DRAFT

Omnibus Essential Fish Habitat Amendment 2
Volume 1: Executive summary, Background and purpose, and Description of the affected environment

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

Draft Environmental Impact Statement

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

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This document is Volume 1 of a five volume Draft Environmental Impact Statement (DEIS) prepared to support the New England Fishery Management Council's Omnibus Essential Fish Habitat Amendment 2. The amendment has been developed to fulfill the essential fish habitat requirements of the Magnuson Stevens Fishery Conservation and Management Act across all New England Council fishery management plans. In addition to meeting Magnuson Stevens Act requirements, this DEIS has been written to comply with the National Environmental Policy Act and other applicable laws. The Executive Summary which follows describes the contents of the amendment and DEIS document (all volumes).

1 Executive summary

This combined amendment document and Draft Environmental Impact Statement (DEIS) is presented in five volumes:

- **Volume 1** – Executive summary, background and purpose, description of the affected environment
- **Volume 2** – Essential Fish Habitat and Habitat Area of Particular Concern designation alternatives, considered and rejected alternatives, and associated impacts analysis
- **Volume 3** – Habitat, spawning, and research area alternatives and framework adjustment procedures, considered and rejected alternatives, and associated impacts analysis
- **Volume 4** – Practicability analysis, cumulative effects, compliance with applicable law, and references
- **Volume 5** – Appendices

1.1 Purpose and need for action

The purpose and need for action is summarized in Table 1. Two purposes are related to Essential Fish Habitat (EFH), including review and revision of the EFH designations (Purpose A), and development of actions needed to minimize the adverse effects of fishing on EFH (Purpose B). These are needed to ensure compliance with the Magnuson Stevens Fishery Conservation and Management Act (MSA). Another purpose related to EFH is the identification of other actions to conserve and enhance EFH (Purpose C). Both the Habitat Area of Particular Concern Designations and the Dedicated Habitat Research Area designations help fulfill this purpose.

The guidelines specify that to meet Purpose A, the Councils should designate EFH for all managed species of finfish and shellfish, by life history stage, using both text descriptions and maps delimiting potential EFH areas. The new designations proposed in this action include additional years of distribution data as well as information about depth and temperature preferences.

EFH designations help the Council identify habitats where adverse impacts should be minimized (Purpose B). Prior efforts to minimize the adverse effects of Council-managed fisheries on EFH have been largely developed and implemented plan by plan. This action is needed to reevaluate and integrate habitat management measures across the fisheries managed by the Council, and to update these measures given new scientific information about habitat distributions and fishing impacts.

Purpose C of the amendment is to identify other actions to encourage conservation and enhancement of such habitat. One set of alternatives related to this purpose is to designate Habitat Areas of Particular Concern. A Habitat Area of Particular Concern is a subset of EFH that represents particularly unique, ecologically important, and/or vulnerable habitat types. This action is needed to highlight these special areas, as Habitat Areas of Particular Concern help inform and receive elevated consideration for both fishery management and EFH consultations. Another set of alternatives that relates to Purpose C is the designation of Dedicated Habitat Research Areas, which will help the Council to better understand how habitat management measures influence stock productivity, to allow for the design of more effective conservation measures in future actions. Other EFH-related provisions of the fishery management plans that will be amended by this action are an update of the primary types of prey consumed by each managed species, and updates of non-fishing activities in the region that have the potential to adversely affect EFH and research and information needs.

Another aim of the amendment is to review and consider revision of the rolling closures and year-round groundfish closed areas, which is needed to ensure that spatial management measures are contributing to optimum yield in the groundfish fishery. There are two purposes to this overall principle. The first groundfish-specific purpose of this amendment is to improve protection for juvenile groundfish and their habitats (Purpose D). Success at younger ages can have positive productivity benefits for managed resources, and therefore action is needed to protect the habitats important for juvenile groundfish, particularly for commercially valuable species.

A second groundfish-specific purpose of this amendment is to identify seasonal closed areas in the Northeast Multispecies FMP that would reduce impacts on spawning groundfish and on the spawning activity of key groundfish species, because the protection of spawning fish is needed to sustainably manage stocks (Purpose E).

Table 1 – Needs for action, with related purposes and management alternatives

Need	Purpose	Alternatives that address this purpose
Meet Magnuson Stevens Act EFH requirements	A. Designate EFH for each species and lifestage	Volume 2, Section 2.1
	B. Minimize the adverse effects of fishing on EFH to the extent practicable	Volume 3, Section 2.1
	C. Identify other actions to encourage conservation and enhancement of such habitat	Habitat Areas of Particular Concern (Volume 2, Section 2.2); Dedicated Habitat Research Areas (Volume 3, Section 2.3)
Achieve optimum yield from the groundfish fishery	D. Improve protection of habitats on which juvenile groundfish depend	Volume 3, Section 2.1
	E. Improve protection of spawning groundfish	Volume 3, Section 2.2

1.2 Alternatives considered

As noted above, six types of management alternatives are considered in this action: (1) EFH designations, (2) HAPC designations, (3) Habitat Management Areas, (4) Spawning Management Areas, (5) Dedicated Habitat Research Areas, and (6) changes to approaches to framework adjustments and monitoring.

1.2.1 EFH and HAPC designation alternatives

The EFH and HAPC designation alternatives are described and analyzed in Volume 2. These alternatives were reviewed by the Council in 2007 and preferred alternatives were selected following public hearings. Since 2007, the EFH designations were refined slightly and reviewed by the Habitat Committee during 2011. The preferred alternatives identified in this DEIS document are consistent with the preferred alternatives identified previously by the Council.

1.2.1.1 EFH designations

Essential fish habitat (EFH) means those waters and substrate necessary to fish for spawning, breeding, feeding, or growth to maturity. EFH designations consist of two complementary elements, the text descriptions, and the map representations. Any specific area is only considered EFH if it is displayed in the EFH map and meets the conditions defined in the text description. Thus, the two components of EFH must be used in conjunction with one another when applying EFH designations to fishery management, EFH consultation, or other questions. This document includes three types of EFH designation alternatives:

- No action
- Preferred alternatives, in some cases subsequently updated by the PDT and reviewed by the Habitat Committee in March 2011. A full set of maps that were approved by the Council in June 2007 (before they were modified by the PDT) are available in Appendix C.
- Non-preferred alternatives as presented in the 2007 DEIS

EFH text descriptions summarize the life history information necessary to understand the relationship of each species and life history stage to, or its dependence on, various habitats. While developing these descriptions, the Council created supplementary tables (provided in Appendix B) that include all the relevant habitat-related information that was compiled. A major improvement in the new text descriptions is their inclusion of specific depth and temperature ranges that more explicitly connect with the map representations of EFH.

EFH maps display, within the constraints of available information, the geographic boundaries within which EFH for each species and life stage exists, subject to the habitat requirements as defined in the text descriptions. Both the no action and alternative mapping methods are described in detail in Appendix A.

In the absence of region-wide habitat maps, EFH maps for most species were based on the spatial distribution of fish caught during 38 years of fishery-independent surveys, and, for most benthic life stages, habitat "layers" defined by their depth and bottom temperature preferences. Maps for benthic life stages (juveniles and adults, in most cases) were derived from trawl survey data collected between 1968 and 2005. Maps for pelagic life stages (usually eggs and larvae) were based on plankton surveys conducted between 1977 and 1987. Numbers of fish (or eggs and larvae) caught per tow were averaged within ten minute squares of latitude and longitude and the squares were categorized according to the relative abundance or "density" of each species and life stage. For the portion of the continental shelf surveyed by NMFS, a series of alternative maps for each species and life stage were developed based on the 25th (fewer squares, highest density), 50th, 75th, 90th and 100th (all squares, lowest density) cumulative percentiles of the average catch rates in each ten minute square. Generally, the 75th or 90th percentile maps (high and moderate density squares) were selected as the preferred alternatives.

For the inshore coastal areas surveyed by the states, any ten minute square in which 10% or more of the tows made in that square caught at least one fish of that species and life stage was added to the map. This was done in order to minimize the effect of varying sampling times of year and differences in the trawl design (e.g., trawl or mesh size) between surveys and make the data sets from each survey more compatible to region-wide analysis. Also included in the maps were certain coastal estuaries and embayments where a life stage of a managed species was identified as being “common”, “abundant”, or “very abundant” by NOAA’s Estuarine Living Marine Resource (ELMR) Program. Additional EFH areas were added to the maps for some deep-water species on the outer continental shelf and slope based on available maximum depth and geographic range information.

The no action egg and larval EFH maps were based on survey data collected between 1977 and 1987. Because no new region-wide survey data were available when the maps were originally developed, the only change made in the EFH maps for the pelagic egg and larval life stages was the removal of ten minute squares that were added in 1998 to “fill in” obvious blank places in the maps. In some cases where egg and larval survey data were lacking, new maps were generated if the juveniles and adults of that species were used as “proxies” for eggs or larvae. Also, for some species, EFH for more than one life stage was shown on the same map. This was usually done because there was insufficient survey information available for a particular life stage and so distributional data for a different life stage was used as a “proxy” for the life stage in question.

Potential EFH designations were developed for most of the 28 species managed by the Council using the data and methods described above. For some species and life stages, however, that are infrequently caught in the trawl surveys or that occupy habitat beyond the range of the surveys, different designation methods were used. These species were Atlantic salmon, Atlantic deep-sea red crab, Atlantic halibut, Atlantic wolffish, offshore hake, and ocean pout and the eggs of winter flounder and Atlantic herring. Updated information on prey and on spawning times and locations for all the managed species was included in Appendix B and on the potential impacts of a variety of non-fishing activities and global effects (e.g., climate change) on managed species and their habitat in the region in Appendix G.

1.2.1.2 HAPC designations

This amendment also includes a number of alternatives to designate habitat areas of particular concern, or HAPCs. Designation of HAPCs is intended to indicate which areas within EFH should receive more of the Council's and NMFS' attention when providing comments on Federal and state actions, and in establishing higher standards to protect and/or restore such habitat. The EFH Final Rule (50 CFR 600.815(8)) states that “FMPs should identify specific habitat types or areas within EFH as habitat areas of particular concern based on one or more of the following considerations:”

- CRITERION 1A: Importance of *Historic* Ecological Function
- CRITERION 1B: Importance of *Current* Ecological Function

- CRITERION 2: Sensitivity to Anthropogenic Stresses
- CRITERION 3: Extent of Current or Future Development Stresses
- CRITERION 4: Rarity of the Habitat Type

An area's status as a HAPC should lead to more careful evaluations of the impacts of fishing in that area. However, management measures such as gear restrictions have not been associated with the HAPC designation itself in the past, and are not proposed as part of the HAPC designations in this amendment. However, there are currently cases where HAPCs and a habitat/EFH closure area overlap, such as the status quo juvenile cod HAPC on the northern edge of Georges Bank. As the HAPC designation and area closure/gear restriction regulation decisions are made separately, changing one of them does not affect the other one. For example, it might be appropriate to designate a larger area as an HAPC, and then restrict gear use in a smaller area within it because the smaller area is more practicable given the value of the area to certain fisheries. Alternatively, there may be HAPCs for which non-fishing impacts are the primary concern, such that management measures intended to reduce fishing impacts would be neither appropriate nor particularly beneficial.

The Atlantic Salmon HAPC and the Northern Edge Cod HAPC are currently in place. Between December 2004 and March 2005, the Council solicited HAPC proposals from the public for HAPCs that (in no particular order):

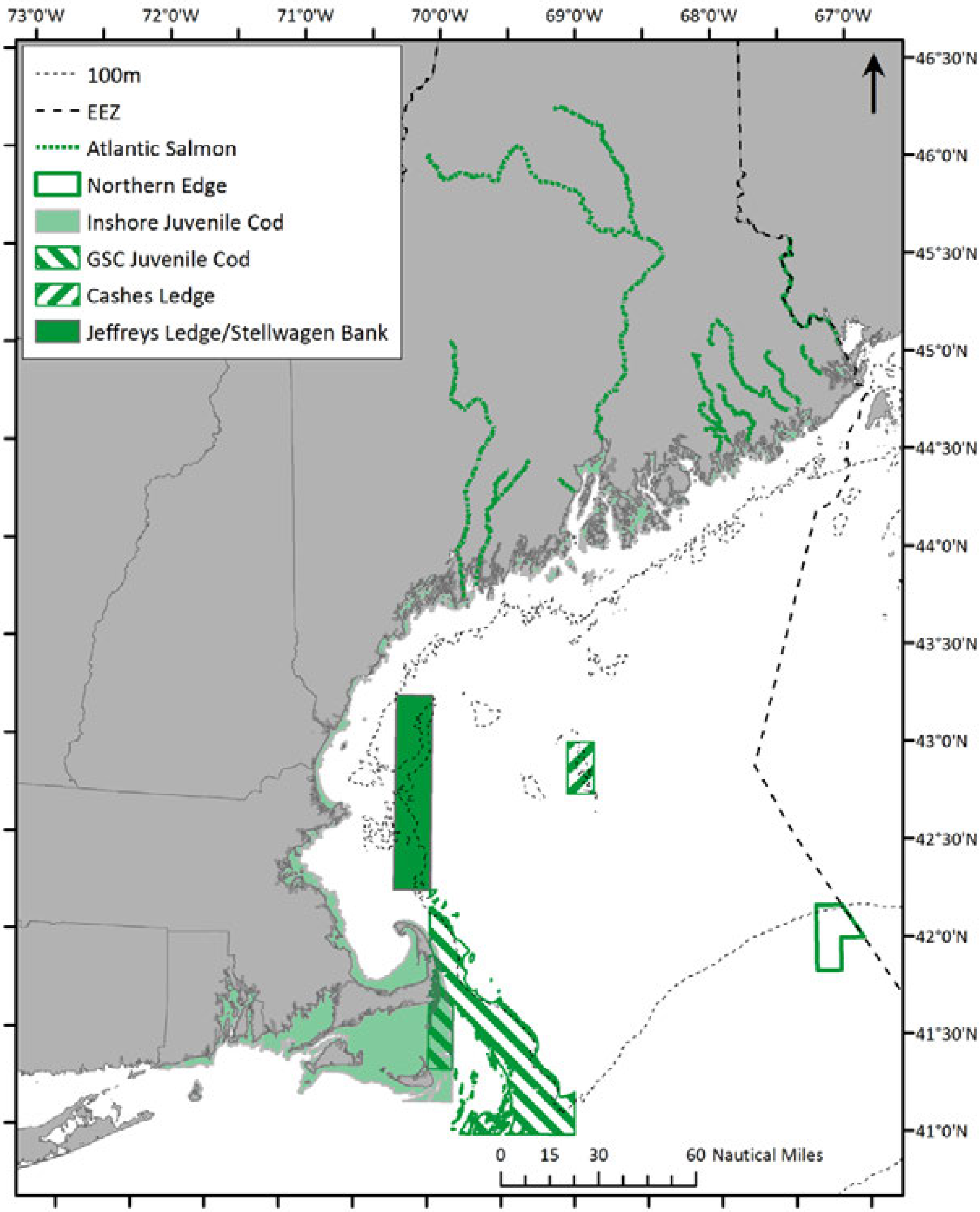
- Will improve the fisheries management in the EEZ;
- Include EFH designations for more than one Council-managed species in order to maximize the benefit of the designations;
- Include juvenile cod EFH; and
- Meet more than one of the EFH Final Rule HAPC criteria.

The HAPCs approved by the Council during Phase 1 (2007) include the following. Because some of these areas as originally identified exceeded the depth of the proposed EFH designations, the boundaries of various seamount and canyon HAPCs were subsequently limited according to the depth of the Council's preferred EFH designation alternatives. A series of maps showing the various HAPCs are provided below.

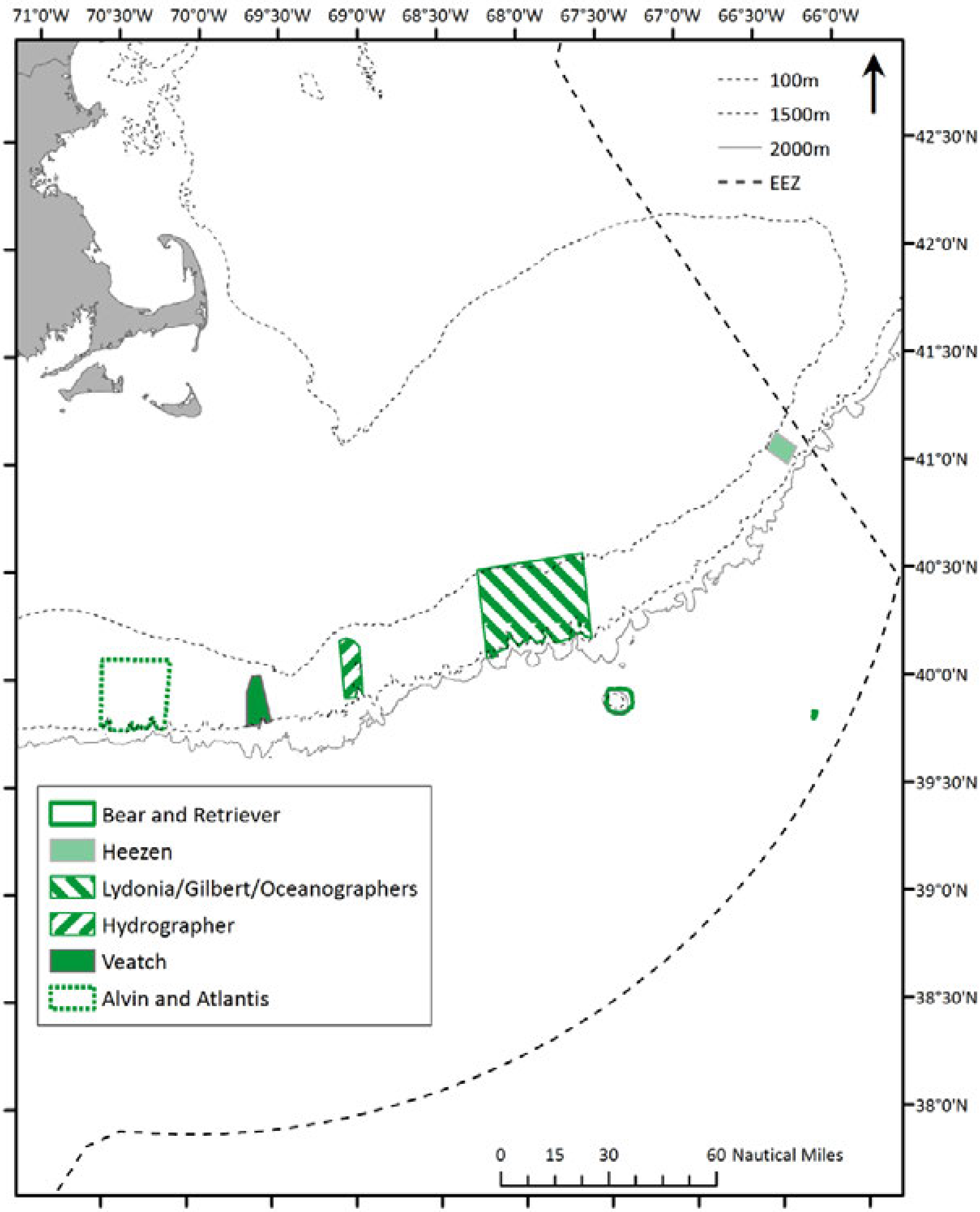
- Inshore Juvenile Cod HAPC
- Great South Channel Juvenile Cod HAPC
- Cashes Ledge HAPC
- Jeffreys Ledge/Stellwagen Bank HAPC
- Bear and Retriever Seamounts HAPC
- Heezen Canyon HAPC
- Lydonia/Gilbert/Oceanographers Canyons HAPC
- Hydrographer Canyon HAPC
- Veatch Canyon HAPC
- Alvin/Atlantis Canyon HAPC
- Hudson Canyon HAPC
- Toms, Middle Toms, and Hendrickson Canyon HAPC

- Wilmington Canyon HAPC
- Baltimore Canyon HAPC
- Washington Canyon HAPC
- Norfolk Canyon HAPC

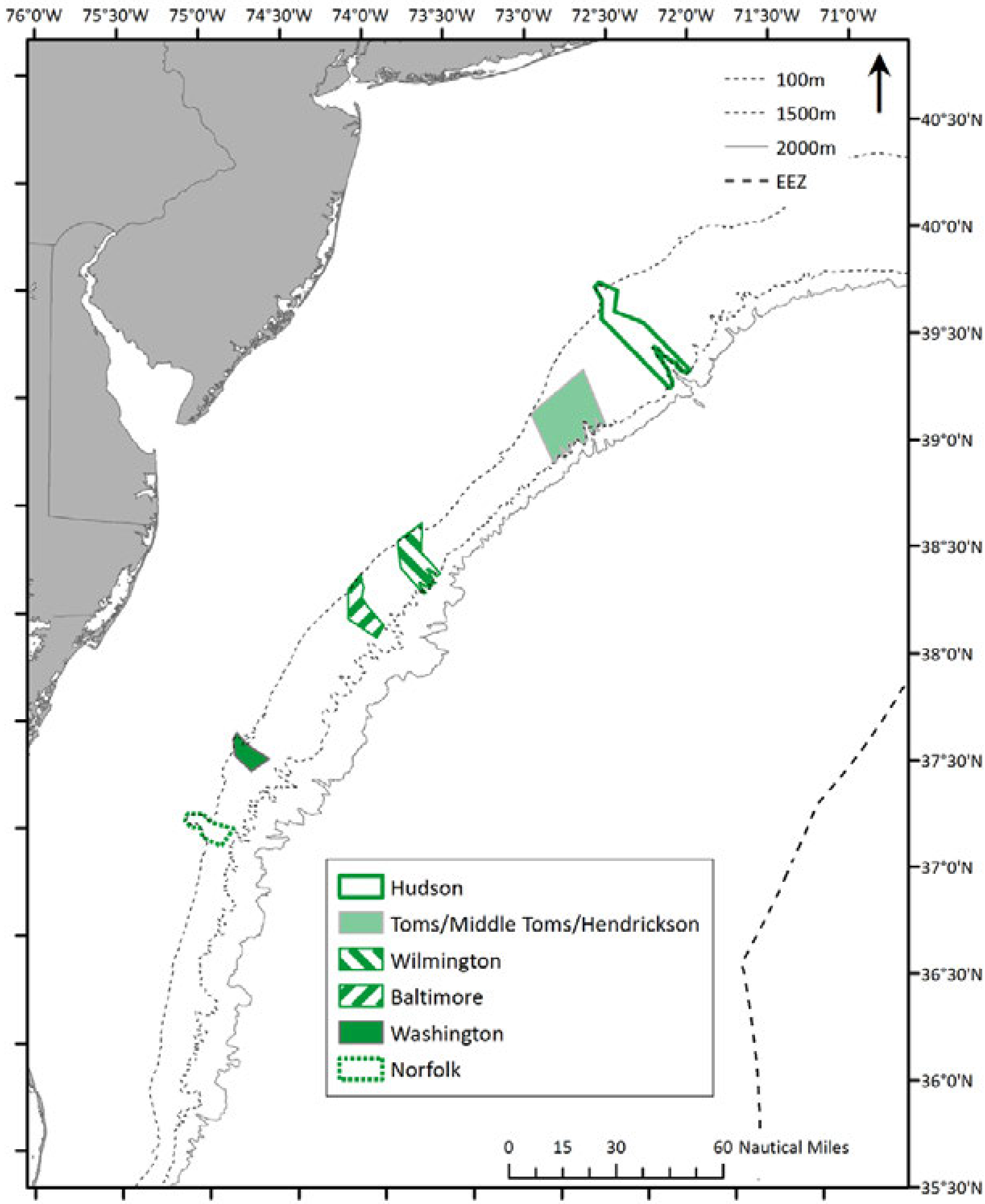
Map 1 – Continental shelf habitat areas of particular concern



Map 2 – New England region seamount and canyon habitat areas of particular concern



Map 3 – Mid-Atlantic region canyon habitat areas of particular concern



1.2.2 Spatial management alternatives

The alternatives related to habitat management, spawning protection, and research areas are described and analyzed in Volume 3. The habitat management and spawning protection alternatives consist of sub-regional (habitat) or regional (spawning) combinations of current areas, modified versions of current areas, or newly identified areas. The alternatives were developed to address either adverse effects minimization, including more focused objectives related to juvenile groundfish habitat protection, or spawning protection objectives, respectively. Fishing restriction measures vary by area and alternative type, and in some cases there are multiple options for fishing restrictions that the Council may identify as preferred for a particular area. An alternative to refine and update the approach taken with framework adjustments of these types of measures, as well as suggested monitoring approaches, is also described and analyzed in Volume 3. To date, preferred alternatives have been identified in most categories, with the exception of habitat management areas in the Georges Bank and Great South Channel/Southern New England sub-regions.

1.2.2.1 Habitat Management Areas

The underlying premise of this amendment is that there are habitats linked to higher survival and/or growth rates of juvenile fish which are vulnerable to the adverse effects of fishing. By protecting these habitats, recruitment rates will increase. By increasing recruitment rates, the productivity of managed species with life stages that rely on those vulnerable habitats will increase.

Some candidate habitat management areas were identified through the Habitat Plan Development Team and Habitat Committee, based on the results of the Swept Area Seabed Impact (SASI) analyses[1] and related extra-SASI information including sources of substrate data not included in SASI and bathymetric data. The primary goal addressed with these areas was to minimize the adverse effects of fishing on vulnerable seabed habitats, across all areas managed by the Council. Additional areas were later identified by the Closed Area Technical Team and Groundfish Committee, based on an analysis of juvenile groundfish distributions[2], combined with information about the current status of various stocks and their affinities for vulnerable habitat types. The primary goal addressed with these areas was to improve groundfish productivity, specifically by protecting habitats used by juvenile life stages and thereby increasing recruitment to exploited groundfish stocks.

The Habitat Plan Development Team areas were originally based on the output of an analysis run on the SASI results to identify areas with that were more vulnerable to the adverse effects of bottom trawls and scallop dredges. The Habitat PDT then removed these summary layer results and focused on identifying potential management areas that encompassed the majority of the highly vulnerable substrate, without overextending into less vulnerable habitat. The Habitat PDT and Committee refined these areas over the course of three years, resulting in highly focused areas, intended to minimize impacts on highly vulnerable habitat with minimal impact to the fishing industry.

[1] See the habitat vulnerability section of this volume as well as Appendix D for details.
[2] See the groundfish hotspot analysis section of this volume as well as Appendix E for details.

In order to identify develop the juvenile groundfish-oriented HMAs where habitat protections would be most likely to increase groundfish productivity, the Closed Area Technical Team analyzed data from a number of fishery-independent trawl and dredge surveys and identified juvenile groundfish hotspots by season. The hotspots were then weighted by species and stocks using the following four factors and, for each season, the number in each 100 km2 grid cell was summed:

- Stock biomass that is required to achieve maximum sustainable yield in the fishery compared to current biomass (a measure of stock status or the extent of overfishing), expressed as B_{MSY}/B (i.e., stock vulnerability),
- Whether or not the stock has known or possible spawning sub-populations which are more susceptible to place-based over-exploitation.
- Whether the stock is more resident (as compared to more migratory).
- The affinity of the species for complex hard-bottom substrates which are more vulnerable to disturbance by fishing.

Stocks that do not have a strong affinity for coarse substrates were zeroed out of the weighted grids, such that the locations of the juvenile groundfish-oriented HMAs were based on the distribution of the following stocks only: Georges Bank cod, Gulf of Maine cod, Georges Bank haddock, Gulf of Maine haddock, pollock, Acadian redfish, Atlantic halibut, ocean pout, and Atlantic wolffish. The hotspot weighting procedure is described fully in Volume 1.

The first step in identifying candidate management areas was to find contiguous areas with numerous hotspots in each of the seasonal weighted hotspot data layers. The result was a set of rough management area boundaries for each season. The seasonal boundaries were then compared to identify areas important to juvenile groundfish across multiple seasons. The seasonal boundaries were also overlaid on the habitat vulnerability layer from the SASI model. Both the weighted hotspot and SASI grids were generated at the same 100 km^2 resolution to facilitate comparison of the two datasets. The final candidate management areas were locations with a contiguous grouping of hotspots across one or more seasons, with relatively high vulnerability values. As a last step, the candidate management areas were limited to areas in Federal waters.

Regardless of the origin of a particular area (SASI or SASI and hotspot analyses), the merged sets of areas in each alternative are intended, collectively, to comply with the requirement of the MSA to minimize the adverse effects of fishing on essential fish habitats:

> *"Fishery Management Plans must describe and identify essential fish habitat for the fishery based on the guidelines established by the Secretary under section 305(b)(1)(A), minimize to the extent practicable adverse effects on such habitat caused by fishing, and identify other actions to encourage the conservation and enhancement of such habitat" (Magnuson-Stevens Fishery Conservation and Management Act, As Amended Through January 12, 2007)*

The Secretarial EFH guidelines (67 FR 2343, January 17, 2002) define an 'adverse effect' as any impact that reduces the quality and/or quantity of essential fish habitat, but only requires that actions be taken to prevent, mitigate, or minimize adverse effects from fishing, if they are both 'more than minimal' and 'not temporary'. However, determinations about what exactly is meant by minimal and temporary, and about what management measures are practicable, are left to the Council's discretion.

All of the habitat management areas would be implemented on an indefinite, year-round basis, and the fishing restriction measures focus, primarily, on minimizing impacts associated with mobile bottom-tending gears. A sub-regional organization was used to facilitate discussion, analysis, and decision making. The five sub-regions are the Eastern, Central, and Western Gulf of Maine, Georges Bank, and the Great South Channel/southern New England area. Each sub-region has a unique mix of habitat types, stocks, and fisheries. Grouping management areas into alternatives at a larger spatial scale (Gulf of Maine vs. Georges Bank/Southern New England, or the full jurisdiction of the New England Council) was thought to be less practical for discussing trade-offs and local considerations.

Alternative 1 for each sub-region (the No Action alternative) consists of mobile-bottom tending gear closures first identified in Northeast Multispecies Amendment 13 (effective as of May 1, 2004) as well as the year-round groundfish closures, which were implemented at various times and for various purposes, but often restrict mobile bottom-tending gears and provide some of the same benefits in terms of minimizing adverse effects on EFH, at least within areas not currently fished.

Alternative 2 for each sub-region is a "no closure" alternative. This means no year-round habitat management areas; however, Alternative 2 does not preclude seasonal closures for spawning, or year-round management areas employed for other purposes (e.g., research). In the Eastern Gulf of Maine sub-region, where there are no current closed areas, the No Action and no closure alternatives are the same and are combined for the purpose of analysis.

Alternatives 3-8 for each sub-region (2-3 for Eastern Gulf of Maine) consist of combinations of new or modified habitat management areas. In some cases, different alternatives in a sub-region include smaller and larger versions of an area. These are named "Small XX HMA and "Large XX HMA" to distinguish between them; the associated maps clarify which area is included in a given alternative. The areas included in each alternative are summarized in Table 2. Sub-regional maps of habitat management alternatives are provided below the table.

With the exception of the Ammen Rock area, which is proposed as a closure to all fishing with the exception of lobster trapping, management measures for each area can generally be selected from the following five options. Different measures could be selected in each area. Information about what constitutes a mobile bottom-tending gear, or a gear capable of catching groundfish, is discussed later in this introduction.

- Option 1, complete restrictions on use of mobile bottom-tending gears, <u>or</u>
- Option 2, restrictions on the use of mobile bottom-tending gear with an exemption for hydraulic clam dredges, <u>or</u>

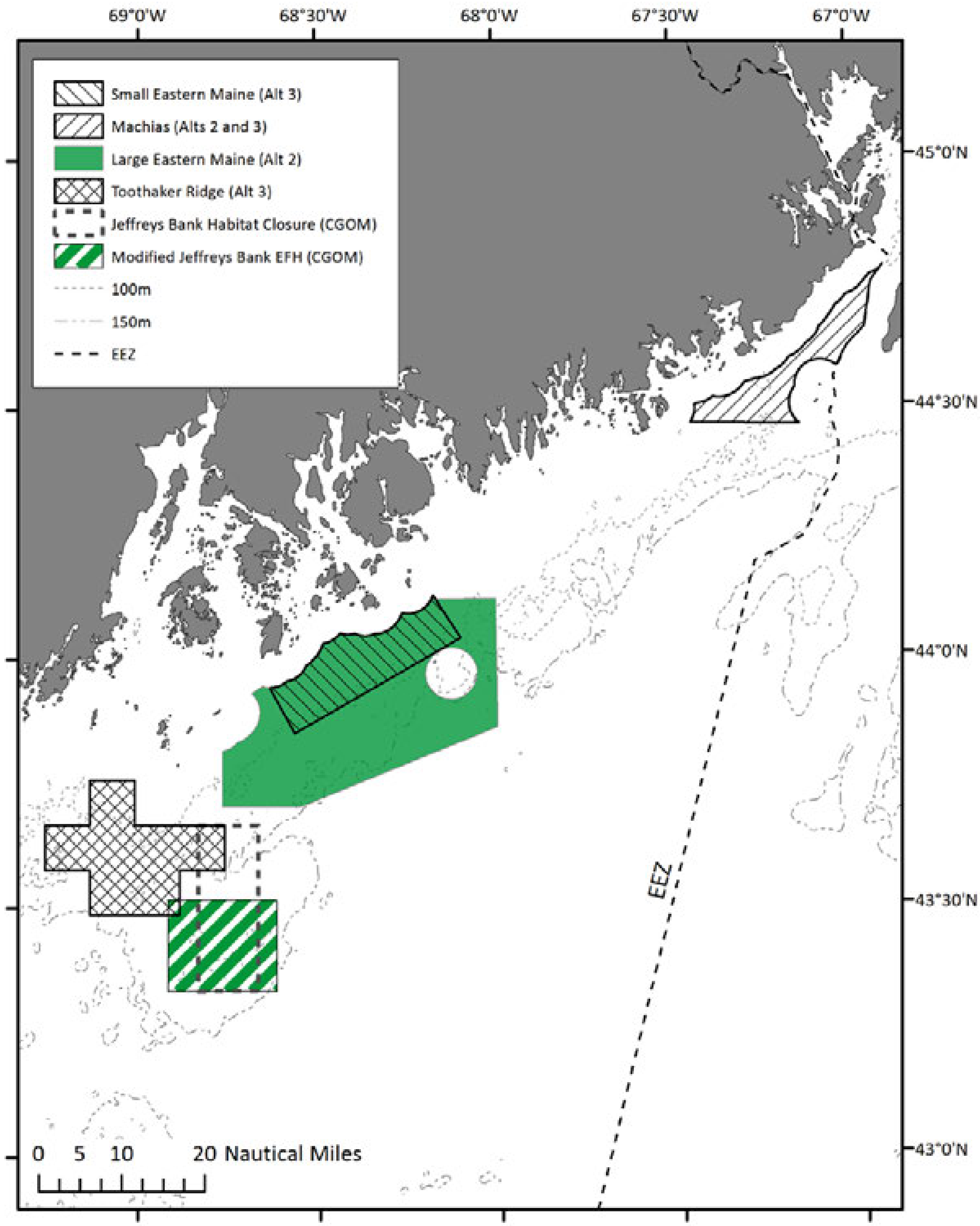
- Option 3, a requirement that bottom trawl vessels use ground cables modified with 20 centimeter diameter elevating disks spaced at 5 fathoms, with a length per side capped at 45 fathoms. Use of dredges would be permitted, or
- Option 4, a requirement that bottom trawl vessels eliminate ground cables entirely and cap bridle lengths at 30 fathoms per side. Use of dredges would be permitted.
- Option 5, complete restriction on gears capable of catching groundfish.

Table 2 – Summary of areas included in the various habitat management alternatives

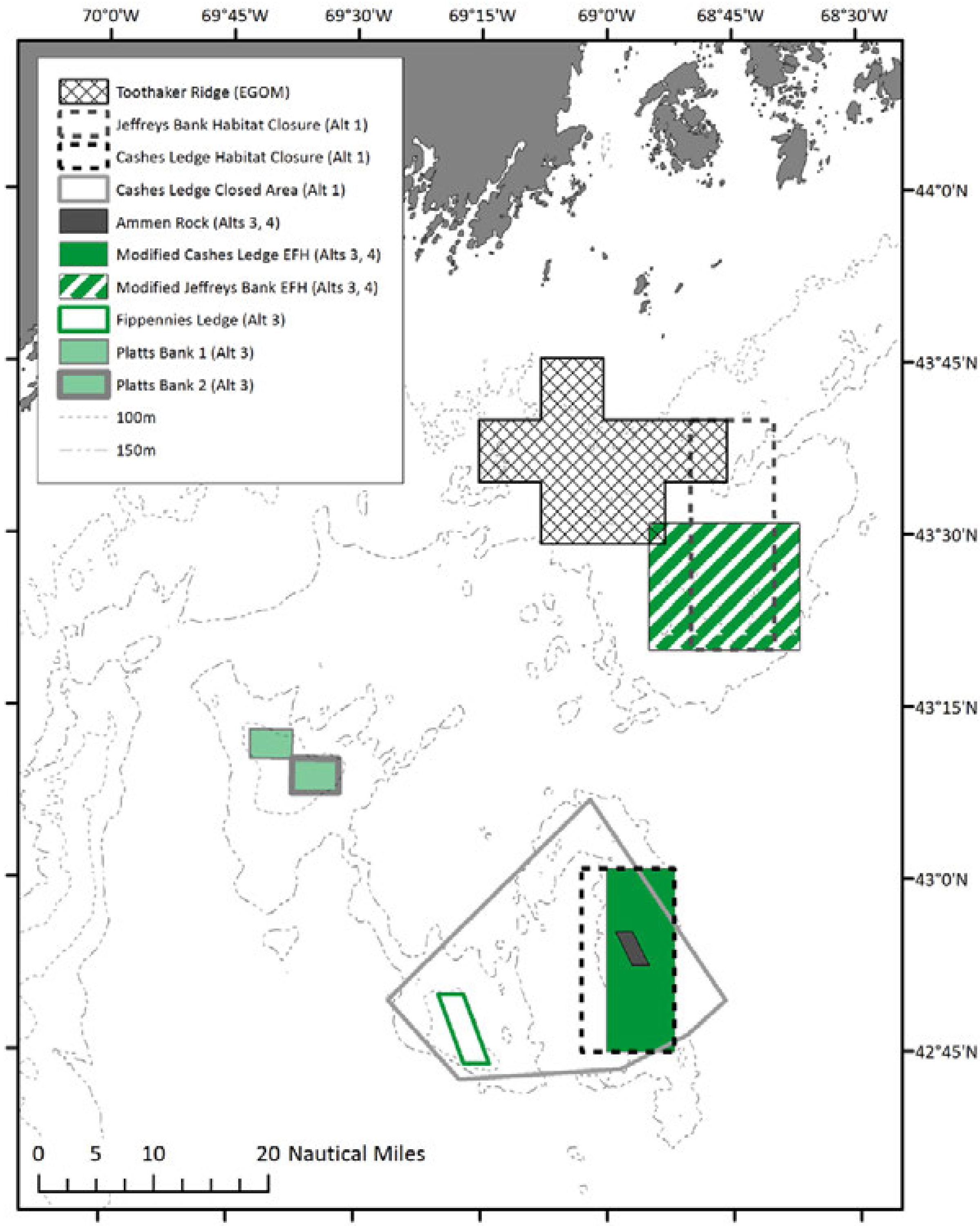
Sub-region	Alternative	Areas included	Fishing restriction options
Eastern Gulf of Maine	1 (No Action, no closure)	None	n/a
	2	Large Eastern Maine HMA, Machias HMA	1-5
	3	Small Eastern Maine HMA, Machias HMA, Toothaker Ridge HMA	1-4
Central Gulf of Maine	1 (No Action)	Jeffreys Bank Habitat Closure Area, Cashes Ledge Habitat Closure Area, Cashes Ledge Closed Area	Current measures
	2 (no closure)	None	n/a
	3	Modified Jeffreys Bank HMA, Modified Cashes Ledge HMA, Ammen Rock HMA, Fippennies Ledge HMA, Platts Bank HMA	1-4, Ammen Rock closed to all fishing
	4	Modified Jeffreys Bank HMA, Modified Cashes Ledge HMA, Ammen Rock HMA	1-4, Ammen Rock closed to all fishing
Western Gulf of Maine	1 (No Action)	Western Gulf of Maine Habitat Closure Area, Western Gulf of Maine Closed Area	Current measures
	2 (no closure)	None	n/a
	3	Large Bigelow Bight HMA, Large Stellwagen HMA	1-4
	4	Large Bigelow Bight HMA, Small Stellwagen HMA, Jeffreys Ledge HMA	1-4
	5	Small Bigelow Bight HMA, Small Stellwagen HMA, Jeffreys Ledge HMA	1-4
	6	Large Stellwagen HMA	1-4
	7a	Inshore Roller Gear Restricted Area	Trawl roller gear limited to 12 inches diameter
	7b	Alternate Roller Gear Restricted Area	Trawl roller gear limited to 12 inches diameter
	8	WGOM Shrimp Trawl Exemption Area	Shrimp trawls exempted from mobile bottom-tending gear closure
Georges Bank	1 (No Action)	CAI and CAII EFH, CAI and CAII GF	Current measures
	2 (no closure)	None	n/a
	3	Northern Edge HMA	1-4
	4	Northern Edge HMA and Georges Shoal Gear Modified Area	NE: 1-4, GS: 3-4

Sub-region	Alternative	Areas included	Fishing restriction options
	5	Georges Shoal 1 MBTG HMA and Northern Georges Gear Modified Area	GS: 1-2, NG: 3-4
	6a	EFH Expanded 1 HMA	1-4
	6b	EFH Expanded 2 HMA	1-4
	7	Georges Shoal 2 MBTG HMA and EFH South MBTG HMA	1-2
	8	Northern Georges MBTG HMA	1-2
Great South Channel/Southern New England	1 (No Action)	Nantucket Lightship Habitat Closure Area, Nantucket Lightship Closed Area	Current measures
	2 (no closure)	None	n/a
	3	Great South Channel East HMA and Cox Ledge HMA	1-4
	4	Great South Channel HMA and Cox Ledge HMA	1-4
	5	Nantucket Shoals HMA and Cox Ledge HMA	1-4
	6	Nantucket Shoals West MBTG HMA, Great South Channel Gear Modified Area, Cox Ledge HMA	NSW: 1-2, GSC: 3-4, CL: 1-4

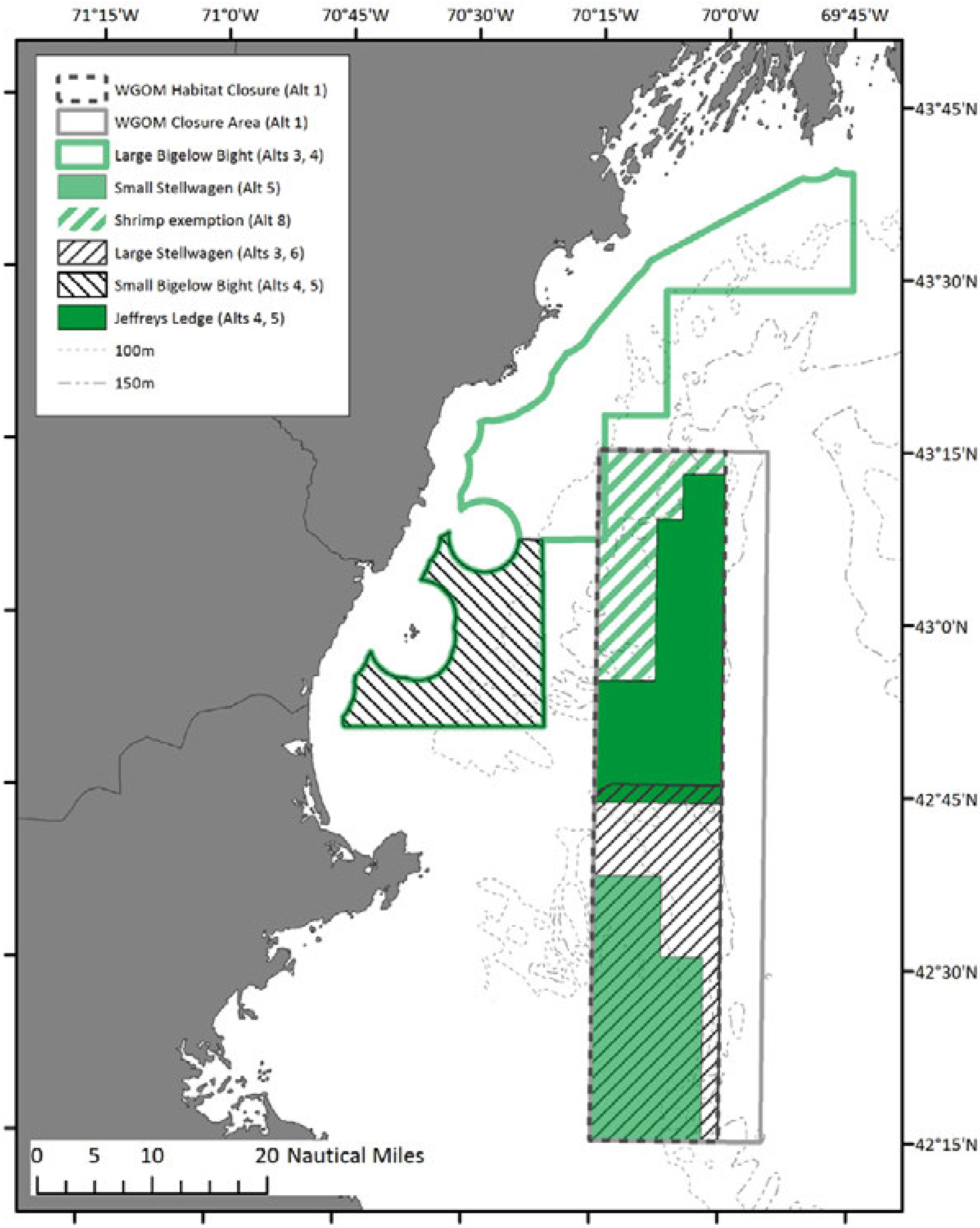
Map 4 – Eastern Gulf of Maine habitat management areas and alternatives. Although not grouped in this sub-region, the Jeffreys Bank areas are shown since they overlap with the Toothaker Ridge area.



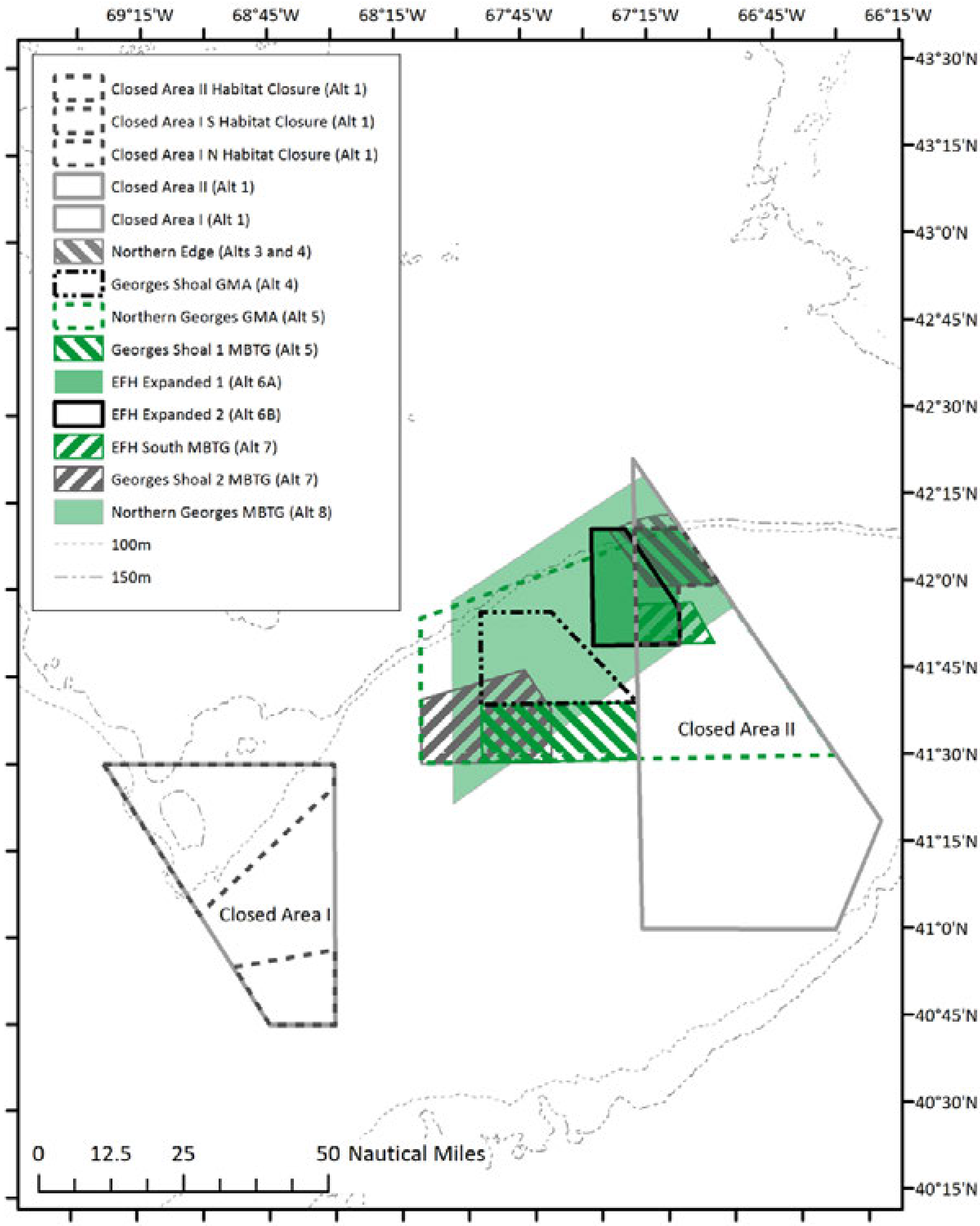
Map 5 – Central Gulf of Maine habitat management areas and alternatives. Although not grouped in this sub-region, the Toothaker Ridge area is shown since they overlap with the Jeffreys Bank areas.



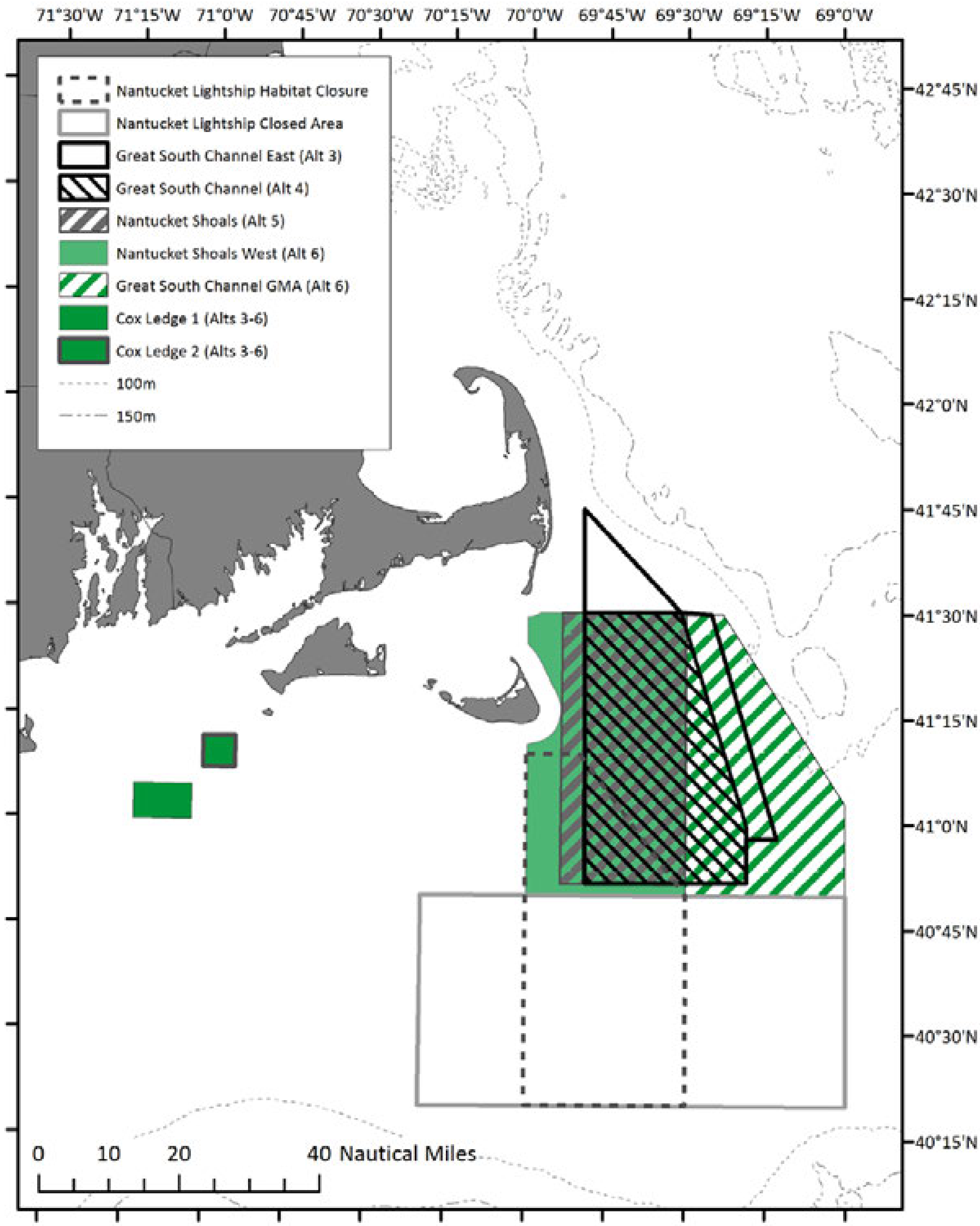
Map 6 – Western Gulf of Maine habitat management areas and alternatives.



Map 7 – Georges Bank habitat management areas and alternatives.



Map 8 – Great South Channel/Southern New England habitat management areas and alternatives.



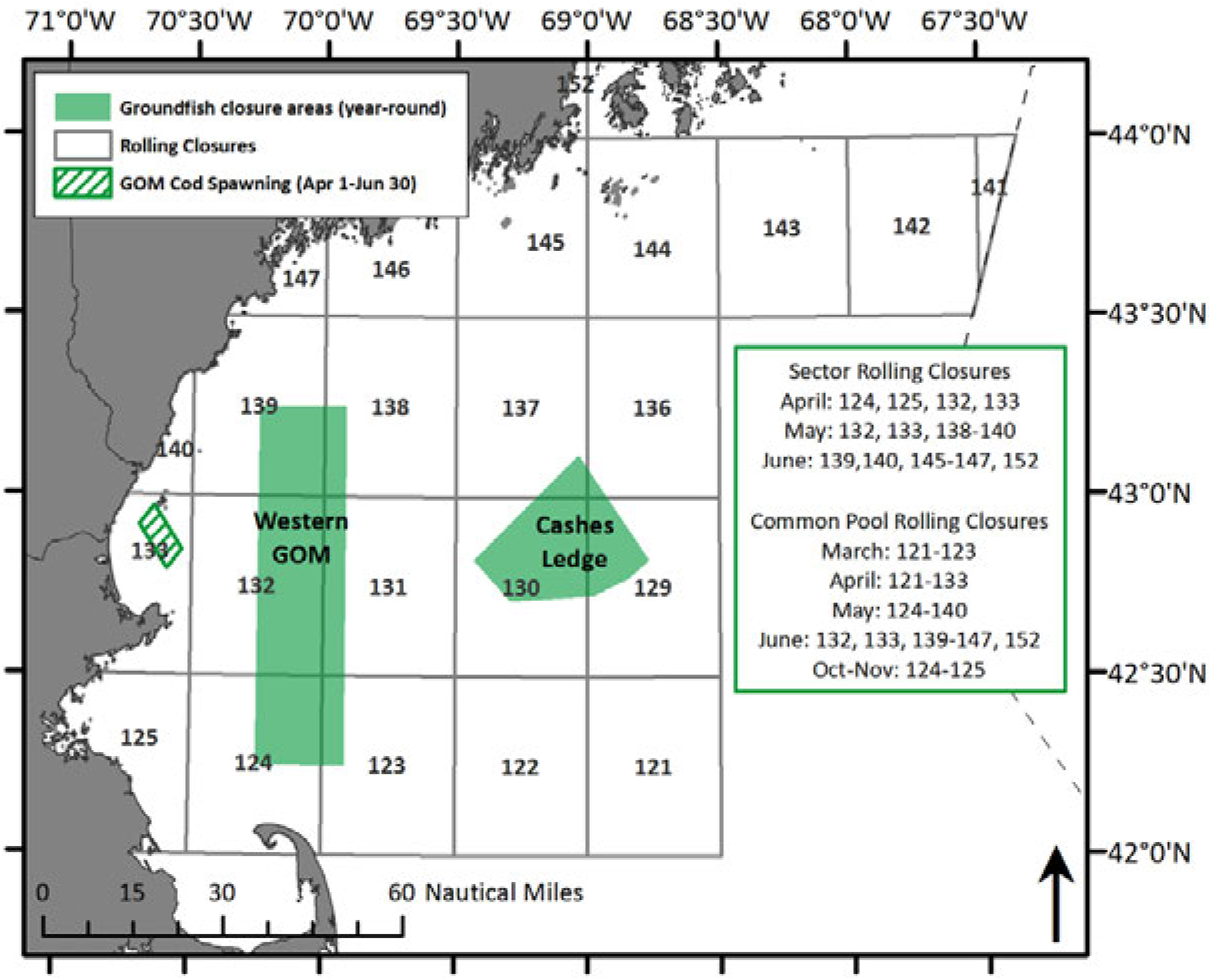
1.2.2.2 Spawning management areas

The spawning management alternatives are designed to improve groundfish spawning protection; including protection of localized spawning contingents or sub-populations of stocks, and improve access to both the use and non-use benefits arising from closed area management across gear types, fisheries, and groups. These objectives reflect the Council's intent to shift the focus of groundfish area management designations based on mortality reduction to those based on protection of specific attributes that contribute to stock productivity, such as spawning.

All of the action alternative spawning protection areas would be defined on a seasonal basis, and the measures focus on limiting the use of gears that are capable of catching groundfish within these areas during the closed seasons, with possible exemptions for recreational groundfish fishing or other fisheries. The no action areas are part of the Northeast Multispecies FMP, and any new areas or adjustments to the prohibited gear types or closed seasons in existing areas would also be changed in the Northeast Multispecies FMP and its corresponding regulations. Adjustment of these measures would be accomplished via an amendment or framework adjustment (as appropriate) to that FMP.

There are three alternatives in the Gulf of Maine. Alternative 1/No Action would retain (1) the Western Gulf of Maine Closure Area and the Cashes Ledge Closure Area, (2) the Gulf of Maine Rolling Closures Areas that apply to sector and common pool vessels, and (3) the Gulf of Maine Cod Spawning Protection Area, commonly referred to as the 'Whaleback' area.

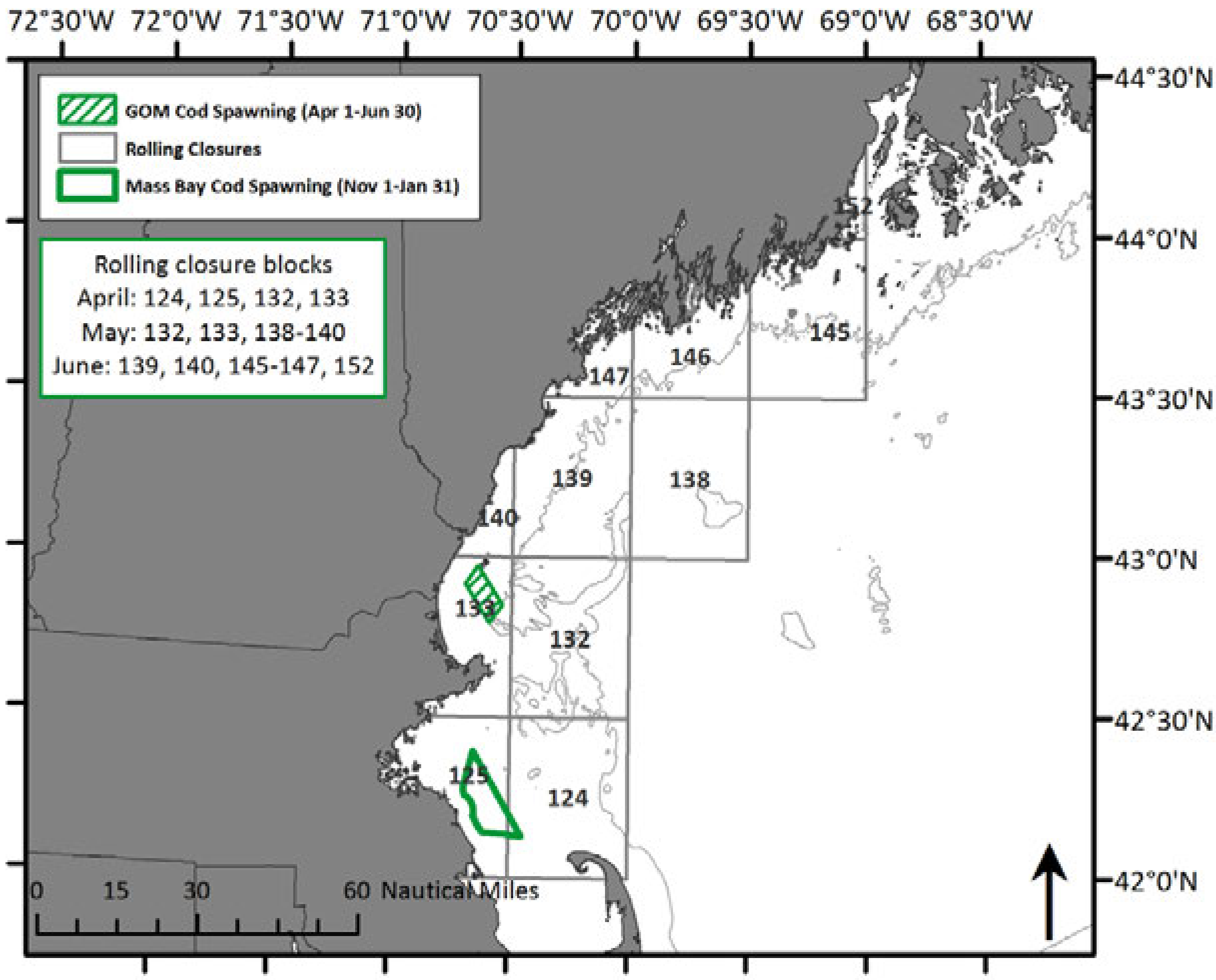
Map 9 – Gulf of Maine Spawning Alternative 1/No Action.



Alternative 2 would maintain the existing rolling closures that currently apply to sector enrolled vessels during April, May, and June for groundfish spawning protection purposes. These closed areas would apply from April to June to all vessels capable of catching groundfish, whether the vessel is in the common pool or enrolled in a sector, with possible exemptions. Alternative 2 Option A would restrict commercial gears only from the rolling closures, and Option B would restrict commercial and recreational gears. Alternative 2 would also designate the Massachusetts Bay Cod Spawning Protection Area, which would be closed from November 1 through January 31 with the same restrictions as the Gulf of Maine Cod Spawning Protection (Whaleback) Area. Under this alternative, the March-June common pool rolling closures would be eliminated. The Western Gulf of Maine and the Cashes Ledge Closure Areas would also be eliminated unless maintained for habitat protection purposes. The Gulf of Maine Cod Spawning Protection (Whaleback) Area would be maintained as is.

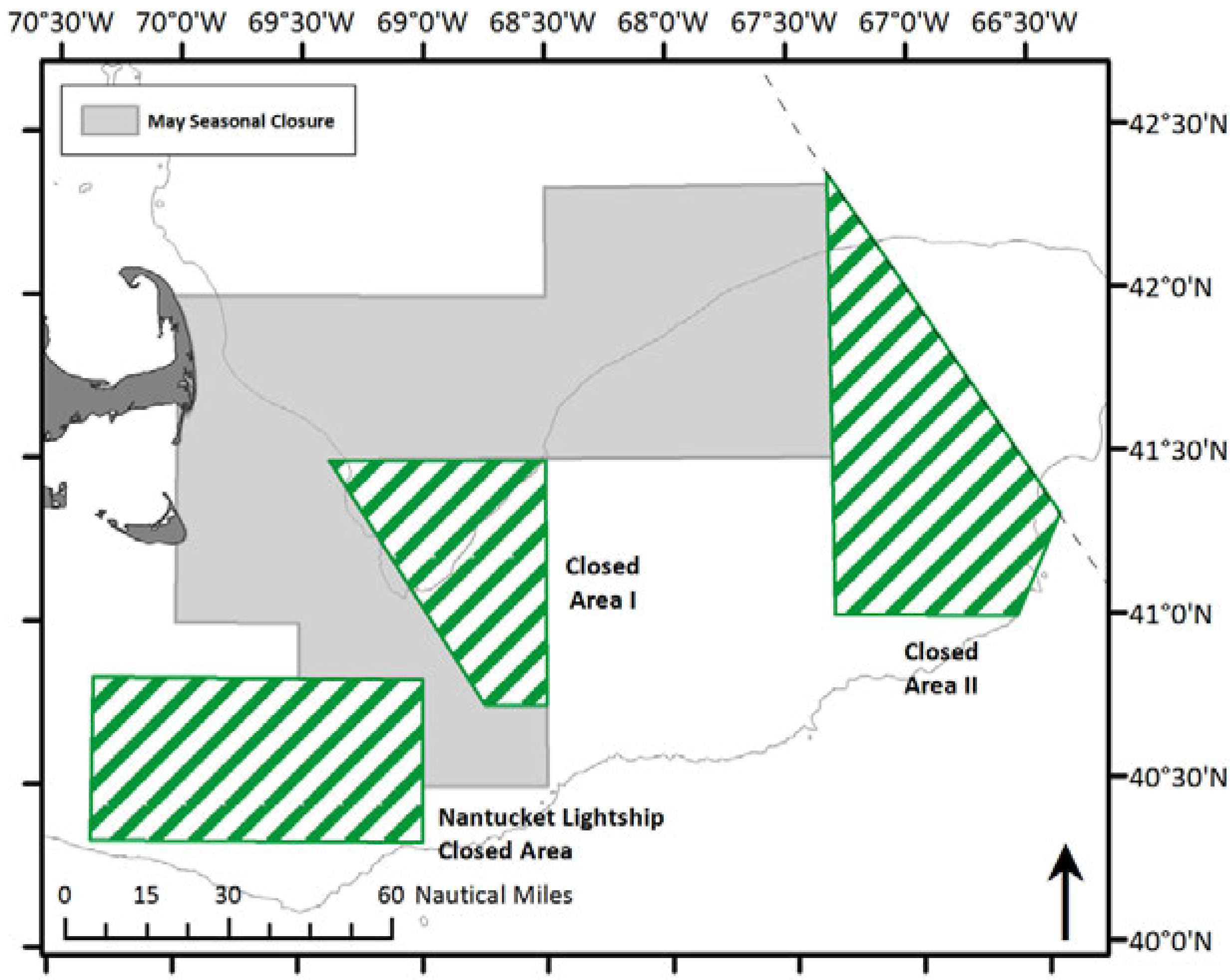
Alternative 3 would designate the Massachusetts Bay Spawning Protection Area as described under Alternative 2A/2B. The Council's intent was that this designation could be combined with Alternative 1/No Action.

Map 10 – Gulf of Maine Spawning Alternative 2. The Massachusetts Bay area only comprises Alternative 3.



There are three alternatives for Georges Bank/Southern New England. Alternative 1/No Action would retain the existing year round closed areas on Georges Bank and in southern New England, specifically Closed Area I, Closed Area II, the Nantucket Lightship Closed Area, and the Georges Bank Seasonal Closure Area which is in place during May.

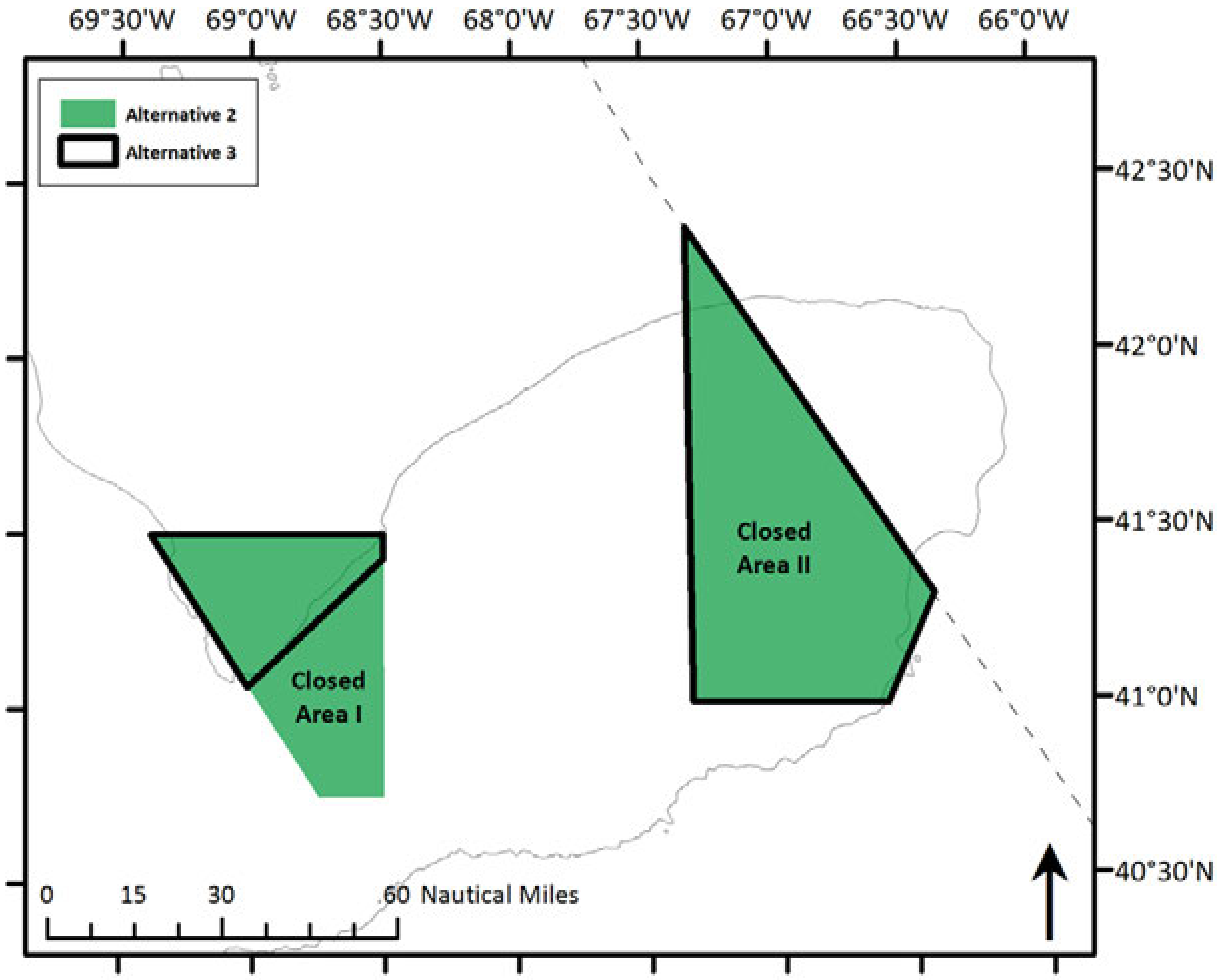
Map 11 – Georges Bank/Southern New England Spawning Alternative 1/No Action.



Alternative 2 would retain as spawning closures Closed Area I and Closed Area II during the months of February, March, and the first half of April. The Nantucket Lightship Closed Area and the Georges Bank Seasonal Closure Area would be eliminated. Two options consider closures to just commercial gears (Option A) or commercial and recreational gears (Option B). Option C contemplates an exemption for sea scallop dredges.

Alternatives 3A, 3B, and 3C are the same as Alternatives 2A, 2Band 2C, except that they would retain only the northern part of Closed Area I, not the entire area.

Map 12 – Georges Bank/Southern New England Spawning Alternatives 2 and 3.



1.2.2.3 Dedicated Habitat Research Areas

One goal of this amendment is to minimize to the extent practicable the adverse effects of fishing on essential fish habitat. In order to better inform managers about trade-offs associated with minimization of adverse effects, the Habitat PDT developed the Swept Area Seabed Impact (SASI) approach, including a spatial model combining habitat maps, habitat vulnerability estimates, and fishing effort data. This approach was intended to aid in identifying areas throughout the region that are most vulnerable to each type of commercial fishing gear. While a clear step beyond previous efforts, the model rests on a set of general assumptions that are not necessarily equally applicable in all habitats and in all sub-regions. There is a need to test these assumptions and to improve the utility of the model with empirical studies from across the region. Further, there is a critical need to improve our understanding of the linkages between habitat and the productivity of managed species (and their prey) in order to better target management and conservation actions.

One approach to address information needs is to designate Dedicated Habitat Research Areas (DHRAs) in concert with Habitat Management Areas. These DHRAs would be the focus of research activities to provide information to managers, improve understanding of the ecological effects of fishing across a range of habitats, and ultimately improve model forecasts and inform future habitat management. An important aspect about DHRAs is that they would allow coordinated research and build upon past studies and baselines. The current ad hoc nature of fish habitat and gear effects research has minimized potential synergies and potentially reduced the amount of information of use to managers.

The Council identified a set of priority research questions that the DHRAs should address. The questions are based on four broad focus areas: gear impacts, habitat recovery, natural disturbance, and productivity.

- How do different types of bottom tending fishing gear (e.g., trawl nets, dredges, hook and line, traps, gillnets, longlines) affect the susceptibility and recovery of physical and biological characteristics of seabed habitat, and how do these impacts collectively influence key elements of habitat including spatial complexity, functional groups, community state, and recovery rates and dynamics?
- Are our estimates of gear contact with the bottom accurate? Can we develop trawl gear that minimizes contact on the bottom, thereby reducing the potential for gear impacts?
- What recovery models (e.g., successional vs. multiple-stable states) are operant in the region and how resilient are seafloor habitats to disturbance? In other words, how do seafloor habitats recover, and are there thresholds after which habitats have achieved an alternate state and are no longer capable of recovering to their previous undisturbed condition?
- Do "small" fishing-caused disturbances surrounded by unimpacted habitat recover more quickly and exhibit greater resilience in contrast to "large" fishing-caused disturbances embedded with small unimpacted patches?
- When a particular area is fished for the first time vs. subsequent efforts, are these impacts equal per unit effort? Or, is the first pass over an area much more detrimental? Conversely, is there a tipping point beyond which the habitat is no longer capable of recovering?
- In the absence of fishing, what are the dynamics of natural disturbance (e.g., major storm events) on seafloor habitat (especially biological components) across five major grain size classes (mud, sand, coarse sand-granule, pebble-cobble, boulder) and across oceanographic regimes? In areas where natural disturbance is high, are signals of the impacts of fishing masked?
- How does the productivity of managed species (and prey species) vary across habitat types nested within the range of oceanographic and regional settings? And how does this productivity change when habitats are impacted by fishing gear? Do durable mobile bottom tending gear closures increase fish production? Why are highly productive areas so productive?

It will be important for the Council to understand how the DHRAs are being used. Coordination and oversight will probably need to happen at the Council level on an ongoing basis, perhaps through the Council's Research Steering Committee or the Habitat Committee and Plan

Development Team. The Greater Atlantic Regional Fisheries Office will also be involved with coordination and oversight to determine where research treatment sites are located and to assure there are no conflicts that would bias results. Researchers may need to obtain letters of acknowledgement, exempted fishing permits, and/or letters of authorization (under the Marine Mammal Protection Act) before conducting research in a DHRA. Researchers should coordinate with the Regional Office prior to conducting research.

The structure of the alternatives in this document implies that DHRA designations would be considered as separate but overlapping management area designations, potentially with different restrictions on fishing activity than the habitat and/or spawning areas that they overlap with.

Currently there are no DHRAs designated in the region. Under Alternative 1/No Action, this would continue and DHRAs would not be designated as part of this amendment.

Alternative 2 would designate a Dedicated Habitat Research Area in the eastern Gulf of Maine. Measures for this area would be closure to all mobile bottom-tending gear on a year round basis. If the DHRA overlaps with a habitat management area with less restrictive measures (i.e., either the Large or Small Eastern Maine HMA), the DHRA measures would take precedence.

Alternative 3 would designate a Dedicated Habitat Research Area in the western Gulf of Maine. Measures for the entire area would be closure to mobile bottom-tending gear, sink gillnet gear, and demersal longline gear on a year round basis. Mid-water and pelagic gears would be permitted throughout. This alternative includes an optional reference area that would additionally be closed to recreational and party/charter groundfish fishing if selected. If the DHRA overlaps with a habitat management area with less restrictive measures, the DHRA measures would take precedence.

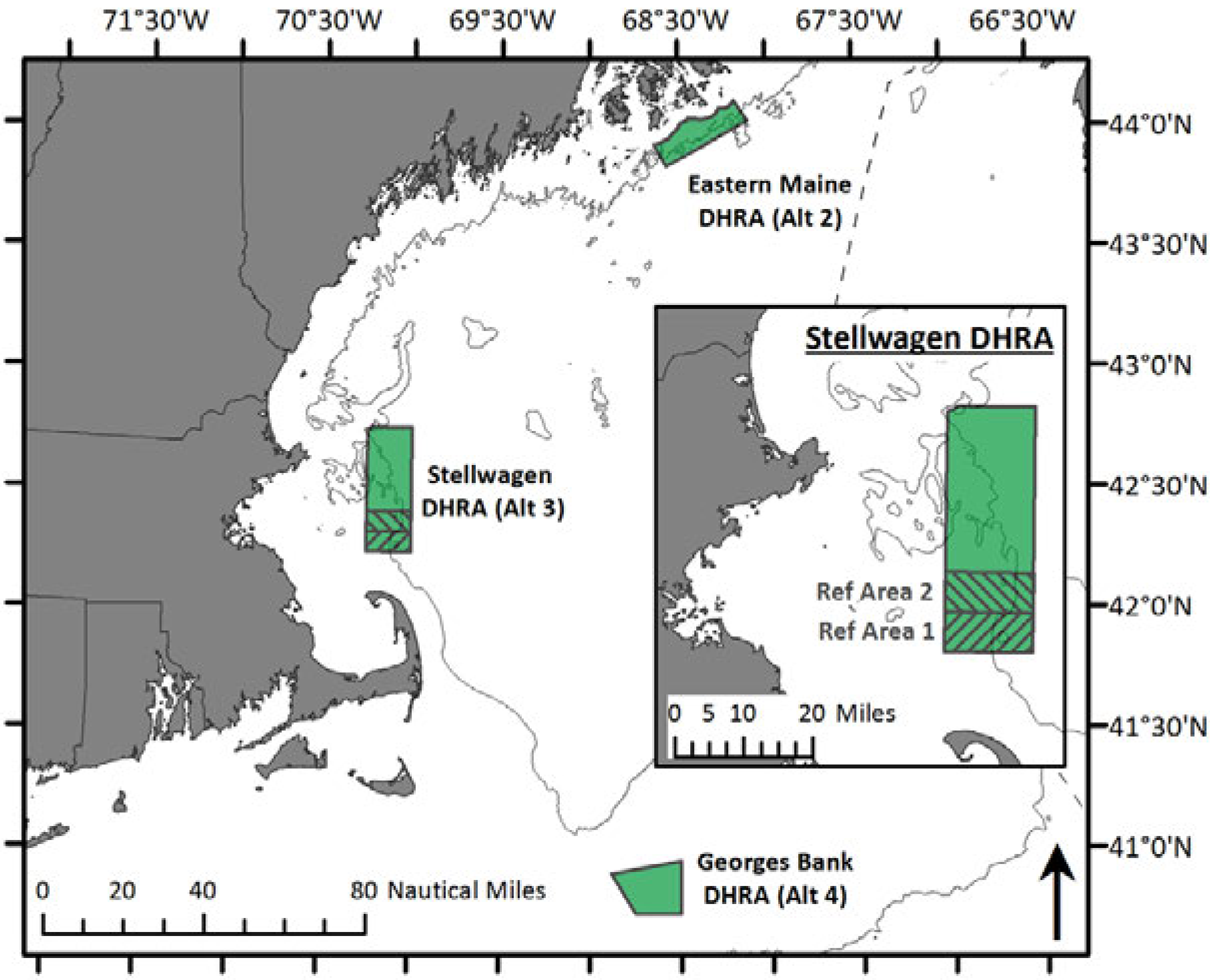
Alternative 4 would designate a Dedicated Habitat Research Area on Georges Bank. Measures for this area would be closure to all mobile bottom-tending gear on a year round basis (not including mobile bottom tending gear deployed by scientific research vessels conducting scientific research, outside of the authority of the Magnuson-Stevens Act. If the DHRA overlaps with a habitat management area with less restrictive measures, the DHRA measures would take precedence.

Finally, Alternative 5 would create a sunset provision for DHRAs that would allow administrative removal without further Council action three years after implementation, if no research that is designed to evaluate habitat effects of fishing had been initiated. This alternative would apply to all DHRAs designated via this action. Removal would be accomplished by NMFS via rulemaking or some kind of notice, and would be coordinated by the Greater Atlantic Regional Fisheries Office, in consultation with the Council. The following criteria must be met in order for the DHRA to continue after the three-year review:

- Documentation of active and ongoing research in the DHRA area, in the form of data records, cruise reports or inventory of samples with analytical objectives focused on DHRA topics outlined in Volume 3, Section 2.3.

- Documentation of pending or approved proposals or funding requests (including ship time requests) with objectives focused on DHRA topics.

Map 13 – Dedicated Habitat Research Area alternatives.



1.2.2.4 Framework adjustments and monitoring

There is extensive language in the fishery management plans developed by the Council and in their implementing regulations related to framework adjustments and measures that can be implemented or changed via framework adjustment. Generally speaking, the framework-related regulations document procedures for analyzing and implementing annual/biennial/triennial fishery specifications, but other measures are specifically identified in the regulations as candidates for implementation via framework (see details in Volume 3, Section 2.4). Specifically, the existing regulations allow the Council to initiate a framework adjustment to modify, add, or eliminate various management measures used to regulate the groundfish fishery, including area closures and gear restrictions.

The decision to initiate an area-management-oriented framework adjustment or amendment is currently made on an ad-hoc basis, responding to specific issues, and there is no schedule for evaluating or updating spatial management measures.

Currently, Council-specified research priorities related to spatial management are embedded within plan-by-plan research priority documents, which are updated periodically by Plan Development Teams, Oversight Committees, Advisory Panels, and the Scientific and Statistical Committee. Existing data collection from areas closed to fishing includes regular resource surveys by government vessels, ad hoc tagging programs and other research, and observed fishing trips surrounding closed areas.

Under Alternative 1/No Action, there would be no changes made to the lists of frameworkable items in the Council's FMPs, or to the procedures for reviewing the effectiveness of spatial management measures. No additional recommendations would be made regarding research priorities specifically intended to improve the development and evaluation of spatial management measures.

Alternative 2 includes three elements. First, it would specify that the designation or removal of habitat management areas and changes to fishing restrictions within habitat management areas are frameworkable in all FMPs.

Second, it would establish a review process to routinely evaluate the boundaries, scope, characteristics, and timing of habitat and spawning protection areas. The foundation of this process would be a technical review that evaluates the performance of habitat and spawning protection areas. This review will be completed at **10 year intervals** following implementation of area management measures proposed by this amendment. Based on this review, the Council may choose to initiate a framework adjustment to change spatial management measures. This review should consider but is not limited to the following questions:

<u>Habitat protection</u>

- Is juvenile abundance increasing in habitat management areas, compared with adjacent open fishing areas?
- Is overall stock-wide recruitment increasing due to better survival of juvenile fish in closed areas?
- Is growth of juveniles faster inside the closed areas than elsewhere?
- Are biotic factors (stomach contents, size at age, prey abundance) of juvenile fish different inside closed areas than elsewhere?
- Are there stronger associations with habitat types in closed areas than elsewhere?
- Is natural mortality for juvenile fish different inside closed areas than elsewhere?
- How long do juvenile fish remain in closed fishing areas?
- Does performance relative to the metrics listed above vary with closed area size?

<u>Spawning protection</u>

- How well does the timing of spawning coincide with the spawning closures?

- Does fishing actually disrupt spawning activity (apart from the effect of removing spawners)?
- Have the closed areas actually improved stock-wide recruitment?
- What is the variability of spawning activity (location and timing) over time? Are spawning closures as configured able to protect spawning activity, given this variability?
- Have new sub-populations of spawners been identified that require specific protection?

Finally, building on what the Council learned during the review of the performance of existing closed areas and the development of new EFH management in this amendment, the Council would identify and periodically revise research priorities to improve habitat and spawning area monitoring. New types of data to enable a satisfactory review of area management performance include:

- Spawning condition and other life history characteristics (stomach content, size at age, robustness)
- Juvenile fish condition, distribution, and movement
- Changes in prey availability
- Habitat quality (type, structure, cover, and size) associated with high abundance of juvenile fish
- Observation of fish spawning behavior within closed and open fishing areas
- Movement and migration
    - Telemetry tagging
    - Acoustic tagging
- Before-After-Control-Impact comparison of changes in fish biomass and characteristics before and after a closure inside a closed area and in surrounding fished areas
- More intensive egg and larval surveys at various times throughout the year
- Oceanographic information that affects egg and larval dispersion

Funding sources could be developed or promoted by a future management action that include, but are not limited to:

- Research set-asides from annual groundfish ACLs and/or extra landings allocations while conducting fishery impact research in habitat or spawning management areas
- Sector set-asides to fund research that collects information that sectors would use to justify closed or restricted area exemptions
- Experimental fisheries
- Cooperative research
- Enhancement of observer coverage in specific areas (e.g. modify Standardized Bycatch Reporting Methodology sampling allocations)
- More intensive survey sampling in and around closed or gear restricted areas.

1.2.2.5 Preferred alternatives

The preferred suite of alternatives combines both No Action and action alternatives for habitat protection, spawning protection, and research (Table 3, Map 14). Importantly, note that the Council has not selected any preferred habitat alternatives in the Georges Bank or Great South

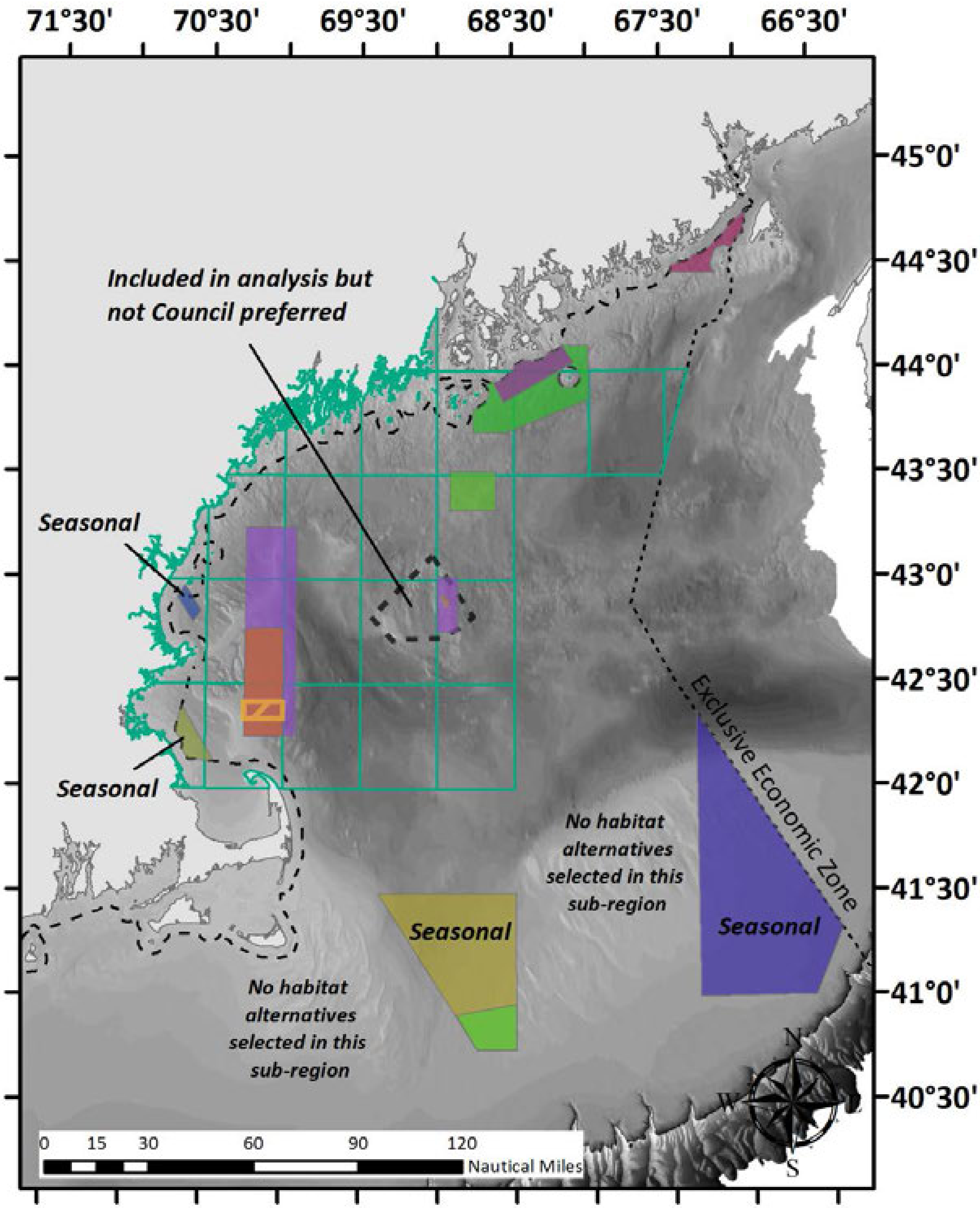
Channel/Southern New England sub-regions The structure of the management alternatives indicates that the Council should select one (or more) alternative per alternative category (habitat, spawning, research) and sub-region or region. In other words, for each of the No Action alternatives, the Council should eventually select an alternative or alternatives (this could, of course, include selection of No Action). Because the Cashes Ledge Closure Area was not identified by the Council as a preferred habitat management alternative, it is likely that the intention was to exclude the area from the preferred spawning management alternative and to remove the area.

Table 3 – Preferred spatial management alternatives

Alt. type	Sub-region or region	#	Areas included	Fishing restriction options
Habitat	Eastern Gulf of Maine	2	Large Eastern Maine HMA, Machias HMA	Options 1 and 5
Habitat	Central Gulf of Maine	4	Modified Jeffreys Bank EFH HMA, Modified Cashes Ledge EFH HMA, Ammen Rock HMA	Option 1, Ammen Rock closed to all fishing
Habitat	Western Gulf of Maine	1	Western Gulf of Maine Habitat Closure Area, Western Gulf of Maine Closed Area	Current measures
Habitat	Western Gulf of Maine	7a	Inshore Roller Gear Restricted Area	Trawl roller gear limited to 12 inches diameter
Habitat	Western Gulf of Maine	8	WGOM Shrimp Trawl Exemption Area	Shrimp trawls exempted from mobile bottom-tending gear closure
Spawning	Gulf of Maine	1	Western Gulf of Maine Closure Area, *Cashes Ledge Closure Area***, Sector rolling closures, common pool rolling closures, GOM Cod Spawning Protection Area	Current measures
Spawning	Georges Bank/ Southern New England	2b	Closed Areas I and II	Option 5 including recreational gears
Research	Eastern Gulf of Maine	2	Eastern Maine DHRA	Option 1
Research	Western Gulf of Maine	3b	Stellwagen DHRA and northern reference area	Options 1 and 5, recreational gears capable of catching groundfish in reference area only
Research	Georges Bank	4	Georges Bank DHRA	Option 1
Research	All	5	Applies to any DHRAs designated	DHRA sunsets after 3 years if not being used

** See discussion in text.

Map 14 – Preferred spatial management alternatives



1.3 Environmental consequences of the alternatives

Environmental impacts are analyzed with respect to four valued ecosystem components (VECs): physical and biological environment, managed species, human communities and the fishery, and protected resources.

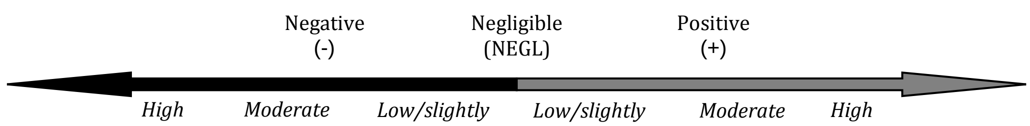
- Physical and biological environment, with a focus on seabed habitats in particular
- Managed species – this includes all species managed by the New England Fishery Management Council as well as species managed by other authorities that occur in the New England Region where changes to spatial management measures are under consideration
- Human communities and the fishery – this includes fisheries targeting the above managed species, and the communities associated with those fisheries
- Protected resources – this includes large and small cetaceans, pinnipeds, sea turtles, Atlantic sturgeon, and Atlantic salmon that occur in the New England Region where changes to spatial management measures are under consideration

Each of the six types of alternatives described above is analyzed separately for each VEC. The analyses of the EFH and HAPC alternatives focus mainly on the value of these designations in the EFH consultation process, as these are administrative actions that do not directly impact the manner or distribution of fishing effort. The analyses of the habitat, spawning, and research area spatial management alternatives focus on the characteristics of the areas and how shifts in the type and distribution of fishing effort may influence those characteristics. Characteristics of these management areas are described for each area individually and collectively as an alternative package of areas. These characteristics include seabed habitat type; distribution of managed species, particularly age 0 and 1 juvenile groundfish and large adult groundfish; current distributions of fishing effort by gear type; and protected resource distributions in each area.

Impacts analyses compare the action alternatives to the impacts of taking no action (no action is always Alternative 1), and compare the action alternatives against one another. The analyses also discuss differences in impacts between different fishing restriction options. At the end of Volume 3, section 4.6 characterizes the impacts of the spatial management alternatives on particular managed species and their associated fisheries. These fishery-specific impacts are intended to complement the human communities and the fishery impacts analyses in sections 4.2.3, 4.3.3, and 4.4.3. Throughout Volumes 3 and 4, the impacts of the alternatives are described using the terminology below (Table 4).

Table 4 – Terms used in the impacts analysis for this amendment

Impact Definition			
	Direction		
VEC	**Positive (+)**	**Negative (-)**	**Negligible (Negl)**
Allocated target species, other landed species, and protected resources	Actions that increase stock/population size	Actions that decrease stock/population size	Actions that have little or no positive or negative impacts to stocks/populations
Physical Environment/ Habitat/EFH	Actions that improve the quality or reduce disturbance of habitat	Actions that degrade the quality or increase disturbance of habitat	Actions that have no positive or negative impact on habitat quality
Human Communities	Actions that increase revenue and social well-being of fishermen and/or associated businesses	Actions that decrease revenue and social well-being of fishermen and/or associated businesses	Actions that have no positive or negative impact on revenue and social well-being of fishermen and/or associated businesses
Impact Qualifiers			
Low/Slightly (as in low positive or low negative)	To a lesser degree		
Moderate (as in moderately positive or moderately negative)	To an average degree (i.e., more than "low", but not "high")		
High (as in high positive or high negative)	To a substantial degree		
Likely	Some degree of uncertainty associated with the impact		



1.3.1 Impacts of the EFH and HAPC designation alternatives

While they do serve an important information and consultation purpose, the EFH and HAPC designations themselves are not associated with any restrictions on the timing or methods of fishing. Thus, the impacts of the designations relate to the applicability of the designations to the consultation process. More narrowly-defined designations are more easily relied upon when conducting EFH consultations as areas that should be the target of conservation actions. Because the designations were not developed with protected resource considerations in mind, no discernable impacts are expected on the protected resources VEC.

The maps for the No Action EFH designation alternatives are mostly based on relative abundance 1963-1997 trawl survey data without any habitat considerations; they also include a limited amount of inshore/state survey data and the same estuarine data used in the action alternatives (see Section 1.2.1). The No Action designations are expected to have indirect, positive impacts on the physical and biological environment, managed resources, and on human communities and the fishery through improvements to management and the EFH consultation process. The magnitude of impacts is relatively small and the impacts are not significant as the designations are administrative in nature.

Maps for the preferred EFH designation alternatives were mostly developed using the relative abundance plus habitat considerations approach. Compared to the current designations, they include a more complete set of inshore/state data and spatial coverages for outer continental shelf and slope areas where certain species were determined to be present. The text descriptions include more specific depth ranges and substrate information. Relative to No Action, the preferred alternatives are collectively more specific, which should improve their use in the consultation process. They also include better coverage of shallow, nearshore habitats, where the great majority of federal projects are conducted that receive attention in the consultation process. Thus, the magnitude of positive habitat benefits is higher than for the No Action Alternatives.

There are a range of non-preferred EFH action alternatives for each species and life stage. Considering alternatives developed using a particular method as a group, there could be greater or lesser positive impacts on the physical and biological habitat, managed species, and human communities VECs relative to No Action. The No Action and preferred alternative designations are typically based on relative abundance data at the 75^{th} and 90^{th} percentile levels of catch (see Section 1.2.1). In this amendment, maps based on the 25^{th} and 50^{th} percentiles were also developed. Compared to the 75^{th} and 90^{th} percentile maps, the non-preferred 25^{th} and 50^{th} percentile maps depict smaller areas, or widely-scattered individual ten minute squares, where the highest average survey catches occurred. If the high density squares cluster together, these designations may be viewed as positive relative to either the No Action or the preferred designations, because they would focus management and conservation efforts on a smaller subset of habitats where the highest catches of each species have been observed historically. However, these more conservative designations may miss important areas of occurrence for some species, which could have a negative impact if it limits the scope of conservation recommendations provided on a given project. Considering these two factors together, increased specificity but the chance of missing important areas, the 25^{th} and 50^{th} percentile maps probably have a slightly less positive impact than the preferred alternative designations which include more area with squares that tend to be more contiguous. Because they include additional state survey information and more recent survey data as compared to the No Action designations, these alternatives are likely neutral relative to No Action. For a given catch percentile, the alternatives that include habitat considerations have more positive impacts relative to the alternatives based on abundance only, because they limit the designations to appropriate depths and temperatures, and are therefore less likely to have EFH map coverages in locations not suitable for a particular species.

The species range designation alternatives are more general in nature and broadly cover all ten minute squares areas where the species was caught in 38 years of the NEFSC trawl surveys, as well as inshore areas, in squares where juveniles or adult fish of any given species were caught in more than 10% of the tows made in each square, estuarine areas where the species was identified as common or abundant. Because these designations are non-specific, they do not differentiate essential habitats areas from areas where a species is only occasionally present and are not useful for targeting areas where habitat conservation measures are needed. However, none of the habitats used by a particular species and lifestage are likely to be missed by the species range alternatives. On balance, the species range designations provide less positive impacts relative to No Action, and especially relative to the preferred alternative designations.

The No Action HAPC designations include two status quo designations, one for Atlantic salmon in select rivers along the coast of Maine, and one for juvenile cod on the northern edge of Georges Bank. Collectively, the preferred alternatives maintain these two HAPCs, and designate some additional HAPCs. These additional designations are expected to have indirect positive impacts on the consultation and fishery management process relative to the No Action designations alone with respect to the biological habitat, managed species, and human communities VECs. Because there are no direct management implications of the HAPC designations, these impacts are not expected to be substantial in magnitude.

1.3.2 Impacts of the spatial management alternatives

In contrast with the EFH and HAPC designation alternatives, the spatial management alternatives affect the types of fishing activities that are authorized in specific management areas. Given the large number of management alternatives, sub-options, and VECs, summary tables of impacts were developed for the cumulative effects section in Volume 4 to allow for quick comparison of impacts across alternatives. Nonetheless, it is important to review the more comprehensive written discussions in Volume 3. Section 4.1 of Volume 3 provides a detailed discussion as to how impacts were evaluated, including general assumptions of the analysis and data sources used.

The Swept Area Seabed Impact (SASI) approach is the primary framework used to evaluate the impacts of the various habitat management alternatives on the physical and biological environment.

- The vulnerability assessment and literature review concluded that cobble-boulder dominated seafloors are most vulnerable to the adverse effects associated with fishing due to the occurrence of biota that is susceptible to injury and in particular has long recovery times.
- A major premise of the SASI approach is that the overall magnitude of the adverse effects of fishing on habitat is related to the total amount of contact between fishing gear and the seabed. Thus, if fishing can be done in such a way as to minimize seabed contact, it will help to reduce the magnitude of adverse effects.
- The SASI analysis concluded that: (1) Mobile bottom-tending gears (bottom trawls and dredges) have a greater per unit area impact than fixed bottom-tending gears (gillnets, longlines, and traps), and (2) they have a greater overall magnitude of impacts, since individual mobile gear fishing events contact more of the seabed than individual fixed gear fishing events and there is more overall fishing effort by mobile gears than fixed gears. Due to the much greater magnitude of mobile vs. fixed bottom-tending gear impacts, eliminating mobile bottom-tending gear use in an area should reduce the adverse effects of fishing on seabed habitats significantly within that area.

The PDT determined that different regions, and sub-regions within them, may have unique qualities based on location, hydrology, and other characteristics. Because of this, the PDT created a range of alternatives for each sub-region. This does not guarantee a closure in each sub-region, as some regions, despite unique characteristics, may not contain enough vulnerable habitat to justify a closure. It is up to the Council to weigh unique characteristics of each area with the amount of vulnerable habitat to determine the alternatives that best meet the purpose and need of this Amendment. Within each alternative, four gear restriction options were analyzed: complete restrictions on use of mobile bottom-tending gears, restrictions on the use of mobile bottom-tending gear with an exemption for hydraulic clam dredges, a requirement that bottom trawl vessels use ground cables modified with 20 cm diameter elevating disks spaced at 5 fathoms with a length per side capped at 45 fathoms, or a requirement that bottom trawl vessels eliminate ground cables entirely and cap bridle lengths at 30 fathoms per side. Gear modifications would not apply to scallop or clam dredges.

Restrictions on mobile bottom-tending gears (Option 1) could be used to achieve the adverse effects minimization objectives. In terms of protecting vulnerable seabed habitats from the adverse effects of fishing, the greatest local reduction in adverse effects to the seabed will be achieved if all mobile bottom-tending fishing is prohibited from the area.

Hydraulic dredges can only be used in sands and fine gravels, which are less vulnerable to the adverse effects of fishing as compared to cobble- and boulder-dominated habitats as long as they are located in high energy environments subject to physical disturbance from bottom currents and storm wave action. The assumption is that hydraulic clam dredges, if exempt from habitat management area restrictions (Option 2), would be operating in the sand and fine gravel patches intermixed between areas dominated by cobble and boulder and, therefore, have a minimal adverse impact on benthic habitats in areas where they can safely be used and where surfclams are more abundant. The area of the seafloor impacted by hydraulic clam dredges during a single tow or trip is relatively low as compared to the per tow or per trip area swept by scallop dredges and otter trawls because they are towed at much lower speeds than a scallop dredge and are much narrower than a trawl. Nevertheless, the per unit area impact of hydraulic clam dredges is high relative to scallop dredges and otter trawls because they remove clams from the bottom by pumping pressurized water 8-10 inches into the sediment. Hydraulic dredge impacts were estimated to be greater in low energy areas than in high energy areas, due to longer estimated recovery times for geological and biological features in low energy environments. Thus, the seabed impacts associated with a hydraulic dredge exemption would be higher in low energy HMAs as compared to high energy HMAs, given similar levels of fishing effort. This does not account for the relative distribution of clams and clam fishing effort between high and low energy areas; both the clams and clam fishing effort tend to be concentrated in high energy areas where recovery would be somewhat more rapid. In some areas, a hydraulic clam dredge exemption would make no difference in terms of habitat impacts because there are few clams and no clam fishing effort.

Options 3 and 4 would allow mobile bottom-tending gear use, but restrict ground cable configuration and length (Option 3) or prohibit ground cable use altogether (Option 4). Ground cables are defined as wire ropes extending along the seabed between the trawl doors and the bridles at either end or "wing" of the net; they serve to herd fish into the path of the net and increase the width of the area of seabed fished (swept) by the trawl. Ground cable diameter can be increased by passing the wires through rubber disks (cookies) or rollers; this modification is designed to assist passage of the ground cables over the seabed. Ground cables are typically constructed from twisted steel wire rope, often with small diameter rubber disks (cookies) compressed together along the entire cable length. In comparison with the sweep and the doors, ground cables are the longest element of bottom trawl gear and thus they contribute significantly to the amount of area swept by the gear. Thus, shortening their length and/or reducing their contact with the seabed provides a mechanism to reduce gear width, assuming that the total length of the tow does not change.

The degree to which adjustments in ground cable lengths affect the adverse impacts of trawl gear on benthic habitats could be calculated using applications of the SASI model, but only if the spatial distribution of trawling activity is well understood and changes in area swept can be estimated pre- and post- gear modification. Because the effect of ground cable modifications on capture efficiency for individual species is not well understood, it is very difficult to say with any certainty that there would be a net habitat benefit of requiring ground cables with elevating disks in habitat management areas. Vessels using trawls equipped with modified ground cables may just tow for longer periods of time to catch the same amount of fish as they would otherwise, thus negating, to some extent, the benefit of raised and shortened ground cables. Overall, Option 3 will have negative impacts on seabed habitats as compared to Options 1 and 2. However, the magnitude of the difference in impacts is uncertain.

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

Overall impacts are difficult to specify because fishing effort could shift in response to spatial management alternatives. With this redistribution of effort, the catch composition will change, making it easier to catch some species and harder to catch others. In the groundfish fishery, where most vessels belong to sectors, the species-specific limits allocated to each sector may be easier or more difficult to achieve if fishermen are forced to shift their fishing location as the result of a new closure. To the extent that fishing effort will be lower in areas with higher amounts of juvenile fish, fishing mortality associated with an ACL level may marginally decline. Alternatively, if fishing effort increases where there is a greater amount of sub-legal fish that are retained by the trawls, fishing mortality associated with an ACL could marginally increase. Other changes in the non-groundfish bycatch in the groundfish fishery may also occur, depending on limits in other fisheries and the overlap in species' distributions with reconfigured open fishing areas.

Overall, the estimated direct impacts of the alternatives vary, in some cases widely, between VECs for the same alternative. Further, impacts often vary across a VEC within a particular category of alternatives. For example, the habitat/seabed impacts of the Georges Bank habitat management alternatives range from highly negative to highly positive, while the impacts of the eastern Gulf of Maine habitat management alternatives are of lower magnitude (generally slightly negative to slightly positive). Also, in some cases impacts are heterogeneous across different sub-components of a VEC. For example, a spawning alternative may effectively encompass times of cod and haddock spawning, but not yellowtail flounder spawning, or may have neutral impacts on commercial fishing but locally negative impacts on recreational fishing.

1.3.3 Alternatives to improve groundfish spawning protection

These alternatives are designed to protect spawning groundfish and are based largely on existing management areas. Spawning protection alternatives generally restrict gears capable of catching groundfish. Some of the areas included in the no action alternatives are currently implemented on a year round basis, but all of the areas included in the action alternatives would be implemented seasonally. Seasonal areas generally have a negligible benefit in terms of increasing benthic habitat protection, because any restrictions on fishing would be temporary, and, once fishing resumes, benthic habitat features would be subjected to renewed disturbance. The benefits of these alternatives in the GOM depend on the duration of the spawning closure – year-round closures benefit seabed habitats, while seasonal closures would have a negative impact on seabed habitats. Benefits on Georges Bank depend more on changes in fishing effort - maintaining the year-round closures on Georges Bank may have low, highly uncertain, negative impact on seabed habitats because the restrictions on fishing effort may prolong fishing effort in this area. Modifications to existing closed areas may have slightly positive impacts on seabed habitat because they allow flexibility in fishing location, potentially increasing efficiency.

1.3.4 Summary of Impacts

Below, tables summarize the impacts conclusions described in Volume 3 for the spatial management alternatives (habitat management, spawning, and Dedicated Habitat Research Areas). Summarizing the impacts, particularly those by the higher level VECs (e.g., habitat, economic impacts, social impacts, etc.), is complicated and should be viewed as an average. The alternatives will impact different fishery resources and different socio-economic groups differently. The impacts to the New England Council, Mid-Atlantic Council, and Commission-managed species and fisheries likely to be impacted are described individually as well.

The tables are grouped by the type of alternative. Table 5 is the legend to assist in reading the summary tables. Table 6 summarizes the impacts from the no action alternatives. Table 3 summarizes the impacts from the preferred alternatives. Table 4 summarizes the impacts from all of the other alternatives under consideration.

For the status quo alternatives, the habitat impacts range from moderately negative (for the research alternatives) to moderately positive, with several alternatives having a slightly negative impact. The socio-economic impacts in the short-term range from highly negative, likely driven by the concentration of scallops on the Northern Edge of Georges Bank, to moderately positive, likely driven by the potential economic impacts to the skate fishery. The impacts to large-mesh groundfish stocks ranges from neutral to moderately positive. The protected resources impacts are generally neutral, as are the impacts to the majority of the other managed fisheries and stocks.

For the preferred alternatives, the habitat impacts range from slightly negative to highly positive. The economic impacts range from slightly negative to moderately positive, in both the short- and long-term. Likewise, the social impacts from slightly negative to moderately positive in both the short- and long-term. The protected resources impacts are generally neutral to negligible. The impacts to other species and fisheries range from one slightly negative alternative to some moderately positive impacts, but the majority of the impacts are expected to be neutral. The impacts to large-mesh impacts range from slightly negative (one alternative) to highly positive (one alternative); however, the large-mesh impacts are largely moderately positive.

The impacts from the other alternatives under consideration range more widely. The habitat impacts range from highly negative to highly positive, with the highly negative impacts more frequently in the sub-regions that have a preferred alternative currently identified. The impacts to large-mesh groundfish likewise range from highly negative to highly positive. The economic impacts also range from slightly negative (three alternatives in the short-term, five alternatives in the long-term) to highly positive, but with several fewer alternatives expected to result in highly positive long-term economic impacts in the long-term compared to the short-term. The short- and long-term social impacts range from moderately negative to moderately positive. The protected resources impacts generally range from slightly negative to negligible/neutral. The impacts to other managed fisheries and stocks range from highly negative to highly positive, with the only highly negative impacts on the scallop fishery (one alternative on Georges Bank) and the only highly positive impacts also on the scallop fishery (several alternatives on Georges Bank). The majority of the impacts on other managed stocks and fisheries are neutral. Cumulatively, it is difficult to summarize across impacts and impacted-aspects of the environment (called Valued Ecosystem Components, or "VECs"). Impacts range from highly negative to highly positive on almost all VECs. However, some present and foreseeable future actions outside this amendment are likely to produce positive impacts on the physical and biological environment, managed resources, including protected resources, and human communities. For example, ongoing habitat restoration activities such as dam removals are expected to produce positive impacts for managed resources and the communities they support, even if no action is taken in this amendment.

Not included in the tables, the, primarily indirect, impacts from the framework alternatives and the reevaluation of the habitat management areas range from moderately negative impacts (from the no action alternative) to highly, indirectly positive (from the preferred alternative in the long-term) on habitat and fishery productivity. Because many of the measures are directly focused on changes to the large-mesh groundfish fishery, the impacts from the preferred alternative to the other managed species, their EFH, and the human communities involved in those fisheries are likely to be slightly positive for those stocks whose life histories and preferred habitats are similar to large-mesh groundfish, and neutral for those species whose life histories and preferred habitats are unaffected by the habitat management alternatives implemented through this amendment. Protected resources impacts are expected to be neutral for either alternative.

Table 5 Summary Table Legend

Symbol	Meaning
+++	Highly Positive
++	Moderately Positive
+	Slightly Positive
0	Neutral
-	Slightly Negative
--	Moderately Negative
---	Highly Negative
Negl	Negligible
Unk	Unknown or Uncertain

Table 6 Summary of Impacts from the No Action Alternatives. (Top panel are general VECs and NEFMC-managed species; bottom panel are MAFMC- or ASMFC-managed species.)

Type	Sub-region/ region	Alt	Habitat	Large mesh res.	Economic		Social		Protected res.	Small-Mesh		Monkfish		Skate		Sea Scallop		Herring		Red Crab	
					short-term	long-term	short-term	long-term		res.	fishery	res.	fishery	res.	fisher y	res.	fishery	res.	fishery	res.	fishery
Habitat	EGOM	1	-	-	0	0	0	0	0	-	0	0	0	0	0	0	0	0	0	0	0
Habitat	CGOM	1	+++	+	+	+	0	0	0	-	0	0	0	+	-	0	0	0	0	0	0
Habitat	WGOM	1	+++	+	++	++	0	0	0	-	0	0	0	++	0	0	0	+	0	0	0
Habitat	GB	1	++	++	---	---	0	0	0	0	0	0	0	+	-	0	-	+	0	0	0
Habitat	GSC-SNE	1	-	0	--	--	0	0	0	0	0	0	0	0	-	0	0	+	0	0	0
Spawn.	GOM	1	-	++	++	++	-	-	Negl	Unk	0	0	0	+	-	0	0	+	-	0	0
Spawn.	GB-SNE	1	-	++	--	--	-	+	0	Unk	0	0	0	++	-	0	0	+	-	0	0
DHRA	n/a	1	--	-	0	0	+	+	0	0	0	0	0	0	0	0	0	0	0	0	0

Type	Sub-region/ region	Alt	Clams		Bluefish		M/S/B		Dogfish		SF/SC/BSB		Tilefish		Shrimp		Lobster	
			res.	fishery	res.	fishery	res.	fishery	res.	fishery	res.	fishery	res.	fishery	res.	fishery	res.	fishery
Habitat	EGOM	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Habitat	CGOM	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Habitat	WGOM	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Habitat	GB	1	0	0	0	0	0	0	0	0	+	0	0	0	0	0	0	0
Habitat	GSC-SNE	1	0	-	0	0	0	0	0	0	+	-	0	0	0	0	0	0
Spawn.	GOM	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Spawn.	GB-SNE	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
DHRA	n/a	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Table 7 Summary of Impacts from the Preferred Alternatives. (Top panel are general VECs and NEFMC-managed species; bottom panel are MAFMC- or ASMFC-managed species.)

Type	Sub-region/ region	Alt	Habitat	Large mesh res.	Economic		Social		Protected res.	Small Mesh		Monkfish		Skate		Sea Scallop		Herring		Red Crab	
					short -term	long- term	short -term	long- term		Res.	Fishery	Res.	Fishery	Res.	Fishery	Res.	Fishery	Res.	Fishery	Res.	Fishery
Habitat	EGOM	Alt. 2 Opt. 1, 2, 5	+	++	-	+	-	+	0	+	0	0	0	+	0	0	0	+	--	0	0
Habitat	CGOM	Alt. 4 Opt. 1 and 2	++	-	+	-	-	-	-	-	0	0	0	-	+	0	+	0	0	0	0
Habitat	WGOM	Alt. 1	+++	+	++	++	0	0	0	-	0	0	0	++	0	0	0	+	0	0	0
Habitat	WGOM	Alt. 7A	+	0	0	0	0	0	0	+	0	0	0	0	0	0	0	0	0	0	0
Habitat	WGOM	Alt. 8	0	+	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Spawn.	GOM	Alt. 1	-	++	++	++	-	-	**Negl**	**Unk**	0	0	0	+	-	0	0	+	-	0	0
Spawn.	GOM	Alt. 3	-	++	-	+	-	-	**Negl**	**Unk**	0	0	0	+	0	0	0	-	+	0	0
Spawn.	GB-SNE	Alt. 2B	+	+	+	+	+	+	-	**Unk**	0	0	0	-	+	++	++	-	+	0	0
DHRA	EGOM	Alt. 2	++	++	-	+	0	0	**Negl**	+	0	0	0	+	0	0	0	0	0	0	0
DHRA	WGOM	Alt. 3B	++	++	-	+	-	+	**Negl**	0	0	0	0	+	++	0	0	0	0	0	0
DHRA	GB	Alt. 4	++	+	-	+	+	+	**Negl**	0	0	0	0	+	+	0	0	0	0	0	0
DHRA	n/a	Alt. 5	0	+	0	+	++	++	**Negl**	0	0	0	0	0	0	0	0	0	0	0	0

Type	Sub-region/region	Alt	Clam		Bluefish		M/S/B		Dogfish		SF/SC/BSB		Tilefish		Shrimp		Lobster	
			res.	fishery	res.	fishery	res.	fishery	res.	fishery	res.	fishery	res.	fishery	res.	fishery	res.	fishery
Habitat	EGOM	Alt. 2 Opt. 1, 2, 5	0	-	0	0	0	0	0	0	0	0	0	0	0	0	+	0
Habitat	CGOM	Alt. 4 Opt. 1 and 2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Habitat	WGOM	Alt. 1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Habitat	WGOM	Alt. 7A	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Habitat	WGOM	Alt. 8	0	0	0	0	0	0	0	0	0	0	0	0	0	+	0	0
Spawn.	GOM	Alt. 1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Spawn.	GOM	Alt. 3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Spawn.	GB-SNE	Alt. 2B	0	0	0	+	0	+	0	+	-	+	0	0	0	0	-	-
DHRA	EGOM	Alt. 2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
DHRA	WGOM	Alt. 3B	0	0	0	0	0	0	0	-	0	0	0	0	0	0	0	0
DHRA	GB	Alt. 4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
DHRA	n/a	Alt. 5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Table 8 Summary of Impacts from the Other Alternatives Under Consideration. (Top panel are general VECs and NEFMC-managed species; bottom panel are MAFMC- or ASMFC-managed species.)

