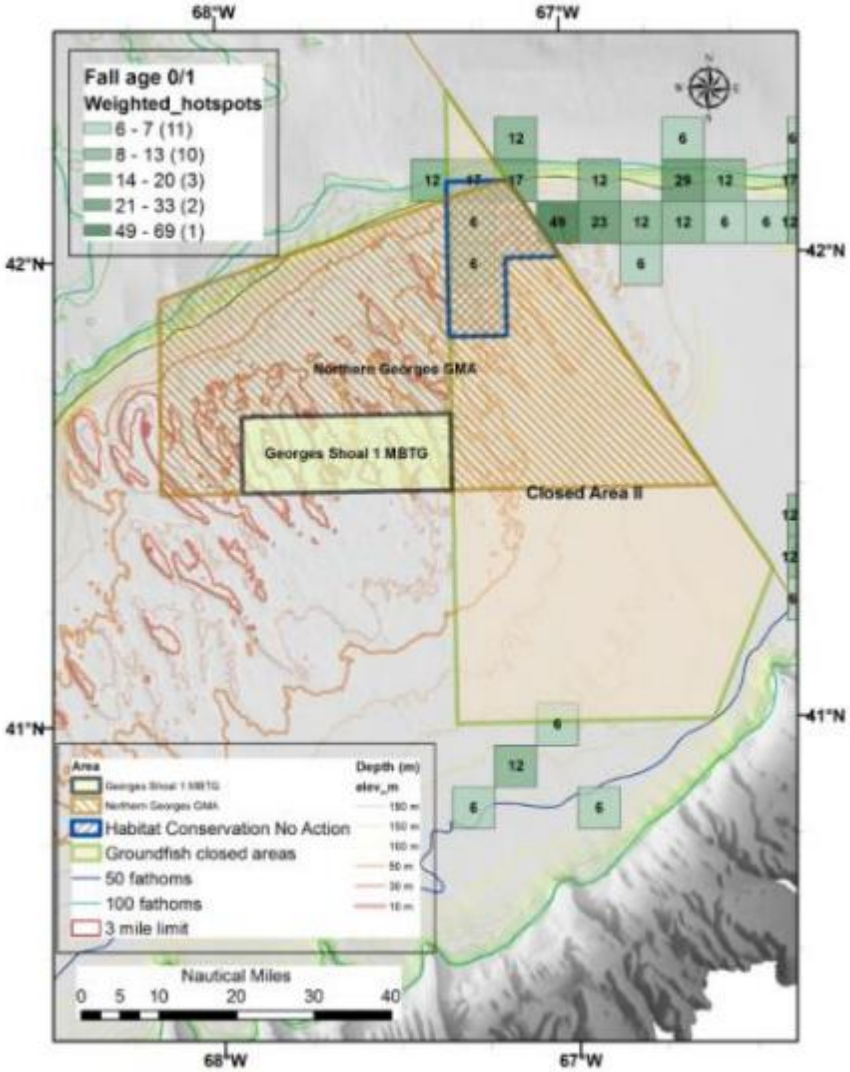


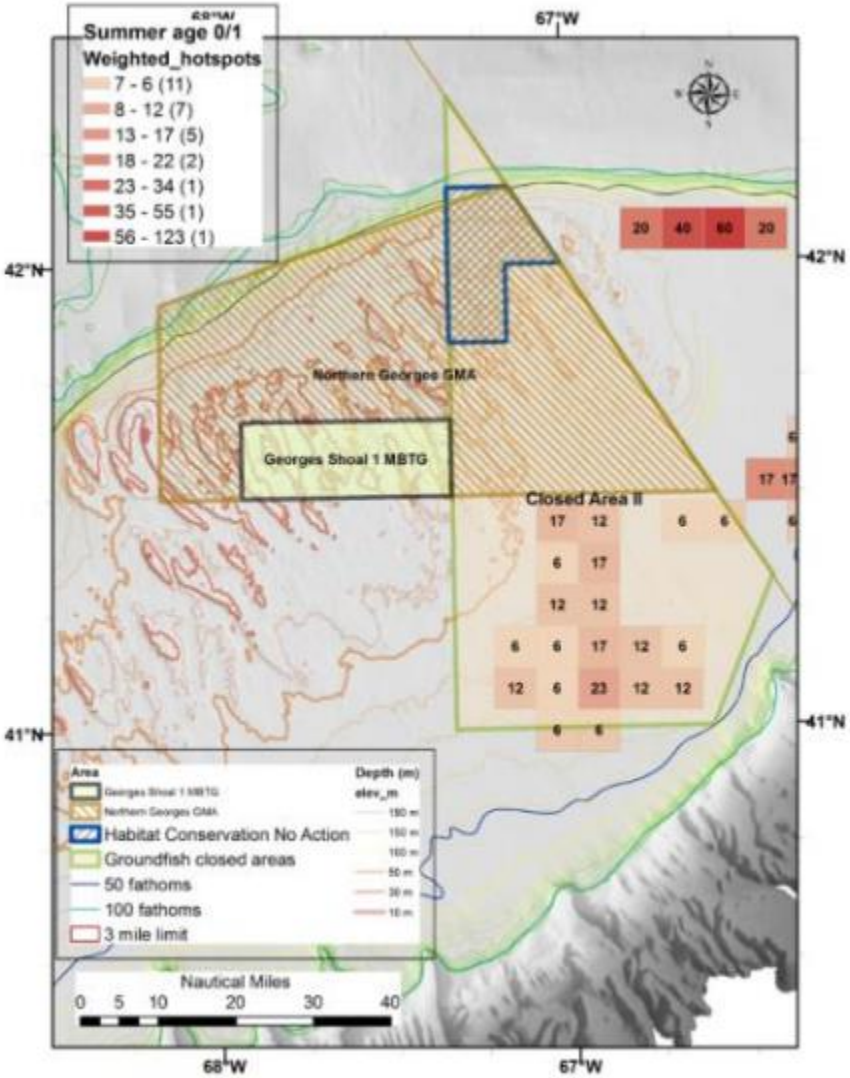
Map 18 – Overlap of GB Alternatives 3 and 4 with distributions of sub-legal haddock number per tow for age 0/1 and age 2+ size classes in 2002-2012 NMFS surveys. Left panel – spring and summer. Right panel – fall and winter.

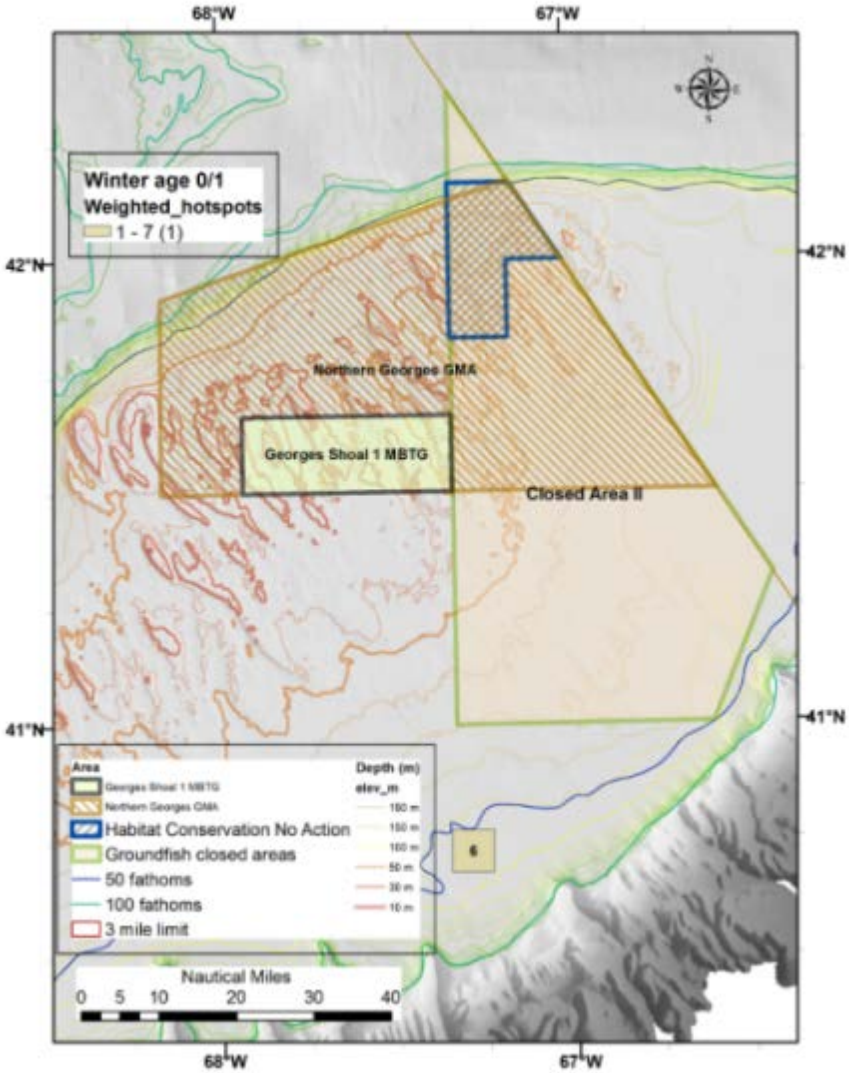


Map 19 – Georges Bank Alternative 5 overlap with spring (left), fall (right), summer (left on next page), and winter (right on next page) total weighted age 0/1 groundfish hotspots from 2002-2012 NMFS trawl and summer dredge survey data.

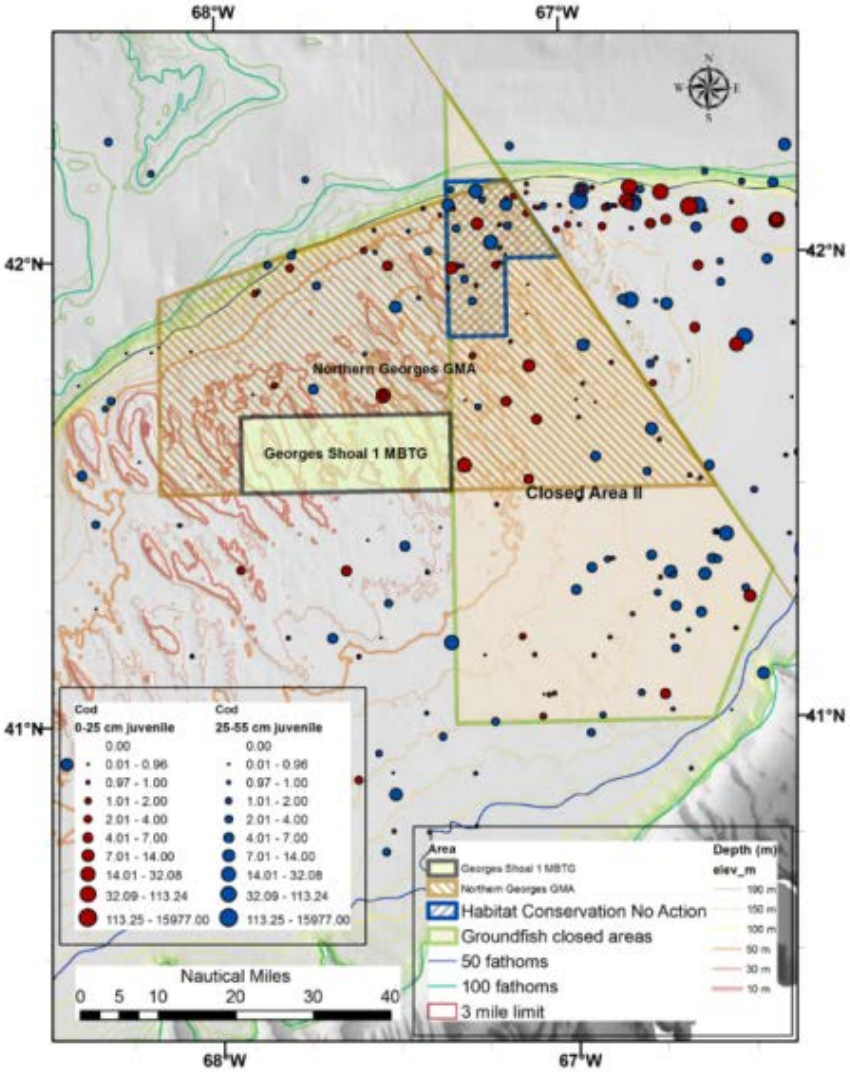


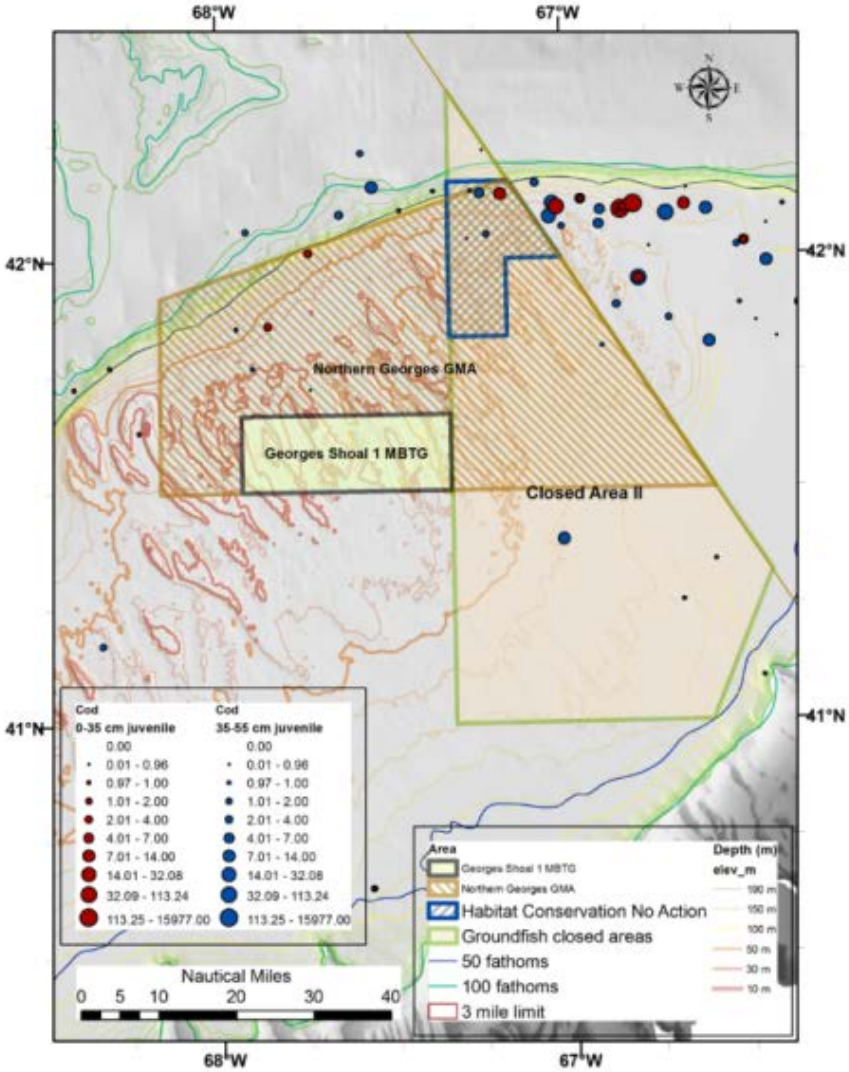



Summer age 0/1
Weighted_hotspots
7 - 6 (11)
8 - 12 (7)
13 - 17 (5)
18 - 22 (2)
23 - 34 (1)
35 - 55 (1)
56 - 123 (1)
67°W
42°N
41°N
68°W
Northern Georges GMA
Georges Shoal 1 MBTG
Closed Area II
Area
Depth (m)
elev_m
Habitat Conservation No Action
Groundfish closed areas
50 fathoms
100 fathoms
3 mile limit
Nautical Miles
0 5 10 20 30 40

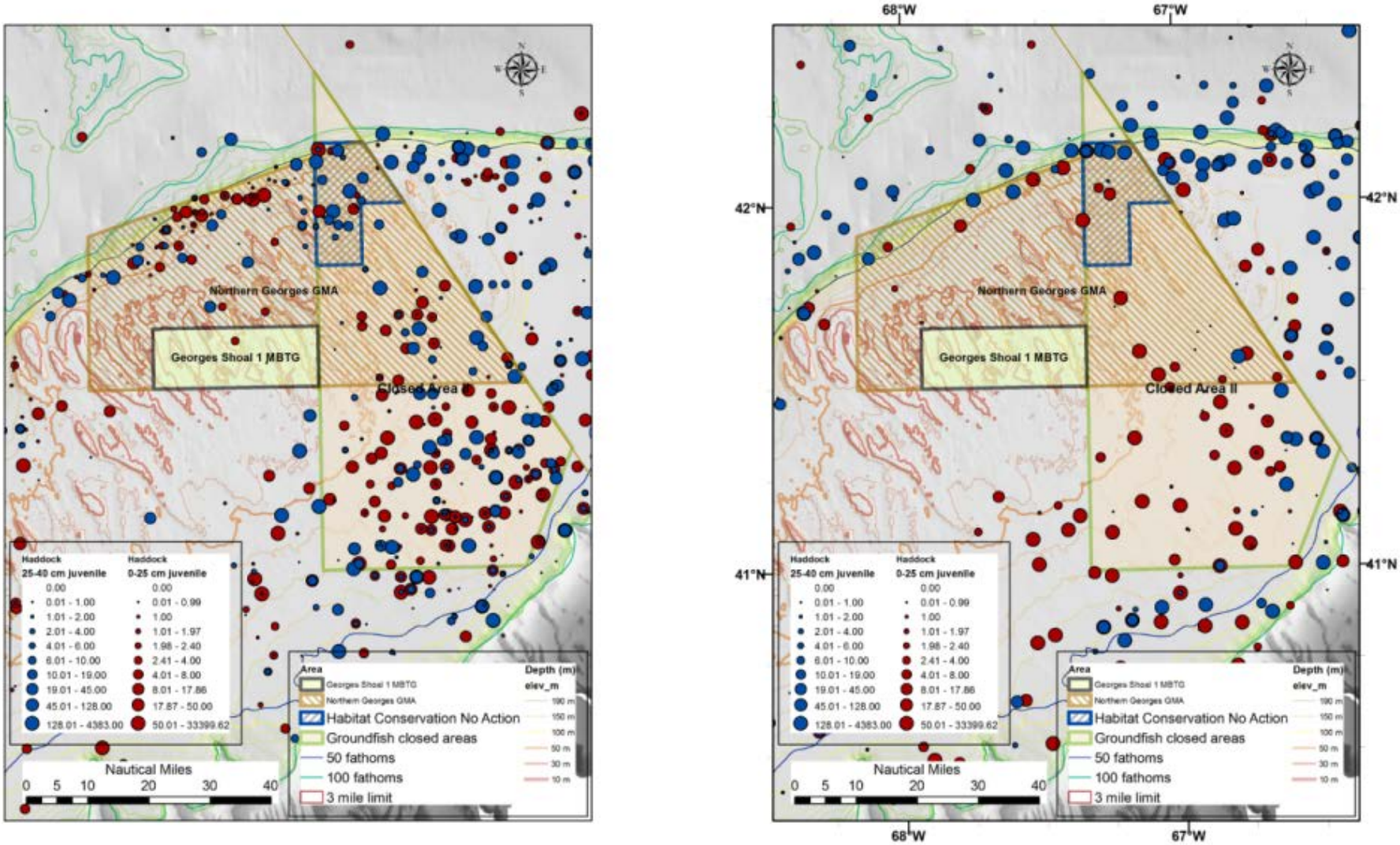

Winter age 0/1
Weighted_hotspots
1 - 7 (1)
68°W
67°W
42°N
41°N
Northern Georges GMA
Georges Shoal 1 MBTG
Closed Area II
Area
Depth (m)
elev_m
Habitat Conservation No Action
Groundfish closed areas
50 fathoms
100 fathoms
3 mile limit
Nautical Miles
0 5 10 20 30 40

Map 20 – Georges Bank Alternative 5 overlap with sub-legal cod number per tow for age 0/1 and age 2+ size classes in 2002-2012 NMFS surveys. Left panel – spring and summer. Right panel – fall and winter.

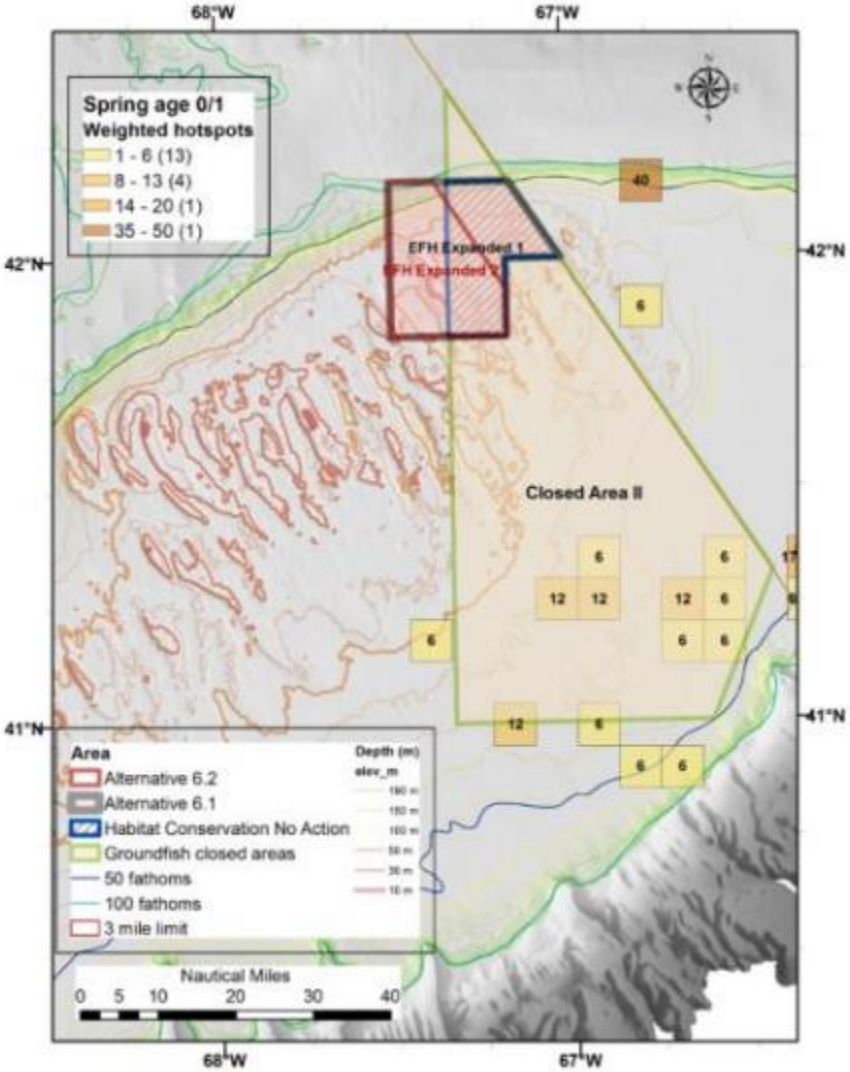


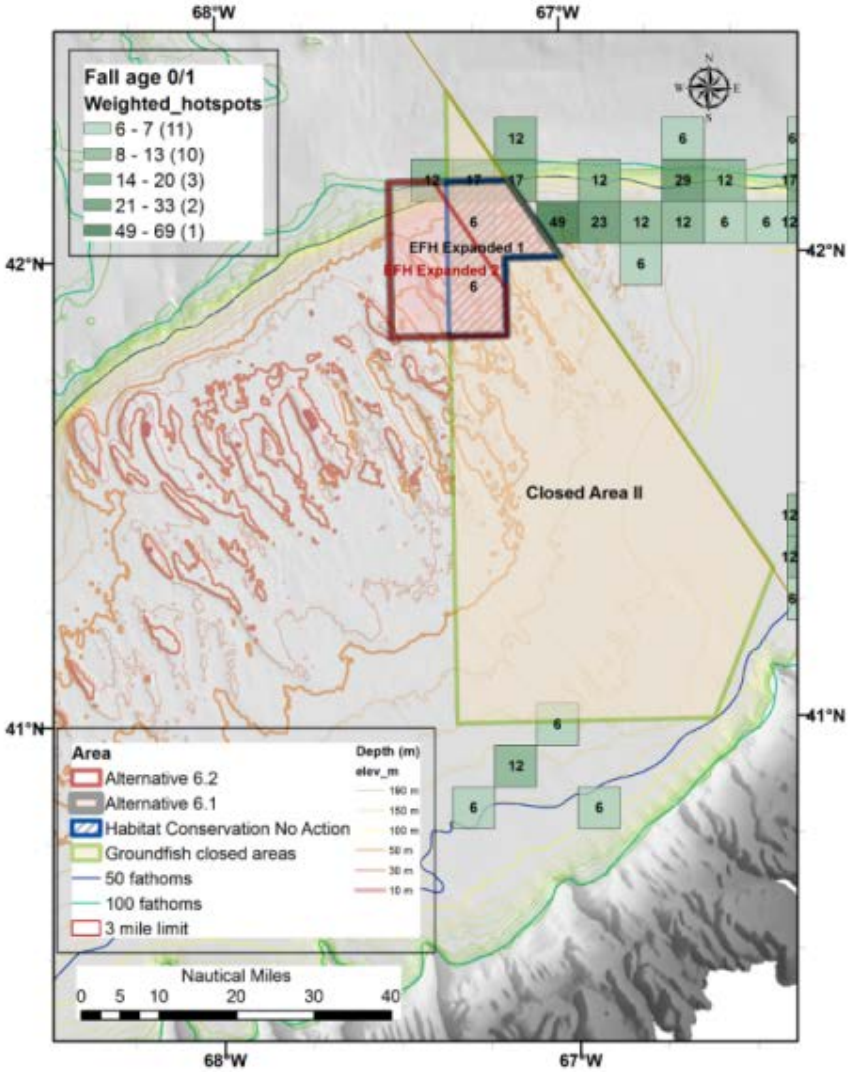


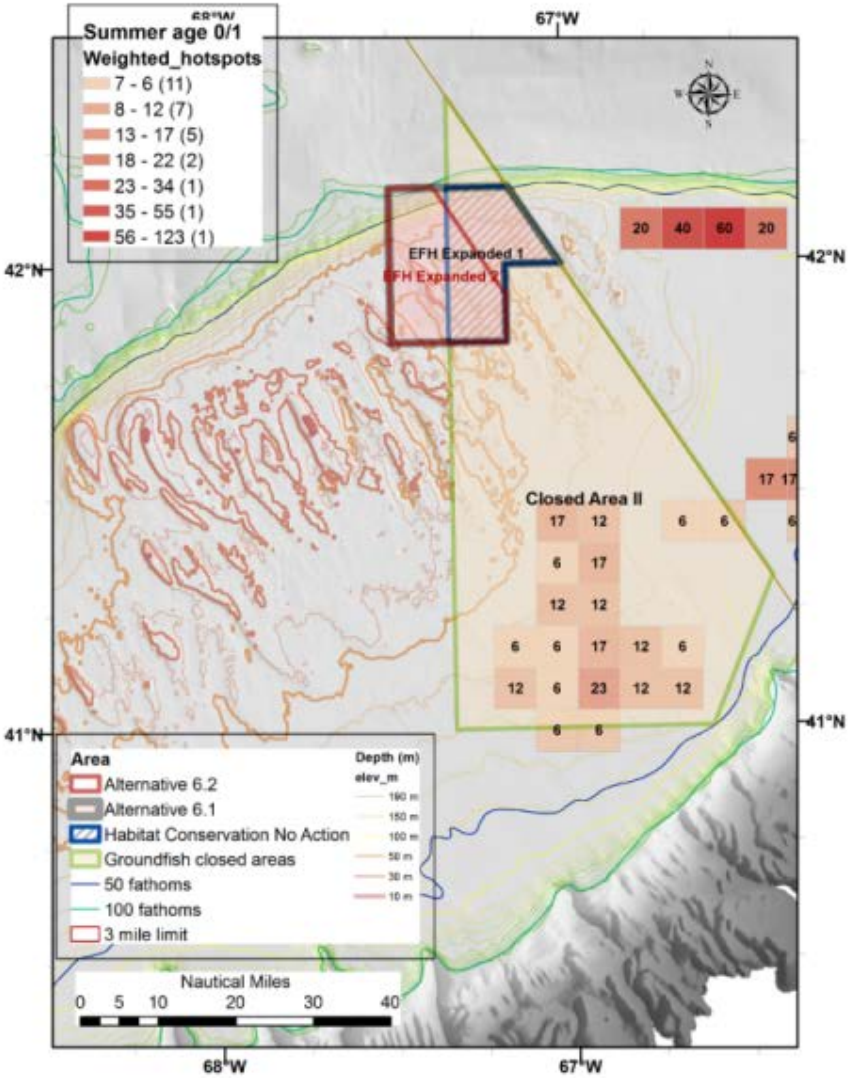
Map 21 – Georges Bank Alternative 5 overlap with sub-legal haddock number per tow for age 0/1 and age 2+ size classes in 2002-2012 NMFS surveys. Left panel – spring and summer. Right panel – fall and winter.

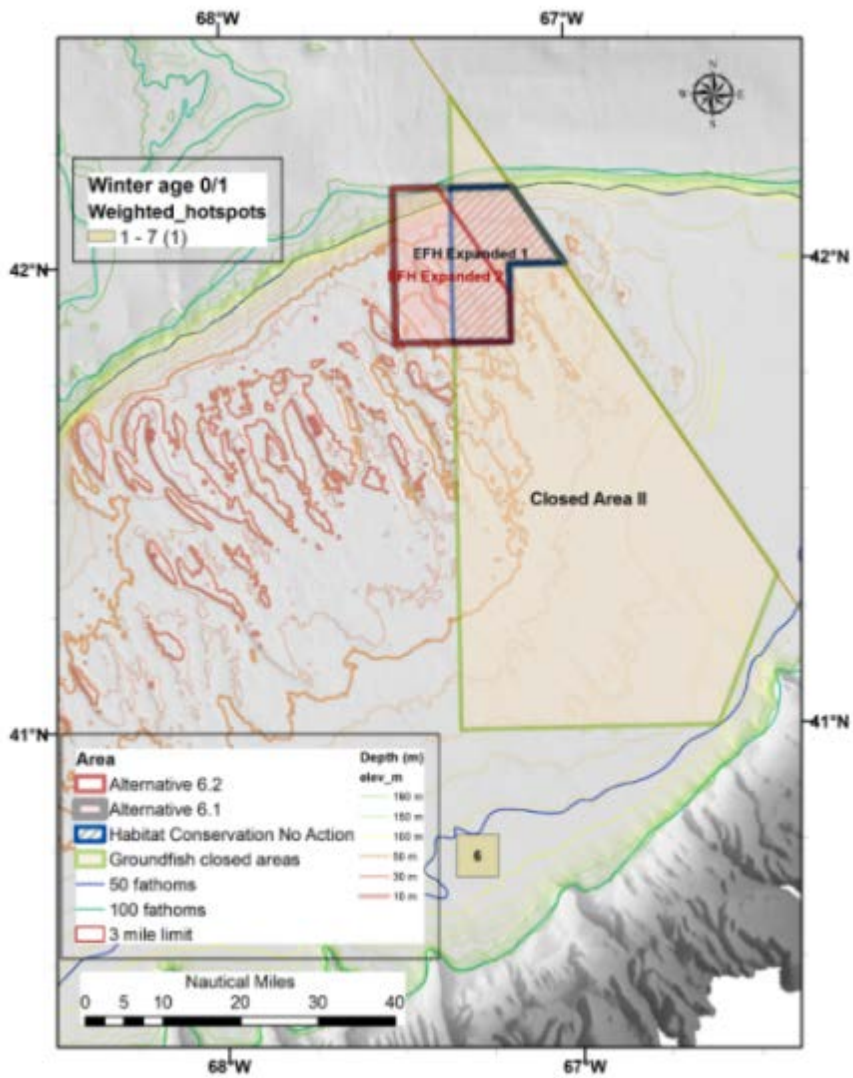


Map 22 – Georges Bank Alternatives 6A and 6B overlap with spring (left), fall (right), summer (left on next page), and winter (right on next page) total weighted age 0/1 groundfish hotspots from 2002-2012 NMFS trawl and summer dredge survey data.

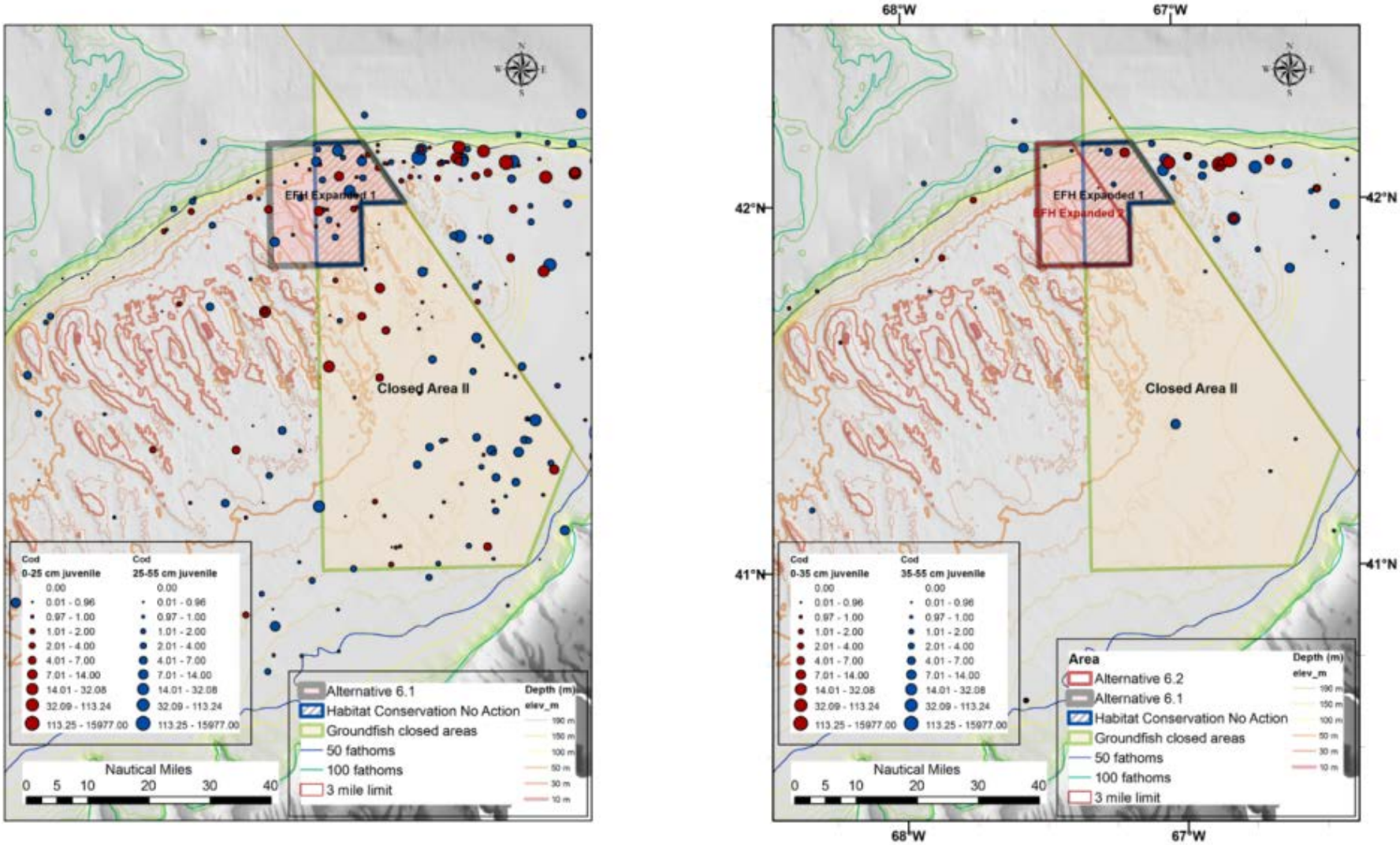




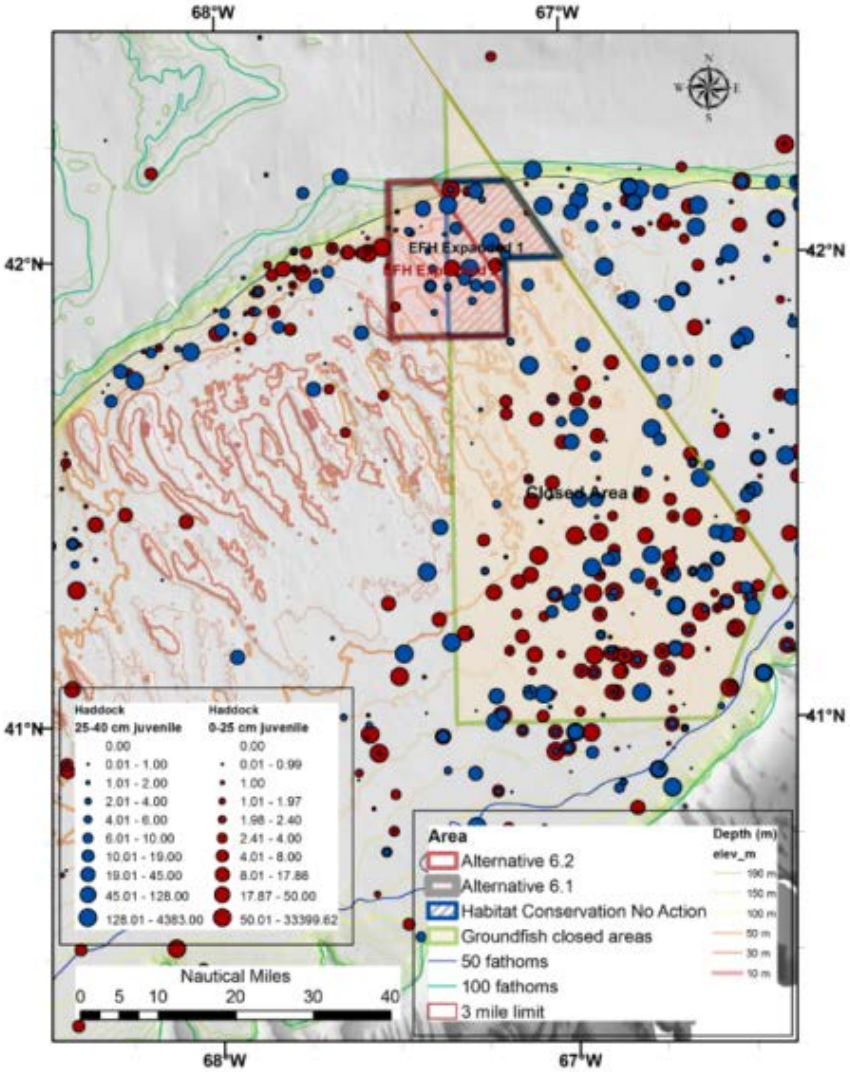

Summer age 0/1
Weighted_hotspots
7 - 6 (11)
8 - 12 (7)
13 - 17 (5)
18 - 22 (2)
23 - 34 (1)
35 - 55 (1)
56 - 123 (1)
67°W
42°N
41°N
68°W
EFH Expanded 1
EFH Expanded 2
Closed Area II
20 40 60 20
17 12
6 17
12 12
6 6 17 12 6
12 6 23 12 12
6 6
17 17
Area
Alternative 6.2
Alternative 6.1
Habitat Conservation No Action
Groundfish closed areas
50 fathoms
100 fathoms
3 mile limit
Depth (m)
elev_m
Nautical Miles
0 5 10 20 30 40

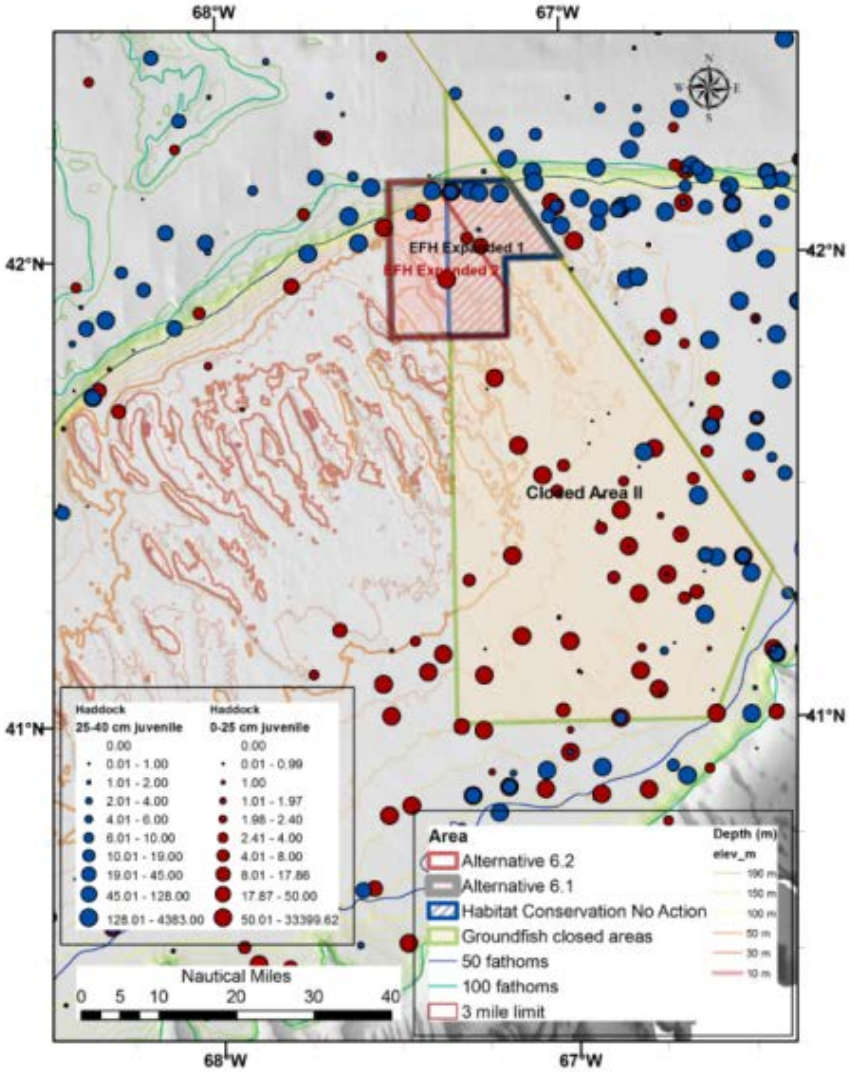

Winter age 0/1
Weighted_hotspots
1 - 7 (1)
68°W
67°W
42°N
41°N
EFH Expanded 1
EFH Expanded 2
Closed Area II
6
Area
Alternative 6.2
Alternative 6.1
Habitat Conservation No Action
Groundfish closed areas
50 fathoms
100 fathoms
3 mile limit
Depth (m)
elev_m
Nautical Miles
0 5 10 20 30 40

Map 23 – Georges Bank Alternatives 6A and 6B overlap with sub-legal cod number per tow for age 0/1 and age 2+ size classes in 2002-2012 NMFS surveys. Left panel – spring and summer. Right panel – fall and winter.

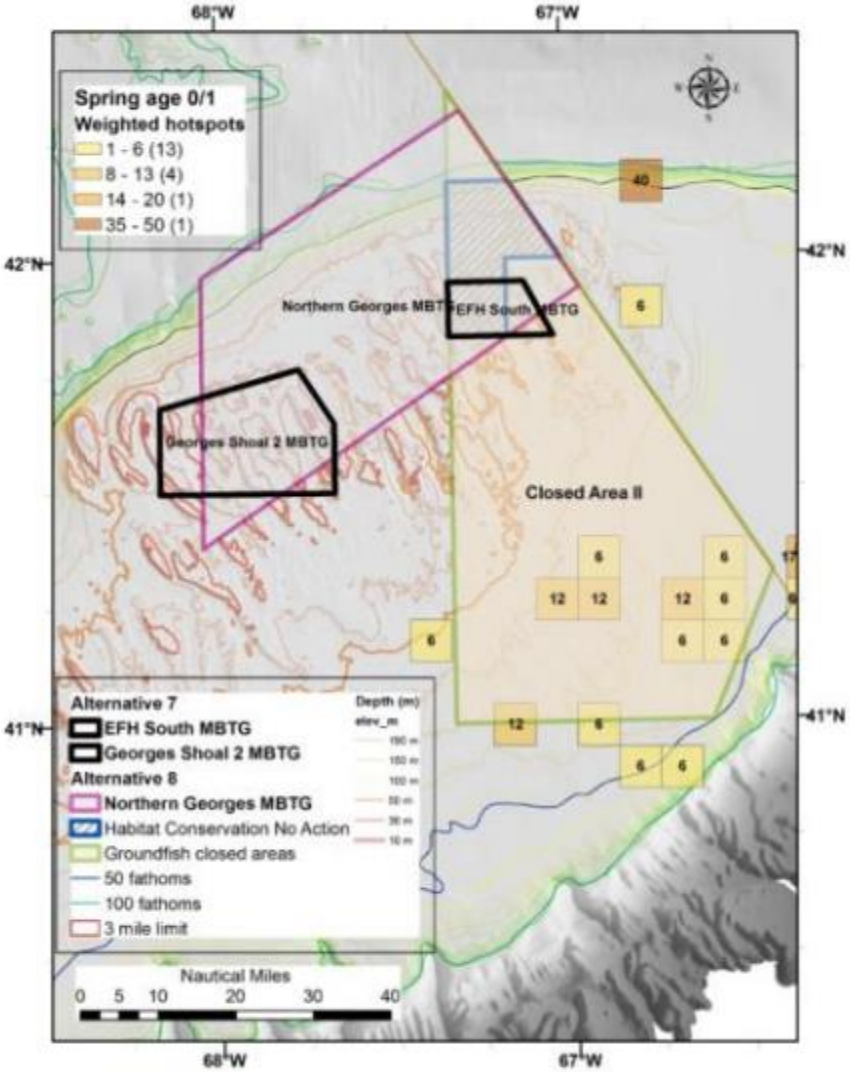


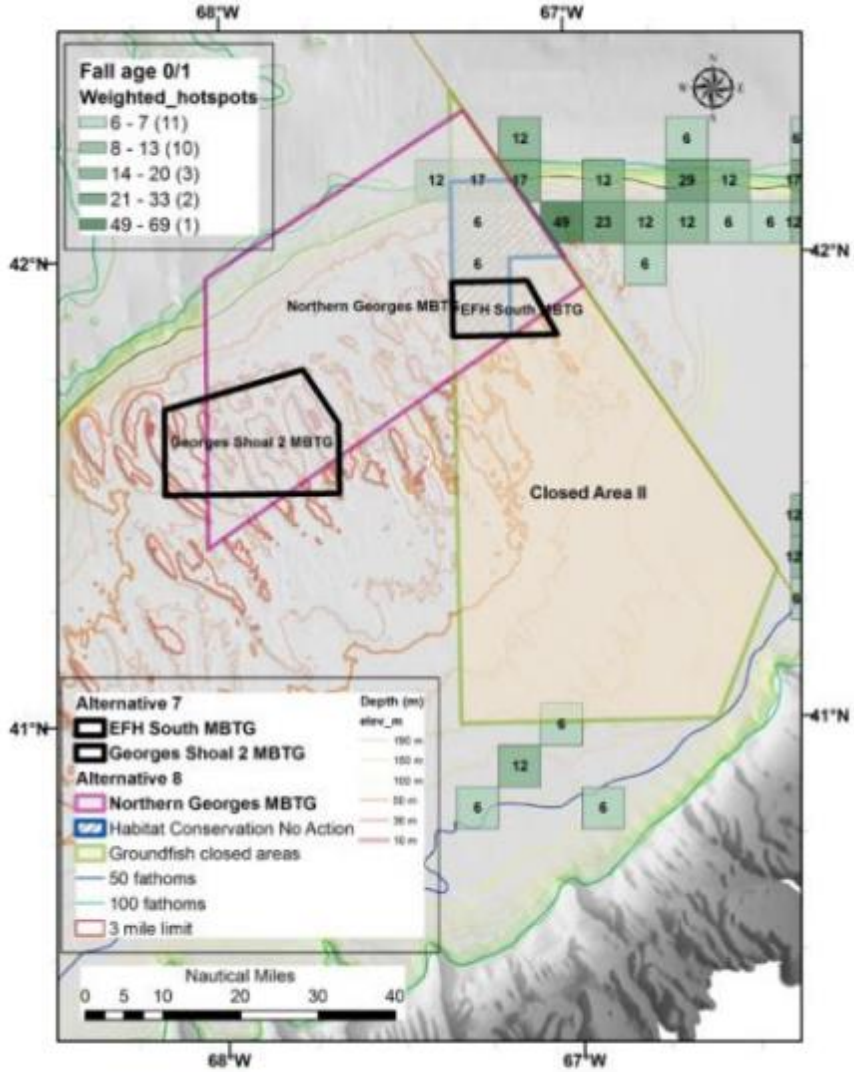
Map 24 – Georges Bank Alternatives 6A and 6B overlap with sub-legal haddock number per tow for age 0/1 and age 2+ size classes in 2002-2012 NMFS surveys. Left panel – spring and summer. Right panel – fall and winter.

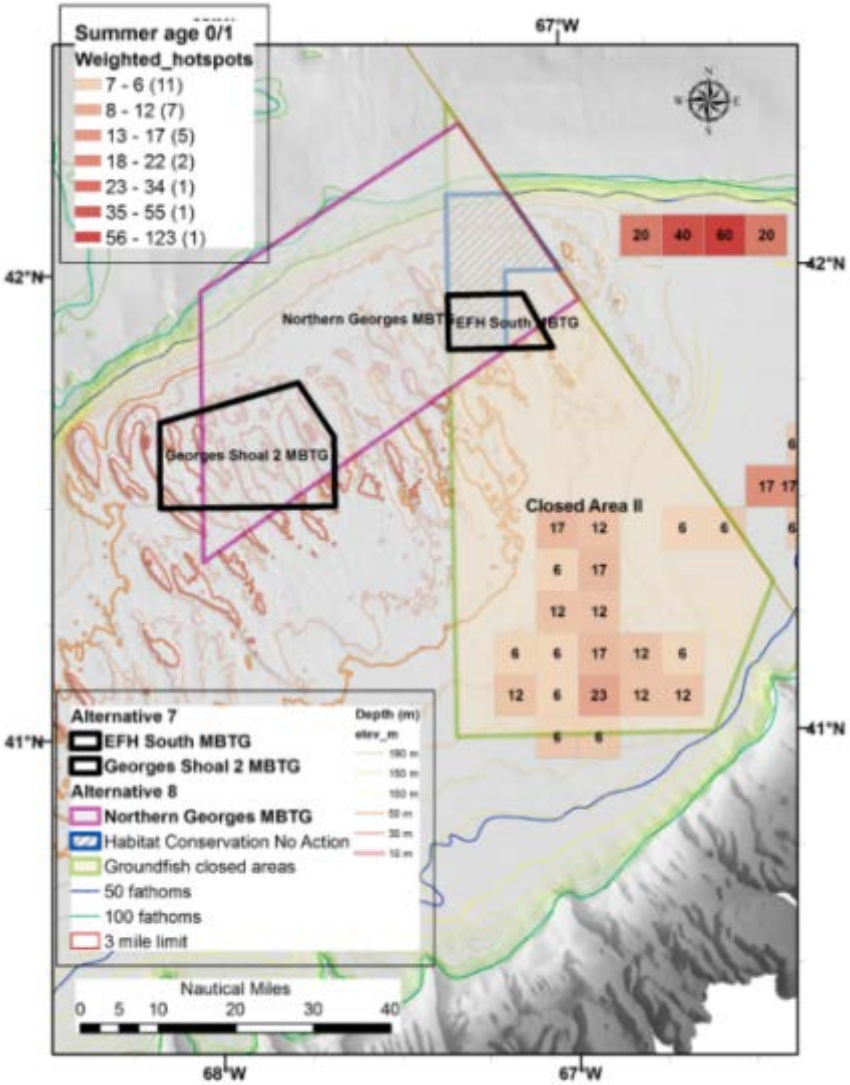


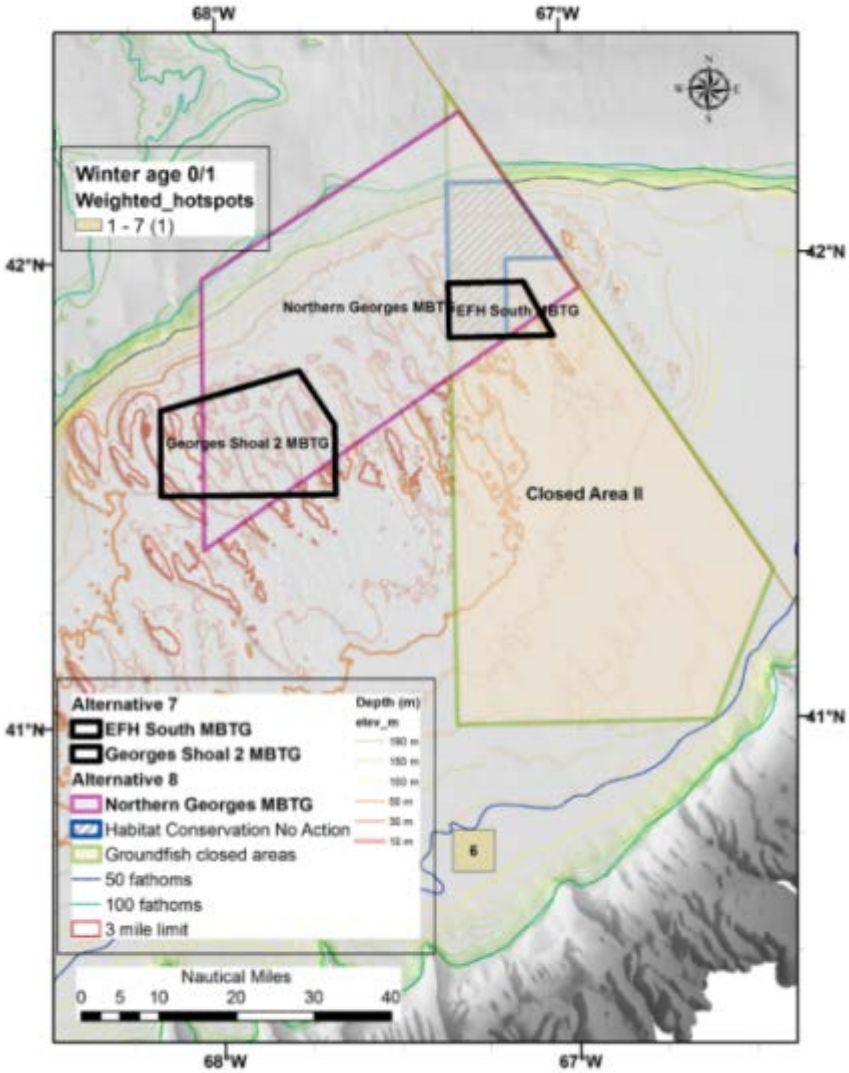


Map 25 – Georges Bank Alternatives7 and 8 overlap with spring (left), fall (right), summer (left on next page), and winter (right on next page) total weighted age 0/1 groundfish hotspots from 2002-2012 NMFS trawl and summer dredge survey data.

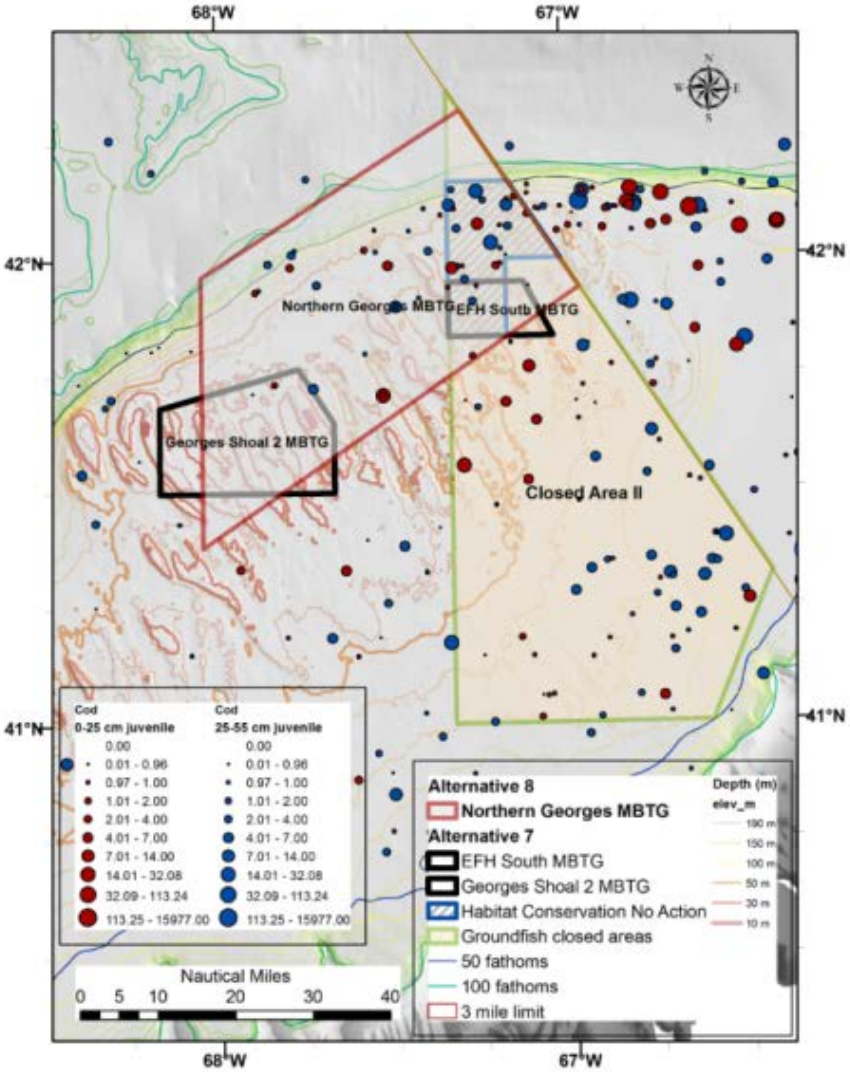


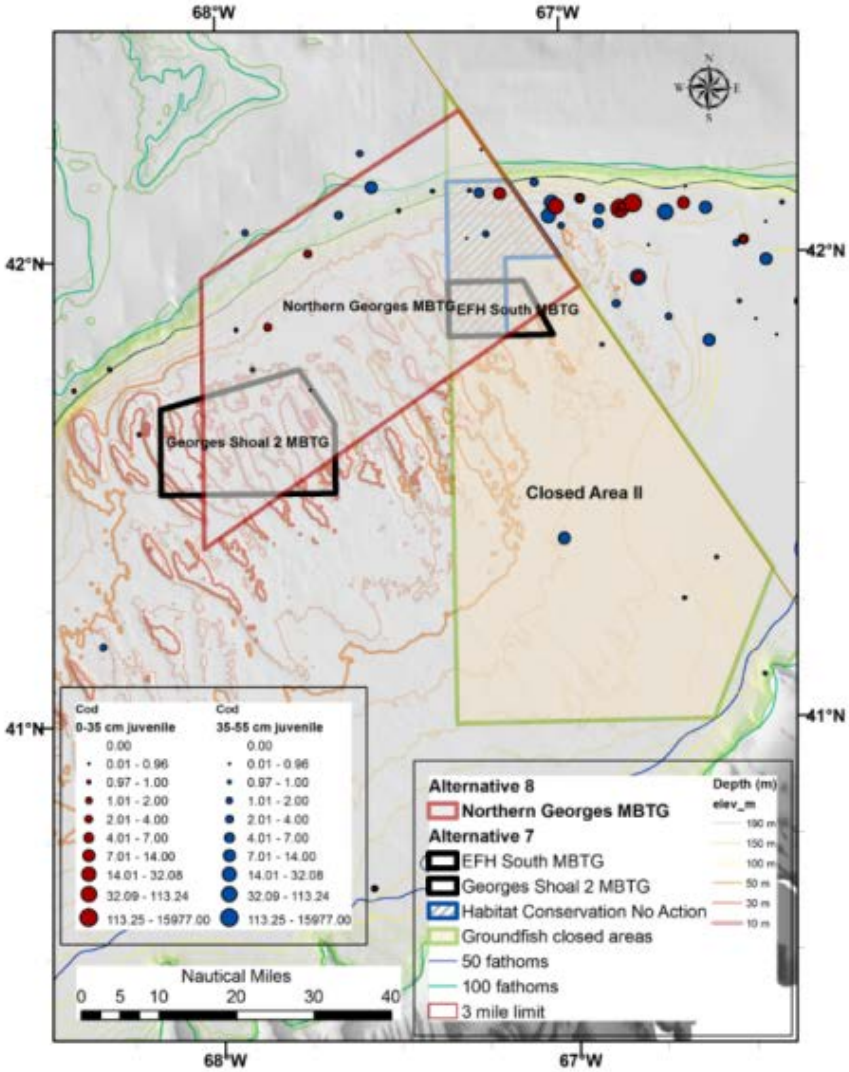



Summer age 0/1
Weighted_hotspots
7 - 6 (11)
8 - 12 (7)
13 - 17 (5)
18 - 22 (2)
23 - 34 (1)
35 - 55 (1)
56 - 123 (1)
67°W
42°N
41°N
68°W
Northern Georges MBTG
EFH South MBTG
Georges Shoal 2 MBTG
Closed Area II
Alternative 7
EFH South MBTG
Georges Shoal 2 MBTG
Alternative 8
Northern Georges MBTG
Habitat Conservation No Action
Groundfish closed areas
50 fathoms
100 fathoms
3 mile limit
Depth (m)
Nautical Miles
0 5 10 20 30 40

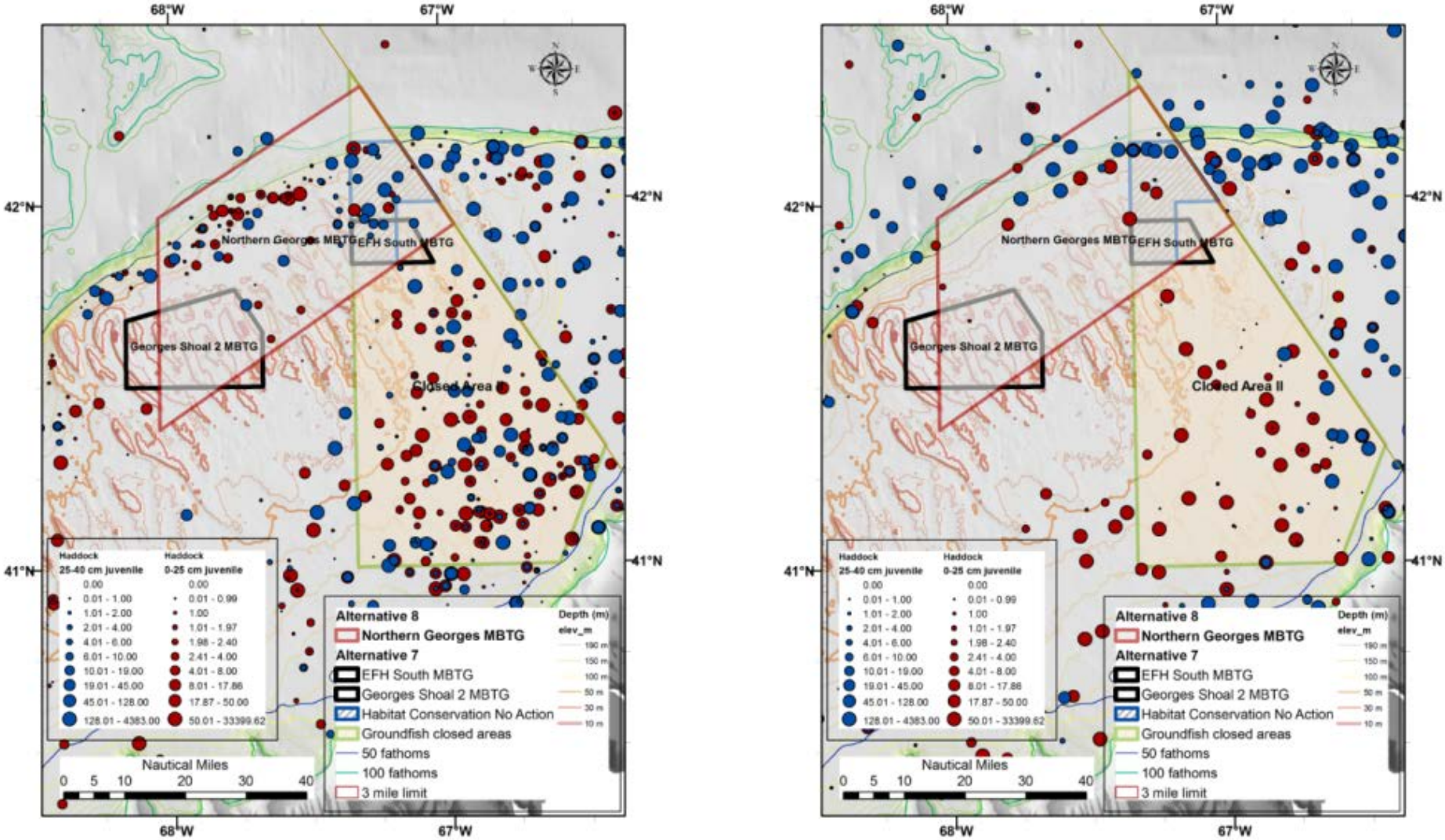

Winter age 0/1
Weighted_hotspots
1 - 7 (1)
68°W
67°W
42°N
41°N
Northern Georges MBTG
EFH South MBTG
Georges Shoal 2 MBTG
Closed Area II
Alternative 7
EFH South MBTG
Georges Shoal 2 MBTG
Alternative 8
Northern Georges MBTG
Habitat Conservation No Action
Groundfish closed areas
50 fathoms
100 fathoms
3 mile limit
Depth (m)
Nautical Miles
0 5 10 20 30 40

Map 26 – Georges Bank Alternatives 7 and 8 overlap with sub-legal cod number per tow for age 0/1 and age 2+ size classes in 2002-2012 NMFS surveys. Left panel – spring and summer. Right panel – fall and winter.

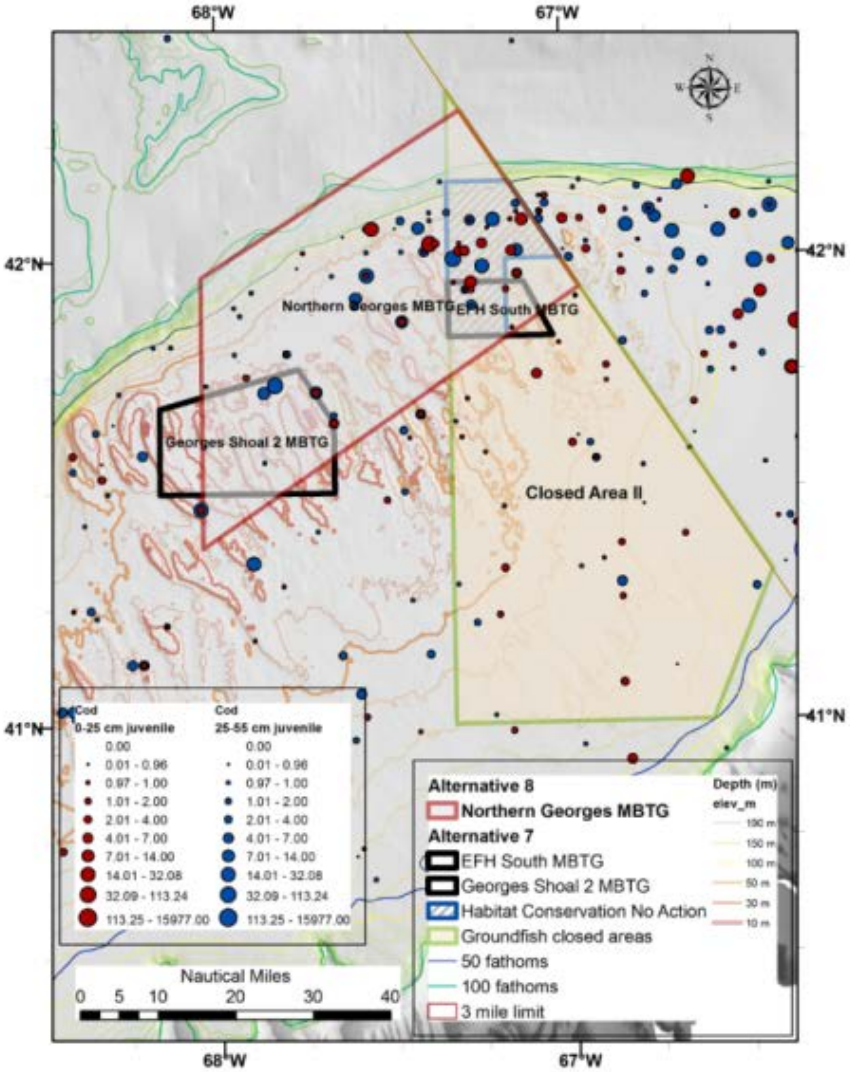


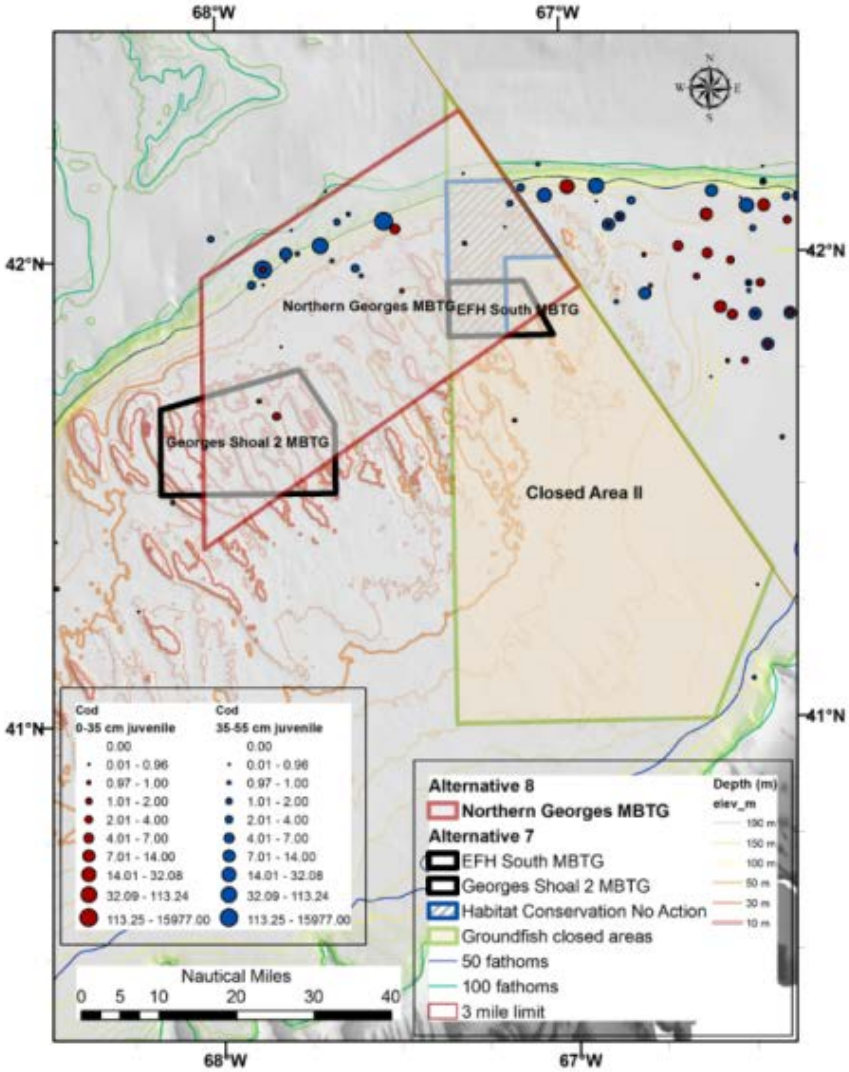


Map 27 – Georges Bank Alternatives 7 and 8 overlap with sub-legal haddock number per tow for age 0/1 and age 2+ size classes in 2002-2012 NMFS surveys. Left panel – spring and summer. Right panel – fall and winter.

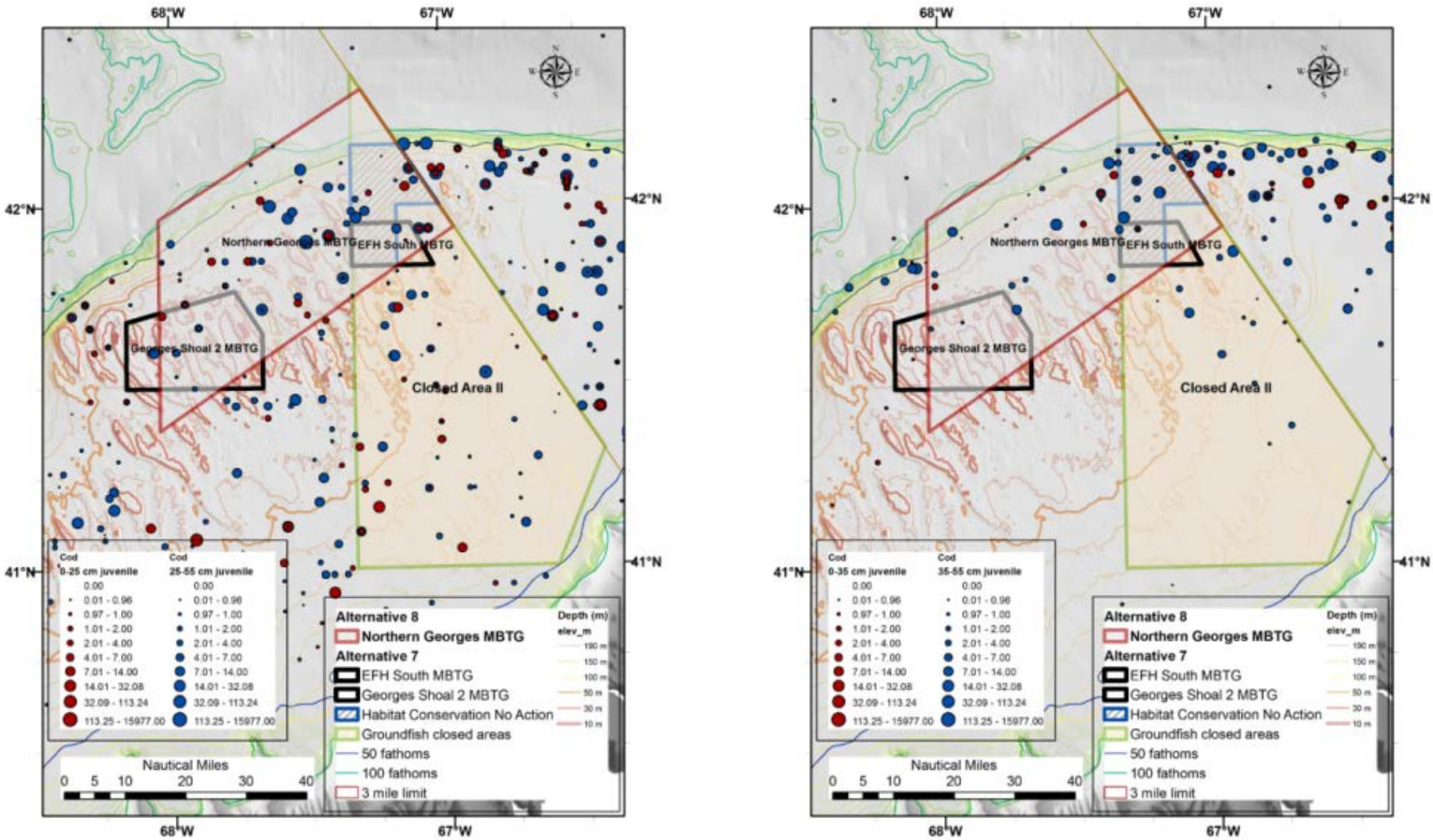


Map 28 – Georges Bank Alternatives 7 and 8 overlap with sub-legal cod number per tow for age 0/1 and age 2+ size classes in 1982-1991 NMFS surveys. Left panel – spring and summer. Right panel – fall and winter.

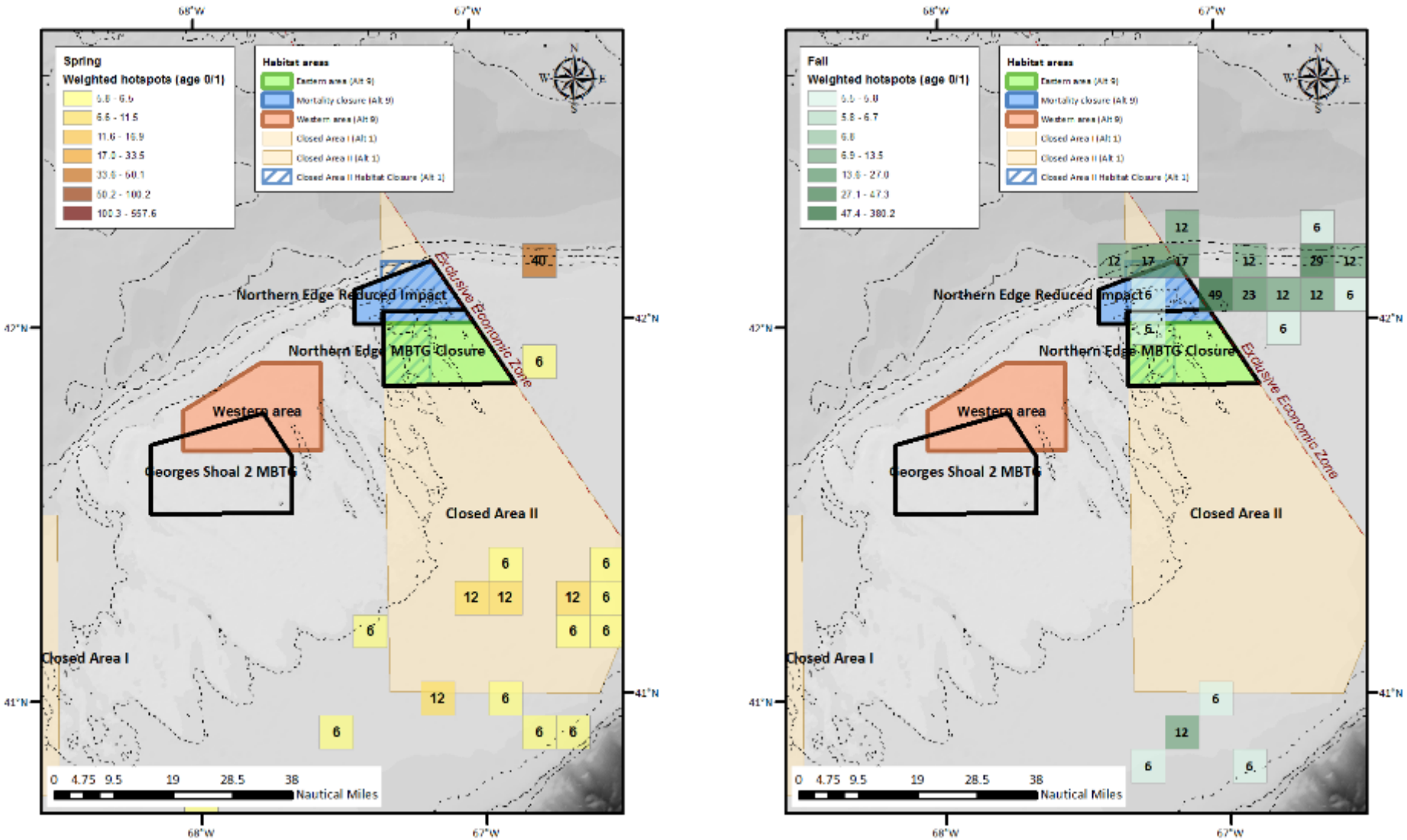


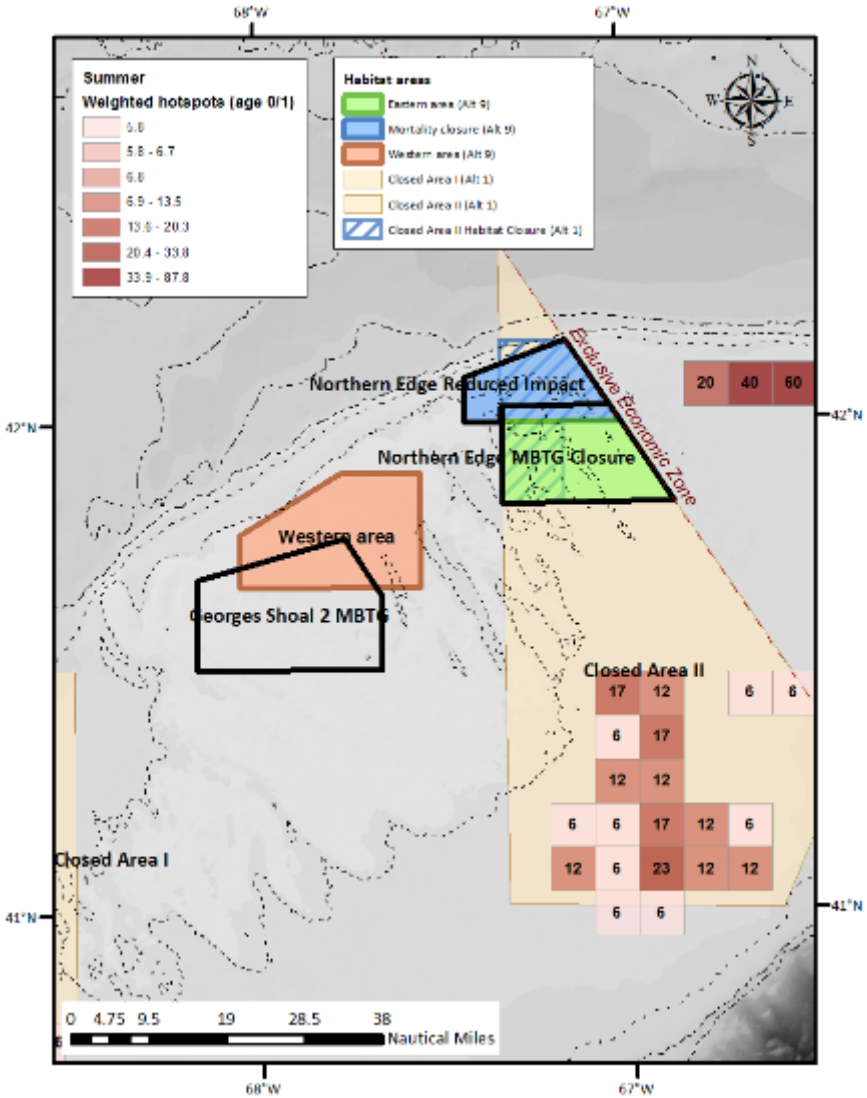


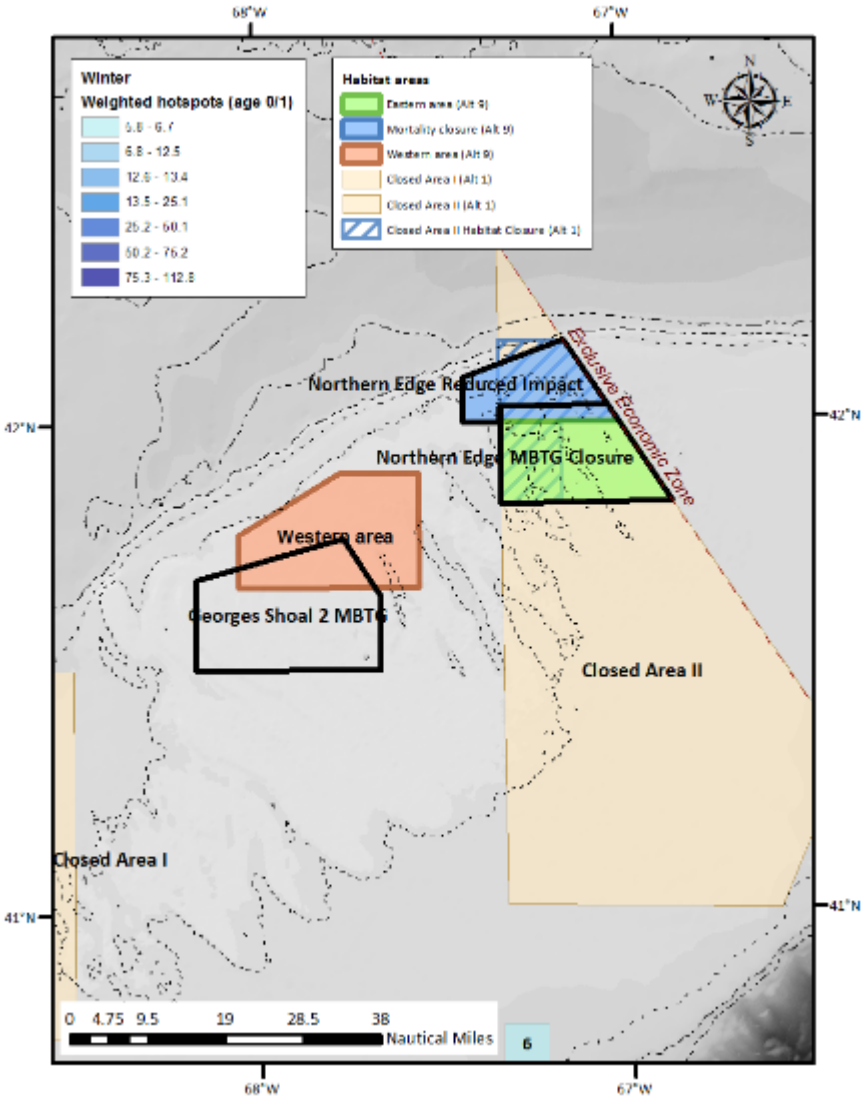
Map 29 – Georges Bank Alternatives 7 and 8 overlap with sub-legal cod number per tow for age 0/1 and age 2+ size classes in 1972-1981 NMFS surveys. Left panel – spring and summer. Right panel – fall and winter.



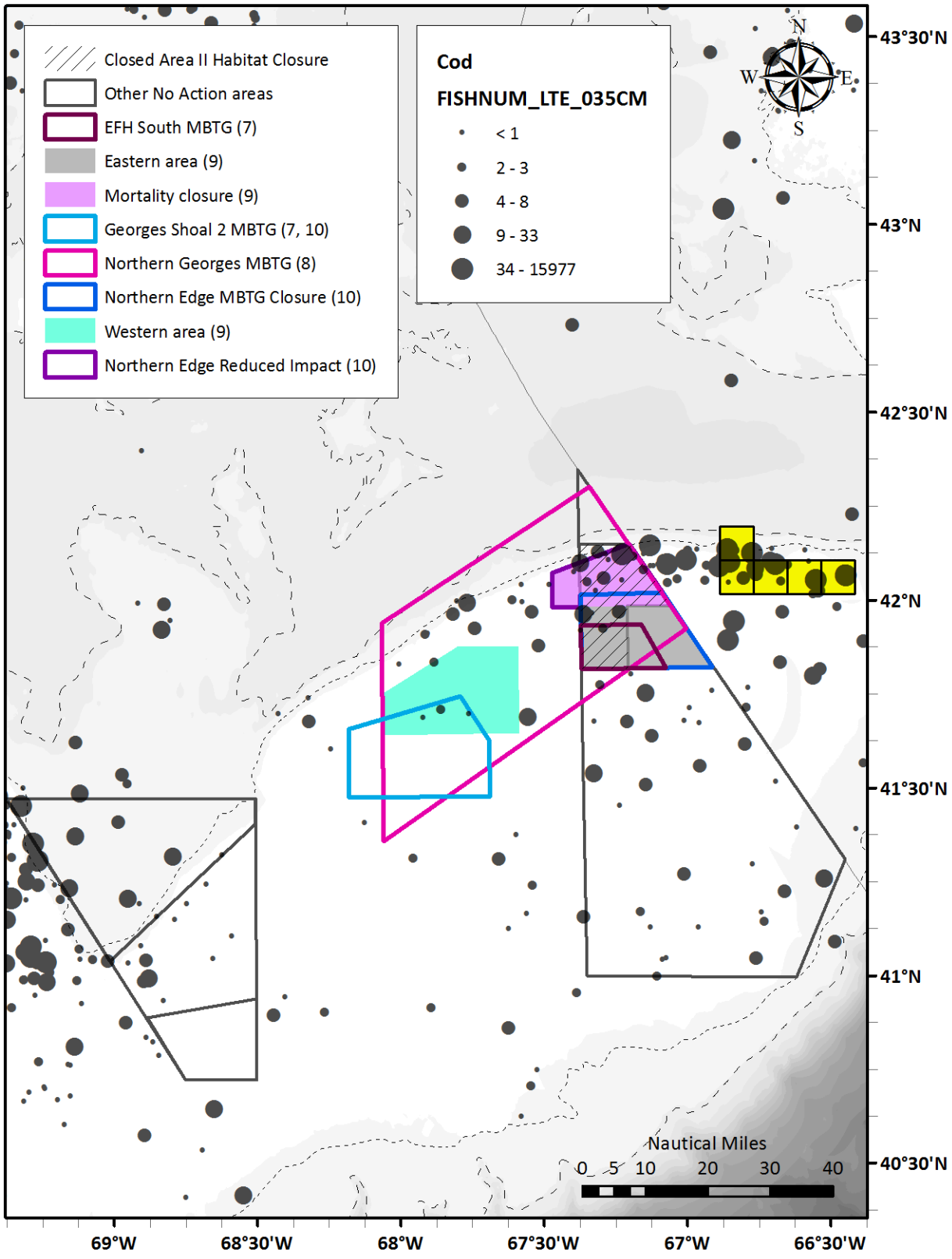
Map 30 – Georges Bank Alternatives 9 and 10 overlap with spring (left), fall (right), summer (left on next page), and winter (right on next page) total weighted age 0/1 groundfish hotspots from 2002-2012 NMFS trawl and summer dredge survey data.



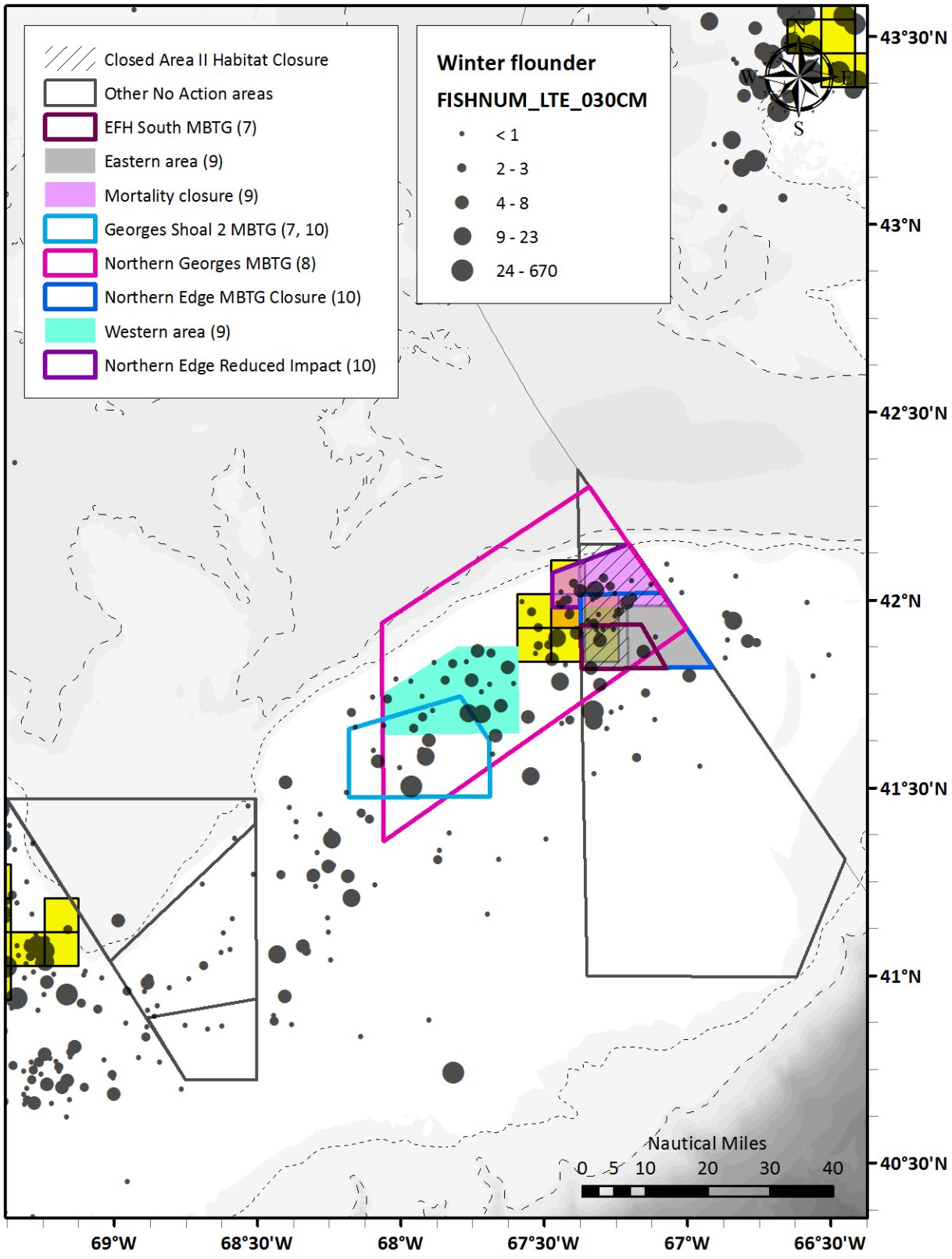

Summer
Weighted hotspots (age 0/1)
5.8 - 6.7
6.8
6.9 - 13.5
13.6 - 20.3
20.4 - 33.8
33.9 - 87.8
Habitat areas
Eastern area (Alt 9)
Mortality closure (Alt 9)
Western area (Alt 9)
Closed Area I (Alt 1)
Closed Area II (Alt 1)
Closed Area II Habitat Closure (Alt 1)
68°W
67°W
42°N
41°N
Northern Edge Reduced Impact
Northern Edge MBTG Closure
Exclusive Economic Zone
Western area
Georges Shoal 2 MBTG
Closed Area II
Closed Area I
20 40 60
17 12 6 6
6 17
12 12
6 6 17 12 6
12 6 23 12 12
6 6
0 4.75 9.5 19 28.5 38
Nautical Miles


Winter
Weighted hotspots (age 0/1)
5.8 - 6.7
6.8 - 12.5
12.6 - 13.4
13.5 - 25.1
25.2 - 50.1
50.2 - 75.2
75.3 - 112.8
Habitat areas
Eastern area (Alt 9)
Mortality closure (Alt 9)
Western area (Alt 9)
Closed Area I (Alt 1)
Closed Area II (Alt 1)
Closed Area II Habitat Closure (Alt 1)
68°W
67°W
42°N
41°N
Northern Edge Reduced Impact
Northern Edge MBTG Closure
Exclusive Economic Zone
Western area
Georges Shoal 2 MBTG
Closed Area II
Closed Area I
6
0 4.75 9.5 19 28.5 38
Nautical Miles

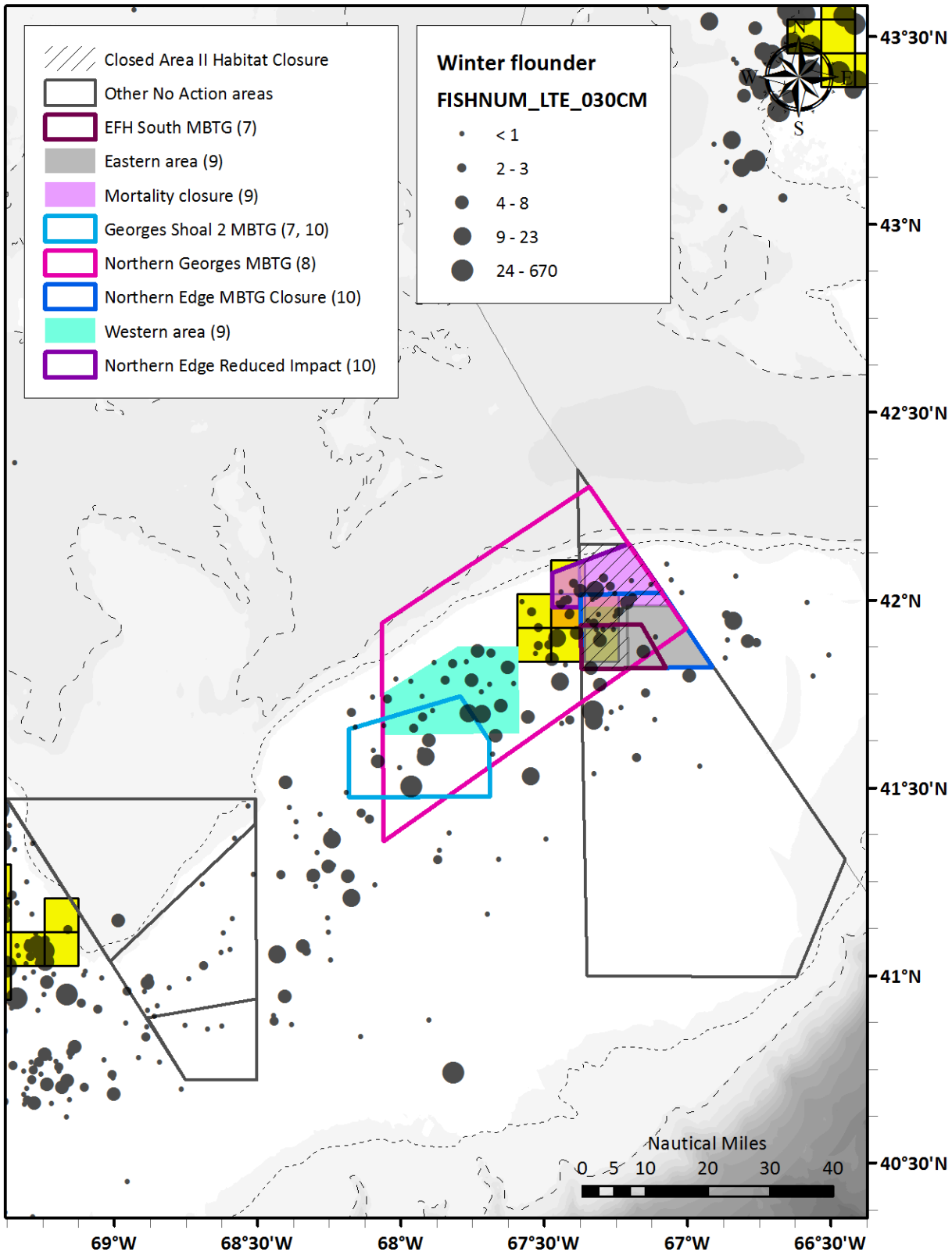
Map 31 – Juvenile age 0/1 (<35 cm) Atlantic cod abundance (number/tow, in quantiles, zeros excluded) and hotspots during 2002-2012, as compared to Alternatives 1, 7, 8, 9, and 10.



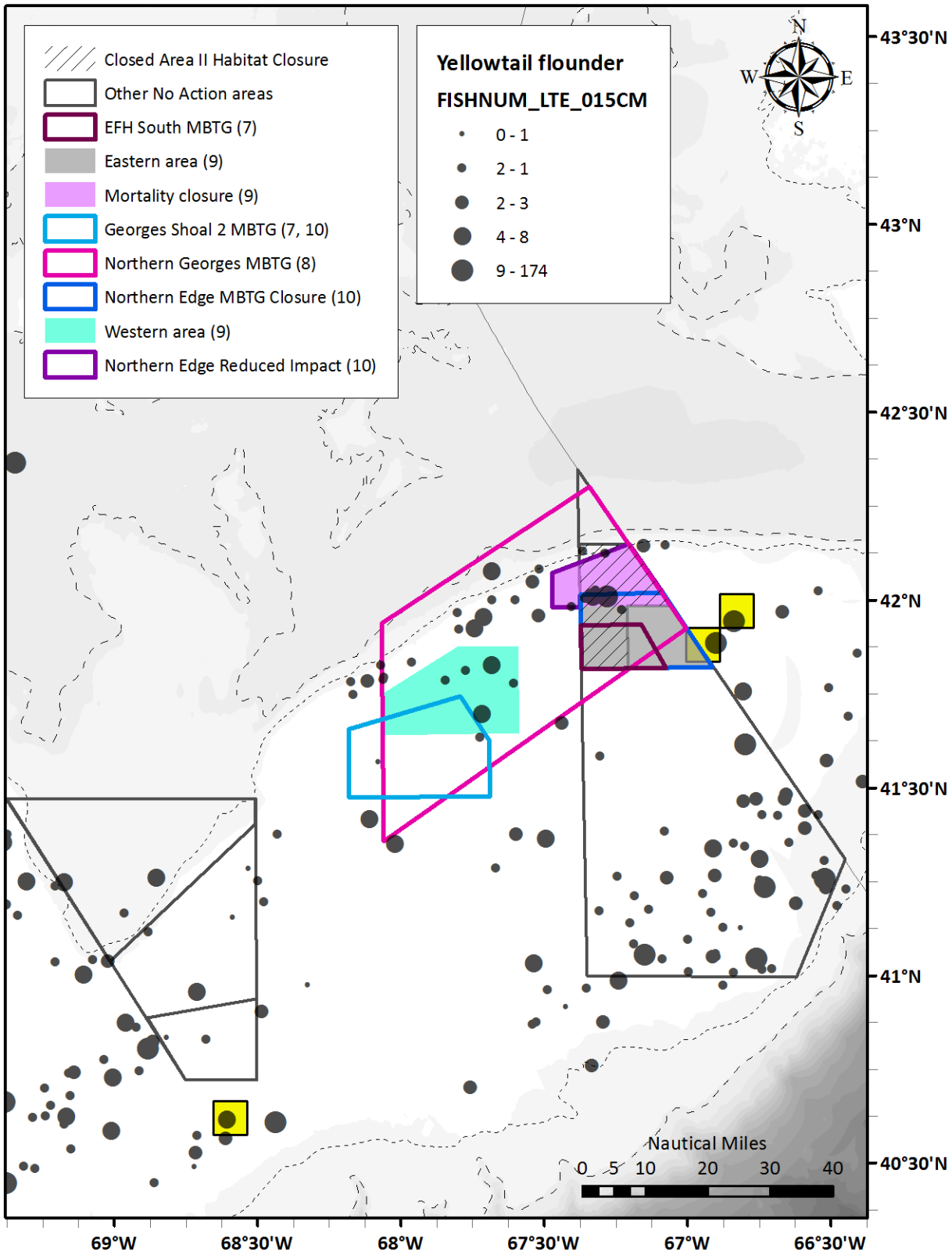
Map 32 – Juvenile age 0/1 (<=35 cm) haddock abundance (number/tow, in quantiles, zeros excluded) and hotspots during 2002-2012, as compared to Alternatives 1, 7, 8, 9, and 10.



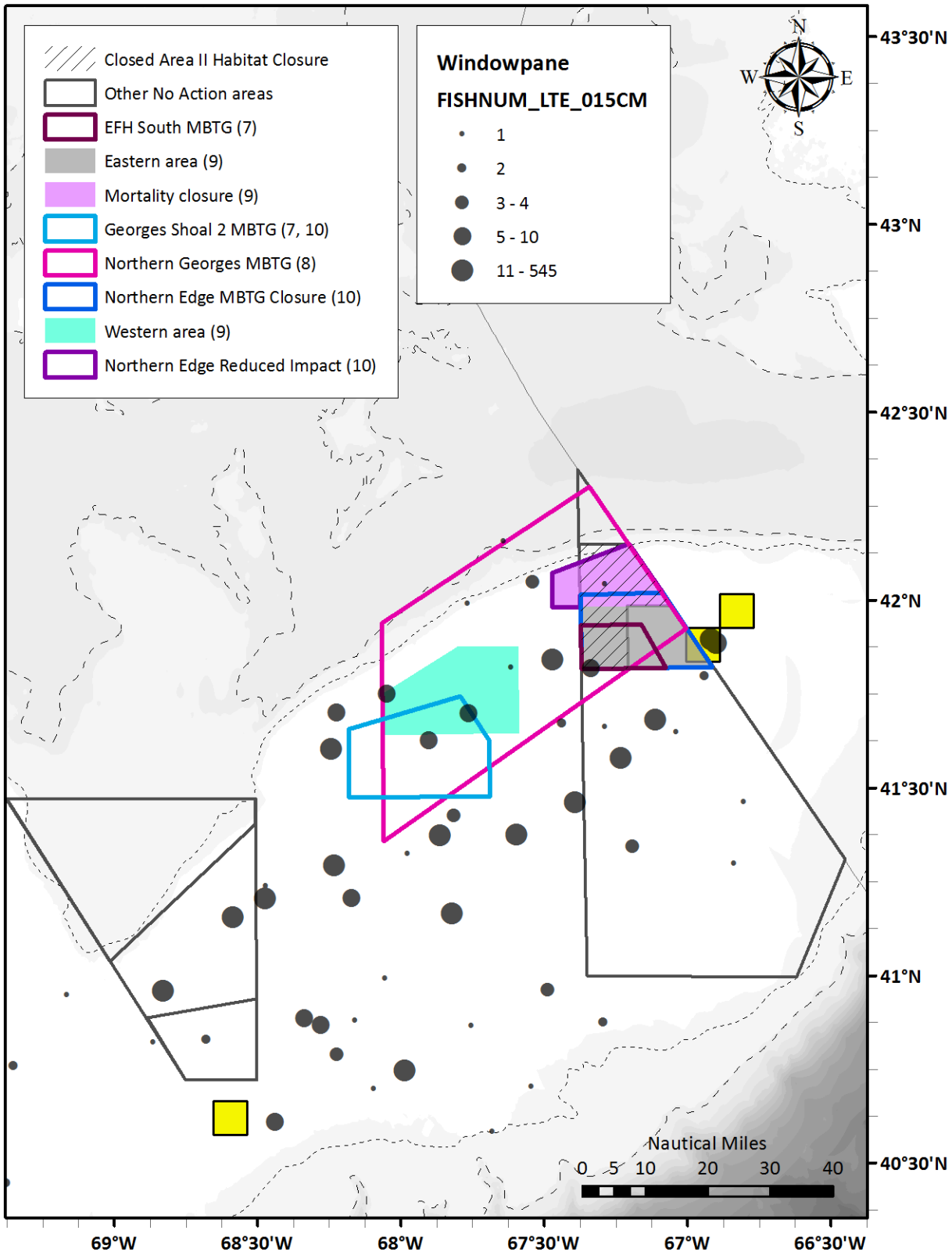
Map 33 – Juvenile age 0/1 (<=15 cm) winter flounder abundance (number/tow, in quantiles, zeros excluded) and hotspots during 2002-2012, as compared to Alternatives 1, 7, 8, 9, and 10.



Map 34 – Juvenile age 0/1 (<=15 cm) yellowtail flounder abundance (number/tow, in quantiles, zeros excluded) and hotspots during 2002-2012, as compared to Alternatives 1, 7, 8, 9, and 10.



Map 35 – Juvenile age 0/1 (<=15 cm) windowpane flounder abundance (number/tow, in quantiles, zeros excluded) and hotspots during 2002-2012, as compared to Alternatives 1, 7, 8, 9, and 10.



2.2.4.1 ***Alternative 1 (No Action)***

Alternative 1/No Action in the Georges Bank sub-region includes the Closed Area I and II groundfish closed areas and the overlapping habitat management areas. It is not the preferred alternative, although Closed Area II and the northern part of Closed Area I will be maintained seasonally under the preferred spawning alternative. Table 9 summarizes the seasonal unweighted and weighted age 0/1 groundfish hotspots in these areas, with the distribution of the weighted hotspots shown in Map 15. Hotspots by species are provided in Table 10. The main data sources used to identify these hotspots included the spring, fall, and winter NMFS trawl surveys and the summer scallop dredge survey. IBS yellowtail flounder and monkfish surveys were also analyzed, but few to no age 0/1 groundfish hotspots were identified from these data. In general, hotspots from the 2002-2012 survey data were less prevalent on Georges Bank than they were in the Gulf of Maine. This outcome may be caused by generally lower survey CPUE on Georges Bank during this period, more dispersion of age 0/1 fish than occurs in the Gulf of Maine, and/or less variation in catches in this region than in the Gulf of Maine (i.e., the Gulf of Maine had more catches that were significantly above the region-wide mean[7]).

Judging the effects of year-round groundfish closed areas and habitat closures on Georges Bank is more complicated than it is in the Gulf of Maine. While the fishing regulations in the habitat closures are the same as they are elsewhere (no fishing with mobile bottom-tending gear), there are a variety of dredge and trawl special access programs that apply to portions of the groundfish closed areas that do not overlap the habitat closures. These include haddock and yellowtail flounder special access programs and scallop access areas in Closed Area I and Closed Area II. Other than the requirement to use a separator panel, which is unlikely to have a positive or negative habitat effect, the SAP and access areas are essentially open to fishing with mobile bottom-tending gear. While there are some seasonal restrictions associated with these programs, seasonal restrictions do not have a substantial positive effect on maintaining the functional value of vulnerable habitat types with lengthy, multi-year recovery times. However, seasonal closures may influence the amount of discards and spawning fish caught by these fisheries and thus have positive impacts on groundfish resources.

The most important groundfish habitat protection is associated with the habitat closures; in this sub-region these include the Closed Area II Habitat Closure and the northern and southern habitat closures in Closed Area I. Total weighted hotspots in the habitat closures were 11.5 in the fall survey and zero during the other survey seasons (Table 9). The total weighted hotspots in the year-round groundfish closed areas were 63.3 in the spring, 195.5 in the summer, 46.0 in the fall, and 0.0 in the winter surveys. A considerable majority of hotspots in the summer were from age 0/1 haddock hotspots in the southern portion of Closed Area II (Map 15), which has been open to both scallop dredge and groundfish trawl fishing in respective access programs.

[7] The Council's Closed Area Technical Team conducted some Georges Bank-only hotspot analyses to test the hypothesis that the catches were lower or had a different spatial autocorrelation, but few hotspots were identified by those sensitivity analyses. This led to the conclusion that the sparseness of age 0/1 hotspots was more due to less variation and more dispersion (i.e. less concentration) of age 0/1 catches in the survey tows on Georges Bank.

Juvenile cod are scattered across eastern Georges Bank, with some concentration on the northern edge, from the Closed Area II Habitat Closure into Canadian waters (Map 17). Although there were few cod hotspots in general, and none outside the habitat closure, the rest of Closed Area II appears to provide some protection to areas where juvenile cod were caught by spring and summer surveys. It is not apparent, however, that Closed Area II (groundfish closure) is protecting critical cod habitat, except possibly for along the northern edge of the bank overlapping the northern portion of the habitat closure. In the fall surveys, it appears that the juvenile cod have left the shallower portions of the bank including most of Closed Area II, except for some age 0/1 and larger sub-legal cod along the northern edge into Canada. As the Georges Bank cod stock is at record low abundance, any conservation benefits afforded by restrictions along the northern edge may be particularly important at this time. It is also worth reiterating that the NEFSC surveys are concentrated in fall and spring, such that habitat usage during the summer and winter months is less well known.

In contrast, age 0/1 and larger sub-legal haddock are distributed across broad regions of eastern Georges Bank during the spring and summer surveys (Map 18, left). Age 0/1 and larger sub-legal haddock appear to be well mixed in the shallower areas of the bank and along the northern edge of the bank, from well west of the Closed Area II Habitat Closure to areas in Canadian waters. During the spring, Closed Area II appears to provide protection for a substantial fraction of the juvenile haddock on eastern Georges Bank given the numbers and distribution of hotspots, which indicate clusters of high catches and potential preferred habitat. Due to the minimal and temporary effects of fishing in sandy areas, this habitat does not appear to be as vulnerable to fishing effects as coarser and harder substrates and associated epifauna found elsewhere.

In the fall and winter, juvenile haddock, particularly the older juveniles, appear to move into deeper water around the perimeter of Georges Bank. Age 0/1 haddock appear to remain in shallower water on Georges Bank compared to older sub-legal haddock (Map 18, right). Both cohorts of haddock seem to take up residence in deeper waters of the Closed Area II Habitat Closure, and this is where age 0/1 haddock hotspots occur. Even though there were few age 0/1 hotspots identified on the U.S. portion of Georges Bank, there were a substantial number of unweighted and weighted hotspots on the northern edge, mostly in Canadian waters and partially in U.S. waters (Map 15).

Impacts on groundfish habitat and groundfish populations from Alternative 1/No Action are likely to be beneficial to species inhabiting coarse and hard substrates in the habitat closures, but limited habitat benefits are generated by the other portions of the year-round groundfish closed areas, partly mitigated by access program fishing. For juvenile groundfish such as haddock, winter flounder, and yellowtail flounder that depend on sandy habitats (including prey species such as polychaetes embedded in sand substrates of Georges Bank), direct impacts of fishing (even considering the effect as temporary due to high wave energy and currents) would likely have more influence on these stocks than protecting vulnerable substrate elsewhere would have on them. In other words, these stocks would not benefit as much from protection of vulnerable substrates located elsewhere, and may in fact experience negative impacts due to effort displacement, although effects related to effort displacement are difficult to estimate..

Based on the above analysis and the analyses in Multispecies Framework Adjustment 48 that suggest positive impacts of closed areas on haddock and winter flounder, plus the potential benefit realized by the fishery fishing along the margins of closed areas (particularly on the western edge of Closed Area II), the Alternative 1/No Action has a highly positive impact of on the groundfish resource. Because a fairly large fraction of the existing groundfish and habitat management areas are comprised of mobile sediments and these areas are open to special access program fishing, the impact of the No Action alternative on age 0/1 groundfish habitats is expected to be slightly positive.

Alternative 1/No Action is expected to have positive impacts on spawning groundfish via Closed Areas I and II, which include broad restrictions on gears capable of catching groundfish. Most of the overlap with large spawner hotspots in this region occurs in Closed Area II, and there are few hotspots in Closed Area I (Map 5). Given that the existing habitat closures are within the boundaries of the groundfish closures, the habitat closure elements of the No Action alternatives do not really afford any additional groundfish spawning benefits beyond those provided by the groundfish closures. The spawning benefits associated with these areas are discussed more fully in the analysis of the spawning alternatives on large mesh groundfish, section 2.3.2.

2.2.4.2 ***Alternative 2***

Alternative 2 proposes no habitat management areas for the Georges Bank sub-region, and positive impacts associated with existing habitat and groundfish management areas would be lost if the areas were removed. This alternative is therefore expected to have highly negative impacts on juvenile groundfish habitat compared to Alternative 1/No Action and other alternatives in this section, and could reduce groundfish productivity. In addition, Alternative 2 is expected to have negative impacts for groundfish stocks as compared to Alternative 1/No Action, or any of the other alternatives, via removal of the year round groundfish closures (Closed Area I, and particularly Closed Area II). However, the spawning alternatives for this region mitigate these impacts for stocks that spawn during February, March, and early April, when the areas would remain as spawning closures under either of the action spawning alternatives for this region. The No Action alternative for spawning protection in this region would maintain the areas year round. If an action spawning alternative is selected, the primary impacts of removing the Closed Area I and II habitat and groundfish closures would be on stocks that spawn outside the February to April window. Thus, depending on the spawning alternative selected, this alternative has neutral (Spawning Alternative 1) to slightly negative (Spawning Alternatives 2 or 3) impacts on groundfish spawning.

2.2.4.3 ***Alternative 3***

Alternative 3 includes the Northern Edge HMA, which largely overlaps the existing Closed Area II Habitat Closure but extends into slightly deeper water on the northern edge. It is not a preferred alternative. The total number of weighted age 0/1 groundfish hotspots was 34.5 in the fall and zero in other survey seasons (Table 9).

This alternative would have slightly negative effects on groundfish habitat relative to that for Alternative 1/No Action, i.e. the alternative would have moderately positive impacts on the resource. The amount of protection of habitat for age 0/1 and larger sub-legal cod is about the same as No Action (Map 17), but the protection of habitats where age 0/1 haddock are present is

considerably less than Alternative 1/No Action. However, an important caveat is that the areas where age 0/1 haddock are abundant (Map 18) and where hotspots occur (Map 16) are already fished by both multispecies trawl and scallop dredge access programs. Haddock and red hake hotspots are present in the proposed Northern Edge HMA (Table 10). Moderately positive impacts are expected if the alternative is implemented with option 1 or 2, as clam dredging is not permitted in the area overlapping the Northern Edge HMA. If option 3 or 4 is selected, the alternative would have highly negative impacts, similar to Alternative 2.
Similar to Alternative 2, depending on the spawning alternative selected for the Georges Bank region, this alternative has neutral (Spawning Alternative 1) to slightly negative (Spawning Alternatives 2 or 3) impacts on groundfish spawning. Mobile bottom-tending gear restrictions in the Northern Edge HMA would likely afford a slightly positive spawning benefit if Option 1 or 2 is selected. While fixed gears capable of catching groundfish would be allowed in the area, gillnet use on the northern edge of Georges Bank is fairly limited, and contributes a very small fraction of overall revenues in the currently open portions of the HMA. Longline gear appears to be more frequently used in the currently open portions of the HMA, based on the distribution of revenue by gear type. If longline use expands in the HMA if the Closed Area II groundfish closure is removed, this could reduce any positive benefits of the Northern Edge HMA on spawning groundfish. If management options 3 or 4 are selected, the HMA would not afford any spawning protection benefits.

2.2.4.4 ***Alternative 4***

Alternative 4 includes the same Northern Edge HMA as Alternative 3, but also includes a Georges Shoal Gear Modification Area (GMA). While any level of habitat management measures could apply to the Northern Edge area, only limits on ground cables would apply in the Georges Shoal GMA, which is entirely outside and west of Closed Area II and the existing habitat closure area.

The total weighted hotspots for Alternative 4 are the same as Alternative 3 (Table 9), with slightly more red hake hotspots, which were not part of the weighted totals (Table 10). Weighted and species hotspots are considerably fewer than those for Alternative 1/No Action. The expected impacts on groundfish habitat and groundfish stocks are therefore slightly negative compared to Alternative 1/No Action, and about the same as Alternative 3, based on the number of weighted hotspots and on the expected effect of gear modifications, i.e. the alternative would have moderately positive impacts on the resource if implemented with option 1 or 2. As with Alternative 3, If option 3 or 4 is selected, the alternative would have highly negative impacts, similar to Alternative 2.

Alternative 4 is expected to have the same negative impacts on groundfish spawning as Alternative 3, given that the additional gear modification area included in the alternative would not prohibit the use of any gear types capable of catching groundfish.

2.2.4.5 ***Alternative 5***

Alternative 5 includes a much larger Northern Georges Gear Modification Area, which overlaps the Closed Area II Habitat Closure, the northern portion of Closed Area II, and the Northern Edge HMA, and the Georges Shoal 1 mobile bottom-tending gear closure area. These areas

together contain fewer weighted age 0/1 groundfish hotspots than any other alternative except for Alternative 2 which includes no habitat management areas (Table 9).

The Alternative 5 HMAs have fewer hotspots for haddock and red hake, but slightly more winter flounder hotspots (Table 10). Both age 0/1 and older sublegal cod and haddock are present in the gear modification area, although many of the larger catches of cod are within the existing closure, or Canadian waters. There are virtually no cod or haddock juvenile catches in the proposed Georges Shoal 1 mobile bottom-tending gear HMA (Map 20, Map 21). Because the Northern Edge GMA is larger and extends into deeper water than the Georges Shoal GMA included in Alternative 4, there does appear to be the potential for added protection for age 0/1 and juvenile haddock on the northern perimeter of Georges Bank (compare Map 21 to Map 18), depending on the effect of gear modifications, which are uncertain.

Presuming negligible impacts associated with the gear modification area, and based on the amount of weighted hotspots and the distribution of age 0/1 and older sublegal cod and haddock, the expected impacts on groundfish habitat and groundfish stocks is expected to be highly negative. Impacts would be negative compared to Alternative 1/No Action. Impacts are also expected to be negative relative to Alternatives 3 and 4 assuming that Option 1 (mobile bottom-tending gear prohibition) is selected for the Northern Edge HMA. Alternative 5 has the potential to have more positive impacts than Alternatives 6A and 6B for some age 0/1 juvenile groundfish habitat, particularly for haddock and to a lesser extent, cod, if Option 3 or 4 (gear modification) is chosen for Alternatives 6A and 6B. A mobile bottom-tending gear closure in 6A and 6B would have more positive impacts than a larger gear modification area, however. Based on the distribution of age 0/1 groundfish weighted hotspots and the distribution of age 0/1 and older juvenile cod and haddock, the impacts of Alternative 5 are expected to be neutral with respect to Alternative 7 and negative relative to the large mobile bottom-tending gear closure in Alternative 8, which includes much of the area encompassed by the gear modification area in this alternative. Alternative 5 is expected to have negative impacts relative to Alternatives 9 and 10.

Similar to Alternative 2, depending on the spawning alternative selected for the Georges Bank region, this alternative has neutral (Spawning Alternative 1) to slightly negative (Spawning Alternatives 2 or 3) impacts on groundfish spawning. There are very few large spawner hotspots that overlap the Georges Shoal 1 mobile bottom-tending gear closure, and the gear modification area included in the alternative would not prohibit the use of any gear types capable of catching groundfish.

2.2.4.6 ***Alternatives 6A and 6B***

Alternative 6A (EFH Expanded 1 HMA) expands the Closed Area II Habitat Closure west to 67º30’ W longitude, encompassing additional areas of vulnerable substrate and juvenile groundfish habitat. Map 22 shows the total number of weighted age 0/1 groundfish hotspots by season. The amount of age 0/1 groundfish unweighted and weighted hotspots (Table 9) is similar to Alternative 5, and less than Alternatives 3 and 4. The total weighted hotspots are more than Alternative 7 and slightly less than Alternative 8.

Although there are few cod and haddock hotspots identified on the U.S. portion of the northern edge, protection for cod and haddock can be evaluated by examining the distribution of all

survey catches of age 0/1 and age 2+ juvenile cod and haddock. One caveat that should be considered when interpreting these results is the effect that fishing has on abundance and presence of juvenile groundfish, i.e. selectivity is higher for age 2+ juveniles.

During the spring and fall (Map 23) most of the age 0/1 cod are in Canadian waters, but there are more catches of age 2+ juvenile cod in U.S. waters, particularly during the spring and summer. Most of the age 2+ cod were observed within the boundary of the existing Closed Area II Habitat Closure. For juvenile cod, expansion of the existing area (as would be the case with Alternative 6A) does not appear to provide additional protection, and there may be less protection relative to the combined habitat and groundfish areas in Alternative 1/No Action. However, the generalized additive model habitat suitability analysis (Appendix F) indicated that both the existing habitat closure and areas to the west are important age 0/1 cod habitat.

Catches of age 0/1 and age 2+ juvenile haddock (Map 24) are more prevalent to the west of the existing habitat closure, an area partially encompassed by the EFH Expanded 1 HMA/Alternative 6A. However, this HMA misses a notable concentration of survey catches extending further to the southwest. Although Alternative 6A includes some locations having age 0/1 and age 2+ haddock, particularly in the spring and summer surveys, it is doubtful that this additional protection completely compensates for the high abundance of haddock in the southern part of Closed Area II, even though the southern area has less vulnerable substrate.

Based on the amount of weighted hotspots and the distribution of age 0/1 and older juvenile cod and haddock, the expected impacts on groundfish habitat and groundfish stocks are expected to be slightly negative compared to Alternative 1/No Action, and slightly positive compared with Alternatives 3 and 4. The assessment of impacts relative to Alternative 1/No Action is made considering the fact that most of Closed Area II is open to mobile bottom-tending gear fishing through haddock and yellowtail flounder special access programs using modified trawls and to periodic scallop fishing in the southern portion of Closed Area II. This also assumes that the 'EFH Expanded 1' (i.e., 6A) area is closed to fishing with mobile bottom-tending gears. If another option is chosen that only requires modified gear, this alternative has considerably more negative impacts on juvenile groundfish habitat protection, compared to Alternative 1/No Action, i.e. highly negative impacts on the groundfish resource. Given that only a small fraction of the area could be fished with hydraulic dredges given the overlapping PSP closure, option 2 is expected to have similar impacts to option 1, perhaps slightly fewer benefits for groundfish.

Impacts on age 0/1 juvenile groundfish habitat compared to Alternative 6B are also expected to be positive, since about half of the hotspots are in the eastern portion of the EFH Expanded 1 area which would be removed under Alternative 6B, and the eastern area also has a substantial fraction of age 0/1 and older juvenile presence of haddock and a greater fraction of cod. The impacts are highly positive compared to Alternative 7, which includes areas that contain few age 0/1 groundfish hotspots and few catches of juvenile haddock and cod. Alternative 8 (discussed further below) encompasses the two Alternative 7 HMAs plus additional areas to the west. Although Alternative 8 does not include any additional age 0/1 groundfish hotspots, the western portion of Alternative 8 encompasses considerable survey catches of age 0/1 and older juvenile haddock, particularly in the fall. Impacts on age 0/1 juvenile groundfish habitat relative to Alternative 8 are therefore negative.

Like Alternative 6A, Alternative 6B would extend the existing Closed Area II Habitat Closure Area west to 67º30' W longitude to create the EFH Expanded 2 HMA. An eight nautical mile 'buffer' between the proposed Habitat Management Area and the Exclusive Economic zone would be open to all fishing gears. This modification re-opens all but about a third of the existing habitat closure to fishing, including the more vulnerable substrates found on the northern edge of Georges Bank. Map 22 shows the total number of weighted age 0/1 groundfish hotspots overlapping this area by season. The numbers of unweighted and weighted age 0/1 groundfish hotspots in Alternative 6B are fewer than any alternative other than Alternative 2 (Table 9), and the area has fewer age 0/1 groundfish hotspots than the existing habitat closure area. Examining the distribution of age 0/1 and age 2+ juvenile cod and haddock catches in survey tows (Map 23 and Map 24), a substantial fraction of high-catch tows are in the 8-mile buffer that would be outside the habitat management area and open to fishing by vessels using mobile bottom-tending gears.

While it may be true that the existing fishing activity immediately west of the current habitat closure removes small cod and haddock and other groundfish that rely on vulnerable substrates (and there has been a detrimental effect of fishing on that habitat), the existing data indicate that this alternative would have only slight positive impacts on groundfish and their habitats. Alternative 6B is expected to have a negative impact on juvenile groundfish habitat relative to Alternative 1/No Action and also relative to all but Alternatives 2 and 7, regardless of the management option selected. Alternative 6B would have positive impacts on age 0/1 juvenile groundfish habitat relative to Alternatives 2 and 7 since neither contains weighted age 0/1 juvenile groundfish hotspots and appear to provide little protection for age 0/1 and older juvenile haddock and cod. Options 1 and 2 are expected to provide similar, slightly positive benefits, fewer for option 2, given that most of the area would remain closed to hydraulic dredges. With option 3 or 4, Alternative 6B would have highly negative impacts.

Similar to Alternative 2, depending on the spawning alternative selected for the Georges Bank region, this alternative has neutral (Spawning Alternative 1) to slightly negative (Spawning Alternatives 2 or 3) impacts on groundfish spawning. Spawning benefits associated with the EFH Expanded HMAs proposed in these alternatives would be slightly positive, similar to those identified for Alternative 3, and would provide some limited protection for spring and fall spawners, given the overlap with spring and fall large spawner hotspots.

2.2.4.7 ***Alternative 7***

Alternative 7 proposes two habitat management areas as mobile bottom-tending gear closures (Options 1 or 2). The EFH South Mobile Bottom Tending Gear HMA overlaps the southern part of the existing habitat closure and about a third of the proposed area is within Closed Area II Groundfish Closure Area, but outside the existing habitat closure. Alternative 7 also includes the Georges Shoal 2 Mobile Bottom Tending Gear HMA to the west of Closed Area II, in the high energy environment on the top of Georges Bank dominated by semi-permanent sand ridges and swales. No age 0/1 groundfish hotspots occur in either area (Table 9) and this alternative allows more fishing in the habitat closure area than most other Georges Bank sub-region alternatives (with the exception of Alternative 2). This existing area tends to have more age 0/1 groundfish

hotspots (Map 25), as well as more catches of age 0/1 and juvenile cod and haddock (see Map 26).

Even broadening the scope of the analysis to include all juvenile cod and haddock, age 0/1 and age 2+ immature fish, for all tows (not just those representative of hotspots) does not suggest any high degree of association of juvenile cod and haddock with habitat in the Alternative 7 areas. During 2002-2012, catches of age 0/1 cod and older juvenile cod were nearly absent from the Alternative 7 HMAs (Map 26). Relative to neighboring areas, few older juvenile haddock (25-40 cm) were captured in 2002-2011 spring trawl surveys in the northern portion of the EFH South Mobile Bottom Tending Gear, but this area of average catches appears to be associated with a concentration of haddock extending to the north of the proposed area, within the existing habitat closure area (see Map 27, left panel).

There were some comments during scoping that juvenile cod and haddock distributions may have been historically different, when stock size (and environmental conditions) were different than they are today. Comparable trawl survey data are available as early as 1963 in the NMFS fall survey and 1967 in the NMFS spring survey. An early 2013 exploratory hotspot analysis of historic cod distributions by the Closed Area Technical Team did not indicate substantially different historical patterns of hotspot distribution. Visual examination of the trawl survey juvenile cod catch distribution in 1982-1991 (Map 28) and particularly in 1972-1981 (Map 29) suggest that juvenile cod were more widespread across Georges Bank than they are today. There does not, however, appear to be any greater historic concentration of age 0/1 and larger juvenile cod in the proposed Alternative 7 HMAs.

Alternative 7 appears more likely than almost any alternative to redistribute hydraulic clam dredge effort into areas with more juvenile groundfish hotspots (weighted to favor species that are have low biomass relative to B_{MSY} and are associated with hard substrates), and also into areas that have higher concentrations of age 0/1 cod and haddock. It is difficult to assess whether clam dredge effort is more likely to shift to east into more vulnerable habitats, or to the west towards Cultivator Shoals, over the long term. The areas proposed for a mobile bottom-tending gear closure are generally in a high energy environment dominated by sand ridges on top of Georges Bank. Neighboring areas on northern Georges Bank tend to have lower energy and are more dominated by gravel and cobble substrates. Because relatively limited bottom trawling and especially scallop dredging occur in the Georges Shoal 2 HMA, limited redistribution of effort with these gear types is expected.

Thus, based on existing data and analysis described above, Alternative 7 is likely to have a highly negative impact on age 0/1 groundfish habitats because important habitat areas would not be protected from fishing gears impacts. Impacts would be negative compared to No Action. Moreover, the impacts on age 0/1 groundfish habitats are likely to be negative compared with all other Georges Bank habitat management alternative, potentially even Alternative 2, which would not shift fishing effort away from areas with high energy and sand dominated substrates, where few age 0/1 cod, haddock and juvenile groundfish hotspots were identified.

Similar to Alternative 2, depending on the spawning alternative selected for the Georges Bank region, this alternative has neutral (Spawning Alternative 1) to slightly negative (Spawning

Alternatives 2 or 3) impacts on groundfish spawning. The EFH South and Georges Shoal 2 mobile bottom-tending gear HMAs proposed in this alternative would have a slight benefit for fall spawners. The Georges Shoal 2 area, which is currently open to fishing, has very limited longline revenues, and no gillnet revenues. Thus, a restriction on mobile bottom-tending gears only would potentially reduce groundfish removals significantly, unless a mobile bottom-tending gear restriction causes an increase in fixed gear usage. It is more difficult to predict potential increases in the EFH South HMA, which is currently closed to most types of fishing as it overlaps the Closed Area II habitat and groundfish closures.

2.2.4.8 ***Alternative 8***

Alternative 8 proposes a single large Northern Georges Mobile Bottom Tending Gear HMA covering most of northern Georges Bank, from the Exclusive Economic Zone boundary to Georges Shoal, including some deeper water off the northern edge of the bank. In size, it is about two thirds of the area covered by Closed Area II (1,396 vs. 2,001 nm^2) and includes all of the existing Closed Area II Habitat Closure. It does not include the groundfish hotspots in the southern portion of Closed Area II. In the spring and summer, it contained 6 and 15 total age 0/1 groundfish hotspots, respectively, but no hotspots weighted in favor of vulnerable species or species associated with hard substrates (Table 9). In the fall, Alternative 8 contained 35 total age 0/1 groundfish hotspots and with a weighted hotspots score of 40.3, compared to 51 and 46.0, respectively, for Alternative 1/No Action.

Broadening the scope of the analysis to include larger cod and haddock juveniles, compared to Alternatives 3,7, 9, and 10 the mobile bottom-tending gear area proposed by this alternative does not encompass many additional above average catches of juvenile cod (Map 26). However, larger juvenile cod are less associated with structured hard substrates than are age 0/1 cod and the southern portion of Closed Area II generally has more mobile, sandy substrates than northern Georges Bank does. On the other hand, during 1982-1991 the area would have encompassed age 0/1 cod in the spring and age 2+ juvenile cod in the spring and fall, west of the existing habitat closure (Map 28). This general pattern of juvenile cod distribution was also apparent in 1972-1981 (Map 29), although the spring distribution of juvenile cod catches were generally indistinguishable from a broad distribution of juvenile cod catch across most of Georges Bank during this period. Whether this difference in cod distribution within Alternative 8 is related to changes in temperature or stock size is difficult to say with existing data. During 2002-2012, age 0/1 and 2+ juvenile haddock catches are apparent along the edge of Georges Bank within the Alternative 8 (Map 27). However, juvenile haddock are rather broadly distributed on eastern Georges Bank.

With respect to age 0/1 juvenile groundfish habitat and presence, Alternative 8 is expected to be neutral or slightly negative compared to No Action. Some species such as juvenile cod and haddock that inhabit the hard substrates on Northern Georges Bank are likely to be positively impacted by this alternative while other species such as yellowtail flounder are likely to have slightly negative impacts from changes in the distribution of fishing effort. However, when making this comparison, it has to be kept in mind that the southern portion of Closed Area II is often open to restricted fishing activity through specific access programs using mobile bottom tending gear, such as trawls and dredges. Alternative 8 is likely to have moderately to highly positive impacts on age 0/1 groundfish habitat compared with other Georges Bank sub-region

alternatives, simply because the proposed mobile bottom-tending gear closure would encompass more area with hard substrates where juvenile cod and haddock exist. The most benefits will be realized under option 1. If hydraulic dredges were exempted under option 2, there would be fewer positive impacts associated with the alternative.

Depending on the spawning alternative selected for the Georges Bank region, this alternative has neutral (Spawning Alternative 1) to slightly negative (Spawning Alternatives 2 or 3) impacts on groundfish spawning. The majority of the revenues from the Northern Georges mobile bottom-tending gear HMA come from bottom trawls and scallop dredges, which would be restricted within the HMA. The relative use of these various gears, combined with large size of the HMA, will likely provide more positive impacts to spawning groundfish than other new HMAs in this sub-region. These benefits would be most likely to accrue to fall spawning groundfish, because the spring spawners will already be protected under the spawning management alternatives, and the fall large spawner hotspots are shifted west into currently open areas within the proposed HMA.

2.2.4.9 ***Alternative 9***

Alternative 9 was developed to build on Alternative 7, moving the Georges Shoal 2 MBTG HMA to the northeast (=Western HMA), expanding the EFH South HMA (=MBTG Closure), and adding a groundfish mortality closure north of the EFH South HMA (=Mortality Closure). Alternative 9 would prohibit mobile bottom tending gear from the MBTG Closure and Western HMA, and the mortality closure would have the restrictions associated with Closed Area II. Presumably this could include scallop access fishing pending additional action in the scallop FMP.

Juvnile groundfish hotspots and abundance were examined for overlaps with the Alternative 9 managements relative to their overall distribution on Georges Bank. Five species, cod (Map 31), haddock (Map 32), winter flounder (Map 33), yellowtail flounder (Map 34), and windowpane flounder (Map 35) were examined for the same time period evaluated in the hotspot analysis, 2002-2012. There are a few juvenile groundfish hotspots within Alternative 9 areas. The weighted hotspot total for the alternative was 11.50 (Table 9, Map 30). Collectively, the three areas contain hotspots for haddock (Table 10, Map 32), winter flounder (Table 10, Map 33), and yellowtail flounder (Table 10, Map 34). Of these species, only haddock were included in the weighted hotspot analysis due to affinity with coarse substrates.

In terms of overall distribution of fish in survey catches and associated hotspots, cod are most abundant on the northern edge and northeast peak in Canadian waters, as well as west of Closed Area I. Some larger catches, but no hotspots, overlap the Mortality Closure and Eastern HMA. For haddock, there are some hotspots within the Mortality Closure, but hotspots are more numerous in the southern portion of Closed Area II, as well as north of the Mortality Closure and east toward the northeast peak in Canadian waters. There are also haddock hotspots overlapping Closed Area I. There are only a small number of positive tows for haddock in the Western HMA, and no hotspots. Winter flounder hotspots are concentrated within and west of the Mortality Closure and Eastern HMA, plus in areas west of Closed Area I. Winter flounder age 0/1 juveniles are often captured in the Western HMA, although there are no hotspots there. Age 0/1 yellowtail flounder catches are broadly distributed on eastern Georges Bank, with a few hotspots

on the northeast peak. Some larger catches do occur in the Altenative 9 areas, but the larger Closed Area II (No Action) and Northern Georges HMA (Alternative 8) better encompass positive survey tows of age 0/1 yellowtail. Positive age 0/1 windowpane catches occur in shallower waters towards the center of the bank, with a few hotspots adjacent to the Eastern HMA, and some catches in the Western HMA. The deeper Mortality Closure does not appear to be a habitat used by age 0/1 windowpane.

Alternative 9 is expected to protect habitats used by cod, haddock, winter flounder, yellowtail, and to a lesser extent, windowpane flounder. Winter flounder in particular have a high degree of overlap with the Alternative 9 HMAs. Among the three HMAs, the Mortality Closure has the best overlap with high catches of haddock and cod, and the Eastern and Western HMAs have less overlap. However, relative to Alternative 1/No Action, Alternative 9 will protect less habitat overall, which could lead to negative impacts for some stocks relative to existing management. While cod are concentrated in areas that would remain under management, the mortality closure would likely be fished on a rotational basis under this alternative, and such fishing could occur year round subject to overlapping spawning closures. Haddock catches and hotspots also overlap the Mortality Closure, where fishing would be limited, but habitats in the northern part of Closed Area I would reopen to many types fishingScallop dredging would remain a rotational activity in southern Closed Area II as Alternative 9 would not modify the access fishery program, but groundfishing restrictions would be lifted except during spawning closures, which could impact juvenile haddock and yellowtail flounder that are relatively abundant in the area. However, this concern is mitigated somewhat as the habitat types in southern Closed Area II are lower vulnerability.

Considering the overlaps with groundfish stocks, the size and fishing restriction measures associated with the three areas, and relative habitat vulnerability (higher along margin of bank including in Alternative 9 HMAs, lower in other parts of existing closures), Alternative 9 likely has moderately positive impacts on juvenile large mesh groundfish and their associated habitats, but fewer positive impacts than Alternative 1/No Action. With Option 2, Alternative 9 is expected to provide fewer benefits, i.e. slightly to moderately positive impacts on the resource, because the Western HMA is an important clam dredging area and this gear would adversely impacts habitats in the HMA.

2.2.4.10 ***Alternative 10 (Preferred Alternative)***

Alternative 10, which combines elements of Alternatives 7 and 9, is the preferred alternative for habitat protection on Georges Bank. It includes the Georges Shoal 2 Habitat Management Area from Alternative 7 as a closure to all mobile bottom-tending gears, with a one-year exemption for hydraulic clam dredges pending development of a framework adjustment to consider longer term access. Similart to Alternative 9, Alternative 10 includes two areas on the northern edge of Georges Bank. The area furthest to the northeast was approved as a Reduced Impact Habitat Management Area, and an adjacent area to the south was approved as a mobile bottom-tending gear closure. Although the overall footprint of the two areas is the same, compared to Alternative 9, the mobile bottom-tending gear closure is slightly larger in Alternative 10. The Reduced Impact HMA would allow limited fishing access for bottom trawls and scallop dredges. West of 67° 20’ W only, groundfish trawling would be allowed consistent with current special access program regulations, and scallop dredges could be fished via a rotational access program

throughout the Reduced Impact HMA. Clam dredges would be prohibited throughout. Due to concerns about impacts to the lobster fishery and resource, any portions of what is currently known as Closed Area II north of 41°30' N would be closed to the scallop fishery between June 15th and October 31st.

Juvnile groundfish hotspots and abundance were examined for overlaps with the Alternative 10 managements relative to their overall distribution on Georges Bank. Five species, cod (Map 31), haddock (Map 32), winter flounder (Map 33), yellowtail flounder (Map 34), and windowpane flounder (Map 35) were examined for the same time period evaluated in the hotspot analysis, 2002-2012. There are a few juvenile groundfish hotspots within Alternative 9 areas. The weighted hotspot total for the alternative was 11.50 (Table 9, Map 30). Collectively, the three areas contain hotspots for haddock (Table 10, Map 32) and winter flounder (Table 10, Map 33). Of these species, only haddock were included in the weighted hotspot analysis due to affinity with coarse substrates.

In terms of overall distribution of fish in survey catches and associated hotspots, cod are most abundant on the northern edge and northeast peak in Canadian waters, as well as west of Closed Area I. Some larger catches, but no hotspots, overlap the Mortality Closure and Eastern HMA. Few cod are caught in the Georges Shoal 2 HMA. For haddock, there are some hotspots within the Reduced Impact HMA, but hotspots are more numerous in the southern portion of Closed Area II, as well as north of the Reduced Impact HMA and east toward the northeast peak in Canadian waters. There are also haddock hotspots overlapping Closed Area I. The Georges Shoal HMA does not appear to be a habitat heaviliy used by haddock. Winter flounder hotspots are concentrated within and west of the Reduced Impact HMA and Mobile Bottom-Tending Gear HMA, plus in areas west of Closed Area I. Winter flounder age 0/1 juveniles are captured in the Georges Shoal 2 HMA, although there are no hotspots there. Relative to Alternative 9, the Georges Shoal 2 HMA appears to align less well with the distribution of age 0/1 winter flounder than the Western HMA, but the larger MBTG HMA in Alterantive 10 would likely benefit winter flounder as compared to the Alternative 9 Eastern HMA.

This comparison between Alternatives 9 and 10 also holds for yellowtail flounder. Age 0/1 yellowtail flounder catches are broadly distributed on eastern Georges Bank, with a few hotspots on the northeast peak. Some larger catches do occur in the Altenative 10 areas, but the larger Closed Area II (No Action) and Northern Georges HMA (Alternative 8) better encompass positive survey tows of age 0/1 yellowtail. Positive age 0/1 windowpane catches occur in shallower waters towards the center of the bank, with a few hotspots adjacent to the MBTG HMA, and some catches in the Georges Shoal 2 HMA, with an adjacent hotspot, indicating at least a localized area of high juvenile abundance. The deeper Reduced Impact HMA does not appear to be a habitat used by age 0/1 windowpane.

Alternative 10 is expected to protect habitats used by cod, haddock, winter flounder, yellowtail, and windowpane flounder. Winter flounder in particular have a high degree of overlap with the Alternative 10 HMAs. However, compared to Alternative 9's Western HMA, the Georges Shoal 2 HMA overlaps less well with juvenile cod, yellowtail, and winter flounder distributions. Among the three HMAs, the Reduced Impact HMA has the best overlap with high catches of haddock and cod. However, the Reduced Impact HMA would likely be fished on a rotational

basis under this alternative. In this regard, the advantage of Alternative 10 as compared to Alternative 9 from a juvenile groundfish perspective is that the seasonal closure element of Alternative 10 would restrict scallop dredging in the Reduced Impact HMA during June 15-October 31, when age-0 groundfish hatched in the spring may be settling to the seabed and are small and vulnerable.

However, relative to Alternative 1/No Action, Alternative 10 will protect less habitat overall, which could lead to negative impacts for some stocks relative to existing management. Habitats in the northern part of Closed Area I, where age 0/1 haddock are relatively abundant, would reopen to many types fishing. Relevant to impacts on haddock and yellowtail, groundfishing restrictions in southern Closed Area II would be lifted except during spawning closures. Scallop dredging would remain a rotational activity as Alternative 9 would not modify the access fishery program, such that scallop dredge effects on haddock and yellowtail habitats in southern CAII would remain similar to what they are now. Concerns about these habitats are mitigated somewhat as the habitat types in southern Closed Area II are lower vulnerability.

Allowing scallop fishery access in the Reduced Impact HMA and expanding the size of the access area in CAI could potentially reduce the frequency with which southern Closed Area II is fished, or take pressure off of heavily fished open fishing grounds west of Closed Area I, where juvenile groundfish are relatively abundant. Because this amendment does not specify the access area, possession limit, or rotational access schedule, these claims are somewhat speculative. As discussed in the habitat impacts analysis in Volume 4, 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). Given these recovery times and the frequency with which fishing might occur, combined with the seasonalility of fishing in the HMA and the limits on groundfish trawling and clam dredging, it seems reasonable to conclude that the Reduced Impact HMA would afford conservation benefits to cod, haddock, and other groundfish occurring there, relative to not having a habitat management area in that location.

Considering the three areas proposed for designation, and the measures associated with each area (i.e. possible clam dredging in the Georges Shoal 2 HMA and scallop dredging in the Reduced Impact HMA), Alternative 10 is expected to have moderately positive impacts on cod, haddock, and winter flounder. The slightly larger MBTG closure HMA in Alternative 9 and the seasonal closure during the summer are expected to balance out the lesser overlap with groundfish habitat in the Georges Shoal 2 HMA as compared to the Western HMA. Impacts will ultimately depend on how the scallop access program in the Reduced Impact HMA is designed, and whether or not clam dredges are allowed long term access to all or part of the Georges Shoal 2 HMA. Clam dredges are the most important mobile bottom-tending gear in the Georges Shoal 2 HMA, based on revenue. As decribed previously, Alternative 1/No Action is expected to have positive to highly positive impacts on these stocks. Therefore, Alternative 10 expected to have negative impacts relative to Alternative 1/No Action with respect to juvenile groundfish and their associated habitats.

2.2.5 Great South Channel/Southern New England

The age 0/1 juvenile groundfish hotspots analysis identified very few hotspots in the Great South Channel and Southern New England sub-region. Survey catches here have been generally average or less compared with the entire surveyed area, including the Gulf of Maine and Georges Bank. Habitat Management Areas in this sub-region were chosen partly due to the presence of vulnerable habitat identified in the SASI model and partly due to public input that juvenile cod are prevalent in the proposed areas. Age 0/1 cod are often found on the western side of the Great South Channel, partially covered by some of the Great South Channel alternatives, but these catches were not significantly higher than average survey catches and therefore did not qualify as a statistically valid hotspot. Furthermore, much of the Nantucket Shoals is not routinely surveyed and is not commonly fished on observed trips, so it is difficult to validate the public input regarding the abundance of age 0/1 juvenile groundfish in parts of the proposed areas.

All alternatives except Alternative 1 and 2 include two very small Habitat Management Areas in the vicinity of Cox Ledge. Although Cox Ledge serves as important habitat for some juvenile groundfish, the areas were too small to detect age 0/1 groundfish hotspots. Moreover, the small sizes of these proposed Cox Ledge Areas would be less effective than larger areas for groundfish stocks that generally have much larger ranges of movement. Additionally, detection of any potential effect on stock productivity from a closure here would be very difficult.

Given these data limitations and lack of hotspots, in many cases the effects of the alternatives in this sub-region on age 0/1 juvenile groundfish habitat and the groundfish resource are characterized as uncertain. Some alternatives were assessed as having positive impacts on age 0/1 juvenile groundfish habitat because they have a greater overlap with the distribution of age 0/1 cod in survey catches within the Great South Channel. Nonetheless it is impossible to determine whether the catches in the Great South Channel are higher or lower than they might be in unsurveyed areas. Consideration should be given that juvenile cod catches occur inshore in state waters (although not sufficiently high enough to qualify as hotspots in the Massachusetts DMF survey) and also to the east of the Nantucket Shoals. How many cod and other groundfish are in the Nantucket Shoals and how much they rely on vulnerable substrates there is highly uncertain.

Red and silver hake are not large mesh species and were not included in the weighted hotspot analysis, but their unweighted hotspots are listed in the table of hotspots by species.

Table 11 – GSC/SNE: Total unweighted and weighted age 0/1 juvenile large mesh groundfish hotspots, by season. Individual areas are listed first, followed by combined alternatives.

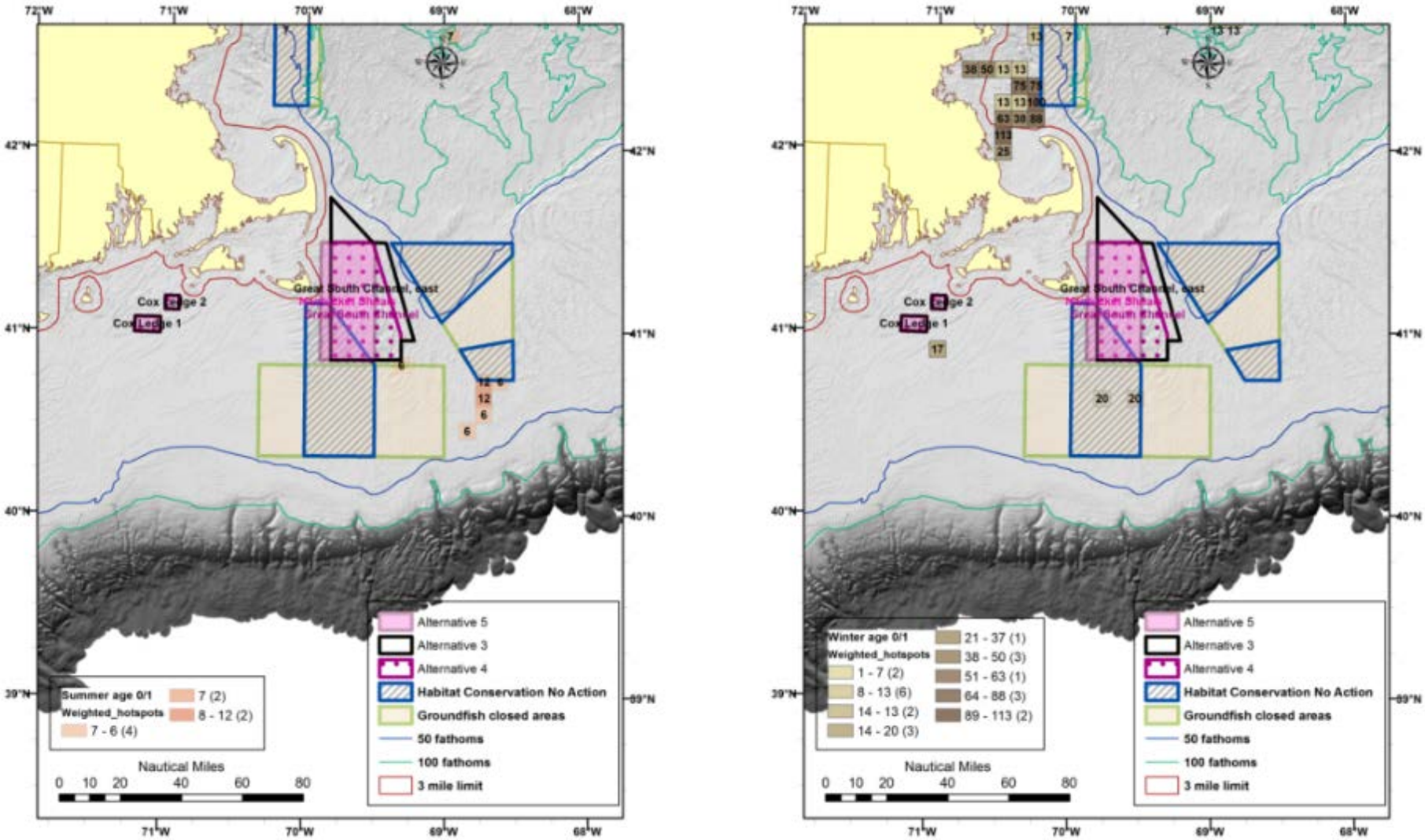
	Spring		Summer		Fall		Winter	
Area name (Alternative)	Number	Weighted	Number	Weighted	Number	Weighted	Number	Weighted
Nantucket Lightship Closed Area (1)	16	0.00	79	5.75	1	0.00	4	40.22
Nantucket Lightship Habitat Closure (1)	10	0.00	54	0.00	0	0.00	2	40.22
Cox Ledge (3-6)	0	0.00	0	0.00	0	0.00	0	0.00
Great South Channel East (3)	0	0.00	0	0.00	9	0.00	0	0.00
Great South Channel (4)	0	0.00	0	0.00	6	0.00	0	0.00

Area name (Alternative)	Spring		Summer		Fall		Winter	
	Number	Weighted	Number	Weighted	Number	Weighted	Number	Weighted
Nantucket Shoals (5)	0	0.00	0	0.00	1	0.00	0	0.00
Nantucket Shoals West (6)	0	0.00	0	0.00	1	0.00	0	0.00
Great South Channel GMA (6)	0	0.00	0	0.00	12	0.00	0	0.00
Alternative 1	16	0.00	79	5.75	1	0.00	4	40.22
Alternative 3	0	0.00	0	0.00	9	0.00	0	0.00
Alternative 4	0	0.00	0	0.00	6	0.00	0	0.00
Alternative 5	0	0.00	0	0.00	1	0.00	0	0.00
Alternative 6	0	0.00	0	0.00	13	0.00	0	0.00

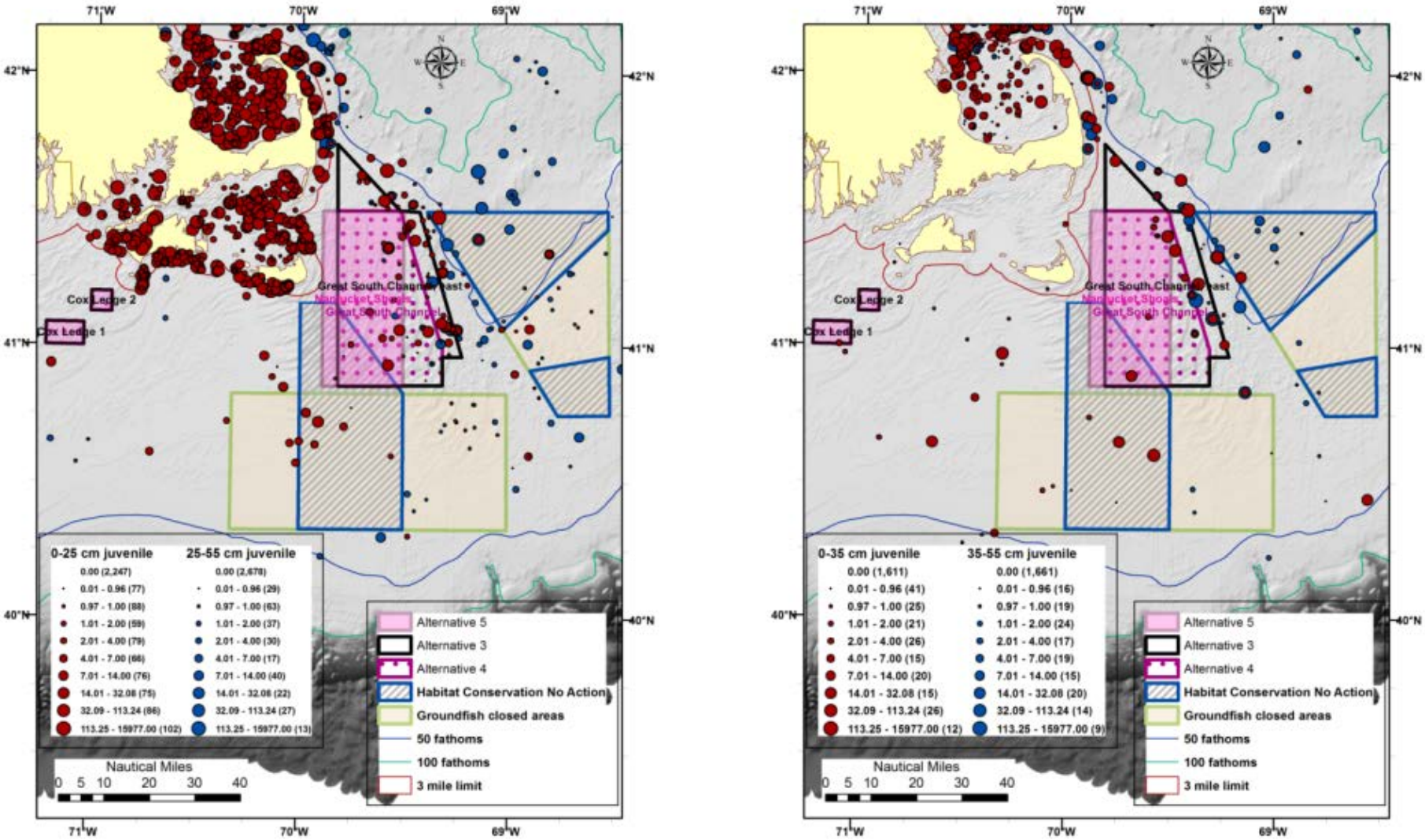
Table 12 – GSC/SNE: Age 0/1 juvenile large mesh groundfish hotspots by species. All seasons are combined. There were no hotspots for redfish, American plaice, halibut, ocean pout, pollock, white hake, yellowtail flounder, or witch flounder in any of the Great South Channel/Southern New England HMAs. Individual areas are listed first, followed by combined alternatives.

Area name (Alternative)	Cod	Haddock	Windowpane	Winter Fl.	Red hake	Silver hake
Nantucket Lightship CA (1)	2	1	1		15	3
Nantucket Lightship Habitat (1)	2				9	1
Great South Channel East (3)				9		
Great South Channel (4)				6		
Nantucket Shoals (5)				1		
Nantucket Shoals West (6)				1		
Great South Channel GMA (6)				10	2	
Alternative 1	2	1	1	0	15	3
Alternative 3	0	0	0	9		
Alternative 4	0	0	0	6		
Alternative 5	0	0	0	1		
Alternative 6	0	0	0	11		

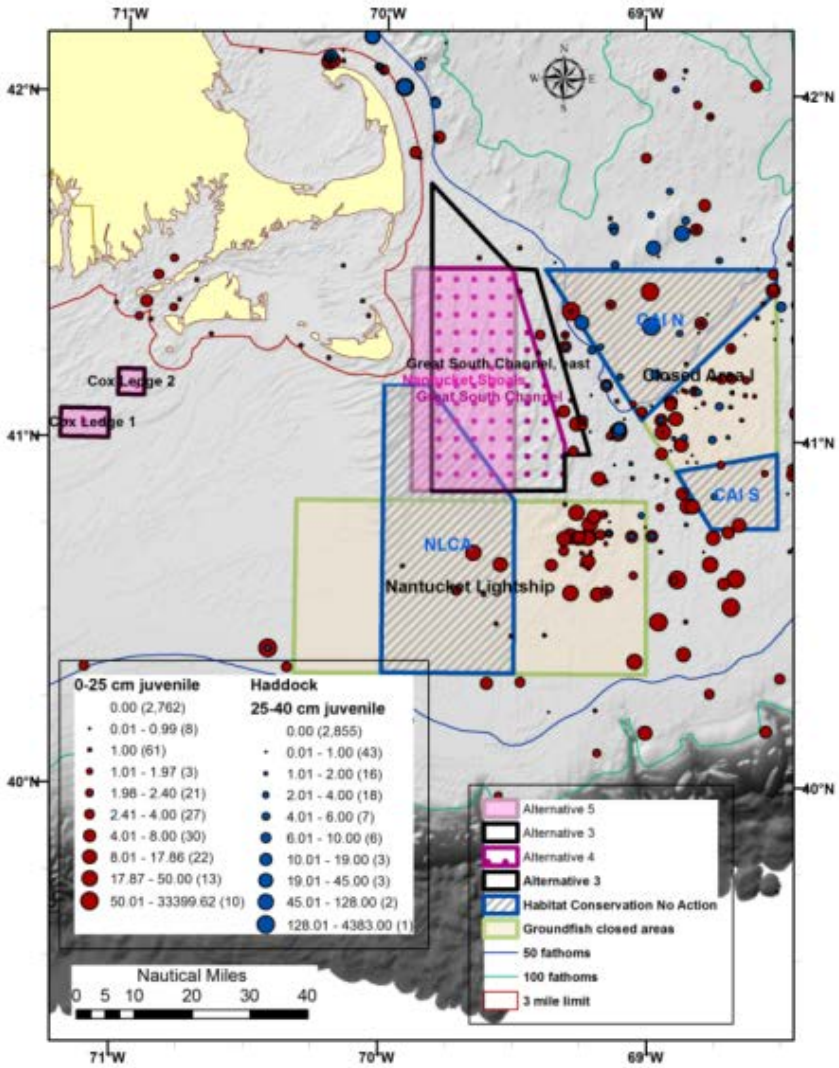
Map 36 – GSC Alternatives 3, 4, and 5 overlap with summer (left) and winter (right) total weighted age 0/1 groundfish hotspots from 2002-2012 NMFS, MADMF, ME-NH, and IBS survey data. There were no spring or fall weighted hotspots overlapping GSC management alternatives.

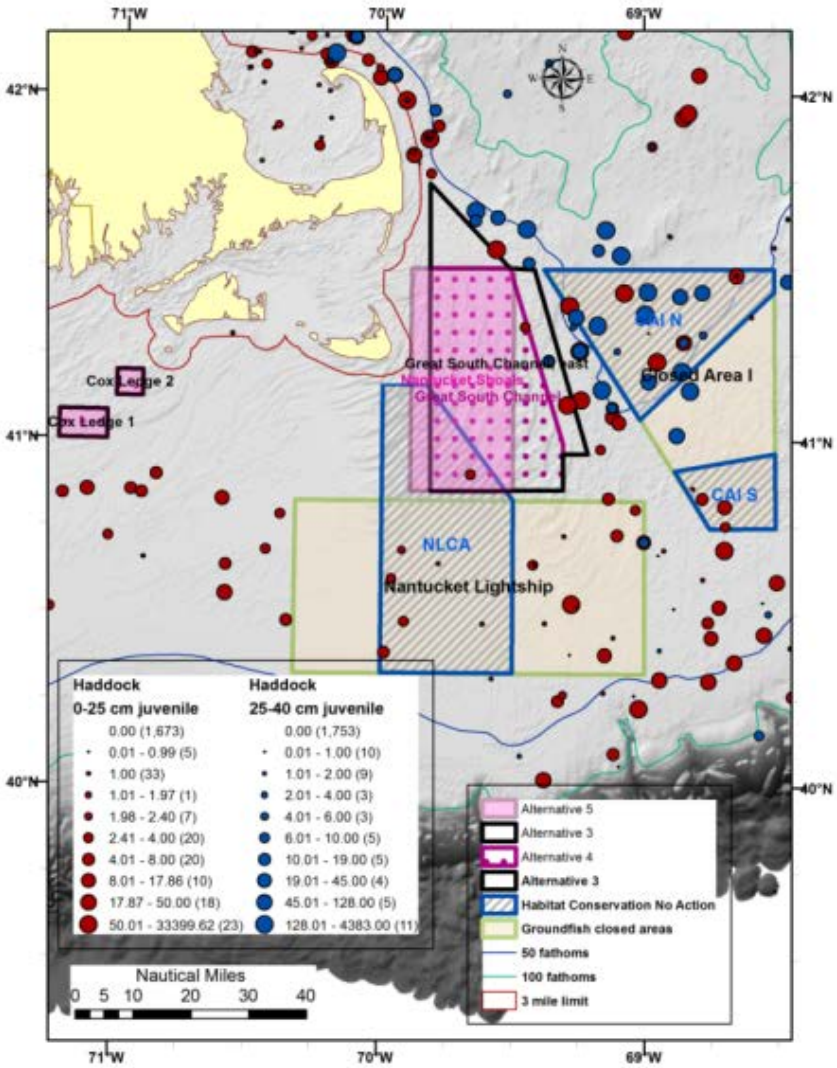


Map 37 – Overlap of GSC Alternatives 3, 4, and 5 with distributions of sub-legal cod number per tow for age 0/1 and age 2+ size classes in 2002-2012 NMFS, MADMF, and IBS surveys. Left panel – spring and summer. Right panel – fall and winter.

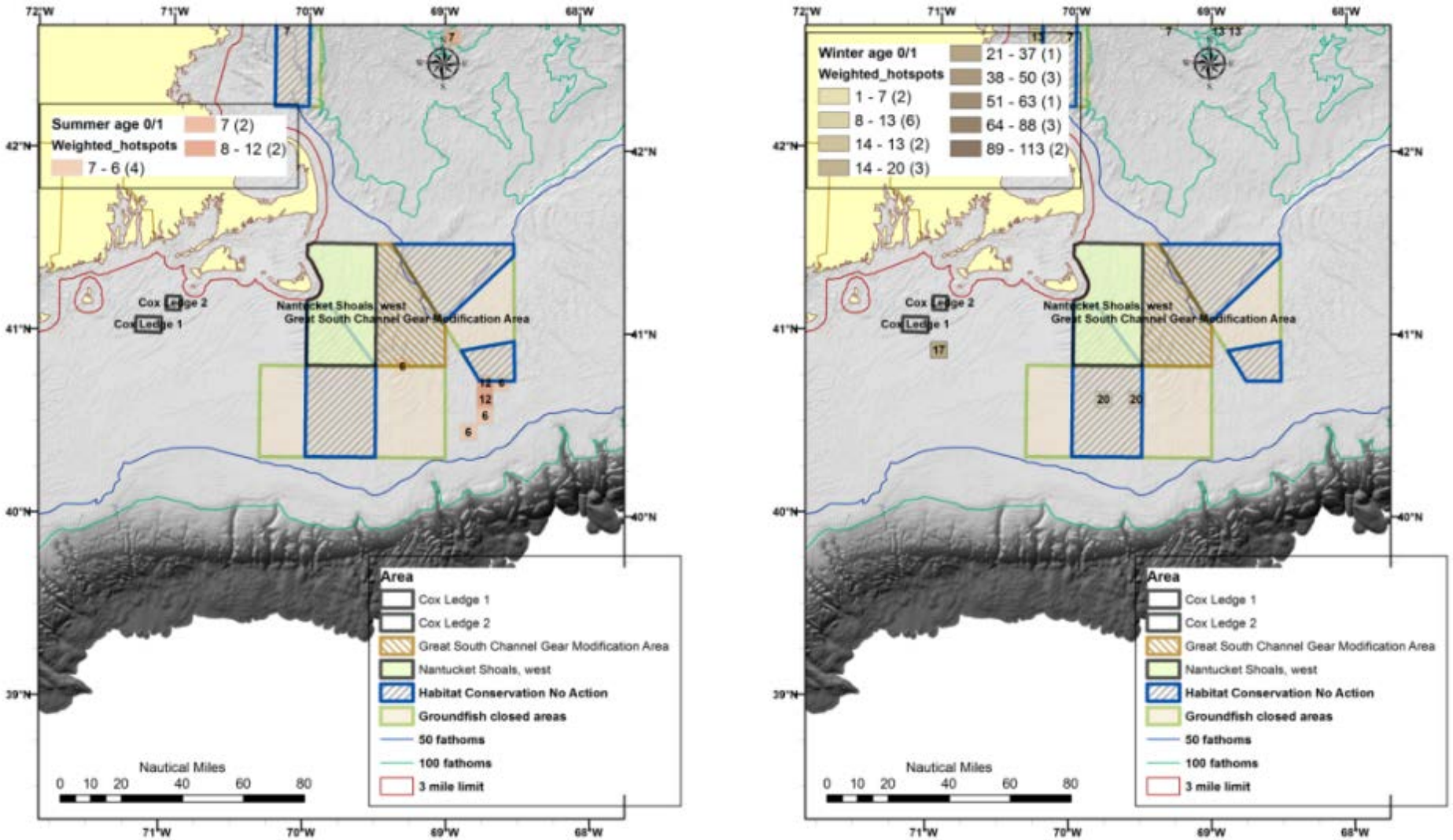


Map 38 – Overlap of GSC Alternatives 3, 4, and 5 with distributions of sub-legal haddock number per tow for age 0/1 and age 2+ size classes in 2002-2012 NMFS, MADMF, and IBS surveys. Left panel – spring and summer. Right panel – fall and winter.





Map 39 – GSC Alternatives 5 and 6 overlap with summer (left) and winter (right) total weighted age 0/1 groundfish hotspots from 2002-2012 NMFS, MADMF, ME-NH, and IBS survey data. Alternative 5 includes the Nantucket Shoals HMA (not shown, but smaller than green shaded area). Alternative 6 includes the Nantucket Shoals west area and a Great South Chanel Gear Modification Area (brown hatching surrounded by a brown border).



2.2.5.1 ***Alternative 1 (No Action)***

Alterntive 1 would maintain the existing closed areas in the Great South Channel/Southern New England, which includes Nantucket Lightship Habitat Closure and the Nantucket Lightship Closure Area. Alternative 1/No Action in the Georges Bank/Southern New England Region includes the Closed Area I, II, and Groundfish Closed Areas. Table 11 summarizes the seasonal unweighted and weighted age 0/1 groundfish hotspots in these areas, with the distribution of the weighted hotspots shown in Map 15. Table 12 provides the number of hotspots by species in each management area. The main data sources used to identify these hotspots included the spring, fall, and winter NMFS trawl surveys and the summer scallop dredge survey. IBS yellowtail flounder and monkfish surveys were also analyzed, but few to no age 0/1 groundfish hotspots were identified from these data. The existing groundfish closure and overlapping part of the existing habitat closure south of 40° 50’ N do not suffer from the same data limitations as some of the other areas in this subregion (see Map 127 in section 4.4.1 of Volume 1), so lack of data does not explain the small number of hotspots.

Judging the effects of year-round groundfish closed areas and habitat closures in this sub-region is complicated by the fact that exemptions for scallop dredges and clam dredges are authorized in the Nantucket Lightship Closed Area. The most important groundfish habitat protection is associated with the habitat closure, which restricts all mobile bottom-tending gears. However total weighted hotspots in the habitat closure were only 40.2 in the winter survey and zero during the other survey seasons (Table 11). The total weighted hotspots in the year-round groundfish closed area were 0.0 in the spring, 5.8 in the summer, 0.0 in the fall, and 40.2 in the winter surveys.

There are some catches of age 0/1 juvenile cod, winter flounder, and yellowtail flounder in the existing closures, indicating habitat for these species exists. However, similar catches of cod and winter flounder occur in the alternative areas proposed in Alternatives 3-6. Yellowtail flounder appears to be more abundant in the existing management areas. Overall, the habitats in the existing closures are not thought to be particularly vulnerable to impact, and the action alternative areas generally are, so it is expected that shifting from the No Action to alternative closures would have positive impacts, in general.

Overall, given the occurrence of some juvenile groundfish within the existing closures, but considering the low vulnerability habitat types present, Alternative 1/No Action is likely having slight positive impacts on juvenile groundfish and their habitats.

2.2.5.2 ***Alternative 2***

Alternative 2 proposes no habitat management areas for the Great South Channel sub-region and therefore no hotspots are encompassed within a habitat management area. This alternative is therefore expected to have negative impacts on groundfish stocks as compared to either Alternative 1/No Action, or any of the other alternatives for this sub-region. Impacts on juvenile groundfish habitat compared to Alternative 1/No Action are uncertain, depending on the amount of effort that shifts into the Nantucket Lightship Closure Area and where it would have occurred if the area remained closed. Effort that shifts from the Great South Channel into the western and central portion of the Nantucket Lightship Closure Area would decrease impacts on juvenile cod

habitat, but increases in the eastern portion of the Nantucket Lightship Closure Area may increase impacts on other groundfish species, such as yellowtail flounder. Impacts on age 0/1 juvenile groundfish habitat from Alternative 2 are expected to be negative compared to other alternatives in this sub-region and could reduce potential improvements in groundfish productivity. Given the relatively small magnitude of positive impacts associated with Alternative 1, removing these areas via Alternative 2 is expected to have slight negative impacts on the groundfish resource.

There are very few large spawner hotspots in the Great South Channel/Southern New England sub-region, such that neither the existing nor any alternative management areas are likely to provide a substantial positive impact on spawning groundfish. All of the action alternatives in this sub-region, including Alternative 2, remove the year-round Nantucket Lightship Groundfish Closed Area, and therefore would have a slight negative impact on groundfish spawning protection.

2.2.5.3 ***Alternative 3***

Alternative 3 includes the Cox Ledge HMA and the Great South Channel East HMA, which includes deeper portions of the Channel as compared to Alternative 4. There were no weighted groundfish hotspots found in the proposed HMAs (Table 11). Relative to Alternative 1/No Action, the impact of this alternative on groundfish habitat and on groundfish stocks is less certain. Much of this uncertainty arises because a large portion of the Nantucket Shoals is unsurveyed and few observed commercial fishing trips occur there. Although there are no weighted hotspots in the two proposed habitat management areas, nine age 0/1 winter flounder hotspots were detected from the fall survey (Table 12). Winter flounder hotspots were given zero weight in the analysis because juveniles are found almost exclusively in less vulnerable mud or sand substrates. Mobile bottom-tending gear restrictions in this area of relatively high winter flounder abudance could still benefit the species through reduced incidental mortality, and through protection of seafloor habitats when age-0 winter flounder are settling to the seabed and particularly susceptible to predation. While the features in low relief sand habitats are expected to recover relatively quickly, minimization of impacts in these habitats may be important during times of settlement. In addition to the Great South Channel, juvenile winter flounder as well as yellowtail flounder overlap the Cox Ledge HMA, although no hotspots for these species overlap the Cox Ledge areas.

Map 37 shows the relationship between the proposed habitat management alternatives and survey catches of age 0/1 and larger sub-legal cod. There appear to be few juvenile cod in the existing habitat closure in any of the seasonal surveys, but there is some overlap with the Great South Channel East HMA. Therefore, Alternative 3 is likely to have positive impacts on cod relative to the No Action alternative. Given the eastern extension into the Great South Channel, Alternative 3 is expected to have positive impacts relative to Alternatives 4,which includes only limited portions of the channel where age 0/1 cod have been observed in survey catches.
Map 38 shows the relationship between Alternative 3 and survey catches of age 0/1 and larger sub-legal haddock. Except for the northeastern part of the Nantucket Lightship Closure Area (which is a scallop dredge access area), and the Gear Modificaiton Area in Alternative 6, there is little overlap of age 0/1 haddock with any management area in this sub-region. Overall, it is

unlikely that any of the alternatives in the sub-region afford substantial benefits to juvenile haddock.

Overall, Alternative 3 with gear option 1 is likely to have slight positive to positive impacts on juvenile groundfish and their habitats. Applying gear option 2 would reduce the positive impacts associated with this alternative, i.e. neutral to slightly positive impacts on juvenile groundfish and their habitats. Applying gear options 3 and 4 (i.e. gear modifications) would have similar impacts to Alternative 2, i.e. slightly negative.

There are very few large spawner hotspots in the Great South Channel/Southern New England sub-region, such that neither the existing nor any alternative management areas are likely to provide a substantial positive impact on spawning groundfish. All of the action alternatives in this sub-region, including Alternative 3, remove the year-round Nantucket Lightship Groundfish Closed Area, and therefore would have a slight negative impact on groundfish spawning protection.

2.2.5.4 ***Alternative 4 (Preferred alternative)***

Alternative 4 is a subset of Alternative 3, but the Great South Channel HMA does not extend as far to the east into the deeper waters of the Great South Channel where age 0/1 cod are more numerous in survey catches. Like any other action alternative for the Great South Channel sub-region, there were no weighted groundfish hotspots found in the proposed habitat areas (Table 11). Similar to Alternative 3, six winter flounder hotspots were detected by the analysis of age 0/1 fish survey catches. They were present in the fall survey, but given zero weight in the final analysis because juvenile winter flounder are found almost exclusively on less vulnerable mud or sand substrates. As with Alternative 3, it is difficult to assess groundfish habitat in the proposed habitat management areas because a large portion that overlaps the Nantucket Shoals is not surveyed, but there are likely slight positive impacts on juvenile winter flounder as noted above.

Due to less overlap with cod distribution in the Great South Channel, and a smaller area of overlap with potential winter flounder habitat, Alternative 4 is likely to have fewer positive impacts than Alternative 3, but have positive impacts compared to Alternatives 5 and 6, where potential mobile bottom-tending gear closures are shifted further west. Overall the impacts of Alternative 4 option 1 are expected to be slightly positive, with neutral to slightly positive impacts associated with Alternative 4 option 2. Impacts of options 3 and 4 are expected to be slightly negative, similar to Alternative 2.

There are very few large spawner hotspots in the Great South Channel/Southern New England sub-region, such that neither the existing nor any alternative management areas are likely to provide a substantial positive impact on spawning groundfish. All of the action alternatives in this sub-region, including Alternative 4, remove the year-round Nantucket Lightship Groundfish Closed Area, and therefore would have a slight negative impact on groundfish spawning protection.

2.2.5.5 ***Alternative 5***

Alternative 5 also includes the Cox Ledge HMA, but proposes the Nantucket Shoals HMA that includes the northern portion of the Nantucket Lightship Habitat Closure Area and overlaps

Nantucket Shoals, where there are few to no survey observations. Like any other action alternative for the Great South Channel sub-region, there were no weighted groundfish hotspots found in the proposed habitat areas (Table 11). As discussed above, it is difficult to assess groundfish habitat in the proposed habitat management areas, because a large portion that overlaps the Nantucket Shoals is not surveyed. Only one winter flounder hotspot was identified in the Nantucket Shoals HMA, from the fall survey data, indicating a lesser degree of overlap with the species and therefore fewer potential benefits relative to Alternatives 3 and 4..

The extent to which mobile bottom tending gear closures in the Natucket Shoals HMA might lead to positive impacts on groundfish and groundfish habitats is uncertain given that Nantucket Shoals is poorly sampled in the groundfish survey. The primary effect of this HMA implemented with option 1 would be to displace hydraulic clam dredge activity, which may have slight positive impacts on any juvenile groundfish occurring in the area, especially when combined with the Cox Ledge HMA. However, displaced clam dredge effort could be redistributed further east, where, based on available survey data, juvenile cod are relatively numerous, and seafloor habitats are complex and relatively vulnerable to impact. This potential for effort displacement limits the positive impacts that may result from designation of a mobile bottom-tending gear closure in the Nantucket Shoals HMA. Particularly due to its lesser degree of overlap with cod distribution in the Great South Channel, Alternative 5 with option 1 is likely to have less habitat benefit than Alternative 3 or 4, likely neutral to slightly positive impacts on juvenile groundfish and their habitats. Exempting hydraulic clam dredge gear under option 2, 3, or 4 and removing the existing habitat management area may result in similar distributions of mobile bottom-tending gear impacts relative to a no closure scenario. Therefore, with option 2, 3, or 4, Alternative 5 is likely to have slightly negative impacts, similar to Alternative 2 with no habitat closures.

There are very few large spawner hotspots in the Great South Channel/Southern New England sub-region, such that neither the existing nor any alternative management areas are likely to provide a substantial positive impact on spawning groundfish. All of the action alternatives in this sub-region, including Alternative 5, remove the year-round Nantucket Lightship Groundfish Closed Area, and therefore would have a slight negative impact on groundfish spawning protection.

2.2.5.6 ***Alternative 6***

Alternative 6 includes the Cox Ledge HMA, the Nantucket Shoals West HMA, which is a slight variation of the Alternative 5 area, and adds a gear modification area which includes all of the Great South Channel east to the boundary of Closed Area I. Assessing the effect on groundfish habitat is difficult because the proposed areas have considerable overlap with unsurveyed areas of Nantucket Shoals. Nonetheless the gear modification area has substantial overlap with known catches of age 0/1 cod that inhabit the Channel. Although there were no weighted age 0/1 groundfish hotspots associated with areas proposed by this alternative, they contained more unweighted hotspots than any other alternative except for Alternative 1 (No Action), given the location of the gear modification area to the east of the other HMAs identified for this sub-region. Two red hake and 11 winter flounder hotspots were detected in these areas by the analysis of age 0/1 survey catches (Table 12). Red hake were given zero weight because they are not large mesh groundfish species and winter flounder were given zero weight because the

juveniles are found almost exclusively on mud or sand substrates (which were classified as less vulnerable). Juvenile cod have a greater degree of overlap with the gear modification area relative to other HMAs considered for this sub-region (the gear modification area is not shown on Map 37, but it lies east of the pink Alternative 5 HMA and west of Closed Area I). However, despite the observation that a larger abundance and variety of juvenile groundfish occur in the gear modification area, the effect of this alternative on groundfish habitat and on groundfish stocks is highly uncertain, and likely has negligible if any positive impacts, due to uncertainties about the effectiveness of proposed trawl gear modifications coupled with exemptions for fishing with scallop and clam dredges.

The impacts of the Nantucket Shoals West HMA are expected to be very similar to the Nantucket Shoals HMA considered under Alternative 5. Given their smaller footprint, the Cox Ledge HMAs are not expected to have a large influence on the overall magnitude of positive or negative impacts associated with the alternative. Similar to Alternative 5, the overall impacts of Alternative 6 are expected to be neutral to slightly positive with option 1, and slightly negative with options 2, 3, or 4.

There are very few large spawner hotspots in the Great South Channel/Southern New England sub-region, such that neither the existing nor any alternative management areas are likely to provide a substantial positive impact on spawning groundfish. All of the action alternatives in this sub-region, including Alternative 6, remove the year-round Nantucket Lightship Groundfish Closed Area, and therefore would have a slight negative impact on groundfish spawning protection.

2.3 Spawning management alternatives

Impacts of all spawning management alternatives are summarized in Table 13.

Table 13 – Summary of impacts of spawning management alternatives on the large mesh groundfish resource. No action and preferred alternatives are identified below.

Region	Alternative	Impacts
GOM	Alt. 1A (Regulatory No Action, preferred)	Positive
GOM	Alt. 1B (Baseline No Action)	Positive
GOM	Alt. 2A	Positive
GOM	Alt. 2B	Positive
GOM	Alt. 3 (preferred)	Positive
GOM	Alt. 4 (preferred)	Positive
GB-SNE	Alt. 1 (No Action)	Positive
GB-SNE	Alt. 2A	Slightly positive
GB-SNE	Alt. 2B	Slightly positive
GB-SNE	Alt. 2C	Slightly negative
GB-SNE	Alt. 3A	Slightly positive
GB-SNE	Alt. 3B (preferred)	Slightly positive
GB-SNE	Alt. 3C (preferred)	Slightly negative

2.3.1 Gulf of Maine

2.3.1.1 *Alternative 1A (regulatory no action, preferred)*

Regulatory No Action would retain the existing spawning protection measures approved under Framework 53 to the Northeast Multispecies FMP. These measures include the seasonal cod protection closure areas in the Gulf of Maine (these replace the previous sector and common pool rolling closures). In conjunction with Alternative 1A, the Council also adopted an additional spawning protection block – Block 125, proposed for closure April 15th through 30th, which is analyzed separately under Alternative 4. In addition, Alternative 1A also includes the Gulf of Maine Cod Spawning Protection Area, closed April 1st through June 30th. The Cod Spawning Protection Area was maintained in Framework 53 as the No Action alternative for spawning protection, in order to continue efforts to protect spawning cod in the area during the spring.

The GOM cod protection measures in Framework 53 are intended to increase protection of GOM cod (spawning protection and mortality reduction), while providing opportunities for the groundfish industry to prosecute healthy stocks in other times and areas. The OHA2 objectives are to improve groundfish productivity and spawning protection generally, not only for cod, and to improve the use and non-use benefits of area closures.

The impacts analysis in Framework 53 concluded that the cod protection measures adopted by the Council would have mixed impacts for groundfish stocks other than cod as compared to the long-standing rolling closures. These included low negative impacts on winter flounder, yellowtail flounder, American plaice, and haddock, and to a lesser extent witch flounder and windowpane flounder. The major difference between Alternative 1A and 1B is the elimination of all rolling closure blocks in April under the Framework 53 Cod Protection Closures. However, Alternative 4 is expected to mitigate some of the negative impacts to the groundfish resource by maintaining spawning protections for part of April.

Compared to the current rolling closures (Alternative 1B), the Framework 53 impacts analysis found that the cod protection measures in Alternative 1A may have a low positive impact for ocean pout because they spawn in the fall and the winter and therefore the closure of 124 and 125 between November and January might provide some protection.

2.3.1.2 *Alternative 1B (baseline no action)*

Baseline No Action would retain the existing set of seasonal rolling closures for sector and common pool groundfish vessels and the April to June Gulf of Maine Cod Spawning Protection Area for commercial and recreational vessels fishing for groundfish. It would also retain the year-round Western Gulf of Maine Closure Area and the Cashes Ledge Closure Area, assuming one or both of these areas is not removed via selection of an alternative set of habiat management areas. Currently an alternative set of management areas in the central Gulf of Maine is the preferred habitat management alternative for that sub-region, which implies removal of the Cashes Ledge Closure Area.

Although this alternative does not change the purpose of seasonal rolling closures or year round groundfish closed areas, this alternative has incidental benefits from reducing fishing effort on

spawning cod and other groundfish. Although the context is different than Alternative 2 below, the impacts on cod and other groundfish spawning and on the stocks are evaluated here.

The existing rolling closures, the Western Gulf of Maine Closure Area, and even to some extent the Cashes Ledge Closure Area have a high degree of overlap with the distribution of large spawning size groundfish hotspots in the Gulf of Maine (Map 40), in both spring and summer when many groundfish, and particularly cod and haddock, are known to spawn. Some winter spawning of cod occurs in the Massachusetts Bay area, where there are state-waters seasonal cod conservation zones. During winter months when cod spawn in the southern part of Massachusetts Bay, the only seasonal closure in Federal waters is an October-December closure (Rolling Closure Area V, thirty minute squares 124 and 125). Various types of fishing vessels are exempted from this rolling closure, and therefore it applies to mostly to common pool groundfish vessels, which account for less than one percent of the total groundfish fishing effort. Sector vessels are not required to comply with this rolling closure, which may in fact promote more intensive fishing during the winter since the sector rolling closures off of Massachusetts are in effect during April and May.

In the winter, the Western Gulf of Maine and Cashes Ledge Closure Areas contained 19 unweighted and 28.5 weighted hotspots[8] (Table 14). (Note that although the Massachusetts state-waters Winter Cod Conservation Zone shown on Map 40 is closed from November 15 through January 31, it was not included in the No Action totals which refer to Federal area closures only.) In the spring, the sector rolling closures, Cashes Ledge, and the Gulf of Maine Cod Spawning Protection Area had 923 unweighted and 2086.8 weighted hotspots. Hotspots in the eastern sliver of the Western Gulf of Maine Closure Area were not included in the total because they contained a negligible amount of large spawner size groundfish hotspots and overlapped with the common pool rolling closure areas. The additional hotspots in the Common Pool Rolling Closures were also not included in the total because they apply to a small fraction of fishing vessels and groundfish fishing effort. The 14 km^2 Gulf of Maine Cod Spawning Protection Area is simply too small for any hotspots at a 100 km^2 grid scale to fit inside.

Table 14 – Total unweighted and weighted groundfish large spawner hotspots from 2002-2007 winter and 2002-2011 spring surveys by management area in the Gulf of Maine region.

	Winter		Spring		Summer		Fall	
Row Labels	Number of Hotspots	Number of Weighted Hotspots	Number of Hotspots	Number of Weighted Hotspots	Number of Hotspots	Number of Weighted Hotspots	Number of Hotspots	Number of Weighted Hotspots
Cashes Ledge GF	0	0	4	15	3	11	2	15
Western Gulf of Maine GF	19	40	19	86	0	0	0	0
Western Gulf of Maine GF modified	19	40	14	63	0	0	0	0
Cod Spawning Protection Blocks	37	128	110	2,223	19	72	3	22.5
Sector Rolling Closure, April	28	98	50	225	0	0	3	23
Sector Rolling Closure, May	23	58	96	431	0	0	3	23
Sector Rolling Closure, June	0	0	55	246	0	0	0	0
MassBay_CodSpawning	1	13	0	0	0	0	0	0
Cod Spawning Protection Area	0	0	3	14	0	0	0	0

On one hand, the Alternative 1/No Action areas encompass a broad area where spring groundfish spawning, primarily cod and haddock, occurs. In contrast to smaller areas meant to protect

[8] Hotspots were weighed more heavily for stocks with low biomass relative to the MSY target, stocks that formed sub-populations, and stocks that were known to have resident populations.

specific spawning components of cod or another species, these large areas are more robust to changes in annual spawning activity caused by environmental variation and climate change. They are also less likely to cause local shifts in fishing effort to nearby areas having unobserved spawning components that are not protected.

Based on the hotspot results (Volume 1, Section 4.4), literature based information on (primarily cod) spawning (see Volume 1, Section 4.3), the distribution of developing and ripe cod and haddock, and on the distribution of survey catches of mature sized cod, the existing set of seasonal and year round closed areas in this alternative encompass a reasonably high proportion of groundfish spawning in the Gulf of Maine. However, the areas do not include spawning of resident cod, halibut, and other species in the eastern Gulf of Maine. They also offer little to no protection for winter cod spawning in Federal waters of Massachusetts Bay and the southern part of the western Gulf of Maine. Despite these gaps in groundfish spawning protection, Alternative 1/No Action likely has positive impacts on groundfish productivity because these areas appear to protect a considerable amount of spawning activity in the western Gulf of Maine and potentially improve groundfish productivity.

2.3.1.3 ***Alternatives 2A and 2B***

Alternative 2 would retain the existing sector rolling closures as spring spawning closures, which would apply to all commercial fishing vessels capable of catching groundfish (Alternative 2A) and additionally to recreational groundfish vessels (Alternative 2B). Specific gears that do not catch groundfish would be exempt from the closure. Successive and overlapping thirty minute squares from Massachusetts Bay to Penobscot Bay would close for one month each from April to June. The existing Gulf of Maine Cod Spawning Protection Area that is closed from April to June to commercial and recreational fishing vessels that catch groundfish would remain. An additional winter spawning closure would apply in Massachusetts Bay during November 1-January 31 to all commercial and recreational fishing vessels capable of catching groundfish.

Compared to other areas, Massachusetts and Ipswich Bays have a fairly high proportion of developing and ripe cod (Map 42). The timing of the spring surveys has to be considered when interpreting maps showing the number or proportion of fish at each maturity stage, because maturation stages typically have unequal durations. The timing of when ripe and running ripe cod may or may not coincide with the timing of the survey, so a high proportion of developing fish is indicative of where spawning may occur soon, but an absence of developing or ripe fish does not mean that spawning will not occur there. The early spring survey probably misses some cod spawning that occurs in late spring from Ipswich Bay and to the north.

Winter cod spawning is known to occur in the middle and southern portions of Massachusetts Bay, and probably off the outer portion of Cape Cod as well. A new area where fishermen have reported intensive cod spawning off Scituate, Massachusetts is being investigated by Massachusetts Division of Marine Fisheries scientists using acoustic tags. While this area appears to be important for immature cod in the spring (Map 42), the winter trawl surveys have caught few large cod in this area, compared to portions of the Western Gulf of Maine Closure Area and the southern portion of Jeffreys Ledge (Map 43). Nonetheless, a winter spawning closure in this area could complement the existing Massachusetts Bay spawning closure in state

waters (Map 43) and potentially other spawning protection areas in state waters that will be identified from this research.

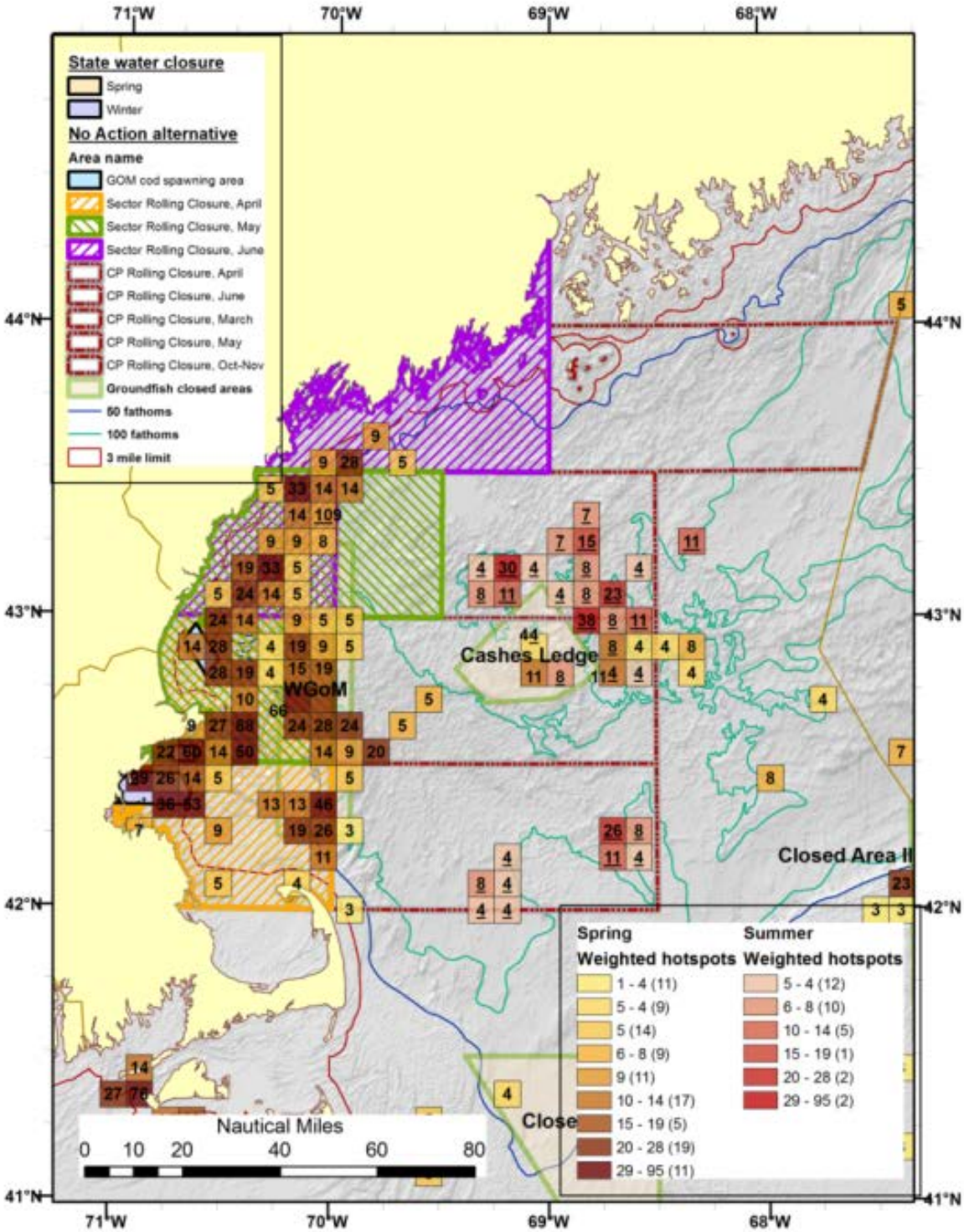
On one hand, small closures that protect well-defined spawning components should be very effective to reduce the impacts on spawning codfish. On the other hand, small closures of relatively short duration (to focus conservation on specific spawning components) carries a higher risk of missing annual spawning events when, for example, environmental events during an abnormal year delay, advance, or cause spawning activity to develop elsewhere. Climate change may also play a role in changing spatial and temporal spawning characteristics. Broad-scale closures, like the ones in this alternative, would also protect less prominent or scientifically unidentified spawning components.

Alternative 2 essentially protects spawning in the same areas and seasons as in Alternative 1 (No Action). Some additional spawning protection may be provided by the Massachusetts Bay Cod Spawning Protection Area. Areas included in this alternative had about the same number of spawning hotspots as those for Alternative 1 (Table 14, Map 41).

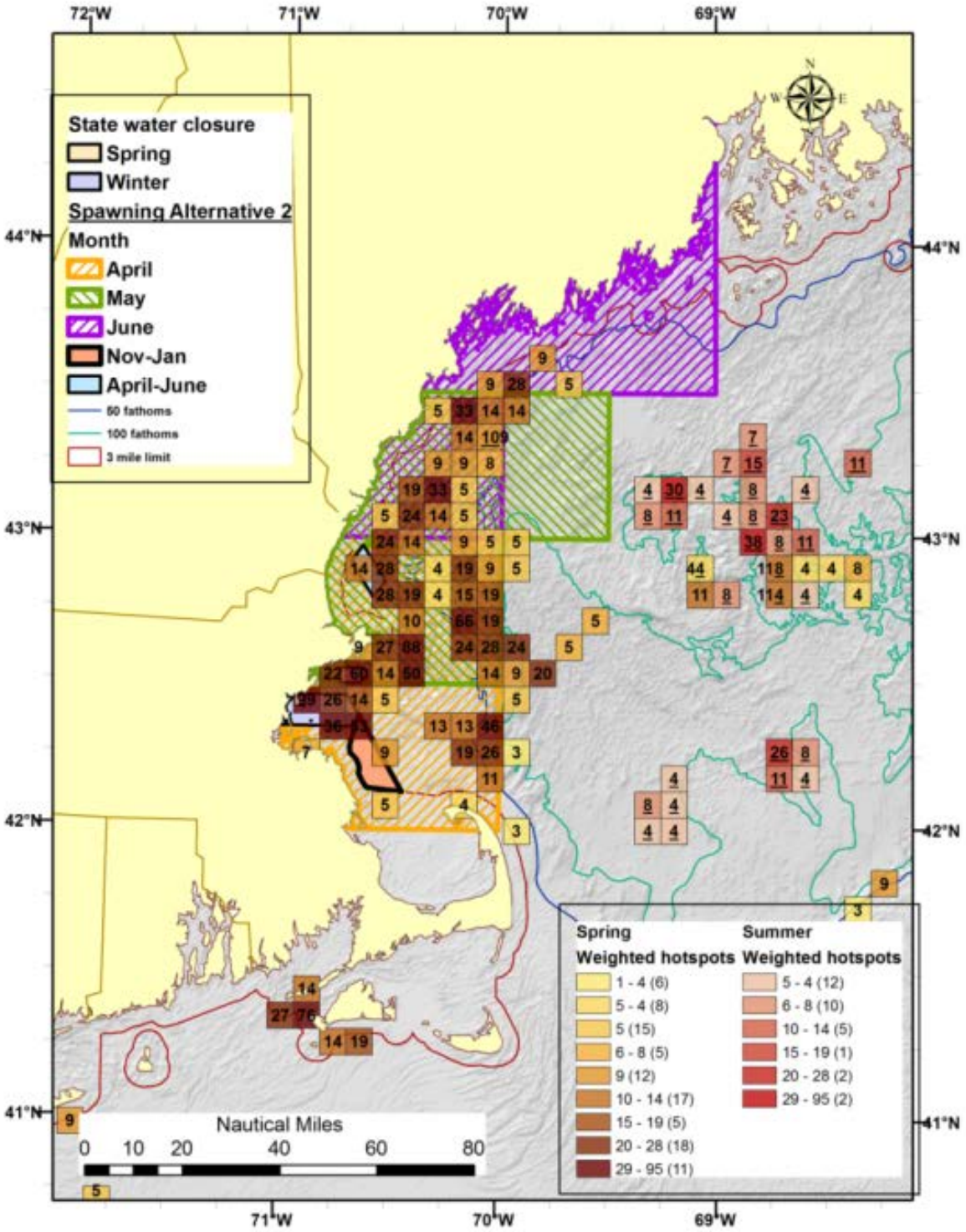
The only difference between Option A and B is that fishing by recreational vessels that catch groundfish would be prohibited during the April to June rolling closures under Option B. While there is no research that suggests that recreational fishing could interfere with spawning behavior, it could cause spawning fish to disperse or avoid areas with many recreational vessels and it certainly contributes to removals of large spawning fish from the population before they have been able spawn in that year. During the 2012 fishing year, estimates indicate that recreational vessels harvested more Gulf of Maine haddock than commercial groundfish vessels, exceeding their 2012 allocation of the Gulf of Maine haddock annual catch limit.

Considering these effects described above, the impact of Alternative 2B on groundfish productivity is expected to be slightly positive compared to Alternative 1/No Action. Because Option B includes measures that restrict recreational fishing effort on spawning groundfish, Option B would have slightly more benefits to groundfish stocks when compared to Option A.

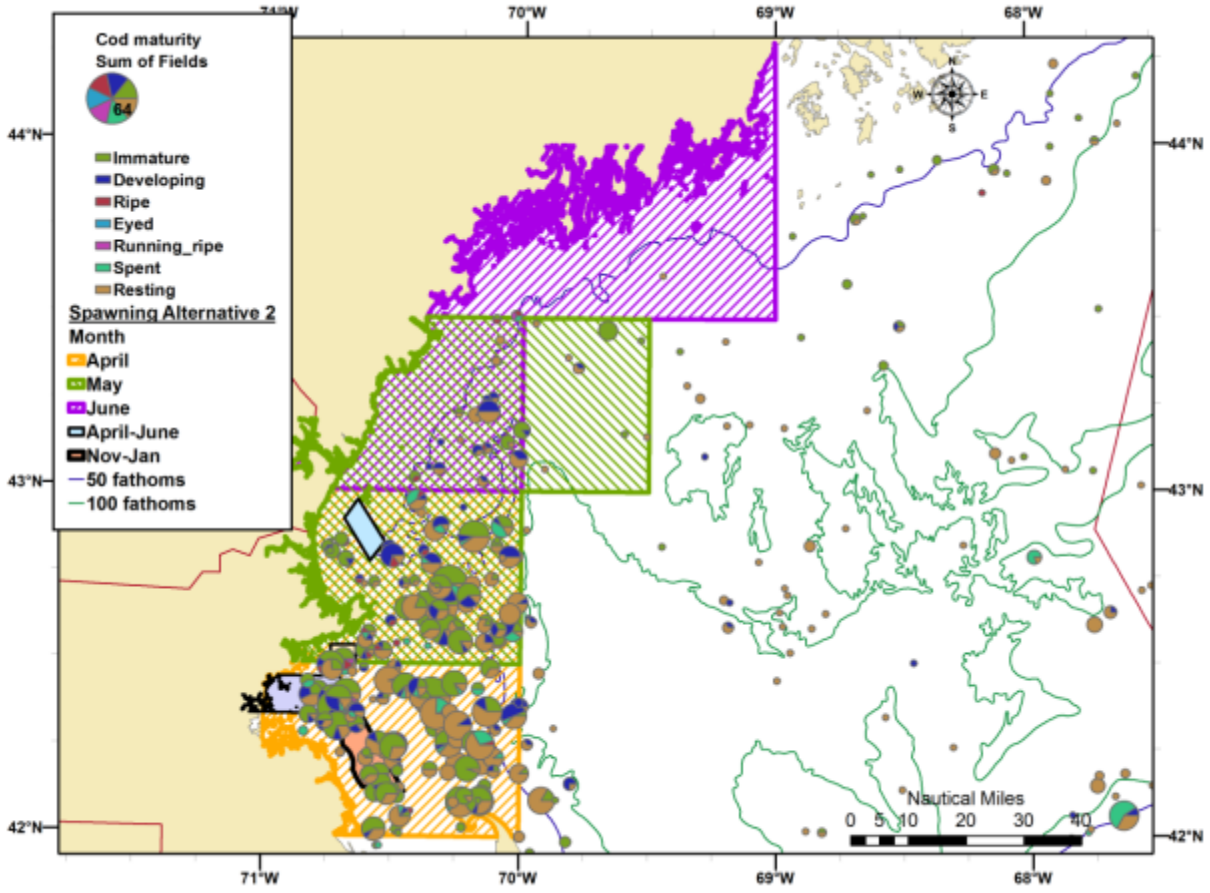
Map 40 – No Action rolling and year round closures compared to the distribution of weighted groundfish spawning hotspots (concentrations of large spawning size groundfish) in the Western Gulf of Maine sub-region, using 2002-2012 spring NMFS, MADMF, ME-NH, and IBS cod survey data.



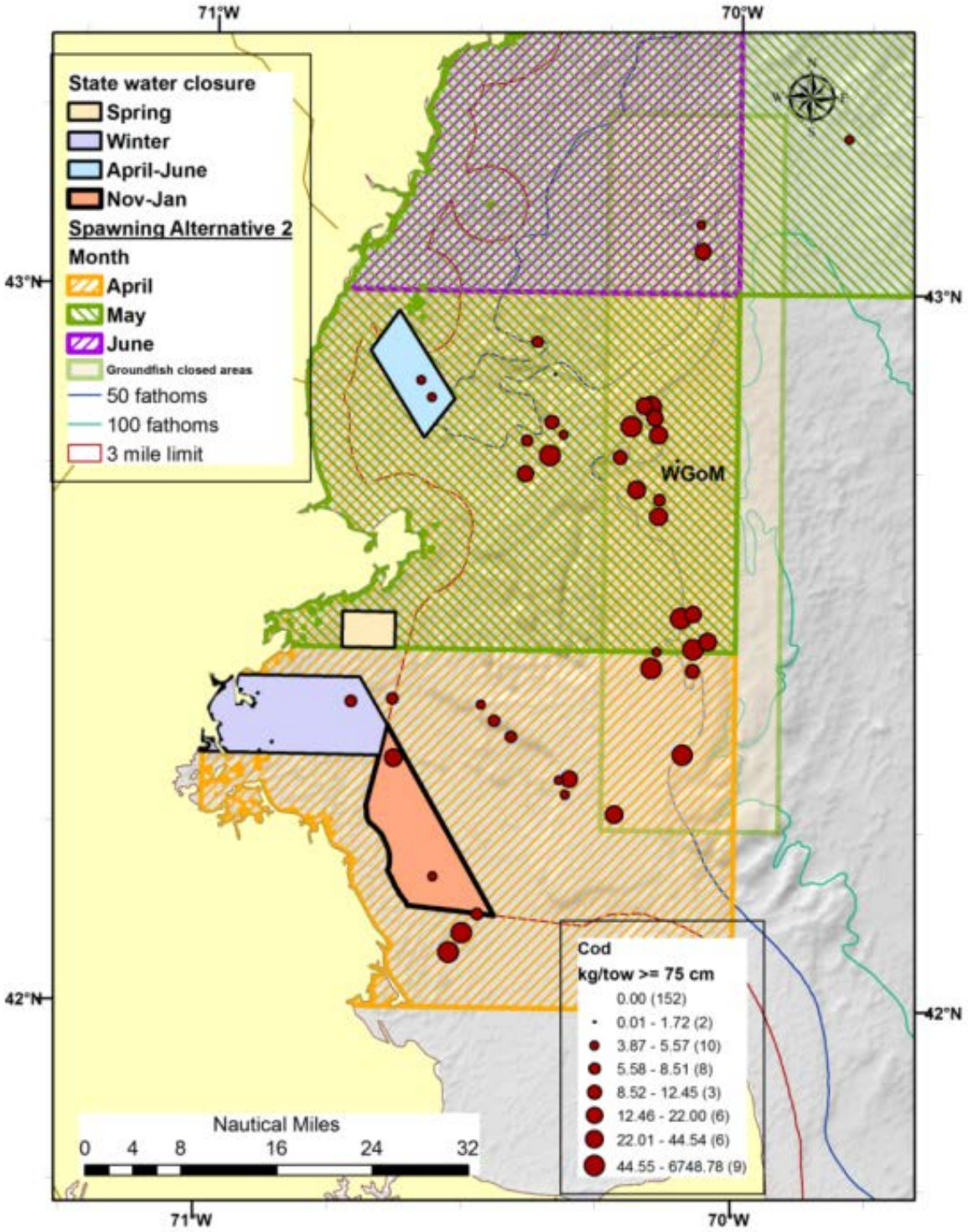
Map 41 – Alternative 2 spawning closures compared to the distribution of weighted groundfish spawning hotspots (concentrations of large spawning size groundfish) in the WGOM sub-region, using 2002-2011 spring NMFS, MADMF, ME-NH, and IBS cod survey data.



Map 42 – Proportion of cod abundance by stage of maturation during NMFS and MADMF spring trawl surveys, 2002-2011.



Map 43 – Distribution of large mature cod during NMFS winter trawl and IBS trawl surveys, 2002-2007.



2.3.1.4 ***Alternative 3 (preferred)***

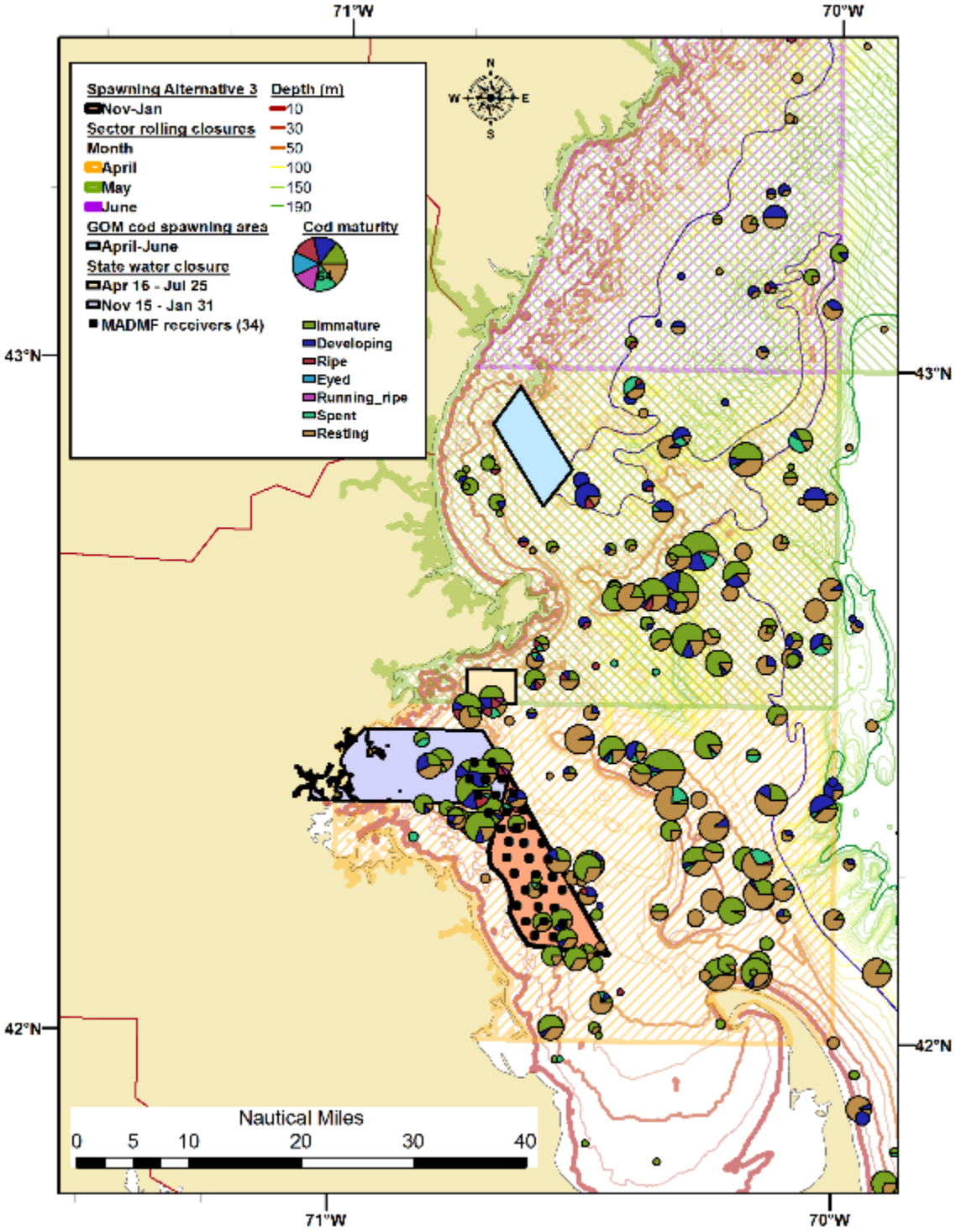
This alternative would designate the Massachusetts Bay Cod Spawning Protection Area between November 1 and January 31. Like the Gulf of Maine Cod Spawning Protection Area, the new spawning area would be closed to all commercial gears capable of catching groundfish and recreational groundfish fishing, primarily to protect spawning cod.

While scant winter survey data support the presence of spawning codfish, fishermen often report the presence of spawning cod in the middle and southern portions of Massachusetts Bay, and probably off the outer portion of Cape Cod as well. A new area where fishermen have reported intensive cod spawning off Scituate, Massachusetts is being investigated by Massachusetts Division of Marine Fisheries (MADMF) scientists using acoustic tags. During winter 2013-2014, MADMF placed 150 acoustic transmitters on large cod and tracked their location and movements with 32 receivers (Micah Dean, MADMF, pers. comm.). The intent of this research was to guide further scientific work, but there was a tendency for cod to remain in the northern portion of the array during the winter study period. It is not known whether this is a persistent feature or changes from year to year.

While this area appears to be important for immature cod in the spring (Map 42), the winter trawl surveys have caught few large cod in this area, compared to portions of the Western Gulf of Maine Closed Area and the southern portion of Jeffreys Ledge (Map 43). Howver, the area has not been well surveyed during the proposed closure months and data from commercial catches rarely has information about spawning condition. The area also does not coincide well with groundfish spawning hotspots (weighted heavily for large spawner cod) in the spring and summer surveys (Map 41). Most of the cod in the area were in immature or resting spawning condition during the spring survey (Map 44), but a notable amount of developing codfish were sampled in the northern portion of the proposed spawning area.

Nonetheless, a winter spawning closure in this area could complement the existing Massachusetts Bay spawning closure in state waters (Map 43) and potentially other spawning protection areas in state waters that may be identified from this research. The proposed spawning winter spawning closure area could have a slightly to highly positive impact on spawning cod, depending on how well the area and season coincide with winter cod spawning activity. It would have a positive cumulative effect when considered in combination with the effects of the Gulf of Maine Cod Spawning area in Ipswich Bay and a continuation of the sector rolling closures in March to June in the western Gulf of Maine (see discussion in the cod section of Volume 1). This measure could have a slight negative impact on other groundfish stocks occupying locations where vessels would fish when displaced from this area.

Map 44 – Location of Massachusetts Bay Cod Spawning Protection Area (orange with black border) compared to the location of acoustic receivers used in 2013-2014 winter cod spawning research by MADMF and to the location of other existing spawning protection areas in the Western Gulf of Maine. The relative number and proportion of cod in 2002-2012 spring surveys by maturation are shown as pie charts at the location of the observation.



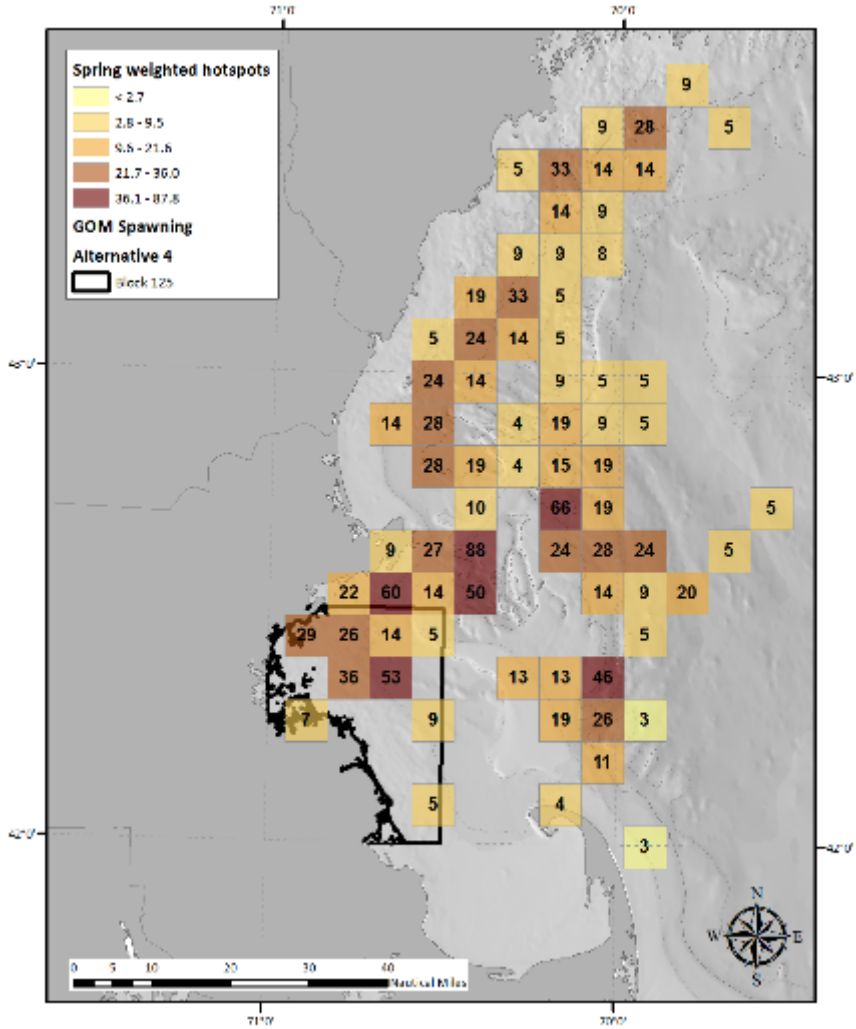
2.3.1.5 ***Alternative 4 (preferred)***

Alternative 4 adds a thirty minute closure block (125) during April 15-30 with the same restrictions as the Cod Protection closures in effect during May, June, and November-January. This are has been closed under the baseline No Action (Alternative 1B until recently (May 2015). Thus, fishing will be allowed in this area during the 2016 fishing year, but not in subsequent years if this alternative is approved. This alternative, when combined with protections afforded by Alternatives 1A and 3, is expected to have positive impacts on groundfish. Overlaps with spring groundfish weighted hotspots are shown in Map 45.

Northeast Multispecies Framework 53, Appendix II investigates the distribution of spawning groundfish in the Gulf of Maine. The first paper, "Identifying location and times of spawning for Gulf of Maine cod" considered cod spawning locations as evidenced from trawl surveys, egg surveys, and acoustic data. During spring industry-based (IBS) cod surveys, Block 125, which overlaps Massachusetts Bay, was identified as having high catch per unit effort of spawning cod. Cod were sexed and staged during the IBS survey, and spawning cod were identified as animals that were ripe, running, or spent. Spring encompassed the March 18-April 19 and April 20-May 31 cruises. Further, Block 125 exhibited significantly skewed cod sex ratios during the spring IBS survey, which indicates spawning activity as males and females segregate themselves on the spawning grounds, but sex ratios are closer to 1 when spawning is not occurring. Marine Resource Monitoring and Assessment Program (MARMAP) egg data investigated for the working paper also suggest that Block 125 is an area of high egg density and therefore a spring spawning ground. Overall, the groundfish PDT recommended closure of various 30 minute blocks during April, including 125, for cod spawning protection.

Many other groundfish besides cod spawn during the month of April. These include American plaice, halibut, haddock, redfish, windowpane, winter flounder, witch flounder, and yellowtail flounder. The working paper "Examination of seven spring spawning groundfish stocks in the NEFSC bottom trawl survey for comparison to spatial management measures under consideration in Framework Adjustment 53" considers spawning locations during the spring (April and May) NEFSC trawl survey for most of these stocks, with the exception of halibut and redfish (see Framework 53, Appendix II). This analysis generated maps of fish above the size at 50% female maturity and applied a percent fish in spawning condition to the total abundance values to map a mature fish index for each species as well. Block 125 overlapped with the spawning fish index maps for all species analyzed, and therefore a rolling closure in this block is expected to have positive impacts across a range of groundfish stocks.

Map 45 – Large spawner groundfish weighted hotspots that overlap GOM Spawning Alternative 4 (30 min block 125 during April).



2.3.2 Georges Bank and Southern New England

2.3.2.1 *Alternative 1 (No Action)*

Alternative 1/No Action would retain the year round groundfish closed areas, Closed Area I, Closed Area II, and the Nantucket Lightship Closed Area. Closed Areas I and II are included in habitat management Alternative 1/No Action for the Georges Bank sub-region, and the Nantucket Lightship Closed Area is part of habitat management Alternative 1/No Action for the Great South Channel/southern New England sub-region, and selection of alternatives to no action could impact the continued existence of these areas. It would also continue the Georges Bank Seasonal Closure Area during May. The latter area is open to fishing to all but a few types of commercial fishing vessels. Vessels that operate under an approved sector operations plan may fish in this seasonal closed area. Recreational fishing vessels targeting groundfish or other species may fish in the Nantucket Lightship Closed Area with a letter of authorization.

Although most groundfish, including cod and haddock, primarily spawn in the spring, groundfish spawning also occurs in other seasons. For example, data from Smolowitz et al. (2012) indicate that yellowtail flounder spawning in Closed Area II occurs during July and August. Although hotspots for large mature groundfish stocks occur in any season to varying extents, the weighted hotspots were given a non-zero multiplier only during the seasons when that stock was known to spawn (Table 15). Non-zero multipliers were assigned to cod, winter flounder, witch flounder, pollock, redfish, halibut, ocean pout, and windowpane flounder during the summer, fall, and winter, varying by factors accounting for stock biomass, subpopulations, and residency. This makes the seasonal weighted hotspots an appropriate metric to evaluate the degree of spawning protection afforded to groundfish stocks by the year-round closures. It is also valid to compare these weighted hotspots with those for Alternatives 2 and 3 in the spring season, when the action alternative spawning closures would apply.

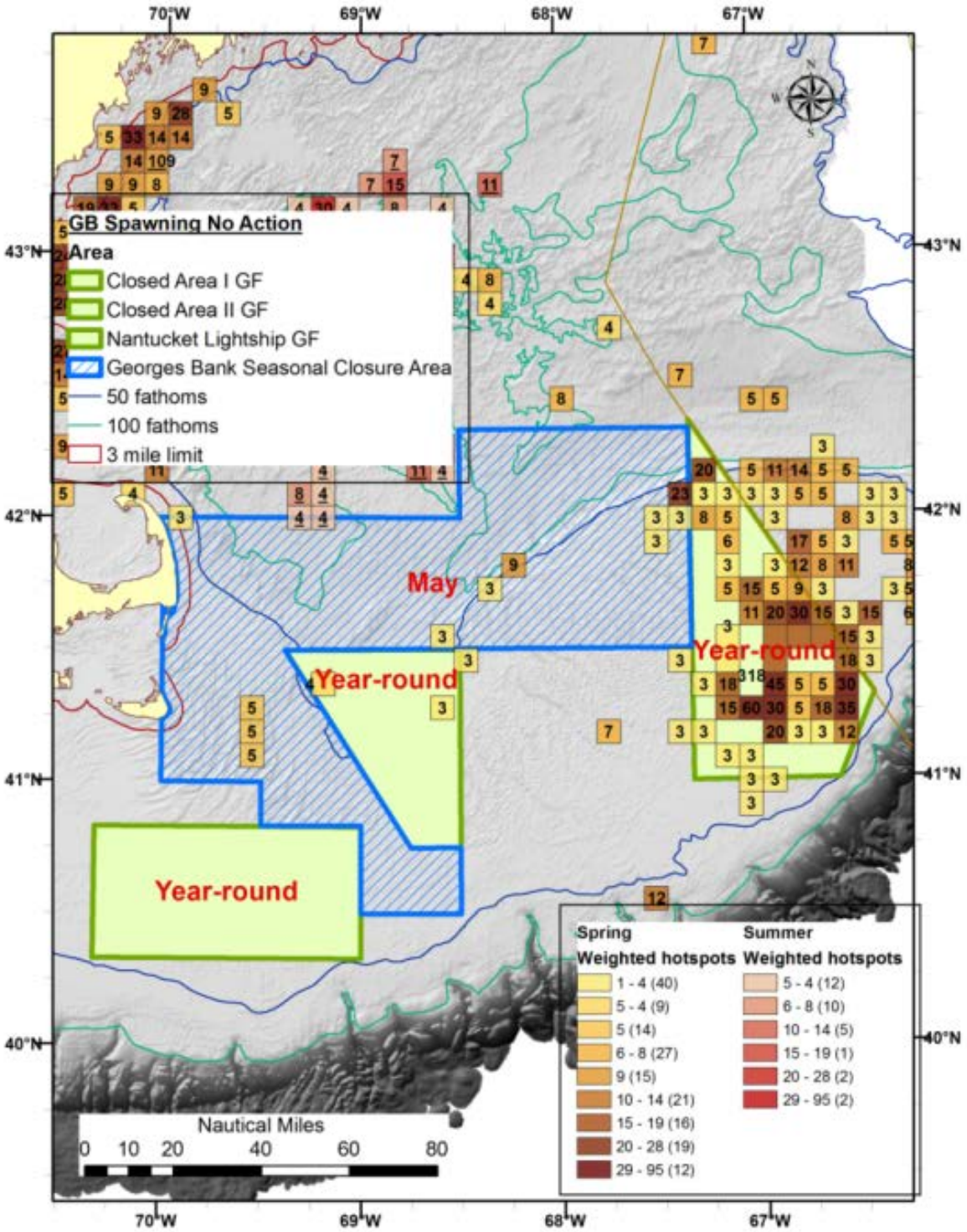
Most of the large spawner hotspots were identified in Closed Area II, totaling 549.8 (97 unweighted) in the spring (Map 46), with some hotspots (22.4) in the fall (Table 15). Closed Area I had a relatively low number of large spawner hotspots in the spring (Map 46) and fall (Map 47), while the Nantucket Lightship Area had 28.1 weighted hotspots in the winter, associated with windowpane flounder.

Table 15 – Seasonal summary of unweighted and weighted large spawner hotspots for the No Action alternative.

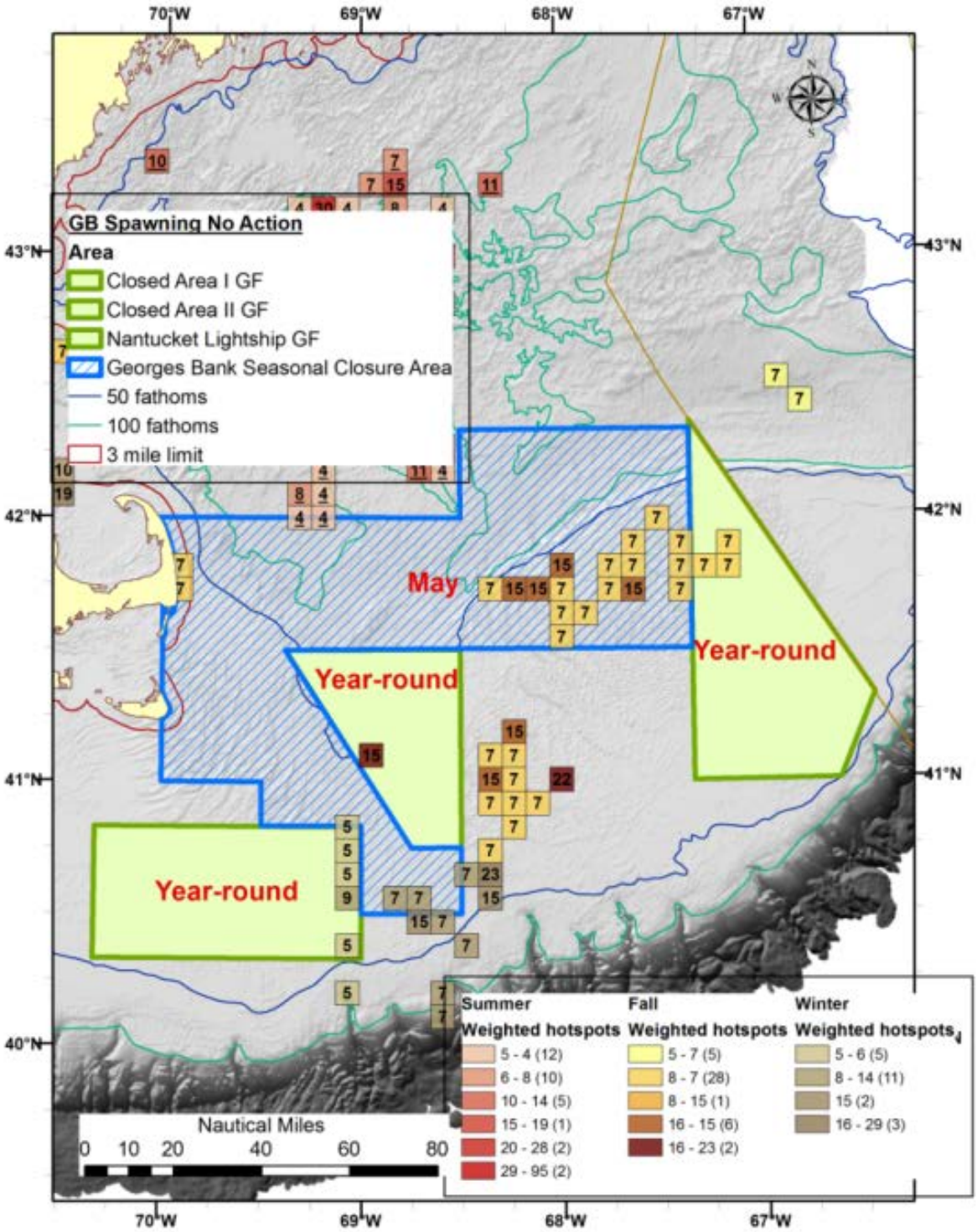
	Spring		Summer		Fall		Winter	
	Total hotspots	Total weighted hotspots	Total hotspots	Total weighted hotspots	Total hotspots	Total weighted hotspots	Total hotspots	Total weighted hotspots
Georges Bank/Southern New England								
Groundfish closure	139	618.4	51	7.5	282	209.5	11	43.1
Closed Area I GF	2	6.5	15	0.0	23	15.1	0	0.0
Closed Area II GF	97	549.8	24	0.0	42	22.4	3	0.0
Nantucket Lightship GF	0	0.0	2	0.0	0	0.0	6	28.1
Georges Bank Seasonal Closure Area	40	62.2						

The existing year-round groundfish closed areas provide a relatively high level of spawning protection, except in areas that are open to fishing under specific groundfish and scallop access programs. The scallop access program currently allows scallop dredge fishing in these areas year-round, with the exception of August 15 to November 15 in Closed Area II, which would continue under Alternative 1/No Action. This measure was adopted by the Scallop FMP via Framework Adjustment 24 to increase yield in the scallop fishery given constraints on yellowtail flounder catches required under Groundfish FMP sub-ACL limits, essentially reducing yellowtail flounder bycatch per pound of scallop landings. **It was not adopted as a measure to protect yellowtail flounder spawning**, which according to industry-generated survey data appears to occur during June to early August. The No Action alternative likely has positive impacts on managed large mesh groundfish because the likely benefits to groundfish productivity are considered to be relatively high, especially for cod, haddock, winter flounder, yellowtail flounder (and probably a considerable number of non-groundfish species).

Map 46 – Distribution of weighted large spawner groundfish hotspots in spring compared to Alternative 1/No Action areas.



Map 47 – Distribution of weighted large spawner groundfish hotspots in summer, fall, and winter seasons compared to Alternative 1/No Action areas.



2.3.2.2 ***Alternatives 2A and 2B***

During February 1 to April 15, Alternative 2A would close all of Closed Areas I and II to commercial fishing with gears capable of catching groundfish, including trawls, gillnets, longlines, hook gear, and scallop dredges. Certain exemptions would apply and are described in Volume 3. The intent is to reduce impacts on spawning groundfish, particularly cod and haddock.

Most of the spring large spawner groundfish hotspots occur in Closed Area II (Table 16; Map 48), particularly for haddock and yellowtail flounder. A few cod hotspots occur, but most are in Canadian waters. Although there are relatively few hotspots located in Closed Area I, there are large cod and haddock caught there by surveys, particularly in portions overlapping the Great South Channel and in the deeper water in the northern half of Closed Area I (Map 49). Past observations indicate that cod and haddock spawn in this area during the spring, and such spawning activities were the basis for the original Closed Area I (and Closed Area II) designations. During the spring surveys, few developing and ripe cod were caught on Georges Bank, except in the southern part of Closed Area I (Map 50, top). A considerable proportion of haddock were, however, in developing or ripe condition during the spring surveys in most areas of eastern Georges Bank and in the northern two thirds of Closed Area I (Map 50, bottom).

Table 16 – Summary of unweighted and weighted large spawner hotspots during spring, comparing Georges Bank Alternatives 1/No Action, 2, and 3.