Type	Sub-region/ region	Alt	Habitat	Large mesh res.	Economic		Social		Protected res.	Small Mesh		Monkfish		Skate		Sea Scallop		Herring		Red Crab	
					Short-term	Long-term	Short-term	Long-term		res.	fishery	res.	fishery	res.	fishery	res.	fishery	res.	fishery	res.	fishery
Habitat	EGOM	Alt. 2 Opt. 3-4	Unk	0	-	-	-	-	0	-	0	0	0	0	0	0	0	+	0	0	0
Habitat	EGOM	Alt. 3 Opt. 1-2	++	++	-	+	-	+	0	+	0	0	0	+	0	0	0	+	0	0	0
Habitat	EGOM	Alt. 3 Opt. 3-4	Unk	0	-	-	-	-	0	-	0	0	0	0	0	0	0	+	0	0	0
Habitat	CGOM	Alt. 2 (No area)	---	--	+	-	+	-	-	-	0	0	0	-	+	0	+	0	0	0	0
Habitat	CGOM	Alt. 3 Opt. 1-2	+++	-	+	-	-	-	-	-	0	0	0	-	+	0	-	0	0	0	0
Habitat	CGOM	Alt. 3 Opt. 3-4	---	--	-	-	-	-	-	-	0	0	0	-	+	0	+	0	0	0	0
Habitat	CGOM	Alt. 4 Opt. 3-4	---	--	-	-	-	-	-	-	0	0	0	-	+	0	+	0	0	0	0
Habitat	WGOM	Alt. 2 (No area)	--	--	++	--	+	--	-	-	+	0	+	--	0	0	0	-	0	0	0
Habitat	WGOM	Alt. 3 Opt. 1-2	+++	+++	--	++	--	++	-	+	--	0	+	-	0	0	0	+	-	0	0
Habitat	WGOM	Alt. 3 Opt. 3-4	---	--	-	--	--	--	-	-	0	0	+	0	0	0	0	+	-	0	0
Habitat	WGOM	Alt. 4 Opt. 1-2	+++	+++	--	++	--	+	-	+	--	0	+	0	0	0	0	+	-	0	0
Habitat	WGOM	Alt. 4 Opt. 3-4	---	--	-	--	--	--	-	-	0	0	+	0	0	0	0	+	-	0	0
Habitat	WGOM	Alt. 5 Opt. 1-2	+++	++	--	++	--	+	-	+	-	0	+	0	0	0	0	+	-	0	0
Habitat	WGOM	Alt. 5 Opt. 3-4	---	--	-	--	-	-	-	-	0	0	+	0	0	0	0	+	-	0	0
Habitat	WGOM	Alt. 6 Opt. 1-2	--	-	+	-	+	-	-	-	Negl	0	+	-	0	0	0	-	0	0	0
Habitat	WGOM	Alt. 6 Opt. 3-4	---	--	-	--	-	--	-	-	+	0	+	-	0	0	0	-	0	0	0
Habitat	WGOM	Alt. 7B	+	+	0	0	0	0	0	+	0	0	0	0	0	0	0	0	0	0	0
Habitat	GB	Alt. 2 (No area)	--	---	+++	+++	++	--	-	0	+	0	++	-	+	0	+++	-	0	0	0
Habitat	GB	Alt. 3 Opt. 1	++	--	+++	++	++	--	-	0	0	0	++	-	++	0	-	+	0	0	0
Habitat	GB	Alt. 3 Opt. 2	++	--	+++	++	++	--	-	0	0	0	++	-	++	0	-	+	0	0	0
Habitat	GB	Alt. 3 Opt. 3-4	--	--	+++	++	++	--	-	0	0	0	++	-	++	0	+++	+	0	0	0
Habitat	GB	Alt. 4 Opt. 1	++	--	+++	++	++	--	-	0	-	0	++	-	++	0	-	+	0	0	0
Habitat	GB	Alt. 4 Opt. 2	++	--	+++	++	++	--	-	0	-	0	++	-	++	0	-	+	0	0	0
Habitat	GB	Alt. 4 Opt. 3-4	--	--	+++	++	++	--	-	0	-	0	++	-	++	0	+++	+	0	0	0
Habitat	GB	Alt. 5	--	--	++	++	-	-	-	0	-	0	++	-	++	0	+++	+	0	0	0
Habitat	GB	Alt. 6A Opt. 1	+++	-	--	---	--	--	-	0	0	0	++	-	++	0	--	+	0	0	0
Habitat	GB	Alt. 6A Opt. 2	+++	-	--	---	--	--	-	0	0	0	++	-	++	0	--	+	0	0	0
Habitat	GB	Alt. 6A Opt. 3-4	--	--	+++	+++	+	--	-	0	0	0	++	-	++	0	+++	+	0	0	0
Habitat	GB	Alt. 6B Opt. 1	-	---	+++	+++	++	--	-	0	0	0	++	-	++	0	+	+	0	0	0
Habitat	GB	Alt. 6B Opt. 2	-	---	+++	+++	++	--	-	0	0	0	++	-	++	0	+	+	0	0	0
Habitat	GB	Alt. 6B Opt. 3-4	--	---	+++	+++	+	--	-	0	0	0	++	-	++	0	+++	+	0	0	0
Habitat	GB	Alt. 7 Opt. 1-2	+	---	+++	+++	++	-	-	0	-	0	0	-	0	0	+++	+	0	0	0
Habitat	GB	Alt. 8 Opt. 2-2	+++	++	---	---	--	--	-	0	-	0	-	-	--	0	---	+	0	0	0

Type	Sub-region/ region	Alt	Habitat	Large mesh res.	Economic		Social		Protected res.	Small Mesh		Monkfish		Skate		Sea Scallop		Herring		Red Crab	
					Short-term	Long-term	Short-term	Long-term		res.	fishery	res.	fishery	res.	fishery	res.	fishery	res.	fishery	res.	fishery
Habitat	GSC-SNE	Alt. 2 (No area)	+	-	+	+	+	-	-	0	Negl	0	+	0	+	0	0	-	0	0	0
Habitat	GSC-SNE	Alt. 3 Opt. 1	++	+	---	---	--	-	-	0	Negl	0	+	0	0	0	--	+	-	0	0
Habitat	GSC-SNE	Alt. 3 Opt. 2	+	+	---	---	--	-	-	0	Negl	0	+	0	0	0	--	+	-	0	0
Habitat	GSC-SNE	Alt. 3 Opt. 3-4	0	Unk	++	++	+	+	-	0	Negl	0	+	0	0	0	0	+	-	0	0
Habitat	GSC-SNE	Alt. 4 Opt. 1	+	Unk	--	+	--	++	-	0	Negl	0	+	0	0	0	0	+	-	0	0
Habitat	GSC-SNE	Alt. 4 Opt. 2	+	Unk	++	-	+	++	-	0	Negl	0	+	0	0	0	0	+	-	0	0
Habitat	GSC-SNE	Alt. 4 Opt. 3-4	0	Unk	++	--	+	-	-	0	Negl	0	+	0	0	0	0	+	-	0	0
Habitat	GSC-SNE	Alt. 5 Opt. 1	+	Unk	-	+	--	++	-	0	Negl	0	+	0	0	0	0	+	-	0	0
Habitat	GSC-SNE	Alt. 5 Opt. 2	+	Unk	+	+	+	++	-	0	Negl	0	+	0	0	0	0	+	-	0	0
Habitat	GSC-SNE	Alt. 5 Opt. 3-4	0	Unk	+	--	+	-	-	0	Negl	0	+	0	0	0	0	+	-	0	0
Habitat	GSC-SNE	Alt. 6	0	Unk	--	--	--	--	-	0	Negl	0	+	0	0	0	0	+	-	0	0
Spawn.	GOM	Alt. 2A	-	++	+	-	0	0	Negl	Unk	0	0	0	-	+	0	0	-	+	0	0
Spawn.	GOM	Alt. 2B	-	++	+	-	-	-	Negl	Unk	0	0	0	-	+	0	0	-	+	0	0
Spawn.	GB-SNE	Alt. 2A	+	+	+	+	0	0	-	Unk	0	0	0	-	+	++	++	-	+	0	0
Spawn.	GB-SNE	Alt. 2C	+	+	+	+	+	+	Negl	Unk	0	0	0	-	+	0	0	-	+	0	0
Spawn.	GB-SNE	Alt. 3A	+	+	+	+	+	+	-	Unk	0	0	0	-	+	++	++	-	+	0	0
Spawn.	GB-SNE	Alt. 3B	+	+	+	+	+	+	-	Unk	0	0	0	-	+	++	++	-	+	0	0
Spawn.	GB-SNE	Alt. 3C	+	-	+	+	+	+	Negl	Unk	0	0	0	-	+	0	0	-	+	0	0
DHRA	WGOM	Alt. 3A	++	++	-	+	+	+	Negl	0	0	0	0	+	++	0	0	0	0	0	0
DHRA	WGOM	Alt. 3C	++	++	0	+	+	++	Negl	0	0	0	0	+	++	0	0	0	0	0	0

Type	Sub-region/ region	Alt	Clams		Bluefish		M/S/B		Dogfish		SF/SC/BSB		Tilefish		Shrimp		Lobster	
			res.	fishery	res.	fishery	res.	fishery	res.	fishery	res.	fishery	res.	fishery	res.	fishery	res.	fishery
Habitat	EGOM	Alt. 2 Opt. 3-4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	+	0
Habitat	EGOM	Alt. 3 Opt. 1-2	0	-	0	0	0	0	0	0	0	0	0	0	0	0	+	0
Habitat	EGOM	Alt. 3 Opt. 3-4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	+	0
Habitat	CGOM	Alt. 2 (No area)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Habitat	CGOM	Alt. 3 Opt. 1-2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Habitat	CGOM	Alt. 3 Opt. 3-4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Habitat	CGOM	Alt. 4 Opt. 3-4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Habitat	WGOM	Alt. 2 (No area)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	+	0

Type	Sub-region/ region	Alt	Clams		Bluefish		M/S/B		Dogfish		SF/SC/BSB		Tilefish		Shrimp		Lobster	
			res.	fishery	res.	fishery	res.	fishery	res.	fishery	res.	fishery	res.	fishery	res.	fishery	res.	fishery
Habitat	WGOM	Alt. 3 Opt. 1-2	0	0	0	0	0	0	0	0	0	0	0	0	0	---	+	0
Habitat	WGOM	Alt. 3 Opt. 3-4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	+	0
Habitat	WGOM	Alt. 4 Opt. 1-2	0	0	0	0	0	0	0	0	0	0	0	0	0	---	+	0
Habitat	WGOM	Alt. 4 Opt. 3-4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	+	0
Habitat	WGOM	Alt. 5 Opt. 1-2	0	0	0	0	0	0	0	0	0	0	0	0	0	--	+	0
Habitat	WGOM	Alt. 5 Opt. 3-4	0	0	0	0	0	0	0	0	0	0	0	0	0	--	+	0
Habitat	WGOM	Alt. 6 Opt. 1-2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Habitat	WGOM	Alt. 6 Opt. 3-4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Habitat	WGOM	Alt. 7B	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Habitat	GB	Alt. 2 (No area)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	-	-
Habitat	GB	Alt. 3 Opt. 1	0	-	0	0	0	0	0	0	+	0	0	0	0	0	-	-
Habitat	GB	Alt. 3 Opt. 2	0	0	0	0	0	0	0	0	+	0	0	0	0	0	-	-
Habitat	GB	Alt. 3 Opt. 3-4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	-	-
Habitat	GB	Alt. 4 Opt. 1	0	-	0	0	0	0	0	0	+	0	0	0	0	0	-	-
Habitat	GB	Alt. 4 Opt. 2	0	0	0	0	0	0	0	0	+	0	0	0	0	0	-	-
Habitat	GB	Alt. 4 Opt. 3-4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	-	-
Habitat	GB	Alt. 5	0	--	0	0	0	0	0	0	+	0	0	0	0	0	-	-
Habitat	GB	Alt. 6A Opt. 1	0	--	0	0	0	0	0	0	+	0	0	0	0	0	-	-
Habitat	GB	Alt. 6A Opt. 2	0	0	0	0	0	0	0	0	+	0	0	0	0	0	-	-
Habitat	GB	Alt. 6A Opt. 3-4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	-	-
Habitat	GB	Alt. 6B Opt. 1	0	--	0	0	0	0	0	0	+	0	0	0	0	0	-	-
Habitat	GB	Alt. 6B Opt. 2	0	0	0	0	0	0	0	0	+	0	0	0	0	0	-	-
Habitat	GB	Alt. 6B Opt. 3-4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	-	-
Habitat	GB	Alt. 7 Opt. 1-2	0	--	0	0	0	0	0	0	+	0	0	0	0	0	-	-
Habitat	GB	Alt. 8 Opt. 1-2	0	--	0	0	0	0	0	0	+	0	0	0	0	0	0	0
Habitat	GSC-SNE	Alt. 2 (No area)	0	++	0	0	0	+	0	0	0	0	0	0	0	0	0	0
Habitat	GSC-SNE	Alt. 3 Opt. 1	0	--	0	0	0	0	0	0	+	-	0	0	0	0	0	0
Habitat	GSC-SNE	Alt. 3 Opt. 2	0	0	0	0	0	0	0	0	+	-	0	0	0	0	0	0
Habitat	GSC-SNE	Alt. 3 Opt. 3-4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Habitat	GSC-SNE	Alt. 4 Opt. 1	0	--	0	0	0	0	0	0	+	-	0	0	0	0	0	0
Habitat	GSC-SNE	Alt. 4 Opt. 2	0	0	0	0	0	0	0	0	+	-	0	0	0	0	0	0
Habitat	GSC-SNE	Alt. 4 Opt. 3-4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Habitat	GSC-SNE	Alt. 5 Opt. 1	0	--	0	0	0	0	0	0	+	-	0	0	0	0	0	0
Habitat	GSC-SNE	Alt. 5 Opt. 2	0	0	0	0	0	0	0	0	+	-	0	0	0	0	0	0
Habitat	GSC-SNE	Alt. 5 Opt. 3-4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Habitat	GSC-SNE	Alt. 6	0	--	0	0	0	0	0	0	+	-	0	0	0	0	0	0

Type	Sub-region/ region	Alt	Clams		Bluefish		M/S/B		Dogfish		SF/SC/BSB		Tilefish		Shrimp		Lobster	
			res.	fishery	res.	fishery	res.	fishery	res.	fishery	res.	fishery	res.	fishery	res.	fishery	res.	fishery
Spawn.	GOM	Alt. 2A	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Spawn.	GOM	Alt. 2B	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Spawn.	GB-SNE	Alt. 2A	0	0	0	+	0	+	0	+	-	+	0	0	0	0	-	-
Spawn.	GB-SNE	Alt. 2C	0	0	0	+	0	+	0	+	-	+	0	0	0	0	-	-
Spawn.	GB-SNE	Alt. 3A	0	0	0	+	0	+	0	+	-	+	0	0	0	0	-	-
Spawn.	GB-SNE	Alt. 3B	0	0	0	+	0	+	0	+	-	+	0	0	0	0	-	-
Spawn.	GB-SNE	Alt. 3C	0	0	0	+	0	+	0	+	-	+	0	0	0	0	-	-
DHRA	WGOM	Alt. 3A	0	0	0	0	0	0	0	-	0	0	0	0	0	0	0	0
DHRA	WGOM	Alt. 3C	0	0	0	0	0	0	0	-	0	0	0	0	0	0	0	0

1.4 Areas of controversy

Areas of controvery in this amendment tend to center on alternative management actions which have substantially different effects across fisheries. These issues often but not always relate to underlying differences in stock status and therefore in current fishery conditions. For example, significant shellfish (scallop and clam) resources exist on northern Georges Bank, but protection of these areas is considered important in terms of conservation of depleted groundfish stocks such as Georges Bank cod. Shifting management areas is also controversial. In particular, while the existing Western Gulf of Maine Habitat Closure Area is thought to have slightly positive impacts on conservation of juvenile groundfish large mesh groundfish and their habitats, other alternatives include the Bigelow Bight area, which is further inshore, are expected to have highly positive impacts on this VEC. While overall positive economic impacts are anticipated due to long term conservation, there would be displacement of inshore fishing effort in the short term. Concerns have also been raised from a conservation standpoint regarding the minimum amount of habitat or spawning protection necessary given current stock and fishery conditions.

1.5 Issues to be resolved

During final action, and prior to finalizing the EIS, the Council will confirm or modify prior decisions for alternatives already identified as preferred. The Council will also need to identify a final preferred alternative for the Georges Bank and Great South Channel/Southern New England sub-regions.

2 Contents

2.1 Table of contents

2.2 Tables

2.3 Figures

2.4 Maps

2.5 Acronyms

ASM – At-sea monitoring
ASMFC – Atlantic States Marine Fisheries Commission
CAI – Closed Area I
CAII – Closed Area II
CATT – Closed Area Technical Team
cdf – cumulative distribution function
DAS – Days at sea
DHRA – Dedicated Habitat Research Area
EFH – Essential Fish Habitat
EIS – Environmental Impact Statement, Draft or Final
F – Fishing mortality
FMP – Fishery Management Plan
GARFO (formerly NERO) – Greater Atlantic Regional Fisheries Office
GARM – Groundfish Assessment Review Meeting
GB – Georges Bank
Gulf of Maine – Gulf of Maine
GSC – Great South Channel
HAPC – Habitat Area of Particular Concern
HCD – Habitat Conservation Division (NMFS)
HMA – Habitat Management Area
ICNAF – International Commission for Northwest Atlantic Fisheries
ITQ – Individual Transferable Quota
MAB – Mid-Atlantic Bight
MARMAP – Marine Resource Monitoring and Assessment Program
MAFMC – Mid-Atlantic Fishery Management Council
MBTG – Mobile bottom-tending gear
MSA – Magnuson-Stevens [Fishery Conservation and Management] Act
MSY – Maximum sustainable yield
    B_{MSY} – Biomass at MSY
    F_{MSY} – Fishing mortality rate at MSY
NMFS – National Marine Fisheries Service
NAFO – Northwest Atlantic Fisheries Organization
NEFMC – New England Fishery Management Council
NEFOP – Northeast Fisheries Observer Program
NEPA – National Environmental Policy Act
NLCA – Nantucket Lightship Closed Area
NS – National Standard
PDT – Plan Development Team
PSP – Paralytic Shellfish Poisoning
SASI – Swept Area Seabed Impact
SIA – Social Impact Assessment
SNE – Southern New England
TMGC – Transboundary Management Guidance Committee
TRAC – Transboundary Resource Assessment Committee

3 Background and purpose

3.1 Need and purpose for action

There are several needs and purposes for developing Omnibus Essential Fish Habitat (EFH) Amendment 2 (Table 9).

Purposes include designating EFH (A) and minimizing adverse fishery effects on EFH (B). These actions are needed to meet requirements of the Magnuson Stevens Fishery Conservation and Management Act. Specific recommendations for EFH designation and adverse effects minimization are provided in the EFH regulatory guidelines, published in their final form in January 2002. The guidelines specify that to meet Purpose A, the Councils should designate EFH for all managed species of finfish and shellfish, by life history stage, using both text descriptions and maps delimiting potential EFH areas. Although some designations, specifically skates, wolffish, and red crab, are more recent, many of the New England designations were developed for the 1998 Omnibus EFH Amendment and the new designations proposed in this action include additional years of distribution data as well as information about depth and temperature preferences. The species managed by the New England Fishery Management Council are listed in Table 10.

EFH designations help the Council identify habitats where adverse impacts should be minimized (Purpose B). Prior efforts to minimize the adverse effects of Council-managed fisheries on EFH have been largely developed and implemented plan by plan, although fishery effects on EFH are cumulative across FMPs because fish and fishery distributions are overlapping across species and plans. This action is needed to reevaluate and integrate habitat management measures across the fisheries managed by the Council, and to update these measures given new scientific information about habitat distributions and fishing impacts.

EFH designations also inform fisheries management decision making, helping the Council and its stakeholders to understand species' distributions and habitat requirements. Finally, EFH designations facilitate outside consultations between NMFS and other ocean users regarding non-fishing projects that may impact fish habitats. Habitat consultations help minimize impacts on EFH, particularly impacts of non-fishery activities. Purpose C of the amendment is to identify other actions to encourage conservation and enhancement of such habitat. One set of alternatives related to this purpose is to designate Habitat Areas of Particular Concern. An Habitat Area of Particular Concern is a subset of EFH that represents particularly unique, ecologically important, and/or vulnerable habitat types. This action is needed to highlight these special areas, as Habitat Areas of Particular Concern help inform and receive elevated consideration for both fishery management and EFH consultations. Another set of alternatives that relates to Purpose C is the designation of Dedicated Habitat Research Areas, which will help the Council to better understand how habitat management measures influence stock productivity, to allow for the design of more effective conservation measures in future actions.

Another purpose of this amendment is to review and consider revising the rolling closures and year round groundfish closed areas. This is needed to ensure that spatial management measures are contributing to the realization of optimum yield in the groundfish fishery. Spatial overlaps between habitat and groundfish management areas make the EFH amendment an appropriate action to meet this need. Specifically, the Council was concerned that the continued existence of the year-round groundfish closures could potentially undermine the practicality of new EFH management areas. In addition, changes to spatial management measure may be appropriate given substantial shifts in groundfish management strategy since the implementation of Amendment 16 to the Northeast Multispecies Fishery Management Plan, which implemented Annual Catch Limits in the fishery and significantly expanded the sector program.

There are two elements to this overall purpose. The first groundfish-specific purpose of this amendment is to increase protection for juvenile groundfish and their habitats (Purpose D). Success at younger ages can have positive productivity benefits for managed resources, and therefore action is needed to protect the habitats important for juvenile groundfish, particularly for commercially valuable species. Scientific data indicate that the current year-round habitat management areas do not optimally encompass concentrations of juvenile groundfish. A second groundfish-specific purpose of this amendment is to identify seasonal closed areas in the NE Multispecies FMP that would reduce impacts on spawning groundfish and on the spawning activity of key groundfish species, since the protection of spawning fish is needed to sustainably manage stocks (Purpose E). Therefore additional alternatives were needed to meet this need.

Table 9 – Needs for action, with related purposes and management alternatives

Need	Purpose	Alternatives that address this purpose
Meet Magnuson Stevens Act EFH requirements	A. Designate EFH for each species and lifestage	Volume 2, Section 2.1
	B. Minimize the adverse effects of fishing on EFH to the extent practicable	Volume 3, Section 2.1
	C. Identify other actions to encourage conservation and enhancement of such habitat	Habitat Areas of Particular Concern (Volume 2, Section 2.2); Dedicated Habitat Research Areas (Volume 3, Section 2.3)
Achieve optimum yield from the groundfish fishery	D. Improve protection of habitats on which juvenile groundfish depend	Volume 3, Section 2.1
	E. Improve protection of spawning groundfish	Volume 3, Section 2.2

Table 10 – Species managed by the New England Fishery Management Council, by plan, with common names.

FMP	Species	Common Names
Multispecies	*Anarhichus lupus*	Atlantic wolffish
Multispecies	*Gadus morhua*	Atlantic cod (official), rock cod
Multispecies	*Glyptocephalus cynoglossus*	witch flounder (official), gray sole, Craig fluke, pole flounder
Multispecies	*Hippoglossus hippoglossus*	Atlantic halibut (official)
Multispecies	*Hippoglossoides platessoides*	American plaice (official), American dab, Canadian plaice, long rough dab
Multispecies	*Limanda ferruginea*	yellowtail flounder (official), rusty flounder
Multispecies	*Macrozoarces americanus*	ocean pout (official), eelpout, Congo eel, muttonfish
Multispecies	*Melanogrammus aeglefinus*	haddock (official)
Multispecies	*Merluccius bilinearis*	silver hake (official), whiting, New England hake
Multispecies	*Pollachius virens*	pollock (official), Boston bluefish, coalfish, green cod
Multispecies	*Pleuronectes americanus*	winter flounder (official), blackback, Georges Bank flounder, lemon sole, sole, flatfish, rough flounder, mud dab, black flounder
Multispecies	*Scophthalmus aquosus*	windowpane flounder (official), sand flounder, spotted flounder, New York plaice, sand dab, spotted turbot
Multispecies	*Sebastes spp.*	redfish (official), rosefish, ocean perch, red sea perch, red bream, Norway haddock
Multispecies	*Urophycis chuss*	red hake (official), squirrel hake
Multispecies	*Urophycis tenuis*	white hake (official), Boston hake, black hake, blue hake, mud hake, ling
Multispecies	*Merluccius albidus*	Offshore hake (official), blackeye whiting
Monkfish	*Lophius americanus*	monkfish (official), American goosefish, angler, allmouth, molligut, fishing frog
Sea Scallop	*Placopecten magellanicus*	Atlantic sea scallop (official), giant scallop, smooth scallop, deep sea scallop, Digby scallop, ocean scallop
Skates	*Amblyraja radiata*	Thorny skate (official), mud skate, starry skate, Spanish skate
Skates	*Dipturus laevis*	Barndoor skate (official)
Skates	*Leucoraja erinacea*	Little skate (official), common skate, summer skate, hedgehog skate, tobacco box skate
Skates	*Leucoraja garmani*	Rosette skate (official), leopard skate
Skates	*Malacoraja senta*	Smooth skate (official), smooth-tailed skate, prickly skate
Skates	*Leucoraja ocellata*	Winter skate (official), big skate, spotted skate, eyed skate
Skates	*Raja eglanteria*	Clearnose skate (official), brier skate
Deep-Sea Red Crab	*Chaceon quinquedens*	Deep-Sea red crab (official)
Atlantic Herring	*Clupea harengus*	Atlantic sea herring (official), Labrador herring, sardine, sperling, brit

FMP	Species	Common Names
Atlantic Salmon	*Salmo salar*	Atlantic salmon (official), sea salmon, silver salmon, black salmon

3.2 Goals and objectives

The Council adopted the following habitat and groundfish management goals and objectives to address the purposes and needs for this action. The Council adopted goals 1-8 and objectives A-J in 2004, for designating EFH and minimizing adverse effects as required by the MSA. Much of the language of these goals and objectives is taken from the EFH regulations. In April 2011, the Council voted to expand the scope of Omnibus EFH Amendment 2 to include modification of groundfish closed areas. Specific goals and objectives for this expansion of scope were approved in November 2012. These include goals 9 and 10 and objectives K-N.

GOALS:

1. Redefine, refine or update the identification and description of all EFH for those species of finfish and mollusks managed by the Council, including the consideration of HAPCs;
2. Identify, review and update the major fishing activities (MSA and non-MSA) that may adversely affect the EFH of those species managed by the Council;
3. Identify, review and update the major non-fishing activities that may adversely affect the EFH of those species managed by the Council;
4. Identify and implement mechanisms to protect, conserve, and enhance the EFH of those species managed by the Council to the extent practicable;
5. Define metrics for achieving the requirements to minimize adverse impacts to the extent practicable;
6. Integrate and optimize measures to minimize the adverse impacts to EFH across all Council managed fishery management plans;
7. Update research and information needs;
8. Review and update prey species information;
9. Enhance groundfish fishery productivity;
10. Maximize societal net benefits from the groundfish stocks while addressing current management needs.

OBJECTIVES:

A. Identify new data sources and assimilate into the process to meet goals (state, federal and other data sources);
B. Implement review of existing HAPCs and consider modified or additional HAPCs (Goal 1);
C. Review EFH designations and refine or redefine where appropriate as improved data and analysis become available (Goal l);
D. Develop analytical tools for designation of EFH, minimization of adverse impacts, and monitoring the effectiveness of measures designed to protect habitat (Goal l, Goal 3 and Goal 5);

E. Modify fishing methods and create incentives to reduce the impacts on habitat associated with fishing (Goal 4);
F. Support restoration and rehabilitation of fish habitat which have already been degraded (by fishing and non-fishing activities) (Goal 4);
G. Support creation and development of fish habitat where appropriate and when increased fishery resources would benefit society (Goal 4);
H. Develop a strategy for prioritizing habitat protection (Goal 4);
I. Develop criteria for establishing and implementing dedicated habitat research areas (Goal 7);
J. Design a system for monitoring and evaluating the benefits of EFH management actions including dedicated habitat research areas (Goal 7);
K. Improved groundfish spawning protection; including protection of localized spawning contingents or sub-populations of stocks (Goals 9 and 10);
L. Improved protection of critical groundfish habitats (Goals 9 and 10);
M. Improved refuge for critical life history stages (Goals 9 and 10);
N. Improved access to both the use and non-use benefits arising from closed area management across gear types, fisheries, and groups. These benefits may arise from areas designed to address the other three groundfish closed area objectives. (Goals 9 and 10).

The Council also requested a mechanism for reviewing and updating spatial management areas.

3.3 Management background

The following sections outline major events in habitat and groundfish management, with a particular focus on seasonal and year-round area closure measures, especially current areas that are part of the No Action alternative for this amendment. In many cases, the general locations of management areas have remained consistent, but with adjustments over time to area boundaries, seasons, and prohibited vs. exempted gears. This summary is by no means a complete accounting of every area management measure, as the management system is complex and has undergone many changes over time. Its intent is to provide an overall picture of how the current measures evolved, as well as references to the original Council action so the reader can find additional details if desired. The dates listed in the following sections are typically the year in which the Council submitted an action, which is not necessarily the implementation date, which is generally 3-6 months later. All fishery management plan (FMP) documents are available from the Council website (http://nefmc.org), and most are posted online in PDF format by amendment or framework number.

3.3.1 EFH designations and habitat closed areas

As discussed in the "Purpose and Need", the Magnuson-Stevens Act requires councils to describe and identify essential fish habitat, defined as those "waters and substrates necessary to fish for spawning, breeding, feeding, or growth to maturity[3]," and "to minimize to the extent practicable the adverse effects on such habitat caused by fishing, and to identify other actions to

[3] Magnuson-Stevens Act definitions, Section 3(10)

encourage the conservation and enhancement of such habitat[4].” Prior efforts to minimize the adverse effects of Council-managed fisheries on EFH have been largely developed and implemented plan by plan, although fishery effects on EFH are cumulative across fishery management plans because fish and fishery distributions are overlapping across species and plans. In proposing this omnibus action, the Council desired to integrate adverse effects minimization measures across plans through actions that will apply to all New England Council-managed fishing activities.

Omnibus EFH Amendment 1 (OA1) identified and described EFH for all 18 species managed by the Council at that time of its development through the following FMP amendments: Northeast Multispecies Amendment 11, Atlantic Sea Scallop Amendment 9, and Atlantic Salmon Amendment 1. OA1 also identified the major threats to EFH from both fishing and non-fishing related activities and proposed conservation and enhancement measures and designated Habitat Areas of Particular Concern for Atlantic salmon and Atlantic cod. As the regulatory guidelines were not yet finalized, the Council relied on preliminary NMFS guidance when developing OA1. On March 1999, the Secretary of Commerce approved the amendments to all FMPs, with the exception of the amendment to Monkfish FMP. The EFH requirements of FMPs not included in the Omnibus Amendment of 1998 were completed on the following schedule: Monkfish FMP (April 1999), Red Crab FMP (October 2002), and Skate FMP (July 2003). Amendment 16 (2010) added Atlantic wolffish to the Northeast Multispecies FMP and designated EFH for the species. The EFH designation for offshore hake was implemented in Amendment 12 to the Multispecies FMP in 2000.

A 2000 Federal District Court ruling on a lawsuit brought by several environmental organizations (American Oceans Campaign et al. v. Daley et al.) required the Department of Commerce and through it, the Council to complete “a new and thorough EA or EIS” for each of the EFH amendments, in compliance with NEPA. The lawsuit challenged the adequacy of the fishing impact analysis in OA1 and the absence of any mitigation measures to minimize the adverse effects of fishing in the document. Although the EFH and Habitat Area of Particular Concern designations for the 18 species included in OA1 went into effect once OA1 was approved by the Secretary of Commerce, the court instructed the Department of Commerce and the Councils to:

- Prepare EISs for all fisheries challenged in the lawsuit.
- Comply with the requirements of all applicable statues, including NEPA; the Council on Environmental Quality (CEQ) NEPA implementing regulations, 40 C.F.R. Parts 1500-1508; and the National Oceanic and Atmospheric Administration (NOAA) Administrative Order 216-6.
- Include analyses of environmental impacts of fishing on EFH, including direct and indirect effects, as defined in the EFH regulations at 50 C.F.R. 600.810, and analyses of the environmental impacts of alternatives for implementing the requirement of the M-S Act, that the FMP “minimize, to the extent practicable, adverse effects on [EFH] caused by fishing.”

[4] Magnuson-Stevens Act, Section 303(a)(7)

- Consider a range of reasonable alternatives for minimizing the adverse effects (as defined by the EFH regulations) of fishing on EFH, including potential adverse effects. This range of alternatives will include "no action" or no action alternatives and alternatives set forth specifying fishery management actions that can be taken by NMFS under the M-S Act. The alternatives may include a suite of fishery management measures, and the same fishery management measures may appear in more than one alternative.
- Identify one preferred alternative, except that, in the draft EIS, NMFS may elect, if it deems appropriate, to designate a subset of the alternatives considered in the draft EIS, as the preferred range of alternatives, instead of designating only one preferred alternative.
- Present the environmental impacts of the alternatives in comparative form, thus sharply defining the issues and providing a clear basis for choice among the options, as set forth in CEQ regulation 40 C.F.R. 1502.14.

In response, the Council determined that the analysis and subsequent management alternatives required by the court order would be presented within a separate NEPA analysis developed by NMFS and the Council for the Northeast Multispecies and Atlantic Sea Scallop FMPs. According to the terms of a negotiated settlement with the plaintiffs, the Northeast Regional Office (now Greater Atlantic Regional Fisheries Office (GARFO)) also agreed to prepare a separate EFH amendment for the Atlantic Herring FMP. The fishing effects analysis for the monkfish fishery was completed in Amendment 2 to the Monkfish FMP in 2004. These documents were completed in 2004 and 2005, and included extensive analyses of the adverse effects of fishing on EFH, and a range of alternatives to address such effects. They included descriptions of regional fishing gears and habitats, and summaries of the existing knowledge on the effects of fishing gears on habitats for the 37 species managed by the New England and Mid-Atlantic Fishery Management Councils. The overall conclusion of the gear effects evaluations in these amendments was that EFH for a number of species with benthic life stages was vulnerable to the adverse effects of mobile bottom-tending gear and that the effects were more than minimal and not temporary in nature, and, therefore, required mitigation. The following is a list of species and life stages that were determined to be adversely affected according to gear type (E=eggs, L=larvae, J=juveniles, A=adults):

- Otter trawls: American plaice (J, A), Atlantic cod (J, A), Atlantic halibut (J, A), Atlantic sea scallop (J), haddock (J, A), ocean pout (E, L, J, A), red hake (J, A), redfish (J, A), white hake (J), silver hake (J), winter flounder (A), witch flounder (J, A), yellowtail flounder (J, A), red crab (J, A), black sea bass (J, A), scup (J), tilefish (J, A), barndoor skate (J, A), clearnose skate (J, A), little skate (J, A), rosette skate (J, A), smooth skate (J, A), thorny skate (J, A), and winter skate (J, A).
- New Bedford scallop dredge: Acadian redfish (J, A), American plaice (J, A), Atlantic cod (J, A), Atlantic halibut (J, A), Atlantic sea scallop (J), haddock (J, A), ocean pout (E, L, J, A), red hake (J, A), white hake (J), silver hake (J), winter flounder (J, A), yellowtail flounder (J, A), black sea bass (J, A), scup (J), barndoor skate (J, A), clearnose skate (J, A), little skate (J, A), rosette skate (J, A), smooth skate (J, A), thorny skate (J, A), and winter skate (J, A).
- Hydraulic clam dredges: Atlantic sea scallop (J), ocean pout (E, L, J, A), red hake (J), silver hake (J), winter flounder (A), yellowtail flounder (J, A), black sea bass (J, A), scup (J), clearnose skate (J, A), little skate (J, A), rosette skate (J, A), and winter skate (J, A).

Building on these conclusions, the documents evaluated measures designed to minimize the adverse effects of fishing on EFH. Specifically, they included the following management options:

- **Incidental benefits of other Amendment 10 and 13 measures:** Because management measures that were designed to reduce fishing mortality may also provide benefits to fish habitat, such management measures were explicitly considered as part of a formal strategy to reduce impacts on habitat.
- **Modification of current groundfish closed areas to protect habitat:** Modifications to the boundaries of the existing closed areas were proposed to better protect sensitive habitat. Some entirely new closed areas were proposed.
- **Identification of important habitat areas within current groundfish closures:** Areas within an existing closed area containing important habitat were identified. Such areas may be subject to more severe restrictions to protect habitat.
- **Closed areas designed to protect habitat and minimize impact on fisheries:** This alternative was proposed to close areas with important habitat elements that were of low value to the multispecies, scallop, and monkfish fisheries in terms of revenue.
- **Current closed areas, with the exception of scallop access areas:** The then-current year round closed areas were considered for designation as habitat closures, with the exception of portions of those areas that have been made accessible to the scallop fishery through time-limited openings.
- **Expand list of prohibited gears in closed areas:** This alternative would have expanded the number of types of fishing gears that may not be used in the closed areas to include shrimp trawls, herring mid-water trawls, clam dredges, and pots and traps.
- **Restrictions on the use of rockhopper and roller gear:** This alternative was proposed to restrict the use of rockhopper and roller trawl gear. Various alternatives with respect to the maximum size of the gear allowed were evaluated.

To assess the impacts of management alternatives on fish habitats, Amendment 10 (Atlantic Sea Scallop FMP) and Amendment 13 (Northeast Multispecies FMP) used various metrics to evaluate the management areas. Alternatives were ranked based primarily on various methods of summing the raw values provided by these metrics:

- Day-at-Sea (DAS) use
- Days absent, as reported in the Vessel Trip Reports (VTRs)
- Percent overlap with areas designated EFH
- Biomass inside/outside area closure alternatives for five trophic guilds and five spatio-temporal species assemblages
- Biomass inside/outside area closure alternative for six species with high levels of association with benthic habitats: longhorn sculpin, sea raven, redfish, ocean pout, jonah crab and American lobster
- Sediment composition inside/outside area closure alternatives based on the Poppe et al. (1989) dataset

Ultimately, Amendment 13 to the Northeast Multispecies FMP adopted the following measures to minimize the adverse effects of fishing on EFH to the extent practicable:

- Effort reductions, by significantly reducing DAS reductions and including seasonal closures
- Area closure, by designating new areas both inside and outside then-existing year-round closures as "habitat closure areas" to reduce the effect of fishing on benthic habitats

Amendment 10 to the Atlantic Sea Scallop FMP implemented the following measures in 2004:

- Effort reductions, by significantly reducing DAS reductions and including seasonal closures
- Area closure, by designating new areas both inside and outside then-existing year-round closures as "habitat closure areas" to reduce the effect of fishing on benthic habitats
- Gear modifications that increased dredge ring size to 4" throughout fishery, which were shown through analysis to be more efficient than 3.5" rings and therefore minimized bottom contact time

The following year, 2005, Monkfish Amendment 2 implemented two EFH areas closed to vessels fishing on a monkfish DAS in Lydonia and Oceanographer canyons.

3.3.2 Groundfish area closure history

Spatial management of groundfish fishing has a long and complicated history in New England. Seasonal and year round closed areas have been used to meet many objectives, including to protect spawning cod and haddock on Georges Bank, reduce discards of small yellowtail flounder in Southern New England, as a means to reduce mortality on certain overfished groundfish stocks and make Day-at-Sea management more effective, and in the Gulf of Maine to reduce discards caused by possession limits on Gulf of Maine cod.

In 1974, the International Commission for Northwest Atlantic Fisheries (ICNAF), precursor to the Northwest Atlantic Fisheries Organization (NAFO), implemented bottom-trawling closures on Georges Bank to protect large mesh species, particularly cod and haddock (Halliday and Pinhorn, 1996). These restrictions at first applied to large vessels over 155 ft. in overall length and eventually to smaller 130 ft. vessels, reducing foreign factory trawl activity.

In 1977, the Council's Fishery Management Plan for Atlantic Groundfish was implemented via emergency secretarial action (42 FR 13998). This plan included two area closures on Georges Bank that were closed to fishing gears other than hook gear larger than 3 cm, scallop dredges, and lobster pots and pelagic gears during March, April, and May (Map 15).

The 1981 Interim Fishery Management Plan for Atlantic Groundfish (Interim Plan) modified the boundaries of Closed Area I (Map 15). In 1985 under the Northeast Multispecies FMP, which replaced the Interim Plan, the Council incorporated the Closed Area I and Closed Area II spawning closures with the 1981 boundaries. The Closed Area I season started in February, a month earlier than under the Interim Plan, and extended into May, opening after April 30 at the NMFS Regional Administrator's discretion. The season for the Closed Area II spawning area was coordinated with Canada. The Southern New England Yellowtail Flounder closure (west of the current Nantucket Lightship Area, see Map 15) was also adopted in the 1985 FMP. This area was closed seasonally to reduce mortality and enhance spawning opportunity for yellowtail flounder. Specifically, areas east of 71°30' W closed March 1, while areas west of 71°30' W closed April 1. The areas remained closed as far into May as the Council determined was appropriate to achieve objectives of FMP.

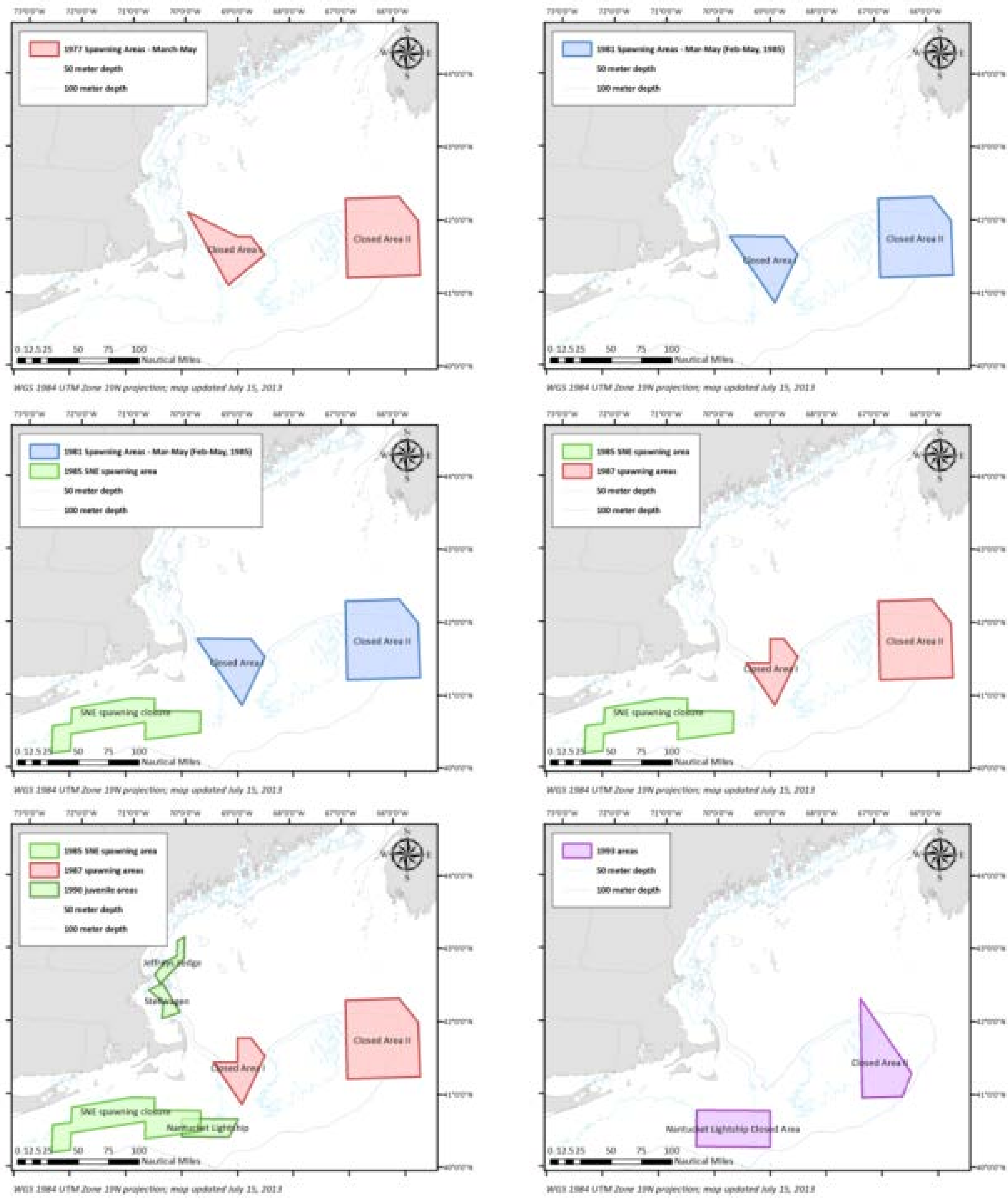
In 1987, the Council's Technical Monitoring Group (TMG) evaluated these spawning closures and removed the northwest corner of Closed Area I, and recommended moving the area south and east via a subsequent action. This change was implemented via Amendment 1 (Map 15). For the Southern New England closed area, Amendment 1 added a prohibition on scallop dredge gear due to yellowtail flounder bycatch concerns, and an exemption for hook and line fishing with zero possession of yellowtail flounder.

Amendment 2 (1989) established a seasonal large-mesh closed area on Nantucket Shoals to protect cod, and excluded trawlers from transiting Closed Area II during the seasonal closure to improve enforcement.

Amendment 3 (1989) implemented the Flexible Area Action System, designed to rapidly identify and implement spatial management in response to changing resource conditions. However, this management framework was never successfully used. Amendment 4 (1990) implemented three areas related to juvenile groundfish protection, the Nantucket Lightship Area in Southern New England for yellowtail flounder, and the Jeffreys Ledge and Stellwagen Bank areas for juvenile cod (Map 15). The Nantucket Lightship area closure was triggered by large concentrations of juvenile yellowtail flounder in the sea sampling data. The Jeffreys and Stellwagen areas were triggered by high juvenile cod discard rates in the sea sampling data. Measures were taken in two stages, with 5.5 inch mesh required first, and a mobile bottom-tending gear closure if high discards persisted. These measures were never implemented because the criteria for triggering them were not met before they were changed in a subsequent amendment.

Amendment 5 to the NE Multispecies FMP was implemented on May 1, 1994 to reduce fishing effort below overfishing limits with the introduction of limited access and day-at-sea limits. In the western Gulf of Maine, Amendment 5 implemented a six-inch square mesh requirement in the Jeffreys Ledge Juvenile Protection Area (fifth panel on Map 15). This L-shaped area extended from the northern-most part of Jeffreys Ledge, including the fingers, and down nearly to the state waters boundary off Cape Ann, Massachusetts. In addition, Amendment 5 suspended Closed Area I, expanded the size of Closed Area II to its current footprint, and created the Nantucket Lightship Closure as it exists today (Map 15). Secretarial action in late 1994 implemented all three areas year round on an emergency basis, modifying the boundaries of CAI to what they are today (Map 16). The Council adopted these areas year-round via Framework 9 (1995) to rebuild Georges Bank fish stocks. Except for tightly defined special access programs to target healthy stocks (starting in 2004) and access programs for scallop fishing (starting in 1999), these areas have remained closed to gears capable of catching regulated groundfish. Currently, recreational and party/charter fishing for groundfish is prohibited in CAI and CAII but allowed in the Nantucket Lightship Closed Area.

Map 15 – Groundfish spatial management, 1977-1993



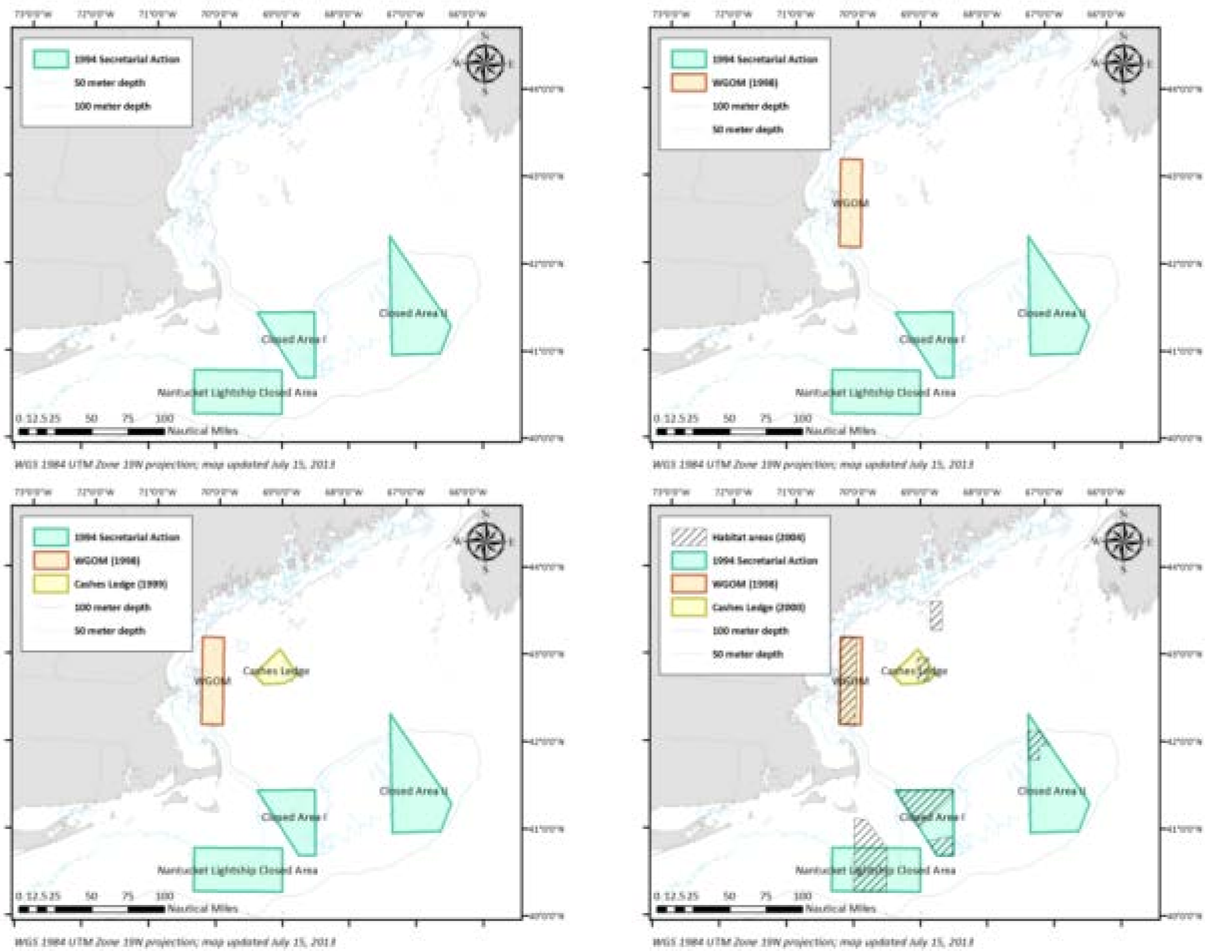
Amendment 7 (1996) recognized that area closures would eventually be developed in the Gulf of Maine on a year round basis. As an interim measure, this amendment extended two seasonal closures that were previously closed to gillnets only for harbor porpoise protection to all vessels to reduce groundfish mortality. These were the Massachusetts Bay closure during March and the Mid-Coast Closure during November and December. These were unpopular among fishermen and efforts to modify them began almost immediately. Framework 19 (October 1996) adopted a March closure of the two thirty-minute squares over Jeffreys Ledge; the plan was to revert to the Mid-Coast Closure during the 1998 fishing year, and change the dates to May, but the Western Gulf of Maine Closure Area was implemented instead, as described below.

Up until 1998, there were no year-round groundfish closed areas in the Gulf of Maine. During the late 1990s, it became apparent that the Amendment 7 day-at-sea allocation to limited access groundfish vessels of 88 days was too high to prevent overfishing, particularly for cod. Fishermen were opposed to reducing days-at-sea allocations because it would limit their ability to target and catch healthier stocks. Therefore in addition to other measures like possession limits to reduce the incentive to target certain species, Framework Adjustment 25 (1998) included year-round closure of the Western Gulf of Maine Closure Area as it is currently configured (Map 16), as well as one month rolling closures during March and June. Most of the rolling closure blocks were inshore, but block 129 that overlaps Cashes Ledge was closed during June. The purpose of the rolling closures was to avoid reducing day-at-sea allocations to allow vessels to fish on healthy stocks and on Georges Bank, while reducing Gulf of Maine cod mortality and cod discards. Note that the Western Gulf of Maine Closure Area was originally intended as a temporary year-round closure; it was extended via various actions including Framework 33 (2000), as the result of lawsuit filed in response to Framework 33, and finally indefinitely via Amendment 13 (2003). During Amendment 13 development, many alternate versions of the Western Gulf of Maine closure were discussed, but none were formally analyzed in the DEIS.

Framework 26 (1998) modified the months and blocks of the rolling closures, increasing the amount of area closed to groundfishing on a monthly basis. There was also a Northeast Closure area in effect in the eastern Gulf of Maine during this time. In 1999, Framework 27 reconfigured block 129 to the current boundaries of the Cashes Ledge groundfish area (Map 16), and the closure period was expanded to four months (July-October). Framework 27 also enacted the 12 inch maximum roller gear size in the western Gulf of Maine as a measure to reduce fishing effort on Gulf of Maine cod, and to achieve some separation between offshore and inshore vessels. It was expected that the roller gear size restriction would "limit the ability of mobile gear vessels to fish in hard bottom areas inshore, where cod and other species aggregate" (Framework 27, p 16).

In 2000, Framework 33 added a November conditional closure for Cashes Ledge, which was triggered if 50% of the Target Total Allowable Catch (TTAC) for Gulf of Maine cod was reached by July 31 of that year. Cashes Ledge was closed to groundfishing year-round by Secretarial action on May 1, 2002, as a result of a settlement agreement among certain parties in the Conservation Law Foundation et al. v. Evans lawsuit. The year-round closure was extended by the Council in 2003 as part of Amendment 13 to the NE Multispecies FMP. This action also designated the habitat closures described in the previous section, including one on Cashes Ledge. Like Closed Area I, Closed Area II, and the Nantucket Lightship Area, the Western Gulf of Maine and Cashes Ledge Closure Areas prohibit fishing by gears capable of catching groundfish. Recreational fishing for groundfish was, and is currently, allowed.

Map 16 – Groundfish spatial management, 1994-present. Gulf of Maine rolling closures in effect from 1998 onward are not shown on these figures.



All these various restrictions became increasingly onerous to the groundfish fleet, reducing the flexibility to make sound fishing and business decisions. Day-at-sea leasing adopted under Amendment 13 helped, but did not resolve the conundrum and day-at-sea management was being seen as ineffective in achieving rebuilding targets for multiple stocks simultaneously. In response, the Council developed and adopted a new form of catch share management in Amendment 16 (2010). Catch share management allocates specific percentages of allowable catch to "sectors", based on the collective contributions from the individual permits that comprise an individual sector. The sectors must submit, for approval, operation plans that specify which vessels belong to each sector and how they would operate and monitor their vessels' catch and landings. This form of management made the sectors accountable for their overages of groundfish catches, but also allowed them to pool groundfish allocations among member vessels.

The sector vessels were also often exempted from possession limits for allocated stocks because possession limits were no longer necessary to manage fishing mortality. For sector vessels, which landed over 95% of groundfish species, Amendment 16 reduced the size and temporal extent of the rolling closures to the most critical blocks during April, May, and June. Sectors were allowed to and many did apply for exemptions to these smaller areas, but to date no rolling closure exemption requests have been approved as part of a sector operations plan.

The Gulf of Maine Cod Spawning Protection Area was developed in Framework 45 and implemented at the start of the 2011 fishing year. The area, also known as the "Whaleback" area, is closed between April 1 and June 30 to all groundfishing. The primary effect was to restrict recreational vessels, except those fishing exclusively with pelagic hook and line gear, from an area south of the Isle of Shoals off the coast of New Hampshire. Except for sector vessels in June, commercial groundfish vessels were already excluded from fishing in the area as a result of the rolling closures.

Low annual catch limits for certain groundfish stocks proposed for fishing year 2013 led the Council to consider measures that might mitigate economic and social impacts of such reductions. NE Multispecies Framework 48 (implemented in 2013) included a measure that allows sector vessels to request exemptions from parts of the year-round groundfish closed areas that are not within existing habitat closures or new habitat management areas proposed via OA2. As is the case with other types of sector exemption requests, requests to access these exemption areas are made and analyzed annually via sector operations plans. In July 2013, NMFS described the range of exemption requests they would grant and under what conditions. Sector vessels were allowed restricted access to portions of the Nantucket Lightship Closed Area for part of the 2013 fishing year, as well as fishing year 2014. Additional research is being conducted through exempted fishing permits to determine if it is feasible (i.e., economically profitable and biologically sustainable) for vessels to fish in Closed Areas I and II to target haddock using selective trawl gears.

3.4 Notices of intent, scoping, and the amendment development process

The Council published the original Notice of Intent to prepare EFH Omnibus Amendment 2 in February 2004, and in September 2005 the Council declared its intent to complete the Omnibus Amendment in two phases, to make the process more transparent to the public and to reduce management complexity. Phase 1 included a review and update of EFH designations and consideration of Habitat Areas of Particular Concern (not including consideration of management measures or restrictions), an update of the prey species list, an update of non-fishing impacts, and an update of research and information needs (since moved to Phase 2). The Phase 1 work was published in a draft Environmental Impact Statement in April 2007. The Council approved the preferred EFH and Habitat Area of Particular Concern designations, as well as the prey species and non-fishing impacts summaries, in June 2007. An additional Habitat Area of Particular Concern in the Great South Channel was approved in September 2007.

Phase 2 included a review and update of a gear effects evaluation and alternatives to optimize management measures for minimizing the adverse effects of fishing on EFH across all FMPs. In late 2007, the Habitat Committee and Plan Development Team began work on Phase 2. From late 2007 through early 2010, the group worked to develop an updated approach (the Swept Area Seabed Impact model) for estimating the magnitude and distribution of the adverse effects of fishing on EFH. In 2009, the Council clarified via an additional notice of intent that it would not publish a final version of the Phase I EIS, but would instead incorporate all Phase 1 elements in a single EIS covering both phases. In spring 2010, the Council's Habitat Oversight Committee used the model outputs and related information to begin development of alternatives to optimize and integrate adverse effects minimization measures across all Council-managed fisheries. These alternatives were substantially developed by August 2011, although additional modifications were made up until the Council approved the alternatives for analysis in June 2013. Dedicated habitat research areas were developed during 2011 and 2012. Minor adjustments to the EFH designations approved during Phase 1 were also completed between 2009 and 2011. This document incorportates all necessary elements of the Phase 1 EIS, which was published in draft format prior to public hearings but never finalized.

Meanwhile, mitigation of fishing impacts to deep-sea corals was added to the amendment shortly after the deep-sea coral discretionary authority was added to the MSA via the 2007 reauthorization. The range of alternatives for analysis was approved by the Council in April 2012, but moved into a separate omnibus action in September 2012. Work on this action will be completed once OA2 is completed, although relevant data gathering efforts are ongoing.

In April 2011, the Council added to the scope of the amendment an evaluation of groundfish management areas, which have substantial spatial overlap with existing habitat management areas. A notice of intent seeking comments on this issue was published in June 2011. Other Council priorities related to groundfish prevented significant progress on this evaluation and the development of new measures until a dedicated, ad-hoc technical team (the Closed Area Technical Team) was convened in August 2012. The technical team drafted goals and objectives for the groundfish elements of the amendment. These were reviewed by the Groundfish PDT and Committee and approved by the Council in November 2012. After completing analyses of the sector groundfish closed area exemption alternative for NE Multispecies Framework 48, the technical team turned its attention to development of OA2 measures in January 2013.

In May and June 2013, the habitat and groundfish technical teams and committees began meeting jointly to finalize a range of spatial management alternatives for Council approval. These alternatives were developed for spawning protection, adverse effects minimization, protection of juvenile groundfish habitats, and designation of dedicated habitat research areas. The Council approved a set of management alternatives for analysis at their June 2013 meeting.

In August 2013, Council staff convened a series of informational meetings to gather information and feedback on the alternatives from industry members, focusing on those who had not previously engaged in the process.

In September and December 2013, the Council made a series of adjustments to the spatial management alternatives. In February 2014, the Council added additional habitat management alternatives for analysis, made more minor adjustments to other alternatives, selected preferred alternatives, and approved the DEIS for initial submission to NMFS. A public comment period will accompany the formal publication of the DEIS during fall 2014.

4 Description of the affected environment

The purpose of this section of the document is to describe the physical, biological, and human elements of the environment as they relate to the management alternatives being analyzed.

4.1 Linkages between habitat and fishery productivity

Information linking managed species of fish to the habitats they occupy and the functional value of those habitats in enhancing fishery resource productivity is crucial in order to identify habitat management measures that will minimize the adverse effects of fishing to the extent practicable. The productivity of a population is a function of recruitment, the process by which younger age groups are added to the population, and growth rates of members. Processes that increase the number of small fish that reach a size at which they enter, or recruit to, the population and/or the rate at which they reach the size at recruitment, build stock biomass. Recruitment is affected by a number of factors, including the number and sizes of spawning fish, the feeding success of young fish, predation, and environmental variables such as temperature and the availability of suitable habitats that affect the survival of eggs, larvae, and pre-recruit age groups of fish (i.e., for shelter from predators, from currents, and for access to prey). Recruitment failures and mortality of adults reduce the abundance of fish available for a sustainable harvest.

Because recruitment is affected by so many factors, it is very difficult to quantify the link between recruitment and habitat protection. There are many cases in which large year classes of fish are produced and sustain exploited populations for years once they reach harvestable sizes without any clear explanation as to what processes caused such high survival of the early life history stages (e.g., the 2003 year class of haddock in the Georges Bank-Gulf of Maine region). However, because recruitment is a function of growth and survival, habitat types that are linked to higher survival and/or growth rates of juvenile fish would benefit from conservation measures designed to minimize the adverse effects of fishing (if those habitat types are vulnerable to the impacts of fishing). The underlying premise of this amendment is that there are habitats linked to higher survival and/or growth rates of juvenile fish which are vulnerable to the adverse effects of fishing. By protecting these habitats, recruitment rates will increase. By increasing recruitment rates, the productivity of managed species with life stages that rely on those vulnerable habitats will increase.

There are a number of studies demonstrating the importance of complex bottom habitats in providing optimum conditions that enhance the survival of recently-settled and older juvenile fish. Complex, highly-structured benthic habitats are relatively rare in continental shelf waters and are used by many species to reduce predation risk and provide food (Caddy 2008, 2013). If suitable habitats are limited, or if the abundance of juveniles that rely on these critical habitats exceeds the amount of suitable habitat that is available, ecological “bottlenecks” to recruitment are created. Fishing gears and practices that reduce the quality and quantity of suitable habitat for these species can be expected to reduce recruitment rates and stock productivity.

Cod have been the subject of a considerable amount of research in the Northwest Atlantic aimed at defining the affinity of different life stages with complex bottom habitats and the effect of habitat type on growth and survival, particularly for the younger age groups. Several studies in

U.S. and Canadian waters have shown that cod move into deeper water as they grow (Tremblay and Sinclair 1985; Wigley and Serchuk 1992; Anderson and Gregory 2000; Dalley and Anderson 2000, Howe et al 2002). A number of field studies conducted in shallow water show that survival rates of juvenile cod were higher in more structured habitats (e.g., in vegetation or rocky reefs and on cobble bottoms) where they find refuge from predators (Linehan et al. 2001, Tupper and Boutilier 1995). In one of these studies, growth rates were also higher in vegetated habitats. Laboratory experiments performed in habitat types of varying complexity with and without predators present have confirmed that juvenile cod, especially young-of-the-year juveniles, survive better in more structured habitats where they are less susceptible to predation (Lindholm et al. 1999, Borg et al. 1997, Gotceitas et al. 1995, and other refs). Lindholm et al. (2001) used a dynamic model to link patterns in habitat-mediated survivorship of post-settlement juvenile cod with spatial variations in habitat complexity. Model results demonstrated that patterns in the relationship between juvenile cod survivorship and density as well as movement rate were similar regardless of the density-dependent nature of predation, that juvenile cod movement rates and post-settlement density were critical for predicting the effects of marine protected-area size on survivorship, and that habitat change caused by fishing had significant negative effects on juvenile cod survivorship.

In deeper water, Lough et al. (1989) used submersible and trawl survey data to show that recently-settled cod and haddock were found primarily on a large pebble-gravel deposit in the northeastern edge of Georges Bank at depths of 70-100 meters. They hypothesized that the gravel habitat (inclusive of the epifaunal invertebrates that provided cover) favors their survival through predator avoidance and may be essential to the recruitment success of the Georges Bank gadid population. In a follow-up paper, Lough (2010) used 1986 and 1987 estimates of pelagic juvenile abundance to estimate settlement mortality rates of 3 to 8% per day. Because the juveniles were much more abundant in 1987 than in 1986, but recruitment at age 1 in both years was similar, he concluded that the mortality of demersal juveniles was much higher in 1987 and that the limited gravel on the northern edge of the bank area may represent a survival bottleneck.

Evidence that complex habitats enhance the survival of juvenile fish in other habitat types is provided by research done in sandy bottom habitats in the Mid-Atlantic Bight. Here, structure is provided by bedforms (sand waves) of varying heights and biogenic structure such as animal tubes, shell and shell aggregation, or pits created by various species (Steves and Cowen 2000, Sullivan et al. 2006). Similar habitat types exist on Georges Bank and in southern New England and in areas of sandy sediment in the Gulf of Maine (Auster et al. 1995, 1998, Langton et al. 1995). Diaz et al. (2003) found more fish associated with larger bedforms that had some biogenic structure. Proximity of complex and simple habitats was important in providing refuge from predators in more complex habitats during the day and foraging opportunities in simpler habitats at night. Such diel patterns of habitat use would be expected to enhance survival and growth. Scharf et al. (2006) exposed prey species of fish (winter flounder, scup, and black sea bass) to predation in habitats of varying complexity in the laboratory and showed that survival increased with greater habitat complexity (bare sand, shell, and sponge). Significant species/habitat interactions implied that the impact of reduced seafloor complexity may be more severe for some species than for others.

4.2 Physical and biological environment including benthic habitats

The Northeast U.S. Shelf Ecosystem has been described as the Gulf of Maine south to Cape Hatteras, extending from the coast seaward to the edge of the continental shelf, plus the slope sea offshore to the Gulf Stream, out to a depth of 2000 m (Sherman et al. 1996). Four distinct sub-regions comprise the ecosystem: the Gulf of Maine (Gulf of Maine), Georges Bank (GB), the Mid-Atlantic Bight (MAB), and the continental slope. Essential Fish Habitats for New England Council-managed species are identified throughout this entire region, although spatial management alternatives focus on the continental shelf, particularly the Gulf of Maine and Georges Bank regions. This section of the document describes the oceanography, geology, and biology of these regions, with a particular focus on benthic habitats. Biological information is focused on non-target resources including benthic invertebrates and non-managed species of fish; managed fishery species and protected resources including turtles, mammals, sturgeon, and salmon are discussed separately in sections 4.2.2 and 4.8, respectively.

Much of this summary was extracted from Stevenson et al. (2004), which is based primarily on the following sources: Backus 1987, Schmitz et al. 1987, Tucholke 1987, Wiebe et al. 1987, Cook 1988, Reid and Steimle 1988, Stumpf and Biggs 1988, Abernathy 1989, Townsend 1992, Mountain 1994, Beardsley et al. 1996, Brooks 1996, Sherman et al. 1996, Dorsey 1998, and Kelley 1998.

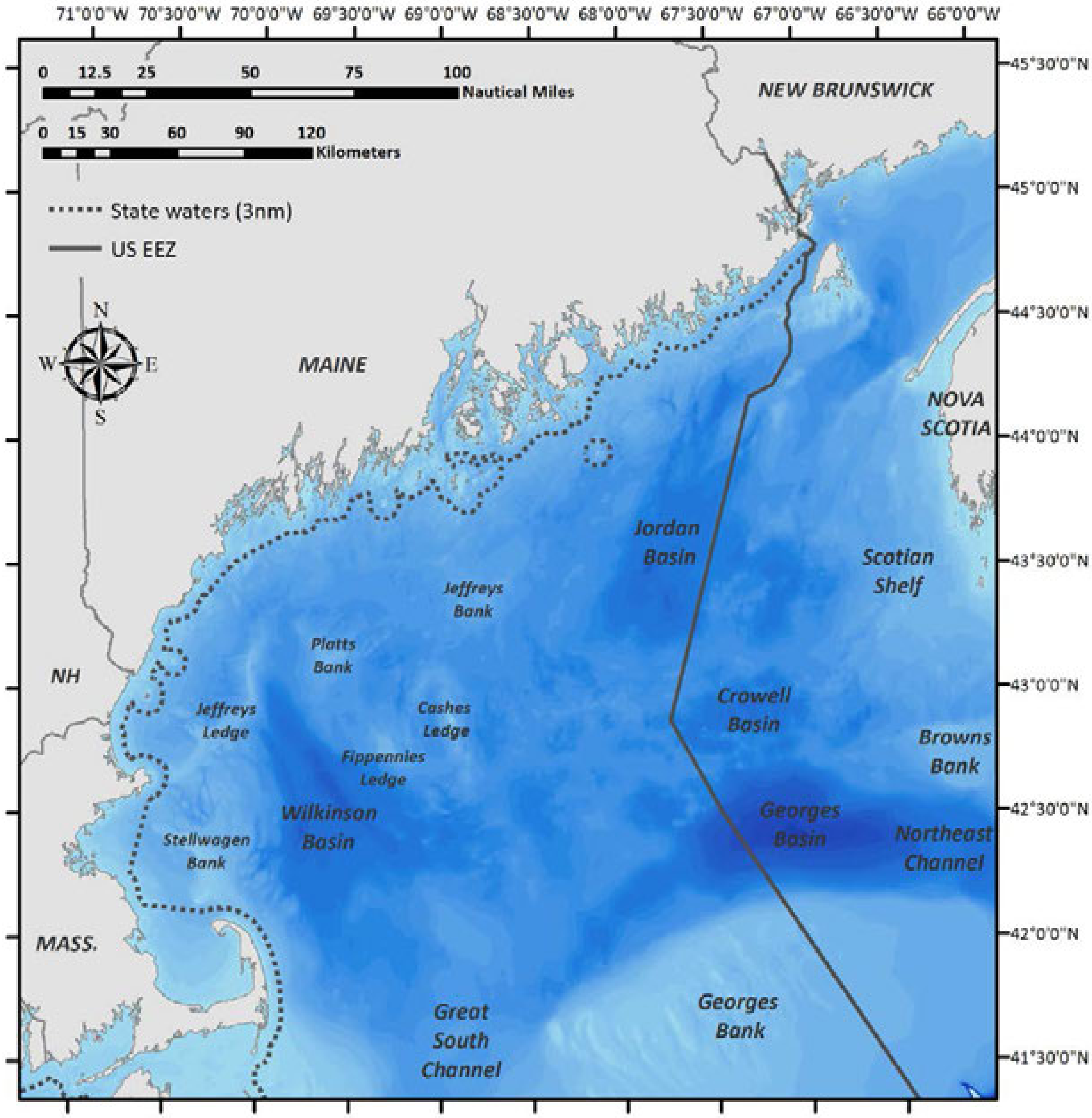
4.2.1 Oceanographic and sedimentary features and benthic fauna

4.2.1.1 Gulf of Maine

The Gulf of Maine (Map 17) is an enclosed coastal sea, bounded on the east by Browns Bank, on the north by the Nova Scotian Shelf, on the west by the New England states, and on the south by Cape Cod and Georges Bank. The Gulf of Maine is glacially derived, and is characterized by a system of deep basins, moraines and rocky protrusions with limited access to the open ocean. This geomorphology influences complex oceanographic processes that in turn produce a rich biological community.

The Gulf of Maine’s geologic features, when coupled with vertical variations in water properties, result in a great diversity of habitat types. There are twenty-one distinct basins separated by ridges, banks, and swells. The three largest basins are Wilkinson, Georges, and Jordan. Depths in the basins exceed 250 m, with a maximum depth of 350 m in Georges Basin, just north of Georges Bank. The Northeast Channel between Georges Bank and Browns Bank leads into Georges Basin, and is one of the primary avenues for exchange of water between the Gulf of Maine and the North Atlantic Ocean.

Map 17 – Bathymetric features of the Gulf of Maine. Data are from the Nature Conservancy's Northwest Atlantic Marine Ecoregional assessment and ETOPO1 Global Relief Model.



Sediment types

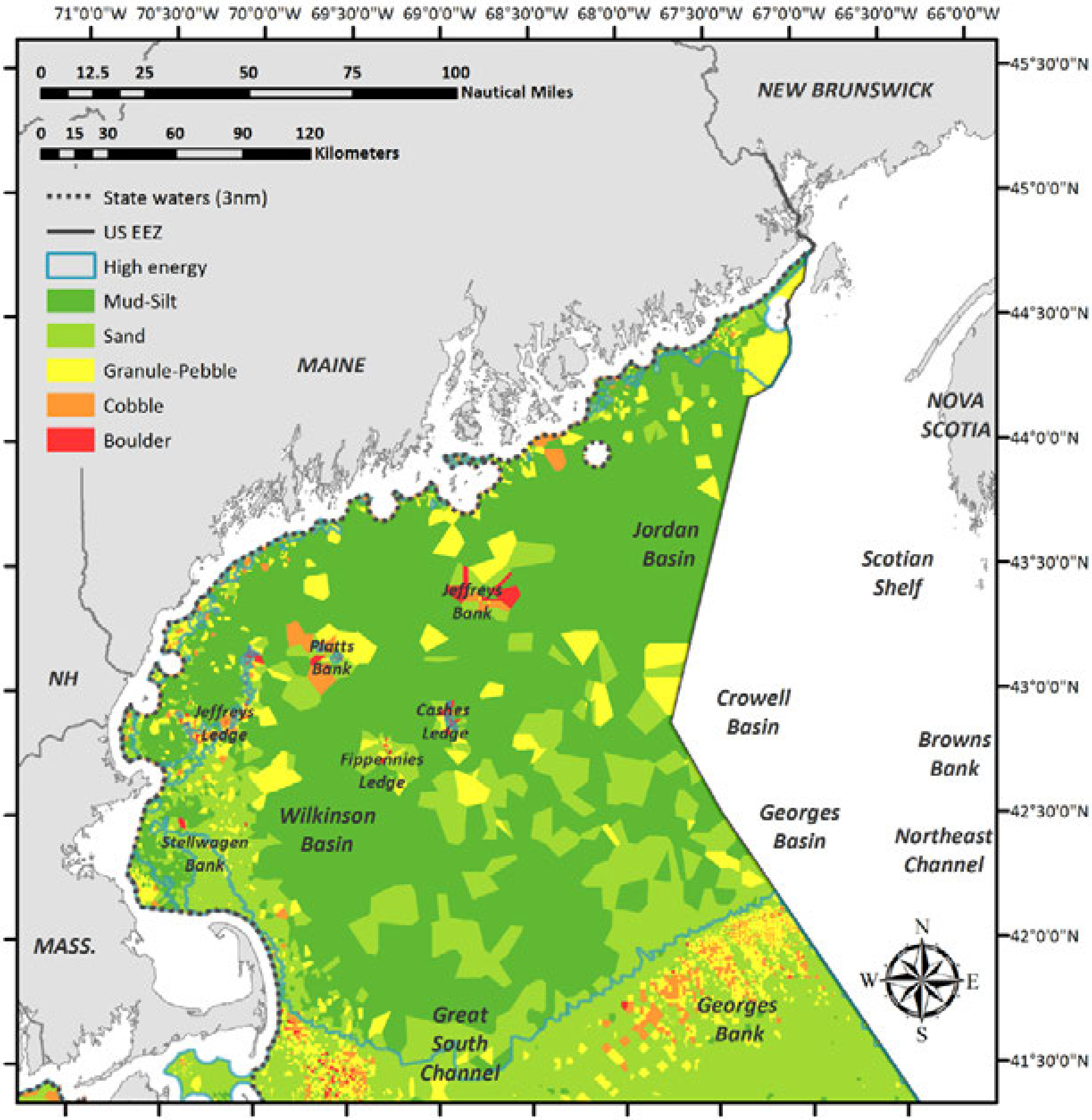
High points within the Gulf of Maine include irregular ridges, such as Cashes Ledge, which peaks at 9 m below the surface, as well as deeper flat topped banks, ridges, and gentle swells. Some of these rises are remnants of the sedimentary shelf that was left after most of it was removed by the glaciers. Others are glacial moraines and a few, like Cashes Ledge, are outcroppings of bedrock. Very fine sediment particles created and eroded by the glaciers have collected in thick deposits over much of the Gulf of Maine, particularly in its deep basins. These mud deposits can blanket and obscure the irregularities of the underlying bedrock, forming topographically smooth terrains. In some areas bedrock protrudes above the sediment layer forming isolated habitats. Some shallower basins are covered with mud as well, including some in coastal waters. In the rises between the basins, other materials are usually at the surface. Unsorted glacial till covers some moraines, as on Sewell Ridge to the north of Georges Basin and on Truxton Swell to the south of Jordan Basin. Sand predominates on some high areas and gravel, sometimes with boulders, predominates on others.

Map 18 depicts dominant sediment type mapped as an unstructured or Voronoi grid, where polygon size reflects data density (i.e. the smaller grid, the more data points there are in that location). This sediment map was developed for use in the Swept Area Seabed Impact model and details can be found in Section 4.1 and the SASI appendix. The muddier basins as well as hard-substrate shallower areas are shown in dark green to red coloration. Higher versus lower energy habitats are delimited by the blue line, with higher energy habitats inshore and on the tops of features including Cashes Ledge, Platts Bank, Jeffreys Ledge, and Stellwagen Bank. In the Gulf of Maine, a depth cut-off of 60 m was used to distinguish high versus low energy habitats. In general, sediment data are fairly low resolution in many parts of the Gulf of Maine. However, one feature that has been mapped in detail is Stellwagen Bank (Map 19).

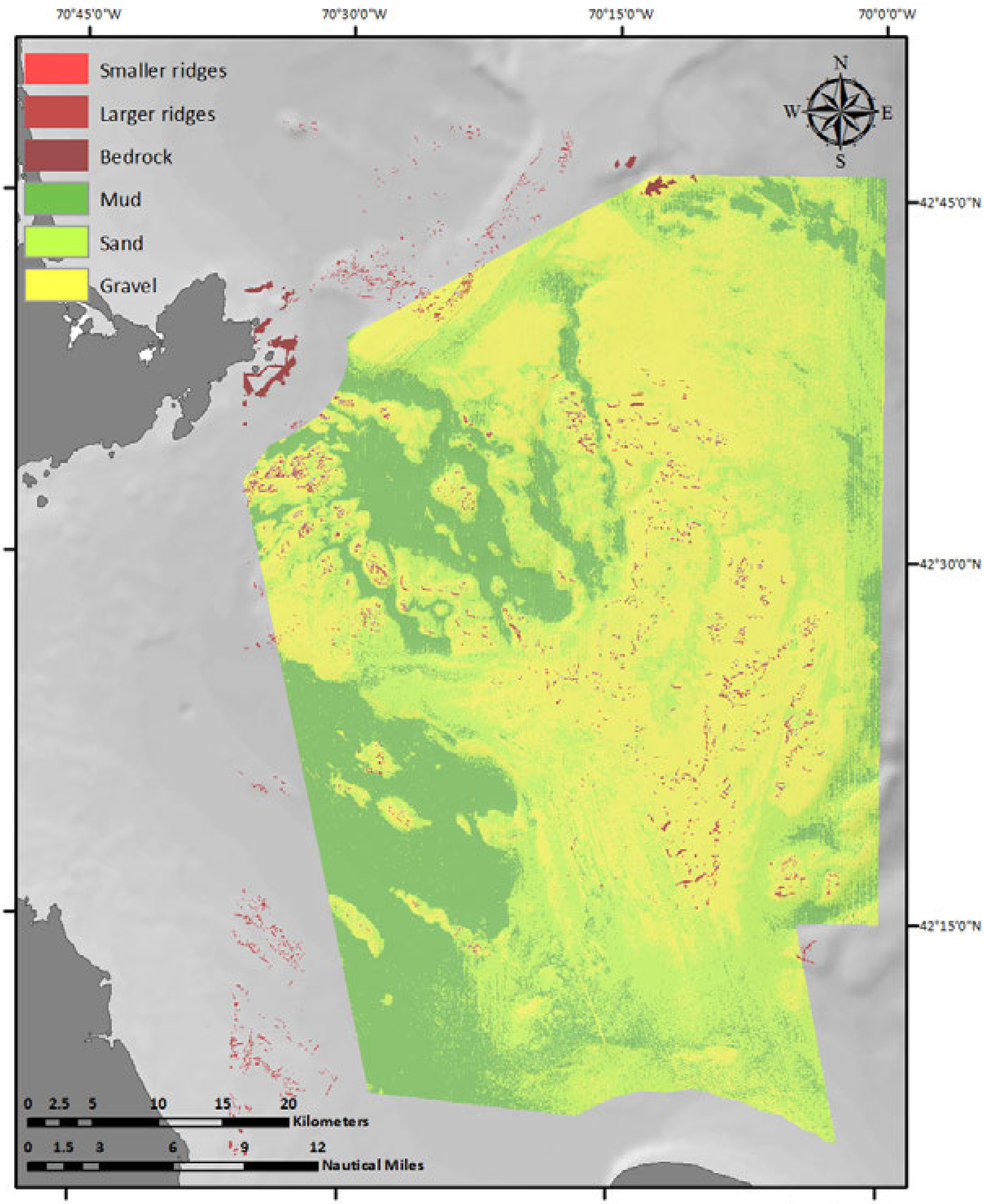
Coastal sediments exhibit a high degree of small-scale variability. Bedrock is the predominant substrate along the western edge of the Gulf of Maine north of Cape Cod in a narrow band out to a depth of about 60 m. Rocky areas become less common with increasing depth, but some rock outcrops poke through the mud covering the deeper sea floor. On the inner continental shelf, mud is the second most common substrate, and it predominates in coastal valleys and basins that often abruptly border rocky substrates. Many of these basins extend without interruption into deeper water. Gravel, often mixed with shell, is common adjacent to bedrock outcrops and in fractures in the rock. Large expanses of gravel are not common, but do occur near reworked glacial moraines and in areas where the seabed has been scoured by bottom currents. Gravel and bedrock are most abundant at depths of 20-40 m, except in eastern Maine where a gravel-covered plain exists to depths of at least 100 m (and in some areas beyond 200 m, for example in western Jordan Basin and at Schoodic Ridges). Bottom currents are stronger in eastern Maine where the mean tidal range exceeds 5 m. Sandy areas are relatively rare along the inner shelf of the western Gulf of Maine, but are more common south of Casco Bay, especially offshore of sandy beaches. The best sediment map of the northern inshore Gulf of Maine is the Maine Bottom Type map developed by Barnhardt et al (1998). These sedimentary features to roughly 100 m depth were delineated using acoustic backscatter data. The four primary classifications, mud, sand, gravel, and rock, are shown in Map 20 (western Maine coast), Map 21 (central Maine coast), and Map 22 (eastern Maine coast).

Massachusetts has developed a sediment map for their state waters as part of their ocean planning efforts. An initial plan was released in 2009, and an updated map (Map 23) has been developed subsequently, based on recent sampling efforts undertaken by the Coastal Zone Management-U.S. Geological Survey (USGS) Seafloor Mapping Cooperative (Regional Sediment Resource Management Workgroup 2014). Closer to shore within the Masssachusetts Ocean Management Planning Area (outlined in black on the map), sediment maps were generated based on ground-truthed acoustic datasets. For the entirety of Massachusetts state waters, a sediment map was created using a Voronoi tesselation approach, where a polygon is drawn around each substrate sample and cell size varies based on data density. The latter analytical approach is very similar to that used in the regional SASI maps, in relies on the same usSEABED dataset. Both approaches identify a dominant sediment type and in many cases, a secondary sediment type (e.g. rock with gravel, sand with rock). Similar to patterns observed along the Maine coast, Massachusetts state waters have a patchy distribution of rock, gravel, sand, and mud-dominated areas. As compared to the Maine coast, there is a higher proportion of sand habitat, especially off Cape Cod and the Islands. Also similar to SASI, the sediment map includes a data quality layer. Generally, there is very high or high data quality in Massachusetts Bay out to the 3nm limit, and in Buzzards Bay out to the northern coast of Martha's Vineyard. Data quality is lower around the outer Cape, in Nantucket Sound, around the island of Nantucket, and south of Martha's Vineyard.

Map 18 – Sedimentary features of the Gulf of Maine. Data sources include usSEABED and SMAST video.

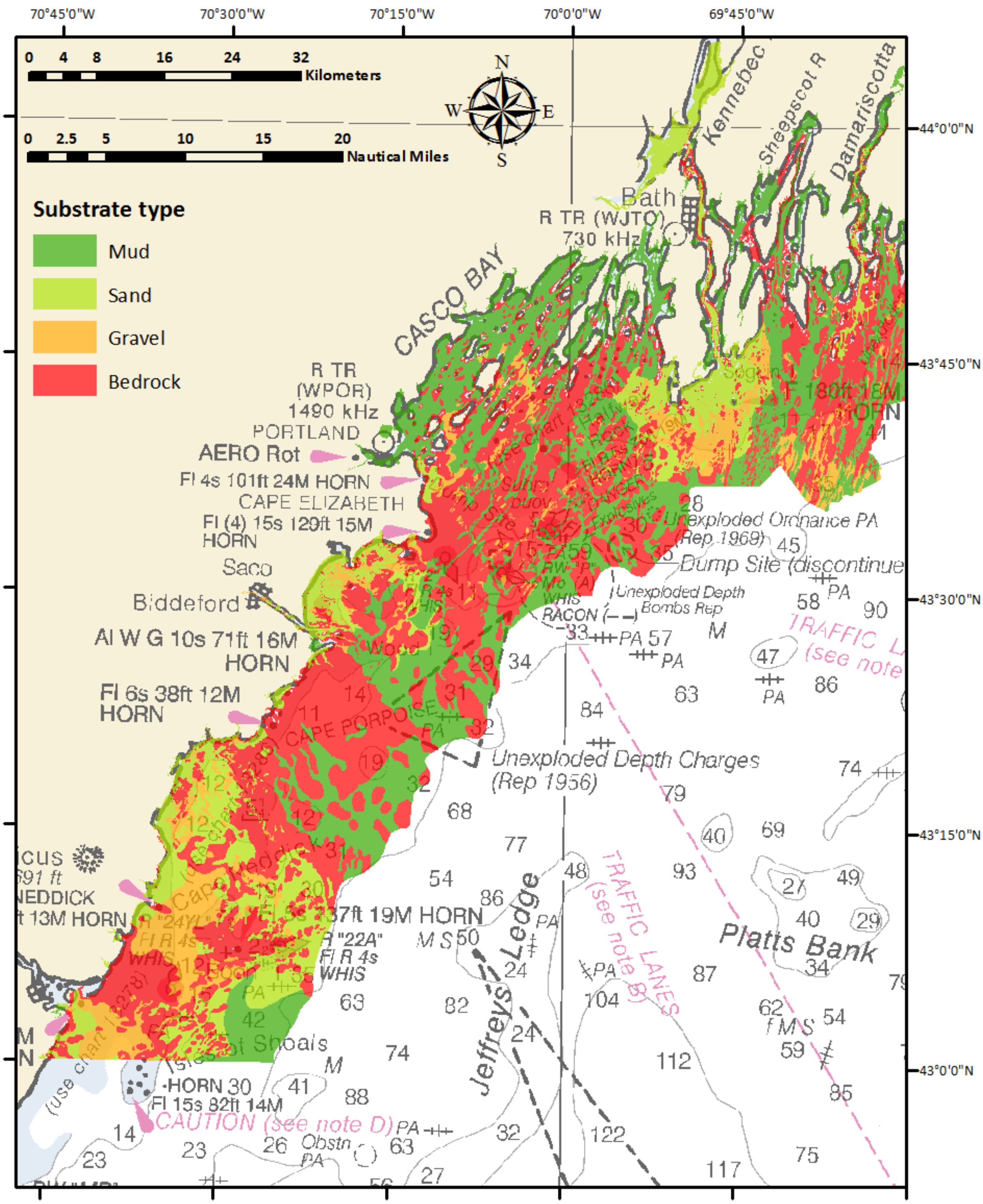


Map 19 – Sedimentary features of Stellwagen Bank. Source: U.S. Geological Survey



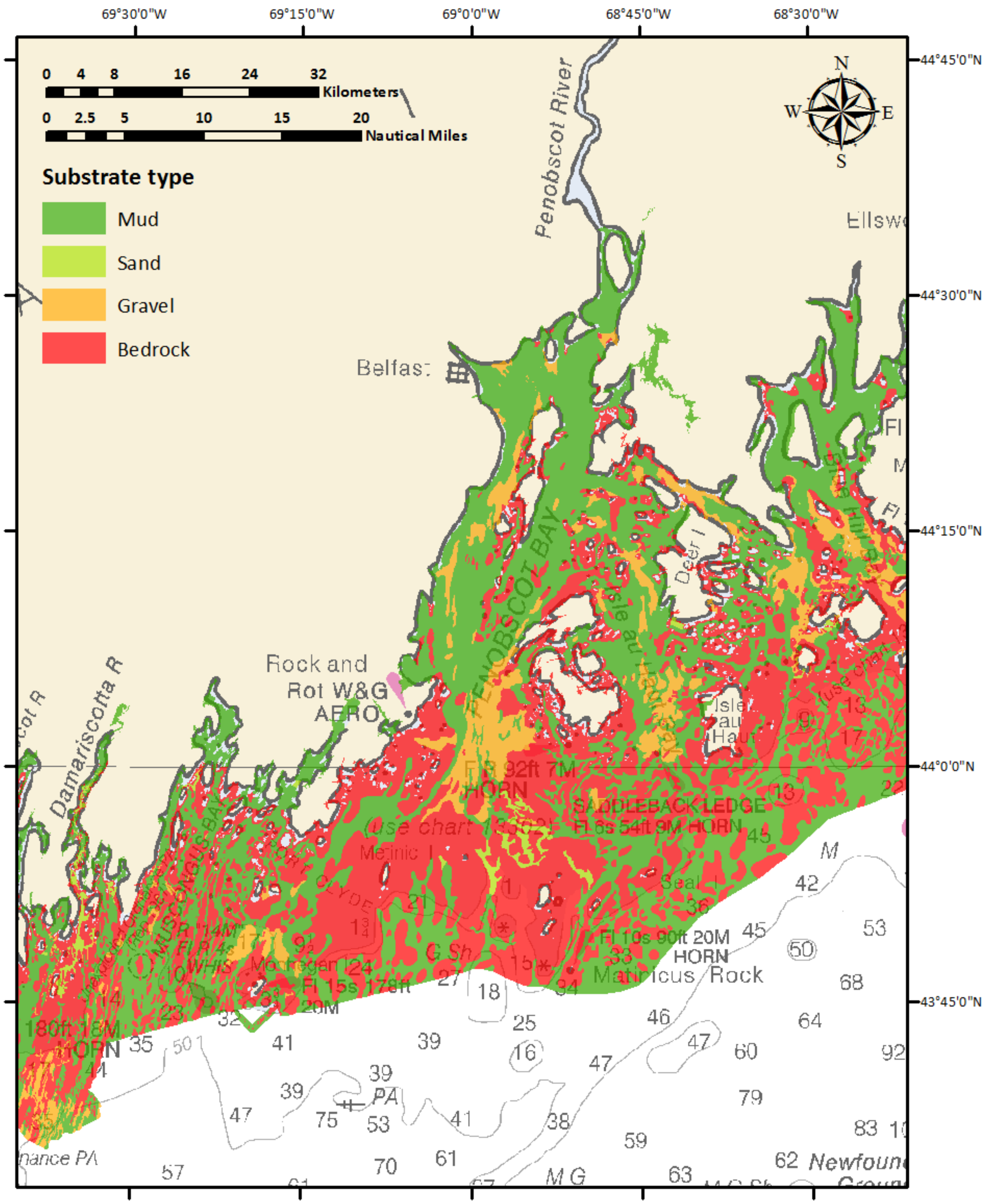
WGS 1984 UTM Zone 19N projection; map updated October 1, 2013

Map 20 – Sediment type along the western Maine coast from the New Hampshire boundary to the Damariscotta River. Source: Barnhardt et al 1998.



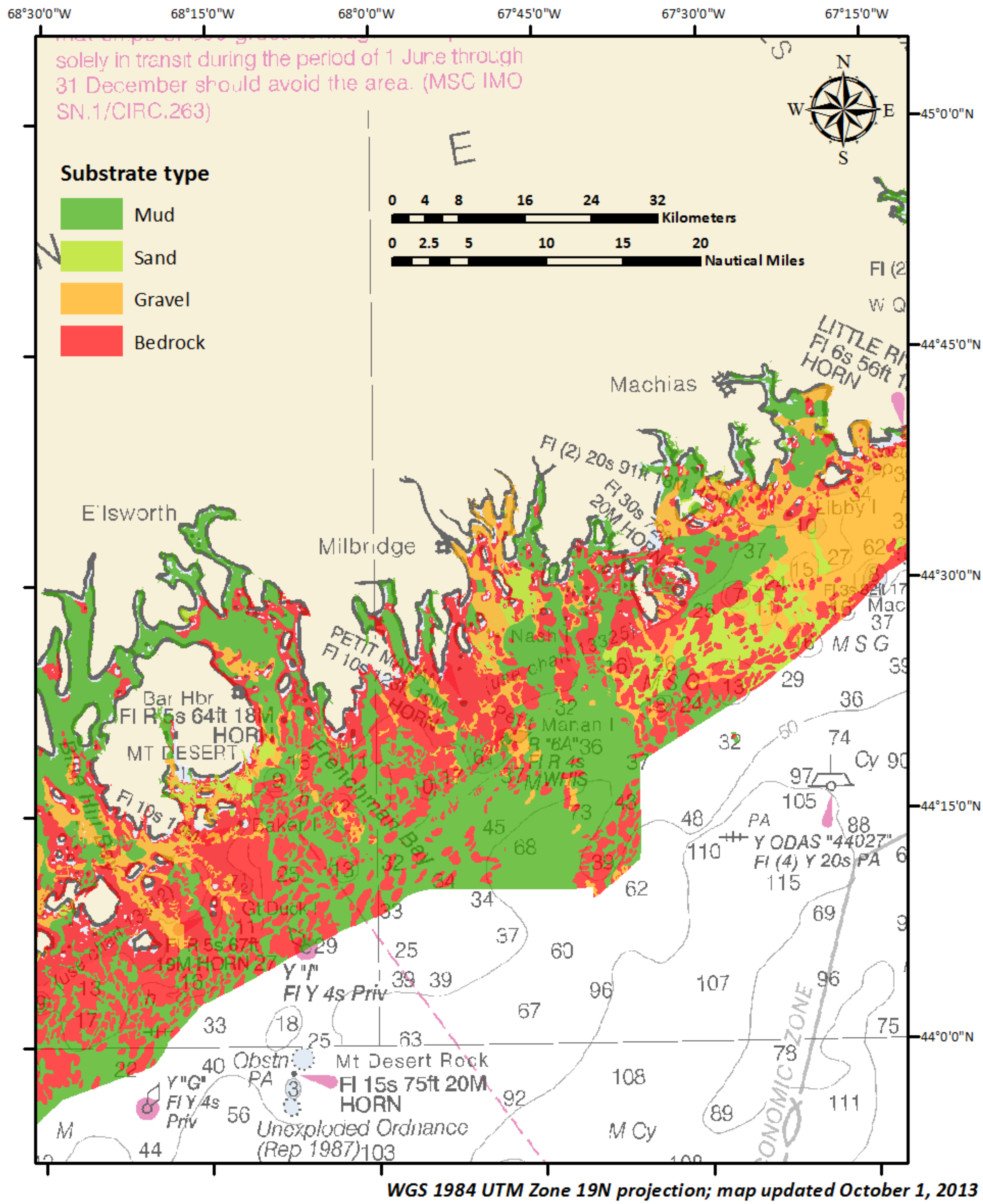
WGS 1984 UTM Zone 19N projection; map updated October 1, 2013

Map 21 – Sediment type along mid-coast Maine from the Damariscotta River to Blue Hill Bay. Source: Barnhardt et al 1998.

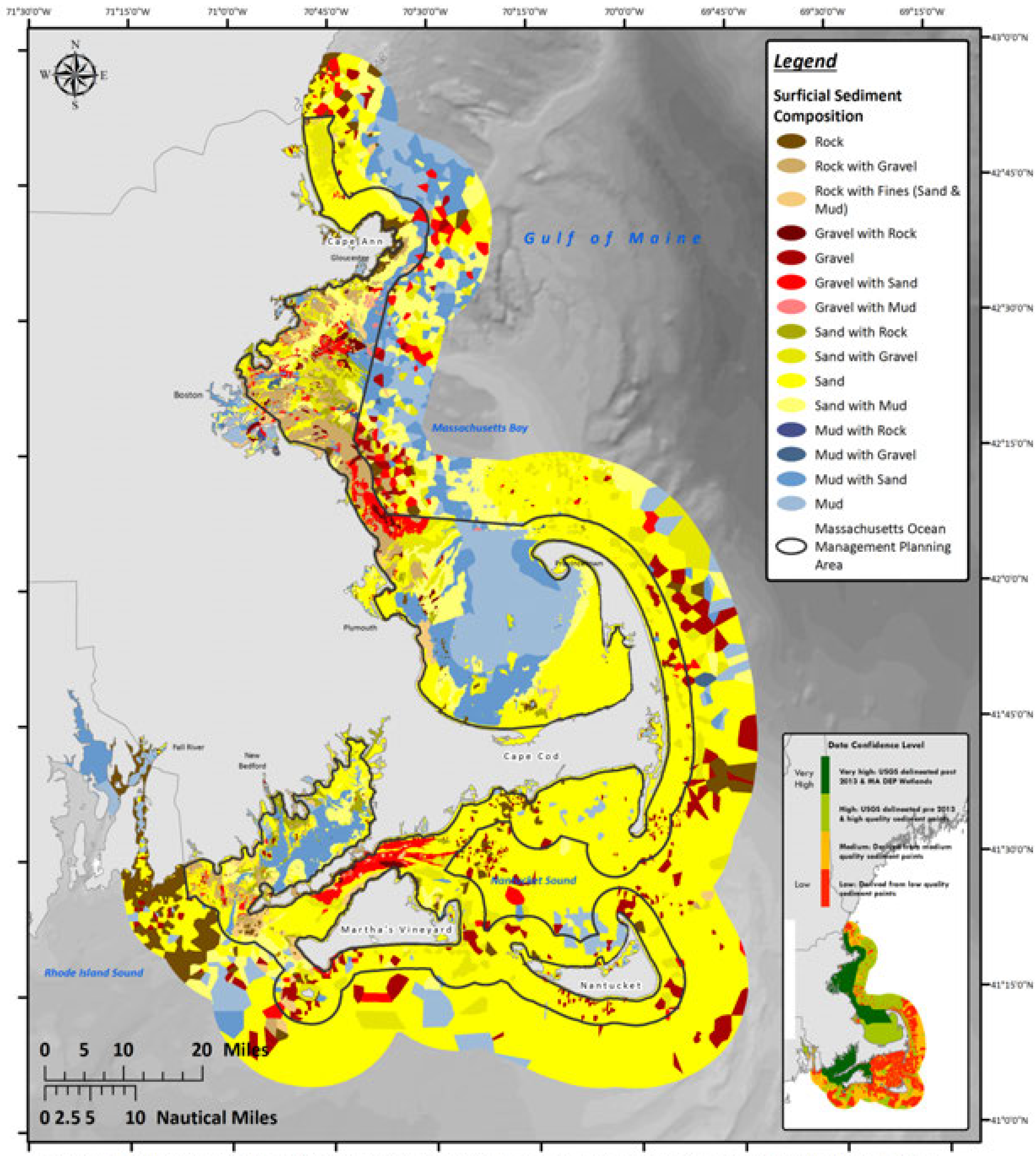


WGS 1984 UTM Zone 19N projection; map updated October 1, 2013

Map 22 – Sediment type along the eastern Maine coast from Blue Hill Bay to Machias. Source: Barnhardt et al 1998.



Map 23 – Sediment distribution for Massachusetts state waters.



Map provided by Massachusetts Office of Coastal Zone Management. Data sources: U.S. Geological Survey, NOAA, CZM, DMF, and others.

Oceanography

An intense seasonal cycle of winter cooling and turnover, springtime freshwater runoff, and summer warming influences oceanographic processes in the Gulf of Maine (Map 24). The Gulf has a general counterclockwise non-tidal surface current that flows around its coastal margin. It is primarily driven by fresh, cold Scotian Shelf water that enters over the Scotian Shelf and through the Northeast Channel, and freshwater river runoff, which is particularly important in the spring. Dense, relatively warm, and saline slope water entering through the bottom of the Northeast Channel from the continental slope also influences gyre formation. Counterclockwise gyres generally form in Jordan, Wilkinson, and Georges Basins and the Northeast Channel as well. These surface gyres are more pronounced in spring and summer; in winter, they weaken and become more influenced by the wind.

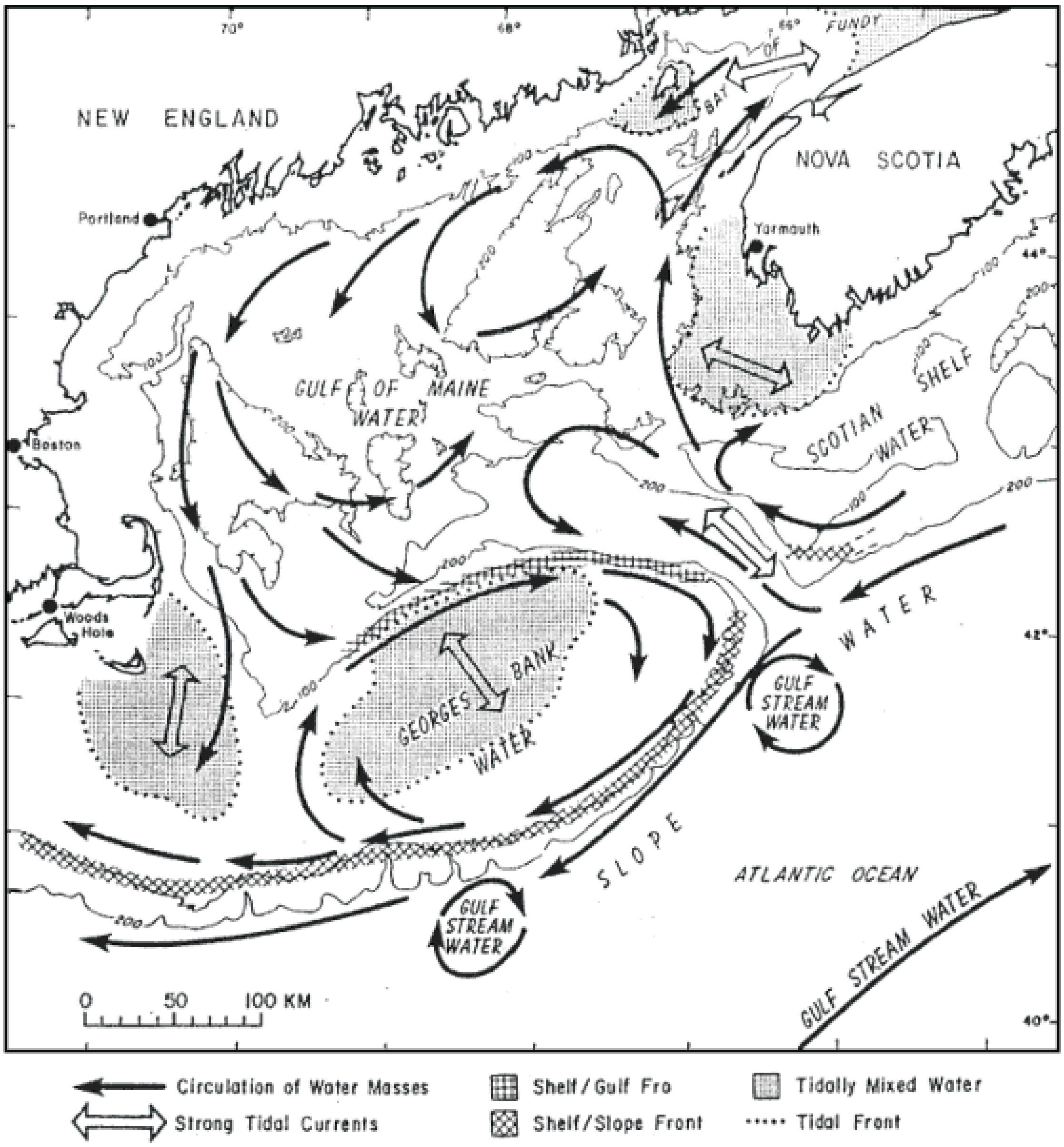
Stratification of surface waters during spring and summer seals off a mid-depth layer of water that preserves winter salinity and temperatures. This cold layer of water is called Maine Intermediate Water and is located between more saline Maine Bottom Water and the warmer, stratified Maine Surface Water. The stratified surface layer is most pronounced in the deep portions of the western Gulf of Maine. Tidal mixing of shallow areas prevents thermal stratification and results in thermal fronts between the stratified areas and cooler mixed areas. Mixed areas include Georges Bank, the southwest Scotian Shelf, eastern Maine coastal waters, and the narrow coastal band surrounding the remainder of the Gulf.

The Northeast Channel provides an exit for cold Maine Intermediate Water and outgoing surface water while it allows warmer, more saline slope water to move in along the bottom and spill into the deeper basins. The influx of water occurs in pulses, and appears to be seasonal, with lower flow in late winter and a maximum flow in early summer.

Gulf of Maine circulation and water properties can vary significantly from year to year. Notable episodic events include shelf-slope interactions such as the entrainment of shelf water by Gulf Stream rings, and strong winds that can create currents as high as 1.1 m/s over Georges Bank. Warm core Gulf Stream rings can influence upwelling and nutrient exchange on the Scotian shelf, and affect the water masses entering the Gulf of Maine. Annual and seasonal inflow variations also affect water circulation.

Internal waves are episodic and can greatly affect the biological properties of certain habitats. Internal waves can shift water layers vertically, so that habitats normally surrounded by cold Maine Intermediate Water are temporarily bathed in warm, organic-rich, surface water. On Cashes Ledge, it is thought that deeper nutrient rich water is driven into the photic zone, providing for increased productivity. Localized areas of upwelling interaction occur in numerous places throughout the Gulf.

Map 24 – Circulation patterns in the Gulf of Maine/Georges Bank region.



Benthic invertebrates and fish

Based on 303 benthic grab samples collected in the Gulf of Maine during 1956-1965, Theroux and Wigley (1998) reported that, in terms of numbers, the most common groups of benthic invertebrates in the Gulf of Maine were annelid worms (35%), bivalve mollusks (33%), and amphipod crustaceans (14%). Biomass was dominated by bivalves (24%), sea cucumbers (22%), sand dollars (18%), annelids (12%), and sea anemones (9%). Watling (1998) used numerical classification techniques to separate benthic invertebrate samples into seven bottom assemblages (Map 25). Further, Watling and Skinder (2007) identified epi- and emergent-fauna from underwater video and used multivariate approaches to classify this fauna into groups based on depth and substrate, corresponding to water masses (Maine surface, intermediate and deep-water) and coarse gradations of sediments (mud, sand, gravel). This classification system considers predominant taxa, substrate types, and seawater properties.

(1) Comprises all sandy offshore banks, most prominently Jeffreys Ledge, Fippennies Ledge, and Platts Bank; depth on top of banks about 70 m; substrate usually coarse sand with some gravel; fauna characteristically sand dwellers with an abundant interstitial component.

(2) Comprises the rocky offshore ledges, such as Cashes Ledge, Sigsbee Ridge and Three Dory Ridge; substrate either rock ridge outcrop or very large boulders, often with a covering of very fine sediment; fauna predominantly sponges, tunicates, bryozoans, hydroids, and other hard bottom dwellers; overlying water usually cold Maine Intermediate Water.

(3) Probably extends all along the coast of the Gulf of Maine in water depths less than 60 m; bottom waters warm in summer and cold in winter; fauna rich and diverse, primarily polychaetes and crustaceans, probably consists of several (sub-) assemblages due to heterogeneity of substrate and water conditions near shore and at mouths of bays.

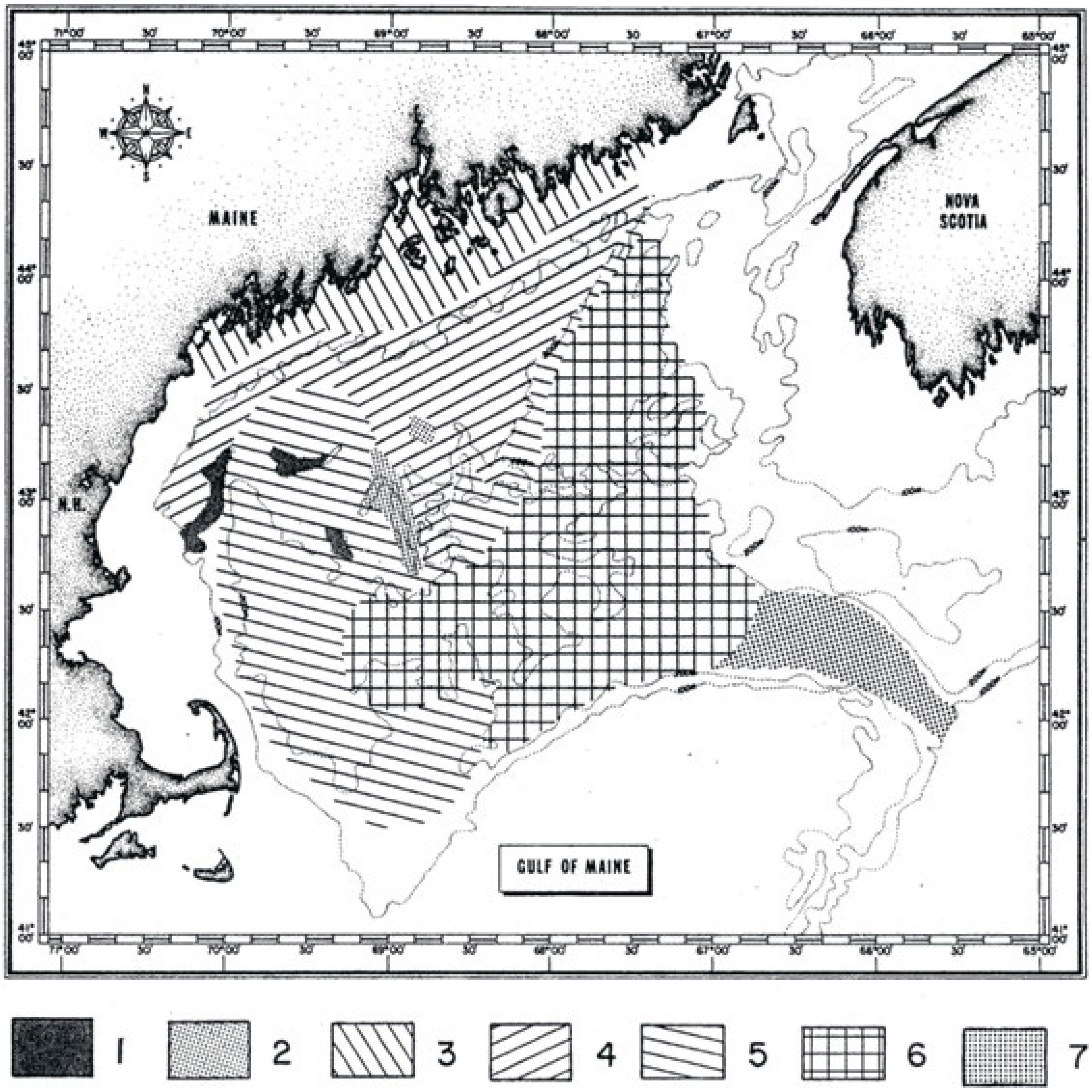
(4) Extends over the soft bottom at depths of 60 - 140 m, well within the cold Maine Intermediate Water; bottom sediments primarily fine muds; fauna dominated by polychaetes, shrimp, and cerianthid anemones.

(5) A mixed assemblage comprising elements from the cold water fauna as well as a few deeper water species with broader temperature tolerances; overlying water often a mixture of Intermediate Water and Bottom Water, but generally colder than 7°C most of the year; fauna sparse, diversity low, dominated by a few polychaetes, with brittle stars, sea pens, shrimp, and cerianthids also present.

(6) Comprises the fauna of the deep basins; bottom sediments generally very fine muds, but may have a gravel component in the offshore morainal regions; overlying water usually 7 - 8°C, with little variation; fauna shows some bathyal affinities but densities are not high, dominated by brittle stars and sea pens, and sporadically by a tube-making amphipod.

(7) The true upper slope fauna that extends into the Northeast Channel; water temperatures are always above 8°C and salinities are at least 35 ppt; sediments may be either fine muds or a mixture of mud and gravel.

Map 25 – Seven major benthic assemblages of the Gulf of Maine. Source: Watling 1988, in Babb and De Luca, eds. Benthic Productivity and Marine Resources of the Gulf of Maine



Demersal fish assemblages for the Gulf of Maine and Georges Bank were part of broad scale geographic investigations conducted by Gabriel (1992) and Mahon et al. (1998). Both these studies and more limited studies by Overholtz and Tyler (1985) and Auster (2002) found assemblages that were consistent over space and time in this region (Table 11). In her analysis, Gabriel (1992) found that the most persistent feature over time in assemblage structure from Nova Scotia to Cape Hatteras was the boundary separating assemblages between the Gulf of Maine and Georges Bank, which occurred at approximately the 100 m isobath on northern Georges Bank. Overholtz and Tyler (1985) identified five assemblages for this region. The Gulf of Maine-deep assemblage included a number of species found in other assemblages, with the exception of American plaice and witch flounder, which was unique to this assemblage. Gabriel's approach did not allow species to co-occur in assemblages, and classified these two species as unique to the deepwater Gulf of Maine-Georges Bank assemblage. It is important to note that these analyses did not attempt to identify associations of these species with particular seafloor features/structures.

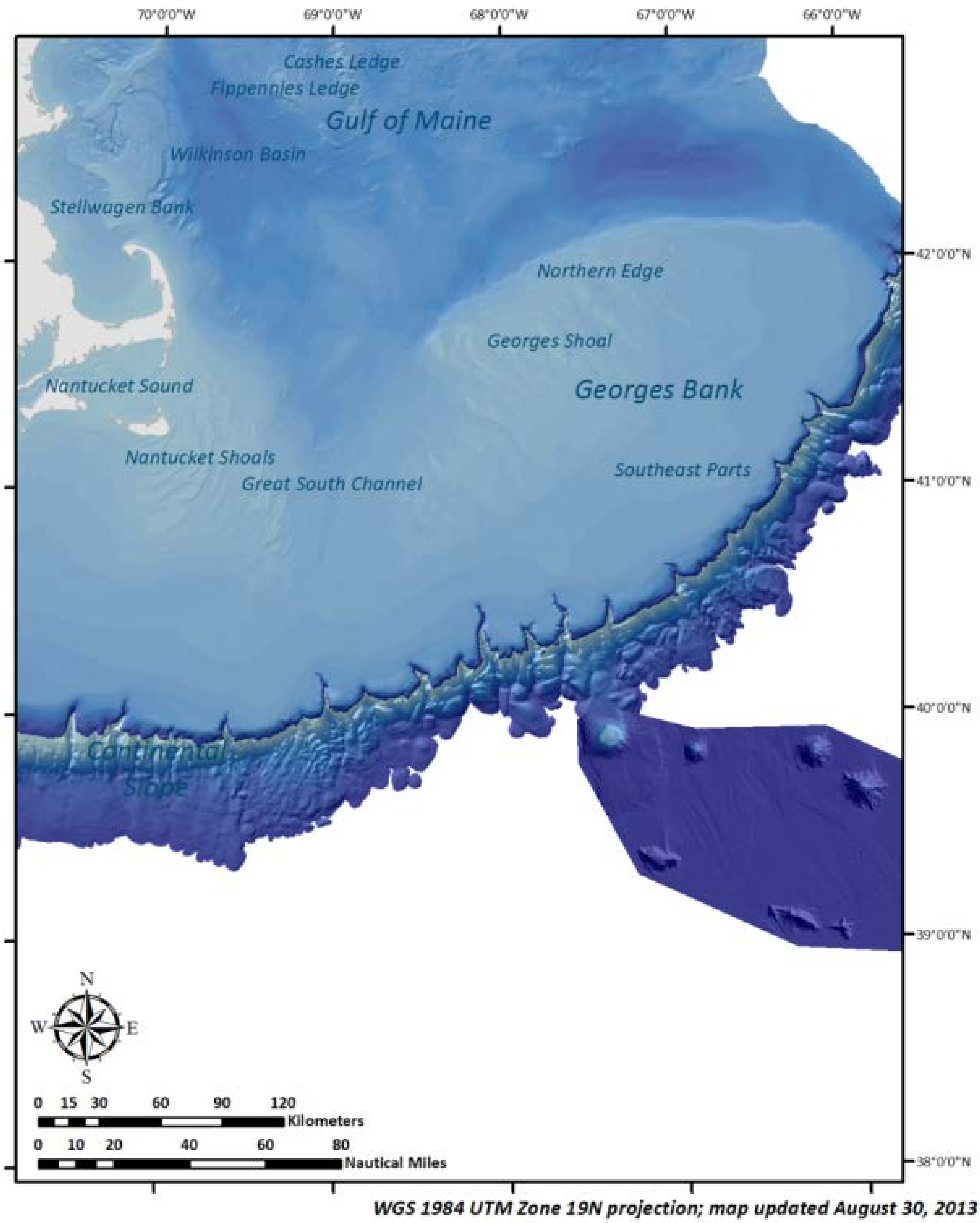
Table 11 – Fish assemblages of the Gulf of Maine and their associated species

Overholtz and Tyler (1985)		Gabriel (1992)	
Slope and Canyon	Offshore hake, blackbelly rosefish, Gulf stream flounder, fourspot flounder, monkfish, silver hake, white hake, red hake	Offshore hake, blackbelly rosefish, Gulf stream flounder, fawn cusk-eel, longfin hake, armored sea robin	***Deepwater***
Intermediate	Silver hake, red hake, monkfish, Atlantic cod, haddock, ocean pout, yellowtail flounder, winter skate, little skate, sea raven, longhorn sculpin	Silver hake, red hake, monkfish, northern shortfin squid, spiny dogfish, cusk	***Combination of Deepwater Gulf of Maine/Georges Bank and Gulf of Maine-Georges Bank Transition***
Shallow	Atlantic cod, haddock, pollock, silver hake, white hake, red hake, monkfish, ocean pout, yellowtail flounder, windowpane, winter flounder, winter skate, little skate, longhorn sculpin, summer flounder, sea raven, sand lance	Atlantic cod, haddock, pollock, yellowtail flounder, windowpane, winter flounder, winter skate, little skate, longhorn sculpin	***Gulf of Maine-Georges Bank Transition Zone and Shallow Water Georges Bank-Southern New England***
Gulf of Maine-Deep	White hake, American plaice, witch flounder, thorny skate, silver hake, Atlantic cod, haddock, cusk, Atlantic wolffish	White hake, American plaice, witch flounder, thorny skate, redfish	***Deepwater Gulf of Maine-Georges Bank***
Northeast Peak	Atlantic cod, haddock, pollock, ocean pout, winter flounder, white hake, thorny skate, longhorn sculpin	Atlantic cod, haddock, pollock	***Gulf of Maine-Georges Bank Transition Zone***

4.2.1.2 Georges Bank, Great South Channel and Nantucket Shoals

Georges Bank is a shallow, elongate extension of the continental shelf that was formed during the Wisconsinian glacial episode (Map 26). It is characterized by a steep slope on its northern edge and a broad, flat, gently sloping southern flank. The Great South Channel lies to the west. Bottom topography on eastern Georges Bank is characterized by linear ridges in the western shoal areas; a relatively smooth, gently dipping sea floor on the deeper, easternmost part; a highly energetic peak in the north with sand ridges up to 30 m high; and steeper and smoother topography incised by submarine canyons on the southeastern margin (see the "Continental Slope" section, below, for more on canyons).

Map 26 – Bathymetric features of Georges Bank and the adjacent continental slope, including the New England seamount chain.



Oceanography

Oceanographic frontal systems separate water masses of the Gulf of Maine and Georges Bank from oceanic waters south of the bank. These water masses differ in temperature, salinity, nutrient concentration, and planktonic communities, which influence productivity and may influence fish abundance and distribution. Currents on Georges Bank include a weak, persistent clockwise gyre around the Bank, a strong semidiurnal tidal flow predominantly northwest and southeast, and very strong, intermittent storm induced currents, which all can occur simultaneously. Tidal currents over the shallow top of Georges Bank can be very strong, and keep the waters over the Bank well mixed vertically. This results in a tidal front that separates the cool waters of the well mixed shallows of the central Bank from the warmer, seasonally stratified shelf waters on the seaward and shoreward sides of the Bank. The clockwise gyre is instrumental in distribution of plankton, including fish eggs and larvae, and the strong, erosive currents affect the character of the biological community.

Bathymetric and sedimentary features

Map 27 depicts dominant sediment types mapped as an unstructured or Voronoi grid, where polygon size reflects data density. Using substrate data derived from systematic video camera surveys of the bank (Harris and Stokesbury 2010, upper panel Map 28) and model estimates of maximum tidal current velocities at the bottom (Chen et al. 2003, 2011, and Cowles et al. 2008), Harris et al. (2012) calculated spatially-explicit sediment stability indices for Georges Bank (lower panel Map 28). On the flanks of the bank between 60 and 100 m, where the tidal currents are weaker, sediment movement is less frequent and transport is primarily associated with strong winter storms. The sediment here is somewhat finer than on the crest of the bank and the seafloor is largely featureless. In these areas, sediments are generally stable due to lower flows. On top of the bank, only the larger grain sizes are stable, in particular sand-dominated areas with cobble, and granule-pebble, cobble, and boulder-dominated sediments.

Northeastern Georges Bank is composed of a series of parallel northwest-southeast trending sand waves with intervening troughs of coarser gravel (granule-pebble and cobble) substrate. There are also some areas dominated by boulders (diameter >10 inches). Strong tidal currents constantly move the sand back and forth and the shallower portions of the bank are also periodically affected by wave action, particularly during winter storms. The coarser gravel substrate is much more stable and provides a more suitable substrate for attached epifaunal organisms (e.g., sponges, bryozoans). Glacial retreat during the late Pleistocene deposited the bottom sediments currently observed on the eastern section of Georges Bank. The interaction of several environmental factors, including availability and type of sediment, current speed and direction, and bottom topography, has formed seven sedimentary provinces on eastern Georges Bank (Table 12).

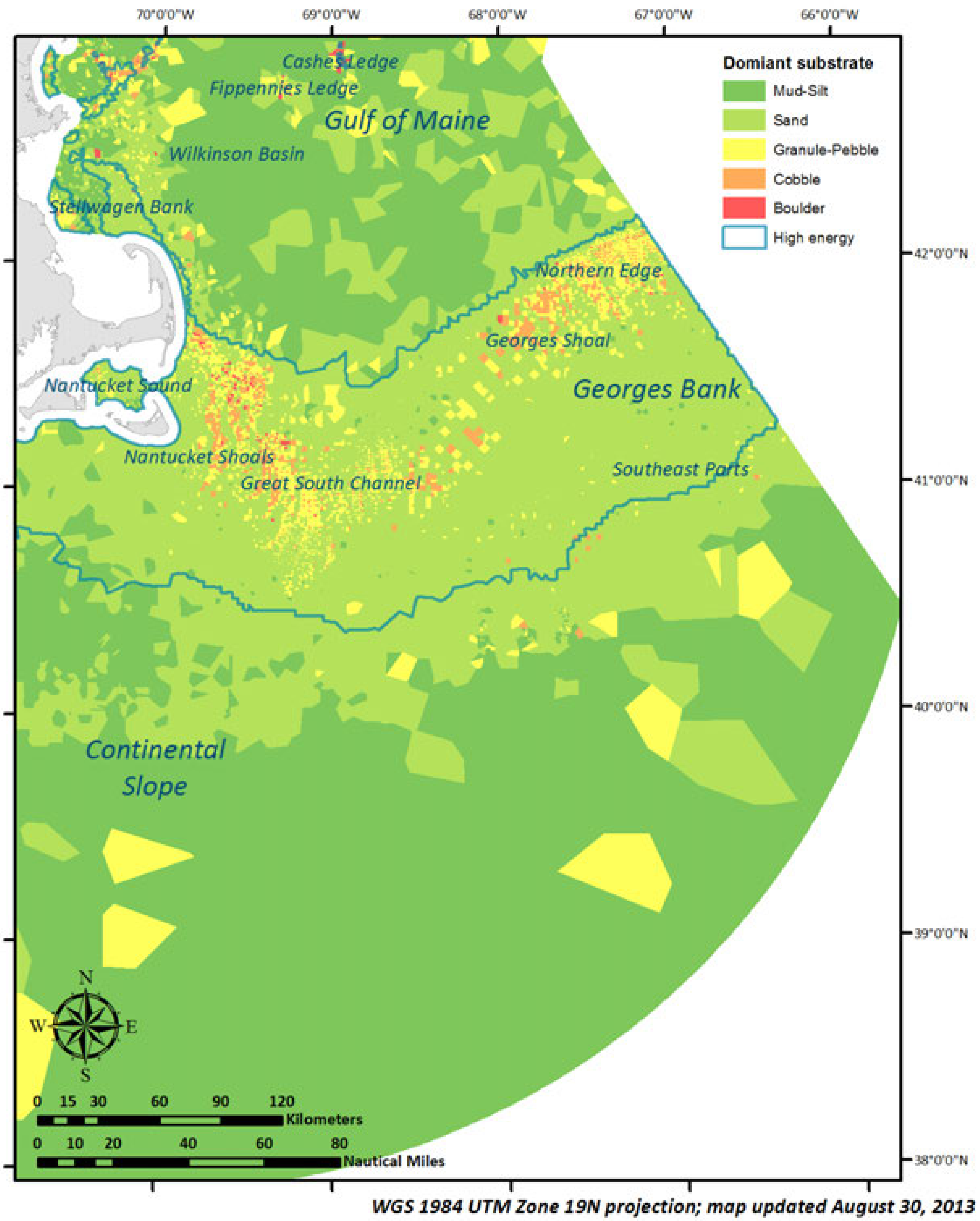
The central region of the Bank is shallow, and the bottom is characterized by shoals and troughs, with sand dunes superimposed upon them. The two most prominent elevations on the ridge and trough area are Cultivator and Georges Shoals. This shoal and trough area is a region of strong currents, with average flood and ebb tidal currents greater than 4 km/h, and as high as 7 km/h. The dunes migrate at variable rates, and the ridges may also move. In an area that lies between the central part and Northeast Peak, Twichell et al. (1987) identified high-energy areas as between 35 - 65 m deep, where sand is transported on a daily basis by tidal currents, and a low-energy area at depths > 65 m that is affected only by storm currents.

The Great South Channel separates the main part of Georges Bank from Nantucket Shoals. Just east of the Great South Channel, the depth is approximately 50-70 m with dominant sand, granule-pebble, cobble, and boulder substrates, transitioning to deeper water and mud substrates in the Channel. Strong southward-flowing tidal and residual currents on the western side of this area have produced 5-15 m high sand waves that run east and west with steeper slopes on their southern sides (Richard Taylor, personal communication). Critical bottom shear stress values ranging from >2 to <0.5 indicate that the coarser sediments are stable under typical tidal currents whereas the finer sediments are not stable. Bottom disturbance can be significant during episodic storms.

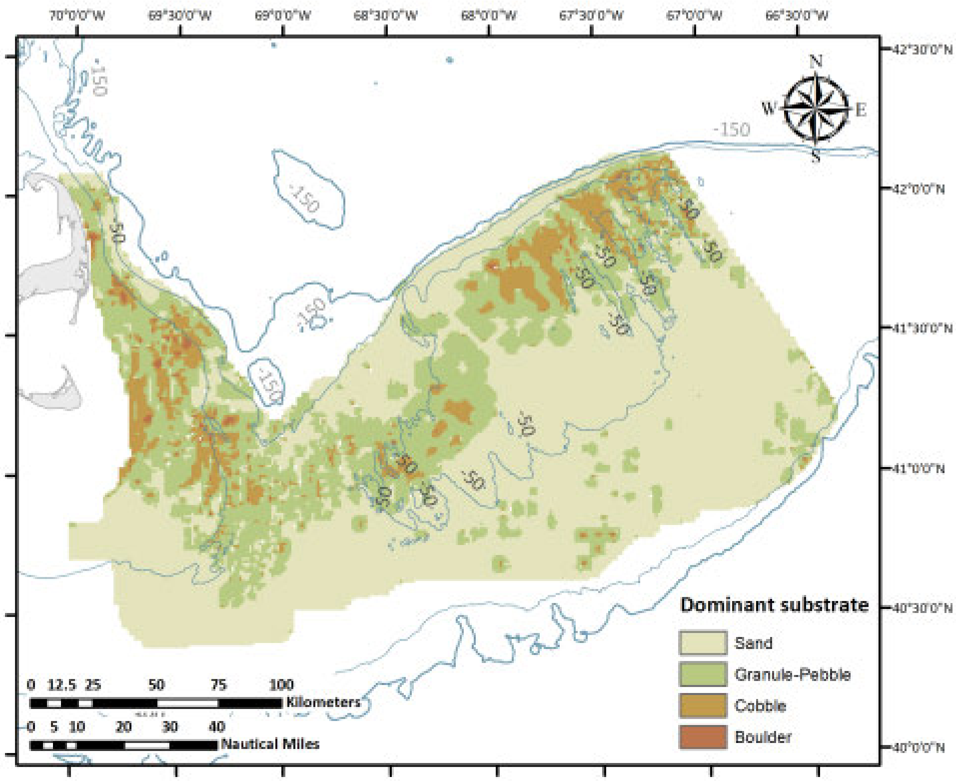
Further to the west, Nantucket Shoals is similar in nature to the central region of the Bank. Currents in these areas are strongest where water depth is shallower than 50 m. This type of travelling dune and swale morphology is also found in the Mid-Atlantic Bight, and further described in section 4.2.1.3. Sediments in this region include gravel pavement and mounds, some scattered boulders, sand with storm generated ripples, and scattered shell and mussel beds. Tidal and storm currents range from moderate to strong, depending upon location and storm activity (Valentine, pers. comm.). Sediment mobility thresholds on Nantucket Shoals are exceeded over 50% of the time (annually) due to the combined effects of currents and wave action (Dalyander et al. 2013).