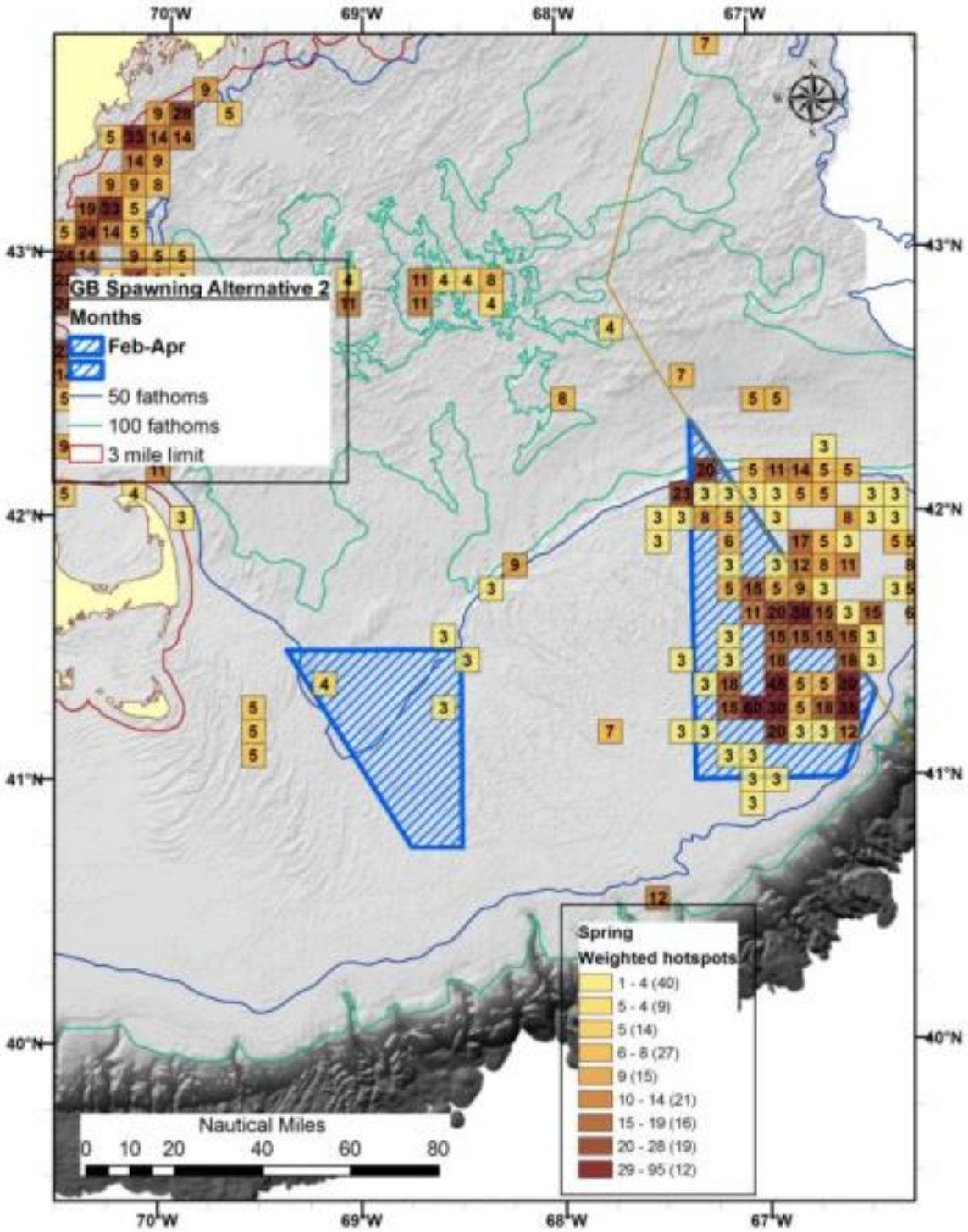
	Spring	
	Total hotspots	Total weighted hotspots
Georges Bank		
No Action	**139**	**618.4**
Seasonal spawning	40	62.2
Year round	99	556.2
Alternative 2	99	556.2
Alternative 3	98	553.5

Using the number of large spawner hotspots as an indicator of groundfish spawning protection, Alternative 2A has slightly positive impacts on groundfish productivity for spring spawners (due partially to the elimination of the scallop access program during Feb to Apr) and large negative impacts on fish that spawn during other seasons. Although larger cod and haddock tend to be able to avoid noisy 15’ dredges, much of the concern is disruption of spawning behavior and dispersion of spawning fish, which can reduce spawning efficiency, vs. removals of spawning fish via directed fishing or bycatch (see additional discussion under Option C, below). The lower number of hotspots in the spring (99 for Alternative 2 as compared to 139 for Alternative 1) is due to the elimination of the May Georges Bank seasonal closure area which includes 40 spring hotspots.

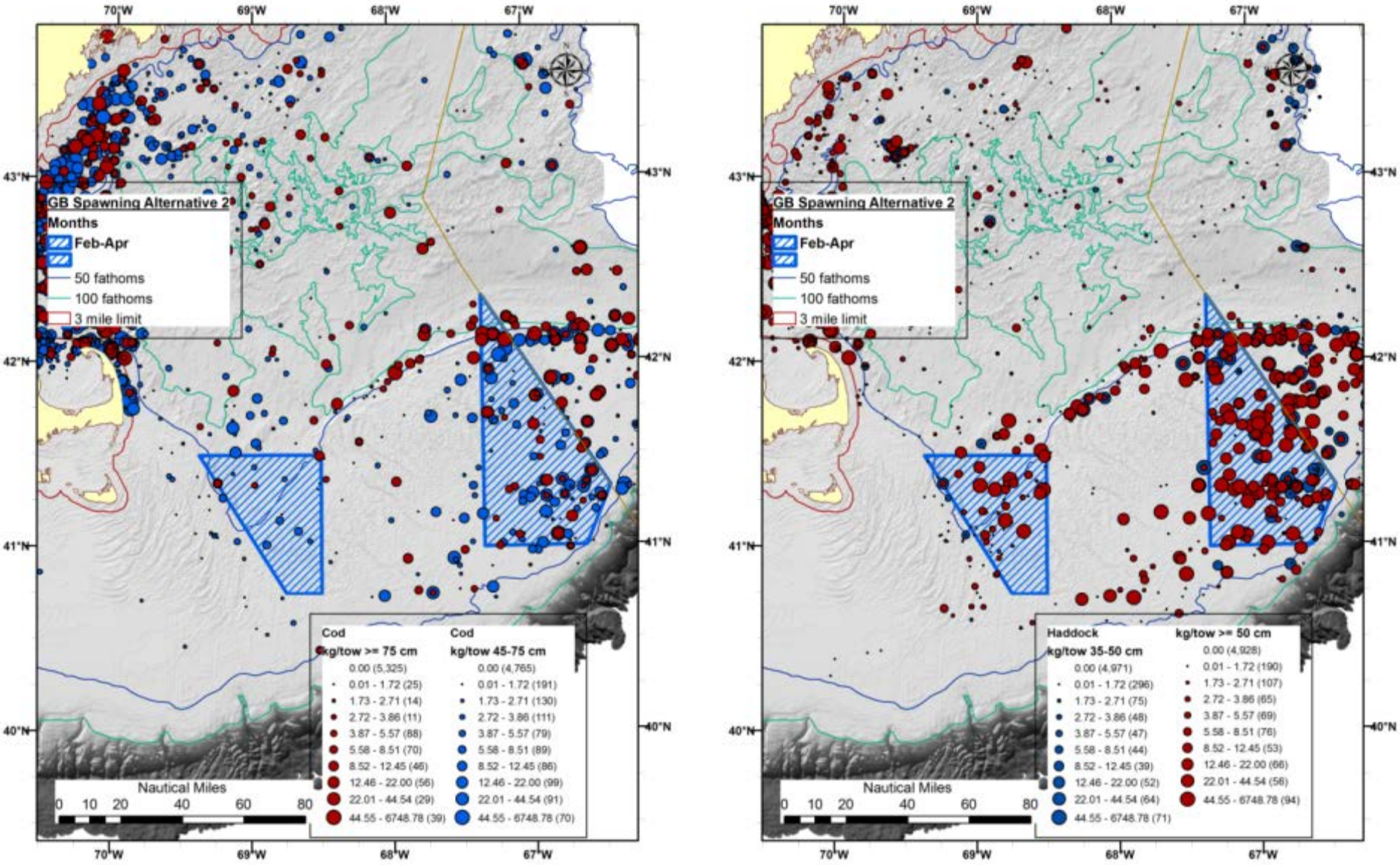
Option B is preferred and differs from Option A only in that it would also prohibit recreational fishing for groundfish (some exemptions for pelagic fishing would apply). This proposed measure is closer to current management status, under which recreational fishing vessels are prohibited from targeting groundfish within the boundaries of Closed Areas I and II. This measure would prevent the recreational fishery from targeting concentrations of cod and haddock in Closed Areas I and II during the spring when the fish spawn. While a relatively small amount of recreational groundfish fishing effort occurs on Georges Bank during February and April, Alternative 2B provides some slight added protection for spawning cod and haddock, both primary recreational target species, compared to 2A.

Thus compared to Alternative 1/No Action, Alternative 2B has slightly positive impacts on groundfish productivity in the spring season (due partially to the exclusion of scallop access during February to April and prevention of recreational fishing for spawning cod and haddock) and large negative impacts on fish that spawn in other seasons. The overall impacts of this alternative on spawning groundfish are expected to be slightly positive, as compared to the moderately positive impacts associated with Alternative 1/No Action.

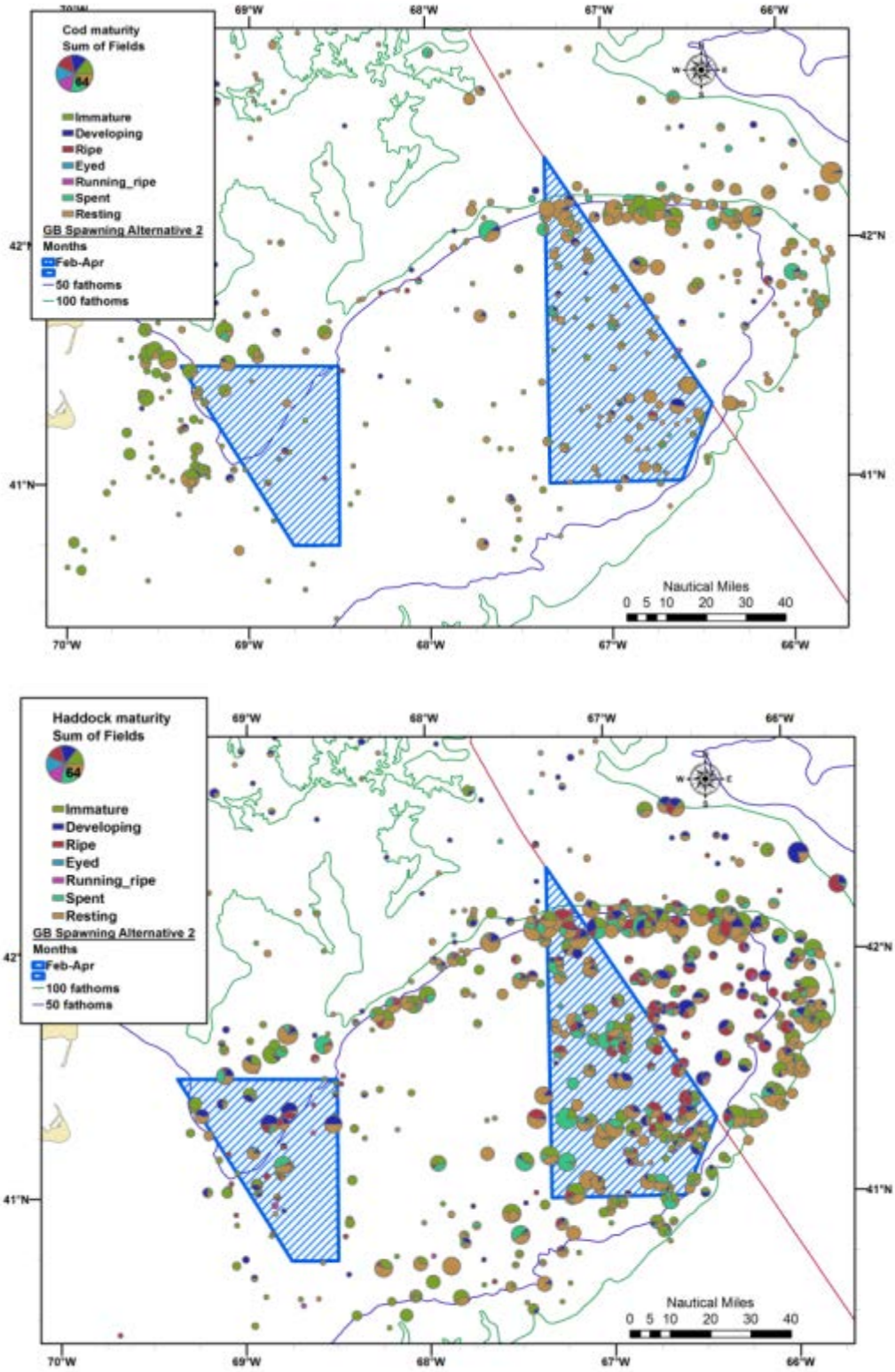
Map 48 – Distribution of weighted large spawner groundfish hotspots in spring compared to Alternative 1 areas. Closures to gears capable of catching groundfish would occur from Feb 1 to Apr 15.



Map 49 – Distribution of cod (left) and haddock (right) by small and large mature fish size classes during spring and summer surveys of Georges Bank during 2002-2011.



Map 50 – Distribution of cod (top) and haddock (bottom) by maturity stage during 2002-2011 surveys.



2.3.2.3 ***Alternatives 3A and 3B (3B preferred)***

Alternative 3 differs from Alternative 2 in that the south and central portion of Closed Area I would not be included as a spawning protection area.However, note that if Closed Area I South is chosen as a dedicated habitat research area (Section 2.3.4), the southern portion of this area would remain closed year round to mobile bottom-tending gears, having a very small positive effect on groundfish productivity through spawning protection.

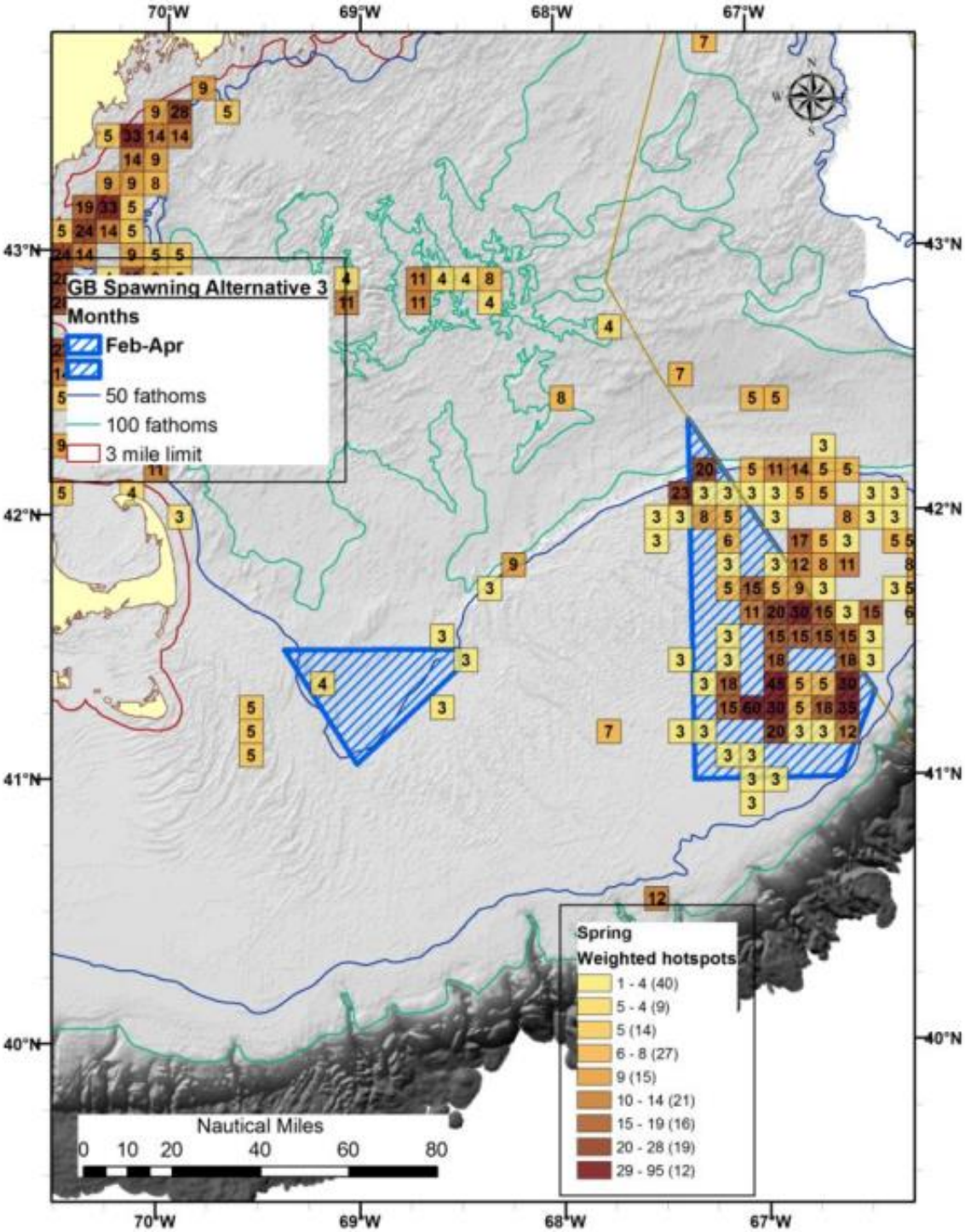
Most of the large spawner hotspots in Closed Areas I and II are included in Alternative 3 (553.5 weighted hotspots vs 618.4 for Alternative 1, Table 16), as there are few large or mature cod and haddock in the south and central portions of Closed Area I during the spring surveys (Map 51). Closed Area I North and all of Closed Area II, have a considerable number of hotspots, large cod and haddock (Map 49), and haddock in developing or ripe condition (Map 50).

Therefore, Alternative 3A has nearly the same impact on groundfish productivity through spawning protection as Alternative 2A, i.e., a slightly positive impacts on spring spawners and negative effects on fish that spawn in other seasons.

Option B differs from Option A only in that it would also prohibit recreational fishing for groundfish (some exemptions for pelagic fishing would apply). This measure would prevent the recreational fishery from targeting concentrations of cod and haddock in Closed Area I North and Closed Area II during the spring when the fish spawn. While a relatively small amount of recreational groundfish fishing effort occurs in Closed Area I and II during February and April (see Human and Community impacts section), Alternative 3B provides a small amount of added protection for spawning cod and haddock, both primary recreational target species.

Thus relative to Alternative 1 (No Action), Alternative 3B has slightly positive impacts on groundfish productivity in the spring season (due partially to the elimination of the scallop access program during February to April and prevention of recreational fishing for spawning cod and haddock) and large negative impacts on fish that spawn in other seasons. The overall impacts of this alternative on spawning groundfish are expected to be slightly positive, as compared to the moderately positive impacts associated with Alternative 1/No Action.

Map 51 – Distribution of weighted large spawner groundfish hotspots in spring compared to Alternative 2 areas. Closures to gears capable of catching groundfish would occur from Feb 1 to Apr 15.



2.3.2.4 ***Alternatives 2 and 3, Option C (3C preferred)***

Option C would exempt scallop dredge vessels from the February 1 to April 15 spawning closures in Closed Areas I and II. Option C could be selected independently of whether the spawning closure allows recreational fishing (Option A) or does not allow recreational fishing (Option B). If Option C is chosen and an exemption was provided, seasonality of scallop fishing in the Georges Bank access areas would still be subject to regulation under the Atlantic Sea Scallop FMP, for example to improve scallop yield or reduce bycatch. Scallop fishing could continued to be prohibited in portions of Closed Areas I and II where habitat management areas restrict the use of dredge gears. Within these areas, scallops are concentrated in the central portion of Closed Area I and the northern and southeastern parts of Closed Area II.

Since catches are capped by an annual catch limit, the purpose of the spawning closures is to enhance spawning success by reducing effects (i.e., removals, disruption, dispersal) on spawning activity. There is no evidence that scallop dredges have less of an impact on spawning than do other types of gears targeting groundfish. Although groundfish trawls typically sweep a larger area, scallop dredges are heavier and noisier, kicking up as much (or possibly more) sediment than a standard groundfish trawl.

Although bycatch of round-bodied groundfish such as cod and haddock is low in scallop dredges, their spawning activity may be disturbed by dredge activity. Mature size (Map 49, left panel) and spawning condition (Map 50, upper panel) cod are abundant in spring survey catches in the northern part of Closed Area II, along the Northern Edge, and the southeastern part of Closed Area II. Both areas have high biomasses of fishable scallops. Mature size (Map 49, right panel) and spawning condition (Map 50, lower panel) haddock occur throughout Closed Area II in spring survey catches, particularly along the Northern Edge of Georges Bank and in the central and northern part of Closed Area I. The central portion of Closed Area I often has high biomass of fishable scallops and is an identified access area.

Note that while scallop dredges capture winter and yellowtail flounder at higher rates in Closed Area II, spawning for these species takes place during seasons other than the proposed February 1 to April 15 spawning closure. Large yellowtail flounder are abundant in the southeastern and central portion of Closed Area II during the summer months.

Thus, based on the distribution of cod and haddock in spring survey catches, the prevalence of groundfish spawning hotspots in Closed Area II, and the probable equivalent effects of dredge and trawl gear on spawning, Alternative 2C is likely to have a slightly negative impacts on the groundfish resource and productivity because scallop dredging would mitigate the possible benefit of prohibiting groundfish fishing in the closed areas during spawning. Similarly, Alternative 3C is also likely to have a slightly negative impact on the groundfish resource and productivity. When combined with other commercial and recreational fishing restrictions proposed in Alternatives 2A, 2B, 3A, and 3B (3B is preferred) that are expected to have slightly positive impacts on the groundfish resource, Alternatives 2C and 3C will dampen this positive impacts expected from those alternatives. Thus, Option C combined with Option A or B will have negative impacts on the groundfish resource relative to Alternative 1/No Action.

2.4 Dedicated Habitat Research Area Alternatives

The discussion below focuses on the expected impacts of Dedicated Habitat Research Area measures on the 19 large-mesh groundfish stocks. Fishing gear restrictions in the DHRAs would affect groundfish habitat and potentially groundfish productivity. Since many of these areas also overlap proposed habitat management areas, only the potential incremental effects of special measures for the DHRAs are discussed below. These impacts could arise from the following measures that could apply in the DHRAs beyond what is proposed for the corresponding habitat management areas:

- Prohibitions on additional gears, such as longlines, gillnets, and recreational gears (Alternative 3), and
- DHRA removal if no research is underway (Alternative 5).

A major focus of the research agenda identified for the DHRAs is to assess some of the assumptions and processes applied in the Swept Area Seabed Impact model, i.e. to what extent specific fishing gears impact habitat (gear impacts), how quickly does habitat recover (habitat recovery), the effects of natural disturbance on various types of habitat, and measurement of how habitat changes and recovery impact fish productivity. Research on these topics is expected to have moderately positive, indirect impacts on groundfish resources, because better science is expected to translate into better, more effective management.

The preferred DHRA alternatives include Alternatives 2, 3B, 4, and 5, which would implement a Small Eastern Maine DHRA, a Stellwagen DHRA with the northern recreational closure reference area/reference area 2, a Georges Bank DHRA (southern portion of Closed Area I), and a three year evaluation and sunset period for DHRA designation, respectively. Especially when considered in combination, the preferred alternative provides a contrast in areas and proposes research areas of sufficient size that habitat research conducted in these areas is likely to have a strong positive impact on the ability to productively conserve age 0/1 juvenile groundfish habitat, and potentially improving the groundfish resource.

2.4.1 Alternative 1 (No Action)

The effects of Alternative 1/No Action are difficult to evaluate distinctly from potential Habitat Management Area impacts discussed above. Depending on the habitat management alternatives selected, management conditions appropriate to conducting habitat research may already apply in these areas, such that DHRA designation would not be necessary for creating appropriate conditions for doing habitat-related research.

If the current habitat closures remain in place and new habitat management areas are not adopted, the current impacts on groundfish productivity could continue, possibly with better data if additional monitoring measures are adopted. However, no newly closed areas would be created to study the initial and sequential recovery of habitat types. If alternative habitat management areas replace current habitat closure areas, the effects of gear impacts in the newly opened habitat closures and groundfish habitat recovery in newly closed habitat management areas could be studied. Whether action or no action habitat management alternatives are selected, the effects of habitat condition and closed area management on groundfish productivity could be studied

given additional monitoring. However, it may be more difficult to conduct comparable research in adjacent and similar habitat types and oceanographic conditions.

While possibly not as beneficial as one or more of the DHRA alternatives, the impact of not deliberately designating DHRAs (i.e. No Action) on groundfish habitat and productivity may only be slightly negative.

Tables summarizing groundfish hotspots in each of the DHRAs are provided below and are referenced in the discussions of individual alternatives.

Table 17 – Total number of unweighted and weighted age 0/1 groundfish hotspots by season and DHRA alternative.

	Spring		Summer		Fall		Winter	
	Total hotspots	Total weighted hotspots	Total hotspots	Total weighted hotspots	Total hotspots	Total weighted hotspots	Total hotspots	Total weighted hotspots
No Action	**0**	**0.0**	**0**	**0.0**	**0**	**0.0**	**0**	**0.0**
Alternative 2	41	0	0	0	110	229.8	0	0
Alternative 3	24	112.9	6	6.8	17	123.5	1	6.7
Alternative 3A	2	25.1	0	0	2	12.5	0	0
Alternative 3B	0	0	0	0	3	37.6	0	0
Alternative 4	0	0	0	0	0	0	0	0

Table 18 – Total number of age 0/1 groundfish hotspots by species and DHRA alternative.

	Acadian redfish	American plaice	Cod	Haddock	Pollock	Red hake	Silver hake	White hake	Windowpane flounder	Winter flounder	Witch flounder	Grand Total
Alternative 2	34	0	0	0	0	0	62	36	13	3	3	151
Spring	0	0	0	0	0	0	37	0	0	3	1	41
Summer	0	0	0	0	0	0	0	0	0	0	0	0
Fall	34	0	0	0	0	0	25	36	13	0	2	110
Winter	0	0	0	0	0	0	0	0	0	0	0	0
Alternative 3	23	4	7	1	0	6	5	1	0	1	0	48
Spring	13	0	2	0	0	5	3	1	0	0	0	24
Summer	1	4	0	0	0	1	0	0	0	0	0	6
Fall	9	0	5	0	0	0	2	0	0	1	0	17
Winter	0	0	0	1	0	0	0	0	0	0	0	1
Alternative 3A	0	0	3	0	0	0	0	0	0	1	0	4
Spring	0	0	2	0	0	0	0	0	0	0	0	2
Summer	0	0	0	0	0	0	0	0	0	0	0	0
Fall	0	0	1	0	0	0	0	0	0	1	0	2
Winter	0	0	0	0	0	0	0	0	0	0	0	0
Alternative 3B	0	0	3	0	0	0	0	0	0	0	0	3
Spring	0	0	0	0	0	0	0	0	0	0	0	0
Summer	0	0	0	0	0	0	0	0	0	0	0	0
Fall	0	0	3	0	0	0	0	0	0	0	0	3
Winter	0	0	0	0	0	0	0	0	0	0	0	0
Alternative 4	0	0	0	0	0	0	0	0	0	0	0	0
Spring	0	0	0	0	0	0	0	0	0	0	0	0
Summer	0	0	0	0	0	0	0	0	0	0	0	0
Fall	0	0	0	0	0	0	0	0	0	0	0	0
Winter	0	0	0	0	0	0	0	0	0	0	0	0

2.4.2 Alternative 2 (Preferred)

This alternative would close the Eastern Maine DHRA to vessels using mobile bottom-tending gear, the same as Eastern Maine HMA Alternative 3, Option 1. The impacts of this alternative on groundfish habitat and productivity are summarized in Section 2.2.1.3. The majority of groundfish hotspots across large and small mesh species are for silver hake, white hake, redfish, and windowpane flounder. Weighted hotspots from groundfish observed in the fall surveys (Table 17, Map 1 in HMA section) arise from redfish, windowpane flounder, winter flounder, and witch flounder.

It is thought that the effects of habitat management in this area will be synergistic with the effects of dam removal and restoration projects on the Penobscot River. These projects are expected to allow recovery of diadromous prey which could improve groundfish productivity. The interaction between better quality groundfish habitat and improvements in prey availability could be very important.

Setting aside this area for dedicated habitat research, particularly on those projects focusing on groundfish productivity changes, would be beneficial and have positive impacts on groundfish resources compared to Alternative 1/No Action. The impacts on groundfish habitat would be the same as Alternative 1/No Action if the Eastern Maine Small habitat management area already prohibits the use of mobile bottom-tending gear (Option 1), but positive if no habitat management area is designated or if the restrictions in that area are ground cable modifications only (Option 3 or 4). These impacts could be very positive and important for groundfish stocks in Eastern Maine and related fisheries in neighboring communities, in particular.

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

This alternative would close a Stellwagen DHRA and maintain the existing restrictions associated with the combined Western Gulf of Maine Closure Area and Habitat Closure Area, i.e. closure to mobile bottom-tending gears and other gears that catch groundfish including sink gillnets and demersal longlines. In addition, if Alternative 3A or 3B is selected, a reference sub-area would also be closed to recreational and party/charter groundfish fishing. The Stellwagen DHRA has the same boundaries as the Stellwagen Large area included in western Gulf of Maine habitat Alternatives 3 and 6. The impacts on groundfish habitat and productivity by habitat Alternatives 3 and 6 are evaluated in Sections 2.2.3.3 and 2.2.3.6, respectively.

Map 52 shows the relationship between the weighted age 0/1 groundfish hotspots and the Stellwagen DHRA (purple outline). More survey catch data for cod and haddock age 0/1 and age 2+ sublegal cod and haddock are shown in Map 53 to Map 56.

Compared to Alternative 1 (No Action) which would have no specific habitat research areas, but would have either existing habitat closures or new habitat management areas, Alternative 3 would provide considerable opportunity to test habitat model assumptions and refine future management. This alternative therefore would have moderately to highly positive impacts overall, and also relative to Alternative 1/No Action.

Measures applied to DHRAs may be more restrictive than habitat management area measures which could prohibit or place restrictions on mobile bottom-tending gears. Although gillnets, longlines, and recreational fishing gears are estimated to have fewer impacts on coarse and hard substrates that are vulnerable to fishing damage, they would otherwise be able to capture groundfish in these areas which have benefited from habitat improvement. The higher amounts of juvenile groundfish may either be caught and discarded in the area, be caught at legal size and landed, or (if no or less groundfish fishing occurs in a DHRA) may continue to survive and grow to older age. As a result of the added restrictions, more of the fish would contribute to stock productivity and biomass rebuilding for a longer time until they become vulnerable to fishing elsewhere. Therefore to the extent that the DHRA and/or reference area overlaps the age 0/1 groundfish weighted hotspots (as a measure of groundfish habitat location) and/or distributions of juvenile cod and haddock, this alternative would likely have moderately positive impacts on groundfish habitat and productivity.

Proposed Reference Areas (Alternatives 3A and 3B)

Indirectly, it is likely that the incorporation of potential habitat research, including the effects of groundfish removals from all fisheries, into the management process would produce long term positive impacts on the groundfish resource through more informed and better management practices. These DHRA areas appear to be ideally suited for comparative research with control and experimental designs, although due to the areas' small size the effects on overall stock productivity may be difficult to detect.

Although some localized direct effects on resident populations of groundfish (to the extent that they occur) and on ecosystem function might be realized, these effects as well as population level effects are going to be very difficult to detect. Fishing within the area and in adjacent areas (including potential increased fishing in the Western Gulf of Maine Habitat Closure by vessels using groundfish gillnets, fishing around the border of a closed area, fishing with lobster traps and other gears that catch a small amount of groundfish, and illegal fishing by a few) could potentially overwhelm a detectable signal from reduced groundfish mortality in a 55 nm^2 area.

Although there are more age 0/1 groundfish hotspots inshore of the Stellwagen DHRA (Table 17; Map 52), some groundfish hotspots occur in the proposed area. Although offshore of most of the small juvenile cod and groundfish, the reference areas are closer to the hotspot concentrations of groundfish associated with coarse and hard substrates. Selective research with separate control and experimental areas could explore the association between age 0/1 groundfish hotspots and habitat types. There are few differences between the two reference areas with respect to hotspots (Map 52), sub-legal cod abundance (Map 53), and sub-legal haddock abundance (Map 54).

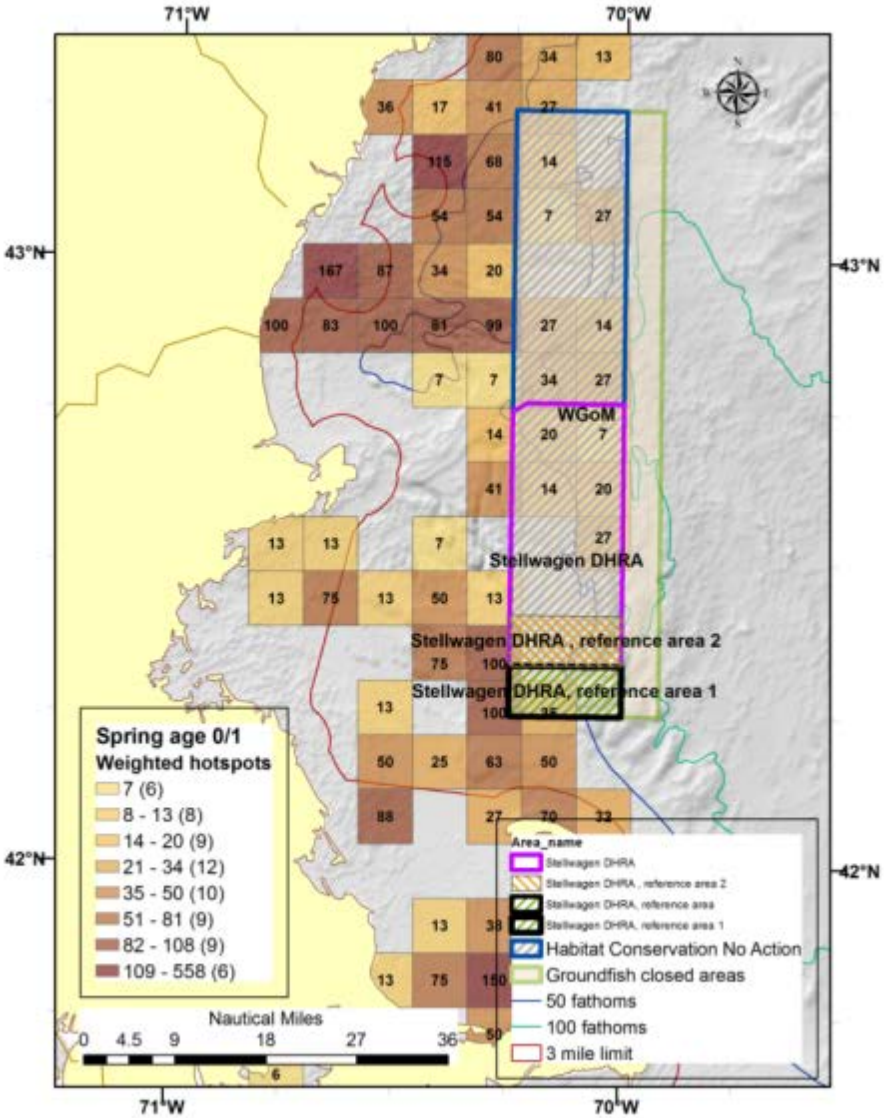
Moreover, such research may address the habitat use by different cohorts of sublegal cod and possibly other groundfish. Many of the smaller age 0/1-sized cod are typically well inshore of the larger sublegal cod in both the spring and fall surveys (Map 53). To a lesser extent, the same is true for juvenile haddock (Map 54). The inshore half of the proposed reference areas appears to contain a higher biomass of legal size cod in both the spring and fall (Map 55), although similar to the amounts of legal size cod found elsewhere in the Stellwagen DHRA (and elsewhere inshore of the Western Gulf of Maine Closure Area). Legal size haddock do not appear to be

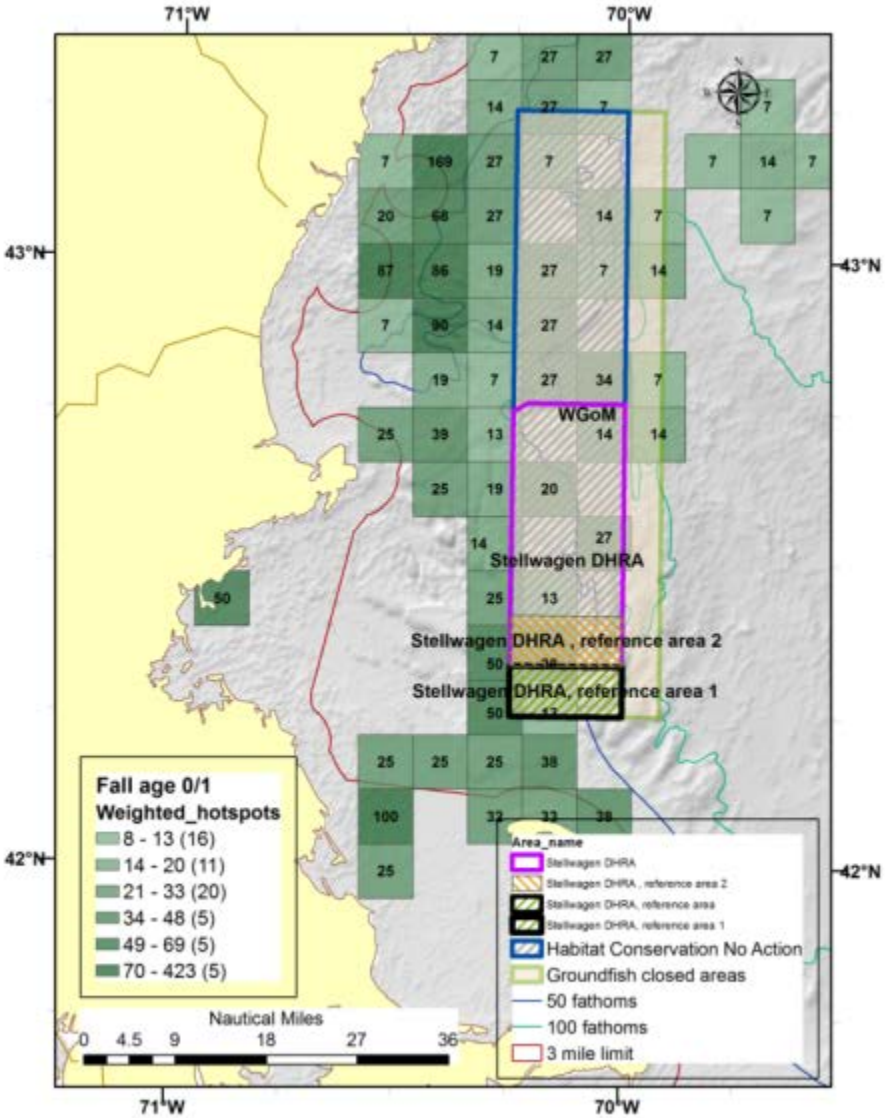
quite as concentrated on the inshore half of the proposed reference areas (Map 56), but do occur within both.

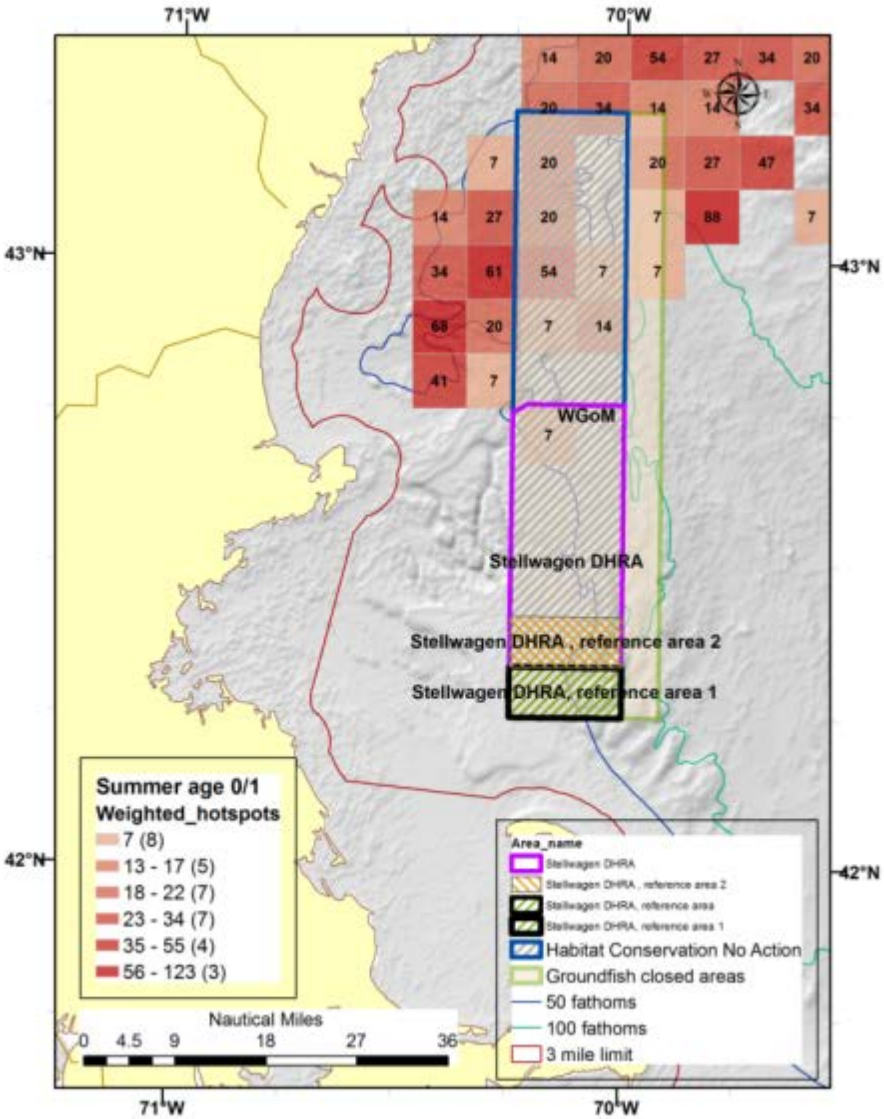
Differences in legal-size cod and haddock survey catches during 2002-2012 are not readily apparent. The area is currently closed to commercial groundfish fishing, but is open to recreational fishing by private anglers and commercial party and charter boats. Map 57 shows the spatial and seasonal (by month) distribution of VTR-reported cod catch per angler on commercial party and charter boats. The data indicate that cod catches are distributed fairly widely through the center of both reference areas. Cod catches in the Reference Area 2 (northern) are a bit more widespread than in Reference Area 1 (southern). If the influence of cod mortality on groundfish habitat and on ecosystem effects is more important, than Reference Area 2 may have a greater probability of producing detectible differences than Reference Area 1.

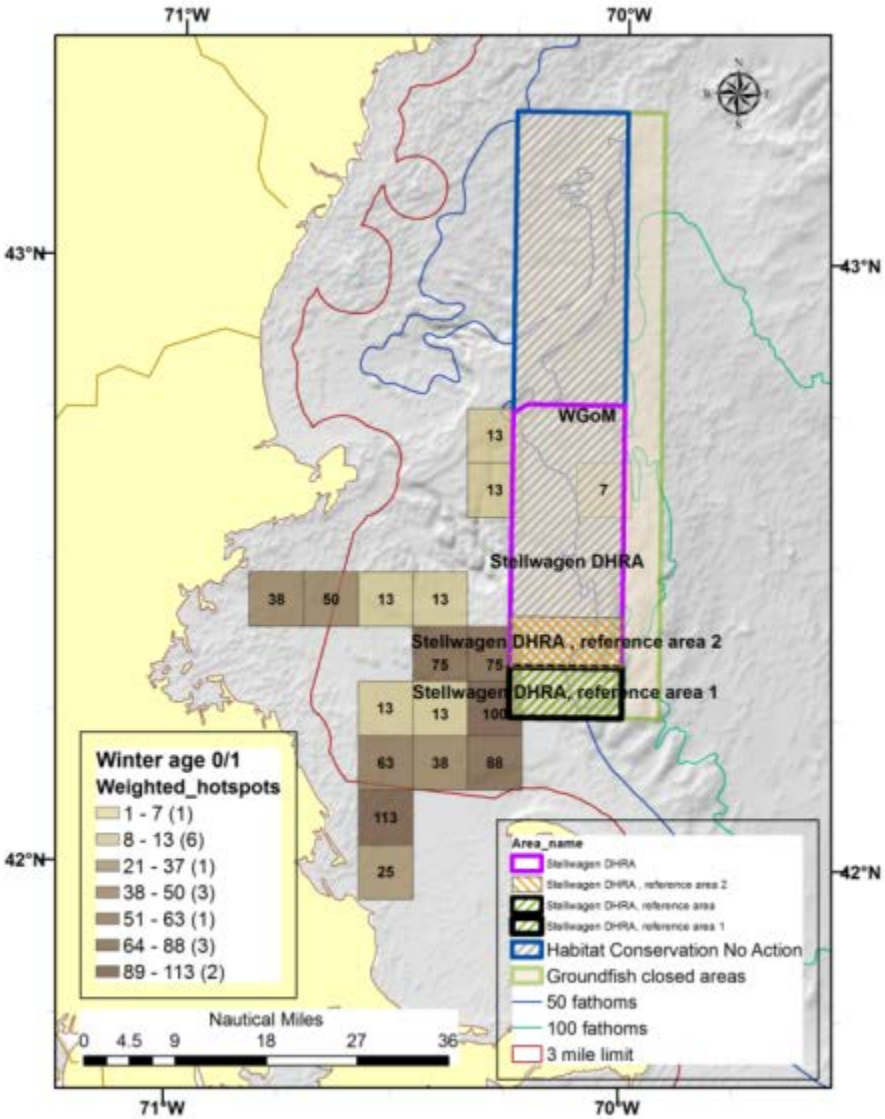
Cautious interpretation of these VTR-reported commercial party and charter boat data should be exercised, however, because many fishermen report one (average) fishing location per trip and do not represent the full range of a trip's fishing activity, much less specifically the locations where cod (or another species) were caught.

Map 52 – DHRA Alternatives 3 overlap with spring (left), fall (right), summer (left on next page), and summer (right on next page) total weighted age 0/1 groundfish hotspots from 2002-2012 NMFS, MADMF, ME-NH, and IBS survey data (continued on next page).

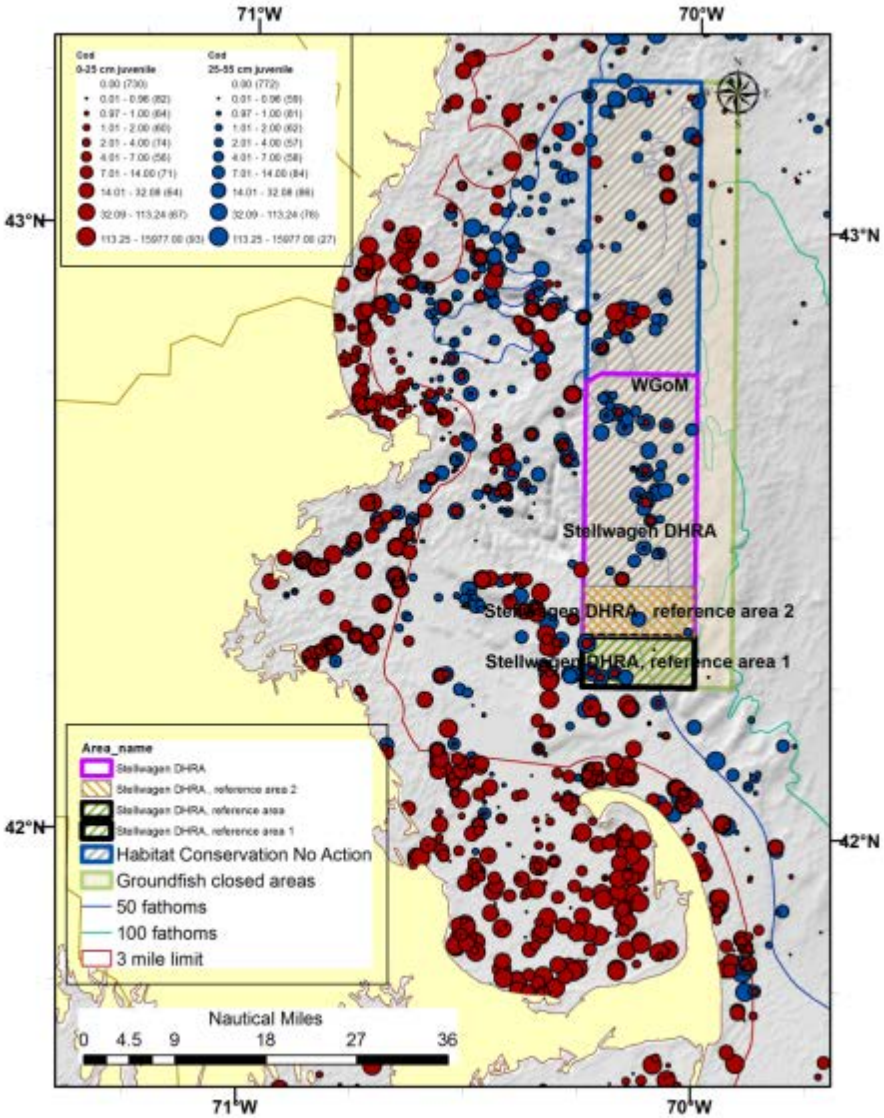


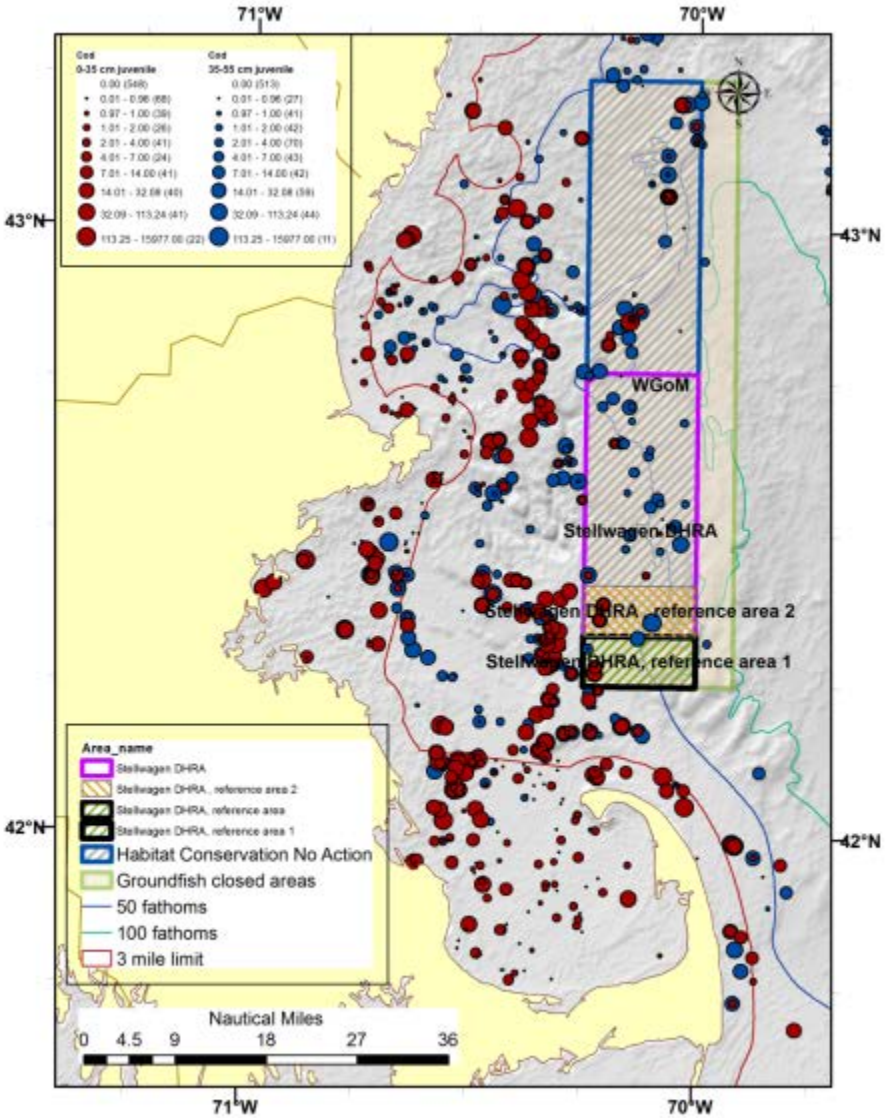



71°W
70°W
43°N
42°N
WGoM
Stellwagen DHRA
Stellwagen DHRA , reference area 2
Stellwagen DHRA, reference area 1
Summer age 0/1
Weighted_hotspots
7 (8)
13 - 17 (5)
18 - 22 (7)
23 - 34 (7)
35 - 55 (4)
56 - 123 (3)
Area_name
Habitat Conservation No Action
Groundfish closed areas
50 fathoms
100 fathoms
3 mile limit
Nautical Miles
0 4.5 9 18 27 36

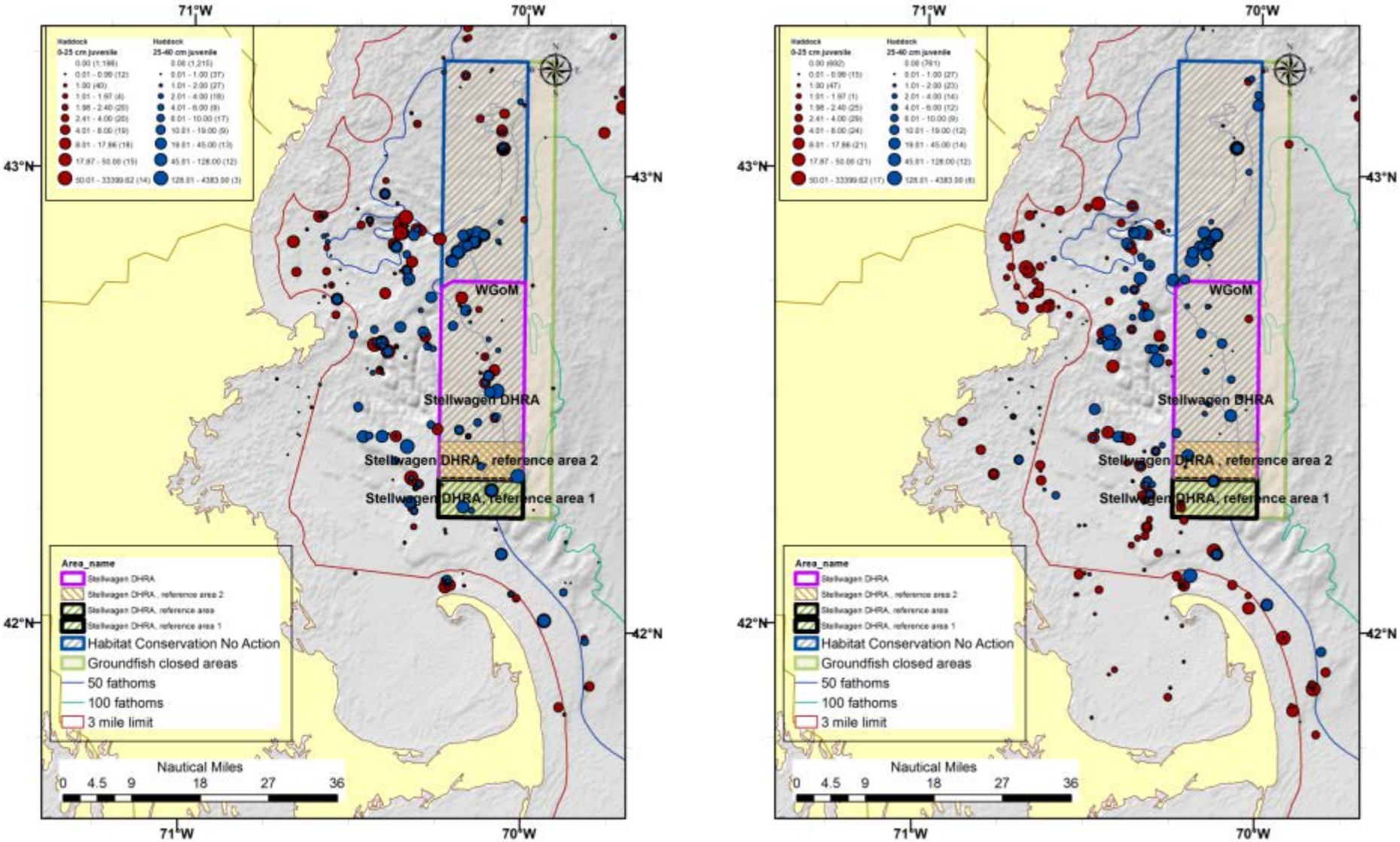

71°W
70°W
43°N
42°N
WGoM
Stellwagen DHRA
Stellwagen DHRA , reference area 2
Stellwagen DHRA, reference area 1
Winter age 0/1
Weighted_hotspots
1 - 7 (1)
8 - 13 (6)
21 - 37 (1)
38 - 50 (3)
51 - 63 (1)
64 - 88 (3)
89 - 113 (2)
Area_name
Habitat Conservation No Action
Groundfish closed areas
50 fathoms
100 fathoms
3 mile limit
Nautical Miles
0 4.5 9 18 27 36

Map 53 – DHRA Alternatives 3 overlap with spring (left) and fall (right) sub-legal cod number per tow from 2002-2012 NMFS, MADMF, ME-NH, and IBS survey data (continued on next page).

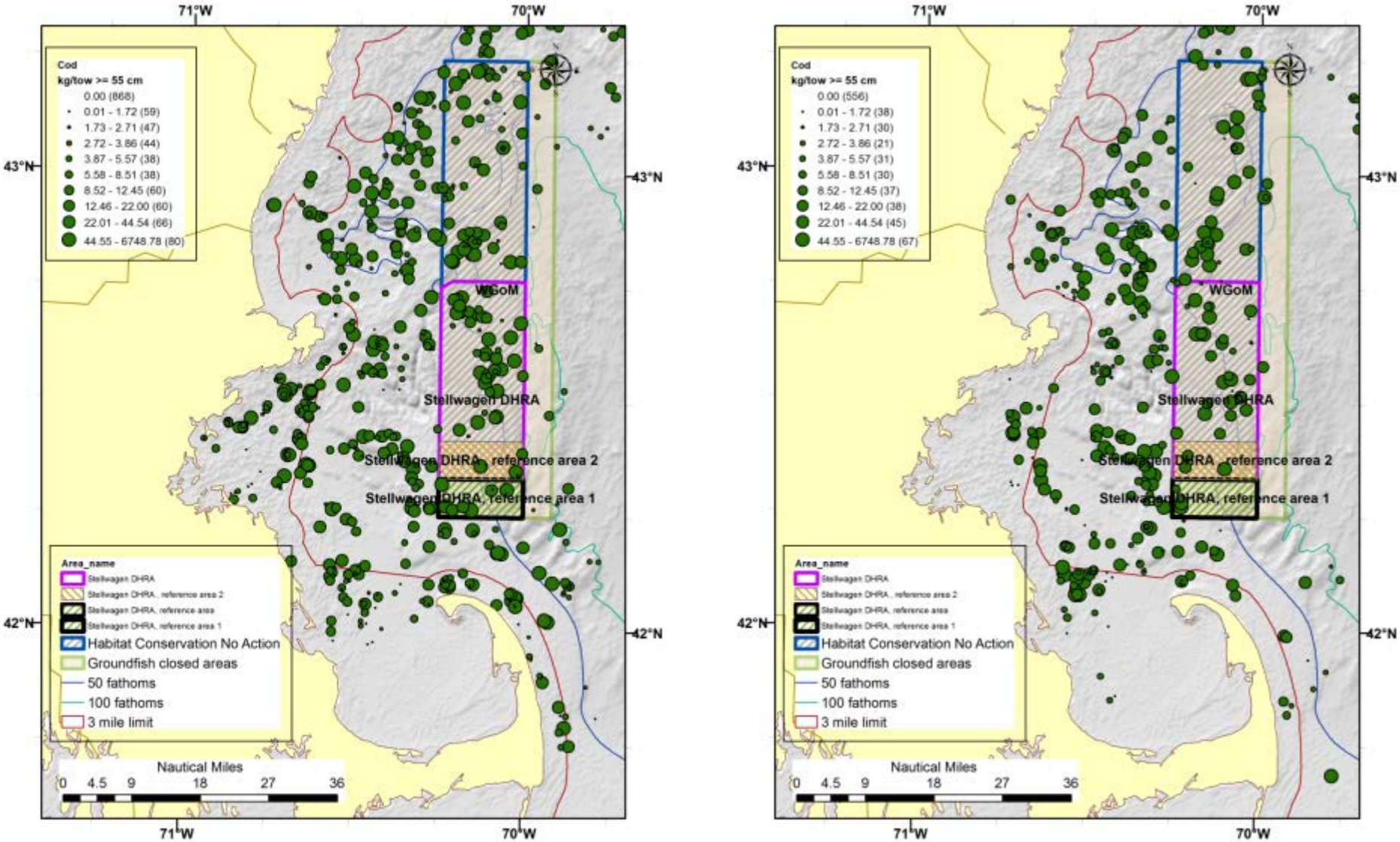




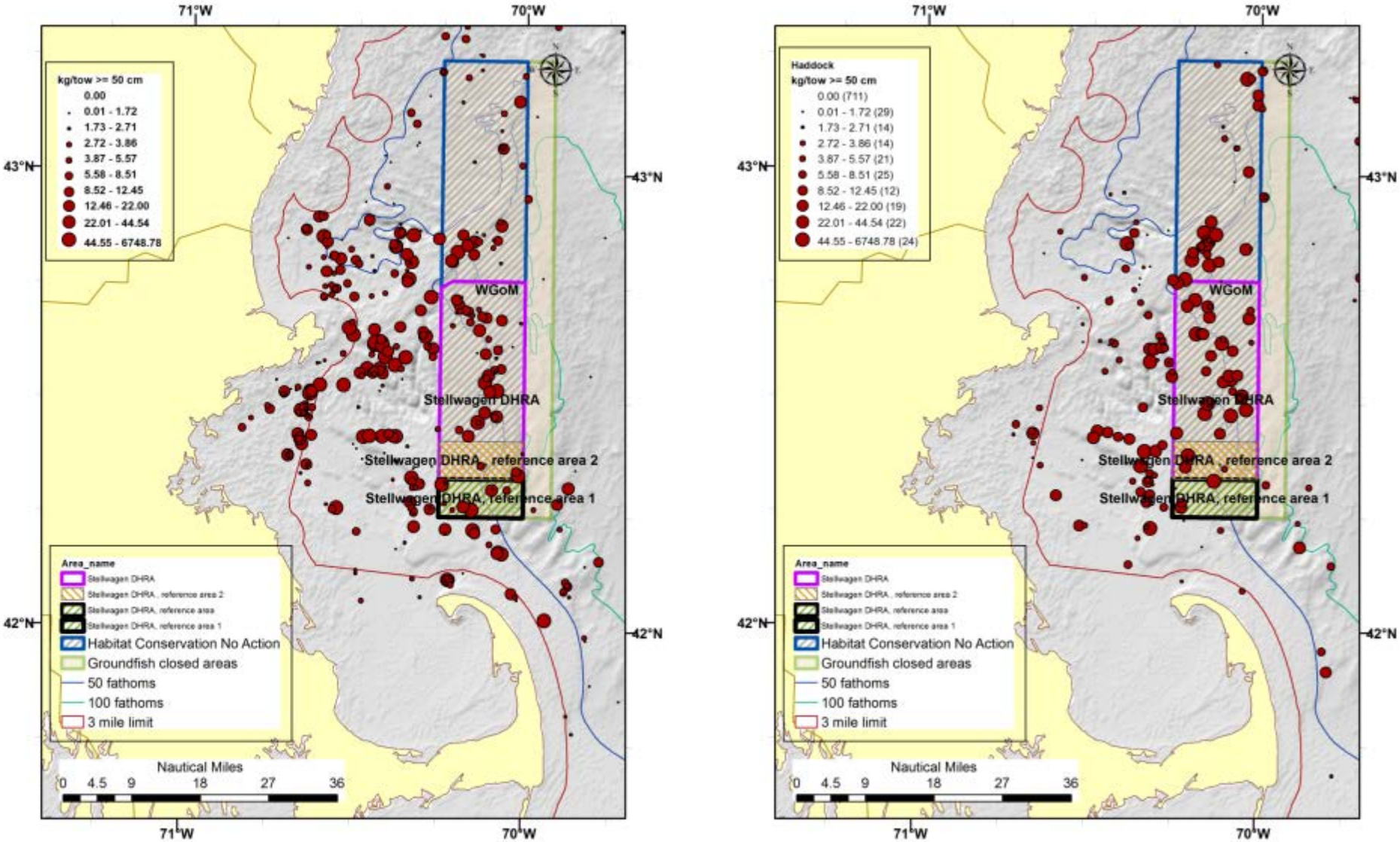
Map 54 – DHRA Alternatives 3 overlap with spring (left) and fall (right) sub-legal haddock number per tow from 2002-2012 NMFS, MADMF, ME-NH, and IBS survey data.



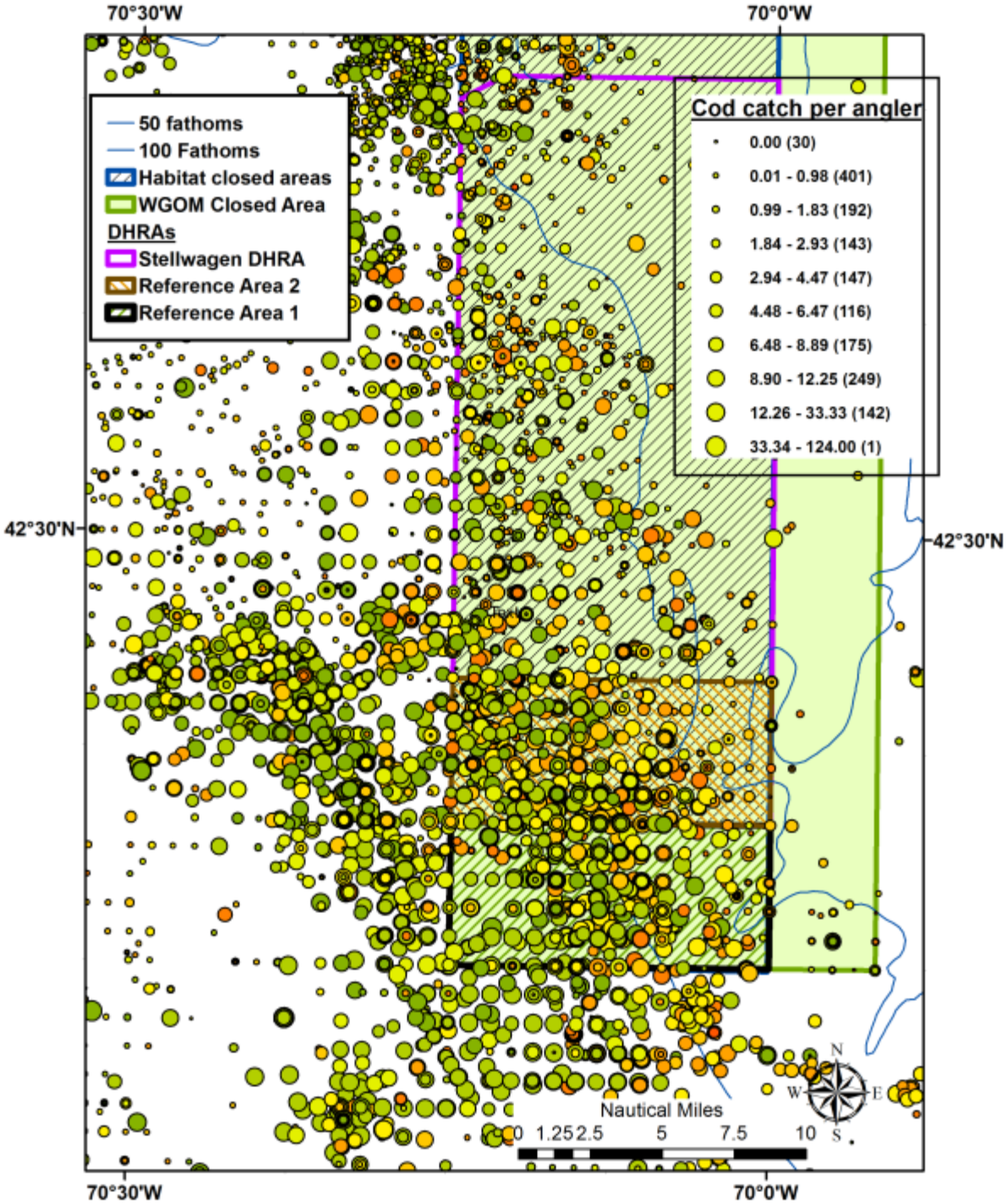
Map 55 – DHRA Alternatives 3 overlap with spring (left) and fall (right) legal cod weight per tow from 2002-2012 NMFS, MADMF, ME-NH, and IBS survey data.



Map 56 – DHRA Alternatives 3 overlap with spring (left) and fall (right) legal haddock weight per tow from 2002-2012 NMFS, MADMF, ME-NH, and IBS survey data.



Map 57 – VTR-reported cod catch per angler for commercial party and charter boats in the proposed Stellwagen Bank Dedicated Habitat Research Area and Reference Areas, 2008-2012. Catches are color coded by month, Jan (dark green) to August (yellow) to December (red). Each point represents a reported trip.



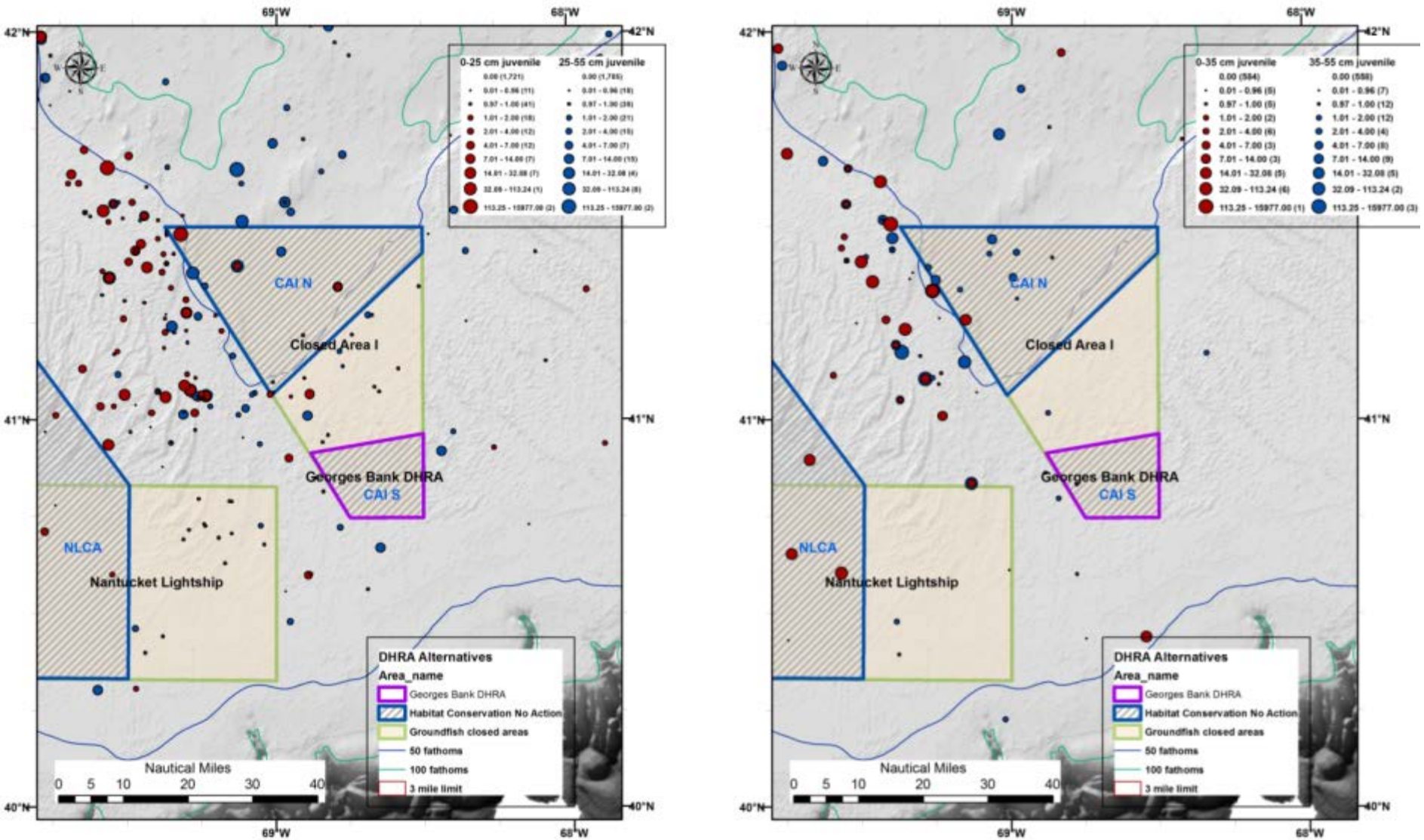
2.4.4 Alternative 4 (Preferred)

This alternative would establish a Georges Bank DHRA in the southern portion of Closed Area I and is the only DHRA alternative that overlaps a portion of one of the existing year round closed areas on Georges Bank. This area has been closed year-round to commercial gears capable of catching groundfish since a Secretarial action taken in late 1994 and to all mobile bottom-tending gear since 2004 (Amendment 13). Unlike some other Georges Bank closed areas, fishing has not been allowed here as part of a special access program or a scallop access area. The Georges Bank DHRA does not overlap with any of the newly proposed habitat management areas. The DHRA designation would maintain the mobile bottom-tending gear restrictions but other gears capable of catching groundfish could be allowed seasonally if Georges Bank Spawning Alternatives 2 or 3 are selected.

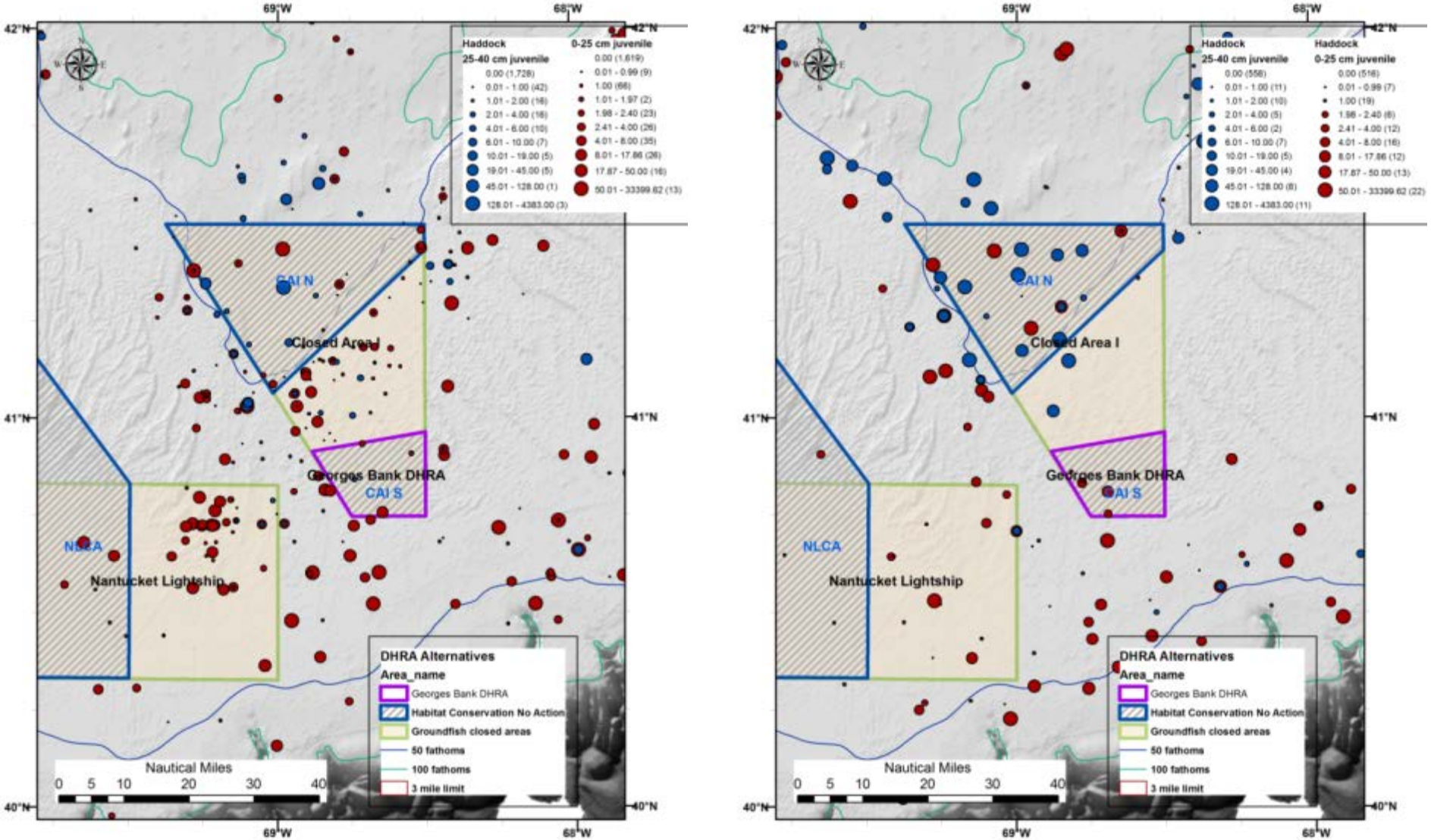
However, this area had no age 0/1 groundfish hotspots (Table 17) which suggests that any positive impact on groundfish habitat and productivity may be low. Looking more broadly at all levels of survey catch of cod and haddock for both age 0/1 and sublegal fish, this DHRA does not appear to be well suited to evaluate the effects of fishing (or not fishing) on groundfish habitat and productivity. Age 0/1 and large sub-legal cod (Map 58) and haddock (Map 59) are less abundant in this area than in other portions of Closed Area I or in the open fishing areas of the nearby Great South Channel.

Relative to Alternative 1 (No Action), the impacts on groundfish habitat and productivity are slightly positive, but potential benefits for the groundfish resource are lower than those expected from Alternatives 2 and 3.

Map 58 – DHRA Alternatives 4 overlap with spring (left) and fall (right) sub-legal cod number per tow from 2002-2012 NMFS survey data.



Map 59 – DHRA Alternatives 4 overlap with spring (left) and fall (right) sub-legal haddock number per tow from 2002-2012 NMFS survey data.



2.4.5 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.

This alternative would only have direct impacts on groundfish habitat or productivity if the fishing restrictions associated with the DHRA designation improve protection of groundfish stocks on top of positive impacts associated with habitat or spawning management area restrictions, which presumably would remain in place longer than three years. In the Stellwagen DHRA, resuming fishing with sink gillnets, longlines, and recreational gears could reverse any gains in productivity that had been achieved through the DHRA, although in the Eastern Maine and Georges Bank areas, fixed gears capable of catching groundfish would be allowed under DHRA management. More importantly, long term monitoring of how groundfish habitat is affected by fishing and how recovered/recovering habitat translates into productivity improvements could be compromised.

Relative to Alternatives 2, 3, and 4 with an unrestricted implementation timeframe, Alternative 5 has a moderately negative impact, but relative to Alternative 1 (No Action), it has a moderately positive impact because there would be at least a three-year opportunity to conduct groundfish habitat research.

2.5 Impacts on the large mesh groundfish fishery

The large mesh groundfish fishery is prosecuted using fixed and mobile bottom-tending gear types. OHA2 includes alternatives to maintain, modify, and adopt new closure areas for habitat protection, spawning protection, and research objectives. The large mesh fishery targets Acadian redfish, American plaice, Atlantic cod, haddock, pollock, white hake, winter flounder, witch flounder, and yellowtail flounder. Wolffish, northern and southern windowpane flounder, and ocean pout are non-allocated large mesh stockes (i.e. bycatch only), and Atlantic halibut catches are limited to one per trip. Additional background information about the large mesh fishery can be found in Volume 1, Section 4.3.

Most of the proposed Habitat Management Area alternatives include options that limit or restrict mobile bottom-tending gear within their boundaries. Impacts are assessed based on the areas where mobile bottom-tending gear would be prohibited and the potential for effort displacement. Spawning Management measures in the amendment are intended to provide large mesh groundfish-specific benefits, and therefore displace groundfish fishing activity with both fixed and mobile gears on a seasonal basis, with recreational restrictions for some alternatives. Dedicated Habitat Research measures may affect both mobile and fixed bottom-tending gears (non-preferred alternatives included recreational restrictions as well). Given that all sub-regions with the exception of the eastern Gulf of Maine have existing area closures, in terms of net impacts on the fishery, the question is whether the new or modified areas would have greater or lesser effects on the fishery than the existing areas. In addition, positive conservation outcomes associated with the alternatives over the long term may have positive effects on the fishery, despite continued or new displacement from fishing grounds.

2.5.1 Eastern Gulf of Maine habitat management and research area alternatives

The overall magnitude of groundfishing activity in the eastern Gulf of Maine is small relative to other sub-region (see Table 31 in Section 4.2.1 of Volume 4), such that habitat management area designations in this sub-region are not expected to have a substantial effect on the fishery, positive or negative. Alternative 1/No Action would continue with the status quo, i.e. no habitat management areas, and therefore would have neutral impacts on the fishery over the short term. The Alternatives 2 and 3 HMA designations would represent an increase in habitat protection, which could lead to long term benefits for the resource, but would also mean new restrictions on mobile bottom tending gear, which could adversely impact the large mesh groundfish fishery in the short term. While a single DHRA was considered in the eastern Gulf of Maine, the DHRA and its mobile bottom-tending gear restrictions overlap the eastern gulf of Maine HMAs. Thus, additional impacts resulting from the DHRA on the fishery are not expected (the DHRA was not identified as a preferred alternative). There are no spawning protection areas that overlap the eastern Gulf of Maine subregion.

The Council's preferred alternative is to designate the Small Eastern Maine habitat management area as a closure to mobile bottom tending gears. Overall, impacts to the large mesh groundfish fishery under the Council's preferred alternative are expected to be neutral to slightly negative, as annual bottom-trawl revenues generated within this HMA were estimated to be only$15,000 for the time period 2012-2014. These values could represent landings of non-groundfish stocks. If the Council had selected Alternative 3 as originally analyzed, i.e. the Small Eastern Maine HMA with the Machias HMA and the Toothaker Ridge HMA, all as closures to mobile bottom-tending gears, impacts would be slightly greater (potential displacement of approximately $75,000 bottom-trawl revenues, mainly from the Toothaker Ridge HMA). Similarly, impacts to the large mesh groundfish fishery would be greater if the Council had selected Alternative 2 (Large Eastern Maine HMA and Machias HMA, approximately $70,000 in bottom trawl revenues would be displaced). Alternative 2 Option 5 would have displaced additional gears capable of catching groundfish, but most of this effort and revenue is for purse seines, which are not used to catch large mesh stocks, but to target Atlantic herring. A small amount of longline revenues (approximately $4,000) would be displaced from the Large Eastern Maine HMA under Alternative 2. It is important to remember that these values represent effort that would likely be displaced, and that fishing activities would redistribute at least somewhat to nearby fishing grounds. Over the long term, conservation gains from the habitat management areas could mitigate any slight negative impacts on the fishery, and potentially lead to slight positive impacts associated with all three alternatives.

The discussion above assumes the habitat management areas would be implemented as mobile bottom-tending gear closures (option 1). Option 2 would exempt hydraulic clam dredges, which are not fished in eastern Maine, and are not used to catch groundfish in general, so the impacts of option 1 and option 2 on the groundfish fishery would be the same. If the HMAs proposed in Alternative 2, Alternative 3 as originally proposed, or Alternative 3 as preferred were adopted with gear modification option 3 or 4, impacts on the groundfishery would likely be slightly negative. In the short term, the small number of groundfish vessels operating in the HMAs would incur the expense of modifying their gear, generating slight negative impacts. The gear modifications are expected to have neglible effects on groundfish and groundfish habitat. Therefore, long term impacts on the fishery would be also be slightly negative, as there would be

no groundfish habitat benefits that could translate into positive impacts on the resource and the fishery, but costs of complying with the gear modification measures would be ongoing.

2.5.2 Central Gulf of Maine habitat management, spawning management, and research area alternatives

In the central Gulf of Maine, the Council's preferred alternative is modified Cashes Ledge, modified Jeffreys Bank, Fippennies Ledge, and Ammen Rock as HMAs (Alternative 3 without Platts Bank HMA). In addition, the Cashes Ledge Closure Area would be maintained. The HMAs would be closed to mobile bottom-tending gears, and Ammen Rock would be closed to all gears (except lobster gear). Short-term impacts to the operations of the large mesh fishery are expected to be neutral because the Cashes Ledge Closure Area is maintained as-is, and is currently closed to gears capable of catching groundfish. The Fippennies Ledge HMA and Ammen Rock HMA are relatively small in size, and are encompassed within the existing Cashes Ledge Closed Area. The overall impacts of Alternative 1/No Action and the preferred alternative on the groundfish fishery are expected to be slightly positive, oweing to the slightly to moderately positive impacts on the large mesh resource associated with this alternative.

While Alternatives 3 and 4 would open parts of the Cashes Ledge Closure Area to groundfishing, which could have slight positive impacts on fishery operations via increased flexibility to fish in Cashes Basin, there could be negative impacts to the groundfish resource. These effects on the resource are expected to lead to slight negative impacts on the fishery over the long term. Alternative 2 (no closures) would allow fishing within the habitat closures as well, which could benefit gillnet vessels that might choose to fish on Cashes Ledge, but over the long-term, negative impacts to the resource could lead to slightly negative impacts on the groundfish fishery.

The discussion above assumes the habitat management areas would be implemented as mobile bottom-tending gear closures (option 1). Option 2 would exempt hydraulic clam dredges, which are not fished in central Maine, and are not used to catch groundfish in general, so the impacts of option 1 and option 2 on the groundfish fishery would be the same. If the HMAs proposed in Alternatives 3 or 4 were adopted with gear modification option 3 or 4, impacts on the groundfishery would likely be slightly negative. In the short term, the small number of groundfish vessels operating in the HMAs would incur the expense of modifying their gear, generating slight negative impacts. The gear modifications are expected to have neglible effects on groundfish and groundfish habitat. Therefore, long term impacts on the fishery would be also be slightly negative, as there would be no groundfish habitat benefits that could translate into positive impacts on the resource and the fishery, but costs of complying with the gear modification measures would be ongoing.

2.5.3 Western Gulf of Maine habitat management, spawning, management, and research area alternatives

Relative to the eastern and central Gulf of Maine, there is more fishing activity in the western Gulf of Maine that could be affected by spatial management restrictions within habitat, spawning, and research areas.

In the Western Gulf of Maine, the Council's preferred alternative is similar to No Action in that it maintains the current habitat and groundfish management areas, but aligns their western boundaries at 70° W rather than the groundfish closure boundary extending to 69° 55' W. This will allow groundfish fishing in the eastern five mile sliver of the current groundfish closure, which should have a positive impact on the groundfish fishery relative to the current area configuration. As described in Volume 4 Section 4.2.3.1, there is substantial fishing activity adjacent to the Western Gulf of Maine Closure, but given current catch limits for cod this expanded fishing area is not expected to generate substantial positive impacts for the groundfish fleet. Despite continued effort displacement associated with both the No Action and preferred alternatives, given positive groundfish resource impacts associated with Western Gulf of Maine Habitat and Groundfish Closures, the long term impacts of Alternative 1 on the groundfish fishery are expected to be positive. Other preferred habitat alternatives in the western Gulf of Maine sub-region include adoption of the roller gear area as a habitat protection measure (Alternative 7A) and the designation of a shrimp trawl exemption area (Alternative 8). The roller gear size limit is already in place in the same location, so the impact on the fishery of making the area a habitat measure is expected to be neutral. Impacts of the alternate roller gear area (Alternative 7B) could be slightly negative, as compliant gear would be required in relatively small additional areas, but more likely neutral, since any trawl vessels fishing in the Bigelow Bight where the roller restriction is not currently required probably fish in the existing roller gear restricted area and have compliant gear already. The Alternative 8 shrimp exemption measure does not affect groundfish trawl vessels, and therefore impacts of this alternative would be neutral.

Other non-preferred HMAs under consideration in the western Gulf of Maine sub-region include the Small and Large Bigelow Bight HMAs, located inshore of the existing closures. Both Bigelow Bight HMAs encompass substantial amounts of bottom trawl activity that would be displaced under these alternatives (over $1.1 million from the Large Bigelow Bight and over $0.5 million from the Small Bigelow Bight). Alternatives 3, 4, and 5, combine one of the Bigelow Bight areas with varying subsets of the existing habitat closure. While parts of the Western Gulf of Maine Habitat Closure would be reopened under all three alternatives, there would likely nonetheless be moderately negative impacts on the commercial groundfish fishery in the short-term given the relatively large amounts of revenue generated in the Bigelow Bight HMAs, assuming the areas were closed to bottom trawls (option 1 or option 2). However, the Bigelow Bight HMAs would be expected to generate positive conservation benefits for large mesh groundfish stocks, such that long-term impacts on the fishery are also expected to be positive. Shifting from existing to new closures under Alternatives 3, 4, and 5 could affect the recreational groundfishery, but it is difficult to estimate the magnitude and direction of impacts associated with such shifts. On one hand, recreational gear is the only groundfish gear allowed to operate in the Western Gulf of Maine Closure Area, and eliminating commercial gear restrictions could generate new conflicts with recreational fishing activity. On the other hand, groundfish trawls would be eliminated from the Bigelow Bight HMAs which would reduce commercial/recreational gear conflict in these areas. Overall, these gear conflict-based effects could have slight negative to slight positive impacts depending on the location in question.

Alternative 6 would remove part of the existing closure but not add new areas in the Bigelow Bight. With option 1 or 2, this alternative would have positive impacts on the commercial fishery

via access to Jeffreys Ledge, and slight negative effects on the recreational fishery over the short-term given possible gear conflicts on Jeffreys Ledge. Given that the Alternative has a smaller magnitude of positive impacts on the groundfish resource relative to No Action, long term effects on both the commercial and recreational fishery could be slightly negative, relative to existing measures.Balancing changes in access with reduced conservation, the long term effects of Alternative 6 with option 1 or 2 are likely slightly positive.

The discussion above assumes the habitat management areas in Alternatives 3-6 would be implemented as mobile bottom-tending gear closures (option 1 or option 2). Option 2 would exempt hydraulic clam dredges, which appear to be fished in limited areas in the western Gulf of Maine, specifically on the sandy portions of Stellwagen Bank west of the existing habitat closure. Because these dredges are not used to catch groundfish, the impacts of option 1 and option 2 on the groundfish fishery would be the same. If the HMAs proposed in Alternatives 3-6 were adopted with gear modification option 3 or 4, impacts on the groundfishery would likely be slightly negative. In the short term, groundfish vessels operating in the HMAs would incur the expense of modifying their gear, but would gain access to the existing habitat closure. However, the long term impacts on the fishery would be negative, as there would be no groundfish habitat benefits that could translate into positive impacts on the resource and the fishery, but costs of complying with the gear modification measures would be ongoing. Alternative 2 would result in no habitat management areas in the western Gulf of Maine. While this alternative would allow the most flexibility in fishing location choice, and therefore have positive short-term impacts, without the burden of gear modification requirements, negative biological impacts on the groundfish resource are expected over the long term.
The Council proposes several options for spawning protection in the Gulf of Maine. Alternative 1A/Regulatory No Action, which is preferred, includes the Northeast Multispecies FMP Framework 53 cod protection closures (implemented May 2015) and the Gulf of Maine Cod Spawning Protection Area. Other preferred alternatives include the Massachusetts Bay Spawning Protection Area (Alternative 3), and thirty-minute Block 125 from April 15 to April 30 (Alternative 4). Fixed and mobile groundfish gear would not be allowed to fish within the spawning closure areas during the closure periods. Alternative 3 includes some additional gear restrictions relative to the overlapping cod protection closures currently in effect, but large differences in impacts are not expected given the scale of the Massachusetts Bay area. Alternative 4 covers a larger area but for a two-week period only. It is difficult to estimate how much activity would occur in this area during this time period because it was part of a long term rolling closure area through this past April, and is scheduled to open for the first time in many years during fishing year 2016. Because it will be the only closure block in April under the preferred alternatives, it is assumed that effort will shift onto adjacent fishing grounds. Overall, the net effects of the Gulf of Maine spawning alternatives on the groundfish fishery are expected to be neutral to slightly positive. While there is effort displacement, it is seasonal, and many of the areas are currently in effect such that new restrictions on the fishery will be limited, suggesting neutral impacts. Positive impacts on the groundfish resource are expected over the long term, such that long-term impacts on the fishery should be positive as well.

2.5.4 Georges Bank and Great South Channel/Southern New England habitat management, spawning management, and research area alternatives

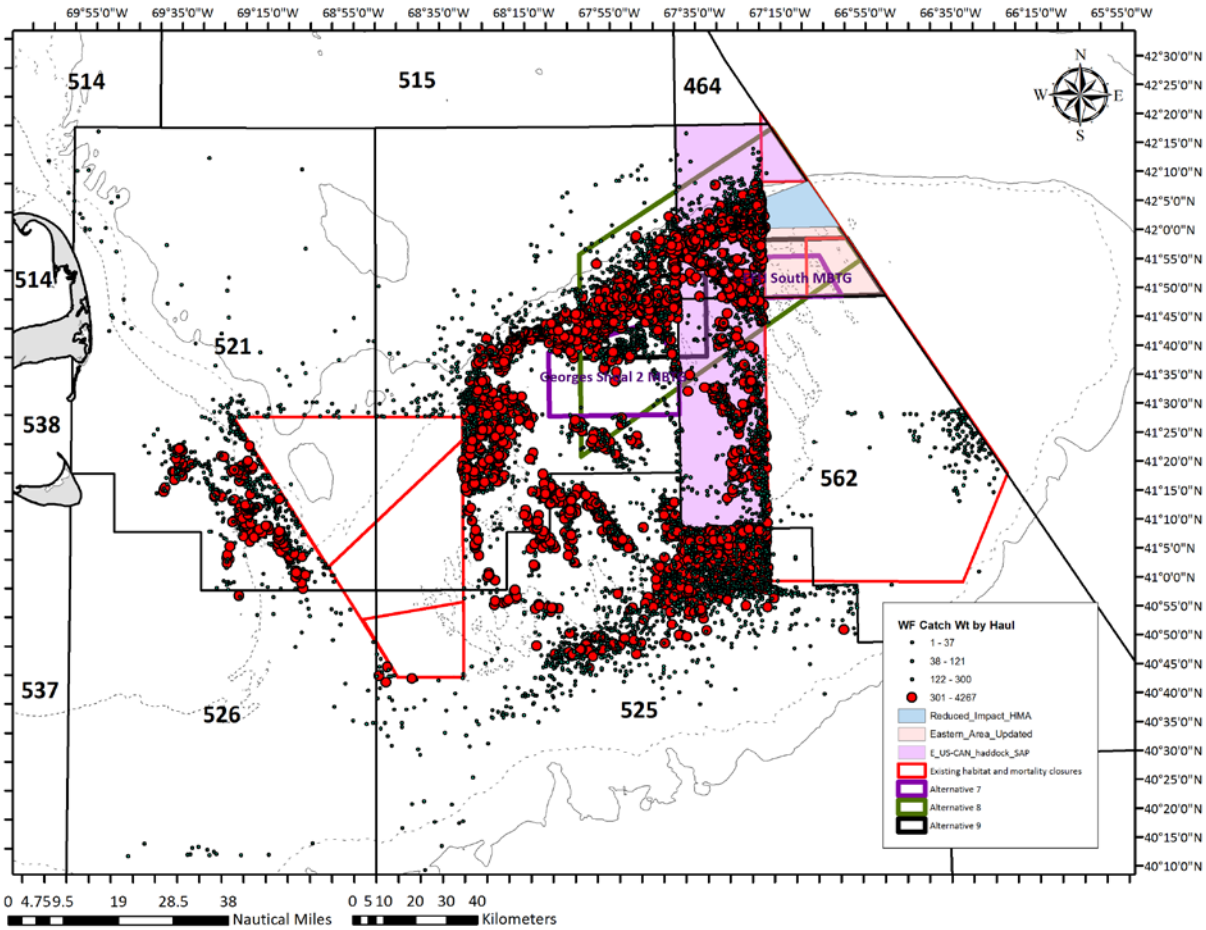
2.5.4.1 ***Data used to analyze impacts to the fishery***

The following information, in addition to the human impacts analysis provided in Volume 4, Section 4.2.4, was used to inform the discussion for large mesh groundfish fishery impacts on Georges Bank.

Observed hauls (NEFOP only) in statistical areas 521, 522, 525, 526, 561, and 562 of vessels using bottom otter trawl, haddock separator trawl, and Ruhle trawls were examined to identify spatial patterns in fishery catches for particular species and management areas. Point locations reflect where the observed haul began, and pounds reflect hail weight. At Sea Monitoring data were not included in this analysis. The focus of the evaluation is winter flounder and haddock that are in high abundance for which fishing displacement due to closures could have an adverse impact on the fishery. Yellowtail flounder and windowpane flounder catches were also plotted because these stocks are at low abundance and constraining to the fishery. Each map shows hauls with kept catch for the species. The hauls encompassing the top 25% of catch for each species are displayed more prominently to indicate locations that have higher catch rates per haul relative to other hauls in the time series. Areas with higher catch rates may indicate important fishing grounds where effort displacement could be of concern if a new area closure is enacted, but they could also indicate locations where effort might shift to under a modified spatial management system.

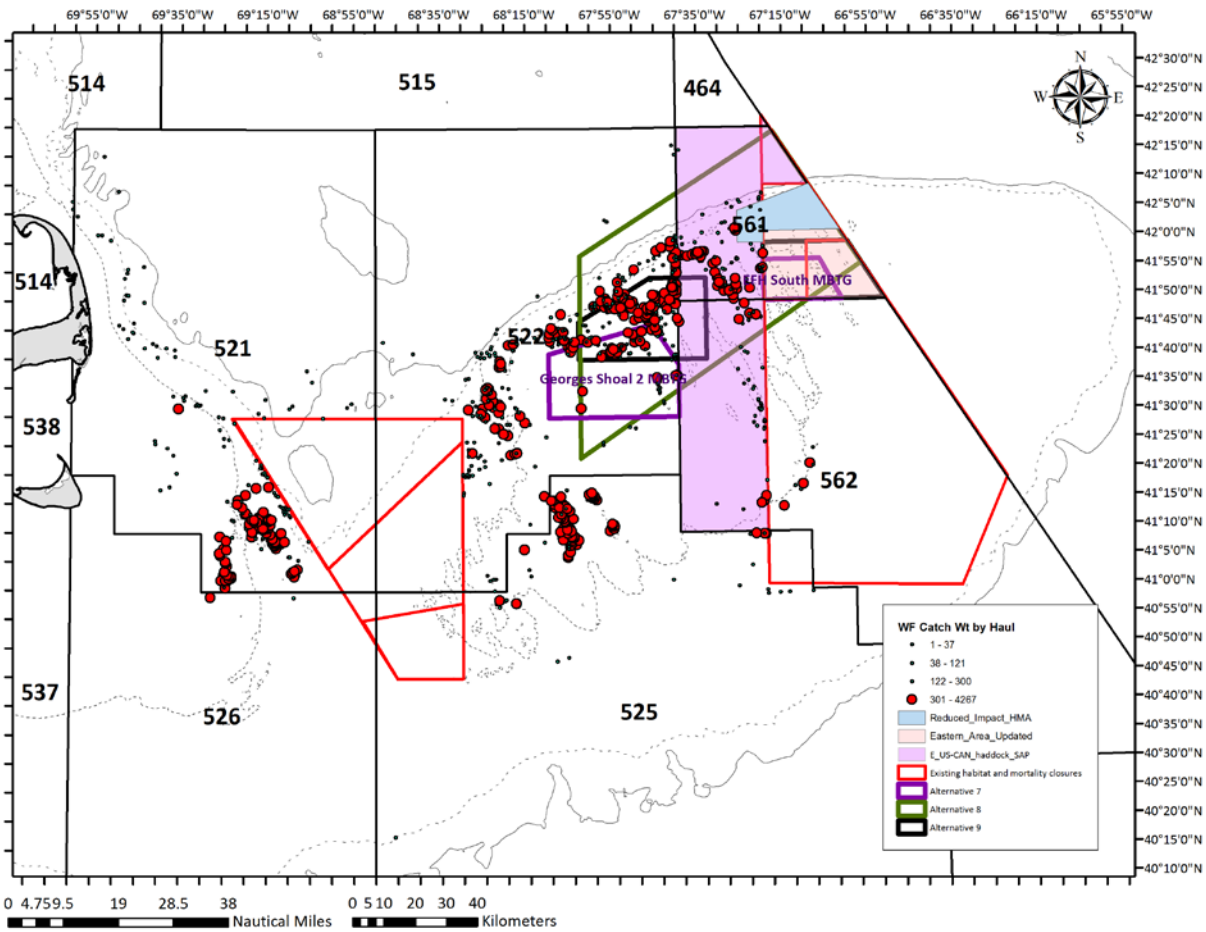
Two time periods were mapped separately for winter flounder, haddock, and yellowtail flounder. The first map for each species covers calendar years 2008-2012, while the second map for each species covers January 2013 to present to illustrate any changes in the patterns of fishery catch in the past 2+ years. For winter flounder only, the last two quarters of 2014 were also plotted. This time period overlaps implementation of the large windowpane AM area, which prohibits the use of standard bottom trawls and requires separator or Ruhle trawls, which are not as effective at capturing flatfish. Windowpane flounder discards from 2010 to present were plotted because windowpane was not allocated through Amendment 16 to the groundfish FMP and possession is prohibited. When comparing the maps across time periods, it is important to note that the 2008-2012 maps cover four years of data, while the 2013-present maps cover less than two and a half years of data, and observer data is not a census of fishing effort. The focus in the discussion is on the relative distribution of hauls with high catch rates, more so than on the number of hauls.

Map 60 – Winter flounder catch weight by haul (lb) from 2008-2012 (calendar year). Hauls colored in red had reported catch weights in the highest quartile (top 25%). Only hauls with positive catch of winter flounder are shown.



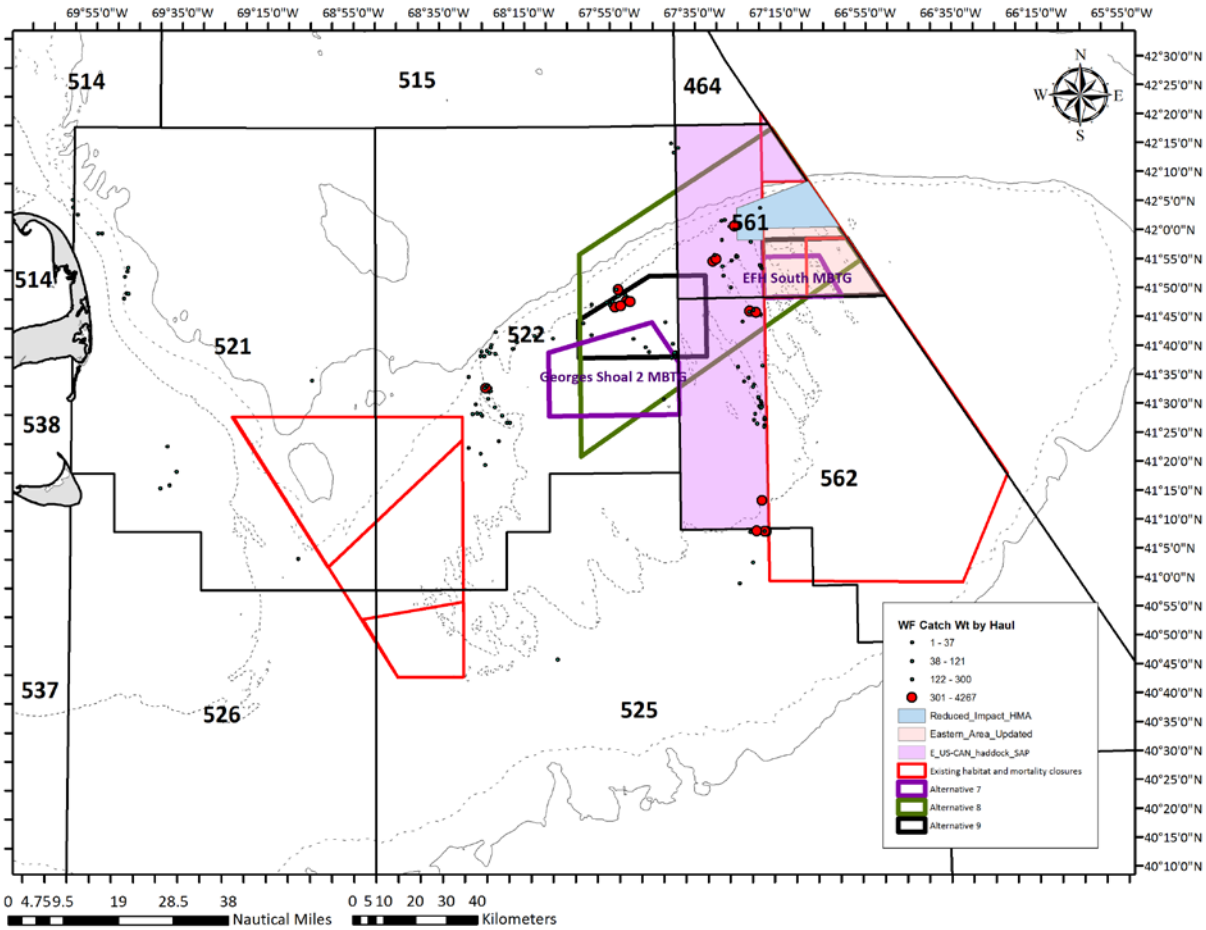
From 2008-2012 (calendar year), kept catches of winter flounder were widely dispersed across Georges Bank and the Great South Channel (Map 60). Note that this map includes kept catch from two winter flounder stock areas – SNE/MA (521 & 526) and GB (522, 525, 561, & 562). Within SA 522 hauls with catch weights in the highest quartile (top 25%; 301 lb - 4267 lb) appear to be aggregated along the northern extent of the eastern boundary of Closed Area I, along the northern flank of the bank between Closed Area I I and Closed Area II, and along the western boundary of Closed Area II. Hauls in the top quartile within SA 525 are aggregated along the southern extent of the US/Canada Haddock SAP and the southwestern boundary of Closed Area II, before fanning out the south and west.

Map 61 – Winter flounder catch weight by haul (lb) from January 2013-present. Hauls colored in red had reported catch weights in the highest quartile (top 25%). Only hauls with positive catch of winter flounder are shown.



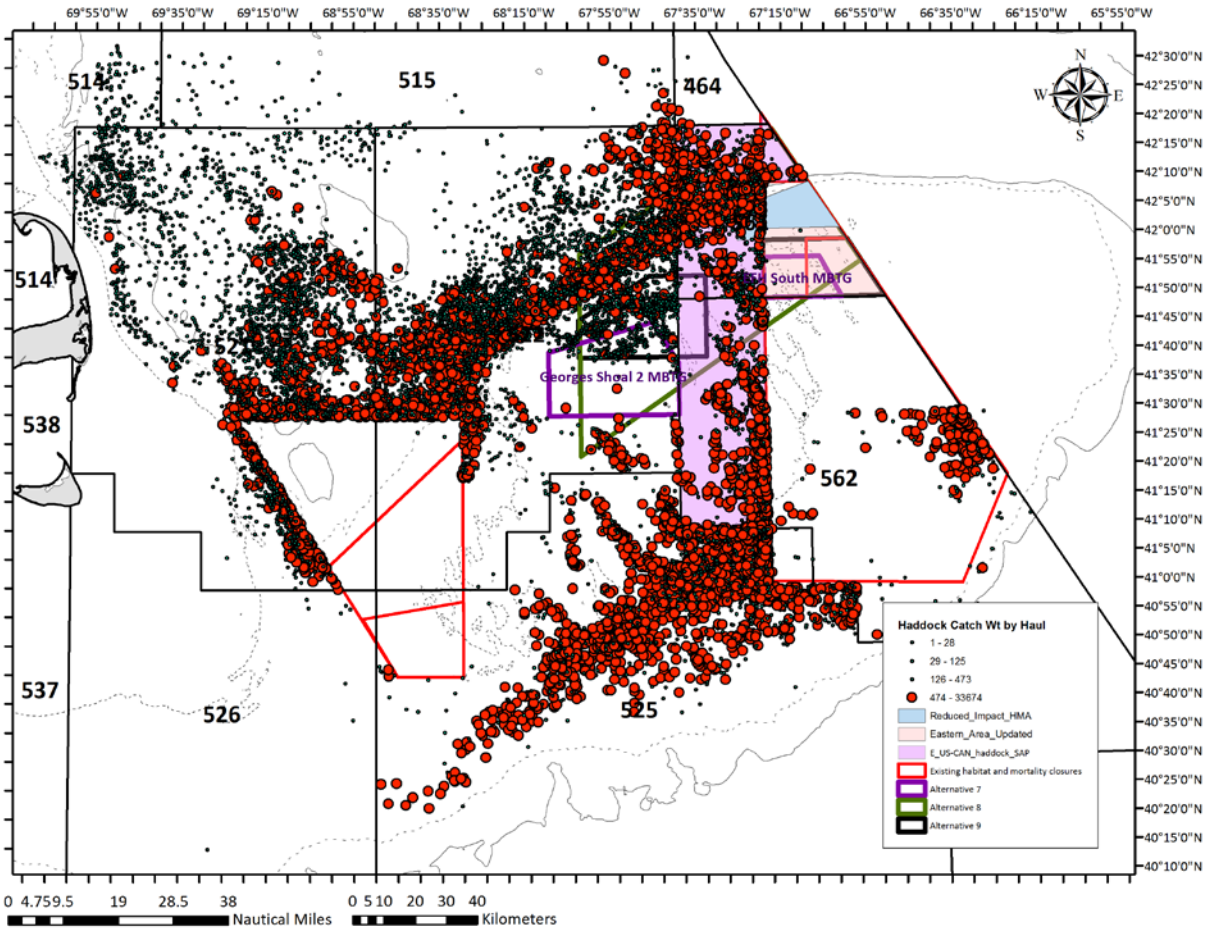
From 2013-present, kept catches of winter flounder have been distributed across the northern half of Georges Bank (Map 61). Note that this map includes kept catch from two winter flounder stock areas – SNE/MA (521 & 526) and GB (522, 525, 561, & 562). Within SA 522 hauls with catch weights in the highest quartile (top 25%; 301 lb - 4267 lb) appear to the northeast of Closed Area I, and concentrated within the extent of Alternative 8 (in green). Hauls in the top quartile appear within the northern portion of Georges Shoal 2 MBTG area where this area overlaps with Alternative 9. In general, a large portion of the observed hauls in the top quartile for this time period occurred within and around the bounds of Alternative 9. Hauls in the top quartile within SA 525 were isolated in the northern extent of the SA and on top of the bank. In FY2014 and FY2015 the larger windowpane flounder AM area (not shown) was triggered for the northern stock. This AM requires trawl vessels to use gear designed to avoid flatfish (e.g separator trawl, Ruhle trawl). With the AM in place, it appears that effort and catch within and to the south of the US/Canada Haddock SAP decreased. Top quartile catches of the SNE/MA winter flounder stock continued within the southern extent of 521 in the Great South Channel.

Map 62 – Winter flounder catch weight by haul (lb) from Q3 and Q4 2014. Hauls colored in red had reported catch weights in the highest quartile (top 25%). Only hauls with positive catch of winter flounder are shown.



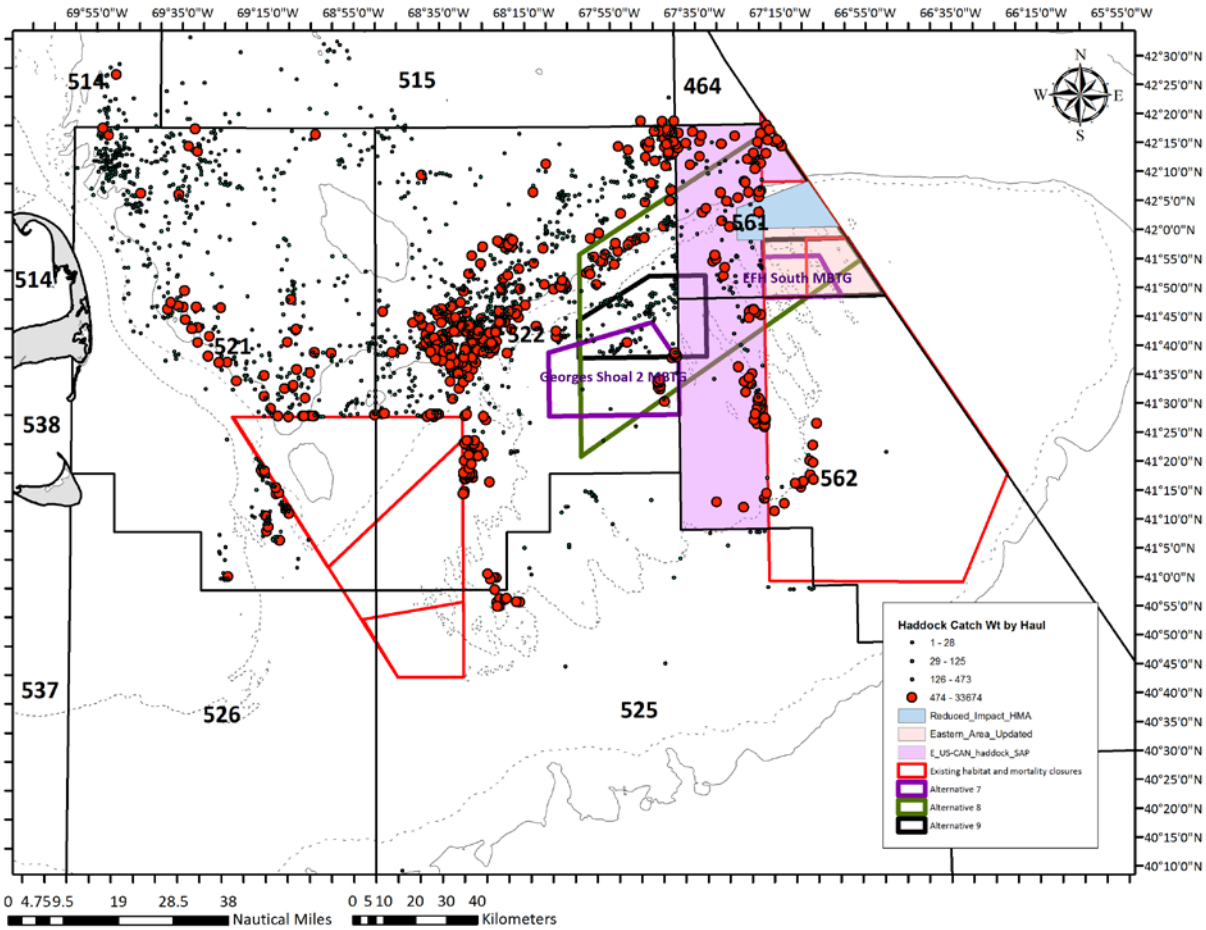
Over a six month period in FY2014, observed hauls with kept catch of winter flounder were limited in area 522, 525, 561, and 562 on Georges Bank (Map 62). Within SA 522, hauls with catch weights in the highest quartile (top 25%; 301 lbs - 4267 lbs) occurred within and around the bounds of Alternative 9. No hauls within the top quartile were observed within the Georges Shoal 2 MBTG area. Hauls in the top quartile within SA 525 were isolated in the to the area in the immediately south of the US/Canada Haddock SAP. In FY2014 and FY2015 the larger windowpane flounder AM area (not shown) was triggered for the northern stock. This AM requires trawl vessels to use gear designed to avoid flatfish (e.g separator trawl, Ruhle trawl). There were no top quartile catches of the SNE/MA winter flounder in SA 521 or 526 in the Great South Channel.

Map 63 – Haddock catch weight by haul (lb) from 2008-2012 (calendar years). Hauls colored in red had reported catch weights in the highest quartile (top 25%). Only hauls with positive catch of haddock are shown.



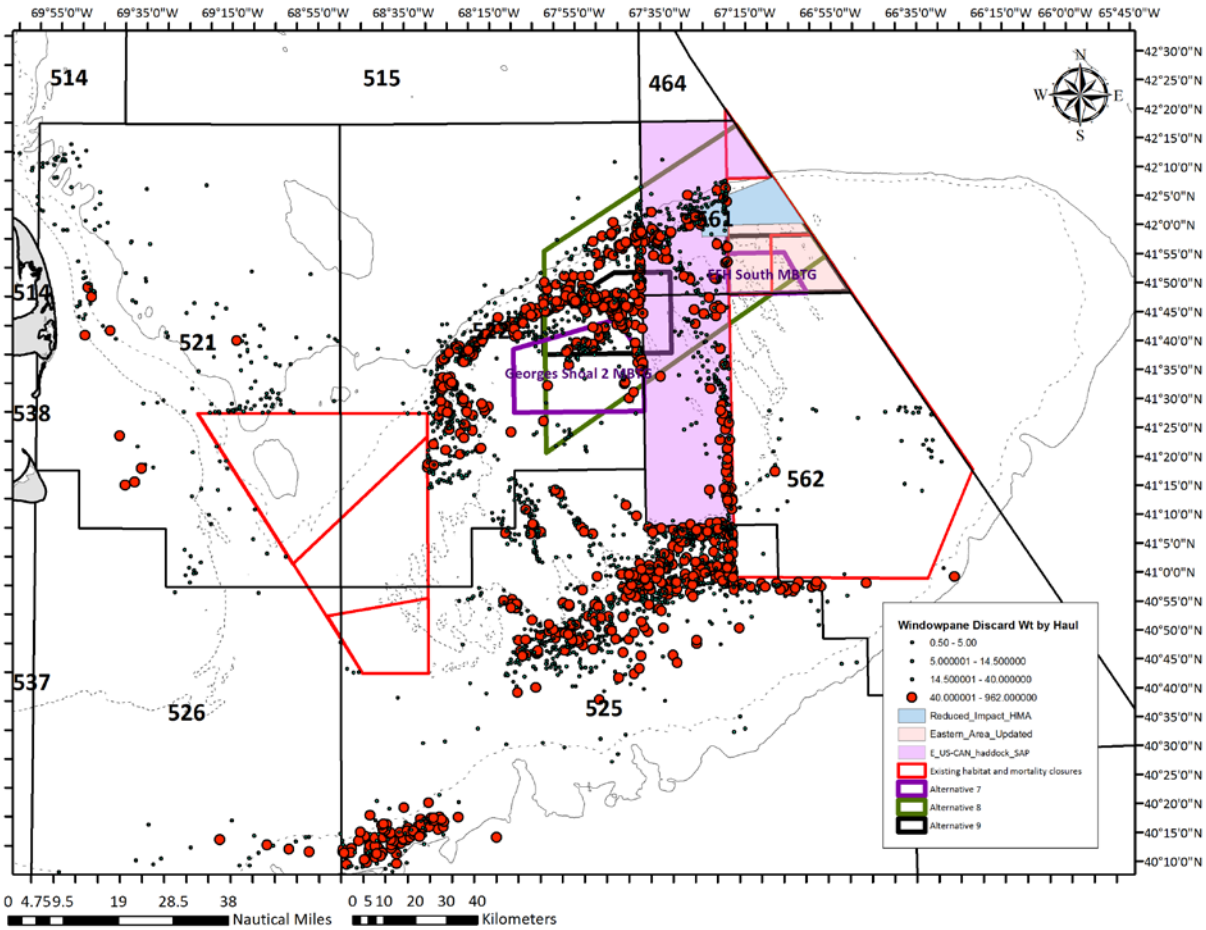
From 2008-2012 (calendar year), kept catches of haddock were widely dispersed across Georges Bank and portions of the Great South Channel (Map 63). Hauls with catch weights in the highest quartile (top 25%; 474 lb - 33674 lb) in SA522 appear to be aggregated along the northern flank of the bank, beginning along the northeast border of Closed Area I. Hauls in the top quartile within SA 525 are aggregated along the southern extent of the US/Canada Haddock SAP and the southwestern boundary of Closed Area II, before fanning out the south and west to the western boundary of SA 525. Observed hauls in SA 561 and 562 in the top quartile run along the western boundary of Closed Area II, and are aggregated in the northern portion of the US/Canada Haddock SAP.

Map 64 – Haddock catch weight by haul (lb) from January 2013-present. Hauls colored in red had reported catch weights in the highest quartile (top 25%). Only hauls with positive catch of haddock are shown.



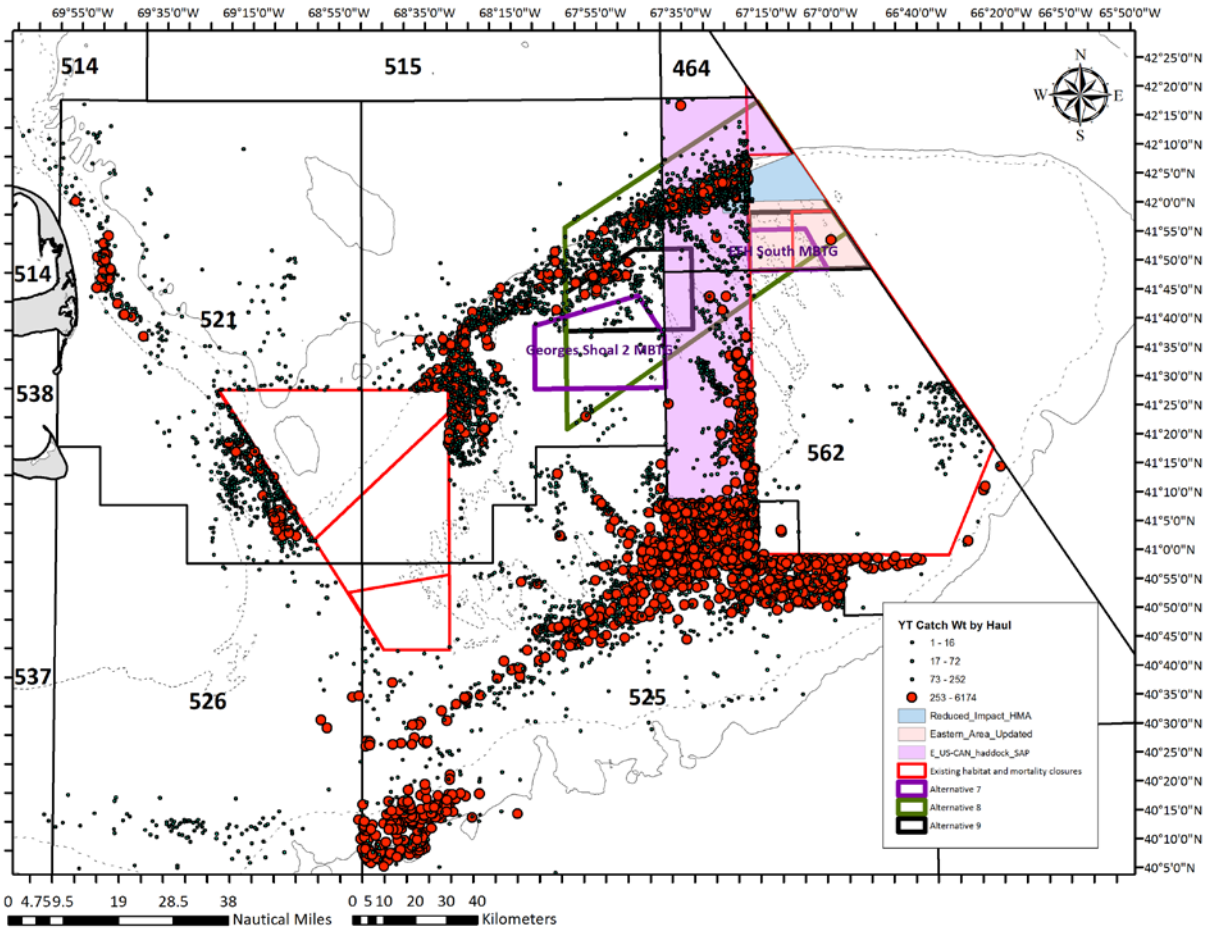
From 2013-present, observed hauls with kept catch of haddock were distributed across the northern half of Georges Bank in SA 521 and 561 (Map 64). Within SA 522, observed hauls with catch weights in the highest quartile appear concentrated to the northeast of Closed Area I, and to a lesser extent in the northeast corner of 522. Alternative 8 (in green) intersects with the highest number of top quartile hauls. Relatively few top quartile hauls occurred within the Georges Shoal 2 MBTG area or Alternative 9. In FY2014 and FY2015 the larger windowpane flounder AM area (not shown) was triggered for the northern stock. This AM requires trawl vessels to use gear designed to avoid flatfish (e.g separator trawl, Ruhle trawl). With the AM in place, it appears that effort and catch within and to south the US/Canada Haddock SAP decreased. Top quartile catches of the SNE/MA winter flounder stock continued within the southern extent of 521 in the Great South Channel.

Map 65 – Windowpane discards by haul (lb) from January 2010-present. Hauls colored in red had reported catch weights in the highest quartile (top 25%). Only hauls with discards of windowpane are shown.



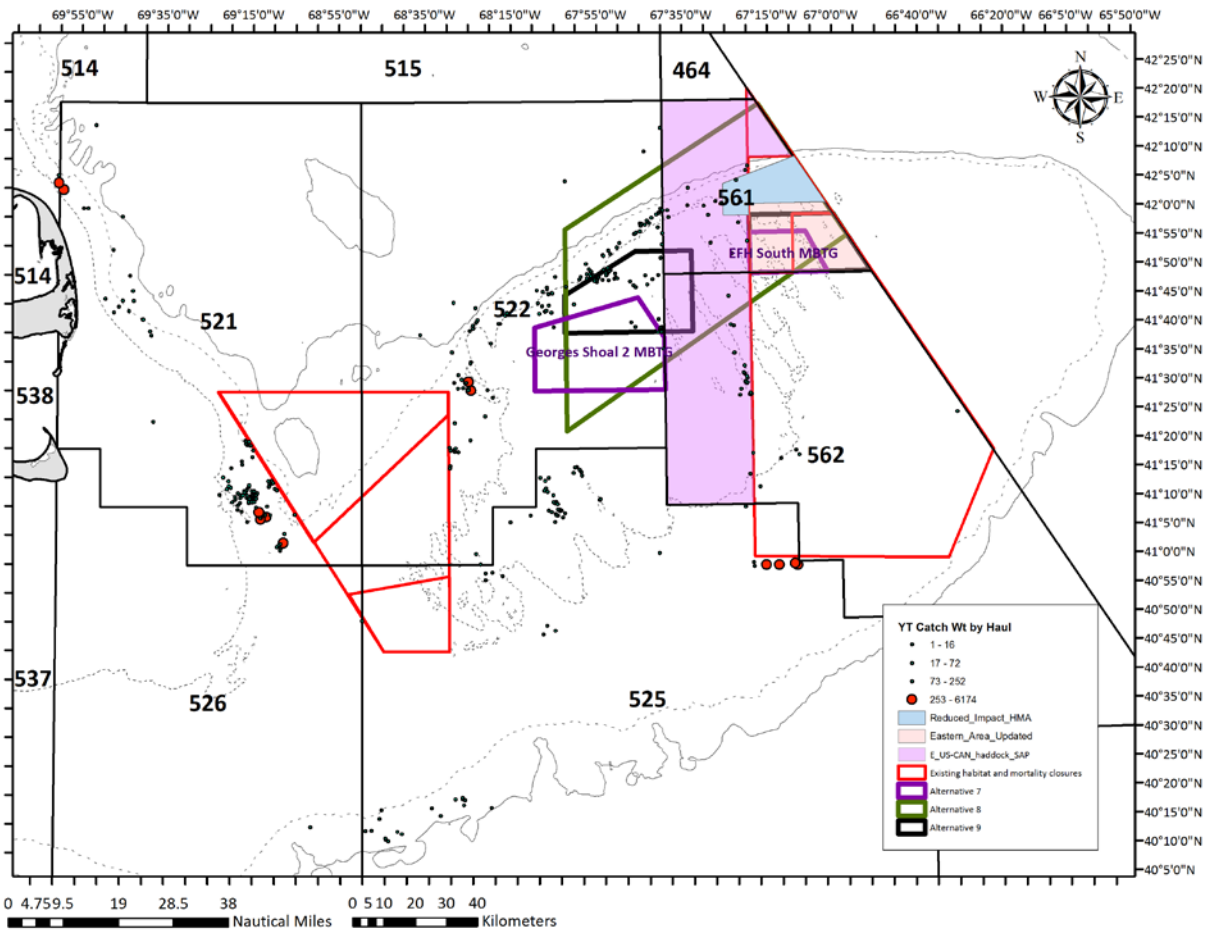
Observed discards of windowpane flounder are shown as windowpane is a non-allocated stock and possession in prohibited. From 2010 to present, observed hauls of windowpane flounder show a broad distribution of effort and catch across Georges Bank (Map 65). During this time period, a large windowpane flounder AM area (not shown) was triggered for the northern stock. The windowpane AM requires trawl vessels to use gear designed to avoid flatfish (e.g separator trawl, Ruhle trawl) in an area to the west of Closed Area II within SA 561, 562, and 525. With the AM in place, the spatial distribution of vessels using traditional trawl gear to prosecute the flounder fishery would shift to the west. Hauls in the top quartile (40 lb – 962 lb) appear within the northern portion of Georges Shoal 2 MBTG area where this area overlaps with Alternative 9. In general, a large portion of the observed hauls in the top quartile for this time period occurred within and around the bounds of Alternative 9. Catches of windowpane occur in both the winter flounder and yellowtail flounder fisheries on Georges Bank.

Map 66 – Yellowtail flounder catch weight by haul (lb) from 2008-2012 (calendar years). Hauls colored in red had reported catch weights in the highest quartile. Only hauls with positive catch of yellowtail flounder are shown.



From 2008-2012 (calendar year), kept catches of yellowtail flounder were widely dispersed across Georges Bank and the Great South Channel (Map 66). Note that this map includes kept catch from multiple yellowtail flounder stock areas. The majority of hauls in the top quartile (253 lb – 6174 lb) occurred within SA 525 in this time series, and are aggregated along the southern extent of the US/Canada Haddock SAP and the southwestern boundary of Closed Area II, before fanning out the south and west. Within SA 522 hauls with catch weights in the highest quartile appear to be aggregated along the northern extent of the eastern boundary of Closed Area I, along the northern flank of the bank between Closed Areas I and II. Top quartile catches of yellowtail flounder are absent from the Georges Shoal 2 MBTG area, with while some top quartile hauls occurred within Alternative 9 during this period.

Map 67 – Yellowtail flounder catch weight by haul (lb) from January 2013-present. Hauls colored in red had reported catch weights in the highest quartile. Only hauls with positive catch of yellowtail flounder are shown.



Observed hauls with kept yellowtail catch in excess of 253 lb (top quartile) are virtually non-existent from 2013 (Map 67). This stark drop in observed kept catch is likely the product of GB yellowtail's poor status and correspondingly low ACL. It is worth noting that there were no hauls in the top quartile that occurred with the boundary of Alternatives 7, 8, or 9. In summary, observed fishing effort and catch distribution for the species examined has decreased within SA 525 on Georges Bank over the time series examined (2008 – 2012, 2013-present), while the trawl fleet has continued to prosecute these fisheries in SA 522.

Fishing activities on Georges Bank are influenced by various management measures, which in combination with the measures implemented as a result of the habitat amendment, could have cumulative effects on the groundfish fishery. For example, through Framework 47, the Council adopted area-based accountability measures (AMs) for both windowpane flounder stocks, which require trawl vessels to use selective trawl gear in the area if the AM is triggered. Framework 52 revised these AMs for the groundfish fishery for both the northern and southern windowpane flounder stocks. The large AM for northern windowpane was triggered in both FY2014 and FY2015 due to ACL overages in the previous fishing year.

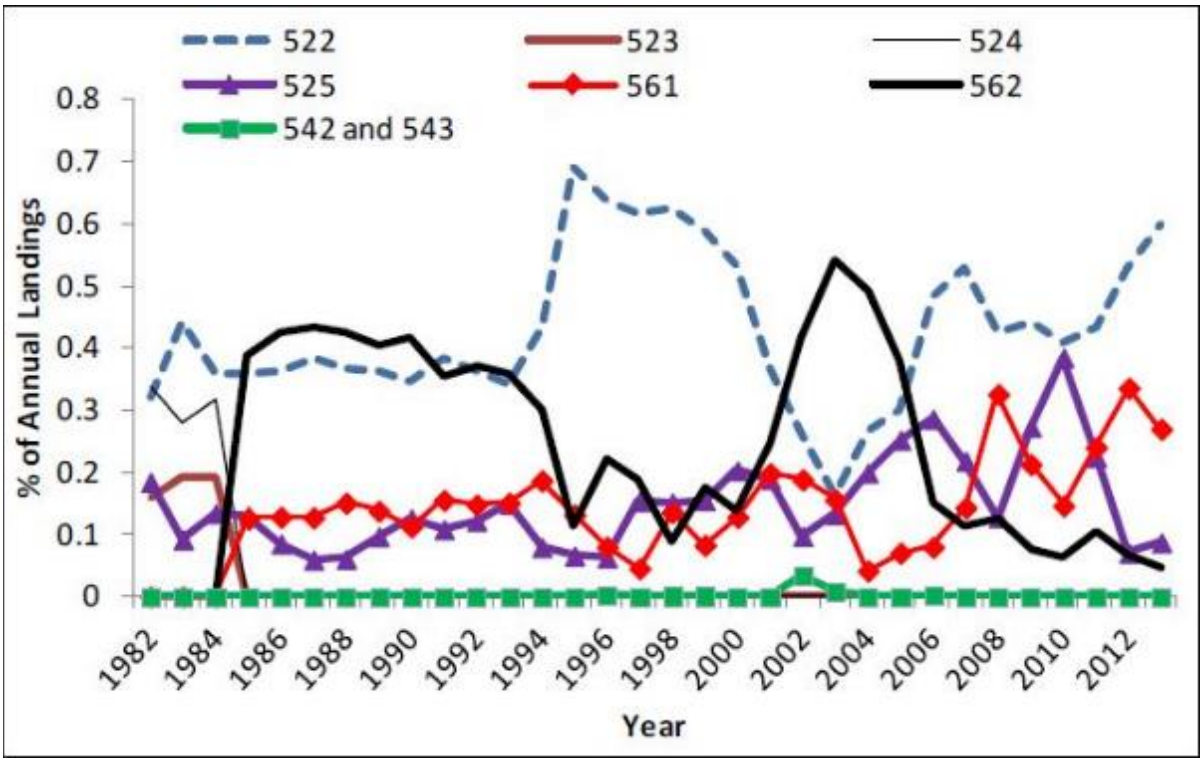
In general, the potential new habitat management areas on Georges Bank that are currently open to fishing lie within Statistical Area (SA) 522, so the overall magnitude of catches from this area indicates an upper bound on potential effort displacement as a result of mobile bottom-tending gear closures that could be implemented via OHA2. Economic analyses of data from FY2010 – FY2012 indicated that excluding the use of traditional mobile bottom-tending otter trawls (OTF) gear in SA 522 from May 1-August 31 may have had a maximum upper bound cost of $7.3 million in groundfish revenue. Extending the gear exclusion from May 1-December 31 could affect $13.2 million in groundfish revenue based on FY2010 – FY2012 VTR data. At the port level, restricting the use of OTF in SA522 would have the greatest impact on New Bedford (Table 19). Flatfish comprised the largest proportion of average total revenue and average revenue per tow in SA 522 from traditional trawl gear between FY2010 – FY2012. In particular, SA 522 is an important fishing area for Georges Bank winter flounder (Figure 6).

Table 19 – Ports with >$100k gross revenue on groundfish trips with landings from inside SA 522, average FY2010-2012.

State	Landings Port	3-year average revenue	
		All Groundfish	Proportion of all GF revenue coming from SA522, May 1-December 31.
ME	Portland	$4,597,840	0.99%
MA	Boston	$12,691,511	6.36%
MA	Gloucester	$23,869,559	7.26%
MA	Chatham	$1,920,625	2.42%
MA	New Bedford	$34,845,427	30.45%
MA	Provincetown	$469,022	0.60%
MA	Nantucket	$274,813	19.36%
MA	Harwichport	$126,393	22.10%
RI	Point Judith	$10,900,442	2.75%
CT	Stonington	$1,111,962	2.97%
CT	New London	$1,962,701	6.32%
NY	Montauk	$5,408,171	2.80%

Notes: VTR data, 2013 constant dollars. Adapted from Framework Adjustment 52. Table 67, page 171.

Figure 6 – US landings of GB winter flounder, by statistical area, 1982-2013.



Source: Figure A4, p.54 of Georges Bank Winter Flounder Operational Assessment. Hendrickson L, Nitschke P, Linton B. 2015. 2014 Operational Stock Assessments for Georges Bank winter flounder, Gulf of Maine winter flounder, and pollock. US Dept Commer, Northeast Fish Sci Cent Ref Doc. 15-01; 228 p. Available from: National Marine Fisheries Service, 166 Water Street, Woods Hole, MA 02543-1026, or online at http://nefsc.noaa.gov/publications/crd/crd1501/

2.5.4.2 ***Discussion of impacts***

In the Georges Bank region, the Council selected Alternative 10 as its preferred alternative for habitat protection, which includes the Georges Shoal 2 HMA as a mobile bottom-tending gear clsoure. Alternative 10 also includes the Northern Edge Reduced Impact HMA which would allow some groundfish trawl access through special access program regulations west of 67° 20' W, plus an adjacent area south of the Reduced Impact HMA as a closure to mobile bottom tending gear.

Alternative 1 includes the existing Closed Area I and Closed Area II habitat and groundfish management areas. Alternative 2 would remove these areas. Under Alternatives 3 through 10, the two Closed Area I Habitat Closures would be re-opened to the fishery, and new areas would be designated on the northeastern portion of Georges Bank. Assuming the preferred spawning alternative which maintains the northern part of Closed Area 1 a winter/spring spawning closure, and the preferred DRHA alternative which keeps the southern part of Closed Area I closed to mobile bottom-tending gears, the central part of Closed Area I would open to the groundfish fishery year round, the northern part would open April 16-January 31, and the southern part would open to fixed gears. These changes are expected to have positive impacts on the groundfish fishery. Based on hauls observed between 2008 and 2012, there is a large amount of

fishing effort along the Closed Area I North boundary, with high catch rates for winter flounder (Map 60) and even higher catch rates for haddock (Map 63). Therefore, re-opening of the closed area would likely lead to an increase in fishing effort within Closed Area I North. There is minimal effort adjacent to Closed Area I South, so there would likely not be a large increase in fishing effort within Closed Area I South if it re-opened under Alternatives 2-10.

Changes overlapping Closed Area II depend on the habitat alternative under consideration. The preferred spawning alternative maintains Closed Area II February 1 to April 15, but informal groundfish sector agreements with the lobster fishery could keep the area north of 41° 30’ N closed during June 15 to October 31. Thus, at most, the groundfish fishery would likely gain access to the Closed Area II south of 41° 30’ N between April 16 and January 31, and the northern area between April 16 and June 14 and again November 1 to January 31. Under most of these alternatives (3, 4, 6A, 6B, 7, 8, 9, and 10, but not 2 and 5) portions of Closed Area II north of 41° 30’ N remain closed, at least to bottom trawls, year round. In addition, some of the habitat alternatives (3, 4, 5, 6A, 7, 8, 9, and 10, which is preferred) propose closures outside of the existing closed areas. The amount of bottom trawl effort potentially displaced by these alternatives varies widely, with approximate revenue displacements for bottom and SAP trawls from the currently open parts of these alternatives as follows, ranked lowest to highest displacement: $120,000 – Alternatives 3 and 4; $750,000 – Alternative 5; $1.1 million – Alternatives 7 and 10; $1.25 million – Alternative 6A; $1.7 million – Alternative 9; $5.75 million – Alternative 8.

These potential shifts in fishing effort combine with expected impacts on the resource to generate an overall magnitude of impacts on the groundfish fishery. Alternatives 3 and 4, and of course the no closure scenario Alternative 2 are smaller areas that displace less fishing. Long term, Alternatives 3 and 4 as with Option 1 or 2 are expected to have positive resource impacts. This combined with limited revenue displacement and access to Closed Area I and the southern part of Closed Area II means these alternatives will likely have a positive impact on the fishery. Because Alternative 2 removes all year-round habitat conservation measures on Georges Bank, resource impacts are expected to be negative, which would neutralize the positive impacts associated with increased access to fishing grounds, and could have net negative effects on the fishery over the long term. Alternatives 3, 4, 6A, and 6B with options 3 and 4 would be similar to Alternative 2, short term positive impacts due to increased accesss to fishing grounds, but long term negative impacts via negative impacts on the resource. Alternatives 5 and 7 and also expected to increase flexibility and have positive short term impacts on the fishery, but have negative impacts on the resource, which would lead to negative impacts on the fishery in the long-term.

Alternatives 6A, 8, 9, and 10 are expected to have positive impacts on the resource. Given increased access in Closed Area I and the southern part of Closed Area II, and the potential for moderate levels of effort displacement in currently open areas, Alternatives 6A, 9, and 10 are expected to have slightly positive to positive long-term impacts on the fishery. Alternative 8 is expected to have highly positive impacts on the resource, but also a much larger displacement of fishing effort over a large area. Net impacts on the fishery in the long run are still expected to be slightly positive to positive, but rely more heavily on conservation benefits of the closure translating into increased catch limits and better fishing opportunities near the closed area. The

short term effects are likely negative, given the magnitude of revenue displaced, despite the fact that the Alternative would allow access to portions of existing closures.

In the Great South Channel/Southern New England sub-region, the Council selected Alternative 4 as the preferred alternative, which includes the Great South Channel HMA and the Cox Ledge HMA. As proposed, the Great South Channel HMA would be closed to bottom trawls. In terms of overlaps with groundfish bottom trawl fishing activity and revenue in and around the Great South Channel and Nantucket Shoals, Alternative 4 is intermediate between Alternative 3 and Alternatives 5 and 6. Alternative 3 extends further east towards the western boundary of Closed Area I and encompasses additional areas where winter flounder are harvested (Map 60, Map 61, Map 62). Haddock are caught just west of Closed Area I but these catches are in deeper water (Map 63, Map 64), generally outside any of the closures analyzed, including the Great South Channel East HMA in Alternative 3. Alternatives 5 and 6 (Nantucket Shoals and Nantucket Shoals West HMAs) are generally located west of where the groundfish fishery targets winter flounder, and are shallower and west of the areas where haddock are caught. Thus, impacts on the groundfish fishery of the Great South Channel-region alternatives are likely to be the result of displacement of fishing activity targeting winter flounder, with the greatest amount of effort displacement associated with Alternative 3, and progressively less displacement for Alternative 4 and Alternatives 5/6. In general, the impacts of Alternatives 3 and 4 are expected to be slightly negative, regardless of management option selected, given the amount of bottom trawl revenue taken from these areas. Given that the Nantucket Shoals HMA is further west, Alternative 5 is expected to have neutral impacts on the fishery. Alternative 6 could have slight negative impacts on the fishery via trawl ground cable requirements in fishing grounds west of Closed Area I in the Great South Channel Gear Modification Area. The gear modification area encompassed roughly $2 million in bottom trawl revenue annually between 2012 and 2014.

The preferred alternative makes Cox Ledge a no ground cable area. Thus, bottom trawling would still be allowed, which mitigates negative impacts of the alternative on the groundfish fishery. Based on the discussion in Volume 4, Section 4.2.5.3, Cox Ledge does have some bottom trawl activity, but the area appears to be at the edge of more productive grounds, rather than a center of fishing activity. This distribution of effort, combined with the fishing restriction measure selected, means that the preferred alternative will have only slight negative effects on groundfishing around Cox Ledge. Other alternatives that would have closed the area to bottom trawling (i.e. Alternatives 3-6 with Option 1 or Option 2) would have had a larger amount, but still only slightly negative impacts on the groundfish fishery.

3 Small-mesh multispecies: silver and red hake

This section describes impacts on small mesh groundfish resources and the fishery that targets them. Silver and red hake are the principal target stocks.Offshore hake, the other small-mesh species, has limited, if any, overlap with the proposed management areas, and is a minor component of the fishery, so impacts to this species are expected to be neutral.

3.1 Impacts on silver and red hake

Juvenile red and silver hake, the target species in the small-mesh multispecies fishery, are not known to associate with coarse substrates which are more vulnerable to adverse impacts from mobile bottom tending fishing gear. However, Habitat Management Area and Dedicated Habitat Research Area measures could restrict or prohibit mobile bottom tending gear fishing, including small-mesh trawls used to target red and silver hake. No Dedicated Habitat Research Areas overlap with existing small-mesh exemption areas, but there are habitat management areas that do (Map 71). Spawning area alternatives could also restrict trawling during specific seasons, but these seasons and areas do not overlap with the existing small mesh-exemption areas.

In habitat management areas that overlap concentrations of small juvenile red and silver hake, the mobile bottom-tending gear restrictions could reduce fishing mortality on young fish, improve selectivity, and increase yield-per-recruit. Small-mesh trawls do not, however, retain many age 0/1 red and silver hake, which are less than 20 cm[9] (Figure 7 and Figure 8, respectively), so only a limited reduction in catch and discards of age 0/1 red and silver hake would be expected from a reduction in fishing where there are large concentrations of age 0/1 red and silver hake.

[9] During 2002-2012 spring trawl surveys, all age 0 and 90% of age 1 fish were less than 20 cm.

Figure 7 – Length frequency distribution of kept and discarded red hake on 2010-2013 observed trips in statistical areas 511-515 (Gulf of Maine) by vessels using trawls. Note low catches of fish below 20 cm.

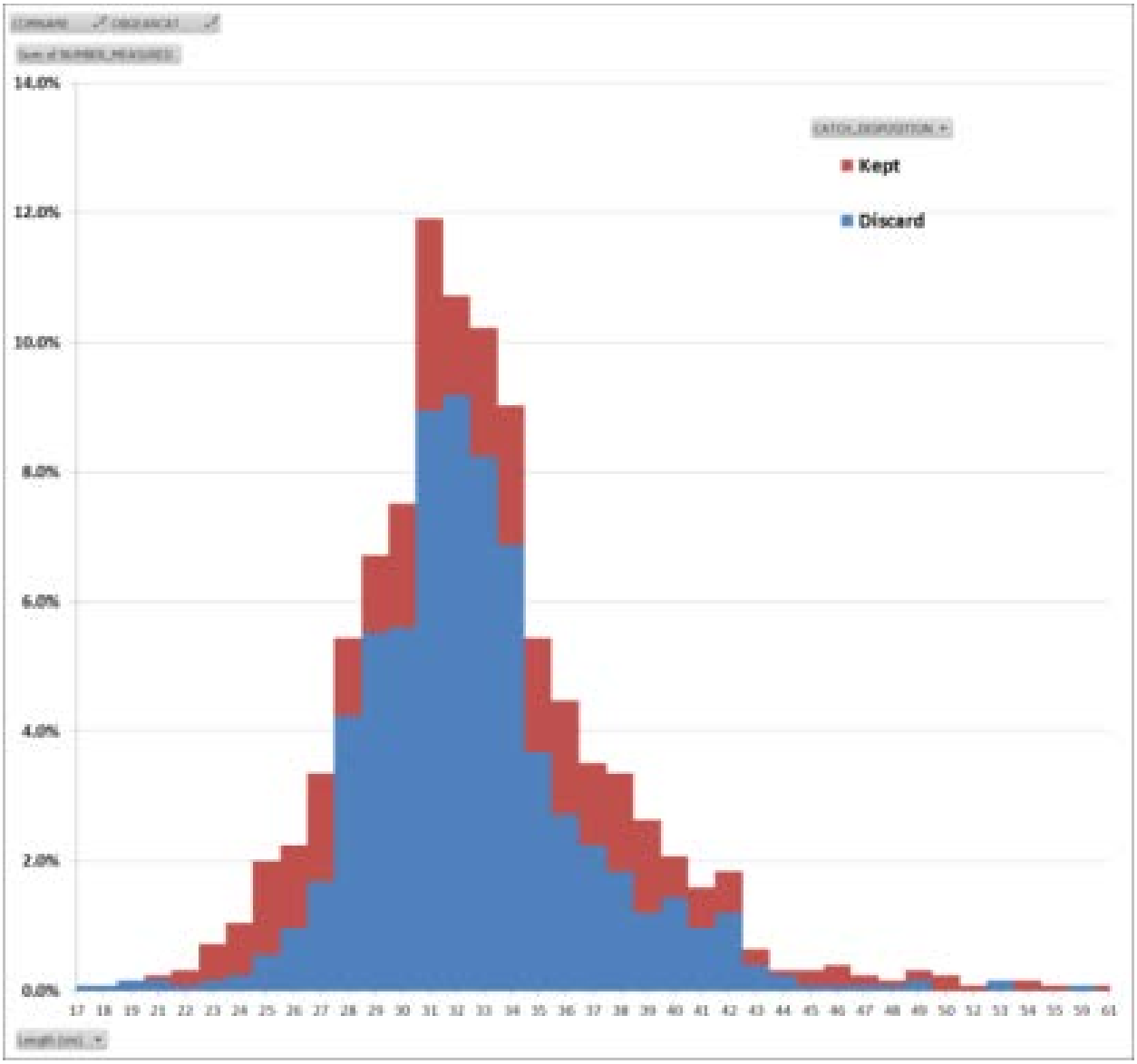
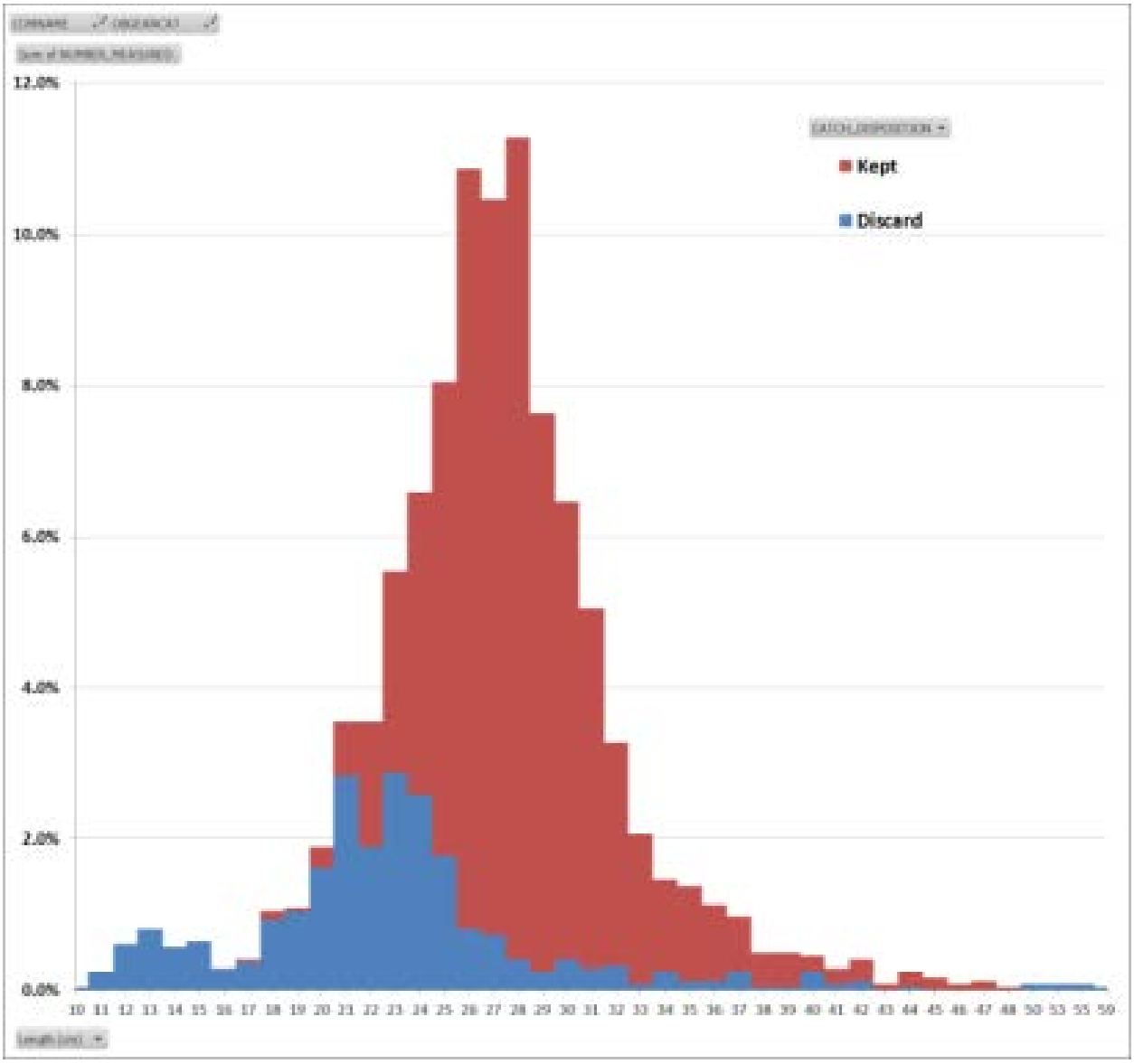


Figure 8 – Length frequency distribution of kept and discarded silver hake on 2010-2013 observed trips in statistical areas 511-515 (Gulf of Maine) by vessels using trawls. Note low catches of fish less than 20 cm.



3.1.1 Habitat management and research alternatives

During the spring and fall trawl surveys, the major concentrations of age 0/1 silver hake hotspots overlap with the Bigelow Bight, Toothaker Ridge, and Eastern Maine HMAs (Map 68 and Map 70). Age 0/1 silver hake appear to be concentrated in deeper water according to the summer shrimp trawl and scallop dredge survey data (Map 69), which have a limited geographical range. No hotspots that overlap with the proposed HMAs were detected in winter trawl surveys.

During the fall, age 0/1 red hake hotspots appear to have a similar geographical distribution as silver hake (Map 70), with significant overlap with the Bigelow Bight, Toothaker Ridge, and

Eastern Maine HMAs. During the spring and summer surveys (Map 68 and Map 69), hotspots appear to be concentrated in deeper waters and do not have significant overlaps with any of the HMAs. No hotspots that overlap with the proposed Habitat Management and Dedicated Habitat Research Areas were detected in winter trawl surveys.

In the Gulf of Maine sub-regions, biological impacts on red and silver hake, targets of the small-mesh multispecies fishery, appear to be minimal, but slightly positive, for alternatives that include the Bigelow Bight, Toothaker Ridge, and Eastern Maine HMAs (Table 20). Alternatives that do not include these proposed HMAs and or the Eastern Maine DHRA would have a neutral or slightly negative impact relative to alternatives that include these three areas, because incidental catch of juvenile red and silver hake will continue to occur in fisheries overlapping these hotspots. Thus, the eastern Gulf of Maine preferred alternative which designates the Small Eastern Maine HMA is expected to have slight positive impacts on small mesh groundfish, and the preferred alternatives in the western Gulf of Maine, which do not include the Bigelow Bight HMAs, are expected to have a slight negative impact. Given that management in the central Gulf of Maine is not changing substantially under the preferred alternatives, and there are few small mesh juvenile hotspots in the central Gulf of Maine, impacts in that sub-region are likely neutral.

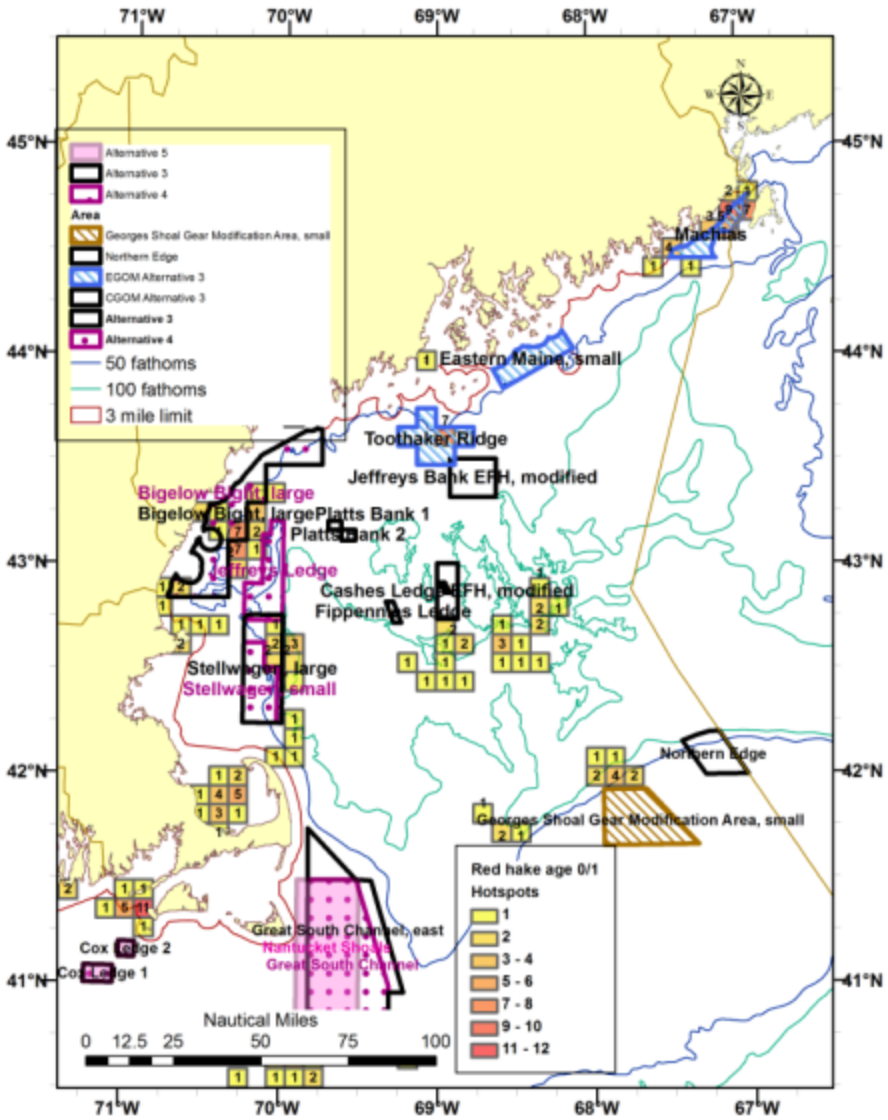
Georges Bank and Great South Channel Habitat Management and Dedicated Habitat Research Area alternatives do not overlap with age 0/1 red and silver hake hotspot distribution to any appreciable degree (Map 68 to Map 70). Thus, the biological impacts of these alternatives on red and silver hake appear to be neutral.

Table 20 – Summary of the impacts of habitat management and research alternatives on small mesh species. No impacts are expected on offshore hake. Preferred alternatives are identified below (*).

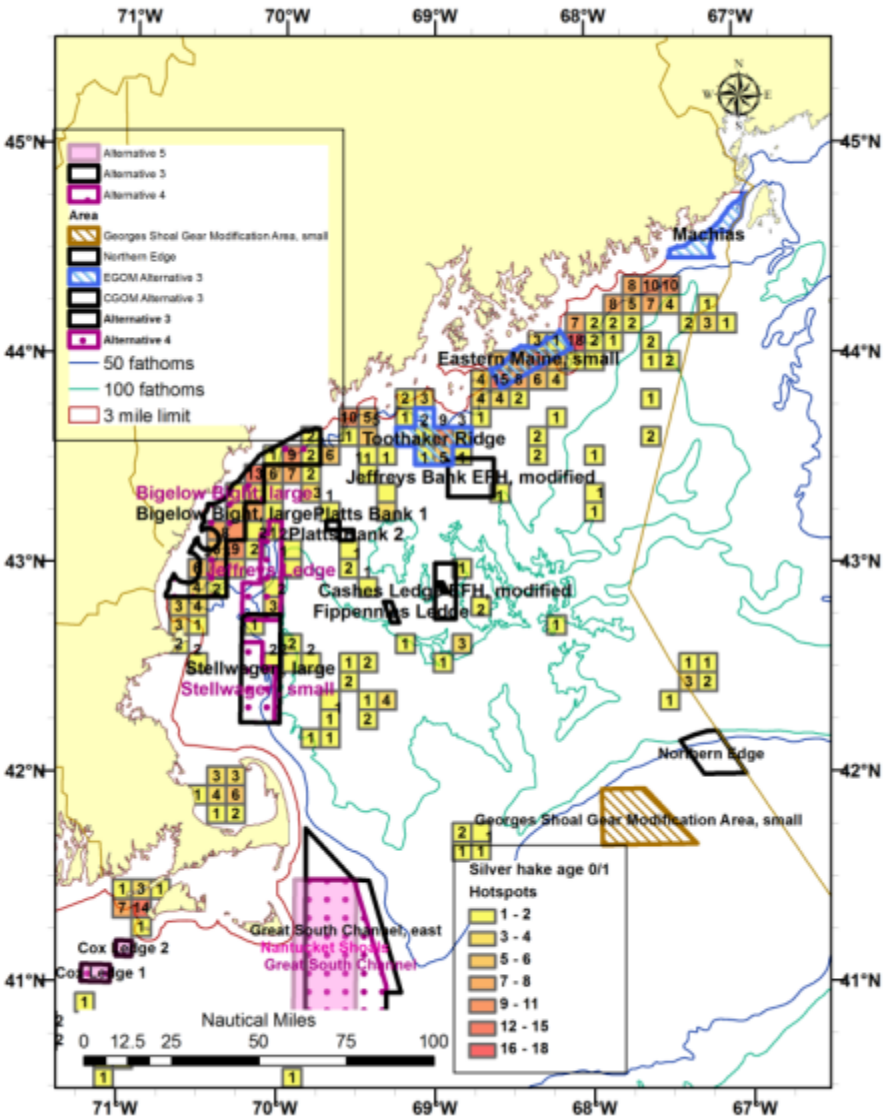
Sub-region	Alt	Impacts
EGOM	1	Neutral
	2	Neutral to slightly positive – some overlap between species and management areas such that elimination of MBTG fishing would benefit the stock.
	3*	
CGOM	1*	Neutral
	2	
	3	
	4*	
WGOM	1*	Neutral to slightly negative
	2	Slight negative
	3	Slight positive
	4	Slight positive
	5	Slight positive
	6	Neutral to slightly negative
	7a* and 7b	Neutral
	8*	Neutral
GB, GSC-SNE	All	Neutral

Map 68 – Distribution of age 0/1 red hake (left) and silver hake (right) hotspots from 2002-2011 spring trawl surveys.

Red hake

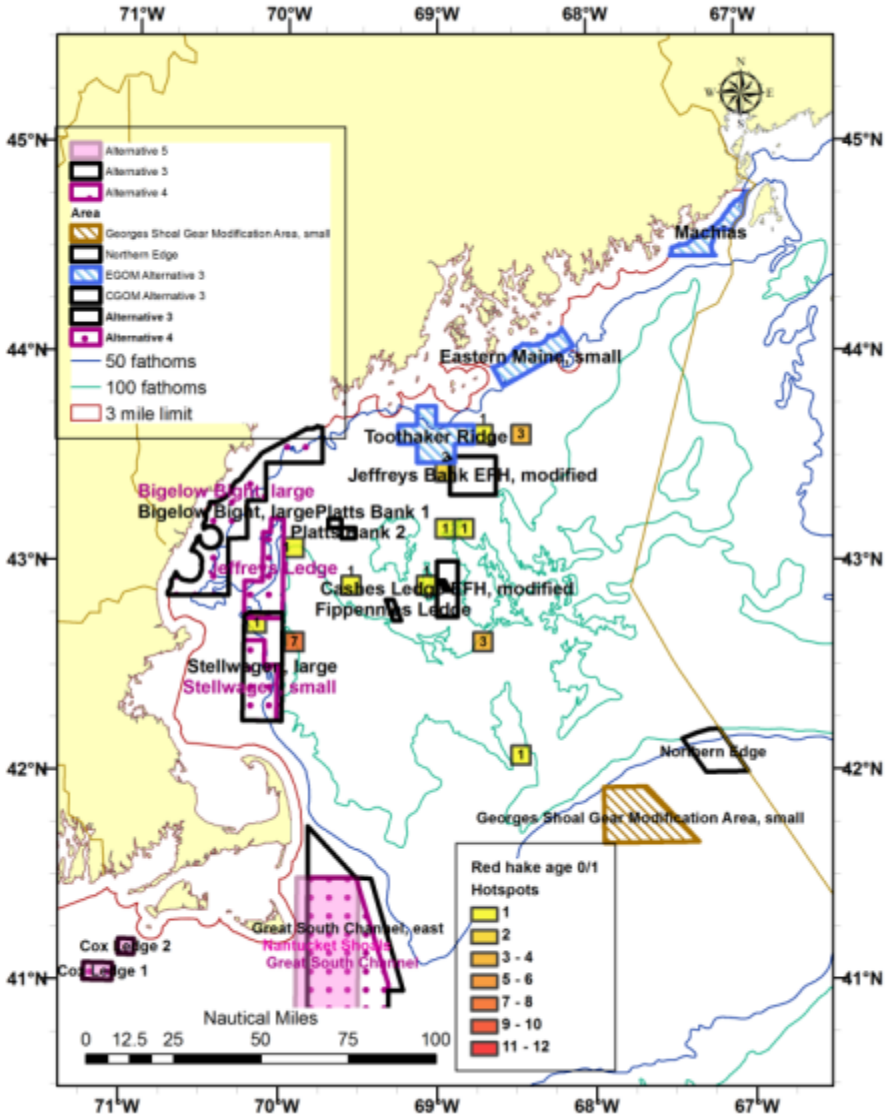


Silver hake

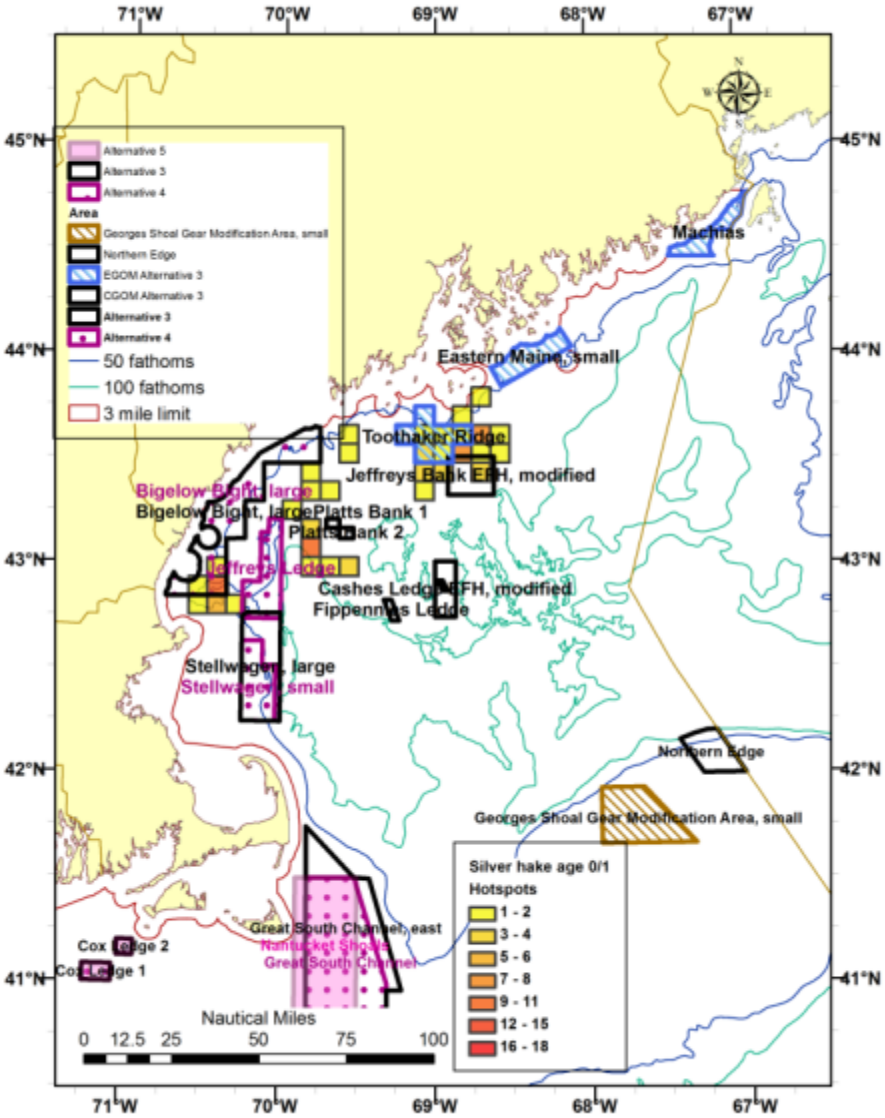


Map 69 – Distribution of age 0/1 red hake (left) and silver hake (right) hotspots from 2002-2011 summer shrimp trawl and scallop dredge surveys.

Red hake

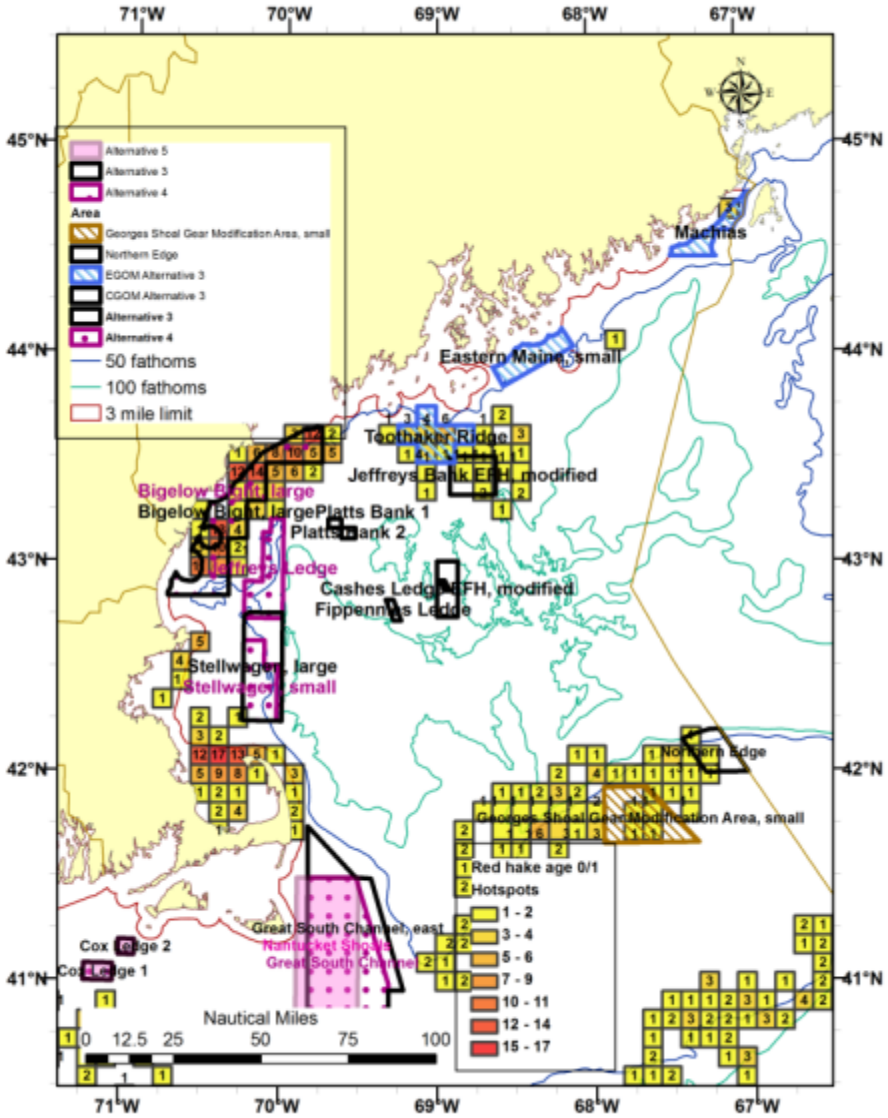


Silver hake

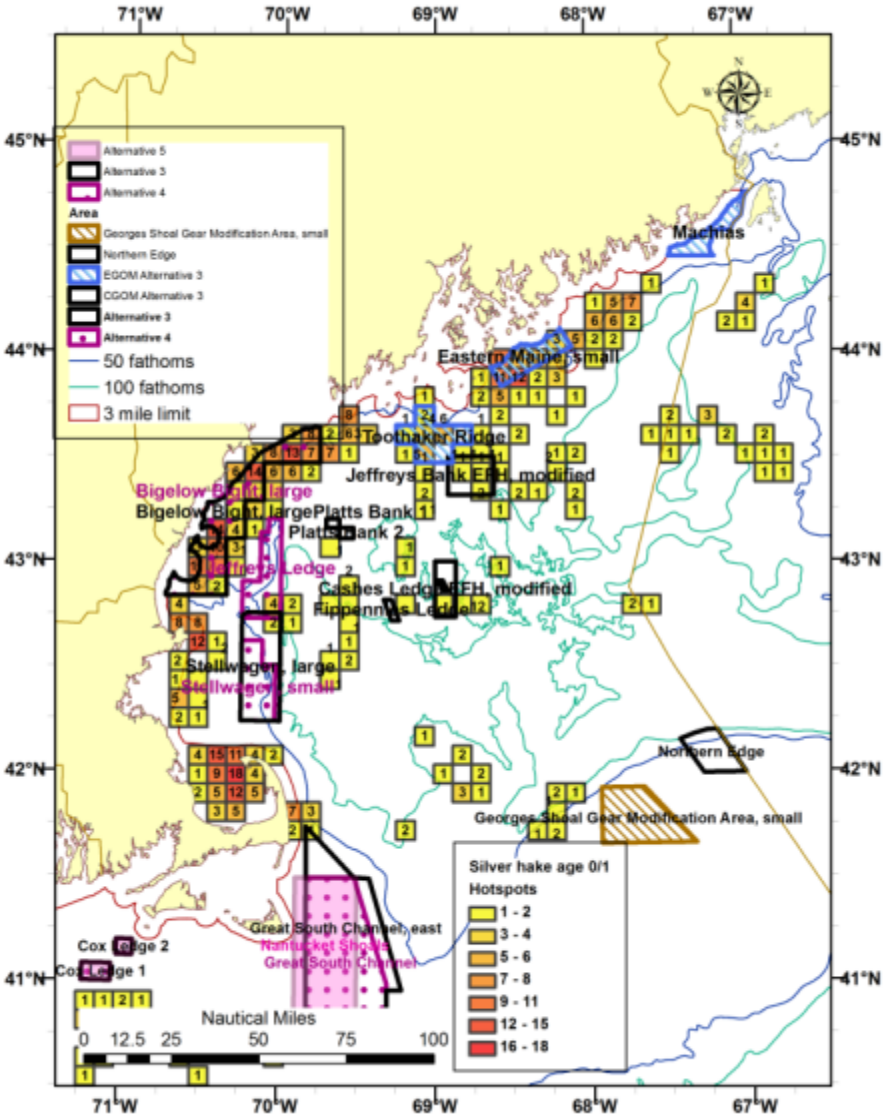


Map 70 – Distribution of age 0/1 red hake (left) and silver hake (right) hotspots from 2002-2011 fall trawl surveys.

Red hake



Silver hake



3.1.2 Spawning management alternatives

It is not known whether and how fishing affects red and silver hake spawning, or precisely where or when this spawning activity takes place. In general, the effects of the proposed spawning protection areas on red and silver hake are uncertain.

For silver hake, spawning occurs on Georges Bank beginning in May, and spawning begins in the Gulf of Maine during June. Peak spawning for the northern stock (Georges Bank and Gulf of Maine areas) occurs during July and August. Alternative 1/No Action for both the Gulf of Maine and Georges Bank includes areas where groundfish catches are regulated year-round, which would include these late spring and summer months, but the action alternatives only include late winter/spring spawning closures. In terms of seasonally-managed areas, spawning Alternatives 2 and 3 on Georges Bank likely miss the temporal window associated with silver hake spawning as they would be in effect February 1-April 15. In the Gulf of Maine, there are some rolling closur/cod protection blocks in effect during June under Alternatives 1A, 1B, and 2, but no seasonal closures in July or August. Since it is not clear whether or not fishing activity actually affects spawning activity in silver hake, the removal of year-round closures via the action alternatives (Alternative 2 in the Gulf of Maine and Alternatives 2 and 3 on Georges Bank) may or may not constitute a negative impact on the silver hake resource.

For red hake, major spawning areas are believed to occur on southwestern Georges Bank and on the continental shelf off southern New England, with spawning beginning during May or June in the New England region. The only spawning management area in this general location is theNantucket Lightship Closed Area which is part of George Bank Spawning Alternative 1/No Action, but maps of red hake larger than 35 cm place biomass offshore of the closure. Therefore, neither the no action nor alternative spawning areas on Georges Bank are likely to provide many benefits in terms of red hake spawning, such that the impacts of the alternatives on the red hake stock are likely neutral. Biomass maps indicate that adult red hake occur in higher abundance in the inshore Gulf of Maine and along the northern margin of Georges Bank. Given that major spawning aggregations are not known to occur in these locations, is is unclear whether either the no action or alternative spawning management areas in the Gulf of Maine would benefit the red hake resource. Removal of the year-round Western Gulf of Maine Closure Area would eliminate restrictions on gears capable of catching groundfish in an area where adult red hake occur, but whether or not this constitutes a negative impact on the stock is unclear, given that fishing impacts on spawning activity are unknown.

3.2 Impacts on the small-mesh fishery

Fishing with small-mesh trawls to target red and silver hake in the Northern Management Area (grey-shaded area in Map 71) is limited to well-defined exemption areas and seasons. Fishing in exemption areas that have a high amount of overlap with proposed Habitat Management Areas will be highly impacted by alternatives that include those specific areas, if mobile bottom-tending gears are prohibited. These impacts may be acute for vessels that cannot fish in remote exemption areas.

3.2.1 Habitat management and research alternatives

All of the Habitat Management Area and Dedicated Habitat Research Area alternatives will have the potential to shift fishing effort, between areas and between fisheries, particularly for the small-mesh multispecies fishery which does not currently have any limited access restrictions and could experience an increase in effort. Specifically, vessels that use mobile bottom tending gear to target other species may find it more attractive to target small-mesh multispecies in the exempted areas. While catches and mortality are limited by annual catch limits, such effort shifts into the small-mesh multispecies fishery, if they occur, could have negative impacts on existing fishery participants, particularly for northern red hake, where catch exceeded the annual catch limit in fishing years 2012, 2013, and 2014, although overfishing is no longer occurring on the stock.

All of the proposed habitat management areas include options that limit or restrict mobile bottom-tending gear within their boundaries. It is more straightforward to assess the impacts in areas where mobile bottom-tending gear would be prohibited (Option 1), with a possible exemption for hydraulic clam dredges (Option 2). For the proposed gear modifications to restrict ground cable length (Options 3 and 4) or require cookies on the ground cable (Option 3), it is more difficult to assess probable impacts, since the proposed gear modifications have not been tested in fisheries targeting red and silver hake with small-mesh trawls (they have only been the subject of pilot testing in the large-mesh multispecies fishery). If the modification is incompatible with the fishery, then the impact would be the same as a total prohibition on mobile bottom-tending gear. If the modification can be accommodated, there would be a small negative impact from the cost of the new fishing gear plus any loss in gear efficiency to catch the target species. Increased fishing time could increase fuel and other variable costs, as well as habitat impacts if there is a net increase in seabed area swept.

Since the small-mesh exemption areas were configured to accommodate the existing year-round groundfish closed areas and do not overlap with the existing EFH closures, Alternative 1/No Action is expected to have a neutral impact on the small-mesh fishery. The no habitat management alternative for any sub-region (typically Alternative 2) does not propose any habitat management areas, and therefore would have no overlap with the small-mesh exemption areas, leading to a neutral impact on the fishery. Other action alternatives are discussed below.

None of the Habitat Management Areas proposed for the central and eastern Gulf of Maine overlap with the small-mesh fishery exemption areas. Therefore, all central and eastern Gulf of Maine Habitat Management Area and Dedicated Habitat Research Area Alternatives are likely to have a neutral impact on the small-mesh multispecies fishery.

In the western Gulf of Maine, the Large Bigelow Bight Habitat Management Area proposed in western Gulf of Maine Alternatives 3 and 4 has a substantial amount of overlap with the Small Mesh Area I and the Gulf of Maine Raised Footrope Trawl Area. Western Gulf of Maine Alternative 5 includes a Bigelow Bight Small Habitat Management Area which has a substantial (but not complete) overlap with the Small Mesh Area I. Western Gulf of Maine Alternative 6 has no overlap with the existing small-mesh multispecies exemption areas. Thus, Alternatives 3 and 4 are expected to have the most negative impact on the small-mesh multispecies fishery, locally acute for vessels that fish in Small Mesh Area I and the Gulf of Maine Raised Footrope Area, but

overall a moderate negative impact on vessels that are able to fish in other small-mesh exemption areas. Alternative 5 is likely to have a low negative impact, but this impact may be acute for vessels that fish in the Small Mesh Area I fishery. Alternative 6 is expected to have neutral impact on the small-mesh multispecies fishery. None of these are preferred alternatives. If gear modification options are selected instead of mobile bottom-tending gear closure for Alternatives 3, 4, and 5, impacts would be uncertain but likely neutral to slightly negative, and fishing could continue in the exemption areas, albeit with modified gears.

On Georges Bank, alternatives include a mix of mobile bottom-tending gear closure options and gear modification options. Closures will have a negative impact on the small mesh fishery if they overlap both exemption areas and fishing activity within the exemption areas. As noted above, gear modification options are more difficult to evaluate. If the proposed gear modifications are compatible with gears currently used to target small-mesh multispecies, then the Georges Bank alternatives that apply reductions in ground cable length or require elevating disks will have a neutral impact on the fishery. Otherwise the gear modification areas would have the same impacts as would mobile bottom-tending gear closures, depending on the degree of overlap with the fishery.

Alternative 3 proposes no Habitat Management Areas that overlap with any of the small-mesh exemption areas. Alternative 4 has a proposed gear modification area that may affect vessels fishing in the Cultivator Shoals Area small-mesh fishery. It is not possible to determine the amount of impacts this area would have on the small-mesh fishery, except that most fishing in the Cultivator Shoals Area does not overlap with this proposed restricted gear area in Alternative 4, such that impacts are most likely neutral. Alternative 5 proposes a larger gear modification than Alternative 4 (see maps of the alternatives individually in Volume 3) and it has a much greater and more meaningful overlap with the Cultivator Shoals Area small-mesh fishery, although the majority of fishing occurs along the boundary with and to the northeast of Closed Area I. Like Alternative 3, it is not possible to determine the amount of impacts this area would have on the small-mesh fishery with any certaintly, but effects are most likely neutral. The proposed Georges Shoal 1 Mobile Bottom-Tending Gear area has only a negligible overlap with the Cultivator Shoals Area. Alternatives 6A and 6B propose a habitat management area that is a moderate westward expansion of the existing Closed Area II Habitat Closure, in statistical area 561. According to 2008-2012 observer and vessel trip report data, no small-mesh fishing targeting whiting occurs in this area.

Although Alternative 7 proposes a Georges Shoal 2 Mobile Bottom-Tending Gear area, half of which is in the Cultivator Shoals Small Mesh Exemption Area (that allows fishing for whiting and squid during June 15 to October 31), no observed or reported small-mesh fishing targeting whiting has occurred in this area since 2008 (Map 72). Alternative 8 proposes the Northern Georges Mobile Bottom-Tending Gear HMA, which does not extend as far to the west and into the Cultivator Shoals Area, but it includes more of the deeper slope on the northern edge of Georges Bank, where some whiting fishing occurs (Map 72). Whiting fishing within the Northern Georges Mobile Bottom-Tending Gear HMA is however a relatively small proportion of observed hauls and reported trips since 2008 within the Cultivator Shoals Area. Thus, Alternative 8 will have a low negative impact on the fishery. Trips targeting whiting in the

proposed habitat management areas could relocate to adjacent areas while the Cultivator Shoals Area is open.

Alternatives 9 and 10 each include three management areas, two of which are just west of Closed Area II and do not overlap small mesh fishery exemption areas. Alternative 10, which is preferred, includes the Georges Shoal 2 HMA, and Alternative 9 includes an area to the north and east of the Georges Shoal 2 HMA (Western HMA). Similar to the Georges Shoal 2 HMA, while the Western HMA overlaps the exemption area, fishing does not appear to overlap the HMA, but instead occurs to the north and west. Therefore, both alternatives are expected to have neutral impacts on the small mesh fishery.

None of the Great South Channel alternatives overlap with the small-mesh multispecies raised footrope exemption areas and they are all north of the Southern New England/Mid-Atlantic Exemption Areas. Thus other than the potential effort shifts discussed above, all of the Great South Channel Habitat Management Area and Dedicated Habitat Research Area alternatives are likely to have negligible impacts on the small-mesh multispecies fishery.

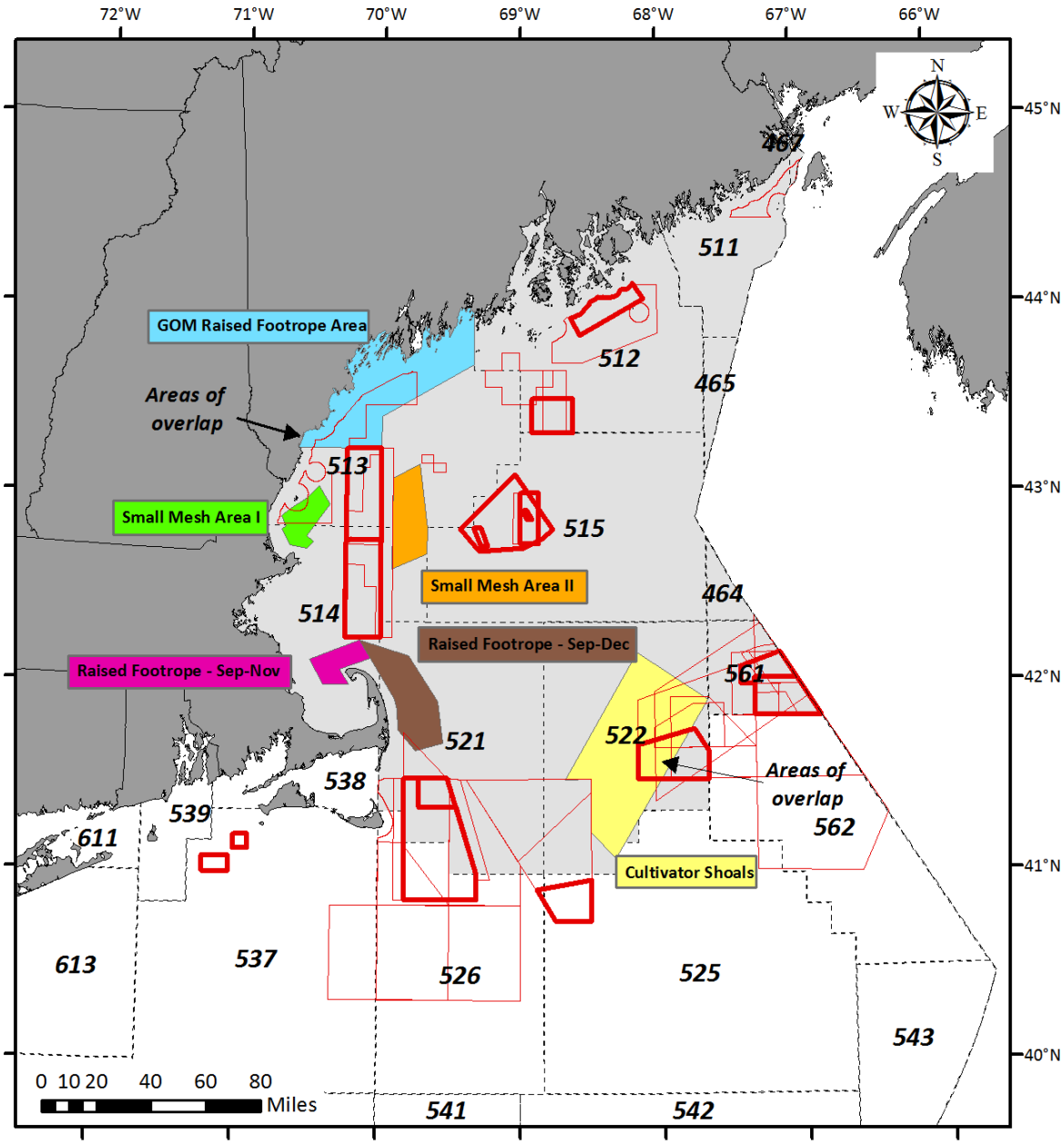
Table 21 – Summary of the impacts of habitat management and research alternatives on the small mesh fishery. Preferred alternatives are identified below (*).

Sub-region	Alt	Impacts
EGOM and CGOM	All	Neutral
WGOM	1*	Neutral
	2	Neutral
	3	Negative (Neutral with Option 3 or 4)
	4	Negative (Neutral with Option 3 or 4)
	5	Slightly negative (Neutral with Option 3 or 4)
	6	Neutral
	7a* and 7b	Neutral
	8*	Neutral
GB	1	Neutral
	2	Neutral
	3	Neutral
	4	Neutral
	5	Neutral
	6	Neutral
	7	Neutral
	8	Slightly negative
	9	Neutral
	10	Neutral
GSC-SNE	All	Neutral

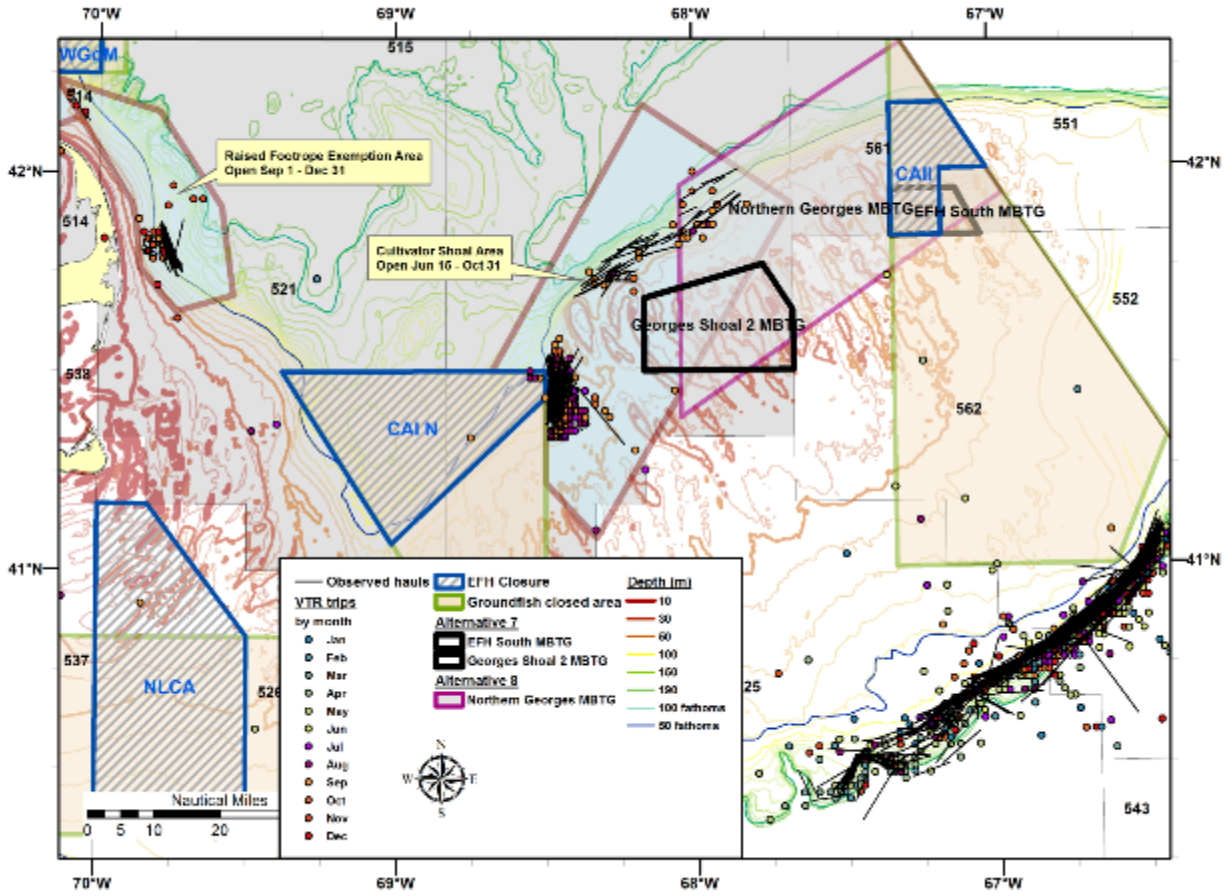
3.2.2 Spawning management alternatives

The proposed seasons when specific areas would be closed to gears capable to catching groundfish do not conflict with the open fishing seasons for the small-mesh exemption areas. Thus, the Spawning Management Area alternatives are unlikely to have any impact on the small-mesh multispecies fishery.

Map 71 – Small-mesh multispecies exemption areas (shaded various colors and with corresponding colored labels) overlap with proposed habitat management areas and research areas (red outline). Preferred habitat and research areas are in heavier red outline. Grey-shaded statistical aras are within the red and silver hake northern stock boundary. Two areas of overlap with the Bigelow Bight HMAs and some of the HMAs on Georges Bank are noted.



Map 72 – Location of the Cultivator Shoals Small-mesh Exemption Area (open to fishing during June 15-Oct 31; blue shading with brown border) compared to the placement of the Georges Shoal 2 MBTG (Alternatives 7 and 10; black border) and Northern Georges MTBG (Alternative 8; grey shading with purple border) areas. Observed trawl locations are represented by black lines, while fishing locations on vessel trip reports are represented by dots color coded by the month of landing, both data sets from 2008-2012.



4 Monkfish

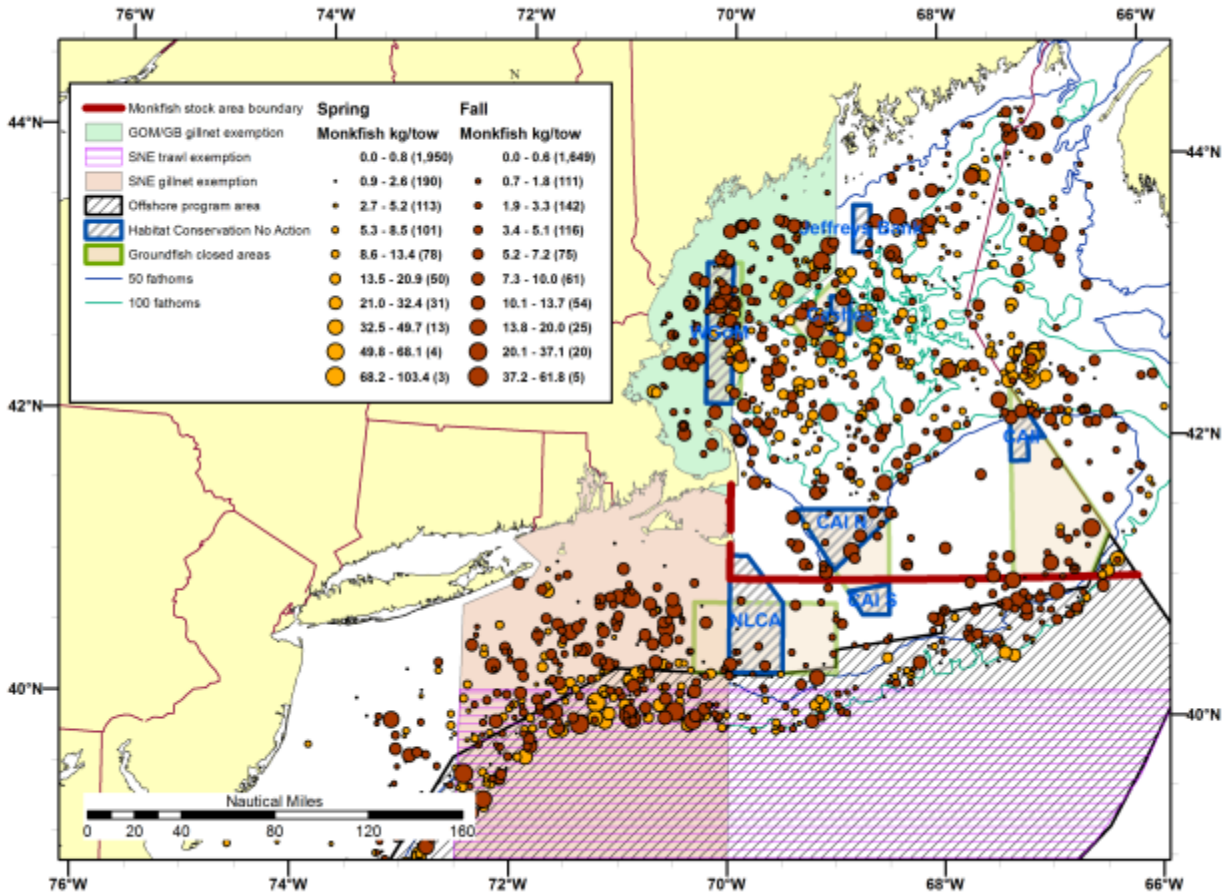
This section evaluates the potential effects on the monkfish resource and fishery based on current resource distribution and fishing patterns. Although monkfish are widely distributed throughout the US EEZ from shallow to deep water and occur on a variety of bottom substrates, they generally prefer softer sediments in deeper water rather than the harder substrate (and more vulnerable seabed structure) addressed by this amendment (see Section 4.4 of Framework Adjustment 7 to the Monkfish FMP for more details about monkfish EFH; see also Monkfish Amendment 2[10]). Use of mobile gear (trawls and dredges) to target and catch monkfish may be directly affected by the proposed habitat alternatives in this amendment. However, given the preferred habitat of the species, fishing for monkfish with mobile bottom-tending gear (i.e. trawls) is less likely to be affected by the proposed alternatives than fishing for other species that inhabit harder substrates and shallower waters.

Vessels in the fishery also frequently use sink gillnets to target and catch monkfish which may be indirectly affected by the habitat alternatives and would be directly affected by the spawning alternatives. Gillnets capture monkfish better when the fish are migrating, often for spawning. Gillnet fishing activity tends to occur in shallower areas throughout the Gulf of Maine, Southern New England, and the Mid-Atlantic. In some areas, such as around Cox Ledge and Jeffreys Ledge, the observed fishing effort also seems to focus on areas surrounding structured habitats, rather than occurring over the structures themselves.

Maps indicating the spatial distribution of trawl and gillnet effort in the fishery is shown in section 4.3.3.2 of Volume 1. Regulations in the fishery are also described in that section.

[10] "The primary sediment type in areas where directed monkfish trawling occurs is mud, in both northern and southern areas, although during migration periods monkfish are caught in sandy and more complex bottom types."

Map 73 – 2002-2012 spring (orange circles) and fall (red circles) biomass distribution with habitat closures, year-round groundfish closures and monkfish exemption areas shown. Source: NMFS trawl survey data.



4.1 Impacts on monkfish

In terms of impacts to the monkfish resource, the question is whether changes to habitat and groundfish management areas cause shifts in effort that would increase harvest of monkfish to the point where negative effects on the resource might result. Overall, such negative effects appear to be unlikely. Under some of the alternatives proposed (discussed by sub-region below) shifts in effort might increase fishing for monkfish. However, the fishery in recent years has not harvested its annual catch limit. This may be as a result of the requirement for vessels in both the northern and southern monkfish management areas to use a monkfish DAS when exceeding the applicable incidental limit. DAS usage has remained relatively stable between fishing years 2009 and 2012 (Monkfish Framework Adjustment 8 – NEFMC, 2014). Therefore, modest increases in fishing effort to target monkfish is unlikely to risk exceeding the ACL, and therefore negative impacts on the resource are not anticipated. In addition, the Monkfish FMP includes measures to control negative impacts on the stock if limits are exceeded. The plan utilizes annual catch targets below the ACL to account for management uncertainty. Amendment 5 established

accountability measures in both management areas for this fishery, which were designed to prevent overfishing. If the accountability measure is triggered, the annual catch target, in the year following the overage, would be reduced on a pound-for-pound basis. Days at sea and trip limits would also be adjusted to ensure the revised annual catch target was not exceeded.

In the three Gulf of Maine sub-regions, impacts on the monkfish resource from the habitat, spawning, or research area alternatives are expected to be neutral. Because the species is distributed so broadly throughout the Gulf of Maine (Map 73), none of the existing or proposed management areas have a disproportionate overlap with the monkfish resource. Therefore, either maintaining the current closures (central and western Gulf of Maine Alternative 1) or exchanging them for new areas (eastern Gulf of Maine Alternatives 2-3, central Gulf of Maine Alternatives 3-4, western Gulf of Maine Alternatives 3-6) is not expected to lead to changes in effort that would negatively affect the resource. Under Alternative 2 in either the central or western Gulf of Maine sub-regions, or if gear modification areas only are selected for the new habitat management areas, year-round bottom trawling restrictions would be eliminated. Similarly, gillnet fishing would be allowed within the existing Cashes Ledge Closure Area and Western Gulf of Maine Closure Area if they were lifted (Alternatives 2-4 central Gulf of Maine; Alternatives 2-6 western Gulf of Maine). However, under any of the alternatives, catch in the fishery will still be capped as described above. As the resource is not overfished, removing these management areas does not pose any particular risk and impacts of any alternative are expected to be neutral.

In the Georges Bank sub-region, monkfish are distributed in deeper waters off the edge of the bank, which overlaps with some management areas moreso than others, in particular the northern portions of Closed Areas I and II (Map 73). In general, a low proportion of monkfish biomass occurs in the proposed Habitat Management Areas, which are located in relatively shallow water on the northen half of the bank. Thus, there could be shifts in fishing activity into areas where monkfish are more common if an action alternative is selected (Alternatives 2-10). However, as there are catch limits and accountability measures in the fishery, and the stock is not overfished, there are no particular risks associated with these shifts in effort, and the impacts of any of the Georges Bank alternatives on the monkfish resource are likely to be neutral.

Similar to the Georges Bank sub-region, in the Great South Channel/Southern New England sub-region, monkfish are distributed mainly within the southern portions of the existing management areas, in deeper waters (Map 73). There appears to be limited overlap with the newly proposed management areas, which are located west of the Great South Channel and overlapping Nantucket Shoals. Although survey effort is very limited on Nantucket Shoals, the unsampled portions are very shallow and unlikely to support a large amount of monkfish biomass. As above, since there are catch limits and accountability measures in the fishery, and the stock is not overfished, there are no particular risks associated with these shifts in effort, and the impacts of any of the Great South Channel/Southern New England alternatives on the monkfish resource are likely to be neutral.

No action measures would be expected to have neutral impacts on the monkfish resource. Under Alternative 2, enhanced data collection and timely review and strategic decision making on

spatial management issues could have indirect, slightly positive impacts on the monkfish resource.

4.2 Impacts on the monkfish fishery

4.2.1 Gulf of Maine habitat and spawning management alternatives

Generally the habitat management action alternatives in the Gulf of Maine are expected to have a positive impact on the monkfish fishery, potentially opening up new areas to fishing using trawls and gillnets which are now year round groundfish or habitat closed areas. Since generally the proposed spawning management alternatives in the Gulf of Maine already exist as Cod Protection Closures (previously rolling closures) and are closed to all gears capable of catching groundfish, including trawls and gillnets used to target monkfish, the proposed spawning management areas are expected to have a neutral impact on the monkfish fishery. Most of the observed trawl fishing activity targeting monkfish since 2008 occurred in deeper water, east of the Western Gulf of Maine Closure Area in Wilkinson Basin and off the northern edge of Georges Bank (Map 74). A smaller amount of observed trawl fishing for monkfish also occurred in Western Jordan Basin, Georges Basin, and in other deep water areas. There appears to be very little overlap between observed monkfish trawl fishing activity and new habitat management areas in the western, eastern, or central Gulf of Maine (Map 74, Map 75, Map 76).

Observed gillnet fishing for monkfish, on the other hand, appears to be concentrated in shallower areas, often surrounding areas with a greater amount of bottom structure. Observed sets were notable west of the Western Gulf of Maine Closure Area, on Stellwagen Bank and around Platts Bank (Map 75). Both locations are within the Gulf of Maine/Georges Bank Monkfish Gillnet Exemption Area. Another concentration of monkfish gillnet fishing effort occurred east of Cape Cod, Massachusetts, and north of Closed Area I (Map 74). A small amount of observed monkfish gillnet fishing effort occurred northwest of Closed Area II, just north of Georges Bank in deeper water (Map 74).

Since trawl fishing to target monkfish occurs along the eastern boundary of the Western Gulf of Maine Closure Area, it is likely that trawl fishing effort may disperse westward, potentially to the eastern boundary of the proposed Habitat Management Areas, if the groundfish closure were lifted (western Gulf of Maine Alternatives 2-6). The preferred alternative (variation of Alternative 1/No Action) which shifts the western boundary east will likely lead to monkfish trawling within the eastern part of the current groundfish closure. Trawling for monkfish might occur in Cashes Basin if the Cashes Ledge Closure Area was lifted under central Gulf of Maine Alternatives 2-4, although this is not the preferred approach and the closure will remain in place. Otherwise, direct effects on trawl fishing are unlikely.

Eliminating the Western Gulf of Maine Closure Area would lift the restriction on fishing with gillnets on the eastern part of Stellwagen Bank, Tillies Bank, and Jeffreys Ledge. Many alternatives would remove gillnet restrictions while maintaining bottom trawl and dredge restrictions in one or both areas (i.e. Alternatives 3-6). Expanded access to gillnet grounds within the existing Western Gulf of Maine Closure would have positive impacts on the fishery. However, the preferred alternative does not change the western portions of the Western Gulf of Maine Closure Area. As noted above, monkfish fishing with gillnets already occurs in and

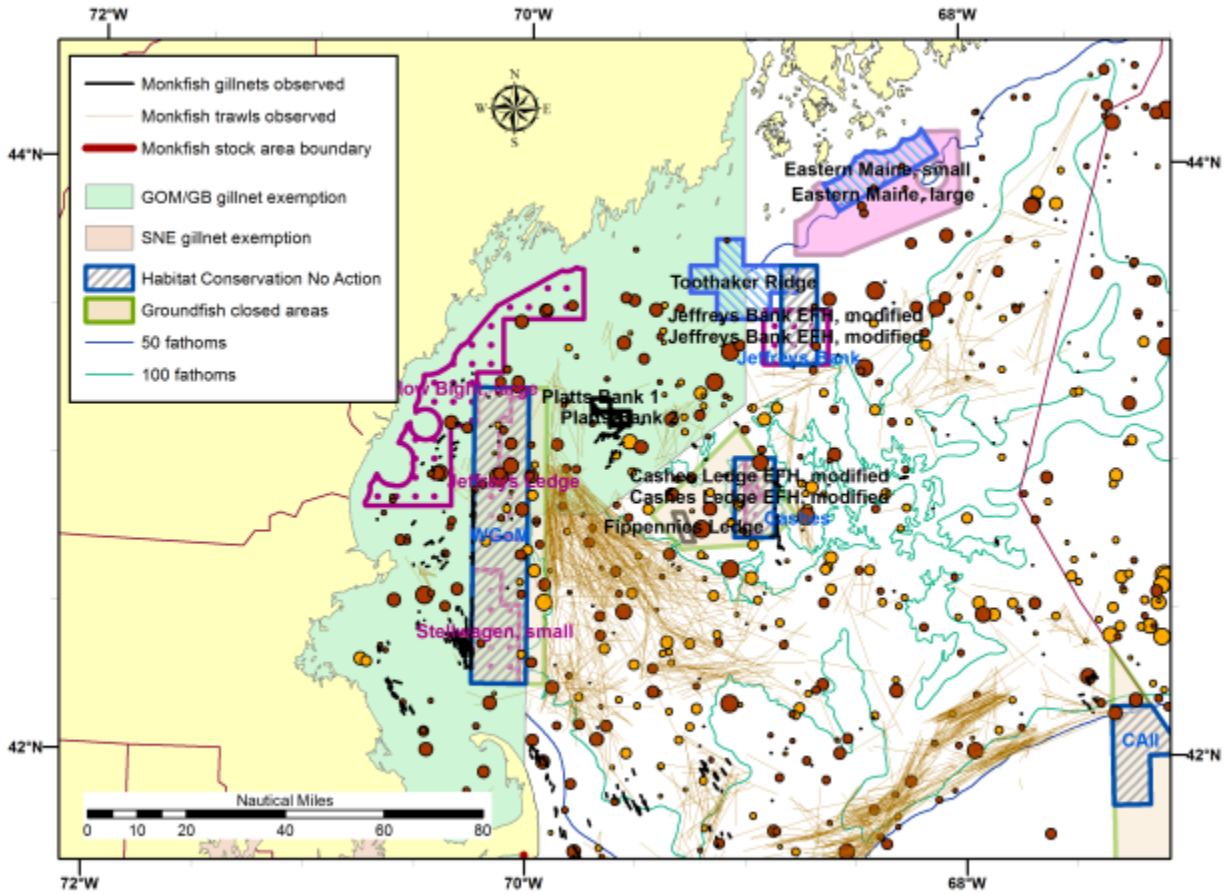
around the proposed Platts Bank Habitat Management Area (Map 74, Map 75). There could be some benefits via reduced gear conflict if the top of the bank were closed to trawls and scallop dredges as a habitat management area (central Gulf of Maine Alternative 3), but since gillnets are already fished on the top of the bank, substantial positive impacts are unlikely. Platts Bank is not part of the preferred alternative for the central Gulf of Maine.

Impacts of the Gulf of Maine spatial management alternatives on the monkfish fishery are summarized below (Table 22).

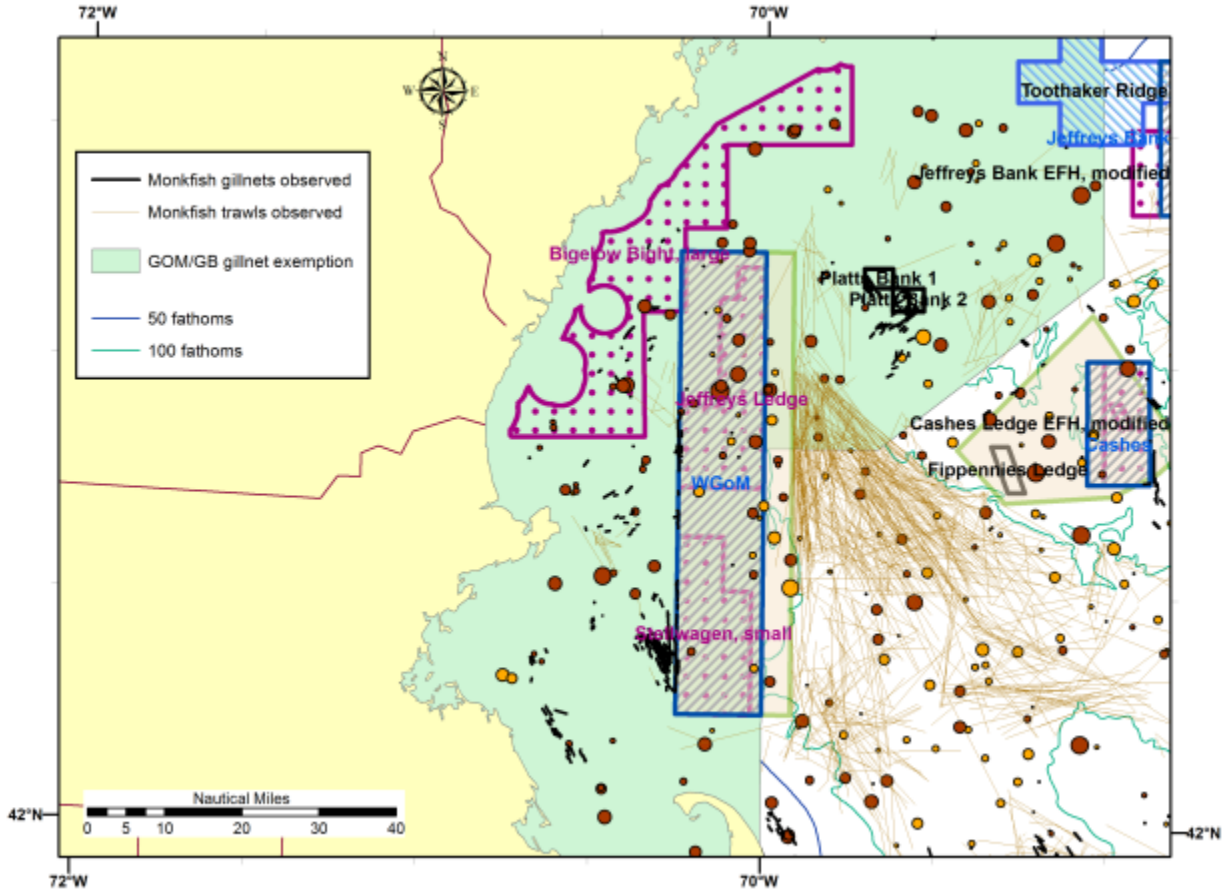
Table 22 – Summary of impacts of the Gulf of Maine spatial management alternatives on the monkfish fishery. Preferred alternatives are identified below (*).

Region and type of alternative	Alternative number	Impacts
Eastern Gulf of Maine habitat	All	Neutral; limited monkfish fishing in sub-region and little overlap with proposed HMAs
Central Gulf of Maine habitat	Alternative 1	Neutral; limited activity around existing closures
	Alternative 2	Slight positive via increased trawl access in Cashes Basin
	Alternative 3	Slight positive via increased trawl access in Cashes Basin and reduced gear conflict for Platts Bank gillnet fishery
	Alternative 4	Slight positive via increased trawl access in Cashes Basin
	Proposed* (combines elements of Alternatives 1 and 3)	Neutral – no management on Platts Bank, Cashes Ledge Closure area remains in place
Western Gulf of Maine habitat	Alternative 1	Slight negative; restricts monkfish fishing with trawls in eastern part of closure, gillnets in western part of closure
	Proposed* (variation of Alternative 1)	Mixed effects, but overall slightly positive; continues to restrict monkfish fishing with gillnets in western part of closure, but allows trawling in eastern part with shift in closed area boundary
	Alternatives 2-6	Slight positive to positive; would increase access in existing closure via removal of groundfish management area restrictions
	Alternatives 7A*, 7B	Neutral; given limited trawling in inshore western Gulf of Maine, roller gear restrictions are unlikely to affect the fishery
	Alternative 8*	Neutral; shrimp trawl exemption would not affect monkfish fishery
Gulf of Maine Spawning	Alternative 1A* (regulatory no action)	Slightly negative; areas are generally inshore such that gillnet fishery is more affected by closures
	Alternative 1B (baseline no action)	Slightly negative; areas are generally inshore such that gillnet fishery is more affected by closures
	Alternative 2	Slightly negative; some gillnet fishing in and around location of Masschusetts Bay Spawning Protection Area, however area is seasonal
	Alternative 3*	Slightly negative; some gillnet fishing in and around location of Masschusetts Bay Spawning Protection Area, however area is seasonal
	Alternative 4*	Slightly negative; some gillnet fishing in and around location of Block 125, however area is seasonal
Research	Alternative 2	Neutral; limited monkfish fishing in eastern Gulf of Maine, including in and around Eastern Maine DHRA
	Alternative 3A, 3B, 3C*	Slightly negative – continues no action displacement of gillnet fishing on eastern Stellwagen Bank

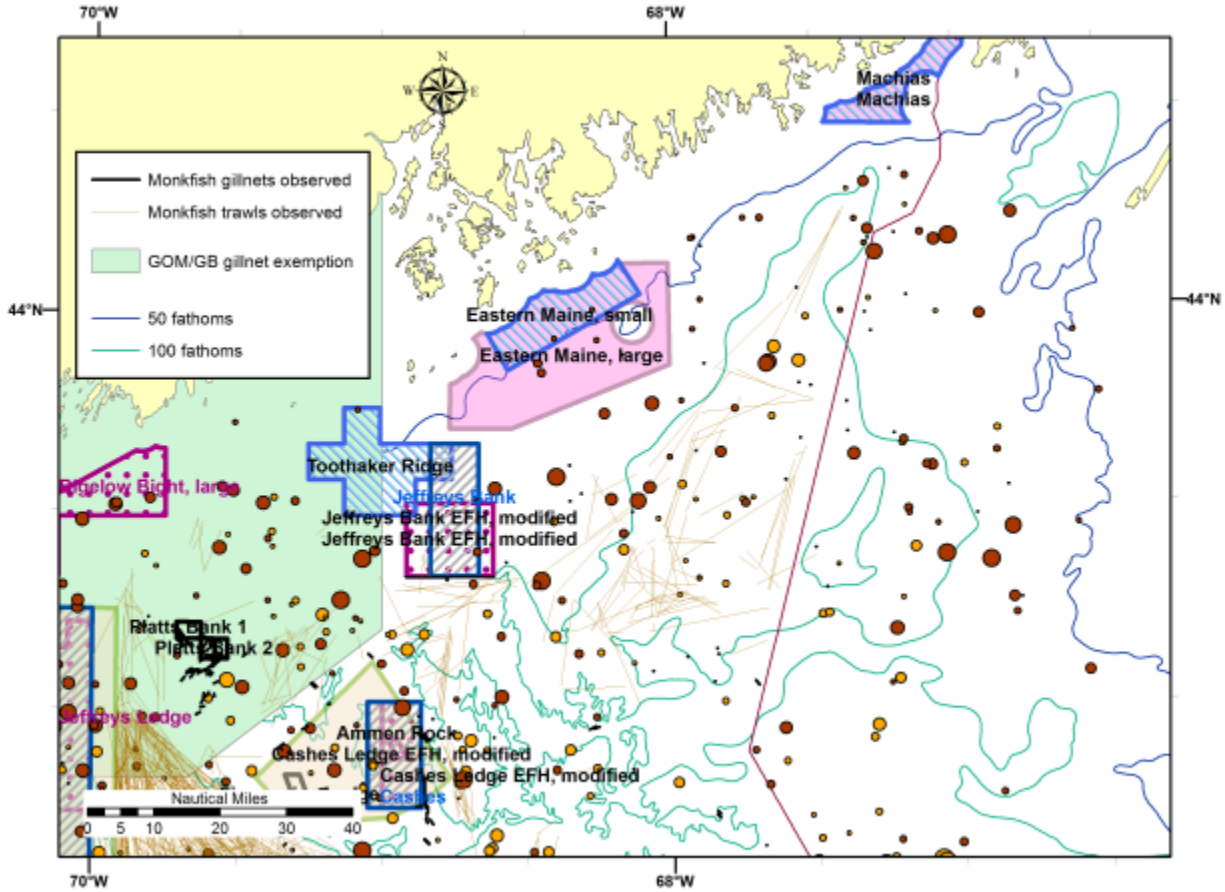
Map 74 – Relationship between habitat management areas and monkfish fishing activity and biomass in the GOM. Specifically, 2008-2012 observed trawl (tan lines) and gillnet (black lines) fishing for monkfish, and 2002-2012 spring (orange circles) and fall (red circles) NEFSC trawl survey weight per tow. Monkfish fishery exemption areas which do not require vessels to be on a Multispecies DAS under certain regulatory constraints are also shown.



Map 75 – Relationship between habitat management areas and monkfish fishing activity and biomass in the western GOM. Specifically, 2008-2012 observed trawl (tan lines) and gillnet (black lines) fishing for monkfish, and 2002-2012 spring (orange circles) and fall (red circles) NEFSC trawl survey weight per tow. Monkfish fishery exemption areas which do not require vessels to be on a Multispecies DAS under certain regulatory constraints are also shown.



Map 76 – Relationship between habitat management areas and monkfish fishing activity and biomass in the central and eastern GOM. Specifically, 2008-2012 observed trawl (tan lines) and gillnet (black lines) fishing for monkfish, and 2002-2012 spring (orange circles) and fall (red circles) NEFSC trawl survey weight per tow. Monkfish fishery exemption areas which do not require vessels to be on a Multispecies DAS under certain regulatory constraints are also shown.



4.2.2 Georges Bank habitat and spawning management alternatives

Due largely to additional access to areas where monkfish occur in the southern half of Closed Area II (currently a year round groundfish closed area with some fishing allowed under groundfish and scallop special access programs) and the northern portion of Closed Area I (currently both a habitat and groundfish closed area), the various habitat management action alternatives are likely to have a moderately positive impact on the monkfish fishery. More areas that have monkfish would become open to fishing with trawls and gillnets, while the proposed habitat management area alternatives do not appear to have as much monkfish biomass.

Closure of Closed Areas I and II from February 1 to April 15 is unlikely to significantly affect access to monkfish that occur in these areas. The proposed Dedicated Habitat Research Area in Closed Area I South appears to have relatively low monkfish biomass, and its closure is therefore unlikely to affect the monkfish fishery.

Nearly all of the observed monkfish fishing on Georges Bank is conducted with trawls, but there are a few observed gillnet trips on Georges Bank (Map 77). Most of the observed monkfish trawl fishing effort occurs along the northern edge of Georges Bank, in deeper water off the edge of the bank. Some of this effort partially overlaps and coincides with the 'Northern Georges Gear Modification Area' (Alternative 5) and the 'EFH Modified 1 and 2 areas' (Alternatives 6A and 6B), but it appears that this fishing effort could shift into a little deeper water to the north, or into Closed Area I North, mitigating the negative effects of these alternatives.

Alternative 7 habitat management areas have no overlap with observed monkfish trawl and gillnet fishing (Map 78). Thus the impact of Alternative 7 on the monkfish fishery is neutral. Alternative 8 has more conflict with the monkfish trawl fishery than any other Georges Bank sub-region alternative. Specifically, the Alternative 8 Northern Georges HMA extends north into deeper waters along the slope, where monkfish trawling often takes place. Vessels that would usually use trawls to target monkfish in this area would probably fish further southwest, closer to Closed Area I, or in deeper waters where other monkfish trawling has been observed. This potential effort shift may reduce monkfish catch per hour fished or otherwise increase fishing costs. Thus, the impact of Alternative 8 on the monkfish fishery is slightly negative.

Alternatives 9 and 10 combine areas within and west of Closed Area II. The areas within Closed Area II are relatively shallow, such that substantial spatial overlaps with the monkfish trawl fishery are not likely even if the area were open to that gear. Thus, continued closure of these areas to trawls is expected to have neutral impacts on the fishery. West of Closed Area II, both the Western HMA (Alternative 9) and Georges Shoal 2 HMA (Alternative 10) are too shallow to overlap with the monkfish resource, and therefore would also have neutral effects on the fishery.

Based on the distribution of monkfish biomass from survey tows, trawl fishing along the northern edge of Georges Bank may also expand southwest into the northern portion of what is now Closed Area I (Map 77). This area is currently closed to groundfish fishing (year round closed area) and to mobile bottom-tending gear fishing (habitat closure). In any of the proposed alternatives, this area would re-open to fishing using either type of gear (trawls or gillnets), except for February-April when the area would potentially be closed to gears capable of catching groundfish during spawning closures.

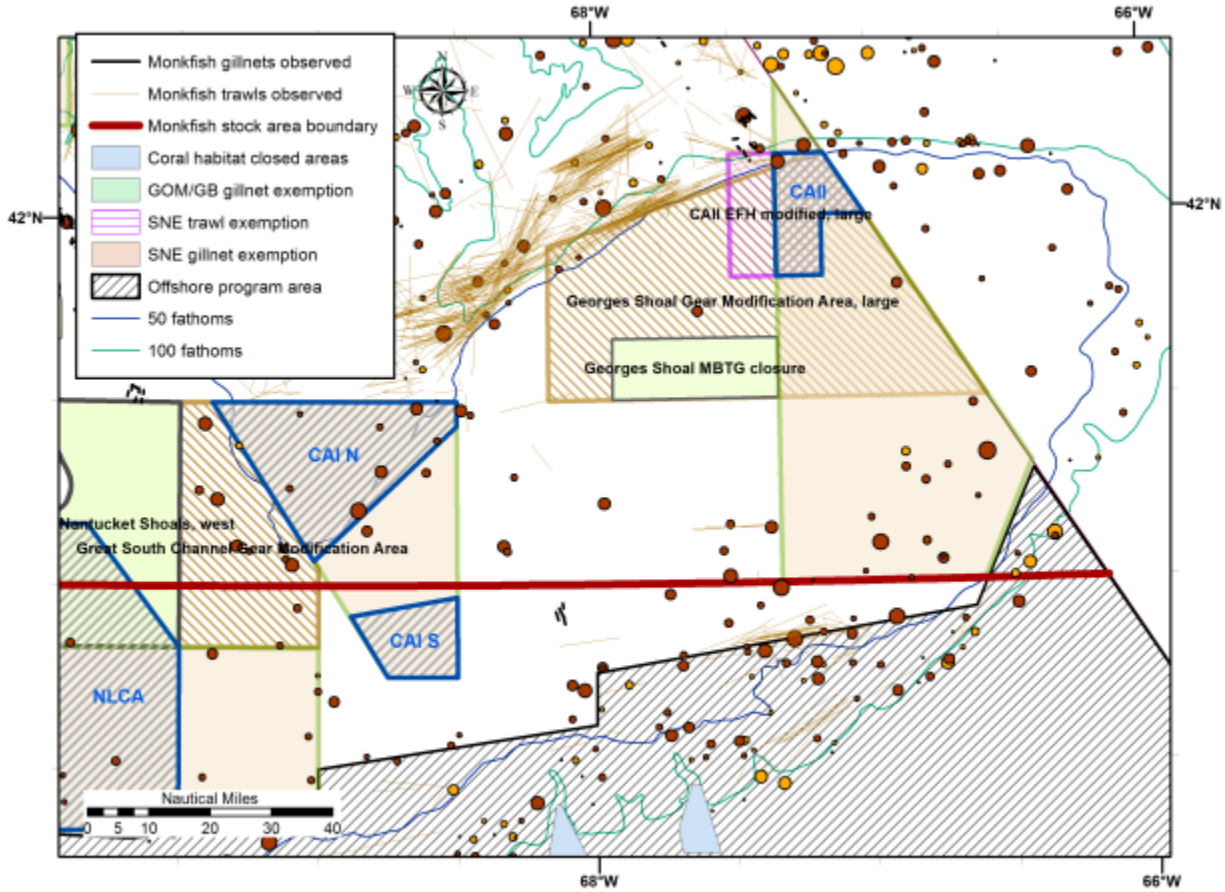
Impacts of Georges Bank spatial management alternatives are summarized below (Table 23).

Table 23 – Impacts of the Georges Bank spatial management alternatives on the monkfish fishery. Preferred alternatives are identified below (*).

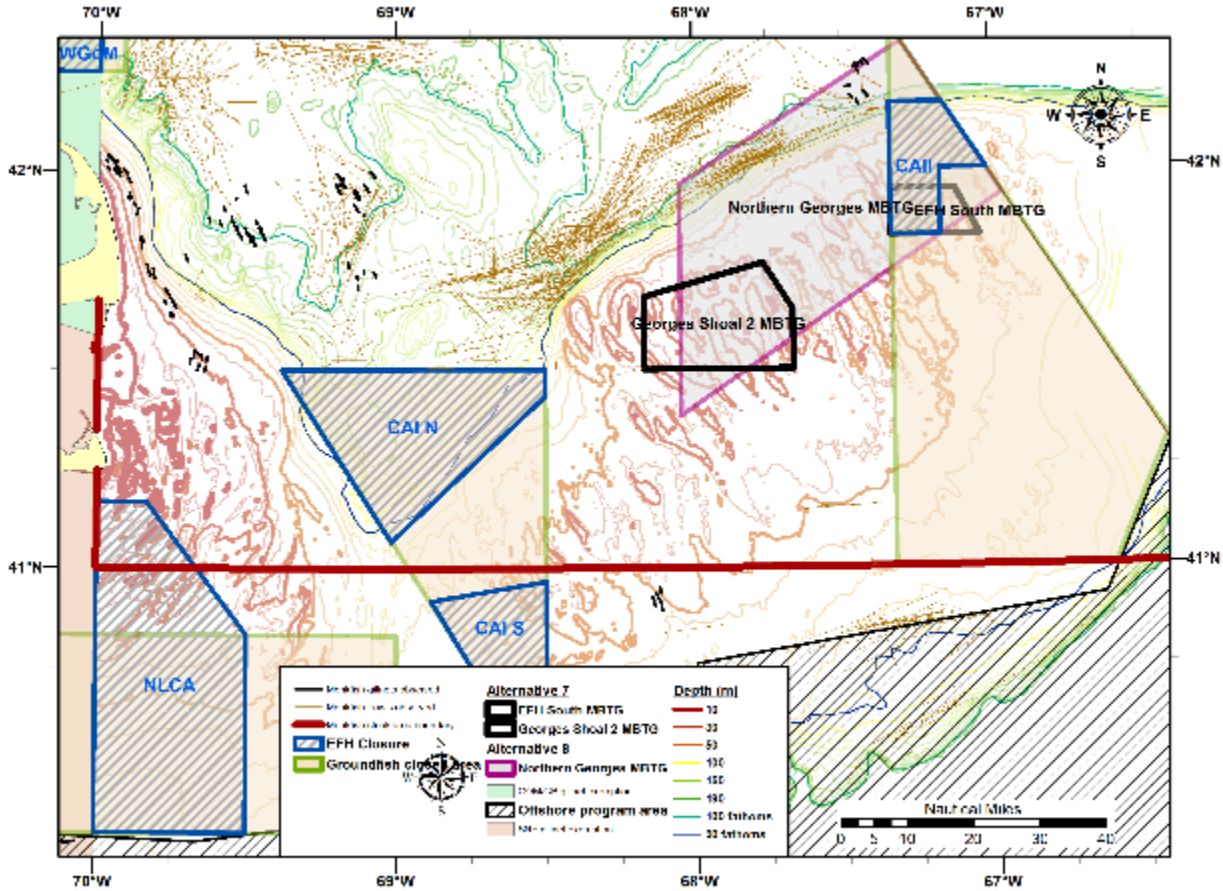
Region and type of alternative	Alternative number	Impacts

Region and type of alternative	Alternative number	Impacts
Georges Bank habitat	Alternative 1	Slight negative; restricts monkfish fishing with trawls in northern Closed Area I, southern Closed Area II, where monkfish trawling occurs at similar depths outside the closures
	Alternative 2	Slight positive – allows access to northern Closed Area I, southern Closed Area II
	Alternatives 3 and 4	Slight positive – allows access to northern Closed Area I, southern Closed Area II; northern Closed Area II along edge of bank would remain closed to trawls
	Alternative 5	Slight positive allows access to northern Closed Area I, southern Closed Area II
	Alternatives 6A, 6B	Slight positive - allows access to northern Closed Area I, southern Closed Area II; northern Closed Area II along edge of bank would remain closed to trawls
	Alternative 7	Slight positive – allows access to northern Closed Area I, southern Closed Area II; new HMAs do not appear to overlap monkfish resource
	Alternative 8	Mixed, but overall likely slightly negative – allows access to northern Closed Area I, southern Closed Area II, but closes trawl grounds along the edge of the bank
	Alternatives 9 and 10*	Slight positive – allows access to northern Closed Area I, southern Closed Area II; new HMAs have limited overlap with monkfish resource
Georges Bank spawning	Alternative 1 (no action)	Slightly negative, restricts monkfish fishing with trawls in northern Closed Area I, southern Closed Area II, where monkfish trawling occurs at similar depths outside the closures
	Alternatives 2A, 2B, 2C and 3A, 3B*, 3C*	Slightly positive – allows access to northern Closed Area I and southern Closed Area II during most of the year. 2C and 3C neutral; only affect scallop dredge use.

Map 77 – Relationship between habitat management areas (Alternatives 1, 5, and 6) and monkfish fishing activity and biomass on Georges Bank. Specifically, 2008-2012 observed trawl (tan lines) and gillnet (black lines) fishing for monkfish, and 2002-2012 spring (orange circles) and fall (red circles) NEFSC trawl survey weight per tow. Monkfish fishery exemption areas which do not require vessels to be on a Multispecies DAS under certain regulatory constraints are also shown.



Map 78 – Relationship between habitat management areas (Alternatives 1, 7, and 8) and monkfish fishing activity and biomass on Georges Bank. Specifically, 2008-2012 observed trawl (tan lines) and gillnet (black lines) fishing for monkfish, and 2002-2012 spring (orange circles) and fall (red circles) NEFSC trawl survey weight per tow. Monkfish fishery exemption areas which do not require vessels to be on a Multispecies DAS under certain regulatory constraints are also shown.



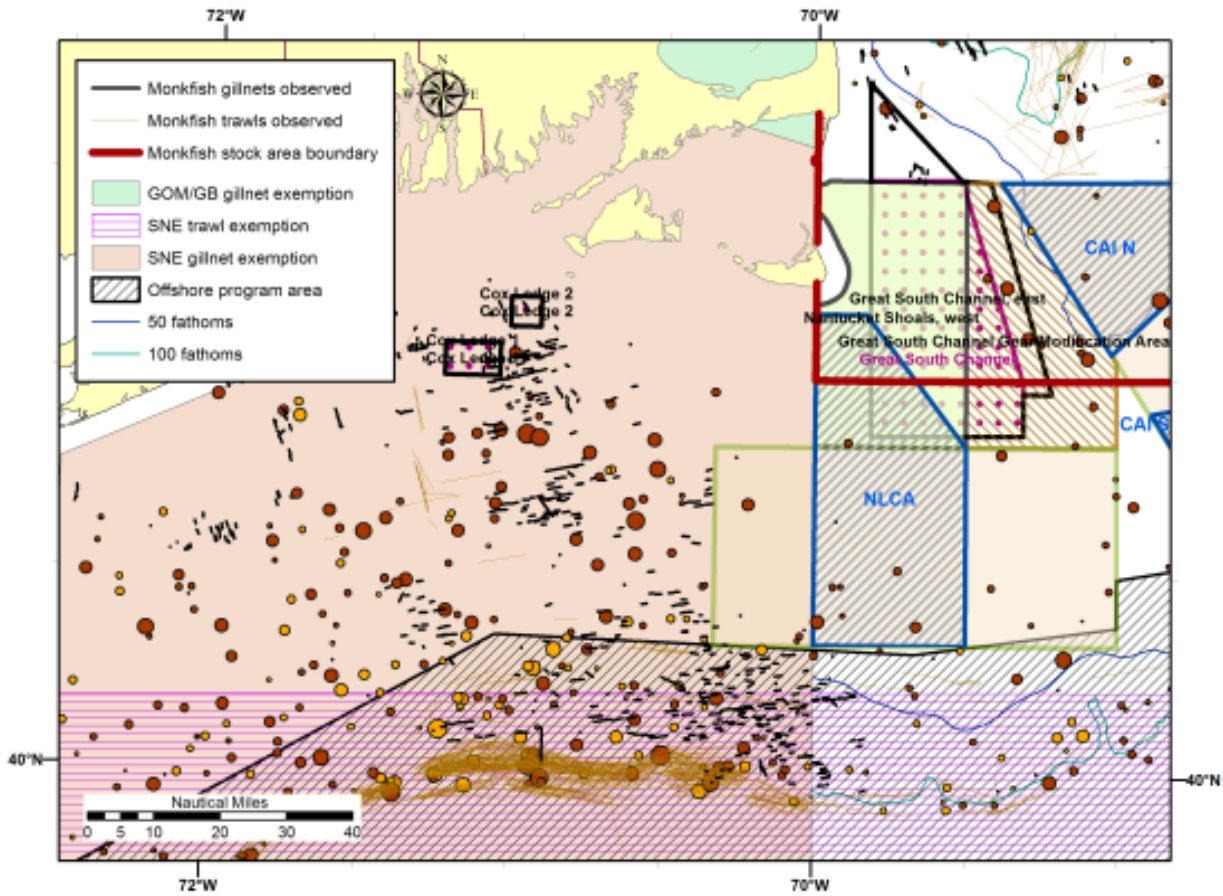
4.2.3 Great South Channel/Southern New England habitat management alternatives

In this sub-region, there is limited overlap with monkfish fishing (Map 79). Inshore gillnetting for monkfish is conducted more frequently in the southern New England region than in the Gulf of Maine or on Georges Bank. Gillnetting occurs west and south of the Nantucket Lightship Closed Area, and would likely expand into the closure if the area were lifted, as would occur with Alternatives 2-6 (Alternative 3 is preferred). There is some gillnetting in the northern portion of the Great South Channel East HMA, but this HMA, which is not a preferred alternative, would not be closed to gillnets, only to bottom-tending mobile gears. Similarly, gillnetting occurs in and around the Cox Ledge HMA, but these areas are not proposed as gillnet closures. Vessels using trawls typically target monkfish along the continental shelf edge, next to canyons and in deeper water than vessels fishing with gillnets. Great South Channel/Southern New England impacts are summarized below (Table 24).