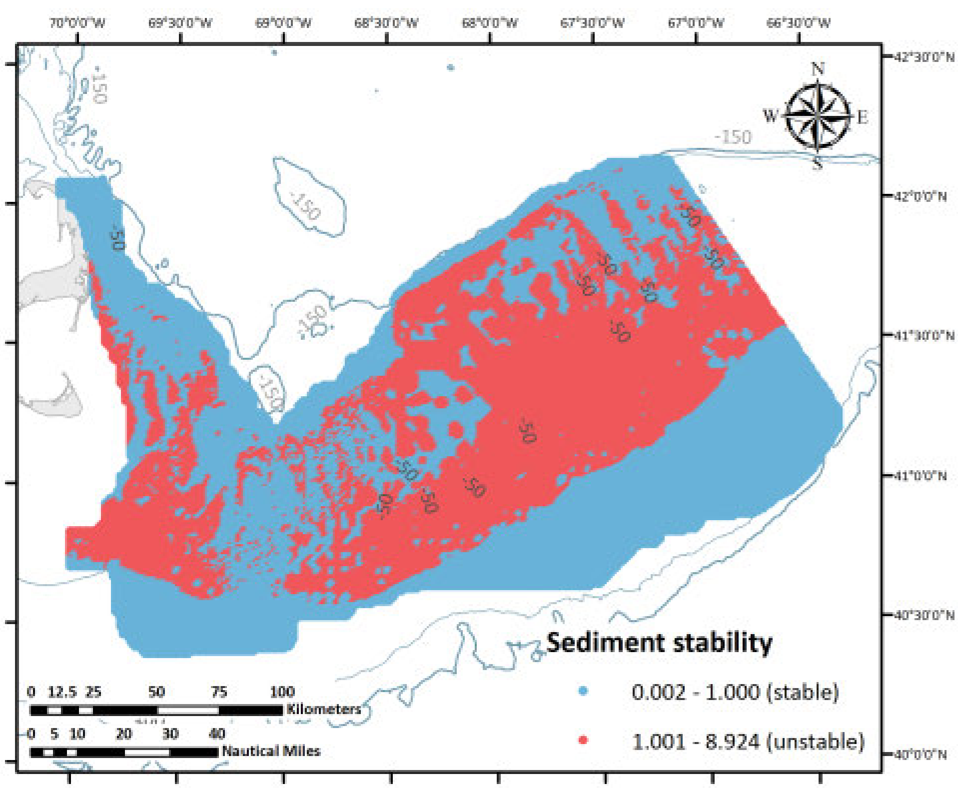
The benthic environment south of Cape Cod is less dynamic. Bottom contours trend east-west with depths increasing from 20-30 m to over 100 m near the shelf break. Sediments in this area are dominated by sand, mixed to varying degrees with silt, however, there are areas of rocky habitats, for example in Nantucket Sound, south of Martha's Vineyard, and off the Rhode Island coast (Cox Ledge). Critical shear stress at the bottom resulting from current and wave action in the region was evaluated by Dalyander et al. (2013) using a different methodology than Harris and Stokesbury (2012) used for Georges Bank. The Dalyander et al. results clearly show how tidal currents diminish in intensity west of Nantucket Shoals and are replaced by wave action as the primary source of sediment suspension and transport in the Mid-Atlantic region (Map 29). The effect of waves is much greater in the winter due to the action of winter storms.

Map 27 – Sedimentary features of Georges Bank

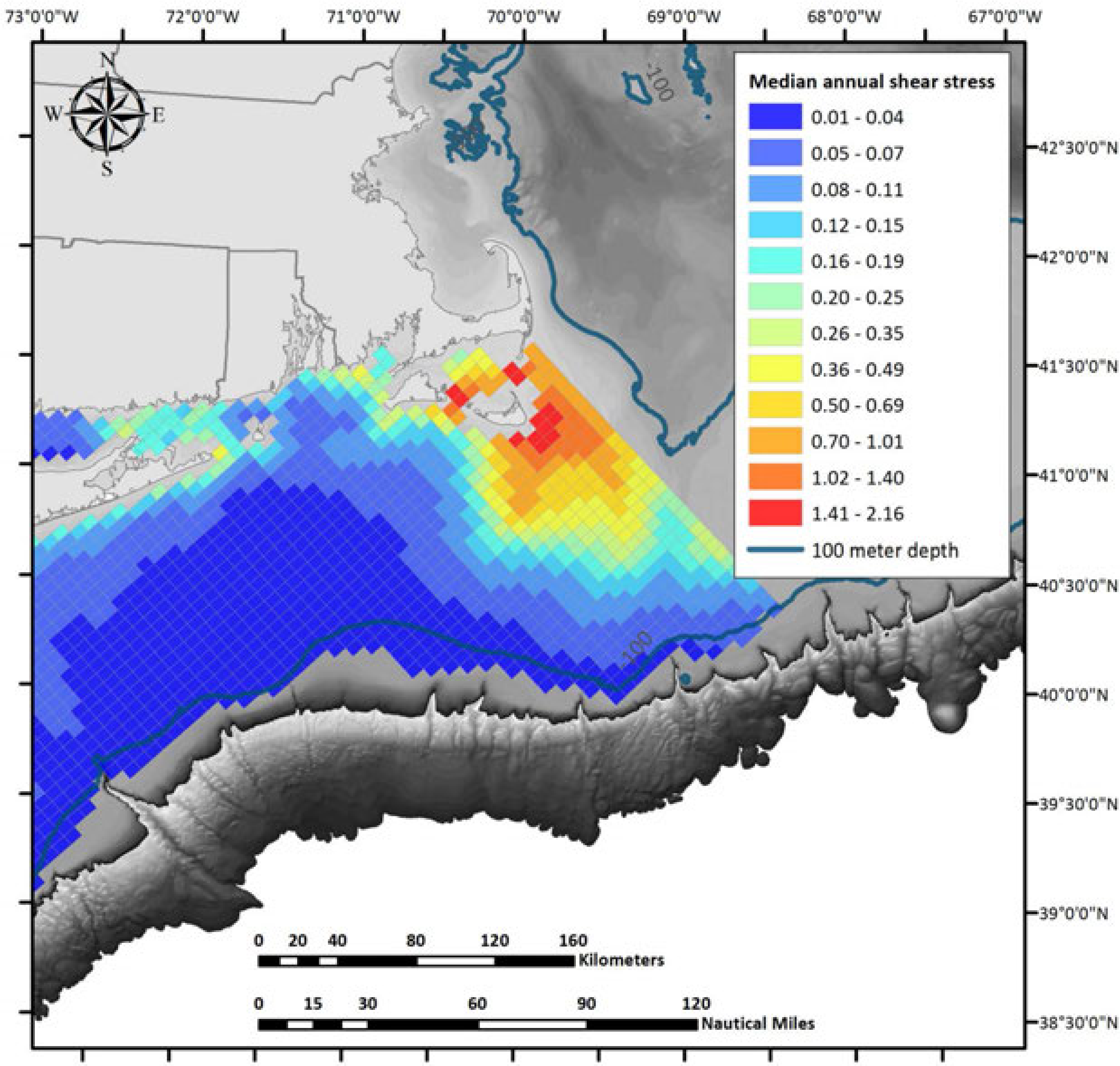


Map 28 – Dominant sediment (Harris and Stokesbury 2010) and sediment stability (Harris et al 2012). Depth contours in meters.





Map 29 – Median annual bottom shear stress values (May 2010-May 2011), Mid-Atlantic Bight. Source: Dalyander et al. 2013. The median indicates the value of bottom shear stress that is exceeded 50% of the time.



Benthic invertebrates and fish

Amphipod crustaceans (49%) and annelid worms (28%) numerically dominated the contents of 211 samples collected on Georges Bank during 1956-1965 (Theroux and Wigley 1998). Biomass was dominated by sand dollars (50%) and bivalves (33%). Theroux and Grosslein (1987) utilized the Theroux and Wigley database to identify four macrobenthic invertebrate assemblages on the bank (Table 12), noting that the boundaries between assemblages were not well defined because there is considerable intergrading between adjacent assemblages.

Along with high levels of primary productivity and a diverse and abundant benthic invertebrate fauna, Georges Bank has been historically characterized by high levels of fish production. Several studies have attempted to identify demersal fish assemblages over large spatial scales. Overholtz and Tyler (1985) found five depth related groundfish assemblages for Georges Bank and the Gulf of Maine that were persistent temporally and spatially. Depth and salinity were identified as major physical influences explaining assemblage structure. Gabriel (1992) identified six assemblages, which are compared with the results of Overholtz and Tyler (1985) in Table 11. Mahon et al. (1998) found similar results. As noted in the Gulf of Maine section, these fish assemblage studies do not attempt to associate individual species with particular seafloor features/structures.

Table 12 – Relationship between sedimentary provinces (Valentine and Lough 1991) and benthic assemblages (Theroux and Grosslein 1987) of Georges Bank.

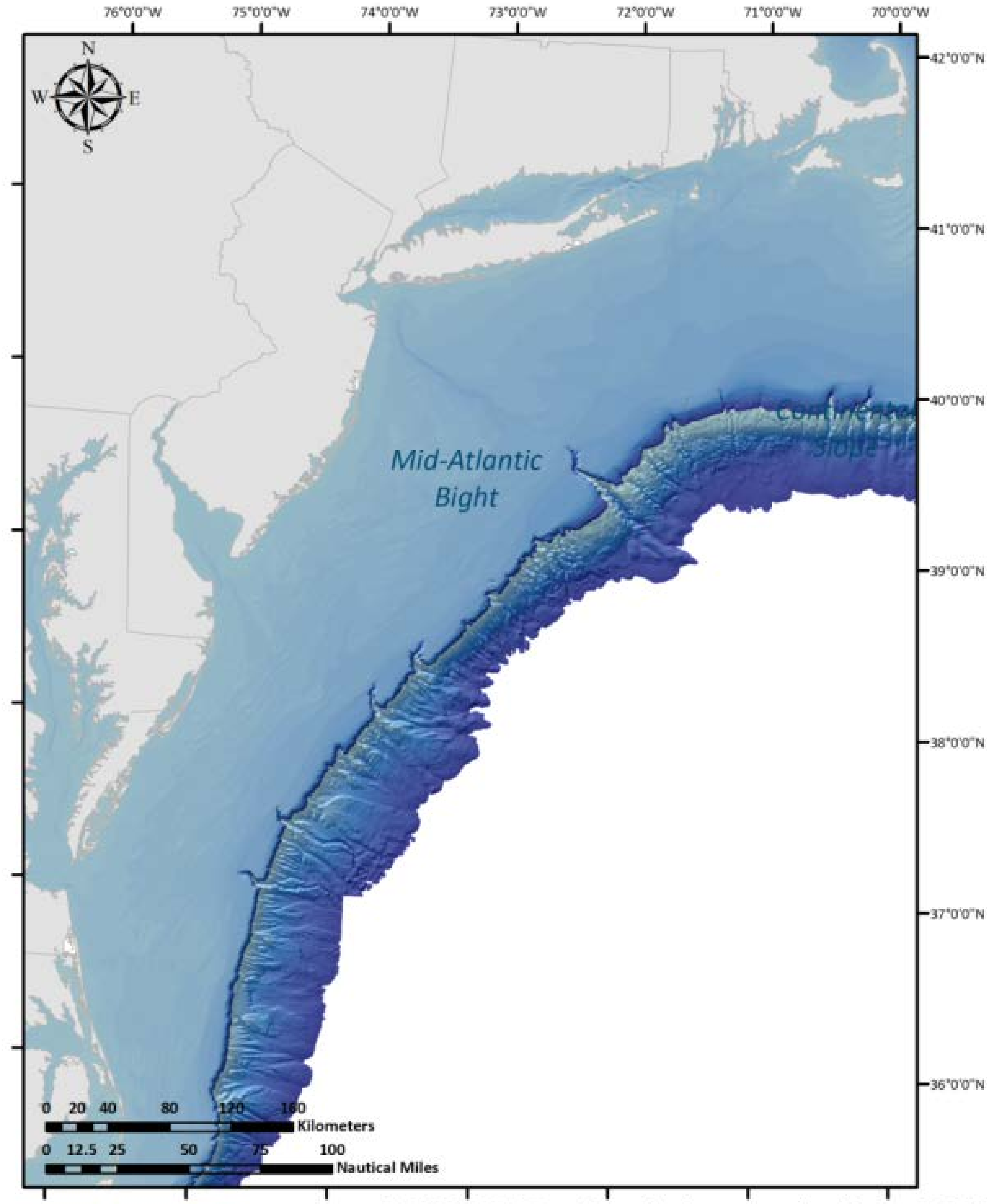
Sedimentary province	Depth (m)	Description	Benthic assemblage
Northern Edge / Northeast Peak (1)	40 - 200	Dominated by gravel with portions of sand, common boulder areas, and tightly packed pebbles. Representative epifauna (bryozoa, hydrozoa, anemones, and calcareous worm tubes) are abundant in areas of boulders. Strong tidal and storm currents.	The Northeast Peak assemblage is found along the Northern Edge and Northeast Peak, which varies in depth and current strength and includes coarse sediments, consisting mainly of gravel and coarse sand with interspersed boulders, cobbles, and pebbles. Fauna tend to be sessile (coelenterates, brachiopods, barnacles, and tubiferous annelids) or free-living (brittle stars, crustaceans, and polychaetes), with a characteristic absence of burrowing forms.
Northern Slope and Northeast Channel (2)	200 - 240	Variable sediment type (gravel, gravel-sand, and sand) scattered bedforms. This is a transition zone between the northern edge and southern slope. Strong tidal and storm currents.	
North /Central Shelf (3)	60 - 120	Highly variable sediment type (ranging from gravel to sand) with rippled sand, large bedforms, and patchy gravel lag deposits. Minimal epifauna on gravel due to sand movement. Representative epifauna in sand areas includes amphipods, sand dollars, and burrowing anemones.	The Central Georges Bank assemblage occupies the greatest area, including the central and northern portions of the Bank in depths less than 100 m. Medium grained shifting sands predominate this dynamic area of strong currents. Organisms tend to be small to moderately large with burrowing or motile habits.
Central and Southwestern Shelf - shoal ridges (4)	10 - 80	Dominated by sand (fine and medium grain) with large sand ridges, dunes, waves, and ripples. Small bedforms in southern part. Minimal epifauna on gravel due to sand movement. Representative epifauna in sand areas includes amphipods, sand dollars, and burrowing anemones.	
Central and Southwestern Shelf - shoal troughs (5)	40 - 60	Gravel (including gravel lag) and gravel-sand between large sand ridges. Patchy large bedforms. Strong currents. (Few samples – submersible observation noted presence of gravel lag, rippled gravel-sand, and large bedforms.) Minimal epifauna on	

		gravel due to sand movement. Representative epifauna in sand areas includes amphipods, sand dollars, and burrowing anemones.	
Southeastern Shelf (6)	80 - 200	Rippled gravel-sand (medium and fine grained sand) with patchy large bedforms and gravel lag. Weaker currents; ripples are formed by intermittent storm currents. Representative epifauna includes sponges attached to shell fragments and amphipods.	The Southern Georges Bank assemblage is found on the southern and southwestern flanks at depths from 80 - 200 m, where fine grained sands and moderate currents predominate. Many southern species exist here at the northern limits of their range.
Southeastern Slope (7)	400 - 2000	Dominated by silt and clay with portions of sand (medium and fine) with rippled sand on shallow slope and smooth silt-sand deeper.	None
Western Basin			The Western Basin assemblage is found in the upper Great South Channel region at the northwestern corner of the Bank, in comparatively deepwater (150 - 200 m) with relatively slow currents and fine bottom sediments of silt, clay and muddy sand. Fauna are comprised mainly of small burrowing detritivores and deposit feeders, and carnivorous scavengers.

4.2.1.3 Mid-Atlantic Bight

The Mid-Atlantic Bight (Map 30) is comprised of the sandy, relatively flat, gently sloping continental shelf from southern New England to Cape Hatteras, North Carolina. Like the rest of the continental shelf, the topography of the Mid-Atlantic Bight was shaped largely by sea level fluctuations caused by past ice ages. The shelf's basic morphology and sediments derive from the retreat of the last ice sheet, and the subsequent rise in sea level. Since that time, currents and waves have modified this basic structure.

Map 30 – Bathymetric features of the Mid-Atlantic Bight



WGS 1984 UTM Zone 19N projection; map updated August 22, 2013

Oceanography

Shelf and slope waters of the Mid-Atlantic Bight have a slow southwestward flow that is occasionally interrupted by warm core rings or meanders from the Gulf Stream. On average, shelf water moves parallel to bathymetry isobars at speeds of 5-10 cm/s at the surface and 2 cm/s or less at the bottom. Storm events can cause much more energetic variations in flow. Tidal currents on the inner shelf have a higher flow rate of 20 cm/s that increases to 100 cm/s near inlets.

Seasonal temperature variation is more pronounced in shallower, nearshore waters. Stratification of the water column occurs over the shelf and the top layer of slope water during the spring-summer and is usually established by early June. Fall mixing results in homogenous shelf and upper slope waters by October in most years. A permanent thermocline exists in slope waters from 200-600 m deep. Temperatures decrease at the rate of about 0.02ºC per meter and remain relatively constant throughout the year except for occasional incursions of Gulf stream eddies or meanders. Below 600 m, temperature declines, and usually averages about 2.2ºC at 4000 m. A warm, mixed layer approximately 40 m thick resides above the permanent thermocline.

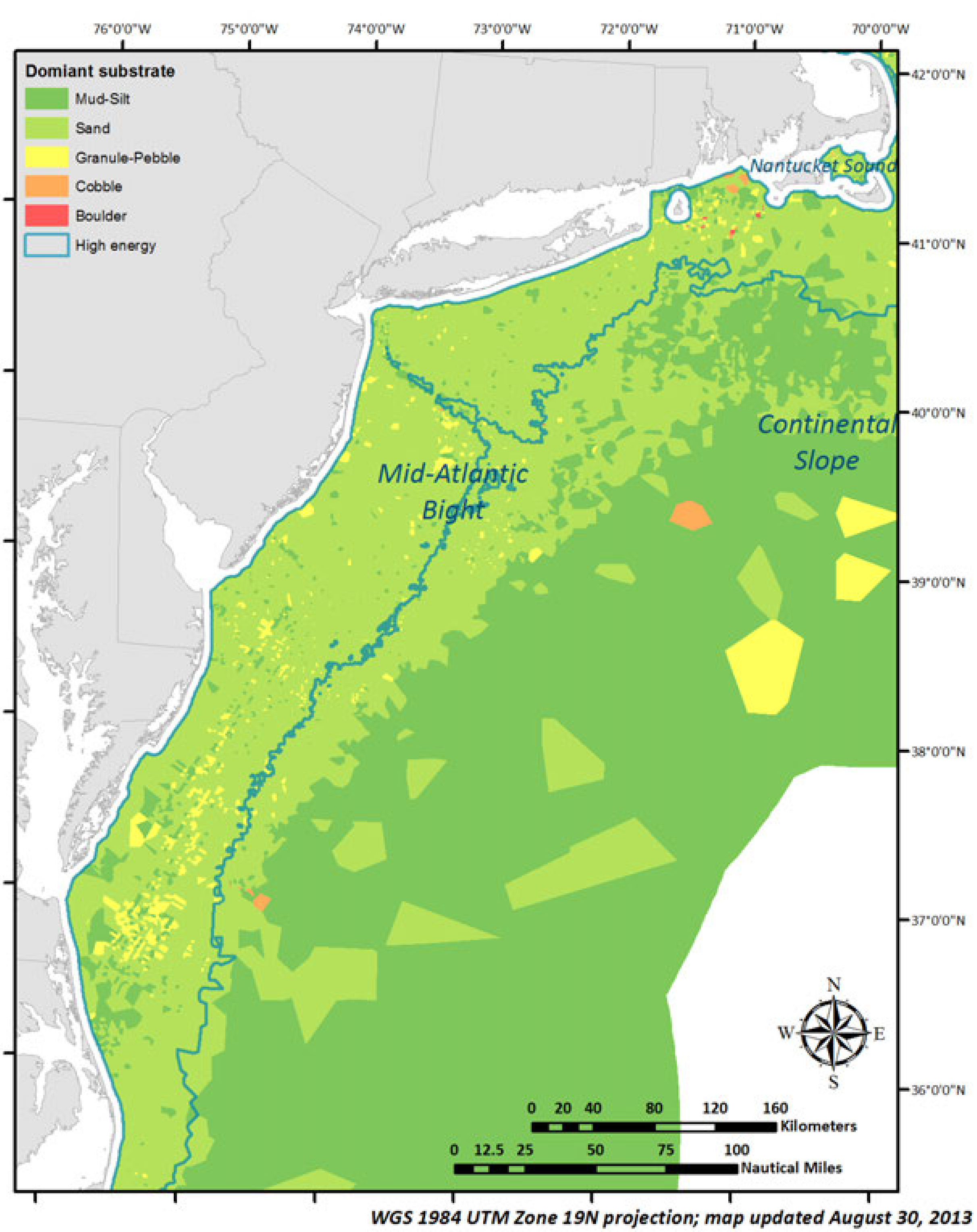
The "cold pool" is an annual phenomenon particularly important to the Mid-Atlantic Bight. It stretches from the Gulf of Maine along the outer edge of Georges Bank and then southwest to Cape Hatteras. It becomes identifiable with the onset of thermal stratification in the spring and lasts into early fall until normal seasonal mixing occurs. It usually exists along the bottom between the 40 and 100 m isobaths and extends up into the water column for about 35 m, to the bottom of the seasonal thermocline. The cold pool usually represents about 30% of the volume of shelf water. Minimum temperatures for the cold pool occur in early spring and summer, and range from 1.1-4.7ºC.

Sedimentary features

The predominant sediment type covering most of the shelf in the Mid-Atlantic Bight is sand, with some relatively small, localized areas of sand-shell and sand-gravel (Map 31). From a broad scale perspective, sediments are uniformly distributed over the shelf in this region. A sheet of sand and gravel varying in thickness from 0-10 m covers most of the shelf. The mean bottom flow from the constant southwesterly current is not fast enough to move sand, so sediment transport must be episodic. Net sediment movement is in the same southwesterly direction as the current. The sands are mostly medium to coarse grains, with finer sand in the Hudson Shelf Valley and on the outer shelf.

Mud is rare over most of the shelf, but is common in the Hudson Shelf Valley. In addition, an area known as the mud patch is located just southwest of Nantucket Shoals and southeast of Long Island and Rhode Island. Tidal currents in this area slow significantly, which allows silts and clays to settle out. The mud is mixed with sand, and is occasionally resuspended by large storms. This habitat is an anomaly of the outer continental shelf. Occasionally relic estuarine mud deposits are re-exposed in the swales between sand ridges. Fine sediment content increases rapidly at the shelf break, which is sometimes called the "mud line", and sediments transition to 70-100% fines on the slope.

Map 31 – Sedimentary features of the Mid-Atlantic Bight



The primary morphological features of the shelf include shelf valleys and channels, shoal massifs, scarps, and sand ridges and swales. Most of these structures are relic except for some sand ridges and smaller sand-formed features. Submarine canyons (described further in section 4.2.1.4) were formed by rivers of glacial outwash that deposited sediments on the outer shelf edge as they entered the ocean. Several large canyons cut across the continental slope and about 10 km into the shelf, with the exception of the Hudson Canyon that incises the shelf about 35 km. Shelf valleys and canyons were partially filled as the glacier melted and retreated across the shelf. The glacier also left behind a lengthy scarp near the shelf break from Chesapeake Bay north to the eastern end of Long Island. Shoal retreat massifs were produced by extensive deposition at a cape or estuary mouth. Massifs were also formed as estuaries retreated across the shelf.

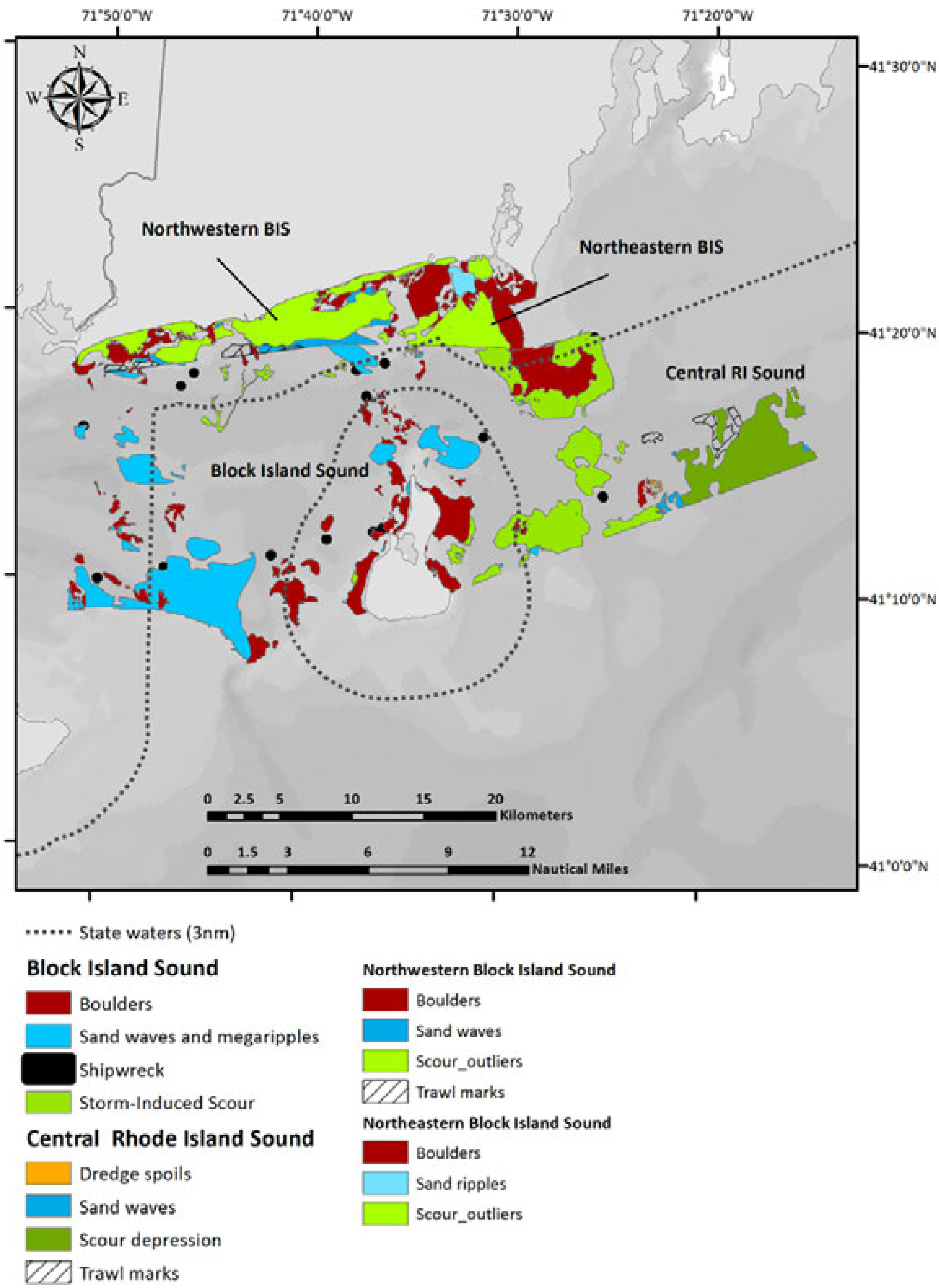
Some sand ridges are more modern in origin than the shelf's glaciated morphology. Their formation is not well understood; however, they appear to develop from the sediments that erode from the shore face. They maintain their shape, so it is assumed that they are in equilibrium with modern current and storm regimes. They are usually grouped, with heights of about 10 m, lengths of 10 - 50 km and spacing of 2 km. Ridges are usually oriented at a slight angle towards shore, running in length from northeast to southwest. The seaward face usually has the steepest slope. Sand ridges are often covered with smaller similar forms such as sand waves, megaripples, and ripples. Swales occur between sand ridges. Since ridges are higher than the adjacent swales, they are exposed to more energy from water currents, and experience more sediment mobility than swales. Ridges tend to contain less fine sand, silt and clay while relatively sheltered swales contain more of the finer particles. Swales have greater benthic macrofaunal density, species richness and biomass, due in part to the increased abundance of detrital food and the physically less rigorous conditions.

Sand waves are usually found in patches of 5-10 with heights of about 2 m, lengths of 50-100 m and 1-2 km between patches. Sand waves are primarily found on the inner shelf, and often observed on sides of sand ridges. They may remain intact over several seasons. Megaripples occur on sand waves or separately on the inner or central shelf. During the winter storm season, they may cover as much as 15% of the inner shelf. They tend to form in large patches and usually have lengths of 3-5 m with heights of 0.5-1 m. Megaripples tend to survive for less than a season. They can form during a storm and reshape the upper 50 - 100 cm of the sediments within a few hours. Ripples are also found everywhere on the shelf, and appear or disappear within hours or days, depending upon storms and currents. Ripples usually have lengths of about 1-150 cm and heights of a few centimeters.

Artificial reefs are a significant Mid-Atlantic habitat, formed much more recently on the geologic time scale than other regional habitat types. These localized areas of hard structure have been formed by shipwrecks, lost cargoes, disposed solid materials, shoreline jetties and groins, submerged pipelines, cables, and other materials (Steimle and Zetlin 2000). While only some of these materials have been deposited specifically for use as fish habitat, all have become an integral part of the coastal and shelf ecosystem. It is expected that the increase in these materials has had an impact on living marine resources and fisheries, but these effects are not well known. In general, reefs are important for attachment sites, shelter, and food for many species, and fish predators such as tunas may be attracted by prey aggregations, or may be behaviorally attracted to the reef structure. The overview by Steimle and Zetlin (2000) used NOAA hydrographic surveys to plot rocks, wrecks, obstructions, and artificial reefs, which together were considered a fairly complete list of non-biogenic reef habitat in the Mid-Atlantic estuarine and coastal areas.

USGS has also mapped areas off the Rhode Island coast in Block Island Sound and Rhode Island Sound (Map 32, USGS Open File Reports 2011-1005, 2012-1005, 2013-1003, and 2014-1018, available from http://pubs.er.usgs.gov/). Generally acoustic data were collected using multibeam echosounder, and ground truth surveys were subsequently conducted to obtain grab and visual samples to confirm interpretation of the acoustic data. In northwestern Block Island Sound, features include boulders, sand waves, scour depressions, modern sediments, and trawl marks (McMullen et al. 2014). Northeastern Block Island Sound also has boulder and scour features, as well as sand ripples (McMullen et al. 2013). In both areas boulders tend to occur in shallower depths and are typically covered by sessile fauna. Further south in Block Island Sound, boulders and gravels dominate high-energy enviornments along topographic highs or near the coast (Poppe et al. 2012). Sand is the most common sediment type in the Sound, and silty sands are relatively rare. Further east in Central Rhode Island Sound, sediments are silty, sandy, or gravely, with scoured areas having larger grain sizes (McMullen et al. 2011).

Map 32 – Sediment data offshore Rhode Island. Source: 2011-2014 USGS Open File Reports.



Benthic invertebrates and fish

Wigley and Theroux (1981) reported on the faunal composition of 563 bottom grab samples collected in the Mid-Atlantic Bight during 1956-1965. Amphipod crustaceans and bivalve mollusks accounted for most of the individuals (41% and 22%, respectively), whereas mollusks dominated the biomass (70%). Three broad faunal zones related to water depth and sediment type were identified by Pratt (1973). The "sand fauna" zone was defined for sandy sediments (1% or less silt) that are at least occasionally disturbed by waves, from shore out to 50 m. The "silty-sand fauna" zone occurred immediately offshore from the sand fauna zone, in stable sands containing a small amount of silt and organic material. Silts and clays become predominant at the shelf break and line the Hudson Shelf Valley, and support the "silt-clay fauna".

Building on Pratt's work, the Mid-Atlantic shelf was further divided by Boesch (1979) into seven bathymetric/morphologic subdivisions based on faunal assemblages (Table 13). Sediments in the region studied (Hudson Shelf Valley south to Chesapeake Bay) were dominated by sand with few finer materials. Ridges and swales are important morphological features in this area. Sediments are coarser on the ridges, and the swales have greater benthic macrofaunal density, species richness, and biomass. Faunal species composition differed between these features, and Boesch (1979) incorporated this variation in his subdivisions. Much overlap of species distributions was found between depth zones, so the faunal assemblages represented more of a continuum than distinct zones.

Table 13 – Mid-Atlantic habitat types. As described by Pratt (1973) and Boesch (1979) with characteristic macrofauna as identified in Boesch (1979).

Habitat Type [after Boesch (1979)]	Description		
	Depth (m)	Characterization [Pratt (1973) faunal zone]	Characteristic benthic macrofauna
Inner shelf	0 - 30	characterized by coarse sands with finer sands off MD and VA (sand zone)	Polychaetes: *Polygordius, Goniadella, Spiophanes*
Central shelf	30 - 50	(sand zone)	Polychaetes: *Spiophanes, Goniadella,* Amphipod: *Pseudunciola*
Central and inner shelf swales	0 - 50	occurs in swales between sand ridges (sand zone)	*Polychaetes: Spiophanes, Lumbrineris, Polygordius*
Outer shelf	50 - 100	(silty sand zone)	Amphipods: *Ampelisca vadorum, Erichthonius* Polychaetes: *Spiophanes*
Outer shelf swales	50 - 100	occurs in swales between sand ridges (silty sand zone)	Amphipods: *Ampelisca agassizi, Unciola, Erichthonius*
Shelf break	100 - 200	(silt-clay zone)	not given
Continental slope	> 200	(none)	not given

Demersal fish assemblages were described at a broad geographic scale for the continental shelf and slope from Cape Chidley, Labrador to Cape Hatteras, North Carolina (Mahon et al.1998) and from Nova Scotia to Cape Hatteras (Gabriel 1992). Factors influencing species distribution included latitude and depth. Results of these studies were similar to an earlier study confined to the Mid-Atlantic Bight continental shelf (Colvocoresses and Musick 1984). In this study, there were clear variations in species abundances, yet they demonstrated consistent patterns of community composition and distribution among demersal fishes of the Mid-Atlantic shelf. This is especially true for five strongly recurring species associations that varied slightly by season (Table 14). The boundaries between fish assemblages generally followed isotherms and isobaths. The assemblages were largely similar between the spring and fall collections, with the most notable change being a northward and shoreward shift in the temperate group in the spring. As noted in the previous Gulf of Maine and Georges Bank sections, these fish assemblage studies did not attempt to associate species with specific seabed features/structures.

Table 14 – Major recurrent demersal finfish assemblages of the Mid-Atlantic Bight during spring and fall. Source: Colvocoresses and Musick (1984).

Season	Species Assemblage				
	Boreal	**Warm temperate**	**Inner shelf**	**Outer shelf**	**Slope**
Spring	Atlantic cod, little skate, sea raven, monkfish, winter flounder, longhorn sculpin, ocean pout, silver hake, red hake, white hake, spiny dogfish	Black sea bass, summer flounder, Butterfish, scup, spotted hake, northern searobin	Windowpane	Fourspot flounder	Shortnose greeneye, offshore hake, blackbelly rosefish, white hake
Fall	White hake, silver hake, red hake, monkfish, longhorn sculpin, winter flounder, yellowtail flounder, witch flounder, little skate, spiny dogfish	Black sea bass, summer flounder, butterfish, scup, spotted hake, northern searobin, smooth dogfish	Windowpane	Fourspot flounder, fawn cusk eel, gulf stream flounder	Shortnose greeneye, offshore hake, blackbelly rosefish, white hake, witch flounder

4.2.1.4 Continental slope, canyons and seamounts

The shelf slopes gently from shore out to between 100 and 200 km offshore where it transforms to the slope at the shelf break (100-200 m water depth), continuing eastward with increasing depth until it becomes the continental rise, and finally the abyssal plain. The width of the slope varies from 10-50 km, with an average gradient of 3-6°; however, local gradients can be nearly vertical. The base of the slope is defined by a marked decrease in seafloor gradient where the continental rise begins. The slope is cut by at least 70 large canyons between Georges Bank and Cape Hatteras and numerous smaller canyons and gullies, many of which may feed into the larger canyon systems. Volcanically-derived underwater mountains called seamounts emerge from the abyssal plain. The New England Seamount Chain including Bear, Mytilus, and Balanus Seamounts occurs on the slope southwest of Georges Bank. Two smaller isolated seamounts to the west (i.e., Caryn, Knauss) occur in deeper water. The canyon and seamount features are shown on Map 26 and Map 30.

Oceanography

Slope water tends to be warmer than shelf water because of its proximity to the Gulf Stream, and tends to be more saline. The abrupt gradient where these two water masses meet is called the shelf-slope front. This front is usually located at the edge of the shelf and touches bottom at about 75-100 m, and then slopes up to the east toward the surface. It reaches surface waters approximately 25-55 km further offshore. The position of the front is highly variable, and can be influenced by many physical factors. Vertical structure of temperature and salinity within the front can develop complex patterns because of the interleaving of shelf and slope waters; e.g., cold shelf waters can protrude offshore, or warmer slope water can intrude up onto the shelf.

The water masses of the Atlantic continental slope and rise are essentially the same as those of the North American Basin (defined in Wright and Worthington (1970)). Worthington (1976) divided the water column of the slope into three vertical layers: deepwater (colder than 4°C), the thermocline (4-17°C), and surface water (warmer than 17°C). In the North American Basin, deepwater accounts for two-thirds of all the water, the thermocline for about one-quarter, and surface water the remainder. In the slope water north of Cape Hatteras, the only warm water occurs in the Gulf Stream and in seasonally influenced summer waters.

The principal cold water mass in the region is the North Atlantic Deep Water. North Atlantic Deep Water is comprised of a mixture of five sources: Antarctic Bottom Water, Labrador Sea Water, Mediterranean Water, Denmark Strait Overflow Water, and Iceland-Scotland Overflow Water.

The thermocline represents a straightforward water mass compared with either the deepwater or the surface water. Nearly 90% of all thermocline water comes from the water mass called the Western North Atlantic Water. This water mass is slightly less saline northeast of Cape Hatteras due to the influx of southward flowing Labrador Coastal Water. Seasonal variability in slope waters penetrates only the upper 200 m of the water column.

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

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

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

The location of the Gulf Stream's shoreward, western boundary is variable because of meanders and eddies. Gulf Stream eddies are formed when extended meanders enclose a parcel of seawater and pinch off. These eddies can be cyclonic, meaning they rotate counterclockwise and have a cold core formed by enclosed slope water (cold core ring), or anticyclonic, meaning they rotate clockwise and have a warm core of Sargasso Sea water (warm core ring). The rings are shaped like a funnel, wider at the top and narrower at the bottom, and can have depths of over 2000 m. They range in size from approximately 150-230 km in diameter. There are 35% more rings and meanders near Georges Bank than in the Mid-Atlantic region. A net transfer of water on and off the shelf may result from the interaction of rings and shelf waters. These warm or cold core rings maintain their identity for several months until they are reabsorbed by the Gulf Stream. The rings and the Gulf Stream itself have a great influence over oceanographic conditions all along the continental shelf.

Sedimentary features

On the slope, silty sand, silt, and clay predominate. A "mud line" occurs on the slope at a depth of 250-300 m, below which fine silt and clay-size particles predominate. Localized coarse sediments and rock outcrops are found in and near canyon walls, and occasional boulders occur on the slope because of glacial rafting. Sand pockets may also be formed because of downslope movements. The morphology of the present continental slope appears largely to be a result of sedimentary processes that occurred during the Pleistocene, including, 1) slope upbuilding and progradation by deltaic sedimentation principally during sea-level low stands; 2) canyon cutting by sediment mass movements during and following sea-level low stands; and 3) sediment slumping.

Gravity induced downslope movement is the dominant sedimentary process on the slope, and includes slumps, slides, debris flows, and turbidity currents, in order from thick cohesive movement to relatively nonviscous flow. Slumps may involve localized, short, down-slope movements by blocks of sediment. However, turbidity currents can transport sediments thousands of kilometers.

Submarine canyons are not spaced evenly along the slope, but tend to decrease in areas of increasing slope gradient. Canyons are typically "v" shaped in cross section and often have steep walls and outcroppings of bedrock and clay. The canyons are continuous from the canyon heads to the base of the continental slope. Some canyons end at the base of the slope, but others continue as channels onto the continental rise. Larger and more deeply incised canyons are generally significantly older than smaller ones, and there is evidence that some older canyons have experienced several episodes of filling and re-excavation. Many, if not all, submarine canyons may first form by mass-wasting processes on the continental slope, although there is evidence that some canyons were formed because of fluvial drainage (e.g., Hudson Canyon). Canyons form by erosion of the sediments and sedimentary rocks of the continental margin. They can be classed as high or low relief. Canyons with high relief that are deeply eroded into the continental margin may be U-shaped or V-shaped. Erosion by glaciers produces U-shaped canyons. These include canyons in Canadian waters in the glacially-eroded Northeast Channel that separates Georges Bank and the Scotian Shelf. These U-shaped canyons contain the following sediment types:

- Glacial gravel (boulders, cobbles, pebbles) that was transported onto canyon rims, walls, and floors by glaciers and floating ice
- Gravel (boulders, cobbles, pebbles) that was transported into canyons by glaciers and floating ice
- Outcropping rocks exposed on canyon walls
- Rock rubble on canyon walls and floor from rock falls

Erosion by rivers, mass wasting, and turbidity currents produces V-shaped canyons. These include the Georges Bank canyons on the bank's southern margin. These canyons did not experience direct glacial erosion because the glaciers terminated on the bank's northern margin. These V-shaped canyons contain the following sediment types:

- Gravel in canyons that was transported by floating ice
- Outcropping rocks exposed on canyon walls
- Rock rubble on canyon walls and floor from rock falls
- Stiff Pleistocene clay exposed on canyon walls; burrowed by crabs and fish to form "pueblo villages"; burrowed clay can collapse to form rubble on canyon walls and floors
- Veneer of modern sediment partly covering canyon walls
- Modern sediment covering canyon floors
- Modern sand transported onto the canyon floor from the shelf can be formed into bedforms by strong tidal currents in some canyons

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

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

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

- Gravel that was transported by floating ice

- Modern sediment

Note that the inter-canyon slope area south of Hudson Canyon is regionally unique and distinct from the Georges Bank areas in that in contains limestone outcrops.

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

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

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

Benthic invertebrates and fish

Polychaete annelids represent the most important slope faunal group in terms of numbers of individuals and species (Wiebe et al. 1987). Ophiuroids (brittle stars) are considered to be among the most abundant slope organisms, but this group is comprised of relatively few species. The taxonomic group with the highest species diversity is the peracarid crustaceans (which includes amphipods, cumaceans, and isopods). Some species of the slope are widely distributed, while others appear to be restricted to particular ocean basins. The ophiuroids and bivalves appear to have the broadest distributions, while the peracarid crustaceans appear to be highly restricted because they brood their young, and lack a planktonic stage of development. In general, gastropods do not appear to be very abundant; however, past studies are inconclusive since they have not collected enough individuals for large-scale community and population studies.

In general, slope inhabiting benthic organisms are strongly zoned by depth and/or water temperature, although these patterns are modified by the presence of topography, including canyons, channels, and current zonations (Hecker 1990). Moreover, at depths of less than 800 m, the fauna is extremely variable and the relationships between faunal distribution and substrate, depth, and geography are less obvious (Wiebe et al. 1987). Fauna occupying hard surface sediments are not as dense as in comparable shallow water habitats (Wiebe et al. 1987), but there is an increase in species diversity from the shelf to the intermediate depths of the slope. Diversity then declines again in the deeper waters of the continental rise and plain. Hecker (1990) identified four megafaunal zones on the slope of Georges Bank and southern New England (Table 15).

Table 15 – Faunal zones of the continental slope of Georges Bank and Southern New England. Source: Hecker 1990.

Zone	Approximate Depth (m)	Gradient	Current	Fauna
Upper Slope	300 - 700	Low	Strong	Dense filter feeders; Scleratinians (*Dasmosmilia lymani, Flabellum alabastrum*), quill worm (*Hyalinoecia*)
Upper Middle Slope	500 - 1300	High	Moderate	Sparse scavengers; red crab (*Chaceon quinqueidens*), long-nosed eel (*Synaphobranchus*), common grenadier (*Nezumia*). Alcyonarians (*Acanella arbuscula*, *Eunephthya florida*) in areas of hard substrate
Lower Middle Slope/Transition	1200 - 1700	High	Moderate	Sparse suspension feeders; cerianthids, sea pens (*Distichoptilum gracile*)
Lower Slope	> 1600	Low	Strong	Dense suspension and deposit feeders; ophiurid (*Ophiomusium lymani*), cerianthids, sea pens

One group of organisms of interest because of the additional structure they can provide for habitat and their potential long life span are the Alcyonarian soft corals. Soft corals can be bush or treelike in shape; species found in this form attach to hard substrates such as rock outcrops or gravel. These species can range in size from a few millimeters to several meters, and the trunk diameter of large specimens can exceed 10 cm. Other Alcyonarians found in this region include sea pens and sea pansies (Order Pennatulacea), which are found in a wider range of substrate types.

As opposed to most slope environments, canyons may develop a lush epifauna (Table 16). Hecker et al. (1983) found faunal differences between the canyons and slope environments. Hecker and Blechschmidt (1979) suggested that faunal differences were due at least in part to increased environmental heterogeneity in the canyons, including greater substrate variability and nutrient enrichment. Hecker et al. (1983) found highly patchy faunal assemblages in the canyons, and also found additional faunal groups located in the canyons, particularly on hard substrates, that do not appear to occur in other slope environments. Canyons are also thought to serve as nursery areas for a number of species (Cooper et al. 1987; Hecker 2001).

Most finfish identified as slope inhabitants on a broad spatial scale (Colvocoresses and Musick 1984, Overholtz and Tyler 1985, Gabriel 1992) are associated with canyon features as well (Cooper et al. 1987). Finfish identified by broad studies that were not included in Cooper et al. (1987) include offshore hake, fawn cusk-eel, longfin hake, witch flounder, and armored searobin. Canyon species (Cooper et al. 1987) that were not discussed in the broad scale studies include squirrel hake, conger eel, and tilefish. Cusk and ocean pout were identified by Cooper et al. (1987) as canyon species, but classified in other habitats by the broad scale studies.

Table 16 – Habitat types and faunal assemblages of the Georges Bank Canyons. Faunal characterization is for depths < 230 m only. Source: Cooper et al 1987.

Habitat Type	Geologic Description	Canyon Locations	Most Commonly Observed Fauna
I	Sand or semiconsolidated silt substrate (claylike consistency) with less than 5% overlay of gravel. Relatively featureless except for conical sediment mounds.	Walls and axis	Cerianthid, pandalid shrimp, white colonial anemone, Jonah crab, starfishes, portunid crab, greeneye, brittle stars, mosaic worm, red hake, fourspot flounder, shellless hermit crab, silver hake, gulf stream flounder
II	Sand or semiconsolidated silt substrate (claylike consistency) with more than 5% overlay of gravel. Relatively featureless.	Walls	Cerianthids, galatheid crab, squirrel hake, white colonial anemone, Jonah crab, silver hake, sea stars, ocean pout, brittle stars, shellless hermit crab, greeneye
III	Sand or semiconsolidated silt (claylike consistency) overlain by siltstone outcrops and talus up to boulder size. Featured bottom with erosion by animals and scouring.	Walls	White colonial anemone, pandalid shrimp, cleaner shrimp, rock anemone, white hake, sea stars, ocean pout, conger eel, brittle stars, Jonah crab, lobster, blackbelly rosefish, galatheid crab, mosaic worm, tilefish
IV	Consolidated silt substrate, heavily burrowed/excavated. Slope generally more than 5º and less than 50º. Termed "pueblo village" habitat.	Walls	Sea stars, blackbelly rosefish, Jonah crab, lobster, white hake, cusk, ocean pout, cleaner shrimp, conger eel, tilefish, galatheid crab, shellless hermit crab
V	Sand dune substrate.	Axis	Sea stars, white hake, Jonah crab, monkfish

4.2.2 Seabed vulnerability

Seabed vulnerability to fishing gear impacts was evaluated using the Swept Area Seabed Impact (SASI) approach. SASI was developed by the Council's Habitat Plan Development Team to assist them in evaluating adverse effects across FMPs, developing measures to minimize those effects, and analyzing the impacts of those measures. This section summarizes some of the conclusions of the SASI analysis, specifically the spatial distribution of vulnerability by area and across gear types. Appendix D details the SASI approach. The approach was approved by the SSC, as well as by a peer-review panel convened specifically to assess the validity of using the SASI approach for development and analysis of management measures.

The SASI approach consists of a vulnerability assessment and a spatial model. The vulnerability assessment reviewed the habitat impacts literature relevant to Northeast US fishing gears and seabed types, and created a framework for organizing and generating susceptibility and recovery values for seabed features based on a scale of relative differences for use in the SASI model. Although both seafloor and water column aspects of habitat are important in determining fish distributions, the focus of the vulnerability assessment is seabed features since fishing activities do not substantively alter the water column. The vulnerability assessment identified low-energy granule-pebble, cobble- and boulder-dominated habitats as being the most vulnerable to fishing impacts (Appendix D, Grabowski et al 2014). This vulnerability is driven primarily by the estimated recovery times, i.e., the amount of time it takes for structural habitat features to return to their prior state.

Next, seafloor substrate and energy maps were created to serve as a foundation for a modeling approach that examines the spatial distribution of vulnerable seafloor habitats. Two data sources were used to develop the substrate map: a video survey conducted by the University of Massachusetts Dartmouth School for Marine Science and Technology, which captures all grain sizes, and the usSEABED database compiled by the United States Geological Survey which consists mainly of grab samples and focuses on mud, sand, and granule-pebble grain sizes only. The substrate classification follows Wentworth (1922) (Table 17). In order to map substrate across the entire domain, a Voronoi tessellation method was used. This method draws lines equidistant between sample points and creates nodes where multiple lines intersect, creating the Voronoi polygons. This results in polygons around each sampling point in which all the space in that polygon is closer to one substrate sampling point than to any other sampling point. All of that space is given the same substrate classification as the sampling point, and in this way the substrate of the whole domain was interpolated and mapped. Voronoi cells are smaller where data points are closely/densely spaced and larger where data points are far apart.

Seafloor energy was classified as either high or low energy based on model estimates of flow rate at the seabed or according to depth in locations where flow estimates were unavailable (less than 0.194 $N \cdot m^{-2}$ flow or deeper than 60 meters was low energy). The substrate grids are shown in Map 18 (Gulf of Maine), Map 27 (GB), and Map 31 (Mid-Atlantic Bight). The energy assessment is more fully described in section 7.2 of Appendix D.

Table 17 – Substrate model classes (mud-boulder) and corresponding grain size range

Mud	< 0.0039-0.0625 mm
Sand	0.0625-2 mm
Granule-pebble	2-64 mm
Cobble	64 – 256 mm
Boulder	> 256 mm

Various seabed features such as sand waves or sponges were inferred to occur in particular substrate-energy types. Then the seabed features were given susceptibility and recovery scores according to the nature of the fishing gear impact (i.e. the type of gear and how it interacts with the seabed). The initial effect of the gear (susceptibility) and the recovery duration were scored on a scale of zero to three (Table 18). The scores were based on interpretations from the literature review, which provided information specific to the susceptibility of benthic habitat features likely to be impacted by each gear type and the time required for those habitats to return to their pre-impact functional value. An example is provided in Table 19, and all susceptibility and recovery scores can be found in Appendix D.

Table 18 – Susceptibility and recovery values used in the SASI vulnerability assessment and model

Relative S or R value	*Quantitative definition of susceptibility*	*Quantitative definition of recovery*
0	0 – 10%	< 1 year
1	>10%-25%	1 – 2 years
2	25 - 50%	2 – 5 years
3	> 50%	> 5 years

Table 19 – Sample of trawl gear vulnerability matrices. The Susceptibility (S) and Recovery (R) values are coded as described above. The literature column indicates those studies identified during the literature review as corresponding to that combination of gear, feature, energy, and substrate. The studies referenced here were intended to be inclusive, so any particular study may or may not have directly informed the S or R score. Any literature used to estimate scores is referenced in Table 31 (Trawl S), Table 39 (Geo R), and Table 40 (Bio R) of the SASI document. High and low energy susceptibility and recovery values are the same unless otherwise noted.

Gear: Trawl					
Substrate: Mud					
Feature name and class – G (Geological) or B (Biological)	**Gear effects**	**Literature high energy**	**Literature low energy**	**S**	**R**
Biogenic burrows (G)	filling, crushing	334, 408, 409	97, 101, 313, 333, 336, 407	2	0
Biogenic depressions (G)	filling	236, 408, 409	101, 247, 336	2	0
Sediments, surface/subsurface (G)	re-suspension of fine sediments, compression, geochemical, mixing	88, 92, 211, 236, 330, 334, 406, 408, 409, 599	88, 97, 211, 247, 277, 283, 313, 320, 333, 335, 336, 338, 372, 407, 414	2	0
Amphipods, tube-dwelling (B) – see note	crushing	34, 113, 119, 211, 228, 292, 334, 408, 409, 599, 658	89, 80, 97, 113, 149, 320, 575	1	0
Anemones, cerianthid burrowing (B)	breaking, crushing, dislodging, displacing	none	None	2	2
Corals, sea pens (B)	breaking, crushing, dislodging, displacing	none	101, 164	2 (low energy only)	2 (low energy only)

Bar charts comparing susceptibility and recovery scores for geological and biological features in high and low energy environments are reproduced from Grabowski et al. 2014 (Figure 1 – otter trawl; Figure 2 – longline and gillnet; Figure 3 – hydraulic clam dredge). The scallop dredge and trap figures are very similar to the otter trawl and longline/gillnet figures, respectively, and are therefore not shown here. The model itself is described below, but in terms of interpreting these figures, it is useful to state that sensitivity analyses demonstrated that recovery scores are an important driver of model results, with longer recovery times contributing to higher estimates of vulnerability. In Figure 1, otter trawl, the lower left panel shows the highest geological recovery scores associated with cobble and boulder habitats in high energy environments (shaded bars). These particular results are an important driver of the trawl vulnerability maps presented later in this section. Similar patterns of mean recovery are evident for the longline/gillnet assessment (Figure 2). The hydraulic dredge vulnerability assessment (and model) operates differently as only two substrate types were evaluated given assumptions about seabed types in which the gear can be fished. In this case (Figure 3), longer recovery times in low energy habitats (open bars) are a key driver of the vulnerability results. Note the differences in the scale of the various results on the vertical axis, which translates to the magnitude of the vulnerability scores across the gear types (high for hydraulic dredges, low for the fixed gears, moderate for otter trawls and scallop dredges).

Figure 1 – Mean susceptibility (S, % damaged) and recovery (R, time in years) of biological and geological features from otter trawl gear impacts; hatched vertical error bars are ±1 SE. High/low refers to energy regime. Source: Grabowski et al. 2014.

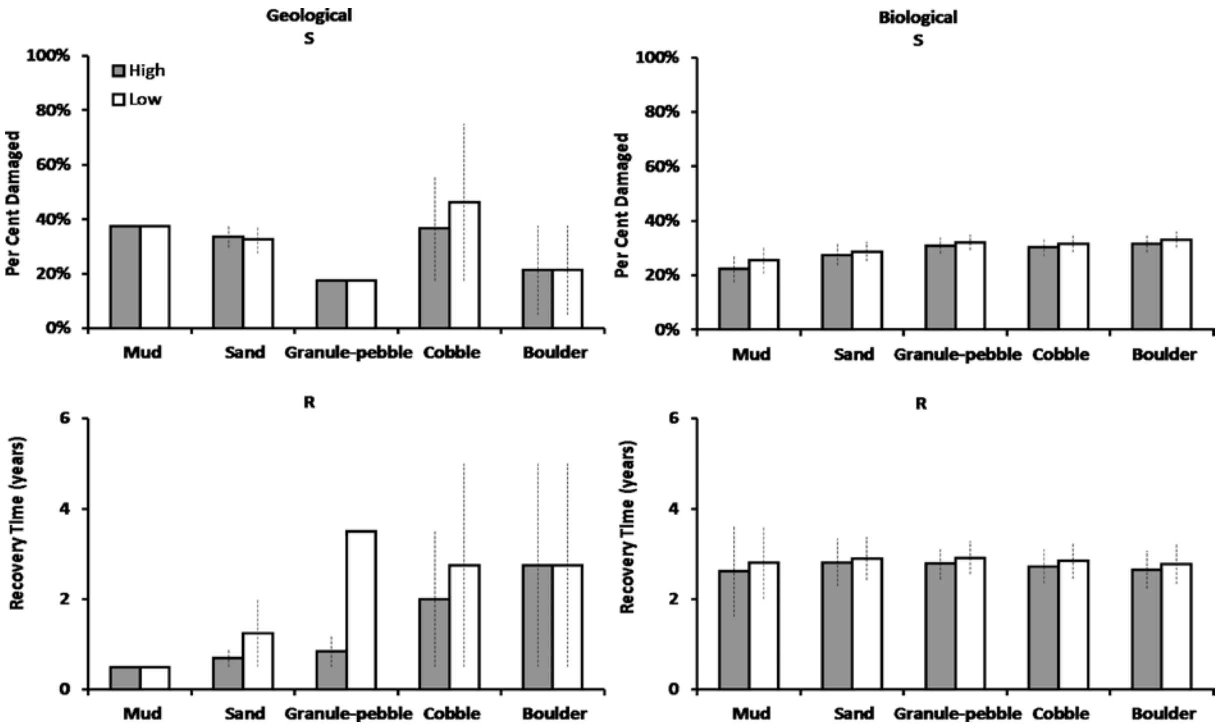


Figure 2 – Mean susceptibility (S, % damaged) and recovery (R, time in years) of biological and geological features from longline and gillnet gear impacts; hatched vertical error bars are ±1 SE. High/low refers to energy regime. Source: Grabowski et al. 2014.

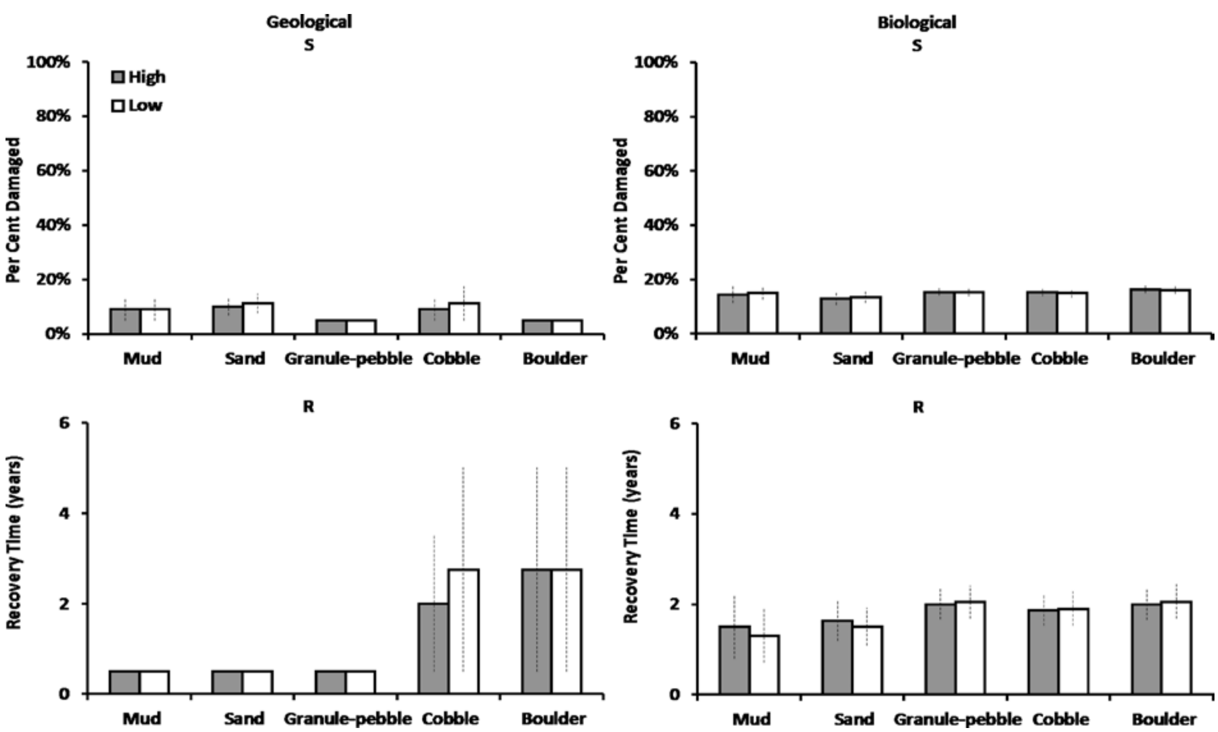
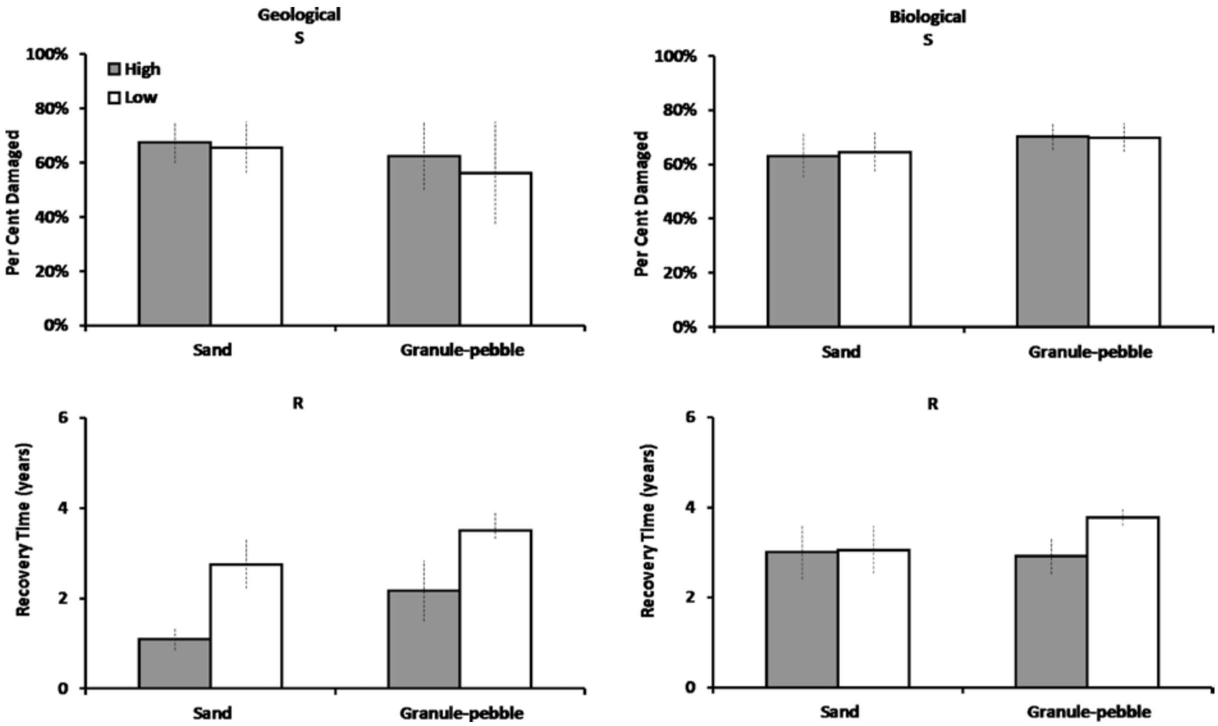


Figure 3 – Mean susceptibility (S, % damaged) and recovery (R, time in years) of biological and geological features from hydraulic dredge gear impacts; hatched vertical error bars are ±1 SE. High/low refers to energy regime. Source: Grabowski et al. 2014.



The underlying substrate Voronoi polygons relate to the SASI grid as shown in Figure 4. A 10km x 10km resolution was selected for the SASI grid because it is roughly commensurate with the spatial scale over which mobile-gear fishing events occur. This structured grid is the resolution of the adverse effects and vulnerability outputs shown in the lower portion of the figure. The estimated vulnerability of these geological and biologal structures to different types of fishing gears, combined with the underlying habitat distribution, generates the vulnerability maps. Thus, the substrate distribution, specifically the area of each 100 km^2 grid dominated by a given substrate type, directly influences the features inferred and therefore the vulnerability results.

Due to the high degree of influence of the substrate model on the vulnerability results, an understanding of the spatial variation in the supporting data is useful when interpreting the modeling outputs. In locations where all substrate sizes (especially larger grain sizes such as boulders and cobbles) were sampled, and where substrate samples were taken close together, the map that serves as the foundation for the model is considered to be a relatively accurate representation of the true conditions of the seabed. These are considered to be areas with high data quality. In locations where gear only capable of sampling finer grain sizes was used (such as those areas where only grab samples were available), and/or where substrate samples were widely spaced, the map is a less accurate representation of the true seabed conditions. These are considered to be areas with low data quality. The substrate and resulting vulnerability results for areas with low data quality should be considered more cautiously. In order to provide a visual representation of data quality, a metric was created based on sampling ability of the gear and spacing between data points, as follows (Map 33):

- Low (1): Voronoi cell size greater than 100 km^2 AND only small grain sizes sampled
- Moderate (2): Voronoi cell size between 10-100 km^2 AND only small grain sizes sampled
- High moderate (3): Voronoi cell size between 1-10 km^2 AND only small grain sizes sampled
- Very high moderate (4): Voronoi cell size less than 1 km^2 AND only small grain sizes sampled
- High (5): Voronoi cell size 10-100 km^2 AND all grain sizes sampled
- Very high (6): Voronoi cell size 1-10 km^2 AND all grain sizes sampled
- Ultra high (7): Voronoi cell size less than 1 km^2 AND all grain sizes sampled

In general, Georges Bank, much of the Mid-Atlantic Bight, and the tops of shallower features in the Gulf of Maine are considered to be high data quality and therefore the spatial distribution of vulnerability is expected to be more accurate in those areas. Coastal areas have moderate data quality; generally the samples are closely spaced such that the grid is highly resolved spatially, but not all grain sizes were sampled in the data so cobble and boulder-dominated habitats are not well mapped. Deep water areas of the Gulf of Maine and areas off the edge of the shelf are generally low data quality.

Because the usSEABED dataset is heavily skewed toward sampling pebble and smaller grain sizes, in general cobble- and boulder-dominated habitats can be poorly mapped by the Voronoi grid. On Stellwagen Bank this resulted in an underestimate of gravel seafloor due to the reliance of the mapping on grab samples. A multibeam backscatter-based sediment map of this area indicates a higher amount of gravel habitat (Map 19) as compared to the SASI grid (Map 18). In contrast, the distribution of cobble- and boulder-dominated habitats in the vicinity of Platts Bank and Jeffreys Bank is thought to be overestimated. There are many closely spaced substrate samples on the shallow portions of these features where the sampling gear used (video) was capable of sampling cobble and boulder, but the surrounding areas are mapped at very low resolution with gear incapable of sampling these larger grain sizes. The result is that the substrate grid has some very large cobble and boulder grid cell sizes along the edges of the features, which makes the vulnerable areas and average scores larger and higher. This is not to say that these offshore features do not contain seabed types vulnerable to impact, only that they are not mapped very accurately (i.e., they have low data density and therefore large Voronoi cells). Generally, the PDT determined that large substrate grain sizes are probably relatively rare in deep mud habitats, although there are exceptions to this (e.g., rocky ‘bumps’ found scattered throughout Jordan Basin). On Georges Bank more widely spaced samples in the central portion of the Bank around Cultivator Shoals resulted in apparently larger areas of vulnerable seafloor compared to areas with more finely spaced samples immediately to the east on the Northeast Peak. The difference in sampling resolution affected the cluster analysis because areas with large Voronoi cells appeared to have larger areas of vulnerable seafloor. Therefore, the cluster analysis was used as a guide to identify regions with generally higher vulnerability, but additional information such as acoustic sampling was also considered when establishing proposed Habitat Management Areas (HMAs).

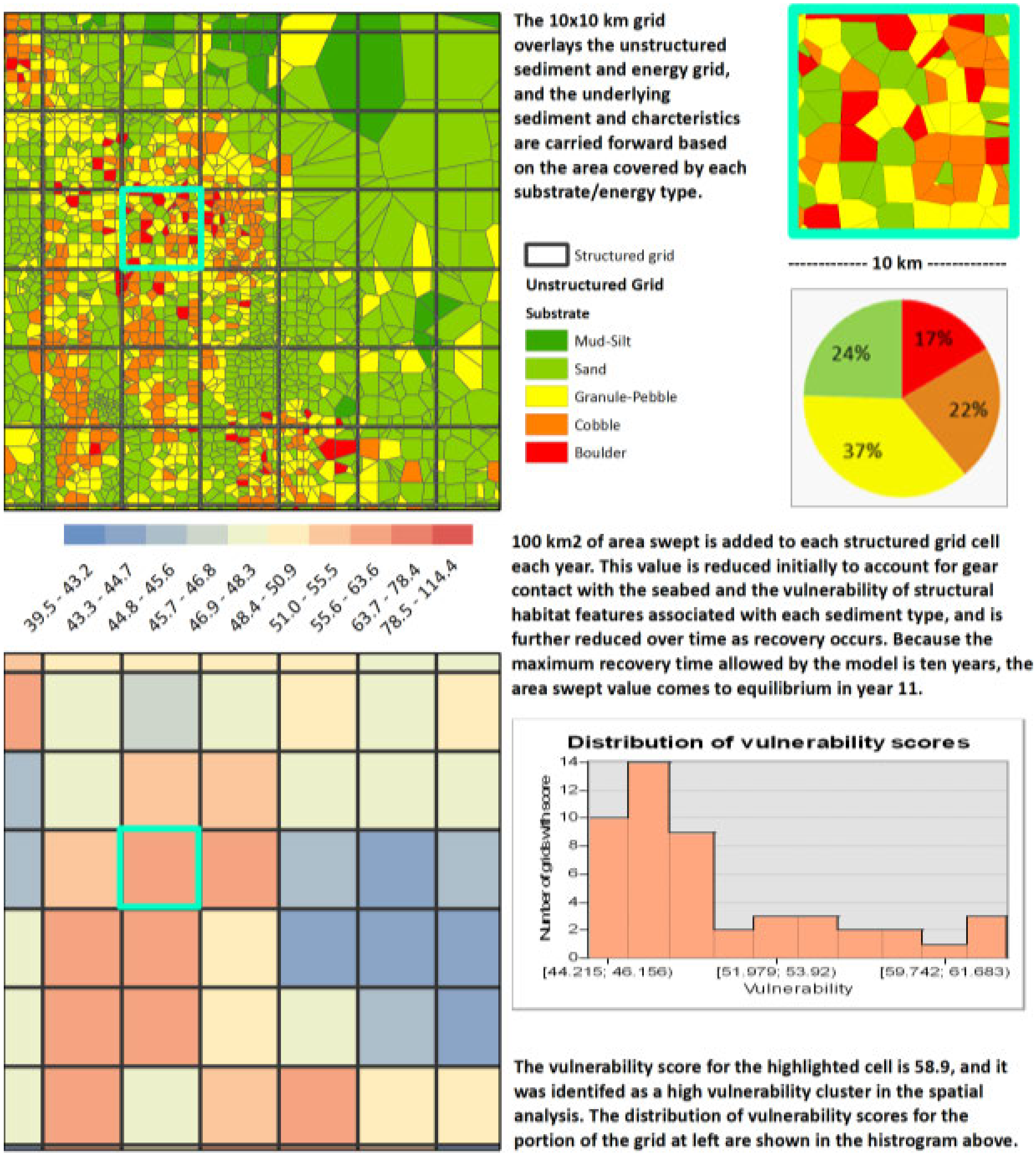
The SASI model was then used to combine area swept fishing effort data with the vulnerability assessment. The model output is a gear-specific, contact- and vulnerability-adjusted area swept value in square kilometers. Habitat vulnerability reflects both its susceptibility to impact and its recovery rate.

There are two main model outputs described in the next two sections: potential adverse effect, which is the underlying vulnerability of the seafloor, and realized adverse effect, which is where adverse effects as a result of actual fishing activity are accumulating. Both of these are assessed by gear type. Each section describes the basic methods used to produce these outputs and discusses the results. Additional information about vulnerability by management area and alternative is presented in the environmental impacts of spatial management alternatives section of this EIS, which is in Volume 3.

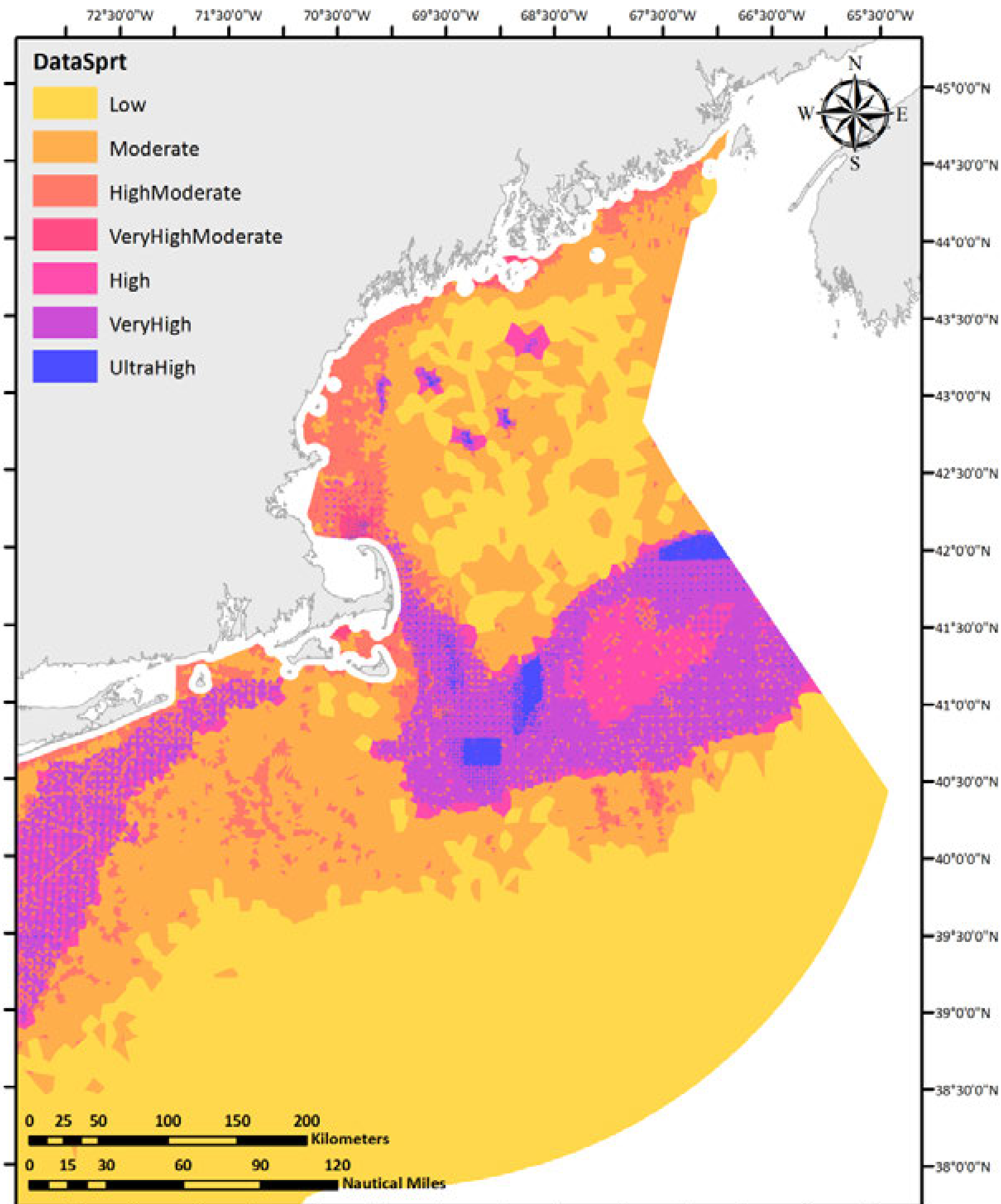
A brief summary of the modeling approach is provided here. First, annual, gear-specific, seabed area swept (fishing effort) data layers are generated from vessel trip report and at-sea observer data (these are referred to as realized area swept data). For the potential adverse effect model runs, a standard value of 100 km^2 area swept per grid cell per year is used. Next, either the realized area swept data or the standard 100 km^2 per grid cell area swept data are adjusted to account for the contact of the gear. For trawls and fixed gears where less than 100% seabed contact was assumed, applying the contact index reduces the area swept from 100% of the footprint swept to a lower value, substantially lower in the case of the fixed gears. These area swept values are scaled according to the area-weighted susceptibility scores estimated for the habitat types present in that particular spatial location. The upper portion of Figure 4 shows how the habitat type/area weighting works spatially.

Once fishing effort data enters the model in year 1, its associated contact-adjusted area swept begins to decay according to the recovery scores assigned to the habitat types present in each grid cell. Depending on the habitat types present and features inferred to those habitat types, it may take up to ten years for the initial impact to be completely dissipated. In year 2, as the year 1 area swept/effort is decaying, year 2 area swept/effort data is added to the model. Thus, the total realized adverse effect in a given model grid cell and year is the composite of past impacts that have not yet fully decayed away, and any new impacts generated during that year. For the potential adverse effect model runs, the year 11 values are shown. This is because the model comes to equilibrium in year 11, since the maximum recovery duration is 10 years.

Figure 4 – Using the SASI model to estimate vulnerability of seabed habitats to otter trawl gear.



Map 33 – SASI substrate grid data support values



4.2.2.1 SASI vulnerability estimates

The underlying vulnerability of the seafloor was assessed using simulation runs of the SASI model. Because the model relies on area swept of each gear type to examine where adverse effects accumulate over time, a uniform area swept fishing effort layer of 100 km^2 area swept per cell, per year was used to produce six sets of vulnerability outputs, one for each gear type (Map 34 - Map 39, methods detailed in Section 8.3.1 of SASI Appendix). **These simulation runs reflect the underlying vulnerability of the seabed in various locations to each gear type.**

The range of the vulnerability estimates varies by gear type; fixed gears, i.e. longlines, gillnets, and traps, have vulnerability scores that are about one third that of scallop dredges and otter trawls (Figure 5). Hydraulic dredges have higher vulnerability scores than otter trawls and scallop dredges, and much higher vulnerability scores than the fixed gears (Figure 5). Vulnerability scores across all gear types except hydraulic dredges have a narrow, skewed distribution, with a single mode and outliers on the upper end (Figure 5). The hydraulic dredge scores are distributed somewhat differently; they have a bimodal distribution (Figure 5), with lower scores in higher energy areas, and higher scores in lower energy areas (Map 36). The hydraulic dredge model is fairly different from the others because the assumption was made that hydraulic dredges can only operate on sand and granule-pebble substrates, so the model ignores other substrate types when they occurred in a particular grid cell. **Overall, the conclusion of the modeling work was that fixed gears have impacts that are of much lower magnitude compared to mobile gear impacts. Further, the scores assigned in the vulnerability assessment point to gear effects from fixed gears that are relatively limited in their magnitude and relatively short in duration**.

A cluster analysis (local indicators of spatial association, LISA) was run on these vulnerability estimates to identify contiguous areas with similar vulnerability scores (Section 9 of SASI Appendix). The cluster analysis tests how probable it is that the spatial distribution of the vulnerability scores is random and it used a probability threshold of less than or equal to 0.05. Therefore, it is unlikely that the vulnerability scores are randomly distributed; it is likely that they are spatially clustered. The clusters of high vulnerability are shown on the figures below (Map 34 - Map 39). Area boundaries drawn around clusters are more likely to encompass more vulnerable seafloor than area boundaries drawn at random. In addition to the varying magnitude of impact by gear type, the different gears also differentially impact the various seafloor features. The model reflects estimated contact of the gear with the seabed, the susceptibility of the seabed features to the gear type, and the recovery rates of the features.

For **otter trawl gear** (Map 34), areas with high potential vulnerability scores include the area between Cape Cod and the deeper waters of the Great South Channel, a small area in central Georges Bank, the northeastern flank of Georges Bank, areas along the coast in the Gulf of Maine, and various offshore banks and ledges in the Gulf of Maine, including Jeffreys Bank, Stellwagen Bank, Platts Bank, Jeffreys Bank, Fippennies Ledge, and Cashes Ledge. An additional high vulnerability area was mapped off the Rhode Island coast. These areas were highlighted by the cluster analysis, with the exception of Fippennies and Cashes Ledges, which are relatively small features.

These model results relate closely to the vulnerability assessment, which identified cobble- and boulder-dominated habitats as being more vulnerable to fishing impacts (Appendix D, Grabowski et al 2013 in press). Although vulnerable seabed habitat types have been positively identified in the Gulf of Maine, due to higher data quality on Georges Bank as compared to the Gulf of Maine, the spatial distribution of vulnerability is expected to be more accurate on Georges Bank. Two types of areas in the Gulf of Maine are problematic in terms of the vulnerability estimates. First, vulnerability in the vicinity of Stellwagen Bank is probably underestimated. Substrate type in this area is sampled as relatively high rate, but mostly with gear not capable of detecting cobble or boulder. A multibeam backscatter-based sediment map of this area (Map 19) indicates a higher amount of gravel habitat as compared to the SASI grid, which is shown on Map 18. The distribution of vulnerability in the vicinity of Platts Bank and Jeffreys Bank is not very accurately mapped because of the underlying substrate grid. There are many closely spaced substrate samples on the shallow portions of these features, where the sampling gear used (video) was capable of sampling cobble and boulder, but the surrounding areas are mapped at very low resolution with gear incapable of sampling these larger grain sizes. The result is that the substrate grid has some very large cobble and boulder grid cell sizes along the edges of the features, which makes the vulnerable areas and average scores larger and higher. This is not to say that these offshore features do not contain seabed types vulnerable to impact, only that they are not mapped very accurately. Generally, the PDT determined that large substrate grain sizes are probably relatively rare in deep mud habitats, although there are exceptions to this (e.g., rocky ‘bumps’ found scattered throughout Jordan Basin).

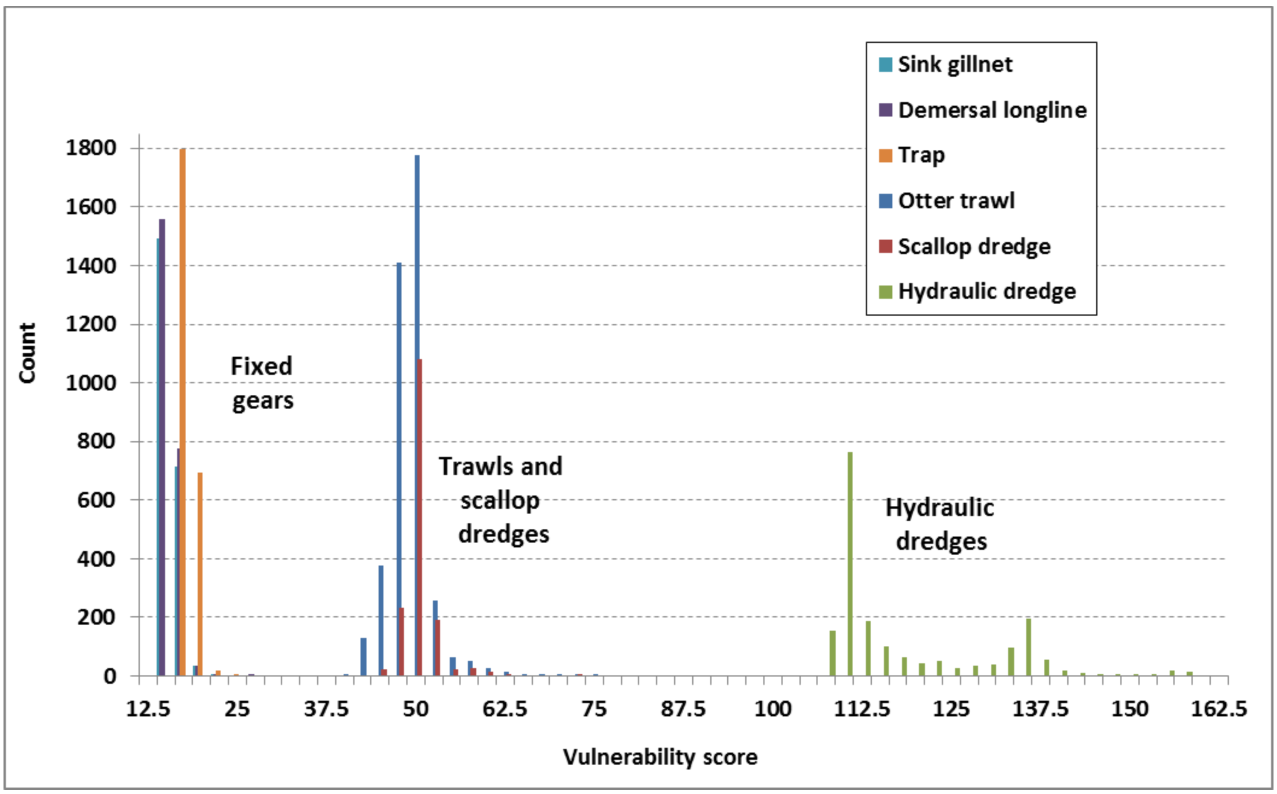
For **scallop dredge gear** (Map 35), the results are very similar to the trawl gear results. However, the domain of the scallop dredge gear map is limited to areas shallower than 83 m, based on the distribution of scallop dredge effort relative to depth in the at-sea fishing observer data. Thus, many of the vulnerable Gulf of Maine areas are not really relevant with regards to the scallop fishery, with the exception of Platts Bank.

The **hydraulic clam dredge gear** model (results on Map 36) assumes the gear can only operate over sand or granule-pebble substrates. Thus, this map is really a depiction of sand and granule-pebble vulnerability to the gear by area. On Georges Bank, there are somewhat higher vulnerability estimates overlapping areas with more granule-pebble vs. sand, i.e. on the northeast part of the bank and in the area west of the Great South Channel, but in general the highest vulnerability scores are in low energy areas along the coast in the Gulf of Maine, and towards the edge of the shelf. The domain of the map extends to a maximum depth of 138 meters.

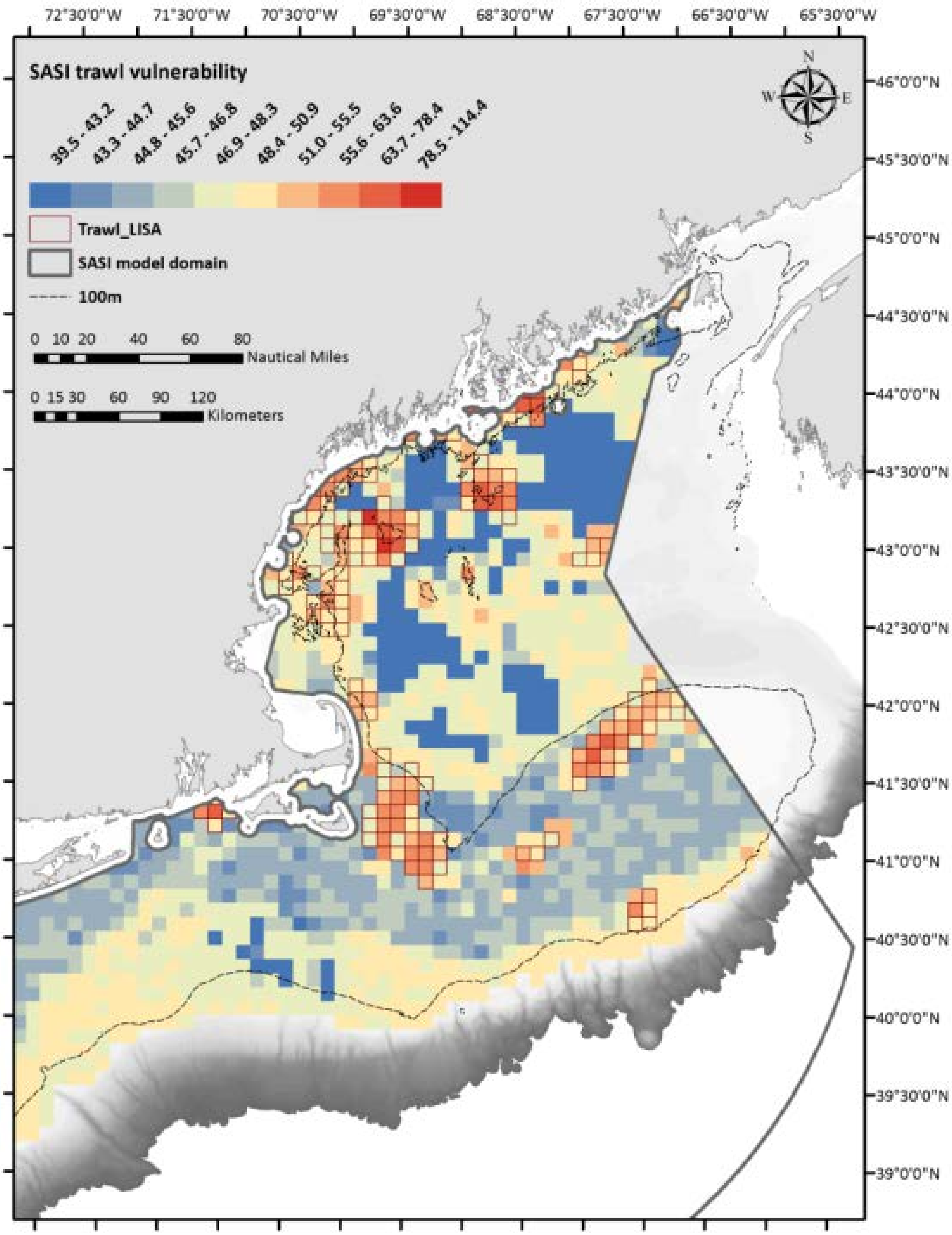
The same areas of Georges Bank and the Gulf of Maine identified as vulnerable to trawl gear are generally identified as vulnerable to the **demersal longline gear** (Map 37), **sink gillnet gear** (Map 38), and **trap gear** (Map 39). Low energy mud areas in the Gulf of Maine and in Southern New England were also estimated to be relatively more vulnerable to the impacts of trap gear. Although the longline/gillnet and trap vulnerability assessment results were very similar, biogenic depressions and surface/subsurface sediments were estimated to be more vulnerable to trap gear, which accounts for the differences between the longline or gillnet vs. trap vulnerability maps.

The trawl vulnerability estimates and associated cluster analyses were used to identify regions of more vulnerable seafloor. This SASI analysis combined with other information guided the design of some of the habitat management areas (HMAs) in this amendment. The trawl vulnerability assessment and map were the primary SASI outputs used to design HMAs because (1) mobile gear impacts are of greater magnitude than fixed gear impacts, (2) the trawl vulnerability maps and scallop dredge vulnerability maps are based on very similar vulnerability assessment results, so the trawl map was used as a proxy because it extends into deeper waters, (3) the hydraulic dredge maps were viewed as a more specialized output, and that fishery is spatially concentrated, as compared to the trawl and scallop dredge fisheries, and (4) the greatest overall magnitude of realized adverse effects throughout the region come from trawl gears (realized adverse effects are explained in the next section).

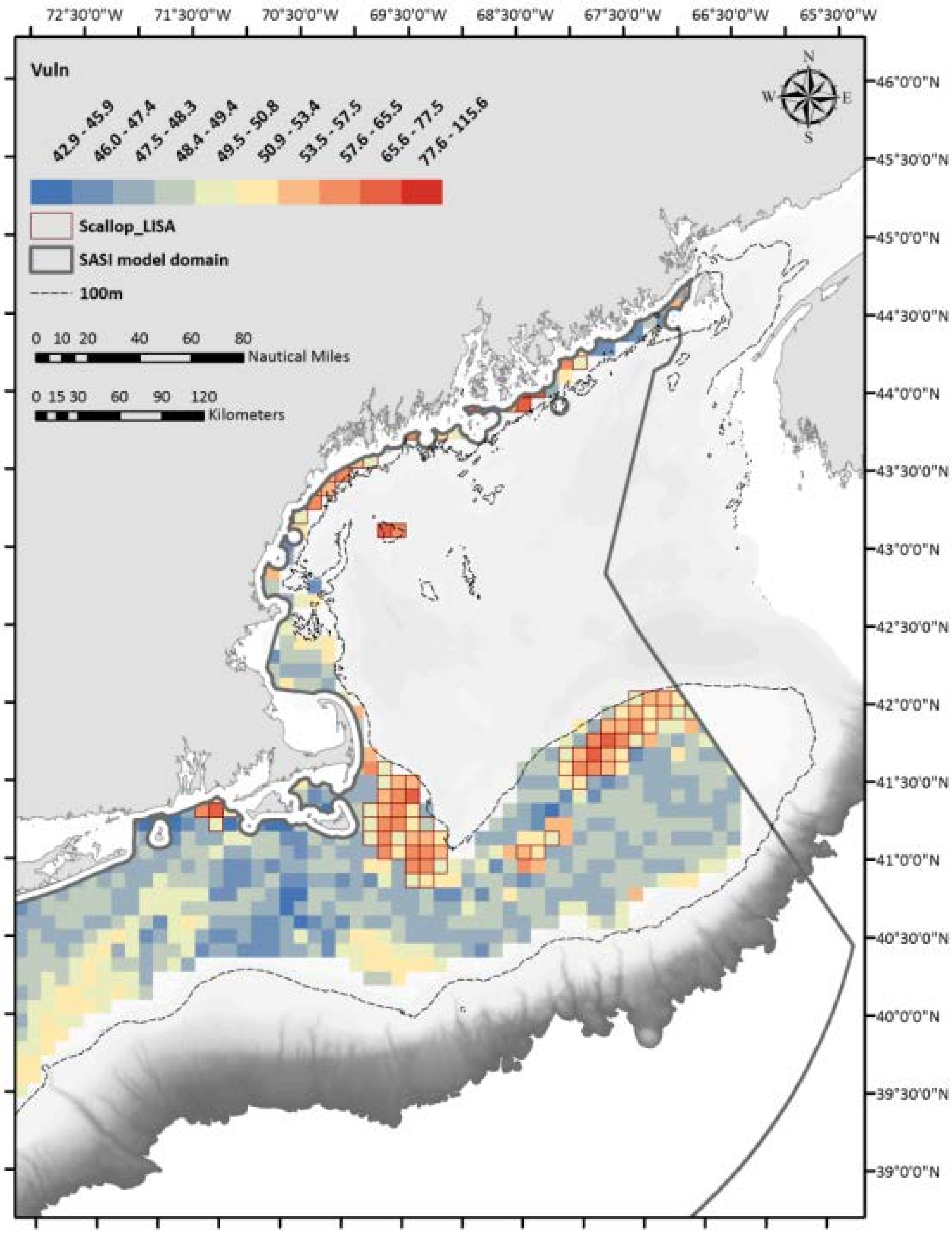
Figure 5 – Distribution of vulnerability scores by gear type



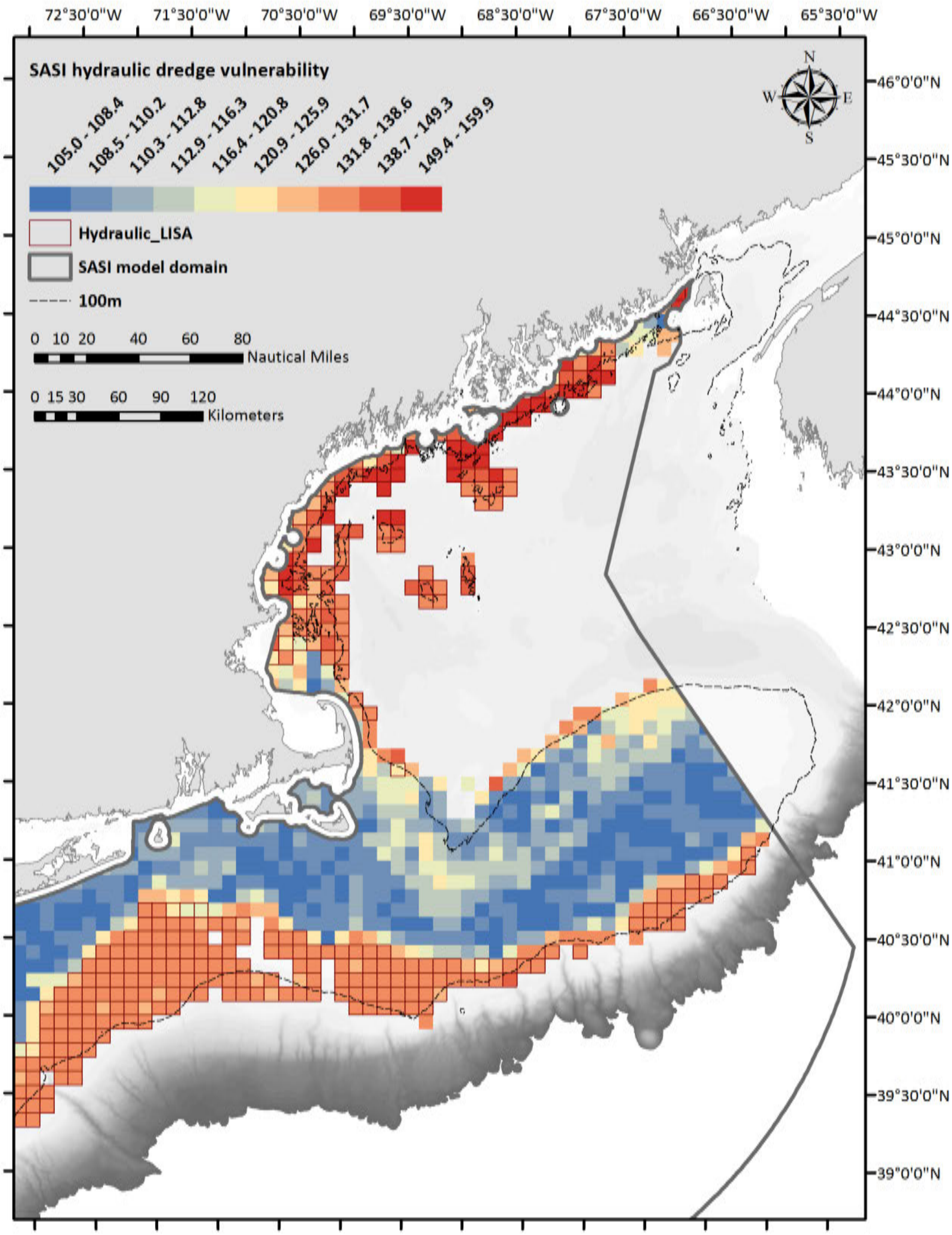
Map 34 – SASI model estimate of seabed habitat vulnerability to adverse effects from demersal otter trawl gears (blue=low vulnerability, red=high vulnerability). Clusters of high vulnerability grids are outlined in red.



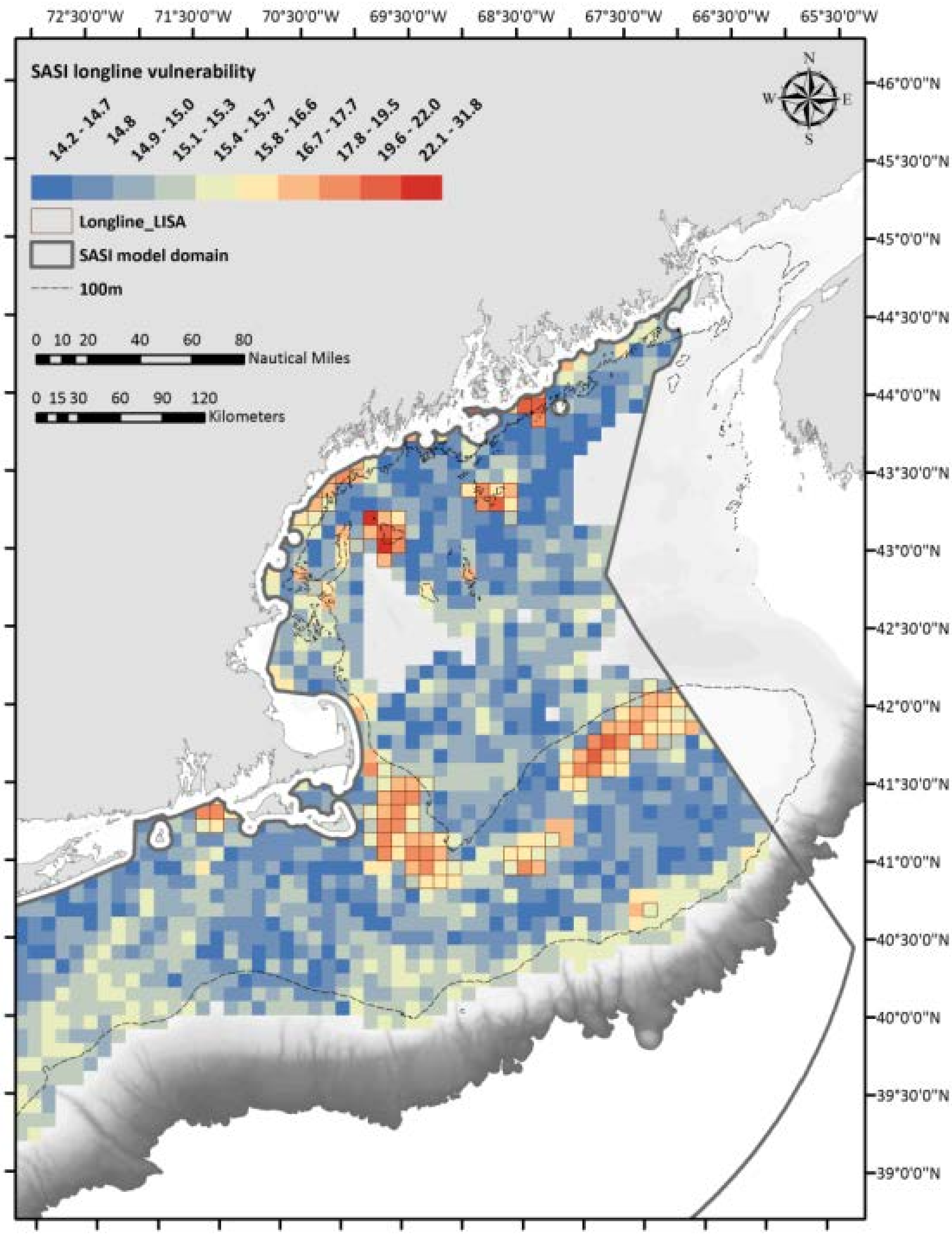
Map 35 – SASI model estimate of seabed habitat vulnerability to adverse effects from scallop dredge gears (blue=low vulnerability, red=high vulnerability). Clusters of high vulnerability grids are outlined in red.



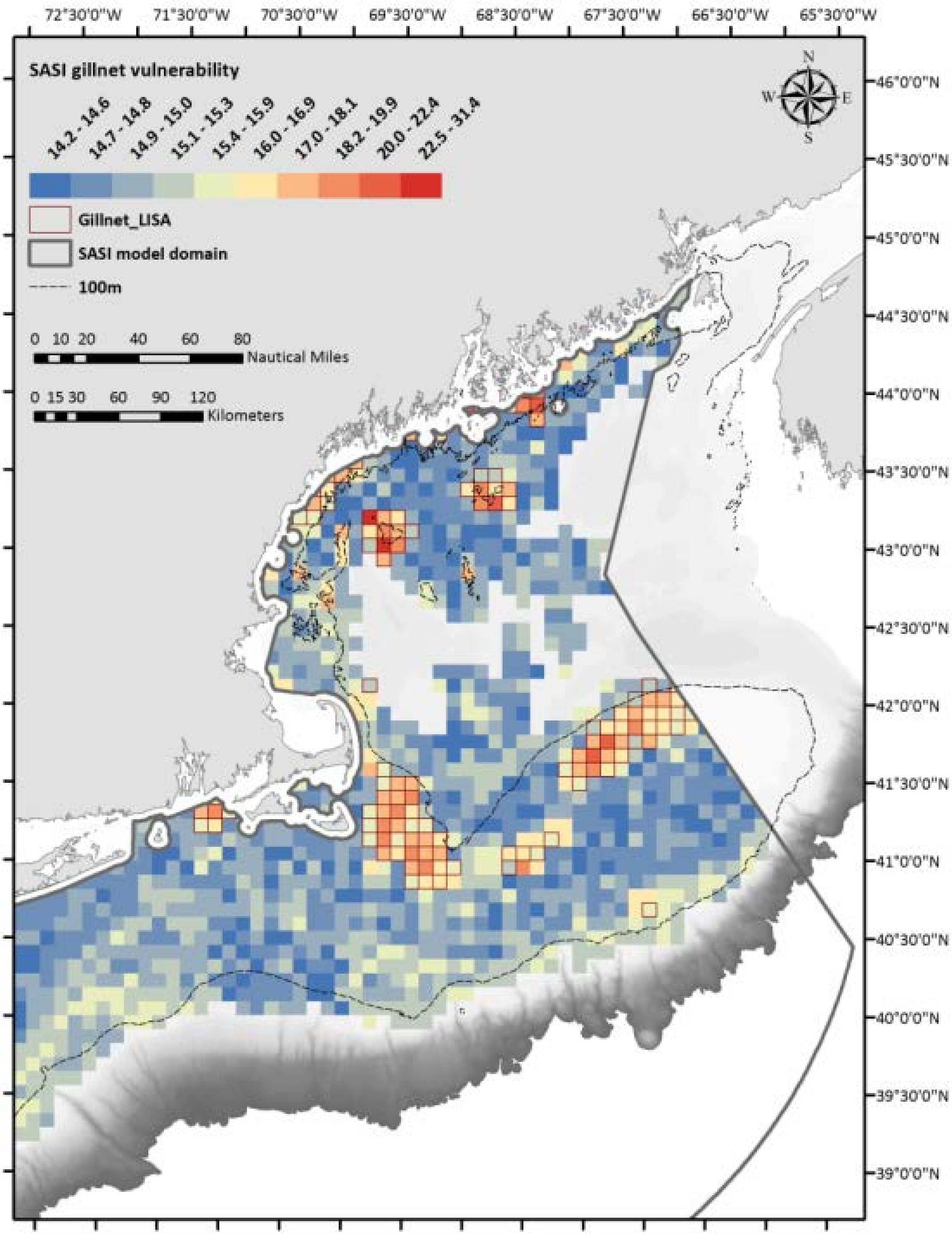
Map 36 – SASI model estimate of seabed habitat vulnerability to adverse effects from hydraulic clam dredge gears (blue=low vulnerability, red=high vulnerability). Clusters of high vulnerability grids are outlined in red.



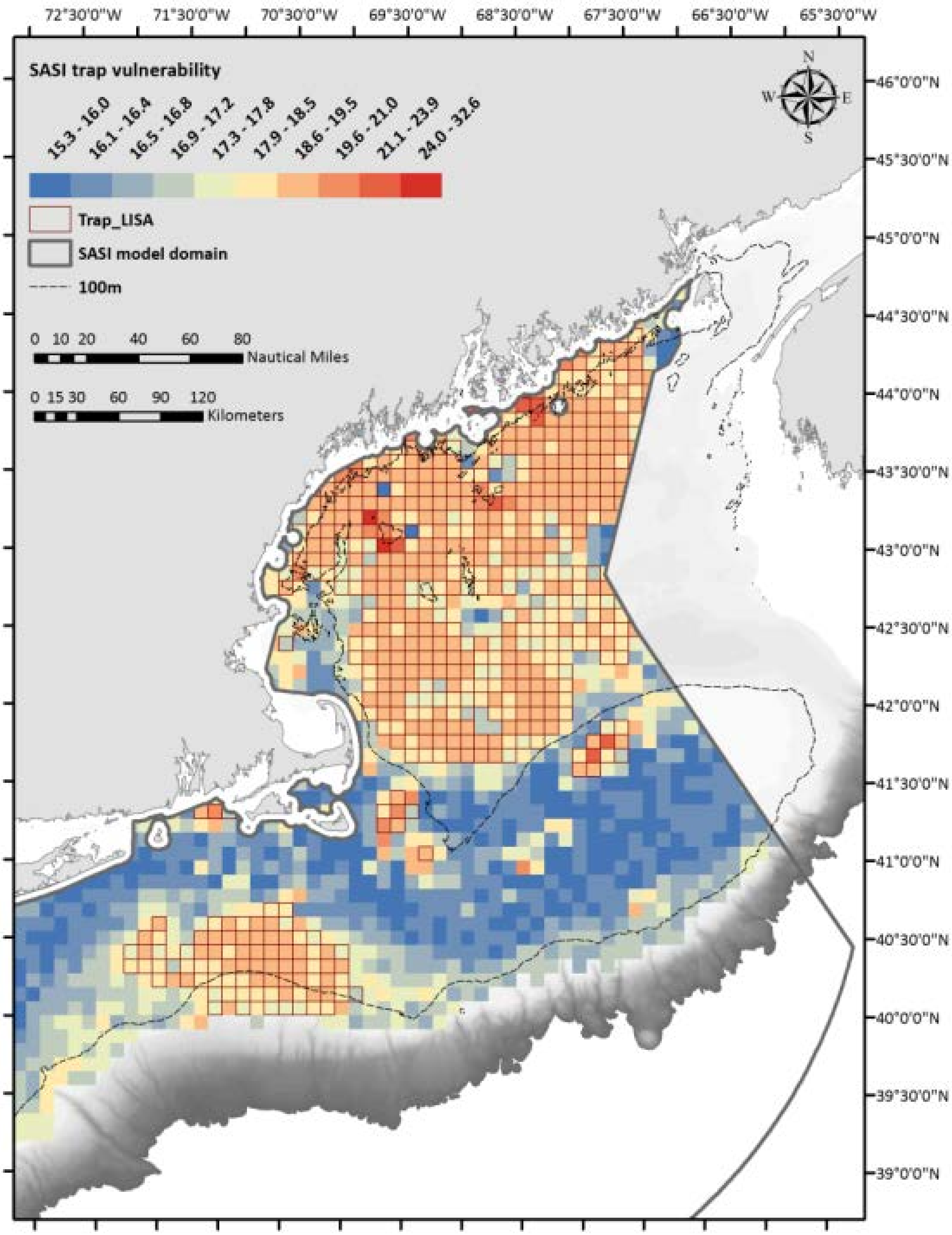
Map 37 – SASI model estimate of seabed habitat vulnerability to adverse effects from demersal longline gears (blue=low vulnerability, red=high vulnerability). Clusters of high vulnerability grids are outlined in red.



Map 38 – SASI model estimate of seabed habitat vulnerability to adverse effects from sink gillnet gear (blue=low vulnerability, red=high vulnerability). Clusters of high vulnerability grids are outlined in red.



Map 39 – SASI model estimate of seabed habitat vulnerability to adverse effects from trap gear (blue=low vulnerability, red=high vulnerability). Clusters of high vulnerability grids are outlined in red.



4.2.2.2 SASI realized area swept and adverse effects

Another way to understand and evaluate adverse effects is to consider how the magnitude and distribution of fishing effort interacts with the vulnerability of the underlying seabed. The SASI model can also be used to compare the realized magnitude of fishing impacts to the seabed across space, time, and gear type. To develop these realized adverse effects estimates, fishing effort was converted to area swept and gridded at 10km x 10km resolution, in annual time steps. The model is then run using these annual effort layers and the vulnerability information appropriate to each gear type. The result is a series of maps and figures that show how the distribution and magnitude of adverse effects have changed over time for the New England region.

The realized effort runs disaggregate fishing gear type to a finer degree as compared to the simulation runs, as listed in Table 20. Trawl gears were disaggregated in the realized effort model because the various sub-types were expected to have different seabed contact indices, as well as a relationship to specific locations and fisheries. Scallop dredge effort was disaggregated by permit type. The area swept models and data sources used are described in section 6.0 of the SASI appendix. The model itself and the realized model runs are described in section 8.0 and 8.3.2 of the SASI appendix.

Table 20 – Gears evaluated using the SASI approach. Left column shows the basic gear type evaluated in the vulnerability assessment and modeled in the simulation runs; right column indicates when the gear type was disagreggated further for realized adverse effects modeling.

Simulation runs; evaluated in vulnerability assessment	Realized runs
Otter trawl	Generic otter trawl, squid trawl, shrimp trawl, raised footrope trawl.
Scallop dredge	Limited access, limited access general category
Hydraulic clam dredge	Same
Demersal longline	Same
Sink gillnet	Same
Trap	Same

Map 40-Map 49 depict the spatial distribution of realized adverse effects by bottom-tending gear type for three years, 2000, 2005, and 2009, which is the last year for which these estimates were developed. The data bins shown in the legend are the same for each panel within a single map, but vary between gear types across the various maps. However, dark blue always represents the lowest adverse effect values per grid, and red always represents the highest adverse effect values per grid. Note that although the map legends indicate that the lower bound of the lowest interval on all maps in zero, these lower values only approach zero, and no zero grids are plotted. This is evidenced by the different 'footprints' on the different maps for different gear types, although the SASI realized adverse effects model domain is the same for all gears. The model domain does not extend into state waters (3 nm or less from shore) so any adverse effects/effort in state waters is not shown. Because the realized adverse effects model is run continuously over time, the adverse effects estimates on the maps are the result of past impacts where the habitat has not yet fully recovered, and new, annual impacts. Thus, each annual panel should be viewed as a snapshot of the conditions present during that year.

The maps indicate the distribution of area swept in aggregate across all trips. It is useful to put these area swept values in context by showing the average annual area swept per trip by gear type. Given the differences in magnitude of these average values between gears, two figures (Figure 6 and Figure 7) are provided to more clearly illustrate the values for the lower area swept per trip gear types. Most of the gears show no particular trends over time. However, there is a decrease in generic otter trawl per trip area swept over the time period, and there are increases in area swept per trip for scallop general category and hydraulic dredge trips. The scallop general category fishery changed around the end of the timeseries when an ITQ system was implemented for that segment of the scallop fishery, so it is possible that the general increasing trend does not continue after 2009.

Increases or decreases in per trip area swept could be driven by a number of factors, which are not evaluated in detail here. For example, higher abundance in general of the target species might result in trips of similar duration and with similar landings but lower area swept due to more efficient fishing. Higher area swept per trip could indicate the reverse, i.e. lower abundance of the target stock, or could indicate longer duration trips with similar catch rates and landings.

Figure 6 – Annual average area swept per trip, in km^2, by gear type. No data for raised footrope trawls prior to 2003.

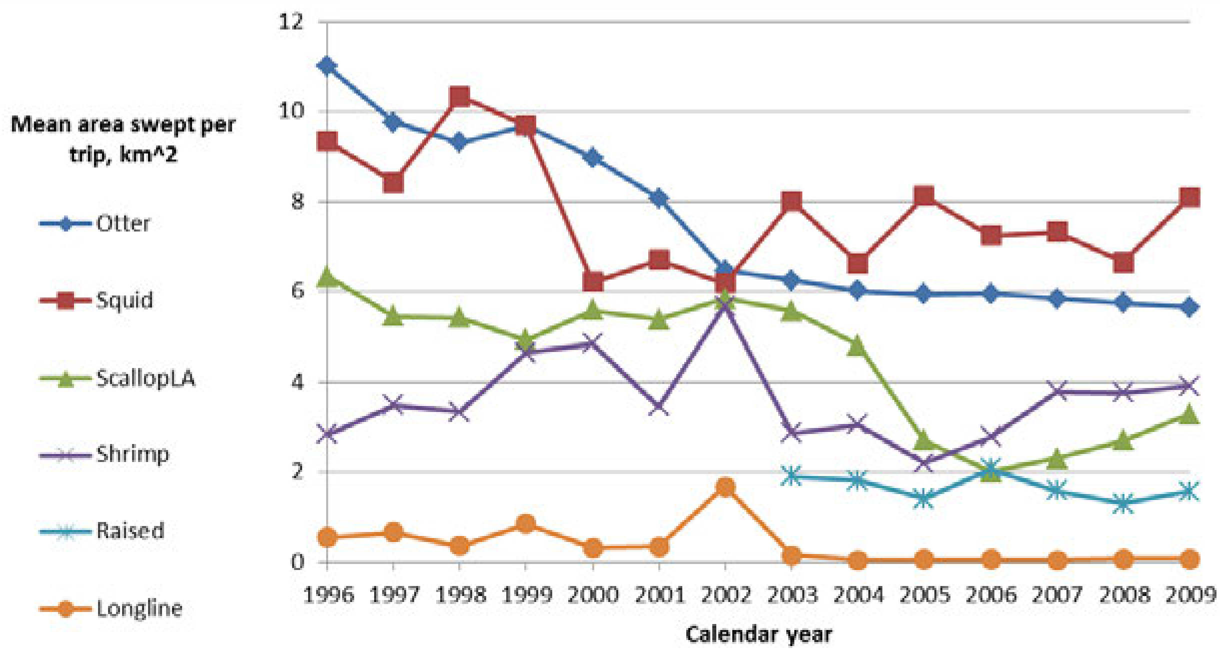
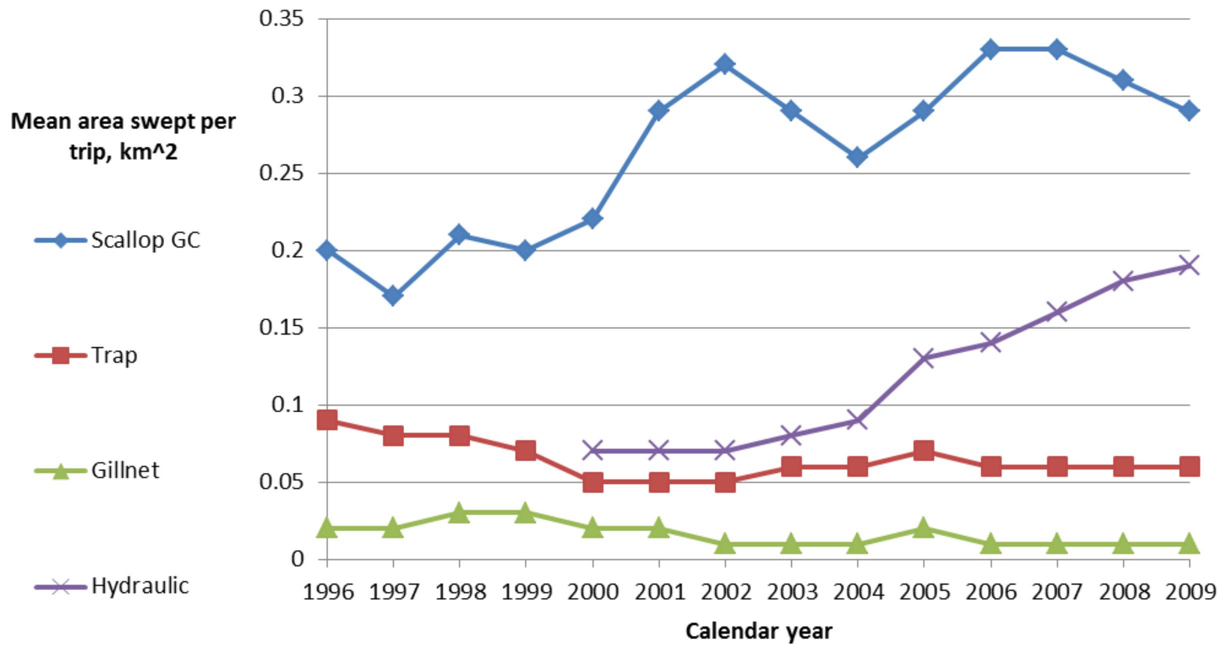


Figure 7 – Annual average area swept per trip, in km^2, by gear type. No data for hydraulic clam dredges prior to 2000.



The magnitude of adverse effects resulting from the **generic otter trawl gear** category have declined substantially over time, as evidenced by the cooler colors shown in the 2005 and 2009 panels as compared to the 2000 panel in Map 40. However, areas of concentrated adverse effects have remained stable over time, including the southwestern Gulf of Maine, the northeast flank of Georges Bank from Cape Cod to the EEZ boundary, and the Southeast Part of Georges Bank. Effects are also concentrated along the coast in Southern New England, and along the shelf break in Southern New England.

Adverse effects from the **shrimp trawl gear** category accumulate in the inshore Gulf of Maine, particularly along the northeastern Massachussetts, New Hampshire, and southern Maine coasts (Map 41). The cooler colors from 2000-2009 indicate a gradual decrease adverse effects over time.

Adverse effects from the **squid trawl gear** category occur along the southern flank of Georges Bank and throughout southern New England and the Mid-Atlantic Bight (Map 42). There appears to be a decrease in the overall and typical per unit area values over time from 2000-2009.

Adverse effects from the **raised footrope trawl gear** category are very localized to the inshore Gulf of Maine and off the eastern side of Cape Cod (Map 43). Within these localized areas, there are no clear spatial patterns evident, and the grids with higher values likely reflect the location of concentrations of effort over time. The limited geographic distribution of raised footrope trawl adverse effects results from restrictions on the areas and seasons during which this gear may be used to fish for small-mesh multispecies (i.e. whiting/silver hake).

Adverse effects from the **limited access scallop dredge gear** category occur around the edges of Georges Bank, in the southwestern Gulf of Maine, and throughout the Mid-Atlantic Bight (Map 44). Annual maps (not shown here) show more clearly the shifting adverse effects over time that accrue due to the highly concentrated access fisheries that occur throughout the region. Certain areas consistently show adverse effects accumulation on Georges Bank, including the area west of the Great South Channel, the area west of the northern part of Closed Area II, and the Southeast Part of the bank. There are relatively low but consistent levels of adverse effects along the coast of Maine (mid-coast to eastern Maine). Adverse effects from the limited access general category scallop dredge gear type have a much more inshore distribution (Map 45). Adverse effects in this fishery appear to have peaked in the mid-2000s, and have declined recently. This is consistent with the overall levels of effort in this fishery over time. Concentrations of adverse effects occur in the southwestern Gulf of Maine, west of the Great South Channel/east of Cape Cod, and more recently, in off the Southern New England coast.

Adverse effects from the **clam dredge** fishery are distributed throughout Southern New England and the Mid-Atlantic Bight, with concentrations that likely correspond to annual shifts in fishing effort (Map 46). There is also a small area with high adverse effects values per grid in eastern Maine, close to the coast. It should be noted that the vulnerability assessment for this gear was completed with hydraulic clam dredges in mind, while the eastern Maine fishery uses a different gear type, i.e. toothed dredges (see section 4.3.8.2). During 2013 much of Georges Bank reopened to the clam fishery, and it is likely that the fishery will shift effort there in the future (see clam fishery impacts section in Volume 3).

The spatial distribution of adverse effects for the **demersal longline gear type** is concentrated inshore, and in muddy areas off the shelf in Southern New England (Map 47). Adverse effects are relatively high in the southwestern Gulf of Maine, and between Cape Cod and the Great South Channel. Similar to the generic otter trawl gear type, the overall magnitude of adverse effects from this gear type have declined over time. **Sink gillnet** adverse effects show a similar pattern, although there are greater adverse effects offshore in the Gulf of Maine and near the coast in Southern New England as well (Map 48). **Trap gear** adverse effects probably reflect concentrations of effort in the lobster fishery, and occur mainly along the coasts of Maine, New Hampshire, Masschusetts, and Rhode Island (Map 49). Adverse effects were lower in 2009 as compared to 2000 and 2005.