Table 24 – Summary of impacts of the Great South Channel/Southern New England habitat management alternatives on the monkfish fishery.

Alternative number	Impacts
Alternative 1	Slight negative; restricts monkfish fishing with gillnets in Nantucket Lightship Closed Area
Alternatives 2-6 (4 is preferred)	Slight positive; removes the Nantucket Lightship Closed Area, which would allows monkfish fishing with gillnets in an area previously closed to the gear

Map 79 – Relationship between habitat management areas and monkfish fishing activity and biomass in southern New England. Specifically, 2008-2012 observed trawl (tan lines) and gillnet (black lines) fishing for monkfish, and 2002-2012 spring (orange circles) and fall (red circles) NEFSC trawl survey weight per tow. Monkfish fishery exemption areas which do not require vessels to be on a Multispecies DAS under certain regulatory constraints are also shown.



4.2.4 Habitat research area alternatives

The impacts of not developing research areas (DHRA Alternative 1) in particular locations could range from neutral to slightly postive, and would depend on the area in question and overlapping habitat and groundfish management areas. Given a lack of monkfishing activity near the eastern

Maine DHRA or Georges Bank DHRA, and considering that long term closures within the Stellwagen DHRA will continue under the preferred alternative, the impacts of DHRA Alternative 1 on the monkfish fishery are expected to be neutral. Impacts of designating the Stellwagen DHRA might be slighty positive if an action alternative were selected for habitat management, lifting gillnet restrictions in the Western Gulf of Maine Closure Area, but this is not preferred. Similarly, given these conditions, the impacts of designating DHRAs in these locations (Alternatives 2-4) are generally expected to be neutral, with possible slight negative impacts of Alternative 3, if an action alternative were selected for habitat management in the Western Gulf of Maine. The option selected for Alternative 3 (A, B, or C) has no effect on impacts on the monkfish fishery, as they are not targeted with recreational fishing gear. The impacts of removing research areas via a sunset provision are expected to be neutral, given the lack of overlap with the resource and fishery, and the expected continuation of the Western Gulf of Maine Closure Area overlapping the Stellwagen DHRA. Absent this groundfish closure, removal of the DHRA could have slight positive impacts on the monkfish gillnet fishery.

Table 25 – Summary of impacts of the research area alternatives on the monkfish fishery. Preferred alternatives are identified below (*).

Alternative number	Impacts
Alternative 1	Neutral to slightly positive
Alternative 2	Neutral; limited monkfish fishing in eastern Gulf of Maine, including in and around Eastern Maine DHRA
Alternative 3A, 3B, 3C*	Slightly negative to neutral; continues no action displacement of gillnet fishing on eastern Stellwagen Bank, but this area is preferred as a habitat and groundfish closure, such that the DHRA has no additional impacts.
Alternative 4*	Neutral; limited monkfish resource in and around Georges Bank DHRA
Alternative 5*	Neutral to slightly positive

4.2.5 Framework and monitoring alternatives

The monkfish fishery is tied to the multispecies fishery via gear regulations, so adjustments to management areas, especially those focused on groundfish, could indirectly affect monkfish fishing opportunities. Improved data collection and a more explicit process for developing management adjustments would indirectly benefit the fishery to the extent that they participate in the management process and benefit from better management that results from improved data collection.

5 Skates

The following two sections describe impacts of the spatial management alternatives in this amendment on the skate resource and fishery.

5.1 Impacts on skates

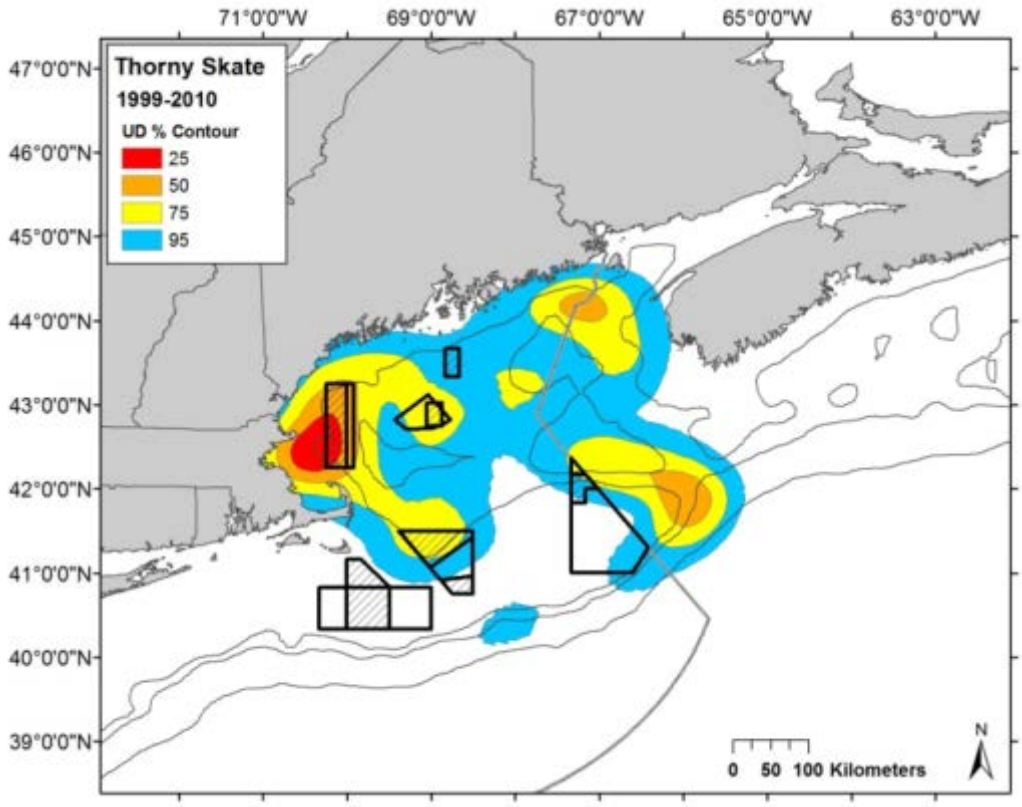
Seven species comprise the skate complex. Clearnose and rosette skate are generally distributed south of the no action and alternative habitat, spawning, and research management areas (see maps for each species in the Affected Environment in Volume 1 and EFH alternatives sections in Volume 2) and constitute a small fraction of landings in the skate fishery, so none of the spatial management alternatives are expected to have a notable impact on these stocks. Rosette skate are caught off the shelf edge and therefore do not intersect with any of the proposed management areas in this amendment. Some clearnose skates may be migrating into Southern New England waters during the summertime, but it is doubtful that many are found as far north as the Great South Channel, although there may be some undocumented intersection with the Cox Ledge area.

5.1.1 Habitat management alternatives

Habitat management areas in the Gulf of Maine overlap with the distribution of thorny and smooth skates, so changes in the boundaries of habitat management areas or the fishing restriction measures within these areas could impact these stocks. Smooth skate is not overfished and not subject to overfishing, but is in a rebuilding plan, and thorny is overfished and just recently over the survey index to where overfishing is not occurring. Impacts on thorny skate are of greater concern. Thorny skate have a somewhat shallower and more inshore distribution as compared to smooth skate, and greater overlap with the various habitat management areas, which tend to occur in shallower waters and do not generally overlap with deeper mud basins.

In the last decade especially, thorny skate have become concentrated in the western Gulf of Maine, both inside and outside of the Western Gulf of Maine Closure Area (Map 80). Increases in either trawl or gillnet effort within the area of highest thorny skate abundance could lead to negative impacts on thorny skate. Increased trawl effort in areas where thorny skate occur in large numbers could result from removal of the existing habitat and groundfish closed areas, although this would be mitigated if new HMAs are designated as mobile gear closures nearby, for example the Bigelow Bight, Stellwagen, or Jeffreys Ledge HMAs in Alternatives 3-6. However, no year-round habitat management areas are proposed south of Cape Ann and west of the current Western Gulf of Maine Habitat Closure, overlapping with the areas of highest density in the figure below. Increases in gillnet effort could result from removal of the groundfish closure, because with no management areas (Western Gulf of Maine Alternative 2) or habitat management areas that only restrict mobile bottom-tending gears (Western Gulf of Maine Alternatives 3-6), the use of gillnets and other fixed gears would be permitted, apart from any spawning closures or protected resource-related management measures that restrict this gear.

Map 80 – Fixed kernel utilization distribution (UD) of positive thorny skate tows from the 1999-2010 NEFSC bottom trawl survey relative to the Northeast Multispecies year-round closed areas and habitat closed areas. Warmer colors indicate higher density of thorny skate presence.



Thorny skate have a zero possession limit, so presumably increases in effort in areas where they are more abundant would not lead to directed fishing on the stock, but they are caught incidentally in various gears (Table 26). Because reporting at the species level is incomplete, these discard values are estimates based on fishing location and discarded to kept catch ratios on observed trips. The overall skate complex Total Allowable Landings (TAL) is a combined value that is primarily based on a moving survey biomass index across the seven skate species. The TAL is set below the annual catch limit at a level that equals the annual catch target (75% of ACL) minus discards, minus state landings. Different species contribute different fractions of the TAL depending on their current stock size. For reference, thorny skate contribute 229 mt to the skate complex TAL under the specifications proposed for fishing year 2014 (Skate Framework Adjustment 2, May 21, 2014; 79 FR 29154). In total, the thorny skate bycatch estimates are of similar magnitude (estimated discards for otter trawl, gillnet and scallop dredge in 2012 was 409 mt). Because it is a skate complex TAL, catch and landings are not managed directly according to an individual species' TAL contribution. However, with current bycatch of thorny skate estimated to be above the fraction they contribute to the TAL, additional bycatch of the species as a result of alternatives proposed in this amendment is of concern, as it could compromise rebuilding of the stock. Fixed gear discards are lower than mobile gear discards, so alternatives that increase the potential for fixed gear use in areas of high thorny skate abundance (i.e. Alternatives 3-6 as mobile bottom tending gear closures) would have smaller negative impacts than those that increase mobile bottom-tending gear use in areas of high thorny skate abundance

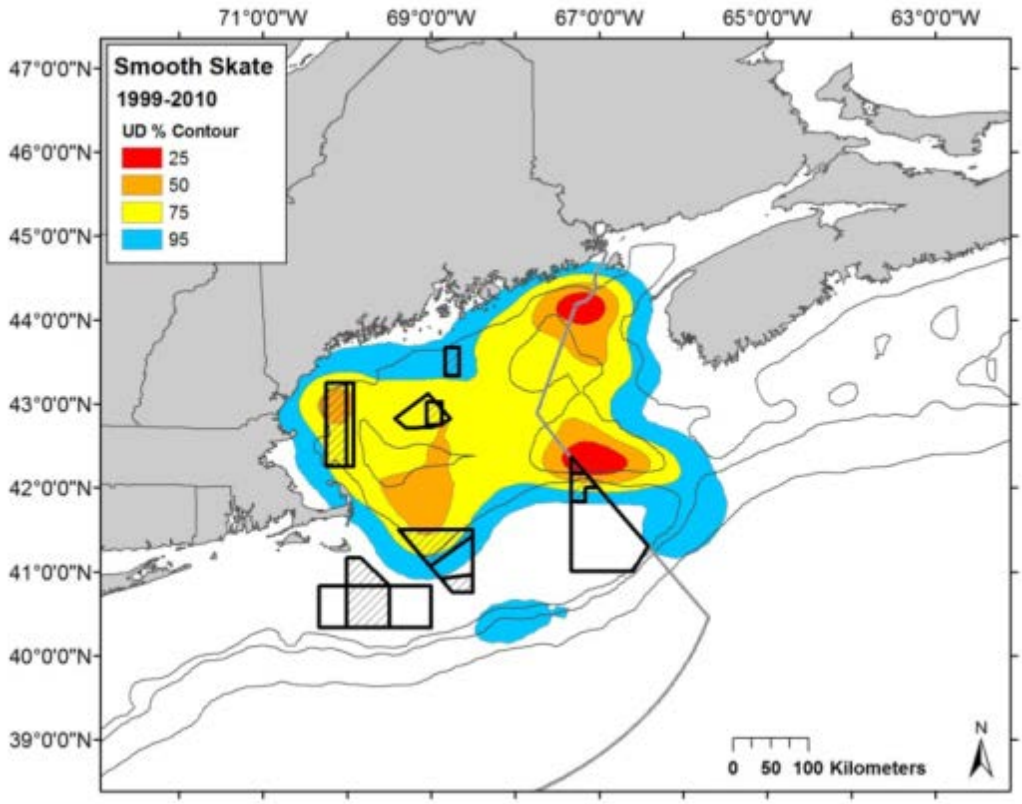
(Alternative 2, Alternatives 3-6 as gear modification areas). Currently, the specifications process assumes a 23% discard mortality rate of otter trawl-caught thorny skates, but this may be an underestimate. A higher discard mortality rate would mean that increased catches of thorny skate result in a higher fishing mortality rate on the stock. The assumed discard rate in fixed gear (e.g. gillnets) is 50%, but this is based on limited data.

Table 26 – Estimated total discards of thorny skate in four bottom-tending gear types, reported annually on a calendar year basis in metric tons. Table adapted from data provided in the 2014-2015 skate specifications document.

	Fixed gears		Mobile gears		
Year	Sink gillnet	Longline	Otter trawl	Scallop dredge	Total
2008	3	1	90	31	125
2009	8	1	179	18	206
2010	6	3	268	22	299
2011	4	1	149	22	176
2012	8	2	326	73	409

Smooth skate have a somewhat different distribution than thorny skate, with the highest concentrations of survey catch north of Jordan Basin and in Georges Basin (Map 81). Moderate concentrations of catch (50% contour on the kernel utilization plots, shown in orange below) are found on Jeffreys Ledge and between Wilkinson Basin and Closed Area I.

Map 81 – Fixed kernel utilization distribution (UD) of positive smooth skate tows from the 1999-2010 NEFSC bottom trawl survey relative to the Northeast Multispecies year-round closed areas and habitat closed areas. Warmer colors indicate higher density of thorny skate presence.



Impacts of habitat management alternatives on smooth skate are somewhat less concerning than for thorny skate, as the status of the stock is better relative to biological reference points, but it is still below the target. Like thorny skate, smooth skate have a zero possession limit, so presumably increases in effort in areas where they are more abundant would not lead to directed fishing on the stock, but they are caught incidentally in various gears (Table 27). For reference, smooth skate contribute 644 mt to the skate complex Total Allowable Landings (TAL) under the alternative specifications currently under development. In total, these bycatch estimates are of similar magnitude.

Otter trawls and scallop dredges make the greatest contribution to estimated smooth skate discards, so alternatives that increase use of these gears in areas of high smooth skate abundance could have a negative impact on the stock. This could be the case if year-round mobile gear restrictions are eliminated on Jeffreys Ledge (Alternative 2, 3, or 6), or if gear modification are the preferred management option for Alternatives 4 or 5, which include the Jeffreys Ledge HMA. The assumed discard mortality rate for smooth skate in otter trawls is 60%, but 50% for all other gear types.

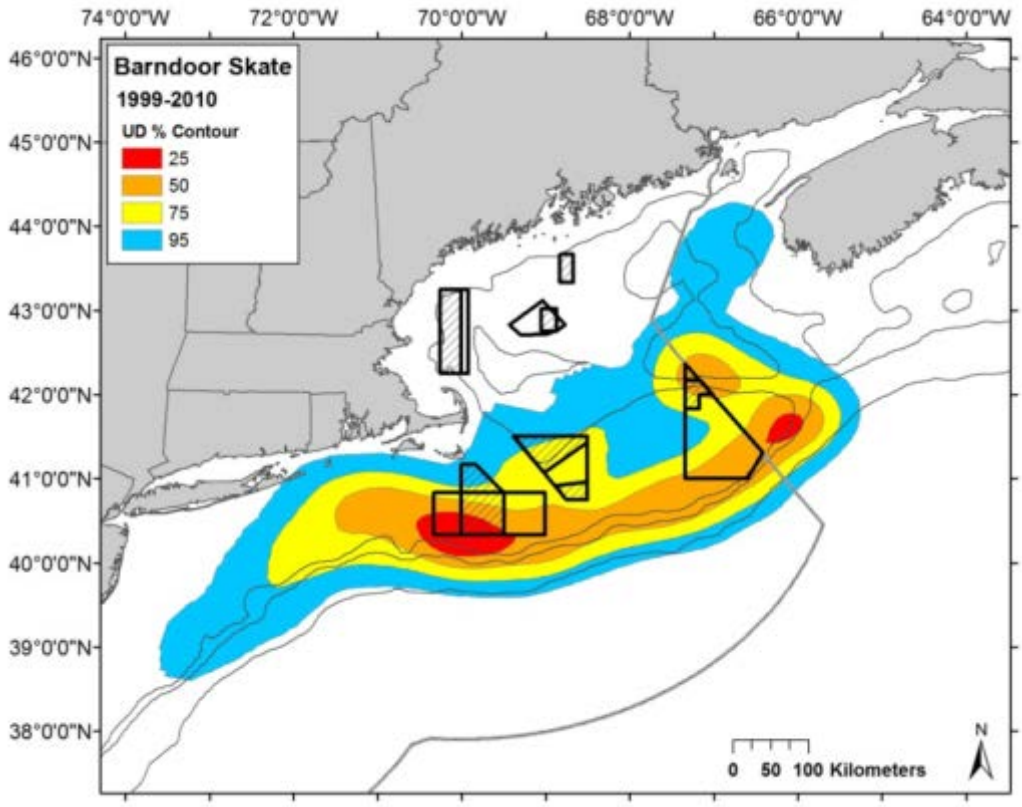
Table 27 – Estimated total discards of smooth skate in four bottom-tending gear types, reported annually on a calendar year basis in metric tons. Table adapted from data provided in the 2014-2015 skate specifications document.

	Fixed gears		Mobile gears		
Year	Sink gillnet	Longline	Otter trawl	Scallop dredge	Total
2008	18	4	591	250	863
2009	23	3	591	48	665
2010	15	15	577	52	659
2011	25	11	637	128	801
2012	20	3	596	172	791

Habitat management alternatives on Georges Bank and in Southern New England overlap with winter, little, and barndoor skate distributions. Both winter and little skate are currently very abundant. It is not known whether these species are resident in closed areas, such that the historic presence of closures may have contributed to their currently high biomass. Both species are very widely distributed over the bank, such that any combination of management areas will overlap their distribution. Altogether, it is unlikely that changing habitat management areas in Georges Bank and Southern New England will have a negative impact on winter skate or little skate. Trip limits and overall total allowable landings limits for the wing and bait fisheries will likely control overall mortality on these stocks, regardless of changes in spatial management, although it should be noted that the approach to developing trip limits and total allowable landings limits could change in the future. Furthermore, recent studies of discard mortality rates (Mandelman et al. 2013) indicate that these rates are lower than previously believed.

Barndoor skate occur in all of the current closed areas, but are most abundant along the margin of the bank, including the southwestern part of the Nantucket Lightship Closed Area and Closed Area II (Map 82). Barndoor skate abundance is increasing, and although it has not yet reached the biomass target, barndoor skate is not overfished and overfishing is not occurring. Retention of barndoor is still prohibited, and additional conservation of the stock may be helpful as it continues to rebuild. Based on its distribution, alternatives that reopen the southern part of Closed Area II and the Nantucket Lightship Closed Area would probably have the greatest effect on discards of barndoor skate.

Map 82 – Fixed kernel utilization distribution (UD) of positive barndoor skate tows from the 1999-2010 NEFSC bottom trawl survey relative to the Northeast Multispecies year-round closed areas and habitat closed areas. Warmer colors indicate higher density of thorny skate presence.



Like thorny and smooth skates, because barndoor skate have a zero possession limit, it is assumed that increases in effort in areas where they are more abundant would not lead to directed fishing effort on the stock. However, they are caught incidentally in various gears so fishing does contribute to mortality (Table 28). The highest discard rates are in the otter trawl and sink gillnet fisheries, and at least some of the effort in those fisheries is directed on skates. If barndoor abundance continues to increase and retention is allowed at some point in the future, these discards would likely be converted to landings, at least in the wing fishery which targets larger animals. For reference, barndoor skate contribute 3,221 mt to the skate complex Total Allowable Landings (TAL) under the proposed 2014 specifications.

Table 28 – Estimated total discards of barndoor skate in four bottom-tending gear types, reported annually on a calendar year basis in metric tons. Table adapted from data provided in the 2014-2015 skate specifications document.

	Fixed gears		Mobile gears		
Year	Sink gillnet	Longline	Otter trawl	Scallop dredge	Total

Year	Fixed gears		Mobile gears		Total
	Sink gillnet	Longline	Otter trawl	Scallop dredge	
2008	742	39	3258	290	4329
2009	188	29	1492	335	2044
2010	764	121	2544	303	3732
2011	1660	36	4370	570	6636
2012	965	9	3413	503	4890

Table 29 summarizes the potential impacts of the various habitat management alternatives on each of the skate stocks, with the exception of rosette and clearnose which do not overlap the current or alternative management areas. In combination, the preferred alternatives in the Gulf of Maine likely have slightly positive impacts on smooth and thorny skate, with no impacts expected on other skate species. The new Small Eastern Maine HMA may provide some protection for these species, especially thorny skate due to its shallower depth preference. The preferred action maintains both the Western Gulf of Maine and Cashes Ledge Closure Areas. The WGOM Closure Area boundary is shifted to the west to align with the boundaries of the WGOM Habitat Closure Area, which removes deeper portions of the closure that could be used by smooth skate in particular. However, while fishing effort currently occurring along the western boundary of the existing closure may shift into the newly reopened area, increases in the overall magnitude of effort are less likely. The preferred action does modify the boundaries of the Jeffreys Bank HMA to focus on shallower areas. While the new, preferred boundary aligns less closely with the distribution of smooth skate EFH (see Volume 4 impacts analysis), both the existing and new areas are within the 95% density contour (Map 81) indicating that Jeffreys Bank is generally a lower density area for the species.

On Georges Bank and in Southern New England, the preferred alternatives likely have neutral to slightly negative impacts on the smooth and thorny skate resources, because limited areas of overlap between these stocks and the deeper water portions of existing Closed Areas I and II would be eliminated. However, no particular increases in overall fishing effort are expected; rather, a redistribution of effort along the northern margin of the bank is likely to occur. Neutral to slightly negative impacts on barndoor skate are expected if fishing effort increases in the existing Nantucket Lightship Closure Area and Habitat Closure Area (the preferred alternative removes these closures) and bycatch increases as a result. Barndoor skate are relatively abundant in these areas in the survey (Map 82).

Table 29 – Summary of the impacts of habitat management alternatives on skate stocks. No impacts are expected on rosette skate or clearnose skate. Preferred alternatives are identified below (*).

<table>
<tr><th>Sub-region</th><th>Alt</th><th>Thorny</th><th>Smooth</th><th>Little</th><th>Winter</th><th>Barndoor</th></tr>
<tr><td rowspan="3">EGOM</td><td>1</td><td colspan="2">Neutral</td><td colspan="3" rowspan="5">Few to no impacts – based on survey data, these three species have very limited distributions in the GOM</td></tr>
<tr><td>2</td><td colspan="2" rowspan="2">Neutral to slightly positive – some overlap between species and management areas such that elimination of MBTG fishing would benefit the stock. Neutral impacts if Options 3 or 4 are selected.</td></tr>
<tr><td>3*</td></tr>
<tr><td rowspan="2">CGOM</td><td>1*</td><td colspan="2">Slightly positive</td></tr>
<tr><td>2</td><td colspan="2">Slightly negative; removes management</td></tr>
</table>

<table>
<tr><th>Sub-region</th><th>Alt</th><th>Thorny</th><th>Smooth</th><th>Little</th><th>Winter</th><th>Barndoor</th></tr>
<tr><td rowspan="2"></td><td>3</td><td colspan="2" rowspan="2">areas in areas where these skates occur</td><td colspan="3" rowspan="10"></td></tr>
<tr><td>4*</td></tr>
<tr><td rowspan="8">WGOM</td><td>1*</td><td>Positive</td><td>Slightly positive</td></tr>
<tr><td>2</td><td>Negative</td><td>Neutral to slightly negative</td></tr>
<tr><td>3</td><td>Slightly negative – removal of management areas on Jeffreys Ledge could cause increased fishing on the stock. Bigelow Bight area would provide some conservation benefits. Negative impacts of Options 3 and 4.</td><td rowspan="5">Neutral to slightly negative – less so than Alt 2</td></tr>
<tr><td>4</td><td rowspan="2">Neutral – similar protection compared to current management area, although fixed gear fishing would be allowed throughout areas. Negative impacts of Options 3 and 4.</td></tr>
<tr><td>5</td></tr>
<tr><td>6</td><td>Slightly negative – removal of management areas on Jeffreys Ledge could cause increased fishing on the stock. More negative than Alternative 3. Negative impacts of Options 3 and 4.</td></tr>
<tr><td>7a* and 7b</td><td colspan="5">Uncertain, probably neutral</td></tr>
<tr><td>8*</td><td colspan="5">The shrimp trawl exemption area would have slightly negative to neutral impacts on thorny and smooth skate in combination with Alternative 1, and neutral impacts on other stocks. The alternative could increase shrimp trawl effort in the exemption area, but large amounts of fishing in the exemption area are unlikely.</td></tr>
<tr><td rowspan="11">GB</td><td>1</td><td colspan="2">Slightly positive – limited distribution of these species in northern parts of existing CAI and CAII which would be retained under no action</td><td colspan="2" rowspan="11">Neutral – species are abundant and found throughout sub-regions, and fishing mortality is controlled via other means</td><td>Neutral to slightly positive</td></tr>
<tr><td>2</td><td colspan="2" rowspan="10">Slightly negative – limited distribution of these species in northern parts of existing CAI and CAII which would be eliminated under these alternatives</td><td rowspan="10">Neutral to slightly negative – increases in fishing could increase bycatch in southern part of CAII; however stock not overfished. Stock does not appear to be more abundant in current closure vs. similar depths</td></tr>
<tr><td>3</td></tr>
<tr><td>4</td></tr>
<tr><td>5</td></tr>
<tr><td>6</td></tr>
<tr><td>7</td></tr>
<tr><td>8</td></tr>
<tr><td>9</td></tr>
<tr><td>10*</td></tr>
</table>

Sub-region	Alt	Thorny	Smooth	Little	Winter	Barndoor
						outslide closure.
GSC-SNE	1	None – very limited distributions of these species in these areas				Slightly positive given overlap between existing closure and high abundance areas
	2					Neutral to slightly negative because areas of higher barndoor abundance would reopen to fishing
	3					
	4*					
	5					
	6					

5.1.2 Spawning management alternatives

Contingent on decisions made about the year-round groundfish closures under the habitat management alternatives, the spawning management alternatives would maintain existing year round and seasonal closures (No Action), modify these areas (Gulf of Maine Alternative 2, GB Alternatives 2 and 3), create new areas (Gulf of Maine Alternatives 3 and 4).

Both Alternatives 1A (regulatory No Action/Northeast Multispecies Framework 53 areas) and 1B (baseline No Action, prior rolling closures) maintain the existing year-round closures. The preferred approach is Alternative 1A, with a shift in the eastern boundary of the WGOM closure area to reduce the size of the area to match the overlapping habitat closure. Gulf of Maine Alternative 2 would remove the Western Gulf of Maine and Cashes Ledge year round closures, as well as the common pool rolling closures. Changes to the Western Gulf of Maine closure could negatively impact thorny skate, and to a lesser extent, smooth skate. Under Alternative 2, portions of these areas would still be closed to many gears capable of catching groundfish on a seasonal basis (April-June, depending on the area). Gulf of Maine Alternative 3 would designate a new spawning area in Massachusetts Bay during November through January. This could have slight positive impacts, especially for thorny skates, if effort is reduced in that season, as their distribution overlaps the area, but it would have neutral impacts if effort simply shifts elsewhere in the inshore western Gulf of Maine. Similarly, Alternative 4 could have slight positive impacts on thorny skate via a spring closure of block 125. Georges Bank Alternatives 2 and 3 would remove the Nantucket Lightship Closure, and make Closed Areas I and II seasonal in the spring. This could increase discards of barndoor skate, and thereby cause negative impacts on the stock relative to no action. The preferred alternative (3), maintains Closed Area II and the northern part of Closed Area I from February 1-April 15 as a closure to various commercial and recreational gears, with an exemption for scallop dredges. In combination, the preferred spawning alternatives may have slightly positive impacts on skates in the Gulf of Maine, and slightly negative impacts on skates in Georges Bank/Southern New England.

Table 30 – Summary of the impacts of spawning management alternatives on skate stocks. No impacts are expected on rosette skate or clearnose skate. Because skates are only infrequently caught in recreational gear, no difference in impacts expected between options A (recreational fishing restricted from spawning areas) and B (recreational fishing exempted). Preferred alternatives are identified below (*).

Region	Alt	Thorny	Smooth	Little	Winter	Barndoor

<table>
<tr><td rowspan="3">GOM</td><td>1A* and 1B</td><td>Positive</td><td>Neutral to slightly positive</td><td colspan="2" rowspan="3">None – very limited distributions of these species in these areas</td></tr>
<tr><td>2A and 2B</td><td>Negative</td><td>Neutral to slightly negative</td></tr>
<tr><td>3* and 4*</td><td colspan="2">Neutral to slightly positive</td></tr>
<tr><td rowspan="3">GB</td><td>1</td><td colspan="2">Slightly positive – limited distribution of these species in northern parts of existing CAI and CAII which would be retained under no action</td><td rowspan="3">Neutral – species are abundant and found throughout sub-regions, and fishing mortality is controlled via other means</td><td>Positive – NLCA and southern part of CAII may limit bycatch on the stock, although there are access programs currently in place in CAII</td></tr>
<tr><td>2A, 2B, 2C</td><td colspan="2" rowspan="2">Slightly negative – limited distribution of these species in northern parts of existing CAI and CAII which would be made seasonal under action alternatives</td><td rowspan="2">Slightly negative – CAII would only be in place 3 months of the year; however stock not overfished; NLCA would be removed.</td></tr>
<tr><td>3A, 3B*, 3C*</td></tr>
</table>

5.1.3 Dedicated Habitat Research Area alternatives

Although they may have costs and benefits due to associated restrictions on fishing, these types of impacts of Dedicated Habitat Research Areas are considered in analysis of their corresponding Habitat Management Areas. Therefore, DHRA impacts are relative to any additional fishing restrictions that might provide enhanced conservation, and to the expected benefits of completing research projects.

Table 31 – Summary of the impacts of research alternatives on skate stocks. No impacts are expected on rosette skate or clearnose skate. Because skates are only infrequently caught in recreational gear, no difference in impacts expected between options A, B, and C in Alternative 3. Preferred alternatives are identified below (*).

<table>
<tr><th>Alt</th><th>Thorny</th><th>Smooth</th><th>Little</th><th>Winter</th><th>Barndoor</th></tr>
<tr><td>1 – No DHRA</td><td colspan="5">Neutral – no research areas designated, but these locations may be managed for habitat or spawning purposes</td></tr>
<tr><td>2 – E Maine</td><td colspan="2">Slightly positive – limited overlap between stocks and this DHRA such that research is likely to generate only limited information about skates in this area.</td><td colspan="3">None – stocks do not occur in DHRA</td></tr>
<tr><td>3A, 3B, 3C* – Stellwagen</td><td>Positive – thorny skates are abundant in this area, such that research should provide information to help better manage the skate resource.</td><td>Slight positive – lesser overlap with distribution of smooth skates.</td><td colspan="3">None – limited overlap between stocks and this DHRA</td></tr>
</table>

4 – Georges Bank*	None – no overlap between stocks and this DHRA	Positive – species are common in this area and research could provide information to help better manage the skate resource.	Neutral to slightly positive– DHRA is not an area of high abundance for barndoor skate
5 – Sunset provision*	Neutral. This alternative is designed to remove a DHRA if it is not being used, and a DHRA that is not in use will not be producing positive benefits in terms of increased information.		

5.1.4 Framework and monitoring alternatives

No action measures would be expected to have neutral impacts on the skate resource. Under Alternative 2, enhanced data collection and timely review and strategic decision making on spatial management issues could have indirect, slightly positive impacts on the skate resource.

5.2 Impacts on the skate fishery

This section describes the impacts of the spatial management alternatives on the skate fishery.

5.2.1 Habitat management alternatives

Skates are caught on both directed and incidental trips in the multispecies, monkfish, and to a much lesser extent, scallop fisheries, in trawl, sink gillnet, and scallop dredge gear. The habitat management alternatives generally restrict mobile bottom-tending gears, so there would be no restrictions on directed or incidental catch of skates using gillnets except where such catches are already prohibited under no action (i.e. in the current year-round groundfish closed areas), should the groundfish closures remain in effect following implementation of the amendment. Statistical areas 521 and 537 have the highest catches of skates in gillnets, and some of this effort likely occurs within the proposed Cox Ledge and Great South Channel HMAs. Restrictions on mobile gears in these areas could potentially increase opportunities for gillnetting, although currently gillnet fishing occurs in conjunction with mobile gear fishing as these are open areas.

The greatest concentration of skate trawl effort is in statistical area 539 south of Rhode Island, but there are relatively high levels of skate trawl effort in areas 537, which includes Cox Ledge, and 522 and 561, which contain the various Northern Edge, Georges Shoal, and Closed Area II HMAs (Georges Bank Alternatives 1, 3-10). Restrictions on trawling in these areas could negatively impact the skate fishery. However, reopening the Nantucket Lightship Closed Area, Closed Area I, and Closed Area II groundfish and habitat closures, either seasonally or year round, could provide increased fishing opportunities for the skate fishery (Georges Bank Alternatives 2-10 and Great South Channel/Southern New England Alternatives 2-6). Although it is difficult to predict future effort distributions, winter and little skate occur throughout these areas and observed haul locations indicate that trawling for skates occurs along the boundaries of the areas. However, because these two stocks are so widely distributed throughout the Georges Bank and Southern New England region, many skates are still available to the fishery even in the presence of area closures.

With the exception of some gillnet activity in statistical area 514, skate landings from the Gulf of Maine are generally fairly limited. Therefore, changes to habitat management areas in the Gulf of Maine would likely have only minimal impacts on the skate fishery, except to the extent that

negative biological impacts on thorny skate, and to a lesser extent, smooth skate, affect the fishery in the long run.

Table 32 – Summary of the impacts of habitat management alternatives on the skate fishery. No impacts are expected on rosette skate or clearnose skate. Preferred alternatives are identified below (*).

Sub-region	Alt	Fishery impacts
EGOM	1	None. There is little to no skate fishing using trawls in this sub-region.
	2	
	3*	
CGOM	1*	Neutral to slightly negative. There are small amounts of skates landed with trawl gear in statistical area 515 overlapping Cashes Ledge, so the no action management areas may limit skate fishing somewhat.
	2	Slightly positive. This alternative would remove current management areas and allow skate fishing throughout the region with trawl and gillnet gears, but since there are zero possession limits on smooth and thorny skates, such benefits are likely to be limited.
	3	Neutral to slightly positive; uncertain. This alternative would adjust current management areas, remove the Cashes Ledge groundfish closure, and would add a management area on Platts Bank. It is unclear how this would affect fishing opportunities for skates.
	4*	Neutral to slightly positive; uncertain. This alternative would adjust current management areas and remove the Cashes Ledge groundfish closure. It is unclear how this would affect fishing opportunities for skates.
WGOM	1*	Neutral. Little and winter skate do not occur in any abundance inside the WGOM or Cashes Ledge closed areas, so impacts of these areas on the skate fishery are probably minor.
	2	Neutral. Providing access to current closures is unlikely to benefit the skate fishery given the distribution of little and winter skates.
	3	Neutral. The various updated closures in these alternatives are unlikely to impact the the skate fishery given the distribution of little and winter skates.
	4	
	5	
	6	
	7a* and 7b	Neutral. Adjustments to gear measures are unlikely to impact the skate fishery since there is limited trawl fishing for skates in this region to begin with. Also, the 12-inch roller gear restriction already applies to Multispecies vessels, which probably contribute most of the skate landings in this location.
	8*	Neutral. Providing shrimp fishery access to current closures will not benefit the skate fishery.
GB	1	Slightly negative to neutral. This alternative restricts trawl and gillnet access to CAI and CAII, but little and winter skate are broadly distributed so this may not be limiting to the fishery.
	2	Neutral to slightly positive – this alternative would generally increase access to fishing areas, although little and winter skate are broadly distributed so current restrictions may not in fact be very limiting to the fishery.
	3	Overall positive impacts of shifting from CAI and CAII areas (habitat and groundfish) to Northern Edge area only. Impacts depend on measure selected for northern edge area; a gear restriction would still allow trawl use.
	4	Overall positive impacts of shifting from CAI and CAII areas (habitat and groundfish) to Northern Edge area and smaller Georges Shoal Gear Modification Area. Impacts depend on measure selected for northern edge area; a gear restriction would still allow trawl use.
	5	Overall positive impacts of shifting from CAI and CAII areas (habitat and groundfish) to the Northern Georges GMA and Georges Shoal MBTG area. Trawling with restricted gear would be allowed throughout, except within the Georges Shoal 1 MBTG area, which contains a relatively

Sub-region	Alt	Fishery impacts
		small fraction of the overall revenue shown for the entire Northern Georges GMA.
	6A and 6B	Overall positive impacts of shifting from CAI and CAII areas (habitat and groundfish) to new areas. Some fishing effort likely to be displaced by the modified area (either Option A or Option B).
	7	Overall neutral – probably positive impacts associated with reducing coverage of habitat and groundfish closure areas, but the trawl fishery overlaps with the Georges Shoal 2 MBTG HMA in this alternative which would displace effort and could have negative impacts. Areas within Closed Area II that would be closed to trawl gear under this alternative are already closed under Alternative 1/No Action.
	8	Negative to slightly negative impacts – probably some positive impacts associated with reducing coverage of habitat and groundfish closure areas, but the trawl fishery overlaps significantly with the large Northern Georges HMA which could have negative impacts.
	9	Overall neutral – probably positive impacts associated with reducing coverage of habitat and groundfish closure areas, but the trawl fishery overlaps with the Western MBTG HMA in this alternative which would displace effort and could have negative impacts. Areas within Closed Area II that would be closed to trawl gear under this alternative are already closed under Alternative 1/No Action.
	10*	Overall neutral – probably positive impacts associated with reducing coverage of habitat and groundfish closure areas, but the trawl fishery overlaps with the Georges Shoal 2 MBTG HMA in this alternative which would displace effort and could have negative impacts. Areas within Closed Area II that would be closed to trawl gear under this alternative are already closed under Alternative 1/No Action.
GSC-SNE	1	Slightly negative to neutral. This alternative restricts trawl and gillnet access to NLCA, but little and winter skate are broadly distributed so this may not be limiting to the fishery.
	2	Neutral to slightly positive – this alternative would generally increase access to fishing areas, although little and winter skate are broadly distributed so current restrictions may not in fact be very limiting to the fishery.
	3	Neutral – these alternatives would remove the NLCA habitat and groundfish areas and create new areas further north and on Cox Ledge. In statistical area 526, observer hauls are concentrated in the south along the edge of the bank. Some trawl effort might be displaced in Area 521, but most of the skate landings in this area are from gillnets, which would not be restricted under these alternatives.
	4*	
	5	
	6	

5.2.2 Spawning management alternatives

In general, the action alternatives will increase access to fishing grounds and make some year-round areas seasonal. This should provide slightly positive impacts to the fishery, although given the ubiquitous distribution of little and winter skate, the No Action closed areas may not be especially limiting to the fishery.

Table 33 – Summary of the impacts of spawning management alternatives on skate stocks. No impacts are expected on rosette skate or clearnose skate. Because skates are only infrequently caught in recreational gear, no difference in impacts expected between options A (recreational fishing restricted from spawning areas) and B (recreational fishing exempted). Preferred alternatives are identified below (*).

Region	Alt	Fishery impacts
GOM	1A*, 1B	Neutral to slightly negative. There are small amounts of skates landed with trawl gear in statistical area 515 overlapping Cashes Ledge, so the no action management areas may limit skate fishing somewhat.

	2A and 2B	Neutral to slightly positive. This alternative would remove the current WGOM and Cashes Ledge groundfish management areas and allow skate fishing with trawl and gillnet gears, but since there are zero possession limits on smooth and thorny skates, such benefits are likely to be limited.
	3*	Neutral
	4*	Neutral
GB	1	Slightly negative to neutral. This alternative restricts trawl and gillnet access to CAI, CAII, and NLCA but little and winter skate are broadly distributed so this may not be limiting to the fishery.
	2A and 2B	Neutral to slightly positive – this alternative would generally increase access to fishing areas, although little and winter skate are broadly distributed so current restrictions may not in fact be very limiting to the fishery.
	3A, 3B*, 3C*	

5.2.3 Dedicated Habitat Research Area alternatives

As noted above, DRHA impacts are relative to the expected benefits of completing research projects.

Table 34 – Summary of the impacts of research alternatives on the skate fishery. Because skates are only infrequently caught in recreational gear, no difference in impacts expected between options A, B, and C in Alternative 3.

Alt	Fishery impacts
1 – No DHRA	Neutral – no DHRAs specifically designated, although there may be management measures in these locations because they have overlapping habitat or spawning management designations.
2 – E Maine	None – there do not appear to be any significant skates or skate landings in this area such that research would provide a benefit to this fishery.
3A, 3B, 3C* – Stellwagen	Positive – there are thorny and smooth skate in this area and research on fish and their ecosystem interactions could help in development of management strategies to rebuild these stocks, especially thorny skate.
4 – Georges Bank*	Slightly positive – little, winter, and barndoor skate occur in this area, and and research on fish and their ecosystem interactions could help in development of management strategies. This is less critical for these stocks as their status is better than for thorny skate.
5 – Sunset provision*	Neutral – if beneficial research is not being conducted, areas would sunset.

5.2.4 Framework and monitoring alternatives

The skate fishery is closely tied to the multispecies fishery, so adjustments to management areas, especially those focused on groundfish, could indirectly affect skate fishing opportunities. Improved data collection and a more explicit process for developing management adjustments would indirectly benefit the skate fishery to the extent that they participate in the management process and benefit from better management that results from improved data collection.

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6 Atlantic sea scallop

These sections describe potential impacts of the alternatives on the scallop resource and fishery. Economic impacts on the scallop fishery are also evaluated as part of the human community impacts sections (Volume 4, Section 4). The Volume 4 analyses are broken out by gear type, but because most revenues in this fishery are generated with scallop dredges, and scallop trawls are not generally used in the locations of the habitat and spawning management areas proposed in this amendment, impacts associated with scallop dredge gear in Volume 4 will reflect impacts to the scallop fishery.

6.1 Impacts on Atlantic sea scallops

The following sections detail considerations relevant to estimating the impacts of the spatial management alternatives in this amendment on the scallop resource. Impacts are summarized in Table 35.

In general, the alternatives are expected to have neutral impacts on the scallop resource. The vast majority of the resource occurs on Georges Bank, in Southern New England, and in the Mid-Atlantic Bight, with fewer scallops and fewer scallop landings in the Gulf of Maine. Potential, localized, effects on the resource in the Gulf of Maine are noted in the table below. On Georges Bank and in Southern New England, impacts are expected to be neutral given the way the fishery is managed. Overall F and F in open areas is capped regardless of shifts in management areas accessible to the fishery, and fishery specifications can be tailored annually to reflect the mix of areas open, closed, or 'permanently' closed (i.e. in habitat closures off limits long term). In addition, while recruitment impacts of area closures have been studied, there is no definitive evidence that suggests area closures are having a substantial effect on recruitment at the scale of the resource.

Exceptions are the seasonal closures of Georges Bank areas due to spawning alternatives 2A/2B and 3A/3B, which would close current and possible future access areas during months when meat weights are low. Because access area trips operate under a fixed possession limit, avoiding fishing during times when meat weights are lower precludes trips during months when a higher number of animals would be required to meet the possession limit. The Georges Bank DHRA will likely facilitate ongoing scallop-related research projects and is therefore expected to have positive impacts on the resource. The Stellwagen and Eastern Maine DHRAs do not overlap substantial concentrations of scallops and therefore neutral impacts are expected.

Table 35 – Summary of the impacts of spatial management alternatives on the sea scallop resource.

Type	Sub-region or region	Alternative	Impacts	Notes
Habitat	EGOM	Alt. 1 (No action)	Neutral	No major effects on scallop resource as a whole.
Habitat	EGOM	Alt. 2 Options 1, 2, 5	Neutral	No major effects on scallop resource as a whole.
Habitat	EGOM	Alt. 2 Options 3 and 4	Neutral	No major effects on scallop resource as a whole.
Habitat	EGOM	Alt. 3 Options 1 and 2	Neutral	No major effects on scallop resource as a whole.
Habitat	EGOM	Alt. 3 Options 3 and 4	Neutral	No major effects on scallop resource as a whole.

Type	Sub-region or region	Alternative	Impacts	Notes
Habitat	EGOM	Sm. Eastern Maine (preferred)	Neutral	No major effects on scallop resource as a whole.
Habitat	CGOM	Alt. 1 (No action)	Neutral	No major effects on scallop resource as a whole.
Habitat	CGOM	Alt. 2 (No area)	Neutral	No major effects on scallop resource as a whole. Possible local negative effects on scallops on Fippennies and Cashes Ledges.
Habitat	CGOM	Alt. 3 Options 1 and 2	Neutral	No major effects on scallop resource as a whole. Possible local positive effects as Platts would close to scalloping relative to No Action status.
Habitat	CGOM	Alt. 3 Options 3 and 4	Neutral	No major effects on scallop resource as a whole. Possible local negative effects on scallops on Fippennies and Cashes Ledges.
Habitat	CGOM	Alt. 4 Options 1 and 2	Neutral	No major effects on scallop resource as a whole. Possible local negative effects on scallops on Fippennies Ledge.
Habitat	CGOM	Alt. 4 Options 3 and 4	Neutral	No major effects on scallop resource as a whole. Possible local negative effects on scallops on Fippennies and Cashes Ledges.
Habitat	CGOM	CL GF, CL HMA, JB HMA, FL HMA, AR HMA (preferred)	Neutral	No major effects on scallop resource as a whole. Cashes and Fippennies would remain closed to scalloping.
Habitat	WGOM	Alt. 1 (No action)		No major effects on scallop resource as a whole.
Habitat	WGOM	Alt. 1 with modified boundary (preferred)	Neutral	No major effects on scallop resource as a whole.
Habitat	WGOM	Alt. 2 (No area)	Neutral	No major effects on scallop resource as a whole. Possible local negative effects on scallops on Jeffreys Ledge.
Habitat	WGOM	Alt. 3 Options 1 and 2	Neutral	No major effects on scallop resource as a whole. Possible local negative effects on scallops on Jeffreys Ledge.
Habitat	WGOM	Alt. 3 Options 3 and 4	Neutral	No major effects on scallop resource as a whole. Possible local negative effects on scallops on Jeffreys Ledge.
Habitat	WGOM	Alt. 4 Options 1 and 2	Neutral	No major effects on scallop resource as a whole.
Habitat	WGOM	Alt. 4 Options 3 and 4	Neutral	No major effects on scallop resource as a whole.
Habitat	WGOM	Alt. 5 Options 1 and 2	Neutral	No major effects on scallop resource as a whole.
Habitat	WGOM	Alt. 5 Options 3 and 4	Neutral	No major effects on scallop resource as a whole.
Habitat	WGOM	Alt. 6 Options 1 and 2	Neutral	No major effects on scallop resource as a whole. Possible local negative effects on scallops on Jeffreys Ledge.
Habitat	WGOM	Alt. 6 Options 3 and 4	Neutral	No major effects on scallop resource as a whole. Possible local negative effects on scallops on Jeffreys Ledge.
Habitat	WGOM	Alt. 7A (preferred)	Neutral	No major effects on scallop resource as a whole.
Habitat	WGOM	Alt. 7B	Neutral	No major effects on scallop resource as a whole.
Habitat	WGOM	Alt. 8 (preferred)	Neutral	No major effects on scallop resource as a whole.
Habitat	GB	Alt. 1 (No action)	Neutral	The FMP will continue to constrain the overall fishing mortality limit (F).
Habitat	GB	Alt. 2 (No area)	Neutral	FMP will limit overall F; no significant effects on recruitment expected due to removal of area closures.
Habitat	GB	Alt. 3 Options 1 and 2	Neutral	FMP will limit overall F; no significant effects on recruitment expected due to removal of area closures.
Habitat	GB	Alt. 3 Options 3 and 4	Neutral	FMP will limit overall F; no significant effects on recruitment expected due to removal of area closures.
Habitat	GB	Alt. 4 Options 1 and 2	Neutral	FMP will limit overall F; no significant effects on recruitment expected due to removal of area closures.
Habitat	GB	Alt. 4 Options 3 and 4	Neutral	FMP will limit overall F; no significant effects on recruitment expected due to removal of area closures.

Type	Sub-region or region	Alternative	Impacts	Notes
Habitat	GB	Alt. 5	Neutral	FMP will limit overall F; no significant effects on recruitment expected due to removal of area closures.
Habitat	GB	Alt. 6A Options 1 and 2	Neutral	FMP will limit overall F; no significant effects on recruitment expected due to removal of area closures.
Habitat	GB	Alt. 6A Options 3 and 4	Neutral	FMP will limit overall F; no significant effects on recruitment expected due to removal of area closures.
Habitat	GB	Alt. 6B Options 1 and 2	Neutral	FMP will limit overall F; no significant effects on recruitment expected due to removal of area closures.
Habitat	GB	Alt. 6B Options 3 and 4	Neutral	FMP will limit overall F; no significant effects on recruitment expected due to removal of area closures.
Habitat	GB	Alt. 7 Options 1 and 2	Neutral	FMP will limit overall F; no significant effects on recruitment expected due to removal of area closures.
Habitat	GB	Alt. 8 Options 1 and 2	Neutral	FMP will limit overall F; no significant effects on recruitment expected due to removal of area closures.
Habitat	GB	Alt. 9 Options 1 and 2	Neutral	FMP will limit overall F; no significant effects on recruitment expected due to removal of area closures.
Habitat	GB	Alt. 10 (preferred)	Neutral	FMP will limit overall F; no significant effects on recruitment expected due to removal of area closures.
Habitat	GSC-SNE	Alt. 1 (No action)	Neutral	FMP will limit overall F; no significant effects on recruitment expected due to removal of area closures.
Habitat	GSC-SNE	Alt. 2 (No area)	Neutral	FMP will limit overall F; no significant effects on recruitment expected due to removal of area closures.
Habitat	GSC-SNE	Alt. 3 Options 1 and 2	Neutral	FMP will limit overall F; no significant effects on recruitment expected due to removal of area closures.
Habitat	GSC-SNE	Alt. 3 Options 3 and 4	Neutral	FMP will limit overall F; no significant effects on recruitment expected due to removal of area closures.
Habitat	GSC-SNE	Alt. 4 Options 1 and 2	Neutral	FMP will limit overall F; no significant effects on recruitment expected due to removal of area closures.
Habitat	GSC-SNE	Alt. 4 Options 3 and 4	Neutral	FMP will limit overall F; no significant effects on recruitment expected due to removal of area closures.
Habitat	GSC-SNE	Alt. 4 with temporary clam dredge exemption (preferred)	Neutral	FMP will limit overall F; no significant effects on recruitment expected due to removal of area closures.
Habitat	GSC-SNE	Alt. 5 Options 1 and 2	Neutral	FMP will limit overall F; no significant effects on recruitment expected due to removal of area closures.
Habitat	GSC-SNE	Alt. 5 Options 3 and 4	Neutral	FMP will limit overall F; no significant effects on recruitment expected due to removal of area closures.
Habitat	GSC-SNE	Alt. 6 Options 1 and 2	Neutral	FMP will limit overall F; no significant effects on recruitment expected due to removal of area closures.
Spawning	GOM	Alt. 1A (Regulatory No Action, preferred)	Neutral	No major effects on scallop resource as a whole.
Spawning	GOM	Alt. 1B (Baseline No Action)	Neutral	No major effects on scallop resource as a whole.
Spawning	GOM	Alt. 2A	Neutral	No major effects on scallop resource as a whole.
Spawning	GOM	Alt. 2B	Neutral	No major effects on scallop resource as a whole.
Spawning	GOM	Alt. 3 (preferred)	Neutral	No major effects on scallop resource as a whole.
Spawning	GOM	Alt. 4 (preferred)	Neutral	No major effects on scallop resource as a whole.
Spawning	GB-SNE	Alt. 1 (No Action)	Neutral	No change in seasonality of access relative to current fishing practices.

Type	Sub-region or region	Alternative	Impacts	Notes
Spawning	GB-SNE	Alt. 2A	Slight positive	Because February 1-April 15 includes several months with lower scallop meat weights, alternative may have moderately positive impacts on the scallop resource and fishery in those areas, and slightly positive impacts on the resource as a whole.
Spawning	GB-SNE	Alt. 2B	Slight positive	Because February 1-April 15 includes several months with lower scallop meat weights, alternative may have moderately positive impacts on the scallop resource and fishery in those areas, and slightly positive impacts on the resource as a whole.
Spawning	GB-SNE	Alt. 2C	Neutral	Scallop dredging exempt so no seasonal restriction during times of low meat weights.
Spawning	GB-SNE	Alt. 3A	Slight positive	Because February 1-April 15 includes several months with lower scallop meat weights, alternative may have moderately positive impacts on the scallop resource and fishery in those areas, and slightly positive impacts on the resource as a whole.
Spawning	GB-SNE	Alt. 3B (preferred)	Slight positive	Because February 1-April 15 includes several months with lower scallop meat weights, alternative may have moderately positive impacts on the scallop resource and fishery in those areas, and slightly positive impacts on the resource as a whole.
Spawning	GB-SNE	Alt. 3C (preferred)	Neutral	Scallop dredging exempt so no seasonal restriction during times of low meat weights.
Research	n/a	Alt. 1 (No Action)	Neutral	No research areas designated
Research	EGOM	Alt. 2	Neutral	Area does not overlap areas of substantial scallop biomass
Research	WGOM	Alt. 3A	Neutral	Area does not overlap areas of substantial scallop biomass
Research	WGOM	Alt. 3B	Neutral	Area does not overlap areas of substantial scallop biomass
Research	WGOM	Alt. 3C (preferred)	Neutral	Area does not overlap areas of substantial scallop biomass
Research	GB	Alt. 4 (preferred)	Positive	Area may support research that benefits management of resource
Research	n/a	Alt. 5 (preferred)	Neutral	Two of three areas do not overlap scallop resource; if Georges Bank DHRA is removed it is because the area is not being actively used for work that might benefit the resource

6.1.1 Eastern, central, and western Gulf of Maine sub-region habitat management alternatives

The potential biological impacts of the Habitat Management Area alternatives in the three Gulf of Maine sub-regions were evaluated using survey and fishery distribution information. Fewer data on scallop distribution are available in these sub-regions as the bulk of the scallop resource is concentrated further south. The federal scallop survey and assessment model do not include the Gulf of Maine, and there is relatively limited resource there relative to Georges Bank and areas further south. The state of Maine has conducted scallop dredge surveys of portions of the federal Northern Gulf of Maine management area that are open to fishing which indicate relatively low scallop biomass levels. A 2009 video survey (Stokesbury et al. 2010) examined offshore bank and ledge features and found scallops on Jeffreys, Fippennies, and Cashes Ledges,

as well as on Platts Bank, but not on Jeffreys Bank. Overall, scallop abundance in the Gulf of Maine is temporally and spatially sporadic.

In general, the Gulf of Maine habitat management alternatives are expected to have neutral impacts on the scallop resource relative to No Action. In the central Gulf of Maine sub-region, action alternatives could remove area closures on Fippennies Ledge (Central Gulf of Maine Alternatives 2 and 4), and Cashes Ledge (Central Gulf of Maine Alternative 2). Both areas contain sea scallops (Stokesbury et al 2010, 2016 Maine DMR surveys) that could be subject to fishing pressure if the areas reopen. Impacts to the resource as a whole would not be expected, but there could be local effects on these populations of scallops. Similarly, in the western Gulf of Maine sub-region, Alternatives 2, 3, and 6 could remove area closures on Jeffreys Ledge, an area which also contains sea scallops (Stokesbury et al 2010). Again, local population effects could result, but impacts to the resource as a whole would not be anticipated since there is a possession limit of 200 pounds for all Limited Access General Category vessels as well as an overall hard quota of 70,000 pounds for the entire Northern Gulf of Maine. Catches from vessels with NGOM permits and vessels with LAGC permits count towards this cap. Limited Access vessels can fish days at sea within the NGOM management area, but there are annual limits on DAS that control effort. Under this system, larger limited access vessels only fish in the Gulf of Maine if catch rates are fairly high, because DAS are very limited and catch rates are typically higher in other areas. Fishing year 2016 has been unusual in terms of much higher activity in the limited access fishery in the western Gulf of Maine, east of Cape Ann, Massachusetts, but previously the 70,000 lb TAC has not proven constraining. Preliminary estimates indicate that nearly 400,000 pounds of scallops were landed from the NGOM in 2016. It is not clear whether this pattern will continue in future years. Overall, the preferred alternatives recommended by the Council for this region are expected to have neutral impacts on the scallop resource because some areas will reopen and some areas will be closed to the scallop fishery. In general, this region has relatively low levels of scallop biomass, so impacts to the resource overall will be minimal.

6.1.2 Georges Bank and Great South Channel/Southern New England sub-region habitat management alternatives

The management areas in the Georges Bank and Great South Channel/Southern New England sub-regions have been dredge surveyed annually for sea scallops by the Northeast Fisheries Science Center since 1979. For most years the survey has been a lined survey dredge, and in more recent years a towed video survey has been added to the federal scallop survey. In addition, since 2003 the University of Massachusetts Dartmouth School for Marine Science and Technology has completed a broadscale video survey of the entire resource area in all years except 2013. Finally, more fine-scale investigations of scallop abundance, distribution, and size frequency are completed in current or potential rotational management areas using video survey, HabCam, and paired commercial/scientific dredge surveys. Given these various sources of data, the distribution and abundance of the scallop resource in these management areas is considered to be well known. Scallop distribution maps are provided in the fishery impacts section below.

As sea scallops are a sedentary species, changing the location of habitat management areas in these sub-regions will influence the fraction of the scallop resource available to the fishery and therefore would influence scallop specifications including rotational management allocations. Despite possible changes in available fishing locations, annual catch limits will remain

constrained by fishing mortality targets. Furthermore, an explicit objective of the rotational management program is to optimize yield by harvesting an area when most of the animals are at a size that is expected to be at or around their maximum yield per individual.

Because the rotational management program is so critical to optimization of yield in the scallop fishery, the Council agreed that areas with significant scallop biomass that are currently off-limits to the scallop fishery should not automatically reopen when this amendment takes effect. Rather, a trailing scallop action should evaluate whether scallop access area boundaries need to be adjusted or if new access areas should be created, and then specifications for the fishery overall would be set in the context of these potential adjustments. Therefore, the direct impacts on the scallop resource in newly opened areas will be more fully considered in a future action that specifies the level of effort that may be allowed. For example, these impacts could range from no impact (if an area remains closed) to higher impacts if an area reverts to an open area under the scallop management plan and vessels use DAS to fish in that area.

In the fishery impacts section, the Scallop Area Management Simulator (SAMS) model is used to evaluate the potential impacts of the No Action alternatives and the preferred alternative (Section 6.2.2.2). This model is used to evaluate annual specifications for the fishery. If the existing habitat closed areas are removed via this amendment, the SAMS model would not simply maintain open area effort as it has been, and add effort into newly opened areas at an uncontrolled level. The FMP would still constrain the overall fishing mortality limit (F) at 0.34, the current fishing mortality rate associated with the Annual Catch Target (ACT), or the fishing mortality rate that has a 25% chance of exceeding than Annual Biological Catch Limit (ABC). Because the overall catch for the fishery would still need to be within these limits, open area DAS would need to be reduced to keep overall F under 0.34.

Thus, some of the trends in the SAMS simulation results, especially the first few years, are an artifact of F_{TARGET} limits used in the Scallop FMP. However, since those limits are how specifications are set in the scallop fishery, these results are more realistic than if effort simply adjusted based on available resource, without consideration for spatial and overall limits. Overall, regardless of whether habitat closure areas are removed in this action or not, the fishery specifications are still controlled by an overall limit on F from all areas, currently set at 0.34. That will not change as a result of this action, so if more areas are open to the fishery that are currently closed, effort levels will be lower in some areas to account for new fishing mortality that used to be zero in the habitat closure areas. In summary, given fishing mortality constraints and the fact that specifications will be reconsidered in their entirety after the habitat amendment takes effect, generally neutral impacts on the scallop resource are anticipated to result from the Georges Bank and Great South Channel/Southern New England habitat management alternatives.

Given possible changes in area closures, a relevant question is whether long-term area closures have potential impacts on recruitment and larval production patterns on Georges Bank. There has been research around the globe on the subject of whether area closures benefit fisheries from spillover of larvae (e.g. Gell and Roberts, 2003; Davies et al, 2015). However, Georges Bank is somewhat unique because it is a mixed larval pool and scallop recruitment on Georges Bank is cyclical. There has been research on transport of scallop larvae on Georges Bank and the

potential benefit of closed areas as population replenishment sources[11]; however, the survival after settlement in open areas is still uncertain and variable. For sessile species like scallops, permanently closed areas can enhance fishery yields only if recruitment outside the closures increases to a level that more than compensates for the loss of yields from within the closures (Hilborn et al., 2004). Some work has been done in this region on the subject of evaluating whether closed areas have contributed to increased biomass and recruitment success, but the results are not black and white.

Hart and Rago (2006) evaluated whether the closures on Georges Bank impacted recruitment on Georges Bank overall. They found that mean recruitment on Georges Bank did increase after the closures, but it was not significant. However, strong recruitment was observed downstream of the Hudson Canyon rotational access area. Their analysis used all federal scallop survey data from 1979 through 2005. During the years after the Georges Bank closures (1994), mean recruitment did not significantly increase; and mean recruitment was similar inside and outside of closed areas suggesting that dredging did not have a significant effect on settlement success; i.e., the area effect was not significant. However, in more recent years (after 2005) there have been very high recruitment levels on Georges Bank, especially in 2014 and 2015. It is possible that with more data points the increase in mean recruitment on Georges Bank may now be significant, but the analyses done for the 2006 paper have not been updated.

A modeling study by Hart (2006) focused on whether marine reserves increase fishery yields, specifically highly productive and fecund sea scallops on Georges Bank versus canary rockfish, a long-lived, low productivity species prone to recruitment overfishing. Models were developed to identify yield as a function of fishing mortality and closure fraction for the two species. The results suggest that closed areas can increase overall yield, but only when spawning stock biomass is low, fishing mortalities are greater than F_{MSY}, and with low closure fractions. Currently on Georges Bank, the spawning stock biomass of scallops is relatively high and fishing mortality is below F_{MSY}; therefore, the potential benefits of area closures to increase total scallop yield may be limited. Above a certain point, additional biomass may not contribute additional recruitment success. As noted above, Georges Bank in particular is a mixed larval pool increasing movement of larvae around the Bank, which could lead to saturation at lower biomass levels.

Hart et al. 2013 concluded that there is no evidence that recruitment of sea scallops increased outside of closed areas from 1994-2006, despite large increases in biomass within the closures.

[11] The Scallop PDT reviewed several papers on scallop larval transport (Davies et al 2015, Davies et al 2014, Gilbert et al 2010, Tian et al 2009). There are three main scallop aggregations on GB: northeast peak (NEP), southern flank (SF), and Great South Channel (GSC). The NEP contains the highest abundance of adult scallops and acts as a significant larval source for other aggregations. The GSC is the most retentive, and the NEP and SF are not retentive and rely on larvae from other aggregations. Dispersal and connectivity are driven by physical processes such as tidal mixing, along shelf currents, and wind; as well as biological processes such as growth, mortality and behavior (Tremblay et al 1994, Tian et al 2009, and Gilbert 2010). There can be great variation in all of these parameters. Davies et al 2015 concluded that the closed areas on Georges Bank have increased the overall abundance and decreased the spatial variability of larvae produced in both Canadian and US waters, and model simulations indicate that the increases were sufficient to affect larval settlement on the bank. However, it is still not clear whether these increases in larval production translate into increased recruitment to the fishery.

While recruitment on Georges Bank has improved recently, it is still unclear whether the more recent increase in recruitment on Georges Bank is due to closures, effort reductions, or random fluctuations, or some combination of these. Therefore it is possible that area closures are having a positive impact on recruitment, but it has yet to be proven.

Another issue that comes into play when evaluating the potential benefits of closed areas and recruitment success is density dependence. It is possible that biomass in open areas may contribute less in terms of fertilization success because animals are more spread out. Scallops are typically more concentrated in closed areas; therefore, if recruitment success is density dependent for sea scallops, closed areas could increase overall yield by improving recruitment success (Smith and Rago, 2004).

Smith and Rago (2004) considered spatial aspects of growth and reproduction for development of reference points for sea scallops. The paper explains that the renewal process, or relationship between stock size and recruitment, involves poorly understood aspects of reproductive biology and difficult to quantify processes governing successful fertilization and survival. There probably is some linkage, but it was not certain in 2004, and it is still not certain today. In addition, there are numerous environmental effects as well, and large year classes may be driven more by favorable environmental effects than population size. The paper also points out that closures cannot increase yield from increased egg production from closures if the magnitude of fishing effort in the remaining open areas increases. If closures cause effort to displace and increase in open areas, gains in yield can be compromised. Overall, the research suggests that concentrating effort in lower productivity areas may be an effective way to reduce recruitment variability, improve yield, and ensure that the reproductive capacity of the resource remains high. There are signals that recruitment patterns on Georges Bank are more likely driven primarily by natural cycles, and not by closed areas. There has also been extensive research about correlations between mass spawning events and environmental variables such as temperature increases or phytoplankton blooms. Bonardelli et al. (1996) studied the correlation of spawning and temperature for sea scallops and found strong correlation with either a sharp temperature increase or strong temperature fluctuations. Another study in the Gulf of St. Lawrence, Canada concluded that phytoplankton blooms appear to be associated with spawning events (Arsenault and Himmelman, 1998).

Questions have been raised as to whether long-term closures may have potentially **positive** impacts on the resource because they contain large proportions of total scallop larvae. The PDT agrees that the existing habitat closures, “Closed Area I Non-Access”, “Nantucket Lightship Non-Access”, and especially “Closed Area II Non-Access”, contain a relatively large proportion of total scallop spawning stock biomass. For example, using 2014 biomass estimates in Scallop Framework 26, the habitat closed areas were estimated to contain about 15% of total biomass and 20% of exploitable biomass. Given the large biomass of spawning stock is closures, it is reasonable to conclude that a relatively large proportion of scallop larvae are generated within the closures. This may be having positive impacts on the resource overall if recruitment has increased as a result of the closures, however, the impacts of long-term closed areas on increased recruitment overall are still uncertain. In conclusion, the impacts of closed areas on increased spawning success and scallop yield are currently uncertain. Because cycles in recruitment have been observed before areas were closed on Georges Bank, and similar cycles have continued

after closures, the Scallop Plan Development Team does not believe that changes to habitat closures on Georges Bank would have a large impact on recruitment. The sense is that Georges Bank is a mixed pool and the larvae production in that area is rather saturated.

In other areas, including the Mid-Atlantic, that is not the case because that sub-region is not a mixed larval pool. If there is no spawning advantage from scallops in high density closed areas, then there is a net loss in yield from long-term closures. But if there are areas that increase fertilization success and contribute to increased recruitment overall in open areas, then closures of these areas may be beneficial and increase overall scallop yield. In conclusion, closed areas may help prevent overfishing as part of an overall management system, but there does not seem to be strong evidence to date that they directly increase scallop recruitment success on Georges Bank. With a greater understanding of these important linkages it is possible, and potentially a very good idea, for the Council to consider specific closures to increase scallop recruitment in a future scallop action. While some of the current and/or proposed habitat closures may have beneficial impacts on scallop biomass and recruitment, it should be noted that increased scallop yield is not the primary goal of the Omnibus Habitat Amendment. Measures to increase scallop recruitment and yield could be considered in a separate action to the Scallop FMP.

Finally, relative to impacts on the scallop resource, questions have been raised as to whether large scallops impact settlement and growth of smaller scallops. There is no evidence that removing larger scallops has positive effects on smaller scallops. In fact, scallop larvae need hard substrate to attach to for settlement success. If there is limited hard substrate in sandy areas for example, larvae can attach to larger scallops instead. This has been documented in video surveys on Georges Bank. Larger scallops also produce more larvae than smaller scallops, and if scallops are density dependent, there may be beneficial impacts on spawning success if scallops are more concentrated and closer together (MacDonald and Thomspon, 1985)

There is no evidence that crowding impacts growth. The NEFSC has a large database of aged scallops; growth is calculated by measuring the distance between rings on the shell. If growth was impacted negatively by crowding in closed areas, the distance between rings would be smaller than in open areas. But the opposite was found, growth is faster in closed areas and higher density portions of closed areas do not grow slower than less dense portions of closed areas (Hart and Chute, 2009).

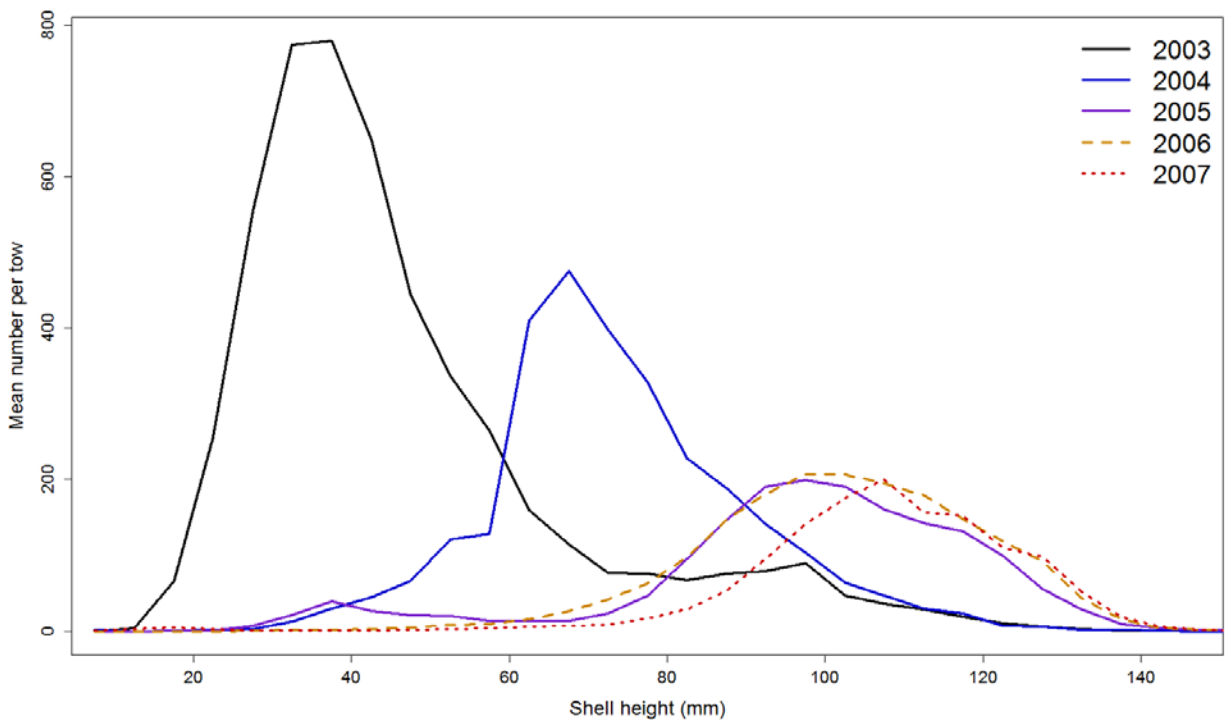
As for food, small scallops eat smaller sized phytoplankton; larger scallops are filtering out larger food in the water column. Overall, scallops are not found in very high densities; one scallop per square meter is considered dense. The most concentrated areas like the Northern Edge Juvenile Cod HAPC has densities of about one scallop per square meter on average, with more dense patches throughout. Even at those relatively high densities, scallops are not removing large portions of food from the water column. Therefore, growth is not food limited, even in high density areas.

One issue that does seem to be density dependent is mortality from predators. When scallops are concentrated, mortality from predators is increased, especially when scallops are small. There have been seeding experiments in Canada that evaluated mortality at different density levels, and mortality was higher for juvenile scallops in higher densities (Barbeau et al, 1996). In 2003, there

was a very large year class of scallops in the Elephant Trunk Access Area in the Mid-Atlantic. The area was closed to fishing in 2004 and based on surveys conducted in the area each year, it was evident that natural mortality of juvenile scallops was very high (Figure 9). After the scallops reached larger sizes the mortality reduced, and fishing was allowed in the area in 2007.

Scallops will eventually die in long-term closures because they are relatively sessile and will not move large distances into areas where they might be subject to fishing mortality, especially as they age. If increasing scallop yield was the only goal of fisheries management in the Northeast, then large long-term closures may not be the ideal tool. However, there are other goals of closures in this region and those need to be weighed against changes in scallop yield. There may be some benefits to the scallop resource from area closures if total recruitment increases, but there are costs as well from the yield lost within the closed area(s).

Figure 9 – Shell heights of scallops observed in Elephant Trunk Access Area in 2003-2007



6.1.3 Spawning management alternatives

As with the Gulf of Maine habitat management alternatives, the areas included in the Gulf of Maine spawning management alternatives have little overlap with the scallop resource. Alternative 2 would remove the Western Gulf of Maine and Cashes Ledge groundfish closures, which could allow fishing on scallops living within those areas, unless prevented by one of the habitat management alternatives. Locally, removing these two groundfish closures could impact scallop populations, but the effects on the resource as a whole would not be expected because this is not an area with major concentrations of scallop biomass and there are measures in place

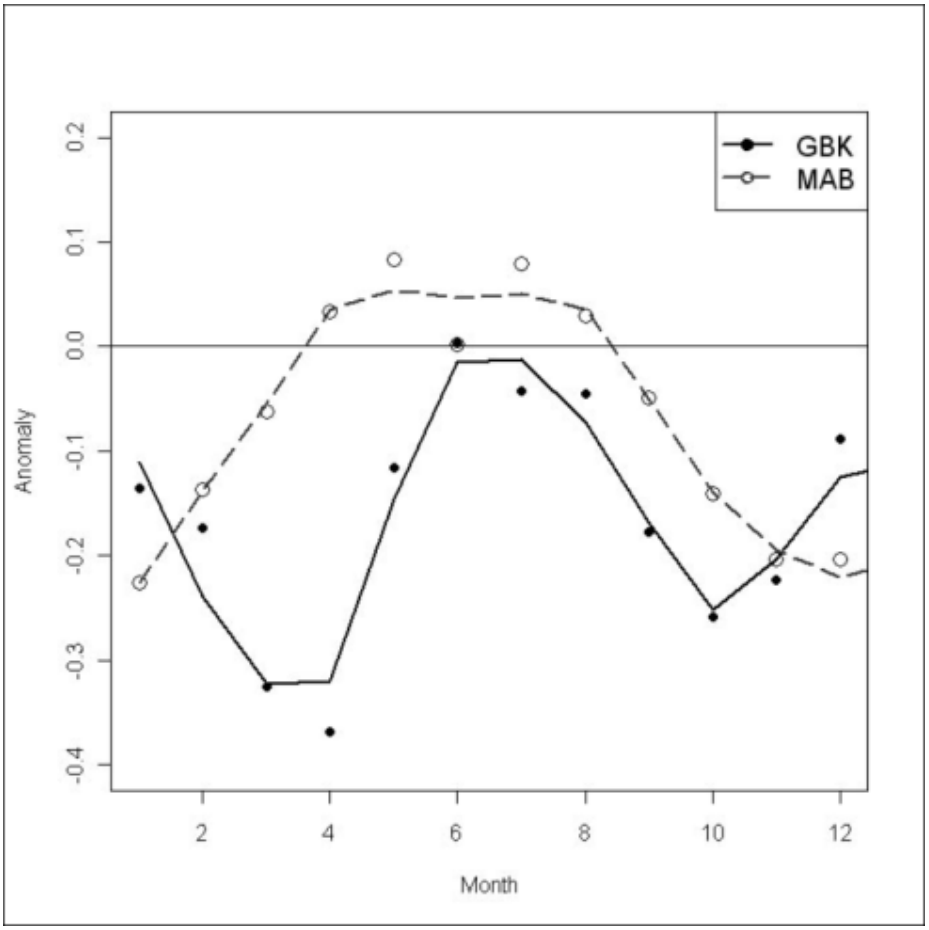
to control overall effort. The hard TAC for the NGOM management area may be more likely to be reached if areas are opened that have harvestable scallops, but the TAC would help prevent excess fishing levels since all vessels with a federal scallop permit would be prohibited from fishing in the entire NGOM management area if the TAC is reached.

In the Georges Bank and Southern New England region, the action alternatives (Alternatives 2 and 3) would eliminate the Nantucket Lightship Groundfish Closure Area and make Closed Areas I and II seasonal, closed February 1 through April 15. The primary source of information used to assess the potential biological impacts to the scallop resource of a seasonal closure to improve groundfish spawning protection is seasonal changes in scallop meat weights. Over the course of a year, the scallop meat weights increase and decrease based on spawning and other factors. If a seasonal closure is implemented during a time of year when meat weights are higher, there could be negative impacts on the resource, but if the seasonal closure is implemented when meat weights are lower, there could be positive impacts. An exemption for scallop dredges under Georges Bank Spawning Alternatives 2C and 3C would eliminate these benefits.

Hennen and Hart (2012) summarized monthly shell height/meat weight data from observed trips, and modeled meat weight by month and region (Georges Bank or the Mid-Atlantic Bight). Those estimates were compared to the month with the highest average meat weights on Georges Bank, June, to calculate a monthly meat weight anomaly (Figure 10). Smaller anomalies indicate months during which yields would be higher (positive resource impacts), and a negative anomalies indicate months of relatively lower yield (negative resource impacts). On Georges Bank, May through September and December/January have smaller anomalies, and February through April and October/November have larger anomalies.

Specifically, the month with the highest meat weights on Georges Bank is typically June, and the lowest is October. The average meat weights are about 20% greater in June than in October. There seems to be a bimodal pattern on Georges Bank for meat weights, with peaks in December and June, and lower meat weights in April and October (Hennen and Hart, 2012). One source of uncertainty with these data is that the number of observed trips is very low on Georges Bank for the months under consideration for the spawning closure (February-April). Most fishing activity on Georges Bank during those months is in the Great South Channel, not Closed Areas I and II. The access areas on Georges Bank were closed from February 1-June14 for most of the years in this data set. Therefore, there are fewer data for these months as compared to the months with higher fishing levels and when Closed Areas I and II were open (June 15-January 31).

Figure 10 – Scallop shell height: meat weight anomaly for GB and MA (Hennen and Hart, 2012)



In addition, a Research Set-Aside project-has been evaluating the seasonal changes in bycatch rates in the scallop fishery in both Closed Area I and II for over two years. Shell height/meat weight samples were collected during monthly cruises. Data have been collected during most months since March 2011. In the first year of this study (2011) about 3,000 scallops were measured, and when all available data are combined for March 2011 through September 2013 almost 9,000 scallops have been measured to date. The meat weight model includes the following fixed effects: shell height, area (Eastern Georges Bank, Western Georges Bank), month, and an interaction between month and area. Non-parametric smoothers were used to display annual and inter-annual trends in the relationship for the two areas analyzed and interpolate across any missing months.

Figure 11 and Figure 12 display trends for the two areas together as well as each area separately with the proposed temporal closures specific to each resource area. Results graphically depict the relative position of temporal closures with respect to observed patterns in meat weight maxima and minima. Overall, it seems that Closed Area I has higher meat weights than Closed Area II, at least for the first year of the study. This could be related to depth differences between the stations since scallops have different growth rates at different depths. But for these analyses depth was not considered separately. In general, the spawning closure season of February 1-April 15 seems to overlap when scallops on Georges Bank are ascending to their max weight in June/July.

It is important to keep in mind that this data set is only 2.5 years long. The spring cycle of scallop growth does vary from year to year based on a variety of factors, so the monthly meat weight variation may not match up precisely with the observer data analyses in Figure 10, which is from a larger area (all of Georges Bank) and longer time series.

Figure 11 – Model generated estimate of meat weights for scallops larger than 125mm for Eastern and Western GB (based on scallops measured in monthy bycatch survey)

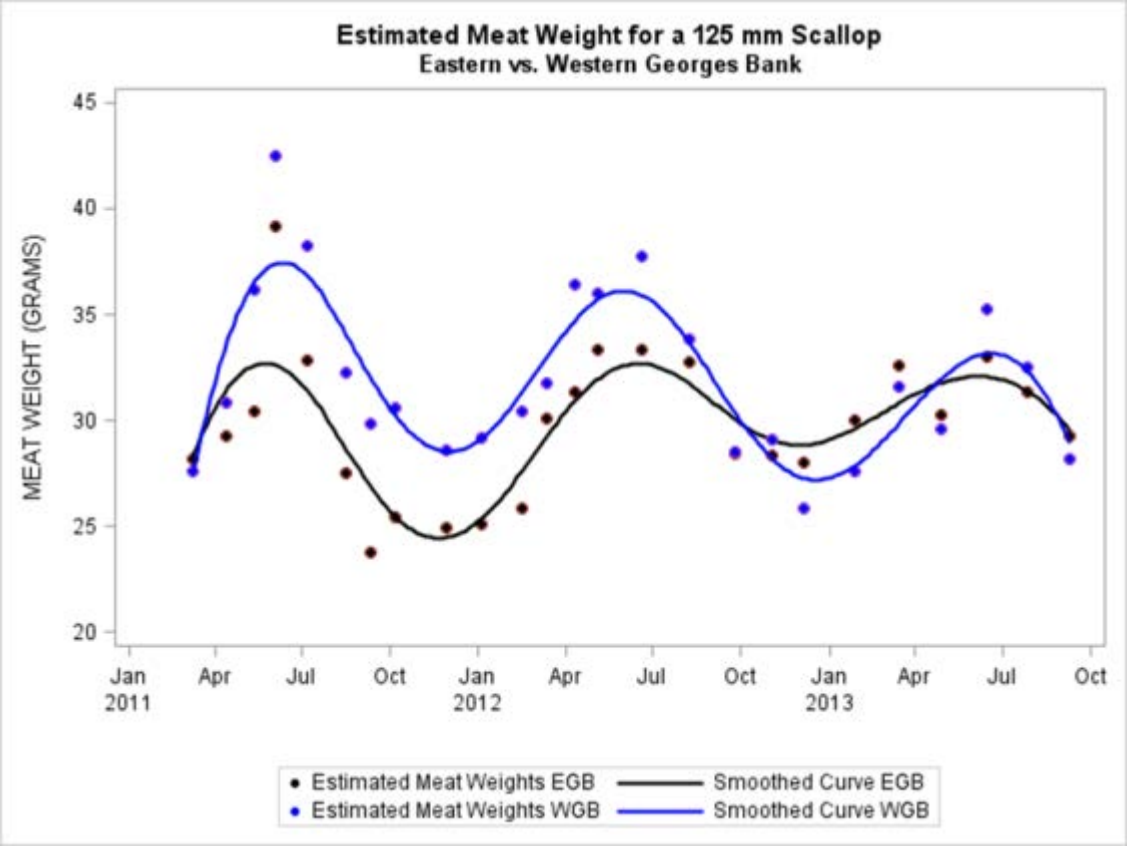
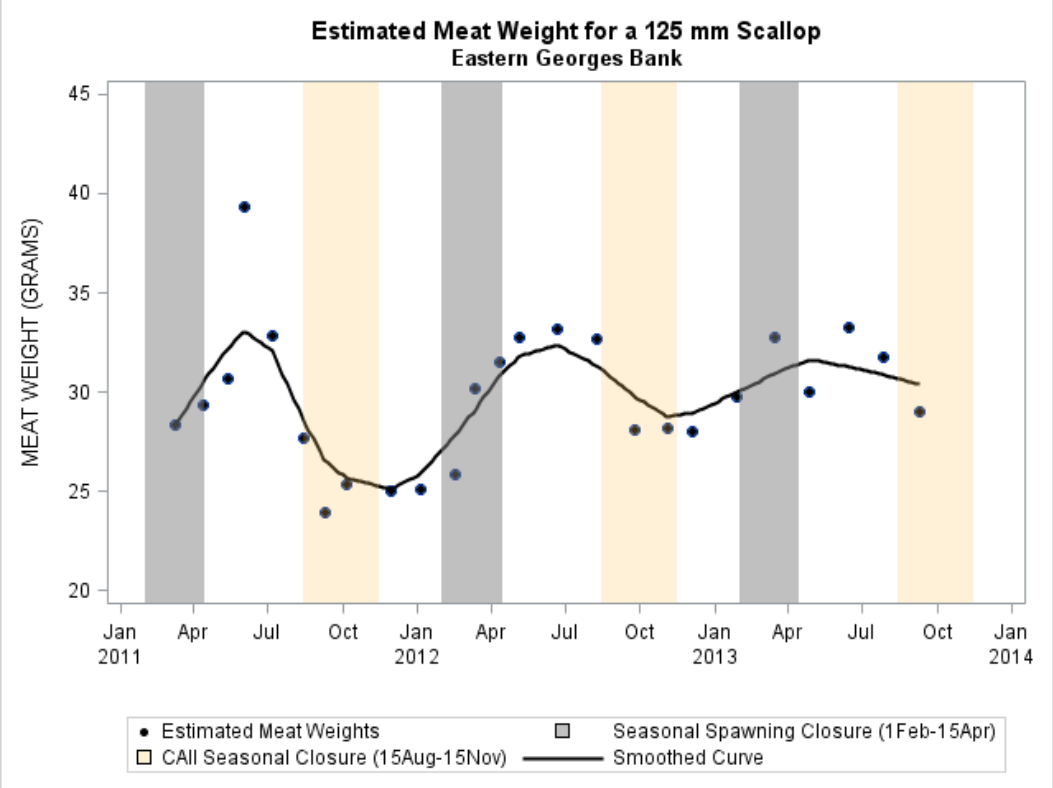
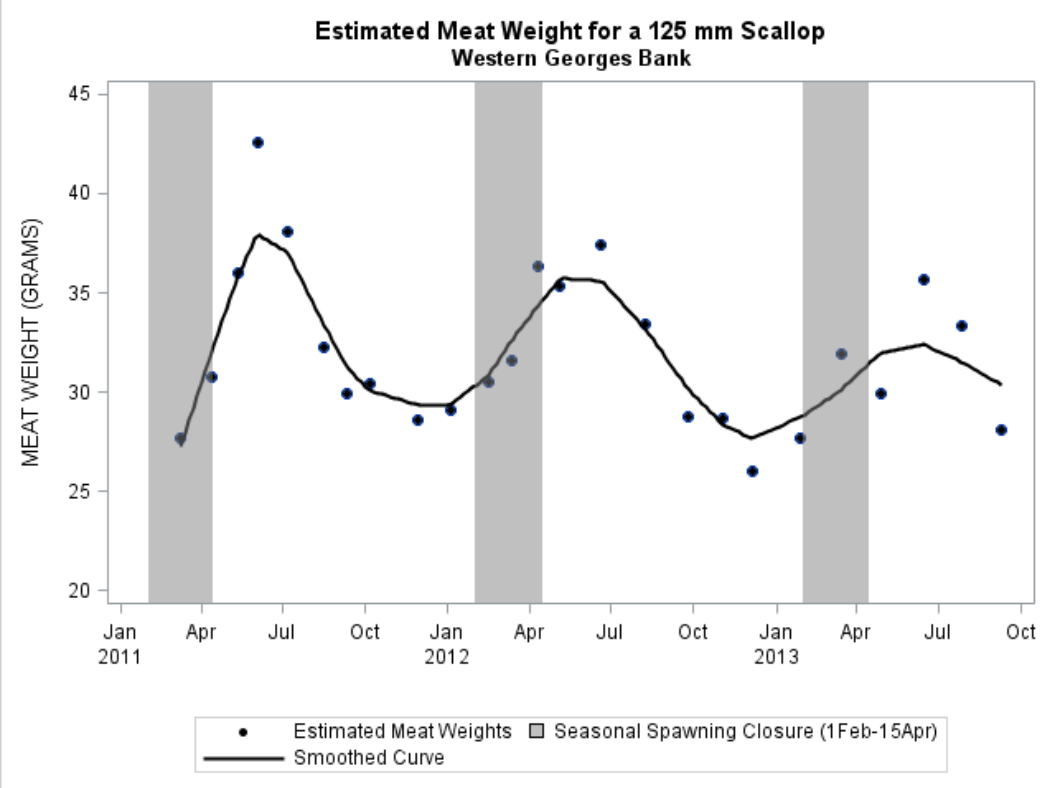


Figure 12 – Model generated estimates of meat weights for scallops larger than 125mm for Eastern (top) and Western GB (bottom) with potential seasonal closures included. Grey is spawning closure under consideration and yellow is in effect already for CAII to reduce yellowtail bycatch.





In general, the overall impacts of seasonal closures are difficult to assess because vessels shift effort differently as a result of a seasonal closure. The closed season will dictate when fishing will not occur in that area, but it could impact fishing patterns in other areas, i.e. open area fishing. Therefore, while a seasonal closure could benefit the scallop resource in that particular area, it could cause effort patterns in other areas to change by season, impacting overall scallop mortality. In this region, there are three options for managing the spawning closures. Options A and B would include restrictions on scallop dredge gear, while Option C would exempt scallop dredge gears from spawning closures. Option C could be selected in addition to Option A or B. The impacts described below assume Option C is not selected.

Because there is a possession limit (maximum number of pounds per trip) for access area trips, the greater the meat weight per animal, the fewer scallops will be harvested. This reduces fishing time compared to fishing when scallop meats weights are lower. Fishing during times of higher meat weights translates into less potential bycatch and lower scallop fishing mortality compared to months with lower scallop meat weights in the fall and winter. Because the season under consideration, February 1 to April 15, includes several months with lower scallop meat weights, Georges Bank Spawning Alternatives 2 and 3 may have moderately positive impacts on the scallop resource and fishery in those areas, and slightly positive impacts on the resource as a whole. In particular, the months of February and March are lower meat weight months, so preventing scallop effort in access areas during these months would potentially shift effort to months with higher meat weights. April is not as clear; meat weights are approaching higher levels in April based on the RSA monthly bycatch data.

Note that Georges Bank Spawning Alternative 3 only includes the northern part of Closed Area I, so fishing in the southern part of the area would be unrestricted during those months. Therefore, fewer positive impacts would be expected from Alternative 3 than Alternative 2. However, overall there is very little scallop biomass in the southern part of Closed Area I, so any potential positive impact from restricting access in lower meat weight months would have very little overall effect in that area since scallop fishing levels would likely be minimal to start with.

The Council's preferred alternative, Spawning Alternative 3, exempts scallop dredging from the spawning closures in Closed Area I and Closed Area II. Given this exemption, neutral impacts on the scallop resource are expected.

6.1.4 Dedicated Habitat Research Area Alternatives

The potential impacts of alternatives to designate Dedicated Habitat Research Areas (DHRAs) on the scallop resource are expected to be neutral. The potential impacts on the fishery are assessed in Section 6.2.4, based on the current or potential level of fishing activity in each dedicated habitat research area alternative.

In general, the dedicated habitat research areas are not expected to have major impacts on the scallop resource or fishery because none of the proposed areas overlap major concentrations of scallop biomass. To the extent this designation would help support research that has beneficial impacts on the scallop resource or fishery, Alternative 4 could have a positive impact. The sunset provision is expected to have a neutral impact; two of the three DHRAs do not overlap areas where scallops are concentrated, and if the Georges Bank DHRA sunsets, it is because the area is

no longer being used for research projects that could benefit the fishery, such that its removal would have neutral effects.

6.2 Impacts on the sea scallop fishery

The following sections detail considerations relevant to estimating the impacts of the spatial management alternatives in this amendment on the scallop fishery. Overall, impacts to the scallop fishery are mixed (Table 36), and depend on the extent of overlap between the management areas and the scallop resource, as well as whether the gear restrictions associated with the alternatives would affect the scallop fishery.

Table 36 – Summary of impacts of the spatial management alterantives on the scallop fishery

Type	Sub-region or region	Alternative	Impacts	Notes
Habitat	EGOM	Alt. 1 (No action)	Neutral	Overlap between eastern GOM areas and scallop fishery is limited
Habitat	EGOM	Alt. 2 Options 1, 2, 5	Neutral	Overlap between eastern GOM areas and scallop fishery is limited
Habitat	EGOM	Alt. 2 Options 3 and 4	Neutral	Overlap between eastern GOM areas and scallop fishery is limited
Habitat	EGOM	Alt. 3 Options 1 and 2	Neutral	Overlap between eastern GOM areas and scallop fishery is limited
Habitat	EGOM	Alt. 3 Options 3 and 4	Neutral	Overlap between eastern GOM areas and scallop fishery is limited
Habitat	EGOM	Sm. Eastern Maine (preferred)	Neutral	Overlap between eastern GOM areas and scallop fishery is limited
Habitat	CGOM	Alt. 1 (No action)	Neutral	No change in existing access to resource.
Habitat	CGOM	Alt. 2 (No area)	Slight positive	Positive impacts on LAGC fishery via access to Cashes and Fippennies
Habitat	CGOM	Alt. 3 Options 1 and 2	Slight negative	Negative impacts on LAGC fishery via closure of Platts Bank
Habitat	CGOM	Alt. 3 Options 3 and 4	Slight positive	Positive impacts on LAGC fishery via access to Cashes and Fippennies
Habitat	CGOM	Alt. 4 Options 1 and 2	Slight positive	Positive impacts on LAGC fishery via access to Fippennies
Habitat	CGOM	Alt. 4 Options 3 and 4	Slight positive	Positive impacts on LAGC fishery via access to Cashes and Fippennies
Habitat	CGOM	CL GF, CL HMA, JB HMA, FL HMA, AR HMA (preferred)	Neutral	No change in existing access.
Habitat	WGOM	Alt. 1 (No action)	Neutral	No change in existing access.
Habitat	WGOM	Alt. 1 with modified boundary (preferred)	Neutral	No change in existing access.
Habitat	WGOM	Alt. 2 (No area)	Slight positive	Positive impacts on LAGC fishery via access to Jeffreys Bank
Habitat	WGOM	Alt. 3 Options 1 and 2	Slight positive	Positive impacts on LAGC fishery via access to Jeffreys Bank
Habitat	WGOM	Alt. 3 Options 3 and 4	Slight positive	Positive impacts on LAGC fishery via access to Jeffreys Bank
Habitat	WGOM	Alt. 4 Options 1 and 2	Neutral	No change in existing access.
Habitat	WGOM	Alt. 4 Options 3 and 4	Slight positive	Positive impacts on LAGC fishery via access to Jeffreys Bank

Type	Sub-region or region	Alternative	Impacts	Notes
Habitat	WGOM	Alt. 5 Options 1 and 2	Neutral	No change in existing access.
Habitat	WGOM	Alt. 5 Options 3 and 4	Slight positive	Positive impacts on LAGC fishery via access to Jeffreys Bank
Habitat	WGOM	Alt. 6 Options 1 and 2	Slight positive	Positive impacts on LAGC fishery via access to Jeffreys Bank
Habitat	WGOM	Alt. 6 Options 3 and 4	Slight positive	Positive impacts on LAGC fishery via access to Jeffreys Bank
Habitat	WGOM	Alt. 7A (preferred)	Neutral	No change in existing access.
Habitat	WGOM	Alt. 7B	Neutral	No change in existing access.
Habitat	WGOM	Alt. 8 (preferred)	Neutral	No change in existing access.
Habitat	GB	Alt. 1 (No action)	Moderately negative	Significant long term yield within area closures
Habitat	GB	Alt. 2 (No area)	Moderately positive	No significant long term yield within areas closed to scallop dredges
Habitat	GB	Alt. 3 Options 1 and 2	Moderately to slightly negative	Significant long term yield within area closures
Habitat	GB	Alt. 3 Options 3 and 4	Moderately positive	No significant long term yield within areas closed to scallop dredges
Habitat	GB	Alt. 4 Options 1 and 2	Moderately to slightly negative	Some long term yield within area closures; but reduced vs. No Action
Habitat	GB	Alt. 4 Options 3 and 4	Moderately positive	No significant long term yield within areas closed to scallop dredges
Habitat	GB	Alt. 5	Moderately positive	No significant long term yield within areas closed to scallop dredges
Habitat	GB	Alt. 6A Options 1 and 2	Moderately negative	Significant long term yield within area closures; similar amount compared to No Action
Habitat	GB	Alt. 6A Options 3 and 4	Moderately positive	No significant long term yield within areas closed to scallop dredges
Habitat	GB	Alt. 6B Options 1 and 2	Slightly negative	Some long term yield within area closures; but amount reduced vs. No Action
Habitat	GB	Alt. 6B Options 3 and 4	Moderately positive	No significant long term yield within areas closed to scallop dredges
Habitat	GB	Alt. 7 Options 1 and 2	Moderately positive	No significant long term yield within areas closed to scallop dredges
Habitat	GB	Alt. 8 Options 1 and 2	Moderately to highly negative	Significant long term yield within area closures; more yield than any other alternative considered on Georges Bank
Habitat	GB	Alt. 9 Options 1 and 2	Moderately positive	No significant long term yield within areas closed to scallop dredges
Habitat	GB	Alt. 10 (preferred)	Moderately positive	No significant long term yield within areas closed to scallop dredges
Habitat	GSC-SNE	Alt. 1 (No action)	Slightly negative	Some long term yield in existing habitat closure that would remain off limits to fishery
Habitat	GSC-SNE	Alt. 2 (No area)	Slightly positive	Long term yield in existing habitat closure would be accessible to fishery
Habitat	GSC-SNE	Alt. 3 Options 1 and 2	Moderately to highly negative	Significant long term yield within area closures; more yield than any other alternative considered
Habitat	GSC-SNE	Alt. 3 Options 3 and 4	Slightly positive	Long term yield in existing habitat closure would be accessible to fishery
Habitat	GSC-SNE	Alt. 4 Options 1 and 2	Slightly	Long term yield in existing habitat closure would be

Type	Sub-region or region	Alternative	Impacts	Notes
			positive	accessible to fishery
Habitat	GSC-SNE	Alt. 4 Options 3 and 4	Slightly positive	Long term yield in existing habitat closure would be accessible to fishery
Habitat	GSC-SNE	Alt. 4 with temporary clam dredge exemption (preferred)	Slightly	Long term yield in existing habitat closure would be accessible to fishery
Habitat	GSC-SNE	Alt. 5 Options 1 and 2	Slightly positive	Long term yield in existing habitat closure would be accessible to fishery
Habitat	GSC-SNE	Alt. 5 Options 3 and 4	Slightly positive	Long term yield in existing habitat closure would be accessible to fishery
Habitat	GSC-SNE	Alt. 6 Options 1 and 2	Slightly positive	Long term yield in existing habitat closure would be accessible to fishery
Spawning	GOM	Alt. 1A (Regulatory No Action, preferred)	Slightly negative to neutral	Minor distributional effects on fishery, areas have relatively low scallop biomass and fishing effort
Spawning	GOM	Alt. 1B (Baseline No Action)	Slightly negative to neutral	Minor distributional effects on fishery, areas have relatively low scallop biomass and fishing effort
Spawning	GOM	Alt. 2A	Neutral to slightly positive	Would provide access to relatively small amount of scallops in existing year round closures, depending on habitat alternative selected
Spawning	GOM	Alt. 2B	Neutral to slightly positive	Would provide access to relatively small amount of scallops in existing year round closures, depending on habitat alternative selected
Spawning	GOM	Alt. 3 (preferred)	Slightly negative to neutral	Minor distributional effects on fishery, areas have relatively low scallop biomass and fishing effort
Spawning	GOM	Alt. 4 (preferred)	Neutral	Gear restrictions would not affect scallop fishery
Spawning	GB-SNE	Alt. 1 (No Action)	Neutral	Fishery already has access to year round groundfish closures via rotational access program
Spawning	GB-SNE	Alt. 2A	Slightly positive	Timing of spawning closures would generate slight positive impacts on resource via increased meat yield, and therefore have slight positive impacts on the fishery
Spawning	GB-SNE	Alt. 2B	Slightly positive	Timing of spawning closures would generate slight positive impacts on resource via increased meat yield, and therefore have slight positive impacts on the fishery
Spawning	GB-SNE	Alt. 2C	Neutral	No effect on seasonality of fishery access to rotational closures vs. No Action
Spawning	GB-SNE	Alt. 3A	Slightly positive	Timing of spawning closures would generate slight positive impacts on resource via increased meat yield, and therefore have slight positive impacts on the fishery
Spawning	GB-SNE	Alt. 3B (preferred)	Slightly positive	Timing of spawning closures would generate slight positive impacts on resource via increased meat yield, and therefore have slight positive impacts on the fishery
Spawning	GB-SNE	Alt. 3C (preferred)	Neutral	No effect on seasonality of fishery access to rotational closures vs. No Action
Research	n/a	Alt. 1 (No Action)	Slightly negative	Lost opportunity to designate areas that would improve habitat management, but impacts would be slight overall relative to scallop fishery given that only one of the three DHRAs has any meaningful overlap with the scallop resource and fishery
Research	EGOM	Alt. 2	Neutral	Limited scallop biomass/fishery in or around DHRA
Research	WGOM	Alt. 3A	Neutral	Limited scallop biomass/fishery in or around DHRA

Type	Sub-region or region	Alternative	Impacts	Notes
Research	WGOM	Alt. 3B	Neutral	Limited scallop biomass/fishery in or around DHRA
Research	WGOM	Alt. 3C (preferred)	Neutral	Limited scallop biomass/fishery in or around DHRA
Research	GB	Alt. 4 (preferred)	Positive	DHRA could generate research that would have positive effects on management of fishery
Research	n/a	Alt. 5 (preferred)	Neutral	If area is being removed via sunset provision, beneficial research is no longer occurring

6.2.1 Eastern, central, and western Gulf of Maine sub-regions habitat management alternatives

The scallop resource in the Gulf of Maine varies widely with sporadic booms and busts. The qualification period adopted under Scallop Amendment 11 for the limited access general category (LAGC) IFQ fishery did not overlap with a period of high scallop abundance in the GOM (FY2000-2004). Therefore, a separate limited entry program was adopted in Amendment 11 with a longer qualification period and no landings history requirement, but more conservative fishing measures including lower possession limits and more restrictive gear requirements. The LAGC Northern Gulf of Maine (NGOM) permit was established and about 125 permits were issued in 2010.

Only a fraction of these permits are active, under 15 vessels, and until more recently total NGOM catches were below 10,000 pounds most years, or 10-15% of the total TAC of 70,000 pounds (Table 37). Landings are now over 40,000 pounds per year (2013 and 2014), and are expected to be at least that much in 2015 as well. Combining LAGC IFQ and LAGC NGOM, catch appears to have slightly exceeded the TAC in 2015, although estimates remain preliminary. As noted above, 2016 catches from the NGOM have been anomalously high, approaching 400,000 pounds in the first three months of the fishing year. More vessels, including some limited access vessels, fished in the area as a result of improved catch rates. While the Council is pursuing efforts to limit shell stocking, overall NGOM catches for 2016 are likely to be much higher than in previous years, and it is unclear if these patterns will continue.

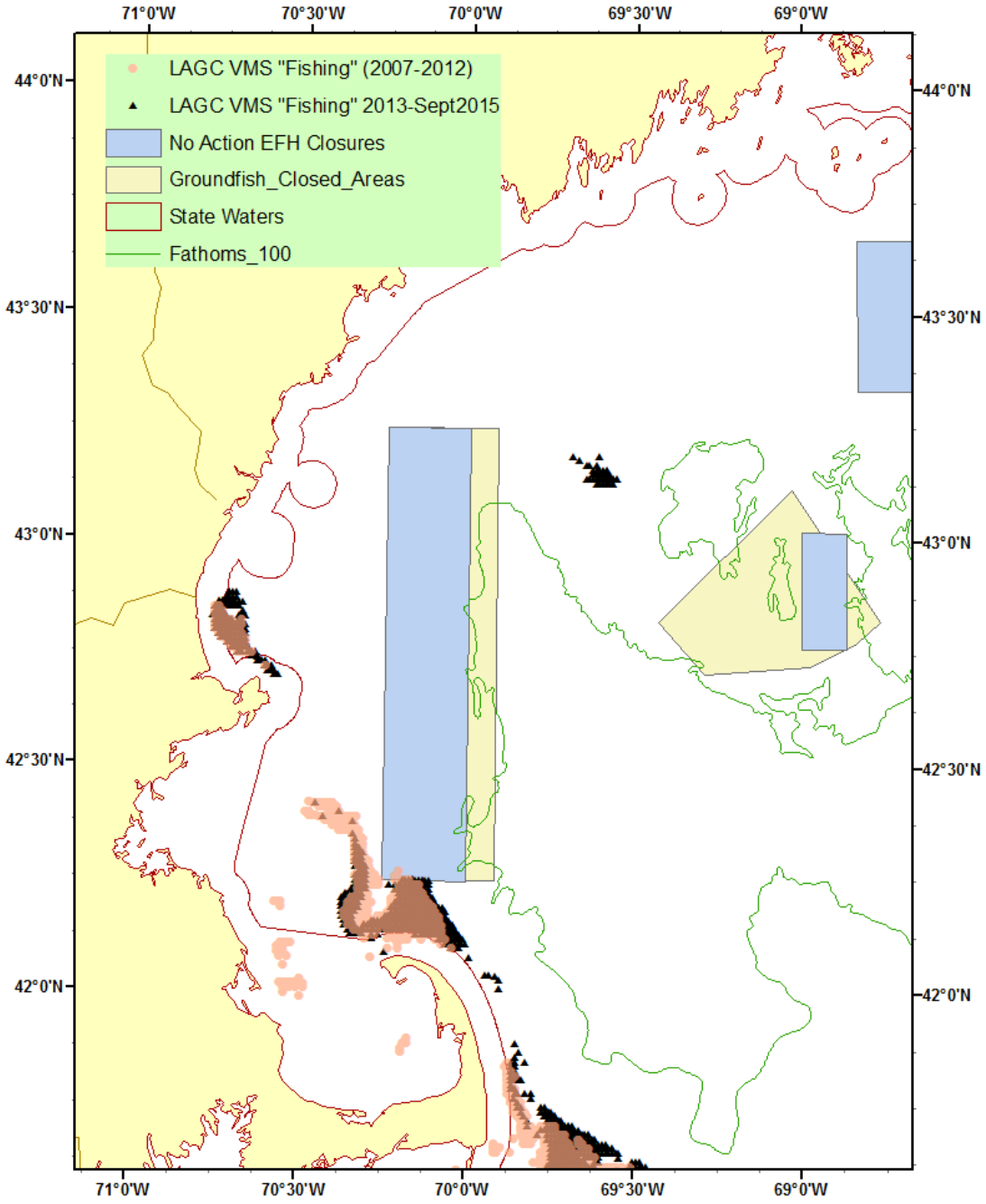
Table 37 – Summary of NGOM scallop catch by permit category. (*) 2015 and 2016 landings are preliminary. (**) Limited access landings are based on point locations from vessel trip reports.

	Landings by Permit Category			Total NGOM Landings	NGOM closure date, (days open)
FY	LAGC IFQ	LAGC NGOM	LA		
2009	0	5793	0	5793	n/a, (entire FY year)
2010	4762	3877	0	8639	n/a, (entire FY year)
2011	6092	816	0	6908	n/a, (entire FY year)
2012	894	6546	0	7440	n/a, (entire FY year)
2013	8907	46501	0	55408	n/a, (entire FY year)
2014	13286	48900	0	62186	n/a, (entire FY year)
2015*	26894	46879	0	73773	n/a, (entire FY year)

2016*	24840	62263	291232**	378335	May 13, (74 days)

In general, the Gulf of Maine habitat management alternatives are expected to have slightly negative to slightly positive impacts on the limited access general category scallop fishery relative to No Action, depending on the alternatives selected. Given limited scallop resources in the eastern Gulf of Maine, these alternatives are expected to have neutral impacts on the fishery. Opening areas that have been closed since 1998 or 2000 will likely have beneficial impacts on the scallop fishery, at least in the short term. Specifically, Central Gulf of Maine Alternative 2 would open Cashes and Fippennies Ledge, Central Gulf of Maine Alternative 4 would open Fippennies Ledge, and Western Gulf of Maine Alternatives 2, 3, and 6 would reopen Jeffreys Ledge. All of the action altenratives in the Central and Western Gulf of Maine would open these areas to scalloping if gear modification options (3 or 4) are selected. There are some exploitable scallops within portions of these areas, and some level of effort would be expected. Conversely, Central Gulf of Maine Alternative 3 with Option 1 or 2 would close an area that is currently open to scallop fishing (Platts Bank). This may have some negative impacts on local vessels. Fishing levels have been relatively low in that area, but effort has increased since 2013 (see Map 83). Potential negative impacts of closing that area could be somewhat neutralized if other areas reopen to the scallop fishery. As noted above, limited access scallop effort levels are very low in the Gulf of Maine, so impacts on that segment of the scallop fishery are expected to be neutral. Given the relatively small proportion of the resource allocated to the LAGC fishery, impacts to the fishery overall would be slight.

Map 83 – LAGC fishing activity in the GOM based on VMS data. Vessel is considered "fishing" if speed between VMS pings is less than 4.5 knots. Pings are binned into a 0.1 nautical mile grid and only locations with 3 or more LAGC vessels are shown. Semi-transparent tan circles are FY2007-2012 combined, and black triangles are March 2013-September 2015. Cluster of black triangles at approximately 43° 7.5' N/69° 35' W represent effort on Platts Bank (over 100 trips, 7 vessels, total landings 18,000 lb in 2013). Fishing effort during 2016 was concentrated south of Cape Ann, Massachussetts.



6.2.2 Georges Bank and Great South Channel/Southern New England sub-regions habitat management alternatives

The potential impacts of Habitat Management Area alternatives in the Georges Bank and Great South Channel/Southern New England sub-regions on the scallop fishery were assessed using the results of the long term and short term potential yield analysis, as well as the results from the SAMS model projections. The former provides a more direct way to evaluate the current and long term scallop yield estimates in various areas, and the latter assesses how modifications to closed areas would fit in with the scallop management program overall in terms of fishery catches. Specifically, the scallop area rotation program provides access to the fishery based on spatially averaged fishing mortality rates that vary depending on whether an area is open or closed, or open and closed sporadically as a scallop access area. The analysis provided in the SAMS model section compares the impacts of the No Action habitat management areas and the preferred alternatives selected by the Council.

In addition to these analyses, differential impacts between the Limited Access General Category and Limited Access fleets are explored for a small number of potential HMAs, using maps of fishing effort binned by ten minute squares to provide some information on potential distributional impacts of the habitat management alternatives considered.

6.2.2.1 *Long and short term yield estimates*

The short-term yield is calculated by applying F_{MSY} to the exploitable portion of the biomass per area, using the NEFSC dredge survey only. Short term is based on 2013 survey results since that is the most recent survey year completed when the DEIS was drafted. Long term uses all years available, 1979-2013 combined. The PDT chose to use the dredge survey estimate for biomass, and not the combined estimates typically used in more recent framework actions because the dredge survey is the only index that has covered most areas over a long time series. It was not practical to use the combined estimates from all available survey data (NEFSC dredge, NEFSC Habcam, VIMS dredge, SMAST drop camera, and Arnie's Fishery Habcam) because they do not all cover the same areas and years.

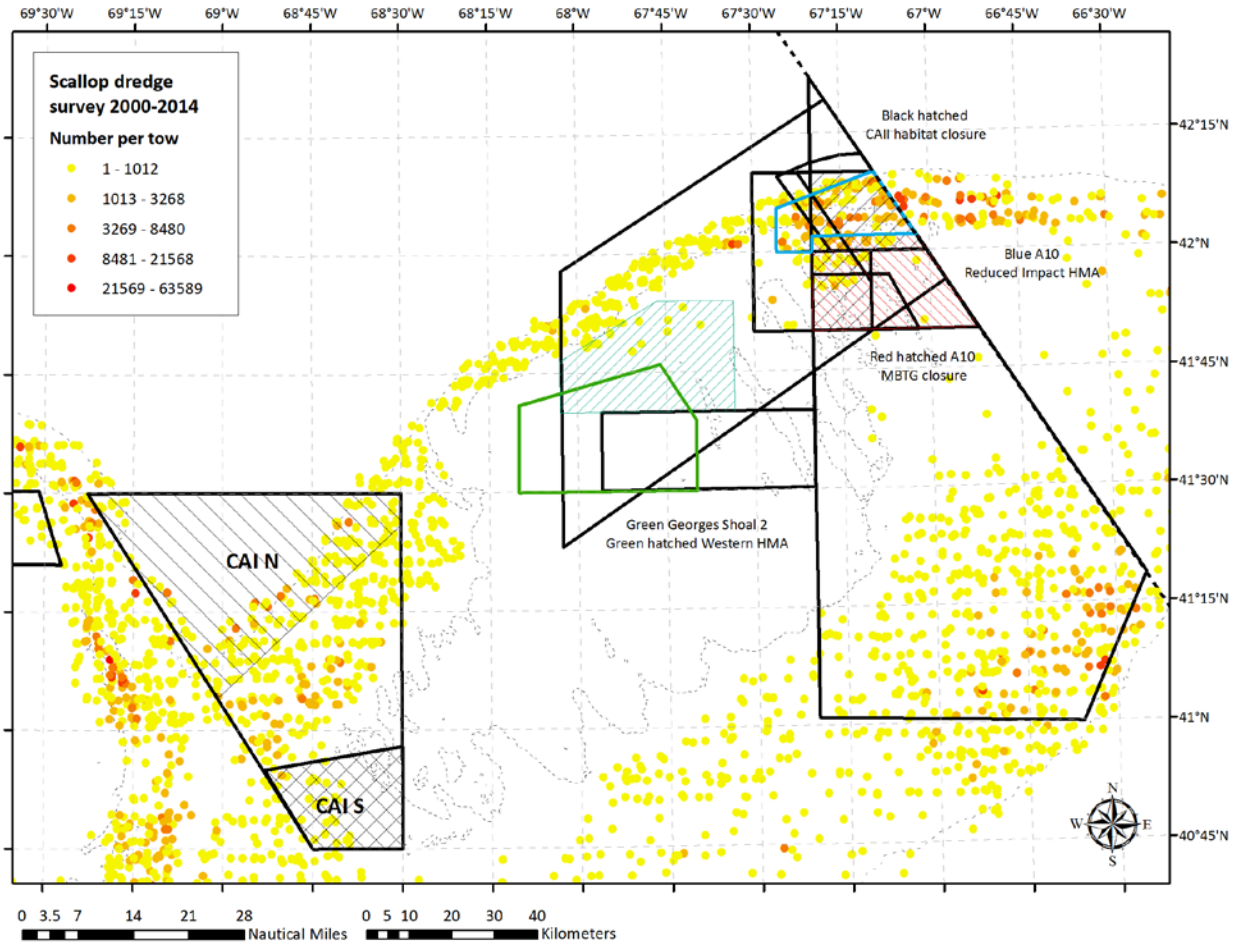
Furthermore, in some cases there was not a sufficient number of dredge survey tows in a particular area in 2013 to produce a reliable short-term biomass estimate; therefore, tows from previous years were combined (2008-2013) and an average biomass over that time frame was used for the 2013 estimate. This produced a more reliable and stable estimate of biomass compared to a single year with limited dredge tows. Therefore, the short term estimates for these analyses should not be compared with other estimates for 2013 biomass the PDT may have used in previous scallop frameworks since those analyses may be reporting biomass estimates using a different method. The estimates in this document were produced separately for these analyses only to create a reliable estimate of biomass to be used as a proxy of potential short-term impacts if areas were fished at F_{MSY}.