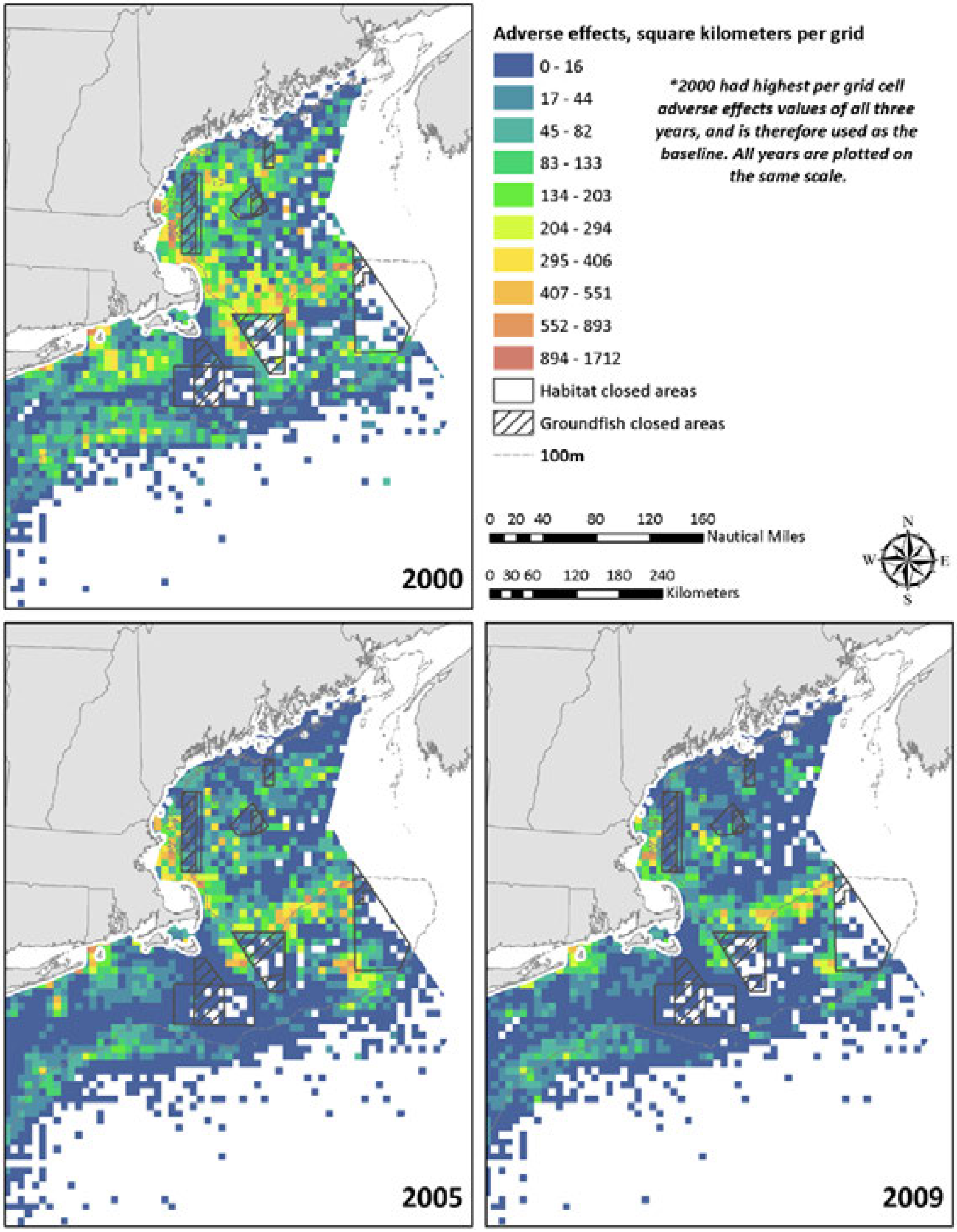
The goal of the amendment is to avoid and minimize to the extent practicable the adverse effects of fishing on the seabed. The realized runs illustrate a reduction in accumulated adverse effects over time. This is due to a reduction in area swept as a result of reduced fishing pressure. It could be argued that existing management actions are reducing area swept and minimizing adverse effect. Due to the potential for fishing pressure to move into areas with high potential vulnerability, it was determined that identifying vulnerable seafloor and designing methods to reduce impacts to those areas was of primary importance. Although adverse impact has been reduced over time, this reduction may be rapidly reversed if the more vulnerable seafloor is not identified and protected from the gear types that could impact it.

Another way to view realized adverse effects is as a single annual value by gear type. Looked at over time, these annual values show trends in a gear’s overall contribution to adverse effects.

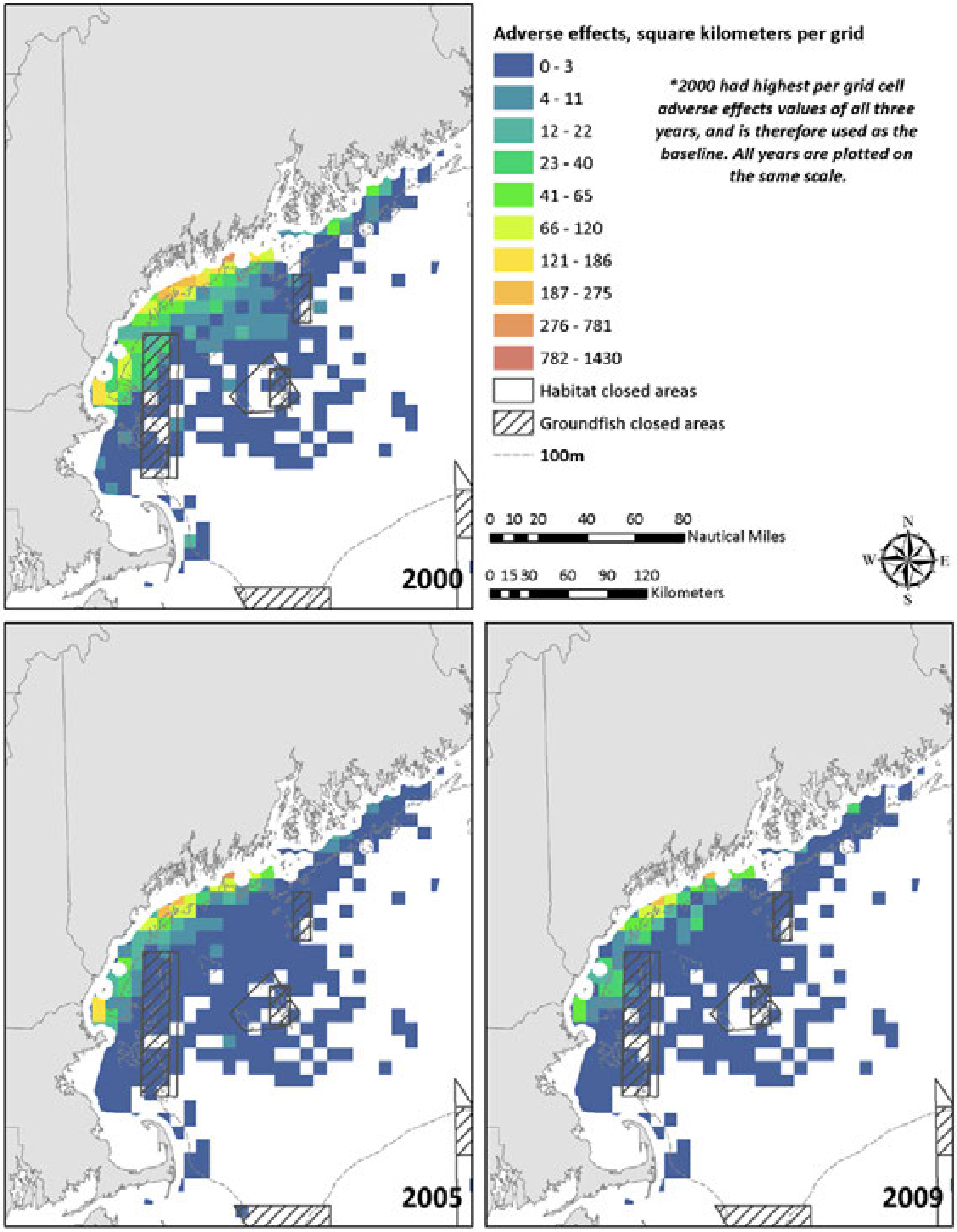
Figure 8, Figure 9, and Figure 10 show this graphically and in tabular form for different sets of gear types. All three figures were prepared because there are order of magnitude differences between the various gears so trends for some gears are difficult to identify in the first figure. Figure 8 shows that adverse effects from bottom otter trawls continue to dominate overall adverse in the SASI domain, but that there has been a substantial decline in adverse effects from this gear over time since 1996. More recent model runs were not available, but this downward trend likely continues during more recent years. Driven largely by changes in otter trawl adverse effects, total region-wide estimates were roughly 170,000 km^2 in 1996, and declined to about 60,000 km^2 in 2009. Total adverse effects are roughly one quarter what they were in 2004, when Amendment 13 went into effect. Shrimp trawl adverse effects have also declined (Figure 9), although they are much smaller in magnitude to begin with.

Other gears have not shown nearly as much temporal variability. For example, limited access scallop dredge adverse effects have remained fairly consistent over time, peaking in 2006 and declining recently (Figure 9). Limited access general category scallop dredges also show an increase in the mid-2000s, and a decline more recently (Figure 10). Squid trawl adverse effects have also remained fairly constant (Figure 9).

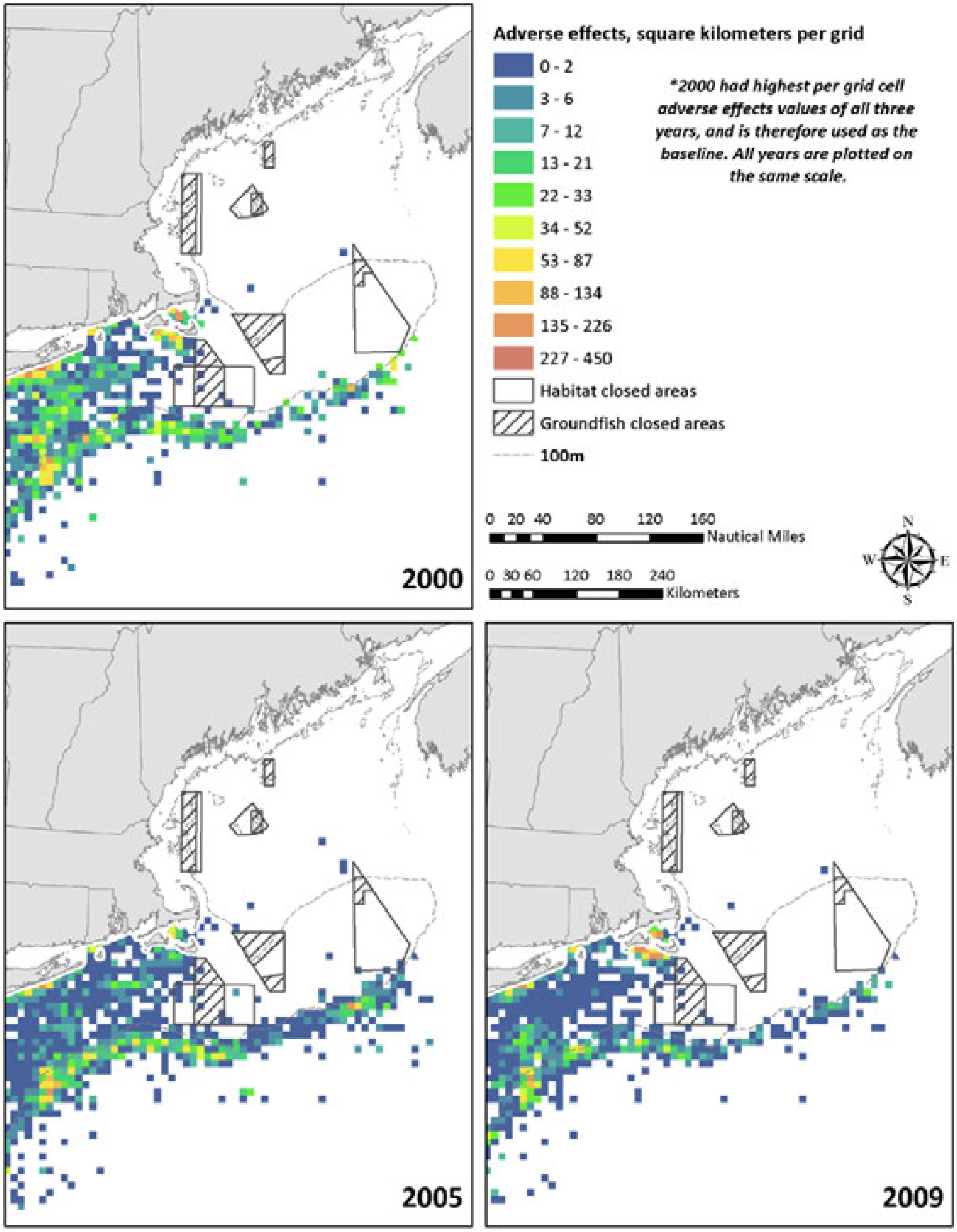
Map 40 – Spatial distribution of realized adverse effects from generic otter trawl gear type at three timesteps: 2000, 2005, and 2009. All panels use the same color scale. The maps given an annual snapshot of adverse effects, summing impacts from previous years fishing where the habitat has not yet fully recovered combined with new impacts.



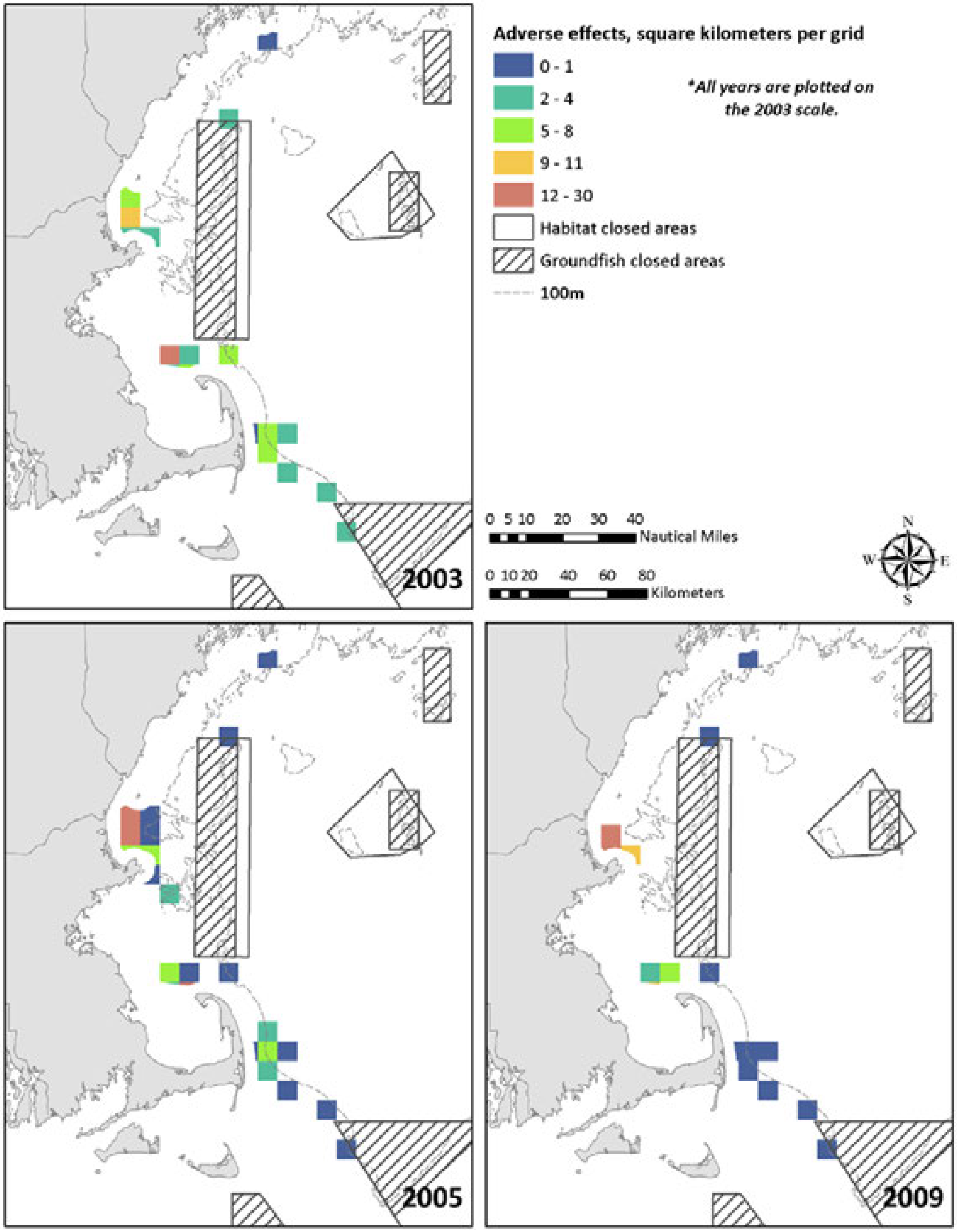
Map 41 – Spatial distribution of realized adverse effects from shrimp trawl gear type at three timesteps: 2000, 2005, and 2009. All panels use the same color scale. The maps given an annual snapshot of adverse effects, summing impacts from previous years fishing where the habitat has not yet fully recovered combined with new impacts.



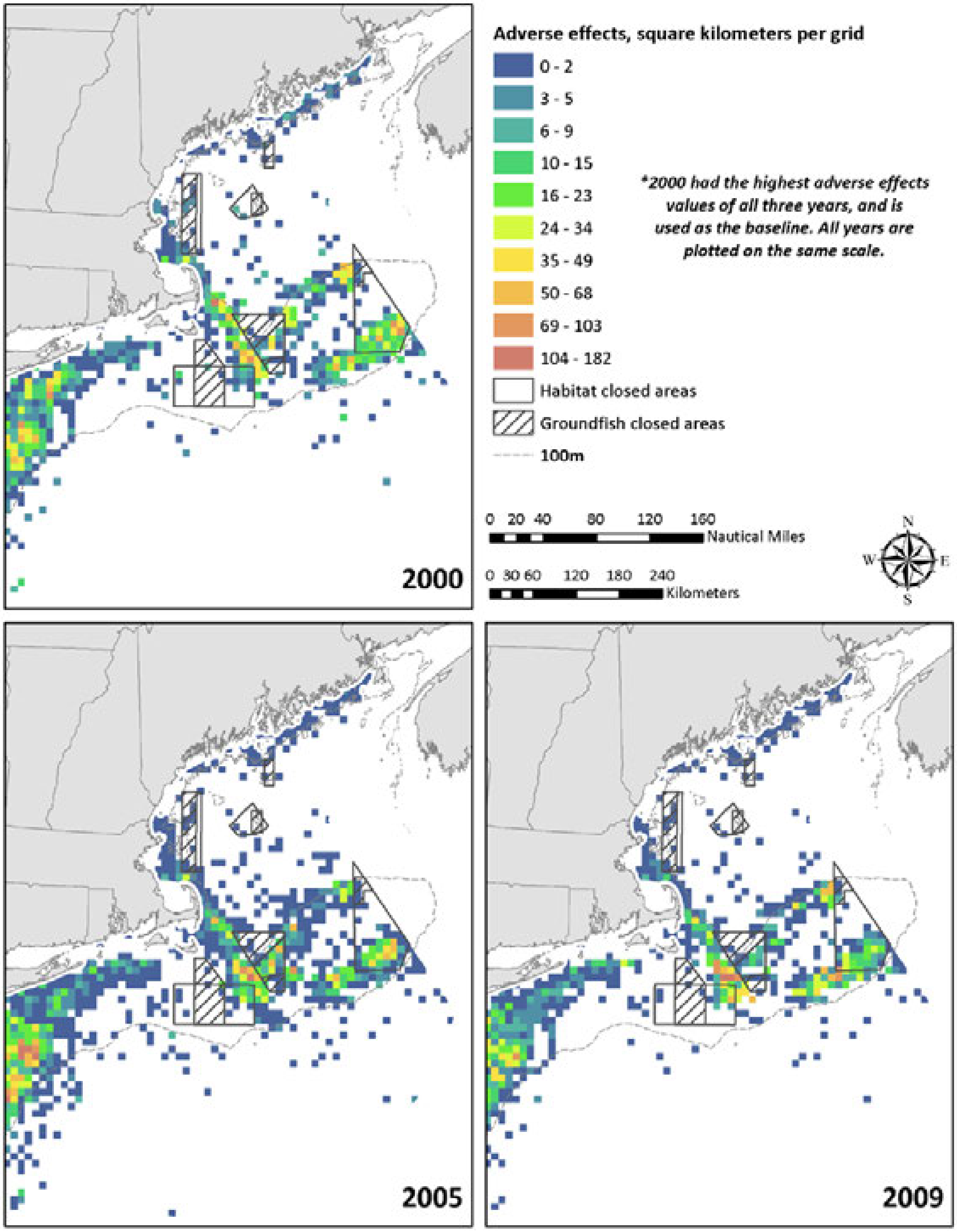
Map 42 – Spatial distribution of realized adverse effects from squid trawl gear type at three timesteps: 2000, 2005, and 2009. All panels use the same color scale. The maps given an annual snapshot of adverse effects, summing impacts from previous years fishing where the habitat has not yet fully recovered combined with new impacts.



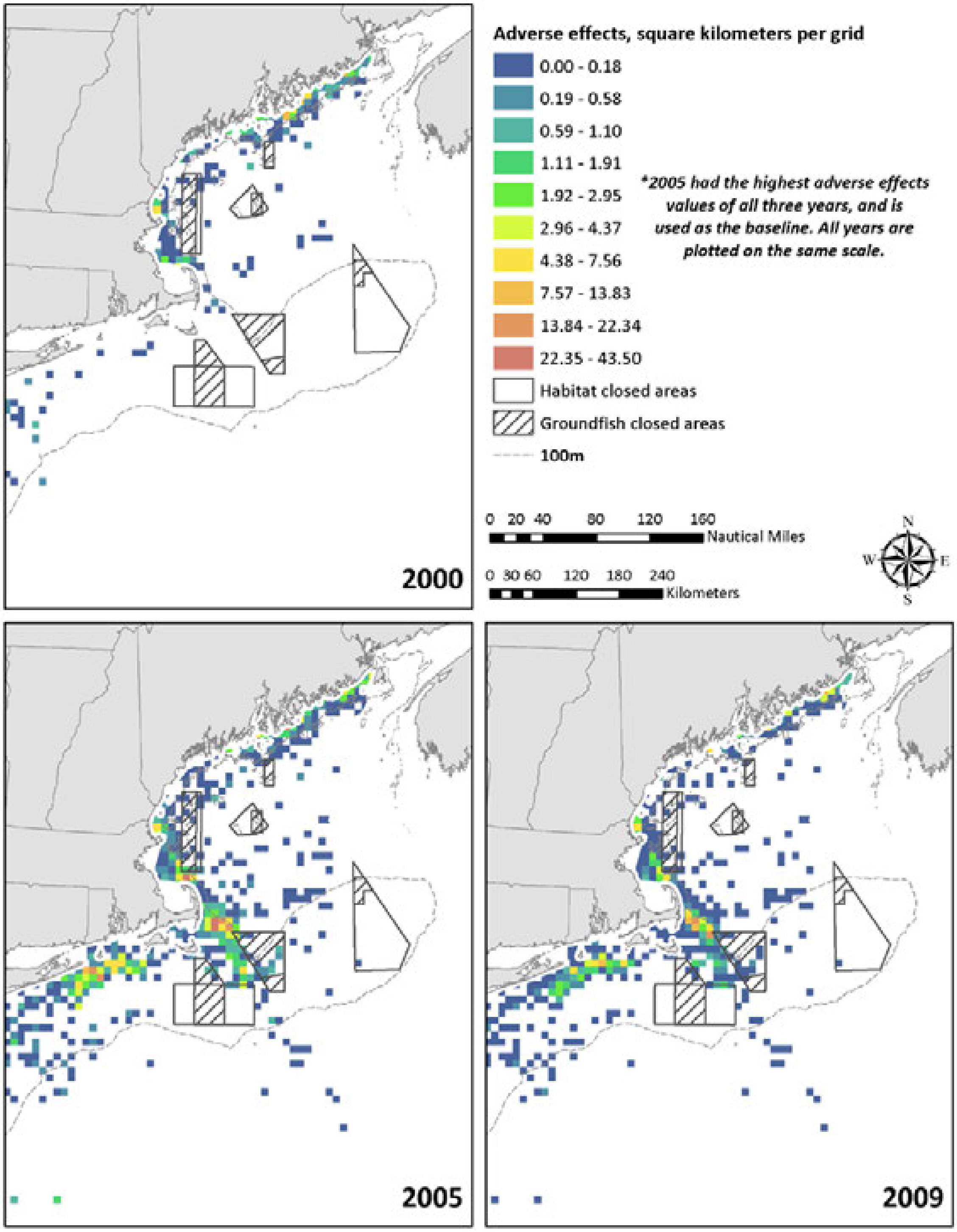
Map 43 – Spatial distribution of realized adverse effects from raised footrope trawl gear type at three timesteps: 2003, 2005, and 2009. All panels use the same color scale. The maps given an annual snapshot of adverse effects, summing impacts from previous years fishing where the habitat has not yet fully recovered combined with new impacts.



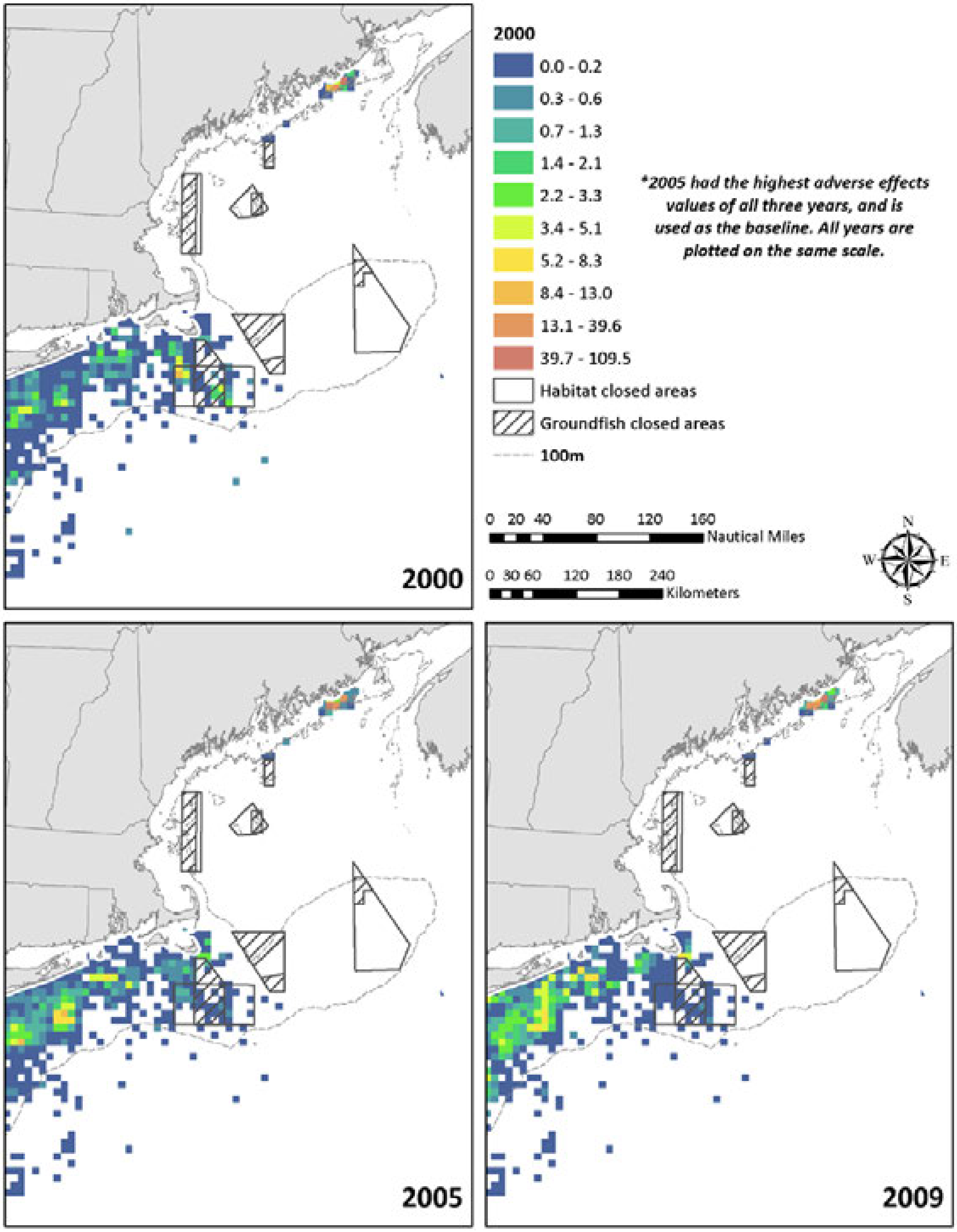
Map 44 – Spatial distribution of realized adverse effects from limited access scallop dredge gear type at three timesteps: 2000, 2005, and 2009. All panels use the same color scale. The maps given an annual snapshot of adverse effects, summing impacts from previous years fishing where the habitat has not yet fully recovered combined with new impacts.



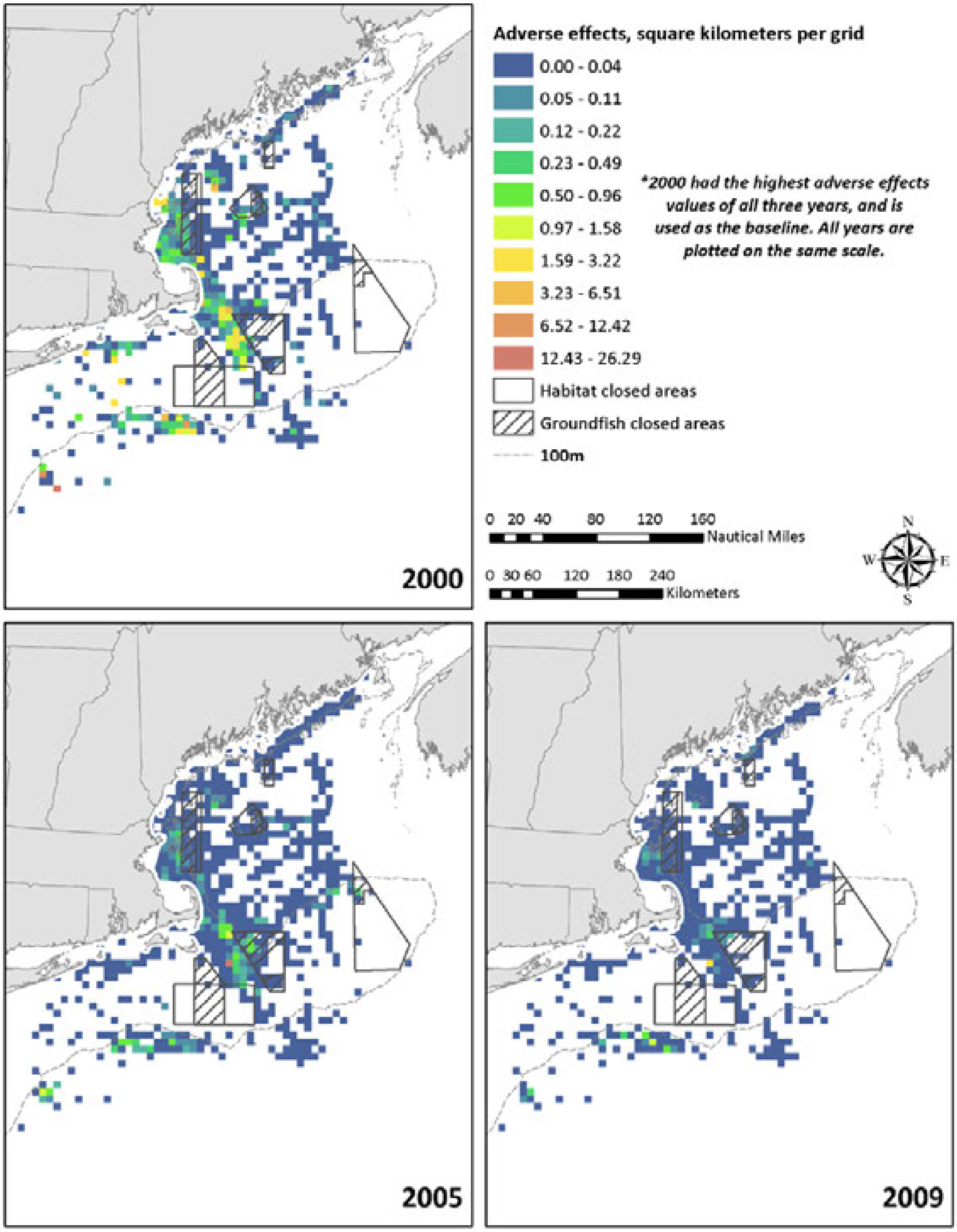
Map 45 – Spatial distribution of realized adverse effects from general category scallop dredge gear type at three timesteps: 2000, 2005, and 2009. All panels use the same color scale. The maps given an annual snapshot of adverse effects, summing impacts from previous years fishing where the habitat has not yet fully recovered combined with new impacts.



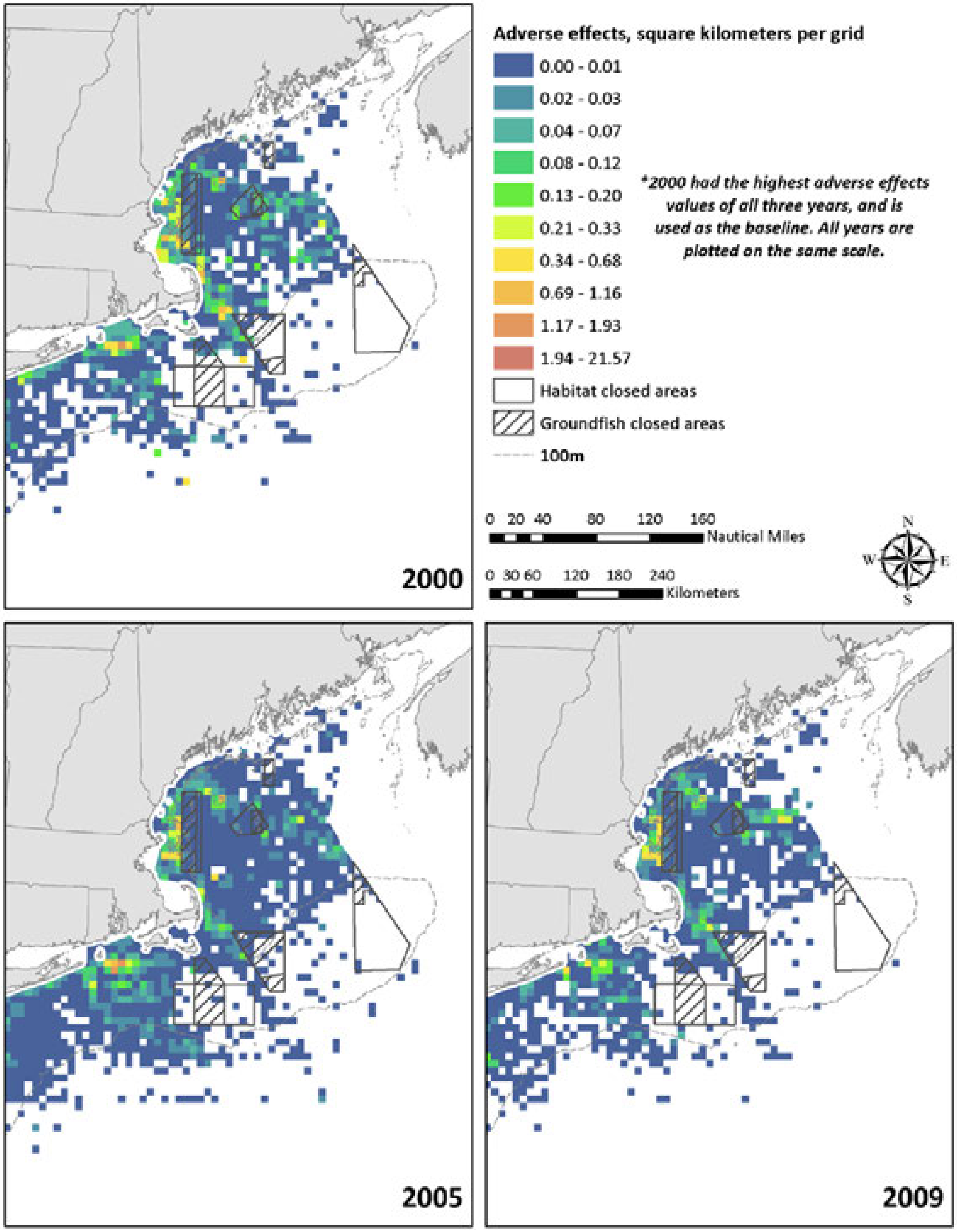
Map 46 – Spatial distribution of realized adverse effects from clam dredge gear type at three timesteps: 2000, 2005, and 2009. All panels use the same color scale. The maps given an annual snapshot of adverse effects, summing impacts from previous years fishing where the habitat has not yet fully recovered combined with new impacts.



Map 47 – Spatial distribution of realized adverse effects from demersal longline gear type at three timesteps: 2000, 2005, and 2009. All panels use the same color scale. The maps given an annual snapshot of adverse effects, summing impacts from previous years fishing where the habitat has not yet fully recovered combined with new impacts.



Map 48 – Spatial distribution of realized adverse effects from sink gillnet gear type at three timesteps: 2000, 2005, and 2009. All panels use the same color scale. The maps given an annual snapshot of adverse effects, summing impacts from previous years fishing where the habitat has not yet fully recovered combined with new impacts.



Map 49 – Spatial distribution of realized adverse effects from trap gear type at three timesteps: 2000, 2005, and 2009. All panels use the same color scale. The maps given an annual snapshot of adverse effects, summing impacts from previous years fishing where the habitat has not yet fully recovered combined with new impacts.

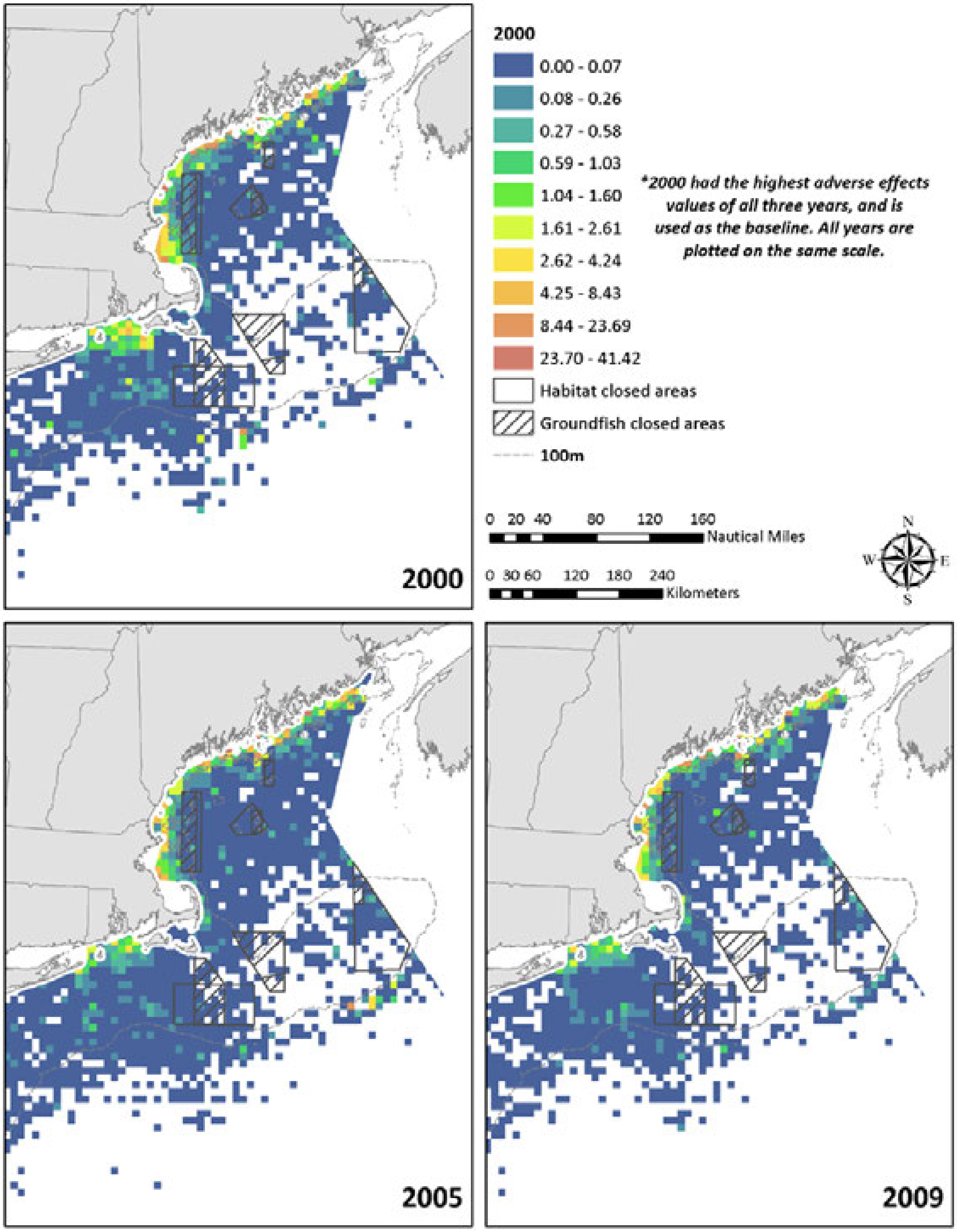
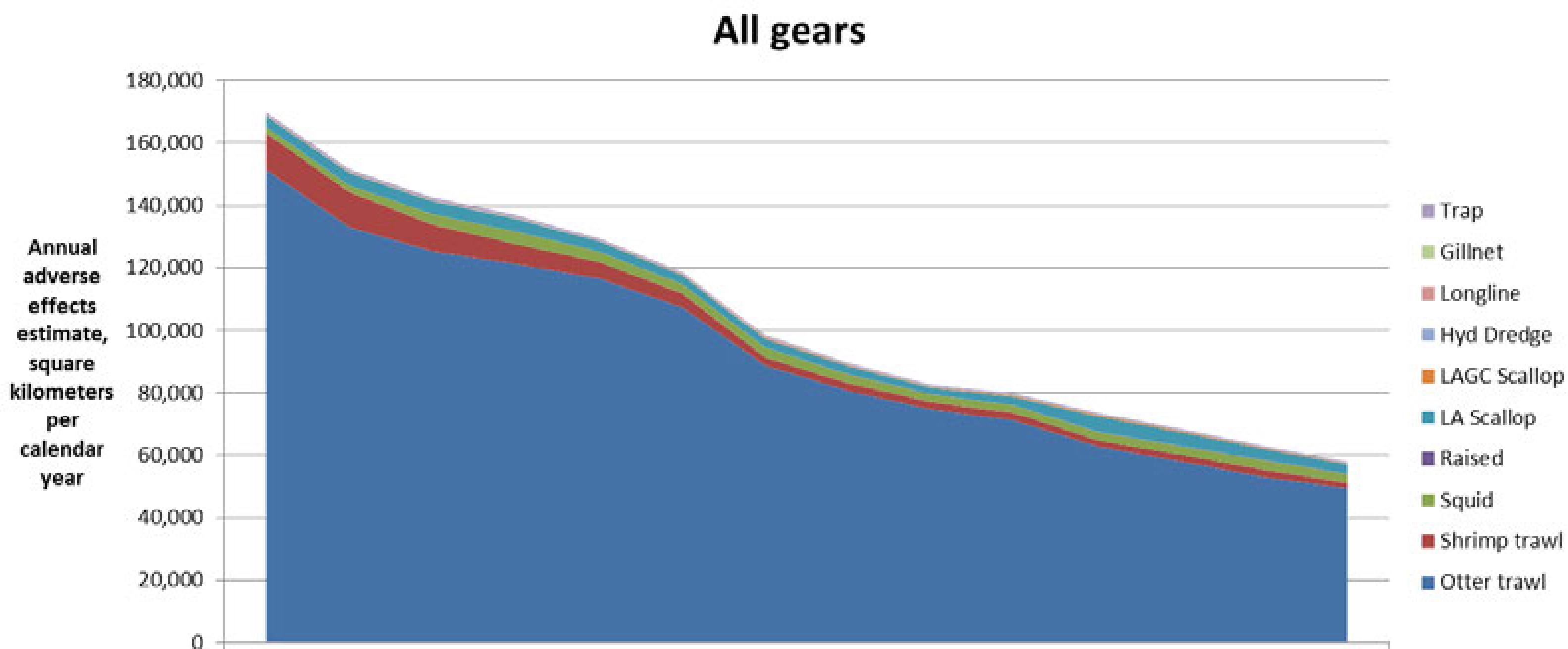
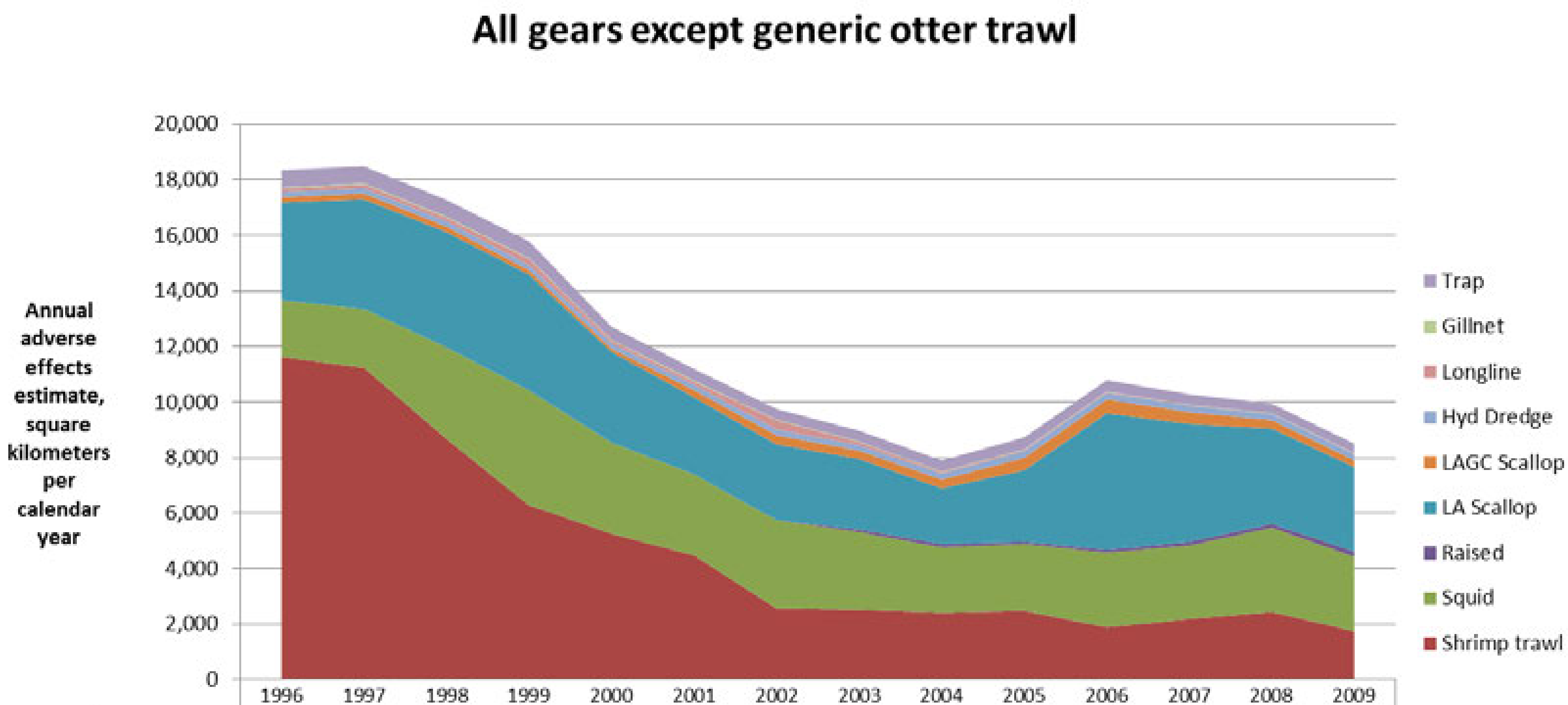


Figure 8 – Comparison of estimated realized adverse effects from the SASI model by gear type and calendar year. All values in km^2.



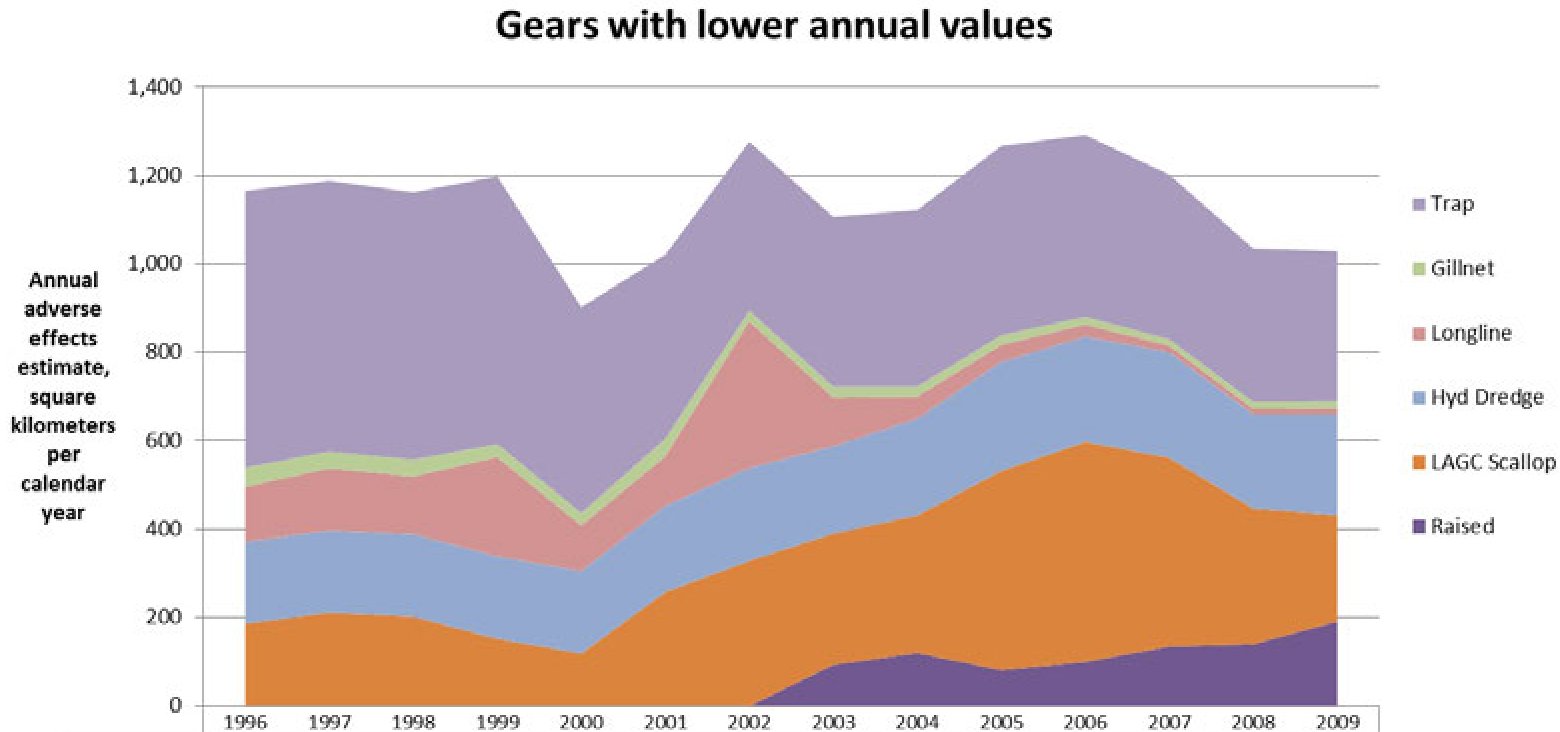
	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
Trap	627	613	605	606	466	417	382	384	400	428	411	372	347	340
Gillnet	43	38	38	30	28	40	24	24	22	22	18	15	16	15
Longline	125	140	130	224	103	112	332	111	50	39	28	15	12	14
Hyd Dredge	185	186	187	187	187	195	209	197	218	247	238	239	213	227
LAGC Scallop	186	211	202	152	119	258	329	297	312	450	498	427	307	241
LA Scallop	3,510	3,938	4,138	4,163	3,264	2,773	2,743	2,558	2,023	2,588	4,934	4,258	3,445	3,059
Raised	0	0	0	0	0	0	0	93	119	81	99	134	140	191
Squid	2,043	2,118	3,291	4,133	3,295	2,929	3,179	2,798	2,358	2,410	2,688	2,644	3,032	2,678
Shrimp trawl	11,633	11,238	8,682	6,290	5,253	4,475	2,562	2,515	2,405	2,474	1,884	2,184	2,437	1,745
Otter trawl	151,483	133,063	125,271	121,239	116,637	107,463	88,799	80,576	74,709	71,099	62,816	58,040	52,944	49,426

Figure 9 – Comparison of estimated realized adverse effects from the SASI model by gear type and calendar year. All values in km^2. The generic otter trawl gear category was removed to better show the temporal trends for other gear types.



	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
Trap	627	613	605	606	466	417	382	384	400	428	411	372	347	340
Gillnet	43	38	38	30	28	40	24	24	22	22	18	15	16	15
Longline	125	140	130	224	103	112	332	111	50	39	28	15	12	14
Hyd Dredge	185	186	187	187	187	195	209	197	218	247	238	239	213	227
LAGC Scallop	186	211	202	152	119	258	329	297	312	450	498	427	307	241
LA Scallop	3,510	3,938	4,138	4,163	3,264	2,773	2,743	2,558	2,023	2,588	4,934	4,258	3,445	3,059
Raised	0	0	0	0	0	0	0	93	119	81	99	134	140	191
Squid	2,043	2,118	3,291	4,133	3,295	2,929	3,179	2,798	2,358	2,410	2,688	2,644	3,032	2,678
Shrimp trawl	11,633	11,238	8,682	6,290	5,253	4,475	2,562	2,515	2,405	2,474	1,884	2,184	2,437	1,745

Figure 10 – Comparison of estimated realized adverse effects from the SASI model by gear type and calendar year. All values in km^2. Only gears with lower values are shown to allow for better comparison between them.



	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
Trap	627	613	605	606	466	417	382	384	400	428	411	372	347	340
Gillnet	43	38	38	30	28	40	24	24	22	22	18	15	16	15
Longline	125	140	130	224	103	112	332	111	50	39	28	15	12	14
Hyd Dredge	185	186	187	187	187	195	209	197	218	247	238	239	213	227
LAGC Scallop	186	211	202	152	119	258	329	297	312	450	498	427	307	241
Raised	0	0	0	0	0	0	0	93	119	81	99	134	140	191

4.2.3 Species diversity

This section summarizes species diversity within existing management areas and new or modified areas under consideration in this amendment. These values are then compared to determine which areas have the highest and lowest diversity. All other factors being equal, management of an area with higher diversity could have positive benefits for more species than management of an area with lower diversity. Certainly, no management area would be chosen solely based on diversity measures. However, using data from both single species and fish community perspectives facilitates informed decision-making.

Species diversity is a measure of both species richness (the number of species in a sample) and species evenness (the relationship between the level of abundance of each species in a sample). An example is shown below to illustrate these concepts. Here, each 'sample' is a survey tow.

<u>Sample #1 – 100 fish total, has lower species richness and higher evenness:</u>

- 23 cod
- 27 haddock
- 24 pollock
- 26 redfish

<u>Sample #2 – 100 fish total, has higher species richness and lower evenness:</u>

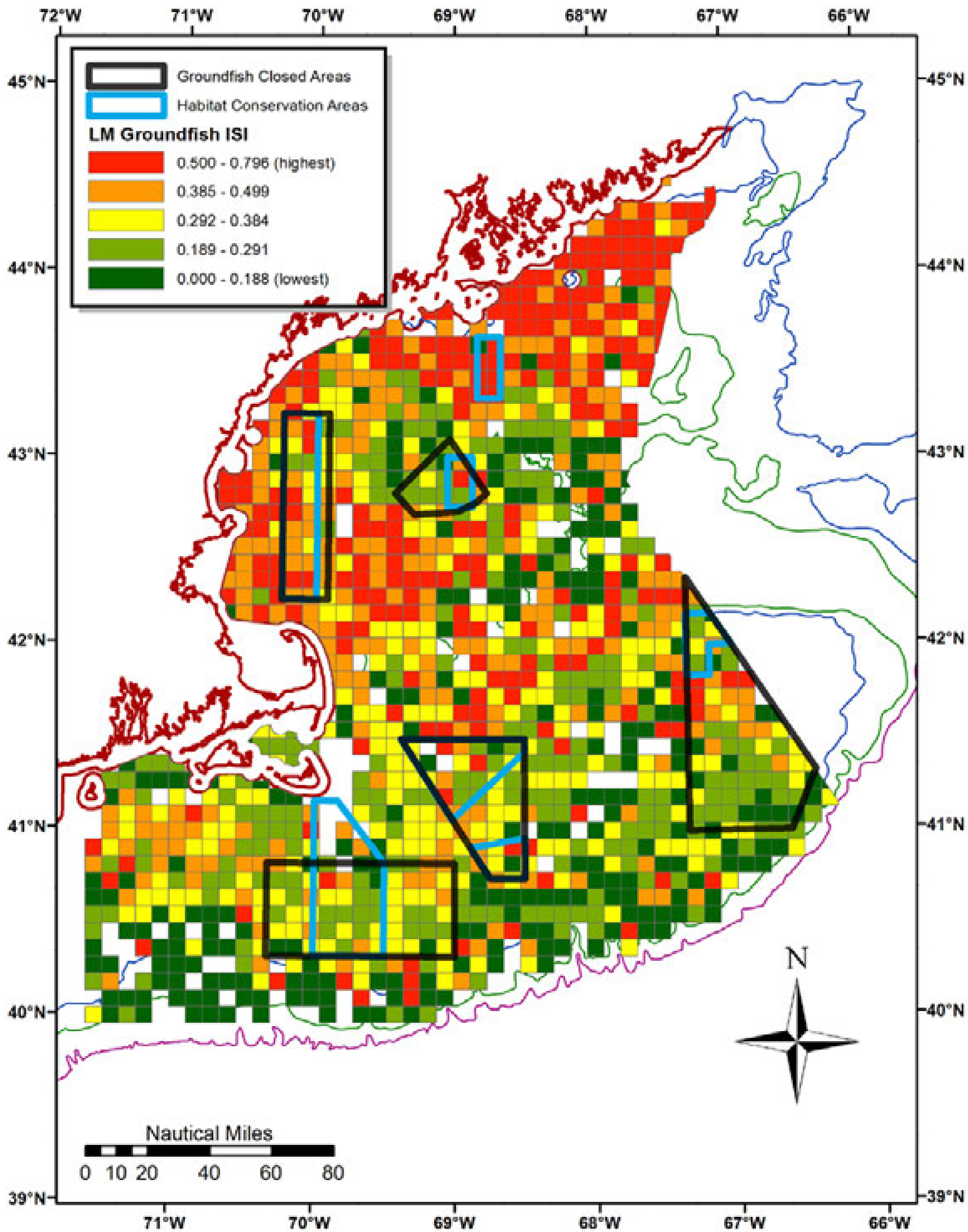
- 2 cod
- 40 haddock
- 12 pollock
- 14 redfish
- 4 silver hake
- 5 red hake
- 4 winter flounder
- 19 yellowtail flounder

Two widely used species diversity measures were used to measure fish community diversity. The **Shannon Diversity Index (SDI)** is the most suitable for comparing areas to identify those with highest overall diversity. The formula used to calculate the Shannon index is $H = -\sum p_i ln p_I$ where p_i represents the proportion of individuals in the *i*th species. The interpretation of SDI values can be difficult due to the lack of a set "scale" of values. However, for this analysis, it can be assumed that if two areas have different SDI values, the area with the higher value is more diverse. The calculation of SDI minimizes the effect of abundant species and therefore is sensitive to the number of rare species in a sample. Conversely, the **Simpson Index** is more sensitive to changes in the abundant species in a sample, so it may be more appropriate for focusing on abundant managed species. The way the Simpson Index is calculated it highlights areas with lower diversity; in this analysis, the Simpson Index is subtracted from 1 to represent an **"Inverted" Simpson Index (ISI)** so that the value represents a probability that any two individuals chosen from the sample will be of two different species. Values closer to 1 indicate higher diversity, while values closer to 0 indicate lower diversity. The formula used to calculated the Inverted Simpson Index is $D = 1 - \sum p_i^2$. The average Shannon and Simpson diversity indices per tow were calculated using the survey data from the NEFSC fall/winter/spring trawl survey, the MADMF spring/fall trawl survey, and industry-based surveys for cod, yellowtail flounder and monkfish from 2002-2012.

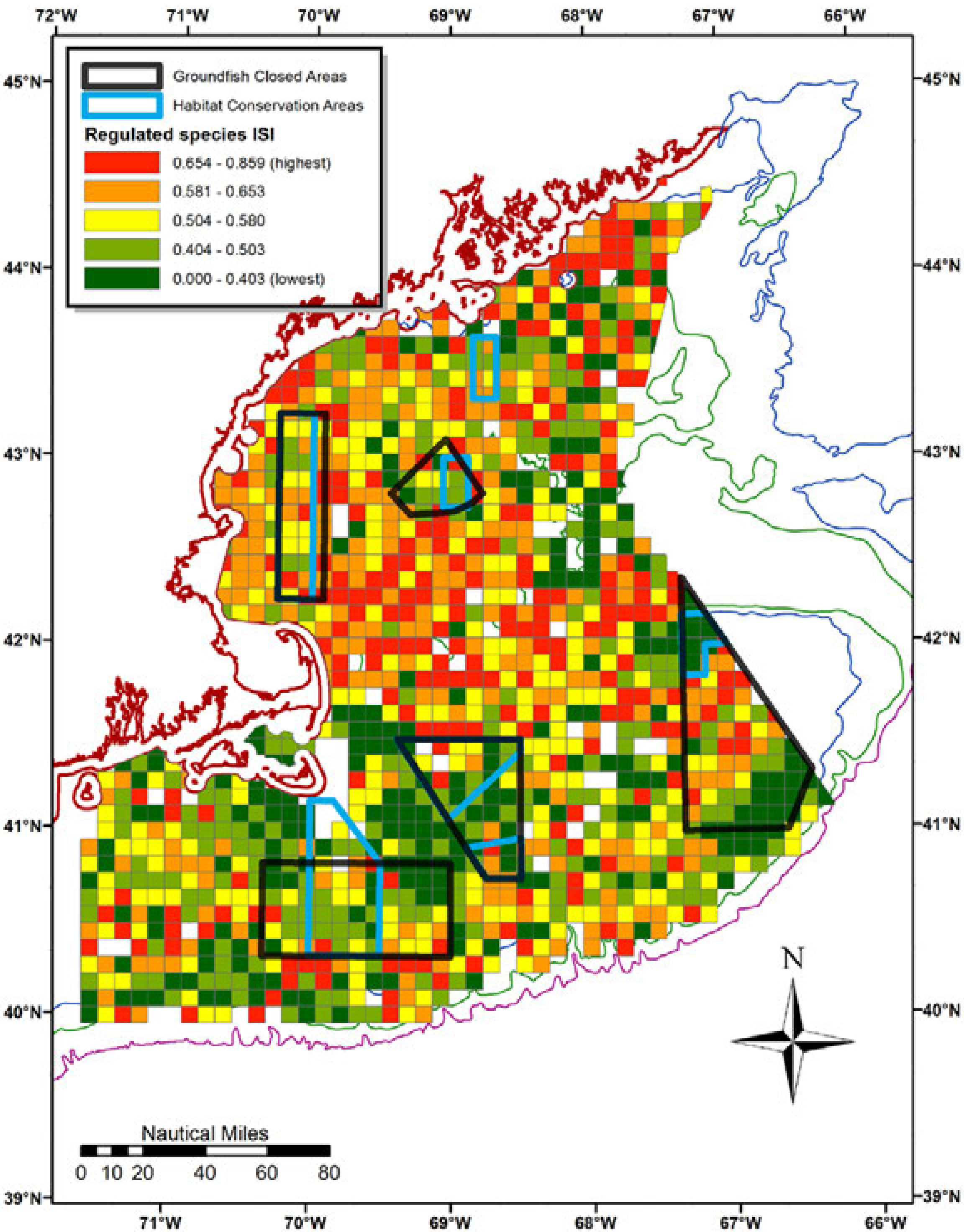
SDI is calculated for all species caught in the survey, and ISI is calculated for two groups of species, large mesh groundfish and all regulated species. **Here, 'regulated' species refers to managed species generally, as opposed to the Northeast Multispecies definition of regulated species, which includes all large mesh species plus ocean pout.** The large mesh groundfish species include Atlantic cod, haddock, yellowtail flounder, winter flounder, redfish, American plaice, witch flounder, windowpane flounder, white hake, pollock, Atlantic halibut, and Atlantic wolffish. Regulated species include all large mesh groundfish as well as silver hake, offshore hake, red hake, spiny dogfish, barndoor skate, winter skate, clearnose skate, rosette skate, little skate, smooth skate, thorny skate, herring, sea scallop, monkfish, summer flounder, black sea bass, Atlantic mackerel, butterfish, tautog, American lobster, northern shrimp, northern shortfin squid and longfin squid.

The diversity values on each tow were averaged within the 10x10 km grids used in the SASI and hotspot analyses (Map 50 – large mesh groundfish, Map 51 – regulated species, and Map 52 – all species). Red squares indicate areas of higher diversity and green squares indicate areas of lower diversity. The survey tows were joined to this grid in order to more easily show any spatial patterns in the data, and to allow a comparison between average diversity and habitat vulnerability in each grid. Generally there did not appear to be a relationship between the two variables. This is not entirely surprising. While higher vulnerability was generally estimated on coarse substrates (see Map 34), different species occupy various ecological niches, and some species are more abundant in lower vulnerability sand or mud habitats. Nonetheless, the figures below serve as a visual method to compare diversity within the existing habitat conservation and groundfish closed areas and in the surrounding habitats.

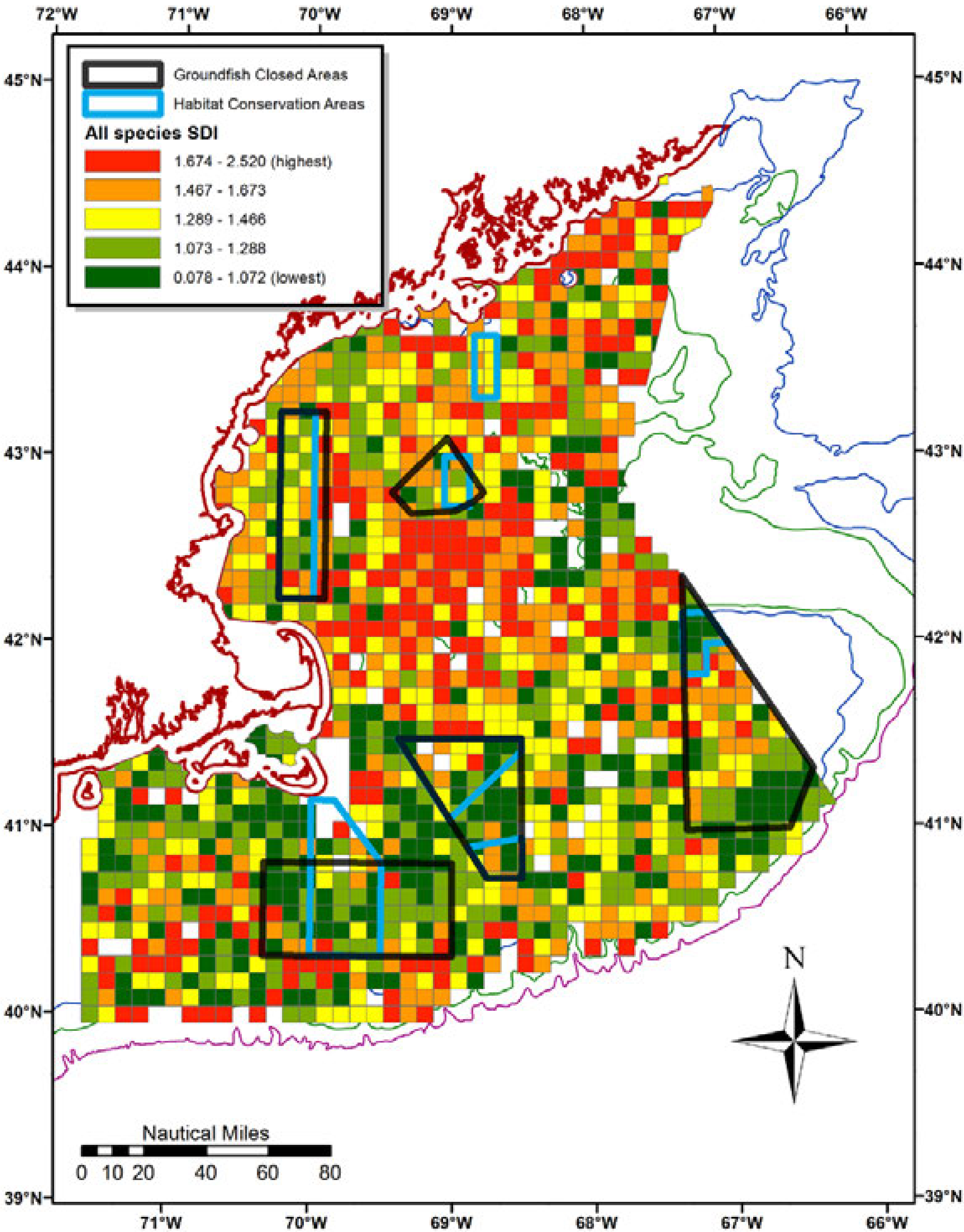
Map 50 – Spatial distribution of large-mesh groundfish diversity. Survey tows from 2002-2012 were used. Per-tow values are averaged within 10x10 km grids. Blank squares indicate grids where no survey tows occurred.



Map 51 – Spatial distribution of regulated species diversity. Survey tows from 2002-2012 were used. Per-tow values are averaged within 10x10 km grids. Blank squares indicate grids where no survey tows occurred.



Map 52 – Spatial distribution of diversity across all species. Survey tows from 2002-2012 were used. Per-tow values are averaged within 10x10 km grids. Blank squares indicate grids where no survey tows occurred.



No Action Habitat Closure Areas/New or Modified Habitat Management Areas

Seasonal species diversity indices (i.e., average index value per tow) of tows within each habitat management area allow comparison of this metric across the alternatives (Table 21). Areas with the highest diversity values (75^{th} percentile) for each diversity index were identified by color (groundfish = red, regulated = yellow, all species = green) to indicate which are most diverse with respect to groundfish, regulated species and all species. In some cases, ranking varied seasonally. For example, if groundfish diversity in the Cashes Ledge Closed Area is highlighted in the spring and not in the summer, then the spring diversity ranks in the 75^{th} percentile while the diversity during the summer season did not.

Groundfish diversity is higher in the **Gulf of Maine** areas overall than in Georges Bank. In the spring, groundfish diversity ranged from 0.334 in the Cashes Ledge Habitat Closure to 0.682 in Toothaker Ridge. Groundfish diversity is also very high in the Jeffreys Bank Habitat Closure (0.632), the Alternate Roller Gear Restricted Area (0.509), the Large Bigelow Bight (0.525) and Eastern Maine (0.612) Areas, the Modified Jeffreys Bank Habitat Closure (0.569) and the Small Eastern Maine (0.629) and Small Bigelow Bight (0.574) Areas. Regulated species diversity ranged from 0.362 in Platts Bank 2 to 0.695 in the Jeffreys Bank Habitat Closure. Regulated species diversity is also high in the Large Eastern Maine Area (0.624), the Machias Area (0.689), the Modified Jeffreys Bank Habitat Closure (0.663), the Small Bigelow Bight (0.635) and Small Eastern Maine (0.654) Areas, and Toothaker Ridge (0.633). Measures of diversity for all species ranged from 0.812 in Platts Bank 2 to 1.660 in the small Eastern Maine area. The Jeffreys Bank Habiat Closure (1.584), Toothaker Ridge (1.563) and the Large Eastern Maine Area (1.576) were the other areas with the highest diversity values for all species.

In the summer, diversity for all species groups in the Gulf of Maine is lower than other seasons. Groundfish diversity ranged from 0.271 in the Cashes Ledge Closed Area to 0.682 in the Large Eastern Maine Area. The areas with highest groundfish diversity in the summer included the Jeffreys Bank Habitat Closure (0.585), the Large and Small Stellwagen Areas (0.508 and 0.502), the Large Eastern Maine Area (0.682) and Toothaker Ridge (0.616). Regulated species diversity ranged from 0.405 in the Large Eastern Maine Area to 0.763 in the Small Stellwagen Area. The Large and Small Bigelow Bight Areas (0.624 and 0.619) and the Large Stellwagen Area (0.697) also ranked in the 75^{th} percentile for regulated species diversity. All species diversity ranged from 1.333 in the modified Jeffreys Bank Habitat Closure to 1.647 in the Cashes Ledge Habitat Closure. The Cashes Ledge Closed Area (1.538), the Large Stellwagen Area (1.555), the Small Stellwagen Area (1.611) and Toothaker Ridge (1.537) also rank in the 75^{th} percentile for all species diversity.

In the fall, groundfish diversity ranged from 0.220 in the Cashes Ledge Closed Area to 0.624 in the Small Stellwagen Area. The Jeffreys Bank Habitat Closure (0.547), the Large Eastern Maine (0.510) and Stellwagen (0.501) Areas, the Modified Cashes Ledge Habitat Closure (0.536), the Modified Jeffreys Bank Habitat Closure (0.503), the Small Eastern Maine Area (0.564) and Toothaker Ridge (0.507) also had high groundfish diversity. Regulated species diversity ranged 0.333 in Platts Bank 1 to 0.795 in the Modified Cashes Ledge Habitat Closure. The Cashes Ledge Habitat Closure (0.786), the Western Gulf of Maine Habitat Closure (0.667), the Cashes

Ledge Closed Area (0.636), the Wester Gulf of Maine Closed Area (0.673), the Inshore Roller Gear Restricted Area (0.627), Jeffreys Ledge (0.636), the Large Stellwagen Area (0.729) and the Small Stellwagen Area (0.747) also had high regulated species diversity. All species diversity is highest overall in the fall. All species diversity ranged from 0.685 in Platts Bank 1 to 1.949 in the Small Stellwagen Area. The Western Gulf of Maine Closed Area (1.581), Cashes Ledge Closed Area (1.513), Cashes Ledge Habitat Closure (1.615), the Inshore Roller Gear Restricted Area (1.555), the Large and Small Eastern Maine Areas (1.519 and 1.649), the Large Stellwagen Area (1.892) and the Western Gulf of Maine Habitat Closure Area (1.569) also had high all species diversity.

Groundfish diversity in the winter ranged from 0.161 in the Cashes Ledge Closed Area to 0.716 in the Small Eastern Maine Area. Winter groundfish diversity is also high in the Jeffreys Bank Habitat Closure (0.583), the Alternate Roller Gear Restricted Area (0.522), the Large Bigelow Bight (0.595), Eastern Maine (0.637) and Stellwagen (0.521) Areas, the Modified Jeffreys Bank Habitat Closure (0.595) and the Small Bigelow Bight Area (0.546). Regulated species diversity ranged from 0.167 in the Cashes Ledge Closed Area to 0.814 in the Small Eastern Maine Area. The Jeffreys Bank Habitat Closure (0.653), the Large Bigelow Bight (0.714) and Stellwagen (0.756) Areas, the Modified Jeffreys Bank Habitat Closure (0.650) and the Small Bigelow Bight Area (0.655) also had high regulated species diversity. All species diversity ranged from 0.389 in the Cashes Ledge Closed Area to 2.063 in the Large Eastern Maine Area. The Large Bigelow Bight Area (1.639) and the Small Eastern Maine Area (1.952) were also among the areas with highest all species diversity.

For the areas in **Georges Bank and Southern New England**, diversity is lowest overall in the spring. Groundfish diversity ranged from 0.269 in Nantucket Shoals West to 0.680 in Cox Ledge 1. Regulated species diversity ranged from 0.195 in the Northern Edge area to 0.633 in Cox Ledge 1. None of the areas sampled in the spring ranks in the 75^{th} percentile for all species diversity. All species diversity ranged from 0.718 in the Northern Edge Area to 1.410 in the Georges Shoal 1 MBTG Closure Area.

In the summer, groundfish diversity ranged from 0.156 in the Nantucket Lightship Habitat Closure to 0.444 in both Georges Shoal MBTG Closure Areas. None of these areas ranks in the 75^{th} percentile for groundfish diversity in Georges Bank and southern New England areas. Regulated species diversity ranged from 0.100 in the Closed Area II habitat closure to 0.740 in both Georges Shoal MBTG areas. The Georges Shoal GMA (0.661) also ranks in the 75^{th} percentile for regulated species diversity. All species diversity ranged from 0.459 in the Northern Edge to 2.068 in both Georges Shoal MBTG Closure Areas.

Groundfish diversity in the fall ranges from 0.237 in Closed Area II to 0.472 in Cox Ledge I. Regulated species diversity ranges 0.047 in Cox Ledge 1 to 0.851 in Cox Ledge 2, although the low number of tows in these areas may affect this result. The Closed Area I North Habitat Closure (0.642), the EFH Expanded 2 Area (0.621), the Georges Shoal GMA (0.709) and the Great South Channel GMA (0.624) also had high regulated species diversity. This is also the widest range of regulated species diversity in the analysis. All species diversity appears to be highest in the fall in Georges Bank/southern New England. All species diversity ranged from 0.193 in Cox Ledge 1 to 2.348 in Cox Ledge 2. The other areas with high all species diversity are the Closed area I North Habitat Closure (1.561), the Closed Area II habitat closure (1.565), the Georges Shoal 2 MBTG Closure Area (1.689), the Georges Shoal GMA (1.847), the Great South Channel GMA (1.587), the Northern Edge Area (1.533) and the Northern Georges MBTG Closure Area(1.545).

The number of tows in Georges Bank/southern New England areas in the winter is among the lowest in the analysis, resulting in potentially misleading diversity values. Winter groundfish diversity ranges from 0.285 in both Nantucket Shoals Areas to 0.719 in the Closed Area I South Habitat Closure. The Closed Area I North Habitat Closure (0.615), Closed Area I (0.611), Cox Ledge 1 (0.594), both of the EFH Expanded areas (0.629), the Northern Georges GMA (0.568) and the Northern Georges MBTG Closure Area (0.580) also rank in the 75th percentile for groundfish diversity. Regulated species diversity ranges from 0.288 in the Closed Area I South Habitat Closure to 0.726 in the Closed Area I North Habitat Closure. Closed Area I (0.626) and Cox Ledge 1 (0.657) also had high regulated species diversity. All species diversity ranged from 0.830 in the Closed Area I South Habitat Closure to 1.858 in the Closed Area I North Habitat Closure. The other areas with high all species diversity are Closed Area I (1.641), Cox Ledge 1 (1.655), both Expanded EFH Areas (1.662) and both Nantucket Shoals Areas (1.571).

Table 21 - Average diversity indices by no action and proposed habitat management areas. The 75th percentile for diversity of each species group is highlighted.

	SPRING				SUMMER				FALL				WINTER			
	Tows	LM Groundfish ISI	Regulated ISI	All species SDI	Tows	LM Groundfish ISI	Regulated ISI	All species SDI	Tows	LM Groundfish ISI	Regulated ISI	All species SDI	Tows	LM Groundfish ISI	Regulated ISI	All species SDI
Gulf of Maine																
EFH closure																
Cashes Ledge Habitat Closure	8	0.334	0.446	1.112	5	0.353	0.510	1.647	3	0.395	0.786	1.615	3	0.198	0.198	0.444
Jeffreys Bank Habitat Closure	20	0.632	0.695	1.584	17	0.585	0.490	1.405	21	0.547	0.567	1.281	13	0.583	0.653	1.474
Western Gulf of Maine Habitat Closure	109	0.478	0.522	1.234	43	0.285	0.514	1.346	51	0.451	0.667	1.569	44	0.499	0.537	1.143
Groundfish closure																
Cashes Ledge Closed Area	18	0.351	0.437	1.109	26	0.271	0.518	1.538	12	0.220	0.636	1.513	7	0.161	0.167	0.389
Western Gulf of Maine Closed Area	120	0.475	0.530	1.265	64	0.279	0.539	1.428	66	0.408	0.673	1.581	46	0.499	0.540	1.162
Habitat Management Area																
Alternate Roller Gear Restricted Area	233	0.509	0.572	1.324	47	0.424	0.618	1.489	123	0.485	0.614	1.422	102	0.522	0.591	1.277
Inshore Roller Gear Restricted Area	776	0.492	0.605	1.495	163	0.338	0.580	1.475	487	0.423	0.627	1.555	188	0.490	0.559	1.209
Jeffreys Ledge	33	0.483	0.537	1.207	7	0.286	0.489	1.391	29	0.449	0.636	1.406	22	0.486	0.530	1.189
Large Bigelow Bight	87	0.525	0.602	1.433	29	0.427	0.624	1.484	39	0.449	0.562	1.325	28	0.595	0.714	1.639
Large Eastern Maine	43	0.612	0.624	1.615	9	0.682	0.405	1.462	17	0.510	0.593	1.519	4	0.637	0.756	2.063
Large Stellwagen	59	0.484	0.535	1.261	10	0.508	0.697	1.555	17	0.501	0.729	1.892	23	0.521	0.554	1.143
Machias	1	0.464	0.689	1.424												
Modified Cashes Ledge EFH	6	0.394	0.448	1.134	3	0.325	0.458	1.477	2	0.536	0.795	1.480	3	0.198	0.198	0.444
Modified Jeffreys Bank EFH	28	0.569	0.663	1.510	7	0.393	0.481	1.333	24	0.503	0.569	1.261	25	0.595	0.650	1.471
Platts Bank 1	3	0.456	0.482	1.067					1	0.302	0.333	0.685	1	0.361	0.361	0.733
Platts Bank 2	2	0.352	0.362	0.812					2	0.362	0.499	1.197				
Small Bigelow Bight	37	0.574	0.635	1.474	18	0.420	0.619	1.484	18	0.430	0.563	1.302	12	0.546	0.655	1.475
Small Eastern Maine	20	0.629	0.654	1.660					6	0.564	0.603	1.649	2	0.716	0.814	1.952
Small Stellwagen	20	0.485	0.543	1.323	4	0.502	0.763	1.611	9	0.624	0.747	1.949	9	0.311	0.380	0.763
Toothaker Ridge	5	0.682	0.633	1.563	17	0.616	0.521	1.537	5	0.507	0.577	1.370				
Georges Bank/Southern New England																
EFH closure																
Closed Area I N Habitat Closure	61	0.336	0.427	1.156	77	0.273	0.338	0.908	25	0.285	0.642	1.561	3	0.615	0.726	1.858
Closed Area I S Habitat Closure	14	0.409	0.597	1.393	17	0.334	0.610	1.476	9	0.354	0.437	1.053	1	0.719	0.288	0.830
Closed Area II Habitat Closure	44	0.293	0.227	0.819	69	0.262	0.100	0.524	11	0.376	0.573	1.565				
Nantucket Lightship Habitat Closure	108	0.348	0.505	1.075	48	0.156	0.452	1.158	101	0.302	0.428	1.069	15	0.356	0.403	1.149
Groundfish closure																
Closed Area I	148	0.371	0.451	1.217	209	0.301	0.371	1.018	51	0.288	0.603	1.469	5	0.611	0.626	1.641
Closed Area II	215	0.355	0.423	1.146	337	0.232	0.343	0.984	99	0.237	0.545	1.375	6	0.412	0.478	1.068
Nantucket Lightship Closed Area	245	0.358	0.509	1.123	162	0.311	0.352	1.024	221	0.292	0.440	1.107	35	0.357	0.474	1.225
Habitat Management Area																
Cox Ledge 1	2	0.680	0.633	1.389					2	0.472	0.047	0.193	2	0.594	0.657	1.655
Cox Ledge 2									1	0.356	0.851	2.348				
EFH Expanded 1	67	0.333	0.240	0.832	94	0.264	0.128	0.606	19	0.293	0.596	1.501	3	0.629	0.605	1.662
EFH Expanded 2	39	0.372	0.277	0.879	45	0.283	0.182	0.762	12	0.268	0.621	1.470	3	0.629	0.605	1.662
EFH South MBTG	6	0.300	0.423	1.312	6	0.303	0.270	0.917	5	0.301	0.555	1.432				
Georges Shoal 1 MBTG	11	0.333	0.593	1.410	1	0.444	0.740	2.068	11	0.229	0.549	1.453				
Georges Shoal 2 MBTG	10	0.286	0.488	1.185	1	0.444	0.740	2.068	12	0.263	0.603	1.689				
Georges Shoal GMA	29	0.359	0.535	1.362	23	0.214	0.661	1.466	12	0.429	0.709	1.847				
Great South Channel	38	0.276	0.380	1.359	16	0.319	0.407	1.248	31	0.266	0.553	1.452	3	0.338	0.432	1.455
Great South Channel East	96	0.336	0.355	1.257	88	0.346	0.271	0.930	44	0.290	0.561	1.479	6	0.357	0.494	1.322
Great South Channel GMA	111	0.334	0.319	1.119	148	0.334	0.252	0.912	36	0.376	0.624	1.587	3	0.356	0.569	1.245
Nantucket Shoals	24	0.280	0.394	1.391	9	0.345	0.412	1.150	21	0.296	0.550	1.456	2	0.285	0.379	1.571
Nantucket Shoals West	29	0.269	0.406	1.398	9	0.345	0.412	1.150	22	0.303	0.561	1.443	2	0.285	0.379	1.571
Northern Edge	37	0.297	0.195	0.718	54	0.240	0.084	0.459	10	0.359	0.574	1.533				
Northern Georges GMA	204	0.368	0.432	1.152	230	0.259	0.394	1.073	95	0.307	0.582	1.469	4	0.568	0.553	1.305
Northern Georges MBTG	163	0.365	0.394	1.100	192	0.249	0.337	0.955	68	0.324	0.598	1.545	4	0.580	0.612	1.381

Spawning Areas

Seasonal species diversity indices of tows within each spawning management area facilitate comparisons of this metric across the possible alternatives (Table 22). The areas with the highest diversity values (75th percentile) for each index were highlighted with a specific color. Groundfish diversity is highlighted in red, regulated diversity in yellow and all species in green. Only the winter and spring tows within the areas were analyzed to overlap with the spawning closure seasons in the action alternatives.

In the **Gulf of Maine** areas, winter diversity for all species groups is highest in the Gulf of Maine Cod Spawning Protection Area and the June Sector Rolling Closure. Winter diversity for all species groups is lowest in the Cashes Ledge Closed Area. Groundfish diversity ranged from 0.161 in the Cashes Ledge Closed Area to 0.565 in the Gulf of Maine Cod Spawning Protection Area. The June Sector Rolling Closure (0.564) also has high groundfish diversity. Regulated species diversity in the winter ranges from 0.167 in the Cashes Ledge Groundfish Closure to 0.681 in the Gulf of Maine Cod Spawning Protection Area. Regulated species diversity is also high within the June Sector Rolling Closure (0.649). All species diversity ranged from 0.389 in the Cashes Ledge Groundfish Closure to 1.606 in the Gulf of Maine Cod Spawning Protection Area. All species diversity is also high in the June Sector Rolling Closure (1.505).

Spring groundfish diversity ranged from 0.351 in the Cashes Ledge Closed Area to 0.644 in the Gulf of Maine Cod Spawning Protection Area. The June Sector Rolling Closure (0.523) also ranks in the 75th percentile for groundfish diversity. Regulated and all species diversity is highest in the Gulf of Maine Cod Spawning Protection Area (0.724 and 1.630, respectively) and lowest in the Cashes Ledge Closed Area (0.437 and 1.109, respectively). Regulated and all species diversity is also high in the April Sector Rolling Closure (0.605 and 1.493).

For areas in **Georges Bank/southern New England**, winter diversity of all species groups is highest in the northern part of Closed Area I (the existing habitat closure; 0.615 for groundfish, 0.726 for regulated species and 1.858 for all species). Closed Area I also has high diversity of each species group (0.611 for groundfish, 0.626 for regulated species and 1.641 for all species). Groundfish and regulated species diversity is lowest the Nantucket Lightship Closed Area (0.357 and 0.474 respectively). All species diversity is lowest in Closed Area II (1.068).

Diversity of each species group is lowest overall in the spring Georges Bank/southern New England areas. Groundfish diversity ranged from 0.336 in Closed Area I North to 0.376 in the Georges Bank Seasonal Closure Area. Regulated species diversity ranges from 0.425 in Closed Area II to 0.509 in the Nantucket Lightship Closed Area. All species diversity ranges from 1.123 in the Nantucket Lightship Closed Area to 1.290 in the Georges Bank Seasonal Closure Area.

Table 22 - Average diversity indices by no action and proposed spawning areas. The 75th percentile for diversity of each species group is highlighted.

	WINTER				SPRING			
	Tows	LM Groundfish ISI	Regulated ISI	All Species SDI	Tows	LM Groundfish ISI	Regulated ISI	All Species SDI
Gulf of Maine								
Groundfish closure								
Cashes Ledge GF	7	0.161	0.167	0.389	18	0.351	0.437	1.109
Western Gulf of Maine GF	46	0.499	0.540	1.162	120	0.475	0.530	1.265
Seasonal rolling closure								
Sector Rolling Closure, April	159	0.482	0.545	1.160	677	0.489	0.605	1.493
Sector Rolling Closure, June	39	0.564	0.649	1.505	124	0.523	0.590	1.449
Sector Rolling Closure, May	140	0.513	0.579	1.272	449	0.496	0.587	1.415
Spawning area								
GOM cod spawning protection area	3	0.565	0.681	1.606	16	0.644	0.724	1.630
MassBay_CodSpawning	5	0.351	0.443	0.907	14	0.381	0.505	1.375
Georges Bank/Southern New England								
Groundfish closure								
Closed Area I GF	5	0.611	0.626	1.641	155	0.371	0.451	1.217
Closed Area II GF	6	0.412	0.478	1.068	222	0.356	0.425	1.150
Nantucket Lightship GF	35	0.357	0.474	1.225	258	0.358	0.509	1.123
Spawning area								
Closed Area I N	3	0.615	0.726	1.858	65	0.336	0.427	1.156
Georges Bank Seasonal Closure Area	27	0.385	0.581	1.383	631	0.376	0.483	1.290

Dedicated Habitat Research Areas

Seasonal species diversity indices of tows within each Dedicated Habitat Research Area (DHRA) were averaged together to allow comparison of this metric across the three possible alternative areas (Table 23). Groundfish diversity ranged from 0.373 in the Georges Bank DHRA to 0.621 in the Eastern Maine DHRA, the highest groundfish diversity value of the proposed DHRAs. The range of regulated species diversity is narrower, ranging from 0.563 in the Georges Bank DHRA to 0.680 in reference area 2 of the Stellwagen DHRA. All species diversity ranged from 1.361 in the Stellwagen DHRA to 1.937 in reference area 2 of the Stellwagen DHRA. No tows occurred in the summer in the Eastern Maine DHRA or reference area 2 of the Stellwagen DHRA. This, coupled with the low amount of fall and winter tows in the Eastern Maine and Georges Bank DHRAs, may have biased the average diversity values.

Table 23 - Average diversity in each DHRA. Reference area 1 is the southern option, and reference area 2 is located to the north.

	Tows	LM Groundfish ISI	Regulated ISI	All species SDI
Eastern Maine DHRA	**28**	**0.621**	**0.654**	**1.679**
SPRING	20	0.629	0.654	1.660
FALL	6	0.564	0.603	1.649
WINTER	2	0.716	0.814	1.952
Georges Bank DHRA	**41**	**0.373**	**0.563**	**1.347**
SPRING	14	0.409	0.597	1.393
SUMMER	17	0.334	0.610	1.476
FALL	9	0.354	0.437	1.053
WINTER	1	0.719	0.288	0.830
Stellwagen DHRA	**109**	**0.497**	**0.584**	**1.361**
SPRING	59	0.484	0.535	1.261
SUMMER	10	0.508	0.697	1.555
FALL	17	0.501	0.729	1.892
WINTER	23	0.521	0.554	1.143
Stellwagen DHRA, reference area 1	**18**	**0.486**	**0.633**	**1.473**
SPRING	10	0.493	0.562	1.319
SUMMER	3	0.463	0.759	1.508
FALL	4	0.486	0.755	1.942
WINTER	1	0.492	0.481	1.037
Stellwagen DHRA, reference area 2	**7**	**0.586**	**0.680**	**1.937**
SPRING	4	0.667	0.713	2.023
FALL	2	0.696	0.840	2.453
WINTER	1	0.040	0.229	0.565

4.3 Managed species and fisheries

The managed species valued ecosystem component includes the following fishery resources:

- Large-mesh northeast multispecies
- Small-mesh multispecies
- Monkfish
- Skates
- Atlantic sea scallop
- Atlantic herring
- Deep-sea red crab
- Surfclam and ocean quahog
- Atlantic bluefish
- Atlantic mackerel, squid, and butterfish
- Spiny dogfish
- Summer flounder, scup, and black sea bass
- Golden tilefish
- Northern shrimp
- American lobster

The biology, status, and overall distribution sections describe the distribution, life history, spawning behavior, habitat associations, and stock status of various managed species. Species are grouped by fishery management plan, with individual species sections listed in alphabetical order by common name. The EFH designations themselves (Volume 2) and the accompanying supplementary Appendix B contain additional information about the distribution and habitat preferences of species managed by the New England Council. Although technically a managed species, imformation about Atlantic salmon is located in the protected resources section, because the fishery management plan prohibits possession of Atlantic salmon and there is no commercial fishery for the stock.

Maps were prepared to show the distribution of each species throughout the New England region. Total biomass per tow for the spring and fall trawl surveys from 2002-summer 2013 was plotted over stock boundaries described in Stock Assessment Workshop (http://www.nefsc.noaa.gov/nefsc/saw/), Transboundary Resource Assessment Committee (http://www2.mar.dfo-mpo.gc.ca/science/TRAC/rd.html), and Status of the Stock (http://www.nefsc.noaa.gov/sos/) documents. For species that had data to analyze age 0/1 and large spawner hotspots, abundance and biomass per tow data were also plotted, respectively.

The purpose of the fishery sections is to describe the major fisheries, managed by the Council or another authority, that operate within the Council's jurisdiction, and could be affected by adjustments made in this action to areas managed or regulations for those areas. This section is intended to describe the basics of the management approach and summarize current conditions in the fisheries, including geographic scope, seasonality, target species, and methods of fishing (see Table 24 and Table 25). This information provides context for the impacts analysis, and will help the reader of the amendment to understand why particular areas and measures may have an impact on specific fisheries. Detailed information about each fishery can be obtained from the descriptions of the affected environment provided in recent FMP documents specific to each plan.

Table 24 – Gear types used in the Northeast region, by FMP

Gear type	NEGEAR	NEGEAR2	Bottom tending gear?	Mobile gear?	FMP in which this gear is used	Notes
Dredge, ocean quahog and surfclam	400	40	Yes	Yes	Surfclam ocean quahog	Includes hydraulic and dry dredges
Dredge, sea scallop	132	13	Yes	Yes	Atlantic sea scallop	
Dredge, sea scallop w/chain mat	132	13	Yes	Yes	Atlantic sea scallop, gear required in particular areas to reduce sea turtle interactions	
Gill net, sink	100	10	Yes	No	Northeast multispecies; Monkfish; Spiny dogfish	
Handline/rod and reel	20	2	Both	No	Northeast multispecies; Bluefish; Summer flounder, scup, and black sea bass	
Longline, bottom	10	1	Yes	No	Northeast multispecies; Spiny dogfish; Golden Tilefish	
Otter trawl, haddock separator	57	5	Yes	Yes	Northeast multispecies	
Otter trawl, scallop	52	5	Yes	Yes	Atlantic sea scallop	
Otter trawl, bottom fish	50	5	Yes	Yes	Northeast multispecies; Monkfish; Bluefish; Atlantic herring; Atlantic mackerel, squid, and butterfish; Spiny dogfish; Summer flounder, scup, and black sea bass	
Otter trawl, midwater	370	37	No	No	Atlantic herring; Atlantic mackerel, squid, and butterfish	
Otter trawl, bottom, other	59	5	Yes	Yes	Northeast multispecies; Monkfish; Bluefish; Atlantic herring; Atlantic mackerel, squid, and butterfish; Spiny dogfish; Summer flounder, scup, and black sea bass	
Otter trawl, Ruhle	54	5	Yes	Yes	Northeast multispecies	
Otter trawl, bottom shrimp	58	5	Yes	Yes	Northern shrimp	
Pot, crab	300	30	Yes	No	Deep-sea red crab	
Pot, fish	181	18	Yes	No	Northeast multispecies; Summer flounder, scup, and black sea bass	
Pot, lobster	200	20	Yes	No	American lobster	

Gear type	NEGEAR	NEGEAR2	Bottom tending gear?	Mobile gear?	FMP in which this gear is used	Notes
Pair trawl, midwater	170	17	No	No	Atlantic herring	
Pot, shrimp	190	19	Yes	No	Northern shrimp	
Seine, purse	120	12	Yes	No	Atlantic herring	

Table 25 – Species associated with each FMP

Species	NESPP_3	FMP	Notes
Acadian redfish	240	Northeast multispecies large mesh	Special small mesh exemption program
American plaice	124	Northeast multispecies large mesh	
Atlantic cod	81	Northeast multispecies large mesh	
Atlantic halibut	159	Northeast multispecies large mesh	Not allocated to sectors, 1 fish per trip limit
Atlantic wolffish	512	Northeast multispecies large mesh	Not allocated to sectors
Haddock	147	Northeast multispecies large mesh	
Ocean pout	250	Northeast multispecies large mesh	Not allocated to sectors; ocean pout is the only' regulated species' that is not a large mesh species
Pollock	269	Northeast multispecies large mesh	
White hake	153	Northeast multispecies large mesh	
Windowpane flounder	125	Northeast multispecies large mesh	Not allocated to sectors
Winter flounder	120	Northeast multispecies large mesh	
Witch flounder	122	Northeast multispecies large mesh	
Yellowtail flounder	123	Northeast multispecies large mesh	
Silver hake	509	Northeast multispecies small mesh	
Offshore hake	508	Northeast multispecies small mesh	Likely to be rare in catches due to distribution
Red hake	152	Northeast multispecies small mesh	
Monkfish	13	Monkfish	
Smooth skate	369	Skates	
Thorny skate	370	Skates	
Barndoor skate	368	Skates	
Little skate	366	Skates	Most landings little or winter
Winter skate	367	Skates	Most landings little or winter
Clearnose skate	372	Skates	Likely to be rare in catches due to distribution
Rosette skate	364	Skates	Likely to be rare in catches due to distribution
Unclassified skate or skate wing	365	Skates	Many landings will fall into this category
Atlantic sea scallop	800	Atlantic sea scallop	
Atlantic herring	168	Atlantic herring	

Species	NESPP_3	FMP	Notes
Deep-sea red crab	710	Deep-sea red crab	
Surfclam	769	Surfclam and ocean quahog	
Ocean quahog	754	Surfclam and ocean quahog	
Atlantic bluefish	23	Atlantic bluefish	
Atlantic mackerel	212	Atlantic mackerel, squid, and butterfish	
Longfin squid	801	Atlantic mackerel, squid, and butterfish	
Shortfin squid	802	Atlantic mackerel, squid, and butterfish	
Butterfish	51	Atlantic mackerel, squid, and butterfish	
Spiny dogfish	352	Spiny dogfish	
Summer flounder	121	Summer flounder, scup, and black sea bass	
Scup	329	Summer flounder, scup, and black sea bass	
Black sea bass	335	Summer flounder, scup, and black sea bass	
Golden tilefish	446	Tilefish	
Northern shrimp	736	Northern shrimp	
American lobster	727	American lobster	

Many of the alternatives in this amendment would shift fishing effort from one area to another. There may be opportunities to increase harvest of some stocks if management area boundaries change. Increased harvest requires that the species occur in a particular location open to fishing in sufficient abundance, and that there is catch available (i.e. catches are generally lower than their annual catch limits/targets). Table 26 summarizes annual catch limit and total catch (when available) for each of the New England and Mid-Atlantic Councils' stocks. This table uses the fishing year 2012 data because it is the most recent year for which total catch is available for most stocks. The table also indicates if an accountability measure was triggered as a result of an overage of the annual catch limit. Details on the accountability measures are more thoroughly described in each fisheries description.

If catches of a particular stock tend to frequently be at or above the annual limits, then there is limited or no opportunity to increase harvest. Nonetheless, there could be economic or social benefits associated with adjusting spatial management, i.e. if management changes create harvest opportunites that are closer to port and have lower costs, or through increased flexibility in fishing location choice. However, in the reverse scenario where catch is below ACL, this table oversimplifies matters because while a gap between current catches and ACLs is required to increase landings, it is not sufficient. For a particular stock and fishery, there may be any number of reasons why catches are low. These include, among others, constraining catch limits associated with other species captured in a multispecies fishery or as bycatch, low prices, a lack of market for the species, or insufficient capacity in the fishery to fully harvest the ACL.

Table 26 – New England and Mid-Atlantic Stocks Annual Catch Limit and Catch Performance. Fishing Year 2012

FMP	Stock	Annual Catch Limit, 2012 (mt)	Catch, 2012 (mt)	Accountability Measure Triggered?
Northeast Multispecies	Georges Bank Cod	4,861	1,724.06	No
	Gulf of Maine Cod	6,700	3,903.83	No
	Georges Bank Haddock	29,260	1,525.49	No
	Gulf of Maine Haddock	958	530.02	Yes; Recreational fishery only
	Georges Bank Yellowtail Flounder	548	384.91	No
	Southern New England/Mid-Atlantic Yellowtail Flounder	936	593.54	No
	Cape Cod/Gulf of Maine Yellowtail Flounder	1,104	1,012.25	No
	Plaice	3,459	1,642.84	No
	Witch Flounder	1,563	1,173.98	No
	Georges Bank Winter Flounder	3,575	2,057.64	No
	Gulf of Maine Winter Flounder	1,040	322.78	No
	Southern New England/Mid-Atlantic Winter Flounder	603	315.89	No
	Redfish	8,786	4,445.43	No
	White Hake	3,465	2,485.36	No
	Pollock	14,736	8,092.40	No
	Northern Windowpane	163	208.9	Yes
	Southern Windowpane	381	520.9	Yes
	Ocean Pout	240	53.19	No
	Halibut	83	75.68	No
	Atlantic wolffish	77	32.37	No
	Northern Red Hake	266	386	Yes
	Northern Silver Hake	12,518	2,199	No
	Southern Red Hake	3,096	1,152	No
	Southern Whiting (Southern Silver Hake and Offshore Hake, Combined)	32,295	6,496	No
Northeast Skate	Northeast Skate Complex	50,435	27,244	No
Atlantic Herring	Atlantic Herring	90,683	90,561	Yes; Area 1B, 2, and 3 sub-ACLs
Atlantic Sea Scallop	Scallops	28,961	26,064	No
Atlantic Deep-Sea Red Crab	Red Crab	1,774	1,315	No

FMP	Stock	Annual Catch Limit, 2012 (mt)	Catch, 2012 (mt)	Accountability Measure Triggered?
Monkfish	Northern Monkfish	7,592	4,565	No
	Southern Monkfish	12,316	8,070	No
Bluefish	Atlantic Bluefish	14,535	8,974	No
Mackerel, Squid, Butterfish	Atlantic Mackerel	43,781	6,019c	No
	Butterfish	3,622	2,353	No
	Illex Squid	22,915a	11,709 c	No
	Longfin Squid	22,220 a	13,408 c	No
Summer Flounder, Scup, Black Sea Bass	Black Sea Bass	2,041	1,315	Yes; Recreational fishery only
	Scup	18,543	9,577	No
	Summer Flounder	11,603	11,227	No
Surfclam and Ocean Quahog	Ocean Quahog	96,600 b	17,913d	No
	Surfclam	26,600 b	15,565 d	No
Spiny Dogfish	Spiny Dogfish	20,292	16,400	No
Golden Tilefish	Tilefish	913	850 d	No

[a] ACLs are not required for the squid fisheries. This is the domestic annual harvest value.
[b] ABCs were implemented for 2012, but ACLs were not. However, under Control Rule, ABC=ACL.
[c] This value is landings, not catch, because total catch was unavailable.
[d] This value is landings, however, discards are presumed to be 0.

4.3.1 Large-mesh groundfish

4.3.1.1 Biology, status, and overall distribution

Information is provided for each of the large-mesh species in the Northeast Multispecies Fishery Management Plan. Note that while small mesh species are also managed under this FMP, the fisheries are very different, and the Volume 3 analyses describing the impacts of the habitat management area alternatives makes a distinction between these two (large- vs. small-mesh) fisheries. Therefore, the small-mesh groundfish biology and fishery information is presented separately.

4.3.1.1.1 Acadian redfish

The Acadian redfish (*Sebastes faciatus*) is a long-lived rockfish species found in moderate to deep waters in the Gulf of Maine as well as in moderate depths (EFH to 600 m) along the continental slope off the Northeast U.S. Adults are found throughout the deep basins in the Gulf of Maine, but juvenile redfish are restricted to somewhat shallower depths (Map 53). A similar species, *S. mentella*, co-occurs with *S. faciatus* along the continental slope and is not distinguished in survey catches.

Redfish are found primarily on mud habitats, often associated with living and non-living structures. Habitat association studies in the deep mud habitats near Stellwagen Bank found that juvenile redfish were one of the most numerous species observed on deep (50-100 m) boulder reefs (Auster and Lindholm 2005). The redfish appear to use these reefs for cover and for access to increased current flows above the reef, where drifting zooplankton prey can be consumed at higher rates. Early juveniles were found primarily on the reefs themselves, while late juveniles were found on both the reefs and among dense aggregations of cerianthid anemones (Auster et al. 2003). These life stages, ages up to 5-7 years, were considered year-round residents with small home ranges (Auster et al. 2003). Redfish have also been observed in association with hard bottom habitat and corals on 'bump' habitats in Western Jordan Basin (Auster 2005).

Crustaceans are the most important prey item for both juveniles and adults. Juveniles and adults also consume larvaceans, which are free-swimming, filter feeding, soft-bodied invertebrates. Adults will eat silver hake, and to a much lesser extent, other fish. The proportion of fish in the diet increases with increasing redfish size.

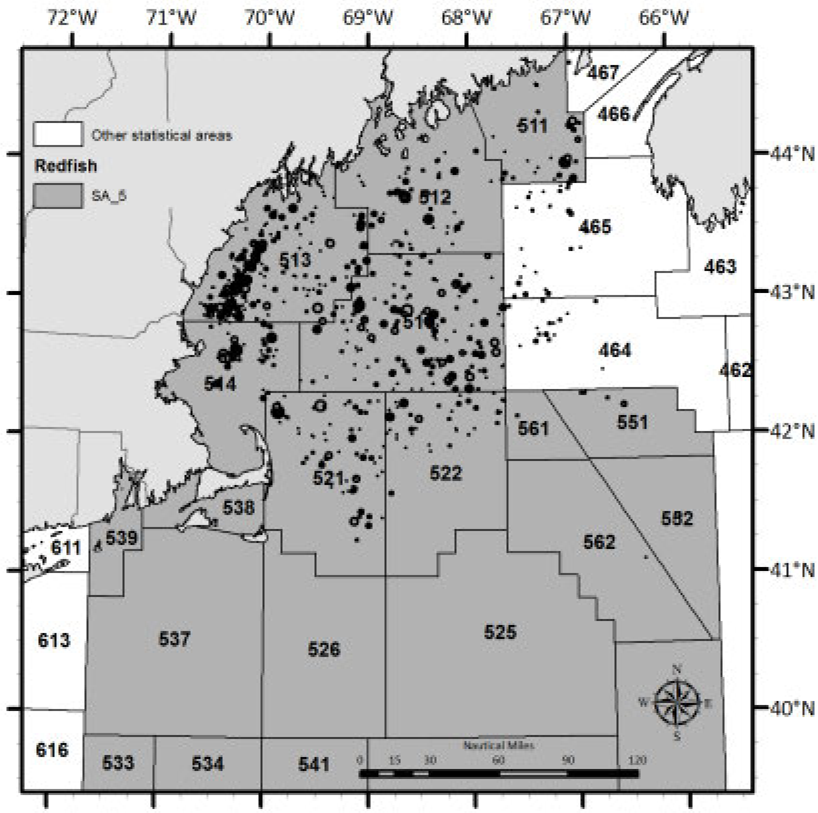
Redfish have internal fertilization and bear live young. The larvae are released throughout the adult range from April through August, with peak activity in late May/early June. Marine Resources Monitoring, Assessment and Prediction (MARMAP) surveys (1977-1987) found larvae between March and October. In spring, abundance was greatest at slope stations off the southern flank of Georges Bank, but by late summer the larvae were more common in the Gulf of Maine. Baillon et al. (2012) found a close association of redfish larvae with five species of sea pens (Octocorallia; Penntulacea) during the spring in the Laurentian Channel and southern Grand Banks. While the significance of this association is uncertain, it suggests a role of these coral as a habitat factor in larval survival, and hence recruitment. Some of the same sea pen species are present in the Gulf of Maine, althought the same association has not been demonstrated here.

Redfish are managed within the Northeast Multispecies FMP as a large mesh species. Biomass of the single stock (Map 53) currently exceeds the target, and appears to have increased between 2007 (NEFSC 2008) and 2010 (NEFSC 2012). Recruitment appears to have increased between 2008 and 2010 (Figure 11). Fishing mortality rates have remained low. Since 1992, there appears to be a moderately positive relationship between recruitment and SSB, with SSB gradually increasing over the time period. Except for a very strong 2007 year class (215 million fish when SSB was relatively high), recruitment has ranged between 32 and 215 million fish since 1992. During 2008 to 2010, recruitment has been 31 percent above the estimated levels since 1992 and 158 percent above the estimated levels since 1963. Likewise, SSB during 2008 to 2010 has been 118 percent above the 1992-2010 time series and 204 percent above the 1963 to 2010 time series.

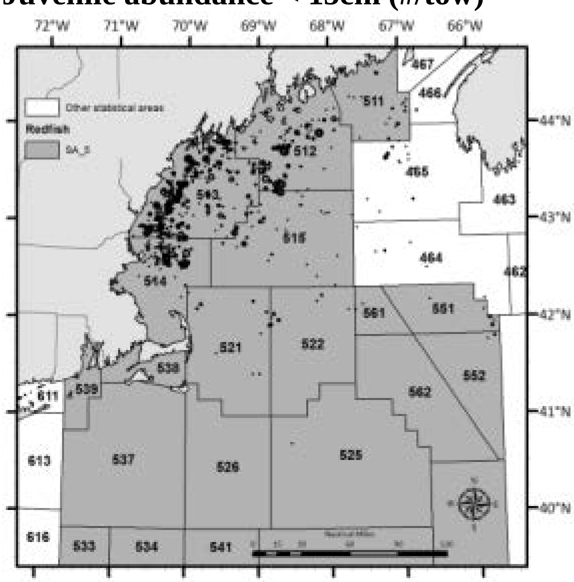
Recently, there has been interest in increasing the harvest of redfish in the Gulf of Maine. While the current mesh size requirements are 6.5 inches, smaller mesh was used in the past to target redfish. An experimental, small mesh trawl fishery was conducted during 2011, and currently a there is a small mesh exemption that can be used to target redfish, provided that there is 100% observer coverage and various other requirements are met (78 Federal Register 14226).

Map 53 – Acadian redfish stock boundary and catch/tow from spring and fall NMFS, MADMF, and ME/NH surveys 2002-2013. Spring survey values shaded grey may obscure fall survey values shaded black. Small juvenile and large spawner size thresholds correspond to sizes used in the hotspot analysis (Section 0) to help identify critical juvenile habitat and spawning areas.

Total biomass (kg/tow)



Juvenile abundance < 15cm (#/tow)



Spawner biomass > 30cm (kg/tow)

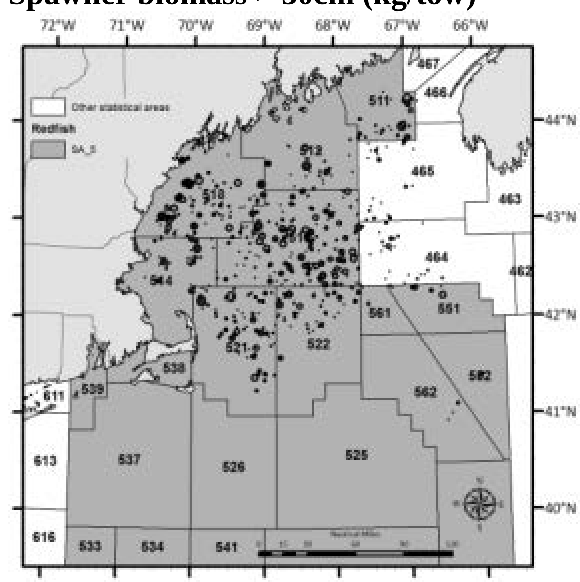
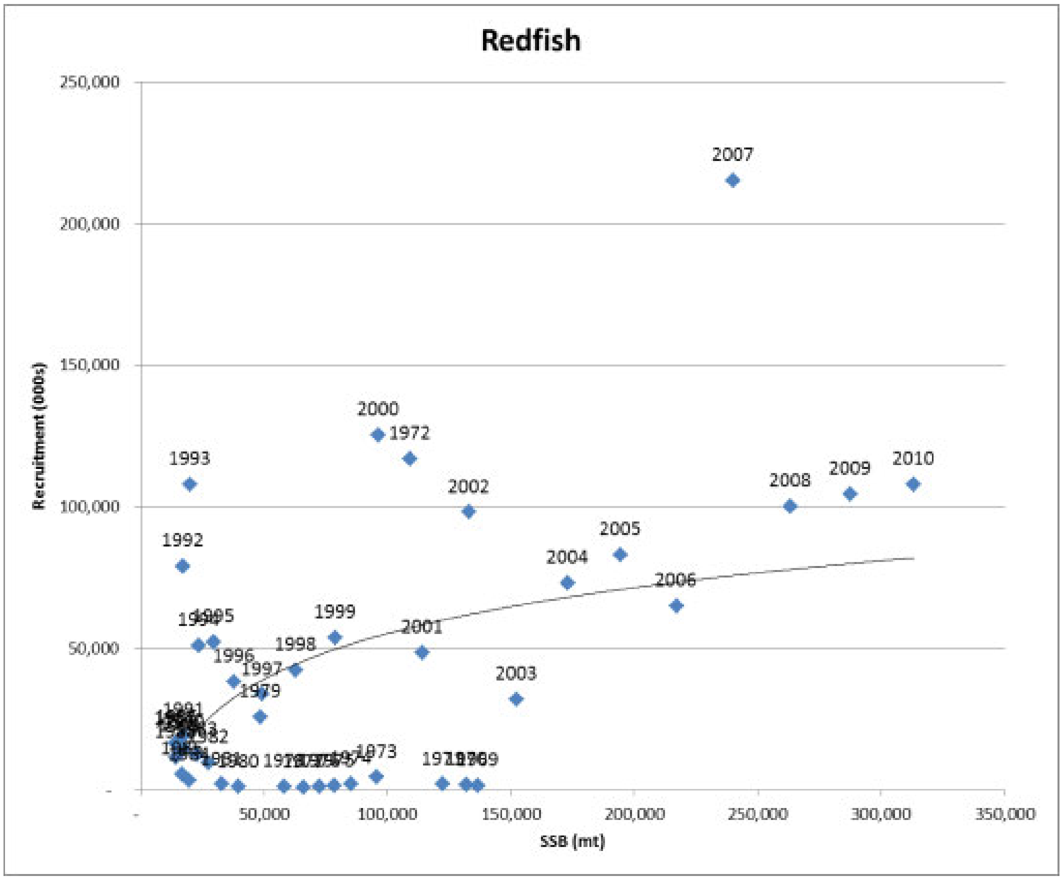


Figure 11 – Recruitment and spawning stock biomass estimates for Acadian redfish (NEFSC stock assessments)



4.3.1.1.2 American plaice

American plaice (*Hippoglossoides platessoides*) are a benthic flatfish found mainly in the Gulf of Maine and to a lesser extent along the northern edge of Georges Bank (Map 54). Juveniles in particular are more abundant in shallower, inshore waters; the adults occur both in coastal regions and in deeper waters (Methratta and Link 2007, Johnson 2004). Plaice travel from relatively cool, deep water in the fall to relatively cool, shallow water in the spring (Methratta and Link 2006). They spawn between March and mid-June in the Gulf of Maine, with peak activity during April and May (Bigelow and Schroeder 1953, Colton et al 1979, Smith et al 1975).

Some distributional metrics have shifted over time. Between 1968 and 2007, plaice have experienced significant range expansion, decrease in maximum latitude, and increase in mean depth. However, there are no significant trends in poleward movement, minimum latitude, or mean temperature (Nye et al 2009).

They are associated with mud, sand, and fine gravel substrates, although gravel associations have been documented based on work conducted off Newfoundland and in the North Sea; not in our portion of the North Atlantic (Sparholt 1990, Langton and Bowman 1981, Scott and Scott 1988, Bowering and Brodie 1991, Morgan 2000, Scott 1982, Keats 1991). Plaice do not use benthic structures for shelter.

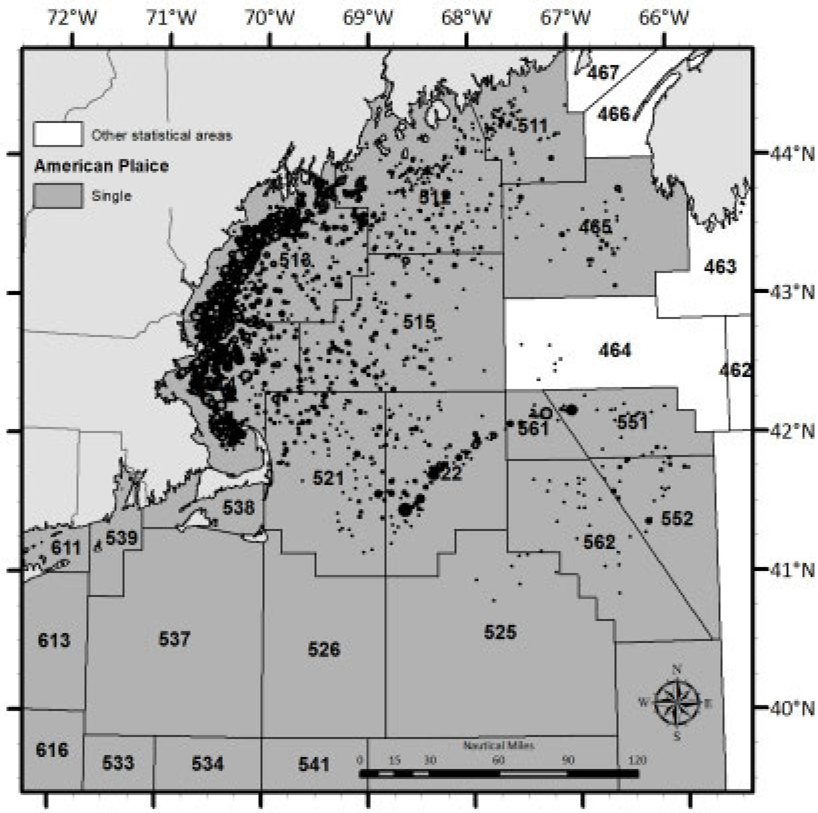
In the southern part of its range in the Gulf of Maine, the spawning season extends from March through the middle of June, with peak spawning activity in April and May (Bigelow and Schroeder 1953; Colton et al. 1979; Smith et al. 1975). Nursery areas are found in coastal waters of the Gulf of Maine (Bigelow and Schroeder 1953).

Plaice feed on a variety of benthic prey including echinoderms such as sand dollars, polychaete worms, crustaceans, and bivalves.

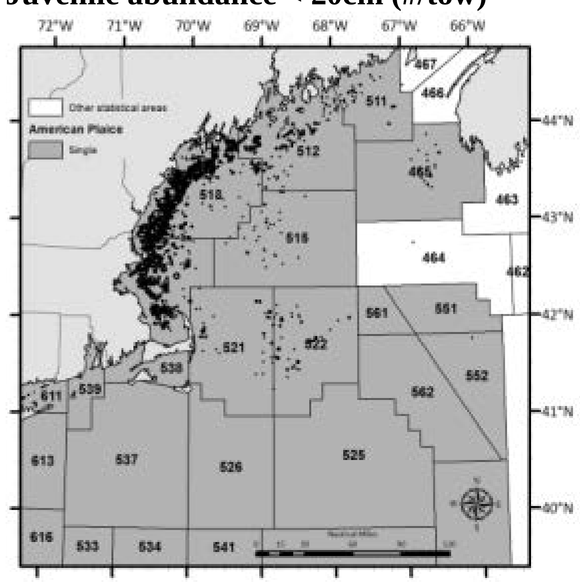
The species is managed as a single stock (Map 54). The Groundfish Assessment Review Meeting III (2008) and the 2012 assessment update indicated that the stock is not overfished and overfishing is not occurring. Biomass increased between 2008 and 2012. Over the observed SSB since 1980, there appears to be no positive relationship between SSB and recruitment (Figure 12). In fact the stronger 1986, 1987, 1992, and 1993 year classes occurred when SSB was relatively low. The highest SSB occurred during 1980 to 1984, suggesting that there was a very strong year class (or several) in the late 1970s. Since then, SSB has varied between 6,200 and 17,600 mt. Although SSB has been increasing and during 2008 to 2010 is 18 percent above average, recruitment was 40% below normal. Recruitment was a time series low in 2009.

Map 54 – American plaice stock boundary and catch/tow from spring and fall NEFSC, MADMF, and ME/NH surveys, 2002-2013. Spring survey values shaded grey may obscure fall survey values shaded black. Small juvenile and large spawner size thresholds correspond to sizes used in the hotspot analysis (Section 0) to help identify critical juvenile habitat and spawning areas.