The long term yield per Habitat Management Area was calculated by multiplying the recruitment in each area by the maximum yield per recruit. A stratified mean was calculated since yield per recruit varies in each strata because of depth. First, the area (in nm^2) of each habitat alternative was calculated, as well as the area within each NEFSC shellfish survey strata. This was done so

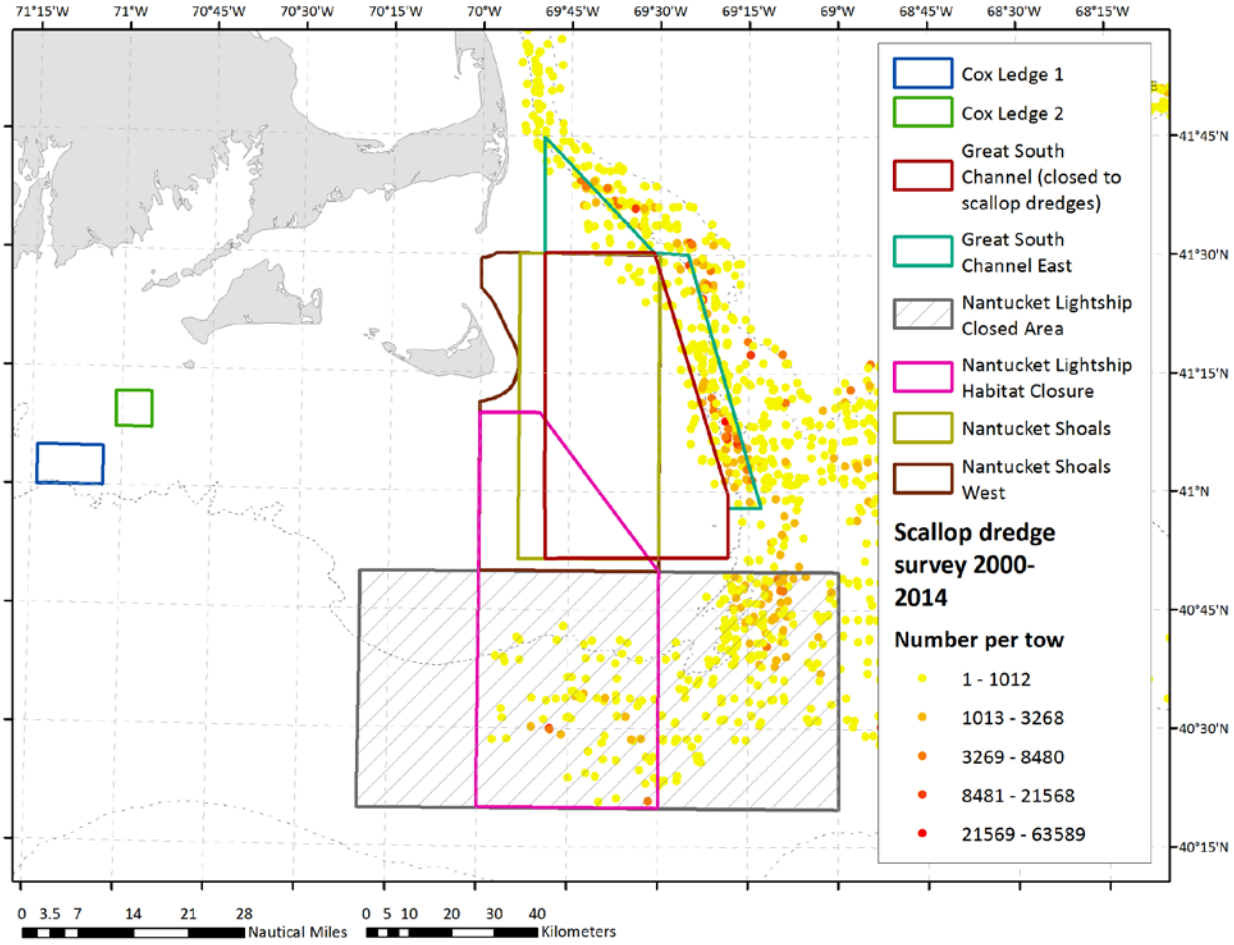
that a stratified mean could be calculated for each Habitat Management Area since yield varies by depth and because all shellfish strata are not sampled equally over time.

Areas with higher and lower long-term yield areas can be seen visually on maps of scallop abundance. Map 84 shows the NEFSC shellfish survey strata and catch per tow in and around habitat management alternatives on the Northern Edge of Georges Bank, and Map 85 shows the Great South Channel. Colored circles indicate the total number of scallops per tow from all survey years combined (1966-2013). Map 86 shows scallop abundance relative to preferred alternative areas.

Map 84 – NEFSC shellfish survey strata with EFH areas under consideration (Georges Bank) with scallop numbers from scallop dredge survey years 2002-2014

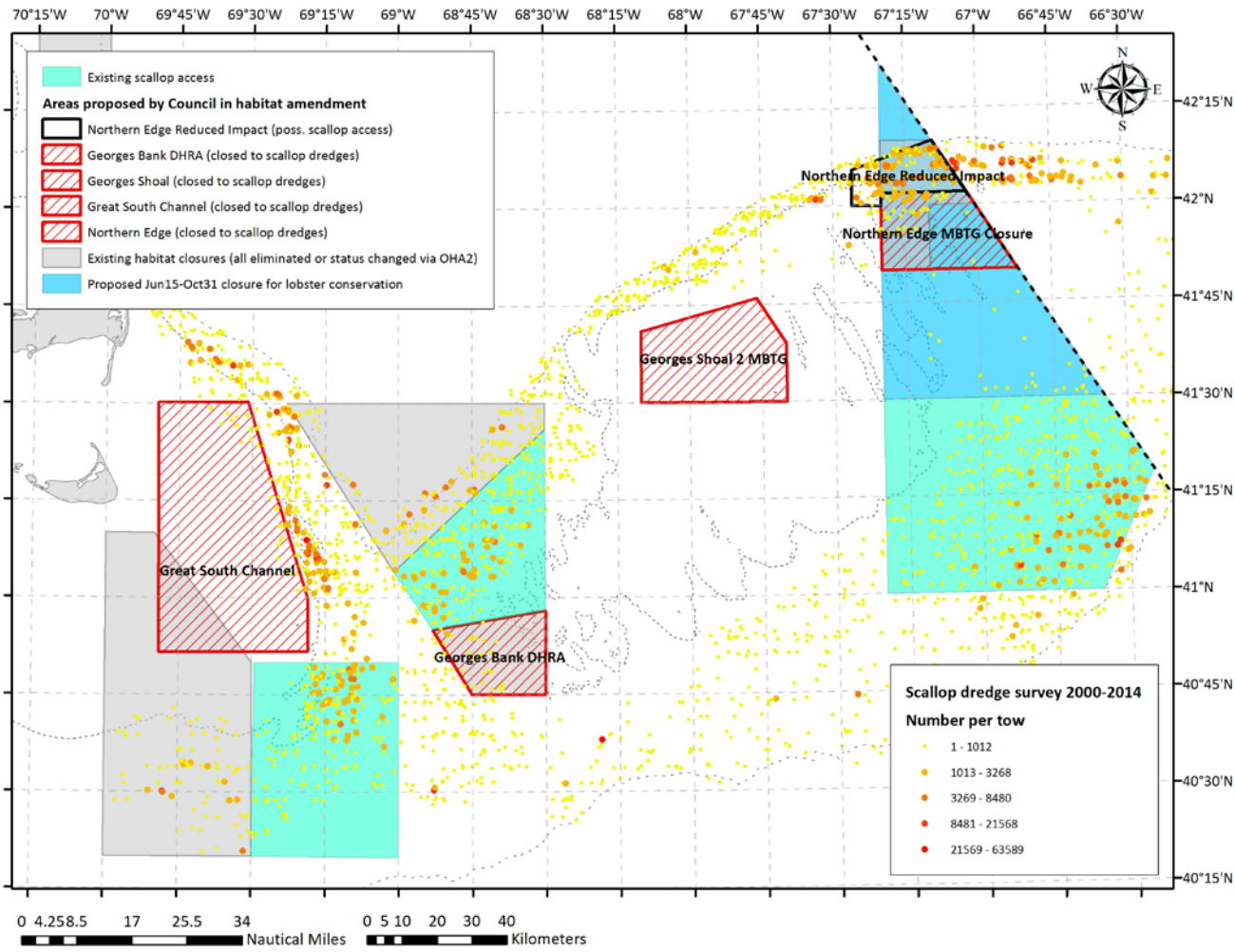


Map 85 – NEFSC shellfish survey strata with EFH areas under consideration (GSC/SNE) with scallop numbers from all scallop dredge survey years (1966-2014)



Key: Great South Channel (Alternative 4); Great South Channel East (Alternative 3); Nantucket Lightship Habitat Closure (No Action); Nantucket Shoals (Alternative 5); and Nantucket Shoals West (Alternative 6)

Map 86 - NEFSC shellfish survey strata with preferred alternative EFH areas under consideration (GB Alt 10, GSC Alt 4, DHRA Alt 4) with scallop numbers from all scallop dredge survey years (1966-2014).



A brief review of the scallop management program may help with the interpretation of the analyses of the potential impacts of Habitat Management Areas (HMAs) on the scallop resource and the scallop fishery. The expected long-term yield from the scallop fishery is about 25,000 mt annually, based on fishing at F_{MSY}. In any given year part of the scallop biomass can be fished from areas that are open, and part of the biomass is in areas that are not open and cannot be fished. The areas that are open may be fished under DAS or as part of an open scallop access area. The areas that are not open can be closed either because they are a scallop access area where scallops are being allowed to grow for a future harvest, or because they are closed for other reasons, such as an HMA.

The scallop overfishing definition is based on an overall fishing mortality (F) for the entire resource in all areas. In effect, this averages the F in open and closed areas. If part of the biomass is in a closed area that is not subject to fishing mortality, then the F in open areas can be higher before the overall F exceeds F_{MSY} and overfishing occurs, or until open area limits are reached

(which are set below F_{MSY} to prevent localized overfishing). In the FMP, measures are designed to achieve an F that is lower than F_{MSY} in order to account for scientific and management uncertainty.

Yield that cannot be harvested from a closed area can be partly recovered from an open area. There are limits to how much can be recovered for several reasons. Scallop densities are not uniform and some areas produce more scallops than others. In addition, the FMP constrains the F in open areas in order to minimize localized depletion. If all areas were uniformly productive and only scallop yield was the concern, in theory a closure could be designed where the yield lost from the closure exactly equals the yield gained by fishing at the constrained F in the open areas. This is clearly not the case because there are large differences in the productivity of different areas. The more productive an area is the more difficult it is to replace the yield lost from closing that area by fishing in open areas.

If there were no closures and fishing mortality was set at F_{MSY}, the annual scallop catch from each of these areas would likely be somewhere between the mean and median long-term yield estimates. However, in reality all of these areas would not be open to the fishery in the same year, and they would not all be fished at F_{MSY} every year due to the fact that total fishing mortality is set lower than F_{MSY}. Yield from these areas would be impacted by other aspects of area rotation such as whether there are other access area closures or opening in the Mid-Atlantic.

The most straightforward way to compare one area to another in terms of the potential impacts of habitat closed areas that are likely to be in place for a relatively long time is to consider the long-term mean and median yield estimates. A value somewhere between the two estimates can be compared to the total estimated annual scallop yield of 25,000 mt, or 55 million pounds. There is quite a difference between the mean and median long-term yield estimates in Table 38. The scallop dredge survey is a random stratified design and in some years there are very few tows in these small areas and a large tow in one year could greatly impact the mean. Also, these estimates are based on all years the NEFSC dredge survey has been conducted (1979-2013) and for many years scallop biomass was very low in all areas. If earlier years were removed from the time series these estimates would likely increase since scallop biomass overall is much higher now than it was in the 1980s and 1990s.

Table 38 summarizes the long-term and short-term yield potential per area. This action has considered a wide range of alternatives for Georges Bank in particular. The range of long-term yield within these areas ranges from two to about 2,000 mt annually, and in terms of short-term yield, the range goes from 1 to over 4,000 mt. Therefore, the range of potential impacts on the fishery in both the short and long-term varies greatly between the alternatives considered. Table 39 shows these values as a percentage of total long-term or short-term yield. This gives a relative sense of the impacts of each individual alternative. Because scallop recruitment is highly variable, these estimates are shown for both median and mean recruitment. Strictly speaking, closing one of these HMAs does not result in a loss in yield equal to the yield potential from that area. This is because the management program would adjust the F in open areas to partly recover the lost yield. As mentioned previously, and while the exact impacts depend on the total areas closed, it is not likely that the yield from a highly productive area can be completely recovered by fishing in open areas.

There is a difference between short-term and long-term yields. If a proposed HMA is currently closed, scallop biomass may have built up in that area that will allow for increased yield in the short-term after opening. For example, since the current EFH closed areas on Georges Bank have been closed for over 20 years the exploitable biomass in those areas has increased over time, thus the short-term yield potential for those areas is higher than the long term estimates. It should be noted however, that scallop settlement is variable and these estimates will change over time, especially the short term yield estimates. In 2014 and 2015 the biomass estimates within the current EFH closed areas on Georges Bank declined overall relative to 2013, likely due to natural mortality[12]. Therefore, the current short-term estimate of yield from those areas is likely lower than the 2013 estimates.

On the other hand, other areas have seen dramatic increases in biomass. For example, in the EFH closed area in Nantucket Lightship, a very large year class was observed in 2014 and 2015. This is unprecedented for this area and in waters deeper than scallops are generally observed in Nantucket Lightship. While the survival and potential yield from this large year class are uncertain, it seems that the short term yield from this area in particular will likely be higher than the 2013 estimates presented below based on the additional observations after these analyses were completed. Summer 2016 survey data are currently being reviewed by the scallop Plan Development Team, and it appears that these recruits are surviving and growing such that substantial yield should be available to the fishery should this area reopen. It was not practical to redo these analyses during development of this action each year new data were available, and the general conclusions are not expected to be very different. However, it should be noted that estimates can change with more years of data included, especially short-term estimates. Therefore, it may be more useful to consider the long-term yield when comparing HMAs, and these decisions are likely to be long term in nature anyway. Scallop distribution is patchy, abundances can vary greatly by area and time; therefore, a longer time series will help smooth out that variation. While these short and long term biomass estimates were not updated beyond 2013, the SAMS projections presented in the DEIS were revised in the FEIS through 2015 to give a more updated estimate of short term and long term impacts of the preferred alternative compared to No Action (Section 6.2.2.2).

[12] Preliminary 2016 data suggest an increase in biomass relative to 2015, but still lower biomass values in CAII North, CAI-N, and CAI-S as compared to 2013.

Table 38 – Long-term and short-term yield potential (mt) from current habitat closed areas and several new areas under consideration. Preferred areas in bold.

Sub-region	Area	Status	Long-term yield (mean)	Long-term yield (median)	Biomass 2013*	Short-term yield
GB	CAII North (all area north of scallop access area within CAII closure (subset of Alt 1)	Current	1,254	536	8,630	2,589
GB	CAI-N Habitat Closure (subset of Alt1)	Current	601	42	4,841	1,452
GB	CAI-S Habitat Closure (subset of Alt 1)	Current	29	11	1,658	497
GB	All Current Habitat Closures on GB (CAII north, CAIN and CAIS). Does not include NL.	Current	1,884	589	15,129	4,538
GB	Northern Edge HMA (Alts 3 and 4)	Proposed, not preferred	1,214	502	7,433	2,230
GB	EFH Extended 1 HMA (Alt 6A)	Proposed, not preferred	1,858	800	11,519	3,456
GB	EFH Extended 2 HMA (Alt 6B)	Proposed, not preferred	825	324	4,493	1,348
GB	**Georges Shoal 2 MBTG HMA (Alt 7, Alt 10)**	**Proposed, preferred**	**2**	**0**	**3**	**1**
GB	EFH South MBTG HMA (Alt 7)	Proposed, not preferred	23	10	440	139
GB	Northern Georges MBTG HMA (Alt 8)	Proposed, not preferred	2,829	1,211	13,654	4,317
GB	Western MBTG closure (Alt 9)	Proposed, not preferred	52	8	22	6
GB	Eastern MBTG closure (Alt 9)	Proposed, not preferred	158	75	1,674	419
GB	Mortality closure (Alt 9)	Proposed, not preferred	1,126	479	11,978	2,995
GB	**Reduced Impact HMA (Alt 10)**	**Proposed, preferred**	**1,079**	**419**	**10,617**	**2,654**
GB	**MBTG Closure (Alt 10)**	**Proposed, preferred**	**258**	**135**	**3,376**	**844**
GSC-SNE	Nantucket Lightship Habitat Closure (subset of Alt 1)	Current	552	3	93	28
GSC-SNE	Great South Channel East HMA (Alt3)	Proposed, not preferred	4,034	1,101	4,460	1,338
GSC-SNE	**Great South Channel HMA (Alt 4)**	**Proposed, preferred**	**313**	**64**	**100**	**30**

- (*) 2013 biomass estimate is based on 2013 dredge survey data from that area, or if there were insufficient tows in a particular area in 2013, an average of biomass from 2008-2013 was used
- Alternatives 5 and 6 in GSC/SNE sub-region not shown; areas have very low yield

Table 39 – Proportion of total long-term yield (mean and median) contained in each alternative as well as the proportion of total short-term biomass and short-term yield (current closures in light peach per area and in total in dark peach). Preferred areas in bold.

Sub-region	Area	Proportion of total potential long-term yield (mean)	Proportion of total potential long-term yield (median)	Proportion of 2013 biomass	Proportion of total short-term potential yield
GB	CAII North (all area north of scallop access area within CAII closure	5.0%	2.1%	7.6%	10.4%
GB	CAI-N Habitat Closure (Alt 1)	2.4%	0.2%	4.3%	5.8%
GB	CAI-S Habitat Closure (Alt 1)	0.1%	0.0%	1.5%	2.0%
GB	All Current Habitat Closures on GB (CAII north, CAIN and CAIS) (Does not include NL)	7.5%	2.4%	13.4%	18.2%
GB	Northern Edge HMA (Alts 3 and 4)	4.9%	2.0%	6.6%	8.9%
GB	EFH Extended 1 HMA (Alt 6A)	7.4%	3.2%	10.2%	13.8%
GB	EFH Extended 2 HMA (Alt 6B)	3.3%	1.3%	4.0%	5.4%
GB	**Georges Shoal 2 MBTG HMA (Alt 7, Alt 10)**	**0.0%**	**0.0%**	**0.0%**	**0.0%**
GB	EFH South MBTG HMA (Alt 7)	0.1%	0.0%	0.4%	0.6%
GB	Northern Georges MBTG HMA (Alt8)	11.3%	4.8%	12.1%	17.3%
GB	Western MBTG closure (Alt 9)	0.2%	0.0%	0.0%	0.0%
GB	Eastern MBTG closure (Alt 9)	0.6%	0.3%	1.5%	1.7%
GB	Mortality closure (Alt 9)	4.5%	1.9%	10.6%	12.0%
GB	**Reduced Impact HMA (Alt 10)**	**4.3%**	**1.7%**	**9.4%**	**10.6%**
GB	**MBTG Closure (Alt 10)**	**1.0%**	**0.5%**	**3.0%**	**3.4%**
GSC-SNE	Nantucket Lightship Habitat Closure (Alt 1)	2.2%	0.0%	0.1%	0.1%
GSC-SNE	Great South Channel East HMA (Alt 3)	16.1%	4.4%	3.9%	5.4%
GSC-SNE	**Great South Channel HMA (Alt 4)**	**1.3%**	**0.3%**	**0.1%**	**0.1%**

- Proportion of long-term yield estimates based on total yield of 25,000 mt or 55 million pounds.
- Total short-term 2013 biomass is based on the estimate used for total scallop biomass in Scallop FW25 (113,242 mt). Biomass values for each area are based on the dredge survey. Using just the dredge survey estimate for the total value, the proportions would increase slightly because the total biomass estimate from dredge only in 2013 was 105,923 mt. The mean of total biomass for 2008-2013 is not available.
- Total short-term yield is assumed to be 25,000 mt or 55 million pounds; equal to the long-term total yield estimate. Proportions of total short-term yield higher than long-term because the current estimates of yield in many of these areas are higher than the long-term estimates because many of the areas have been closed.
- Alternatives 5 and 6 in GSC/SNE sub-region not shown; areas have very low yield

In the Georges Bank sub-region, the areas under consideration vary greatly in terms of long-term mean and median yield estimates. The Northern Georges Bank MBTG HMA (Alternative 8) has the highest estimate: about 2,800 mt (using the mean) and about 1,200 mt (using the median). The extended version of the Closed Area II Habitat Closure (Alternative 6A) has the next highest long-term yield potential (1,800 mt using mean recruitment and 800 mt using median recruitment), followed by the Northern Edge HMA (Alternatives 3 and 4) with about 1,200 mt (mean) and 500 mt (median).

Any alternative that contains some or all of the current EFH closed area (Closed Area II) has the highest estimates of short-term yield since that area has been closed to fishing for many years and scallops in that area are relatively large in size. For example, Alternative 8 includes all of the current habitat closure area, as well as most of the northern flank of Georges Bank; therefore, the short-term yield is estimated to be over 4,000 mt. The total biomass in that area is over 13,500 mt, but the portion of that biomass that could potentially be allocated to the scallop fishery is about 4,000 mt (applying F_{MSY} to exploitable scallops only). Similar to long-term yield estimates, Alternative 6A has the second highest estimate of short-term yield as well (about 3,500 mt) followed by Alternatives 3 and 4 at 2,200 mt. Alternative 6B also has relatively high estimate of short-term yield since it includes much of the current EFH closed area, but not as much as Alternative 6A. With all of the alternatives that overlap the current EFH closed areas in Closed Area II, the estimates of short term yield potential will likely decline with additional years of data added. Given the length of time the areas have been closed, biomass values in these areas are generally decreasing, because the older scallops in these areas have limited additional growth potential and higher rates of natural mortality.

In a scallop rotational fishery context, 2,500 mt long-term mean yield is equivalent to about one 18,000 pound trip per vessel, or about 6 million pounds overall. Therefore, an area like the Northern Edge HMA (Alternatives 3 and 4) has an estimated long-term yield mean of about 1,200 mt, so on average if that area was open to the fishery and managed rotationally, it would provide about one trip for half the fishery every year, or one trip for the entire fishery every other year. Closed Area I North has only 601 mt long-term yield potential, and Closed Area I South does not have much yield potential at all. When the three existing habitat closures on Georges Bank are combined, the long-term yield potential based on mean recruitment is about 1,884 mt. Therefore, about 7% of the total potential long-term yield for the entire scallop resource is within the current habitat closed areas, using the mean long-term yield estimates. The median combined estimate is closer to 600 mt, or 2.4% of the total potential long-term yield.

The Northern Edge HMA area (Alternatives 3 and 4) has similar long term yield potential (1,214 mt) as the No Action Closed Area II north area (1,254 mt). The majority of the yield potential in the Northern Edge HMA comes from a very small “triangle” just east of the western boundary of Closed Area II, and not from the deeper waters along the northern part of the new area. The western part of the Northern Edge HMA which is currently open to the scallop fishery likely has higher long-term yield potential than the southern part of the No Action Closed Area II Habitat Closure area that would potentially open if the No Action habitat closure is eliminated. Specifically, in terms of long-term yield potential, the additional area closed in the Northern Edge HMA is more productive than the area that would open in the southern part of the Closed Area II Habitat Closure on the northern edge. Therefore, over the long term the potential impacts of the Northern Edge HMA (Alternatives 3 and 4) on the scallop fishery would likely be slightly to moderately negative, but positive relative to No Action/Alternative 1 which encompasses a larger amount of long term yield considering both Closed Area I and Closed Area II. Selecting Option 3 or 4 for Alternatives 3 and 4 (or for Alternatives 6A or 6B) would remove existing management areas and implement new habitat management areas as trawl gear modification areas. These options would not restrict scallop dredges and therefore would have impacts similar to no closures/Alternative 2, i.e. moderately positive.

The long term yield potential of the EFH Extended 1 HMA (Alternative 6A) is about 50% greater than the existing area or the Northern Edge HMA. Opening a buffer zone along the EEZ (Alternative 6B) reduces the area's size and lowers the long term yield potential. Alternative 6A is expected to have neutral impacts on the fishery relative to No Action due to reduced access to high abundance scallop areas on the northern edge, combined with increased access in Closed Area I. Overall, the long term yield potential in closures is similar between Alternative 1/No Action and Alternative 6A. Alternative 6B, however, is expected to have only slightly negative impacts on the fishery, and positive impacts relative to No Action since the estimates of both long-term and short-term yield are lower for Alternative 6B compared to No Action.

Alternative 7 includes two areas, the EFH South Mobile Bottom-Tending Gear HMA and the Georges Shoal 2 Mobile Bottom-Tending Gear HMA. Both areas have very low long term yield potential and therefore implementing these areas in combination as mobile-bottom tending gear closures would have moderately positive impacts on the fishery relative to Alternative 1/No Action and relative to all other alternatives. Neutral impacts are expected relative to Alternative 2.

Alternative 8 includes a single larger area, the Northern Georges Mobile Bottom-Tending Gear HMA. This area encompasses significant long term yield potential and therefore Alternative 8 would have highly negative impacts on the scallop fishery. In total, the current EFH closed areas on Georges Bank (Closed Area II, Closed Area I North, and Closed Area I South only, not including the current closure in Nantucket Lightship) contain about the same short-term yield as Alternative 8 under consideration (both above 4,000mt). The row in dark orange in Table 38 summarizes the yield and biomass estimates for the three current EFH closed areas on Georges Bank combined. However, the current No Action habitat closures on Georges Bank contain less long-term yield based on these analyses (589-1,884mt in the No Action EFH closures on Georges Bank compared to 1,211-2,829mt in Alternative 8). Therefore, in the short-term, the current EFH closed areas on Georges Bank and Alternative 8 may have similar impacts on the scallop fishery, but in the long-term Alternative 8 contains more long-term yield potential compared to the No Action areas and would have more negative impacts. The total long term mean yield estimate for the entire resource is 25,000 mt; Alternative 8 has a mean estimate of about 2,800 mt or 11% of the total long-term yield. The three No Action habitat closure areas combined have a mean estimate of about 1,900 mt, or 7% of the total long-term yield. Therefore, compared to Alternative 1/No Action, Alternative 8 would have higher negative impacts on the scallop fishery (i.e. moderately to highly negative impacts), and since it has the highest estimate of long-term yield of the Georges Bank HMAs, it is expected to have more negative impacts on the scallop fishery compared to the other areas under consideration (but, see Great South Channel Alternative 3 discussion below).

Alternative 9 and Alternative 10, the preferred alternative, are more complex to analyze because they include three areas, two that are habitat closures to all mobile bottom tending gear, and a third area that is a reduced impact habitat management area. For the reduced impact area in both alternatives it is assumed that in the future there may be some level of scallop fishery access, which would be authorized under a future action. Specifically, the Habitat Committee envisioned a scallop access program would be allowed in that entire area as well as groundfish special

access program, limited to waters west of 67° 20’ W only. Therefore, the short and long-term yield estimates for the reduced impact HMA need to be interpreted differently than those for the eastern and western mobile bottom-tending gear closures.

The eastern and western HMAs in Alternative 9 are similar to other alternatives in that the short and long-term yield potential within those areas would not be available to the scallop fishery. The western area in particular does not contain much scallop biomass, but it does overlap with slightly more than the western area under consideration in Alternative 7. In addition, the eastern area in Alternative 9 does not contain much scallop biomass, but more than the eastern area in Alternative 7. Both areas combined (primarily from the eastern area) are estimated to contain less than 1% of the long-term yield and less than 2% of the short-term yield. Therefore these two closures are not expected to have negative impacts on the scallop fishery.

The scallop yield potential of the Georges Shoal MBTG HMA that is part of Alternative 10 is very low. The MBTG in Alternative 10 on the northern edge has higher short and long term yield estimates (135-258 mt long-term, and 844mt short-term). But this area is completely within an area currently closed to the scallop fishery; therefore, there are no additional impacts from this closure compared to No Action.

The reduced impact HMAs that are part of Alternative 9 and 10 are more complex to evaluate because some limited level of fishing activity will likely be permitted in all or parts of those areas in a future action. Some portion of the yield potential in these areas will likely be harvested. For example, in a future action under the scallop plan it is possible that a very limited level of access would be granted annually in those areas, or the areas would potentially be closed for several years and then open to the fishery for one or two years when scallops are larger. If the areas are managed as rotational areas the overall strategy is to close an area with high densities of small scallops and reopen the area when scallops are larger. Therefore, these area would potentially be fished at low levels at first to remove larger scallops, and then potentially closed for several years to increase overall yield from the area. Area rotation can reduce the area swept by the gear for the same amount of scallop catch if effort is concentrated in high density areas. The details of a potential access program would be developed and analyzed in a future scallop action. Overall, the short-term and long-term biomass estimates for both reduced impact areas are relatively high; the reduced impact area under consideration in Alternative 9 is slightly higher than the reduced impact area in Alternative 10 because it includes additional areas.

In general, the reduced impact HMA in Alternative 9 contains more short-term and long-term yield than the current EFH closed area because it includes the northern part of the existing cod HAPC, which is the more productive area for scallops, as well as an extension to the west, which is currently open to the scallop fishery and is relatively productive. If this area was a long-term closure there would be negative impacts on the scallop fishery compared to No Action because this area contains 12% of short-term yield and 1.9 – 4.5% of long-term yield potential. But if it is managed as a reduced impact HMA with controlled access, the impacts may be positive on the fishery because a proportion of that yield potential would convert to landings, so the impacts would be moderately positive compared to No Action which keeps these relatively high density areas closed to the fishery. The reduced impact HMA in Alternative 10 has slightly lower long term impacts than the No Action EFH closed area in Closed Area II, and about the same short

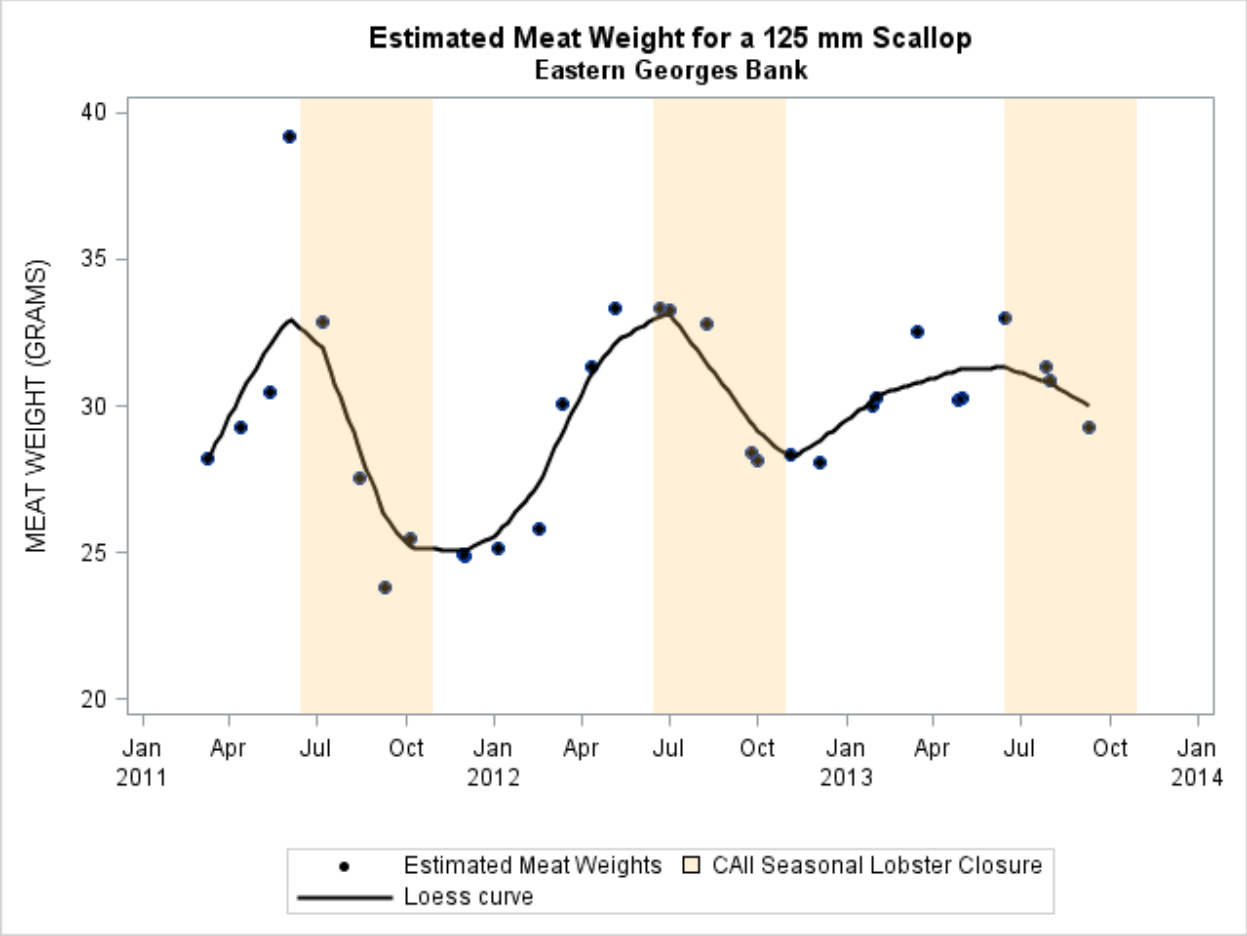
term yield estimate. The impacts of Alternative 10 are also expected to be moderately positive. Overall, when highly productive areas are in long-term closures it is not always possible to compensate for that loss in other areas. The benefits may not be as high as the yield estimates provided because there may be other constraints on the scallop fishery that could reduce catches, such as seasonal restrictions to limit fish bycatch, or other measures. Because this is such a high density area, in years it is available to the fishery mortality in other areas would potentially need to be reduced to keep total fishing mortality under target levels.

Alternative 10 also includes a seasonal closure from June 15 – October 31. If approved, scallop vessels would not be permitted to fish within Closed Area II north of 41° 30' N during those months. In addition, the Reduced Impact HMA would be required to be managed as a scallop access area; therefore access to that area would be restricted and total removals would be controlled. With the seasonal closure, vessels would be restricted to fish allocations between November 1 – June 14, 4 months at the end of one fishing year (Nov-Feb) and 3.5 months in the beginning of the next fishing year (March1-June14).

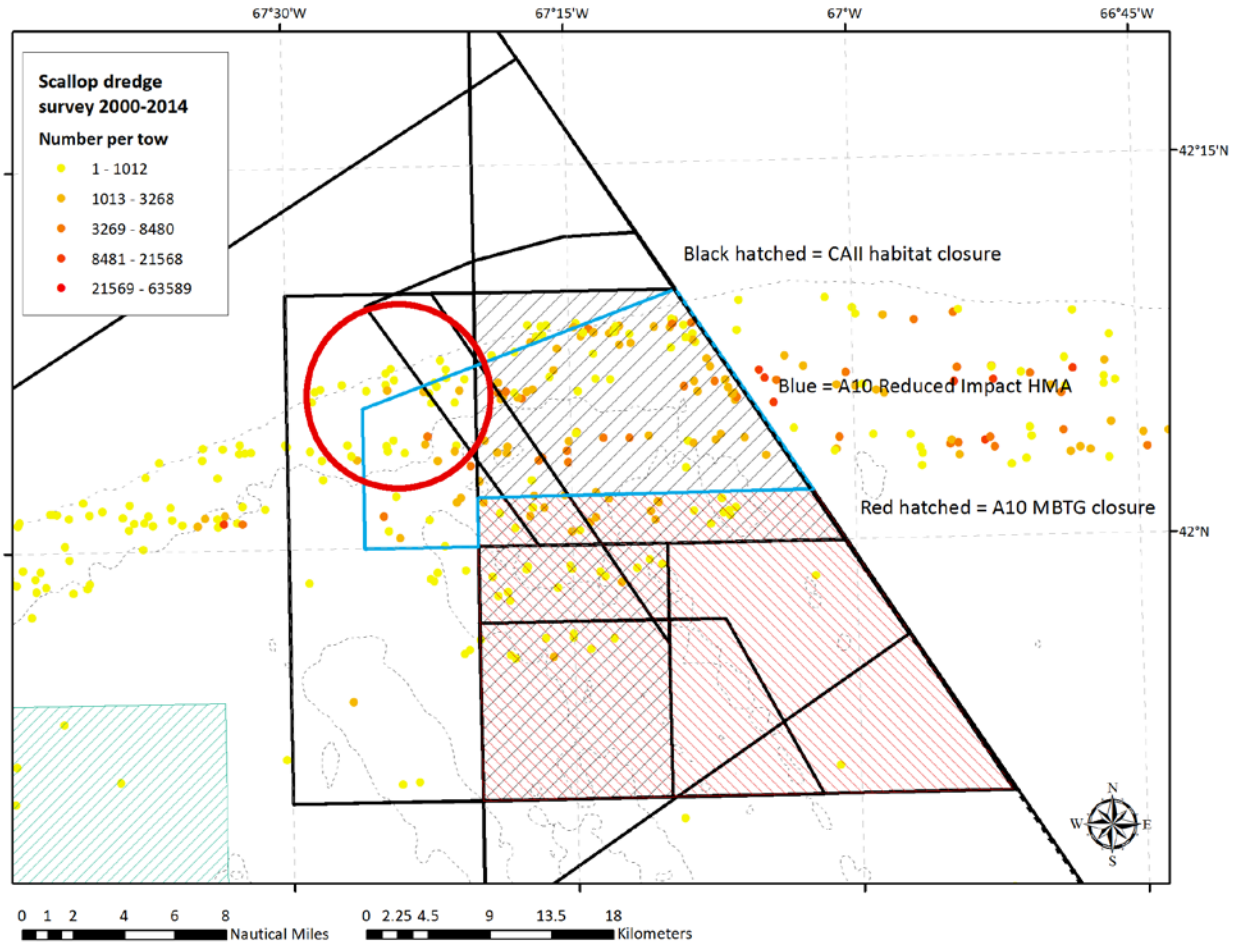
In general, this seasonal restriction begins when scallops are near their peak meat weight on Georges Bank (June) and remains closed as average meats weights decline to their lowest (typically fall-winter) (Figure 13). If the proposed seasonal restriction shifts effort to higher meat weight months only (i.e. May – June 14) there may be beneficial impacts on the resource. However, this restriction may also shift effort into lower meat weight months. The other issue to keep in mind is that this seasonal restriction may affect when vessels decide to take open area trips. Vessels generally take open area trips when meat weights are higher to maximize catch per DAS. Seasonal restrictions can reduce flexibility and cause effort shifts that are difficult to predict and can have unintended consequences if effort shifts into seasons with lower meat weights. Because many vessels are fished by the same captain and crew, there are constraints on how much effort can be shifted before seasonal closures since many crew members fish on multiple vessels. In summary, the direct impacts of this seasonal closure on the resource are difficult to asses. Some effort may shift into seasons with higher meat weights, which could have beneficial impacts on the resource, and some effort may shift into seasons with lower meat weights that could have negative impacts on the resource.

The limited access general category fishery does not currently fish in these offshore areas; therefore closing them may not have direct impacts on that segment of the fishery. The LAGC IFQ is based on 5.5% of the total ABC, which includes all areas (open or closed); thus, the status of these areas should not have a direct effect on the IFQ allocation. However, fishing mortality may be increased in other areas to compensate for these closures, and that could have negative impacts on the LAGC fishery, but there are currently limits on how high fishing mortality in other areas can be set, which should minimize those potential impacts.

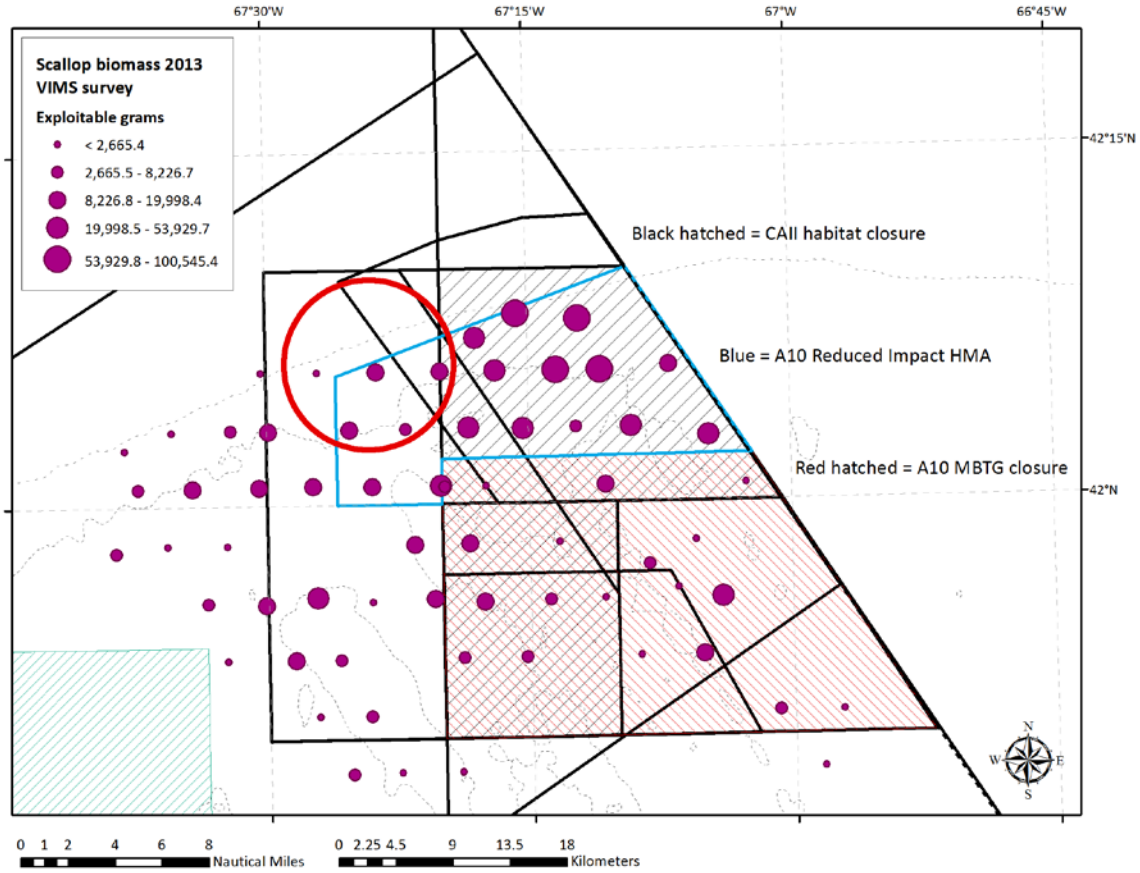
Figure 13 – Model generated estimates of meat weights for scallops larger than 125mm for Eastern GB with proposed seasonal closure for lobster included (June15-October31)



Map 87 – Scallop (number/tow) from NEFSC scallop dredge surveys (all years) with EFH areas on the northern edge of Georges Bank. There is substantial long term yield potential west of the existing habitat closure (indicated by a red circle). This area would close under the new Northern Edge HMA (Alternative 3 or 4), the EFH Expanded 1 and 2 HMAs (Alternatives 6A/6B), or under the Northern Georges MBTG HMA (Alternative 8). It could be fished rotationally under Alternative 9 or 10.



Map 88 – Total scallop biomass (2013 VIMS dredge survey data) relative to Alternative 1, 3/4, 6A, 6B, 7, and 8 Habitat Management Areas.



The areas in the Great South Channel, Nantucket Lightship Habitat Closed Area (Alternative 1), Great South Channel East (Alternative 3), and Great South Channel (Alternative 4), have very different results in terms of long-term and short-term yield potential. The No Action Nantucket Lightship Habitat Closed Area has relatively low long-term yield potential, 552 mt based on the mean and 3 mt based on the median estimate (Table 38). This large difference suggests that the yield potential from this area is dominated by a few years with high levels of observed recruitment, and most years with relatively low levels of recruitment. The Great South Channel HMA has even less, 313 mt based on the mean and 64 based on the median. All of the HMAs under consideration in the Great South Channel are currently open to the scallop fishery. If the Great South Channel HMA is closed, about 1% of the total long-term yield would no longer be available to the fishery (313 mt / 25,000 mt). On the other extreme, Great South Channel East HMA contains about 16% of the total long-term yield for the fishery.

In contrast, the Great South Channel East HMA has very high scallop yields over both the long-term and short-term. Even though the boundary only extends slightly farther east than the Great South Channel area, it includes scallop survey strata 50 which is very productive. The estimated potential yield from this area is over 4,000 mt based on the mean. That is 16% of the 25,000 mt total potential yield for the entire scallop fishery. Using the median long-term yield estimate instead (1,101 mt), the percentage of total yield is lower, under 5%), but both are substantial.

Furthermore, this area is roughly 2-4+ times as productive as the reduced impact HMA proposed on the northern edge, depending on whether the long-term median or long-term mean is compared. The other Channel areas (Nantucket Shoals and Nantucket Shoals West) have not been evaluated for long-term and short-term impacts the same way. However, since they are shallower that the Great South Channel alternative, the impacts on the scallop resource and fishery are expected to be lower than the Great South Channel HMA alternative.

Given uncertain but positive impacts of accessing scallops that are within the existing Nantucket Lightship Habitat Closure under one of the action alternatives, there are low negative impacts associated with Alternative 1/No Action, which keeps this area closed, and low positive impacts associated with alternatives that allow access to this area. The exception is Alternative 3 with Option 1 or 2, which would close the Great South Channel East HMA to the scallop fishery. Because this area has such high long term yield potential, this closure would outweigh access to the Nantucket Lightship Habitat Closure and lead to moderately to highly negative impacts.

In summary, for both the Georges Bank and Great South Channel-Southern New England sub-regions combined, about 10% of the total long-term yield for the scallop fishery is estimated to be within the No Action EFH closed areas, (2,500 mt/25,000 mt). If the No Action HMAs are replaced with the suite of preferred HMAs, there would be less scallop biomass protected in closed areas. Under the preferred alternatives, about 2.3% of the mean long-term yield potential would be in closed areas, and an additional 4.3% would be in the reduced impact habitat area, which would be managed as a scallop access area with periodic limited levels of access. Closed areas can be a tool to help prevent overfishing and address uncertainty, especially for stocks that are overfished, by always having some fraction of the resource protected from fishing. The preferred alternative would reduce the amount of total yield potential in closed areas, which could increase the potential for overfishing. However, the scallop resource is not overfished and overfishing is not occurring and the FMP has other measures in place to help prevent overfishing. Primarily, setting fishing limits at a level well below overfishing limits helps keep fishing mortality low.

Overall, closing areas with some scallop biomass could have neutral to potentially positive impacts on the scallop resource and fishery by helping to prevent overfishing if some level of scallop biomass is protected from fishing pressure. However, if a substantial amount of total scallop biomass is in closed areas, as is the case with some of these alternatives, impacts on the resource could be negative since effort would be shifted to areas with lower catch rates to compensate for yield losses within closures. Fishing in areas with lower catch rates can have negative impacts on the resource if increased fishing time leads to increases in incidental mortality.

6.2.2.2 ***Model projected biomass and catch***

When considering the potential benefits of opening areas that have been closed to the scallop fishery it is important to keep in mind that allocations in the scallop fishery are complex. There is an overall catch limit or ACL, but there is no overall TAC, and fishery allocations are set well below the ACL to account for uncertainty and principles of area rotation. Therefore, if areas convert from closed to open as a result of this action, the potential yield in those areas will not automatically convert to landings. Under area rotation, there are both spatial limits on fishing

mortality (i.e. caps on open area F) as well as overall fishing mortality limits (which combine open, rotational access, and closed areas) that are much lower.

To express how these closures impact fishery allocations under area rotation, this section describes the short and long-term impacts of how these various habitat closed areas would be integrated into the overall scallop area rotation program, using the SAMS model approach to show how fishing mortality limits would affect allocations (Section 6.2.2.1 above). This provides a more holistic picture of the impacts of HMA alternatives as they relate to overall fishery allocations under area rotation. The scallop area rotation program provides access to the fishery based on spatially averaged fishing mortality rates that vary depending on whether an area is open or closed, or open and closed sporadically as a scallop access area. The analysis provided in this section compares the impacts of the No Action habitat management areas and the preferred alternatives selected by the Council.

The SAMS (Scallop Area Management Simulator) model has been used since 1999 to project scallop biomass and catch to aid management decisions. SAMS is a size-structured model that forecasts scallop populations in a number of areas. For this analysis, the Scallop Plan Development Team modified the boundaries of the typical SAMS areas to include the preferred alternatives in this action. Modifying the typical SAMS boundaries allows the model to estimate the long term biomass inside and outside of various Habitat Management Areas by adjusting fishing mortality in open vs. closed areas. Other than the changes in area boundaries, this analysis uses the same model and constraints used to develop scallop specifications. While the SAMS model presents a more holistic representation of what may occur, it is a time-consuming analysis and resource limitations prevented it from being run for the dozens of possible combinations of HMAs. For that reason the only runs completed in this analysis are the No Action run and the preferred alternative. These runs have been updated using all available data through 2015. Other runs were completed in the DEIS to capture the range of impacts, but those were only run using data through 2013 and are not provided in this final document. The SAMS model results are then used to evaluate the overall potential economic impacts of this action. Vessel revenues are not the sole measure of economic impact, and the analysis takes this into account. It also considers the effect of yield on prices.

While these analyses help describe how HMAs may impact the overall area rotation program and fishery allocations, the long and short term yield analysis (Section 6.2.2.1) above should be used to make direct comparisons between individual management areas in terms of their impacts on the scallop resource and fishery, because that analysis indicates differences in yield from various areas. However, it is important to remember that all additional yield in reopened areas will not necessarily be converted to landings, given spatial and temporal caps on fishing mortality under the area roation system. Thus, the added benefit of the SAMS analyses is that they are more dynamic than the short term/long term yield estimates because they do not simply focus on the area being assessed. Rather, these analyses simulate fishing activity and associated impacts to the fishery overall. The model makes assumptions about where effort will be displaced based on fleet dynamics observed in the fishery and estimated catch rates in various areas. When reviewing the results it is important to keep in mind that there are a handful of constraints placed on the model in terms of how much effort is allowed in a certain area. Mainly, the principles used in the Scallop FMP to set target catches are maintained in these simulations; total fishing

mortality cannot exceed 0.34 in all areas, the F rate associated with the Annual Catch Taret (ACT) in the Scallop FMP, and open area fishing mortality cannot exceed 0.48, Fsmy for the scallop resource. Therefore, the SAMS results show the potential impacts of the HMAs under consideration, but as constrained by the area management principles in the Scallop FMP.

The final runs include:

1. No Action: Closed Area I, II, and Nantucket Lightship Habitat Closure Areas remain closed to the scallop fishery. Note that under No Action all of Closed Area II north of 41° 30' N including the triangle-shaped deeper-water area is considered closed to the scallop fishery because it is closed to the scallop fishery under the Northeast Multispecies FMP.

2. Preferred Alternative: Removes all of the current EFH closures and adds several new areas proposed in this action. Specifically, Georges Bank Alternative 10 and GSC Alternative 4 are included in the preferred alternative run.

   The preferred alternative run maintains the GF closed areas that are not open to the scallop access area fishing. This runs assumes that the first fishing year the proposed EFH measures are effective is 2017. In 2017 this run assumes the scallop fishery has access in Closed Area I North, which is currently closed to scallop fishing, and the reduced habitat impact area, which is currently closed in the northern part of Closed Area II. The reduced habitat impact area is assumed to be fished at F=0.4 in year 1 and then F=0.25 for the rest of the time series. Although this area would not likely be open every year and fished at the same rate, for analysis purposes assuming F=0.25 each year allows potential removals from that area at a reasonable level (F_{MSY} for Georges Bank is 0.3, and in some years the area will likely be closed). In 2018, the current Nantucket Lightship EFH closed area is assumed to open. This run delays access to this area until 2018 because recent surveys show very large sets of small scallops in those areas that would not be ready for harvest until at least 2018.

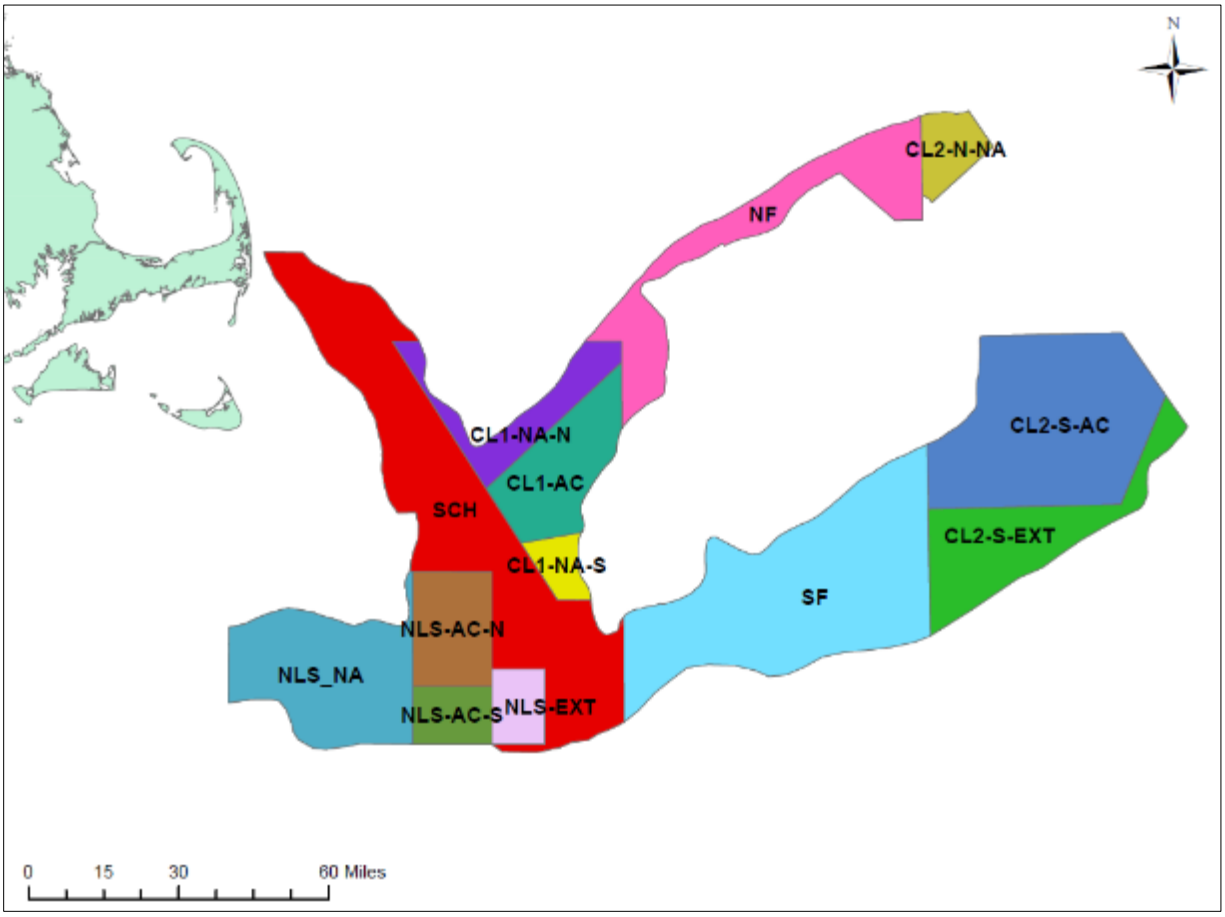
Note that the closures in the Gulf of Maine are not part of the scallop projection model because they are outside of the scallop survey area. The scallop fishery specifications are based on the Georges Bank and Mid-Atlantic resource areas only. The Gulf of Maine is managed under a separate hard-TAC; therefore, modifications to the EFH areas in that region do not affect the fishery specifications for the limited access and limited access general category scallop fisheries.

There is an important note of caution about the model runs included in this FEIS; the projections of biomass and landings are very high in the short- to medium-term. This is true of both the No Action and preferred alternative runs. In both 2014 and 2015 (and in preliminary 2016 data), very high levels of scallop biomass have been observed in both Georges Bank and Mid-Atlantic, and in particular in the EFH closed area in Nantucket Lightship. Note that the Nantucket Lightship area is not typically a hotspot for scallop recruitment. While the long-term estimates for this area are relatively low, recent recruitment and thus the biomass projections in a few years are very high.

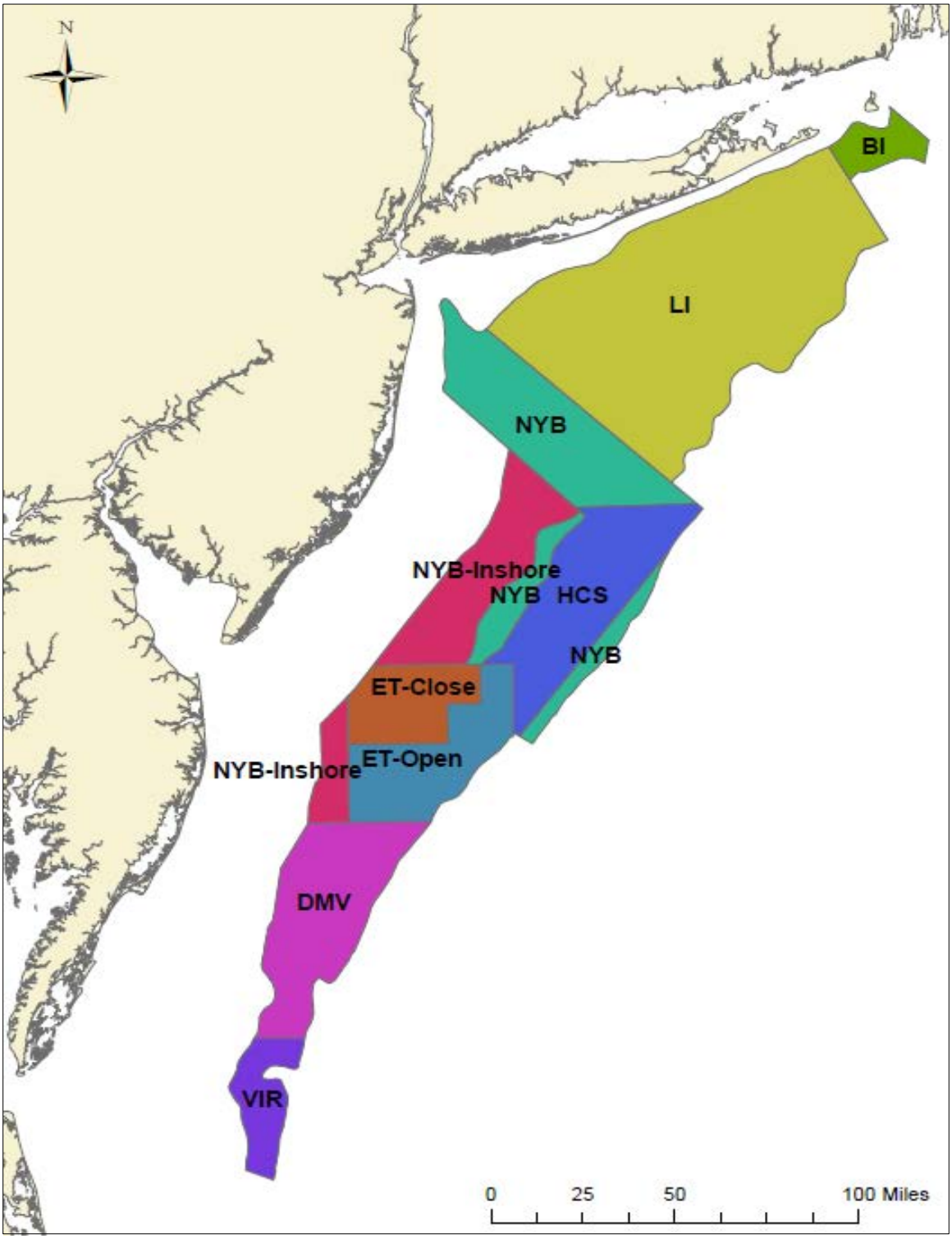
In areas like the Nantucket Lightship where short- to medium-term projections are heavily dependant on the survival of large numbers of recruits, the model results presented here may be optimistic because they do not take density dependent mortality into account. Although 2016 survey data suggest good survival and growth in the Nanctucket Lighship Habitat Closed Area, the SAMS model assumes a constant natural mortality that may be too low for juveniles may be higher in areas of high density. While the SAMS assumption is M=0.16 on Georges Bank and M=0.2 in the Mid-Atlantic on all sizes except the very large scallops (greater than 140mm), there is some evidence from the large 2003 year class in Elephant Trunk that natural mortality was closer to 50% on juvenile scallops (Figure 9).

While natural mortality is always uncertain and may vary by area, the PDT believes that the current assumption of 20% is too low for juvenile scallops in high density areas. If 20% is too low, the overall biomass and yield projections for FY2018-2020 will be too high, because they assume too many animals survive and recruit to the fishery. In Scallop Framework 27 (FY 2016 specifications), the Scallop PDT assessed the potential impacts of higher mortality of juvenile scallops in high density areas and it was found that the impacts of density dependent mortality may be 9-29%. This means that projected landings could be 9-29% lower than projected if mortality of juvenile scallops is higher than M=0.2. Therefore, the projections presented here could be overestimating future landings if density dependent effects are realized in areas with high densities of juvenile scallops. Very large year classes were observed in many areas of Georges Bank and the Mid-Atlantic in 2014 and 2015, but particularly for the EFH area within Nantucket Lightship which would be available to the fishery under the preferred alternative, but closed to the fishery under No Action. These potentially inflated catch projections are temporary, and mostly affect only a few fishing years in the time series when these large year classes are exploitable (FY2018-2020). After those years projected catches begin to return to more normal levels. The differences in short- vs. long-term projections are discussed further below.

Map 89 – SAMS boundaries used for the No Action run on Georges Bank.



Map 90 – SAMS boundaries used for the No Action run in the Mid-Atlantic Bight.



6.2.2.2.1 Short-term impacts on the resource

Table 40 summarizes estimated short-term impacts during fishing year 2017, specifically projected overall fishing mortality, open area fishing mortality, landings, and bottom area swept. Under both scenarios, the open area limit of F=0.48 is the binding constraint on effort for 2017; total fishing mortality is less than the limit of F=0.34 (F=0.15 No Action, F=0.17 preferred). Overall, the projected fishing mortality and area swept estimates are about the same for the two runs in the first year, but landings are higher for the preferred alternative compared to Run 1/No Action. This is driven by fishery access into areas that have been closed (northern part of Closed Area I and the EFH closed area in Closed Area II). This additional access increases the overall fishing mortality and area swept for the preferred alternative in year 1. The landings per area swept are higher under the preferred alternative. In general, the short term impacts on the resource are similar for No Action and the preferred alternative. Note that these area swept values are not conditioned on vulnerability so they are only a rough proxy for impacts to habitat.

Table 40 – Summary of 2017 SAMS results for the No Action and Preferred alternative

	Overall fishing mortality	Open area fishing mortality	Landings (mt)	Bottom Area Swept
Run 1: No Action/Alternative 1	0.15	0.48	37,585	4,139
Run 2: Preferred Alternative	0.17	0.48	39,811	4,242

6.2.2.2.2 Long-term impacts on the resource

The SAMS model is even more useful for assessing potential long-term impacts. Figure 14, Figure 15, Figure 16 and Figure 17 compare the projected landings, biomass, bottom area swept and overall fishing mortality results. These projections are driven by the current fishing target principles used in the Scallop FMP. Specifically, the overall fishing mortality cannot exceed an F=0.34, or the fishing mortality rate associated with the annual catch target for the scallop fishery. In addition, the fishing mortality in open areas cannot exceed 0.48, or F_{MSY} for the resource overall. In some cases the overall limit of F=0.34 constrains the fishery (when the resource is mostly distribued in areas accessible to the fishery), and in other years the open area limit of F=0.48 constrains the fishery. This latter situation occurs when the resource is predominantly in closed areas not available to the fishery.

Table 41 shows the estimated overall and open area fishing mortality estimates for the two runs to illustrate how these principles work together. In the earlier years (2017-2019) a great deal of scallop biomass is contained in closures (EFH closures as well as scallop access areas that have been closed to protect small scallops). Therefore, the overall fishing mortality rates are relatively low for both runs in these years (0.15 – 0.29) because the fishery does not have access to these areas. For these years for both runs, the driver for constraining the fishery is the open area limit, under which F cannot exceed 0.48 in open areas (see purple shaded cells for fishing years 2017-2019 in Table 41). Under the preferred alternative, more areas with scallops are accessible to the fishery (current EFH closed areas), so total F as well as total landings is higher compared to No Action (see Table 41). While the FMP allows the total fishing target to be set at 0.34 overall, the estimated total F rates for both runs are lower than this, because the open area F limit is reached before the overall F limit reaches its limit.

Beyond 2020 for the No Action run, the open area limit of 0.48 remains the constraining factor in every year (see blue shaded cells in Table 41). This is because fishing mortality is zero on the relatively large amounts of biomass in long term closures. Fishing mortality can be higher in other areas, but the open area F=0.48 limit proves constraining. Under the preferred alternative, more areas with significant scallop biomass are open to the fishery, and the overall fishing mortality limit of F=0.34 is the driving factor (see yellow shaded cells in Table 41). This leads to reduced fishing mortality in open areas compared to No Action, but higher total fishing mortality (and higher landings).

As mentioned earlier, it is important to keep in mind that the very unusual and large year class of scallops recently observed in 2014 and 2015 are probably overestimated and this affects projected landings and biomass. The last time a very high abundance of scallops was observed to this degree was in Elephant Trunk in 2003. In that instance, the original projections were 50% lower in subsequent years. Here, the Scallop PDT believes that the actual biomass and landings from these areas will likely be lower than these projections. The overall trend of the preferred alternative having higher landings and fishing mortality, lower biomass, and lower area swept is still expected, just not to this scale. In general when long term closures are in areas with high scallop abundance, overall landings are lower, and total area swept may increase if effort is shifted to areas with lower abundance.

The analyses assume that the first fishing year the EFH measures are effective is FY2017. The model is then projected for 23 years forward (2017-2039). In year 1 the preferred alternative has higher landings (over 2,000 mt or 5 million pounds, Figure 14). This is from access in the EFH closed area in Closed Area I North and the EFH closed area in Closed Area II. In years 2 and 3, both runs see an increase in landings from a very large year class on Georges Bank that has been observed all along the southern flank. The most concentrated areas are within the EFH closed area in Nantucket Lightship, so if that area is opened in this action under the preferred alternative, total landings are expected to increase. The model assumes access in that area would not be until 2018 in the preferred alternative run because the scallops would still be too small in 2017. As described earlier, the Scallop PDT believes the model projections are optimistic because they do not take density dependent mortality into consideration. The actual landings and biomass estimates for these high density areas will likely be lower than the current projections.

After several years once the very large year class moves through the fishery, the landings stream returns to more typical levels between 20-30,000 mt. Overall the preferred alternative has higher projected landings than the No Action alternative. Similarly, in terms of biomass, both runs have very high biomass at first driven by the very large year classes observed in Georges Bank and Mid-Atlantic, and after a few years that declines again to current observations of 150-200,000 mt (Figure 15). The No Action run is projected to have slightly higher biomass than the preferred alternative run for all years until the very end of the time series (2034-2039).

Table 41 – Projected total fishing mortality rates and open area fishing mortality rates for No Action compared to the preferred alternative. During 2017-2019, the preferred alternative has higher fishing mortality overall. Total fishing mortality is the constraint for the preferred alternative in 2020 and beyond (yellow shading). Through 2019, open area F=0.48 is the constraint (purple). Beginning in 2020, open area F=0.48 is the constraint under the No Action areas (blue).

Fishing year	Total Fishing Mortality		Open Area Fishing Mortality	
	No Action	Pref	No Action	Pref
2017	0.15	0.17	0.48	0.48
2018	0.21	0.26	0.48	0.48
2019	0.26	0.29	0.48	0.48
2020	0.32	0.34	0.48	0.35
2021	0.32	0.34	0.48	0.35
2022	0.30	0.34	0.48	0.36
2023	0.28	0.34	0.48	0.36
2024	0.27	0.34	0.48	0.36
2025	0.27	0.34	0.48	0.37
2026	0.27	0.34	0.48	0.38
2027	0.27	0.34	0.48	0.37
2028	0.28	0.34	0.48	0.36
2029	0.28	0.34	0.48	0.36
2030	0.28	0.34	0.48	0.36
2031	0.28	0.33	0.48	0.36
2032	0.28	0.34	0.48	0.36
2033	0.29	0.34	0.48	0.36
2034	0.28	0.34	0.48	0.36
2035	0.28	0.34	0.48	0.36
2036	0.29	0.34	0.48	0.36
2037	0.29	0.34	0.48	0.36
2038	0.29	0.34	0.48	0.36
2039	0.29	0.34	0.48	0.37

Figure 14 – Projected scallop landings (mt, y-axis) for fishing years 2015-2027.

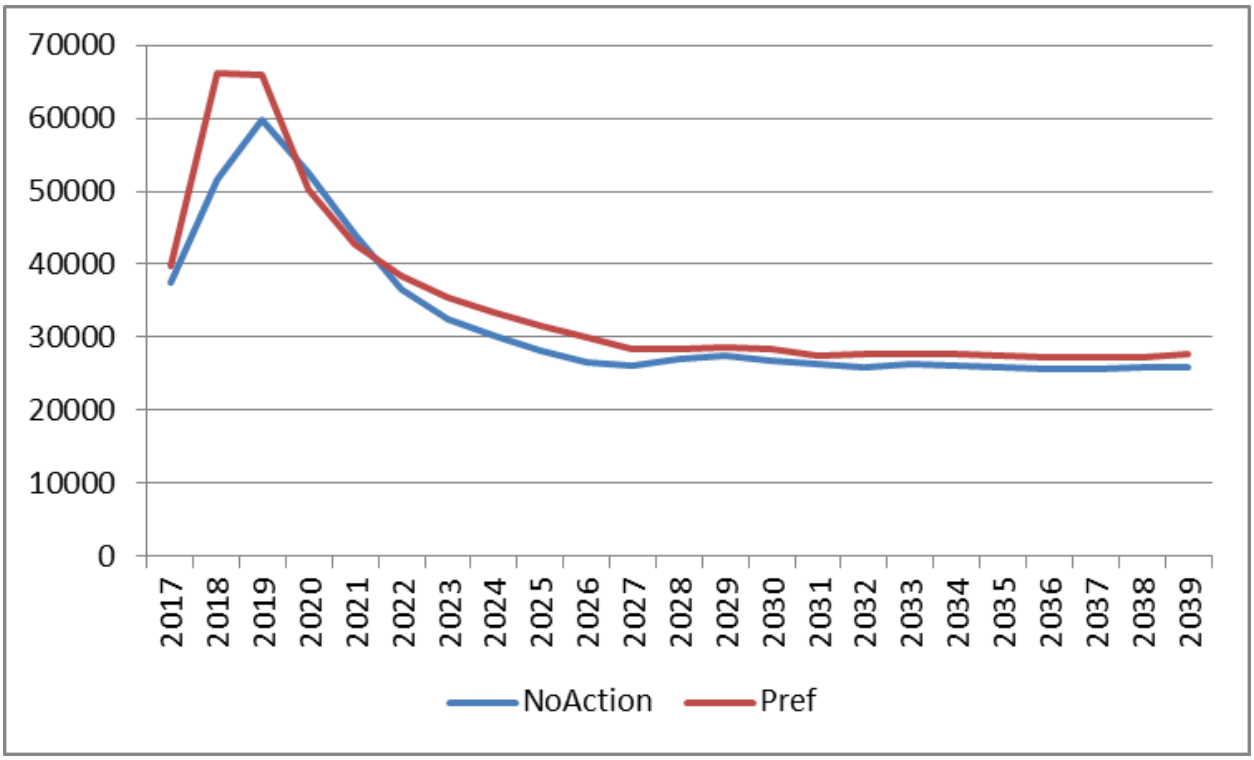
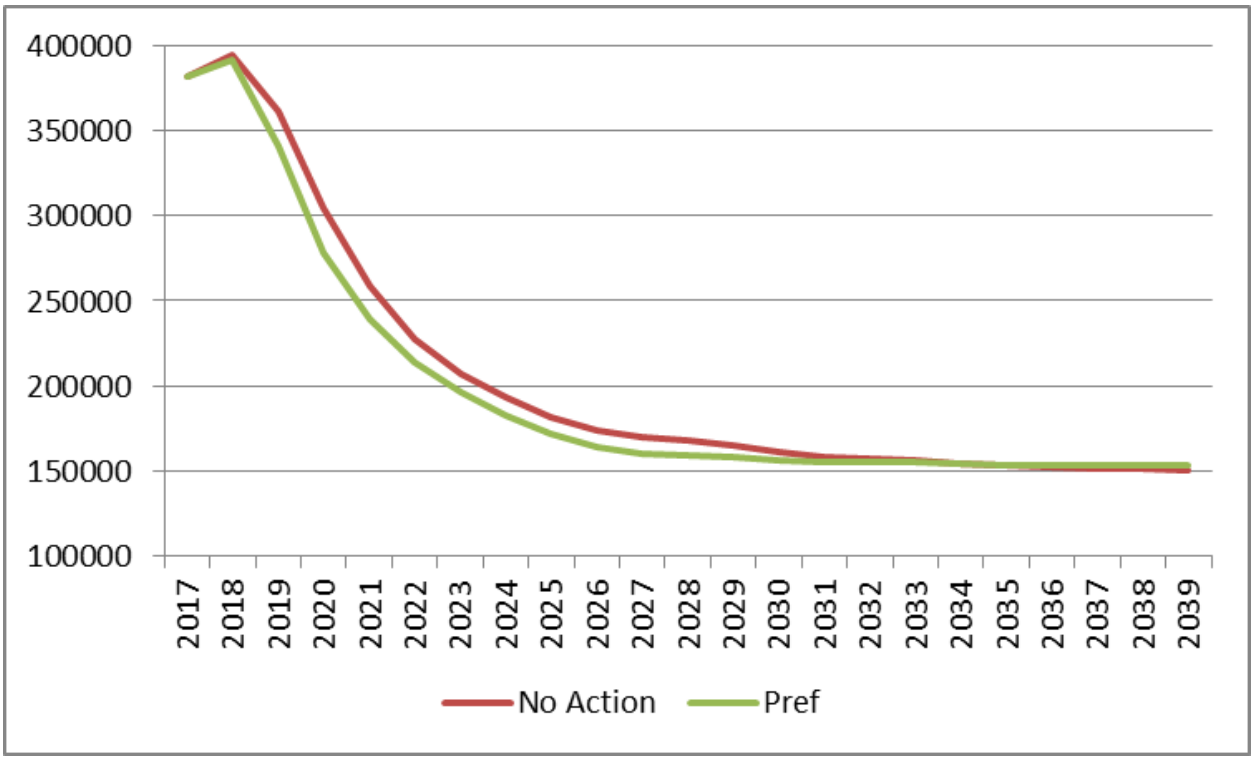


Figure 15 – Projected scallop biomass (mt, y-axis) for fishing years 2015-2027.



In terms of impacts on the resource and the environment it is important to consider the area swept projections (Figure 16). It is important to note that even though total fishing mortality is projected to be higher for the preferred alternative (Figure 17), total area swept is lower for the preferred alternative, while providing higher landings (Figure 14). The projections of area swept are very similar in the first few years for the No Action and Preferred Alternative, but after the large year class is fished out, starting in 2020, the Preferred Alternative has much lower area swept, even though landings are higher under that alternative. This is because under No Action some areas with high densities of scallops will be closed to the fishery. Therefore, fishing effort will increase in other areas to compensate for that lost yield, but the open area limit of 0.48 constrains how high overall fishing can increase to compensate for lower landings. It is important to note that these area swept values are not adjusted for habitat vulnerability. It is possible that the differences in area swept between the two scenarios would be reduced if the SAMS and SASI models were integrated.

In general, the Preferred Alternative does not place habitat closures in areas with high densities of scallops; therefore, the short-term and long-term bottom area swept estimates are lower since the fishery has access to areas with highest catch rates. Overall, the difference in area swept between No Action and the Preferred Alternative is about 1,000 nm^2 per year (5000 No Action vs. 4000 preferred), or about 20% less. Under both the preferred and No Action scenarios, area swept increases between 2017 and 2018, but landings also increase between 2017 and 2018, and do so at a greater rate under the preferred alternative. Area swept values spike during 2019, but examining detailed model results (not shown), this is due to a more than doubling of open area days at sea combined with a dip in open area LPUE across both scenarios.

In summary, the long-term projected landings for the Preferred Alternative are higher than No Action. Not surprisingly, these results suggest that long-term landings would be higher if long-term closures did NOT overlap productive scallop grounds. Some proportion of landings could be made up by increasing effort in other areas, but that is limited by the limit on open area fishing and can increase area swept. Long-term biomass is higher for No Action compared to the Preferred Alternative by about 3% overall for all years combined (2017-2039). The model suggests it will even out in the long term, and after about 2033 the projected biomass for the preferred alternative is actually slightly higher than No Action.

It is difficult to estimate the impacts on future scallop landings and revenue far into the future because it is possible that if this action greatly modifies long-term closed areas the principles currently used to set scallop specifications may be adjusted. For example, if less area is closed in HMAs based on this action, the current limits set for open areas may be reduced and vice versa. These issues would need to be carefully considered and evaluated in future scallop actions that set fishery allocations.

Figure 16 – Projected area swept (nm^2, on y-axis) for fishing years 2015-2027.

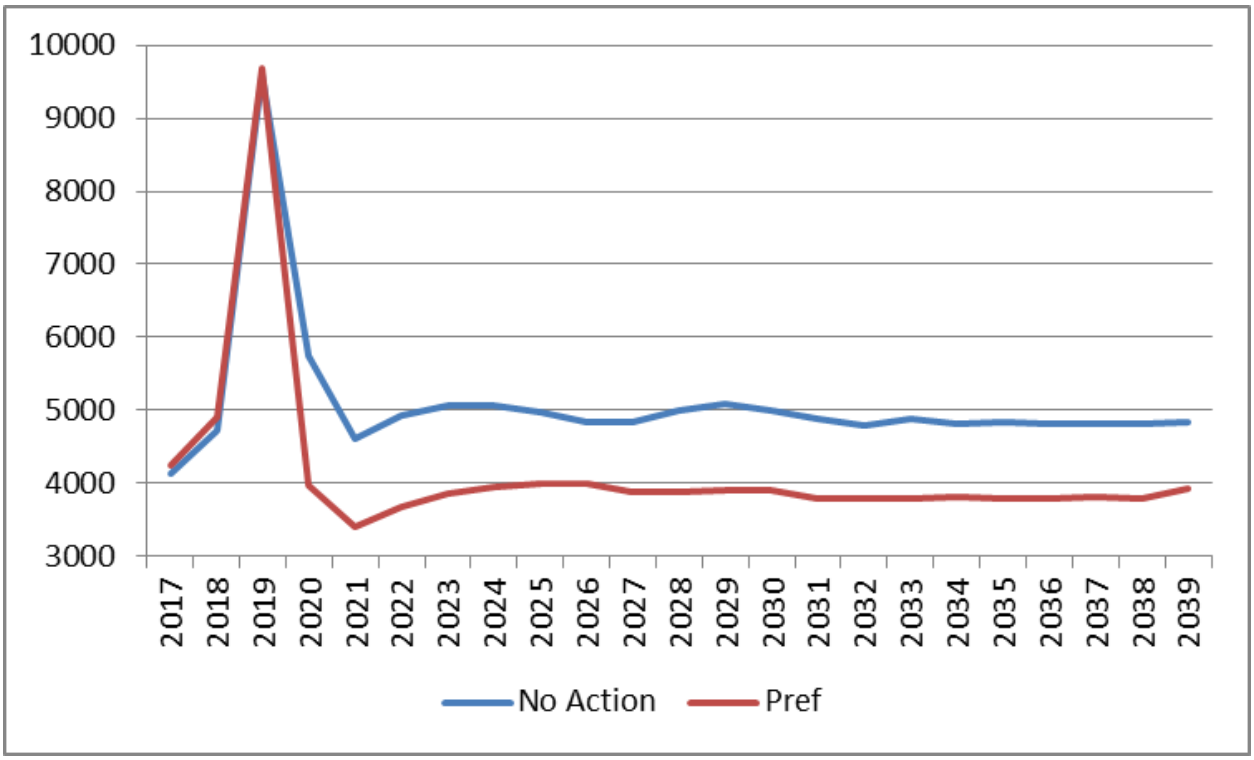
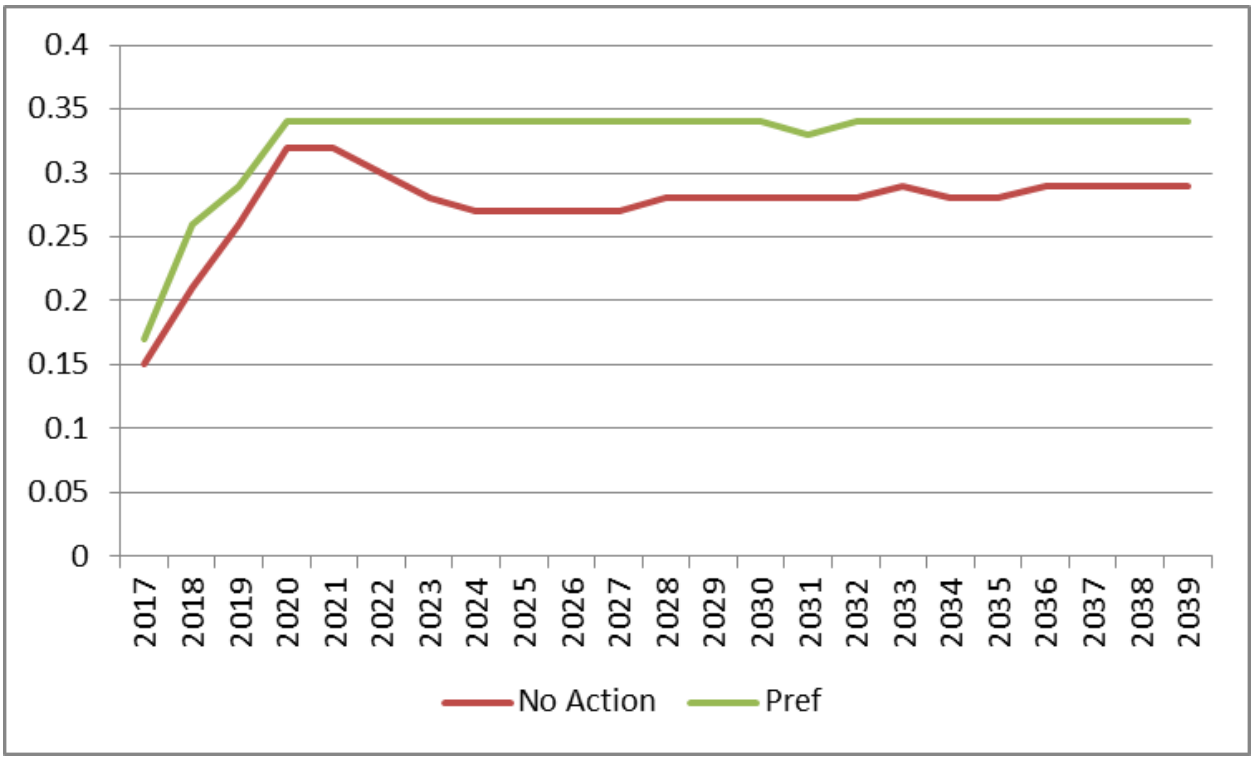


Figure 17 – Projected overall fishing mortality (F, y-axis) for fishing years 2015-2027.



6.2.2.2.3 Short and long-term economic impacts

The following sections use the output results from SAMS to estimate both short-term and long-term economic impacts of the No Action and preferred alternatives. The biological model projected landings, LPUE and size composition of landings for each of these alternatives for 2017-2039. These projections were then used as inputs in the economic model to estimate prices, revenues, costs, producer and consumer surpluses and total economic benefits from the scallop fishery. The impacts of alternatives on individual vessels are expected to be proportional to the aggregate impacts on revenues, fishing costs and net revenues (producer surplus).

Following the 2007 NMFS Guidelines for the Economic Analysis of the Fishery Management Action, the biological and economic impacts of the preferred alternative is compared in this Section to the "No Action". No Action represents current EFH closures, including Closed Area I, Closed Area II, and Nantucket Lightship habitat and groundfish closures, as currently configured, with scallop access areas in the various groundfish closures. The preferred action removes all of the existing habitat closures (Closed Area I, Closed Area II, and Nantucket Lightship), and adds the following areas: two areas on the northern edge (these overlap the existing Closed Area II habitat area, and one can be fished with scallop dredges), the Georges Shoal habitat area (no dredging), the Great South Channel HMA (no dredging) and the Cox Ledge HMA (no dredging). The middle of Closed Area II is also closed June 15-Oct 31 under the preferred action. Under the preferred habitat action, Nantucket Lightship and Closed Area I EFH areas, as well as a portion of the Closed Area II EFH area, will be opened for scallop fishing.

The estimates for the revenues, producer and consumer surpluses and total economic benefits were presented in the majority of Tables in 2015 dollars to provide insight for the managers and the industry participants about the impacts of the proposed measure relative to the current values. They were also summarized in Table 55 and Table 56 in terms of constant 2001 dollars to be consistent with the requested format in OMB Circular A-4 and in assessing the regulatory significance under E.O.12866.

6.2.2.2.3.1 Summary of economic benefits of the preferred alternative and no action

The preferred habitat management alternative is expected to have positive economic impacts on the scallop fishery. Annual economic benefits net of no action will be considerably higher in the short- to medium-term (Table 52 and Table 53) mostly due to the unprecedented increase in the projected exploitable biomass especially in fishing years 2017 to 2019. Landings are estimated to reach historically record levels of about 86 million lb. for No Action and to 90 million lb. for the preferred alternative in 2017, and to about 110 million for No Action and 132 million for the preferred alternative in 2018 (Table 42). As a result, the present value of the economic benefits for the preferred action will increase by about $38 million ($41 million), or by 5% , in 2017 using a 7% (3%) discount rate compared to the No Action benefits as the EFH portions of Closed Areas I and II are reopened in 2017 (Table 51, Table 52, and Figure 18). It should be noted that the Scallop PDT believes these estimates are very optimistic and total landings will likely not reach these levels (this issue is described in detail above). There are two very large year classes of juvenile scallops along the southern flank of Georges Bank and throughout the scallop access areas in the Mid-Atlantic, which are driving these increases in projected landings for the first few years of this analysis. The Scallop PDT believes that natural mortality of juvenile scallops is

relatively high in areas with high concentrations of scallops. There is some evidence from the large 2003 year class in Elephant Trunk that natural mortality was closer to 50% on juvenile scallops, compared to the current assumption of 20% used in the assessment model (Figure 9).

In the fishing year 2018, the present value of economic benefits for the preferred alternative is expected to exceed the levels for no action by about $169 million ($189 million) using a 7% discount rate (3% discount rate) as the EFH portion of Nantucket Lightship is reopened as well in this year. However, the scallop PDT believes the current projections are overly optimistic because they do not take density dependent mortality into account inflating the estimates for the exploitable biomass. As a result, landings and economic benefits could be greatly overestimated, particularly for the preferred alternative run because the fishery would have access to the EFH closed area in Nantucket Lightship, compared to the No Action run that maintains that closure (see Section 6.2.2.1 for more discussion). Figure 18 shows that the jump in economic benefits as well as the surge in net economic benefits for the preferred alternative compared to No Action in 2018. The difference between the value of economic benefits for the preferred and no action alternatives is estimated to taper off especially after the 2019 fishing year.

Present values of the cumulative economic benefits and net of no action values are summarized in Figure 19 to Figure 22 for three time periods. The cumulative present value of total economic benefits for the preferred action is projected to exceed the no action value by about $313 million ($278 million) during the first three years of implementation (from 2017 to 2019) using a 3% discount rate (7% discount rate). However, the increase in the cumulative present value of the economic benefits net of no action benefits is smaller in the following periods due to discounting of the future values, and also because landings projections go down to about 60 million pounds in the later years. The lower, future projections are more in line with the maximum historical levels experienced prior to the current fishing year.

From 2020 to 2028, the cumulative present value for the preferred alternative is projected to exceed no action values by $363 million ($250 million) using a 3% discount rate (7 % discount rate). Over the long-term from 2028-2039, economic benefits for the preferred alternative are expected to exceed the no action values by $289 million ($142 million) using a 3% discount rate (7 % discount rate). From these values, it is clear that a significant portion of the increase in total economic benefits occurs in the first three years of implementation and tapers off afterwards.

The preferred alternative also includes a seasonal closure of Closed Area II north of 41° 30’ N from June 15-October 30. This would prevent fishing in most of the reduced impact habitat area on the northern edge during that time. Seasonal closures can reduce flexibility for vessels, increase fishing costs and have other unpredictable economic consequences. If approved this closure is 4.5 months in length, so the fishery would still have the majority of the year to fish access area trips between November 1 and June 14 (7.5 months). However, some of this period is during the fall and winter, when scallop meat weights are at their lowest. Because scallop prices are usually higher for larger scallops, fishing during the months when scallop meats are lower could have some negative impacts on overall prices and revenues. On the other hand, seasonal closures can restrict the overall supply of scallops in the market and can lead to a rise in prices during the closure months, counteracting any potential price declines in other periods. There could be some low long-term negative impacts on the overall yield and economic benefits, as

well, due to an increase in mortality if fishing shifts to these lower meat weight months. However, these potential effort shifts are uncertain. Therefore, overall impacts of the seasonal closure could be low negative to low positive depending on effort shifts, but in general seasonal closures limit flexibility for the fishery, which can have unintended economic consequences.

Figure 18 – Present value of annual total economic benefits ($ million, in 2015 constant dollars and using a 7% discount rate)

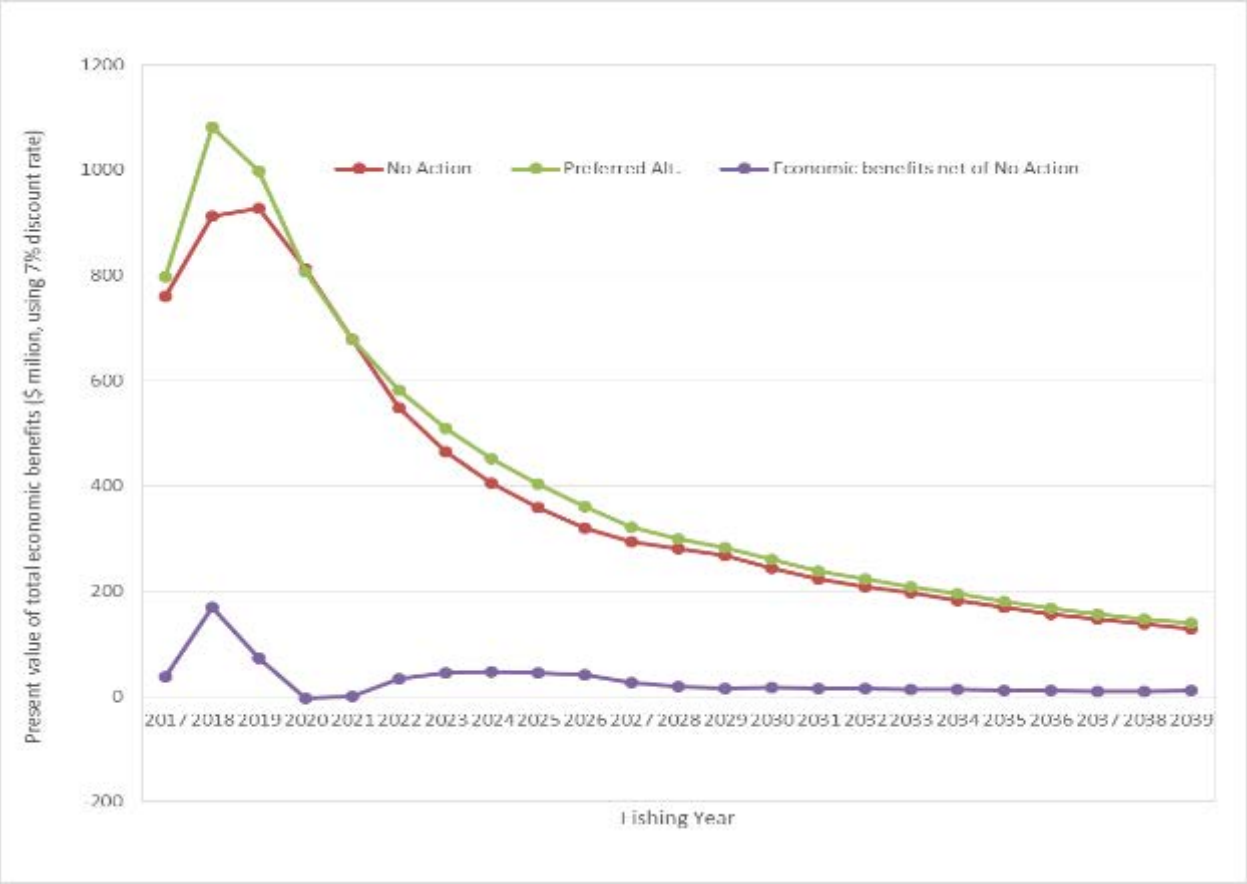


Figure 19 – Cumulative present value of total economic benefits for the scallop fishery: Values are millions of dollars, 7 percent discount rate (in 2015 constant dollars). The darker shading on the left encompasses fishing years 2017-2019, the lighter shading in the center encompasses fishing years 2020-2028, and the medium shading on the right encompasses fishing years 2029-2039. Combining all three time periods, the cumulative present value of total economic benefits is higher for the preferred alternative by $670 million dollars.

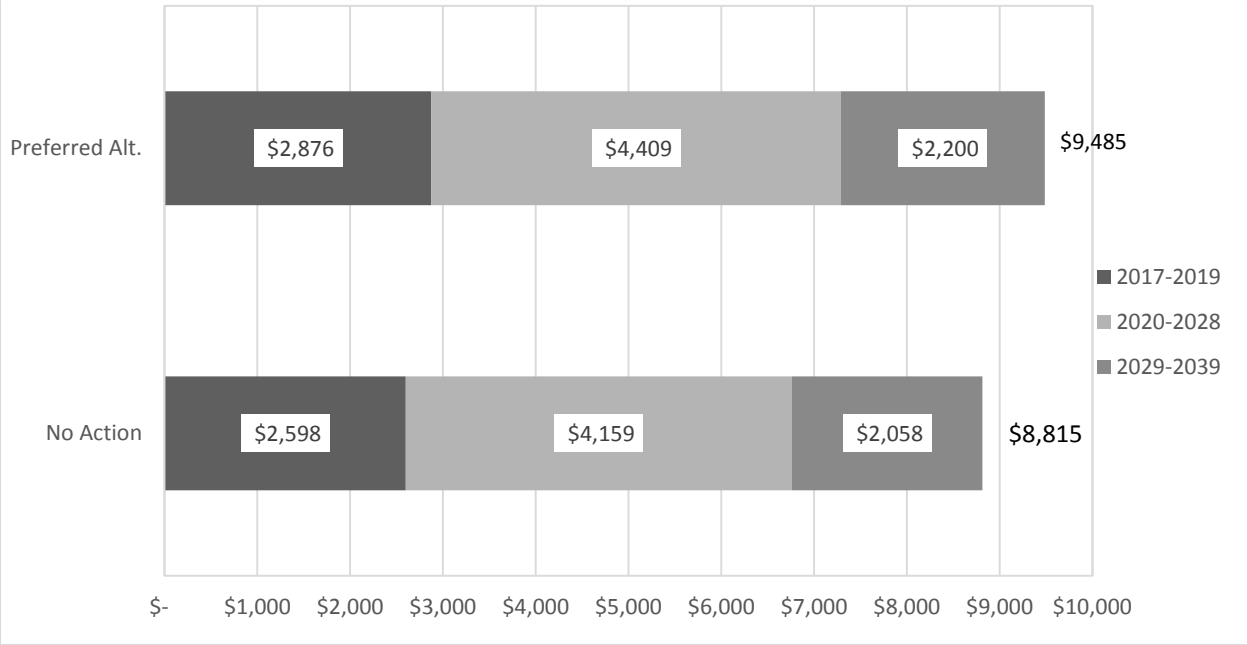


Figure 20 – Cumulative present value of total economic benefits for the scallop fishery. Values are millions of dollars, 3 percent discount rate (in 2015 constant dollars).

Figure 21 – Cumulative present value of net economic benefits for the scallop fishery. Values are millions of dollars net of No Action, 7 percent discount rate (in 2015 constant dollars).

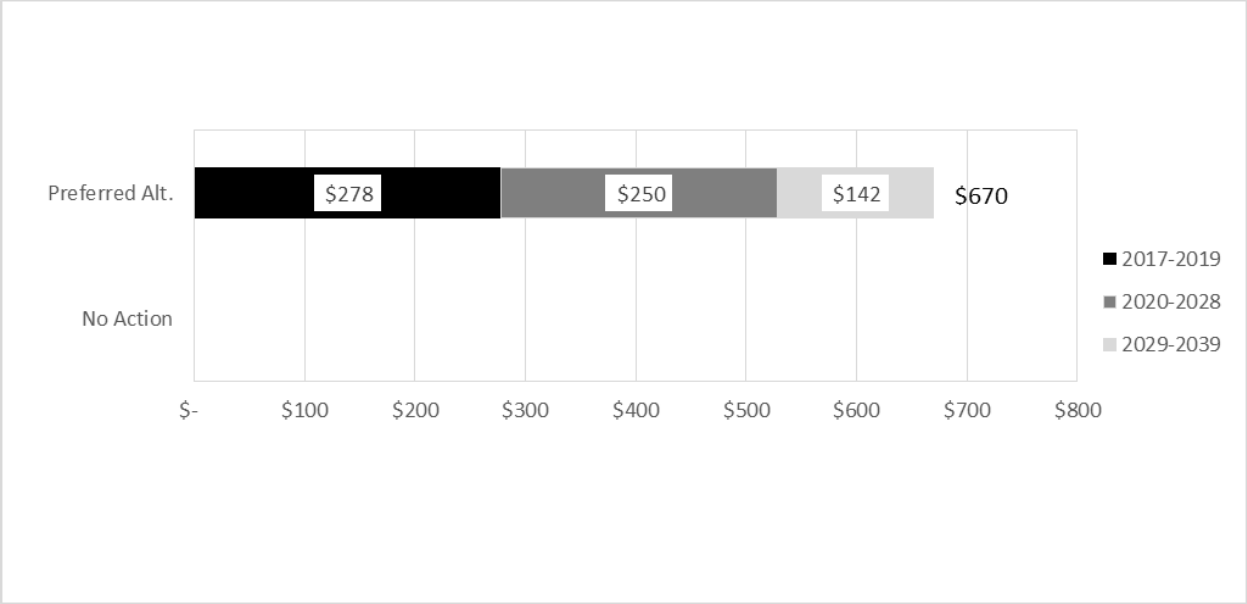
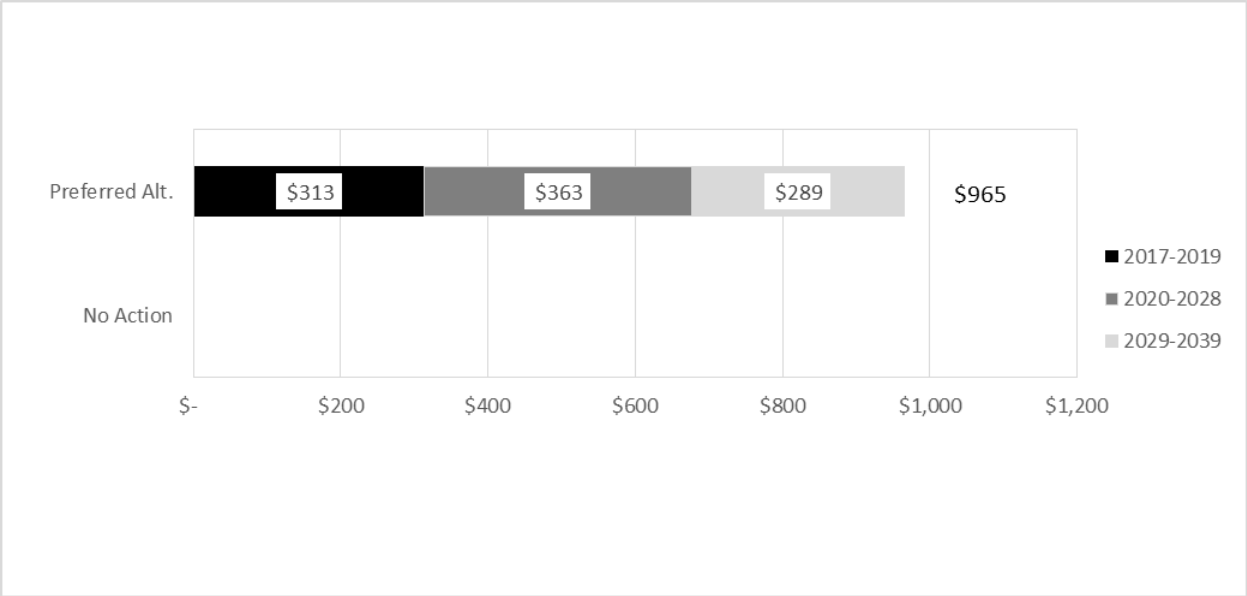


Figure 22 – Cumulative present value of net economic benefits for the scallop fishery. Values are millions of dollars net of No Action, 3 percent discount rate (in 2015 constant dollars).



6.2.2.2.3.2 Landings, effort and trip costs

Annual average landings for the preferred alternative are projected to exceed the landings for No Action by about 6% in the first fishing year of implementation (2017) and over the long-term from 2017 to 2039. However, the percentage difference between the landings for No Action and the preferred alternative is not uniform and ranges from a maximum of 28% in fishing year 2018

to -3% in fishing year 2022. The landings in the short-term are higher under the preferred alternative, especially starting in 2018, due to the opening of the Nantucket Lightship EFH area that was estimated to have a large exploitable biomass. As previously noted, the estimates are likely high and actual landings and benefits may be lower if the mortality rate of juvenile scallops increases under high density situations. The cumulative landings for 2017-2039 for the preferred alternative are estimated to be 118.5 million lb. higher than the levels for No Action, mainly because of the large increase in landings in the short-term. As explained in detail above, very large year classes were observed in many areas of Georges Bank and the Mid-Atlantic in 2014 and 2015, but particularly for the EFH area within Nantucket Lightship. Therefore, landings under both scenarios could be lower than projected if mortality of juvenile scallops is higher than rates used in the SAMS model. Landings for the preferred alternative might be overestimated somewhat more relative to No Action, because the EFH area within Nantucket Lightship would be available to the fishery under the preferred alternative but not under No Action.

However, very large year classes are observed in other areas of Georges Bank and the Mid-Atlantic as well. Therefore, landings for the preferred alternative are expected to exceed the levels for No Action both in the short and the long-term although the increase in landings and benefits relative to the No Action could be smaller in absolute values than the estimates provided in this section. In addition, potentially overestimated landings estimates are temporary and mostly affect only a few fishing years when these large year classes are exploitable. After those years, landings are projected to be similar to the historically observed values, and the annual landings for the preferred alternative are estimated to exceed the No Action levels by a more modest 4% to 13% between 2022 and 2039. In short, present value of the cumulative long-term economic benefits of the preferred action relative to the No Action levels are still expected to be positive, but the magnitude of the difference will depend on realized natural mortality rates in high density areas, which cannot be precisely forecast at this time.

Estimated DAS per limited access vessel in the access areas in 2017-2019 is higher for the preferred alternative compared to No Action. This is because preferred alternative opens the CL-1 EFH areas and a portion of the Closed Area 2 EFH area in 2017 and opens Nantucket Lightship EFH area in 2018 for scallop fishing. Open area allocations would be equivalent to the no action DAS in 2017 and slightly higher than no action in 2018-2019.

Estimated total trip costs for the fleet under the preferred alternative would be higher in the short-term from 2017 to 2019 as new areas are opened to fishing and effort in those areas increases (Table 44). Trip costs will be lower, however, for the preferred alternative after 2020 as LPUE increases and overall DAS spent for fishing relative to No Action levels goes down (Table 43 and Table 45). The decline in effort would considerably reduce the area swept by 31% in 2020 and about 20% thereafter (Table 40).

Table 42 – Estimated landings (Million lb.)

Fishing year	No Action	Preferred Alternative	Net of No action	% Change from No Action
2017	82.9	87.8	4.9	6%
2018	113.7	145.7	31.9	28%

Fishing year	No Action	Preferred Alternative	Net of No action	% Change from No Action
2019	131.7	145.2	13.5	10%
2020	115.9	110.7	-5.2	-4%
2021	97.0	94.2	-2.8	-3%
2022	80.6	84.5	3.9	5%
2023	71.8	78.3	6.5	9%
2024	66.4	73.6	7.2	11%
2025	62.2	69.7	7.4	12%
2026	58.7	66.1	7.4	13%
2027	57.7	62.4	4.7	8%
2028	59.8	62.7	2.9	5%
2029	60.8	63.2	2.4	4%
2030	59.0	62.5	3.5	6%
2031	57.8	60.8	3.0	5%
2032	57.3	61.0	3.6	6%
2033	58.2	61.1	2.9	5%
2034	57.5	61.0	3.5	6%
2035	57.1	60.4	3.3	6%
2036	56.7	60.0	3.3	6%
2037	56.8	60.0	3.2	6%
2038	57.0	60.1	3.2	6%
2039	56.9	61.2	4.2	7%
2017-2039 total	1633.7	1752.2	118.5	6%

Table 43 – Estimated DAS per Limited Access Vessel

Fishing year	Open Area DAS		Estimated total DAS	
	No Action	Preferred Alternative	No Action	Preferred Alternative
2017	47	47	86	90
2018	49	50	110	132
2019	112	113	145	154
2020	105	82	116	102
2021	84	69	95	86
2022	74	65	84	80
2023	69	64	78	76
2024	66	62	74	73
2025	62	60	71	70
2026	59	58	67	68
2027	59	55	67	65
2028	62	56	69	65
2029	63	57	70	66
2030	62	57	69	65
2031	60	55	67	63
2032	59	55	66	64
2033	61	55	67	64
2034	60	55	66	64
2035	59	55	66	63

Fishing year	Open Area DAS		Estimated total DAS	
	No Action	Preferred Alternative	No Action	Preferred Alternative
2036	59	54	66	63
2037	59	54	66	63
2038	59	54	66	63
2039	59	56	66	64

Table 44 – Estimated total trip costs for the fleet ($ Million, in 2015 constant dollars)

Fishing year	No Action	Preferred Alternative	% Change from No Action
2017	73	76	4%
2018	94	112	20%
2019	123	130	6%
2020	98	86	-12%
2021	80	73	-10%
2022	71	67	-5%
2023	66	64	-3%
2024	63	62	-2%
2025	60	60	0%
2026	57	57	1%
2027	56	55	-3%
2028	59	55	-6%
2029	60	56	-7%
2030	58	55	-5%
2031	57	54	-6%
2032	56	54	-4%
2033	57	54	-5%
2034	56	54	-4%
2035	56	53	-5%
2036	56	53	-5%
2037	56	53	-5%
2038	56	53	-5%
2039	56	54	-3%
Grand Total	1524	1492	-2%

Table 45 – Average LPUE for all areas

Fishing year	No Action	Preferred Alternative	Preferred Alternative – No Action	% Change from No Action
2017	2695	2734	39	1%
2018	2888	3084	196	6%
2019	2552	2652	100	4%
2020	2809	3058	249	8%
2021	2870	3085	215	7%
2022	2690	2976	286	10%
2023	2570	2890	320	11%
2024	2509	2831	322	11%

2025	2473	2782	309	11%
2026	2451	2741	290	11%
2027	2431	2713	282	10%
2028	2419	2694	275	10%
2029	2421	2696	275	10%
2030	2412	2686	274	10%
2031	2413	2687	274	10%
2032	2422	2688	266	10%
2033	2423	2689	266	10%
2034	2428	2690	262	10%
2035	2422	2687	265	10%
2036	2416	2680	264	10%
2037	2416	2677	261	10%
2038	2423	2681	258	10%
2039	2421	2673	252	9%
Average	2521	2773	252	9%

6.2.2.2.3.3 Price and Revenue

- Ex-vessel prices of scallops are expected to be lower for the preferred alternative in the short-term from 2017 to 2019 compared to No Action because landings will be higher when the current EFH areas are opened to scallop fishing (Table 46). Over the long-term, however, average annual prices are expected to be similar for both the No Action ($11 per lb.) and preferred alternative ($10.9 per lb.).
- The annual scallop revenues expressed in 2015 constant prices (undiscounted values) will be higher for the preferred alternative compared to No Action scenario both in the short- and the long-term due to higher landings under this action (Table 47). Scallop revenues are expected to exceed the revenues for no action by $35.1 million in 2017.
- The cumulative present value of revenues for the preferred action are projected to exceed the no action values by about $195.8 million ($174.1 million) from 2017 to 2019 using a 3% discount rate (7% discount rate) in terms of 2015 constant dollars (Table 48 and Table 49).
- Over the long-term from 2017 to 2039, preferred alternative would result in larger cumulative revenues exceeding the No Action values by $716.4 million ($485.9 million) estimated using a 3% discount rate (7 % discount rate, Table 48 and Table 49). Again, this is the result of higher expected landings for the preferred alternative (Overall 6% higher for 2017-2039, Table 42)

Table 46 – Projections for average annual price (in 2015 constant dollars)

Period	Fishing year	No Action	Preferred Alternative
2017-2019	2017	10.2	10.0
	2018	9.1	7.9
	2019	8.4	8.0
2017-2019 average		9.2	8.6
2020-2028	2020	9.1	9.4
	2021	9.9	10.2
	2022	10.6	10.6
	2023	10.9	10.8
	2024	11.1	11.0
	2025	11.3	11.1
	2026	11.5	11.3
	2027	11.5	11.4
	2028	11.4	11.4
2020-2028 average		10.8	10.8
2029-2039 average		11.5	11.5
2014-2039 average		11.0	10.9

Table 47 – Revenue projections (in 2015 constant dollars)

Period	Fishing year	No Action	Preferred Alternative	Net of No Action	% Change form No Action
2017-2019	2017	842.7	877.8	35.1	4%
	2018	1032.3	1154.6	122.3	12%
	2019	1107.4	1164.6	57.3	5%
2017-2019 Total		2982.4	3197.0	214.6	7%
2020-2028	2020	1050.1	1043.3	-6.8	-1%
	2021	960.1	958.1	-1.9	0%
	2022	852.4	892.1	39.8	5%
	2023	783.7	844.6	61.0	8%
	2024	740.1	807.8	67.8	9%
	2025	704.6	775.7	71.1	10%
	2026	673.8	745.8	72.1	11%
	2027	664.4	714.5	50.1	8%
	2028	680.1	714.5	34.4	5%
2020-2028 Total		7109.1	7496.5	387.4	5%
2029-2039 Total		7292.3	7699.4	407.2	6%
Grand Total		17383.7	18392.9	1009.2	6%

Table 48 – Cumulative present value of total scallop revenue (using 3% discount rate, in 2015 constant dollars)

Period	No Action	Preferred Alternative	Net of No Action	% Change from No Action
2017-2019	2722.9	2918.7	195.8	7.2%
2020-2028	5528.9	5817.3	288.4	5.2%
2029-2039	4181.8	4413.9	232.1	5.6%
Grand Total	12433.5	13149.9	716.4	5.8%

Table 49 - Present value of total scallop revenue (using 7% discount rate, in 2015 constant dollars)

Period	No Action	Preferred Alternative	Net of No Action	% Change from No Action
2017-2019	2423.5	2597.6	174.1	7.2%
2020-2028	4033.4	4231.2	197.9	4.9%
2029-2039	2068.5	2182.5	114.0	5.5%
Grand Total	8525.4	9011.3	485.9	5.7%

6.2.2.2.3.4 Present Value of Total Economic Benefits

Economic benefits include the benefits both to the consumers and to the fishing industry and equal the sum of consumers and producers surpluses. Producer surplus shows the difference between the gross revenue and variable costs of production (excluding the crew shares). Consumer surplus is the difference between the total amount that consumers are willing and able to pay for scallops and the total amount that they actually do pay at the determined market price of scallops.

- The annual values for the producer and consumer surpluses expressed in 2015 constant dollars (undiscounted values) will be higher for the preferred alternative compared to No Action both in the short- and the long-term due to higher landings under the preferred alternative (Table 50). Producer surplus is expected to be 4% higher and consumer surplus 11% higher from No Action values in 2017 due to higher landings, and also due lower prices in the case of consumer surplus.
- The cumulative present value of total economic benefits for the preferred action are projected to exceed the no action values by about $313 million ($278 million) from 2017 to 2019 using a 3% discount rate (7% discount rate) in terms of 2015 constant dollars (Table 53 and Table 54).
- Over the long-term from 2017 to 2039, preferred alternative would result in the largest cumulative economic benefits exceeding the No Action values by $965 million ($670 million) estimated using a 3% discount rate (7 % discount rate, Table 53 and Table 54).

Table 50 – Producer and consumer surpluses (undiscounted values, million $ in 2015 constant dollars)

	No Action	Preferred Alternative	% Change from No Action

Fishing year	Producer Surplus	Consumer Surplus	Producer Surplus	Consumer Surplus	Producer Surplus	Consumer Surplus
2017	770	100	801	111	4%	11%
2018	939	179	1042	282	11%	58%
2019	985	230	1035	274	5%	19%
2020	952	186	957	174	1%	-6%
2021	880	138	886	132	1%	-4%
2022	781	98	825	108	6%	10%
2023	717	79	780	94	9%	19%
2024	677	69	746	84	10%	22%
2025	645	61	716	76	11%	24%
2026	617	55	689	69	12%	26%
2027	608	53	660	62	9%	17%
2028	621	57	659	62	6%	10%
2029	630	58	663	63	5%	9%
2030	616	55	657	62	7%	12%
2031	607	53	645	59	6%	11%
2032	603	52	645	59	7%	13%
2033	610	54	646	60	6%	11%
2034	605	53	646	59	7%	13%
2035	602	52	642	58	7%	12%
2036	598	51	638	58	7%	12%
2037	598	51	637	58	7%	12%
2038	600	52	639	58	6%	12%
2039	600	52	646	60	8%	15%
Grand Total	15860	1888	16901	2183	7%	16%

Table 51 – Present value of annual total economic benefits (using 3% discount rate, million $ in 2015 constant dollars)

Fishing year	No Action	Preferred Alt.	Economic benefits net of No Action	% change
2017	820	860	41	5.0%
2018	1023	1212	189	18.5%
2019	1079	1163	83	7.7%
2020	981	976	-5	-0.5%
2021	852	852	0	0.0%
2022	715	759	44	6.1%
2023	629	690	61	9.8%
2024	572	636	64	11.3%
2025	525	589	64	12.2%
2026	485	547	62	12.8%
2027	464	506	43	9.2%
2028	462	491	30	6.5%
2029	455	480	26	5.7%
2030	431	462	31	7.2%
2031	411	439	27	6.6%
2032	396	426	30	7.5%
2033	390	415	25	6.4%
2034	375	402	27	7.2%

Fishing year	No Action	Preferred Alt.	Economic benefits net of No Action	% change
2035	362	388	25	7.0%
2036	349	374	25	7.1%
2037	339	363	24	7.0%
2038	330	353	23	6.8%
2039	321	347	26	8.3%
Grand Total	12766	13731	965	7.6%

Table 52 – Present value of annual total economic benefits (using 7% discount rate, million $ in 2015 constant dollars)

Fishing year	No Action	Preferred Alt.	Economic benefits net of No Action	% change
2017	760	797	38	5.0%
2018	912	1081	169	18.5%
2019	927	998	72	7.7%
2020	811	807	-4	-0.5%
2021	678	678	0	0.0%
2022	548	581	33	6.1%
2023	464	509	45	9.8%
2024	406	451	46	11.3%
2025	359	403	44	12.2%
2026	319	360	41	12.8%
2027	294	321	27	9.2%
2028	281	299	18	6.5%
2029	267	282	15	5.7%
2030	243	261	18	7.2%
2031	224	238	15	6.6%
2032	207	223	16	7.5%
2033	196	209	13	6.4%
2034	182	195	13	7.2%
2035	169	181	12	7.0%
2036	157	168	11	7.1%
2037	147	157	10	7.0%
2038	138	147	9	6.8%
2039	129	139	11	8.3%
Grand Total	8815	9485	670	7.6%

Table 53 – Cumulative present value of total economic benefits (using 3% discount rate, in 2015 constant dollars)

Period	Values	No Action	Preferred Alternative	Net of No Action	% Change in benefits
2017-2019	PV of total Benefits	2921.4	3234.5	313	10.7%
	PV of producer surplus	2459.5	2628.6	169	6.9%
	PV of consumer surplus	461.9	606.0	144	31.2%

2020-2028	PV of total Benefits	5684.7	6047.8	363	6.4%
	PV of producer surplus	5053.4	5367.7	314	6.2%
	PV of consumer surplus	631.3	680.1	49	7.7%
2029-2039	PV of total Benefits	4159.5	4448.6	289	6.9%
	PV of producer surplus	3824.0	4073.3	249	6.5%
	PV of consumer surplus	335.6	375.2	40	11.8%
2017-2039	PV of total benefits	12765.7	13730.9	965	7.6%
	PV of producer surplus	11336.9	12069.6	733	6.5%
	PV of consumer surplus	1428.8	1661.3	233	16.3%

Table 54 – Cumulative present value of total economic benefits (using 7% discount rate, in 2015 constant dollars)

Period	Values	No Action	Preferred Alternative	Net of No Action	% Change in benefits
2017-2019	PV of total Benefits	2598.3	2876.2	278	10.7%
	PV of producer surplus	2189.8	2340.2	150	6.9%
	PV of consumer surplus	408.5	536.0	128	31.2%
2020-2028	PV of total Benefits	4158.8	4408.9	250	6.0%
	PV of producer surplus	3686.0	3903.8	218	5.9%
	PV of consumer surplus	472.9	505.0	32	6.8%
2029-2039	PV of total Benefits	2057.8	2199.9	142	6.9%
	PV of producer surplus	1891.4	2014.0	123	6.5%
	PV of consumer surplus	166.4	185.8	19	11.7%
2017-2039	PV of total benefits	8814.9	9485.0	670	7.6%
	PV of producer surplus	7767.2	8258.0	491	6.3%
	PV of consumer surplus	1047.7	1226.9	179	17.1%

Table 55 – Economic Impacts for 2017: revenues and total economic benefits (million $, in 2001 constant dollars)

Values	Present Values using a discount rate of 7%		Present Values using a discount rate of 3%	
	No Action	Preferred Action	No Action	Preferred Action
Revenue ($ Million)	557.6	580.8	601.7	626.8
Total Benefits ($ Million)	575.5	604.0	621.1	651.8
Difference from No Action				
Revenue ($ Million)		23.2		25.0
Total Benefits ($ Million)		28.5		30.7

Table 56 – Long-term Economic Impacts from 2017 to 2039 fishing years: Cumulative present value of revenues and total economic benefits *net of No Action* values (in 2001 constant dollars)

Values	Present Values using a discount rate of 7%	Present Values using a discount rate of 3%

	No Action	Preferred Action	No Action	Preferred Action
Revenue ($ Million)	6458.6	6826.8	9419.4	9962.1
Total Benefits ($ Million)	6678.0	7185.6	9671.0	10402.2
Difference from No Action				
Revenue ($ Million)		368.1		542.7
Total Benefits ($ Million)		507.6		731.2

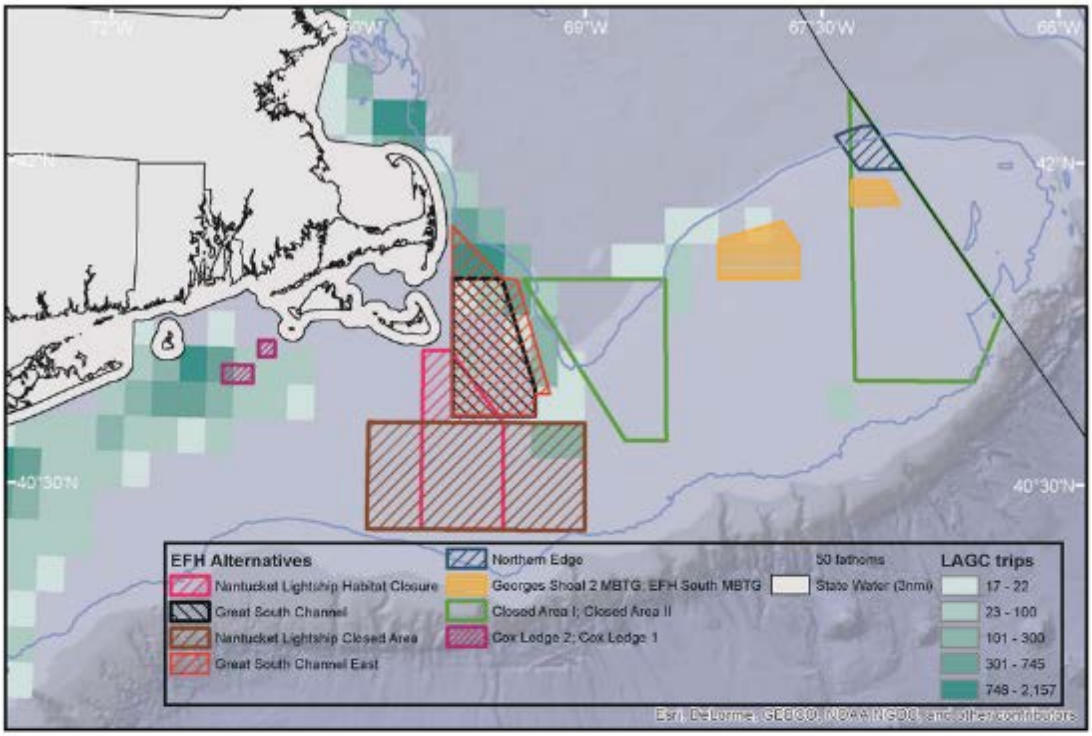
6.2.2.3 ***Differential impacts between LA and LAGC fleets***

For the most part, the analysis of fishery impacts is by gear type, which combines both segments of the scallop dredge fishery. While the economic analyses are by vessel size, the potential for distributional effects between the LAGC and LA fleets is not discussed in detail. The maps on the following pages were used to evaluate the impacts of closed areas on the LA and LAGC fisheries separately. Specific attention was given to the areas of concern mentioned in public comments, Alternative 3 in the Channel (Great South Channel East HMA) and Cox Ledge 1 HMA. Trips were binned into ten minute squares, and areas with less than three unique vessels, or relatively low levels of effort are not shown (less than ten trips per TMS are not shown on the LA map and less than 17 trips per TMS are not shown on the LAGC map).