Total biomass (kg/tow)



Juvenile abundance < 20cm (#/tow)



Spawner biomass > 40cm (kg/tow)

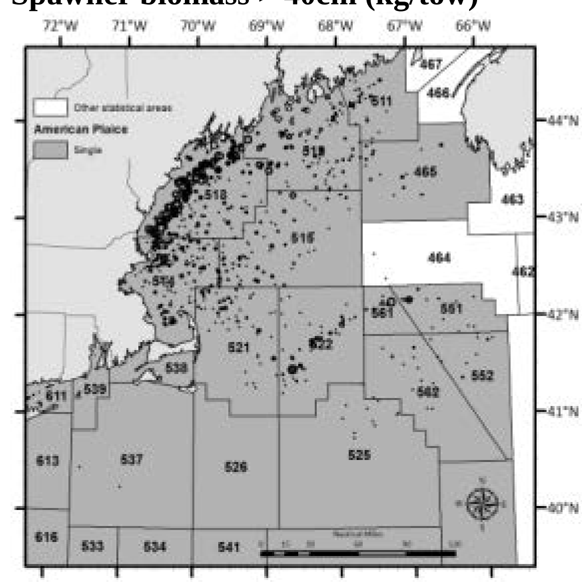
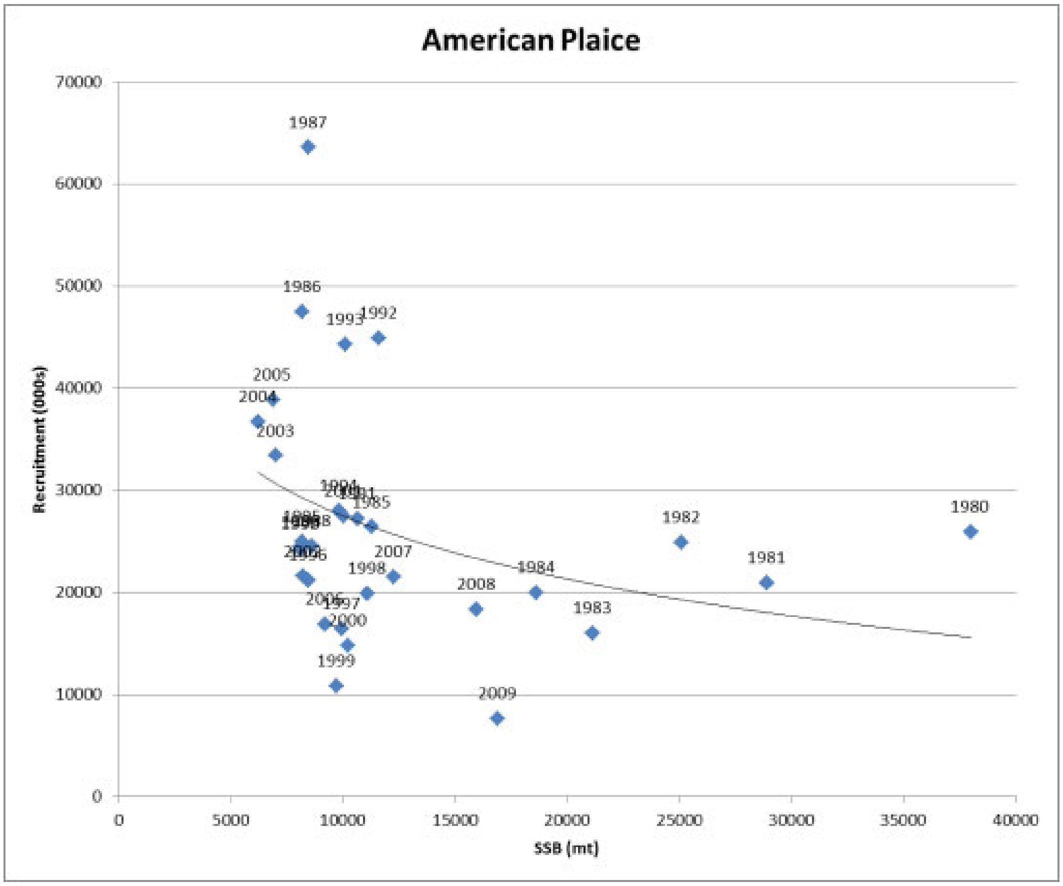


Figure 12 – Recruitment and spawning stock biomass estimates for American plaice (NEFSC stock assessments)



4.3.1.1.3 Atlantic cod

In U.S. waters, adults and juveniles are widespread in the shallower areas of the Gulf of Maine, including inshore waters as well as on shallow offshore banks and ledges. They are particularly concentrated in the southwestern Gulf of Maine. Howe et al. 2002 analyzed 22 years of semi-annual inshore research-trawl survey and calculated the mean catch per tow, mean length and frequency of occurrence for age 0 and 1 cod to conclude that age 0 cod preferred depths <90' while age 1 cod stayed within 61-180. In the fall, age 0 cod were widely distributed from 31-180' and age 1 cod preferred 121-180' (Howe et al. 2002). As a general conclusion, smaller and younger cod occupied shallower depths and would move deeper in the water column as they would grow and age.

Howe et al. compiled these data to determine which coastal embayments served as a settlement area for juvenile cod. Age 0 densities were highest in Ipswich Bay and on the shore of Massachusetts Bay and Cape Cod Bay in the spring and highest north of Cape Ann, on the shore of Massachusetts Bay and in all of Cape Cod Bay in the autumn. Age 1 densities were highest in Ipswich Bay, Massachusetts Bay and northern Cape Cod Bay in the spring and highest north of Cape Ann and in central Massachusetts Bay in the autumn.

Cod are widely distributed on Georges Bank, with the highest concentrations on the northern edge and in the Great South Channel. Adults are found somewhat further south than juvenile cod, to at least New Jersey in spring. A recent analysis of 1968-2005 NEFSC survey data from the northeast region shows that juvenile cod (<35 cm) were more likely to be caught in depths of 30-120 m, whereas adults were more likely to be caught between 30 and 160 m. Analysis of trawl survey data from the Northwest Atlantic shows that, as they age, cod inhabit increasingly deeper waters (Tremblay and Sinclair 1985; Wigley and Serchuk 1992; Anderson and Gregory 2000; Dalley and Anderson 2000).

Over time, the range of Georges Bank cod has contracted and their center of distribution has moved north. Gulf of Maine cod have not experienced significant range contraction, but the stock has moved south (Nye et al. 2009).

Lough (2010) concluded that the northeastern gravel area on Georges Bank may provide a "survival bottleneck" depending on the distribution and abundance of juvenile cod settlement in relation to that of their predators. Juveniles were widespread across Georges Bank in June and in mid-July they were found on all bottom types from sand to gravel on eastern Georges Bank. By late July/early August they were found to be most abundant on the northeastern edge gravel deposit where the complex relief levels provided abundant prey and refuge from predators (Lough 2010). The distribution patterns of pelagic and recently settled juvenile cod were examined from nine surveys on Georges Bank in the summer from 1984-1989 to relate the survival of juveniles to the sedimentary environment (Lough 2010).

Analyzing the vertical distribution patterns of juvenile haddock and cod on Georges Bank, Lough and Potter 1993 found that pelagic juveniles moved deeper as they grew. By mid-July most juveniles (~40 mm in length) were associated with deeper waters. The juveniles would remain demersal during the day and migrate 3-5m upwards at night. Cod would typically be situated at shallower depths than haddock at smaller sizes (Lough and Potter 1994). These distribution patterns were summarized from eight research cruises that took place on Georges Bank during the spring and summer from 1981-1986.

Cod exhibit seasonal migrations. Methratta and Link (2006) analyzed 1968-2002 spring and fall NEFSC trawl survey data in relation to depth and bottom temperatures and described cod as a species that remains in cool water, migrating from deeper water in the fall to shallower water in the spring. A similar pattern has been observed in the Maine/New Hampshire (ME/NH) inshore trawl survey. Specifically, data from 2000-2007 showed that juveniles (<35 cm) were more likely to be caught between 10 and 50 m in the spring and at two different depth intervals (20-30 and 50-90 m) in the fall, while adults were more likely to be caught between 80 and 110 m in the spring and 80-140 m in the fall, with a very abrupt increase in catch rates at 80 m during both seasons.

Cod are demersal gadids, usually found within two meters or so of the bottom (Klein-MacPhee 2002). Larger fish generally stay closer to the bottom unless feeding in the water column. They are associated with a variety of bottom types, but prefer coarser substrates. Analysis of trawl survey data (all sizes) from the NEFSC survey stratum that includes the Stellwagen Bank National Marine Sanctuary (southwester Gulf of Maine) showed a significant positive relationship with bottom reflectance, i.e., higher catches on harder bottom (Auster et al. 2001). Acoustic tagging studies and underwater observations in this same area have revealed that cod are associated with gravel and deep (50-100 m) boulder reef habitats (Lindholm and Auster 2003, Auster and Lindholm 2005, Lindholm et al. 2007). Some adults remained on the reef while others departed the area rapidly following release. Video surveys and hook-and-line sampling suggested that cod are most abundant in complex habitats such as rocky ledge and cobble habitats. Analysis of 1998-2002 spring and fall NEFSC trawl survey data (kg/tow, all sizes) in relation to sediment type showed that cod catch rates were higher in coarse sand, fine rock, and coarse rock substrates (ten minute squares with mean grain sizes of 0.25-8 mm) and that cod consistently distinguished fine rock (2-8 mm) from all finer-grained substrates (Methratta and Link 2006).

Juvenile settlement studies have mainly been conducted in the laboratory and in nearshore locations, even though young-of-the-year cod are known to also utilize deeper, offshore habitats. Inshore studies generally confirm a preference among young-of-the-year juveniles for structured bottom habitats that provide shelter from predators (see, for example, Gotceitas and Brown 1993; Gotceitas et al, 1995; Borg et al. 1997; Gregory and Anderson 1997, Linehan et al. 2001; Lazzari and Stone 2006).

Age 0-1 cod preferred gravel substrates when the threat of predation was not present, but older cod (age 2+) would move into more coarse substrates (Gregory et al. 1997, Gotceitas and Brown 1993). Based on an analysis of the distribution of juvenile cod relative to available habitat in Newfoundland waters, Gregory et al. (1997) concluded that 80% of age 2-4 juvenile cod were associated with coarse substrate areas and high bathymetric relief. In contrast, 59% of age-1 cod were associated with areas with a gravel substrate and low relief. They considered numerous factors in their classification of habitat: depth, substrate type, bathymetric relief and the presence or absence of macroalgae. Neither of the age groups appeared to show a preference for the presence or absence of macroalgae. Most of the juvenile cod in both age groups were found at depths greater than 60 meters.

Gotceitas and Brown (1993) analyzed the effect of predation as a factor influencing the distribution of juvenile cod amongst substrate types, concluding that juvenile cod will move from sand/gravel-pebble substrates to cobble substrates in the presence of a predator. The tested cod were collected from an inshore area at Bellevue, Newfoundland and split into two age groups. The first group was juvenile cod age 0+ and the second group was larger cod age 3+, which were introduced as the predators. Before the age 3+ cod were introduced into the tanks, juveniles settled into either the sand/gravel-pebble substrates and in the presence of a predator, juveniles hid in the substrates where cobble was present (Gotceitas and Brown, 1993). Two and a half hours after the age 3+ cod were removed, the larger juvenile cod showed a preference to the finer-grained substrates whereas the smaller juvenile cod continued to associate with the cobble.

Offshore habitat association studies on Georges Bank indicate that there is a narrow window when cod are closely associated with gravel substrates. Submersible studies on eastern Georges Bank (Lough et al. 1989, Valentine and Lough 1991) showed that recently-settled cod and haddock are widely dispersed over the bank and are present on a range of sediment types from sand to gravelly sand to gravel pavement. However, by late July and August, these fish occur predominantly on the gravel pavement habitat on the northeastern part of the bank and are absent from sandy areas. It is not clear if this represents low survival on sand, or migration to gravel habitats. During late summer, as they continue to grow, they are carried to the east and southeast in the residual bottom current, and by fall they are more widely dispersed and are no longer confined to gravel pavements.

Studies in the southwestern Gulf of Maine have found very young juvenile cod along the margins of boulder reefs (Lindholm and Auster 2003, Auster and Lindholm 2005, Lindholm et al. 2007). These juveniles would hide amongst the cover provided by rocky substrate and epifauna when disturbed. Grabowski et al. (in preparation) analyzed trawl survey data from mid-coast Maine and reported that larger juveniles (10-25 cm) were far more abundant on gravel than on mud or sand bottom. Examination of tows conducted at similar depths demonstrated that juvenile cod densities on gravel were more abundant than those on either sand (20-35 m) or mud (35-50 m).

Colton et al. (1979) summarized that cod spawned on Browns Bank from March-April (peaking in March), in what may be the most comprehensive layout of spawning locations and times for cod and other species in this review. While the modern relevance of the analysis may be questionable due to the year in which it and the cited papers were published, it does nonetheless provide a simple and informative look at spawning in New England waters. The spawning summaries are based primarily on published data collected by the National Marine Fisheries Service, icthyoplankton surveys of the Gulf of Maine performed in the 1950s and 1960s, and published data from earlier literature ranging from 1929 to 1953 (Colton et al. 1979).

Perkins et al. (1997) conducted a cod tagging study within Sheepscot Bay and concluded there were seasonal cod spawning aggregations within Sheepscot Bay from May to July. Of 4,191 cod tagged between 1978 and 1983, over 7% of the tagged fish were recaptured within six years of their release. The cod were tagged and released offshore within Sheepscot Bay and most of the recaptured cod were caught along the coast from Cape Elizabeth to the Bay of Fundy. The authors observed the emission of milt and eggs by mature Atlantic cod from late March to mid-July within the tagging area.

Ames (2004) analyzed cod larval and egg data from the 1920s and corroborated that data with surveys of retired fishermen to identify numerous cod spawning locations mostly within the inshore Gulf of Maine (Figure 13). This was one of the most comprehensive analyses on cod spawning locations in New England waters. He concluded that these data were consistent with current cod populations and with the existence of localized spawning components.

Huret et al. (2007) identified a larger range of cod spawning areas at different times of the year within Ipswich Bay, Cape Cod Bay and Saco Bay. Cod spawning periods were May to July and December to January in Ipswich Bay, December to January in Cape Cod Bay and July and October for Saco Bay (Figure 14). They assessed transport success of larvae from these identified spawning grounds to nursery areas with particle tracking using the unstructured grid model FVCOM (finite volume coastal ocean model).

Deese (2005) reviewed observations of Atlantic cod spawning aggregations off the northeastern United States, synthesizing data from sources such as research surveys and fishermen's observations. Cod spawning aggregations were identified in the Gulf of Maine and on Georges Bank (Figure 15). In the inshore Gulf of Maine specifically, she identified fall and winter spawning in Cape Cod Bay, Massachusetts Bay and Ipswich Bay. Aggregations of cod that may be spawning occur along the western Maine coast and on Jeffreys Ledge (Deese 2005). Fall spawning also occurs in the inshore areas of Cape Cod down to Nantucket Shoals and winter spawning is observed in the Cox Ledge area (Deese 2005). Outside of fall and winter, major aggregations of spawning cod are observed off Cape Ann from March-April and in Ipswich Bay from May-June.

After analyzing the results of a mark and recapture study of cod in the western Gulf of Maine, Howell et al. (2008) concluded that there were two spawning groups in thirty minute square 133; a winter group that spawns from November to January and a spring group that spawns from April to July. A total of 27,772 cod were tagged and 1334 were recaptured with sufficiently detailed recapture location for analysis. They observed that the general pattern was a concentration of large cod in the area in both the spring and winter, with dispersion from that area in the ensuing months.

Siceloff and Howell (2012) identified the "Whaleback" feature (Figure 16) as a location where spawning cod aggregate, at depths > 40m, based on a tagging study in Ipswich Bay. The tagged spawning cod aggregated in small, concentrated groups around specific humps and ridges. The spawning areas were <60 km^2 in size with a mean size of 41 km^2. The analysis was instrumental in establishing the GOM Cod Spawning Protection Area in Northeast Multispecies Framework Adjustment 45.

In the Gulf of Maine, Cape Cod Bay, Ipswich Bay, and Massachusetts Bay were most often cited in the literature as cod spawning areas. Saco Bay and Jeffreys Ledge were identified as cod spawning locations less frequently in the reviewed literature. There were no conclusions within the literature that directly disputed the evidence that cod spawning is occurring in those areas. However, after conducting a region-wide tag and recapture study on Atlantic cod, Tallack (2008) concluded that spawning in the Gulf of Maine is occurring year-round and throughout the entire region rather than within specific areas and times.

Berlinsky (2009) and Morin (2000) identified two cod spawning complexes; a spring spawning complex in the northern Gulf of Maine and a spring/winter spawning complex in the western Gulf of Maine (Figure 17). Berlinsky's research was a partnership of commercial fisherman and scientists from UNH and NYU with the purpose of investigating stock definitions for Atlantic cod using 10 microsatellite and 6 SNP markers, while Morin used a mark and recapture method.

Berlinsky (2009) concluded that cod spawning on Georges Bank was concentrated within the northeast area, mostly in gravel substrates with complex relief levels. Lough (2010) reinforced that conclusion, having concluded that peak cod spawning on Georges Bank occurs in that same area, peaking in February and March. The northeast peak, previously identified as the location where most cod spawning takes place, was cited as "dominated by gravel with portions of sand, common boulder areas and tightly packed pebbles. The Colton et al. (1979) analysis also noted that cod spawning occurred on Nantucket Shoals from January-April (peaking in January). Literature on cod spawning in Georges Bank was scarcer than for the Gulf of Maine and the conclusions drawn from the available literature cited indicate larger and less specific spawning areas. While not directly disputing the conclusions of other authors, Tallack's 2008 analysis indicates that spawning is very protracted and occuring throughout all of Southern New England, as well.

Overall, 90% of spawning occurs from mid-November to mid-May with a peak in late winter and early spring (60% between February 23 and April 6, MARMAP data, 1978-1987). On Georges Bank, spawning peaks in February and March (GLOBEC data, 1995-1999). Spawning periods are shifted later in the Gulf of Maine.

Copepods of various species are important prey for larvae and pelagic juveniles. After settlement, cod switch to benthic prey items. Juveniles consume mainly crustaceans, while adults eat mostly fish, and also crabs and squid. Herring and silver hake are common in the diet of adult cod.

The Atlantic cod is managed as two stocks in U.S. waters, Gulf of Maine and Georges Bank and further south (Map 55). The Gulf of Maine stock was last assessed at the 55rd Stock Assessment Workshop in December 2012 (NEFSC 2013). The workshop reached the same conclusion as the 23rd Stock Assesment Workshop, that Gulf of Maine cod are overfished and overfishing is occurring. Two models using data from 1982 forward but with different natural mortality assumptions were put forward for management consideration. The $M_{0.2}$ model assumes a constant natural mortality of M=0.2 over time, while the M_{Ramp} model assumes a higher natural mortality rate of M=0.4 between 2003 and 2011, with a ramping up period from 0.2 to 0.4 between 1989 and 2002. The assessment updated approaches for use of fishery data, including revised discard mortality rates from 100% to a range of 20-80%, depending on gear and fishery.

Recruitment of Gulf of Maine cod has varied between 1.17 to 27.95 million fish during 1982 to 2010 (Figure 18). SSB varied between 6,268 and 22,036 mt. Compared to the 1980s and early 1990s, recent SSB and recruitment have been low. Recruitement for the 2008-2010 year classes was 65% below the time series average while SSB was only 1% below average.

The Georges Bank assessment model was also reviewed at the 55th Stock Assessment Workshop (NEFSC 2013). The stock was determined to be overfished with overfishing occurring using a bias corrected assessment model with a natural mortality rate of M=0.2, although uncertainty remains about whether natural mortality in the stock has changed. Cod on eastern Georges Bank are assessed by the Transboundary Resource Assessment Committee, or TRAC, which is a joint effort between U.S. and Canadian scientists and managers. Similar to GOM cod, the TRAC relied on two models with differing natural mortality assumptions, but as of the 2012 Status Report, either approach indicates a status of overfished with overfishing occurring relative to reference points. Recruitment and weights at age have both been low in recent years relative to historical observations.

Similar to the recruitment trend for Gulf of Maine cod, recent recruitment and SSB were low compared to 1978 to 1990 (Figure 19). Recruitment of Georges Bank cod ranged from 1.26 and

47.15 million fish during 1978 to 2010, while SSB declined from as high as 44,386 mt in 1980 to 1,526 mt in 2004. The 2008-2010 year classes were 40% below the time series mean while 2008-2010 SSB was 64% below average.

Figure 13 – Cod spawning areas. Circled areas indicate former spawning grounds that are no longer active. Ames, 2004.

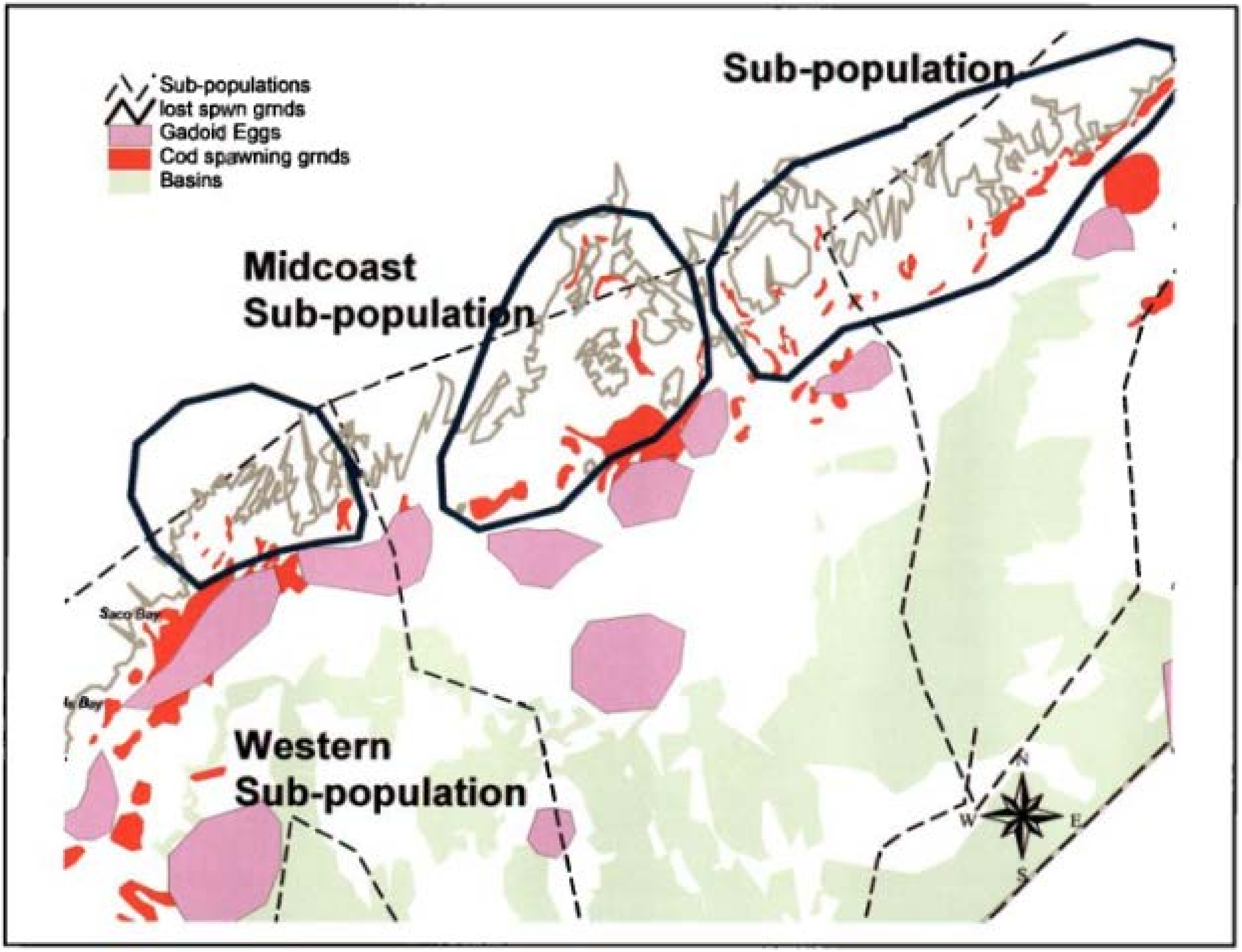


Figure 14 – Locations of 3 identified cod spawning grounds. 1 - Saco Bay. 2 - Ipswich Bay. 3 - Cape Cod Bay. Source: Huret et al. 2007.

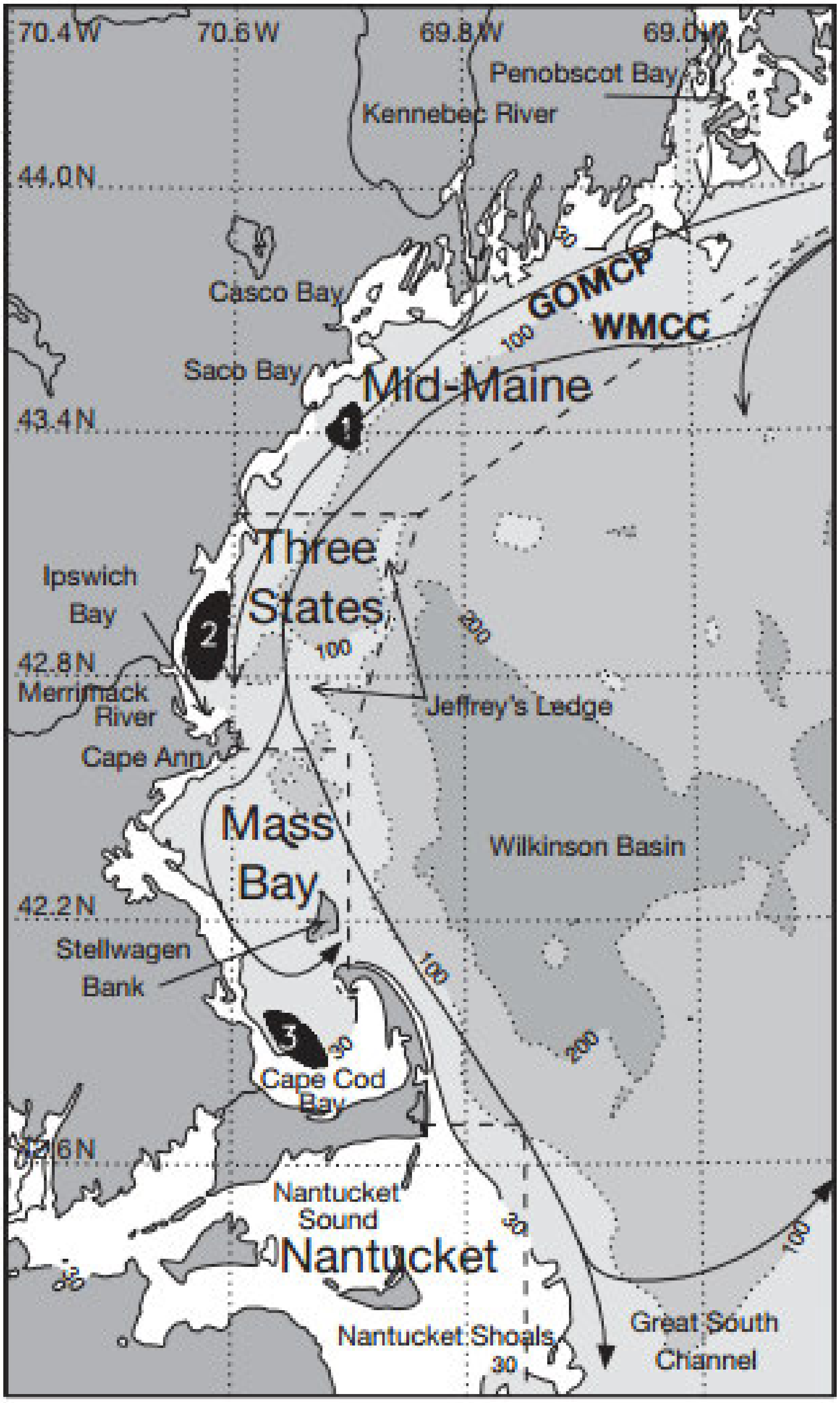


Figure 15 – Summary of cod spawning areas. Source: Deese 2005.

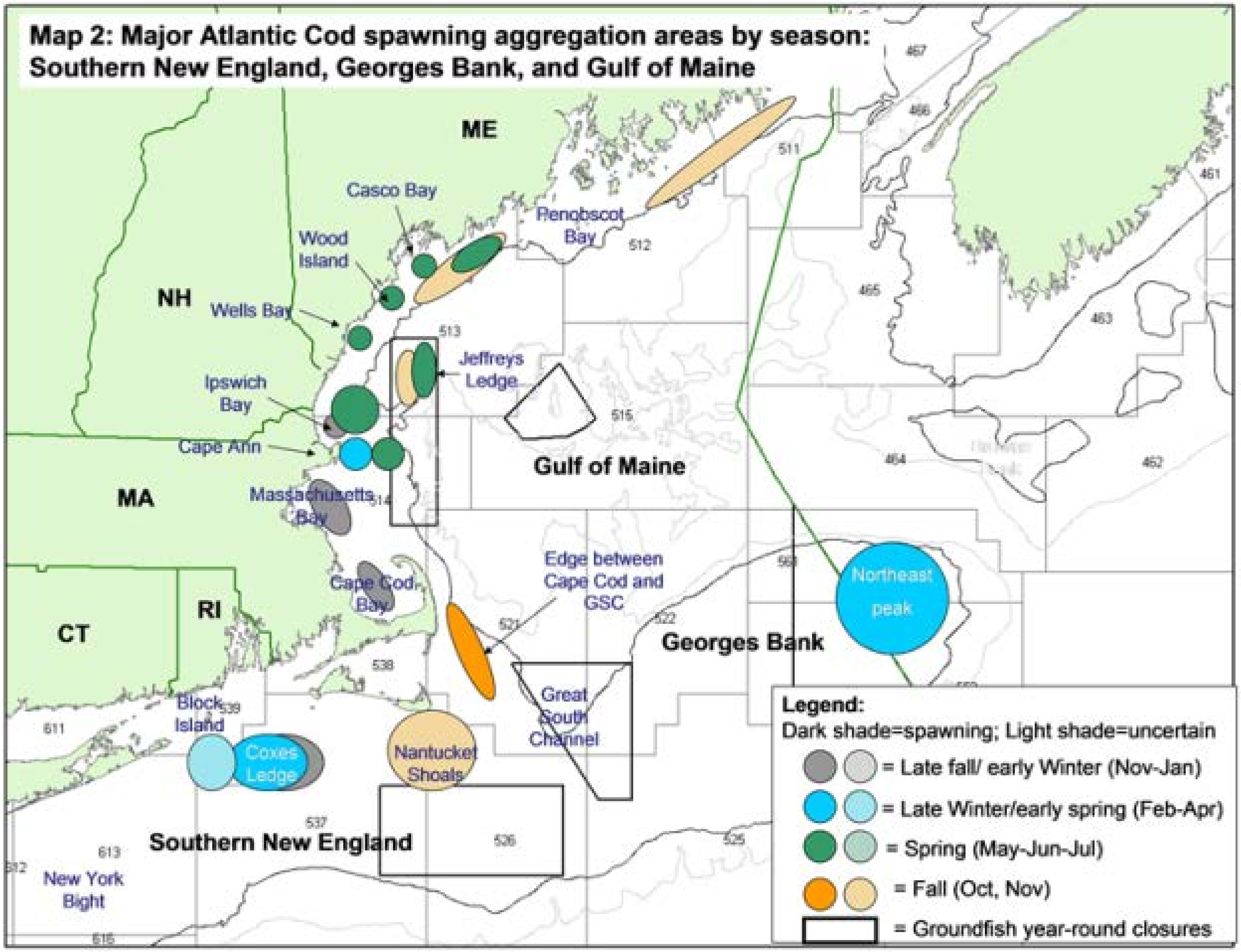


Figure 16 – Bathymetic map of Ipswich Bay. Black dotted rectangle highlights the elevated bathymetric feature "Whaleback". Source: Siceloff and Howell 2012.

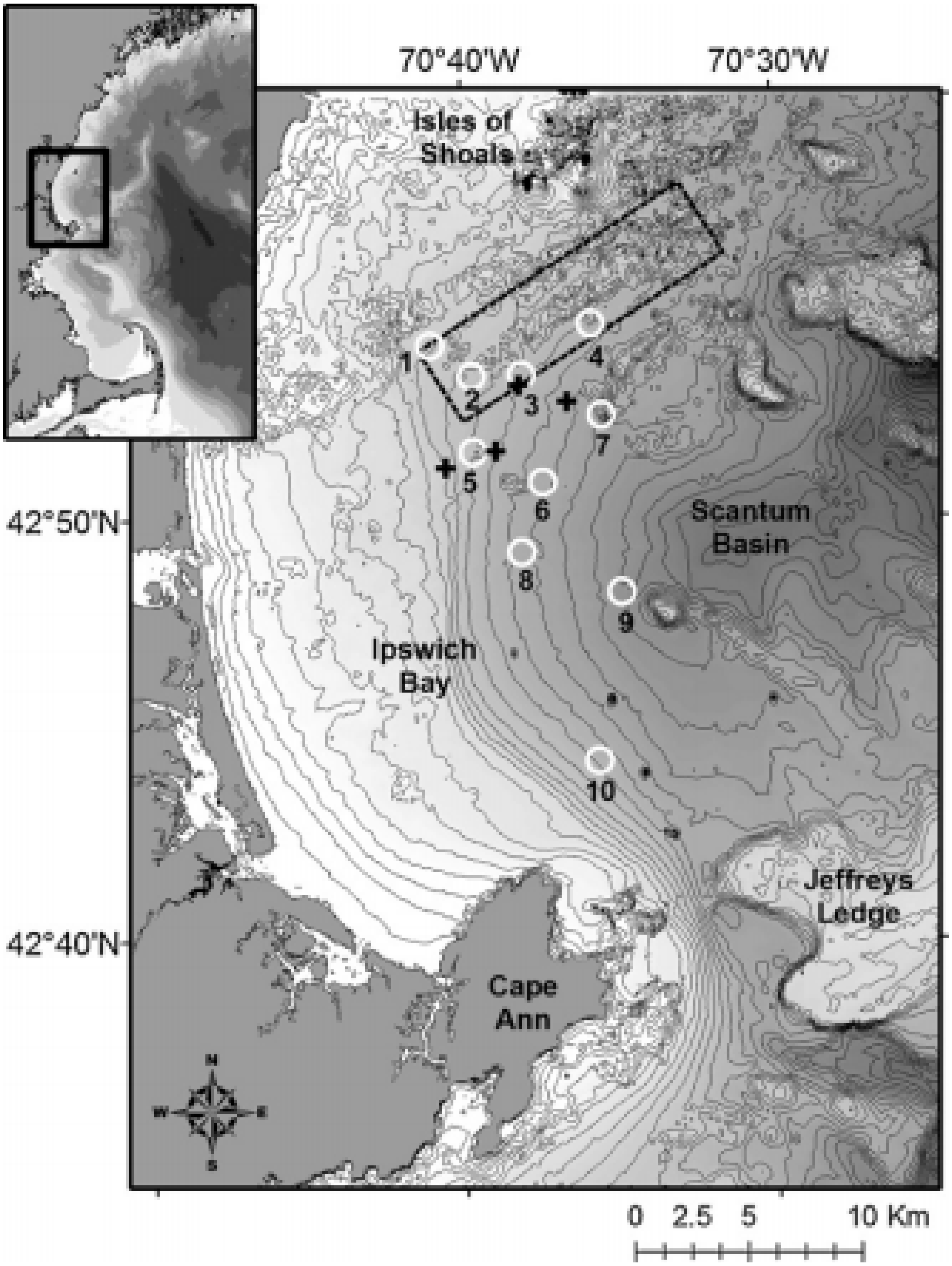


Figure 17 – Proposed cod spawning complexes. Source: Berlinsky 2009.

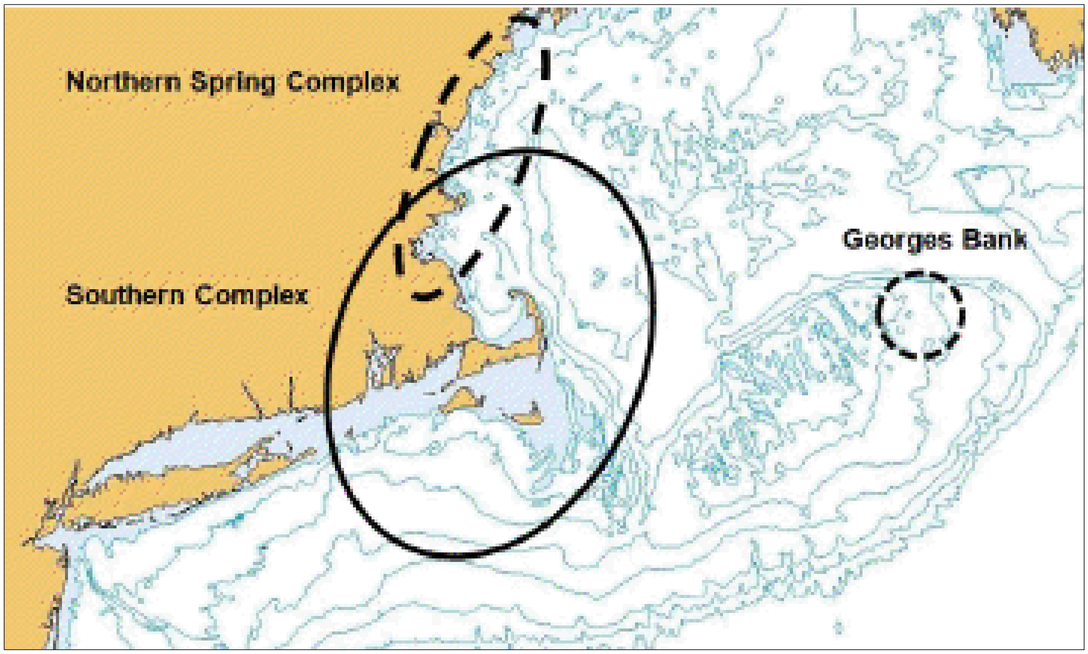


Figure 18 – Recruitment and spawning stock biomass estimates for Gulf of Maine cod (NEFSC 2013b)

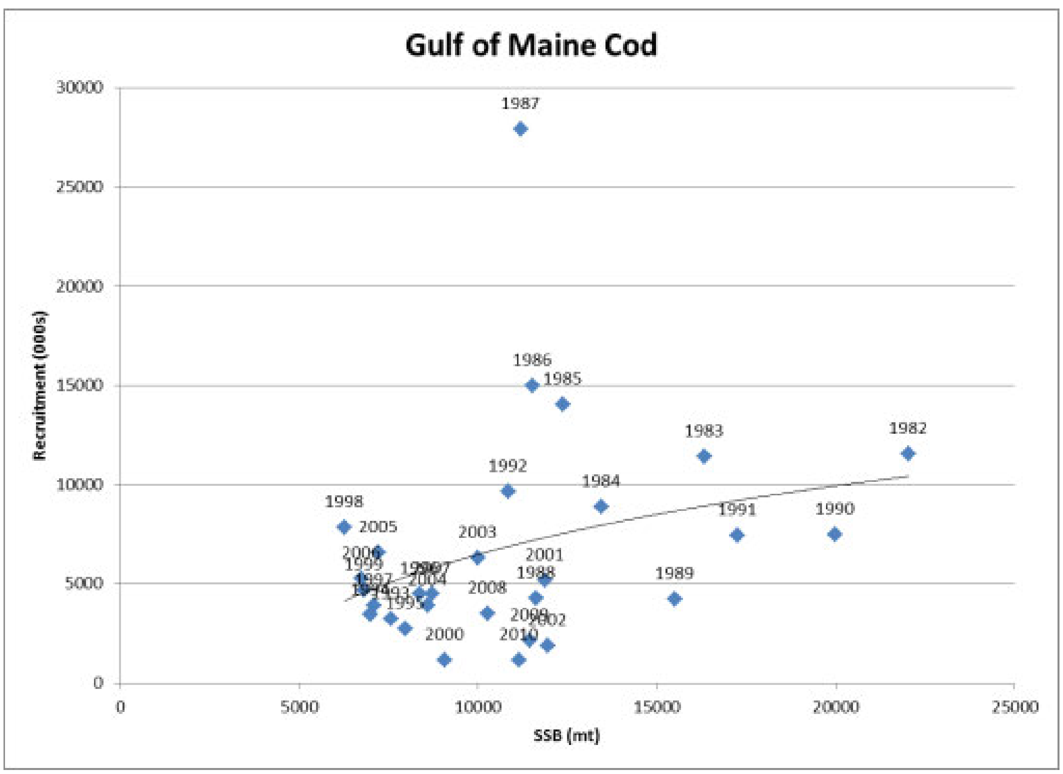
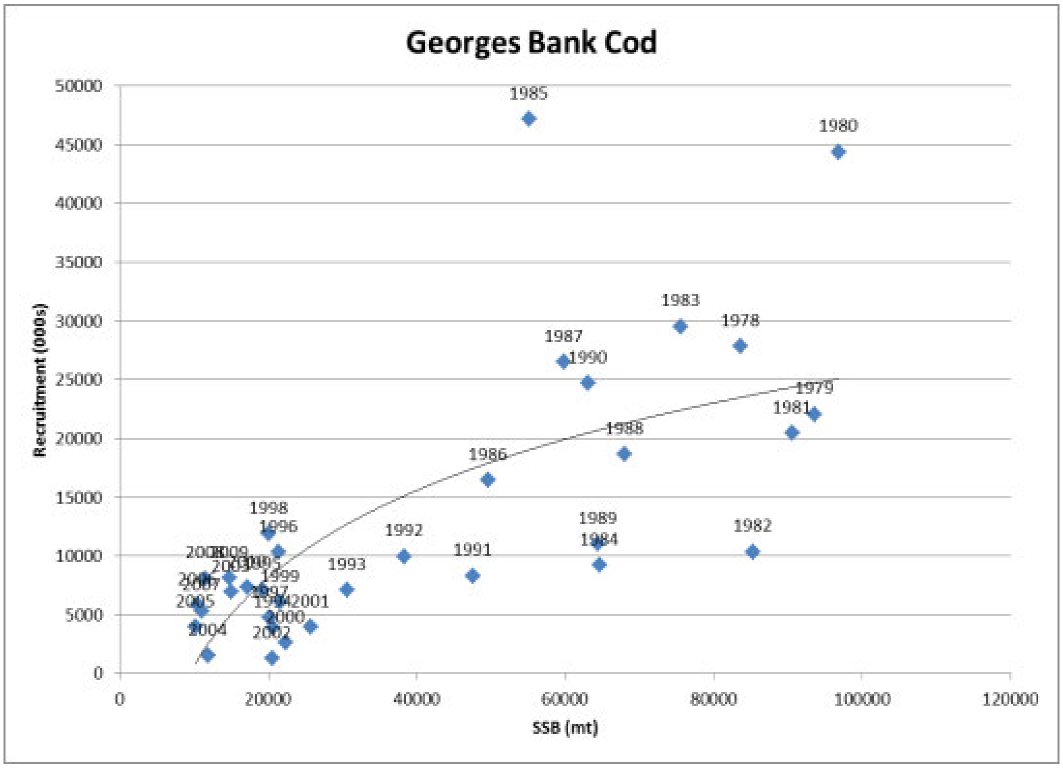
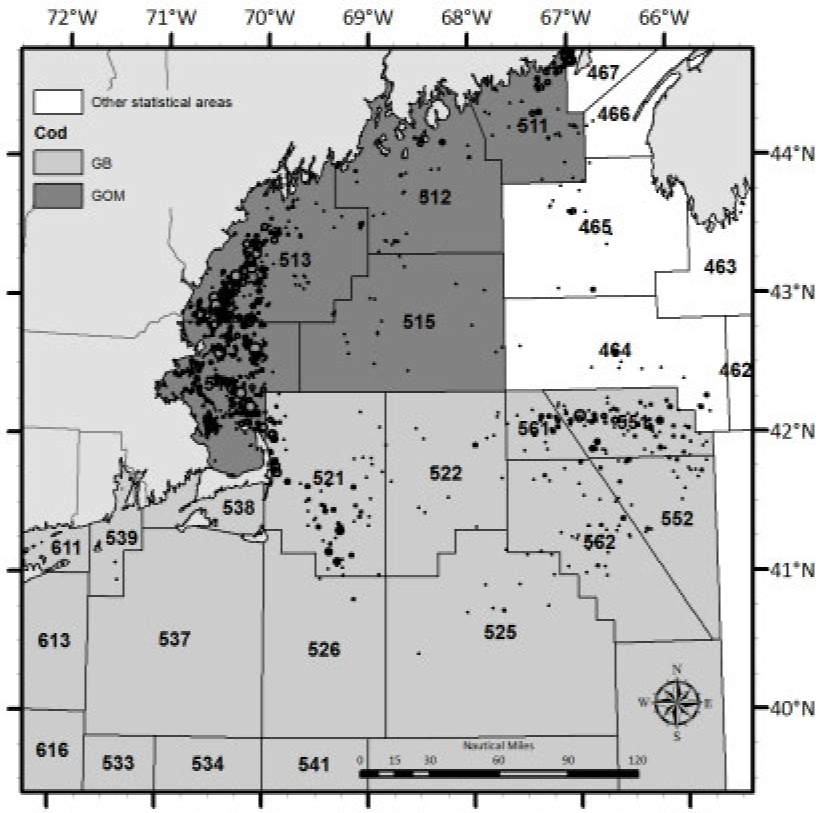


Figure 19 – Recruitment and spawning stock biomass estimates for Georges Bank cod (NEFSC 2013b)

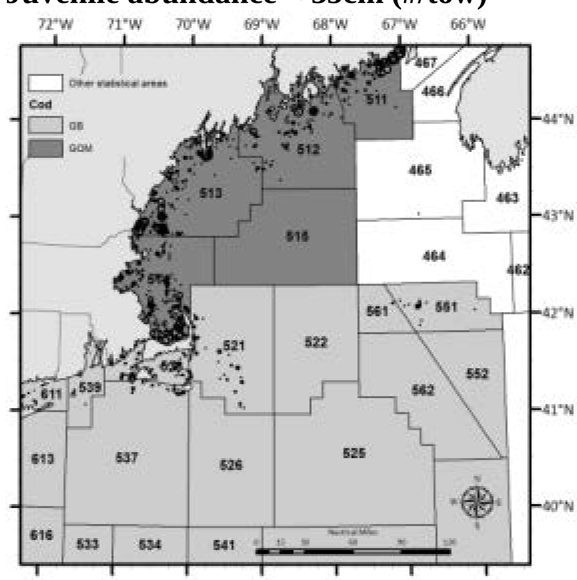


Map 55 – Atlantic cod stock boundaries and catch/tow from spring and fall NEFSC, MADMF, and ME/NH surveys, 2002-2013. Spring survey values shaded grey may obscure fall survey values shaded black. Small juvenile and large spawner size thresholds correspond to sizes used in the hotspot analysis (Section 0) to help identify critical juvenile groundfish habitat and spawning areas.

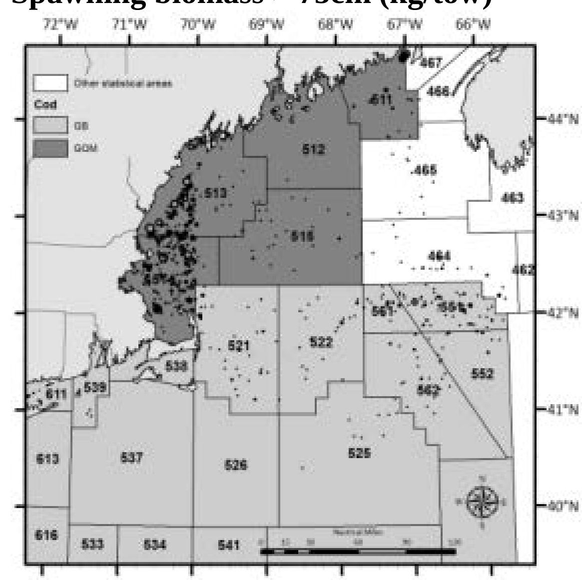
Total biomass (kg/tow)



Juvenile abundance < 35cm (#/tow)



Spawning biomass > 75cm (kg/tow)



4.3.1.1.4 Atlantic halibut

Atlantic halibut (*Hippoglossus hippoglossus*) is a long-lived benthic flatfish found in moderate depths in the Gulf of Maine and on Georges Bank. The greatest concentrations in the NEFSC fall and spring surveys are found along the eastern Maine coast and on the Scotian Shelf. They are the largest flatfish found in the region: length at maturity is 103 cm for females and 82 cm for males.

Some distributional metrics have shifted over time. Between 1968 and 2007, halibut have experienced a poleward shift in their distribution, and increase in minimum latitude, and an increase in mean depth, however there were no significant trends in area occupied, maximum latitude, or mean temperature (Nye et al 2009).

There is little information available on their habitat associations. Adults are found over sand, gravel or clay substrates, but not on soft mud or rock bottom (Klein-MacPhee 2002).

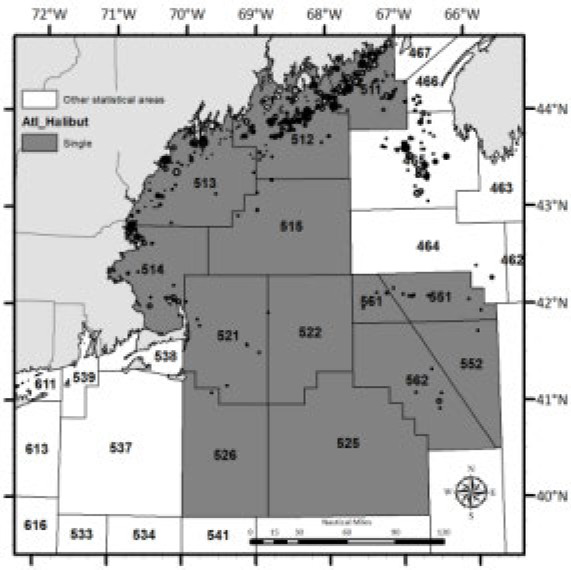
Spawning in the western Atlantic is believed to occur on the slopes of the continental shelf and on the offshore banks (McCracken 1958; Nickerson 1978; Neilson et al. 1993), at depths of at least 183 m (Scott and Scott 1988), over rough or rocky bottom (Collins 1887). Juvenile Atlantic halibut nursery grounds are in water of 20-60 m in coastal areas with sandy bottoms (Haug 1990, Miller et al. 1991). There is no present day spawning population in the Gulf of Maine (Klein-MacPhee 2002). Much of what we know about the habitat and spawning preferences of Atlantic halibut comes from other regions. Immature fish typically occurred on the southwestern Scotian Shelf, supporting the view that this area is an important rearing area for immature halibut (Neilson et al. 1993). Stobo et al. (1988) hypothesized that the area around Sable Island Gully on the Scotian Shelf may serve as a nursery area for juveniles before they begin to disperse. In Norwegian coastal waters, halibut spawning has been reported over soft clay or mud bottom, in deepwater (300-700 m) locations (Haug 1990).

Most of what we know about the food habits of halibut comes from smaller sized individuals. Dominant prey items include fish such as sculpin, cod, and silver hake, shrimp, and crabs, with the composition of their diet shifting with age.

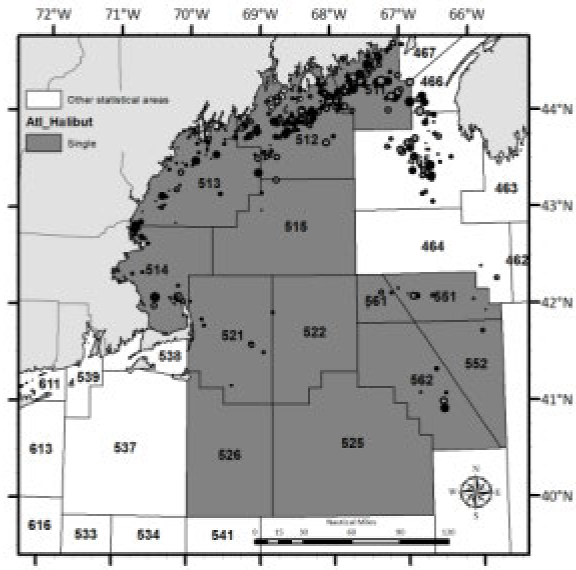
Halibut once supported a substantial fishery, but the stock is currently depleted and landings are restricted. They are managed as a single Gulf of Maine/Georges Bank stock. The 2012 assessment update indicated that the stock is overfished, and is currently at less than 10% of the target biomass. However, overfishing is not occurring; directed fishing is limited to Maine state waters, and exploitation rates are very low. There appears to be a slight increase in the stock biomass and a slight decrease in fishing mortality as compared to the Groundfish Assessment Review Meeting III (2008).

Map 56 – Atlantic halibut stock boundary and catch/tow from spring and fall NEFSC, MADMF, and ME/NH surveys, 2002-2013. Spring survey values shaded grey may obscure fall survey values shaded black.

Total abundance (#/tow)



Total biomass (kg/tow)



4.3.1.1.5 Atlantic wolffish

Atlantic wolffish (*Anarichus lupus*) was added to the Northeast Multispecies FMP via Amendment 16 (2009). Currently, the stock is overfished, but overfishing is not occurring (2012 Groundfish Assessment Update). There appears to be a moderately positive relationship between Atlantic wolffish recruitment and SSB (Figure 20). The strong 1972 year class of 1.6 million fish occurred when SSB was 4,100 mt. Most of the high SSB and recruitment occurred during the 1970s and 1980s, while SSB and recruitment in the last decade has been among the lowest in the assessment time series. Stock recruitment appears to have increased between 2005-2012, while spawning biomass declined. During 2008 to 2010, recruitment was 16 percent below average, while SSB was 80 percent below the time series mean.

Atlantic wolffish was recently proposed for listed under the Endangered Species Act. Ultimately it was not listed, but the 2009 Status Review document (AWBRT 2009) and the most recent stock assessment (NEFSC 2009) provide a comprehensive overview of what is known about the species distribution, spawning, habitat associations, etc.

Atlantic wolffish range as far north as Davis Strait, south regularly to Cape Cod, less often west along southern New England, and exceptionally to New Jersey (Rountree 2002). West of the Scotian shelf, their abundance is highest in the southwestern Gulf of Maine from Jeffreys Ledge to the Great South Channel. They are also abundant on the northeast peak of Georges Bank, and on Browns Bank. Smaller concentrations appear off southwestern Nova Scotia and throughout the central Gulf of Maine (Map 57).

Wolffish is a benthic, cold-water species that changes its depth distribution seasonally to maintain a narrow temperature range (see Kulka et al. 2004, Keats et al. 1985, Scott 1982, Nelson and Ross 1992 for information about their distribution in different regions and season). Distribution by depth was evaluated in the status review document. Recreational catches of wolffish in the party and charter data are greatest in the southwestern Gulf of Maine and in the Great South Channel, as well as in shallower water (<100 m) north of Closed Area I, on the northern edge of Georges Bank, and on Nantucket Shoals.

Rocky, nearshore habitats are plentiful in the Gulf of Maine and appear to provide critical spawning habitat for Atlantic wolffish. Auster and Lindholm (2005) analyzed data collected during submersible (July 1999) and ROV surveys (May-September 1993-2003) of deep boulder reefs in the Stellwagen Bank National Marine Sanctuary at depths of 50-100 meters. Nineteen single and paired Atlantic wolffish were observed in 110 hours of observation. All used crevices under and between boulders on deep boulder reefs. Shell debris from bivalves and crustaceans was scattered at crevice entrances, evidence of "central place foraging activities."

Based on the depth distribution information from the NEFSC trawl surveys in the Gulf of Maine region, the adults move into slightly shallower water in the spring where they have been observed with and without egg masses inhabiting shelters in deep boulder reefs in depths between 50 and 100 meters. Once they have finished guarding the eggs and resume feeding, adults move into deeper water where they have been collected over a variety of bottom types (sand and gravel, but not mud). Juvenile wolffish are found in a much wider variety of bottom habitats.

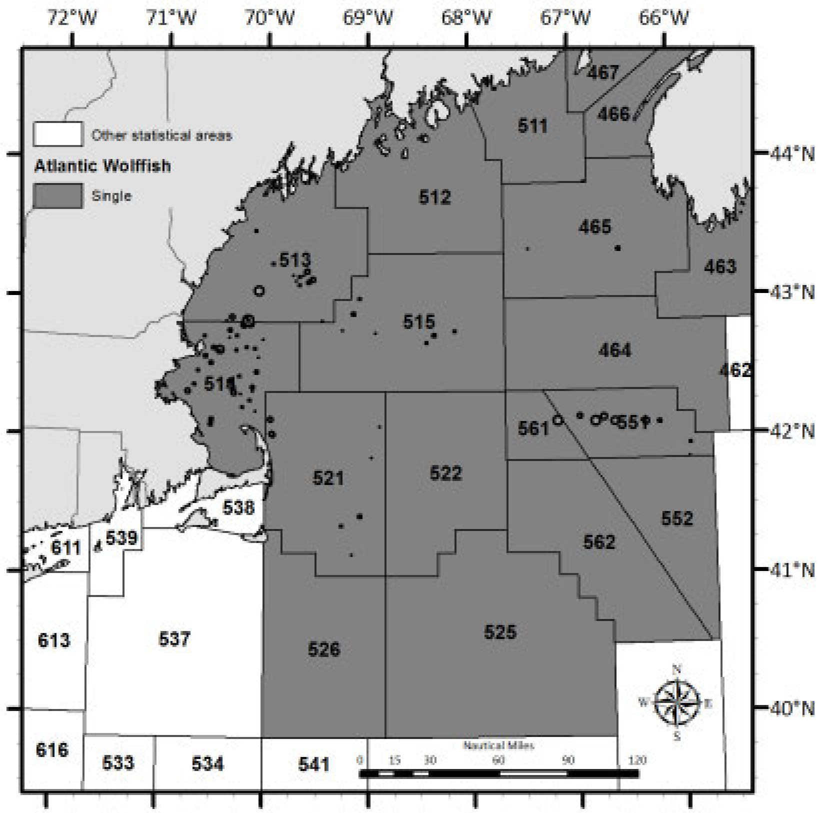
Similar associations with nearshore rocky spawning habitats have been observed in the Gulf of St. Lawrence and Newfoundland. However, the collection of "aggregations" of Atlantic wolffish eggs in bottom trawls fishing in 130 meters of water on LeHave Bank (Scotian Shelf) in March 1966 (Powles 1967; Templeman 1986) indicates that spawning is not restricted to nearshore habitats, and may not be restricted to rocky habitats.

It should be noted that trawl gear is not very suitable for catching wolffish in rocky habitats. Attempts to relate catches of Atlantic wolffish in bottom trawl surveys to substrate types are of limited value and somewhat contradictory, but the data indicate that the juveniles do not have strong habitat preferences, and that adults are more widely distributed over a variety of bottom types once they leave their rocky spawning grounds.

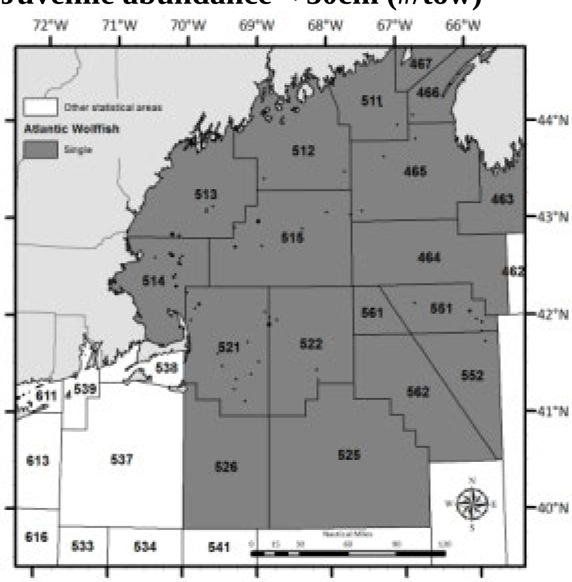
Wolffish feed almost exclusively on hard-shelled benthic invertebrates including mollusks, crustaceans, and echinoderms.

Map 57 – Atlantic wolffish stock boundary and catch/tow from spring and fall NEFSC, MADMF, and ME/NH surveys, 2002-2013. Spring survey values shaded grey may obscure fall survey values shaded black. Small juvenile and large spawner size thresholds correspond to sizes used in the hotspot analysis (Section 0) to help identify critical juvenile habitat and spawning areas.

Total biomass (kg/tow)



Juvenile abundance < 50cm (#/tow)



Spawner biomass > 45cm (kg/tow)

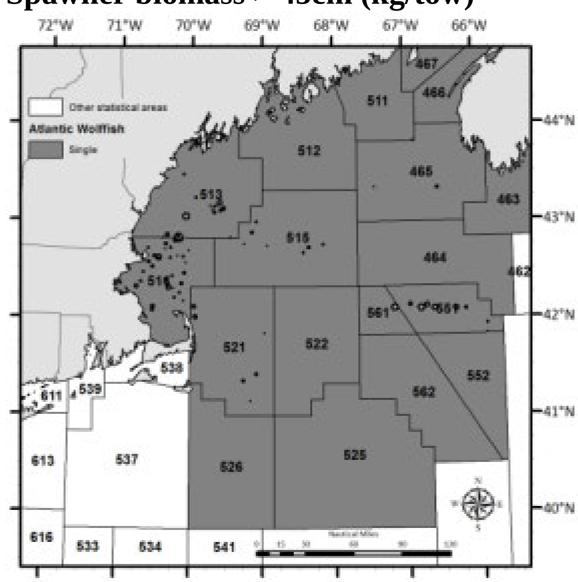
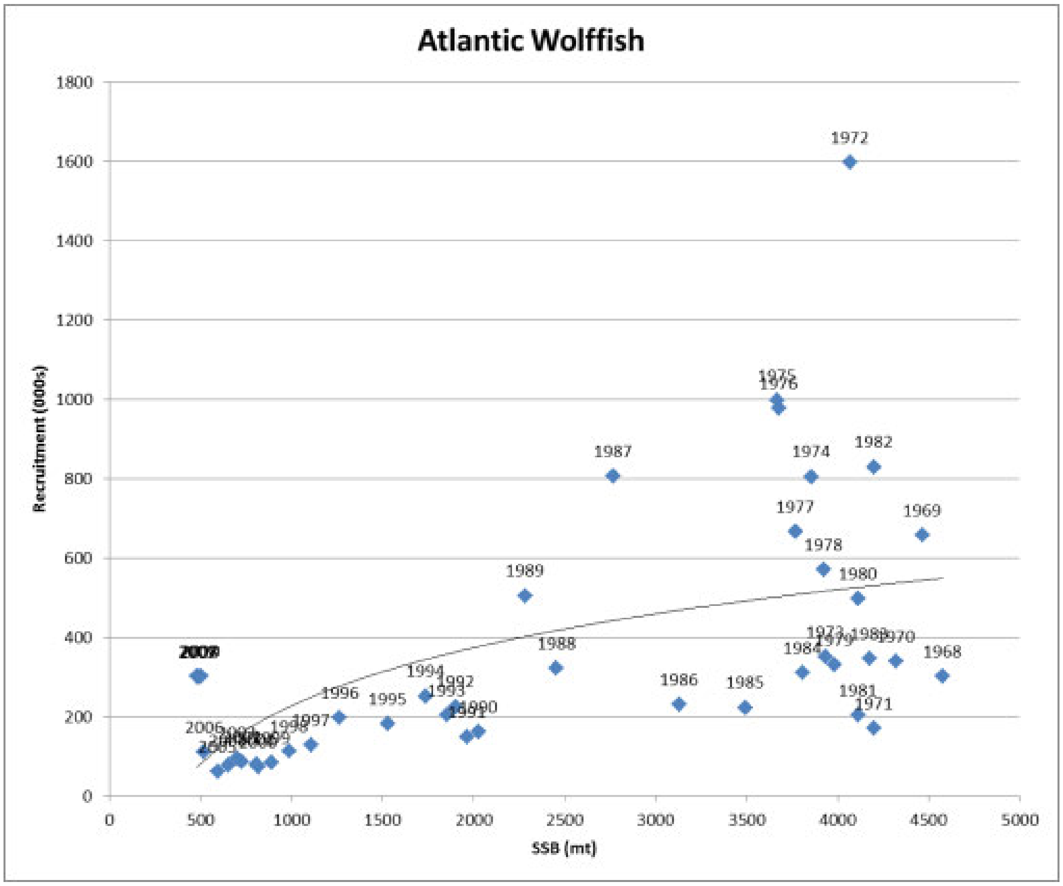


Figure 20 – Recruitment and spawning stock biomass estimates for Atlantic wolffish (NEFSC 2012a)



4.3.1.1.6 Haddock

Haddock (*Melanogrammus aeglefinus*) are found in relatively shallow inshore waters in the Gulf of Maine and in moderate depths on Georges Bank. In the NEFSC trawl survey, catch rates for juveniles and adults are high on the northeast peak of Georges Bank, in the Great South Channel and in Closed Areas I and II, and in the southwestern Gulf of Maine (Brodziak 2005). Juveniles are found in slightly deeper waters in spring, while adults are found in slightly deeper waters in the fall (juveniles, 60-140 m spring, 40-120 fall; adults 50-140 spring, 60-160 fall). The seasonal migration pattern for haddock is very similar to cod: they occupy deeper water in the fall in order to remain in the same temperature range year round (Methratta and Link 2006).

Haddock prefer gravel, pebbles, clay, broken shells, and smooth hard sand, particularly smooth areas between rocky patches (Klein-MacPhee 2002). These habitat types are common on Georges Bank, and less prevalent in the Gulf of Maine, which helps explain the increased abundance of haddock on Georges Bank (Brodziak 2005). In the southwestern Gulf of Maine, haddock catches were positively correlated with bottom reflectance (Auster et al. 2001). In the same area, Auster and Lindholm (2005) observed station-keeping adjacent to partially buried boulders as well as near boulders and cobbles with large globular sponges along the margins of deep boulder reefs. They considered haddock to be transient visitors to these reefs, and noted that bottom structure provides a refuge from flow.

Haddock do not frequent ledges, rocks, kelp, or soft oozy mud. Catch rates in the NEFSC bottom trawl survey are much higher in coarser substrates (coarse rock, fine rock, coarse sand (Methratta and Link 2006). They are generally less selective for bottom type than cod, but feed on benthic prey more so than cod and are thus more closely associated with the seabed.

Like cod, young of the year haddock settle on a variety of sediment types on eastern Georges Bank, but by August they are found primarily on gravel pavement areas (Lough et al. 1989, Valentine and Lough 1991). Young of the year haddock do not inhabit shallow (<10 m) inshore areas in the Gulf of Maine (Lazzari and Stone 2006).

Major spawning areas are those with suitable substrates. The most important location is the northeast peak of Georges Bank (Colton and Temple 1961; Lough and Bolz 1989). Other locations include Nantucket Shoals (Smith and Morse 1985), along the Great South Channel (Colton and Temple 1961), and Stellwagen Bank and Jeffreys Ledge in the Gulf of Maine (Colton 1972). Retention of larval haddock in the clockwise gyre around Georges Bank is important in determining year class strength; this retention is in turn influenced by interannual variation in oceanographic patterns (Brodziak 2005 and references therein). Although there is limited information on retention of larval haddock in the Gulf of Maine, Ames (1997) suggests that haddock eggs and larvae in coastal Gulf of Maine waters may be retained in suitable habitats by tidal currents. The timing of spawing on Georges Bank ranges from January to June, with peak activity between February and early April, depending on temperature (see Smith and Morse 1985 and other source document references for details).

Overholtz (1987) analyzed the dates, location and temperature preferences of spawning Georges Bank haddock from data collected on spring bottom-trawl surveys from 1977-1983, concluding that the northeast peak of Georges Bank is the most important haddock spawning area, peaking in late March and early April at bottom temperatures from 4-7°C (Overholtz 1987). He also noted that the area to the east of the Great South Channel at depths shallower than 100 m were important spawning areas at the same peak times and bottom temperatures.

Haddock have a varied diet consisting of polychaetes, crustaceans, mollusks, echinoderms, and fish. Fish are more important for larger individuals.

Haddock are managed as two stocks: Gulf of Maine and Georges Bank. The Georges Bank stock was last evaluated during a 2012 assessment update, and the Gulf of Maine assessment was updated during July 2014, although a final report is not yet available as of August 2014. As of the 2012 assessment update, the Gulf of Maine stock is not overfished, but overfishing is occurring. The stock showed lower biomass and higher recruitment estimates as compared to 2007 (previous assessment GARM III 2008), and a higher fishing mortality rate during 2010 as compared to 2007. The Georges Bank stock is not overfished and overfishing is not occurring. This stock showed both a lower biomass estimate as compared to 2007, and a lower fishing mortality rate. Recruitment was at an all-time high during 2010. Like cod, Eastern Georges Bank haddock are also assessed by the Transboundary Resource Assessment Committee. The 2012 TRAC update had the same status determination, with the assessment summary noting positive features including expanding age structure, broad spatial distribution, and occasional exceptional year classes, but below-average fish condition since 2003.

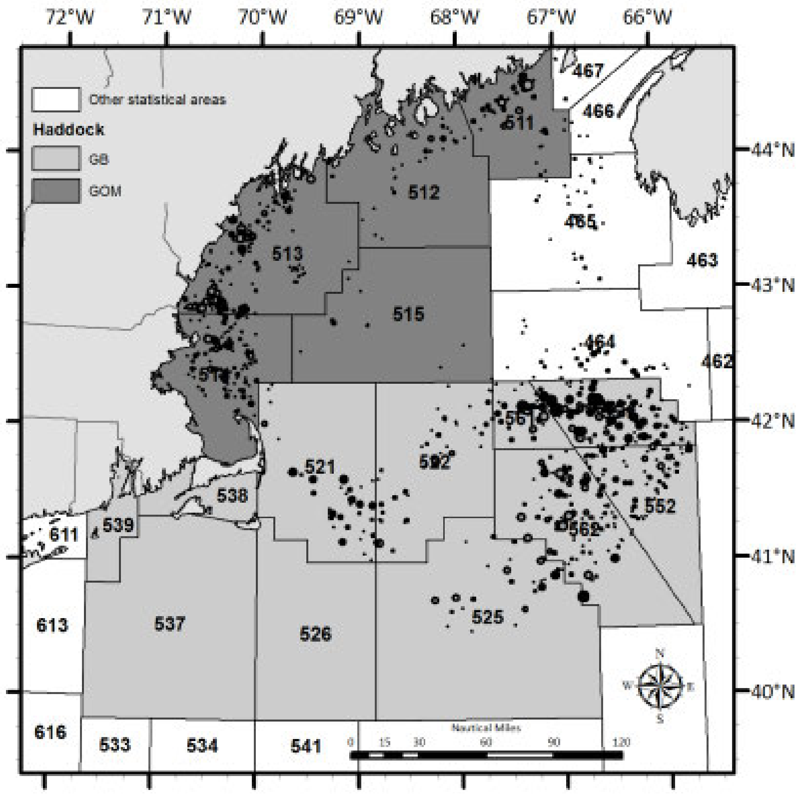
Gulf of Maine haddock recruitment has varied between 82,000 and 4 million fish during 1977 to 2010, punctuated by several strong year classes in 1978, 1979, 1980, 1998, and 2003 (Figure 21). SSB has ranged between 543 and 16757 mt. During 2008 to 2010, SSB has been 46% below the time series average while recruitment has been 67% below average. It is notable that other than the extremely strong 1998 year class, other strong year classes only occurred when SSB has been above 12,000 mt. Some people speculate that some of the Gulf of Maine haddock originate from Georges Bank, particularly when strong year classes occur there.

Recruitment of Georges Bank haddock has a similar pattern as Gulf of Maine haddock, but the time series trend is different, and the stock size is considerably larger (Figure 22). During the 1960 to 2010 time series, recruitment has ranged between 267,000 and 100 million fish, punctuated by extremely strong year classes in 1962, 1963, 2003, and 2010. The 2010 year class of 748 million fish was by far the largest on record, but its true size will be better estimated in future years as more survey and fishery data are collected. As has been noted before in stock assessments, strong Georges Bank haddock year classes are more likely when SSB is above 100,000 mt. During 2008 to 2010, SSB has averaged 206 thousand mt, or 149% above the time series average. Including the extremely strong (and uncertain) 2010 year class, 2008 to 2010 recruitment has been 390% above average.

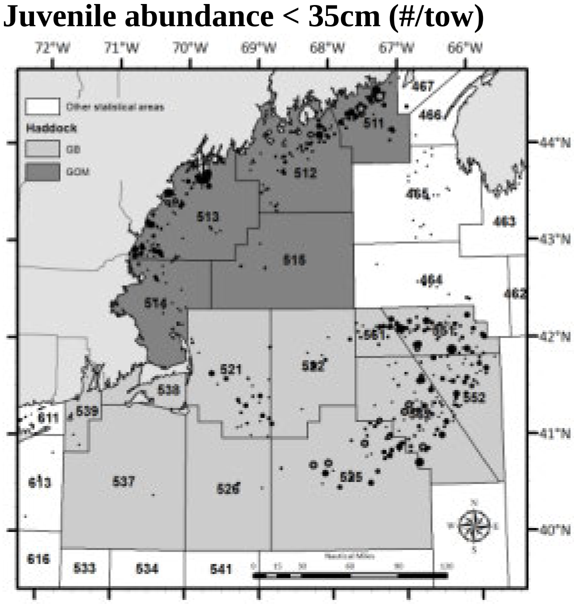
In fishing year 2014, an accountability measure was triggered for the Gulf of Maine haddock recreational fishery. This resulted in the Regional Administrator implementing more restrictive recreational management measures (i.e., bag limit, minimum size, and season) than had previously been allowed. The accountability measure is intended to ensure that the recreational haddock sub-annual catch limit is not exceeded.

Map 58 – Haddock stock boundaries and catch/tow from spring and fall NEFSC, MADMF, and ME/NH surveys, 2002-2013. Spring survey values shaded grey may obscure fall survey values shaded black. Small juvenile and large spawner size thresholds correspond to sizes used in the hotspot analysis (Section 0) to help identify critical juvenile habitat and spawning areas.

Total biomass (kg/tow)



Juvenile abundance < 35cm (#/tow)



Spawner biomass > 50cm (kg/tow)

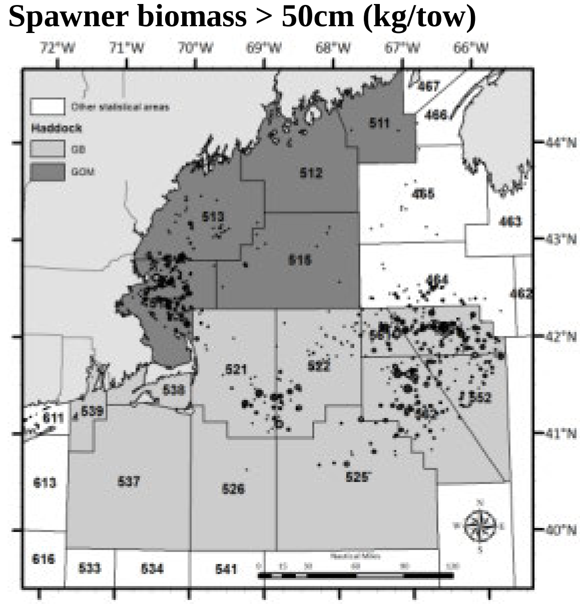


Figure 21 – Recruitment and spawning stock biomass estimates for Gulf of Maine haddock (NEFSC 2012a)

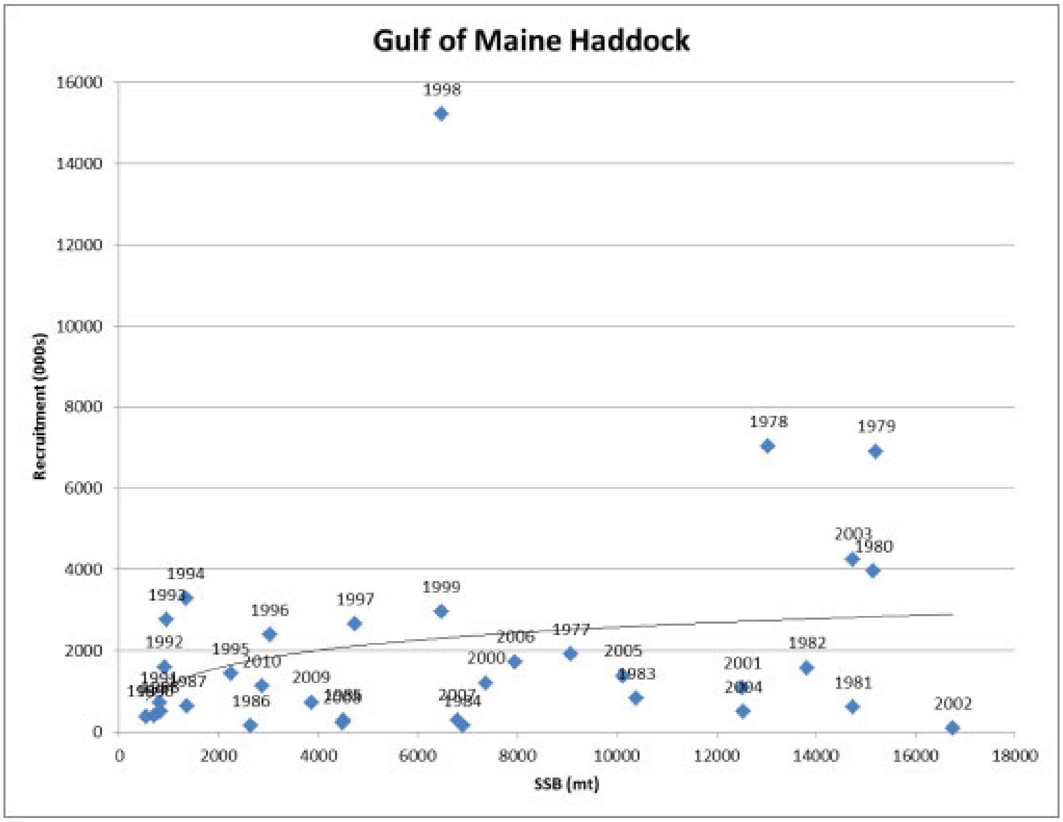
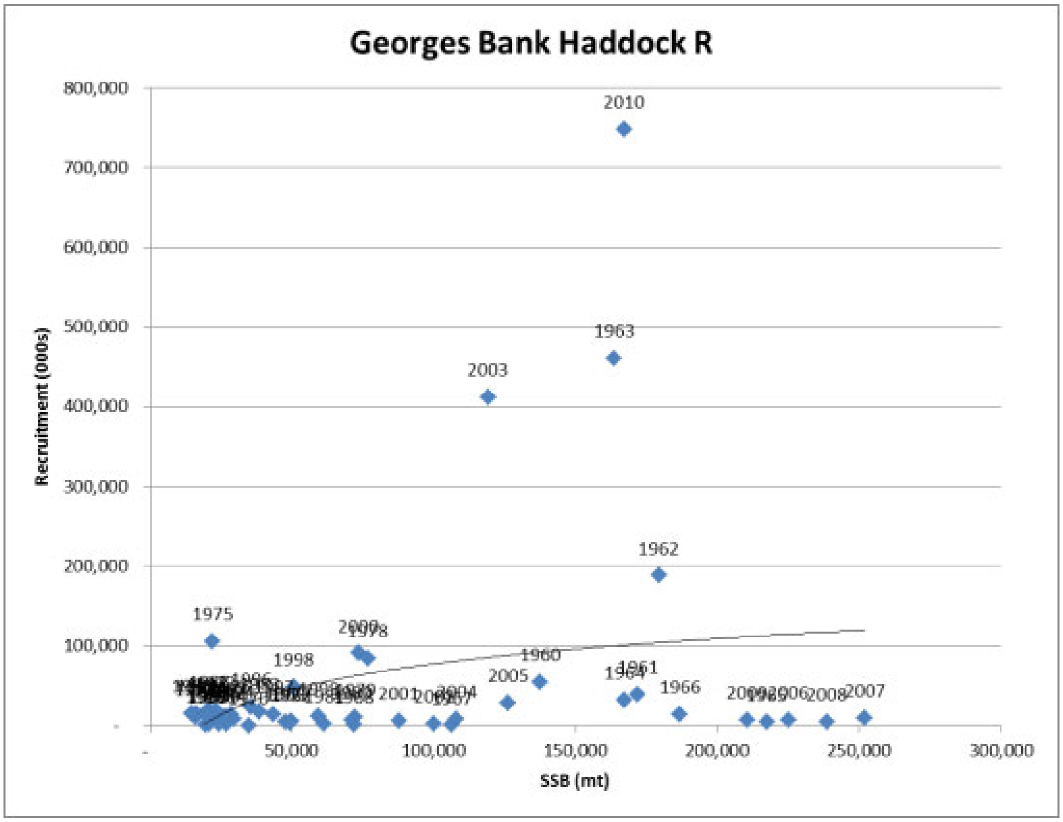


Figure 22 – Recruitment and spawning stock biomass estimates for Georges Bank haddock (NEFSC 2012a)



4.3.1.1.7 Ocean pout

In the NEFSC surveys, both juveniles and adult ocean pout (*Macrozoarces americanus*) are found in shallower, cool waters in the spring and in deeper, cool water areas during the fall (Methratta and Link 2006). Juveniles occur mostly in the New York Bight area and in the southwestern Gulf of Maine, rarely in the remainder of the Gulf of Maine or on Georges Bank. In spring, the adults are very numerous in southern New England (inner/middle shelf), northern New Jersey, southwestern Gulf of Maine, and in the Great South Channel, and they also occur on Georges Bank. In the fall, fewer adults are found in deeper water in the same areas.

Ocean pout lack a swim bladder and are therefore strict bottom-dwellers. They are not known to form schools or aggregations (Steimle et al. 1999). Habitat preference depends on location (Klein-MacPhee and Collette 2002). Juveniles are found on a wide variety of substrates, including shells, rocks, algae, soft sediments, sand, and gravel. Adults prefer sand and gravel substrate on the shelf (including shells, Southern New England, Auster et al. 1991, 1995), but are also found on muddy, sandy, and pebble and gravel bottom types in the Gulf of Maine (Bigelow and Schroeder 1953). In the NEFSC trawl survey area, the highest catch rates are on coarse sand (Methratta and Link 2006). During ROV/submersible observations on deep boulder reefs in the southwestern Gulf of Maine, ocean pout were observed singly in crevices, on the sediment surface in the open between boulders, and as pairs within crevices (Lindholm and Auster 2005). Given spawning behavior, they were classified as seasonal residents of the reefs.

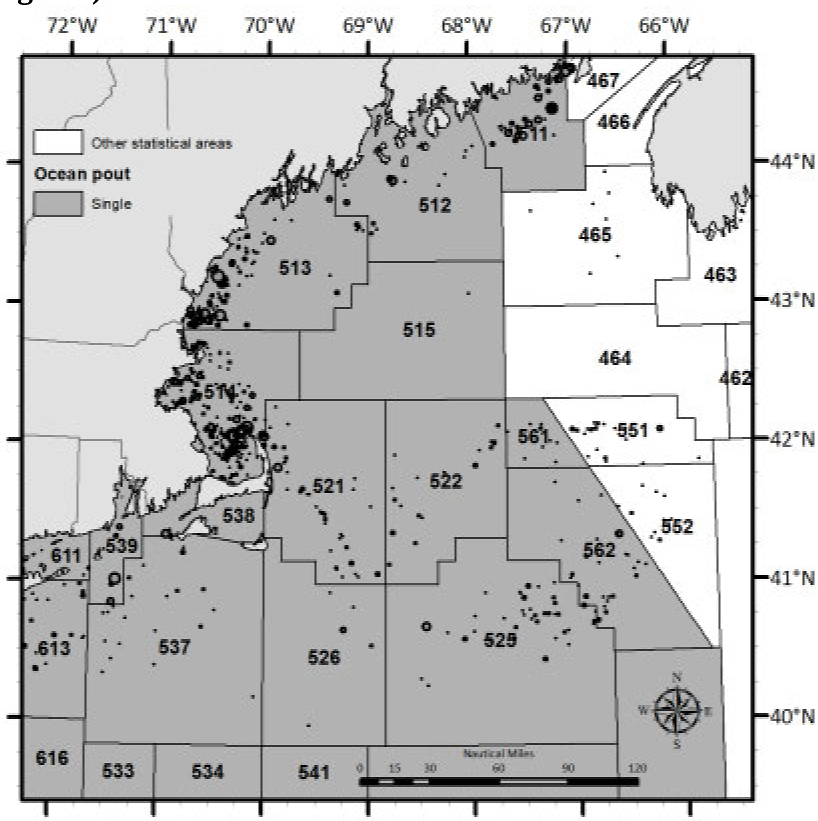
Spawning occurs in late summer through early winter, with a peak in September-October in the north and earlier peaks in the south. They spawn on hard bottom in sheltered areas in depths less than 100 meters (Keats et al. 1985). Eggs are demersal and are deposited in sheltered nests in depths <50 m (see Steimle et al. 1999); the ocean pout burrows tail first, and leaves a depression on the sediment surface (Auster et al. 1995).

Juveniles consume mostly polychaete worms, amphipod crustaceans, scallops, and brittlestars. Adults have a similar diet but also eat crabs and sand dollars.

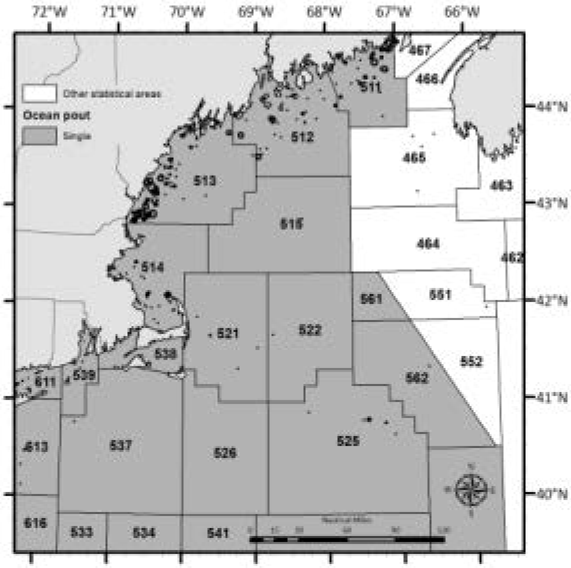
Ocean pout are managed in the Northeast Multispecies FMP. They are considered overfished, but overfishing is not currently occurring (2012 Assessment Update).

Map 59 – Ocean pout stock boundary and catch/tow from spring and fall NEFSC, MADMF, and ME/NH surveys, 2002-2013. Spring survey values shaded grey may obscure fall survey values shaded black. Small juvenile and large spawner size thresholds correspond to sizes used in the hotspot analysis (Section 0) to help identify critical juvenile habitat and spawning areas.

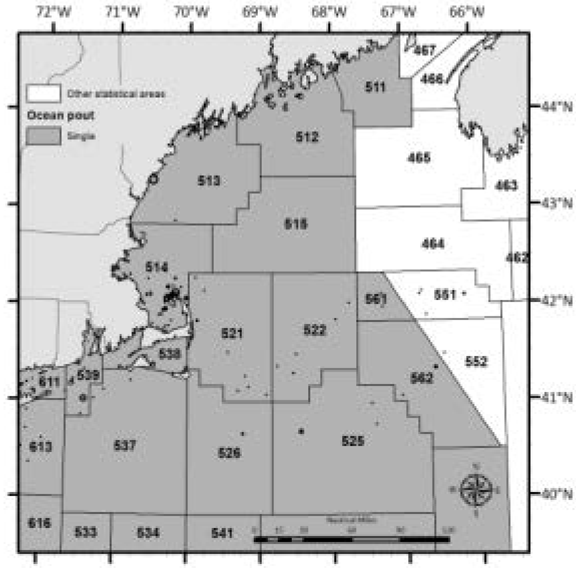
Total biomass (kg/tow)



Juvenile abundance < 30cm (#/tow)



Spawner biomass > 60cm (kg/tow)



4.3.1.1.8 Pollock

Pollock (*Pollachius virens*) are found primarily in the Gulf of Maine, and also in the deep waters of the Great South Channel and in the deeper waters off the southern edge of Georges Bank (Map 60). In the NEFSC bottom trawl survey, juveniles (<38 cm) have a shallower distribution than adults and both age groups are found in shallower waters in the spring as compared to the fall. (juveniles 40-160 m spring, 40-180 m fall; adults 90-200 m spring and 80-300 m fall). The youngest pollock use inshore subtidal and intertidal zones (Cargnelli et al. 1999, age 0+ and 1+), shallow-water habitats <10 m in the Gulf of Maine (Lazzari and Stone 2006, YOY), and shallow marsh creeks in southern New Jersey (Rountree and Able 1992, YOY).

Over the period between 1968-2007, pollock exhibited significant changes in their distribution in the spring NEFSC trawl survey, including: decrease in area occupied, decrease in maximum latitude, increase in minimum latitude, increase in mean temperature, and increase in mean depth (Nye et al. 2009).

Although YOY juveniles have been associated with rocky shallow water habitats containing macroalgae and eelgrass (Rangeley and Kramer 1995, 1998), pollock found further offshore are not strongly associated with any particular substrate type, at least according to the NEFSC trawl survey. Simlarly, Scott (1982) found that larger pollock on the Scotian shelf show little preference for bottom type. However, it should be noted that distribution and abundance information from the NEFSC bottom trawl survey is somewhat challenging to interpret because pollock are at times pelagic and schooling, which influences their catchability as compared to other fishes more closed associated with the bottom.

In the Gulf of Maine, spawning occurs between November and February (Steele 1963; Colton and Marak 1969), peaking in December (Klein-MacPhee 2002). Important locations include Massachusetts Bay, Stellwagen Bank, and coastal areas from Cape Ann to the Isles of Shoals.

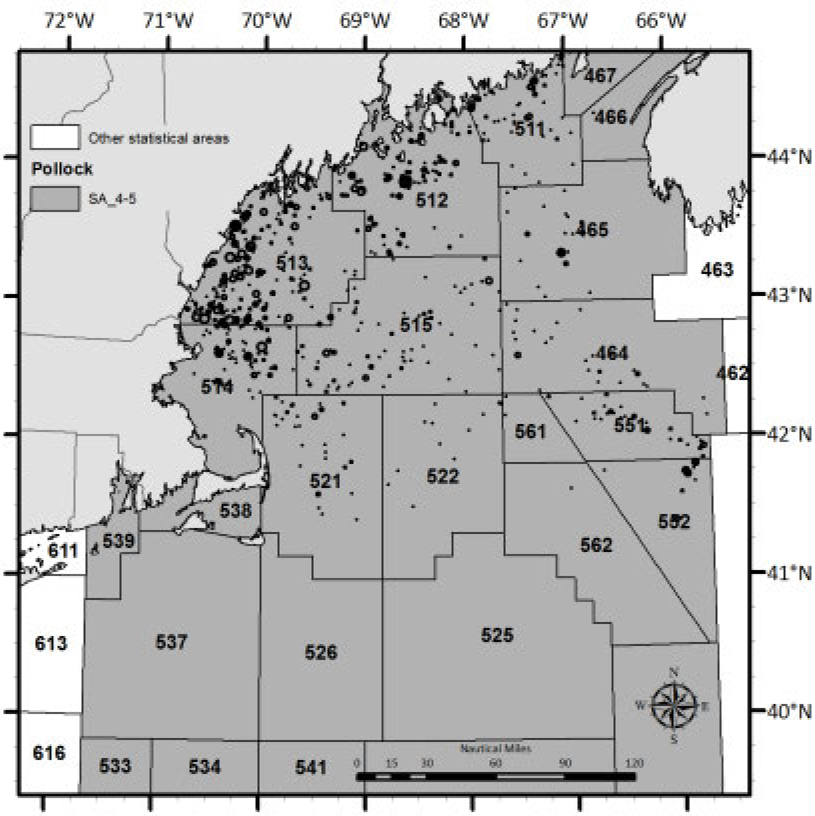
Juveniles and adults prey on pelagic species including crustaceans, especially euphausiids, mollusks and fish. Larval pollock consume copepods.

Pollock are managed as a single stock. During the 2010 assessment (NEFSC 2011), a new model that incorporates age structure, additional surveys, more comprehensive catch information, changes in selectivity, and uncertainty in the input data was used for the first time. The 2010 assessment implied that there is a large "cryptic" biomass of pollock not available to the survey or the fishery, and 2010 and later specifications were revised significantly upward as a result. The stock is not overfished and overfishing is not occurring.

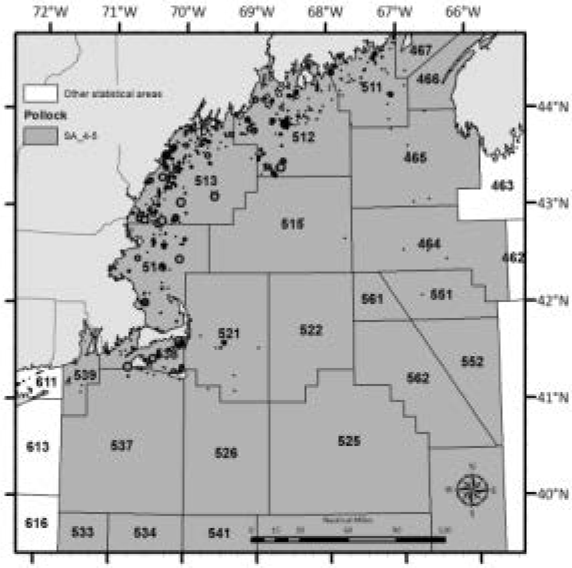
Over the range of observed SSB since 1970, pollock do not exhibit a strong relationship between recruitment and SSB, and no extraordinarily strong year classes have been observed (Figure 23). Recruitment has ranged between 7.2 and 57.5 million fish, while SSB has ranged between 1,500 and 12,500 mt. During 2006 to 2008, recruitment was nine percent below average while SSB was 30 percent above average. SSB genrally declined from 1970 to 1990 and then increased through 2008.

Map 60 – Pollock stock boundary and catch/tow from spring and fall NEFSC, MADMF, and ME/NH surveys, 2002-2013. Spring survey values shaded grey may obscure fall survey values shaded black. Small juvenile and large spawner size thresholds correspond to sizes used in the hotspot analysis (Section 0) to help identify critical juvenile habitat and spawning areas.

Total biomass (kg/tow)



Juvenile abundance < 35cm (#/tow)



Spawner biomass > 75cm (kg/tow)

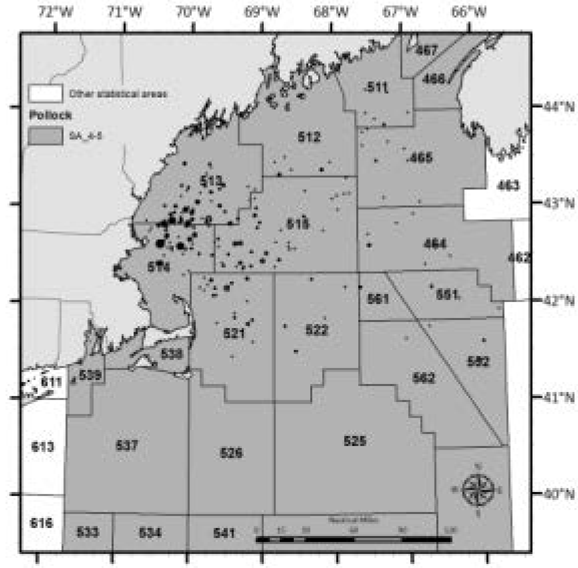
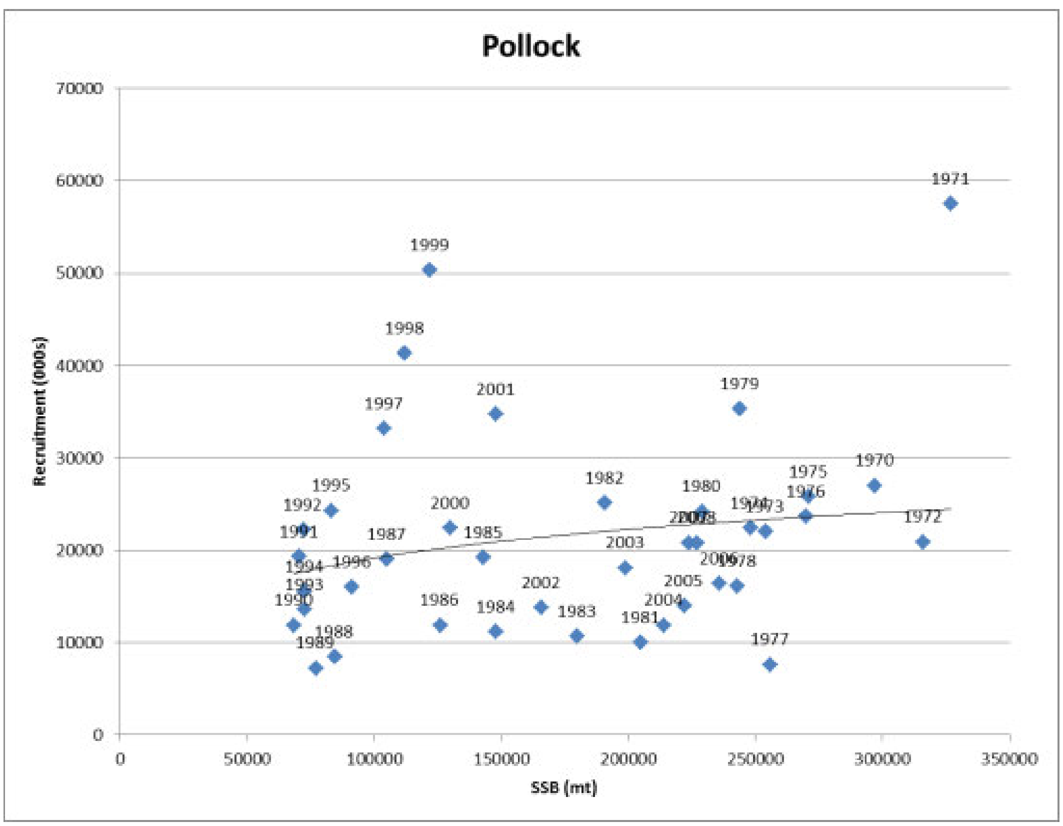


Figure 23 – Recruitment and spawning stock biomass estimates for pollock (NEFSC 2010)



4.3.1.1.9 White hake

White hake (*Urophycis tenuis*) occur predominantly in the deeper waters of the Gulf of Maine and along the edge continental shelf. The juvenile distribution extends into shallower waters in the Gulf of Maine, where they are most abundant, as well as into moderate depths over much of Georges Bank and in Southern New England. Young of the year hake are found in shallow (less than 10 m) coastal Maine waters (Lazzari and Stone 2006). In the NEFSC trawl surveys, both lifestages are found in deeper waters in the spring (juveniles 80-300 m, adults 160-400 m) than in the fall (juveniles 30-120 m, adults 100-400 m). The ME/NH survey, which occurs in inshore/nearshore Gulf of Maine waters, finds juvenile white hake at depths of 50-190 m.

Juveniles and adults occur on mud and fine sand substrates (Chang et al. 1999). Eelgrass is an important habitat for demersal juveniles (Bigelow and Schroeder 1953; Fahay and Able 1989; Heck et al. 1989). Younger fish are spatially segregated from older year classes by occupying shallow areas, but they are not tied to eelgrass, other vegetation, or structured habitats (Markle et al. 1982; Able and Fahay 1998, also see Lazzari and Stone 2006). Although white hake are adapted to a wider range of depths and temperatures, juvenile and adult white hake co-occur with adult red hake (Klein-MacPhee 2002; off Canadian maritimes, see Markle et al. 1982). They appear to have a stronger preference than red hake for fine sediments (regional analysis in Methratta and Link 2006, southwestern Gulf of Maine analysis in Auster et al 2001). In fact, sediment associations for white hake more closely resemble those of whiting.

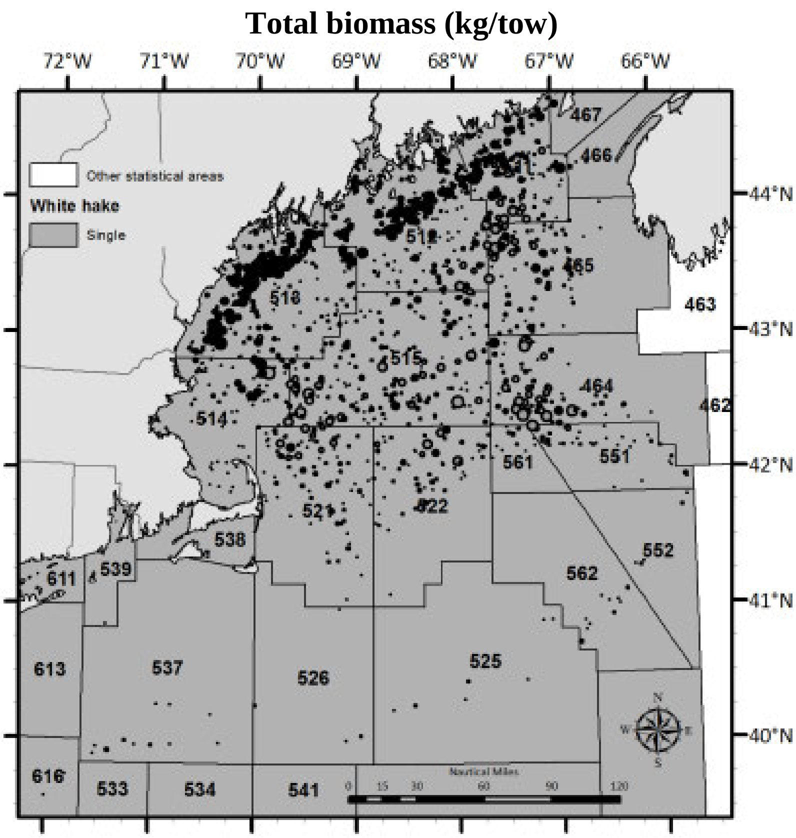
The spawning contribution of the Gulf of Maine population is negligible (Fahay and Able 1989). The timing and extent of spawning in the Georges Bank/Mid-Atlantic Bight stock has not been clearly determined. However, based on the distribution and abundance of pelagic juveniles, as well as circulation patterns throughout the region, Fahay and Able (1989) suggested that the southern stock spawns in early spring (April-May) in deep waters along the continental slope, primarily off southern Georges Bank and the Mid-Atlantic Bight (Lang et al. 1996).

Juveniles prey on polychaetes and crustaceans, while adults feed on crustaceans, mollusks, and fish. Larger adults feed almost exclusively on fish.

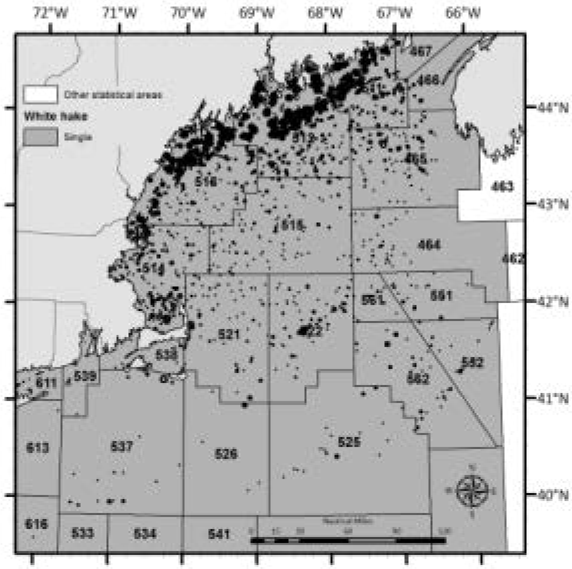
White hake are assessed as a single stock. During the 2008 Groundfish Assessment Review Meeting, 2007 fishing mortality was estimated to be above the threshold F_{msy}, and biomass estimates were below the threshold, ½ B_{msy} using an age structured production model. The stock was assessed through 2011 at the 56th Northeast Regional Stock Assessment Workshop. The June 2013 report indicated that the stock was not overfished nor was overfishing occurring. This status determination was made using a new statistical catch-at-age model (ASAP) and relative to reference points updated at the assessment. Specifically, spawning stock biomass in 2011 was estimated at 26,877 mt, above the ½ SSBMSY threshold of 16,200 mt, and 2011 fully selected fishing mortality was estimated to be 0.13, 66% of the reference point of 0.2.

Recruitment increased during 2008 and 2009, but decreased between 2009 and 2010 (Figure 24). White hake recruitment has varied between 2.3 and 13.1 million fish during 1963 to 2010, with strong year classes appearing in 1984, 1988, and 1989 (Figure 24). These data do not exhibit a strong relationship between SSB and recruitment, although the strongest year classes appeared during the mid-1980s at a near average SSB. Compared to the time series average, 2008 to 2010 SSB was 4% below average while recruitment was 5% below average.

Map 61 – White hake stock boundary and catch/tow from spring and fall NEFSC, MADMF, and ME/NH surveys, 2002-2013. Spring survey values shaded grey may obscure fall survey values shaded black. Small juvenile and large spawner size thresholds correspond to sizes used in the hotspot analysis (Section 0) to help identify critical juvenile groundfish habitat and critical spawning areas.



Juvenile abundance < 40cm (#/tow)



Spawner biomass > 75cm (kg/tow)

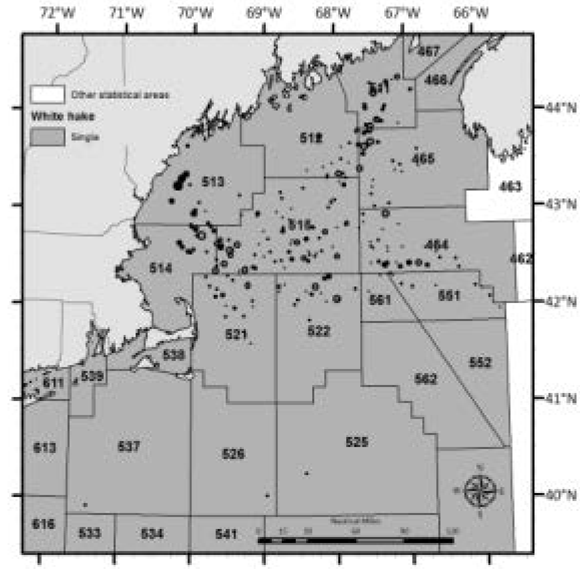
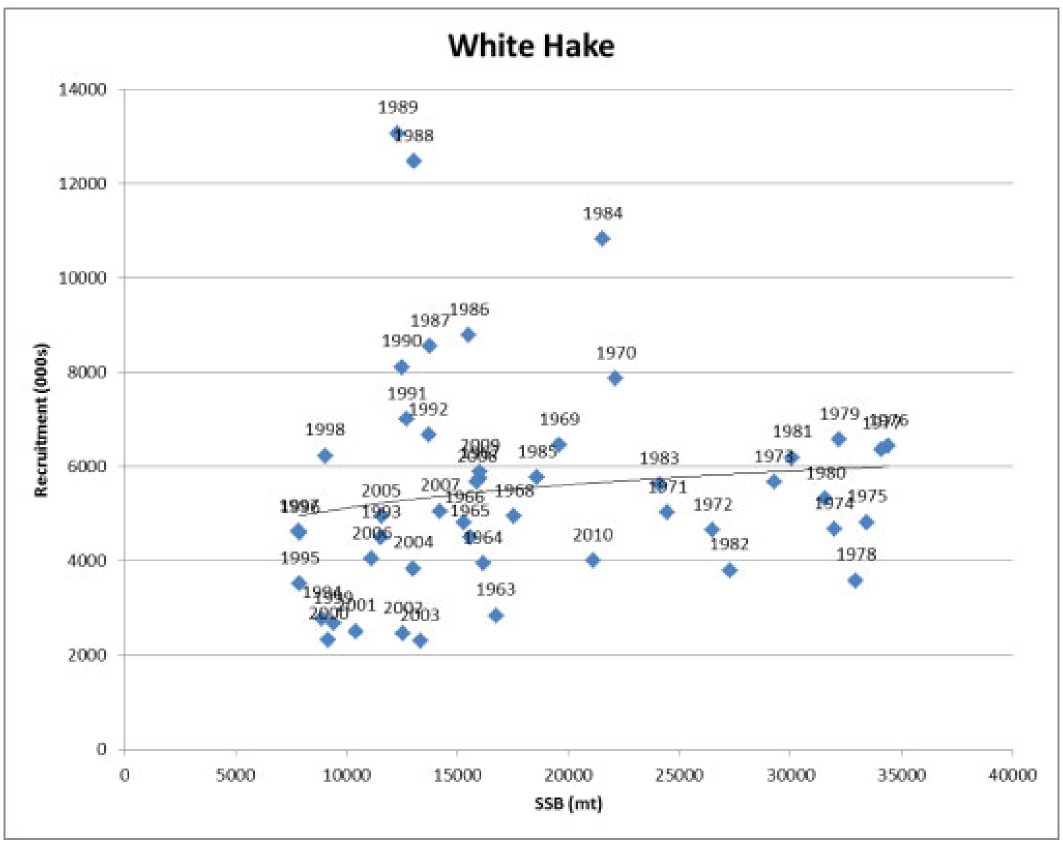


Figure 24 – Recruitment and spawning stock biomass estimates for white hake (NEFSC 2013a)



4.3.1.1.10 Windowpane flounder

Windowpane flounder (*Scophthalmus aquosus*) occur inshore out to moderate depths in the Gulf of Maine, on Georges Bank, and in southern New England and the Mid-Atlantic Bight. The depth range in the NEFSC trawl surveys for juveniles is 0-60 m fall and spring. For adults the range is 0-50 m spring and 0-70 m fall. They are found in deeper waters in the Gulf of Maine, according to the ME/NH trawl survey, with juveniles mostly found at 20-100 m and adults found at 50-130 m.

Windowpane flounder are caught on sandy bottoms off southern New England and southwards but also frequent softer and muddier grounds in the Gulf of Maine (Klein-MacPhee 2002). Mean biomass in the Georges Bank-Gulf of Maine region is generally associated with intermediate-sized sediments, with the highest catch rate on fine rock, but with very high variance (Methratta and Link 2006).

Based on the 1973-2005 NEFSC food habits data, windowpane flounder feed primarily on shrimp, amphipods, sand lance, and other fish species, with fish increasing in importance in the diet in older flounder.

Windowpane flounder appear to spawn throughout most of the year, based on examinations of reproductive state in adults and the presence of eggs and larvae in survey catches. Peak spawning occurs in the Mid-Atlantic Bight in May and on Georges Bank during the summer months. There is evidence for a split spawning season (spring and autumn) in parts of the Mid-Atlantic Bight.

Historically, most windowpane flounder have been landed with otter trawls. Most discarding occurs in the large mesh bottom trawl fishery, although discards also occur in the scallop dredge fishery. Currently, possession of both Gulf of Maine-Georges Bank and Southern New England-Mid-Atlantic Bight windowpane flounder is prohibited, so recent landings are very low. Note that for both stocks (Map 62), the catch and survey biomass time series were entirely revised during the recent ‘update’ assessment, mostly because shallow depths cannot be sampled by the new survey vessel, the R/V H. B. Bigelow. Reference points were also revised.

The 2012 update indicated that the northern stock is overfished with overfishing occurring, while the southern stock is not. For the northern stock, fishing mortality is down and biomass is up from the Groundfish Assessment Review Meeting III (2008). For the southern stock, biomass now exceeds the target and it is no longer overfished as the Groundfish Assessment Review Meeting III indicated.

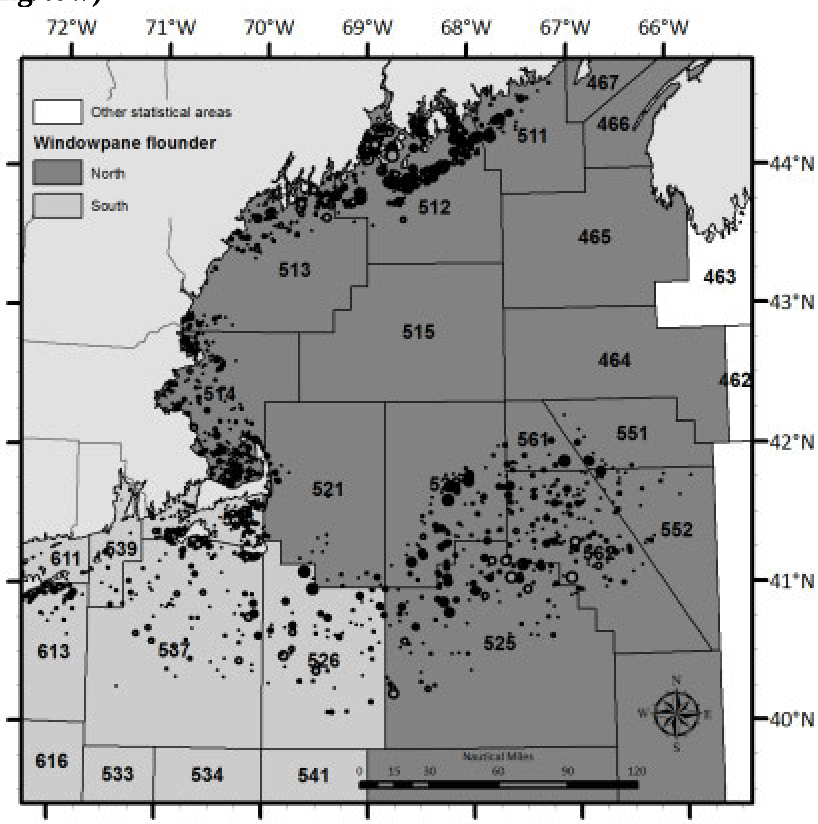
While vessels are prohibited from landing windowpane flounder, bycatch of both stocks exceeded the total allowable catch in fishing year 2012, and the fishery triggered an accountability measure for both stocks of windowpane flounder in that year. The current accountability measures for windowpane flounder are small and large year-round gear-restricted areas. Bottom-trawl vessels are required to use selective trawl gear, such as the haddock separator or Ruhle trawl. There are no restrictions on longline or gillnet gear because these gear types comprise a small amount of the total catch for these stocks. The applicable Georges Bank area is implemented if the catch limit for northern windowpane is exceeded, and the applicable southern New England area is implemented if the southern windowpane catch limit is exceeded.

The size of the gear restricted area depends on how much the catch limit is exceeded. The overage has to be greater than the management uncertainty buffer, which is currently 5 percent, for a windowpane flounder AM to be triggered. If the overage is between 5 and 20 percent, a smaller gear restricted area is triggered. If the overage is more than 20 percent, a larger gear restricted area is triggered. The accountability measures are intended to restrict catch by common pool and sector vessels, so sectors cannot request an exemption from the gear restriction. In addition, scallop vessels have a separate allocation of southern windowpane, so the groundfish southern New England accountability is only triggered when both the groundfish-specific and total-stock allocations are exceeded.

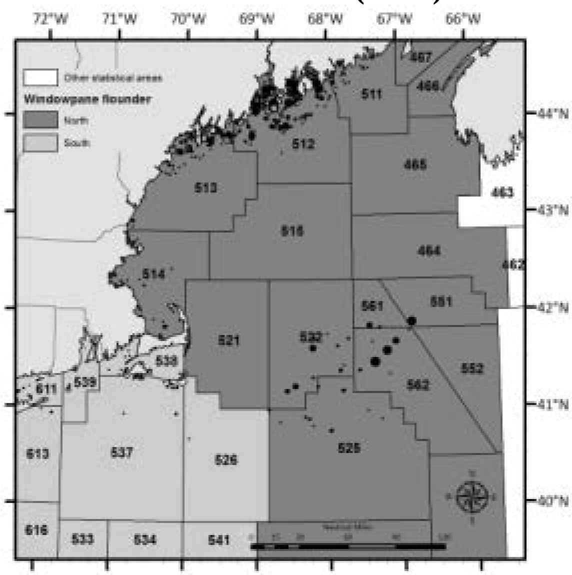
In fishing year 2012, the northern windowpane flounder catch limit was exceeded by 28 percent, while the southern windowpane flounder catch limit was exceeded by 36 percent. Because both of these overages exceeded 20 percent, the larger gear restricted areas were triggered as an accountability measure for the 2014 fishing year. However, the Council initiated Framework 52 to develop modifications to the current accountability measures to account for an overage of windowpane flounder while reducing the economic costs to industry.

Map 62 – Windowpane flounder stock boundaries and catch/tow from spring and fall NEFSC, MADMF, and ME/NH surveys, 2002-2013. Spring survey values shaded grey may obscure fall survey values shaded black. Small juvenile and large spawner size thresholds correspond to sizes used in the hotspot analysis (Section 0) to help identify critical juvenile groundfish habitat and critical spawning areas.

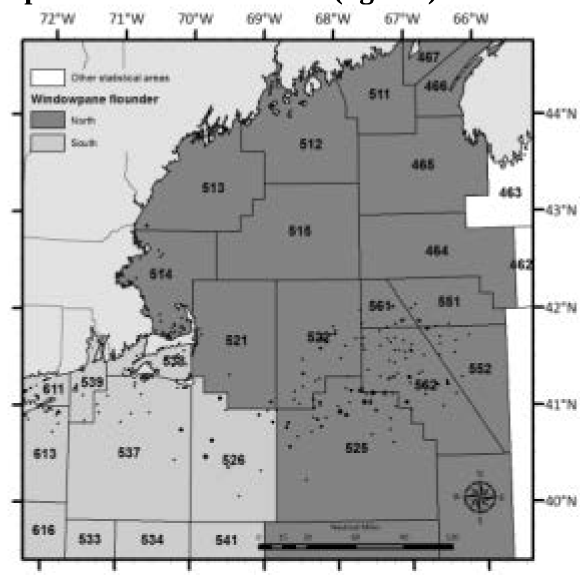
Total biomass (kg/tow)



Juvenile abundance < 15cm (#/tow)



Spawner biomass > 30cm (kg/tow)



4.3.1.1.11 Winter flounder

Winter flounder (*Pseudopleuronectes americanus*) is found in shallow inshore areas out to moderate depths in the Gulf of Maine, on Georges Bank, and in the Mid-Atlantic Bight to around Delaware Bay (Map 63). Their distribution tends to be deeper in the fall than in the spring, and adults have a slightly deeper distribution than the juveniles. In the southern part of their distribution, juveniles also occur further north in the spring, when they are concentrated in coastal waters from Delaware Bay to southern New England, whereas in the fall, they are concentrated from the New York Bight to southern New England. Adults are similarly distributed in coastal waters, but also abundant on Georges Bank, with a fishery on Georges Shoal. See Methratta and Link 2006 and Methratta and Link 2007 for more information.

Methratta and Link (2006b) found that winter flounder caught in the NEFSC trawl surveys had higher mean biomass on fine rock (6 kg/tow) than on coarse rock and coarse sand (2-3 kg/tow) and very low biomass (<1 kg/tow) on fine sand and silt (Methratta and Link 2006). They are not known to rely on complex structures for shelter.

Winter flounder have been described as opportunistic/omnivorous predators, feeding on a wide variety of different species. Polychaetes and crustaceans make up the bulk of their diet (Link et al 2002).

Except for the winter flounder found on Georges Bank, the species moves inshore to spawn in the late winter and early spring, with peak activity earlier or later depending on latitude. Their demersal eggs tend to be found in very shallow waters. The species is managed as three stocks based on mixing/lack of mixing during reproduction: Southern New England/Mid-Atlantic, Georges Bank, and Gulf of Maine. The stock definitions are based on both tagging and meristic (e.g. counting fin rays) studies (see recent stock assessment documents for references).

DeCelles and Cadrin (2010) analyzed the movement and spawning patterns of 72 adult winter flounder using acoustic telemetry and concluded that there were two contingent spawning groups of flounder in the region: coastal spawners and estuarine spawners. The majority of the tagged winter flounder were shown to exhibit coastal spawning behavior, with the spawning season peaking from March to May. Their analysis was conducted within the Plymouth Estuary and Plymouth Bay in the southern portion of the Gulf of Maine where adult winter flounder were historically abundant (Map 64).

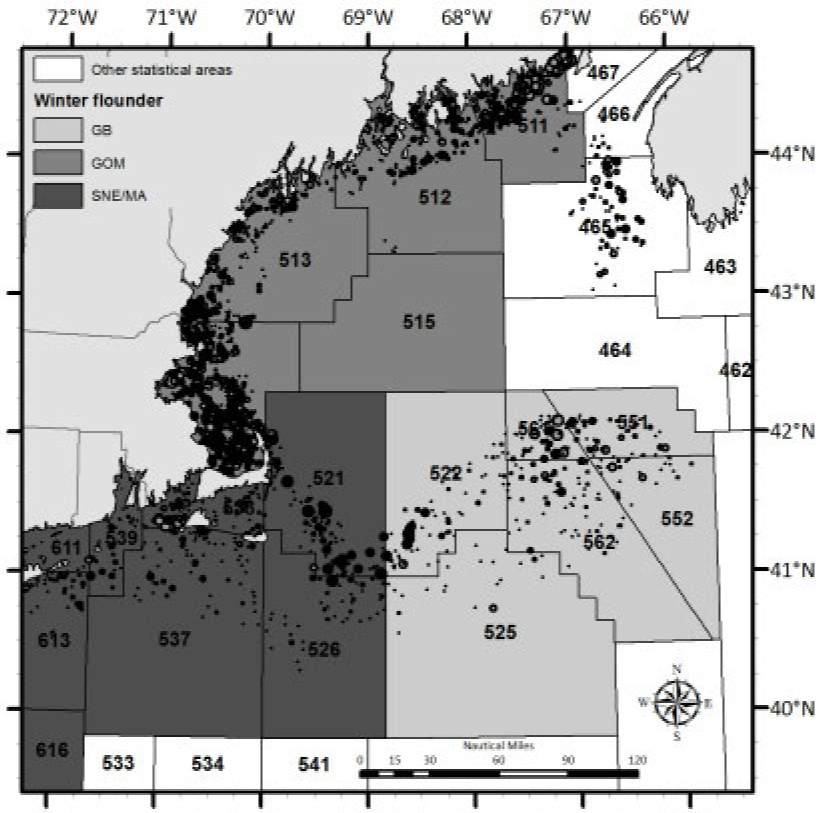
The 52nd Stock Assessment Workshop (2011) did not reach a conclusion on the status of Gulf of Maine winter flounder, but noted that overfishing was probably not occurring. The statistical catch at age model could not account for conflicting trends in catch and survey data, and the fallback area-swept method provided trends only. Spawning stock biomass for Gulf of Maine winter flounder increased between 2003 and 2009 (Figure 25). Recruitment was very low in 2009.

The 52nd SAW used a virtual population analysis modeling approach to determine that the Georges Bank stock was not overfished with overfishing not occurring, and noted declines in fishing mortality over time. Spawning stock biomass and recruitment for the Georges Bank stock increased between 2004 and 2009 (Figure 26). The 52nd SAW found that Southern New England/Mid-Atlantic winter flounder was overfished during 2010, but that overfishing was not occurring.

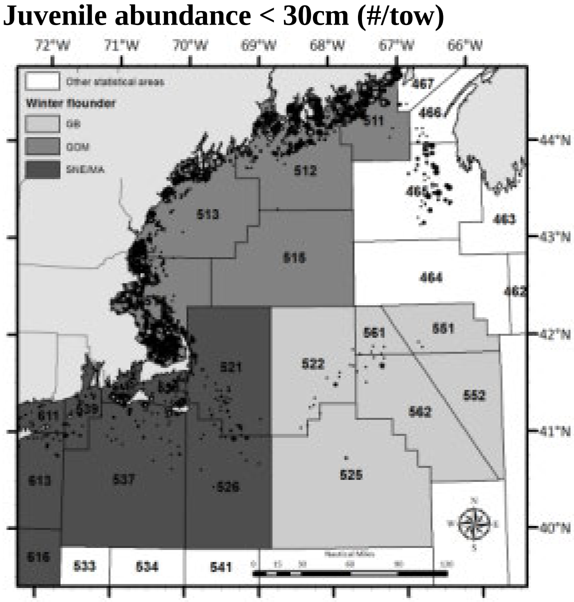
The Southern New England/MA assessment relies on a statistical catch at age modeling approach, and both the natural mortality rate assumption and the assessment model itself were updated in 2010. The 52nd SAW noted that Southern New England/Mid-Atlantic landings had recently been low. The assessment also noted very low spawning stock biomass and recruitment in 2009 (Figure 27). Following the implementation of Amendment 16 to the Northeast Multispecies FMP, vessels were prohibited from possessing Southern New England/Mid-Atlantic winter flounder. However, following the findings of the 52nd SAW, the Council decided to allow a targeted fishery for Southern New England/Mid-Atlantic winter flounder.

Map 63 – Winter flounder stock boundaries and catch/tow from spring and fall NEFSC, MADMF, and ME/NH surveys, 2002-2013. Spring survey values shaded grey may obscure fall survey values shaded black. Small juvenile and large spawner size thresholds correspond to sizes used in the hotspot analysis (Section 0) to help identify critical juvenile habitat and spawning areas.

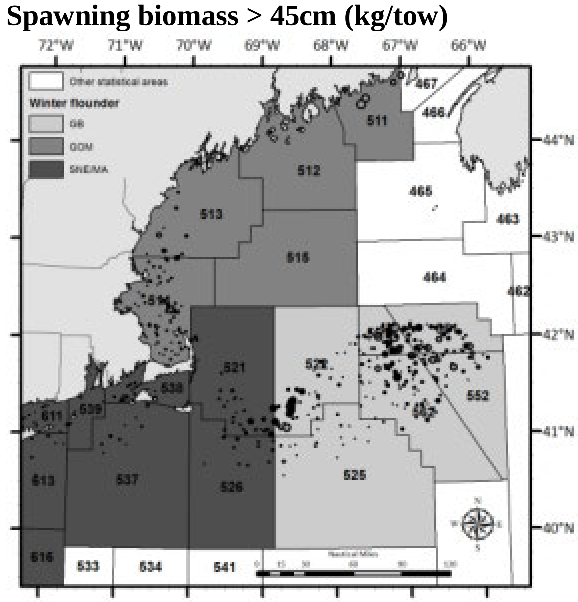
Total biomass (kg/tow)



Juvenile abundance < 30cm (#/tow)



Spawning biomass > 45cm (kg/tow)



Map 64 – Map of the research site showing the locations in Plymouth Bay and Plymouth estuary where winter flounder were tracked with passive acoustic telemetry (DeCelles and Cadrin 2010).

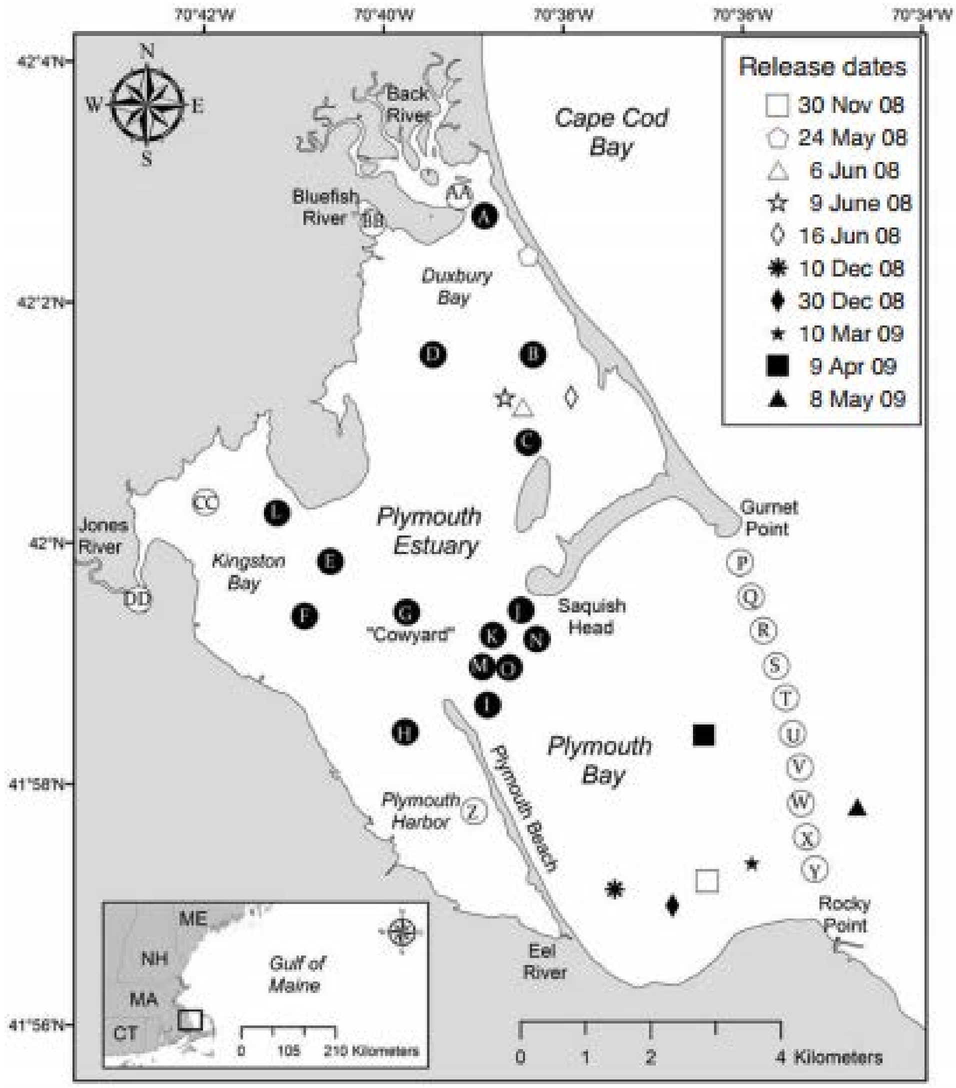


Figure 25 – Recruitment and spawning stock biomass estimates for Gulf of Maine winter flounder (NEFSC 2011)

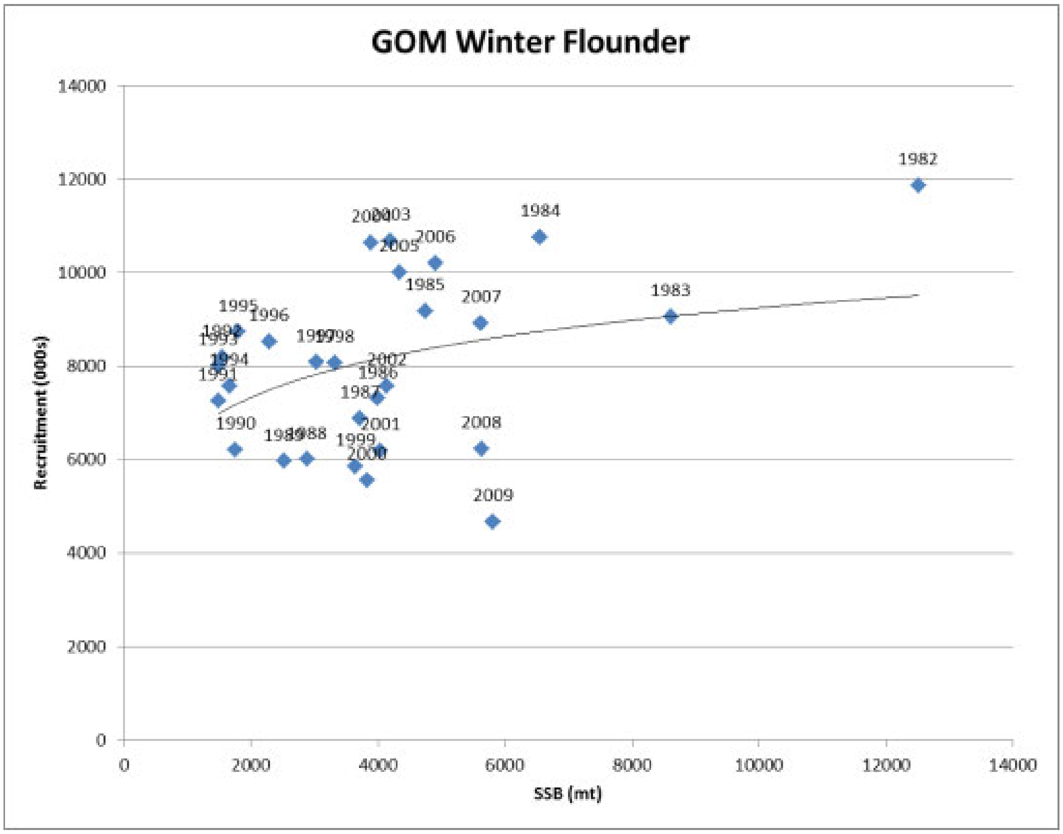


Figure 26 – Recruitment and spawning stock biomass estimates for Georges Bank winter flounder (NEFSC 2011)

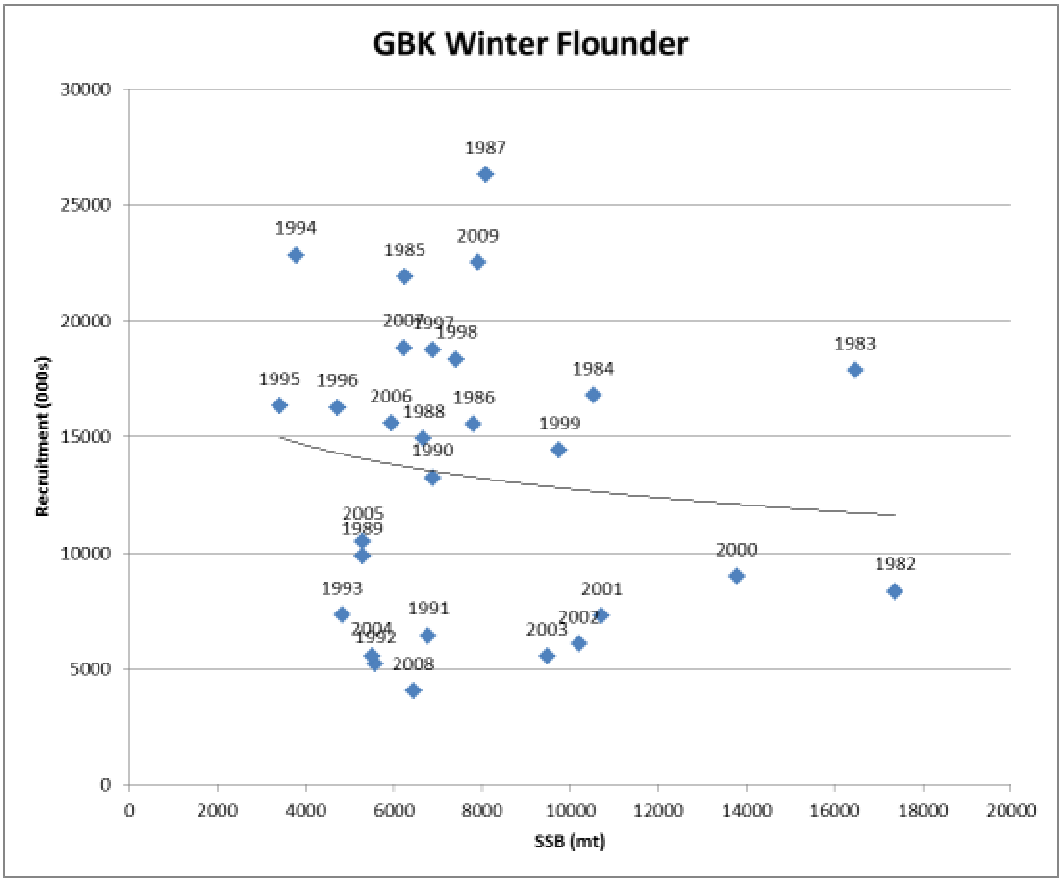
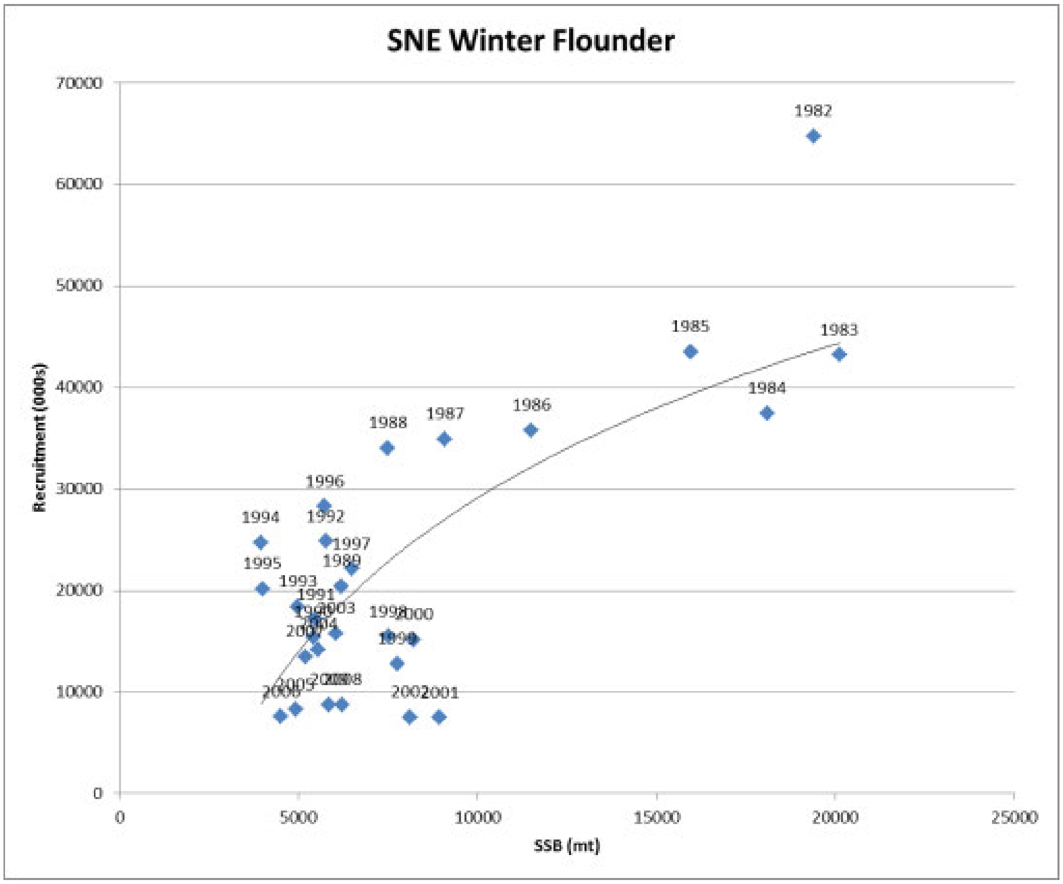


Figure 27 – Recruitment and spawning stock biomass estimates for Southern New England winter flounder (NEFSC 2011)



4.3.1.1.12 Witch flounder

Witch flounder (*Glyptocephalus cynoglossus*) is a deeper-water flounder that occurs throughout the Gulf of Maine and along the shelf/slope break along Georges Bank and the Mid-Atlantic Bight (Map 65). In the NEFSC trawl surveys, juveniles (≤29 cm) are found at depths of 80-400m during both spring and fall, while adults are in shallower waters during the fall, 100-200m, and move into deeper areas in the spring (100-400 m). Highest catches in the survey occur in the Gulf of Maine, generally north of 43 degrees north latitude, and in selected areas along the shelf break.

The witch flounder is very closely tied to mud/silt, muddy-sand, and clay substrate (Powles and Kohler 1970; Martin and Drewry 1978; Scott 1982; MacDonald et al. 1984) and rarely occurs on any other bottom type. The 1973-2005 NEFSC food habits data for witch flounder verify that polychaetes are by far the most important food source of witch flounder. This close association with soft substrate may be the result of their preference for polychaete prey (Susan Wigley, NEFSC, Woods Hole Laboratory, personal communication). Auster et al. (1991) showed small scale habitat associations of witch flounder with depressions in mud bottom. This association could possibly serve as a means of evading strong currents. In the Gulf of Maine-Georges Bank region, witch flounder catch rates trended to higher values with decreasing sediment grain size (Methratta and Link 2006).

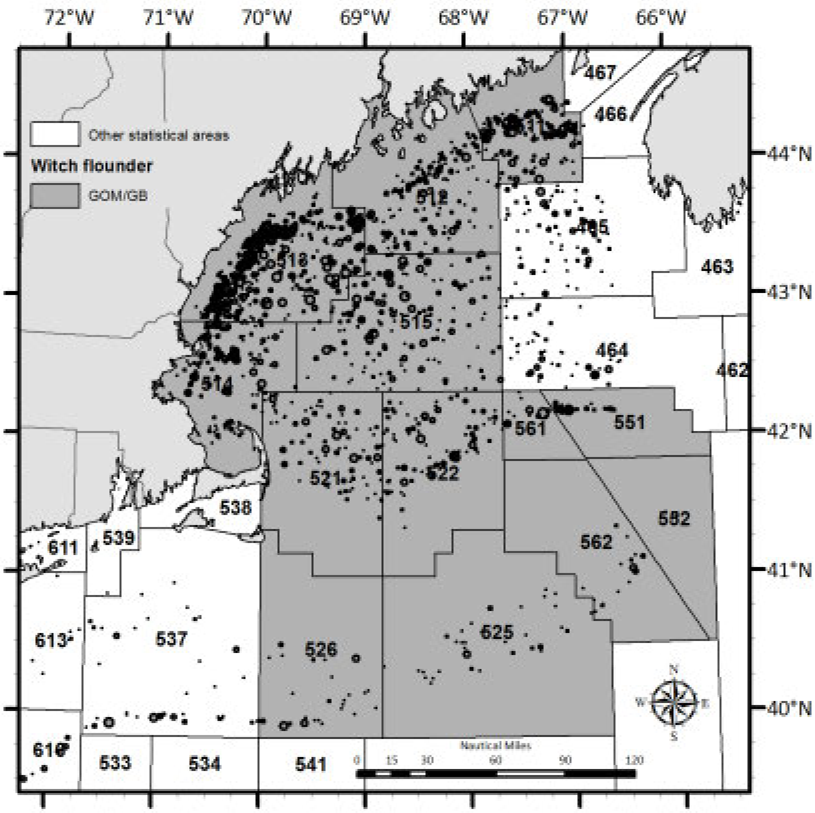
Witch flounder spawn from March to November, with peak spawning occurring in summer. The general trend is for spawning to occur progressively later from south to north (Martin and Drewry 1978; Brander and Hurley 1992). The MARMAP offshore ichthyoplankton surveys found the highest egg densities in the Gulf of Maine and Massachusetts Bay in May and June. The western and northern areas of the Gulf of Maine tend to be the most active spawning sites (Burnett et al. 1992). In the Mid-Atlantic Bight, the most important spawning grounds are off Long Island (Smith et al. 1975). Wigley and Burnett (2003) examined the deep-water population of witch flounder on the continental slope and concluded that deep-water witch flounder are de-coupled from those in the Gulf of Maine/Georges Bank region and probably reflect local spawning populations.

Most witch flounder are landed with otter trawls. Discards, which make up a small fraction of total catch, have been estimated for the large and small mesh otter trawl and also the shrimp trawl fisheries. The stock remains at low abundance and the current estimate of fishing mortality is high. The NEFSC trawl survey catches very few witch flounder overall, and at low abundance, the data may not be sufficient to provide reliable abundance and biomass estimates (see section 7.0 of assessment update document). As of the 2012 assessment update, witch flounder, which is managed as a single stock throughout its range, was overfished with overfishing occurring during 2010. The assessment report commented that fishing mortality on witch flounder is very high relative to the reference point.

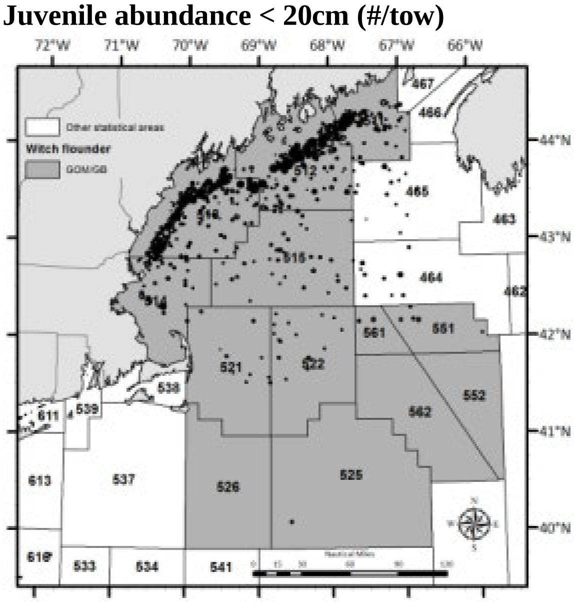
At observed SSB, there does not appear to be a positive relationship between SSB and recruitment (Figure 28). The assessment noted that recruitment was very high in 2008, while spawning stock biomass had only slightly increased from 2006. Including the 2008 year class, recruitment during 2008 to 2010 was 72% above average while SSB was 43% below average.

Map 65 – Witch flounder stock boundary and catch/tow from spring and fall NEFSC, MADMF, and ME/NH surveys, 2002-2013. Spring survey values shaded grey may obscure fall survey values shaded black. Small juvenile and large spawner size thresholds correspond to sizes used in the hotspot analysis (Section 0) to help identify critical juvenile habitat and spawning areas.

Total biomass (kg/tow)



Juvenile abundance < 20cm (#/tow)



Spawner biomass > 45cm (kg/tow)

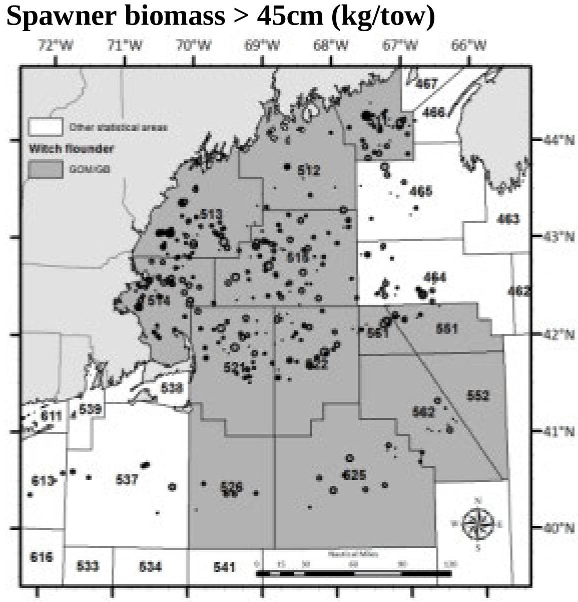
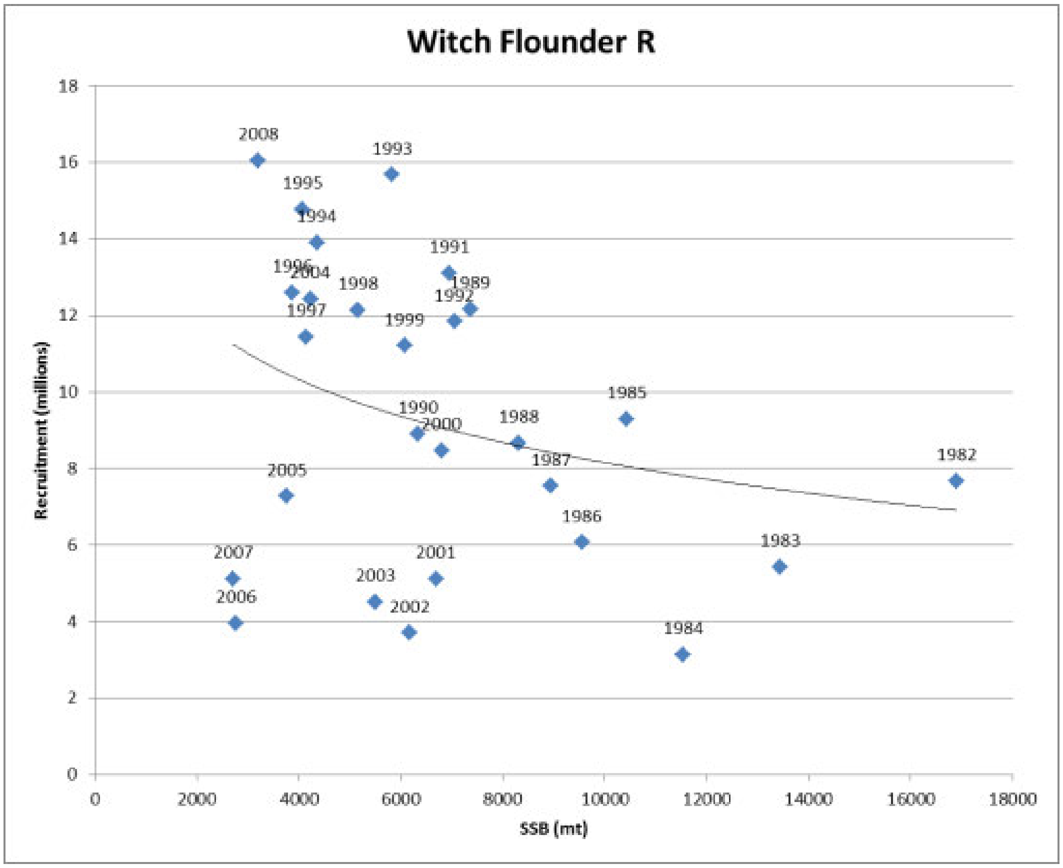


Figure 28 – Recruitment and spawning stock biomass estimates for witch flounder (NEFSC 2012a)



4.3.1.1.13 Yellowtail flounder

Yellowtail flounder (*Limanda ferruginea*) are distributed from Labrador to Cape Henry, Virginia. This is a common species in bottom trawl surveys in the southwest Gulf of Maine (Gulf of Maine), on Georges Bank and in the Mid-Atlantic Bight as far south as 39˚N (off Cape May, New Jersey) (Johnson et al. 1999). During 1990-2002 NEFSC spring and fall bottom trawl surveys in Georges Bank-Gulf of Maine region, small 0-20 cm yellowtail were caught in low numbers in the southwest Gulf of Maine, on Georges Bank, and in Southern New England; larger 20-40 cm yellowtail were abundant in the southwest Gulf of Maine and in deeper water on eastern Georges Bank (the southern part of Closed Area II), but were also common in Southern New England and elsewhere on Georges Bank (Methratta and Link 2007). EFH includes inshore waters of the Gulf of Maine and on the continental shelf on Georges Bank and in the Mid-Atlantic Bight. Young of the year juveniles use continental shelf waters in the Mid-Atlantic (NY Bight) as nursery habitat, settling predominantly at mid-shelf study sites at depths of 40-70 m (Steves et al. 1999; Sullivan et al. 2006). In the Mid-Atlantic, juveniles and adults move out of inner shelf waters (e.g. New York Bight) in the fall; otherwise, there is very little evidence of seasonal migration (this can be seen by comparing spring/fall survey distribution charts in Johnson et al. 1999).

Yellowtail flounder prefer sand and muddy sand, and avoid rocks, stony ground, and very soft mud (Klein-MacPhee 2002). In Gulf of Maine-Georges Bank region, catch rates were highest on coarse sand, about three times higher than on coarse and fine rock, with very low catches on fine sand and silt (Methratta and Link 2006). Smaller fish were associated with larger grain size sediments (Methratta and Link 2007). Young of the year juveniles in the New York Bight settled in the available habitat (bare sand, shell hash, sand dollars) or associated with clean sand substrates, which often included peaks of sand wave crests (Sullivan et al. 2006).

Comparing the prediction of three different models of habitat use, Pereira et al. (2012) concluded that eastern Georges Bank, specifically within Closed Area II, provided a high quality sand habitat for yellowtail flounder. Pereira et al. (2012) performed a geospatial analysis of habitat use of yellowtail flounder on Georges Bank to reach this conclusion. The prediction of the three tested models (the constant density model, the proportional density model and the basin model) were compared with survey data on yellowtail flounder in Georges Bank that took place in the spring and fall. The high quality sand habitat harboring approximately 2/3 of the yellowtail flounder population during periods of low and high abundance is shown in Map 66.

Based on MARMAP ichthyoplankton survey data from 1977-1987 (see Johnson et al. 1999), spawning begins in February or March, occurring first in the northern half of the Mid-Atlantic and then extending rapidly into southern New England and Georges Bank. In April and May, spawning increased in intensity in these areas, and began in the Gulf of Maine. Eggs were found in the Gulf of Maine from April to September, with peak abundance between April and June.

Smolowitz et al. (2012) analyzed the bycatch rates of 14 trips using scallop dredges within Closed Area I and II from October 2010 to April 2012, indicating that peak spawning for yellowtail flounder on Georges Bank within Closed Area I and II is around May/June and peak spawning for winter flounder is around February/March. The bycatch rates (catch of yellowtail flounder per pound of landed scallop meats) for yellowtail flounder in the scallop fishery within Closed Area II were found to be highest from August to October.

Yellowtail flounder is managed as three stocks in U.S. waters – Cape Cod/Gulf of Maine, Georges Bank, and Southern New England/Mid-Atlantic (Map 67). The Georges Bank stock is managed as a transboundary resource with Canada and joint assessment activities are conducted via the Transboundary Resource Assessment Committee (TRAC).

Status of the Cape Cod/Gulf of Maine stock was updated in March 2012, with the status determination overfished with overfishing occurring. There was little change in biomass from the 2008 Groundfish Assessment Review Meeting III estimate, although the update showed a decrease in fishing mortality rate between 2007 (GARM III) and 2010 (2012 update). Stock recruitment decreased from 2008 to 2009. With the exception of an extraordinary 1987 year class (23.8 million fish), Cape Cod yellowtail flounder recruitment has had little variation, ranging between 3.0 and 10.5 million fish during 1985 to 2010 (Figure 29). Except for 1990 (SSB = 2663 mt), SSB has generally varied between 670 and 1,795 mt. It is not known whether the apparent lack of a strong SSB and recruitment relationship is due to the small variation in stock size or due to other biological factors. During 2008 to 2010, recruitment has been 3% below average while SSB has been 40% above average.

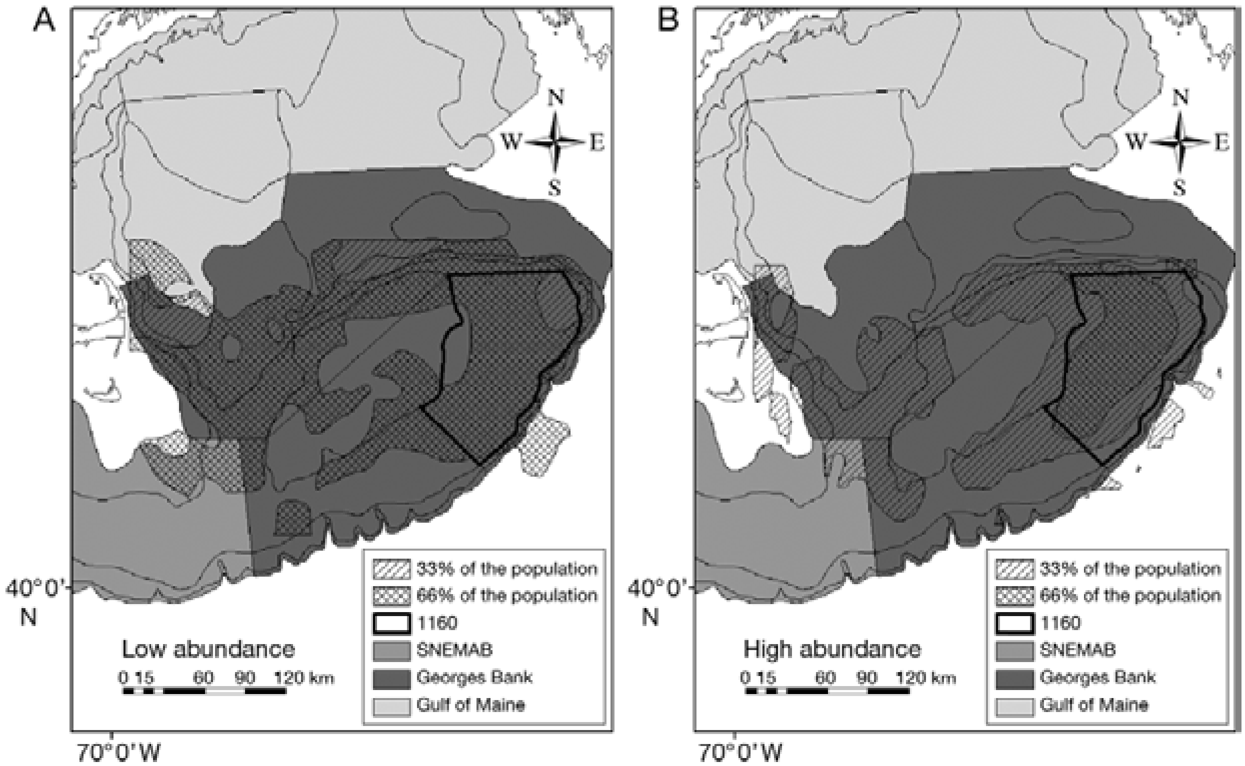
The assessment for the Southern New England/Mid-Atlantic stock was updated in June 2012 (NEFSC 2012). Projections based on two alternative recruitment scenarios both indicated that overfishing was not occurring in 2011. The different recruitment assumptions produced conflicting results as to whether biomass was above the reference point, but the Stock Assessment Review Committee concluded that the "recent recruitment" scenario was most likely, which would mean that the stock is not overfished.

Southern New England yellowtail flounder recruitment has been invariably low, less than 20 million fish, at low SSB. Low SSB has been observed since 1990 (Figure 30) and recruitment has been less than 20 million fish. During 2008-2010, recruitment averaged 7.1 million fish or 75% below the time series mean, while SSB has been been below 3,300 mt. Before 1990, recruitment ranged from 3.3 million to 85 million fish and SSB ranged from 2,800 to 21,800 mt. Two exceptionally strong year classes occurred in 1980 and 1987, 178 million and 190 million fish, respectively. These exceptional year classes supported the Southern New England groundfish fishery for several years thereafter.

The Transboundary Resource Assessment Committee reviewed the status of the Georges Bank stock in June 2012 (TRAC 2012). Spawning stock biomass was estimated at 4,600 mt in 2011, and fishing mortality on fully recruited flounder (age four and over) was estimated to be 0.31 in 2011, above the overfishing reference point of F_{ref}=0.25. Recruitment has recently been low, and if observed retrospective patterns continue, fishing mortality rates are expected to increase and biomass is expected to decrease in the next assessment. The Georges Bank yellowtail stock is overfished and subject to overfishing.

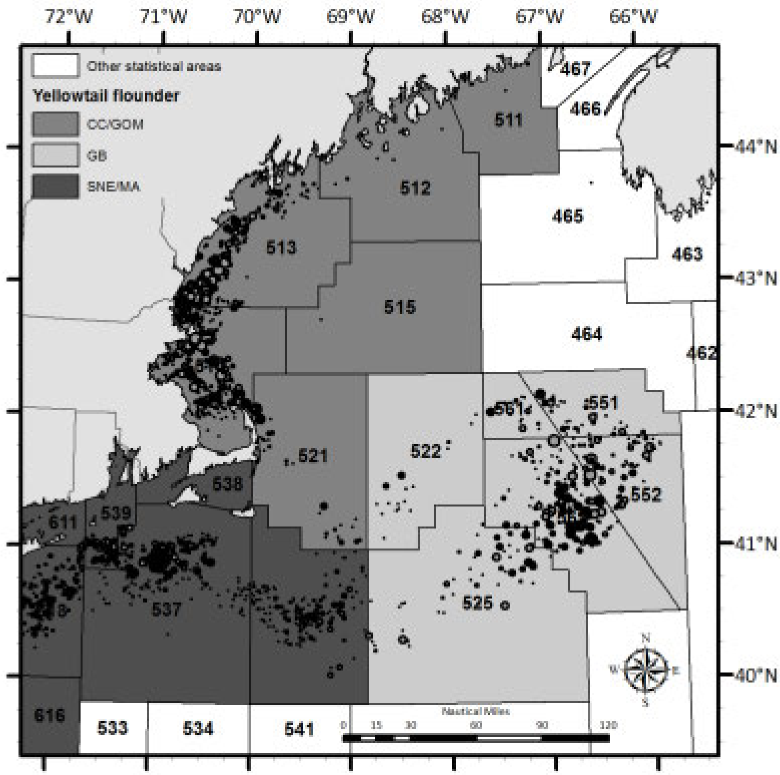
Recruitment of Georges Bank yellowtail flounder exhibits a pretty strong positive relationship with SSB (Figure 31). Exceptionally strong year classes were observed in 1973 (52 million fish), 1974 (71 million fish), 1977 (54 million fish), and 1980 (63 million fish); all when SSB was higher than 8,300 mt. Since 1990, recruitment ranged from 3 to 25 million fish and SSB was between 2,200 and 10,300 mt. During 2008-2010, recruitment average 4.3 million fish, or 77% below the time series mean, while SSB was 39% below average.

Map 66 – Georges Bank yellowtail flounder preferred sand habitat (Pereira et al. 2012). Crosshatched areas encompass approximately two thirds of the population. During times of high abundance, the cross hatched area is located within the black polygon.

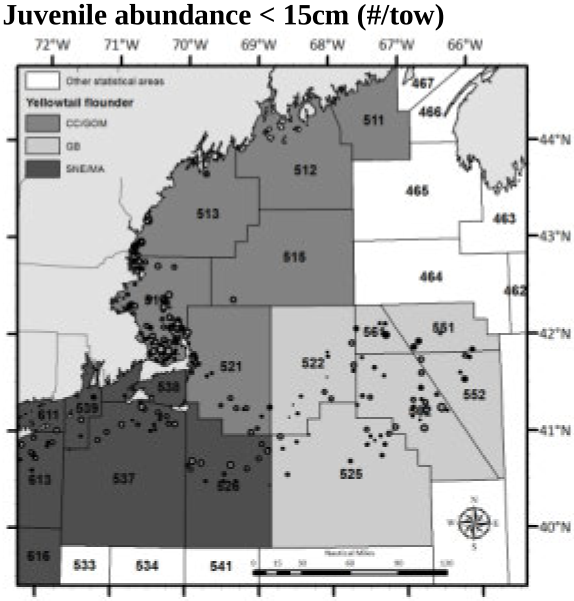


Map 67 – Yellowtail flounder stock boundaries and catch/tow from spring and fall NEFSC, MADMF, and ME/NH surveys, 2002-2013. Spring survey values shaded grey may obscure fall survey values shaded black. Small juvenile and large spawner size thresholds correspond to sizes used in the hotspot analysis (Section 0) to help identify critical juvenile habitat and spawning areas.

Total biomass (kg/tow)



Juvenile abundance < 15cm (#/tow)



Spawner biomass > 40cm (kg/tow)

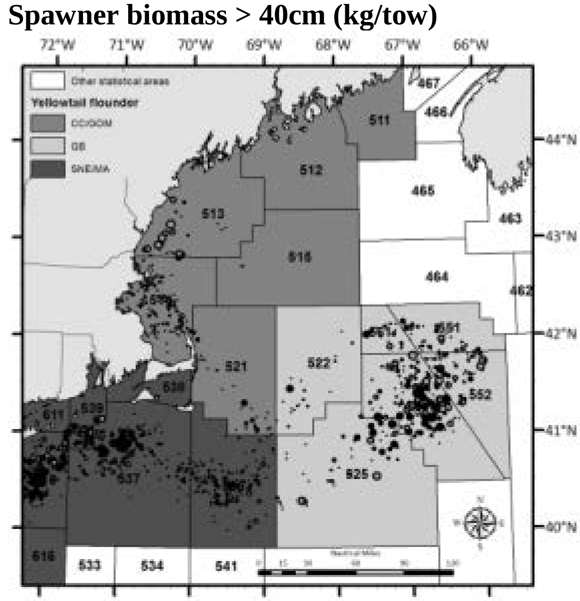


Figure 29 - Recruitment and spawning stock biomass estimates for Cape Cod/Gulf of Maine yellowtail flounder (NEFSC 2013a)

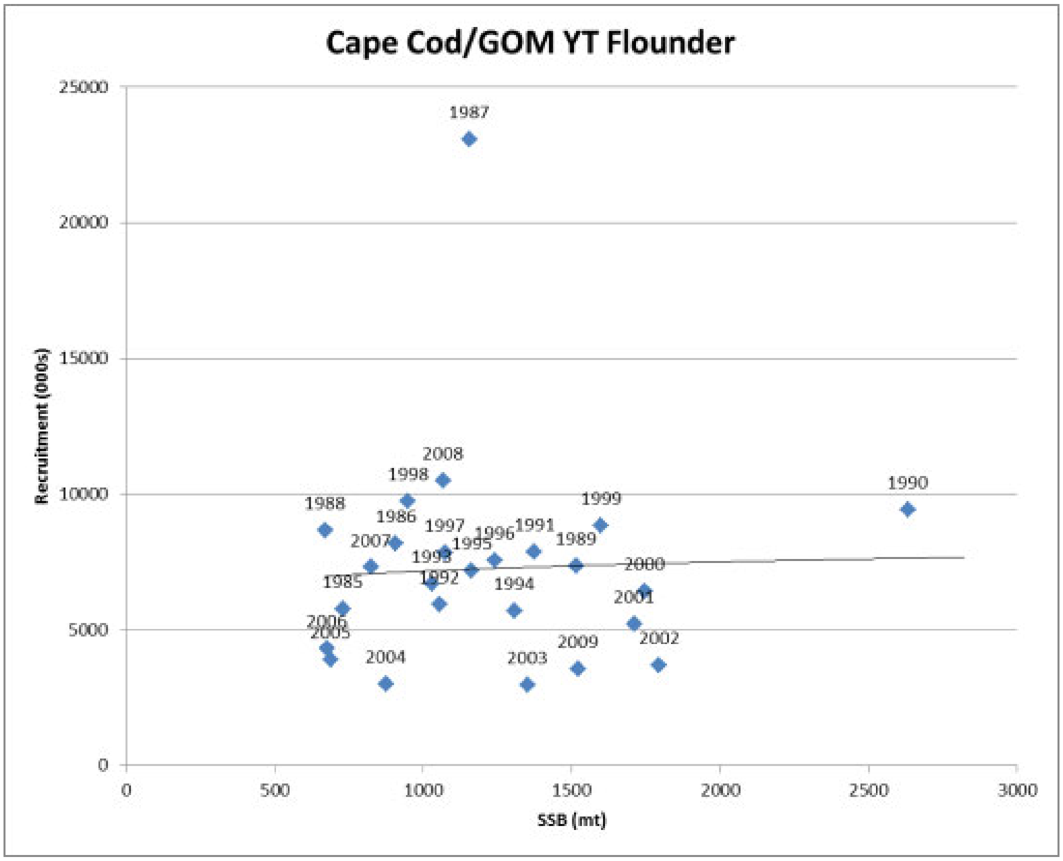


Figure 30 - Recruitment and spawning stock biomass estimates for Southern New England yellowtail flounder (NEFSC 2012b)

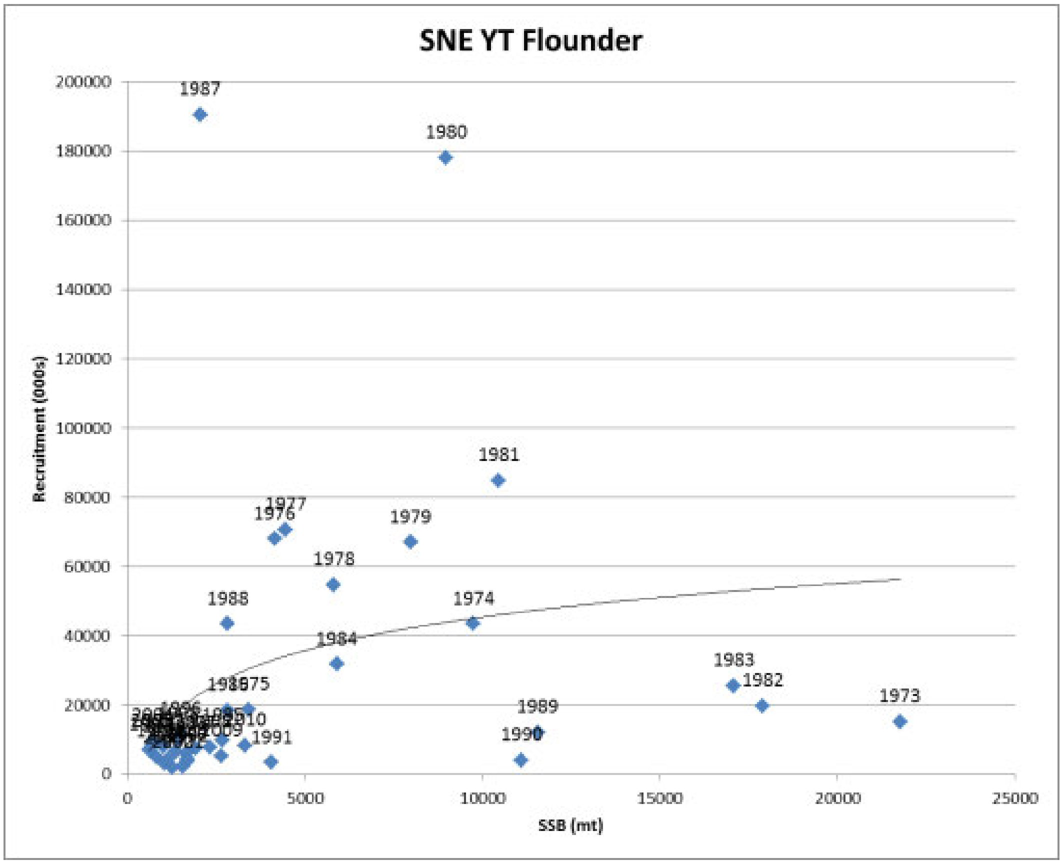
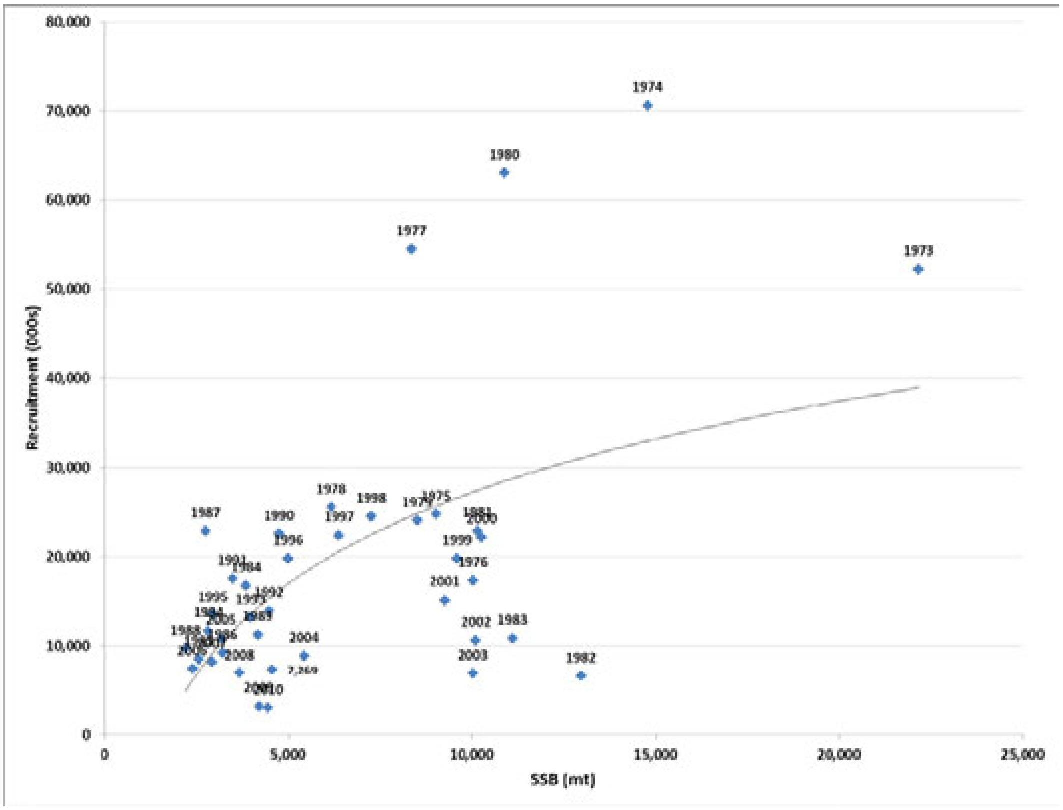


Figure 31 – Recruitment and spawning stock biomass estimates for Georges Bank yellowtail flounder (Legault et al. 2012).



4.3.1.2 Fishery

The Northeast Multispecies Fishery Management Plan developed by the NEFMC regulates catches of both large mesh and small mesh groundfish. Although managed under a single plan, the large mesh and small mesh groundfish fisheries operate differently and the regulations for large mesh and small mesh are generally developed by separate NEFMC committees and via separate FMP amendments, framework adjustments, and specifications packages. A brief history specific to spatial management measures in the multispecies fishery is provided in the management background section of this document (section 3.3.2).

Large mesh species include the following (some species are assessed and allocated by stock):

- Acadian redfish
- American plaice
- Atlantic cod (Gulf of Maine, Georges Bank)
- Atlantic halibut*
- Atlantic wolffish**
- Haddock (Gulf of Maine, Georges Bank)
- Ocean pout**
- Pollock
- White hake
- Windowpane flounder (Northern, Southern)**
- Winter flounder (Gulf of Maine, Georges Bank, Southern New England/Mid-Atlantic)
- Witch flounder
- Yellowtail flounder (CC/Gulf of Maine, Georges Bank, Southern New England/Mid-Atlantic)

** Stock is not allocated to sectors as an Annual Catch Entitlement, limit of one halibut per trip*
*** Stock is not allocated to sectors as an Annual Catch Entitlement, bycatch only fishery*

In 1986, the Council implemented the Northeast Multispecies FMP with the goal of rebuilding stocks. Since Amendment 5 in 1994, the multispecies fishery has been administered as a limited access fishery managed through a variety of effort control measures including DAS, area closures, trip limits, minimum size limits, and gear restrictions. Landings decreased throughout the latter part of the 1980's until reaching a more or less constant level of around 40,000 tons (36,287 mt) annually since the mid 1990's.

Over a ten year period, the fishery has gradually transitioned to a management system where most commercial fishermen participate in sectors. In 2004, the final rule implementing Amendment 13 to the Northeast Multispecies FMP allowed for self-selecting groups of limited access groundfish permit holders to form sectors. These sectors developed a legally binding operations plan and operated under an allocation of Georges Bank cod. While approved sectors were subject to general requirements specified in Amendment 13, sector members were exempt from Days-at-Sea and some of the other effort control measures that tended to limit the flexibility of fishermen. The 2004 rule also authorized implementation of the first sector, the Georges Bank Cod Hook Sector. A second sector, the Georges Bank Cod Fixed Gear Sector, was authorized in 2006.

Amendment 16 (implemented 2010) expanded the sector program substantially. In addition, Amendment 16 brought the FMP into compliance with the catch limit requirements and stock rebuilding deadlines of the 2006 reauthorization of the Magnuson-Stevens Act. This amendment included Annual Catch Limits for all 20 large-mesh stocks in the groundfish complex. Since Amendment 16, sectors are allocated subdivisions of Annual Catch Limits called Annual Catch Entitlements based on the sector's members collective catch history, and became exempt from many of the effort controls previously used to manage the fishery. During fishing year 2013, sectors received Annual Catch Entitlements for 9 of 16 groundfish species (15 stocks + quotas for Eastern U.S./Canada cod and haddock; 17 catch entitlements in total) in the FMP. Non-sector vessels fish in a "common pool" subject to a shared Annual Catch Limit.

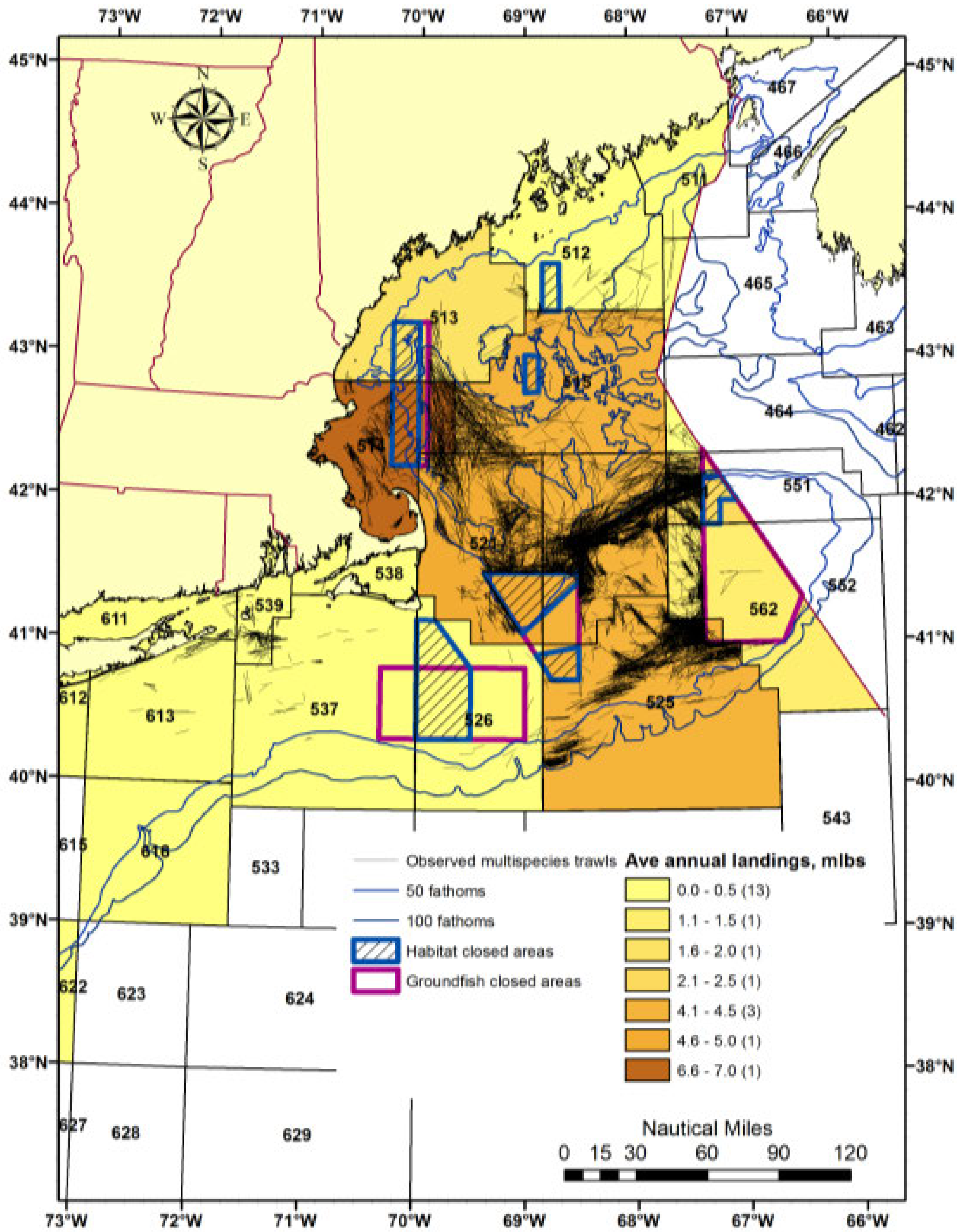
During the 2010-2011 fishing year, seventeen sectors operated, each establishing its own rules for using its allocations. One sector operated as a "lease-only" sector with no active vessels. Vessels with limited access permits that joined sectors were allocated 98% of the total commercial groundfish sub-Annual Catch Limit, based on their collective level of historical activity in the groundfish fishery. Approximately half (46%) of the limited access groundfish permits opted to remain in the common pool. Common pool vessels act independently of one another, with each vessel constrained by the number of Days-at-Sea it can fish, by trip limits, and by all of the time and area closures. These restrictions help ensure that the groundfish catch of common pool vessels does not exceed the common pool's portion of the commercial groundfish sub-Annual Catch Limit for all stocks (about 2% for 2010) before the end of the fishing year.

In 2011-2012, the second year of sector management, 57% of active vessels participated in one of 16 sectors or one of two lease-only sectors. The same effort controls employed in 2010 were again used in 2011, to ensure the groundfish catch made by common pool vessels did not exceed the common pool's portion of the commercial groundfish sub-Annual Catch Limit. During 2012-2013, 58% of active vessels participated in sectors.

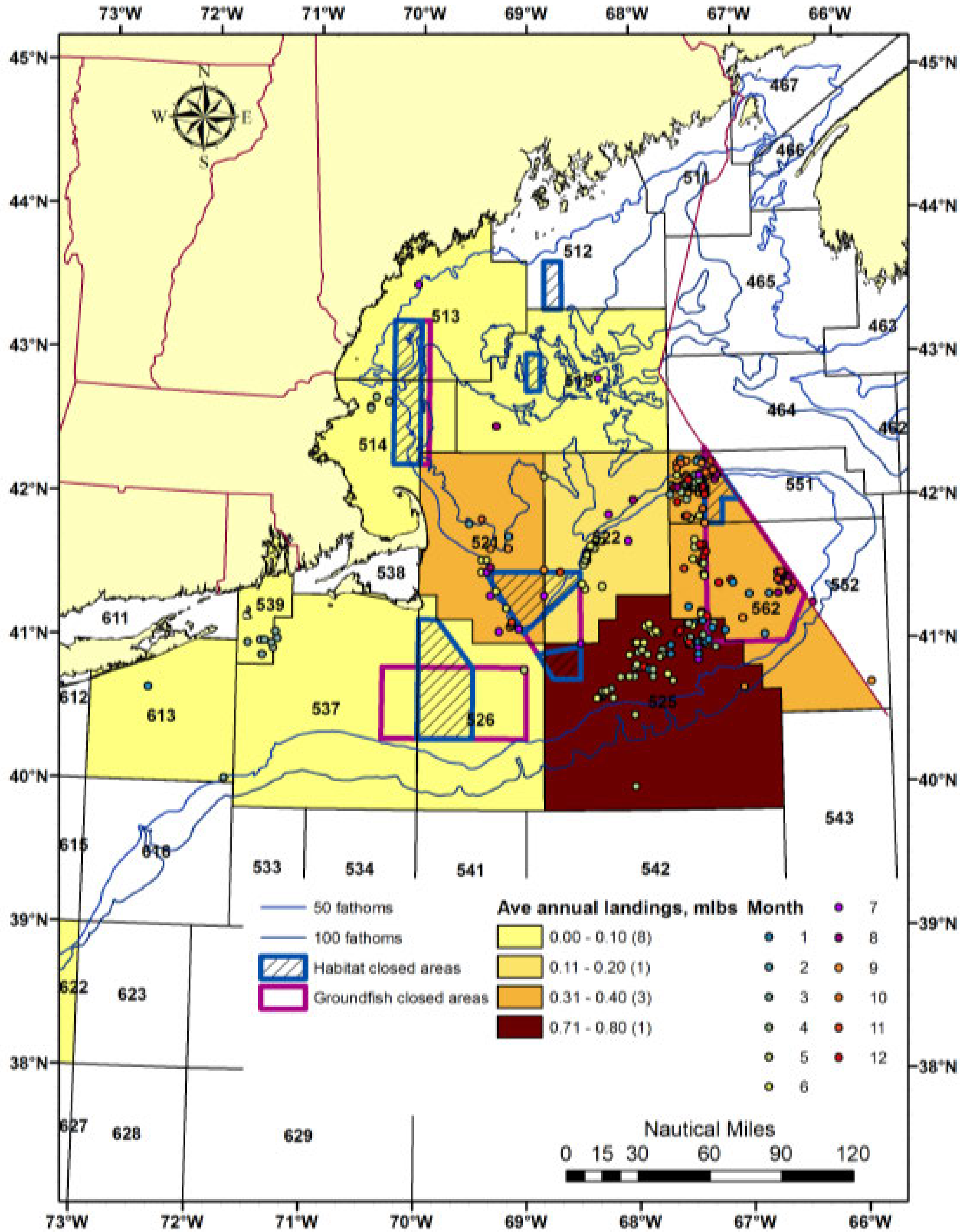
The commercial groundfish fishery operates throughout the Gulf of Maine, on Georges Bank, and in southern New England using a variety of fishing gears depending on the location and target species. Otter trawls are the primary gear type used for all species (Map 68) and flatfish are caught almost exclusively with otter trawls. Based on fishing vessel trip report data for 2007-2011, gillnets caught substantial fractions of the Atlantic cod, pollock, redfish, and white hake landings (Map 70). Separator trawls are used to target haddock (Map 69). Other gears identified in the fishing vessel trip report data associated with landings of groundfish include longlines (Map 71), handlines, and fish pots.

Recreational fishing for groundfish is focused primarily on Atlantic cod, pollock, haddock, red hake, and winter flounder, although based on comments made during August 2013 informational meetings, redfish are increasingly important to the charter fleet as well. Recreational vessels have a closed season from November through April 15, bag limits for some species, and minimum size limits by species. Recreational fishing is conducted by shore-based anglers and anglers with private boats, as well as by anglers aboard party/charter vessels. Amendment 16 includes a detailed description of this fishery through 2007. Amendment 16 also allocated a portion of the Annual Catch Limits of Gulf of Maine cod and Gulf of Maine haddock to the recreational fishery. In the New England region, recreational groundfishing is concentrated in the western Gulf of Maine and off the Rhode Island coast (Map 72).

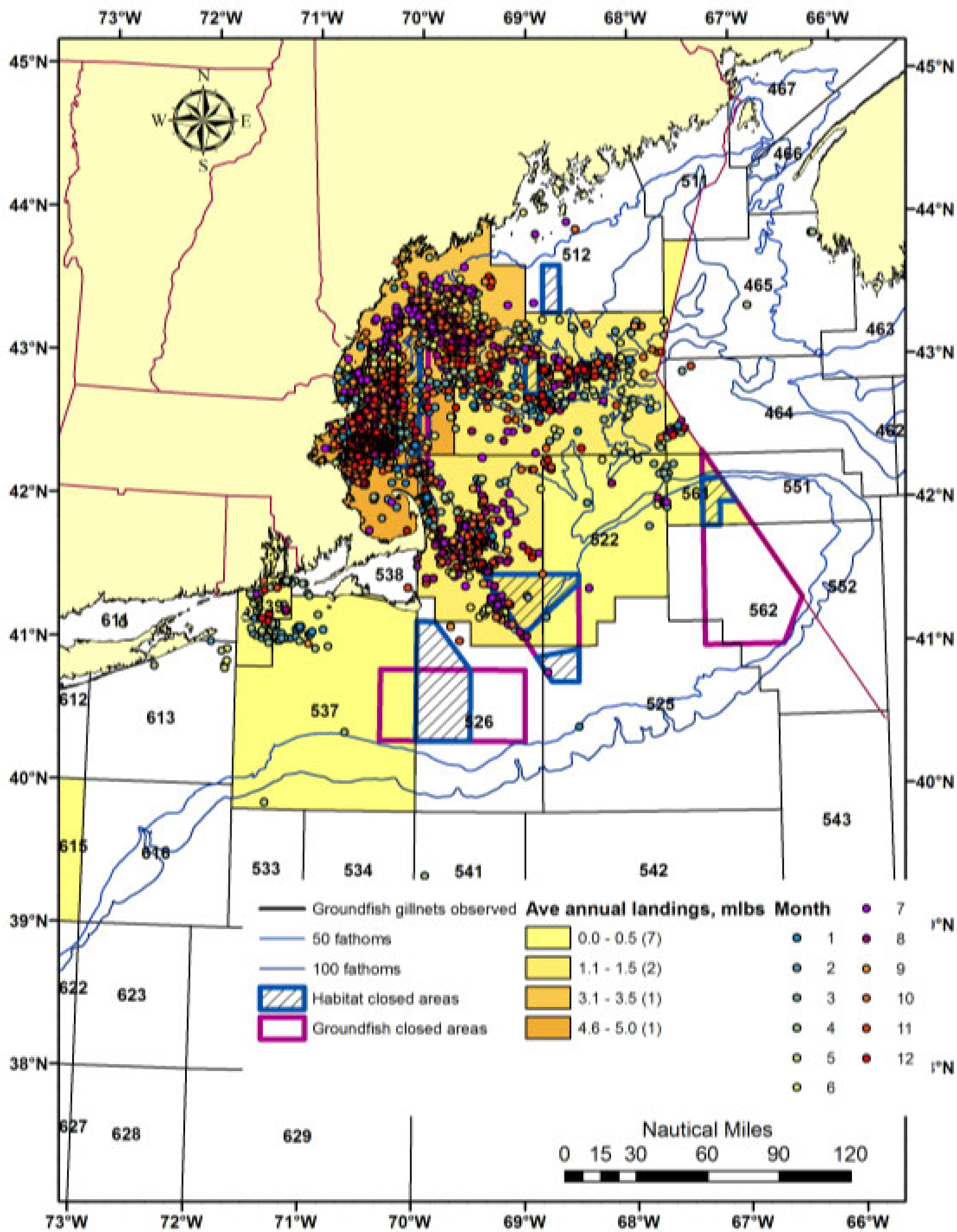
Map 68 – Large mesh demersal otter trawl effort 2008-2012. Yellow to brown shading shows average annual landings (live weight) by statistical area from the dealer tables. Black lines show start/end positions of hauls observed at sea.



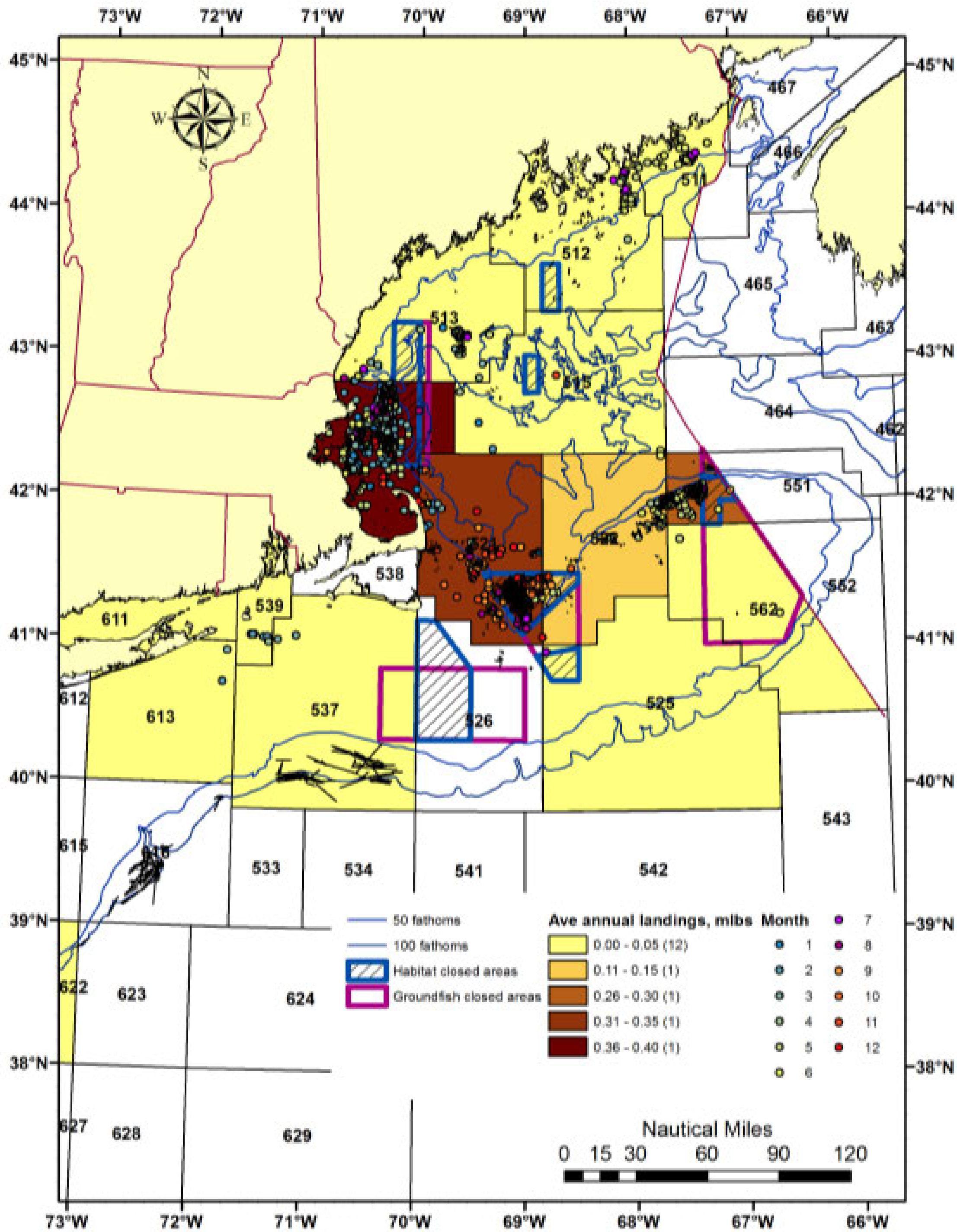
Map 69 – Large mesh multispecies separator trawl effort 2008-2012. Yellow to brown shading shows average annual landings (live weight) by statistical area from the dealer tables. Colored circles show the locations of trips as reported on vessel trip reports, from January (blue) to December (red).



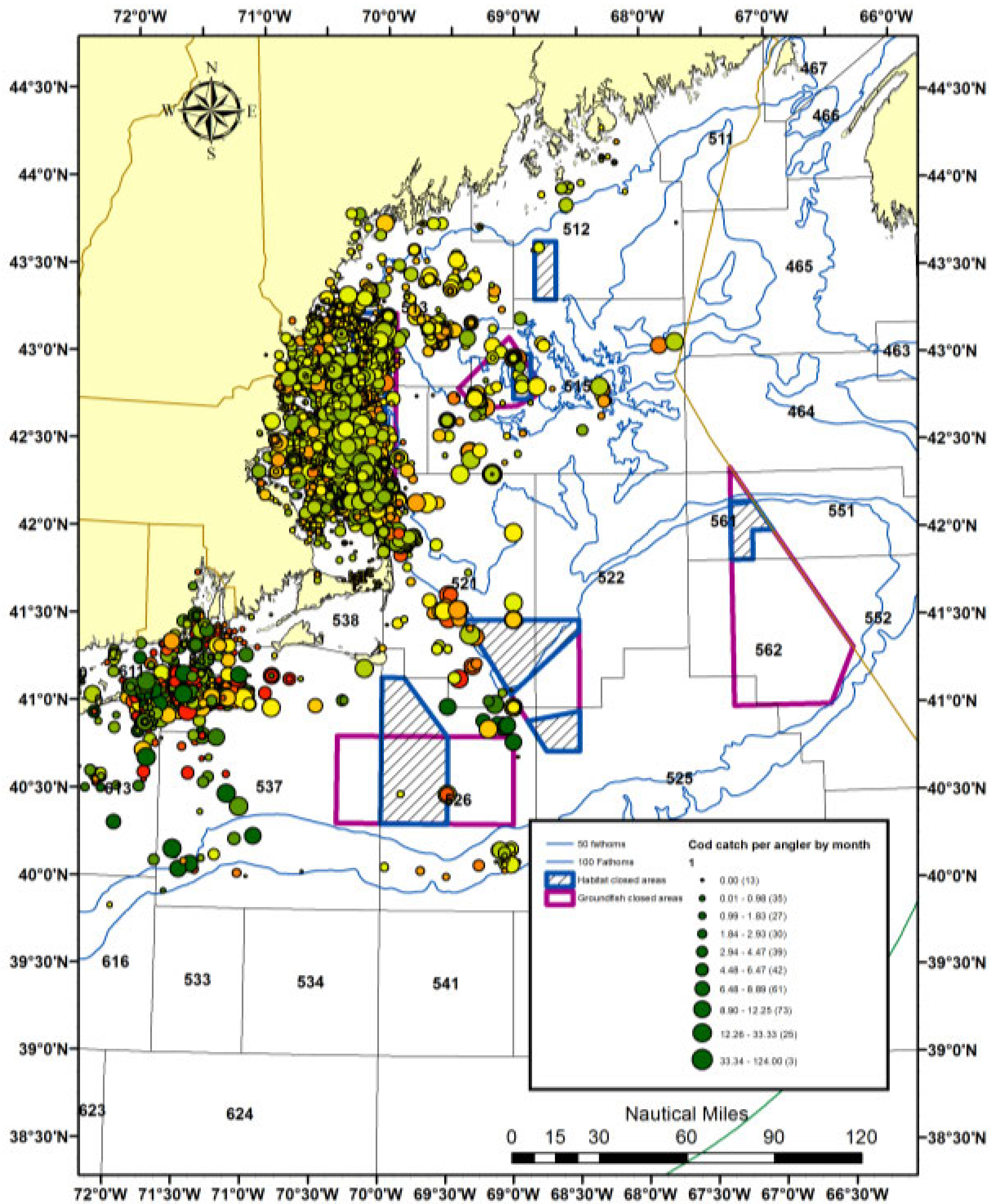
Map 70 – Large mesh multispecies gillnet effort, 2008-2012. Yellow to brown shading shows average annual landings (live weight) by statistical area from the dealer tables. Colored circles show the locations of trips as reported on vessel trip reports, from January (blue) to December (red).



Map 71 – Large mesh multispecies longline effort, 2008-2012. Yellow to brown shading shows average annual landings (live weight) by statistical area from the dealer tables. Colored circles show the locations of trips as reported on vessel trip reports, from January (blue) to December (red). Black lines show start/end positions of hauls observed at sea.



Map 72 – Trip location and cod catch per angler as reported on 2008-2012 Vessel Trip Reports. Increasing circle size indicates amount of catch, and circle color from dark green to red indicates month of the year, starting in January.



Data describing the catch of groundfish by gear type is relevant to the question of which gears should be included or excluded from spawning closures. This section summarizes the proportion of catch by weight in various species categories by gear within the rolling closures. High proportions for a given species or mix of species are assumed to indicate the species or species grouping is being targeted with that gear type, while low percentages are assumed to indicate incidental catches.

The species groups analyzed are cod, large mesh groundfish, other regulated/managed species, and other. The species included in large-mesh groundfish are: Atlantic cod, haddock, yellowtail flounder, Acadian redfish, winter flounder, American plaice, windowpane flounder, white hake, pollock, Atlantic halibut, witch flounder and Atlantic wolffish. The species included in other managed/regulated species are: spiny dogfish, barndoor skate, winter skate, clearnose skate, rosette skate, little skate, smooth skate, thorny skate, Atlantic herring, offshore hake, silver hake, red hake, summer flounder, Atlantic mackerel, butterfish, black sea bass, tautog, monkfish, American lobster, northern shrimp, sea scallop, shortfin squid and longfin inshore squid. Any species that was not included within large-mesh groundfish or managed/regulated species was listed under "other".

Catch on trips in the sector rolling closures from March-June during 2010-2013 is summarized in Table 27. Portions of these areas are closed during April, May, and June on a rolling south to north basis, so these data represent fishing with exempted gears, or fishing with restricted gears in open months/locations. Proportion of cod catch is highest on trips using the haddock separator trawl gear, making up 39% of total catch. Groundfish catch makes up the large majority of catch on trips using bottom trawl gear, indicating that gear is being used to target groundfish. Anchored-floating gillnets and bottom trawl gears are not exempted from the rolling closures. Total catch on trips using lobster pots/trap and scallop dredges is made up almost entirely of other managed/regulated species. These are exempted gear types in the rolling closures. Other species made up the majority of the catch on trips using shrimp trawl gear.

Table 27 – Summary of catch on trips inside the rolling closures from March-June in 2010-2013. Catch of each species group is averaged as a proportion of total catch for each gear type.

	Cod	LM Groundfish	Regulated Species	Other Species	Trips
Large mesh					
TRAWL,OTTER,BOTTOM,HADDOCK SEPARATOR	39.2%	82.1%	14.2%	3.6%	10
LONGLINE, BOTTOM	37.7%	77.4%	18.1%	4.5%	671
TRAWL,OTTER,BOTTOM,FISH	26.6%	68.9%	25.5%	5.6%	2482
GILL NET, DRIFT-SINK, FISH	14.7%	53.2%	44.4%	2.4%	67
GILL NET, ANCHORED-FLOATING, FISH	-	-	-	-	2
GILL NET, FIXED OR ANCHORED,SINK, OTHER/NK SPECIES	22.3%	47.1%	49.5%	3.4%	3366
POT/TRAP, LOBSTER OFFSH NK	0.3%	0.9%	94.4%	4.7%	137
DREDGE, SCALLOP,SEA	0.0%	0.9%	78.0%	21.1%	207
Small Mesh					
GILL NET, FIXED OR ANCHORED,SINK, OTHER/NK SPECIES	-	-	-	-	1
TRAWL,OTTER,BOTTOM,SHRIMP	0.0%	2.3%	8.8%	88.9%	12
TRAWL,OTTER,MIDWATER PAIRED	-	-	-	-	1

4.3.2 Small-mesh groundfish

Information is provided for each of the small-mesh species in the Northeast Multispecies Fishery Management Plan.

4.3.2.1 Biology, status, and overall distribution

4.3.2.1.1 Silver hake

Silver hake (*Merluccius bilinearis*) occur throughout the Gulf of Maine and in moderate to deeper depths on Georges Bank and in the Mid-Atlantic Bight. In the NEFSC trawl survey, larger and older fish are found further north and in deeper waters, and smaller younger fish are found in relatively shallow waters (NEFSC 2006). Depth appears to be a more important determinant of silver hake distribution than temperature (NEFSC 2006).

In terms of substrate associations, in the NEFSC trawl survey, catch rates increase from fine sand to silt to clay; and are generally higher in all these than on coarser substrates (Methratta and Link 2006). This conclusion is consistent with an analysis relating survey catches to bottom reflectance in the southwestern Gulf of Maine, where trawl catches were significantly negatively correlated with bottom reflectance (low reflectance = soft substrates) (Auster et al. 2001). Silver hake have been observed at high densities in mud habitats bordering deep boulder reefs, resting on boulder surfaces, and foraging over deep boulder reefs in the southwestern Gulf of Maine (Auster and Lindholm 2005).

In terms of structural habitat feature associations, Auster et al. (1997) found that small silver hake (1.5-5 cm) in the Mid-Atlantic Bight were more abundant on silt-sand bottoms containing amphipod tubes at depths of 55 m. Steves and Cowen (2000) found amphipod tube mats to be associated with 0-group silver hake within the New York Bight. Auster et al. (2003) studied the small scale spatial distributions of both juvenile and adult silver hake within sand wave habitats and the diel patterns of habitat use on the southern side of Georges Bank and on Stellwagen Bank. Silver hake were not randomly distributed within sand wave habitats; there was a positive relationship between fish length and sand wave period. However, other factors, such as currents and available prey, may also influence their distribution in these habitats. Fish were in direct contact with these sand wave habitats with greater frequency during the day, and fish were observed in social or co-operative foraging (polarized groups of fish swimming in linear formation) during the day and at dusk. At one site in the Mid-Atlantic Bight, silver hake (12.6-27.6 cm) were found on flat sand, sand-wave crests, shell and biogenic depressions, but most often on flat sand (Auster et al. 1991). Silver hake were associated with particular microhabitats (e.g., sand-wave crests, biogenic depressions) at the 55 m site during the day but were randomly distributed during the night; this may be attributed to diel differences in feeding behavior (Auster et al. 1995). At the larger, regional scale within the New York Bight, juveniles showed high variability in abundance between stations in a study by Sullivan et al. (2000).

Steves and Cowen (2000) also suggest that early settlement patterns of silver hake are cued to a narrow interaction of temperature and depth, with a subsequent broadening of habitat preference as juveniles grow and local physical regimes shift. Steves et al. (2000) found that age-0 silver hake showed some movement in depth between their settlement and nursery areas within the outer shelf of the New York Bight; also, settlement did not peak until bottom temperature was > 9ºC.

This species makes greater use of the water column (for feeding, at night) than other two hakes and avoids gravel, rocky habitats, preferring fine sediments and deeper water (>70 m for adults).

Silver hake eggs and larvae have been collected in all months on the continental shelf in U.S. waters, although the onset of spawning varies regionally (Bigelow and Schroeder 1953; Marak and Colton 1961; Sauskan and Serebryakov 1968; Fahay 1974; Morse et al. 1987; Waldron 1988; Berrien and Sibunka 1999). The primary spawning grounds most likely coincide with concentrations of ripe adults and newly spawned eggs. These grounds occur between Cape Cod, Massachusetts, and Montauk Point, New York (Fahay 1974), on the southern and southeastern slope of Georges Bank (Sauskan 1964) and the area north of Cape Cod to Cape Ann, Massachusetts (Bigelow and Schroeder 1953).

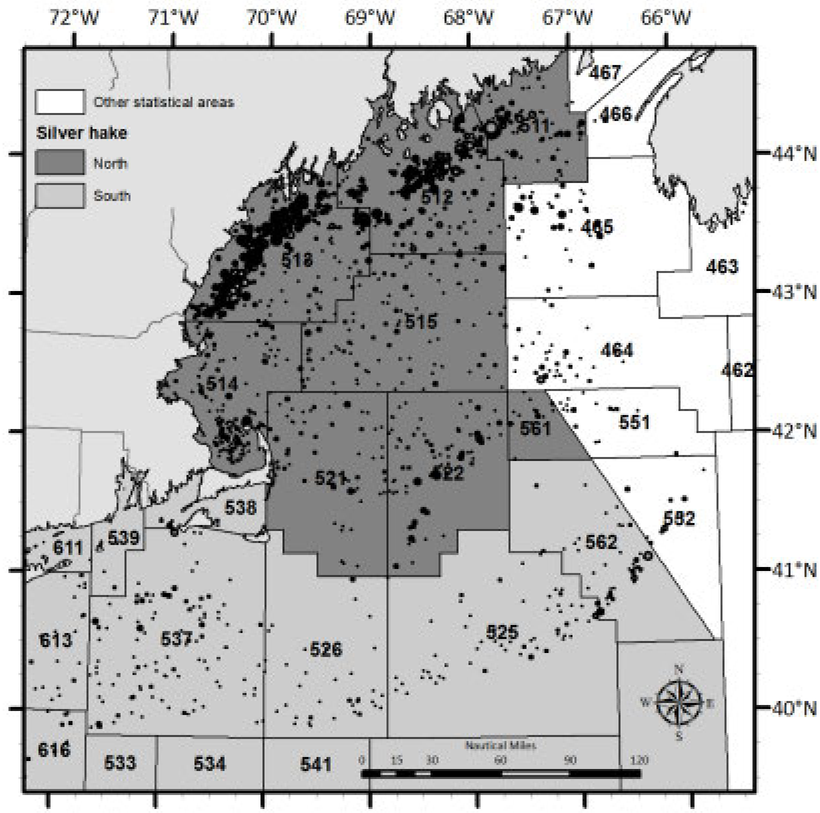
Spawning begins in January along the shelf and slope in the Mid-Atlantic Bight. During May, spawning proceeds north and east to Georges Bank. By June spawning spreads into the Gulf of Maine and continues to be centered on Georges Bank through summer. In October, spawning is centered in southern New England and by December is observed again along the shelf and slope in the Mid-Atlantic Bight. Peak spawning occurs from May to June in the southern stock and July to August in the northern stock (Klein-MacPhee 2002).

Variations in diet of silver hake are dependent upon size, sex, season, migration, spawning, and age with size having the most influence on diet. Silver hake larvae feed on planktonic organisms such as copepod larvae and younger copepodites. The diet of young silver hake consists of euphausiids, shrimp, amphipods, and decapods. All silver hake are ravenous piscivores that feed on smaller hake and other schooling fishes such as young herring, mackerel, menhaden, alewives, sand lance, or silversides, as well as crustaceans and squids.

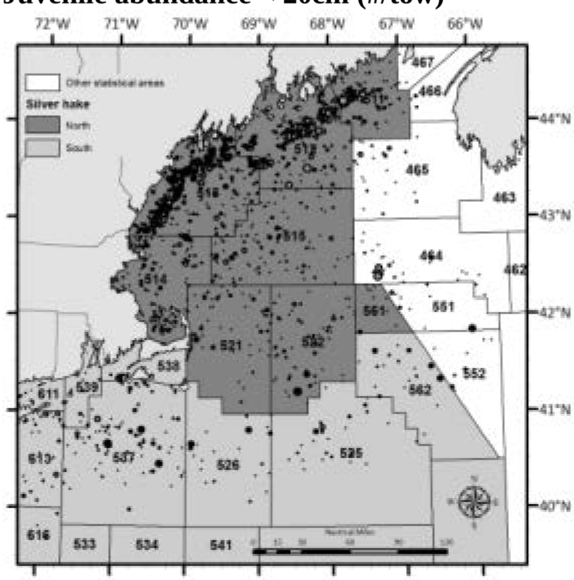
Silver hake, red hake, and offshore hake were last assessed at the 51st Northeast Regional Stock Assessment Workshop held in November-December 2010 (NEFSC 2011). Northern and southern silver hake are assessed separately. While a formal analytical assessment was attempted, the model was deemed insufficient for use in providing management advice, due in part to questions about survey catchability across ages and years. Based on reference points updated during the assessment, the stocks are not overfished and overfishing is not occurring. The biomass reference point is based on catch per tow in the trawl survey, and the fishing mortality reference point is based on an exploitation index, i.e. fishery catch divided by the survey catch per tow biomass index.

Map 73 – Silver hake stock boundaries and catch/tow from spring and fall NEFSC, MADMF, and ME/NH surveys, 2002-2013. Spring survey values shaded grey may obscure fall survey values shaded black. Small juvenile and large spawner size thresholds correspond to sizes used in the hotspot analysis (Section 0) to help identify critical juvenile habitat and spawning areas.

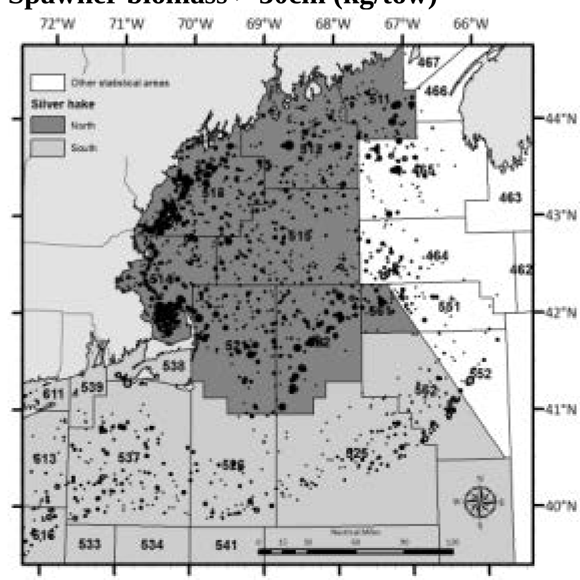
Total biomass (kg/tow)



Juvenile abundance < 20cm (#/tow)



Spawner biomass > 30cm (kg/tow)



4.3.2.1.2 Red hake

Red hake (*Urophycis chuss*) are found throughout the Gulf of Maine, on Georges Bank, and in the Mid-Atlantic Bight.

They occur at a wide range of depths throughout the year, the juveniles in particular making seasonal migrations to follow preferred temperature ranges. Specifically, in the Mid-Atlantic Bight, the juveniles move into deeper waters in the fall, while on Georges Bank, they are found in shallower waters in fall and nearly absent in the spring, when they occur mostly on the northern edge. Overall, juveniles have a shallower distribution in the NEFSC trawl surveys, 0-30 m in spring and 40-80 m in fall, while adults are found between 60-300 m in spring, and 50-160 m in the fall.

During the warmer months, adults are most common in depths < 100 m; during colder months, they are most common in depths > 100 m. Fritz (1965) reported that they range from 30-370 m and that they are most common in the fall between 50-210 m. In the spring and fall, the adults remain in deeper water off the northern edge and southern flank of Georges Bank, and are found throughout the Gulf of Maine, especially the southwestern Gulf of Maine. Some adults move inshore in the Mid-Atlantic Bight in the spring, but do not exhibit the extensive seasonal migration as the juveniles do. In the Great South Channel, both life stages are mostly limited to depths >60 m; a few juveniles are found <60m in the fall.

Shelter is a critical habitat requirement for juvenile red hake (Steiner et al. 1982). Newly settled juveniles occur in depressions on the open seabed (Able and Fahay 1998). Young of the year red hake are found in shallow coastal and estuarine habitats associated with eelgrass and macroalgae on mud and sand sediments (Lazzari et al. 2003). Older juveniles commonly associate with shelter or structure, including: live sea scallops (*Placopecten magellanicus*) where they can be found under the scallops on the sediment or within their open mantle cavity (Steiner et al. 1982; Garman 1983; Able and Fahay 1998); Atlantic surfclam (*Spisula solidissima*) shells; seabed depressions made by larger fish or decapod crustaceans; moon snail egg case collars; anemone and polychaete tubes (Wicklund 1966; Ogren et al. 1968; Stanley 1971; Shepard et al. 1986); and submerged man-made objects, debris, and artificial reefs (Eklund 1988). Larger juveniles remain near scallop beds and other structures in coastal areas and embayments; later they join older fish in an offshore migration in the Mid-Atlantic Bight.

Adults prefer soft sediments over gravel or hard bottoms, and can also be found in the water column (Collette and Klein-MacPhee 2002; Gottschall et al. 2000). Similar to juveniles, adults are not common on open sandy bottom, and instead occur in depressions, which they either find or create themselves (Auster et al. 1991). Adults also inhabit inshore artificial reefs off New York during the summer (Ogren et al. 1968); Eklund (1988) reported that they were most abundant on natural and artificial reefs off Delaware-Virginia during April to May.

Major spawning areas occur on the southwestern part of Georges Bank and on the continental shelf off southern New England and eastern Long Island. Spawning adults and eggs are also common in the marine parts of most coastal bays between Narragansett Bay, Rhode Island, and Massachusetts Bay, but rarely in coastal areas to the south or north (Jury et al. 1994; Stone et al.

1994). Spawning begins earlier, around March, in the Mid-Atlantic Bight and later, around May or June, further north.

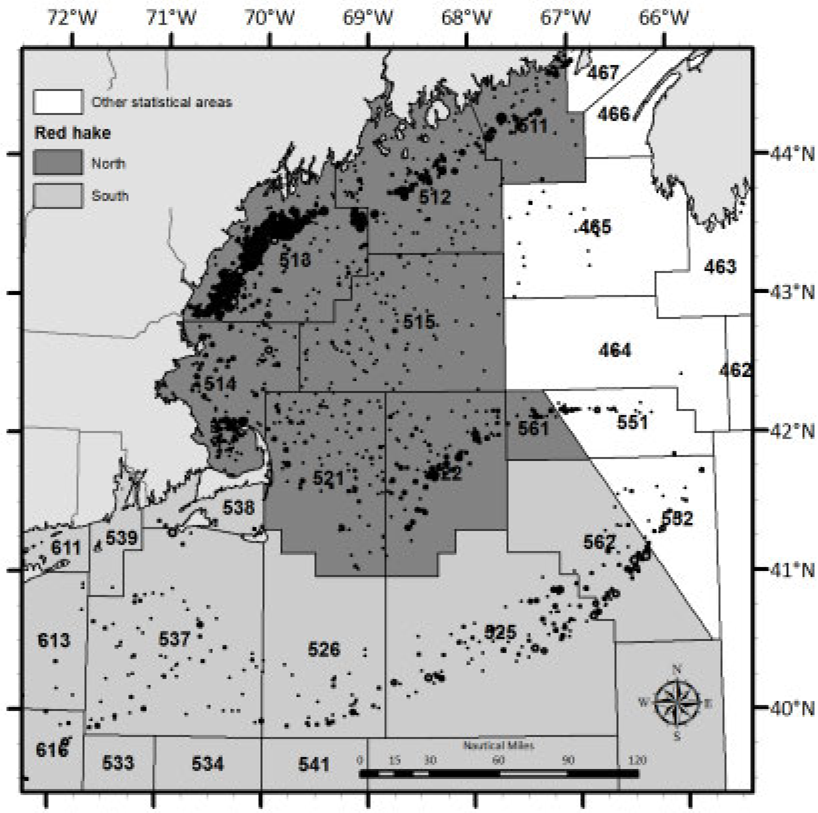
Juveniles consume small benthic and pelagic crustaceans, as well as polychaete worms. Larger juveniles and adults consume mostly decapods and gadids, in addition to amphipods, euphausiids, squid, and other types of fish. Prey selection varies by season and according to the size of the hake.

Red hake is managed as a component of the Northeast Multispecies FMP as two stocks. Northern and southern red hake are assessed separately. While a formal analytical assessment was attempted in 2010 (51st Stock Assessment Workshop, 2011), the model was deemed not sufficient for use in providing management advice. The biomass reference point is based on catch per tow in the trawl survey, and the fishing mortality reference point is based on an exploitation index, i.e. fishery catch divided by the survey catch per tow biomass index. Based on reference points updated during the assessment, neither of the stocks is overfished and overfishing is not occurring.

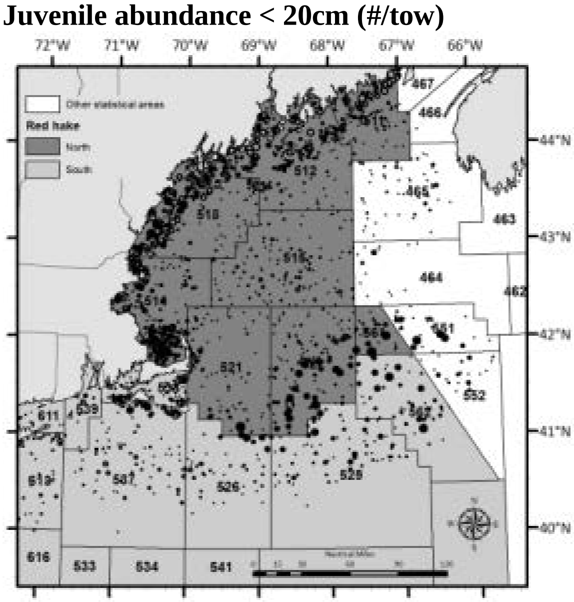
In 2013, the small-mesh multispecies fishery took 145 percent of its annual catch limit for northern red hake. Generally, the fishery is restricted to an incidental trip limit when 90 percent of the total allowable landings has been harvested. The annual catch limit overage trigged an accountability measure for the 2014 fishing year. As a result, in 2014, the trip limit will be reduced to the 400 lb incidental limit when 45 percent of the TAL is harvested.

Map 74 – Red hake stock boundaries and catch/tow from spring and fall NEFSC, MADMF, and ME/NH surveys, 2002-2013. Spring survey values shaded grey may obscure fall survey values shaded black. Small juvenile and large spawner size thresholds correspond to sizes used in the hotspot analysis (Section 0) to help identify critical juvenile habitat and spawning areas.

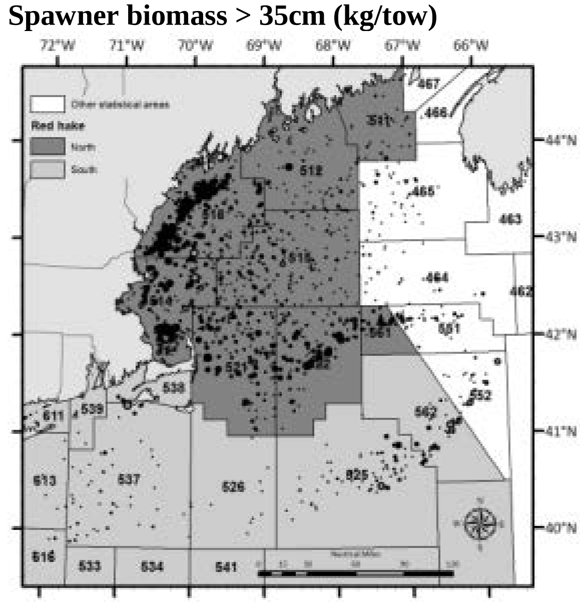
Total biomass (kg/tow)



Juvenile abundance < 20cm (#/tow)



Spawner biomass > 35cm (kg/tow)



4.3.2.1.3 Offshore hake

Offshore hake (*Merluccius albidus*) are found along the shelf/slope break. Their distribution in the Northeast US extends from the southeastern flank of Georges Bank to Cape Hatteras.

At night, juveniles and adults are found in the water column. During the day, both life stages are found in mud, mud/sand, and sand habitats. As their common name implies, offshore hake have the deepest distribution of any of the four hake species managed by NEFMC.

There is little information available on the reproductive biology of offshore hake. Spawning appears to occur over a protracted period or even continually throughout the year from the Scotian Shelf through the Mid-Atlantic Bight.

Offshore hake feed on pelagic invertebrates, e.g. euphausiids and other shrimps, and pelagic fish, including conspecifics.

Offshore hake, red hake, and silver hake were last assessed at the 51st Northeast Regional Stock Assessment Workshop held in November-December 2010 (NEFSC 2011). While a first attempt at a formal analytical assessment was attempted, the model was deemed insufficient for use in providing management advice. It was determined that there is insufficient evidence to make a status determination for the stock, and current reference points were rejected. The primary issues in determining reference points are that the surveys cover an unknown and variable portion of the stock, and that commercial catch data are insufficient to understand trends.

4.3.2.2 Fishery

Silver hake, red hake, and offshore hake are targeted by the small mesh groundfish fishery and are managed under the Northeast Multispecies FMP.

The Council developed Amendment 19 to bring the small-mesh multispecies portion of the Northeast Multispecies FMP into compliance with the Annual Catch Limit and accountability measure requirements of the reauthorized Magnuson-Stevens Act. Development of Amendment 19 was delayed for several reasons, so NMFS implemented Annual Catch Limits and Accountability Measures for the small-mesh multispecies in 2012 through a Secretarial Amendment. The Council continued development of Amendment 19 in order to adopt the Annual Catch Limit framework used by the Secretarial Amendment, as well as to modify other management measures for the small-mesh multispecies fishery. The measures included an incidental trip limit trigger to prevent the Annual Catch Limit from being exceeded, a year-round trip limit for red hake, and the potential to implement a quarterly quota system in the southern area, should landings increase rapidly. Because these species are caught incidentally in many fisheries, landings are never prohibited if a quota is projected to be reached, just reduced to an incidental limit to discourage directed fishing.

In general, small-mesh multispecies are managed using mesh-size-dependent trip limits for whiting (silver and offshore hake, combined), a new year-round trip limit for red hake, and area restrictions on small-mesh use, which are implemented as a series of exemptions from the Northeast Multispecies FMP (Map 75). The small mesh fishery is prosecuted using otter trawls.

The FMP requires that a fishery should routinely catch less than 5% of regulated multispecies (i.e. large mesh species and ocean pout described in the previous section) to be exempted from the minimum mesh size. In the Gulf of Maine and Georges Bank Regulated Mesh Areas (Map 75), there are six exemption areas, which are open seasonally (Table 28). The Southern New England and Mid-Atlantic Exemption Areas allow small-mesh fishing year-round and the small-mesh fishery uses mesh-size dependent trip limits.

Table 28 – Small mesh exemption area seasons.

<table>
<tr><th>Area name</th><th>May</th><th>Jun</th><th>Jul</th><th>Aug</th><th>Sep</th><th>Oct</th><th>Nov</th><th>Dec</th><th>Jan</th><th>Feb</th><th>Mar</th><th>Apr</th></tr>
<tr><td>Cultivator Shoals Exemption Area</td><td></td><td colspan="5">Jun 15 – Oct 31</td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>Gulf of Maine Grate Raised Footrope Area</td><td></td><td></td><td colspan="5">Jul 1 – Nov 30</td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>Small Mesh Area I</td><td></td><td></td><td colspan="5">Jul 15 – Nov 30</td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>Small Mesh Area II</td><td colspan="2">Jan 1 –Jun 30</td><td></td><td></td><td></td><td></td><td></td><td></td><td colspan="4">Jan 1 –Jun 30</td></tr>
<tr><td>Cape Cod Raised Footrope Trawl – western area</td><td></td><td></td><td></td><td></td><td colspan="3">Sep 1 – Nov 20</td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>Cape Cod Raised Footrope Trawl – eastern area</td><td></td><td></td><td></td><td></td><td colspan="4">Sep 1 – Dec 31</td><td></td><td></td><td></td><td></td></tr>
</table>

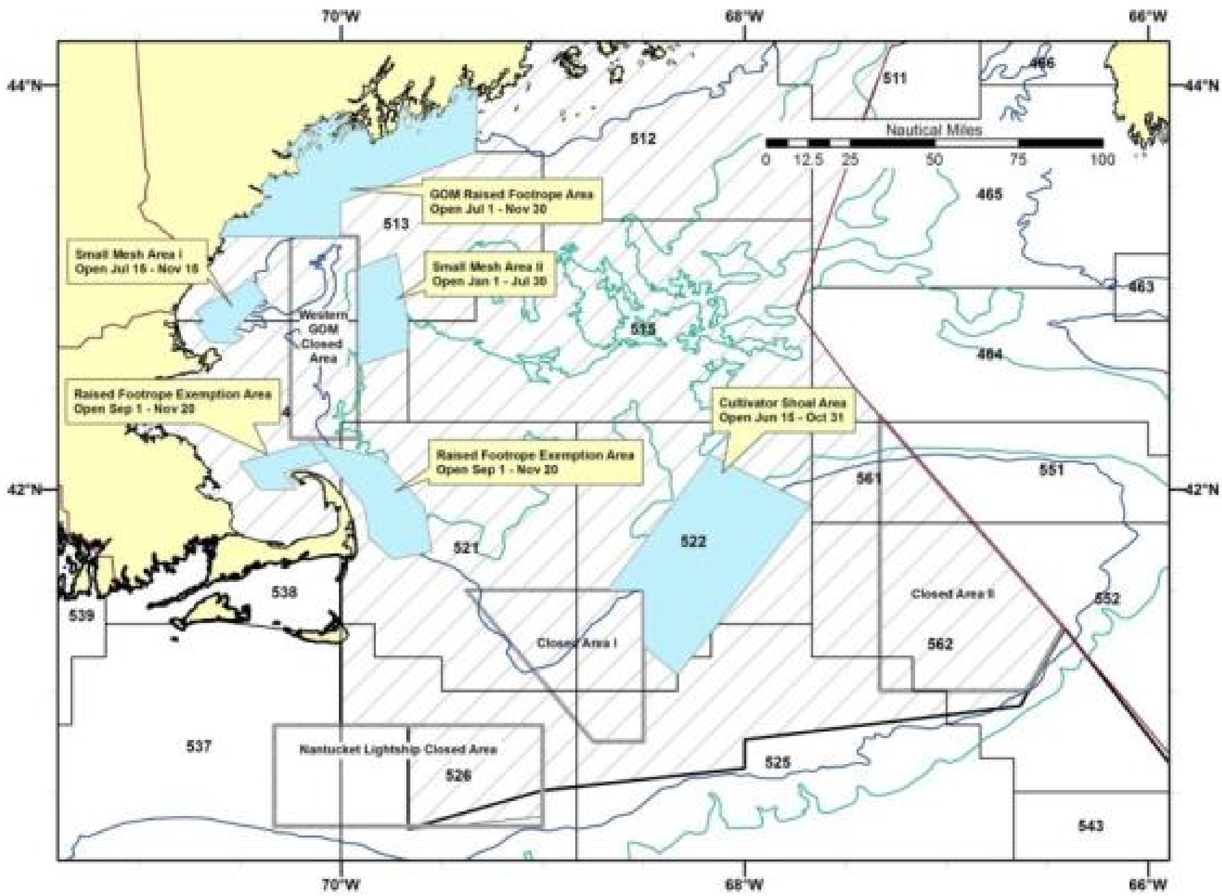
The exemption areas were implemented as part of several different amendments and framework adjustments to the FMP. In 1991, Amendment 4 incorporated silver and red hake and established an experimental fishery on Cultivator Shoal. Framework Adjustment 6 (1994) was intended to reduce the catch of juvenile whiting by changing the minimum mesh size from 2.5 inches to 3 inches. Small Mesh Areas I and II, off the coast of New Hampshire, were established in Framework Adjustment 9 (1995). The Council added offshore hake in Amendment 12 (2000). The Raised Footrope Trawl Area off of Cape Cod was established in Framework Adjustment 35 (2000). A modification to Framework Adjustment 35 in 2002 adjusted the boundary along the eastern side of Cape Cod and extended the season to December 31 in the new area. Framework Adjustment 37 modified and streamlined some of the varying management measures to increase consistency across the exemption areas. In 2003, Framework Adjustment 38 established the Grate Raised Footrope Exemption Area in the inshore Gulf of Maine area.

The Gulf of Maine Grate Raised Footrope area requires the use of an excluder grate on a raised footrope trawl with a minimum mesh size of 2.5 inches. A raised footrope trawl is required in Small-mesh Areas I and II, and the trip limits are mesh size dependent. Cultivator Shoal Exemption Area requires a minimum mesh size of 3 inches. The Raised Footrope Trawl Exemption Areas around Cape Cod require a raised footrope trawl, with a minimum mesh size of 2.5-inch square or diamond mesh. The Southern New England and Mid-Atlantic Regulated Mesh Areas are open year-round and have mesh size dependent possession limits for the small-mesh multispecies. The mesh size dependent possession limits are: smaller than 2.5” - 3,500 lb; larger than 2.5”, but smaller than 3.0”, - 7,500 lb; equal to or greater than 3.0”- 30,000 lb.

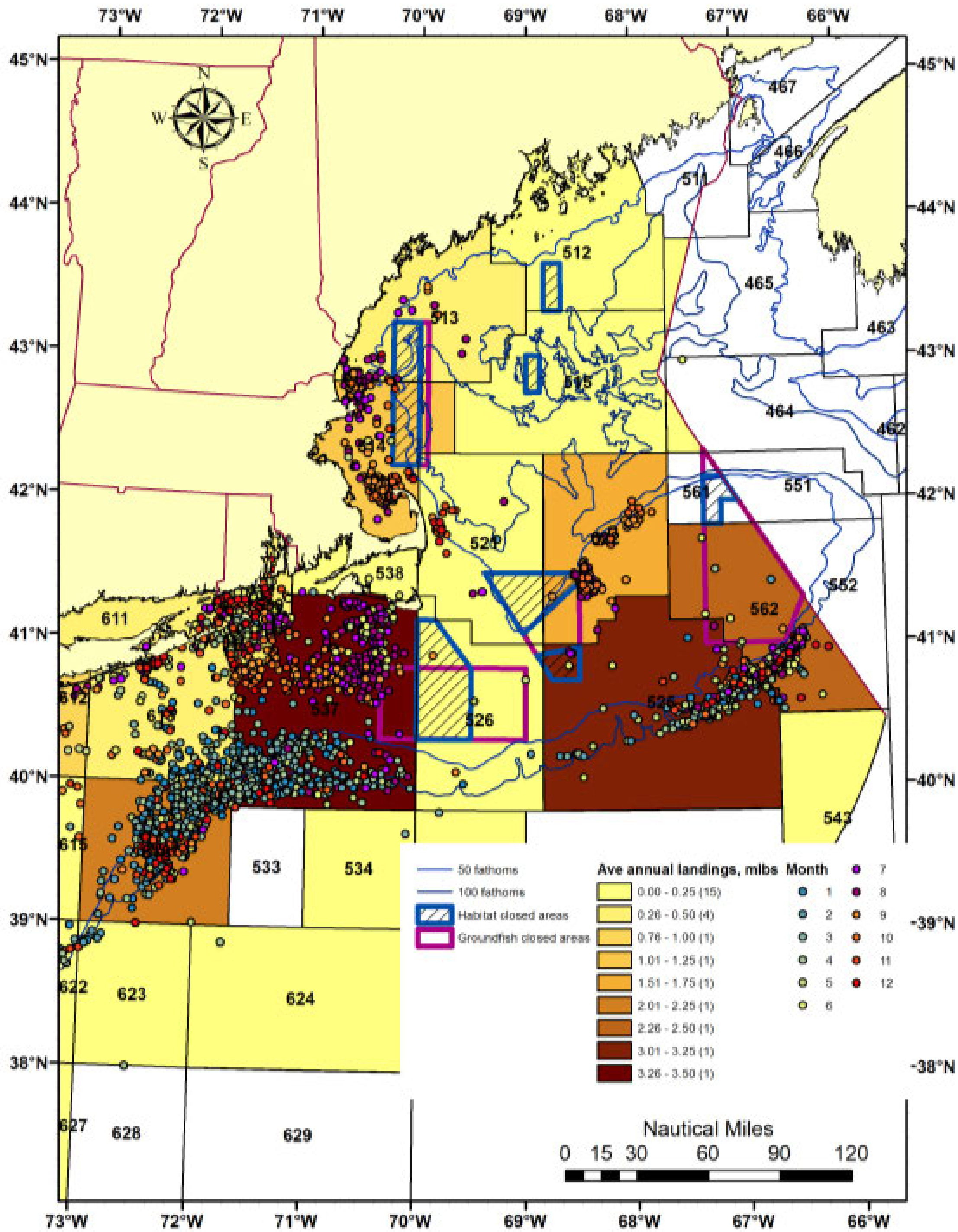
Vessels participating in any of the exemption areas must have a Northeast Multispecies limited access or open access category K permit and must have a letter of authorization from the Regional Administrator to fish in Cultivator Shoal and the Cape Cod Raised Footrope areas. All of the exemption areas, including the Mid-Atlantic and Southern New England regulated mesh areas, have a 5,000 lb possession limit for red hake.

The general distribution of effort and landings in the small mesh multispecies fishery is shown below.

Map 75 – Small-mesh exemption areas in the Gulf of Maine and on Georges Bank.



Map 76 – Small mesh multispecies trawl effort, 2008-2012. Yellow to brown shading shows average annual landings (live weight) by statistical area from the dealer tables. Colored circles show the locations of trips as reported on vessel trip reports, from January (blue) to December (red).



4.3.3 Monkfish

4.3.3.1 Biology, status, and overall distribution

Juvenile and adult monkfish (*Lophius americanus*, also referred to as goosefish) are common and widespread in mud habitats throughout the Gulf of Maine, and in muddier and deeper (<50 m) shelf-slope waters from the Hague Line to Cape Hatteras.

In broad scale surveys of the Gulf of Maine/Georges Bank/Northern Mid-Atlantic Bight region, monkfish remain in deep water during both fall and spring, and are generally associated with fine-grained sediments, i.e. silt and clay (Methratta and Link 2006). Pairwise comparisons showed monkfish biomass in kilograms per tow was lower in fine rock (granule-pebbles, 2-8 mm grain size) than in silt or clay. Results of more targeted bottom trawling in the southwestern Gulf of Maine on isolated mud bottom versus mud that is next to rocky bottom shows that monkfish were equally abundant (number/tow) in both habitats, but adult fish on edge of structured habitat had more to eat and were in better condition (Smith et al 2008). The northern portion of the Western Gulf of Maine Closure Area was not found to be a good nursery area for juveniles: they were more abundant and had more to eat outside the closed area (Smith et al. 2008).

Monkfish spawn between spring and early fall with a peak in May-June. Spawning occurs earlier in low latitudes and later in the northern part of their range. Their eggs are deposited in a veil, which remains in the surface currents for a few weeks before it disintegrates and the larvae hatch. Based on their size and shape, it appears that the egg veils are designed for surface current transport (http://www.nefsc.noaa.gov/read/popdy/monkfish/MonkfishEggveilReporting/)

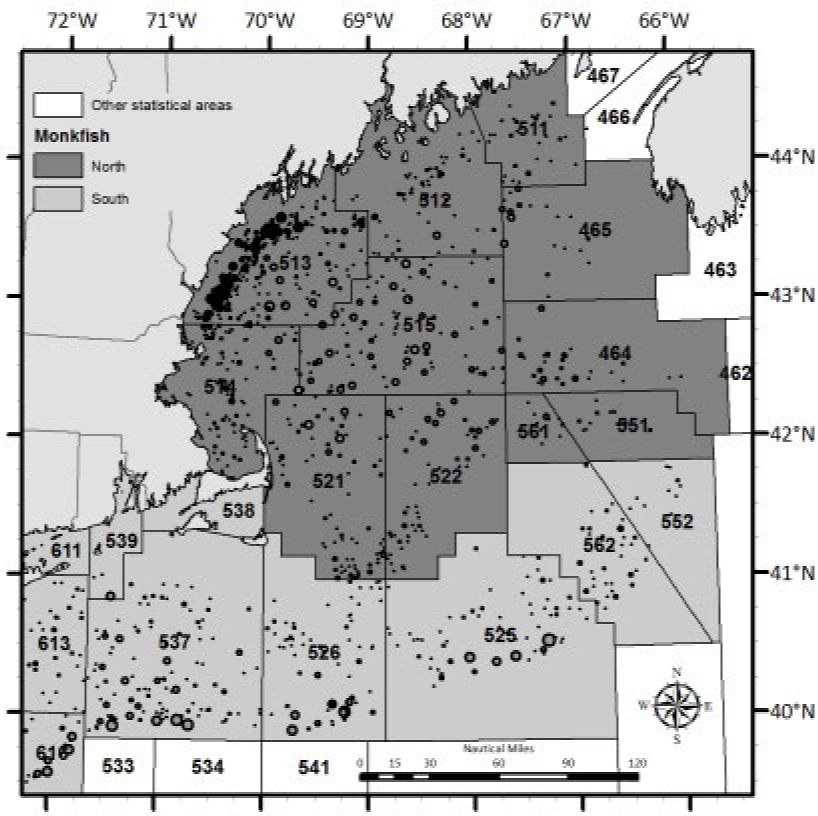
Monkfish are opportunistic predators that feed on a wide variety of benthic and pelagic species, depending on availability. However, the major prey items of juveniles and adults are squid and fish. Juveniles consume silver hake and flounders, and adults eat a wide range of fish species.

Monkfish north of Georges Bank and south of Georges Bank are managed separately, and both reference points and the assessment model were updated during the 2010 assessment, with reference points further refined during the 2013 operational assessment. While the 2007, 2010, and 2013 assessments suggested that the stocks are not overfished and overfishing is not occurring, there are considerable uncertainties in many assessment inputs and outputs (NEFSC 2010; NEFSC 2013). The 2011 biomass estimate for the northern component is well above the biomass threshold, and about 55 percent higher than the biomass estimated for 2006 (NEFSC 2013). The 2013 stock assessment also emphasized a high degree of uncertainty, stating: "The assessment results continue to be uncertain due to cumulative effects of under-reported landings, unknown discards during the 1980s, uncertainty in survey indices, and imcomplete understanding of key biological parameters such as age and growth, longevity, natural mortality and stock structure contributing to retrospective patterns primarily in the northern management area."

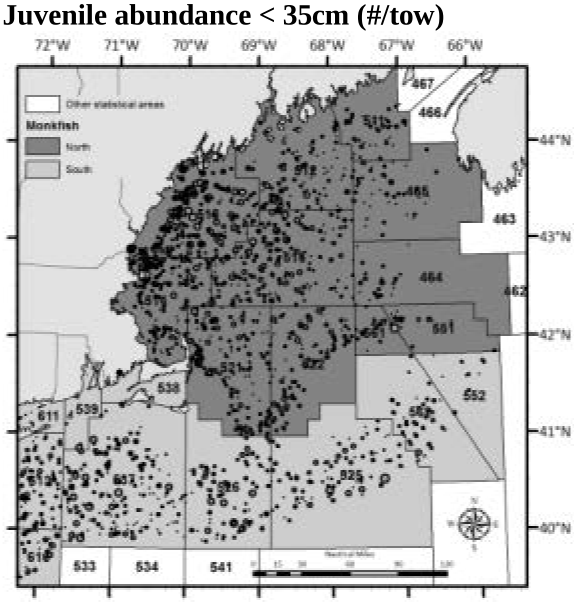
Relatively infrequent catches in various surveys contribute uncertainty to the assessment, although the new R/V Henry B. Bigelow catches more monkfish and covers the entire range of the species in U.S. waters (Richards et al. 2012, NEFSC 2010). Another issue is that the rate of mixing between the two populations is not well known (Richards et al. 2012). There are also questions about monkfish growth and aging, commercial landings and discards, natural mortality rates, and sex ratios. Tagging studies are underway to investigate mixing, growth, and aging questions (some results presented in Richards et al. 2012).

Map 77 – Monkfish stock boundaries and catch/tow from spring and fall NEFSC, MADMF, and ME/NH surveys, 2002-2013. Spring survey values shaded grey may obscure fall survey values shaded black.

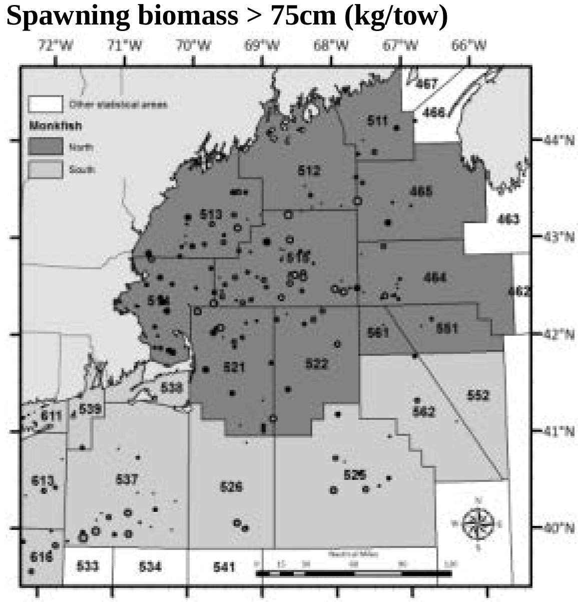
Total biomass (kg/tow)



Juvenile abundance < 35cm (#/tow)



Spawning biomass > 75cm (kg/tow)



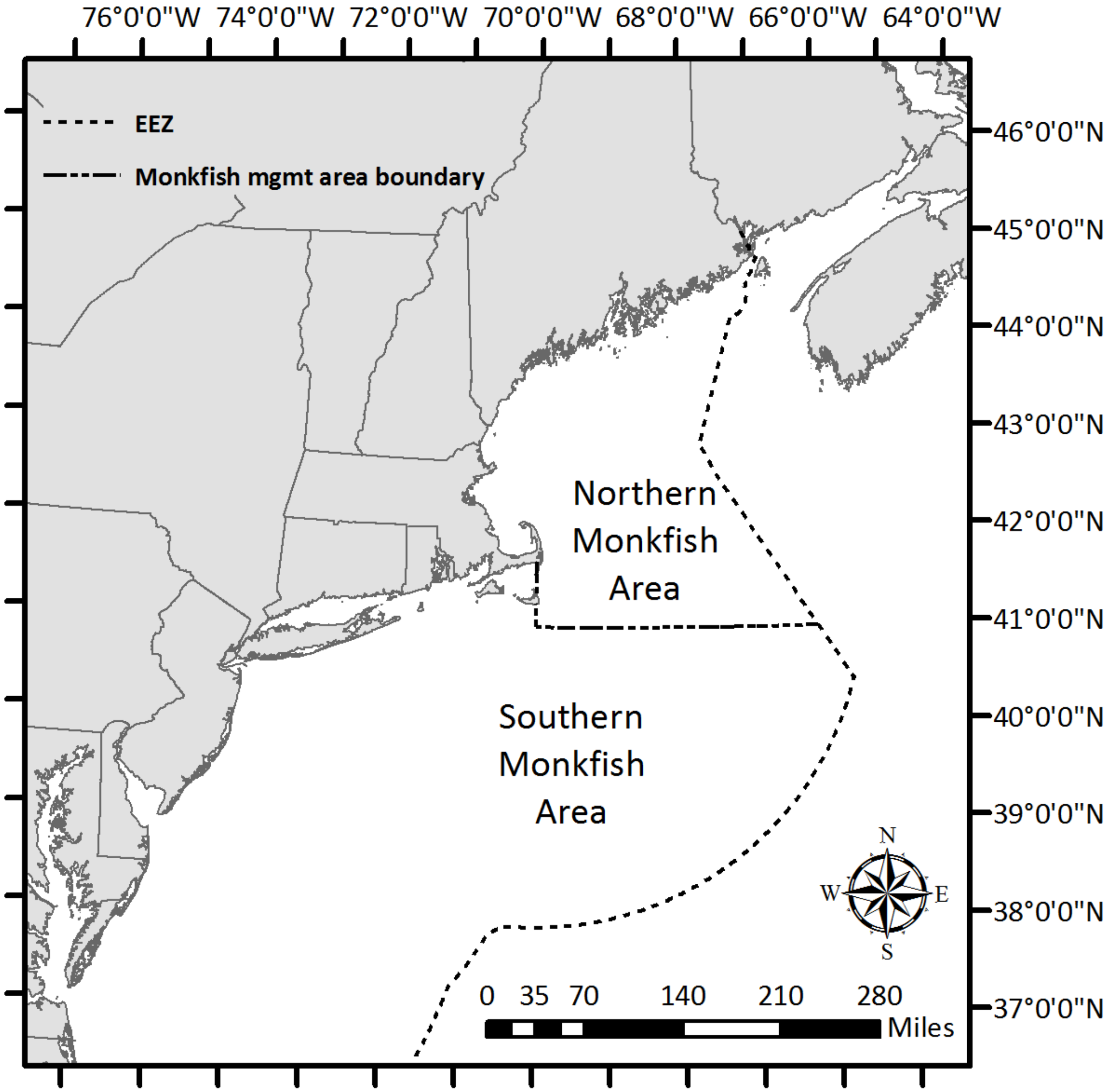
4.3.3.2 Fishery

Monkfish have a large, bony head and are harvested for their livers and the tender meat in their tails. During the early 1990s, fishermen and dealers in the monkfish fishery approached both the New England and Mid-Atlantic Councils with concerns about the increasing amount of small fish being landed, the increasing frequency of gear conflicts between monkfish vessels and those in other fisheries, and the expanding directed trawl fishery. In response, the Councils developed a joint FMP that was implemented in 1999. Since the implementation of the FMP, vessels are more commonly landing large, whole monkfish for export to Asian markets.

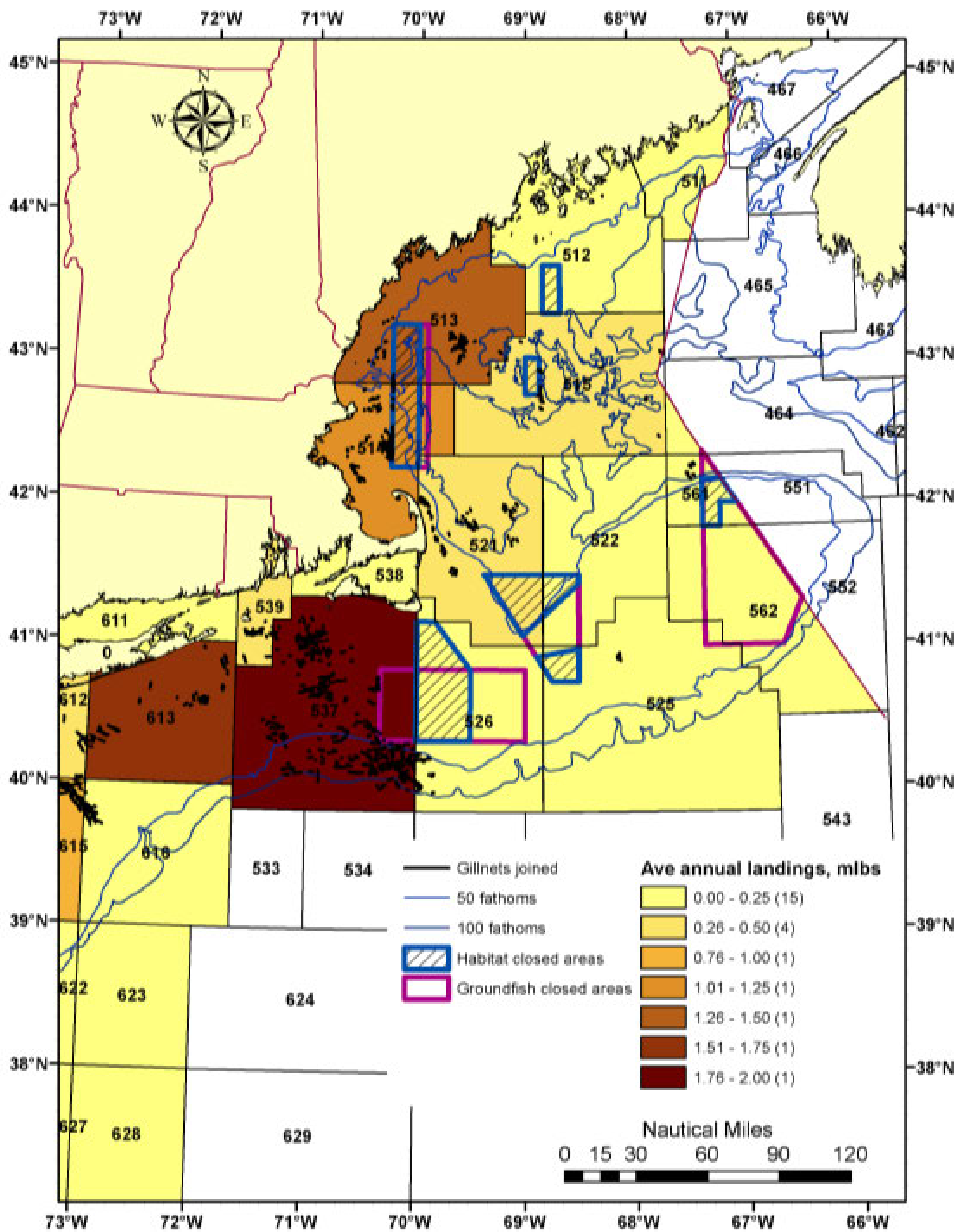
For management purposes, the monkfish fishery is divided into two areas, the Northern and Southern Management Areas (Map 78). While scientific evidence for two biological stocks is uncertain, and additional research, including archival tagging, is ongoing, the fisheries in the two areas are clearly distinct. Stock assessments are done on the two areas separately to be able to support the management plan. The Northern Management Area monkfish fishery is closely integrated with the northeast multispecies fishery, and is primarily a trawl fishery, while the Southern Management Area fishery is primarily a gillnet fishery targeting monkfish almost exclusively. These differences have resulted in some differences in management measures, such as trip limits and DAS allocations, between the two areas.