The Great South Channel East HMA encompasses effort from both segments of the fishery, but the Cox Ledge 1 HMA appears to only overlap with the LAGC fishery. In the Great South Channel, LAGC effort is concentrated east of Cape Cod, while LA effort is concentrated further to the south and east.

A LAGC vessel is not allowed to fish for scallops with a dredge in areas outside of a scallop dredge exemption area. The figure below shows the current scallop dredge exemption areas. If any areas that are currently closed as EFH closures open as a result of this action, LAGC dredge vessels would not be permitted to fish in those areas unless the area is modified to a scallop access area. LAGC dredge vessels can fish with a dredge within a scallop access area, even if it is outside of a dredge exemption area.

Map 91 – FY2010-2014 scallop fishing locations from all LAGC IFQ trips (top) and LA trips (bottom). VTR location binned by ten minute square. Note: Ten minute squares are colored only when three or more vessels fished during this time period. Areas not colored represent 0-3 vessels. The colored areas, therefore, represent the most intensively utilized areas. As there are no dredge exemption areas east of Closed Area I, trips mapped in that location are assumed to be reporting errors.



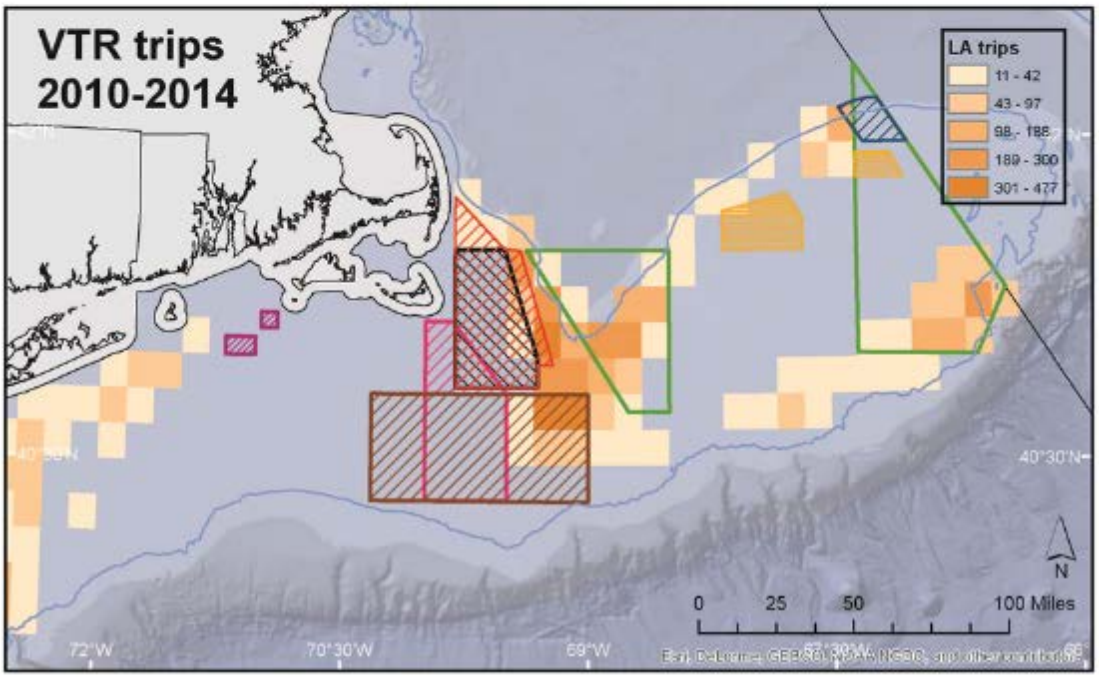
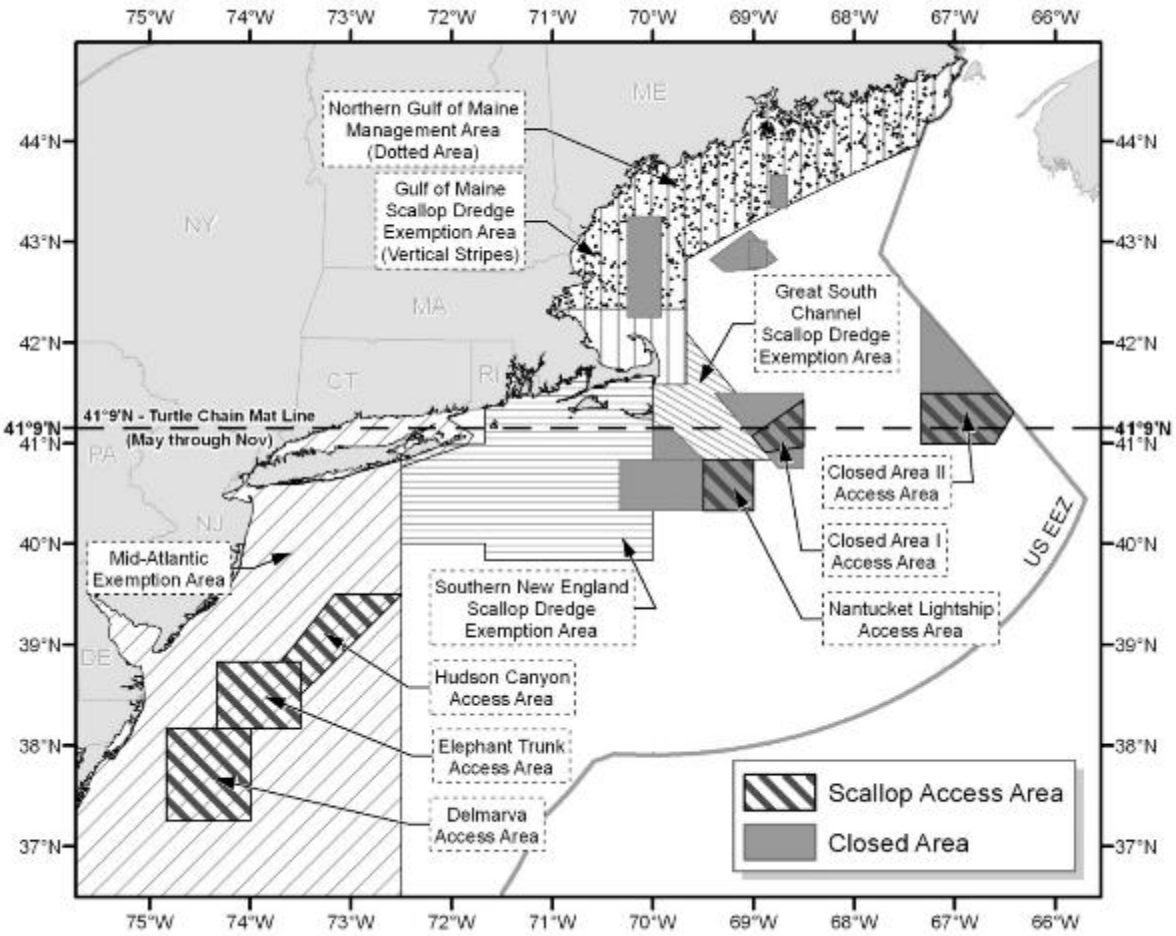


Figure 23 – Scallop dredge exemption areas implemented under the Groundfish FMP.



- ***Gulf of Maine Scallop Dredge Exemption Area (SDEA)–*** *Groundfish FW 21 (Feb 1997). Rationale for only possessing scallops: Eliminates any incentive not to minimize the catch of regulated multispecies*
- ***Great South Channel Scallop Dredge Exemption Area –*** *RA Authority (August 2006), based on industry request (requested October 2005). Same rationale as other SDEAs*
- ***Southern New England Scallop Dredge Exemption Area –*** *Groundfish Amendment 13 (April 2004). Same rationale as other SDEAs*
- ***Mid-Atlantic Exemption Area –*** *Fisheries that occur in the Mid-Atlantic Regulated Mesh Area (West of 72°30') are exempted from needing to establish an exempted fishery (i.e., you can fish in this area with a trawl and not be on a multispecies trip or on a DAS, etc).*

6.2.3 Spawning management alternatives

6.2.3.1 ***Gulf of Maine***

There is some analysis of the potential impacts of the GOM options (Whaleback and Mass Bay seasonal closures) on human communities and fisheries based on VTR data between 2005 and 2012 (see Volume 4). The Scallop PDT has prepared additional analyses using biomass information from limited surveys of the NGOM and updated VTR data through 2014 because scallop fishing effort has increased in the GOM since 2012.

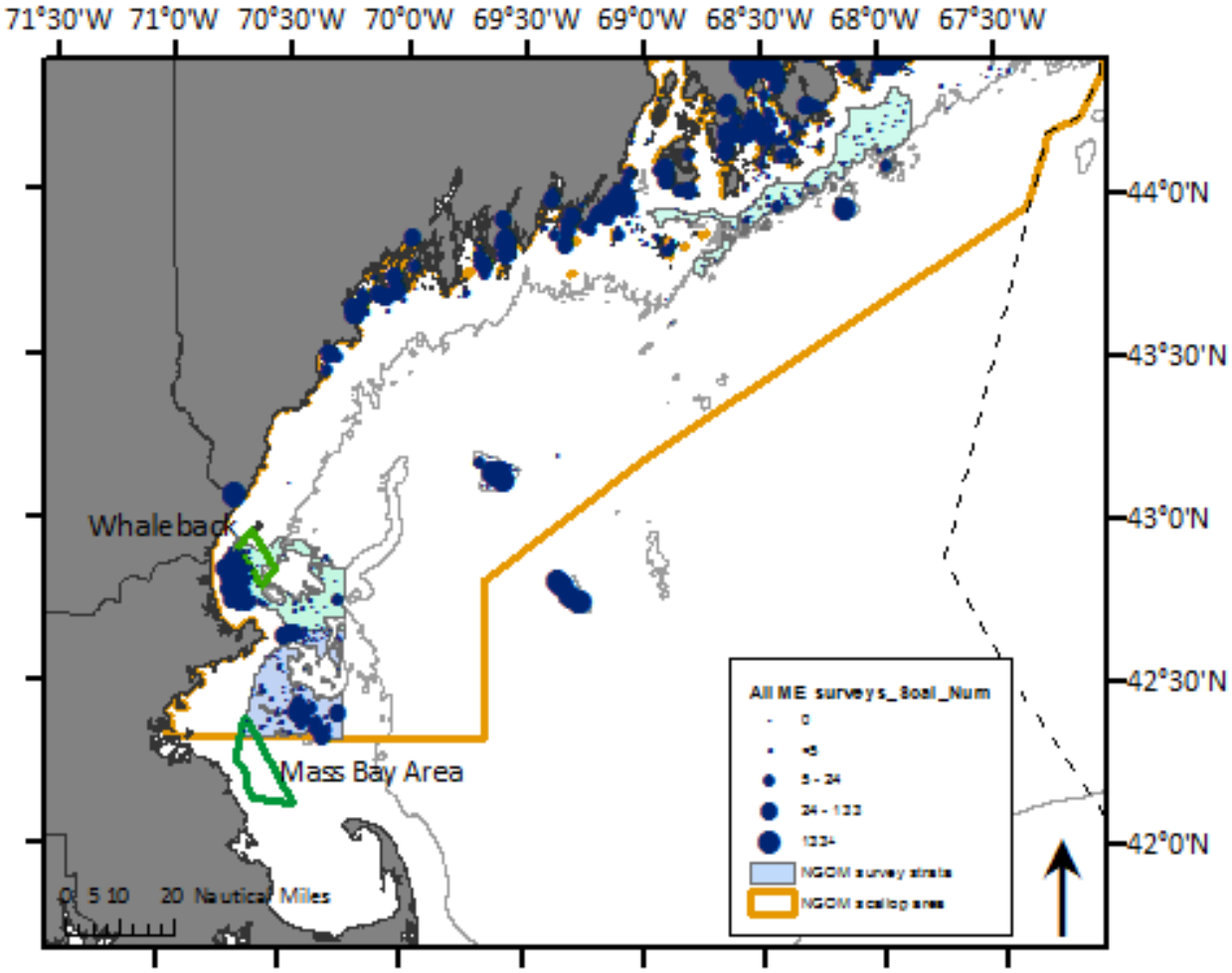
Some of the areas included in Alternatives 1A and 1B apply to scallop dredge vessels, including year round closure in the Western Gulf of Maine and Cashes Ledge, as well as a seasonal closure, the Gulf of Maine Cod Spawning Protection Area, or Whaleback. The Whaleback seasonal closure (between April 1 – June 30) has been in place for scallop vessels for some time; therefore the impacts of continuing that restriction is expected to be minimal.Map 92 shows that there has not been much survey effort in and around the proposed seasonal spawning closures. There is some overlap with Whaleback in the federal NGOM survey strata, but limited tows in that area. The area inshore of whaleback seemed to have higher abundance of scallops than the limited tows within Whaleback. In terms of fishing effort, there also seems to be limited effort in these areas. Map 93 summarizes VTR fishing location data for all general category vessels from 2010-2014. While VTR data has limitations in terms of identifying fishing location, when all these years are combined and binned into ten minute squares, neither proposed spawning closure area overlaps with concentrated fishing levels. Overall the current restrictions that are part of Alternatives 1A and 1B are expected to have slightly negative to neutral impacts on the scallop fishery. Note that while Alternatives 1A and 1B differ in terms of rolling closure 30 minute blocks, these do not apply to the scallop fishery, such that the impacts of these two alternatives with respect to the scallop fishery are the same. Similarly, Alternative 4 would have neutral impacts on the scallop fishery as the seasonal restriction in Area 125 would not apply to scallop dredge vessels.

In the Gulf of Maine, Alternative 2 could remove year round groundfish closures unless these areas remain in place under the habitat management alternatives. While this would provide some additional access to the fishery, the limited extent of the scallop resource in this region is not expected to result in substantial benefits in the context of the fishery as a whole. Therefore, Alternative 2 is expected to have neutral to slightly positive impacts on the scallop fishery relative to Alternative 1/No Action. Positive benefits of increased access in the Western Gulf of Maine Closure Area and Cashes Ledge Closure Area are expected to outweight negative impacts of the seasonal Masschusetts Bay area, which is included in Alternative 2.

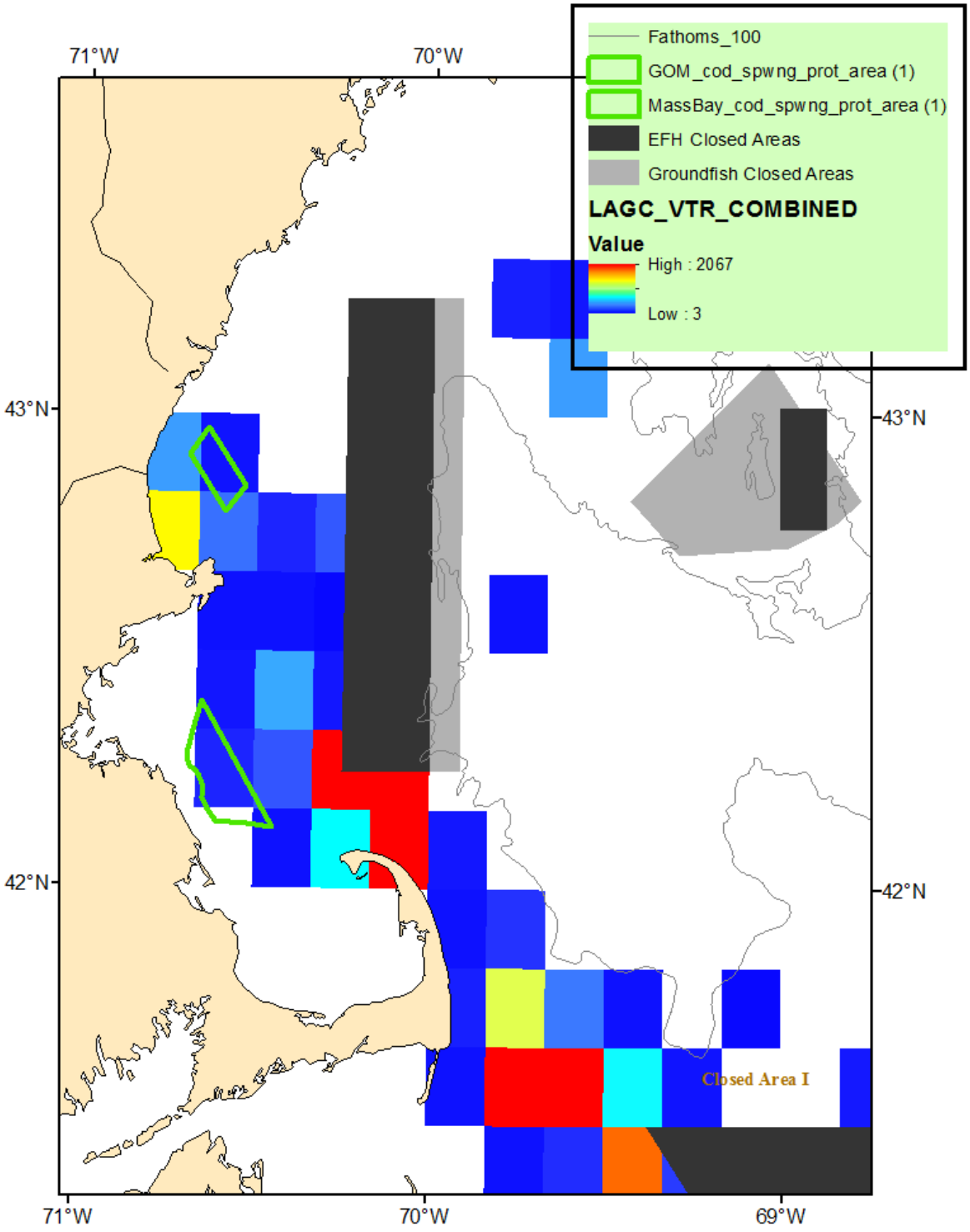
The seasonal closure proposed in the Massachusetts Bay Area (Alternatives 2 and 3) from November 1 – January 31 is not expected to have impacts on the fishery because that is not a season with historically high catch levels. Meat weights are typically low in this season, so if a vessel did want to fish in that area there may be low positive impacts if effort is confined to other months with higher catch rates. In some years a handful of vessels have landed scallops from within the Massachusetts Bay proposed seasonal closure (Nov1-Jan31). The Mass Bay area is within block 125 off the southern coast of Massachusetts east of Scituate. The overall impacts on the fishery are likely minor, but there could be some distributional impacts on a small number of

scallop vessels that fish in the Mass Bay seasonal closure. The Mass Bay closure is south of the NGOM scallop management area; therefore, the scallop vessels that could potentially be impacted are LAGC IFQ and LAGC incidental catch vessels, since LAGC NGOM vessels are prohibited from fishing for scallops outside of the NGOM area. LA vessels could be impacted by this seasonal closure as well, but historically LA vessels are not fishing in the vicinity of this closure. Overall, the impacts of Alternative 3, which includes the Massachusetts Bay area as a standalone measure, are expected to be slightly negative to neutral, likely closer to neutral.

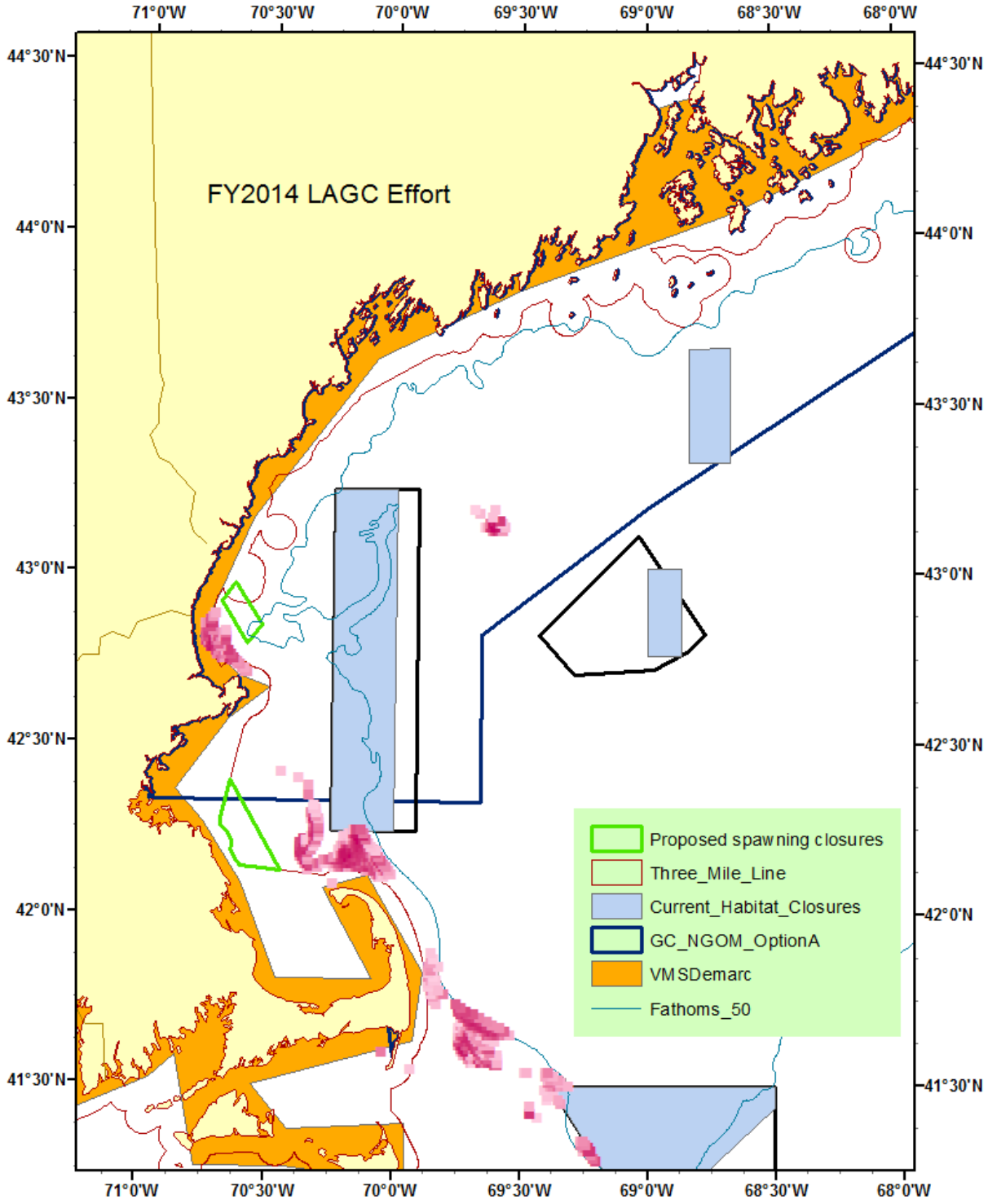
Map 92 – Scallop abundance from all state and federal scallop surveys in Maine overlaid with proposed seasonal spawning areas



Map 93 – General category VTR trips summarized into ten-minute squares for FY2000-2014 combined overlaid with proposed seasonal closed areas. VTR trips are combined into cells based on the number of trips reported per TMS



Map 94 – LAGC effort from FY2014 VMS data (estimate of fishing activity binned into 1/100 of a TMS for cells with 3 or more LAGC vessels) in relation to proposed seasonal spawning closures in OHA2.



6.2.3.2 ***Georges Bank and Southern New England***

On Georges Bank, scallop vessels are excluded from year round groundfish closures but have been afforded access to biomass outside the habitat closure parts of the areas via the rotational management program. Thus, the impacts of Alternative 1/No Action on the scallop fishery are estimated to be neutral.

Seasonal variation in meat yield on Georges Bank is discussed above in the biological impacts section (Section 6.1.3). Generally, the Alternative 2 and 3 spawning closure seasons coincide with times of lower yield. When evaluating fishery impacts, it is important to consider this seasonal restriction in combination with one that is already in place for Closed Area II under the access area regulations in the scallop FMP. Since FW24 (implemented during fishing year 2013), Closed Area II south is closed to the scallop fishery from August 15 – November 15 to reduce yellowtail flounder bycatch. If the two seasonal restrictions are implemented, the area would only be open to the scallop fishery for 6.5 months of the year, April 16 – August 14 and again from November 15 – January 31. Having both seasonal restrictions could shift more effort into the winter when scallop meat weights are lower, having negative impacts on the resource and fishery.

However, seasonal closures tend to shift effort right before or after a closure, so if effort is mostly concentrated in May, impacts on the resource could be positive. Finally, six months is generally enough time for a vessel to make a trip or two in Closed Area II if allocated access, but it does reduce flexibility for the fishery, which can have potentially negative impacts. Overall, seasonal closures have tradeoffs: limiting flexibility for the fishery, but if closures are during periods of time when scallop meat weights are lower, there can be positive impacts on the resource by maximizing yield. Because this closure season is primarily when meat weights are lower, the overall impacts on both the resource and the fishery are expected to be slightly positive. Although seasonal closures do reduce flexibility and can have some unintended negative effects, fishing at times when meat weights are higher instead of fishing during the closure season, could lead to lower fishing costs and higher prices and revenues.

Alternatives 2C and 3C would exempt scallop dredges from the seasonal spawning closures, thereby eliminating these slight positive impacts. Overall, the impacts of Alternative 3C on the scallop fishery are expected to be neutral, as the seasonality of access area fishing would remain as is under existing management.

6.2.4 Dedicated Habitat Research Area alternatives

The potential impacts of alternatives to designate Dedicated Habitat Research Areas (DHRAs) on the scallop fishery were assessed qualitatively related to the potential indirect impacts on the scallop resource and fishery from research that may be conducted in the various areas. In addition, some input has been provided about potential fishery displacement from these candidate research areas.

There may be indirect benefits to the scallop resource or fishery if research is conducted in these areas, which improves the understanding of fishery impacts on EFH, and in turn, general fisheries management. There is one study already proposed for the Georges Bank DHRA that is

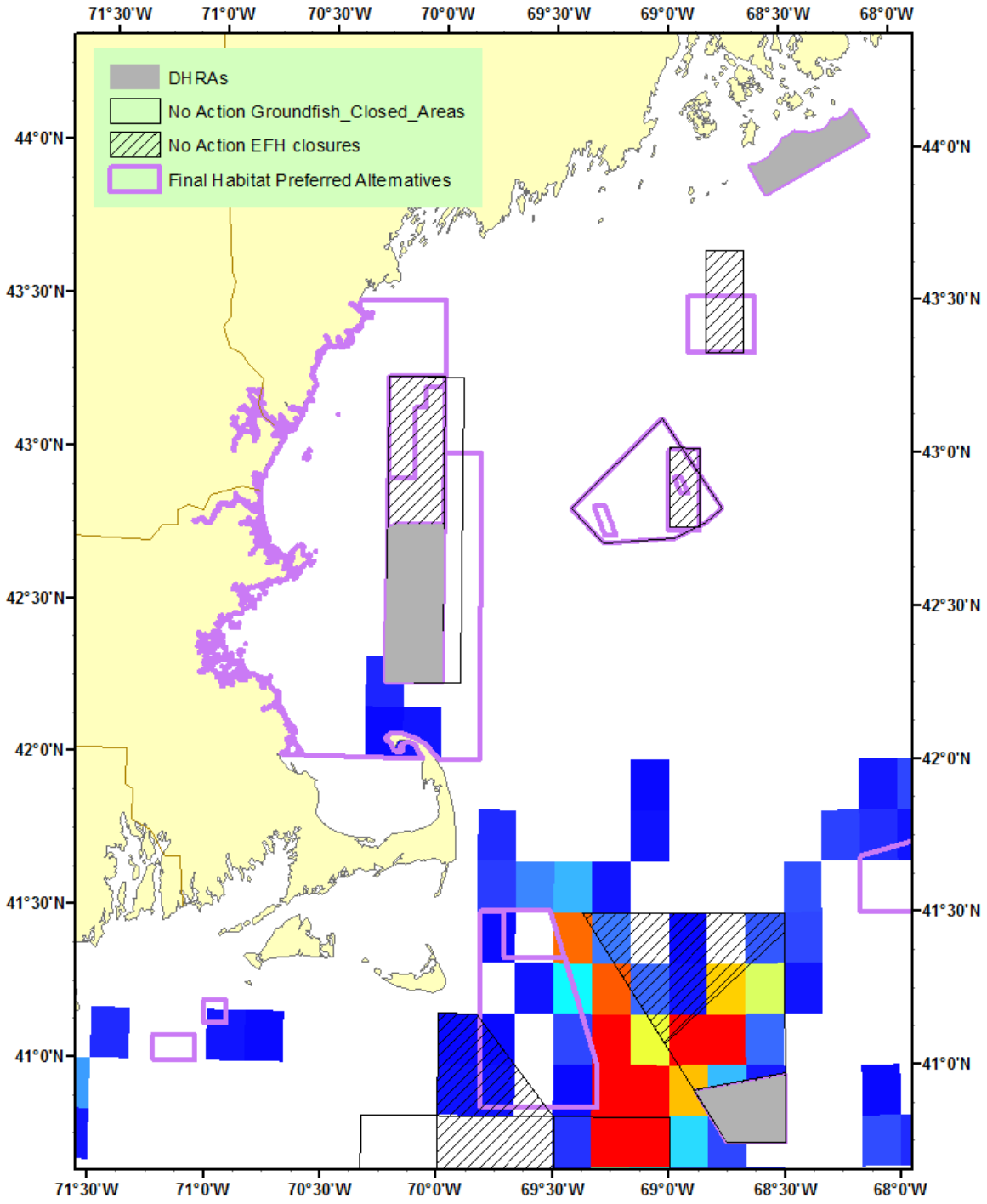
looking at scallop recruitment. To the extent this designation would help support research that has beneficial impacts on the scallop resource or fishery, Alternative 4 could have a positive impact. Therefore, Alternative 1/No Action, which does not designate any DHRAs, has a slightly negative impacts in terms of the opportunity cost of not designating this research area and not realizing these benefits. Research in the other two DHRAs would likely not have a positive impact on scallop management in particular, and therefore the impacts of these DHRAs are expected to be neutral. If the DHRAs are removed via the sunset provision (Alternative 5), it would mean that relevant research was not being conducted in the DHRA, and therefore impacts of Alternative 5 would be neutral.

In general, the dedicated habitat research areas are not expected to have major impacts on the scallop fishery because none of the proposed areas overlap major concentrations of scallop biomass. To evaluate this claim in more detail, the Scallop PDT considered the scallop resource and current or potential level of fishing activity in each dedicated habitat research area alternative.

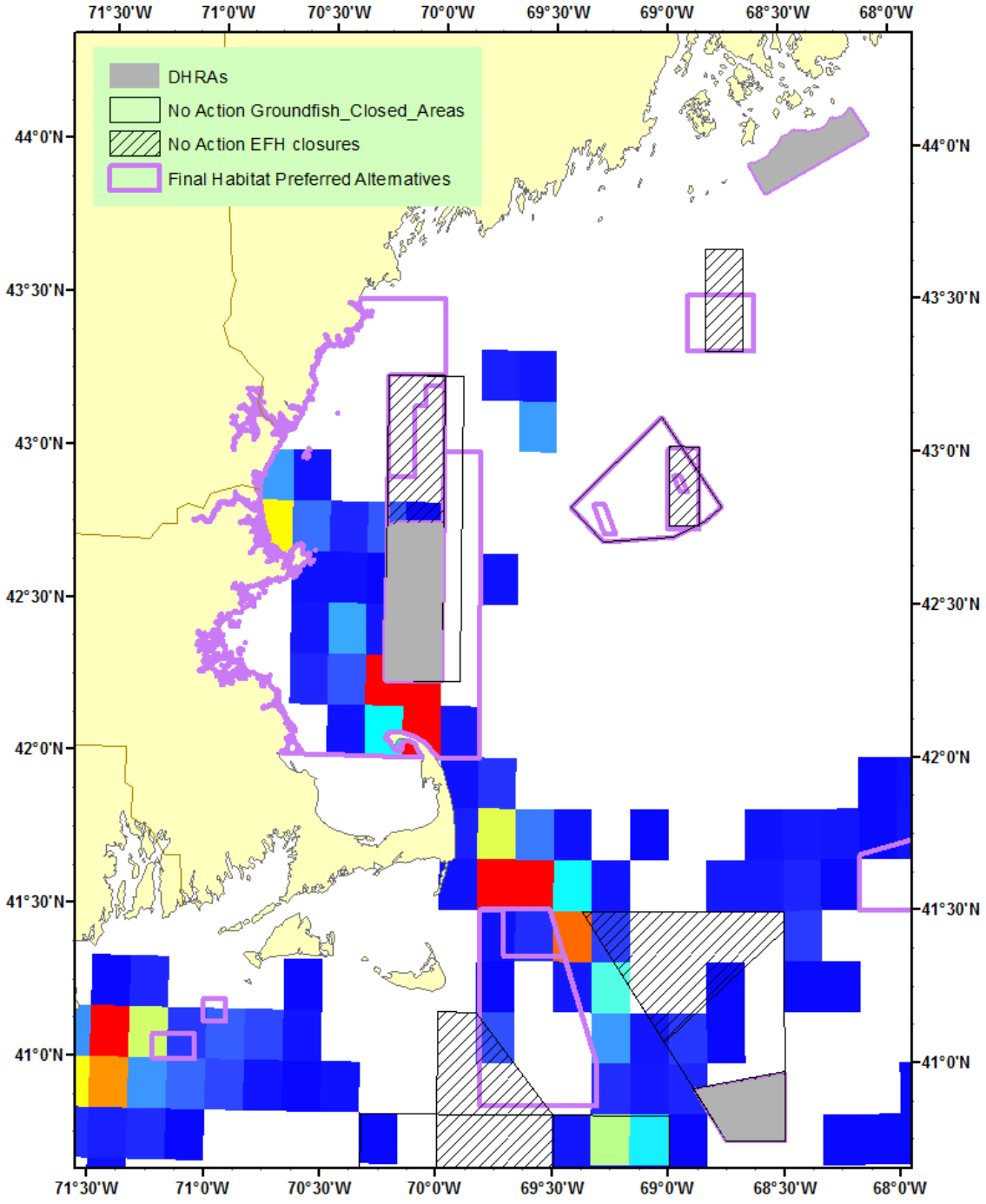
For the area in Closed Area I (Georges Bank DHRA, Alternative 4) the NEFSC dredge survey was used to get a sense of the scallop biomass within that alternative. Table 38 in the habitat alternatives section above shows the long-term yield potential from Closed Area I South to be 29 mt (mean estimate), and 11 mt (median estimate). This is a very small proportion of total scallop long-term yield (about 0.1%). For the areas in the Gulf of Maine (Eastern Maine DHRA, Alternative 2, and Stellwagen DHRA, Alternative 3), results from a 2012 RSA project were used. Sampling was not very dense in this survey. In addition, VTR data for the scallop fishery were plotted to get a sense of the level of Limited Access and Limited Access General Category fishing activity inside these areas. Two of the areas (Alternatives 3 and 4) are within current habitat management closed areas and the one in the Eastern Gulf of Maine (Alternative 2) is not a major area for scallop abundance. The Stellwagen and Eastern Maine DHRAs are closer to shore so fishing restrictions associated with a DHRA designation could have potentially higher impacts on smaller vessels that are homeported near these areas.

VTR data was plotted for trips over 600 pounds to represent limited access trips (Map 95) as well as trips less than 600 pounds to represent limited access general category trips (Map 96). Based on these data there has been very little scallop fishing activity in or around any of the three DHRAs. However, relative to the Eastern Maine DHRA, inshore scallop populations, particularly off the coast of Maine are rebounding. Therefore, while there does not seem to be much fishing activity within the Eastern Maine DHRA at this time, there may be more interest in that area in the future if inshore populations continue to recover. Overall, given limited overlap with the scallop resource and fishery within or adjacent to the DHRAs, the potential direct impacts of DHRA designation on the scallop fishery are likely negligible.

Map 95 – VTR effort FY2010-2014 for LA scallop fishery binned into ten minute squares. VTR trips are combined into cells based on the number of trips reported per TMS



Map 96 – VTR effort FY2010-2014 LAGC scallop fishery binned into ten minute squares. VTR trips are combined into cells based on the number of trips reported per TMS



7 Atlantic herring

7.1 Impacts on Atlantic herring

This action will have limited impacts on the Atlantic herring resource. With the exception of their demersal egg beds, herring are a pelagic species, so measures that restrict mobile bottom-tending gears to protect seabed habitats are not expected to have much benefit for herring stocks. However, some management areas that are part of the habitat, spawning, and research area alternatives do overlap with the preferred alternative herring egg Essential Fish Habitat designation (Map 97). Alternatives that include these areas would provide positive benefits for herring eggs, and thereby slightly positive impacts to the resource overall. Gear modification only options (3 and 4) would have slightly negative impacts if they allow mobile bottom-tending gear fishing in areas where egg beds occur.

Spawning generally begins in July (earlier in the northern Gulf of Maine) and lasts until December, so the management areas would have a positive impact if they displace mobile bottom-tending gear fishing activities that occur during the second half of the calendar year. All of the habitat management areas are year-round and would include these times. The preferred alternative habitat and research areas are shown in yellow on Map 97. Those that overlap herring egg EFH include the WGOM habitat closure and and groundfish closure area, Stellwagen DHRA, Northern Edge reduced impact HMA, Northern Edge MBTG HMA, Georges Bank DHRA, Georges Shoal HMA, and the Great South Channel HMA. The WGOM areas and the Georges Bank DHRA only have slight overlaps.

Seasonal spawning management areas in this amendment also restrict some mobile bottom-tending gears, but these areas tend to be in effect during the spring. Two exceptions to this are the Massachusetts Bay spawning protection area (Gulf of Maine Spawning Alternative 3), which is a preferred alternative that would be in effect from November through January, and the larger overlapping cod protection closures in effect during this same time period. These are shown in pink on Map 97. Additional non-preferred habitat management areas and dedicated habitat research areas throughout the region also overlap with herring egg EFH. Potential impacts of all alternatives are summarized in Table 57.

The framework and monitoring alternatives are expected to have neutral impacts on the herring fishery, as the alternatives do not (Alternative 1/No Action) or will not (Alternative 2, preferred) have a direct effect on the herring management process and therefore should not impact the herring resource.

Map 97 – Overlap between herring egg EFH (blue) with Habitat Management Areas (preferred in yellow; other alternatives in black outline). The fall/early winter spawning alternatives are shown in pink.

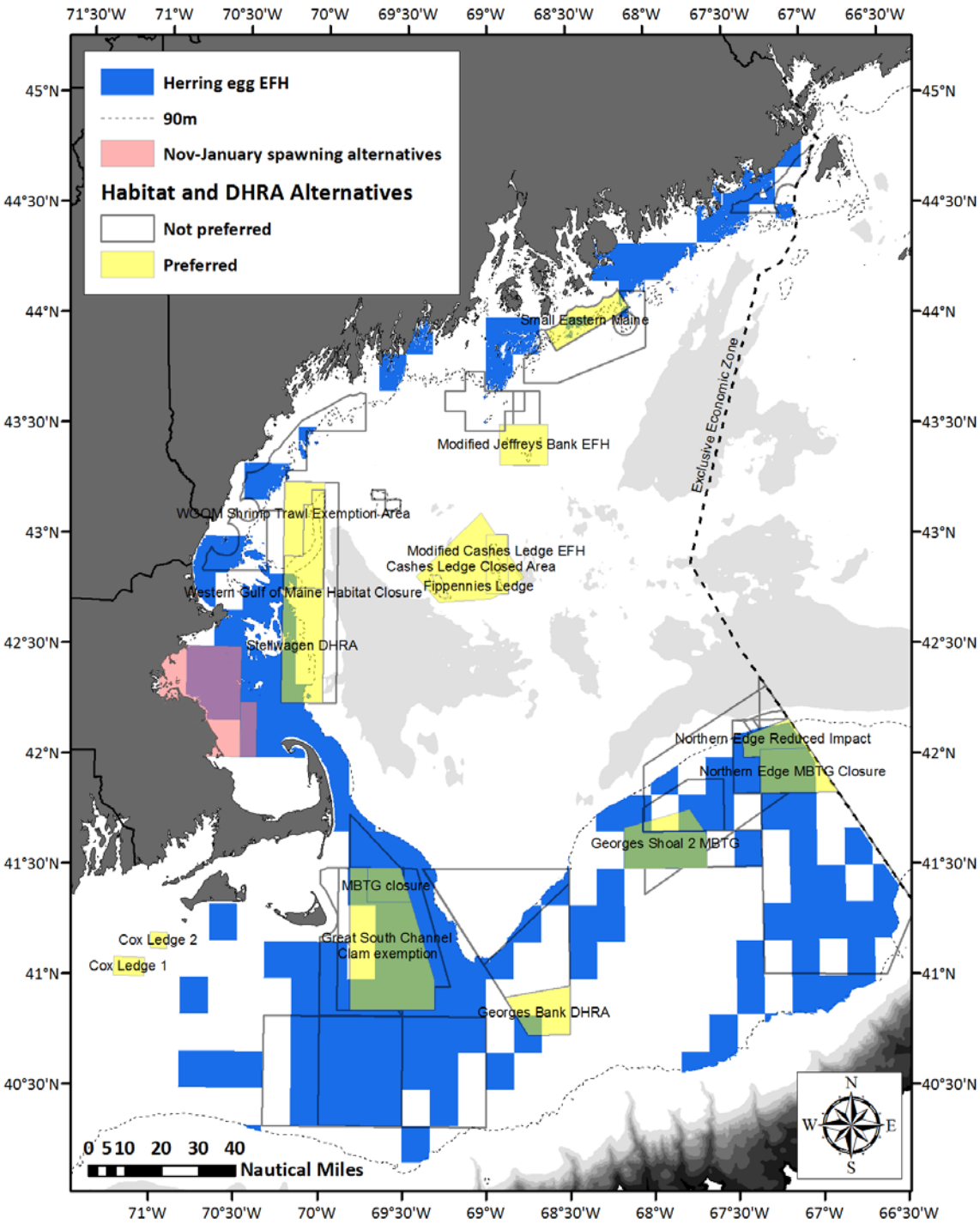


Table 57 – Impacts of spatial management alternatives on the Atlantic herring resource. Preferred alternatives denoted as (*).

Alternative type	Alternative	Impacts
Habitat Management Alternatives	EGOM Alt 1/No Action	Neutral – currently no management areas that restrict MBTG in region, this would maintain no action
	EGOM Alts 2, 3*	Slightly positive – adds Machias HMA, which would restrict MBTG in an area with herring egg EFH (neutral with option 3 or 4)
	Preferred alternative with Small Eastern Maine HMA only	Neutral impacts – area does not overlap herring egg EFH
	CGOM Alts 1-4	Neutral – no herring egg beds in this region
	WGOM Alts 1*, 3, 4, 5, 6	Slightly positive – maintains or adds MBTG protections in areas with herring egg beds (3-6 with options 3 or 4 slightly negative)
	WGOM habitat alternatives 7A, 7B, and 8	Neutral impacts
	WGOM Alts 2	Slightly negative – removes current MBTG protections in areas with herring egg beds
	GB Alts 1, 3, 4, 5, 6, 7, 8, 9, 10*	Slightly positive – maintains or adds MBTG protections in areas with herring egg beds (3-6 with options 3 or 4 slightly negative)
	GB Alt 2	Slightly negative - removes current MBTG protections in areas with herring egg beds
	GSC-SNE Alts 1, 3, 4*, 5, 6	Slightly positive - herring egg beds overlap areas included in all these alternatives (3-5 with options 3 or 4 slightly negative)
	GSC-SNE Alt 2	Slightly negative - removes current MBTG protections in areas with herring egg beds
Spawning Management Alternatives	GOM Alt 1A*, GOM Alt 1B, GOM Alt 3*, GB Alt 1	Slightly positive – maintains MBTG protections in areas with herring egg beds (GOM 1B, GB 1), or adds protections in the fall during spawing season (GOM Alt 1A, GOM Alt 3)
	GOM Alt 4*	Neutral; spring area would not benefit egg habitat
	GOM Alt 2, GB Alt 2, 3*	Slightly negative – GB Alts 2 and 3 makes existing areas seasonal, which will not protect herring eggs. GOM Alt 2 could remove WGOM closure which overlaps egg EFH.
Dedicated Habitat Research Area Alternatives	1, 2, 5	Neutral. Alternative 2 Eastern Maine DHRA does not overlap with egg beds. Alternative 1 maintains status quo, no DHRAs. Alternative 5 enacts sunset provision.
	3, 4	Slight positive – would have mobile bottom-tending gear restrictions in areas slightly overlapping herring egg beds

7.2 Impacts on the herring fishery

This action will likely have fairly limited impacts on the Atlantic herring fishery, as the fishing restrictions associated with the alternatives generally do not extend to gears used to target herring, with exceptions discussed below.

The Ammen Rock HMA (Central Gulf of Maine Habitat Alternatives 3 and 4) in this amendment is proposed as a closure to all gears managed by the Council, including mid-water trawl gears. While there is mid-water trawl activity in the vicinity of Cashes Ledge where this area is located,

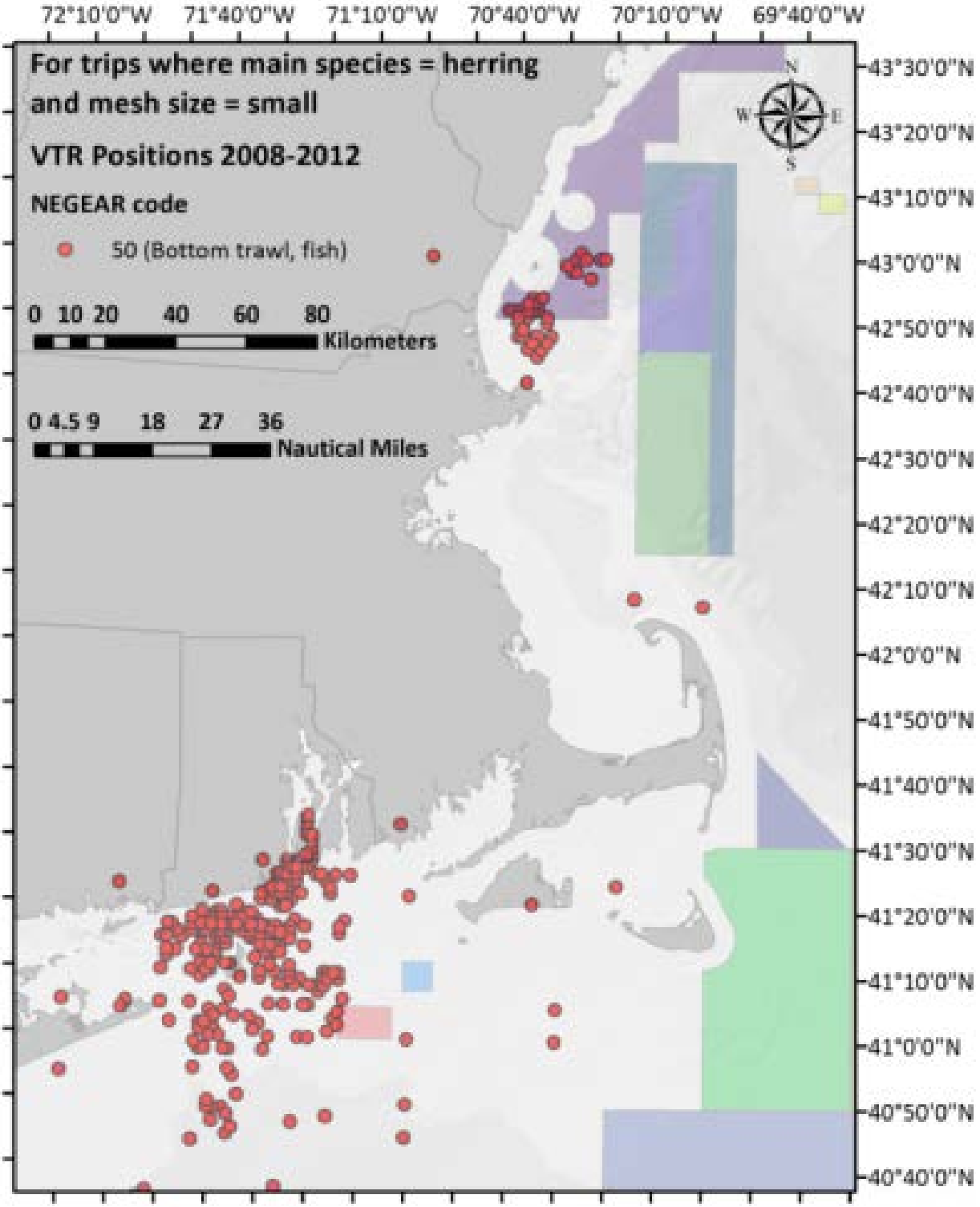
the Ammen Rock HMA is very small (15 km^2) and is unlikely to have a substantial impact on the activity of herring vessels fishing in the area. Designation of this area is part of the preferred management approach.

Another exception is small mesh bottom trawls used in specific locations. Small mesh bottom trawls could be restricted under all three types of alternatives, habitat, spawning, and research. Generally, the trawls are used in the Gulf of Maine to catch relatively small amounts of herring under a Category C permit, and in Southern New England off the coast of Rhode Island to target larger amounts of herring under Category A and B permits. Between 2008 and 2011, these small-mesh bottom trawls represented 4% of herring landings, so they constitute a small fraction of the fishery (2013-2015 Herring Specifications, NEFMC 2013). These landings are spatially concentrated, with the majority (roughly 14 mt) coming from Area 2, representing 16% of Area 2 landings during that same period.

Given the general fishing locations of these small-mesh bottom trawls, in terms of evaluating the impacts of the habitat management alternatives in this amendment on this component of the fishery, the question is the extent to which these boats fish within the two areas that appear to overlap with their activity (Map 98). Both the Cox Ledge HMA and the Small and Large Bigelow Bight HMAs are currently open to fishing and have small mesh bottom trawl effort. Category A and B vessels with higher possession limits may be directing effort on Atlantic herring in the Cox Ledge areas, and Category C vessels with lower possession limits may be fishing in the Gulf of Maine HMA areas in addition to or incidental to fishing for whiting. Map 98 indicates that there appears to be limited overlap between small mesh bottom trawl trips where the main species was identified as herring and the Cox Ledge area. There are small-mesh bottom trawl trips in the southern part of the Large Bigelow Bight HMA and the Small Bigelow Bight HMA that would be excluded from those areas if one or the other of them is closed to mobile bottom-tending gears. These trips probably represent a low value relative to the herring fishery overall, assuming that they are landing small amounts of herring, which is a low value species.

Neither of the Bigelow Bight areas are part of the preferred action. The Cox Ledge HMAs are proposed in the amendment, but would not be closed to trawl gears, rather ground cables would be prohibited. So, with this provision, bottom trawling including small mesh bottom trawling would still be allowed within the Cox Ledge HMAs.

Map 98 – VTR locations (red circles) of small mesh bottom trawl trips where the main species was noted as 'herring', 2008-2012.



Also, Eastern Gulf of Maine Alternative 2, Option 5, would restrict purse seines. This gear is not used frequently in the Machias HMA, but it is used in the Large Eastern Maine HMA, and almost all the purse seine landings in that area are herring. The economic impacts analysis in Volume 4 discusses purse seine revenues from this area in greater detail. According to the 2013-2015 herring specifications, 133,463 mt herring were taken from Area 1A during 2008, 2009, 2010, and 2011, with 52% landed by purse seine vessels. Assuming an equal distribution of landings across all four years, and a herring price per mt ranging between $221 and $296, this translates to annual Area 1A landings between $7.4 and $9.9 million for 2008-2011. In the most recent three years (2012-2014), average annual purse seine revenues estimated for the Large Eastern Maine area were just under $1 million annually, or roughly 11-15% of total area 1A landings for 2008-2011. Across all gear types that land herring, more herring are landed from Area 1A than from any other herring management area. Year-round closure of the Large Eastern Maine HMA to purse seine fishing under Alternative 2 Option 5 would likely have a slightly negative impact on the herring fishery overall, although these effects would be more significant for the small subset of vessels conducting purse seine fishing for herring in the area. Additional discussion of this issue is provided in Volume 4. This alternative is not preferred.

Currently, there are impacts to the Atlantic herring fishery associated with monitoring programs in the year-round groundfish closed areas, implemented in Amendment 5 to the Atlantic Herring FMP (March 2014). According to Amendment 5, 100% observer coverage is required, along with full sampling provisions (and measures to address net slippage) on limited access midwater trawl herring vessels when fishing in the year-round groundfish closed areas. Midwater trawl herring vessels are prohibited from fishing in the year-round groundfish closed areas without an observer. If Federal funds are not available to pay for 100% observer coverage in the closed areas, then herring vessels will be responsible for the costs, under the provisions that will be implemented through the omnibus industry-funded monitoring amendment (in progress). The costs of these coverage requirements were estimated in the Amendment 5 FEIS (Section 6.5.6) to be around $169,000, assuming that Federal funds would cover around 30% of midwater trawl trips in the closed areas.

The monitoring requirements for the limited access midwater trawl herring fishery in the groundfish year-round closed areas could be eliminated if one or more of the corresponding areas are removed or made seasonal under the habitat or spawning action alternatives. In this case, the action alternatives may reduce impacts on the limited access midwater trawl herring fishery in terms of reduced monitoring costs from those expected under Amendment 5; this would result because the year round groundfish closures are eliminated or made seasonal under the sub-regional/regional habitat and spawning action alternatives. Alternatively, a trailing action might be developed by the Council to adjust or specify herring monitoring requirements in similar areas or in the new closed areas so that groundfish bycatch, specifically haddock bycatch, can continue to be effectively monitored. If the preferred alternatives or a subsequent action result in monitoring requirements that are consistent with those specified by Atlantic Herring Amendment 5 regardless of whether the year-round groundfish closures are adjusted, then the action alternatives will have neutral impacts on the herring fishery.

Table 58 – Impacts of spatial management alternatives on the Atlantic herring fishery

Alternative type	Alternative	Impacts

Alternative type	Alternative	Impacts
Habitat Management Alternatives	EGOM Alts 1-3; CGOM Alts 1-4; WGOM Alts 1, 2, 6, 7, 8; GB Alts 1-10; GSC-SNE Alt 1-2	Neutral, except for EGOM Alternative 2 if Option 5 is selected, which would restrict additional gears capable of catching groundfish, including purse seines and would therefore have a slightly to moderately negative impact on the herring fishery overall. See economic impacts section for additional discussion. CGOM Alts 3 and 4 include the small Ammen Rock HMA, closed to all gear types including herring gears. Given the size of this area neutral impacts on the herring fishery are expected.
	WGOM Alts 3, 4, 5	Slightly negative – small mesh bottom trawling for herring overlaps the large and small Bigelow Bight HMAs, which are included in these alternatives. Neutral if gear modification options 3 and 4 are selected.
	GSC-SNE Alt 3-6	Neutral to slightly negative – if small mesh bottom trawl herring fishing occurs on Cox Ledge it would be displaced, but it appears that this effort does not occur within the management areas. Neutral with gear modification options for Cox Ledge (Alts 3-5 with option 3 or 4, Alt 4 as preferred)
Spawning Management Alternatives	GOM Alt 1A, 1B; GB Alt 1	Slightly negative - maintains year round groundfish closures which would maintain existing monitoring requirements
	GOM Alt 2A, 2B; GB Alt 2A, 2B, 3A, 3B	Neutral or slightly positive – removing groundfish closures might not impact monitoring (neutral), or might eliminate monitoring requirements (slightly positive). GB 2C and 3C neutral, only affects scallop fishery.
	GOM Alt 3	Neutral - designates the Massachusetts Bay Spawning Protection Area, which would be closed to all gears that catch groundfish including herring gear between November and January. However, these gears do not appear to be contributing much if any revenue to the catches from the Mass Bay area during that season (see Volume 4).
	GOM Alt 4	Neutral – closes block 125 April 15-30 to gears capable of catching groundfish but does not restrict primary herring gears
Dedicated Habitat Research Area Alternatives	1-5	Neutral – no effect on herring operations, probably limited research to benefit herring management
Framework and monitoring Alternatives	1, 2	Neutral – alternatives do not/will not have a direct effect on the herring management process

8 Atlantic deep-sea red crab

Deep-sea red crabs are found in deep water areas of the Gulf of Maine and along the continental slope south of Georges Bank to the Gulf of Mexico. There may be limited overlap between their Gulf of Maine distribution and some of the habitat and spawning areas, but generally speaking red crabs occur in deeper waters than are contained within the management areas, particularly the habitat management areas which tend to be identified in waters shallower than 100m. Thus, there are likely no impacts of the spatial management alternatives (HMAs, Spawning, and DHRAs) on this stock.

The red crab fishery operates entirely along the continental slope in depths between 600-640 m. There is no overlap between this fishery and any of the spatial management alternatives proposed in this amendment, so therefore no impacts to the fishery are expected.

9 Atlantic salmon

Although there is a fishery management plan for Atlantic salmon, there is not a directed fishery that would be impacted by the alternatives in this action.The alternatives in this amendment are expected to have low negative to neutral impacts on Atlantic salmon, as described in the protected species impacts discussion in Volume 4.

10 Surfclams and ocean quahogs

Atlantic surfclams are found in the western North Atlantic from the southern Gulf of St. Lawrence to Cape Hatteras, North Carolina. They are most abundant on Georges Bank, the south shore of Long Island, New Jersey, and the Delmarva Peninsula. EFH for juveniles and adults is found throughout the substrate, to a depth of three feet below the water/sediment interface, within Federal waters from the eastern edge of Georges Bank and the Gulf of Maine throughout the Atlantic EEZ, in areas that encompass the top 90% of all the ranked ten-minute squares for the area where surfclams were caught in the NEFSC surfclam and ocean quahog dredge surveys. Surfclams generally occur from the beach zone to a depth of about 200 feet, but beyond about 125 feet abundance is low.

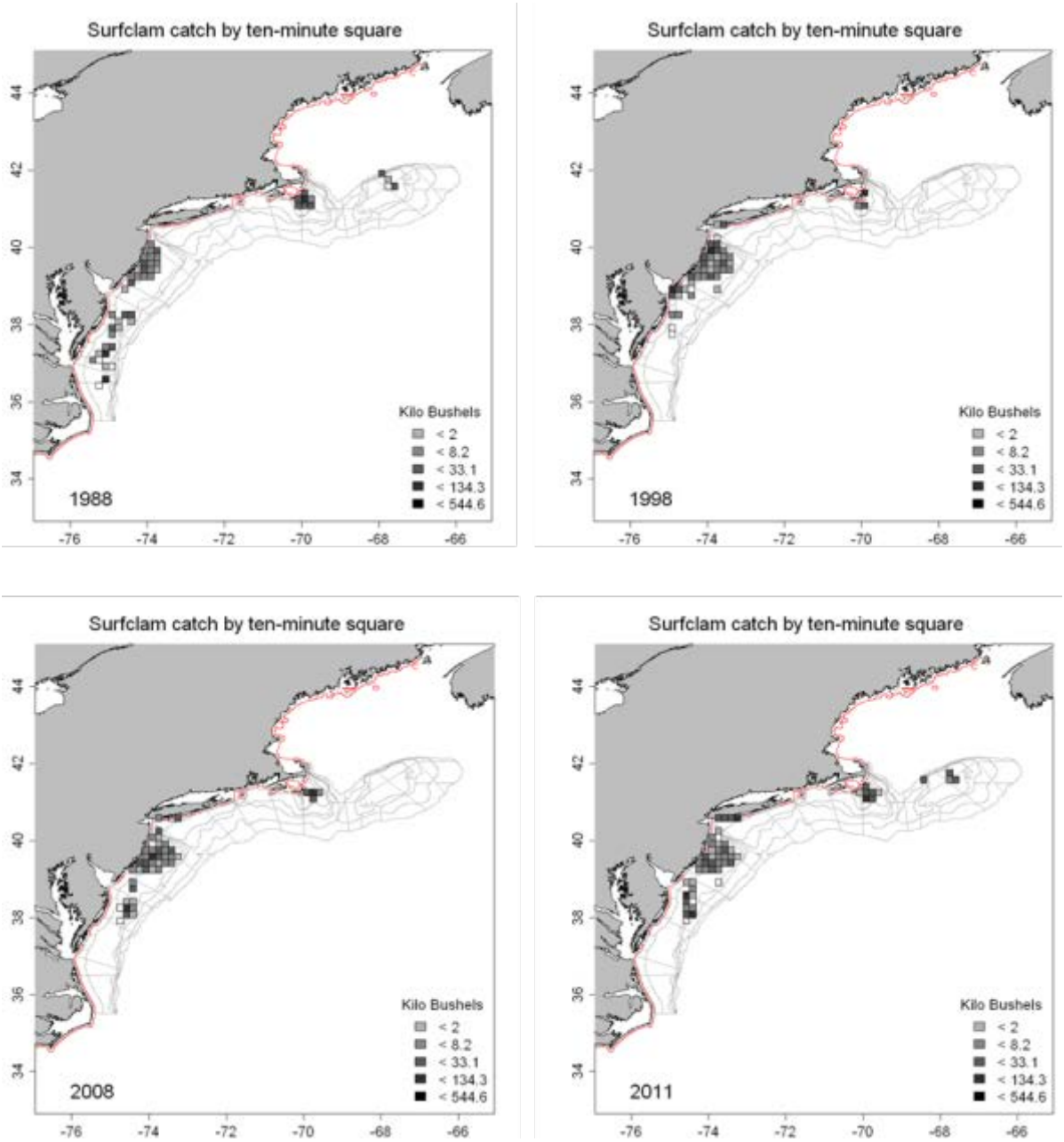
Ocean quahogs are common around Iceland, in the eastern Atlantic as far south as Spain, and in the western Atlantic as far south as Cape Hatteras, North Carolina. Ocean quahogs live in water between 25 and 1,300 feet and are extremely slow-growing and long-lived, reaching ages of 200 years or more. In the northern part of their range, they are found in shallower water closer to shore. The U.S. stock is almost entirely within Federal waters (3 to 200 miles from shore), except for a modest amount off the coast of Maine and in waters between 65 and 260 feet deep. EFH for juveniles and adults is found throughout the substrate, to a depth of three feet below the water/sediment interface, within Federal waters from the eastern edge of Georges Bank and the Gulf of Maine throughout the Atlantic EEZ, in areas that encompass the top 90% of all the ranked ten-minute squares for the area where ocean quahogs were caught in the NEFSC surfclam and ocean quahog dredge surveys. Distribution in the western Atlantic ranges in depths from 30 feet to about 800 feet. Ocean quahogs are rarely found where bottom water temperatures exceed 60° F, and occur progressively further offshore between Cape Cod and Cape Hatteras. Because juvenile and adult surfclams and ocean quahogs live in (not on) the bottom, they are not very susceptible to impacts from bottom tending fishing gears, other than hydraulic or “dry” clam dredges that are designed specifically to dig into bottom sediments to remove them.

In US waters, ocean quahogs are most abundant in the southern New England, Long Island, and Georges Bank regions, and surfclams are abundant off New Jersey, the Delmarva Peninsula, and on Georges Bank. However, these regions have recently seen a loss of overall biomass, except Georges Bank where harvesting has historically been prohibited. The ocean quahog fishery has shifted north over the last three decades away from the original fishing grounds off Delmarva and New Jersey, and followed the concentrations of quahogs. For the past ten years, the majority of fishing effort has been in the Long Island region. Overall landings in the surfclam fishery have remained relatively consistent since 1998, ranging from 2.3 million to 3.2 million bushels per year, but effort has shifted north in recent years.

The Georges Bank region had not been open to ocean quahog fishing since 1990 due to the risk of paralytic shellfish poison (PSP) contamination. Portions of this area were reopened to harvesting at the beginning of 2013 with experimental fishing in years prior. Georges Bank contains about 43% of total ocean quahog fishable biomass (2011 NEFSC survey data) and approximately one third of the Atlantic surfclam biomass (assessment through 2011).

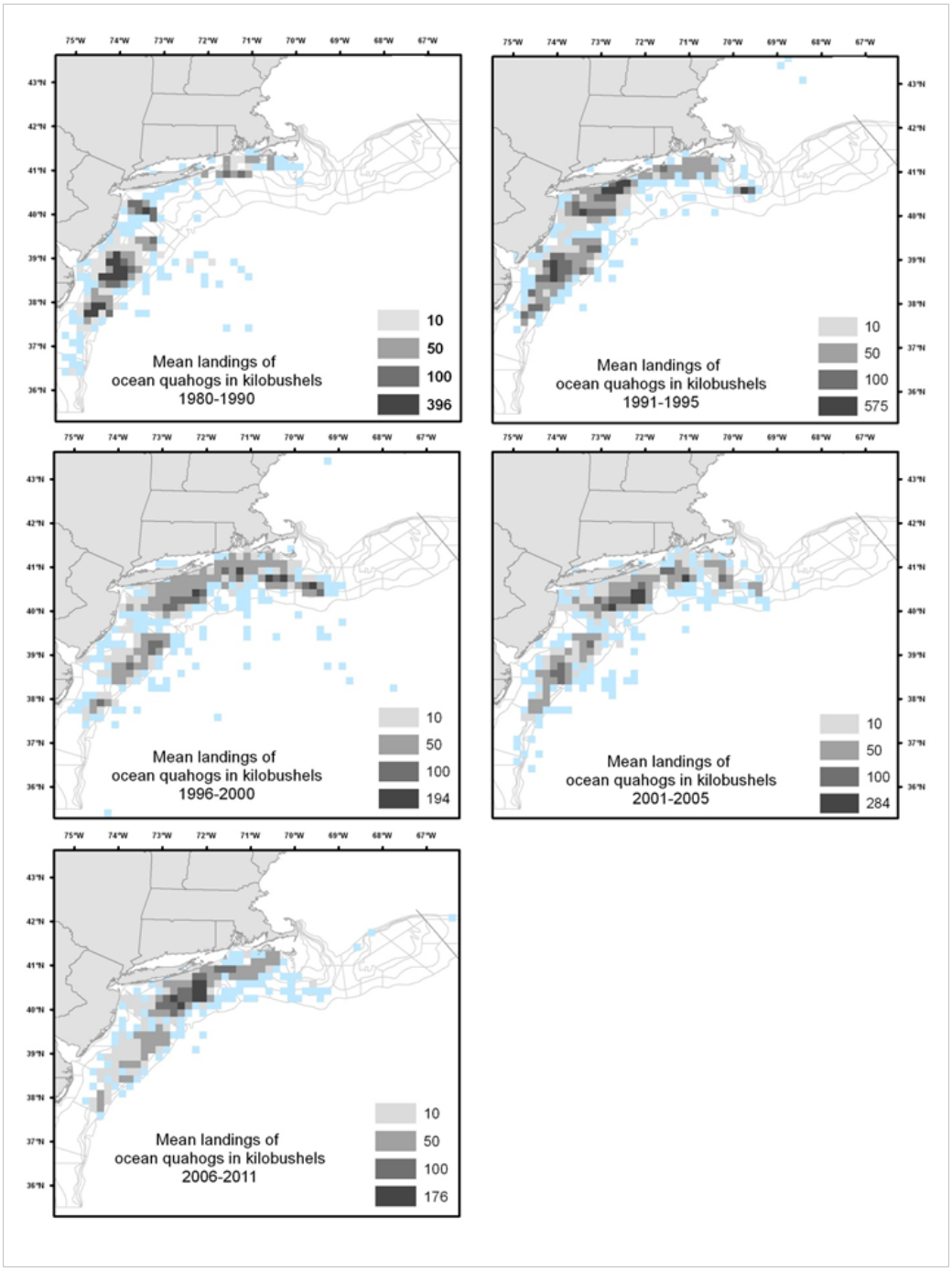
The commercial fishery for Atlantic surfclams and ocean quahogs in Federal waters is prosecuted with large vessels and hydraulic dredges, except in Eastern Maine where toothed dredges are used to harvest quahogs. The distribution of the surfclam fishery has changed over time, as shown in Map 99. The distribution of the ocean quahog fishery has changed over time, with the bulk of the fishery from 1980-1990 being prosecuted off the Delmarva region, to more Northern areas (Map 100).

Map 99 – Surfclam landings by ten-minute square (TMSQ), the finest scale location for landings reported in logbooks, by year (1 kilobushel = 1000 bu y-1). Source: Stock Assessment Summary (NEFSC 2013)[13]



[13] Northeast Fisheries Science Center. 2013. 56th Northeast Regional Stock Assessment Workshop (56th SAW) Assessment Summary Report. US Dept Commer, Northeast Fish Sci Cent Ref Doc. 13-04; 42 p. Available from: National Marine Fisheries Service, 166 Water Street, Woods Hole, MA 02543-1026, or online at http://nefsc.noaa.gov/publications/

Map 100 – Ocean quahog landings by ten-minute square (TMSQ), the finest scale location for landings reported in logbooks, and time period. TMSQ in light blue had reported landings, but from fewer than three vessels (1 kilobushel = 1000 bu y-1). Source: Stock Assessment Update (Chute at al. 2013)[14]



[14] Chute A, Hennen D, Russell R, Jacobson L. 2013. Stock Assessment Update for Ocean Quahogs (Arctica islandica) through 2011. NEFSC Ref Doc 13-17; 156 p. Available from: National Marine Fisheries Service, 166 Water Street, Woods Hole, MA 02543-1026, or online at http://nefsc.noaa.gov/publications/

10.1 Impacts on surfclams and ocean quahogs

The impacts of all alternatives on the clam resource are expected to be neutral, for various reasons, as discussed in the following sections.

10.1.1 Habitat management alternatives

As described above, while surfclams and ocean quahogs occur within various habitat management areas analyzed in this amendment, hydraulic and toothed clam dredges are the only mobile bottom-tending gears that capture surfclams and ocean quahogs. Because clams are not susceptible to trawls or scallop dredges, they would not be impacted positively or negatively by shifts in trawl or scallop dredge effort associated with changes to habitat management areas. In other words, only those alternatives that are likely to change patterns of fishing with clam dredges have the potential to impact the surfclam and ocean quahog resources.

The commercial fisheries for surfclams and ocean quahogs are managed using annual catch limits, which limit overall removals (landings and discards) to levels that are sustainable. However, there may be the potential with both stocks for localized depletion of surfclams or ocean quahogs in some areas, depending on the spatial distribution of fishing effort, which could have negative impacts at these local scales. Localized depletion occurs as clams are harvested in a discrete area until catch rates decline to the point when it is no longer profitable to remain there. Both species occur in fairly well-defined “beds” and are susceptible to local depletion because they are immobile and live in the bottom. Ocean quahogs in particular are very long-lived and slow growing, which makes them particularly susceptible to localized depletion because growth and reproduction cannot keep pace with fishery removals. Although noted here for completeness, the identification and management of areas of localized depletion are beyond the scope of this FEIS.

On the other hand, positive biological impacts might occur through improved opportunities for recruitment in areas closed to clam dredging. The recent stock assessment for Atlantic surfclam at SAW 56 suggested there are source/sink dynamics relative to recruitment for this stock. The Georges Bank portion of the stock appears to be its own source for recruits, and does not appear to receive significant recruit contributions from other areas. Recruitment in the ocean quahog stock is poorly understood, and recruitment at a small, local scale is not well understood for either stock. Allowing for these uncertainties, the closure of some areas to dredging for both surfclams and ocean quahogs has the potential to result in slightly positive local impacts on the stock, because animals in the closure would be allowed to grow and reproduce without being subject to fishing mortality. Note that the clam FMP does not have any spatial management areas designed to increase recruitment or yield per recruit, but some existing and proposed habitat and groundfish management areas restrict clam dredging, and there are various shellfish safety closures that prohibit clam harvest.

Given that the various habitat management areas vary in terms of their overlaps with the two species of clams, and with ongoing closures for paralytic shellfish poisoning, the local-scale biological impacts of the proposed habitat management alternatives on surfclams and ocean quahogs could vary from slightly negative to slightly positive. However, impacts on the resources overall are expected to be neutral, given the proposed habitat management areas are

small relative to the overall distribution of the stocks, and do not include any mid-Atlantic habitats.

10.1.2 Spawning management alternatives

While there is overlap with surfclam and ocean quahog EFH and distributions and spawning management alternative areas, surfclam and quahog life stages are not susceptible to gears other than hydraulic and toothed clam dredges, and would not likely be impacted (either positively or negatively) by any prohibitions on use of other gear types. Therefore, the biological impacts of the proposed spawning management alternatives on surfclams and ocean quahogs are expected to be neutral.

10.1.3 Dedicated Habitat Research Area alternatives

Dedicated Habitat Research Areas would restrict all mobile bottom tending gear fishing, including clam dredging. The Georges Bank (Alternative 5) and Stellwagen (Alternative 3C) DHRAs are preferred alternatives. Quahogs occur in the Georges Bank DHRA, but the area is already closed to clam dredging, as it is a designated mobile bottom-tending gear habitat closure, and overlaps with a PSP closure and Closed Area I, which both restrict clam dredging. Clams may occur in both the Eastern Maine and Stellwagen DHRAs (Alternatives 2 and 3), but neither area represents a major fishing ground. Similar to the habitat management areas, while there could be local effects on the clam resource as a result of the DHRAs, impacts on clam stocks overall are expected to be neutral, given the proposed areas are small relative to the overall distribution of surfclams and ocean quahogs.

10.1.4 Framework and monitoring alternatives

These alternatives are administrative and do not have any impacts on the biological processes of Atlantic surfclams and ocean quahogs; therefore no biological impacts are expected on these species when compared to No Action.

10.2 Impacts on the clam fishery

Impacts of the spatial management alternatives on the clam fishery are discussed in the sections below, and are summarized in Table 59.

Table 59 – Summary of impacts of spatial management alternatives on the clam fishery. Preferred alternatives are identified below (*).

Type	Sub-region/region	Alternative	Impacts
Habitat	EGOM	Alt. 1 (No action)	Neutral
Habitat	EGOM	Alt. 2 Options 1, 2, 5	Slightly negative
Habitat	EGOM	Alt. 2 Options 3 and 4	Neutral
Habitat	EGOM	Alt. 3 Options 1 and 2	Slightly negative
Habitat	EGOM	Alt. 3 Options 3 and 4	Neutral
Habitat	EGOM	Sm. Eastern Maine *	Neutral
Habitat	CGOM	Alt. 1 (No action)	Neutral

Type	Sub-region/region	Alternative	Impacts
Habitat	CGOM	Alt. 2 (No area)	Neutral
Habitat	CGOM	Alt. 3 Options 1 and 2	Neutral
Habitat	CGOM	Alt. 3 Options 3 and 4	Neutral
Habitat	CGOM	Alt. 4 Options 1 and 2	Neutral
Habitat	CGOM	Alt. 4 Options 3 and 4	Neutral
Habitat	CGOM	CL GF, CL HMA, JB HMA, FL HMA, AR HMA *	Neutral
Habitat	WGOM	Alt. 1 (No action)	Slightly negative
Habitat	WGOM	Alt 1 with modified boundary *	Slightly negative
Habitat	WGOM	Alt. 2 (No area)	Neutral
Habitat	WGOM	Alt. 3 Options 1 and 2	Slightly negative
Habitat	WGOM	Alt. 3 Options 3 and 4	Neutral
Habitat	WGOM	Alt. 4 Options 1 and 2	Slightly negative
Habitat	WGOM	Alt. 4 Options 3 and 4	Neutral
Habitat	WGOM	Alt. 5 Options 1 and 2	Slightly negative
Habitat	WGOM	Alt. 5 Options 3 and 4	Neutral
Habitat	WGOM	Alt. 6 Options 1 and 2	Slightly negative
Habitat	WGOM	Alt. 6 Options 3 and 4	Neutral
Habitat	WGOM	Alt. 7A *	Neutral
Habitat	WGOM	Alt. 7B	Neutral
Habitat	WGOM	Alt. 8 *	Neutral
Habitat	GB	Alt. 1 (No action)	Neutral
Habitat	GB	Alt. 2 (No area)	Neutral
Habitat	GB	Alt. 3 Option 1	Neutral
Habitat	GB	Alt. 3 Option 2	Neutral
Habitat	GB	Alt. 3 Options 3 and 4	Neutral
Habitat	GB	Alt. 4 Option 1	Neutral
Habitat	GB	Alt. 4 Option 2	Neutral
Habitat	GB	Alt. 4 Options 3 and 4	Neutral
Habitat	GB	Alt. 5	Highly to moderately negative
Habitat	GB	Alt. 6A Option 1	Slightly negative to neutral
Habitat	GB	Alt. 6A Option 2	Neutral
Habitat	GB	Alt. 6A Options 3 and 4	Neutral
Habitat	GB	Alt. 6B Option 1	Slightly negative to neutral
Habitat	GB	Alt. 6B Option 2	Neutral
Habitat	GB	Alt. 6B Options 3 and 4	Neutral
Habitat	GB	Alt. 7 Option 1	Highly to moderately negative
Habitat	GB	Alt. 7 Option 2	Neutral
Habitat	GB	Alt. 8 Option 1	Highly to moderately negative
Habitat	GB	Alt. 8 Option 2	Neutral
Habitat	GB	Alt. 9 Option 1	Highly to moderately negative
Habitat	GB	Alt. 9 Option 2	Neutral
Habitat	GB	Alt. 10 *	Highly to moderately negative
Habitat	GSC-SNE	Alt. 1 (No action)	Slightly negative
Habitat	GSC-SNE	Alt. 2 (No area)	Slightly positive
Habitat	GSC-SNE	Alt. 3 Option 1	Highly negative
Habitat	GSC-SNE	Alt. 3 Option 2	Slightly positive

Type	Sub-region/region	Alternative	Impacts
Habitat	GSC-SNE	Alt. 3 Options 3 and 4	Slightly positive
Habitat	GSC-SNE	Alt. 4 Option 1	Highly negative
Habitat	GSC-SNE	Alt. 4 Option 2	Slightly positive
Habitat	GSC-SNE	Alt. 4 Options 3 and 4	Slightly positive
Habitat	GSC-SNE	Alt. 4 with temporary clam dredge exemption *	Highly negative
Habitat	GSC-SNE	Alt. 5 Option 1	Highly negative
Habitat	GSC-SNE	Alt. 5 Option 2	Slightly positive
Habitat	GSC-SNE	Alt. 5 Options 3 and 4	Slightly positive
Habitat	GSC-SNE	Alt. 6 Option 1	Highly negative
Habitat	GSC-SNE	Alt. 6 Option 2	Slightly positive
Spawning	GOM	Alt. 1A (Regulatory No Action, preferred)	Neutral
Spawning	GOM	Alt. 1B (Baseline No Action)	Neutral
Spawning	GOM	Alt. 2A	Neutral
Spawning	GOM	Alt. 2B	Neutral
Spawning	GOM	Alt. 3 *	Neutral
Spawning	GOM	Alt. 4 *	Neutral
Spawning	GB-SNE	Alt. 1 (No Action)	Neutral
Spawning	GB-SNE	Alt. 2A	Neutral
Spawning	GB-SNE	Alt. 2B	Neutral
Spawning	GB-SNE	Alt. 2C	Neutral
Spawning	GB-SNE	Alt. 3A	Neutral
Spawning	GB-SNE	Alt. 3B	Neutral
Spawning	GB-SNE	Alt. 3C *	Neutral
Research	n/a	Alt. 1 (No Action)	Neutral to slightly positive
Research	EGOM	Alt. 2	Neutral
Research	WGOM	Alt. 3A	Slightly negative to neutral
Research	WGOM	Alt. 3B	Slightly negative to neutral
Research	WGOM	Alt. 3C *	Slightly negative to neutral
Research	GB	Alt. 4 *	Slightly negative to neutral
Research	n/a	Alt. 5 *	Neutral to slightly positive

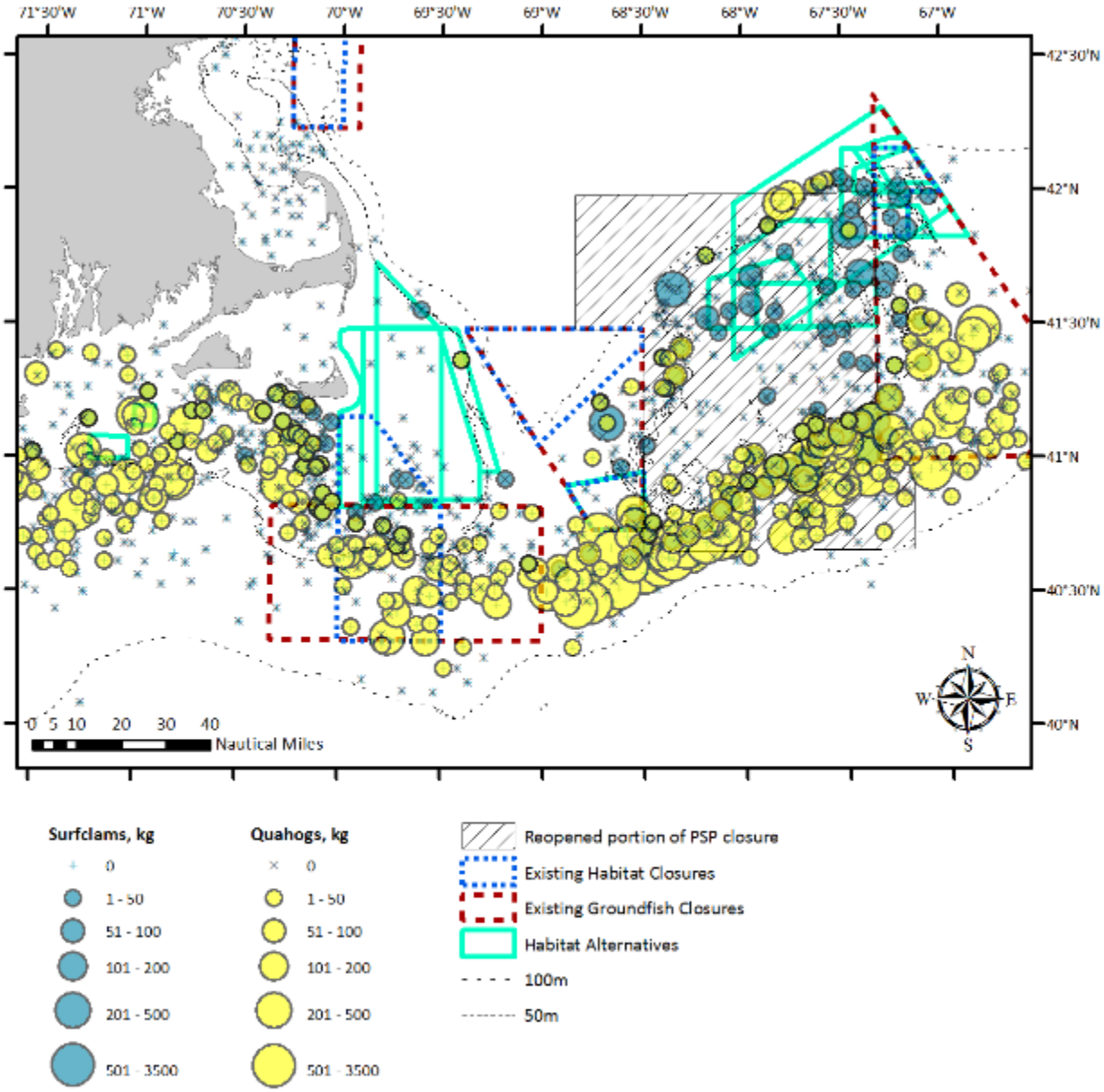
10.2.1 Habitat management alternatives

The commercial clam dredge fishery operates primarily in the Mid-Atlantic Bight and also in Southern New England and on Nantucket Shoals. There is an emerging fishery on Georges Bank (discussed further below) and a small quahog fishery in eastern Maine. In terms of evaluating the impacts of habitat management areas on the fishery, the question is whether a particular alternative is expected to lead to a net increase in the amount of area that can be fished with clam dredges, a net decrease in fishable area, or if shifts in access are expected. This issue is explored relative to the various habitat management areas below.

A related question is the abundance of clams in open vs. closed areas. The distribution of the clam resource relative to various management areas is shown on Map 101. Because there is no

clam survey in the Gulf of Maine, only the Georges Bank and Great South Channel/Southern New England sub-regions are shown on the figure. Note that this provides a somewhat incomplete view of clam distribution, as the clam survey does not cover some areas of Nantucket Shoals, including areas within the proposed Habitat Management Areas that are currently fished for clams. All zero tows are shown on the maps. In general, the extent of overlap between the various HMAs and the clam fishery, relative to the total extent of the clam fishery, is small. However, for some HMAs, clam catch rates are higher than other areas fished. While the impacts that result from these changes in gear restrictions may be relatively minor at the scale of the fishery, there could be local impacts on particular vessels or ports.

Map 101 – Distribution of the surfclam (blue) and ocean quahog (yellow) resources during summer clam dredge surveys from 1978-2014, relative to the PSP exemption area, No Action management areas, and new/modified habitat management areas that could potentially be closed to clam dredges. Locations where both species were caught may appear green due to the overlap of blue and yellow shading.



10.2.1.1 ***Gulf of Maine***

Because the fishery has limited overlap with habitat management areas under consideration in the Gulf of Maine, impacts from the alternatives in these sub-regions are generally expected to

be neutral. One exception to this is the Machias HMA, included in Eastern Gulf of Maine Alternatives 2 and 3. While fishing effort appears to be more concentrated south of the Machias area boundary, if the area is managed as a mobile bottom tending gear closure (Option 1 or 2), there could be some displacement of mahogany quahog catches, leading to low negative impacts associated with eastern Gulf of Maine Alternatives 2 and 3 with Option 1 or Option 2. As stated in the economic impacts analysis in Volume 4, in Machias, the fishery with the most potential revenue displacement is the clam fishery. While average revenue displaced per trip is relatively low, the Machias HMA abuts productive quahog clam beds to the south (see for instance the 44th SAW Assessment Report Appendix A8, Stock Assessment for Ocean Quahog in Maine Waters). Although there is evidence of clam dredge fishery activity, the majority of the clam dredge activity in the area, as represented by the logbook data, looks to occur outside of the Machias management area alternative. The Machias HMA is not part of the preferred alternative. In the eastern Gulf of Maine, both Alternative 1/No Action and the preferred alternative (Small Eastern Maine HMA) are expected to have neutral impacts.

The habitat closures in the Central Gulf of Maine are not known contain either species. Although the areas are not surveyed for clams, as there is currently no clam dredging occurring in the central Gulf of Maine, it is reasonable to conclude that fishery impacts of either maintaining or modifying management areas in this region would be neutral.

Both Atlantic surfclams and ocean quahogs are thought to occur, but in unknown quantities, in the southwestern portion of the Western Gulf of Maine Closure Area, which overlaps the proposed Small Stellwagen and Large Stellwagen HMAs and the No Action habitat closure. Another species, Stimson's surfclam, also occurs in this area. Previously, none of these clams could not be harvested due to a larger overlapping PSP closure. However, at the end of 2014, the Northern Temporary Paralytic Shellfish Poisoning Closure Area[15] expired, and therefore reopened to allow harvest of clams. Although the distribution and biomass of clams in this area is not well known, if the management areas noted above remain closed to all mobile bottom-tending gears, these closures would limit the ability of the clam fishery to be prosecuted in the reopened PSP closure. Because the area has only recently become accessible to the fishery, and had not previously been accessible since 2005 (see 70 FR 35047), there is little fishery dependent data to inform an assessment of the magnitude of the impact. It is likely that preventing access to clams as a result of Alternatives 1, 3, 4, 5, or 6 with Option 1 would have a small negative impact on a particular subset of vessels in the fishery. Continuation of the existing Western Gulf of Maine Habitat Closure is the preferred alternative, and this area is already closed to mobile bottom-tending gears including clam dredges, so there would be no change in fishery access going forward relative to the status quo. Western Gulf of Maine alternatives 2, 7A, 7B, and 8 will have neutral impacts on the clam fishery.

10.2.1.2 ***Georges Bank and Great South Channel/Southern New England***

The remainder of this section will address the impacts of the Georges Bank and Great South Channel/Southern New England habitat alternatives, which have a much greater degree of

[15] The PSP area is shown in yellow on the map in the clam fishery portion of the affected environment section of Volume 1. It extends north/south from 43° N to 41° 39' N and west to east from the state waters boundary to 69° W.

overlap with the clam resource and fishery relative to the Gulf of Maine areas. The habitat management alternatives for the Georges Bank region include various combinations of 19 areas: Closed Area II Habitat Closure Area (no action), Closed Area I N Habitat Closure Area (no action), Closed Area I S Habitat Closure Area (no action), Closed Area II (no action), Closed Area I (no action), Northern Edge HMA, Georges Shoal Gear Modification Area, Georges Shoal 1 MBTG HMA, Northern Georges Gear Modification Area, EFH Expanded 1 HMA, EFH Expanded 2 HMA, Georges Shoal 2 MBTG HMA, EFH South HMA, Northern Georges MBTG HMA, Alternative 9 Western and Eastern MBTG HMAs and Mortality Closure, Alternative 10/Northern Edge MBTG HMA and Alternative 10/Northern Edge Reduced Impact HMA. Depending on the options selected, these areas could include a complete prohibition of bottom tending mobile gear use, including exclusion of hydraulic dredges (Option 1), or hydraulic clam dredges could be exempted from the requirements in those areas (Option 2). The "Gear Modification Areas" listed would not restrict dredge activity, only bottom trawls. Going forward, PSP closures will remain in place within Closed Areas I and II, such that selecting an action alternative that removes these areas will not increase clam dredge access.

The habitat management alternatives for the Great South Channel and Southern New England region include various combinations of seven areas: Nantucket Lightship Habitat Closure Area (no action), Great South Channel East HMA (Alternative 3), Great South Channel HMA (Alternative 4), Nantucket Shoals HMA (Alternative 5), Nantucket Shoals West HMA (Alternative 6), Great South Channel Gear Modification Area (Alternative 6), and the Cox Ledge HMA (which is comprised of two sub-areas that would be implemented together, Alternatives 3-6). In this sub-region, adopting any action alternative with Option 2 measures, which would restrict mobile bottom-tending gears but exempt hydraulic clam dredges, would lead to a net increase in area that could be fished with hydraulic dredges. This is because under Alternatives 3-6 with Option 2 the existing Nantucket Lightship habitat closure would be removed, but the new habitat management areas could still be fished with clam dredges. The same conclusion would hold for Great South Channel HMAs implemented with Options 3 or 4, which require trawl gear modifications but do not restrict other gears, including clam and scallop dredges. Alternatives 3-6 with Option 1 would shift the areas where clam dredges can operate, closing grounds on Nantucket Shoals and opening grounds in the existing Nantucket Lightship Habitat Closure.

Recent changes to the Georges Bank fishery influence the magnitude of potential impacts. Since January 1, 2013, the fishery has expanded onto Georges Bank now that portions of the bank are accessible to the fishery. Georges Bank was previously closed due to paralytic shellfish poisoning and now accessible when following a testing protocol. Thus far, this effort shift has not been significant relative to the distribution of landings in the fishery as a whole, due to the increased costs associated with a longer steam time to the Georges Bank grounds and the costs to comply with PSP testing protocols.

The reopening of Georges Bank is expected to have a larger effect on the surfclam fishery than on the ocean quahog fishery. The catch rates for surfclams in the Mid-Atlantic Bight have decreased over time and are lower than the catch rates expected in the previously unfished areas of Georges Bank. Therefore, industry has indicated they will be shifting substantial amounts of effort to these newly opened areas, and away from areas with lower catch rates. It is unclear

whether current effort for surfclams fishing on Nantucket Shoals would shift to Georges Bank. Fishing conditions on Georges Bank are more hazardous and the steam time is longer, therefore small clam dredge fishing vessels are not expected to shift their effort to Georges Bank. For ocean quahogs, there is not the disparity in catch rates between the near shore area catch rates versus Georges Bank. Industry has indicated that they will be fishing for ocean quahogs on Georges Bank; however, it is not clear if the incentive to shift effort to these areas is as strong for the quahog fishery.

The Council's preferred alternatives for this amendment include designating the Great South Channel and Georges Shoal 2 HMAs as closures to mobile bottom tending gears (Option 1), with a one-year exemption for hydraulic dredges (the northeastern part of the Great South Channel HMA would not have this exemption). This one-year exemption is intended to allow for longer term access to be developed. A framework adjustment action to consider longer term access for hydraulic dredging in both of the HMAs was initiated by NEFMC in October, 2015 and is currently under development.

Based on overlaps with the clam resource and the estimates of displaced revenue provided in the economic impacts sections in Volume 4, the year round closure of one or more of the habitat management areas in these two sub-regions has the potential for negative impacts on the clam fisheries. Effects on clam dredging will vary by management area (likely changes are summarized in Table 60), and will depend on whether fishermen using clam dredges would have chosen to dredge in these areas and would be excluded under the alternatives. A few factors make precise determinations of the degree of impacts to the clam fishery challenging. First, the extent of overall fishery expansion onto Georges Bank fishing grounds in the coming years is not precisely known, as discussed above. It can be assumed that recent fishing effort in the Georges Bank areas previously closed due to PSP occurred in locations expected to have relatively high catch rates, such that these past estimates of displaced revenue are a good indicator of future revenue displacement, but it is likely that past revenue displacements underestimate future fishing activity on Georges Bank. In the Great South Channel sub-region, there is a tradeoff between the existing Nantucket Lightship Habitat Closure Area (Alternative 1) and the new areas proposed in Alternatives 3-6. Because the Nantucket Lightship Habitat Closure has been in effect since 2004, it overlaps completely with the time period reflected in the economic analysis (2005-2012), making it difficult to compare the potential for revenue displacement in the existing vs. new areas. Overall, the bulk of the clam fishery is prosecuted in the Mid-Atlantic, such that impacts could be high for vessels fishing exclusively or predominately in New England, but impacts for the fishery as a whole may be slight. Individual-level impacts on small businesses are evaluated in the regulatory flexibility analysis (Volume 6).

Table 60 – Current and future clam dredge effort in GSC/SNE and GB habitat areas. Preferred areas indicated with a (*).

Area	Alternative	Species	Current clam effort	Potential for future clam effort	Impacts on clam fishery of removing current area or adding new area

Area	Alternative	Species	Current clam effort	Potential for future clam effort	Impacts on clam fishery of removing current area or adding new area
CAII groundfish (current closure)	GB1	SC (north) and OQ (south)	None – PSP closure and clam dredges are not exempt from the fishery closure	None immediately – area would still be a PSP closure even if CAII is eliminated or made seasonal	Neutral
CAII EFH (current closure)	GB1	SC	None – PSP closure	None immediately – area would still be a PSP closure even if CAII EFH is eliminated	Neutral
CAI groundfish (current closure)	GB1	SC and OQ	None – PSP closure and clam dredges are not exempt from the fishery closure	None immediately – most of the area would still be a PSP closure even if CAI is eliminated or made seasonal, and there do not appear to be clams in the parts outside the PSP closure	Neutral
CAI N EFH (current closure)	GB1	Neither	None – PSP closure	None immediately – most of the area would still be a PSP closure even if CAI N EFH is eliminated, and there do not appear to be clams in the parts outside the PSP closure	Neutral
CAI S EFH (current closure)	GB1	SC and OQ	None – PSP closure	None immediately – area would still be a PSP closure even if CAI S EFH is eliminated or made seasonal	Neutral
Northern Edge (new area)	GB3 and GB4	SC	None – PSP closure	None – PSP closure	Neutral
Georges Shoal 1 MBTG (new area)	GB5	SC	Yes – area is in recently reopened part of GB PSP area	Yes – substantial shift to these areas, as stated by industry	Moderately to highly negative
EFH Expanded 1	GB6A	SC	Yes – southwestern corner in recently reopened part of GB PSP area	Yes – shift to these areas, as stated by industry	Neutral to slightly negative
EFH Expanded 2	GB6B	SC	Yes – southwestern corner in recently reopened part of GB PSP area	Yes – shift to these areas, as stated by industry	Neutral to slightly negative
Georges Shoal 2 MBTG*	GB7, GB10	SC	Yes – area is in recently reopened part of GB PSP area	Yes – substantial shift to these areas, as stated by industry	Moderately to highly negative

Area	Alternative	Species	Current clam effort	Potential for future clam effort	Impacts on clam fishery of removing current area or adding new area
EFH South MBTG	GB7	SC	None – PSP closure	None – PSP closure	Neutral
Northern Georges GMA	GB8	SC	Roughly half the area overlaps recently reopened part of GB PSP area	Yes – substantial shift to these areas, as stated by industry	Neutral – restrictions would not affect clam dredges
Western MBTG HMA	GB9	SC	Yes – area is in recently reopened part of GB PSP area. Less revenue than Georges Shoal 2 HMA	Yes – substantial shift to these areas, as stated by industry	Moderately to highly negative
Eastern MBTG HMA	GB9	SC	None – in PSP closure	None – PSP closure	Neutral
Mortality Closure	GB9	SC	None – mostly in PSP closure, open areas do not appear to have clam fishing	None – PSP closure	Neutral
Northern Edge MBTG HMA*	GB10	SC	None – in PSP clsoure	None – PSP closure	Neutral
Northern Edge Reduced Impact HMA*	GB10	SC	None – mostly in PSP closure, open areas do not appear to have clam fishing	None – PSP closure	Neutral
NL groundfish (current closure)	GSC-SNE1	SC and OQ	Yes – especially quahogs	Yes	Neutral – area already accessible to gear
NL EFH (current closure)	GSC-SNE1	SC and OQ	No – gear prohibited by EFH closure	Yes	Slightly to moderately positive if area reopens
Great South Channel East HMA (new area)	GSC-SNE3	SC	Yes	Yes	Highly negative
Great South Channel HMA (new area)*	GSC-SNE4	SC	Yes	Yes	Highly negative
Nantucket Shoals HMA (new area)	GSC-SNE5	SC	Yes	Yes	Highly negative

Area	Alternative	Species	Current clam effort	Potential for future clam effort	Impacts on clam fishery of removing current area or adding new area
Nantucket Shoals West HMA (new area)	GSC-SNE6	SC	Yes	Yes	Highly negative
Cox Ledge HMA	GSC-SNE 3, 4, 5 and 6	SC and OQ	Yes – but may be occurring near area – does not appear to be a center of activity	Same as existing	Neutral to slightly negative

Because harvesting clams remains prohibited on parts of Georges Bank as a result of a PSP closure, Georges Bank Alternative 1/No Action, Alternative 3, and Alternative 4 are expected to have neutral impacts on the clam fishery, regardless of the management option selected for Alternative 3 or 4. Alternatives 5, 6A, 6B, 7, 8, 9, and 10 would have negative impacts on the fishery, if implemented with Option 1, because some of the HMAs that are part of these alternatives would restrict clam dredging in recently reopened areas of Georges Bank. The magnitude of these impacts will vary between alternatives, given the area of overlap between the HMAs and the reopened portion of the PSP closure (Table 61) and the relative catch rates of clams.

As indicated in Table 61, the area with the largest overlap with the open part of the PSP closure is the Northern Georges HMA, followed by Georges Shoal 2 HMA, Georges Shoal 1 HMA, Western HMA, and EFH Expanded 1 and 2 HMAs. For reference, the entire reopened area of the PSP closure is 16,500 km^2, although some of this area (approximately 2300 km^2) is in deep water off the northern margin of the bank and likely would not be fished for clams, and the shallowest parts of Georges Bank have few positive tows in the clam survey and are generally not fished. The surfclam resource is concentrated in the northern fishable portions of the reopened area and has a high degree of overlap with the proposed HMAs. Recent clam dredging on Georges Bank has focused almost exclusively on surfclams. Thus, while there are large areas of Georges Bank that would remain open to clam dredging despite closure of any of the areas listed in the table below, these particular HMAs are currently very important to the fishery.

Given their relative size and lack of overlap with fishing during 2012-2014, Alternatives 6A and 6B (the EFH Expanded 1 and 2 HMAs) would have neutral to low negative impacts on the fishery. While during the recent three year period no clams were harvested from these areas, and the area of overlap with the reopened PSP closure is smaller, surfclams do occur in this location based on survey data. If implemented with Option 1, Alternatives 5, 7, 8, 9, and 10 (preferred) would have moderately to highly negative impacts on the fishery, given the higher area of overlap with the reopened part of the PSP closure and the magnitude of revenue displaced. From greatest to least impact, the alternatives would rank as follows: 8, 7/10, 5, and 9. For reference, the total ex vessel value of the surfclam fishery averaged 29.5 million between 2012 and 2014, which means that these areas accounted for between 5-13% of surfclam revenues over this time period. Total ex-vessel value of the quahog fishery, combining Maine and non-Maine landings,

averaged 23.8 million over the same time period. Considering the clam fishery as a whole, these areas accounted for between 3-7% of landings of both surfclams and quahogs combined.

Table 61 – Overlap between HMAs and the reopened portion of the Georges Bank PSP closure.

Area name	Alternative(s)	Total size of HMA	Area within reopened part of PSP closure	Mean clam dredge revenue 2012-2014
Georges Shoal 1 MBTG	5	913 km^2	913 km^2	$ 1,990,936
EFH Expanded 1	6A	1,152 km^2	256 km^2	$ 0
EFH Expanded 2	6B	804 km^2	256 km^2	$ 0
Georges Shoal 2 MBTG	7, 10 (preferred)	1,025 km^2	1,025 km^2	$ 3,102,489
Northern Georges MBTG	8	4,788 km^2	2,845 km^2	$ 3,842,700
Western MBTG	9	900 km^2	900 km^2	$ 1,335,997

In the Great South Channel/Southern New England sub-region, the four HMAs overlapping Nantucket Shoals, i.e. Great South Channel East, Great South Channel, Nantucket Shoals, and Nantucket Shoals West, all encompass surfclam fishing grounds. Mean revenue between 2012-2014 was 6.7 million, 6.6 million, 6.1 million, and 6.3 million for each area, respectively, which is approximately 21% of the ex-vessel value of the surfclam fishery over this time period (12% considering revenues from both surfclams and ocean quahogs). Relatively small amounts of revenue are expected to be displaced by the Cox Ledge HMA. Given the overlap with clam beds on Nantucket Shoals, Alternatives 3, 4, 5, or 6 with Option 1 would have highly negative impacts on the surfclam fishery.

A mitigating factor is that these alternatives would reopen the majority of the Nantucket Lightship Habitat Closure, such that clams in that area could be harvested (a small section of this closure overlaps the various new HMAs). Based on survey data, ocean quahogs are the primary species occurring in the Nantucket Lightship Habitat Closure. Because the two species are allocated separately, vessels that target surfclams on Nantucket Shoals might or might not shift effort onto quahog grounds in the Nantucket Lightship Habitat Closure, depending on their allocations. Given the presence of clams in the existing habitat closure, Alternative 1/No Action likely has slightly negative impacts on the fishery through continued prohibitions on fishing, and Alternative 2, which would remove the existing area and would not designate any new areas, would have a slight positive impact.

If Alternatives 3-6 were implemented with Option 2, 3, or 4, they would have slightly positive impacts on the clam fishery as increased access would be afforded via removal of the Nantucket Lightship Habitat Closure, but no new restrictions would be imposed on the fishery. The preferred alternative's impacts are somewhere in between. The preferred approach is Alternative 4, with part of the Great South Channel HMA closed to clam dredges, and the remainder of the area accessible for one year, with potential exemption opportunities after one year if developed in a trailing framework. The Cox Ledge HMA, which is a much less important clam dredge ground, would be closed to clam dredges. Thus, if only a portion of the Great South Channel

HMA and the Cox Ledge HMA are closed and the Nantucket Lightship Habitat Closure is reopened, longer term impacts could be slightly negative to slightly positive, depending on the tradeoffs between the open and closed areas in terms of clam production. However, impacts of the preferred alternative could be highly negative if the one year exemption sunsets and the entire area was closed to hydraulic dredging.

10.2.2 Spawning management alternatives

Many types of fishing gears are currently prohibited in the Nantucket Lightship Closure Area, Closed Area I, and Closed Area II year round, and in the Georges Bank Seasonal Closure from May 1 to May 31. Under Georges Bank spawning Alternatives 2 and 3, the Nantucket Lightship Closure Area and the Georges Bank Seasonal Closure would be eliminated. In addition, Closed Area I and II would only have restrictions in place during 3 months of the year (February-April) as opposed to year round. Clam dredges are currently exempted from the Nantucket Lightship Closure Area. Although they are not allowed in Closed Area I or Closed Area II, there remains a PSP closure in these areas, so making Closed Area II and Closed Area II seasonal and adjusting the restrictions to exempt clam dredges from the spawning closures would not have an immediate impact on the clam fishery. These alternatives do not alter other aspects of the fishery, including the limits on catch and landings in this fishery. Therefore, the impacts of the spawning management alternatives on the surfclam and ocean quahog fisheries are expected to be neutral.

10.2.3 Dedicated Habitat Research Area alternatives

Dedicated habitat research areas would restrict mobile bottom-tending gears including clam dredges, and in the case of Alternative 3 (Stellwagen DHRA), additional gear types as well. Because of the lack of clam resource overlap within the Eastern Maine DHRA (Alternative 2), impacts are expected to be neutral. Designating the Stellwagen area as a DHRA (Alternative 3) would have neutral impacts, given the preferred habitat and spawning alternatives keep sand habitats in the southern part of the Western Gulf of Maine Closure closed to the clam fishery. In the absence of these other closures, the DHRA alternative might have slightly negative impacts.

The only DHRA that is in close proximity to substantial commercial fishing for Atlantic surfclam and ocean quahog is the Georges Bank DHRA, Alternative 4. This area is currently a habitat closure area and is thus closed to all mobile bottom-tending gears, including clam dredges. Recently, the clam fishery has expanded onto Georges Bank given an exemption area from a previous PSP closure. However, the Georges Bank DHRA boundaries remain within the PSP closure, and the area's PSP closure status is unlikely to change in the near term. This means that in the short term, the DHRA would have neutral impacts on the clam fishery.Over the longer term, if the current PSP exemption area on Georges Bank is expanded, it might be desirable to harvest clams from the Georges Bank DHRA. If the exemption area is expanded, Alternative 4 could have a slight negative impact on the clam fishery. The magnitude of this negative impact is probably not substantial given the overall distribution of clams on Georges Bank, but it would depend on the location of any other closures to clam dredges and the resulting amount of clam resource available for harvest elsewhere.

Alternative 1/No Action, which would not designate these DHRAs, would have neutral to slightly positive impacts, given that it would not designate research areas with slightly negative

to neutral expected impacts. Similarly, the sunset provision (Alternative 5) would have impacts ranging from neutral to slightly positive

10.2.4 Framework and monitoring alternatives

These measures are focused on describing the process by which the habitat, spawning, and dedicated habitat research alternatives would be reviewed and modified in the future. These alternatives are administrative and are unlikely to have impacts on Atlantic surfclam and ocean quahog fisheries. Action that results from application of this process (e.g., modifications to boundaries for areas, changes to gear restrictions within areas, etc.) would be proposed and implemented through a Framework or other actions which would include an analysis of the impacts for that specific action.

11 Atlantic bluefish

11.1 Impacts on Atlantic bluefish

Bluefish (*Pomatomus saltatrix*) are found along the entire east coast of the United States from Maine through Florida. Bluefish travel in schools of like-sized individuals and undertake seasonal migrations, moving into the Mid-Atlantic Bight during spring and south or farther offshore during fall.

North of Cape Hatteras, North Carolina, EFH for bluefish eggs and larvae is pelagic waters found over the Continental Shelf (from the coast out to the limits of the EEZ), most commonly in the upper 49 ft (15 m) of the water column, from Montauk Point, New York south to Cape Hatteras, in the highest 90% of the area where bluefish larvae were collected during the MARMAP surveys. For bluefish juveniles, EFH is pelagic waters found over the Continental Shelf (from the coast out to the limits of the EEZ) from Nantucket Island, Massachusetts south to Cape Hatteras, in the highest 90% of the area where juvenile bluefish are collected in the NEFSC trawl survey. EFH for adult bluefish is the pelagic waters found over the Continental Shelf (from the coast out to the limits of the EEZ), from Cape Cod Bay, Massachusetts south to Cape Hatteras, in the highest 90% of the area where adult bluefish were collected in the NEFSC trawl survey. All bluefish life stages are pelagic and are therefore not highly susceptible to impacts from bottom tending fishing gears.

There is little to no overlap between bluefish distribution and EFH and the proposed habitat management alternatives. The areas proposed are in the upper end of the seasonal migratory range. In addition, bluefish life stages are pelagic and not susceptible to mobile bottom tending gears, and would not likely be impacted (either positively or negatively) by any prohibitions on use of those gear types. In addition, the commercial and recreational fisheries for bluefish are managed using annual catch limits, which limit removals (landings and discards) to levels that are sustainable. Therefore, the biological impacts of the habitat management alternatives on bluefish are expected to be neutral when compared to Alternative 1/No Action.

There is little to no overlap between bluefish distribution and EFH and the proposed spawning management alternatives. The areas proposed are in the upper end of the seasonal migratory range. In addition, bluefish life stages are pelagic not susceptible to mobile bottom tending gears or fixed gears used to catch groundfish and prohibited from spawning areas, and would not likely be impacted (either positively or negatively) by any prohibitions on use of those gear types. In addition, the commercial and recreational fisheries for bluefish are managed using annual catch limits, which limit removals (landings and discards) to levels that are sustainable. Therefore, the biological impacts of the spawning management alternatives on bluefish are expected to be neutral when compared to Alternative 1/No Action.

Dedicated habitat research areas would be closed to mobile bottom-tending gears (Alternatives 2 and 4), or mobile bottom-tending gears and other demersal gears capable of catching groundfish (Alternative 3). As described above, there is little to no overlap between bluefish distribution and EFH and the DHRA alternatives. The areas proposed are in the upper end of the seasonal migratory range. In addition, bluefish life stages are pelagic not susceptible to bottom tending

gears, and would not likely be impacted (either positively or negatively) by any prohibitions on use of those gear types. Therefore, the biological impacts of the dedicated habitat research area alternatives on bluefish are expected to be neutral when compared to Alternative 1/No Action.

The framework and monitoring alternatives are administrative and do not have any impacts on the biological process of bluefish; therefore no biological impacts are expected on bluefish when compared to No Action.

11.2 Impacts on the bluefish fishery

About 98% of the commercial fishery for bluefish is prosecuted with gillnets (sink or anchored) and hook and line. About 2% of the fishery landings are in "other" gears such as mobile bottom-tending gear. However, mobile bottom-tending gear is not an efficient gear type for catching bluefish, which are highly mobile, pelagic, schooling fish. Bluefish are not typically targeted with trawls or other mobile bottom-tending gear and are considered incidental catch in those gear types.

Table 62 – Commercial gear types associated with bluefish harvest by federally permitted vessels in 2011.

Commercial Gear Type	Trips	Landings (lb)	Pct Total
Gillnet	818	1,494,252	93.4%
Hook and line	545	72,404	4.5%
Other	20	33,319	2.1%
Total	1,383	1,599,975	100%

Source: VTR Data as of Nov 20, 2012.

According to VTR data, bluefish were commercially harvested in 40 statistical areas in 2011, but seven statistical areas collectively accounted for 75.1% of VTR-reported landings in 2011, with individual areas contributing 7% to 14% of the total. These areas also represented 69.6% of the trips that landed bluefish. These include statistical areas 538, 611, 612, 613, and 615 off Rhode Island, Long Island, and New Jersey, and areas 635 and 636 off North Carolina. Because the core of the commercial fishery does not coincide with the areas under consideration, it is unlikely to be impacted by any proposed measures that restrict or prohibit the use of mobile bottom-tending gear under the habitat management alternatives.

The core of the commercial fishery (about 92% of the landings) is prosecuted in areas south of Nantucket Island such that there is limited overlap with the spawning management alternatives. The only area of overlap is the Nantucket Lightship Closed Area, which was intended to protect groundfish spawning. The use of sink or anchored gillnets is currently prohibited in this area year round. Under Georges Bank/Southern New England spawning Alternatives 2 and 3, the Nantucket Lightship Closure Area would be eliminated. Therefore, there is the potential for slightly positive impacts on the bluefish fishery, if fishermen choose to expand the use of sink or anchor gillnets used to catch bluefish into this area. Recreational vessels are exempted under Alternatives 2A and 3A, but limited recreational fishing effort is expected to flow into Closed Areas I and II even if they did reopen to recreational fishing (see economic impacts analysis

section). Therefore, impacts on the recreational fishery are not expected. Alternatives 2C and 3C (scallop dredge exemption) would have neutral impacts on the bluefish fishery.

Dedicated habitat research areas would be closed to mobile bottom-tending gears (Alternatives 2 and 4), or mobile bottom-tending gears and other demersal gears capable of catching groundfish (Alternative 3). Sink or anchored gillnets would be prohibited in the Stellwagen DHRA. However, because the core of the bluefish commercial fishery (about 92% of the landings) is prosecuted in areas south of Nantucket Island, it is unlikely the fishery will be impacted by these proposed measures.

The framework and monitoring alternatives are administrative and are unlikely to have impacts on the bluefish fishery because of minimal overlap with the directed fishery.

12 Atlantic mackerel, squids, and butterfish

12.1 Impacts on the mackerel, squid, and butterfish resources

Atlantic mackerel (*Scomber scombrus*) are found on both sides of the North Atlantic Ocean, including the Baltic Sea. In the western Atlantic, they are found from Labrador to North Carolina. Atlantic mackerel are common in cold and temperate waters over the continental shelf. They swim in schools near the surface, and travel to and from spawning and summering grounds.

Butterfish (*Peprilus triacanthus*) range from Florida to Newfoundland, but are primarily found from Cape Hatteras, North Carolina, to the Gulf of Maine. Butterfish are sensitive to and migrate in response to seasonal changes in water temperature. During summer, butterfish move northward and inshore to feed and spawn. During winter, butterfish move southward and offshore to avoid cold waters. Butterfish are semi-pelagic, and form loose schools that feed upon small squid, and crustaceans.

The northern shortfin squid (*Illex illecebrosus*, referred to in this section as Illex) is a highly migratory, transboundary species that is distributed in the Northwest Atlantic Ocean from the Florida Straits to Newfoundland. The southern and U.S. stock component extends from the Gulf of Maine to Florida.

Longfin squid (*Doryteuthis (Amerigo) pealei*) is found from Newfoundland to the Gulf of Venezuela. In the northwest Atlantic Ocean, longfin squid are most abundant between Georges Bank and Cape Hatteras, North Carolina. Squid eggs are attached to rocks and small boulders or aquatic vegetation on sandy or muddy bottoms. Larvae are found in surface waters. Juveniles also live in the upper water column in water 165 to 1,650 feet deep. Adults live over mud or sand/mud substrates of the continental shelf and upper continental slope in waters up to 1,300 feet deep.

EFH for life stages for Atlantic mackerel, longfin squid, Illex, and butterfish are pelagic (water column itself), and the species have temperature and prey preferences/needs that drive the suitability of any particular area/depth, thus fishing activity has minimal impacts on their habitats. Longfin squid also use hard bottom, submerged vegetation, other natural or artificial structure, and sand or mud to attach/anchor eggs, but there are no known preferences for different types of substrates or indications that fishing activity may negatively affect longfin squid egg EFH.

As described above, there is overlap between Atlantic mackerel, longfin squid, Illex (shortfin squid), and butterfish distribution and EFH and the proposed habitat management alternatives. However, because EFH for these species are not susceptible to mobile bottom-tending gears, their EFH would not likely be impacted (either positively or negatively) by any prohibitions on use of those gear types in habitat management aras. If these gear restrictions go into place, it is expected that fishing effort with mobile bottom-tending gear would likely shift to other unrestricted areas. In addition, the commercial fisheries for Atlantic mackerel, longfin squid, Illex, and butterfish are managed using annual catch limits, which limit removals (landings and discards) to levels that are sustainable. Therefore, the biological impacts of the proposed habitat

management alternatives on these species are expected to be neutral when compared to Alternative 1/No Action.

Because EFH for Atlantic mackerel, longfin squid, Illex, and butterfish life stages are not susceptible to the gears regulated in spawning areas, their EFH would not likely be impacted (either positively or negatively) by any prohibitions on use of those gear types under the spawning management alternatives. In addition, the commercial fisheries for Atlantic mackerel, longfin squid, Illex, and butterfish are managed using annual catch limits, which limit removals (landings and discards) to levels that are sustainable. Therefore, the biological impacts of the proposed spawning management alternatives on these species are expected to be neutral when compared to Alternative 1/No Action.

Dedicated habitat research areas would be closed to mobile bottom-tending gears (Alternatives 2 and 4, or mobile bottom-tending gears and other demersal gears capable of catching groundfish (Alternative 3). Because EFH for Atlantic mackerel, longfin squid, Illex, and butterfish life stages are not susceptible to mobile bottom-tending gears, or other gear types, their EFH would not likely be impacted (either positively or negatively) by any prohibitions on use of those gear types. The commercial fisheries for Atlantic mackerel, longfin squid, Illex, and butterfish are managed using annual catch limits, which limit removals (landings and discards) to levels that are sustainable. None of the measure proposed would alter that aspect of the management program. Therefore, the biological impacts of the proposed dedicated habitat research area alternatives on these species are expected to be neutral, when compared to Alternative 1/No Action.

The framework and monitoring alternatives are administrative and do not have any impacts on the biological processes of Atlantic mackerel, longfin squid, Illex, and butterfish; therefore no biological impacts are expected on these species from these alternatives.

12.2 Impacts on the mackerel, squid, and butterfish fishery

Mackerel are primarily caught by mid-water trawls, but longfin squid, Illex, and butterfish are primarily caught with bottom trawls (mobile bottom-tending gear). A small recreational fishery exists for Atlantic mackerel and butterfish. While there is a recreational fishery for longfin squid, information on the recreational landings of invertebrates is not collected. The core of the fishery for Atlantic mackerel is prosecuted in four statistical areas in the Mid-Atlantic Bight (Table 63).

Table 63 – Mackerel landings (mt) in statistical areas with at least 1,000 mt of mackerel landed in at least one recent year.

Year	612	616	622	621	Total fishery harvest (commercial and recreational) all statistical areas
2010	57,602	383	1,260	1,131	10,635
2011	4	100	18	59	1,463
2012	2,393	1,527	3	-	6,085

Source: Unpublished NMFS vessel trip reports

The core of the commercial fishery for butterfish and longfin squid is in the Mid-Atlantic region; however, significant catch and landings occur in the Southern New England and Georges Bank area in statistical areas 522, 525, and 562 for butterfish (Table 64), and 525 and 562 for longfin squid (Table 65). Because squid are captured with small mesh bottom trawls, they operate in areas delineated as exemptions from the regulated mesh areas (hatched areas on Map 102). The regulated mesh areas require 6.5 inch codend mesh to minimize impacts on regulated multispecies (large mesh stocks such as cod and haddock, plus ocean pout). The Southern New England Exemption Area is generally west and south of the various habitat management areas, including the No Action areas. The exception to this is the western half of the Nantucket Lightship Closed Area and the Nantucket Lightship Habitat Closure Area, which overlaps the small mesh area and could be fished with the gear if the groundfish and habitat closures were lifted.

Table 64 – Butterfish landings (mt) in statistical areas with substantial recent butterfish catch.

Year	537	611	539	616	613	525	522	562	612	Total commercial fishery harvest, all statistical areas
2010	128	54	65	37	29	26	20	68	12	576
2011	105	81	62	72	31	31	10	9	9	664
2012	103	58	64	37	44	31	19	13	23	627

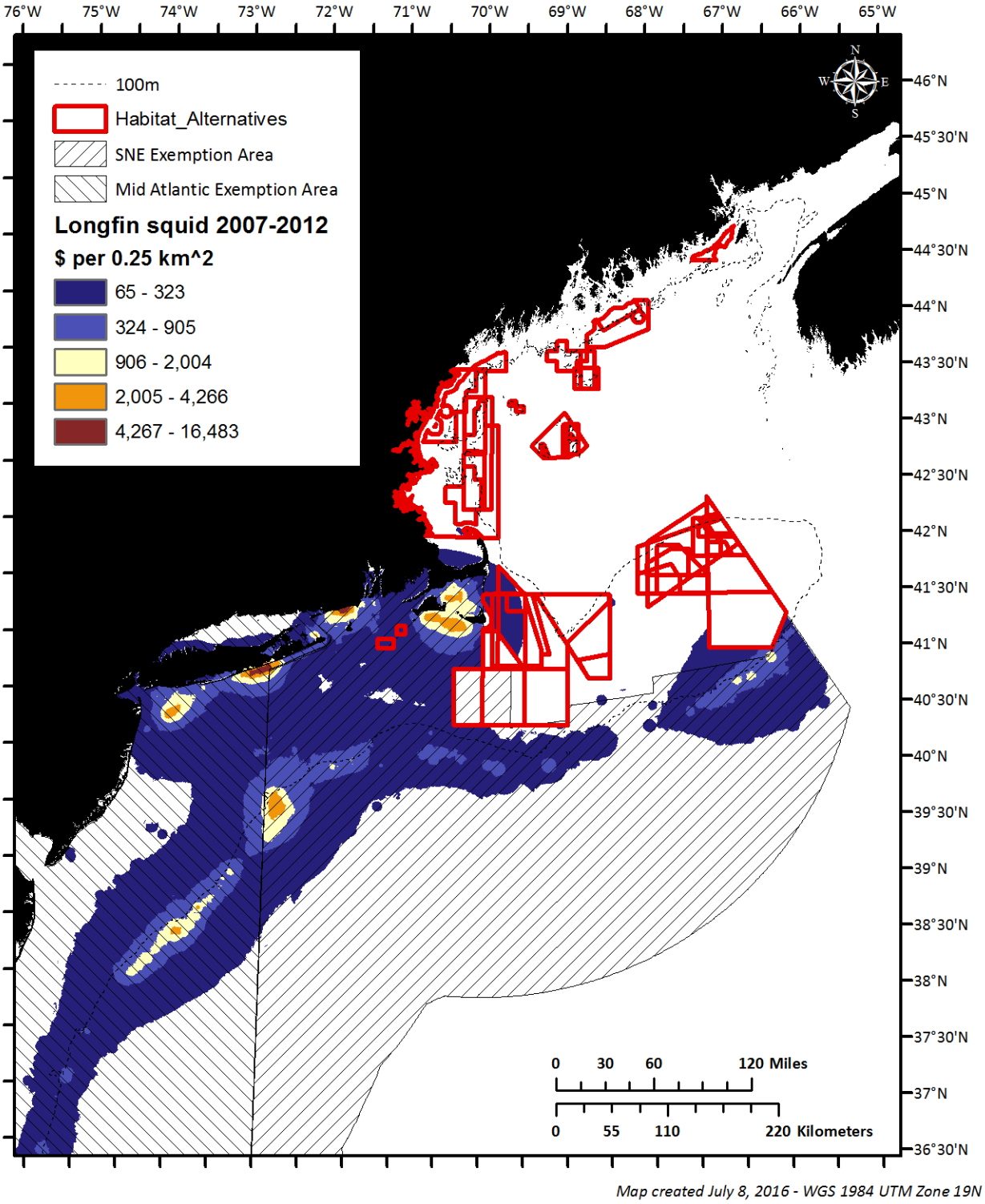
Source: Unpublished NMFS vessel trip reports

Table 65 – Longfin squid landings (mt) in statistical areas with at least 250 mt of longfin squid landed in at least one recent year.

Year	616	537	622	612	613	539	538	626	525	623	611	632	562	526	Total commercial fishery harvest, all statistical areas
2010	2,505	604	1,043	475	474	333	199	173	348	52	226	275	224	51	6,750
2011	1,321	1,252	1,608	1,630	642	327	114	417	459	235	313	137	110	324	9,556
2012	1,419	2,501	1,244	1,765	1,699	407	722	385	114	433	174	130	95	12	12,750

Source: Unpublished NMFS vessel trip reports

Map 102 – Longfin squid revenue relative to habitat management area alternatives. Exemption areas where the fishery is allowed to use small mesh bottom trawls are hatched. Revenues are per 0.25 km^2, and are summed across calendar years 2007-2012.



During summer through fall, a bottom trawl fishery for Illex occurs on the U.S. shelf, primarily in the Mid-Atlantic Bight. Annual landings by state are given in Table 66; in 2012 Illex were landed in mainly in New Jersey (6,054 mt) and Rhode Island (5,366 mt), and to a lesser extent in Virginia (288 mt).

Table 66 – Illex landings (mt)

Year	Total commercial fishery harvest
2010	15,825
2011	18,797
2012	11,709

Source: unpublished NEFSC dealer reports

Because the core of the commercial fisheries for Atlantic mackerel and Illex do not coincide with the habitat management areas under consideration, these fisheries are unlikely to be impacted in any way by proposed measures that restrict or prohibit the use of mobile bottom-tending gear under the habitat management alternatives proposed. As noted above, the current Nantucket Lightship closures partially overlap the Southern New England small mesh exemption area, such that removing these areas via Great South Channel/Southern New England Alternatives 2-6 could have slight positive impacts on the butterfish and longfin squid fisheries. The impacts are expected to be slight, because these areas only represent a small portion of the overall area over which these fisheries are prosecuted. Impacts of all other alternatives are expected to be neutral. The impacts on the Atlantic mackerel and Illex fisheries are expected to be neutral.

In terms of spawning management alternatives, none of the Gulf of Maine alternatives would affect the fishery. On Georges Bank, many types of fishing gears are currently prohibited in the Nantucket Lightship Closed Area, Closed Area I, and Closed Area II year round; most vessels are exempt from the Georges Bank Seasonal Closure from May 1 to May 31. Under Georges Bank Alternatives 2 and 3, the Nantucket Lightship Closed Area and the Georges Bank Seasonal Closure would be eliminated. In addition, Closed Areas I and II would only have these gear prohibitions in place during 2.5 months of the year (February-April 15) as opposed to year round. The core of the Atlantic mackerel and Illex fisheries are not prosecuted in these areas. However, there is the potential for slightly positive impacts of some of the spawning management alternatives on the butterfish and longfin squid fisheries, specifically Georges Bank Alternatives 2 and 3 which would remove the Nantucket Lightship Closed Area. The impacts will depend on whether fishermen chose to take advantage of the newly open areas and expand the use of bottom trawls into these areas during the open times of the year. These impacts are considered slight because these areas only represent a small portion of the area over which these fisheries are prosecuted. Alternative 1/No Action would have neutral impacts as it would not affect current fishing operations. The spawning management alternatives do not alter other aspects of these fisheries, including the limits on catch and landings. Therefore, expected slight positive impacts of Georges Bank Alternatives 2 and 3 result from in increased flexibility and area in which butterfish and longfin squid fishermen can choose to use bottom otter trawling gear. No difference in impacts is expected between Alternatives 2 and 3, regardless of the option (A, B) selected, because both alternatives and all options affect trawl gear use in the Nantucket

Lightship in the same way (i.e. current prohibitions are removed). Alternatives 2C and 3C would not affect the trawl fishery, only the scallop fishery, and would therefore have neutral impacts.

Neutral to slightly positive impacts on the recreational fisheries are expected. Party and charter vessels may obtain a letter of authorization to fish in the Nantucket Lightship Closed Area, and this area would be removed under Alternatives 2 and 3. Recreational vessels are currently prohibited from fishing in Closed Area I and II (unless they are using pelagic hook and line gear) such that making these areas seasonal under Alternative 2 or 3 would expand party/charter access. If Alternative 2A is selected, Closed Areas I and II would be closed to commercial vessels capable of catching groundfish only, which would allow recreational fishing in the areas year round. Because there is currently limited charter/party recreational fishing activity surrounding Closed Areas I and II, it is assumed that there is limited interest in party/charter fishing within these closures, such that any positive benefits associated with increased access under Alternatives 2 and 3 would be slight.

Dedicated habitat research areas would be closed to mobile bottom-tending gears (Alternatives 2 and 4), or mobile bottom-tending gears and other demersal gears capable of catching groundfish (Alternative 3). Because the core of the commercial fisheries for Atlantic mackerel, longfin squid, Illex, and butterfish do not overlap to a large extent with the DHRAs proposed, these fisheries are unlikely to be significantly impacted by proposed measures. The butterfish and longfin squid fishery overlap with the Georges Bank DHRA. However, the extent of overlap of these fisheries with the Georges Bank DHRA, relative to the total extent of the fishery, is small. The commercial fisheries for Atlantic mackerel, longfin squid, Illex, and butterfish are managed using annual catch limits, which limit removals (landings and discards) to levels that are sustainable. None of the measures proposed would alter that aspect of the management program. Therefore, the impacts of the proposed dedicated habitat research area alternatives on the longfin squid and butterfish fisheries are expected to be neutral. The impacts on the Atlantic mackerel and Illex fisheries are expected to be neutral.

The framework and monitoring measures are focused on describing the process by which the habitat, spawning, and dedicated habitat research alternatives would be reviewed and modified in the future. These alternatives are administrative and are unlikely to have impacts on the Atlantic mackerel, longfin squid, Illex, and butterfish fisheries. Action that results from application of this process (e.g., modifications to boundaries for areas, changes to gear restrictions within areas, etc.) would be proposed and implemented through a Framework or other actions which would include an analysis of the impacts for that specific action.

13 Spiny dogfish

Spiny dogfish (*Squalus acanthias*) in the Northwest Atlantic are found from Labrador to Florida and are most abundant between Nova Scotia and Cape Hatteras. Spiny dogfish live inshore and offshore, usually near the bottom but also in mid and upper water column and at the surface. They are also found in enclosed bays and estuaries. Spiny dogfish swim in large schools and migrate seasonally, with changes in water temperature. Much of the population travels north in the spring and summer and south in the fall and winter. Some spiny dogfish remain in northern waters throughout the year and move offshore during the winter.

North of Cape Hatteras, EFH is:

- *Juveniles (male and female, <36 cm)*: Pelagic and epibenthic habitats, primarily in deep water on the outer continental shelf and slope between Cape Hatteras and Georges Bank. Recently-born dogfish (neonates, <24 cm in length) have been collected in bottom trawl survey tows in nearshore waters, but less often and/or in fewer numbers than on the outer shelf.
- *Female Sub-Adults (36-79 cm)*: Pelagic and epibenthic habitats throughout the region. Generally, sub-adult females are most commonly found in full salinity seawater (32-35 ppt) where bottom depths and temperatures range from 8 to 14°C and 50-160 meters. The females are more widely distributed over the continental shelf than the males.
- *Male Sub-Adults (36-59 cm)*: Pelagic and epibenthic habitats throughout the region. Generally, sub-adult females are most commonly found in full salinity seawater (32-35 ppt) where bottom depths and temperatures range from 8 to 14°C and 50-160 meters. The males are not as widely distributed over the continental shelf as the females and are generally found in deeper water.
- *Female Adults*: Pelagic and epibenthic habitats throughout the region. Generally, adult females are most commonly found in full salinity seawater (32-35 ppt) where bottom depths and temperatures range from 7 to 15°C and 20-160 meters. Young are born mostly on the offshore wintering grounds from November to January, but new borns (neonates or "pups") are sometimes taken in the Gulf of Maine or southern New England in early summer.
- *Male Adults*: Pelagic and epibenthic habitats throughout the region. Generally, adult females are most commonly found in full salinity seawater (32-35 ppt) where bottom depths and temperatures range from 7 to 15°C and 20-160 meters.

13.1 Impacts on spiny dogfish

There is overlap between spiny dogfish distribution and EFH and the proposed habitat management alternatives. Because EFH for all the spiny dogfish life stages are not susceptible to mobile bottom-tending gears, their EFH would not likely be impacted (either positively or negatively) by any prohibitions on use of those gear types. If these gear restrictions go into place, it is expected that fishing effort with mobile bottom-tending gear would likely shift to other unrestricted areas. It is expected that spiny dogfish will continue to be incidentally caught in bottom tending gears (such as bottom trawls). However, the commercial fishery for spiny dogfish is managed using annual catch limits, which limit removals of spiny dogfish (landings

and discards) to levels that are sustainable. Therefore, the biological impacts of the habitat management alternatives on spiny dogfish are expected to be neutral when compared to Alternative 1/No Action.

The use of sink or anchored gillnets is currently prohibited in the Nantucket Lightship Closed Area, Closed Area I, and Closed Area II year round, and in the Georges Bank Seasonal Closure from May 1 to May 31 for common pool groundfish vessels. Under Georges Bank Spawning Alternatives 2 and 3, the Nantucket Lightship Closure Area and the Georges Bank Seasonal Closure would be eliminated. In addition, Closed Areas I and II would only have sink or anchored gillnet gear prohibitions in place during 2.5 months of the year (February-April 15) as opposed to year round.

Because EFH for all the spiny dogfish life stages are not susceptible to mobile bottom-tending gears, their EFH would not likely be impacted (either positively or negatively) by any expansion of gear types used in these areas. There is the potential that spiny dogfish fishermen will choose to expand the use of sink or anchored gillnets into these areas during the open times of the year. However, the commercial fishery for spiny dogfish is managed using annual catch limits, which limit removals of spiny dogfish (landings and discards) to levels that are sustainable. Therefore, biological impacts are expected to be neutral on spiny dogfish as a result of the proposed spawning management measures.

Dedicated Habitat Research Areas would be closed to mobile bottom-tending gears (Alternatives 2 and 4), or mobile bottom-tending gears and other demersal gears capable of catching groundfish (Alternative 3). Spiny dogfish life stages are not generally targeted mobile bottom-tending gears, and would not likely be impacted (either positively or negatively) by any prohibitions on use of those gear types. In addition, these measures are not expected to alter the sustainability of spiny dogfish. Therefore, the biological impacts of the proposed dedicated habitat research area alternatives on spiny dogfish are expected to be neutral when compared to Alternative 1/No Action.

The framework and monitoring alternatives are administrative and do not have any impacts on the biological processes associated with spiny dogfish; therefore no biological impacts are expected on spiny dogfish when compared to Alternative 1/No Action.

13.2 Impacts on the spiny dogfish fishery

Sink and anchored gear nets produced about 71% of the landings for spiny dogfish from 2008-2012 (Table 67). Bottom trawls followed by hook and line were responsible for the bulk of the landings that remained. Spiny dogfish are not typically targeted with trawls or other gears and are considered incidental catch in those gear types. No significant recreational fishery exists for spiny dogfish, although some retention of recreationally caught spiny dogfish does occur. Dogfish trawl and gillnet effort is mapped in section 4.3.11 of Volume 1.

Table 67 – Commercial gear types associated with spiny dogfish harvest for calendar years 2008-2011. Note that vessels with state issued permits only are not required to complete VTRs so total VTR landings are less than total dealer-reported landings.

Year	Gillnet	Bottom trawl	Hook and line	Other*	Total
2008	2,619,441	531,572	336,444	24,114	3,511,571
2009	6,144,699	1,904,194	766,083	22,338	8,837,314
2010	5,892,778	1,533,946	1,225,233	10,004	8,661,961
2011	10,757,661	2,381,889	1,542,412	53,513	14,735,475
2012	12,367,393	1,791,693	3,067,743	29,962	17,256,791
Average % 2008-2012	71.4%	16.2%	12.1%	0.3%	100.0%

** Combined landings which may include unknown, mid-water trawl, beam trawl, seine, pots and traps, and dredge.*

Vessel trip report data indicate that six statistical areas collectively accounted for 73.04 % of spiny dogfish landings in 2010, with each contributing greater than 5.0 % of the total. These areas also represented 73.5% of the trips that landed spiny dogfish.

Statistical areas 513, 514, and 521 do coincide with areas proposed for habitat management alternatives. However, the directed fishery for spiny dogfish is prosecuted primarily with sink or anchored gillnets. Shifts in spatial management areas may have some effect on the locations in which gillnets are deployed to target spiny dogfish, and some individuals may experience lower variable costs of fishing due to closer access to fishing grounds. However, economic conditions in the dogfish fishery in particular relatively low demand for spiny dogfish product are currently driving low landings relative to catch limits, and access to the resource is not limiting (J. Armstrong, personal communication). Therefore, the directed fishery is unlikely to be impacted by any proposed habitat management measures that restrict or prohibit the use of mobile bottom-tending gear. It is expected that spiny dogfish will continue to be incidentally landed in smaller amounts in other gear types such as trawls or hook and line while targeting other species, wherever that fishing effort may occur. Therefore, the habitat management alternatives are expected to have neutral impacts on the fishery.

Under the No Action spawning management alternatives for Georges Bank, the use of sink or anchored gillnets is currently prohibited in the Nantucket Lightship Closure Area, Closed Area I, and Closed Area II year round, and in the Georges Bank Seasonal Closure from May 1 to May 31 for common pool vessels only. Under Alternatives 2 and 3, the Nantucket Lightship Closed Area and the Georges Bank Seasonal Closure would be eliminated. In addition, Closed Areas I and II would only have sink or anchored gillnets gear prohibition in place during 2.5 months of the year (February-April 15) as opposed to year round. Therefore, there is the potential for neutral to slightly positive impacts on the spiny dogfish fishery. The impacts will depend on whether fishermen chose to take advantage of the newly open areas and expand the use of sink or anchor gillnets into these areas during the open times of the year. These alternatives do not alter other aspects of the fishery, including the limits on catch and landings in this fishery. Therefore, the slightly positive impacts are a result of increased flexibility and less constraint on where and when the spiny dogfish fishermen choose to use sink or anchored gillnets to target spiny dogfish.

Impacts on the recreational fishery are expected to be negligible because the recreational component of the spiny dogfish fishery is very small, less than 2% of total catch.

Dedicated Habitat Research Areas would be closed to mobile bottom-tending gears (Alternatives 2 and 4), or mobile bottom-tending gears and other demersal gears capable of catching groundfish (Alternative 3). Sink or anchored gillnets would be prohibited in the Stellwagen DHRA. Because the core of the spiny dogfish commercial fishery overlaps with these areas, there is the potential for slightly negative impacts if use of this gear continues to be prohibited in the Stellwagen DHRA (sink/anchored gillnets are currently prohibited in the Western Gulf of Maine Closure Area, of which the Stellwagen DHRA is a subset). However, given that the research areas proposed are relatively small, it is likely that spiny dogfish fishermen would shift their effort to other surrounding areas that are not under such gear restrictions. On that basis, the impacts on the spiny dogfish fishery are expected to range from neutral to slightly negative, depending which research areas are implemented and how fishermen respond to the prohibition of sink or anchored gillnets use in those areas. Bottom otter trawl catches of spiny dogfish would be restricted in all DHRAs, but this is expected to have a smaller impact on the fishery as this gear contributes a small amount of overall landings.

The framework and monitoring measures are focused on describing the process by which the habitat, spawning, and dedicated habitat research alternatives would be reviewed and modified in the future. These alternatives are administrative and are unlikely to have impacts on the spiny dogfish fishery. Action that results from application of this process (e.g., modifications to boundaries for areas, changes to gear restrictions within areas, etc.) would be proposed and implemented through a Framework or other actions which would include an analysis of the impacts for that specific action.

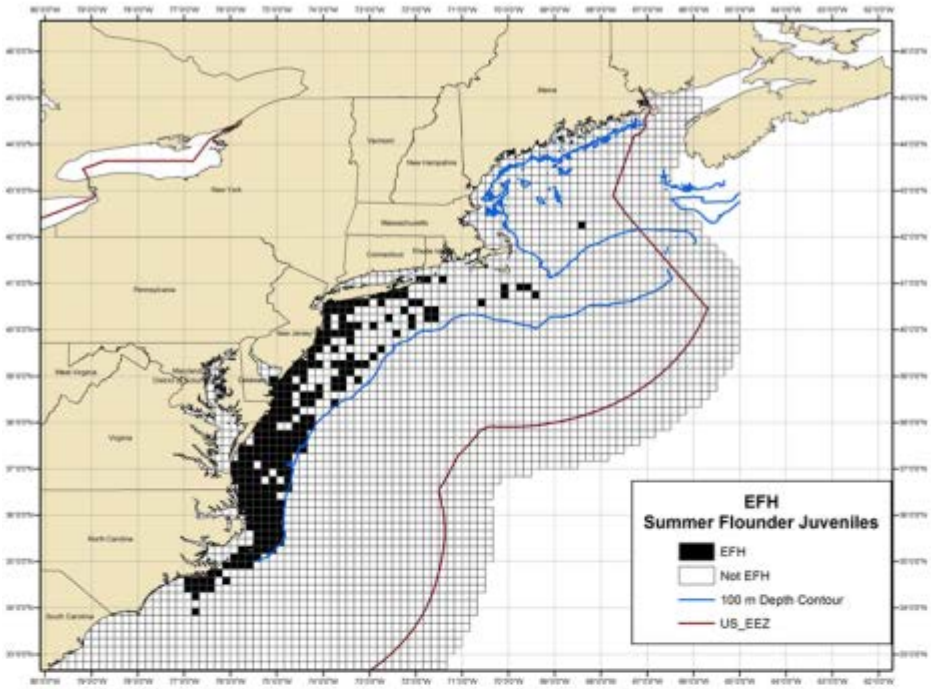
14 Summer flounder, scup, and black sea bass

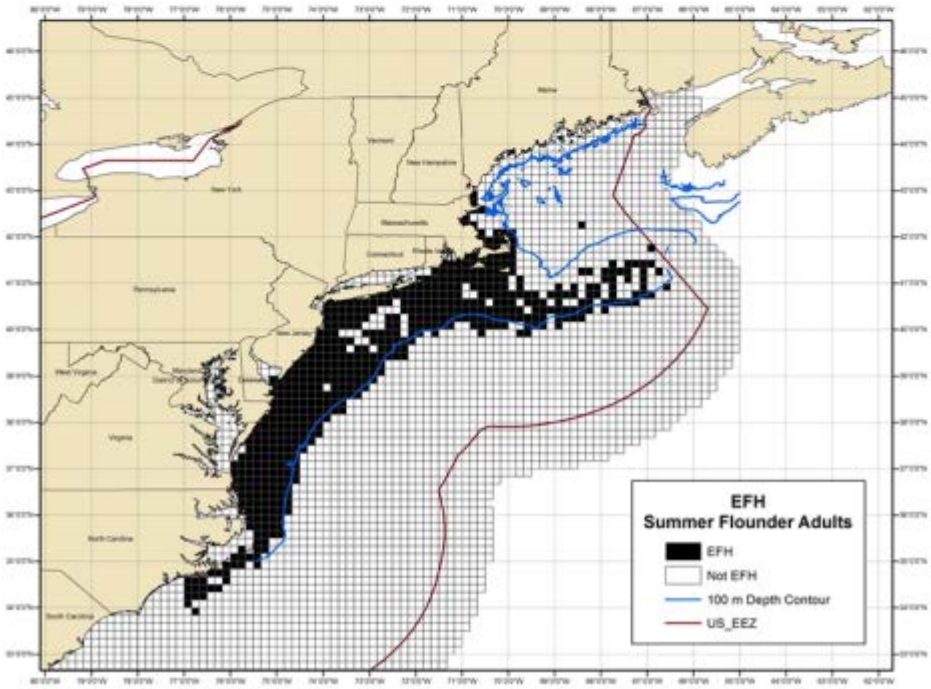
Summer flounder are found in the Atlantic Ocean from Nova Scotia to the east coast of Florida. In U.S. waters, summer flounder are most common in the Mid-Atlantic region from Cape Cod, Massachusetts, to Cape Fear, North Carolina. Larval summer flounder live in estuaries and coastal lagoons. Juveniles bury in the sediment in marsh creeks, seagrass beds, mud flats, and open bays, notably Pamlico Sound and Chesapeake Bay. Adult summer flounder migrate inshore and offshore seasonally with changes in water temperature. In the winter and early spring, they are found offshore along the outer edge of the continental shelf. In late spring and early summer, they move inshore into shallow coastal waters and estuaries. Summer flounder migrate back offshore in the fall. Both summer flounder juvenile and adult EFH are considered vulnerable to mobile bottom-tending gears. The distribution of EFH for those life stages is shown in Map 103.

Scup are found in the Northwest Atlantic Ocean, primarily between Cape Cod and Cape Hatteras, North Carolina. Their eggs and larvae are found in the water column in coastal waters during warmer months. As larvae mature, they settle to the seafloor and develop into juveniles. Juveniles live in a variety of habitats including rocky ledges, artificial reefs, mussel beds, sand, silty-sand, shell, and mud bottoms, and eelgrass. During the summer and early fall, juveniles and adults are common in large estuaries, open sandy bottoms, and structured habitats such as mussel beds, reefs, or rock rubble. Scup migrate north and inshore to spawn in the spring, then migrate south and offshore in autumn as the water cools, arriving by December in offshore areas where they spend the winter. Both scup juveniles and adult EFH are considered vulnerable to mobile bottom-tending gears. The distribution of EFH for those life stages is shown in Map 104.

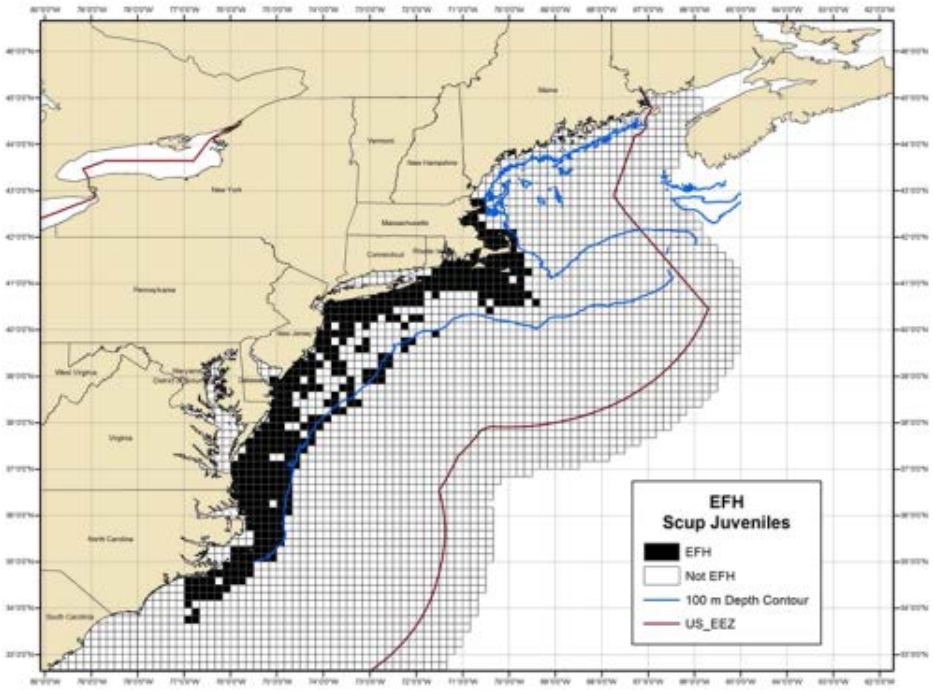
Black sea bass are found along the U.S. East Coast from Cape Cod to the Gulf of Mexico. They prefer structured habitats such as reefs, wrecks, or oyster beds in temperate and subtropical waters. In the Mid-Atlantic (north of Cape Hatteras, North Carolina), black sea bass migrate seasonally as water temperature changes. They generally migrate to inshore coastal areas and bays in the spring and offshore in the fall. Both black sea bass juveniles and adult EFH are considered vulnerable to mobile bottom-tending gears. The distribution of EFH for those life stages is shown in Map 105.

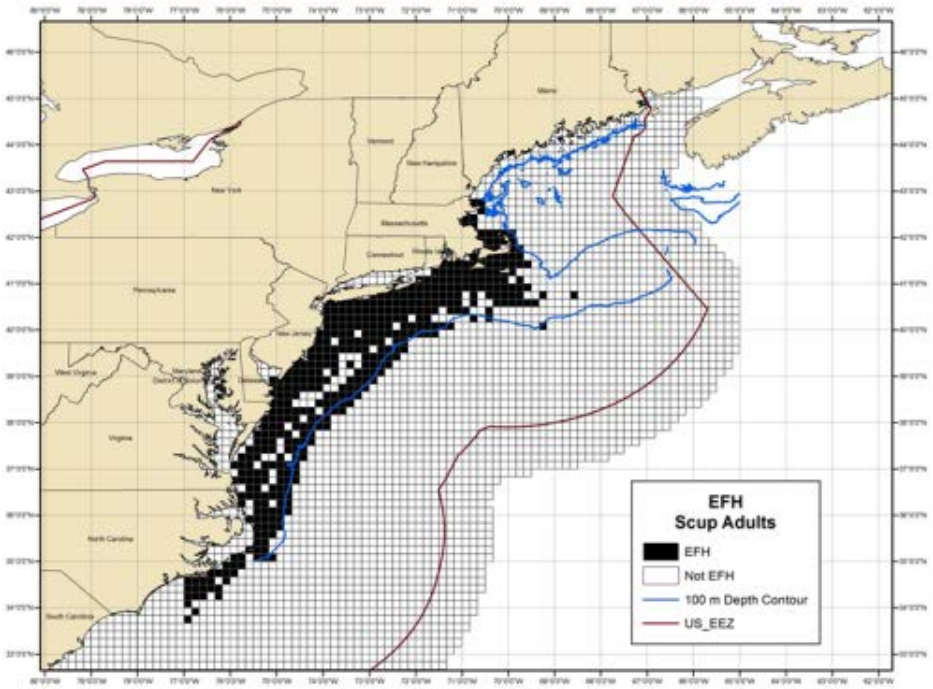
Map 103 – Distribution of EFH for juvenile and adult summer flounder.



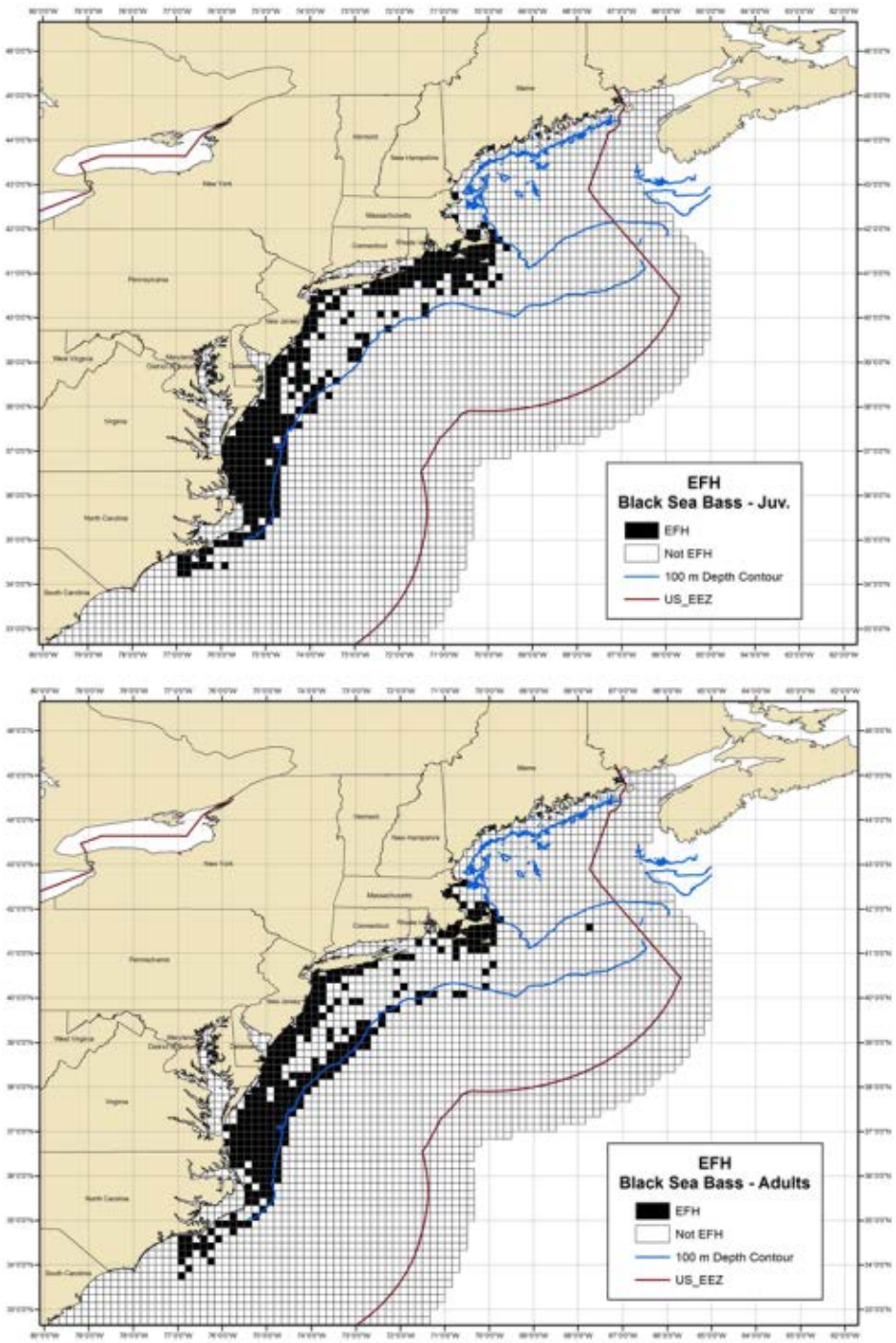


Map 104 – Distribution of EFH for juvenile and adult scup.





Map 105 – Distribution of EFH for juvenile and adult black sea bass.



14.1 Impacts on the summer flounder, scup, and black sea bass

Summer flounder juvenile and adult EFH overlaps with some of the proposed habitat management alternatives. In particular, juvenile and adult summer flounder EFH extends through Southern New England and the Great South Channel, with adult EFH extending out to Georges

Bank. Because juvenile and adult summer flounder EFH is susceptible to mobile bottom-tending gears, their EFH would likely be positively impacted by prohibitions on use of these gear types. If these gear restrictions go into place, it is expected that fishing effort with mobile bottom-tending gear would likely shift to other unrestricted areas, which would offset possible benefits. Because summer flounder juvenile and adult distribution and EFH has minimal to no overlap with the Gulf of Maine, the proposed habitat alternatives in those areas are expected to have neutral biological impacts on summer flounder. The commercial fishery for summer flounder is managed using annual catch limits, which limit removals of summer flounder (landings and discards) to levels that are sustainable. None of the measures proposed would alter that aspect of the management program. Therefore, the biological impacts of the proposed Georges Bank and in Great South Channel/Southern New England habitat management alternatives on summer flounder are expected to be neutral to slightly positive. Impacts of alternatives that remove habitat management areas in these sub-regions (Alternative 2) or designate gear modification areas only (Alternatives 3-6 on Georges Bank and Alternatives 3-5 in the Great South Channel with options 3 or 4) are expected to be neutral to slightly negative. While effects will vary between alternatives because they encompass different areas, given that the core of the resource occurs south of the management areas proposed, impacts of all alternatives are expected to be slight.

Juvenile and adult scup and black sea bass distributions and EFH overlap with some the proposed habitat management alternatives. In particular, the scup and black sea bass EFH extends through Southern New England/Great South Channel and the western Gulf of Maine. Because juvenile and adult scup black sea bass EFH are susceptible to mobile bottom-tending gears, their EFH would likely be positively impacted by prohibitions on use of these gear types. If these gear restrictions go into place, it is expected that fishing effort with mobile bottom-tending gear would likely shift to other unrestricted areas, which would offset possible impacts. As above for summer flounder, impacts of alternatives that remove habitat management areas in these sub-regions (Alternative 2) or designate gear modification areas only (Alternatives 3-6 in the western Gulf of Maine and Alternatives 3-5 in the Great South Channel with options 3 or 4) are expected to be neutral to slightly negative. Because juvenile and adult scup and black sea bass distribution and EFH has minimal to no overlap with the eastern Gulf of Maine, central Gulf of Maine, and Georges Bank, the proposed habitat alternatives in those areas are expected to have neutral biological impacts on scup and black sea bass. The commercial fishery for scup and black sea bass is managed using catch limits, which limit removals (landings and discards) to levels that are sustainable. None of the measures proposed would alter that aspect of the management program. Therefore, the biological impacts of the proposed habitat management alternatives on scup and black sea bass are expected to be neutral to slightly positive. As above, while effects will vary between alternatives because they encompass different areas, given that the core of the resource occurs south of the management areas proposed, impacts of all alternatives are expected to be slight.

As shown above, adult summer flounder, juvenile and adult scup, and juvenile and adult black sea bass distributions and EFH overlap with the proposed spawning management alternatives**.** Because these EFH life stages are susceptible to bottom tending fishing gears, there is potential for neutral to slightly negative impacts on summer flounder, scup, and black sea bass as compared to Alternative 1/No Action. The impacts are considered slight as these measures have

the potential to affect a small portion of the species ranges. The use of many gears capable of catching groundfish is currently prohibited in the Nantucket Lightship Closed Area, Closed Area I, and Closed Area II year round, and in the Georges Bank Seasonal Closure from May 1 to May 31(common pool vessels only). Under Alternatives 2 and 3, the Nantucket Lightship Closure Area and the Georges Bank Seasonal Closure would be eliminated. In addition, Closed Areas I and II would only have the mobile bottom-tending gear prohibition in place during 2.5 months of the year (February-April 15) as opposed to year round.

The extent of impacts will depend on whether fishermen choose to take advantage of the newly open areas and expand the use of mobile bottom-tending gears in particular into these areas during the open times of the year. The commercial fisheries for summer flounder, scup, and black sea bass are managed using annual catch limits, which limit removals (landings and discards) to levels that are sustainable. None of the measures proposed would alter that aspect of the management program. Therefore, the biological impacts of the proposed spawning management alternatives on summer flounder are expected to be neutral to slightly negative when compared to Alternative 1/No Action.

Dedicated habitat research areas would be closed to mobile bottom-tending gears (Alternatives 2 and 4), or mobile bottom-tending gears and other demersal gears capable of catching groundfish (Alternative 3). Summer flounder adult and juvenile EFH overlaps with the Georges Bank DHRA. Scup and black sea bass EFH does not. Adult and juvenile summer flounder EFH is susceptible to mobile bottom-tending gears, and would likely be impacted positively by any prohibitions on use of those gear types in the Georges Bank DHRA. However, the extent of overlap with the Georges Bank DHRA when compared to the overall extent of the species range is quite small, such that impacts are expected to be slight. The commercial fisheries for summer flounder, scup, and black sea bass are managed using annual catch limits, which limit removals (landings and discards) to levels that are sustainable. None of the measures proposed would alter that aspect of the management program. Therefore, the biological impacts of the proposed dedicated habitat research area alternatives management alternatives on summer flounder are expected to be neutral to slightly positive, and neutral for scup and black sea bass. Not designating DHRAs (Alternative 1), or removing these DHRA via a sunset provision (Alternative 5) are expected to have neutral to slightly negative impacts.

The framework and monitoring alternatives are administrative and do not have any impacts on the biological process of summer flounder, scup, and black sea bass; therefore, no biological impacts are expected on these species when compared to the status quo.

14.2 Impacts on the summer flounder, scup, and black sea bass fisheries

Based on VTR data for 2012, the bulk of the summer flounder landings were taken by bottom otter trawls (over 97 percent), with other gear types (e.g. hand lines, scallop dredges, sink gillnets) each accounting for less than 1 percent of landings. The bulk of scup landings in 2012 were taken by bottom otter trawls (96 percent), followed by pots and traps (~1 percent), and hand lines (~1 percent). Other gear types each accounted for less than 1 percent of landings. The majority of black sea bass landings were taken by bottom otter trawls (51 percent), followed by pots and traps (30 percent), hand lines (10 percent), and offshore lobster pots and traps (6 percent). Other gear types each accounted for less than 1 percent of landings.

Six statistical areas individually accounted for greater than 5 percent of the summer flounder catch in 2012 (Table 68). Collectively, these six areas accounted for 71 percent of the summer flounder catch. There were five statistical areas that individually accounted for greater than 5 percent of the scup catch in 2012 (Table 68). Collectively, these five areas accounted for 82.5 percent of the scup catch. There were five statistical areas that individually accounted for greater than 5 percent of the black sea bass catch in 2012 (Table 68). Collectively, these four areas accounted for 60.3 percent of the black sea bass catch.

Table 68 – Statistical areas that accounted for at least 5 percent of the summer flounder, scup, or black sea bass catch in 2012, NMFS VTR data.

Statistical Area	Summer Flounder (percent)	Scup (percent)	Black Sea Bass (percent)
616	18.55	9.02	16.56
537	18.15	26.79	6.99
613	11.36	18.73	4.90
612	9.79	2.24	2.38
626	6.85	0.02	3.67
622	6.32	0.09	9.20
539	4.60	13.02	4.52
621	3.82	0.06	16.52
615	3.27	1.54	11.05
611	1.90	14.95	2.37

The bulk of the commercial fishery landings for all three species occur in statistical areas south of Cape Cod, as indicated by the 2012 VTR data. Because the core of the commercial fisheries for summer flounder, scup, and black sea bass do not coincide with the habitat management areas under consideration, the fishery is unlikely to be significantly impacted by proposed habitat management measures that restrict or prohibit the use of mobile bottom-tending gear. Some areas of overlap include Georges Bank and in the Southern New England area, where mixed fishery bottom trawls may catch summer flounder, scup, or black sea bass. Any prohibitions on mobile bottom-tending gear may affect landings of these species in these areas, resulting in slightly negative impacts. Given the distribution of these resources relative to the distribution of the habitat management areas under consideration, the impacts on the directed summer flounder, scup, and black sea bass fisheries are expected to be neutral to slightly negative. Neutral to slightly positive impacts are likely for alternatives on Georges Bank that manage the northern half of the bank only, i.e. Alternatives 3-10, or remove existing restrictions without implementing new closures (Alternative 2 in both the Georges Bank and GSC/SNE sub-regions). Neutral to slightly negative impacts could result from continued mobile bottom-tending gear restrictions in the Great South Channel/Southern New England sub-region (Alternatives 1, 3, 4, 5, and 6). Alternatives that enact gear restrictions only are expected to have neutral to slightly positive effects on the fishery (GB 3, 4, and 6 and GSC/SNE 3-5 with options 3 and 4).

The use of various gears capable of catching groundfish, such as bottom trawls, is currently prohibited in the Nantucket Lightship Closed Area, Closed Area I, and Closed Area II year round, and in the Georges Bank Seasonal Closure from May 1 to May 31 (common pool vessels only). Under Alternatives 2 and 3, the Nantucket Lightship Closed Area and the Georges Bank

Seasonal Closure would be eliminated. In addition, Closed Areas I and II would only have these gear prohibitions in place during 2.5 months of the year (February-April 15) as opposed to year round. Therefore, there is the potential for the spawning management alternatives to have neutral to slightly positive impacts on the summer flounder, scup, and black sea bass fisheries. The impacts will depend on whether fishermen chose to take advantage of the newly open areas and expand the use of bottom trawls into these areas during the open times of the year. For scup and black sea bass, the use of pots and traps to catch these species was already an exempted gear type. These impacts are considered slight because the areas under consideration are a small portion of these species range and their EFH. These alternatives do not alter other aspects of the summer flounder, scup, or black sea bass fisheries, including the limits on catch and landings in this fishery. Therefore, expected impacts range from neutral to slightly positive, resulting increased flexibility and area in which summer flounder, scup, and black sea bass fishermen can choose to use bottom otter trawling gear. Alternatives 2C and 3C affect the scallop fishery only, and therefore would have neutral impacts on the summer flounder, scup, and black sea bass fisheries.

Impacts on the recreational fishery are not expected. In the Nantucket Lightship Closed Area, party and charter vessels may obtain a letter of authorization to fish under Alternative 1/No Action, and under Alternatives 2 or 3 this area would be eliminated. Recreational fishing is currently restricted in Closed Areas I and II under Alternative 1/No Action, but it would be allowed for much of the year under Alternatives 2 and 3, or for the entire year if recreational vessels are exempted from the spawning area restrictions (Option A). Therefore in all cases the action alternatives provide increased opportunities and therefore positive impacts for recreational fishing as compared to Alternative 1/No Action. These are probably slightly positive impacts since summer flounder is the only species found in Closed Areas I and II, and all three species are concentrated south of the management areas in this amendment.

Dedicated habitat research areas would be closed to mobile bottom-tending gears (Alternatives 2 and 4), or mobile bottom-tending gears and other demersal gears capable of catching groundfish (Alternative 3). Because the core statistical areas in which the commercial fisheries for summer flounder, scup, and black sea bass do not with the DHRAs proposed, the fishery is unlikely to be significantly impacted by proposed measures that restrict gear use or put constraints on commercial fishing access in these areas. Some areas of overlap with a small part of the fishery include Georges Bank, where mixed fishery bottom trawls may catch summer flounder, scup, and/or black sea bass. However, the extent of overlap of the fisheries with the Georges Bank DHRA, relative to the total extent of the fishery, is small. The commercial fisheries for summer flounder, scup, and black sea bass are managed using annual catch limits, which limit removals (landings and discards) to levels that are sustainable. None of the measures proposed would alter that aspect of the management program. Therefore, the impacts of the proposed DHRA alternatives on summer flounder, scup, and black sea bass are expected to be neutral. This includes the impacts of not designating (Alternative 1/No Action), designating (Alternatives 2-4), or removing (Alternative 5) DHRAs.

The framework and monitoring measures are focused on describing the process by which the habitat, spawning, and dedicated habitat research alternatives would be reviewed and modified in the future. These alternatives are administrative and are unlikely to have impacts on the summer

flounder, scup, and black sea bass fishery. Action that results from application of this process (e.g., modifications to boundaries for areas, changes to gear restrictions within areas, etc.) would be proposed and implemented through a Framework or other actions which would include an analysis of the impacts for that specific action.

15 Golden tilefish

Golden tilefish (*Lopholatilus chamaelonticeps*) are found along the outer continental shelf and upper continental slope of the entire U.S. East Coast and Gulf of Mexico. They are most abundant from Nantucket Island, Massachusetts to Cape May, New Jersey. Tilefish typically live at depths of 250 - 1,500 feet (76 m - 457 m) where water temperatures range from 49 to 58°F. They are often found in and around submarine canyons where they burrow in mud or sand sediment. Some tilefish build large sand and rubble mounds, which provide habitat for other bottom-dwelling creatures and fishes. Tilefish eggs and larvae are found along similar isobaths as the adults.

There is little to no overlap between tilefish distribution and EFH and the proposed habitat management, spawning management, or research area alternatives. Therefore, the biological impacts of the proposed alternatives on tilefish are expected to be neutral when compared to Alternative 1/No Action. The framework and monitoring alternatives are administrative and do not have any impacts on the biological processes of tilefish; therefore no biological impacts are expected on tilefish when compared to the status quo.

The fishery is prosecuted where tilefish are found, at depths of 250 - 1,500 feet (76 m - 457 m) where water temperatures range from 49 to 58° F. The Northern areas for this fishery are typically prosecuted in deeper waters within the range. There is no overlap between the tilefish fishery and the habitat management, spawning management, or research area alternatives proposed in this amendment; therefore, no impacts to the fishery are expected. The framework and monitoring alternatives are administrative and do not have any impacts on the tilefish fishery because there is no overlap with the fishery.

16 Northern shrimp

16.1 Impacts on northern shrimp

The northern shrimp resource occurs in the Gulf of Maine. Therefore, the Georges Bank spatial management alternatives are not expected to have any influence on the stock, positive or negative.

In general the habitat management alternatives influence the distribution of mobile bottom-tending gear fishing effort, including shrimp trawl effort. With the exception of shrimp trawls and traps, catch rates of shrimp in fishing gears are very minimal. Shrimp traps would not be restricted by any of the alternatives. Therefore, the redistribution of effort by gears other than shrimp trawls will have no impacts positive or negative on the shrimp resource. The shrimp fishery, if available in a given year, typically begins on or around December 1, when many shrimp have already hatched their eggs for the breeding season. Therefore, no particular biological impacts are expected if the management alternatives lead to shifts in the distribution of shrimp trawling effort, because the seasonality of the shrimp fishery already controls for impacts on shrimp spawning. While the fishery is open access in terms of participation, it is limited by a total allowable catch which triggers closure of the fishery once harvested. There are also trip limits, trap limits, and days out which control the rate of harvest within the season.

As noted above, there is little to no bycatch of shrimp in gears other than shrimp trawls and shrimp traps, and the spawning management alternatives will not affect the use of shrimp trawl or trap gears. Therefore, no impacts to the shrimp resource are expected to result from the spawning alternatives.

There is some overlap between the shrimp fishery and the two DHRAs in the Gulf of Maine, Eastern Maine (Alternative 2, not preferred) and Stellwagen (Alternative 3, preferred), but neither of these areas is a center of shrimp fishing effort. The conclusions above apply here as well, i.e. no particular biological impacts are expected if the management alternatives lead to shifts in the distribution of shrimp trawling effort.

As none of the above alternative types are expected to impact the shrimp resource, the schedule and approach to adjusting these impacts (i.e. existing framework and monitoring approaches, Alternative 1, or updated approaches, Alternative 2) will also have no impacts.

16.2 Impacts on the shrimp fishery

The shrimp fishery is prosecuted out of Massachusetts, New Hampshire, and Maine ports in the inshore Gulf of Maine during the winter months. The stock status and specifications are evaluated annually. Due to collapse of the stock, there were no fisheries during the 2013-2014 and 2014-2015 seasons. It is not known when a fishery may be resumed. Therefore, in the short term, the spatial management alternatives will not affect prosecution of the shrimp fishery. Also, there is no shrimp fishery in the Georges Bank/Southern New England region so those alternatives would have no impact on the shrimp fishery.

Prior distributions of shrimp trawl effort relative to the various management areas are discussed in the human community and fishery impacts sections for each type of alternative, and shrimp trawl effort is generally separated out as a separate gear type, unless data confidentially issues caused shrimp trawl data to be pooled with other bottom trawls. The intent of this section is to briefly summarize the information already provided specifically with respect to the shrimp trawl fishery, but the reader interested in impacts to the shrimp fishery should also review the human and community impacts sections for the Gulf of Maine habitat, spawning, and research area alternatives.

16.2.1 Habitat management alternatives

If management option 1 or 2 is selected for an alternative set of habitat management areas, shrimp trawl vessels would be prohibited along with other mobile bottom-tending gears. One metric that can be used to assess the impacts of these habitat management alternatives on the shrimp fishery is the amount of shrimp trawl effort in currently open HMAs. If areas currently fished are closed, that effort would have to be displaced to other locations. Another consideration is how much effort might occur in areas that are now closed that might reopen to the fishery under an alternative action. This is more difficult to assess because it requires an inference about future fishing effort based on past effort and/or a distribution of the shrimp stock.

Because shrimp undergo inshore/offshore migrations seasonally, the distribution of shrimp and therefore shrimp fishing effort relative to habitat management areas may vary from year to year. Mature female shrimp move inshore in early winter and offshore following larval hatching. The shrimp assessment defines inshore vs. offshore using a depth of 55 fathoms (about 100 m). Much of the Small and Large Bigelow Bight areas are considered inshore according to this definition. In seasons where the fishery occurs earlier in the calendar year, there would presumably be a greater overlap with this area, and therefore a greater displacement of effort if it were adopted as a mobile bottom-tending gear closure (western Gulf of Maine Alternatives 3, 4, or 5 with Options 1 or 2; Alternatives 3 and 4 include the larger area, and Alternative 5 includes the smaller area). The Bigelow Bight HMAs are not part of the preferred alternatives.

According to the 2013 shrimp assessment update, overall commercial landings of northern shrimp during the seasons ending in 2010, 2011, and 2012 were 6.99 million, 10.63 million, and 5.21 million dollars, respectively, or an average of 7.61 million dollars per season (ASMFC NSTC 2013). Average annual shrimp trawl revenues for the Large Bigelow Bight HMA are approximately 1.55 million, which means the area accounted for roughly 20% of revenues in the fishery across these years. Revenues from the Small Bigelow Bight area, which is a subset of the Large Bigelow Bight area, accounted for about 4% of total shrimp fishery revenues across the three years. Annual revenue estimates in the FEIS include the last two years, when there was no shrimp fishery, such that the average values for the entire 2010-2014 time period are lower.

These percentages may be slight underestimates because only Federal VTRs were used in the revenue analysis, and some shrimp vessels report on state VTRs only. Overall, Federal VTRs used in the revenue analysis accounted for approximately 82% of total shrimp trawl revenues in the dealer data during 2012; somewhat less than this during 2010 and 2011 (see VTR/observer/dealer comparison section in Volume 1). Also note that the shrimp season

generally starts December 1 of the previous year (i.e. the 2010 season started on December 1, 2009, whereas the VTR revenue analyses are based on a calendar year).

Table 69 – Shrimp trawl revenue in the Large and Small Bigelow Bight areas, calendar years 2010-2012. All variables represent annual estimates derived from federal VTRs. Vessel sizes: S < 50 ft, 50 ft <= M < 70 ft, L >= 70 ft, U = unknown vessel characteristics. Dashes indicate information dropped due to privacy concerns. Note that the small area is a subset of the large area.

Area	Vessel Size	Mean Revenue	Median Revenue	SD Revenue	Max Revenue	Min Revenue	Individ.	Trips
Bigelow Large	L/U	176,087	155,447	37,396	-	-	4	87
Bigelow Large	M	524,001	457,520	210,129	759,329	355,154	19	470
Bigelow Large	S	847,795	969,194	298,789	1,066,776	507,414	59	1,128
Bigelow Large	***Total***	***1,547,883***	***1,582,161***	***546,314***	***1,826,105***	***862,568***	***82***	***1,685***
Bigelow Small	OTHER	144,517	144,517	79,146	200,482	88,552	11	278
Bigelow Small	S	205,282	205,282	117,275	288,207	122,356	30	518
Bigelow Small	***Total***	***349,799***	***349,799***	***196,421***	***488,689***	***210,908***	***41***	***796***

Thus, western Gulf of Maine Alternatives 3 and 4 with Options 1 or 2 could have a highly negative impact on the shrimp fishery if the fishery resumes and has a similar footprint as it did previously; Alternative 5 which includes the smaller Bigelow Bight Area would have a moderately negative impact, again, contingent upon the fishery resuming. Shrimp traps could continue to be used in the area, although the bulk of the fishery is prosecuted using trawls. It is unlikely that vessels would switch between the two gear types. Other than alternatives that include the Large or Small Bigelow Bight areas and would close them to trawl gears, the alternatives in this amendment would result in relatively little displacement of future shrimp fishing effort, assuming that effort in the future has a similar spatial distribution to that observed in recent years. It is possible that some of this effort could be displaced into more offshore grounds if these alternatives are adopted, because deeper mud habitats west of Jeffreys Ledge would be open to shrimp trawls under these alternatives, as well as under Alternative 2 and Alternative 6. There has been shrimp fishing in these areas historically, although this only occurs when the season is long enough that the shrimp move back from their spawning grounds into offshore waters. As shown in the table above, smaller vessels (<50 ft) constitute the bulk of the revenue in the Bigelow Bight areas, and they may be less able to fish further offshore. Western Gulf of Maine Alternative 8, which would exempt the shrimp fishery from habitat management restrictions in the northwestern corner of the Western Gulf of Maine Habitat Closure Area, would have some slight positive impacts on the shrimp fishery, if the fishery reopens in the future.

16.2.2 Other spatial management alternatives

As currently written, shrimp trawls would be exempted from the Gulf of Maine spawning management areas, so the no action and action alternatives are not expected to impact this fishery.

Shrimp trawl vessels would be prohibited in the Alternative 2 (Eastern Maine DHRA) and Alternative 3 (Stellwagen DHRA) dedicated habitat research areas because they are a mobile bottom tending gear. The Eastern Maine DHRA is currently open to shrimp trawls and there appears to be little overlap with this gear type, so neutral to slightly negative impacts are expected if this area is implemented as a DHRA. The Stellwagen DHRA is currently closed, so it is difficult to infer the potential for different types of fishing activities, but it is generally south and east of where shrimp fishing typically occurs, so impacts are expected to be neutral. The types of information expected to be generated by research in these areas is not expected to have a direct benefit on management of the shrimp fishery.

The process by which spatial management measures are evaluated and updated is not expected to have a direct impact on the fishery. The direct impacts of any future changes on the shrimp fishery would be evaluated in future framework or amendment analyses. Thus no direct or indirect impacts are expected to result from the framework and monitoring alternatives.

17 American lobster

The American lobster fishery occurs from Maine to Cape Hatteras, North Carolina. There are seven Lobster Conservation Management Areas (Areas): Areas 1, 2, 3, 4, 5, 6 (state-only waters), and the Outer Cape Cod Area. The American lobster resource and fishery are cooperatively managed by the states (0-3 nautical miles) and the National Marine Fisheries Service (3-200 nautical miles) through the Atlantic States Marine Fisheries Commission. The 2009 lobster stock assessment assumed three distinct stocks, Gulf of Maine, Georges Bank, and Southern New England. However, the 2015 lobster stock assessment combines the Gulf of Maine and Georges Bank stocks for modeling purposes. This action is relevant to the Gulf of Maine and Georges Bank lobster resource.

Based the 2015 lobster stock assessment, the Gulf of Maine and Georges Bank lobster stocks are not depleted and overfishing is not occurring. The Southern New England lobster stock is depleted mainly due to recruitment failure, but the stock is not experiencing overfishing. The 2015 stock assessment indicates that the stock is not rebuilding, suggesting that broader effort control measures in Southern New England may be necessary to increase the spawning stock biomass.

Over the period 1981 to 2013, the Georges Bank stock averaged 5 percent of the US fishery, although landings from this stock have increased to over 2,000 metric tons annually between 2008 to 2013. The Georges Bank fishery is mainly prosecuted by fishermen from Rhode Island and Massachusetts, and a smaller number of participants from Connecticut and New Hampshire. Trap hauls would be the most useful effort metric (ASMFC 2009 and 2015) but catch and effort data are not available for all states. Vessels from Massachusetts harvest approximately 71 percent of total lobster catch on Georges Bank. Massachusetts vessels tend to fish the northern and eastern side of Georges Bank, and landings from these areas (Statistical Areas 521, 522, 561, 562) have increased recently. The 2007 and 2015 stock assessments note that effort on Georges Bank is not well characterized due to a lack of both mandatory reporting and appropriate resolution in the reporting system. Based on Massachusetts data only, the number of traps fished has remained stable around a mean value of 43,000 from 1993 to 2009. Based on 2014 permit data, there are sixteen vessels from New Hampshire and five vessels from Maine that may fish on Georges Bank, and most of the activity from the New Hampshire vessels is likely relevant. Total Area 3 trap allocations for Maine and New Hampshire are roughly 22,300 traps. For comparison, in 2014 there were 37 Massachusetts vessels electing to fish in Area 3 with 44,564 traps allocated.

Over the same timeframe (1981-2013), the Gulf of Maine stock averaged 79 percent of the US fishery, accounting for 90 percent of total U.S. landings since 2009. Landings in the Gulf of Maine reached an all-time high in 2013, accounting for 95 percent of total U.S. landings. Southern New England constitutes the remainder of the fishery, averaging 22 percent of total U.S. landings from 1981 to 2001, butlandings have declined recently in response to stock conditions. Since 2002, Southern New England landings have decreased, reaching historically low landings accounting for 2 percent of the total U.S. landings in 2013.

The majority of lobsters (about 96%) are taken with traps (1981-2013), but lobsters are also taken as bycatch by federal lobster permit holders who primarily use bottom otter trawl, gillnet, and scallop dredge. Information on commercial discards and bycatch is incomplete because federal lobster permit holders that do not have other federal permits are not required to report their harvest via vessel trip reports. This combined with limited sea sampling in the offshore fishery has resulted in minimal fishery-dependent information in this portion of the fishery. Regulatory discards include under and oversized animals, v-notched females, and egg-bearing females. Incidental catch limits for non-directed trips (e.g. groundfish trawl trips) may also lead to discards. Non-trap vessels with a Federal lobster permit may retain up to 100 lobsters per day at sea, for a maximum of 500 lobsters per trip of five days or more.

There are no published discard mortality studies from Georges Bank. A comparative study in Long Island Sound (Smith and Howell 1987) investigated trap vs. trawl mortality during different seasons, to quantify lobsters with minor or major external damage.The results of the study discussed immediate mortality rates caused by trawl-induced physical injury to lobsters, and delayed mortality rates for lobsters with or without physical damage. Immediate mortality rates were low for both trap and trawl gears across all lobsters, including egg bearing females, which have not yet molted and still have hard shells. Immediate mortality rates of trawl-caught lobsters ranged from 0 to 2.2 percent depending on the month. Major damage rates were also relatively low at 0 to 11.8 percent, depending on the month. Delayed mortality, measured by holding fishery caught lobsters in a laboratory setting, was relatively high for lobsters that sustained major damage (42.4 to 100 percent, depending on the month), or for lobsters that were newly molted and had soft shells (33 percent). Undamaged trawl caught lobsters and trap caught lobsters showed little delayed mortality. These results suggest that the fraction of the catch that sustains immediate major damage or is soft-shell can be used to predict delayed mortality rate in lobsters caught by trawl gear. In addition, undamaged lobsters with long laboratory exposures to freezing temperatures (-9.5° C) also sustained high mortality rates (none at 30 minutes, but 70 percent at 60 minutes and 100 percent at 120 minutes). While the authors note that the laboratory conditions may have resulted in greater exposure for each lobster as compared to catch piled on the deck of a vessel where some lobsters were insulated from the cold, this result indicates that long exposures during sorting would cause incidental mortality.

Another study (Jamieson and Campbell 1985) examined incidental catch and damage rates in lobster caught in the Gulf of St. Lawrence scallop dredge fishery. Researchers observed that spatial shifts in the distribution of lobsters affected the overlap of lobsters within the scallop fishery in this region. Overall, the study concluded that the scallop fishery did not have substantial negative impacts on the lobster resource since few lobsters occurred on the fishing grounds during the months in which the scallop fishery was most heavily prosecuted. It was not clear whether scallop fishing activity was driving lobsters off the fishing grounds, or if the lobsters were moving off the grounds during that time for other reasons. Lobster catch rates in three types of dredges were compared; one of their dredge types, the Gulf sweep chain dredge, was noted as being most similar to the offshore dredge. Catches of lobsters in unlined Gulf sweep chain dredges were low – 0.07 lobsters per meter per minute – but were higher for lined dredges, and in hoods and covers attached to the dredges. This indicated that some lobsters escaped through the rings and others swam over the dredge.

One source of bycatch information available to the Council is Coonamessett Farm Foundation's monthly scallop bycatch survey, which has been collecting detailed information on lobster bycatch since November 2012. The survey collects data on the number and weight of lobsters caught per tow, and lobster condition, including size, sex, occurrence of shell disease, shell hardness, presence of eggs, and damage resulting from the current tow. Their survey covers the Closed Area II access area (Closed Area II south of 41° 30' N), an open fishing area southwest of Closed Area II, and the Closed Area I access area (Map 106). The analyses in this amendment, which considers changing fishing privledges in the northern part of Closed Area II, would benefit from information on bycatch in the existing Closed Area II Habitat Closure Area. However, the Coonamessett Farm Foundation (CFF) survey to date has not included the northern part of Closed Area II, and therefore it is not known how similar bycatch rates might be in that area relative to areas currently sampled. However, given that NEFSC survey data indicate a relatively low percentage of Closed Area II lobsters are within the Closed Area II Habitat Closure Area, at least in the fall trawl survey, the bycatch rates from the CFF survey for the southern part of Closed Area II might be high relative to what would be caught in the existing Closed Area II Habitat Closure Area. Despite the limitations in terms of the survey's spatial coverage, the CFF survey results are valuable because they provide coverage across all months of the year, and monthly data are not available for these same areas in the commercial or NMFS survey catch.

Major results of the CFF bycatch survey are described here. Between May 2013 and March 2014, total catch across all three areas was low during May and December through March, and higher between June and October, with the highest total catch in October (Figure 24 shows total catch by area, and Figure 25 pools all catch, but breaks out lobster type into sub-legal lobsters, legal-sized lobsters, and females with eggs). Looking just at the Closed Area II scallop access area (Figure 26), both the total catch and the proportion of egg bearing females was highest in October. In this part of Closed Area II, the fraction of egg bearing females is highest during November 2012, June 2013, and October 2013 (there appears to be a high proportion in January 2013 as well, but overall numbers of lobsters caught during that month were very low). Scallop meat yield, also shown on this figure, declines over the summer and into the fall. Scallop yield information is relevant because the scallop fishery in this area is governed by a total possession limit, such that fishing during months when yields are higher may help to reduce bycatch if vessel operators can catch their trip limits with less fishing effort. In terms of condition, approximately one third of lobsters caught in this dredge survey were in good condition, one third had moderate damage, and one third had lethal damage (Figure 27).

Map 106 – Location of the 2013 CFF seasonal bycatch survey (CAI, CAII and Open Area). Figure courtesy of CFF.

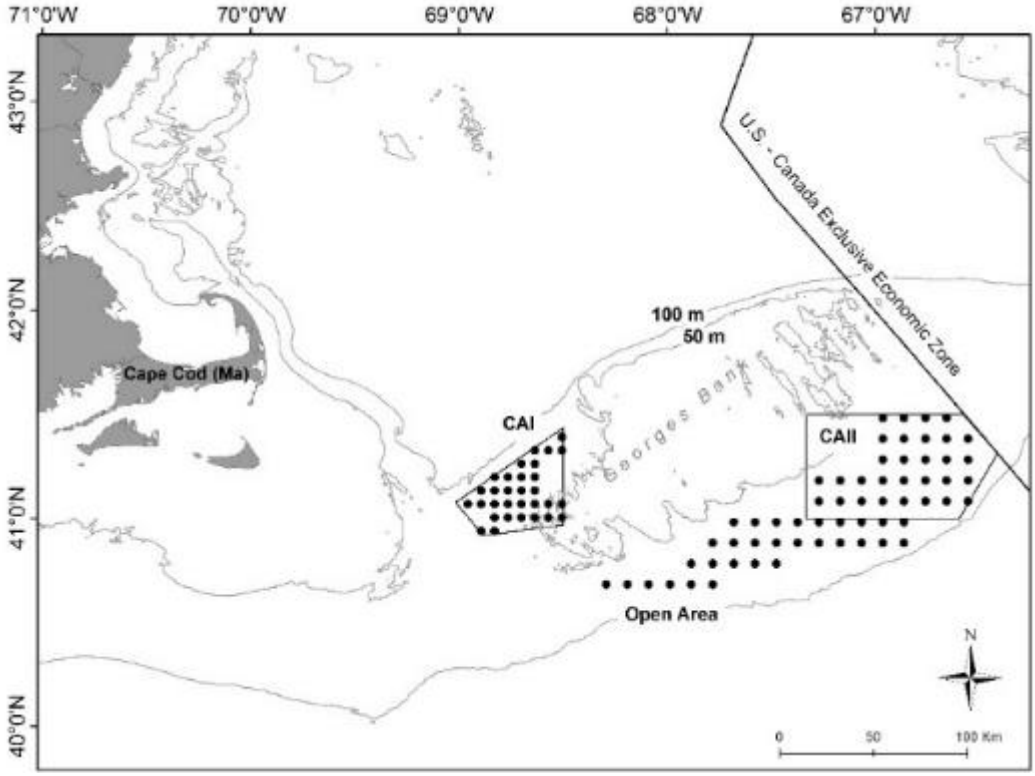


Figure 24 – CFF bycatch survey lobster catch by survey area, May 2013-March 2014. Figure courtesy of CFF.

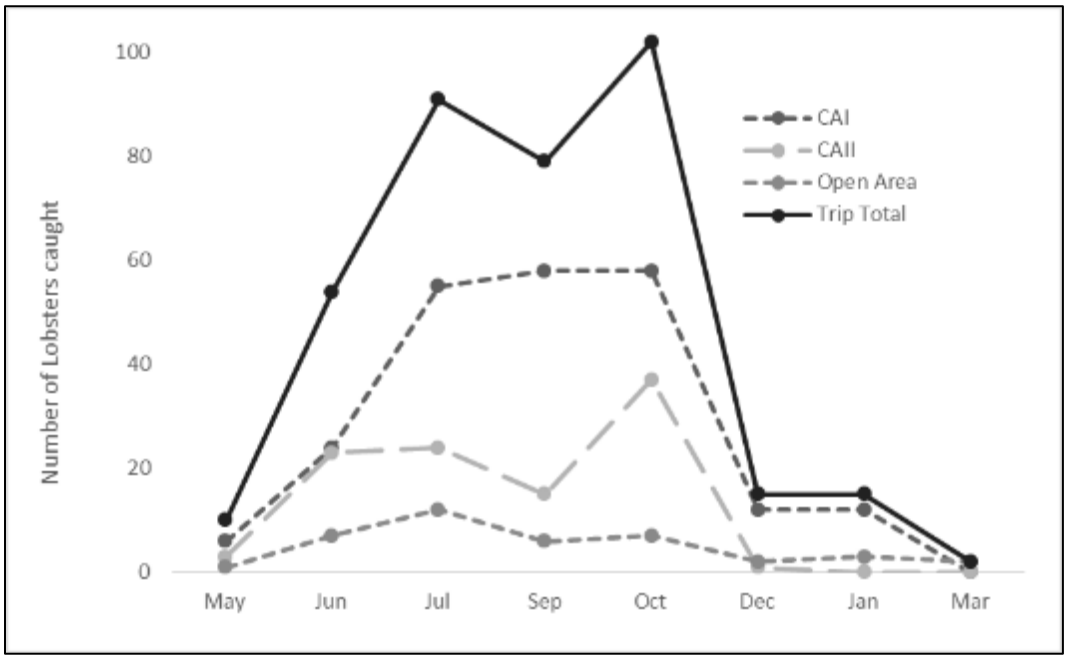
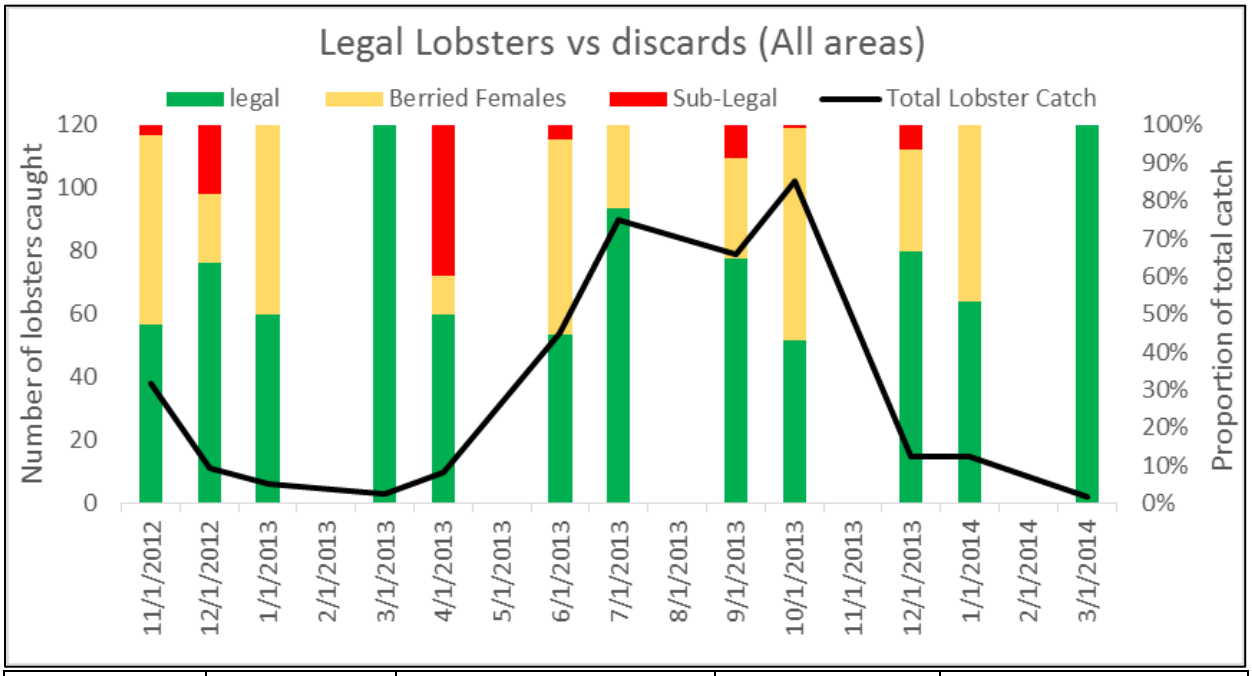


Figure 25 – Lobster catch (numbers) and proportion legal vs. egg bearing vs. sub-legal size, for all three areas combined (CAI scallop access, CAII scallop access, and open areas near CAII). Table below the figure gives numbers for each month. Figure courtesy of CFF.



Survey date	Legal catch	Egg-bearing females	Sub-legal size	Total Lobster Catch
11/3/12	18	19	1	38
12/5/12	7	2	2	11
1/28/13	3	3	0	6
3/15/13	3	0	0	3
4/27/13	5	1	4	10
6/14/13	24	28	2	54
7/26/13	70	20	0	90
9/9/13	51	21	7	79
10/26/13	44	57	1	102
12/6/13	10	4	1	15
1/14/14	8	7	0	15
3/8/14	2	0	0	2

Figure 26 – Lobster catch in Closed Area II south of 41° 30' N (scallop access area), shown as total females, number of females with eggs, and males. Calculated meat yield for a scallop at 127 mm are displayed in blue on the right axis. Seasonal yellowtail closures for CAII are from August 15th to November 15th. Figure courtesy of CFF.

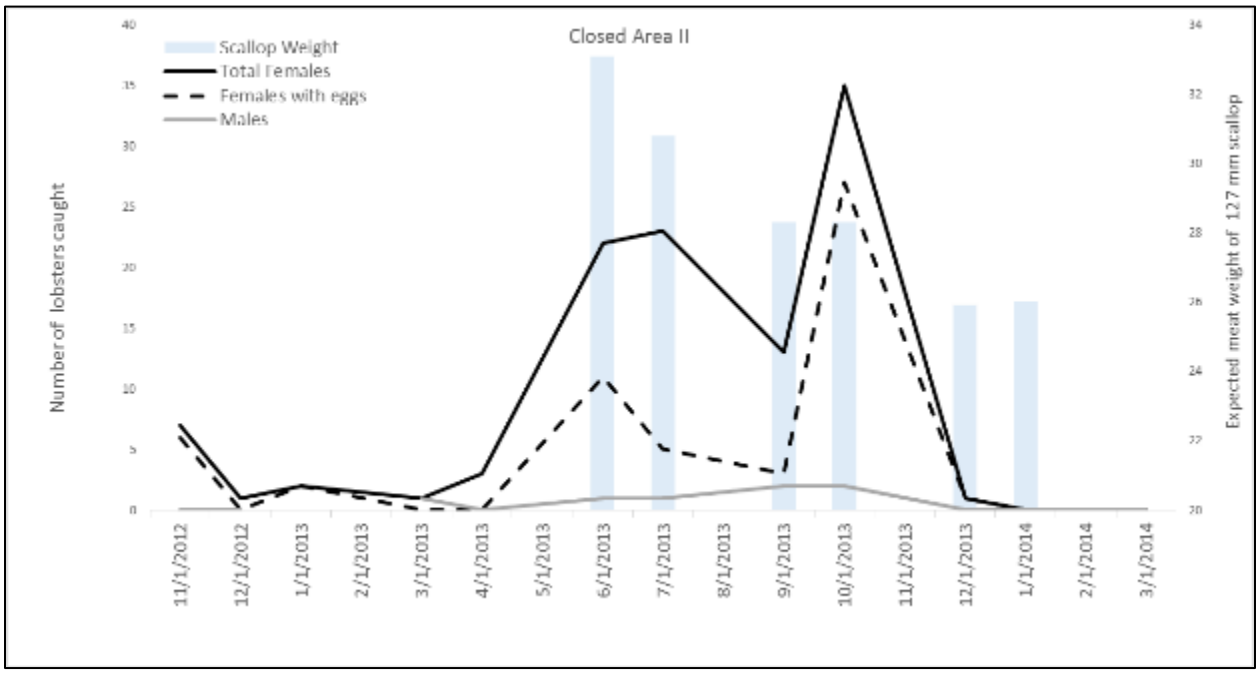
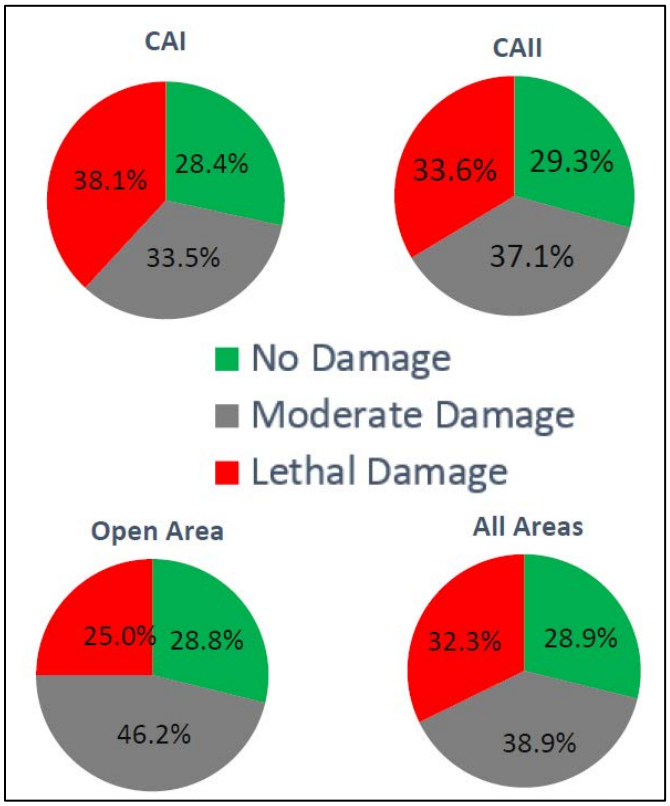


Figure 27 – Condition of lobsters caught in CFF bycatch survey.



Recent sex ratios in commercial and survey catches on Georges Bank have indicated a heavily skewed number of female lobsters. The reason for this is not clear but may relate to increased conservation of egg-bearing females (which cannot be landed as a conservation measure) and the influence this conservation has over time on population structure. It is also not clear if the population is experiencing sperm limitation. The reproductive patterns for larger lobsters are not very well known. Large females may molt and extrude eggs in alternate years, and many factors appear to influence molt rate/intermolt interval. As indicated by the Smith and Howell study, incidental mortality rates on these females would be affected to the extent that these females are post-molt and therefore softshell during times when other fisheries are being heavily prosecuted in the area, and during the times when there are more lobsters in the area in general (similar to Gulf of St. Lawrence observations).

17.1 Impacts on American lobster

This action proposes to alter fishing privileges in specific Habitat Management Areas, Spawning Management Areas, and Dedicated Habitat Research Areas. Changes to areas in and around Closed Area II are of particular concern to the American lobster fishery. Some of the habitat management alternatives would result in maintenance of existing areas or portions of them as mobile bottom-tending gear closures. Others would result in reopening of existing areas to mobile bottom-tending gears, or closure of new areas to mobile bottom-tending gears. On Georges Bank, the Council's preferred alternative includes two HMAs on the northern edge, and one overlapping Georges Shoal. The area furthest to the northeast within the Northern Edge is proposed as a Reduced Impact Habitat Management Area (RIHMA), and an adjacent area to the south is proposed as a mobile bottom-tending gear closure. The RIHMA would allow limited fishing access for bottom trawls and scallop dredges but would otherwise be closed to mobile bottom-tending gears. Trawls would only be allowed in the portion of the area outside what is currently Closed Area II. The preferred alternative includes a seasonal closure to scallop dredges within what is now Closed Area II, north of 41° 30' N between June 15th and October 31st.

Biological concerns relative to the lobster resource center on how alternatives that increase access for mobile bottom-tending gear fishing on eastern Georges Bank might increase incidental mortality of lobsters, especially egg bearing females, in non-trap gears. In particular, the objective of the seasonal closure to scallop dredges is to reduce incidental mortality of these females in scallop dredge gear during the months that a larger number of ovigerous female lobsters are present on the bank.

Biological sampling data from the Northeast Fisheries Observer Program (NEFOP) was used to verify the occurrence of ovigerous female lobsters in Closed Area II during the seasonal closure as compared to the remainder of the year. Haul locations from this data set can be plotted to indicate the spatial distribution of ovigerous females during the closed/open seasons.

NEFOP observers quantify total American lobster catch during all observed trips (Table 70). On a subset of trips, NEFOP observers also collect biological information on lobsters, which is recorded on a Crustacean Sample Log. Biological information includes the number of lobsters caught (per haul), the size and sex of the lobsters caught, and the presence/absence of eggs for female lobsters. There are a very small number of crustacean sample logs completed during

observed trips (Table 71). Of the 33,300 observed trips from 2004 to 2014, only 15,206 of those trips caught lobster (approximately 50 percent). Of those 15,206 observed trips that caught lobster, a very small percentage of the trip information included biological information from crustacean sample logs (874 trips or 5.7 percent).

Biological sampling for lobsters on observed trips is opportunistic and completed only when the observer has the time to do so, such that the data cannot be viewed as a representative sub-sample. Furthermore, during hauls that include a crustacean sample log, sex and reproductive stage may not be determined for all lobsters, depending on the size of the catch and the amount of time available for sampling. This limits the utility of the data; for example, it cannot be used to indicate relative catch rates of egg bearing females between hauls, trips, or gear types, and does not provide a complete picture of the spatial distribution of ovigerous lobsters in Closed Area II. Rather, the data should be viewed as confirmatory of the presence of ovigerous female lobsters in the closed area between June 15 and October 31.

Recent NEFOP data from 2010-2014 was used to show locations where observer data recorded ovigerous female lobsters in Closed Area II. Map 107 shows instances of observed ovigerous lobsters during the months where limited fishing access for the scallop and groundfish industry is proposed (January-May, November-December). Map 108 shows instances of observed ovigerous lobsters during the proposed seasonal closure (June-October). Although mobile gear fisheries would be allowed to fish during the first two weeks of the month, data from June 1 to June 14 are shown on the seasonal closure map because data could be most easily filtered at a monthly vs. weekly resolution.

The lobster catches shown on the maps are primarily from dedicated lobster pot/trap trips, particularly within Closed Area II where many other gear types are restricted. Other observations of ovigerous lobsters have taken place outside of Closed Area II, with several gear types: bottom otter trawl (with and without haddock separator), gillnets, scallop dredges, and fish pots. The results indicate that there are fewer observations of ovigerous female lobsters between November and May, and these observations are concentrated in the very northern edge of Closed Area II along the continental shelf break. Ovigerous lobsters are also observed along the continental shelf break between June and October. In addition, during the June to October time period, there are observations of ovigerous lobsters in central Closed Area II north of 41°30’ N, which is the seasonal closure boundary.

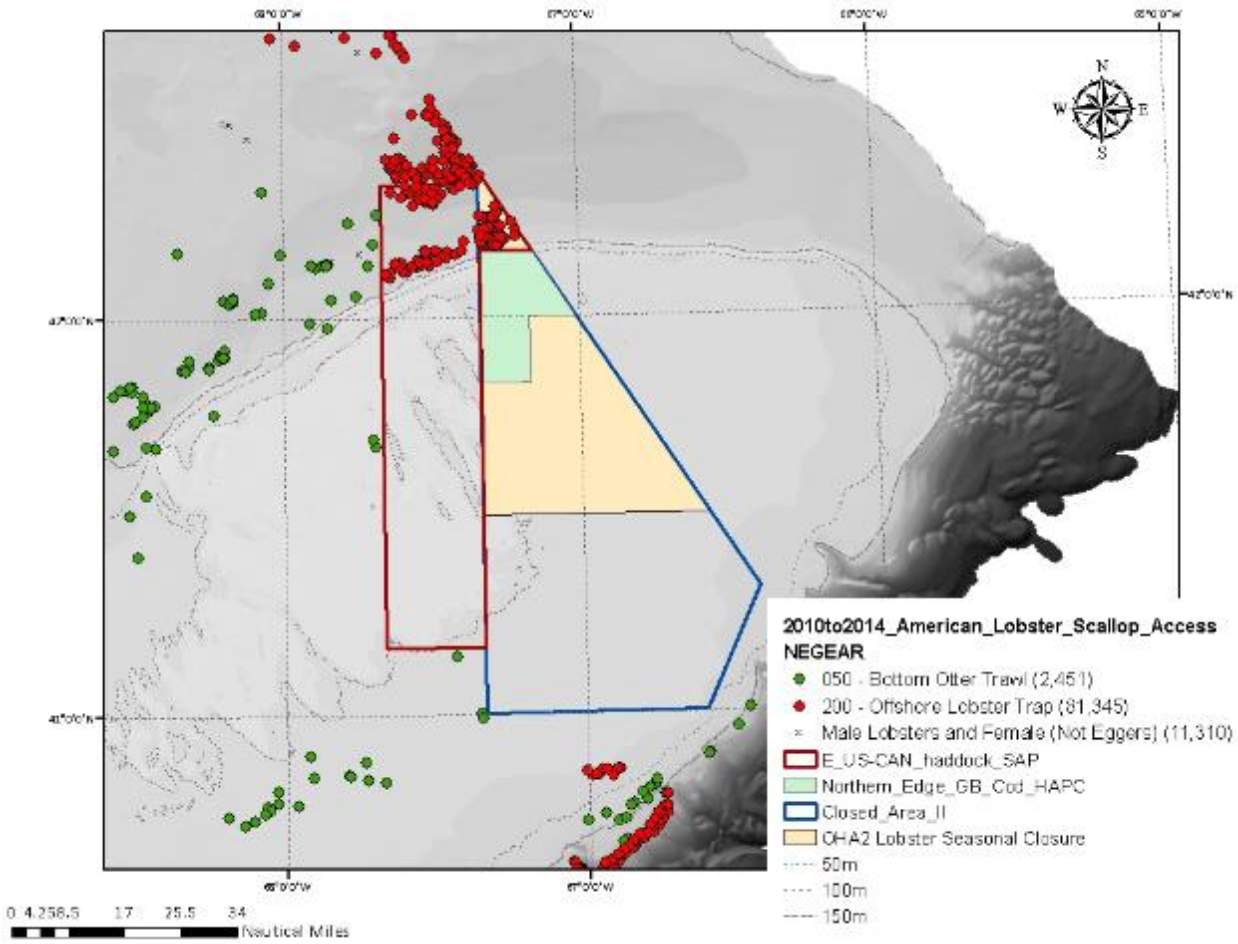
Table 70 – Number of observed trips with American lobster catch

Year	Number of Observed Trips	Number of Observed Trips where Lobsters were caught	Number of Observed Lobster Pot/Trap Trips
2004	3,527	1,769	43
2005	4,522	2,473	46
2006	2,430	1,039	26
2007	2,904	1,195	40
2008	2,974	1,213	43
2009	3,249	1,361	44
2010	2,712	1,059	12
2011	2,695	1,298	5
2012	2,539	1,314	28
2013	2,572	1,151	37
2014	3,176	1,334	67

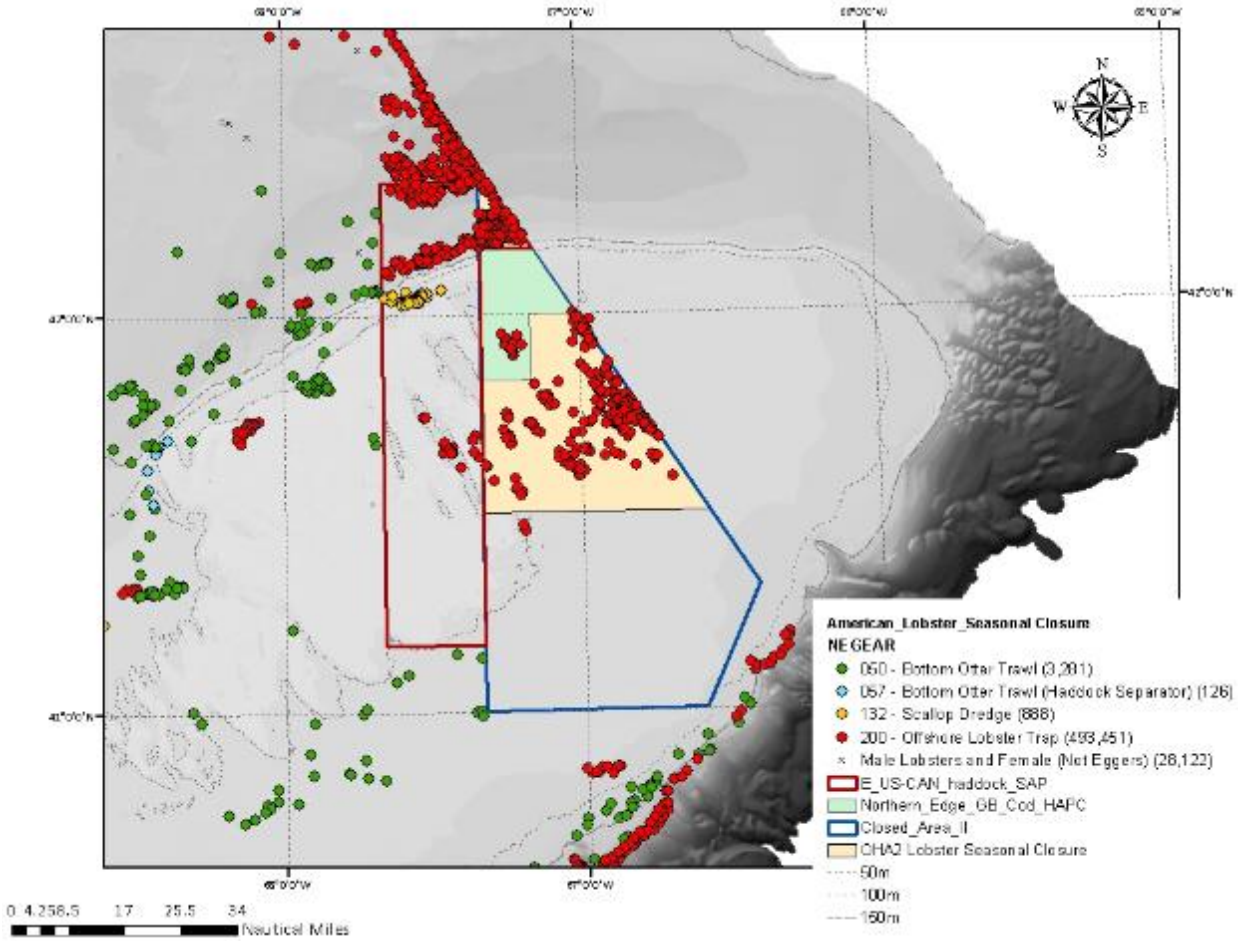
Table 71 – Number of Biologically Sampled Lobsters on Observed Fishing Trips, 2004-2014

Year	Sex Unknown	Male	Female	Female Eggers	Grand Total
2004	2	35	56	25	93
2005	4	42	57	22	103
2006	2	20	25	9	47
2007	0	28	32	7	60
2008	3	33	47	23	83
2009	7	28	39	17	74
2010	2	9	12	6	23
2011	0	4	6	4	10
2012	5	26	52	26	83
2013	9	35	66	29	110
2014	11	59	116	57	186

Map 107 – Observations of ovigerous American lobster by gear type during November-December and January-May, 2010-2014



Map 108 – Observations of ovigerous American lobster by gear type during June-October 2010-2014 (proposed seasonal closure to scallop dredges)



17.1.1 Gulf of Maine habitat management and spawning management alternatives

In the Gulf of Maine, the lobster population is concentrated relatively inshore (see distribution map in the Affected Environment section of Volume 1). The preferred alternative Small Eastern Maine HMA would impose restrictions on mobile bottom-tending gears inshore, although mobile bottom-tending gear fishing activity in this area currently is relatively minimal. In addition, seasonal spawning alternatives restrict mobile bottom-tending gears in various areas during the winter and spring months. Overall, incidental mortality increases are of limited concern in this region. Therefore, the preferred habitat management alternatives and spawning management alternatives in the Gulf of Maine would likely have a neutral to slightly positive impact on the resource. Neutral impacts would be most likely for alternatives that would not affect the amount of mobile bottom-tending gear use inshore, and slightly positive impacts would be most likely for alternatives that reduce the use of mobile bottom-tending gears inshore relative to No Action.

Table 72 – Summary of impacts to the lobster resource associated with Gulf of Maine habitat management alternatives.

Sub-region	Alternatives expected to have neutral impacts	Alternatives expected to have slightly positive impacts
Eastern Gulf of Maine	Alternative 1/No Action; Alternatives 2 or 3 with gear modification options 3 or 4. These alternatives are not expected to increase or decrease mobile bottom-tending gear use in inshore areas with a high degree of overlap with the lobster resource.	Alternatives 2 and 3, with mobile bottom-tending gear closure options 1 and 2, including the preferred alternative (Small Eastern Maine HMA as a mobile bottom-tending gear closure). These alternatives could lead to slight reductions in mobile bottom-tending gear use in inshore areas overlapping the lobster resource.
Central Gulf of Maine	All alternatives (1-4). Given that the lobster resource is concentrated in inshore areas, changes to spatial management further offshore in the central Gulf of Maine is not expected to have an impact on the resource, positive or negative.	None.
Western Gulf of Maine	Alternatives that would not decrease fishing effort in nearshore areas: Alternative 1/No Action, including preferred alternative, Alternative 2, Alternatives 3-5 with options 3 or 4, Alternative 6 with any management option, Alternative 7A, Alternative 7B, Alternative 8.	Alternatives 3, 4, and 5 with Options 1 or 2, which would decrease fishing with mobile bottom-tending gears in the Bigelow Bight via the small or large Biglelow Bight HMA.

17.1.2 Georges Bank habitat management and spawning management alternatives

Alternatives that increase lobster bycatch, particularly in mobile gears, could lead to increased incidental mortality of lobsters. As discussed in the introduction above, the limited literature on lobster bycatch indicates that fishing mortality rates are relatively high for lobsters that have recently molted and have soft shells. Thus, the fraction of recently molted lobsters will influence the incidental mortality rate. Incidental mortality rates are also high for hard shelled lobsters that suffer major damage, such as in mobile bottom-tending gears. Whether or not any increase in incidental mortality constitutes a significant impact on the stock depends on the magnitude of incidental mortality relative to stock size.

According to the 2015 lobster stock assessment, lobsters were evenly distributed in the fall, with marginally higher densities in the northern and eastern areas of Georges Bank in recent years. The spring survey has many fewer tows with lobster catch, and the positive catches are concentrated along the northern and eastern edge of Georges Bank. The Council's proposed HMA for the Georges Bank sub-region would remove Closed Areas I and II from a year-round habitat protection to a seasonal spawning protection. Closed Area II is proposed to be opened to

some mobile gear fishing, bottom trawls and scallop dredges. Currently, specific areas within the closure have been closed to mobile gear, with exceptions including Special Access Programs and scallop access fisheries. Closed Area II is located within Lobster Management Area 3, and is fished year-round by some or all of its 137 lobster trap permit holders that have access to these fishing grounds. Closed Areas I North and II would be closed seasonally (February, March, and the first half of April). Information gathered from fishery independent trawl surveys show that the Gulf of Maine and Georges Bank stock should be combined into one stock, based on indicators of seasonal lobster movemement between the two stock areas. Therefore, the 2015 stock assessment combines the Gulf of Maine and Georges Bank stock into one stock. The question is how abundant lobsters are in these reopened areas between April 15 and January 31, and when and at what rate soft-shell lobsters are present. Based on data provided by the Commission, lobster fishing effort peaks from July to October, and discard rates appear to be highest in August and September. Discards would be due to lobsters being undersized, oversized, egg bearing females, or v-notched females.

The Commission provided the Council with lobster bycatch data collected by the Atlantic Offshore Lobstermen's Association from two vessels. These data indicate that about half the lobsters sampled in July-September are egg bearing females, and about 80% of lobsters sampled October-December are egg bearing females, which would help explain the high discard rates. It is not clear from the data provided whether lobsters are more abundant on Eastern Georges Bank during July-October, or if that is simply the preferred season for lobster fishing. Because most of these lobsters are ovigerous, they have not yet molted, so there should not be an increase in incidental mortality on most of the animals as a result of their soft-shell status. Nonetheless, injury-related delayed incidental mortality on these females may be of concern. Sub-lethal effects including loss of eggs could also have negative impacts on the resource. These concerns are tempered by the fact that the Georges Bank stock status is at record high abundance as of the last assessment, with large numbers of female lobsters in the population. Due to concerns about impacts to the lobster fishery and resource on Georges Bank, any portions of what is currently known as Closed Area II north of 41°30' N would be closed to the scallop fishery between June 15th and October 31st.

Under No Action for both habitat and spawning on Georges Bank, maintaining Closed Area II is expected to have slightly positive impacts on the Georges Bank stock. This is because the existence of the closed area limits incidental non-trap mortality on ovigerous female lobsters prevalent in the area during the summer and early fall. Given that this stock is currently highly abundant, impacts at the stock level are expected to be slight.

The preferred habitat management alternative (Georges Bank Alternative 10) would allow scallop dredging in the RIHMA. Under No Action, scallop dredges are prohibited from the RIHMA, except for the small portion west of 67° 20' W which is currently open to fishing. Thus, the RIHMA element of the preferred alternative will most likely lead to increased mobile bottom-tending gear use within Closed Area II. However, the preferred alternative includes a seasonal closure would prohibit scallop dredges from being used in the RIHMA east of 67° 20' W between June 15 and Ocotober 31. The NEFOP catch data presented above indicate that the proposed seasonal closure to scallop dredges seems to align well with times when ovigerous female lobsters are present. Fewer observations of ovigerous females have been made during

November to June. In addition, observations of ovigerous females presented above do not overlap the RIHMA during either time period. The area immediately south of the RIHMA would remain closed to mobile bottom-tending gears year round. Given the seasonal restriction, the preferred alternative is expected to have slight positive impacts on the lobster resource.

The June 15-October 31 seasonal closure is specific to the preferred alternative. Other alternatives could have slightly to moderately negative impacts on the lobster resource on Georges Bank, as fishing effort with mobile bottom-tending gears would be allowed within Closed Area II. These include Alternatives 2, 3, 4, 5, 6A, 6B, 7, 8, and 9. Alternative 2 and 5 do not include mobile bottom-tending gear closures in Closed Area II, and Alternatives 3, 4, 6A, and 6B with Options 3 and 4 would restrict trawl gear groundcable configurations but would not prohibit the use of trawls or dredges. These alternatives would have the greatest magnitude of negative impacts. Alternatives 3, 4, 6A and 6B with Options 1 and 2, or Alternatives 7, 8, and 9 would maintain year-round closures in portions of Closed Area II. In general, these alternatives protect the northen part of Closed Area II overlapping the habitat closure, and not the central part of the area, so there would likely be some potential for incidental lobster mortality in open parts of Closed Area II. These alternatives would have a smaller magnitude of negative impacts. Regardless of alternative, it is difficult to estimate the extent to which trawling and dredging would cause incidental mortality of lobsters. While a comparison of the spring and fall trawl surveys indicates that lobsters migrate into shallower waters on the bank during the summer months, the trawl survey does not help elucidate lobster distribution pattens in Closed Area II during the summer. Because the area has been closed to scallop dredging and trawling for such a long time, it is difficult to predict patterns of effort should all or part of the area reopen to these gears. Finally, as noted previously, there are few studies of incidental mortality rates. Thus, any of these alternatives could have negative effects. Considering the entire lobster resource, which is concentrated in the Gulf of Maine, these effects are likely slight, but could be moderately negative for the Georges Bank stock in isolation. If a previously negotiated seasonal closure to trawl gear were combined with the various habitat closures, the possibility of negative impacts would be reduced, since under the agreement sector trawl vessels would be prohibited during times when lobsters are most abundant in Closed Area II.

The preferred spawning management alternative for Georges Bank would make Closed Area II as a whole a seasonal closure, from February 1 – April 15. The seasonal spawning closure would apply to bottom trawls, but not scallop dredges. Combining this closure with the habitat measures described above, trawl gear use in the portions of Closed Area II not overlapping the new habitat management areas could increase during the period from April 16 to January 31 relative to what is allowed under No Action. There was an agreement between sector groundfish trawl vessels and the lobster industry that would have prohibited groundfish trawl activity between June 15 and October 31; however, this agreement is not codified in the regulations so it is unclear if the seasonal restriction would still apply. Assuming that trawl gear is prohibited during this window, and because this time period overlaps with most of the observations of ovigerous females, it appears that the preferred spawning management alternative will have limited negative impacts on the lobster resource.

Considering the preferred habitat and spawning alternatives in combination, impacts to the lobster resource are expected to be neutral to slightly negative. Incidental damage would likely

only increase in the very northern parts of the Closed Area II where ovigerous female lobsters have been observed.

Another consideration is the extent to which habitat management areas that minimize impacts to structural seabed features could benefit lobsters in terms of providing increased shelter and feeding opportunities, particularly for smaller animals. Improved protection for structural habitats occupied by lobsters could lead to positive impacts on the resource, whereas decreased protection for structural habitats could have negative impacts. Wahle and Steneck (1991) identify lobsters from settlement size (.5 cm carapace length) to between 2 and 4 cm carapace length as 'early benthic phase'. They note these animals are ecologically and behaviorally distinct from larger lobsters, and that the upper size limit on this phase appears to vary by location. During an observational field study of coastal benthic habitats in the Gulf of Maine, these early benthic phase lobsters (up to 4 cm CL) were found almost exclusively in shelter-providing habitats, generally with cobble substrates, and were generally absent from other habitat types. They theorize that due to the relative rarity of cobble habitats over the range of the American lobster, availability of habitat suitable for sheltering young juveniles may represent a recruitment bottleneck. Conversely, they noted that cobble habitats at some of their study sites did not have juveniles of this size; obviously pre-settlement sized lobsters must be present for the structured habitats in a particular area to provide this type of sheltering function to post-settlement animals. In the context of this amendment, habitat management areas that do not have large numbers of early benthic phase lobsters will not have a biological benefit for lobster stocks. A subsequent experiment by the same authors (Wahle and Steneck 1992) provided evidence that early benthic phase lobsters are using shelter as a mechanism to escape predation; perhaps because lobsters of this size are unable to rapidly bury themselves in the sediment to avoid capture.

A 1993 field experiment by Bologna and Steneck demonstrated that kelp habitats also provide suitable shelter for lobsters. Compared to otherwise similar, nearby, unvegetated habitats, natural or artificial kelp habitats had significantly higher biomass of lobsters. These animals were slightly larger than early benthic phase on average (5-6 cm CL depending on the treatment and year). Because lobsters were present in similar abundance at artificially-placed and natural kelp habitats, the authors surmised that the structural characteristics of the kelp were most critical to determining lobster abundance, as compared to higher trophic/feeding benefits associated with natural kelp habitats. With the exception of the Ammen Rock habitat management area, kelp habitats are not likely to be found in the alternatives proposed in this amendment, because kelp is generally a shallow water feature due to light dependence. However, this study does indicate that larger juvenile lobsters occur in higher densities in a structured habitat as compared to more featureless seabed.

17.1.3 Great South Channel/Southern New England habitat alternatives

In general, there appears to be limited overlap between the lobster fishery and the the habitat management areas in this sub-region. Therefore, maintaining or modifying year round habitat management areas would likely have neutral impacts on the lobster resource. Based on the lobster survey and landings distributions in the maps in Volume 1, Section 4.3.15, Alternative 3, which includes the Great South Channel East HMA, extends the furthest north and east and has the greatest degree of overlap with the lobster resource. Therefore, restricting mobile bottom-

tending gears in this HMA could have a slightly positive impact on Georges Bank lobsters. To a lesser extent this would be true of the preferred alternative (4) as well.

17.2 Impacts on the lobster fishery

Lobster trapping, which comprises the vast majority of lobster fishing effort, would not be restricted under any of the management alternatives in this amendment, so there would not be any direct impacts through displacement of lobster trapping effort. Any positive or negative impacts on the lobster fishery would be indirect, and will relate to increases or decreases in the use of other gears on lobster fishing grounds.

One of the main concerns with opening Closed Area II to mobile gear is that gear conflicts may arise between fixed lobster gear vessels and mobile gear vessels. The Council proposes to establish a seasonal scallop fishing restriction within Closed Area II north of 41°30' N between June 15th and October 31st. The lobster industry, specifically in Area 3, and the Commission are aware of this potential for increased gear conflict. The Commission has addressed the issue by adopting Addendum XX to Amendment 3 of the Interstate Fishery Management Plan for American lobster. Addendum XX formalized, through 2014, a previous agreement between the groundfish sector industry and the offshore Area 3 lobster industry. The trawl gear sharing agreement is not part of the Omnibus EFH Amendment and it is unclear if it remains in effect.

Interactions between the lobster trap and scallop dredge fisheries could also occur under the alternatives under consideration, and there is not a formal or informal agreement to prevent gear conflict similar to the trawl/trap agreement described above. Impacts of scallop dredge/lobster trap interactions could range from neutral to slightly negative, depending on various factors.

One factor is the behavior of individual fishermen, specifically whether they would seek to avoid gear conflict with the lobster industry that currently fishes in Closed Area II. Under the Council's preferred alternative, Closed Area II north of 41°30' N would be closed to the scallop fishery between June 15th and October 31st. The stated rationale for this seasonal closure was to protect ovigerous female American lobsters on Georges Bank. However, the closure would also reduce adverse impacts from gear conflicts between the scallop and lobster fishery. The same area was discussed as a closure to bottom trawls during the same time period through a gear sharing agreement between the Atlantic Lobstermen's Offshore Association and the groundfish sector vessels, however, it is unclear if this agreement remains in effect.

A second factor is the spatial overlap between the two target stocks (Map 117), with greater overlap leading to higher potential for gear conflicts. Sea scallops are a sedentary species that occur patchily on the northern edge of Georges Bank including within Closed Area II, with local abundance ranging from extremely high in the northern part of the closure to no abundance in the central part of Closed Area II. Lobsters are more widely distributed throughout the area, including in the center of the closure where scallops do not occur. Thus, lobster effort occurring south of the existing habitat closure would likely have no or very limited potential gear conflict impacts with scallop dredging.

Impacts of spatial management alternatives on the lobster fishery are summarized in Table 73.

Map 109 - Overlap between lobster and scallop distributions in all NEFSC surveys, 2002-2012. Scallop weight per tow (blue) is partially transparent to show lobster distribution underneath (red). The central part of Closed Area II (shaded) contains lobsters but few scallops.

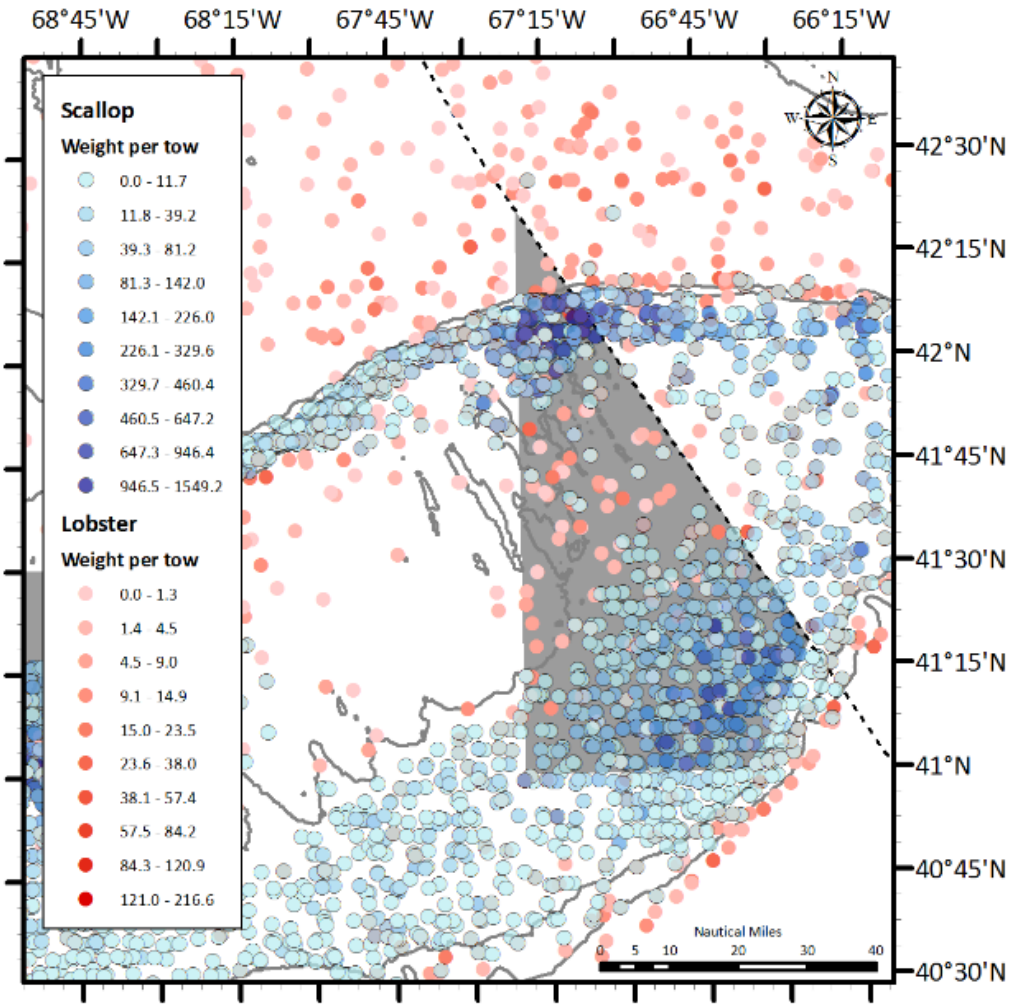


Table 73 - Summary of impacts on the lobster fishery. Preferred alternatives denoted as (*).

Type	Sub-region/region	Alternative	Impacts	Notes
Habitat	EGOM, CGOM, WGOM	All	Neutral	
Habitat	GB	Alt. 1 (No action), Alt. 8	Neutral	
Habitat	GB	Alt. 2 (No area), Alts 3-7, 9, 10*	Slightly negative to neutral	
Habitat	GSC-SNE	All	Neutral	
Spawning	GOM	All	Neutral	
Spawning	GB-SNE	Alt. 1 (No Action)	**Neutral**	
Spawning	GB-SNE	Alt. 2A, 2B, 2C, 3A, 3B*, 3C*	Slightly negative to neutral	
Research	All	All	**Neutral**	

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