According to 2007-2012 vessel trip reports, 47% of monkfish landings were made using gillnets (Map 79) with most of the remainder (45%) landed by otter trawls (Map 80, percentages based on data from the Regional Office's Analytical and Program Support Division). Scallop dredges also catch monkfish, but in much smaller amounts. No other gear types account for more than trace landings of monkfish, and there is no recreational component to this fishery. Revenues have generally increased since the mid-1980s, peaking in 1999 and 2000, before declining through 2010. Monkfish revenues in 2012 are about equal to those observed in the early to mid-1990s.

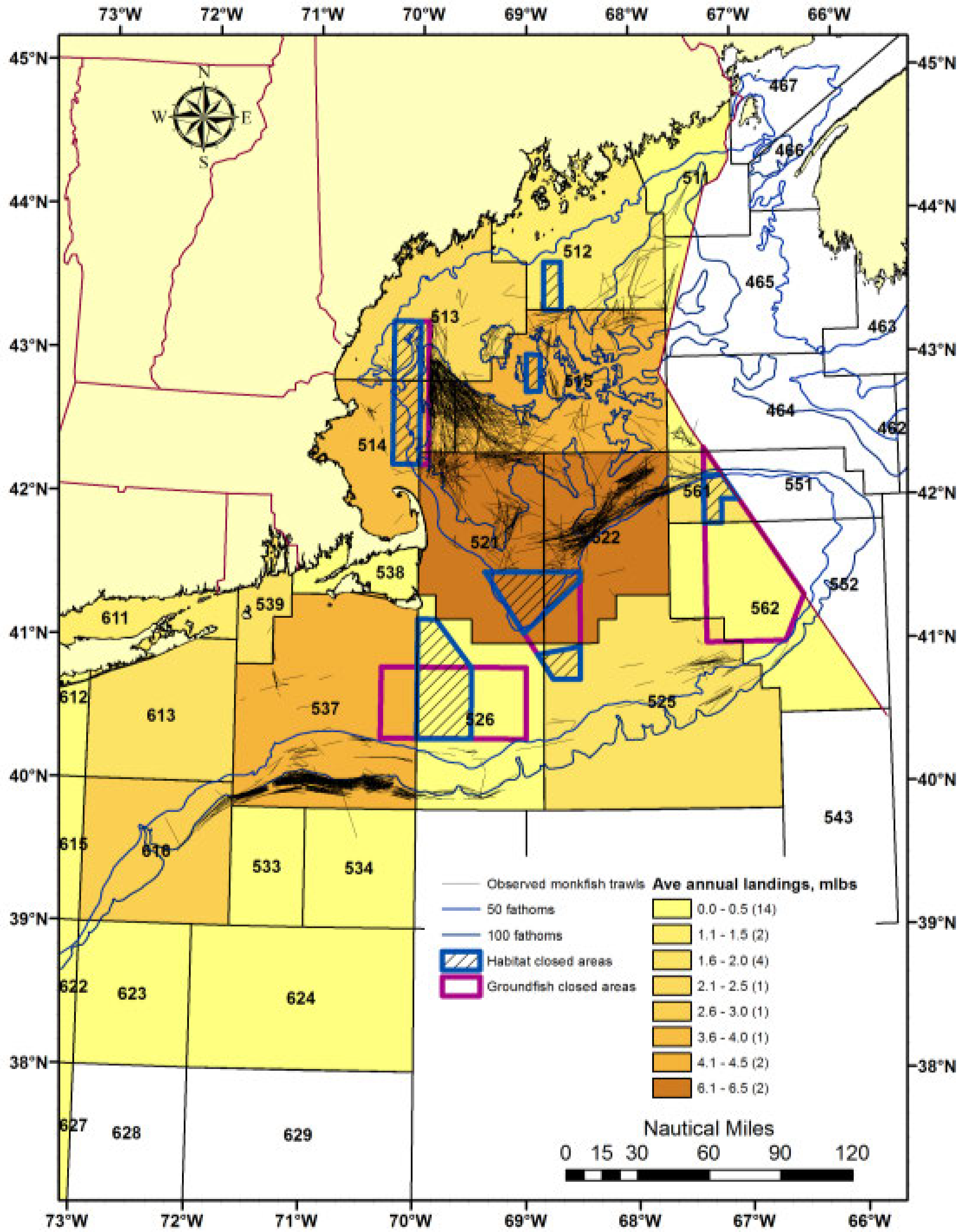
Map 78 – Monkfish management areas



Map 79 – Monkfish gillnet effort 2008-2012. Yellow to brown shading shows average annual landings (live weight) by statistical area from the dealer tables. Black lines show start/end positions of hauls observed at sea.



Map 80 – Monkfish trawl effort 2008-2012. Yellow to brown shading shows average annual landings (live weight) by statistical area from the dealer tables. Black lines show start/end positions of hauls observed at sea.



4.3.4 Skate complex

Seven species of skate are managed by the Council: smooth, thorny, barndoor, little, winter, rosette, and clearnose. Because individual species are in some cases difficult to distinguish in commercial landings and at-sea observer data, especially at smaller sizes/ages, the skates are managed as a complex. Assessment of the status of various skate species is based on NEFSC trawl survey indices. The assessment approach was last reviewed at the December 2008 Data Poor Stocks Working Group (DPSWG) meeting (NDPSWG 2009, report available at http://nefsc.noaa.gov/publications/crd/crd0902/). Status is updated annually based on the most recent trawl survey catch indices.

4.3.4.1 Biology, status, and overall distribution

Collectively these skate species are distributed across the full range of shallow inshore to deep offshore waters, ranging from eastern Maine to Cape Hatteras. In general, skates do not undertake large scale migrations, but they do exhibit movements inshore in winter/spring and offshore into deeper waters during summer and fall. Skates do not have a larval stage, hatching from leathery egg cases as benthic juveniles that resemble small adults.

4.3.4.1.1 Smooth skate

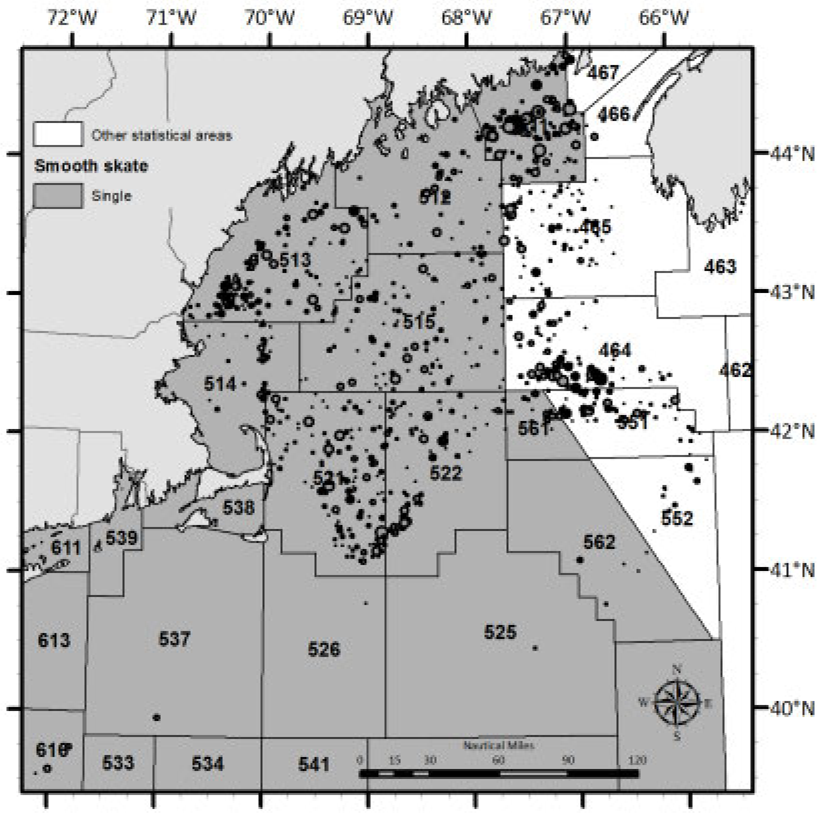
Smooth skate (*Malacoraja senta*) are found throughout the Gulf of Maine and along the shelf/slope transition to Cape Hatteras. The species is found mainly in deeper waters, although it does occur in some inshore areas including bays and estuaries along the Maine coast.

Smooth skates are most often found on soft mud substrate, but also occur on sand/shell/gravel/pebble substrates. They feed mainly on epifaunal crustaceans, primarily shrimp and euphausiids, and appear to be reproductively active year round.

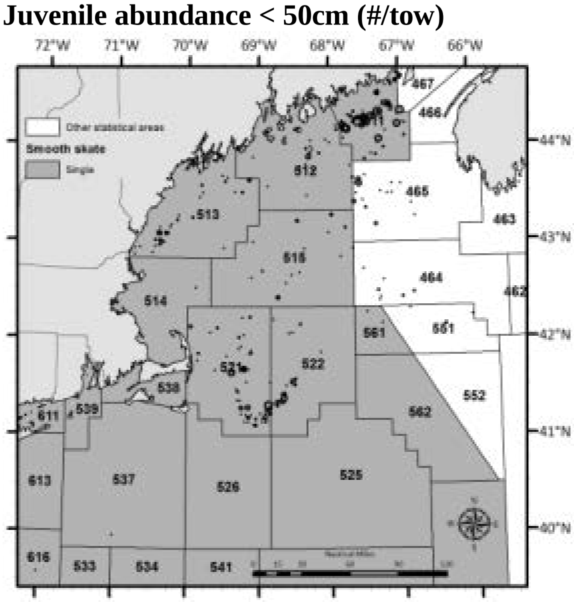
As of the 2008 DPSWG meeting, smooth skate biomass was at the overfished threshold reference point of 0.14 kg/tow. Based on the coefficient of variation in the survey index, the species is not experiencing overfishing. Data collected through spring 2013 indicate that the status remains not overfished/overfishing not occurring.

Map 81 – Smooth skate stock boundary and catch/tow from spring and fall NEFSC, MADMF, and ME/NH surveys, 2002-2013. Spring survey values shaded grey may obscure fall survey values shaded black.

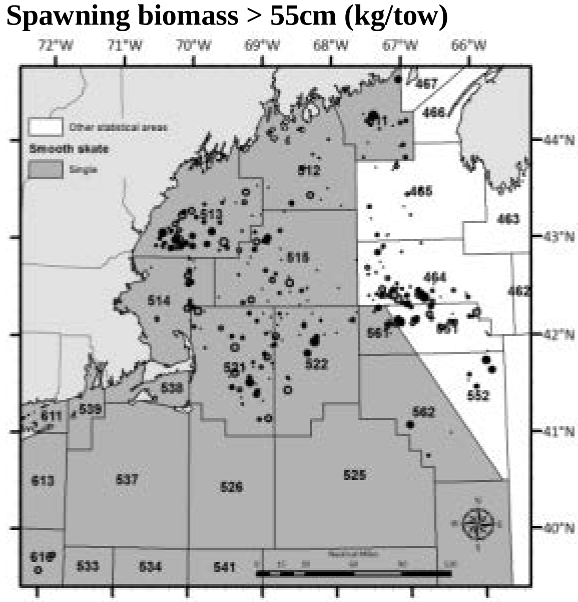
Total biomass (kg/tow)



Juvenile abundance < 50cm (#/tow)



Spawning biomass > 55cm (kg/tow)



4.3.4.1.2 Thorny skate

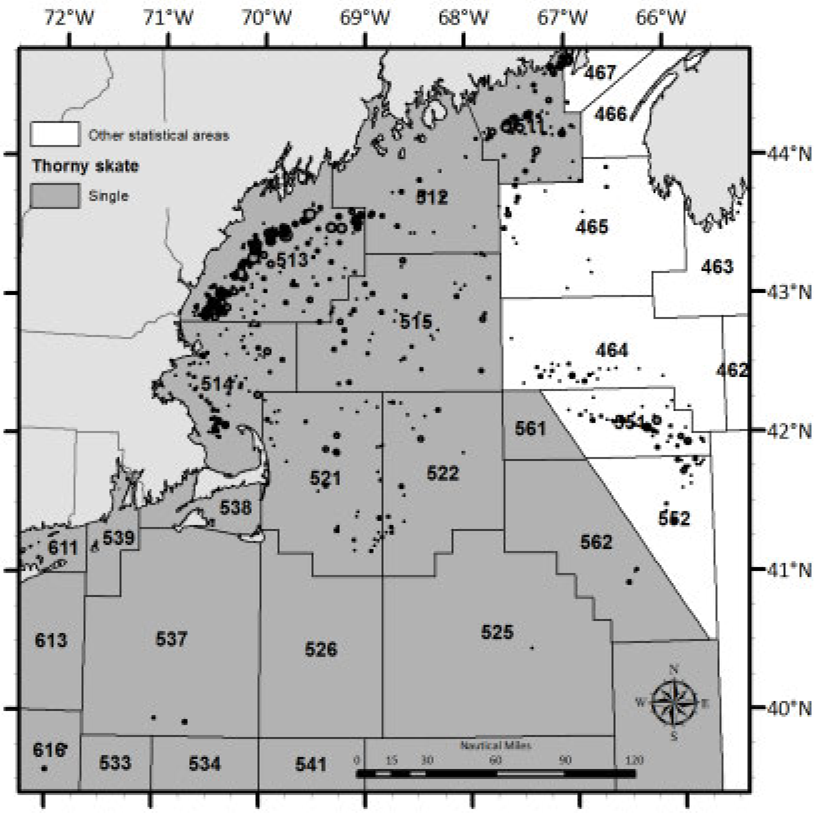
Thorny skate (*Amblyraja radiata*) is most abundant in moderately deep waters of the Gulf of Maine, although the species does occur in shallower inshore waters as well, including in the full-salinity zones of certain coastal Maine bays and estuaries. They are found over various substrates including sand, gravel, broken shell, pebbles, to soft mud (Bigelow and Schroeder 1953; McEachran 2002). Scott (1982) found thorny skates on all substrates, with the highest catch rates on sand and gravel deeper than 100 m.

Thorny skate are opportunistic predators, eating a wide variety of benthic invertebrates. Dietary composition does change with size/age. Like smooth skates, thorny skates reproduce year round (Templeman 1982, Sulikowski et al. 2007), although the percentage of mature females with capsules is higher during the summer (McEachran 2002).

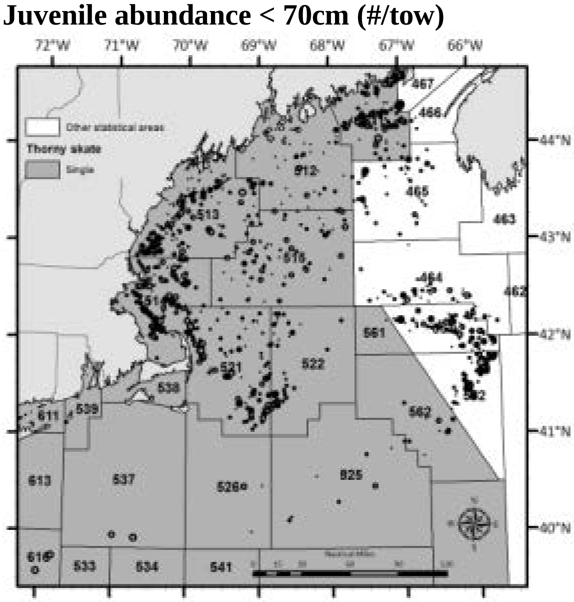
As of the 2008 DPSWG meeting, thorny skate biomass was at 0.42 kg/tow, which is below the overfished threshold reference point of 2.06kg/tow indicating that the species is overfished. Based on the coefficient of variation in the survey index, the species is also experiencing overfishing. Through spring 2013, the three year moving average catch per tow decreased to 0.18 kg/tow, which indicates that the stock is still overfished, and that biomass has decreased since the 2008 meeting. This reduction in the survey index means that overfishing is occurring on thorny skate.

Map 82 - Thorny skate stock boundary and catch/tow from spring and fall NEFSC, MADMF, and ME/NH surveys, 2002-2013. Spring survey values shaded grey may obscure fall survey values shaded black.

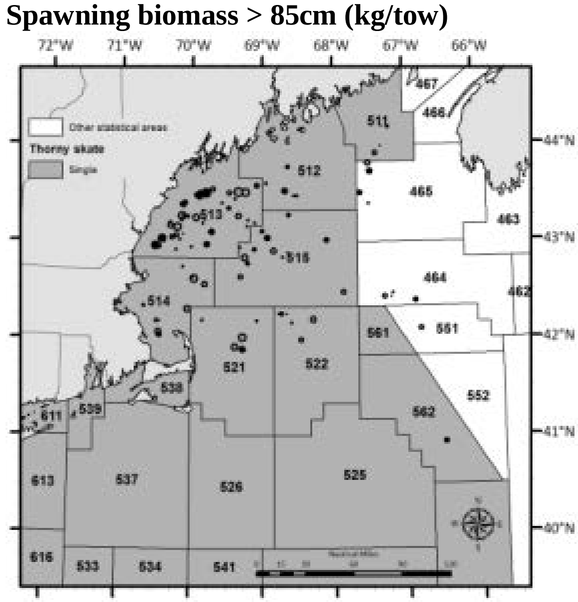
Total biomass (kg/tow)



Juvenile abundance < 70cm (#/tow)



Spawning biomass > 85cm (kg/tow)



4.3.4.1.3 Barndoor skate

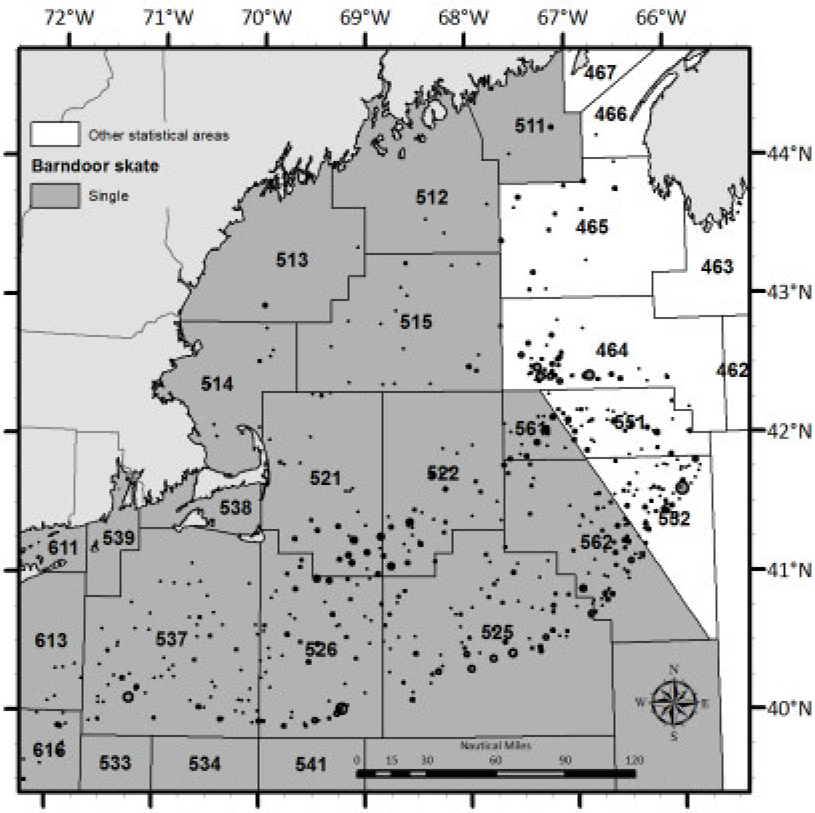
Barndoor skate (*Dipturus laevis*) is mainly distributed over Georges Bank, with concentrations on the southeastern part of the bank and in the northern, deeper parts of the Great South Channel. They are also found in Southern New England. Juveniles and adults are common in moderate depths beginning at 51 m and 61 m respectively, with the adult distribution extending into deeper waters. Barndoor skate have been found on both mud and sand/sand-gravel substrates, although sand is more common in the areas of high abundance over Georges Bank. The barndoor is the largest of the northeast region skate species, and consumes a wide variety of prey types, including benthic invertebrates and benthic fish.

The peak spawning times of barndoor have not been well characterized. Females containing fully formed egg capsules have been taken in December and January (Vladykov 1936; Bigelow and Schroeder 1953), although it is not known if egg capsule production and deposition is restricted to the winter (McEachran 2002).

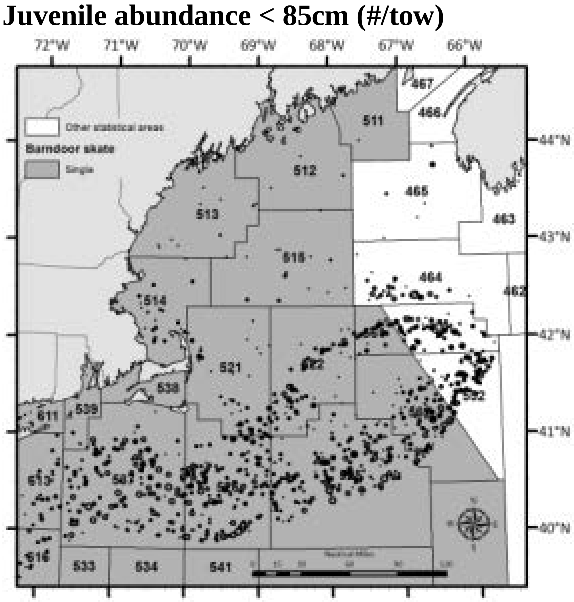
As of the 2008 DPSWG meeting, barndoor skate biomass was at 1.00 kg/tow, which is above overfished threshold reference point of 0.81 kg/tow indicating that the species is not overfished. Survey catch per tow was very low for many years and an endangered species act listing was requested, but the index been increasing since the late 1990s. Based on the coefficient of variation in the survey index, the species is not experiencing overfishing. Data collected through spring 2013 indicate that the status remains not overfished/overfishing not occurring.

Map 83 - Barndoor skate stock boundary and catch/tow from spring and fall NEFSC, MADMF, and ME/NH surveys, 2002-2013. Spring survey values shaded grey may obscure fall survey values shaded black.

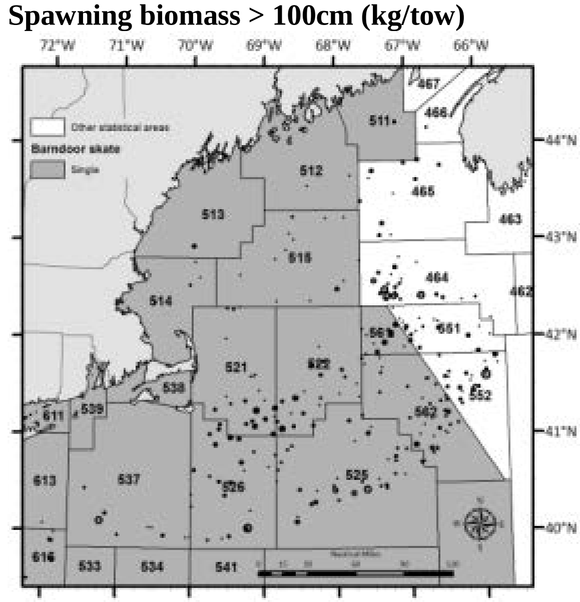
Total biomass (kg/tow)



Juvenile abundance < 85cm (#/tow)



Spawning biomass > 100cm (kg/tow)



4.3.4.1.4 Little skate

The geographical distribution of little skate (*Leucoraja erinacea*) includes the southwestern Gulf of Maine, specifically Cape Cod Bay and inshore north of Cape Ann, Georges Bank, Southern New England, and the Mid-Atlantic Bight. The highest abundances are on Georges Bank and in Southern New England. They are occasionally caught in the ME/NH trawl survey. Little skate are generally found on sandy or gravelly bottoms, but also occur on mud (Bigelow and Schroeder 1953; McEachran and Musick 1975; Langton et al. 1995; Packer and Langton, unpublished manuscript). In southern New England, at a depth of 55 m, little skate was associated with particular microhabitat features on the surface of the sediment during the day, including biogenic depressions and flat sand, but were randomly distributed at night (Auster et al. 1995). Skates are known to remain buried in depressions during the day and are more active at night (Michalopoulos 1990).

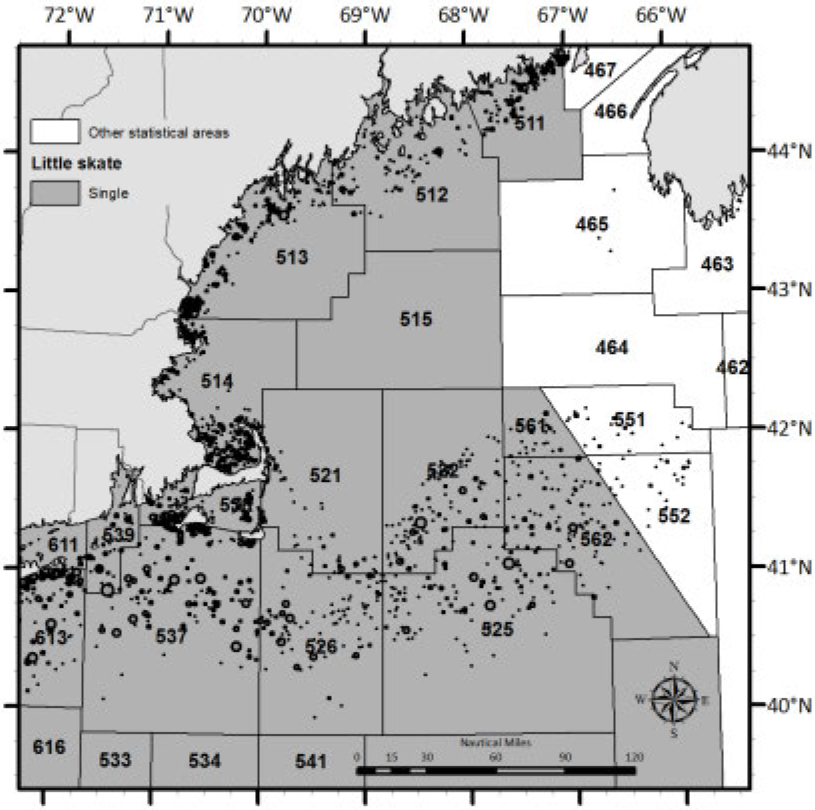
Generally, invertebrates such as decapod crustaceans and amphipods are the most important prey items, followed by polychaetes. Isopods, bivalves, and fishes (sand lance, alewives, herring, cunners, silversides, tomcod, and silver hake) are of minor importance. Little skate also eat hydroids, copepods, ascidians and squid.

Egg cases are found partially- to fully-developed in mature females year-round but several authors report that they are most frequently encountered from late October-January and from June-July (Fitz and Daiber 1963; Richards et al. 1963; Scott and Scott 1988). Little skate gestation is at least six months after the cases are deposited (Bigelow and Schroeder 1953, Richards et al. 1963).

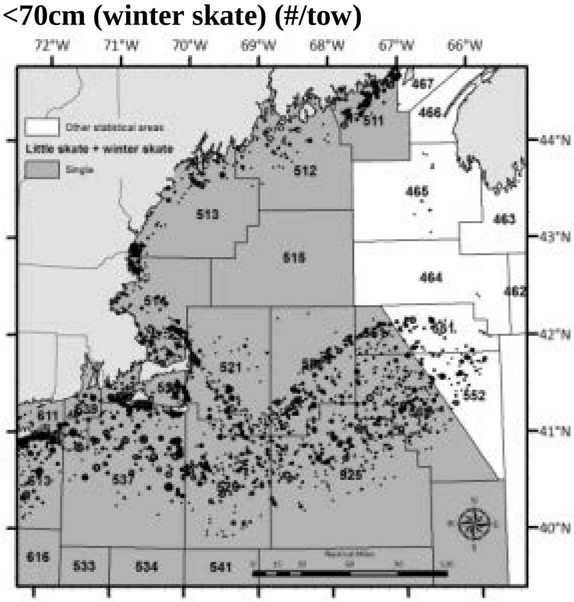
As of the 2008 DPSWG meeting, little skate biomass was at 5.04 kg/tow, which is above overfished threshold reference point of 3.51 kg/tow indicating that the species is not overfished. Based on the coefficient of variation in the survey index, the species is not experiencing overfishing. Data collected through spring 2013 indicate that the status remains not overfished/overfishing not occurring.

Map 84 – Little skate stock boundary and catch/tow from spring and fall NEFSC, MADMF, and ME/NH surveys, 2002-2013. Spring survey values shaded grey may obscure fall survey values shaded black.

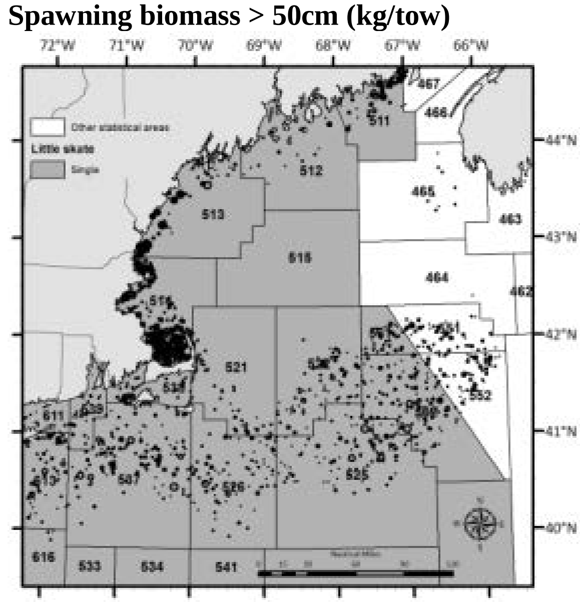
Total biomass (kg/tow)



Juvenile abundance < 45cm (little skate) and <70cm (winter skate) (#/tow)



Spawning biomass > 50cm (kg/tow)



4.3.4.1.5 Winter skate

Similar to little skate, the geographical distribution of winter skate (*Leucoraja ocellata*) includes the southwestern Gulf of Maine, specifically Cape Cod Bay and inshore north of Cape Ann, Georges Bank, Southern New England, and the Mid-Atlantic Bight. The highest abundances are on Georges Bank. Relative to other skates (smooth, thorny, barndoor), winter skate has a fairly shallow distribution. Bigelow and Schroeder (1953) stated that this species is confined to sandy and gravelly bottoms, but Tyler (1971) reported it from mud bottoms in Passamaquoddy Bay. In Long Island Sound during the spring, winter skate were most abundant on sand bottoms in the Mattituck Sill and Eastern Basin (Gottschall et al. 2000). On the Scotian Shelf, Scott (1982) reports that the distribution of winter skate was confined to sand and gravel bottoms and Scott (1982) suggests that bottom type, rather than depth, appears more important in determining the distributions of winter skate.

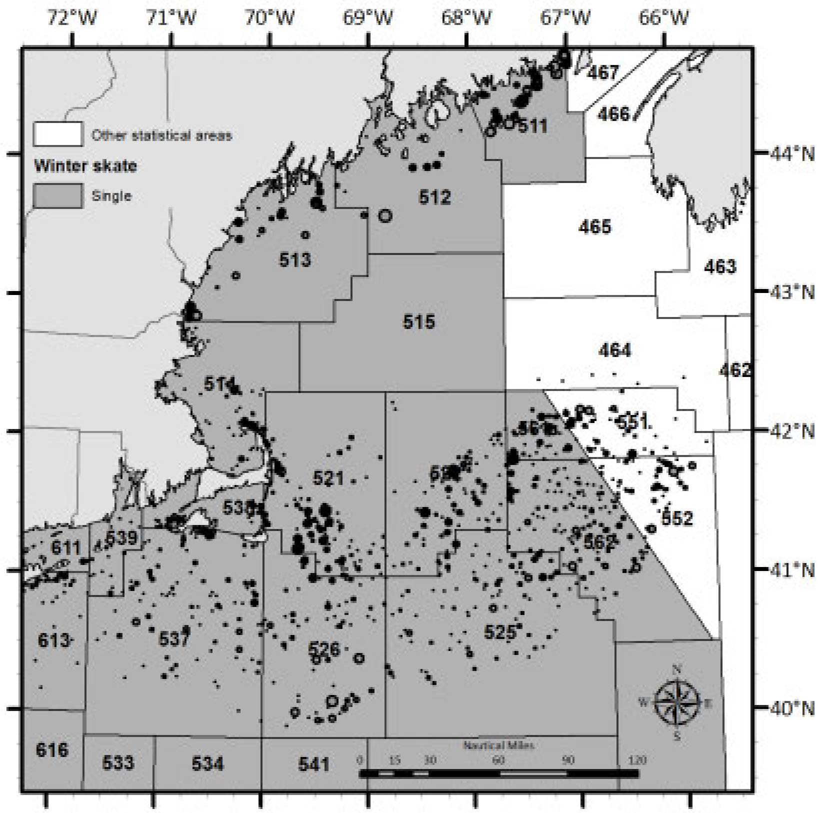
According to the NEFSC food habits database, crustaceans make up more than half the diet of smaller winter skates (<61 cm TL), and fish dominate the diet for larger winter skates (>91 cm TL). The proportion of polycheates in the diet increases until the skates are 81 cm TL. Prey exceeding the 5% by weight threshold in the stomachs of juvenile and adult winter skate include: sand lance (17%), bivalve mollusks (13%), polychaetes (12%), other fish (8%), and gammarid amphipods (7%).

Bigelow and Schroeder (1953) report egg deposition to occur during summer and fall off Nova Scotia and, quoting Scattergood, probably in the Gulf of Maine as well. They also state that egg deposition continues into December and January off southern New England. Sulikowski et al. (2004) found that egg-case production is highest in the fall in the Gulf of Maine off New Hampshire. However, the presence of reproductively capable females during most months of the year and spermatocysts within the male testis year round implies that reproduction could occur at other times of the year.

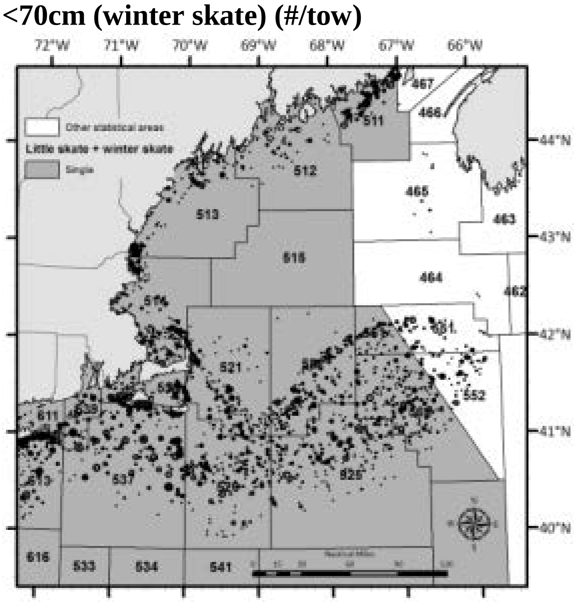
As of the 2008 DPSWG meeting (NDPSWG 2009), winter skate biomass was at 2.93 kg/tow, which is above overfished threshold reference point of 2.83 kg/tow indicating that the species is not overfished. Based on the coefficient of variation in the survey index, the species was not experiencing overfishing at that time. However, the most recent assessment update indicates a 23% decrease in survey catch per tow during 2010-2012 as compared to 2009-2011, which means that overfishing is occurring on the stock. At 6.68 kg/tow, the stock is still above the biomass threshold, so it is not overfished.

Map 85 – Winter skate stock boundary and catch/tow from spring and fall NEFSC, MADMF, and ME/NH surveys, 2002-2013. Spring survey values shaded grey may obscure fall survey values shaded black.

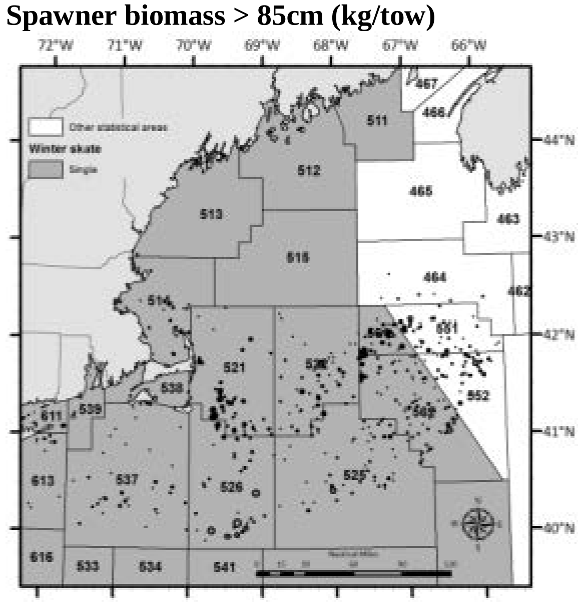
Total biomass (kg/tow)



Juvenile abundance < 45cm (little skate) and <70cm (winter skate) (#/tow)



Spawner biomass > 85cm (kg/tow)



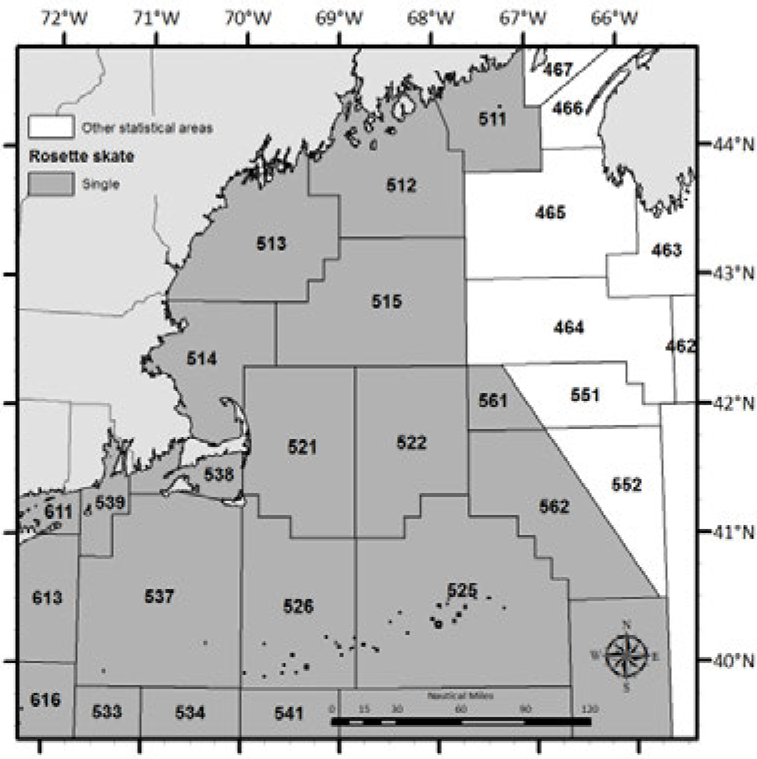
4.3.4.1.6 Rosette skate

Rosette skate (*Leucoraja garmani virginica*) occur along the shelf/slope break in the Mid-Atlantic Bight, primarily on sand and mud substrates. Rosette skate feed primarily on crustaceans and polychaetes. North of Cape Hatteras the egg capsules are found in mature females year-round but are most frequent during the summer (McEachran 1970).

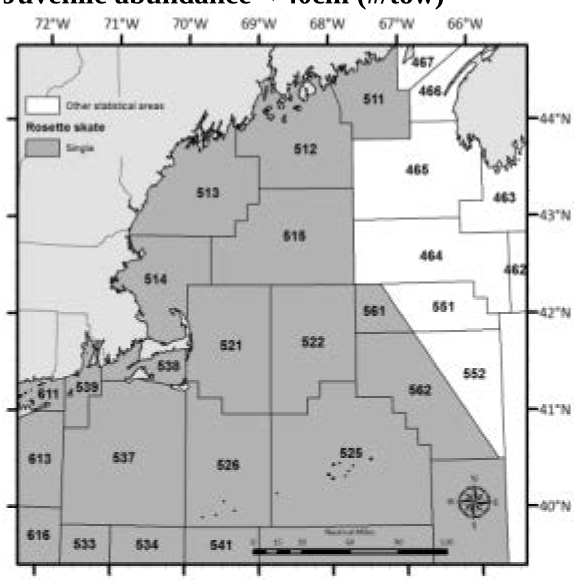
Biomass trends for rosette skate (measured as catch in kg/tow during the NEFSC trawl surveys) have been increasing since the late 1980s and the species is currently above the target biomass index. Catchability of rosette skate in the spring and fall surveys is relatively poor, but more are caught in the now-defunct winter survey, which used a chain sweep and focused on offshore survey strata in southern New England and the Mid-Atlantic Bight. According to the 2008 DPSWG (NDPSWG 2009), in 2007 the species was not overfished and overfishing was not occurring. Data collected through spring 2013 indicate that the status remains not overfished/overfishing not occurring.

Map 86 – Rosette skate stock boundary and catch/tow from spring and fall NEFSC, MADMF, and ME/NH surveys, 2002-2013. Spring survey values shaded grey may obscure fall survey values shaded black.

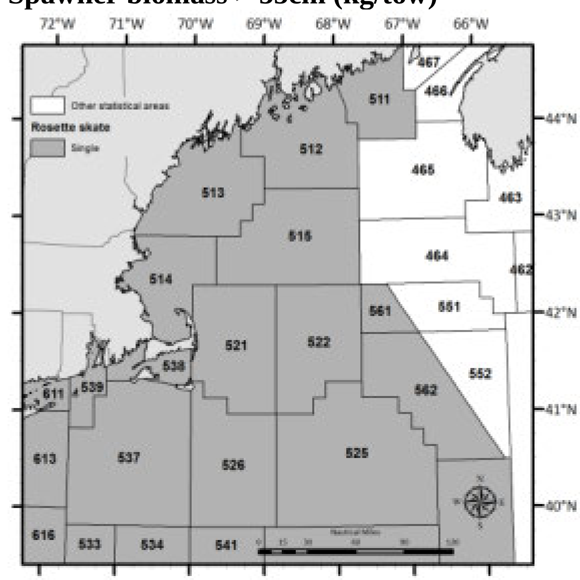
Total biomass (kg/tow)



Juvenile abundance < 40cm (#/tow)



Spawner biomass > 55cm (kg/tow)



4.3.4.1.7 Clearnose skate

The distribution of adult clearnose skate (*Raja eglanteria*) is concentrated along the coast from New Jersey to Cape Hatteras, with the highest spring and fall trawl survey abundances south of Chesapeake Bay. The spatial distribution of juvenile EFH extends further south based on the inshore Southeast Area Monitoring and Assessment Program (SEAMAP) survey. Of all the skates, clearnose has the shallowest distribution.

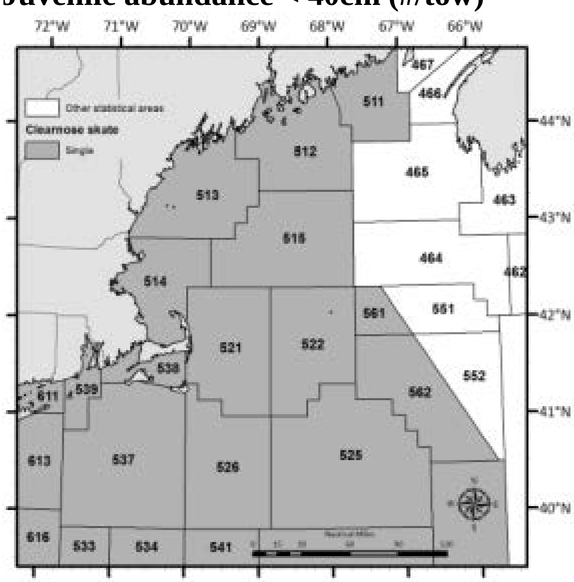
Clearnose skate are found primarily on sand and mud, but also occur in gravel habitats. They feed primarily on fish, crabs, and longfin squid.

Mating and egg deposition in clearnose skates takes place from December to mid-May (Rasmussen et al. 1999). North of Cape Hatteras the egg cases are deposited in the spring and summer; in Delaware Bay, Fitz and Daiber (1963) reported spawning to occur only in the spring. Off the central west coast of Florida, egg deposition occurs from December through mid-May (Luer and Gilbert 1985).

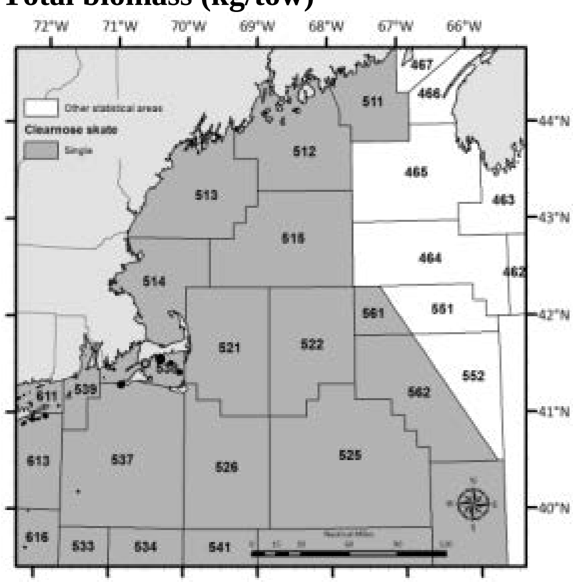
Biomass trends for clearnose skate (measured as catch in kg/tow during the NEFSC trawl surveys) have generally been increasing since the mid-1980s. Although there has been a decline in the last few years, and the species is currently above the threshold biomass index, although not above the target. Like the rosette skate, catchability of clearnose skate in the spring and fall surveys is relatively poor, but more are caught in the now-defunct winter survey, which used a chain sweep and focused on offshore survey strata in southern New England and the Mid-Atlantic Bight. According to the 2008 DPSWG (NDPSWG 2009), in 2007 the species was not overfished and overfishing was not occurring. Data collected through spring 2013 indicate that the status remains not overfished/overfishing not occurring.

Map 87 - Clearnose skate stock boundary and catch/tow from spring and fall NEFSC, MADMF, and ME/NH surveys, 2002-2013. Spring survey values shaded grey may obscure fall survey values shaded black.

Juvenile abundance < 40cm (#/tow)



Total biomass (kg/tow)



4.3.4.2 Fishery

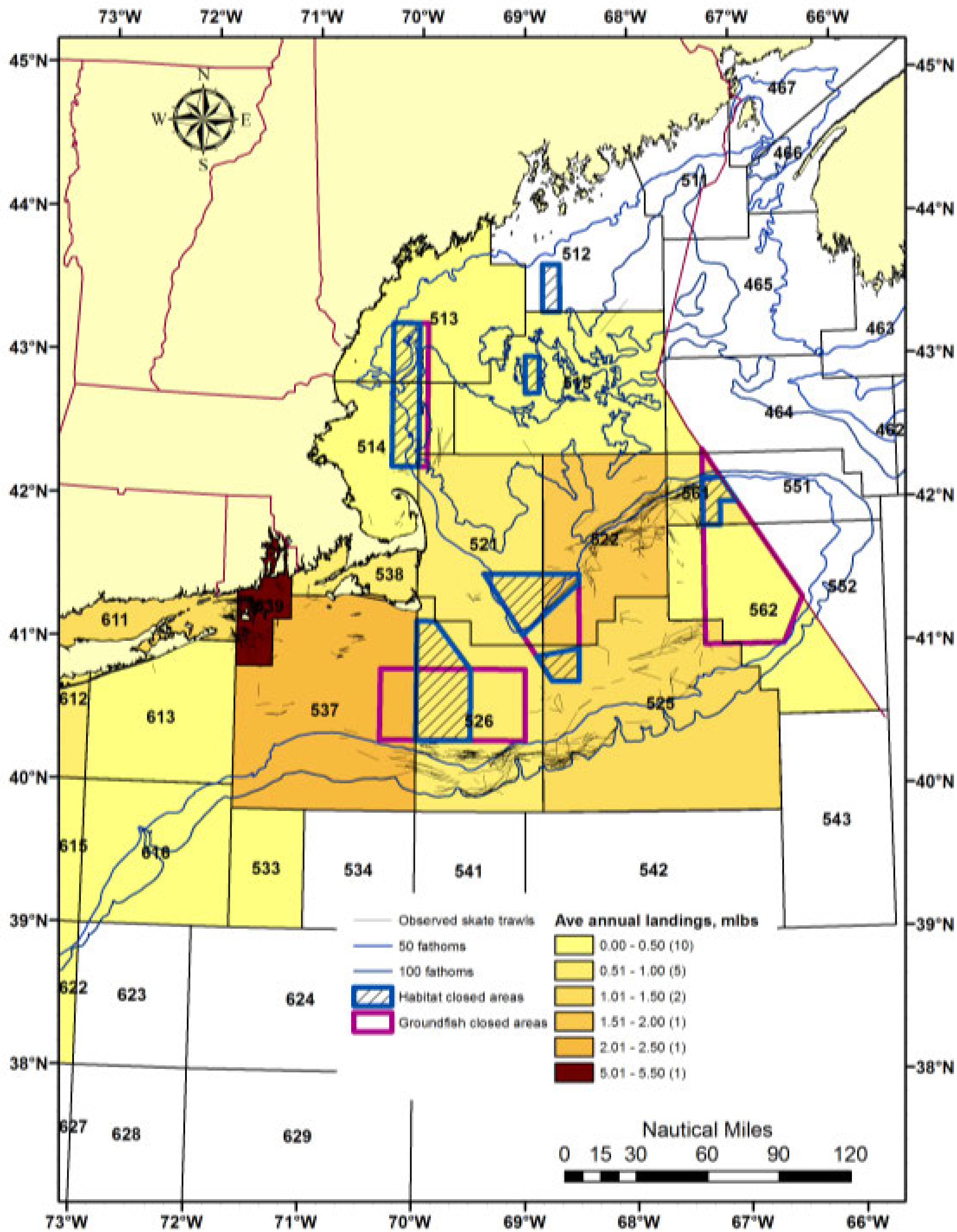
Amendment 3 to the Skate FMP was implemented in 2010 to establish Annual Catch Limits and Accountability Measures for the skate complex, as required by the 2006 reauthorization of the Magnuson-Stevens Act, and to implement measures to rebuild overfished skate stocks. Amendment 3 implemented a stock complex Annual Catch Limit for skates, but created separate landing quotas for the skate wing and bait fisheries (described below), and reduced the skate wing and bait possession limits. The skate bait fishery annual Total Allowable Landings were divided into three separate seasonal quotas to maintain year-round supply of bait. Framework Adjustment 1 to the Skate FMP was subsequently implemented in 2011, to further reduce the skate wing possession limits, and adjust the in-season trigger of the incidental possession limit.

Skates are harvested for two very different commercial markets—one market supplies whole skates to be used as bait in the lobster fishery, and one market supplies skate wings for human consumption. The skate wing fishery developed in the 1990s when skates were promoted as "underutilized species," and fishermen shifted effort from groundfish and other fisheries to skates and spiny dogfish. The wing fishery is largely an incidental catch fishery that involves vessels that also participate in the groundfish and/or monkfish fisheries. Although some vessels will make trips specifically targeting winter skates for the wing market, most skates caught for this market are retained by vessels engaged in other fisheries.

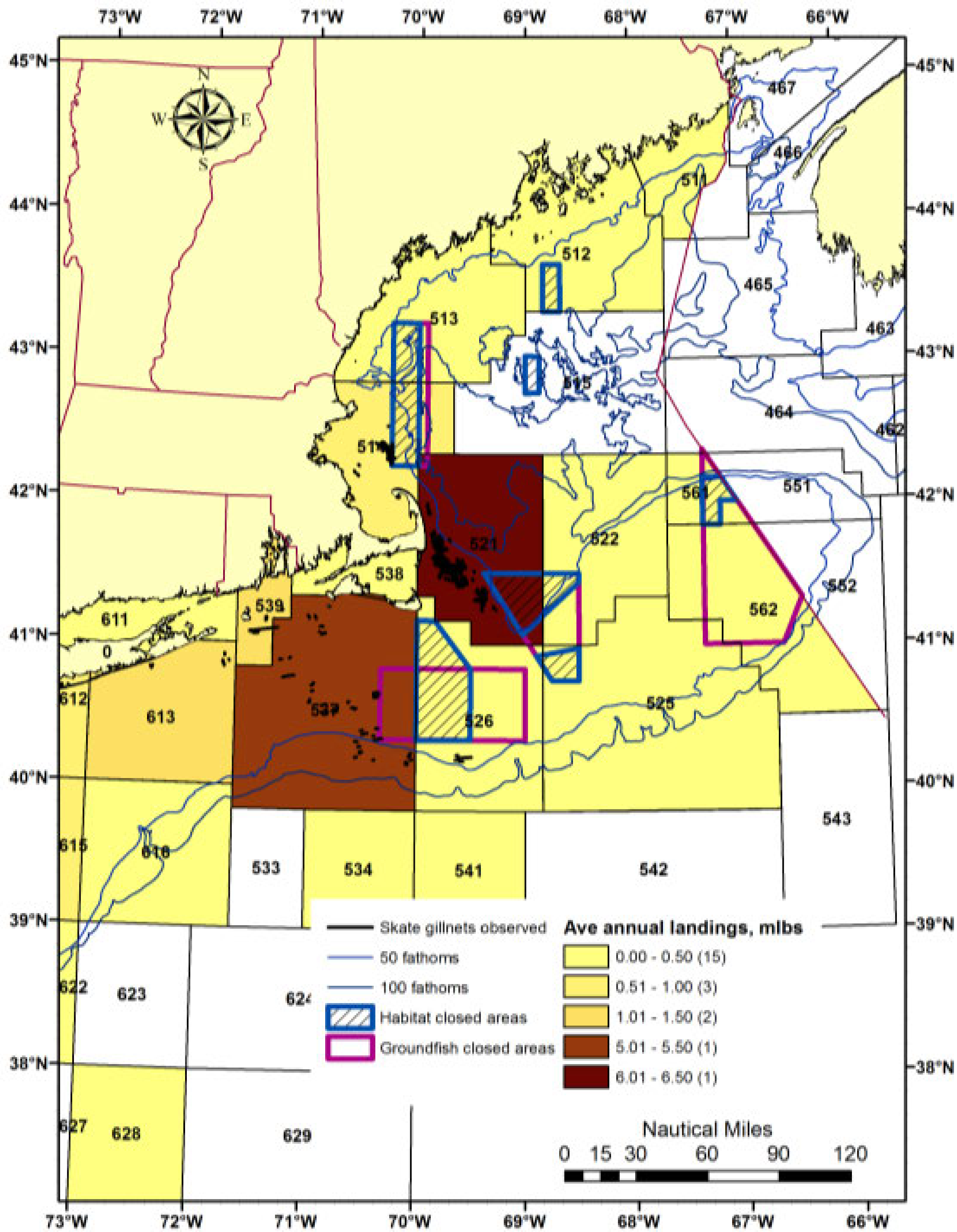
The skate bait fishery is a directed fishery and is more traditional, involving vessels primarily from southern New England ports that target a combination of little skates (>90 percent) and, to a much lesser extent, juvenile winter skates (<10 percent). The vessels supplying skates for the bait market tend to make dedicated trips targeting skates and land large quantities of skates per trip.

Most skates are caught using an otter trawl (according to the Fishing Vessel Trip Report database for 2007-2011, almost 65 percent of landings were from an otter trawl), although gillnets are also used (the remaining 35 percent of 2007-2011 landings were from gillnets). Small amounts of landings are associated with hook and line gear and scallop dredges. Although some skates are caught by recreational fishermen, recreational landings of skates are negligible both in the context of all recreational fisheries and in the context of the overall skate fishery. Even though skates are now managed under a Federal FMP, reported landings remain incomplete at the species level.

Map 88 – Skate trawl effort 2008-2012. Yellow to brown shading shows average annual landings (live weight) by statistical area from the dealer tables. Black lines show start/end positions of hauls observed at sea.



Map 89 – Skate gillnet effort 2008-2012. Yellow to brown shading shows average annual landings (live weight) by statistical area from the dealer tables. Black lines show start/end positions of hauls observed at sea.



4.3.5 Atlantic sea scallop

4.3.5.1 Biology, status, and overall distribution

Scallops (*Placopecten magellanicus*) are distributed throughout Georges Bank and the Mid-Atlantic Bight in shallow to moderate water depths. Local concentrations of scallops may be very high in some areas. They also occur in selected locations in the Gulf of Maine, including inshore areas as well as some offshore banks and ledges. The species generally inhabits waters less than 20^{o} C and depths that range from 30-110 m on Georges Bank, 20-80 m in the Mid-Atlantic, and less than 40 m in the near-shore waters of the Gulf of Maine.

Egg and larval stages are pelagic until the larvae settle to the seabed. Spat survival is enhanced on sedentary branching plants or animals, and on hard surfaces. Juveniles and adults occur on sand, gravel, and areas of mixed sand and gravel substrates. They are also associated with shell debris. Once settled, scallops are generally sessile, although they do exhibit local movements, e.g. for predator avoidance. Larval sea scallops are pelagic filter feeders; juveniles and adults are benthic suspension feeders.

Scallop spawning times vary by location. Generally spawning occurs in summer in the southern part of their U.S. distribution, and into fall in the northern areas. A biannual spawning cycle has been documented south of Hudson Canyon, with both spring and fall events (DuPaul et al. 1989; Schmitzer et al. 1991; Davidson et al. 1993). Scallop beds generally spawn synchronously in a short time, going from completely ripe to completely spent in less than a week (Posgay and Norman 1958; Posgay 1976), although more continuous spawning has been reported (Naidu 1970 - Newfoundland coastal waters, Langton et al. 1987 - possibly in the Gulf of Maine, MacDonald and Thompson 1988 - off New Jersey in June and July).

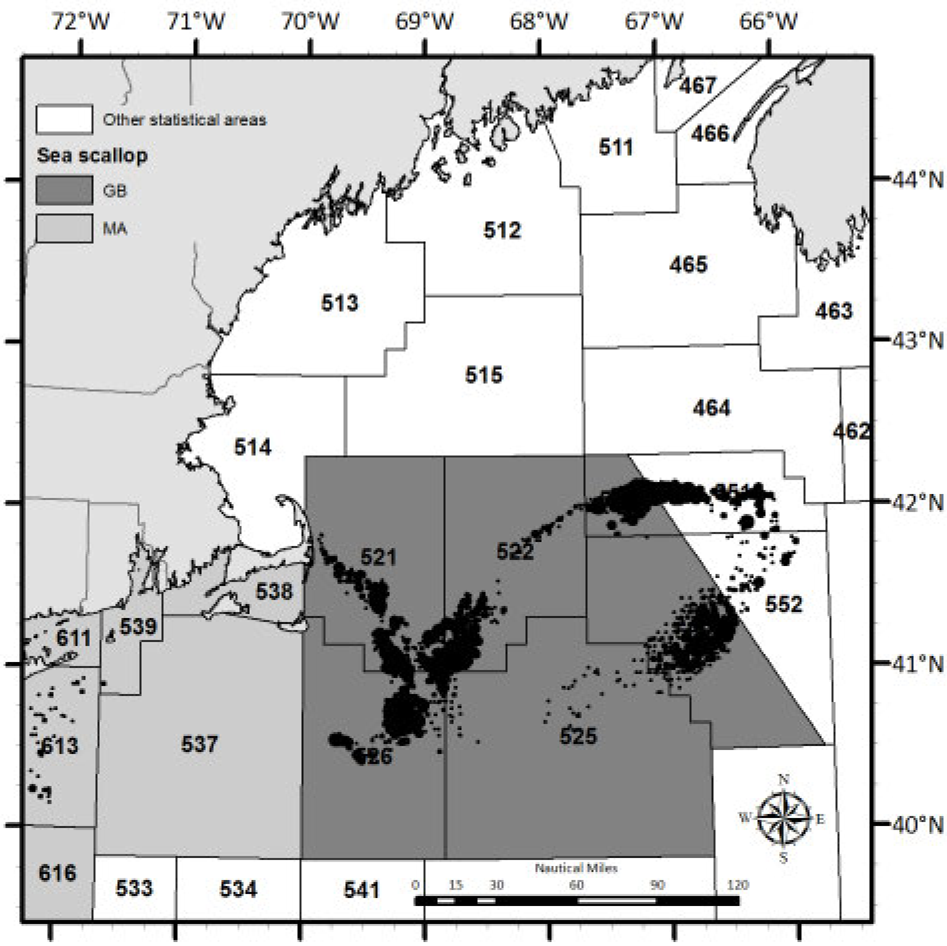
All sea scallops in U.S. waters are managed as a single stock per Amendment 10 to the fishery management plan. However, assessments focus on two main parts of the stock and fishery that contain the largest concentrations of sea scallops: Georges Bank and the Mid-Atlantic, which are combined to evaluate the status of the whole stock. The formal stock status update was prepared through fishing year 2009 as part of Stock Assessment Review Committee 50 (NEFSC 2010). SARC 50 estimated that overall fishing mortality in 2009 was 0.38. As this fishing mortality is equal to, but not above, the F_{MSY} threshold, overfishing did not occur in 2009.

Currently, the stock is above the biomass threshold. Abundance and biomass on Georges Bank increased from 1995-2000 after implementing closures and effort reduction measures. Biomass and abundance then declined from 2006-2008 because of poor recruitment and the reopening of portions of groundfish closed areas. Biomass increased on Georges Bank in both 2009 and 2010, mainly due to increased growth rates and strong recruitment in the Great South Channel, along with continuing concentrations on the Northern Edge and in the central portion of Closed Area I.

In general, Mid-Atlantic scallop biomass is declining. This is primarily from the depletion of the large biomass in the Elephant Trunk and several years of poor recruitment (2009-2011). However, stronger Mid-Atlantic recruitment has been observed in 2012 and 2013. Once these scallops grow larger, biomass in the Mid-Atlantic is expected to increase. Relatively little is known about scallop biomass in the Gulf of Maine. A 2012 dredge survey conducted mostly in inshore areas found that biomass was generally patchy, and that scallops on some of the offshore features (Platts Bank, Fippennies Ledge) had relatively low meat weights for their size as compared to other areas.

The sea scallop stock assessment was updated during July 2014 and a final report is pending as of this writing (August 2014).

Map 90 – Sea scallop stock boundaries and kg/tow (0-1549 kg/tow) from summer NEFSC scallop dredge survey, 2002-2013.



4.3.5.2 Fishery

Sea scallops are managed in collaboration with the Mid-Atlantic Council. The Atlantic Sea Scallop FMP was implemented in 1982 to restore adult scallop stocks and reduce year-to-year fluctuations in stock abundance caused by variation in recruitment. One of the foundations of the Scallop FMP is its area rotational management programs, established in 2004 under Amendment 10. Under this program, areas are defined, then closed and reopened to fishing on a rotational basis, depending on the condition and size of the scallop resource in the areas. As a result of Amendment 10, controls on scallop effort differ depending on whether a fishing trip occurs in an access area or in an open area. Vessels either fish in access areas under allocated trips, or in open areas under DAS. Amendment 11, implemented in 2008, included measures to control capacity and mortality in the general category scallop fishery. Primary measures included a limited entry program for general category vessels, as well as other permit provisions including an individual fishing quota (IFQ) program. The most recent amendment, Amendment 15, introduced Annual Catch Limits and accountability measures to the Scallop FMP in 2011, as required by the Magnuson-Stevens Act.

Under current regulations, the scallop fleet can be differentiated by vessel permit category: limited access vessels that are subject to area-specific days-at-sea controls and trip allocations; and limited access general category vessels that are not subject to days at sea controls, but are subject to a possession limit per fishing trip. There are three types of limited access general category permits: individual fishing quota permits with a possession limit of 600 lb. per trip; Northern Gulf of Maine permits with a possession limit of 200 lb. per trip; and incidental permits with a possession limit of 40 lb. per trip. The limited access and limited access general category scallop fleets receive total allocations of 94.5 percent and 5 percent, respectively, of the scallop fishery's Annual Catch Limit, with the remaining 0.5 percent allocated to IFQ permits on vessels that have both LAGC IFQ and limited access scallop permits. There are no open access permits in this fishery.

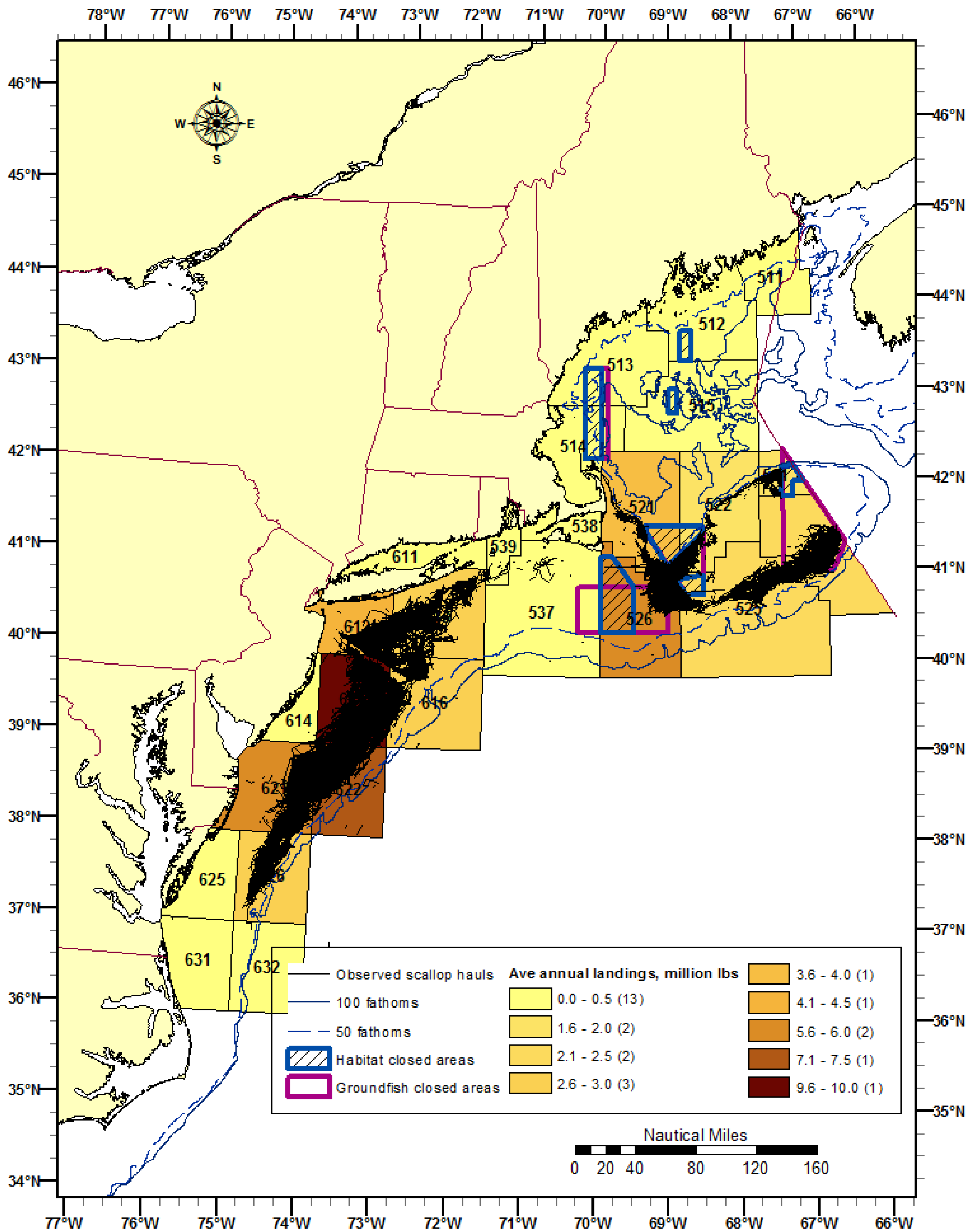
Most limited access effort is from vessels using scallop dredges, including small dredges. The number of vessels using scallop trawl gear has decreased continuously and has been at 11 full-time trawl vessels since 2006. In comparison, there has been an increase in the number of full-time and part-time small dredge vessels after 2002. About 80% of the scallop pounds are landed by full-time dredge and about 13% landed by full-time small dredge vessels since fishing year 2007 (Section 1.1.6 of Appendix I to Framework Adjustment 24).

Most LAGC effort is, and has been, from vessels using scallop dredge and other trawl gear. The percentages of scallop landings show that landings made with a scallop dredge in 2012 continue to be the highest compared to other general category gear types (Table 18 and Table 22, Appendix I to Framework Adjustment 24). The majority of limited access vessels are based in Massachusetts, Virginia, New Jersey, and North Carolina, and the primary scallop ports are located in New Bedford, Massachusetts, Cape May, New Jersey, and Newport News, Virginia.

In fishing years 2003-2011, the landings from the northeast sea scallop fishery stayed above 50 million pounds, surpassing the levels observed historically. The recovery of the scallop resource and consequent increase in landings and revenues was striking given that average scallop landings per year were below 16 million pounds during the 1994-1998 fishing years, less than one-third of the present level of landings. The increase in the abundance of scallops coupled with higher scallop prices increased the profitability of fishing for scallops by the general category vessels. As a result, general category landings increased from less than 0.4 million pounds during the 1994-1998 fishing years to more than 4 million pounds during fishing years 2005-2009, peaking at 7 million pounds in 2005 or 13.5% of the total scallop landings. Landings from general category vessels declined after 2009 as a result of the Amendment 11 implementation that restricts Total Allowable Catch for the limited access general category fishery to 5.5 percent of the total Annual Catch Limit. However, the landings by limited access general category IFQ fishery increased in 2011 from its levels in 2010 due to a higher projected catch and a higher

Annual Catch Target for all permit categories. Recent dredge landings and the distribution of observed dredge hauls are shown on Map 91.

Map 91 – Sea scallop dredge effort 2008-2012. Yellow to brown shading shows average annual landings (meat weight) by statistical area from the dealer tables. Black lines show start/end positions of hauls observed at sea.



4.3.6 Atlantic herring

4.3.6.1 Biology, status, and overall distribution

Herring (*Clupea harengus*) are found throughout the region except in the deepest waters off the shelf. With the exception of their demersal eggs, herring are a pelagic species, feeding on various types of zooplankton. The eggs are deposited in benthic habitats with boulders, coarse sand, cobble/pebble, gravel, and/or macroalgae, not on mud or on fine sand. Strong bottom currents enhance survival. The spawning season in the Gulf of Maine/Georges Bank region begins in July and lasts until December. Spawning begins earlier in the northern areas of the Gulf of Maine.

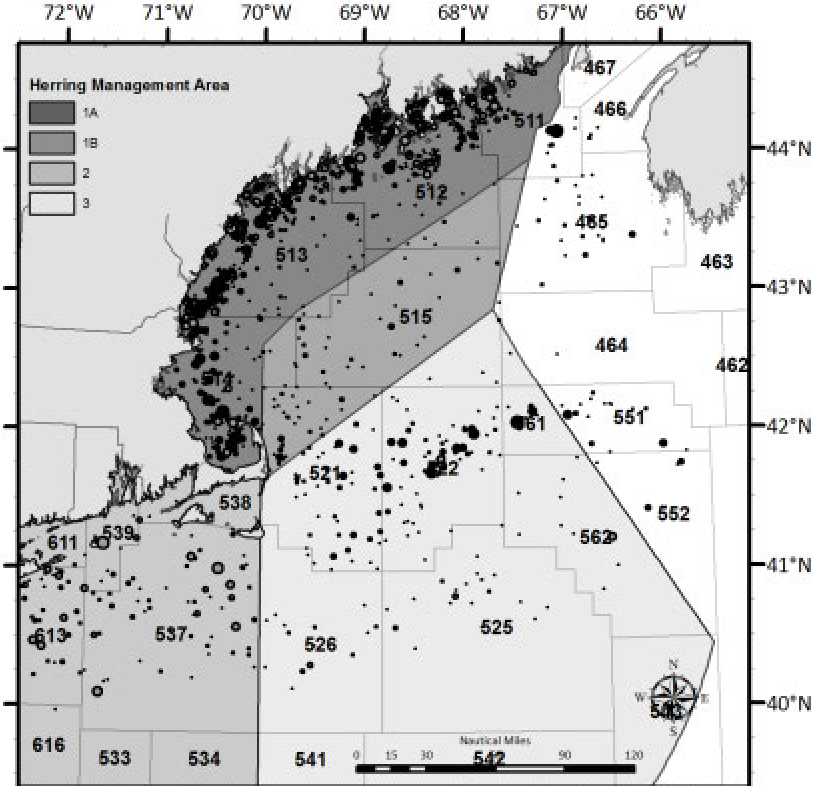
In the U.S. waters of the Gulf of Maine, herring eggs have been observed along the eastern Maine coast, at several other locations along the Maine coast (e.g., outer Penobscot Bay and near Boothbay), on Jeffreys Ledge and Stellwagen Bank, and on eastern Georges Bank. Nantucket Shoals is known to be an important spawning ground based on the concentrations of recently-hatched larvae that were repeatedly collected there during the 1970s and 1980s (Grimm 1983; Smith and Morse 1993). High concentrations of recently-hatched larvae have also been collected in the vicinity of Cultivator Shoals on western Georges Bank, in the vicinity of Stellwagen Bank and Jeffreys Ledge, and on the outer continental shelf in southern New England (Grimm 1983; Smith and Morse 1993). High densities of recently-hatched larvae have also been observed in Saco Bay and Casco Bay on the southern Maine coast (Graham et al. 1972).

Herring are managed as a single stock, which is currently not overfished with overfishing not occurring. The stock was most recently assessed in 2012 during Stock Assessment Workshop 54 (NEFSC 2012). This benchmark stock evaluation included many significant changes from the 2009 Transboundary Resource Assessment Committee assessment (TRAC 2009). During the 2012 assessment, a new model was accepted, assuming a higher natural mortality rate. The revised natural mortality rate was consistent with data on consumption of herring by predators, and largely resolved retrospective patterns observed in the 2009 assessment. The assessment noted that the large number of age-1 fish in 2009 constitute a significant component of projected future yield.

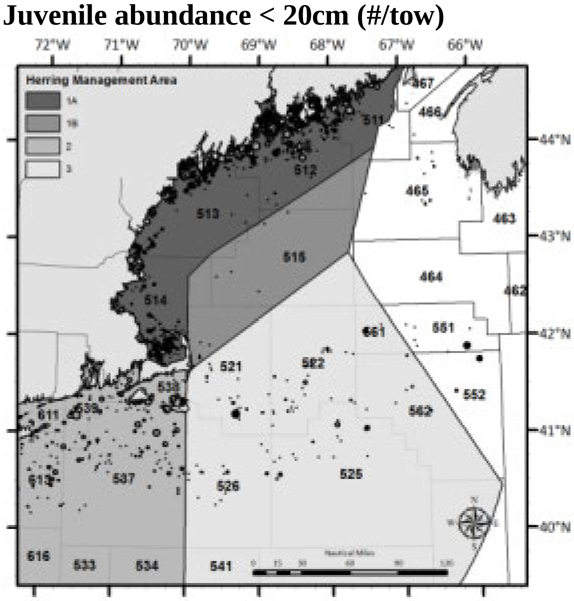
In fishing year 2012, three of the herring sub-annual catch limits were exceeded, triggering accountability measures, even though the overall annual catch limit was not exceeded. The accountability measures reduce the sub-annual catch limits for herring management areas 1B, 2, and 3 for the 2014 fishing year.

Map 92 – Atlantic herring management areas and catch/tow from spring and fall NEFSC, MADMF, and ME/NH surveys, 2002-2013. Spring survey values shaded grey may obscure fall survey values shaded black.

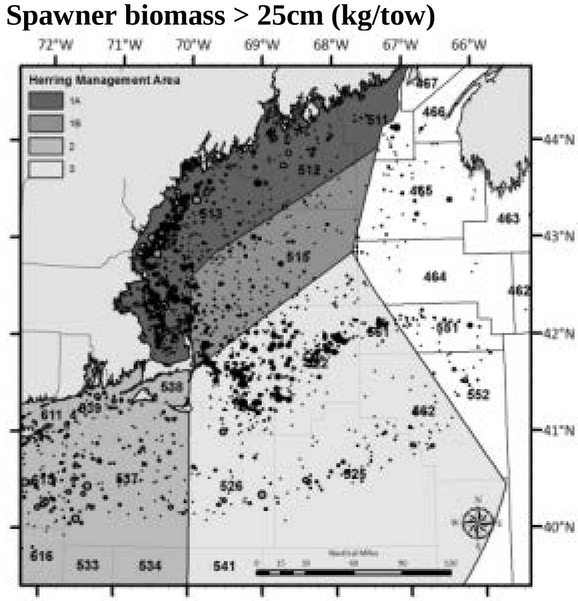
Total biomass (kg/tow)



Juvenile abundance < 20cm (#/tow)



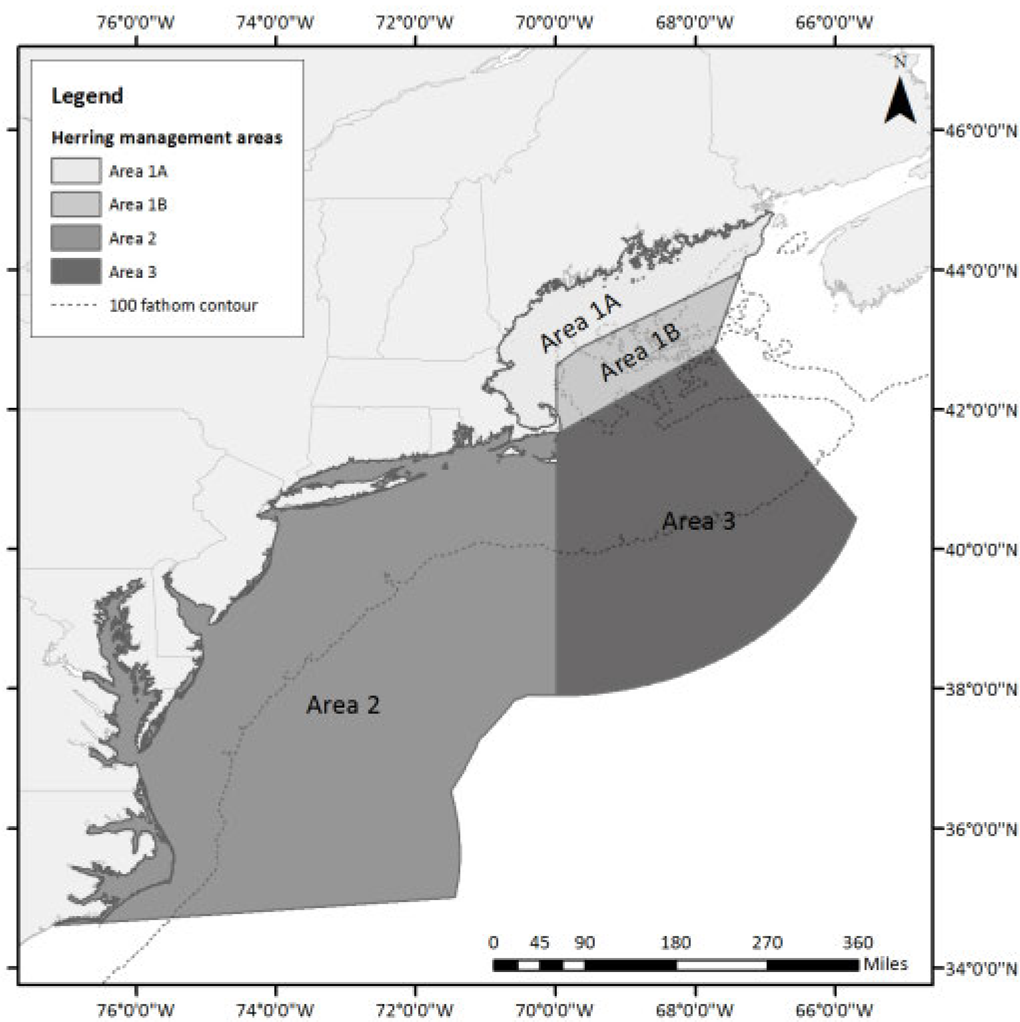
Spawner biomass > 25cm (kg/tow)



4.3.6.2 Fishery

The Council's fishery management plan for Atlantic herring (2000) established total allowable catches for each of four management areas (Map 93). The FMP established requirements for vessel, dealer, and processor permits, as well as reporting requirements and restrictions on the size of vessels that can catch herring. Amendment 4 (2011) implemented a process for establishing Annual Catch Limits and accountability measures in the herring fishery. Amendment 5 (February 13, 2014; 79 FR 8786), focuses on establishing a comprehensive catch monitoring program for the limited access herring fishery, addressing river herring bycatch, establishing criteria for midwater trawl vessel access to groundfish closed areas, and adjusting other aspects of the fishery management program to keep the Herring FMP in compliance with the Magnuson-Stevens Act and ensure sustainable long-term management. Amendment 5 became effective March 27, 2014. Additional measures to implement river herring catch caps through Framework Adjustment 3 were adopted by the Council and are under review by NMFS.

Map 93 – Atlantic herring management areas



Although some herring are caught incidentally in recreational fisheries for Atlantic mackerel and silver hake, this is limited to coastal New Jersey, and almost all herring are caught for commercial purposes. Commercially-caught herring are primarily used as bait in the lobster or tuna fisheries, or as a food fish for the export market.

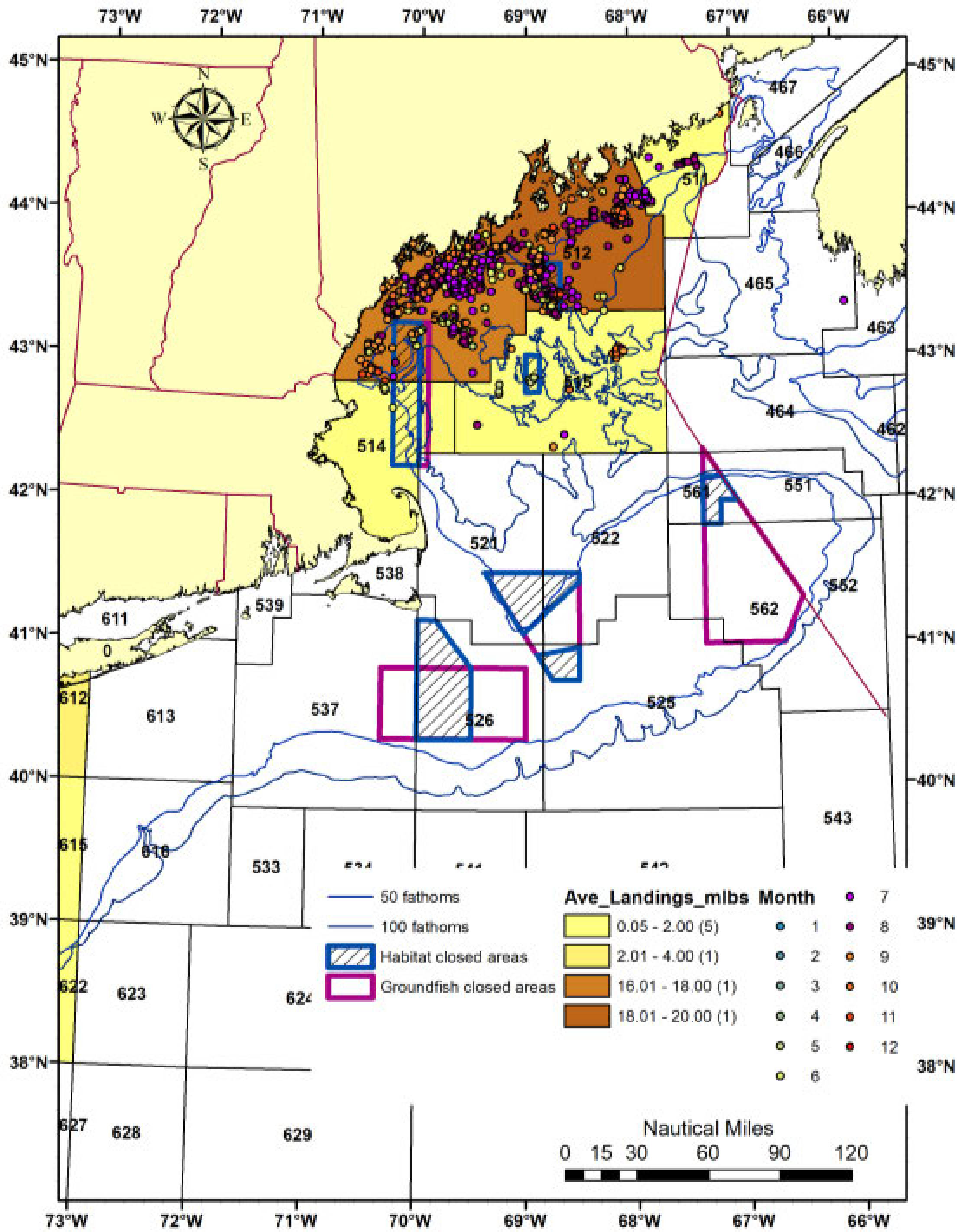
The U.S. Atlantic Herring fishery occurs over the Mid-Atlantic shelf region from Cape Hatteras, North Carolina to Maine, including an active fishery in the inshore Gulf of Maine and seasonally on Georges Bank. The Atlantic herring winter fishery is generally prosecuted south of New England in Management Area 2 during the winter (January-April), and oftentimes as part of the directed mackerel fishery. There is significant overlap between the herring and mackerel fisheries in Area 2 and in Area 3 during the winter months, although catches in Area 3 tend to be relatively low. The herring summer fishery (May-August) is generally prosecuted throughout the Gulf of Maine in Areas 1A, 1B and in Area 3 (Georges Bank) as fish are available. Restrictions in Area 1A have pushed the fishery in the inshore Gulf of Maine to later months (late summer). The midwater trawl (single and paired) fleet is restricted from fishing in Area 1A in the months of January through September because of the Area 1A split that is currently enforced through Atlantic States Marine Fisheries Commission's days-out measures (0% January-May) and the purse seine-fixed gear only area (all of Area 1A) that is effective June-September. Fall fishing (September-December) tends to be more variable and dependent on fish availability; the Area 1A quota is almost always fully utilized, and the inshore Gulf of Maine fishery usually closes sometime around November. As the Area 1A and 1B quotas are taken, larger vessels become increasingly dependent on offshore fishing opportunities (Georges Bank, Area 3) when fish may be available.

Atlantic herring vessel permit categories are: Category A limited access, all management areas; Category B limited access, Areas 2 and 3 only; Category C limited access, incidental catch of 25 mt per trip; and Category D open access, incidental catch of 3 mt per trip. Category A and B vessels comprise the majority of the directed herring fishery. Many of the Category A, B, and C vessels are also active in the Atlantic mackerel fishery

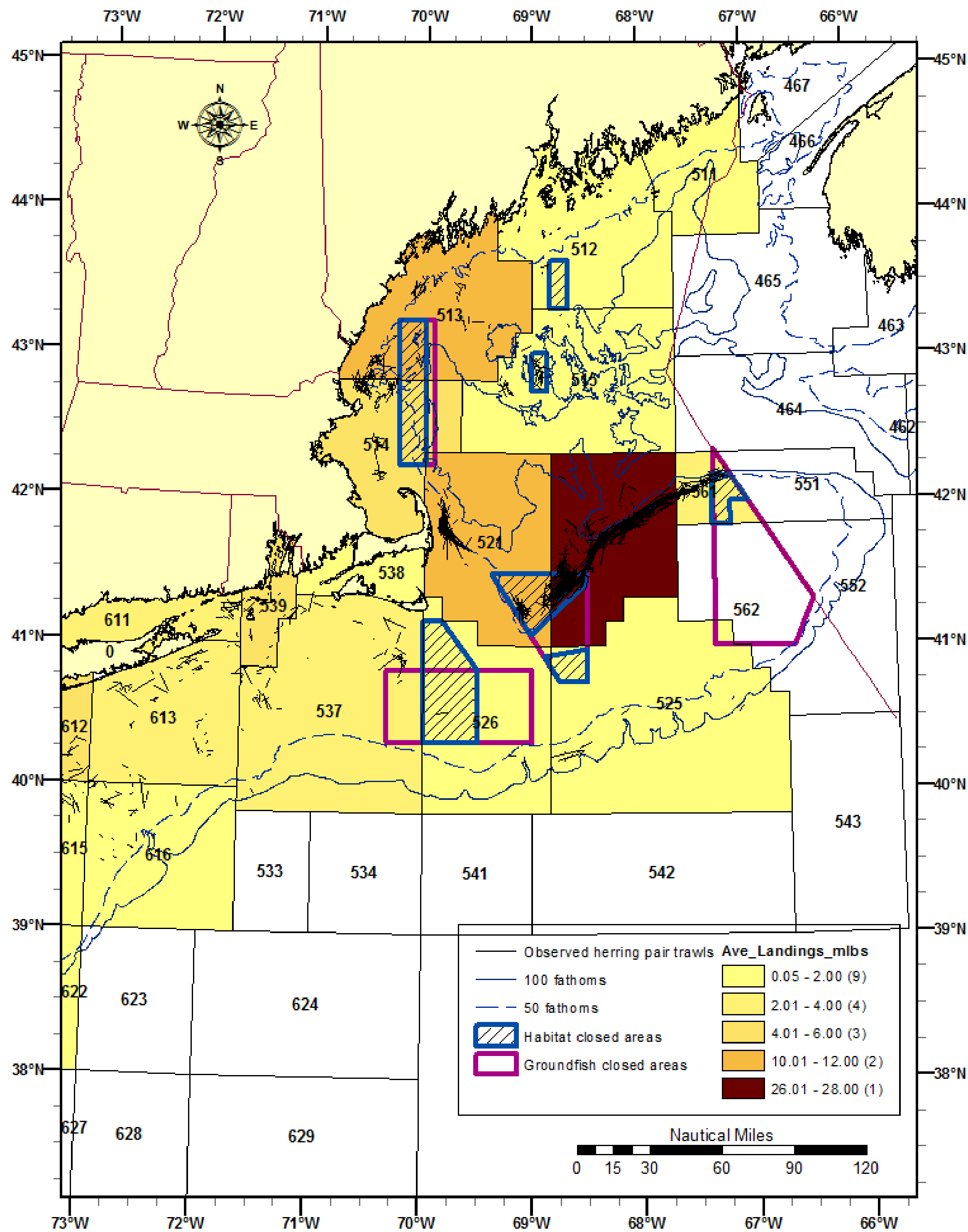
Atlantic herring vessels fish with purse seines (Map 94), or single or paired midwater trawls (Map 95), with the midwater pair trawl fleet harvesting the majority of landings from 2008 to 2011 (65% according to July 2013 specifications document). Some herring vessels use multiple gear types during the fishing year. Single and pair trawl vessels generally fish in all areas (October-December in Area 1A). The purse seine fleet fishes in the inshore Gulf of Maine (Area 1A and, to a lesser extent, Area 1B) and in Area 2. The single midwater trawl has been most active in Area 3. Small-mesh bottom trawl vessels represented 4% of herring landings over the time series; other gear types (e.g. pots, traps, shrimp trawls, hand lines) comprise less than 1% of the fishery.

Atlantic herring harvested from Areas 1A and 1B are landed in fishing communities in Maine, New Hampshire, and Massachusetts, whereas herring from Areas 2 and 3 are landed in a wider range of ports. Communities in Rhode Island and New Jersey fish in Area 2 for herring almost exclusively. Portland, Rockland, Gloucester, and New Bedford are ports with the most herring landings in recent years. Within New Jersey, Cape May is the most active landing port.

Map 94 – Atlantic herring purse seine effort 2008-2012. Yellow to brown shading shows average annual landings (live weight) by statistical area from the dealer tables. Colored circles show the locations of trips as reported on vessel trip reports, from January (blue) to December (red).



Map 95 – Atlantic herring single and paired midwater trawl effort 2008-2012. Yellow to brown shading shows average annual landings (live weight) by statistical area from the dealer tables. Colored circles show the locations of trips as reported on vessel trip reports, from January (blue) to December (red).



4.3.7 Deep-sea red crab

4.3.7.1 Biology, status, and overall distribution

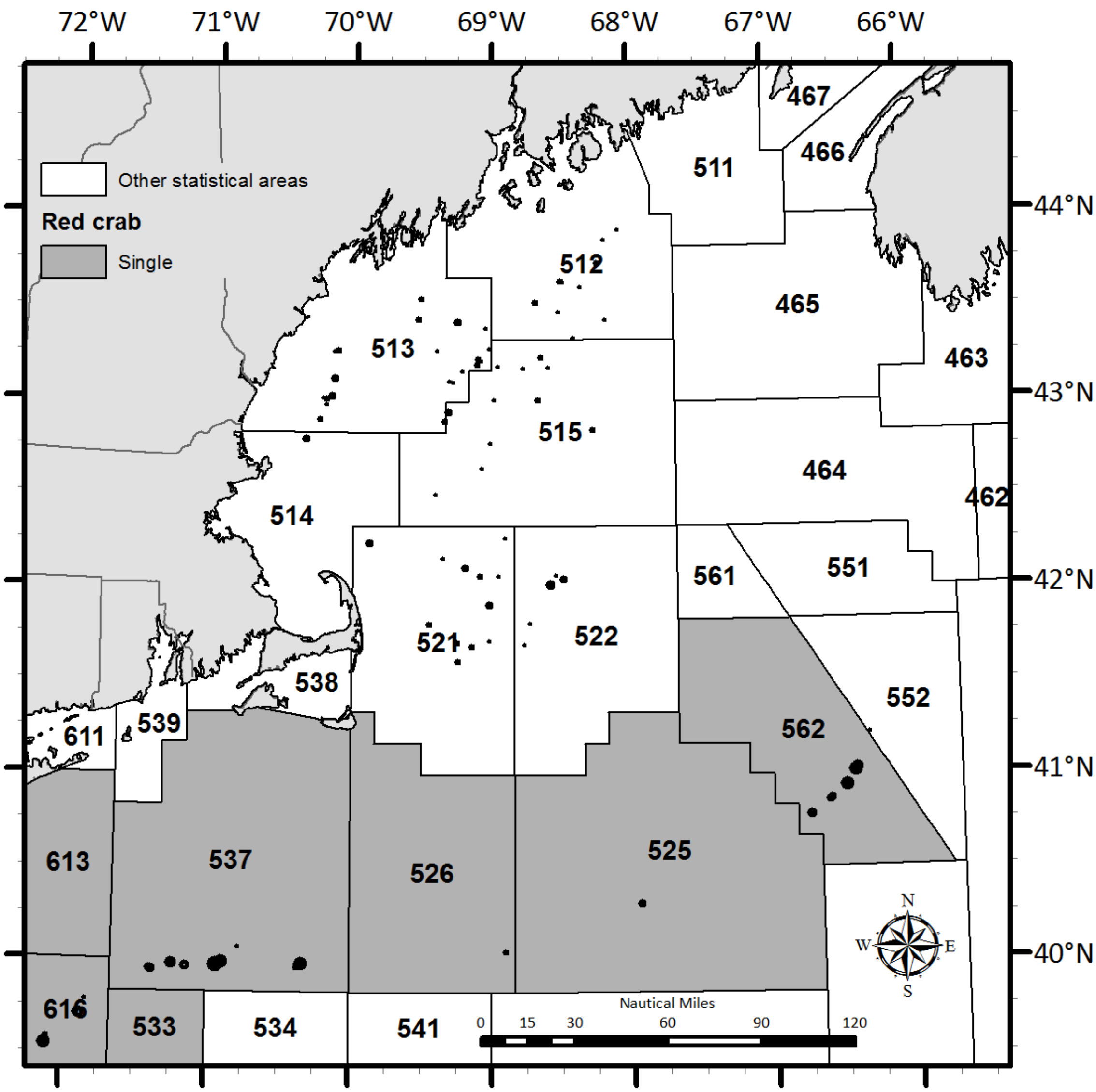
In U.S. waters, deep-sea red crab (*Chaceon quinquidens*) occur in the Gulf of Maine, along the continental slope from Georges Bank to the Gulf of Mexico, and on the seamounts.

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

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

Deep-sea red crab is considered a data poor stock since they inhabit deep water, are rarely caught in the trawl survey, and there is little information about their life history. Only male red crabs are landed in the trap fishery, which is managed via the Atlantic Deep-Sea Red Crab FMP, implemented in 2002. The species is managed as a single stock (Map 96), and red crabs in the Gulf of Maine are not included in reference point, biomass, or management calculations. Additional details are provided in the 2008 Data Poor Stocks Working Group Report (NEFSC 2009), which found that as of 2008, the stock status was unknown.

Map 96 – Red crab stock boundary and kg/tow (0-94 kg/tow; classified by 10 natural breaks (Jenks)) from spring and fall NEFSC, MADMF, and ME/NH surveys, 2002-2013. Spring survey values shaded grey may obscure fall survey values shaded black.



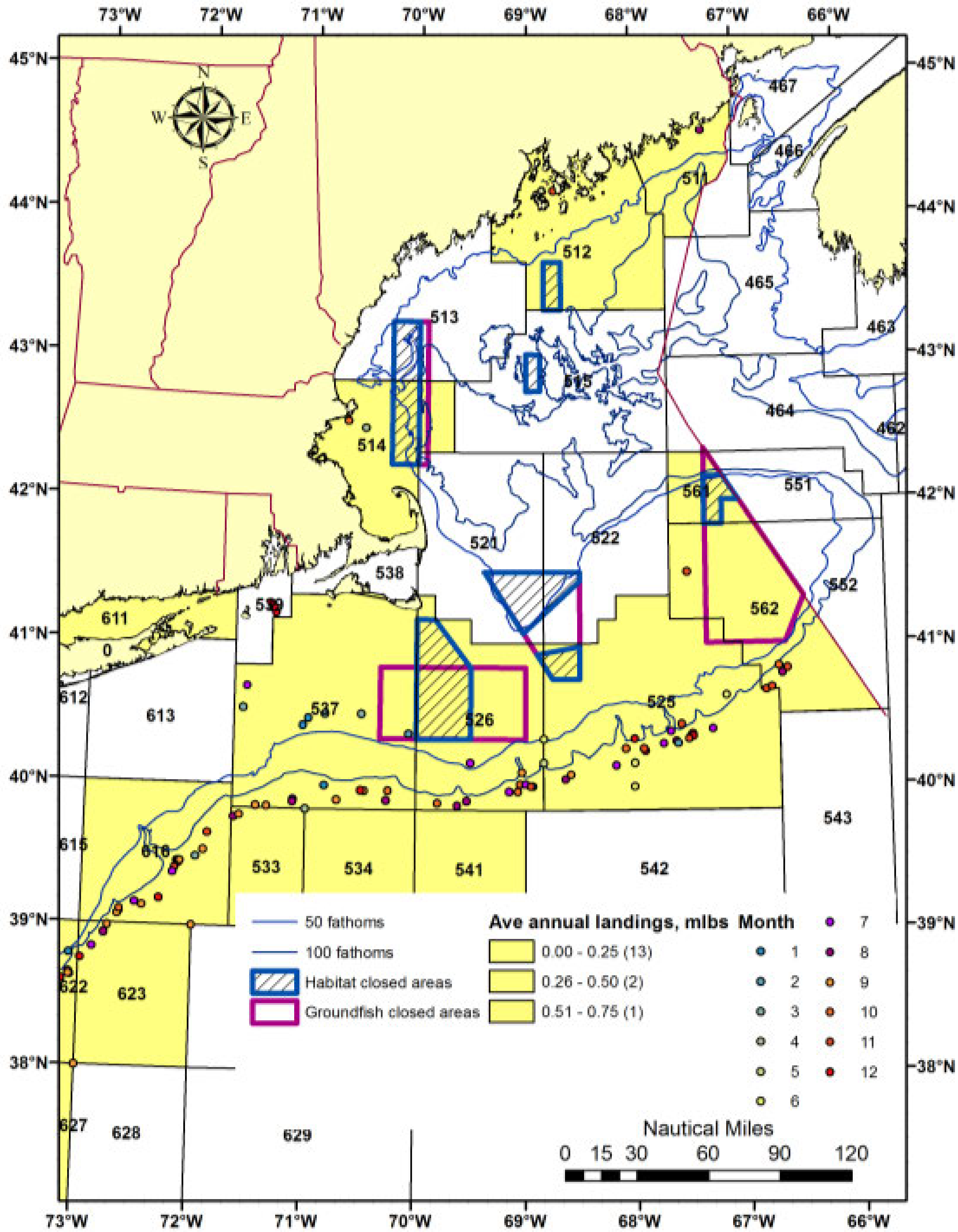
4.3.7.2 Fishery

There has been a small directed fishery off the coast of New England and in the Mid-Atlantic for deep-sea red crab since the early 1970s. Though the size and intensity of this fishery has fluctuated, it has remained consistently small relative to more prominent New England fisheries such as groundfish, sea scallops, and lobster. In 1999, at the request of members of the red crab fishing industry, the Council began development of an FMP to prevent overfishing of the red crab resource and address a threat of overcapitalization of the red crab fishery. The FMP was implemented in 2002.

The primary management control was to establish a limited access permit program for qualifying vessels with documented history in the fishery. Other measures included days-at-sea limits, trip limits, gear restrictions, and limits on processing crabs at sea. Amendment 3 was implemented in 2011 to bring the FMP into compliance with the revised Magnuson-Stevens Act by implementing Annual Catch Limits and accountability measures. Amendment 3 also revised the management measures, by eliminating DAS and the vessel trip limit.

The directed, limited access red crab fishery is a male-only fishery, that is currently managed with a "hard" quota (i.e., the fishery is closed when the quota is reached), gear restrictions, and limits on processing crabs at sea. Although there is an open access permit category, the small possession limit of 500 pounds per trip has kept this sector of the fishery very small. The directed red crab fishery is limited to using parlor-less crab pots (Map 97), and is considered to have little, if any, incidental catch of other species. There is no known recreational fishery for deep-sea red crab. Landings of red crab varied somewhat before the implementation of the FMP, but have stabilized. All vessels with limited access permits now fish out of Fall River, Massachusetts.

Map 97 – Deep-sea red crab trap effort 2008-2012. Yellow to brown shading shows average annual landings (live weight) by statistical area from the dealer tables. Colored circles show the locations of trips as reported on vessel trip reports, from January (blue) to December (red).



4.3.8 Surfclam and ocean quahog

4.3.8.1 Biology, status, and overall distribution

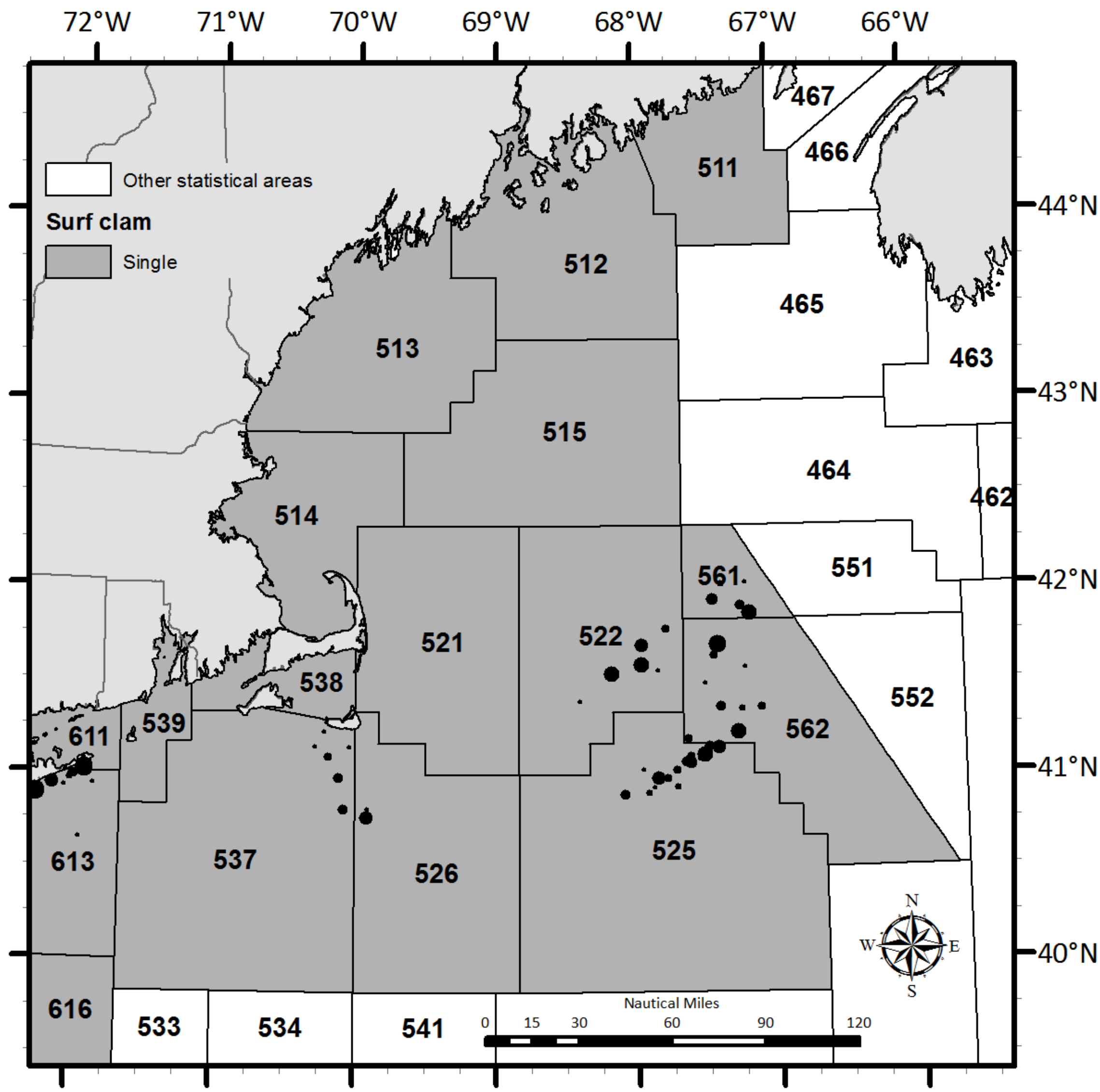
Atlantic surfclams (*Spisula solidissima*) and ocean quahogs (*Arctica islandica*) are bivalve mollusks that are found in continental shelf waters from Cape Hatteras, North Carolina, north to the Gulf of St. Lawrence/Newfoundland (Map 98 and Map 99). Note, however, that the maps based on the survey catches can be misleading because the survey area does not extend north of Georges Bank and Southern New England. There are Atlantic surfclams in the southwestern portions of the Gulf of Maine and ocean quahogs (referred to as "Maine Mahogany Quahogs") along the Maine coast.

Major concentrations of surfclams are found on Georges Bank, south of Cape Cod, off Long Island, southern New Jersey, and the Delmarva Peninsula, and there is a large biomass on Georges Bank that has only recently been opened to fishing. The greatest concentrations of ocean quahogs are fished in offshore waters south of Nantucket to the Delmarva Peninsula. Ocean quahogs are referred to as mahogany quahogs in Maine, as they are harvested at smaller sizes when they tend to have a more brownish coloration. Ocean quahogs should not be confused with the species *Mercenaria mercenaria*, which is also commonly referred to as a quahog. Another commercially important surfclam, *Mactromeris* (or *Spisula*) *polynyma*, the arctic or Stimpson's surfclam, is found in the Gulf of Maine, on Georges Bank, and possibly as far south as southern New England. Neither *M. mercenaria* or *M. polynyma* is a managed under a Federal fishery management plan.

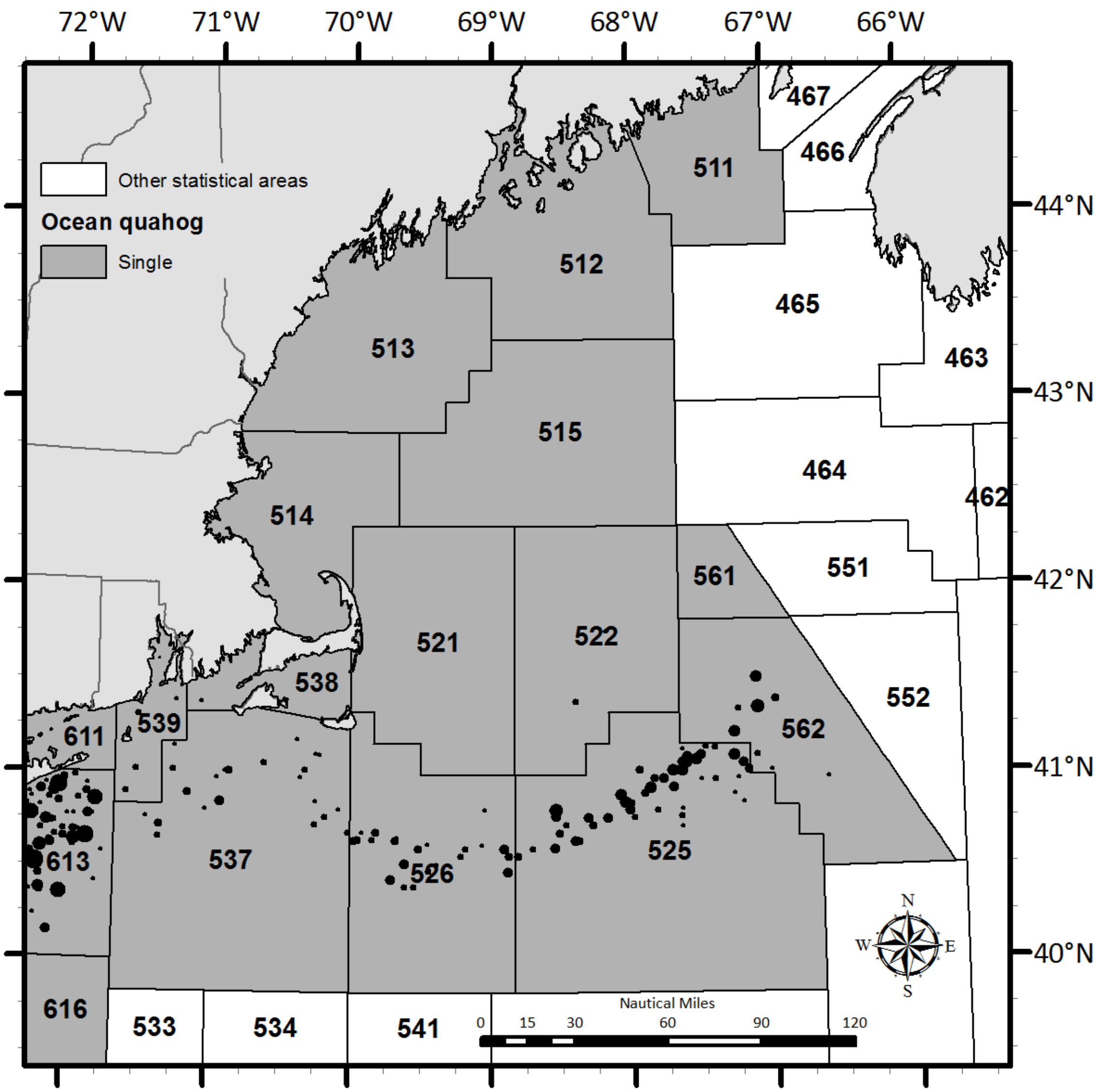
In general, Atlantic surfclams are found in shallower depths than ocean quahogs (most common at 10-40 meters as compared to 40-80 m), although ocean quahogs are found in shallower waters along the Maine coast. The greatest concentrations of surfclams are usually found in well-sorted, medium sand, but they may also occur in fine sand and silty fine sand. Adult ocean quahogs are usually found in dense beds over level bottoms, just below the surface of the sediment which ranges from medium to fine grain sand. Both species live in the sediment and are vulnerable to clam dredges that penetrate sandy bottom sediments to a depth of 8-10 inches.

Ocean quahogs are an extremely slow-growing, long-lived species that can reach 200 years of age under normal conditions. Surfclams can live to over 30 years of age and 15-20 year old clams are common. The assessments for both stocks were updated during 2013 and neither is overfished, nor is overfishing occurring (NEFSC 2013). The assessment estimated low fishing mortality rates for both stocks during 2011: F=0.007 y^{-1} for ocean quahogs and F=0.027 y^{-1} for surfclams.

Map 98 – Surf clam stock boundary and kg/tow (0-543 kg/tow, classified by 10 natural breaks (Jenks)) from the clam dredge surveys (2002, 2005, 2008, 2011, 2012).



Map 99 – Ocean quahog stock boundary and catch/tow from the clam dredge surveys (2002, 2005, 2008, 2011, 2012).



4.3.8.2 Fishery

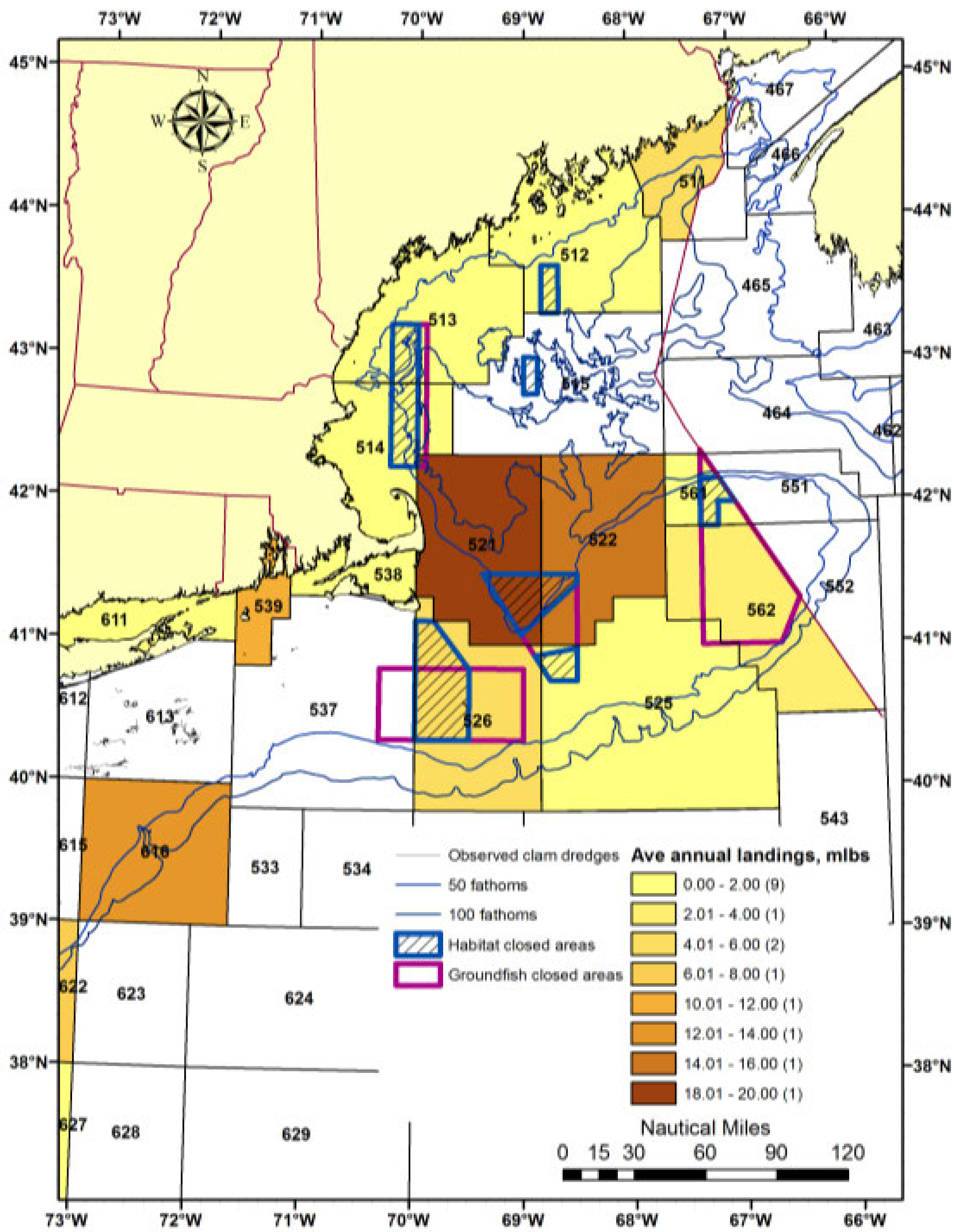
The Mid-Atlantic Council developed the FMP in the mid 1970's and it was implemented in 1977. Amendment 8 to the FMP, implemented in 1990, established an individual transferable quota (ITQ) system for the fisheries. Quota shareholders are allowed to purchase, sell, or lease quota to and from other shareholders. Amendment 10 incorporated management measures for ocean quahogs (mahogany clams) in Maine; a separate portion of the quota is set aside for this area, which is shown in green on Map 101. A framework adjustment in 2007 required the use of VMS for all vessels participating in the surfclam or ocean quahog fisheries.

There is no recreational fishery for either species. Most of the landings of ocean quahogs and almost all landings of surfclams are associated with the hydraulic clam dredge (see description in

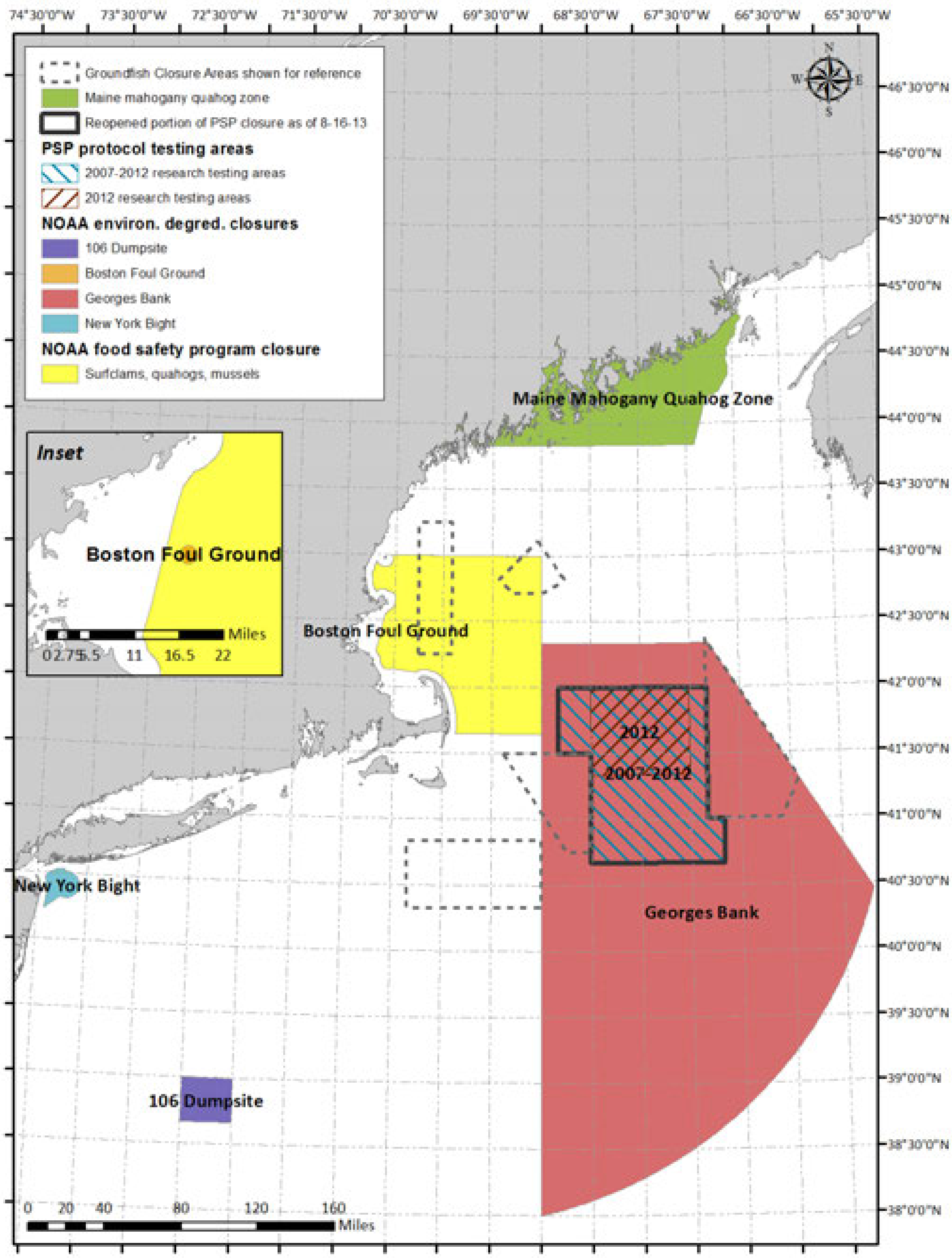
SASI appendix). The relatively small Maine mahogany quahog fishery uses a non-hydraulic dredge. These dredges rely on 6-inch teeth along the leading edge to rake the seabed and lift quahogs into the cage (Stevenson et al 2004). They are fished from small 30-40 ft vessels in areas of sand and sandy mud between bedrock outcrops (Stevenson et al 2004). The state of Maine caps the width of these dredges at 36” (24” between the Spurwink River in Scarborough and Fletcher's Neck in Biddeford Pool). Landings by dredge type are shown in Map 100.

Waters of the Gulf of Maine and Georges Bank are subject to intermittent harmful algal blooms, or “red tide,” caused by the dinoflagellate *Alexandrium fundyense*, which produces a toxin known to cause paralytic shellfish poisoning (PSP) in people consuming contaminated clams. Because of a history of harmful algal blooms and limited testing in the area, eastern Georges Bank was closed to the harvest of clams in 1990. In 2013, a portion of Georges Bank (grey outlined area shown on Map 101) was opened for the harvest of surfclams and ocean quahog by vessels using a new PSP testing protocol. This area was accessible to vessels developing the PSP testing protocol during 2007-2012 (hatched areas shown on Map 101). Other areas in the Gulf of Maine and in Southern New England were closed in 2005 due to an outbreak of *A. fundyense* in these areas (70 FR 35047, the Gulf of Maine or Northern PSP Closure Area is shown in yellow on Map 101). This northern area is scheduled to reopen in late 2014 (see additional discussion in clam section of Volume 4). A Southern Temporary PSP Closure Area also restricted clam harvesting briefly during summer 2005, but the area was reopened later that year (70 FR 53580).

Map 100 – Clam dredge effort 2008-2012. Yellow to brown shading shows average annual landings (live weight) by statistical area from the dealer tables. Black lines show start/end positions of hauls observed at sea.



Map 101 – Management areas relevant to the clam fishery. The year round groundfish closure areas are shown for reference – vessels dredging for surfclams or ocean quahogs are exempted from the Western Gulf of Maine, Cashes Ledge, and Nantucket Lightship closures.



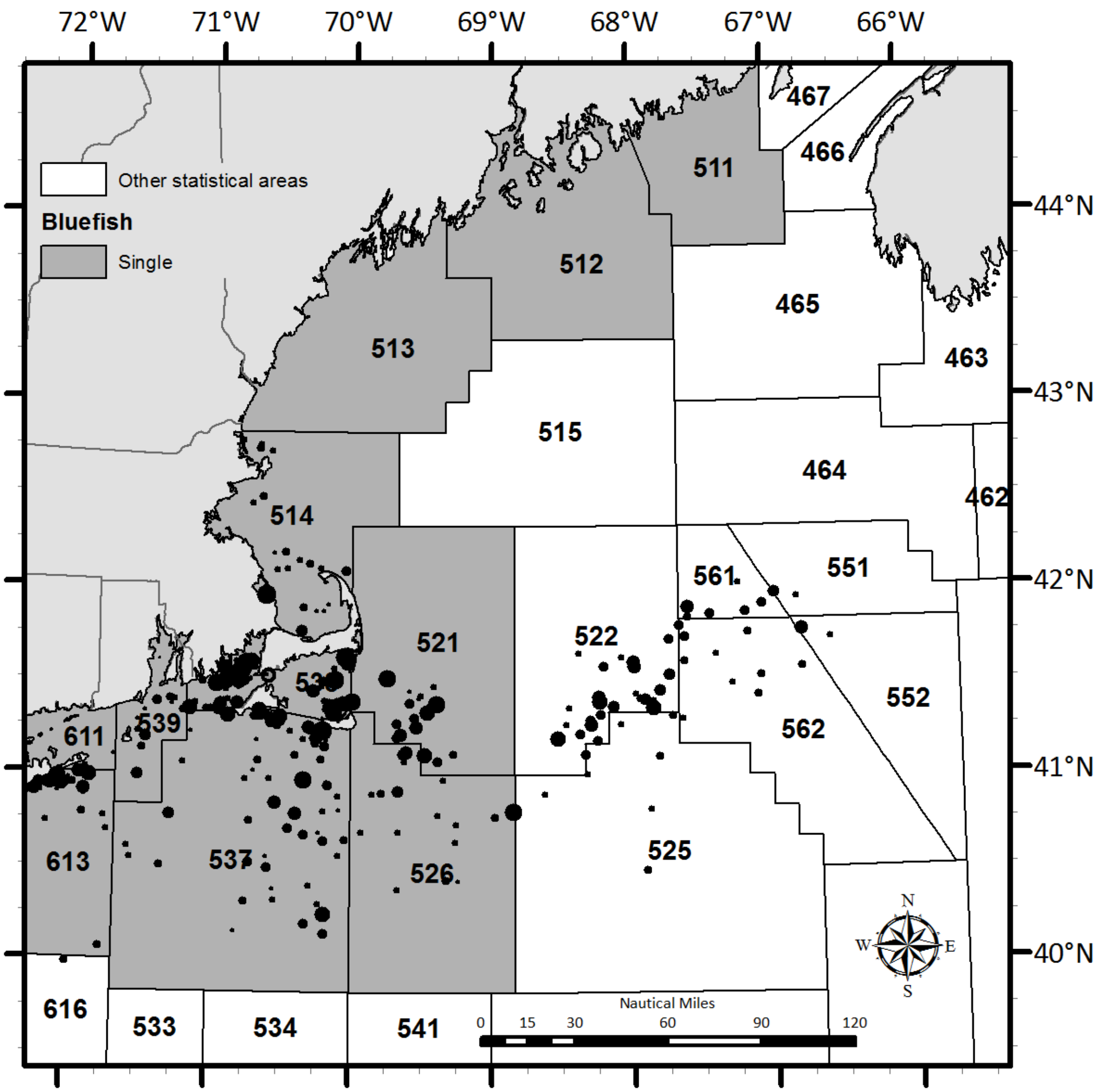
4.3.9 Atlantic bluefish

4.3.9.1 Biology, status, and overall distribution

Bluefish (*Pomatomus saltatrix*) is a migratory pelagic species found in most temperate and tropical marine waters throughout the world. Along the U.S. Atlantic coast, bluefish commonly are found in estuarine and continental shelf waters (Map 102). Bluefish are a schooling species that migrate in response to seasonal changes, moving north and inshore during spring and south and offshore in the late autumn.

The Atlantic bluefish fishery exploits what is considered to be a single stock of fish. According to the 2012 assessment update, the stock was above the threshold of ½ B_{MSY} during 2011, so it was not overfished during 2011. The stock assessment was updated in July 2013 and the stock is not overfished and overfishing is not occurring. The updated stock assessment also indicates that the fishing mortality rate continues to be below the threshold F_{MSY}, and has been since the late 1990s. With the exception of 2007, the Mid-Atlantic Council's recommended harvest limit has never been exceeded.

Map 102 – Bluefish stock boundary and kg/tow (0-5 kg/tow; classified by 10 natural breaks (Jenks)) from spring and fall NEFSC, MADMF, and ME/NH surveys, 2002-2013. Spring survey values shaded grey may obscure fall survey values shaded black.

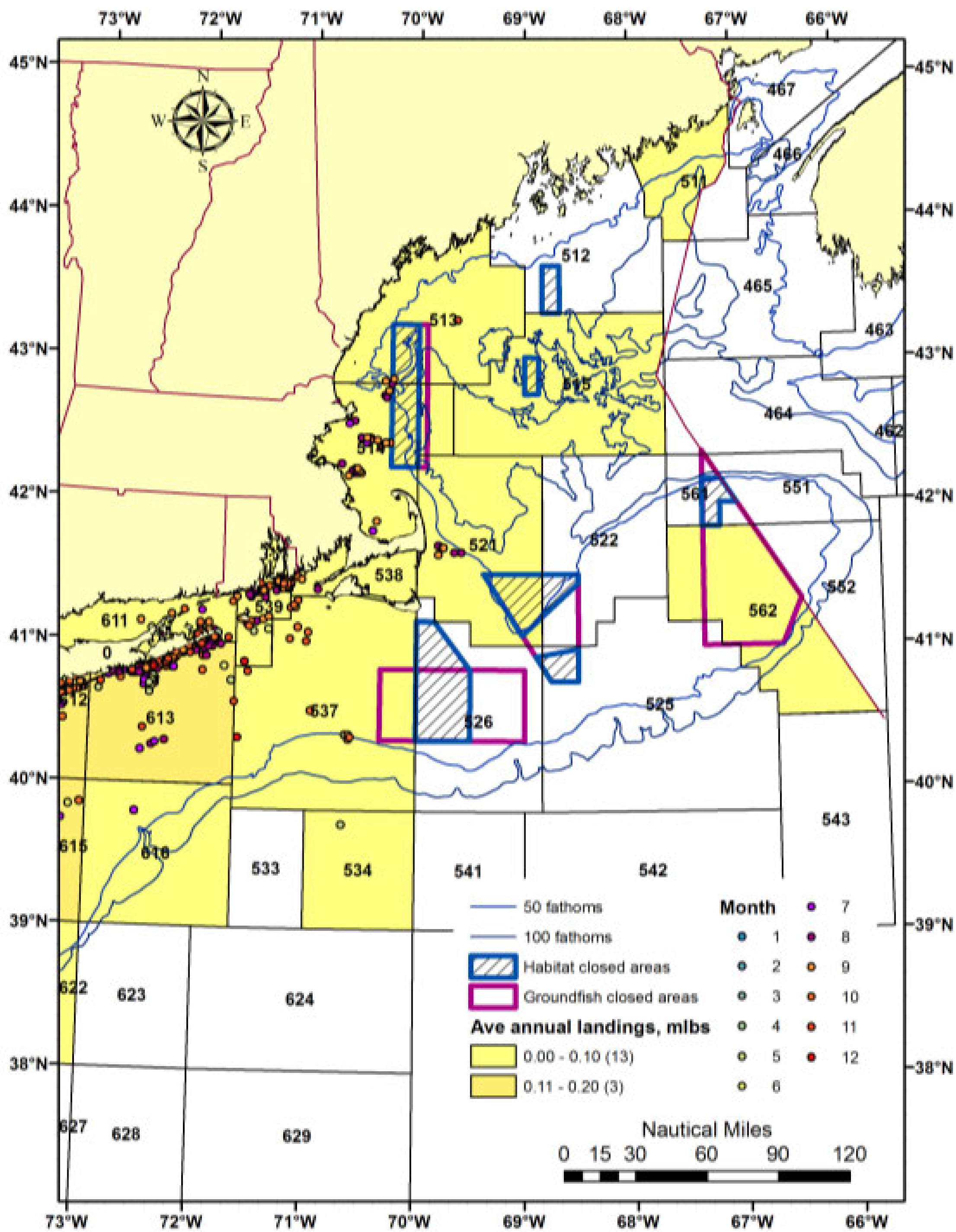


4.3.9.2 Fishery

The Mid-Atlantic Council began developing the Atlantic Bluefish FMP in 1979 in response to a petition by concerned fishermen reacting to developments in international markets for bluefish. The final FMP was adopted as a joint plan between the Mid-Atlantic Council and Atlantic States Marine Fisheries Commission in 1989 and was implemented in 1990. The FMP established a state-by-state commercial quota system and a coast-wide recreational harvest limit. The Mid-Atlantic Council and the Commission decide annually on a total allowable landings level that is divided between the commercial and recreational sectors. The commercial quota is then further allocated to the states from Maine through Florida based on percentage shares specified in the FMP. The FMP calls for 83 percent of the total allowable landings to be allocated to the recreational sector and 17 percent allocated to the commercial sector, but provides for a transfer of quota to the commercial sector from the recreational sector within certain limits.

The primary gear types used in the commercial fisheries that land bluefish include gillnets (Map 103), rod and reel, and otter trawls, although there are small localized fisheries, such as the beach seine fishery that operates along the Outer Banks of North Carolina that also catch bluefish. Recreational fishing, which dominates the catch of bluefish, is almost exclusively rod and reel, and includes shoreside recreational anglers, party/charter boats, and private recreational boats. There is a lot of seasonality to both the commercial and recreational fisheries for bluefish due to the migratory nature of the species.

Map 103 - Bluefish gillnet effort 2008-2012. Yellow to brown shading shows average annual landings (live weight) by statistical area from the dealer tables. Colored circles show the locations of trips as reported on vessel trip reports, from January (blue) to December (red).



4.3.10 Atlantic mackerel, squid, and butterfish

4.3.10.1 Biology, status, and overall distribution

Mackerel (*Scomber scombrus*), butterfish (*Peprilus triacanthus*), and squid are schooling pelagic species that range from at least the Gulf of St. Lawrence south to at least Cape Lookout, North Carolina. Two squid species are managed, shortfin squid (*Illex* sp.) and longfin inshore squid (*Doryteuthis (Amerigo) pealeii*), which until recently was referred to as *Loligo pealeii*. They follow seasonal migration patterns based largely on water temperature. *Illex* move offshore in spring, and inshore in the summer and fall (Map 104). In contrast, longfin squid move offshore in the fall, and overwinter along the shelfbreak, returning inshore in spring (Map 105).

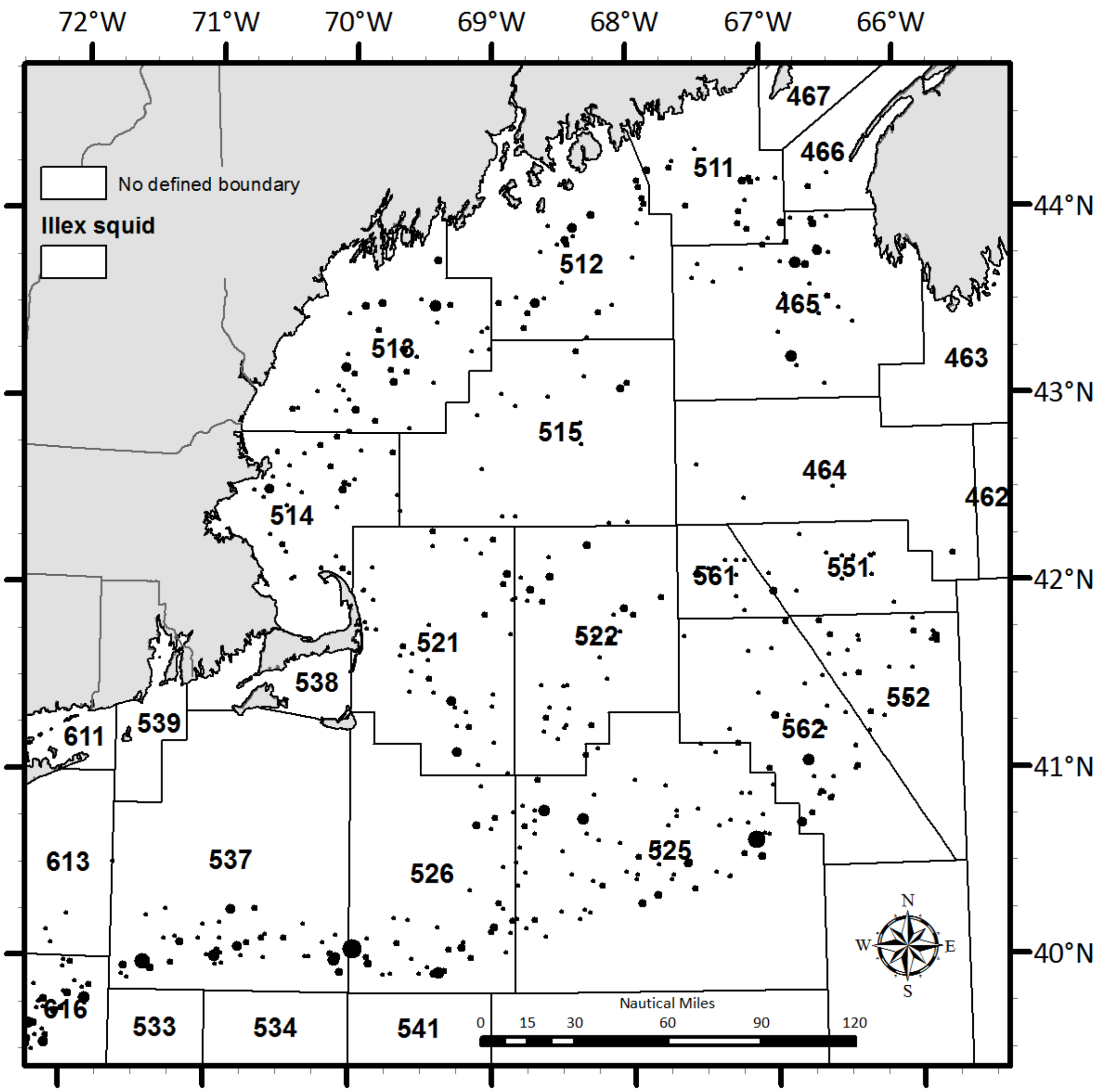
Squid are fast-growing, short-lived species, living about a year, while Atlantic mackerel grows more slowly with a maximum observed age of 17 years, with all fish reaching sexual maturity at age 3. Butterfish are intermediate in lifespan and growth rate, maturing at age 1 and typically living to age 3, rarely to 6 years. All are important prey species for other managed resources.

In general, assessment of all four species has proven challenging and status determinations are often unknown or highly uncertain. Mackerel are managed as a single stock (Map 106), and although technically classified as not overfished and overfishing not occurring, there was substantial uncertainty associated with the most recent assessment, conducted in 2010 by the Transboundary Resource Assessment Committee. The TRAC recommended management based on recent landings history, rather than on the basis of short term projections and characterization of the stock relative to specific reference points.

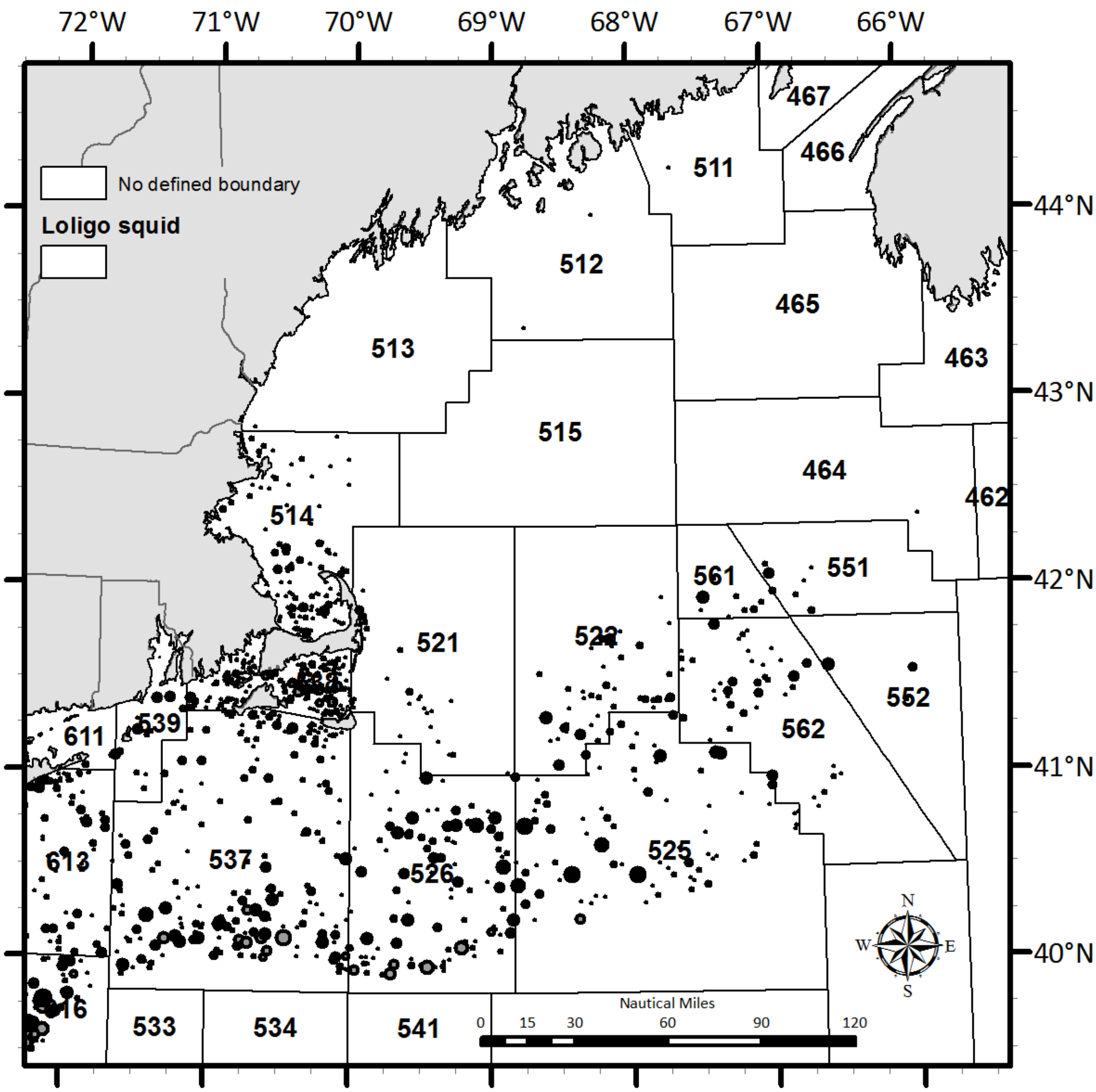
Butterfish are also managed as a single stock (Map 107). The most recent assessment in 2010 questioned the 2004 reference points, and while it was agreed that overfishing was not likely to be occurring, the overfished status of butterfish was classified as unknown. A benchmark assessment of the stock is ongoing.

A determination of overfished/overfishing status in *Illex* was not possible during the last assessment, which occurred in 2006. However, data updates provided by NEFSC indicate that catch indices and landings are within their typical ranges. Longfin squid were assessed more recently, and based on a new reference point, the stock was not overfished in 2009. An overfishing threshold was not recommended during this assessment, so an overfishing determination is not possible.

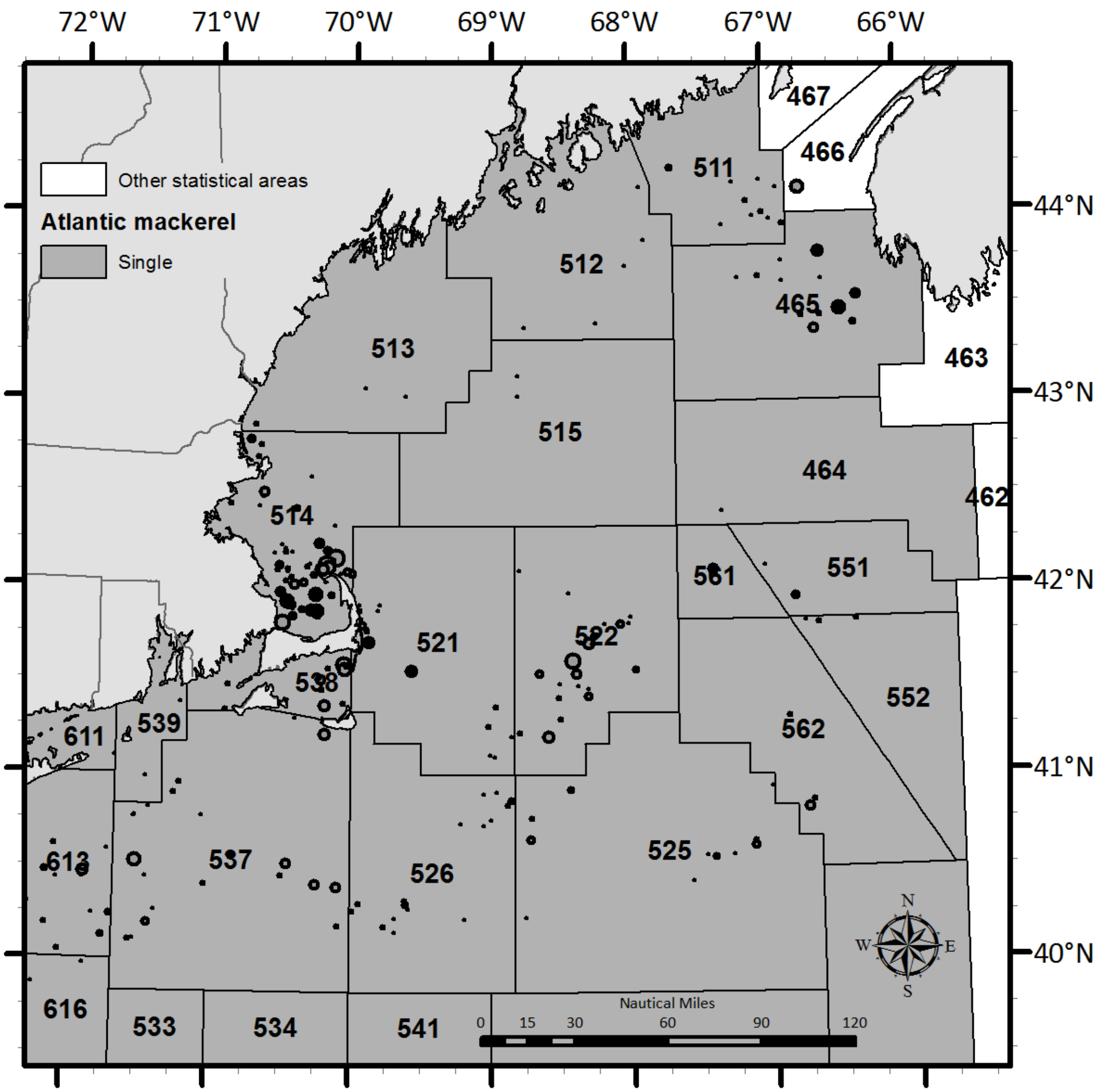
Map 104 - Illex squid kg/tow (0-272 kg/tow; classified by 10 natural breaks (Jenks)) from spring and fall NEFSC, MADMF, and ME/NH surveys, 2002-2013. Spring survey values shaded grey may obscure fall survey values shaded black.



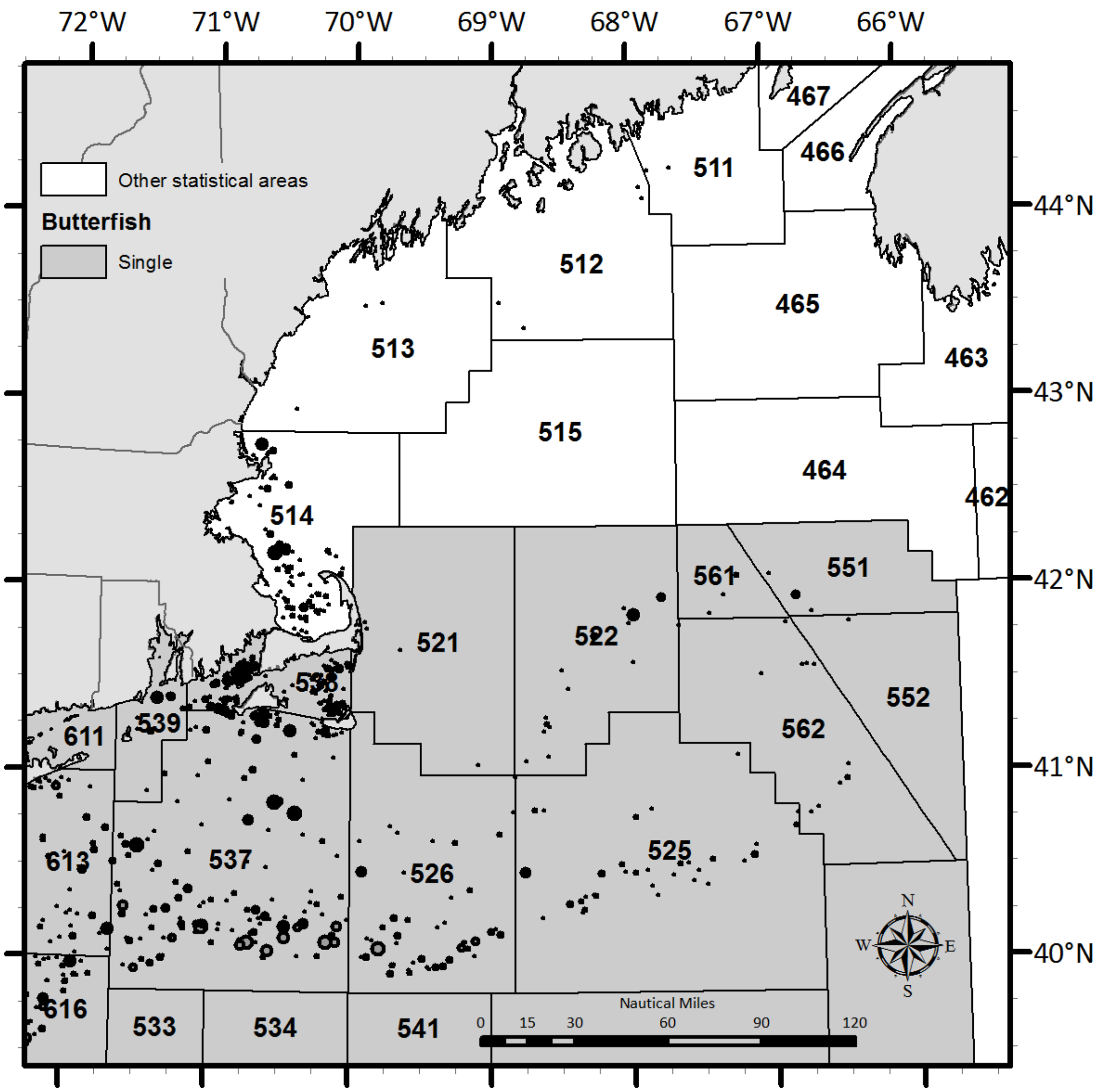
Map 105 – Loligo squid kg/tow (0-465 kg/tow; classified by 10 natural breaks (Jenks)) from spring and fall NEFSC, MADMF, and ME/NH surveys, 2002-2013. Spring survey values shaded grey may obscure fall survey values shaded black.



Map 106 – Atlantic mackerel stock boundary and catch/tow from spring and fall NEFSC, MADMF, and ME/NH surveys, 2002-2013. Spring survey values shaded grey may obscure fall survey values shaded black.



Map 107 - Butterfish stock boundary and kg/tow (0-4566 kg/tow; classified by 10 natural breaks (Jenks)) from spring and fall NEFSC, MADMF, and ME/NH surveys, 2002-2013. Spring survey values shaded grey may obscure fall survey values shaded black.



4.3.10.2 Fishery

The mackerel, squid, and butterfish fisheries are all managed by directly controlling harvest under an FMP developed by the Mid-Atlantic Council in 1983. The directed mackerel fishery can be closed when landings are projected to reach 95 percent of the total domestic harvest. The mackerel incidental catch fishery can be closed when landings are projected to reach 100 percent of the total domestic harvest. The directed longfin squid fishery is managed via trimester quota allocations and the directed fishery is closed when 90 percent of the trimester quota allocations or 95 percent of the total domestic harvest is projected to be landed. There is also a cap on butterfish discards in the longfin squid fishery that is allocated by trimester, and closes the longfin squid fishery to directed harvest once it has been exceeded. The directed *Illex* fishery closes when 95 percent of the total domestic harvest is projected to be landed. Finally, butterfish is managed using a phased system. The system triggers butterfish possession limit reductions at different points to ensure quota is available for directed harvest throughout the fishing year. During closures of the directed longfin squid, *Illex*, or butterfish fisheries, incidental catch fisheries for these species are permitted.

Amendment 14 to the FMP (February 24, 2014; 79 FR 10029) was effective on March 26, 2014, implementing a comprehensive catch monitoring program for the mackerel fishery. The focus of Amendment 14 was to address river herring and shad catch in the mackerel fishery. The action was similar to Amendment 5 to the Herring FMP, described in Section 4.3.6.2. Amendment 14 established provisions to allow the Mid-Atlantic Council to set river herring and shad catch caps for the mackerel fishery, and the first cap was established through the 2014 Mackerel, Squid, Butterfish specifications, effective April 4, 2014 (79 FR 18834).

Although 1.5 percent of butterfish landed from 2007-2011 were reported as caught with gillnets, and trace amounts of these species were reported as caught with a variety of fishing gears, more than 98 percent of reported landings of all four species during this period were caught with otter trawls (midwater and bottom). Management measures implemented under this FMP restrict only the commercial fishing sectors, although there is a recreational fishery for Atlantic mackerel. Fishing for Atlantic mackerel occurs year-round, although most fishing activity occurs from January through April. The *Illex* squid fishery occurs largely from June through October, although this can vary somewhat from year to year. In some years, the longfin squid fishery remains relatively consistent throughout the year, but in most years, landings peak during October through April. Butterfish are landed year-round, with no apparent seasonal patterns.

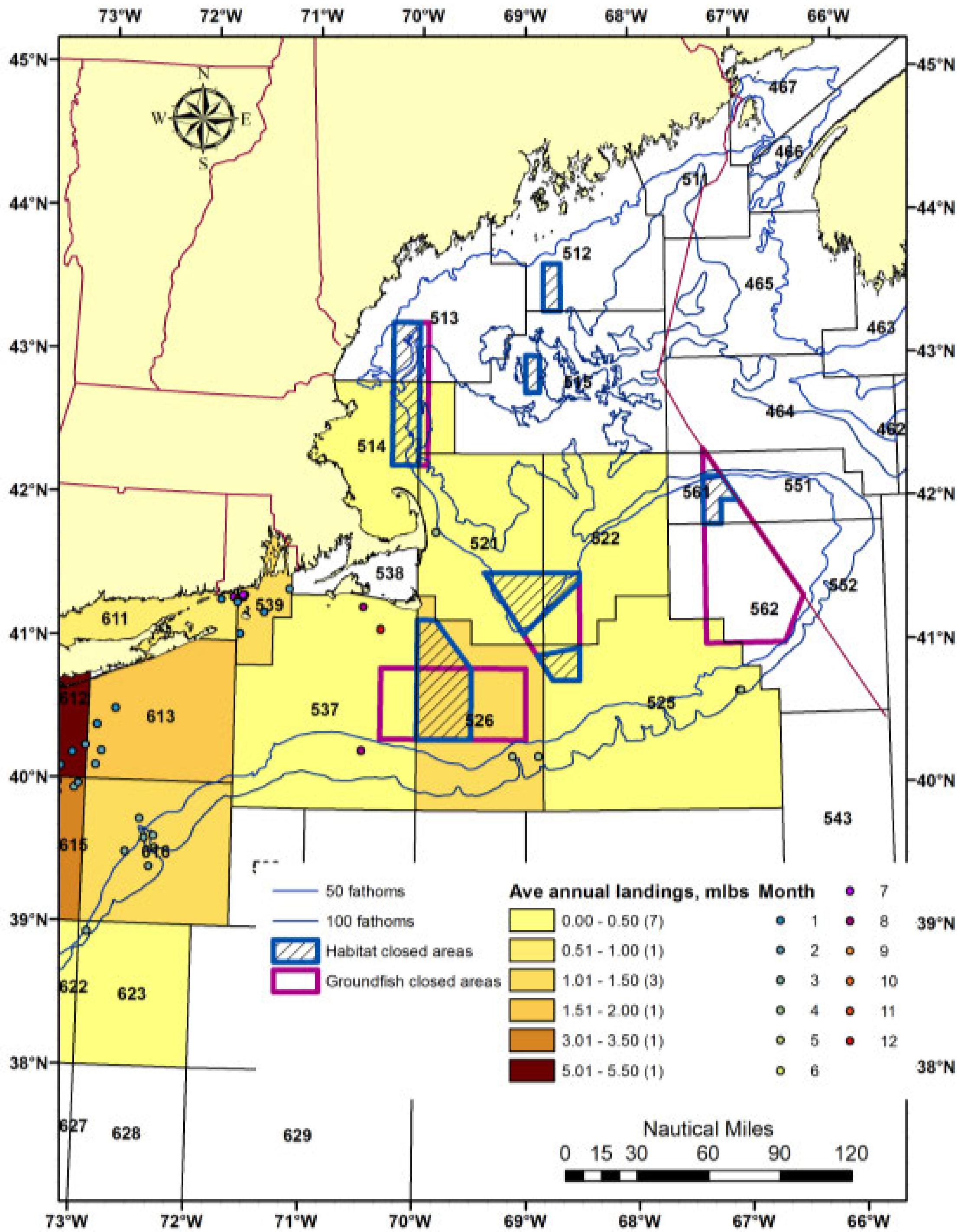
Mackerel harvest has declined since about the mid-2000s and the fishery has harvested at most about 50% of the quota since that time.

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

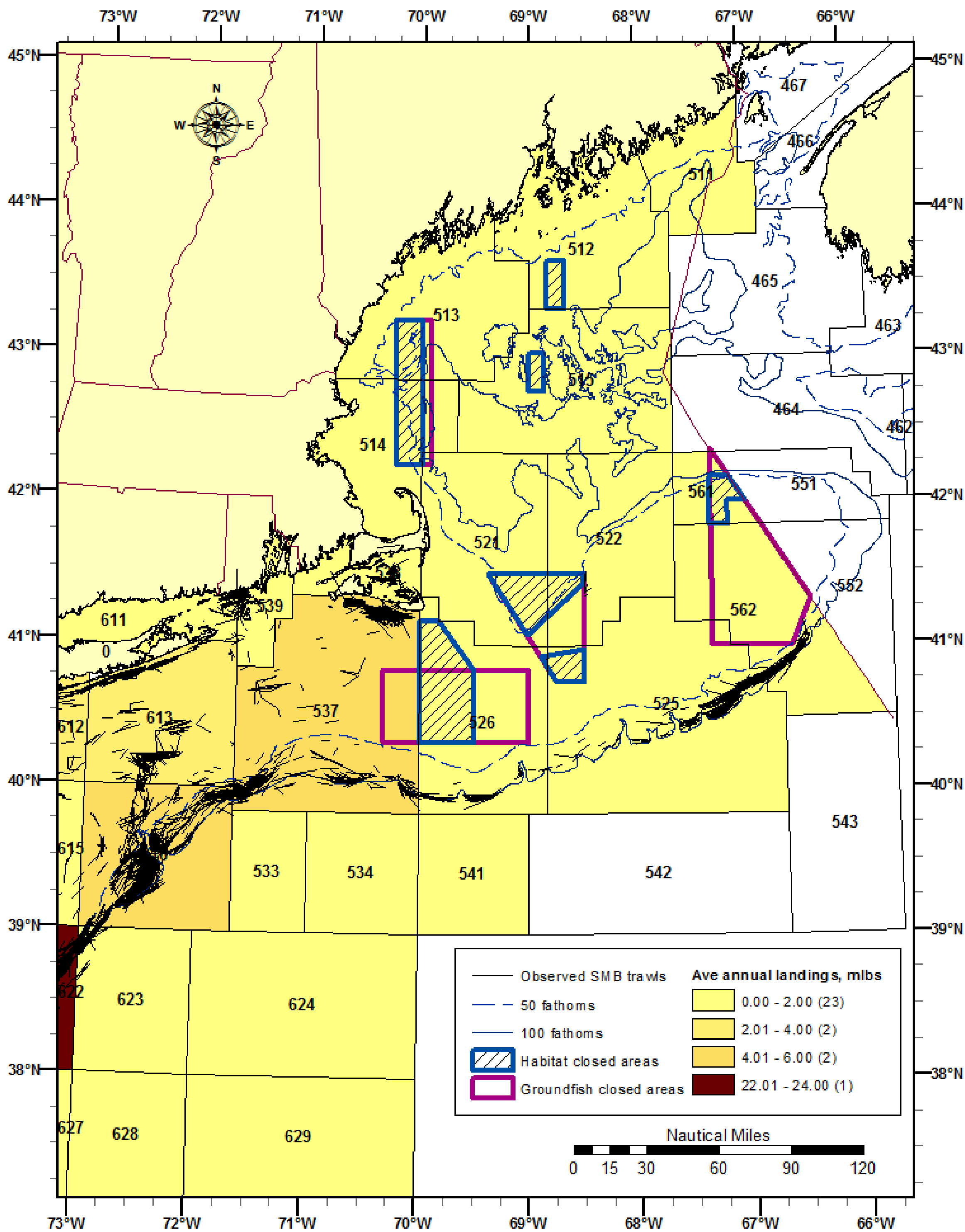
Like butterfish, *Illex* were also subject to substantial foreign fishing from the 1960s to the 1980s. Domestic harvest increased as foreign fishing mortality was reduced in the 1980s, and have remained between 10,000 and 20,000 mt per year since the mid-2000s. Longfin squid were fished domestically in the 1960s and 1970s, while foreign fishing occurred on this squid when they were offshore. An offshore U.S. fishery developed in the late 1980s. Currently, offshore fishing occurs between October and March and inshore fishing occurs from April through September. There has been a slight downward trend in longfin squid landings since the late 1980s, although 2011 and 2012 show an upward trend.

Landings for all species in mid-water and bottom trawls are shown on Map 108 and Map 109.

Map 108 – Atlantic mackerel, squid, and butterfish midwater trawl effort 2008-2012. Yellow to brown shading shows average annual landings (live weight) by statistical area from the dealer tables. Colored circles show the locations of trips as reported on vessel trip reports, from January (blue) to December (red).



Map 109 – Atlantic mackerel, squid, and butterfish bottom trawl effort 2008-2012. Yellow to brown shading shows average annual landings (live weight) by statistical area from the dealer tables. Black lines show start/end positions of hauls observed at sea.



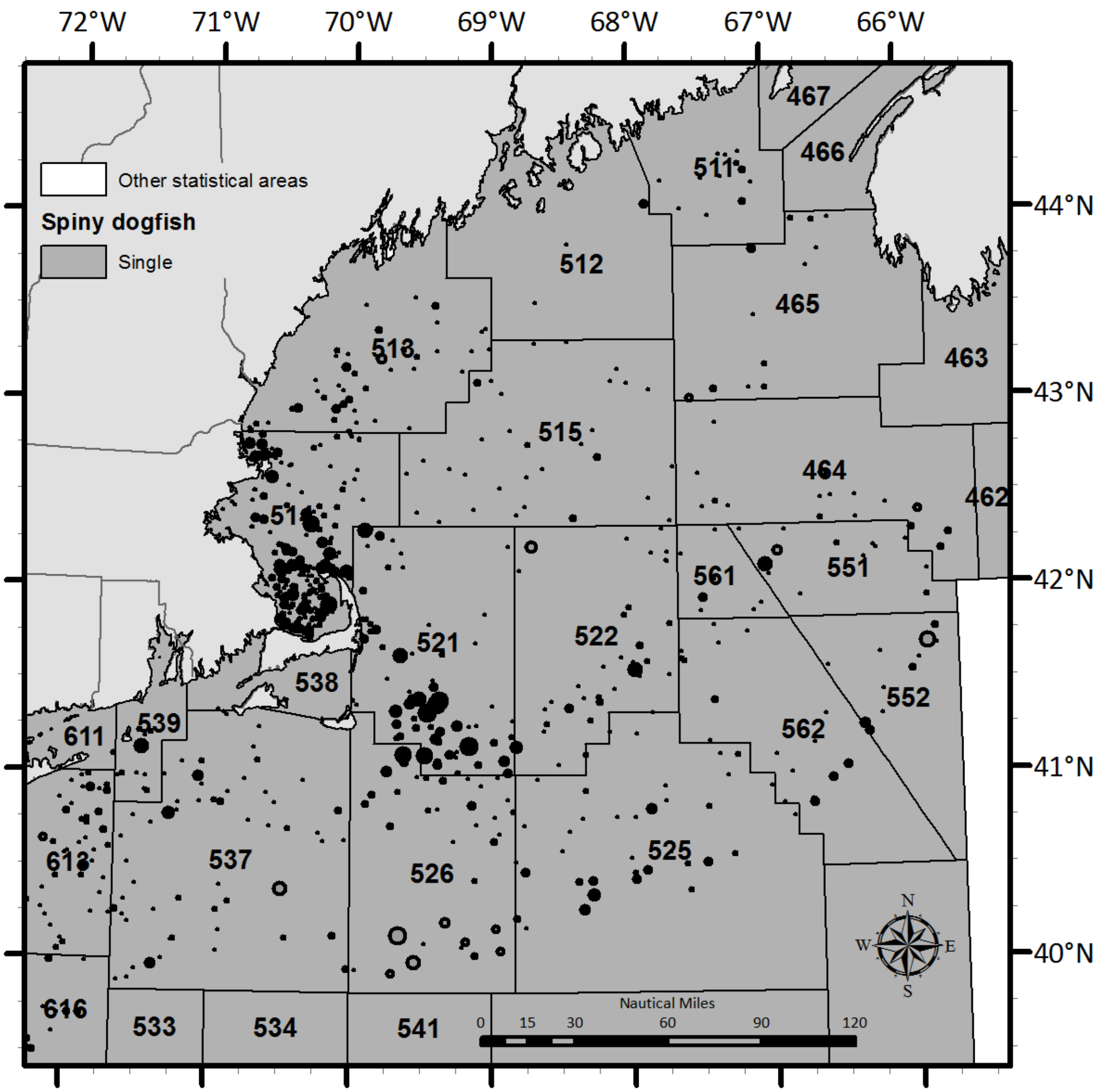
4.3.11 Spiny dogfish

4.3.11.1 Biology, status, and overall distribution

Spiny dogfish (*Squalus acanthias*) are the most abundant sharks in the western North Atlantic, and range from Labrador to Florida, although they are most abundant from Nova Scotia to Cape Hatteras, North Carolina. Spiny dogfish are highly migratory, often traveling in large troops, and they move northward in the spring and summer and southward in the fall and winter. Spiny dogfish are known to be opportunistic predators, consuming whatever prey are readily abundant in their environment, including pelagic and benthic invertebrates and fishes. Although dogfish have a varied diet, most of what they eat are invertebrates (ctenophores in particular) and a recent study of 40,000 stomachs found that less than 1 percent of their diet was composed of principal groundfish species (Link et al. 2002).

In spite of their large numbers and opportunistic feeding, spiny dogfish, like many elasmobranchs, suffer from several reproductive constraints. Females may take 7-12 years to reach maturity, growing more than one-third larger than their mature male counterparts before becoming sexually mature. Fertilization and egg development are internal, and gestation takes roughly 2 years, resulting in litters that usually average 6-7 dogfish. As a result of these factors, spiny dogfish are vulnerable to overfishing, particularly if fishing activities focus on the largest individuals, which are almost all mature females. As a result of increased fishing pressure, spiny dogfish were classified as overfished in 1998. In 2010, the stock was declared rebuilt, and in 2012, the stock was about 35% above its biomass reference point and the fishing mortality rate of F=0.148 was well below the MSY reference point of F=0.2439.

Map 110 – Spiny dogfish stock boundary and kg/tow (0-12870 kg/tow; classified by 10 natural breaks (Jenks)) from spring and fall NEFSC, MADMF, and ME/NH surveys, 2002-2013. Spring survey values shaded grey may obscure fall survey values shaded black.

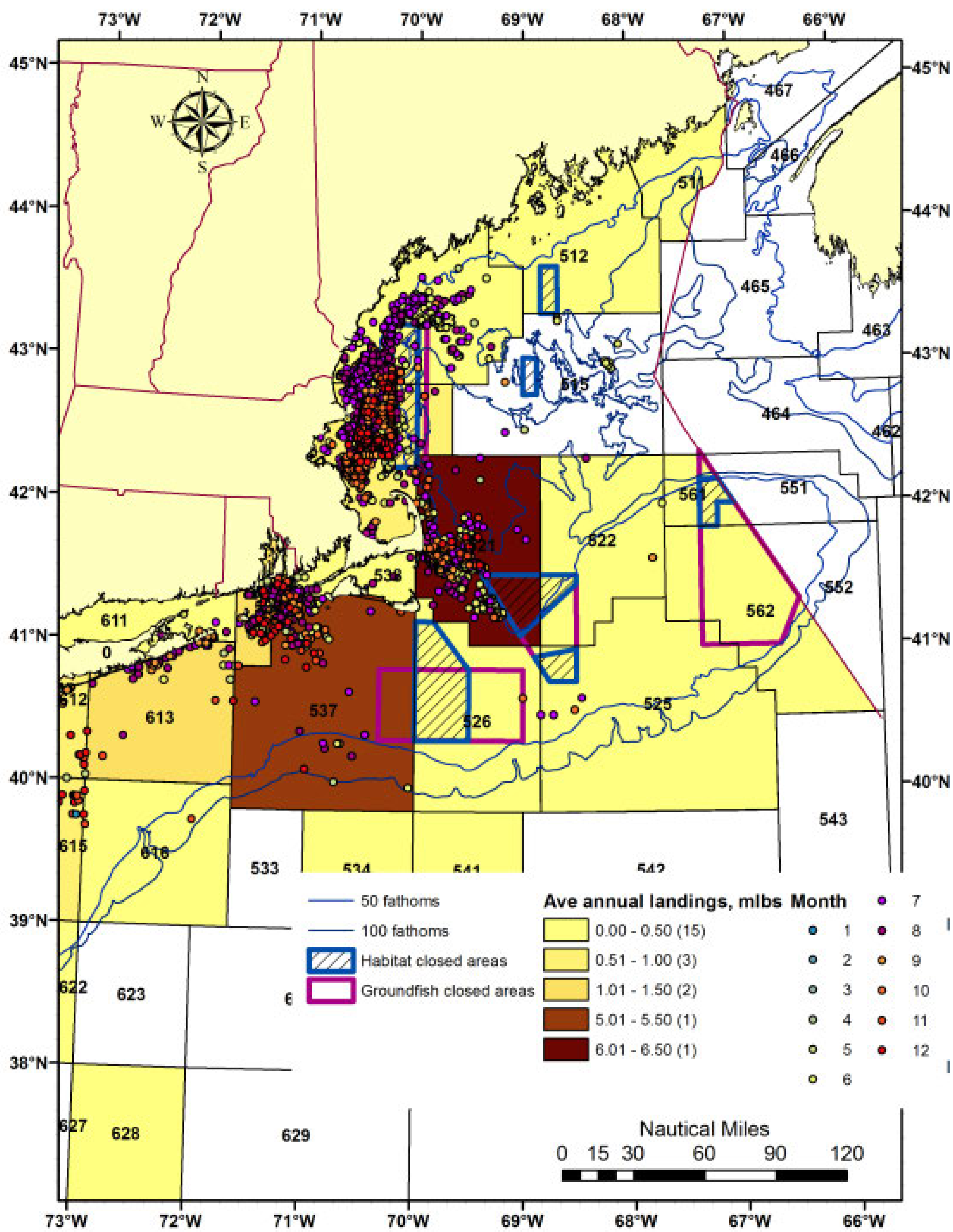


4.3.11.2 Fishery

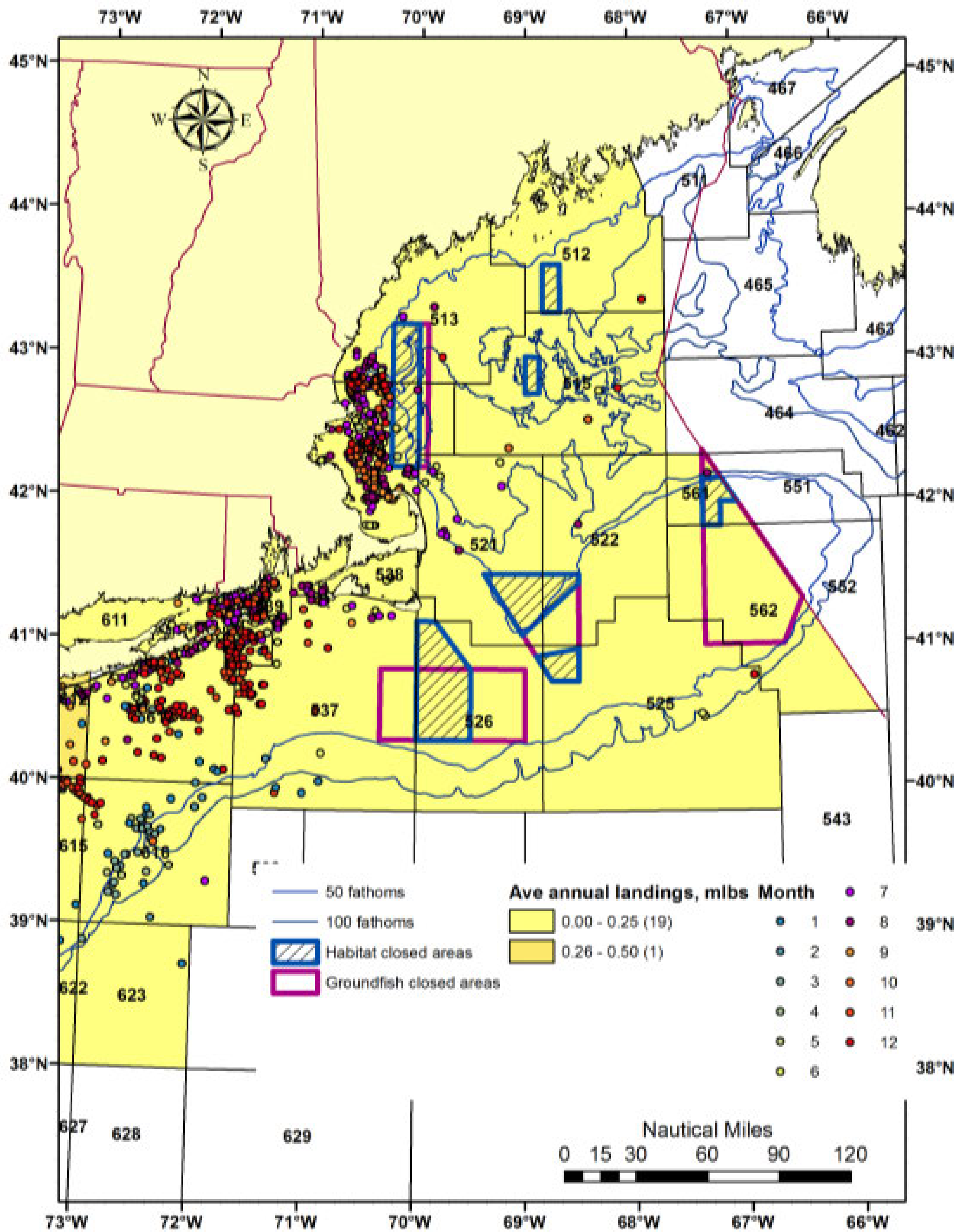
The Mid-Atlantic and New England Councils jointly developed an FMP for spiny dogfish, which was partially approved in 1999 and implemented in 2000. Management measures included an overall commercial quota, allocated into two semiannual periods; restrictive trip limits; a prohibition on finning; an annual quota adjustment process; and permit and reporting requirements. The Atlantic States Marine Fisheries Commission implements complementary management measures for spiny dogfish in state waters. The spiny dogfish stock was officially declared to be rebuilt in 2010, and commercial quotas have been significantly increased in recent years.

Most spiny dogfish landings are the result of commercial fishing activities, as reported recreational landings comprise less than 2 percent of the total catch. Sink gillnets (Map 111), bottom longlines, and bottom otter trawls (Map 112) are the primary commercial fishing gears that catch spiny dogfish and these three gear types accounted for 97 percent of all dogfish landed in 2007-2011. For fishing years 2007-2011 combined, Massachusetts ports had the most commercial landings (42.5 percent), with another 19 percent made in Virginia, and 10 percent in New Hampshire.

Map 111 – Spiny dogfish gillnet effort 2008-2012. Yellow to brown shading shows average annual landings (live weight) by statistical area from the dealer tables. Colored circles show the locations of trips as reported on vessel trip reports, from January (blue) to December (red).



Map 112 – Spiny dogfish trawl effort 2008-2012. Yellow to brown shading shows average annual landings (live weight) by statistical area from the dealer tables. Colored circles show the locations of trips as reported on vessel trip reports, from January (blue) to December (red).



4.3.12 Summer flounder, scup, and black sea bass

4.3.12.1 Biology, status, and overall distribution

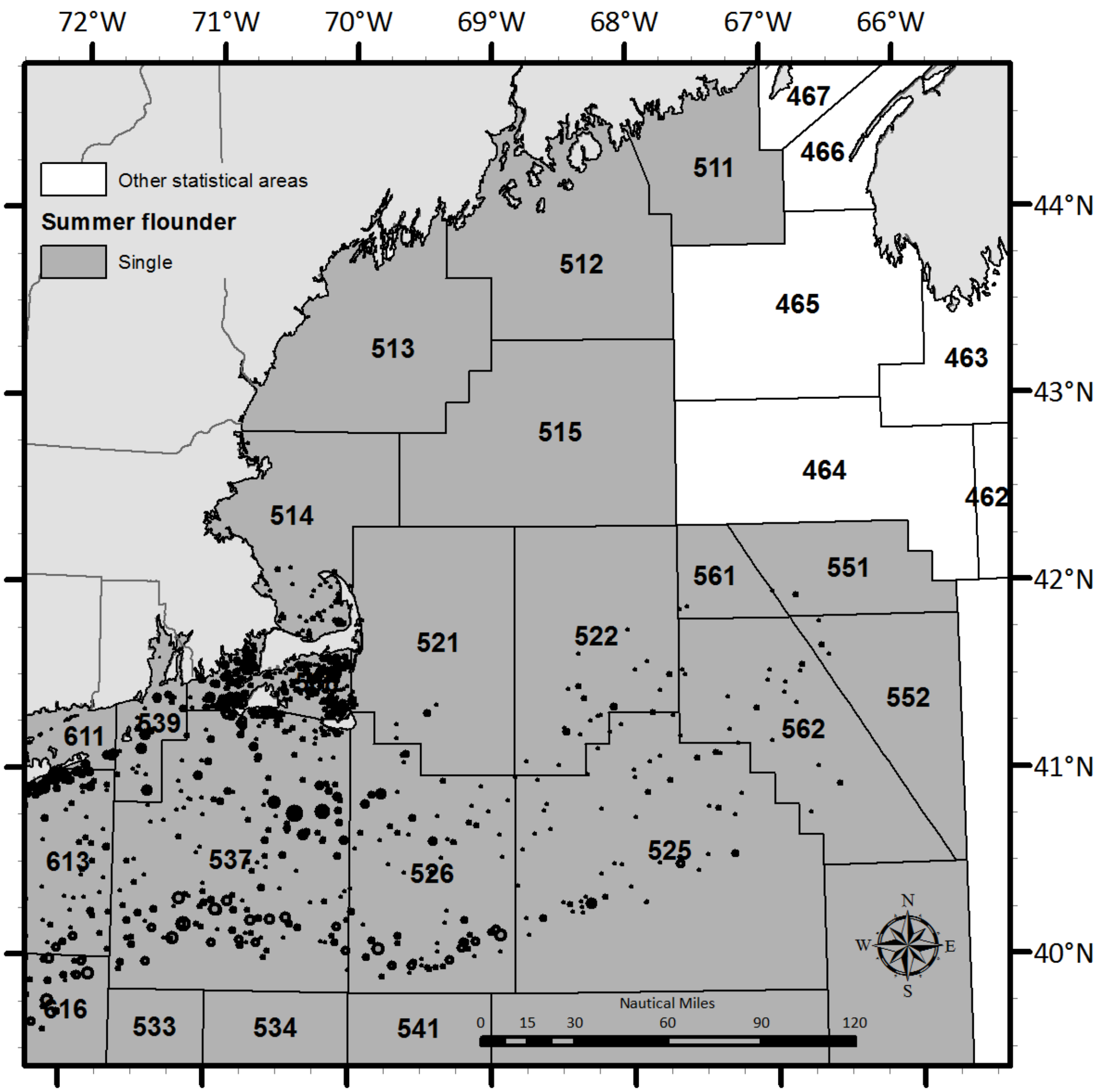
Summer flounder (*Paralichthys dentatus*), scup (*Stenotomus chrysops*), and black sea bass (*Centropristis striata*) are three demersal finfish species that occur primarily in the Middle Atlantic Bight from Cape Cod, Massachusetts, to Cape Hatteras, North Carolina. All three species exhibit seasonal movement or migration patterns. Summer flounder move inshore to shallow coastal and estuarine waters during warmer months and move offshore during colder months. Scup is a schooling species that undertakes extensive migrations between the coastal waters in the summer and outer continental shelf waters in the winter. Black sea bass are most often found in association with structured habitats, and they migrate offshore and to the south as waters cool in the fall, returning north and inshore to coastal areas and bays as waters warm in the spring.

All three species are managed as single stocks throughout their ranges. In 2011, summer flounder was declared rebuilt. Fishing mortality has been fluctuating around the threshold value since the mid-2000s, and currently the rate is below the threshold so overfishing is not occurring.

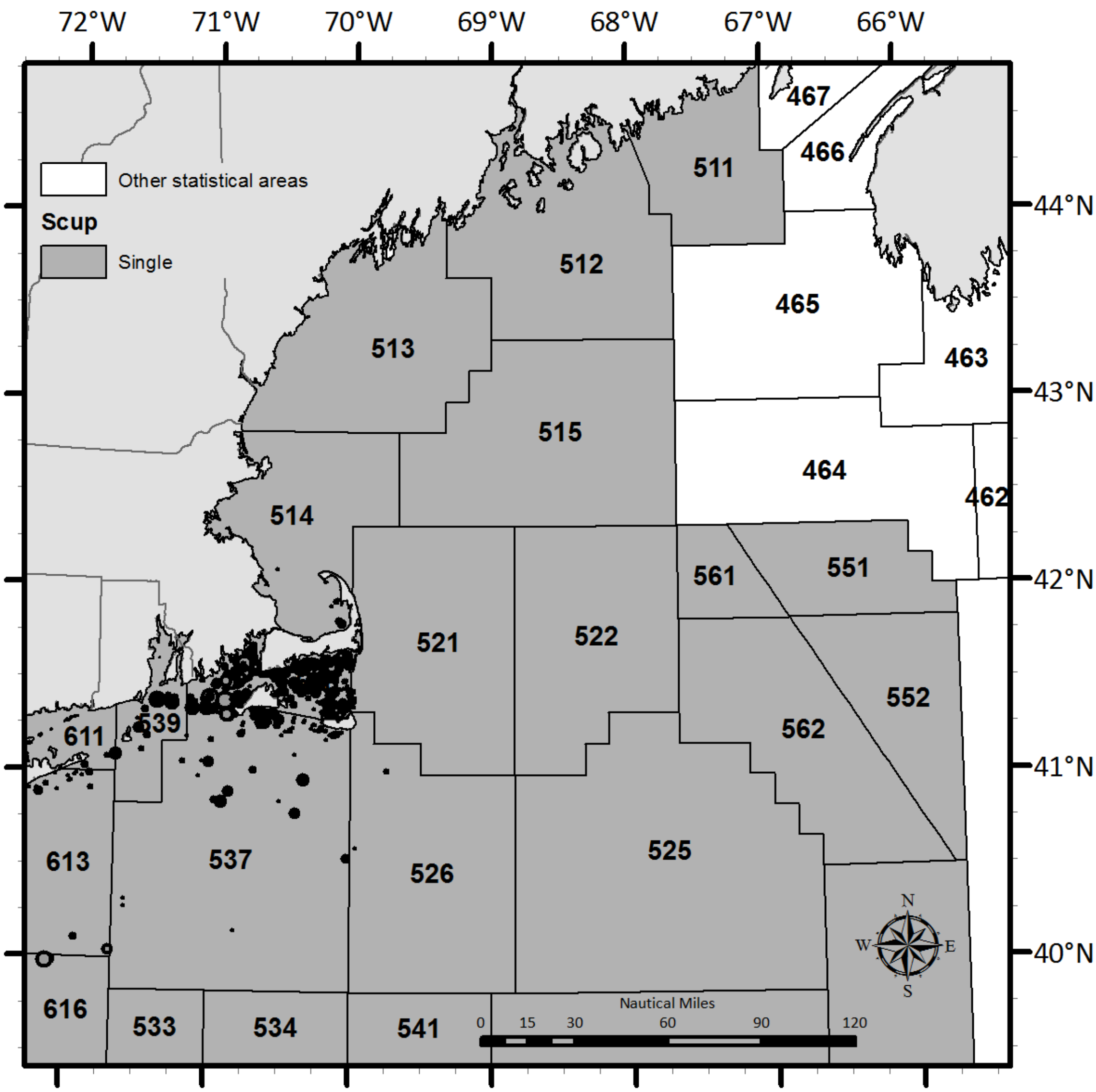
Scup spawning stock biomass has been increasing since the late 1990s, and is now more than double the reference spawning stock biomass at MSY reference point. Fishing mortality on scup has been below the threshold since the early 2000s.

The most recent accepted benchmark assessment of black sea bass occurred in 2008. The 2012 update indicated that the stock was not overfished and overfishing was not occurring in 2011. In 2011, the stock size was roughly equal to the biomass at MSY reference point, and fishing mortality rate was about half the threshold rate.

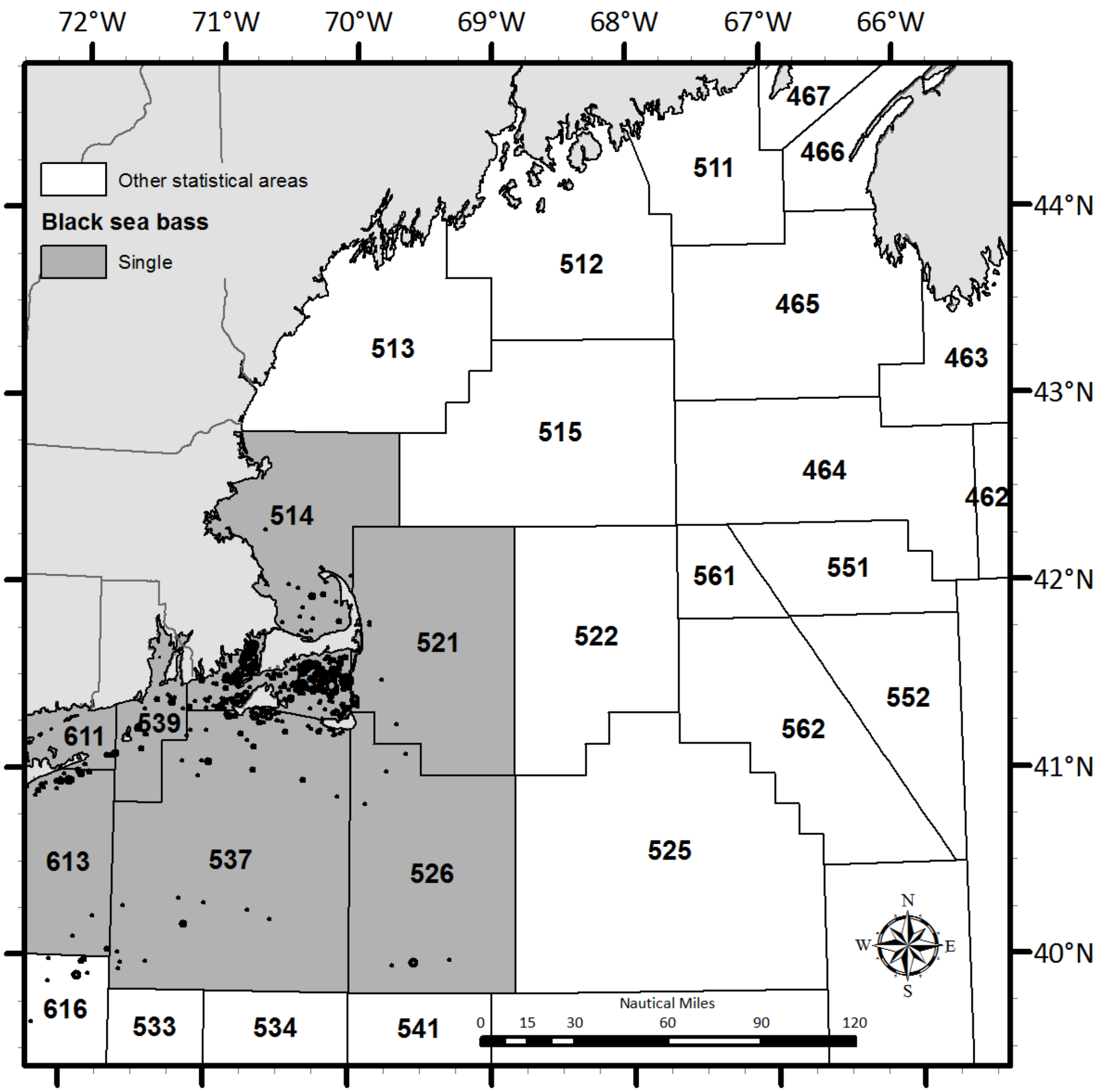
Map 113 – Summer flounder stock boundary and kg/tow (0-315 kg/tow; classified by 10 natural breaks (Jenks)) from spring and fall NEFSC, MADMF, and ME/NH surveys, 2002-2013. Spring survey values shaded grey may obscure fall survey values shaded black.



Map 114 – Scup stock boundary and kg/tow (0-692 kg/tow; classified by 10 natural breaks (Jenks)) from spring and fall NEFSC, MADMF, and ME/NH surveys, 2002-2013. Spring survey values shaded grey may obscure fall survey values shaded black.



Map 115 – Black sea bass stock boundaries and catch/tow from spring and fall NEFSC, MADMF, and ME/NH surveys, 2002-2013. Spring survey values shaded grey may obscure fall survey values shaded black.



4.3.12.2 Fishery

The Atlantic States Marine Fisheries Commission and the Mid-Atlantic Council work collaboratively to manage these three species, as a significant portion of both the commercial and recreational landings come from state waters. The Federal FMP was developed by the Mid-Atlantic Council, initially just for summer flounder (fluke), and approved by the Secretary of Commerce in 1988. This original Summer Flounder FMP was based largely on the Commission's plan. Amendment 2 (1993) established much of the current management regime, including a commercial quota allocated to the states, a recreational harvest limit, minimum size limits, gear restrictions, permit and reporting requirements, and an annual review process to establish specifications for the coming fishing year.

Although initially intended to be separate FMPs, work on the development of the Scup FMP and the Black Sea Bass FMP was folded into the Summer Flounder FMP, which was broadened to incorporate management measures for scup and black sea bass through Amendments 8 and 9, respectively. These amendments included management measures for scup and black sea bass such as commercial quotas and quota periods, commercial fishing gear requirements, minimum fish size limits, recreational harvest limits, and permit and reporting requirements. Both amendments were implemented in 1996.

For each of these three species, an annual acceptable biological catch is established by the Mid-Atlantic Council. The acceptable biological catch is then divided, using percentages identified in the FMP, into a commercial Annual Catch Limit and a recreational Annual Catch Limit. The Mid-Atlantic Council then sets corresponding annual catch targets for each fishing sector. The commercial quota and recreational harvest limit are the amount of landings remaining after deducting discards from the respective annual catch targets. The commercial fisheries for all three species are managed through a combination of limited access (moratorium) fishing vessel permits, annual quotas that result in closures of the fisheries upon reaching the quota, gear restrictions, and minimum fish sizes.

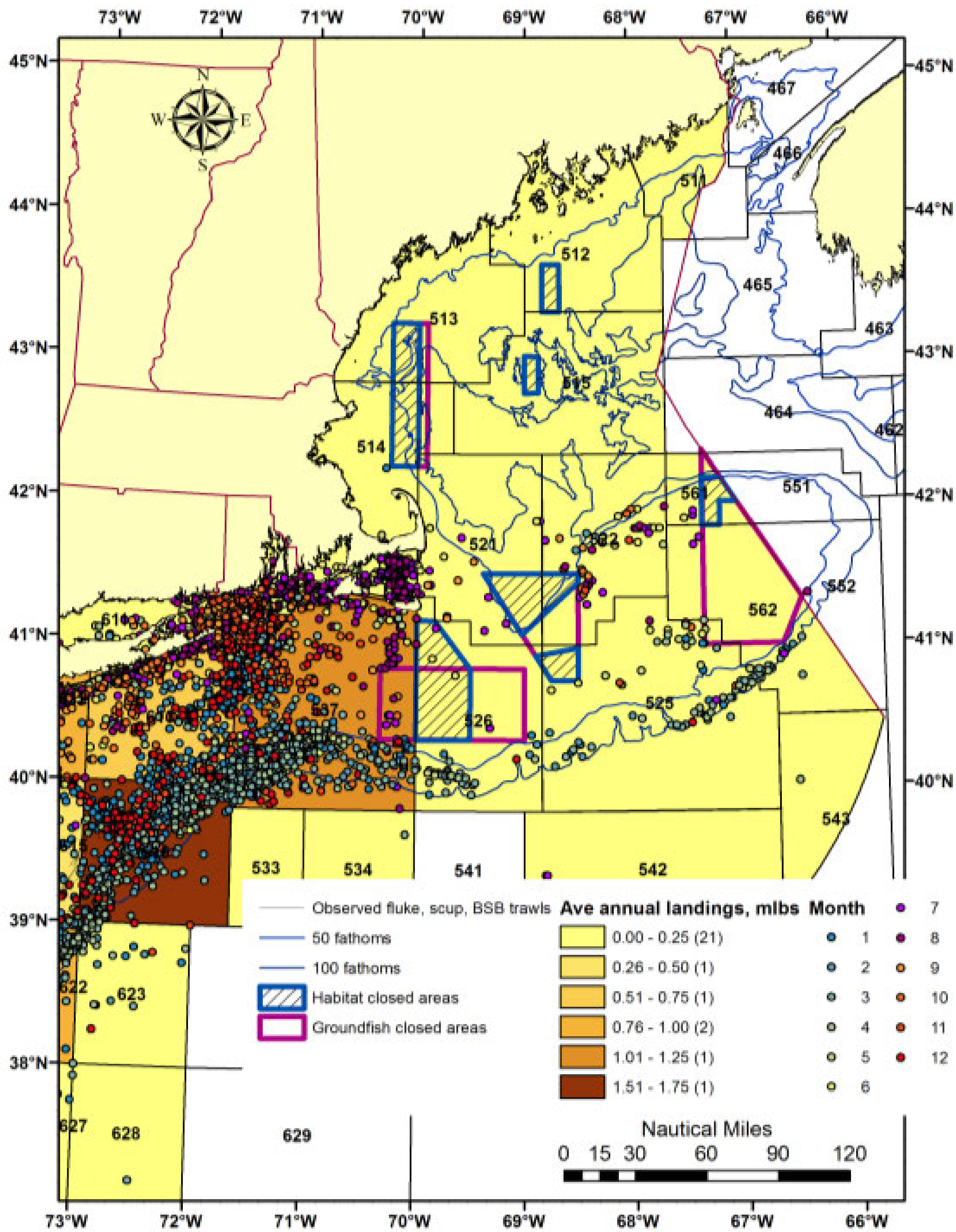
The recreational fisheries are not subject to a “hard” quota, but instead are subject to a set of management measures designed to constrain catch to a target level. Management measures used include minimum fish sizes, bag (possession) limits, and fishing seasons. Party/charter vessels operating in Federal waters are required to obtain Federal permits. Coast-wide management measures are established for the black sea bass and scup recreational fisheries operating in Federal waters. For summer flounder, however, the states have the option to develop state-by-state measures that, in sum, would achieve the equivalent level of conservation as would the coast-wide measures. All decisions regarding annual quotas and management measures for these commercial and recreational fisheries are made in conjunction with the Commission.

All three of these species support significant recreational as well as commercial fisheries. On average, commercial landings over the last several years accounted for slightly more than half to two-thirds of the total landings of summer flounder and scup, while black sea bass recreational landings typically exceed commercial landings. The primary gears used in the commercial fisheries for these species vary. Based on fishing vessel trip report data from 2007-2011, summer flounder are caught almost exclusively (95 percent) with bottom otter trawls; scup are caught primarily (92 percent) with bottom otter trawls, but handlines/rod and reel combined with pots, traps, and weirs accounted for another 6 percent; and black sea bass are caught in roughly equal amounts by bottom otter trawls (47 percent), and pots and traps (46 percent), and to a much lesser extent by handlines/rod and reel (5 percent). Recreational fishing for these species is enjoyed by shore-based anglers, private recreational boat anglers, and anglers on party and charter vessels.

Although the stock areas for these species are described as Maine through North Carolina, very little recreational or commercial catch is allocated to New Hampshire or Maine, and there are no dealers buying summer flounder, scup, or black sea bass in these states.

In fishing year 2012, the recreational black sea bass annual catch limit was exceeded by approximately 140 percent. Under the original accountability measures, this would have resulted in a pound for pound payback of the overage and little to no recreational black sea bass fishery in fishing year 2014. As a result, the Mid-Atlantic Council initiated, and NMFS approved, a modification to the recreational accountability measures. The Recreational Accountability Measures Omnibus Amendment allows the Mid-Atlantic Council to take stock status into account when determining the biological consequences of an annual catch limit overage. As such, because black sea bass is not overfished and not subject to overfishing, the accountability measure required the recreational management measures implemented for fishing year 2014 to be more restrictive than they otherwise would have been, had the overage not occurred.

Map 116 – Summer flounder trawl effort 2008-2012. Yellow to brown shading shows average annual landings (live weight) by statistical area from the dealer tables. Colored circles show the locations of trips as reported on vessel trip reports, from January (blue) to December (red).

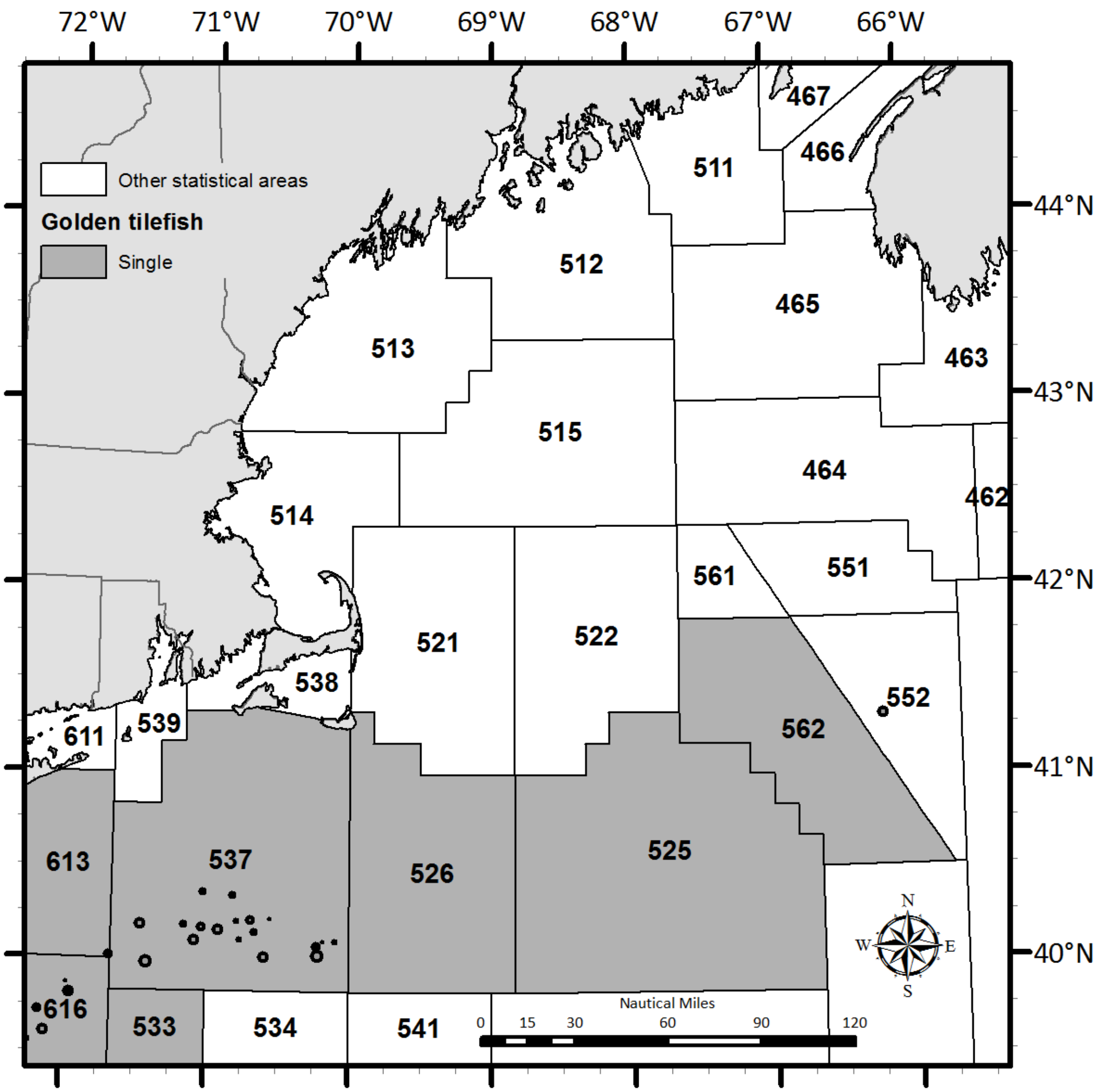


4.3.13 Golden tilefish

4.3.13.1 Biology, status, and overall distribution

The golden tilefish (*Lopholatilus chamaeleonticeps*) is the largest and longest lived of all the tilefish species, and in U.S. waters ranges from Georges Bank to Key West, Florida, and throughout the Gulf of Mexico (New England survey catches shown on Map 117). Golden tilefish occupy a fairly restrictive band along the outer continental shelf and are most abundant in depths of 100-240 meters. Temperature may also constrain their range, as they are most abundant near the 15° C isotherm. Although this species occupies a variety of habitats, it is somewhat unique in that they create and modify existing vertical burrows in the sediment as their dominant habitat in U.S. waters. The most recent stock assessment, SAW 58, determined that tilefish is not overfished and overfishing is not occurring (NEFSC 2014). In addition, it was determined that the stock was rebuilt in 2012.

Map 117 – Golden tilefish stock boundary and kg/tow (0-108 kg/tow; classified by 10 natural breaks (Jenks)) from spring and fall NEFSC, MADMF, and ME/NH surveys, 2002-2013. Spring survey values shaded grey may obscure fall survey values shaded black.



4.3.13.2 Fishery

The Tilefish FMP (implemented 2001) was developed by the Mid-Atlantic Council to implement management measures for the tilefish fishery north of the Virginia/North Carolina border intended to address the overfished status of the species. Amendment 1 to the Tilefish FMP, implemented in 2009, eliminated the limited access permit categories and adopted an IFQ program. Initially, thirteen allocation holders received quota share based primarily on historical participation in the fishery. All vessels landing tilefish are required to have an open access permit, which authorizes a vessel to land up to 500 lb. per trip. An IFQ allocation permit exempts the vessel from the possession limit. Each year, 95 percent of the total allowable landings are allocated to the IFQ fishery, and the remaining 5 percent is allocated to the incidental fishery.

The commercial tilefish fishery is relatively small, with only a dozen vessels participating in the IFQ fishery. Tilefish are primarily caught with bottom longlines (98 percent of landings reported in the fishing vessel trip report database from 2007-2011), and approximately 1.8 percent of landings are associated with bottom otter trawls. There is a minimal recreational fishery for this species, with less than 8,300 lb. landed annually for the last 30 years. In only two years since 2000 does the Marine Recreational Information Program database (the primary source for recreational fishing statistics on the east coast) report trips with tilefish as the primary target species.

4.3.14 Northern shrimp

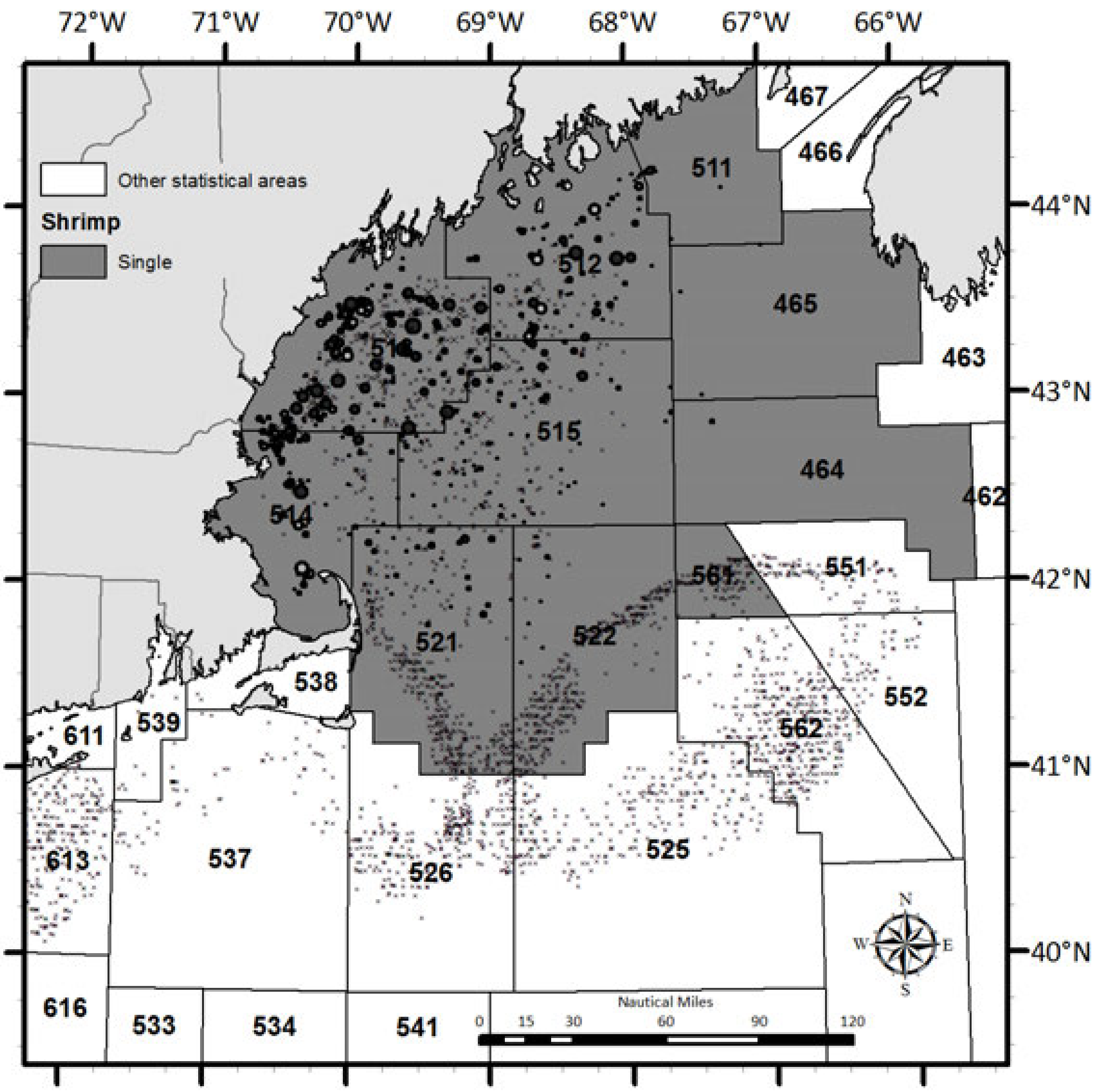
4.3.14.1 Biology, status, and overall distribution

Northern shrimp (*Pandalus borealis*) are found in U.S. waters off Maine, New Hampshire, and Massachusetts and also in Atlantic Canada. They mature first as males and then transform into females at around age 3.5 years; females live until about age 5. Growth rate, size at age, and age of male-female transition can vary with environmental parameters and by stock density. The shrimp spawn offshore in the late summer and the egg-bearing females move inshore in late fall and winter. The juveniles then remain inshore for a year or more before moving offshore.

The northern shrimp stock is assessed annually by the Atlantic State Marine Fisheries Commission's Northern Shrimp Technical Committee; the most recent assessment report was released in November 2013 (ASFMC Northern Shrimp Technical Committee 2013). Various surveys inform this assessment, including an annual summer shrimp survey, the fall NEFSC trawl survey, the spring ME/NH trawl survey, and historical surveys by the state of Maine. The most recent stock assessment report provides a summary of the biology and status of the species.

The 2013 assessment indicated that the stock has collapsed. Biomass peaked around 2007 and has since declined to an estimated 500 mt in the terminal year of the model, which is a very low biomass relative to values typically estimated since the mid-1980s, and the future does not look promising. The female population in 2013 consists of the 2008 and 2009 year classes, and although these year classes were above average in size when first observed in the surveys, they have since declined to low levels. In 2011 recruitment was poor, and the 2012 recruitment index was even lower. Relatively higher temperatures in the Gulf of Maine suggest "an increasingly inhospitable environment for northern shrimp" (ASMFC Northern Shrimp Technical Committee 2012, page 23). A benchmark assessment will be conducted in early 2014.

Map 118 – Northern shrimp stock boundary and kg/tow (0-7340 kg/tow; classified by 10 natural breaks (Jenks)) from summer NEFSC shrimp, spring and fall NEFSC, MADMF, and ME/NH surveys, 2002-2013. Summer (marked by X's) and spring survey values shaded grey may obscure fall survey values shaded black. The concentration of small dots on Georges Bank are summer survey values.



4.3.14.2 Fishery

The northern shrimp fishery is managed by the states of Maine, New Hampshire, and Massachusetts, through the Commission. The first Interstate Fishery Management Plan was approved in October 1986, and Amendment 1 (2004) established biological reference points.

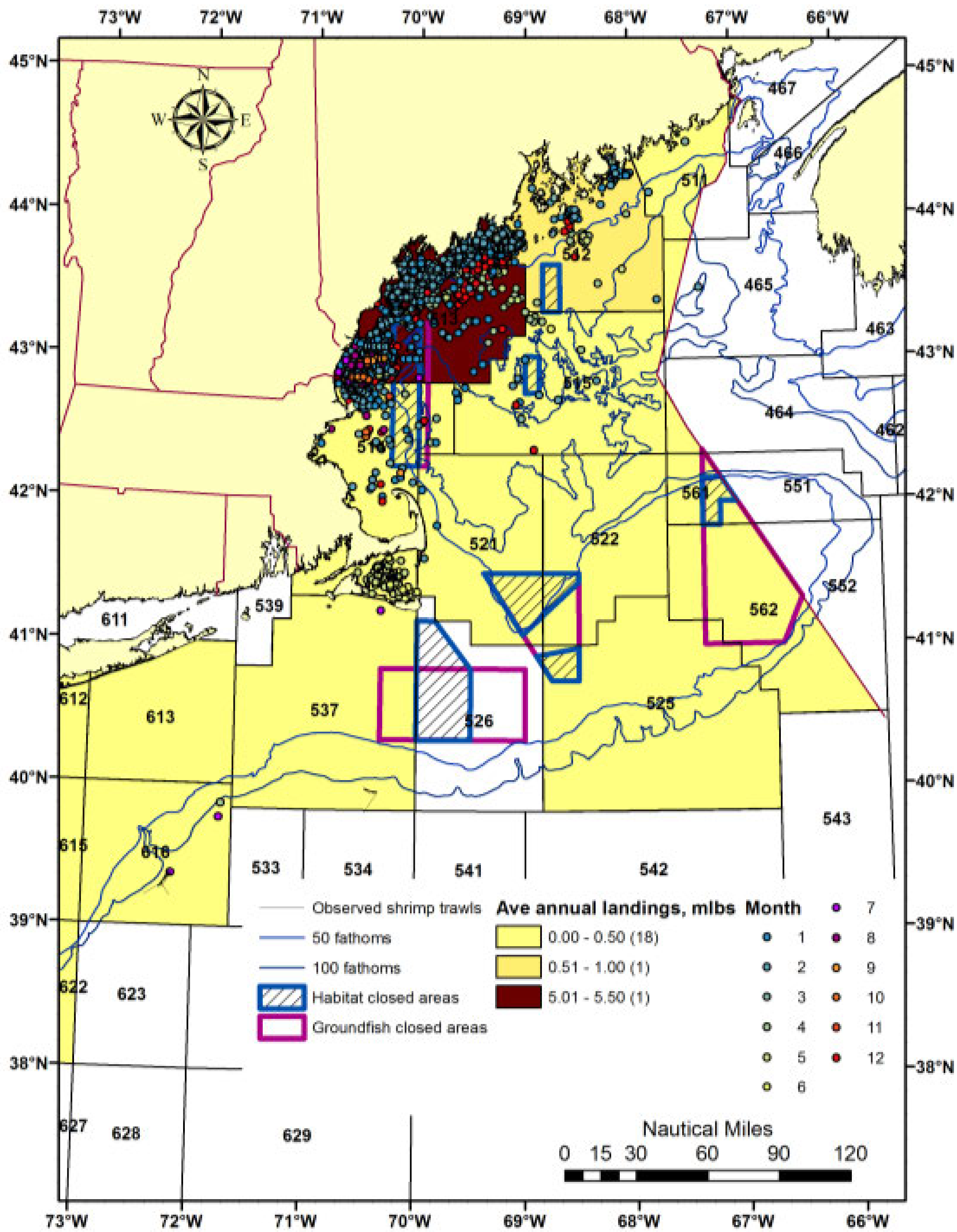
The northern shrimp fishery is seasonal, targeting female shrimp when they come inshore to spawn. When the annual total allowable catch has been harvested, the fishery closes. Both the 2009/2010 and 2010/2011 seasons were relatively short (156 days and 90 days, respectively).

Delays in reporting landings resulted in short notice of the early closures during these seasons, and the total allowable catches were exceeded in both years. As a result, Amendment 2 implemented trip limits, trap limits, and days out of the fishery, in an effort to slow down catch rates and extend the season. Despite these changes, the 2011/2012 season was also brief, opening on January 2, 2012 for trawls and February 1 for traps, and closing on February 17.

Addendum I to Amendment 2 allocated 87% of the Total Allowable Catch to the trawl fishery (Map 119) and 13% to the trap fishery. Shrimp trawl gear is described in Appendix D. Trawl vessels must use a Nordmore grate, which is intended to eliminate most of the bycatch of finfish. Addendum I to Amendment 2 authorized the use of a double Nordmore or compound grate which minimizes retention of small shrimp. Most trawling occurs inshore, defined as shallower than 55 fathoms in the assessment document. In 2012, 235 Maine trawl fishermen interviews placed 92% of their trips inshore and 8% offshore. The trawl fleet includes 30-46' lobster vessels that re-rig for shrimping, 40-56' stern trawlers, and larger 56-79' vessels. The Commission reports "a trend in recent years towards the use of heavier, larger roller and/or rockhopper gear. These innovations, in concert with substantial improvements in electronic equipment, have allowed for much more accurate position and towing in formerly unfishable grounds, thus greatly increasing the fishing power of the Gulf of Maine fleet" (ASMFC 2011).

The most recent assessment indicates collapse of the stock (see section 4.3.8.2), and future prospects look bleak. In December 2013, the Commission's Northern Shrimp Section approved a moratorium for the 2014 northern shrimp fishing season.

Map 119 – Northern shrimp trawl effort 2008-2012. Yellow to brown shading shows average annual landings (live weight) by statistical area from the dealer tables. Colored circles show the locations of trips as reported on vessel trip reports, from January (blue) to December (red).

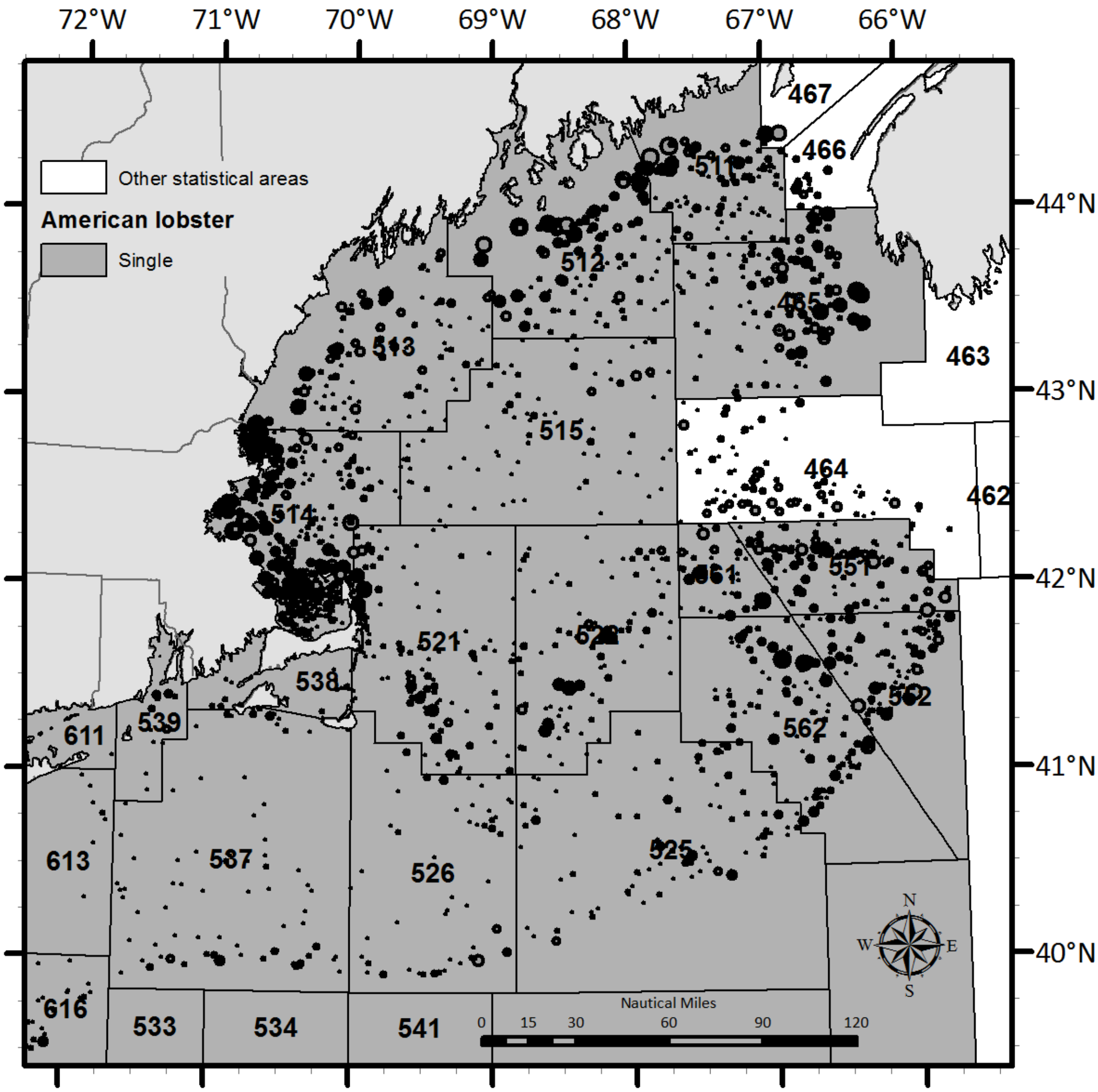


4.3.15 American lobster

4.3.15.1 Biology, status, and overall distribution

American lobsters (*Homarus americanus*) are benthic crustaceans that are found in U.S. waters from Maine to New Jersey inshore and Maine to North Carolina offshore. Lobsters tend to be solitary, territorial, and exhibit a relatively small home range of 5-10 square kilometers, although large mature lobsters living in offshore areas may migrate inshore seasonally to reproduce, and southern inshore lobsters may move to deeper areas to seek cooler temperatures on a seasonal or permanent basis. Lobsters are assessed in three stock units, Gulf of Maine, Georges Bank, and Southern New England. The 2009 lobster stock assessment indicated that none of the stocks is experiencing overfishing, but the Southern New England stock is overfished (ASMFC American Lobster Stock Assessment Subcommittee 2009). A new assessment will be completed soon.

Map 120 – American lobster stock boundary and kg/tow (0-154 kg/tow, classified by 10 natural breaks (Jenks)) from spring and fall NEFSC, MADMF, and ME/NH surveys, 2002-2013. Spring survey values shaded grey may obscure fall survey values shaded black. Lobsters are also caught in the summer scallop dredge survey.



4.3.15.2 Fishery

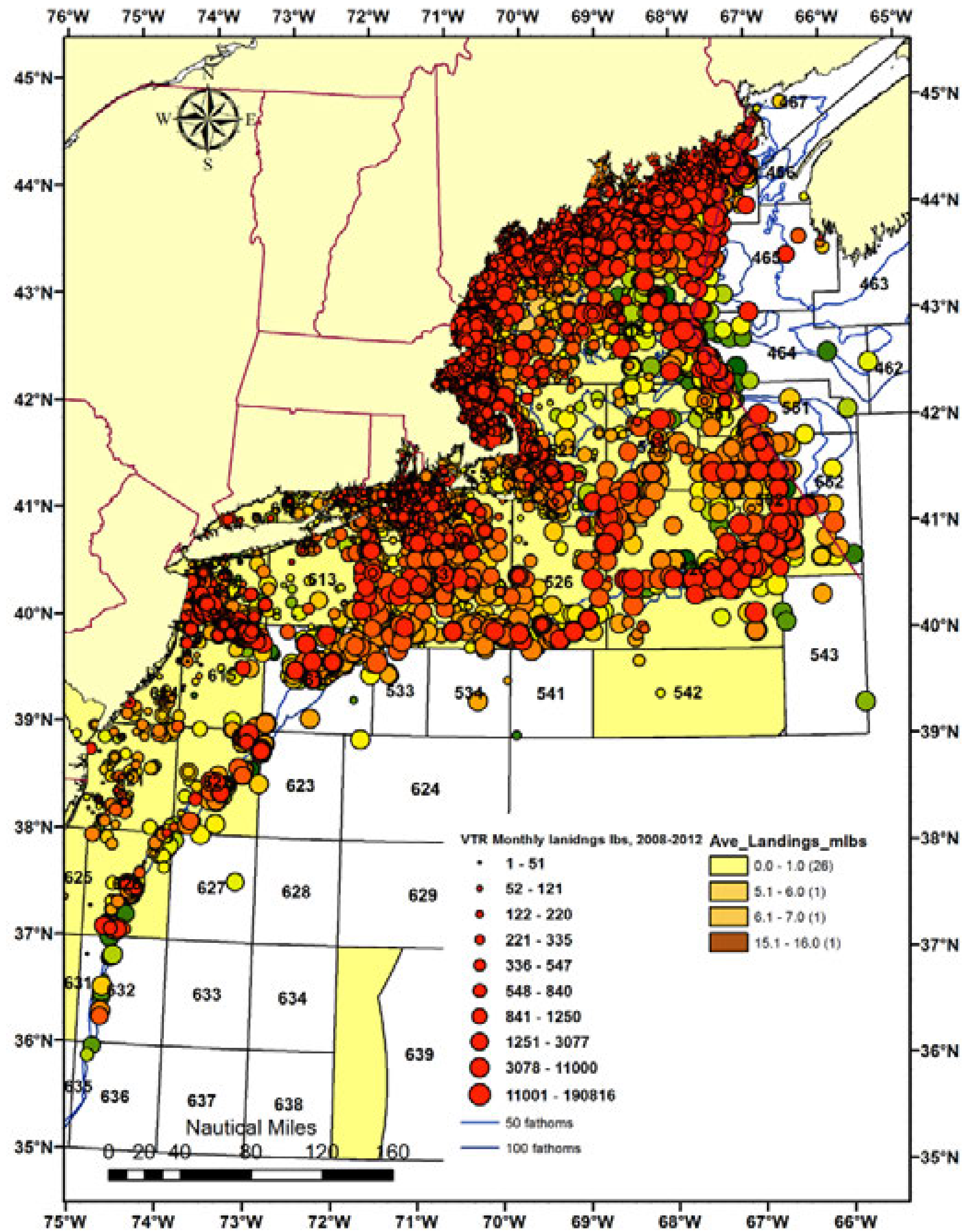
The lobster fishery is managed by the Atlantic States Marine Fisheries Commission, with measures developed by Lobster Conservation Management Teams specific to seven management areas. The most relevant areas to this action are Area 1 (inshore Gulf of Maine), Outer Cape Cod, Area 2 (south of Massachusetts and Rhode Island), and Area 3 (offshore Gulf of Maine, Georges Bank, and Mid-Atlantic Bight to the EEZ). Management measures include minimum and maximum sizes; trap limits and configuration requirements; prohibitions on possessing egg-bearing females or v-notched lobsters, lobster meat, or lobster parts; prohibitions on spearing lobsters; and limits on non-trap landings. Most landings coast-wide come from Area 1, and are taken with traps (Map 121). Trawls and other commercial gears account for a small fraction of the commercial landings. Recreationally, lobsters are harvested with traps and by hand while SCUBA diving, but the magnitude of recreational landings is unknown.

The Gulf of Maine fishery is prosecuted mainly with small, 22-42' vessels that conduct day trips within about 12 miles of shore. There are some larger vessels that fish offshore in the Gulf of Maine. Maine vessels account for most of the fishing effort, and the number of traps fished increased substantially between 1993 and 2002, and has remained at over 3.5 million since then. Trap effort in New Hampshire and Massachusetts are much smaller in magnitude compared to Maine; since 1989 effort in New Hampshire has increased and Gulf of Maine effort in Massachusetts has declined.

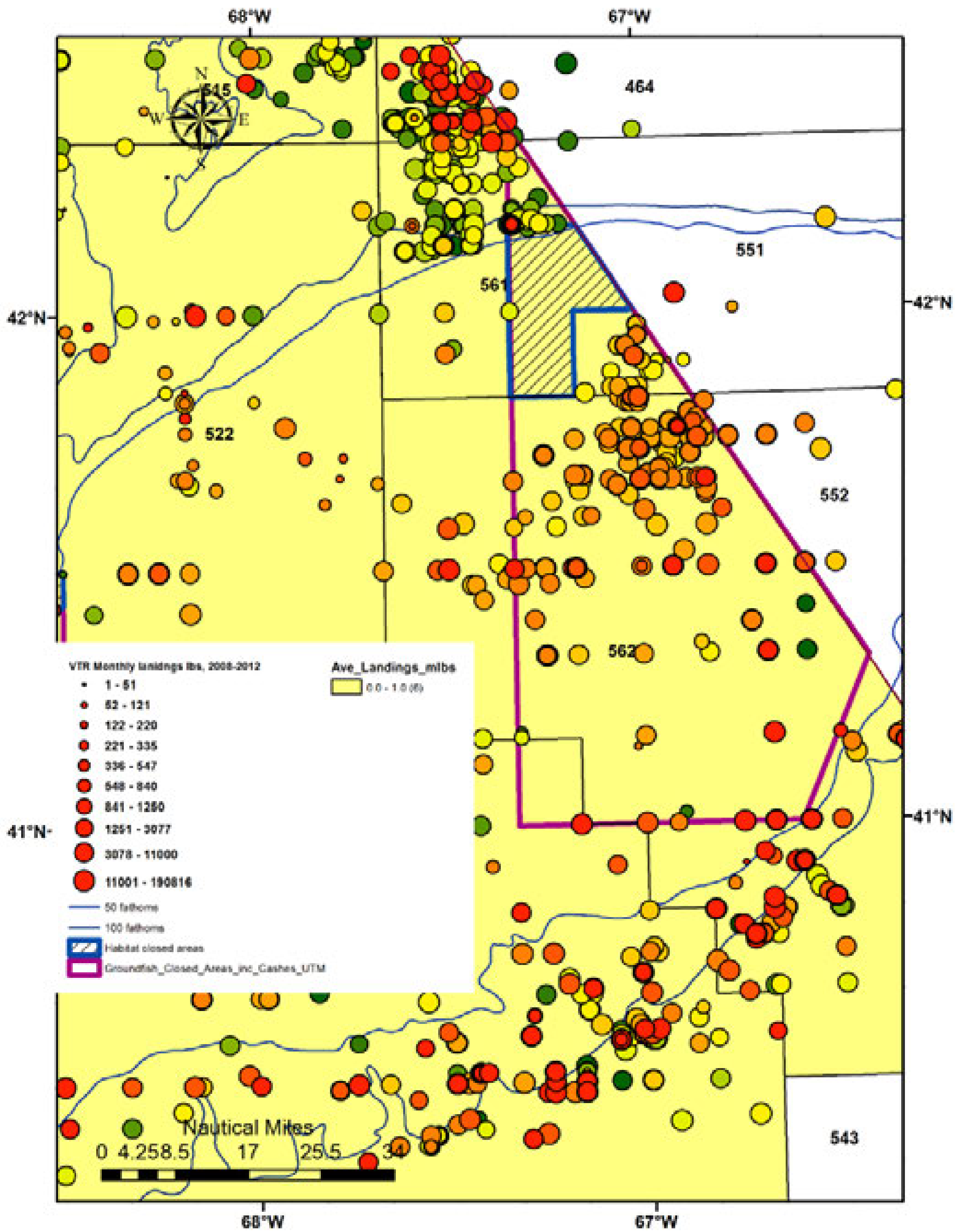
On Georges Bank, most of the effort (Map 122) is on multi-day trips taken using larger, 55-75'vessels. There is day trip fishery in the Outer Cape Cod area. According to the 2009 stock assessment, the number of traps fishing on Georges Bank is "not well characterized, due to a lack of mandatory reporting, and/or a lack of appropriate resolution in the reporting system" (ASMFC 2009, p 42). Data from Massachusetts, which constitutes a large fraction of the Georges Bank fishery, indicate that the number of traps remained relatively stable between 1994 and 2007.

In Southern New England, there is a nearshore, small vessel day boat fleet as well as an offshore fleet that takes multi-day trips to the canyons along the edge of the continental shelf.

Map 121 – Lobster trap effort and landings 2008-2012. Yellow to brown shading shows average annual landings (live weight) by statistical area from the dealer tables. Colored circles show the locations of trips as reported on vessel trip reports, from January (green) to July (yellow) and December (red). VTR-reported landings at a specific location (rounded to 0.01 decimal degrees) are summed over all trips in a month over the five year period.



Map 122 – Lobster trap effort and landings from eastern Georges Bank 2008-2012. Yellow shading shows average annual landings (live weight) by statistical area from the dealer tables (see previous map). Colored lines show the distribution of observed hauls from January (green) to July (yellow) and December (red). VTR-reported landings at a specific location (rounded to 0.01 decimal degrees) are summed over all trips in a month over the five year period.



4.4 Hotspot analyses

In addition to the goals and objectives to reduce the adverse effects of fishing on EFH, the Council's management priorities focused on conservation of important groundfish stocks and integrate a re-evaluation of existing groundfish seasonal and year round closed areas into this action. In late 2012, the Council added two goals to enhance groundfish fishery productivity and maximize societal net benefits from the groundfish stocks while addressing current management needs (see Section 3.2). Four objectives are to improve groundfish spawning protection, including protection of localized spawning contingents or sub-populations of stocks; improve protection of critical groundfish habitats; improve refuge for critical live history stages; and improve access to both the non-use benefits arising from closed area management across gear types, fisheries, and groups.

It is notable that these objectives seek improvements relative to the status quo set of seasonal and year-round closed areas, so that to meet these objectives, alternative spatial management of fishing should either improve conservation or maintain the existing level of conservation while reducing the effects on the groundfish fishery.

The Council developed the Swept Area Seabed Impact (SASI) approach (described in section 4.1 and in Appendix D) to evaluate the potential for mitigating the adverse effects of fishing on EFH, by area and gear type. However, SASI does not specifically identify which species would benefit from habitat protections, or how reductions in impacts would lead to long term improvements in groundfish productivity. Thus, the Council developed a groundfish-focused analysis to evaluate and identify management areas designed to meet the groundfish-related goals and objectives specified above. The scientific literature does identify species associations by habitat types (see descriptions by species in section 4.2.2, particularly groundfish species), including vulnerable cobble- and boulder-dominated habitats. In theory, species that are associated with hard, stable habitats derive protection from predators and food from animals that live in these locations. Thus protection of these habitats is expected to improve survival and growth for these species. Improved survival and growth could result in increased recruitment of juveniles into the fishery, potentially improving overall fishery production. Focusing on the most critical groundfish lifestages, the Closed Area Technical Team (CATT) evaluated the distribution of age 0 and 1 groundfish and the largest adults using a geostatitical approach to identify "hotspots" in various surveys.[5] The small fish tend to be most closely associated with complex substrates and therefore are most likely to derive benefit from the protection that it provides. Larger adults were viewed as the most important spawners.

The following sections describe the analytical approach and results for small juveniles and large adults (spawners). Like the SASI model approach, the hotspot analyses were peer-reviewed by the Council's SSC, which concluded that "the analyses, results, and hotspot summaries used by the [Closed Area Technical Team] are appropriate for developing management alternatives". More details and an example of what was considered to be a hotspot for this analysis are provided Appendix E, which was adapted from the report provided for the SSC review.

[5] Note that this is a narrower focus than the juvenile groundfish EFH designations, which are based on the distribution of groundfish below the size at 50% maturity.

4.4.1 Age 0/1 juvenile hotspot and generalized additive model analyses

For the hotspot analysis, several sources of fishery dependent and independent data were considered, including observed catches on commercial fishing boats and various periodic fish surveys conducted by NEFSC, various coastal states, and others. The advantage of observed catches on commercial boats is the sheer amount of data in recent years and continuous sampling throughout the year, with over 1,500 Georges Bank and 2,000 Gulf of Maine observed trips each year since 2010 (Table 29). Although there is some seasonality in the At-Sea Monitoring (ASM) observed trips, sampling occurs throughout the year (Table 30). There are two major deficiencies in the observed data that make it unsuitable for examining the distribution of age 0 and 1 groundfish. One is that fishing locations are of course influenced by a variety of factors. The most problematic factor is tha they naturally exclude observations in closed areas which in this case are very important to the analysis (particularly if the No Action closed areas are having a positive effect on protection of juvenile groundfish). Fishermen also target areas having high catches and other areas are, therefore, undersampled. The second problem is that due to minimum mesh size and other factors, commercial fishing gears catch a relatively low fraction of small fish.

Table 29 – Number of observed trips for all gears by the At-sea Monitoring and Observer programs on Georges Bank (statistical areas 521-543) and in the Gulf of Maine (statistical areas 464-515).

	Georges Bank			Gulf of Maine		
YEAR	ASM	OBDBS	Total	ASM	OBDBS	Total
1989	-	124	**124**	-	191	**191**
1990	-	86	**86**	-	186	**186**
1991	-	291	**291**	-	939	**939**
1992	-	407	**407**	-	1,064	**1,064**
1993	-	288	**288**	-	676	**676**
1994	-	177	**177**	-	195	**195**
1995	-	185	**185**	-	223	**223**
1996	-	108	**108**	-	154	**154**
1997	-	102	**102**	-	74	**74**
1998	-	93	**93**	-	93	**93**
1999	-	121	**121**	-	119	**119**
2000	-	309	**309**	-	207	**207**
2001	-	141	**141**	-	193	**193**
2002	-	206	**206**	-	318	**318**
2003	-	427	**427**	-	642	**642**
2004	-	879	**879**	-	1,299	**1,299**
2005	-	1,746	**1,746**	-	1,481	**1,481**
2006	-	779	**779**	-	440	**440**
2007	-	937	**937**	-	455	**455**
2008	-	1,009	**1,009**	-	528	**528**
2009	-	997	**997**	-	861	**861**
2010	900	788	**1,688**	1,532	594	**2,126**
2011	1,095	749	**1,844**	1,978	781	**2,759**
2012	964	785	**1,749**	1,719	884	**2,603**
2013	588	426	**1,014**	733	249	**982**

Table 30 – Number of observed trips by program, month, and region from 2002-2012.

PROGRAM	REGION	01	02	03	04	05	06	07	08	09	10	11	12
ASM	Georges Bank	137	143	131	166	190	322	379	474	380	284	196	157
	Gulf of Maine	261	264	330	89	404	646	660	633	538	496	457	451
ASM Total		398	407	461	255	594	968	1,039	1,107	918	780	653	608
OBDBS	Georges Bank	620	588	497	637	820	881	1,084	933	787	844	832	779
	Gulf of Maine	843	745	580	157	223	571	967	939	834	706	804	914
OBDBS Total		1,463	1,333	1,077	794	1,043	1,452	2,051	1,872	1,621	1,550	1,636	1,693

In contrast, scientific surveys have some major advantages that observed commercial catches do not have. First, they catch a relatively large proportion of age 0 and 1 groundfish because mesh liners are used. The surveys are designed to catch small fish and detect incoming year classes. Second, the tows sample randomly from each stratum (Map 123-Map 126), regardless of management status of the area being sampled, bottom type, or availability of fish. One disadvantage is that although there are seasonal surveys (primarily spring and fall), the surveys occur during specific periods and the resulting fish distribution data reflect what occurs only during that time period. Fish distribution during the late spring and early summer (late April to June, for example) is unobserved in these data (Table 31). A less problematic issue is that the survey tow locations sometimes avoid certain areas, such as very shallow depths and extra hard bottom, the latter causing gear damage. Thus, certain areas such as the center of Cashes Ledge, Fippennies Ledge, and Nantucket Shoals are not sampled (Map 128).

Using the survey data, the CATT applied scientifically-accepted methods to identify locations of well above average survey catches of age 0 and 1 groundfish, often called a "hotspot analysis". A hotspot in this analysis was identified when there was a cluster of significantly above average catches ($p>0.05$) for each survey over the 10-year period (2002-2011 in the fall and summer surveys; 2003-2012 for the spring surveys). A single catch that was significantly above the survey mean was not deemed to represent a hotspot, nor was a cluster of above average catches that were not significantly above average.

The various surveys occurred during various periods, the longest being the fall NEFSC trawl survey which has been conducted annually since 1963. Data for all of the regular surveys, including the ME/NH trawl survey was available during 2002-2012. The CATT analyzed age 0/1 groundfish distribution data during the fall 2002 to spring 2012 period because it was more likely than earlier data to represent current and future conditions, at least over the near term. Data before 2002 are probably reflective of differing conditions that affect geographical distributions, including changing temperature and stock abundance. Survey data from Industry Based Surveys (IBS) for monkfish, cod, and yellowtail flounder were included in the hotspot analysis, even though a proportion of survey tows were directed by fishermen specifically to target spawning cod[6]. Summer (primarily the shrimp and scallop surveys) and winter (primarily the NEFSC trawl survey that terminated in 2007) only partially covered the range of species

[6] A sensitivity analysis conducted by the Council's Closed Area Technical Team showed that clustering of data did not affect the results, unless areas of high concentration went unsampled or were not surrounded by other samples.

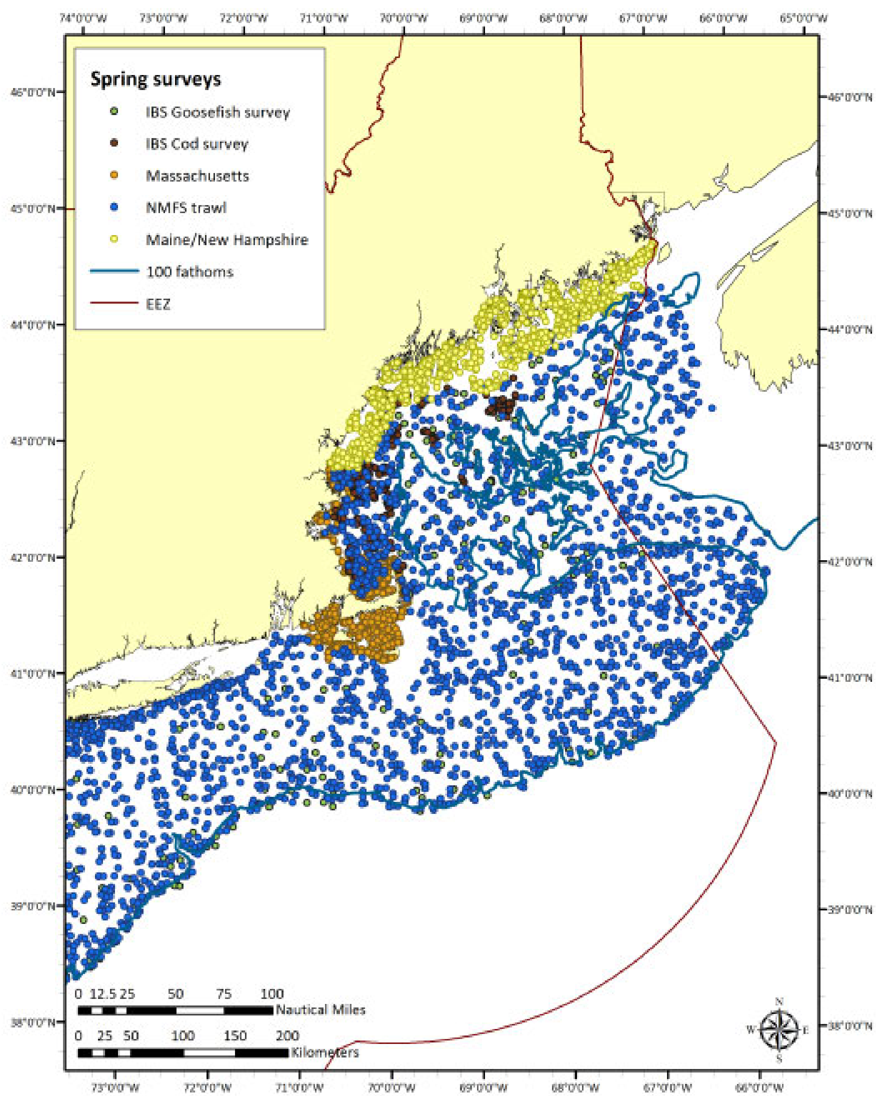
included in this analysis. Obviously hotspots during these seasons were undetectable in unsurveyed areas not covered by these surveys.

Species included in the hotspot analysis were large mesh groundfish, i.e. Acadian redfish, American plaice, Atlantic cod, Atlantic halibut, Atlantic wolffish, haddock, ocean pout, pollock, white hake, windowpane flounder, winter flounder, witch flounder, and yellowtail flounder. Wolffish catches were relatively sparse and no hotspots were identified. This may be related to the fish's behavior of husbandry of young around hard bottom. Some of the more rugged hard bottom areas are avoided during trawl surveys to avoid gear damage, so they likely do not sample young Atlantic wolffish very well. Hotspot analyses were also completed for alewife, Atlantic herring, monkfish, red hake, silver hake, and barndoor skate. Alewife and Atlantic herring in particular were of interest because they are a forage species for some groundfish.

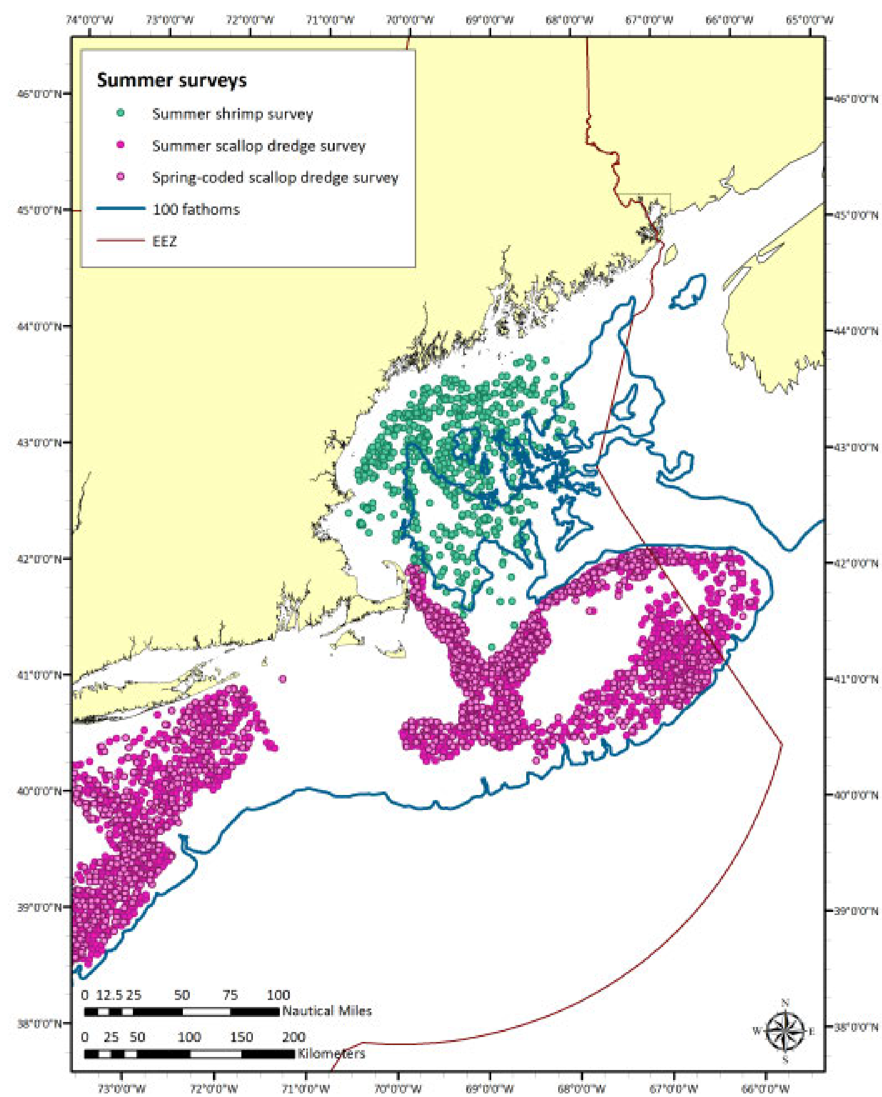
Hotspot analyses were conducted for the entire range for each species in the survey data, a matrix of weightings was developed to focus the analysis and provide greater emphasis to stocks having low biomass (i.e. overfished), existence of sub-populations, a high degree of residency, and high substrate affinity. In other words, stocks that were in greater need of rebuilding assistance were given a higher hotspot "weight." The weighted hotspot results were used to identify critical habitat areas for juvenile groundfish. The weights associated with these factors and applied to the number of hotspots in each 100 km^2 grid are listed in Table 32.

Since the purpose of the analysis was to identify areas that were vulnerable bottom habitat, only stocks that either "occur in a variety of substrates including gravels" or had "strong affinity for coarse or hard substrates" were given non-zero weights. The species that were given non-zero weights in the composite scoring to identify habitat areas included cod, haddock, pollock, redfish, halibut, pout, and wolffish. All other species were given zero weights, and as a result, are not factored into any of the weighted hotspot analyses.

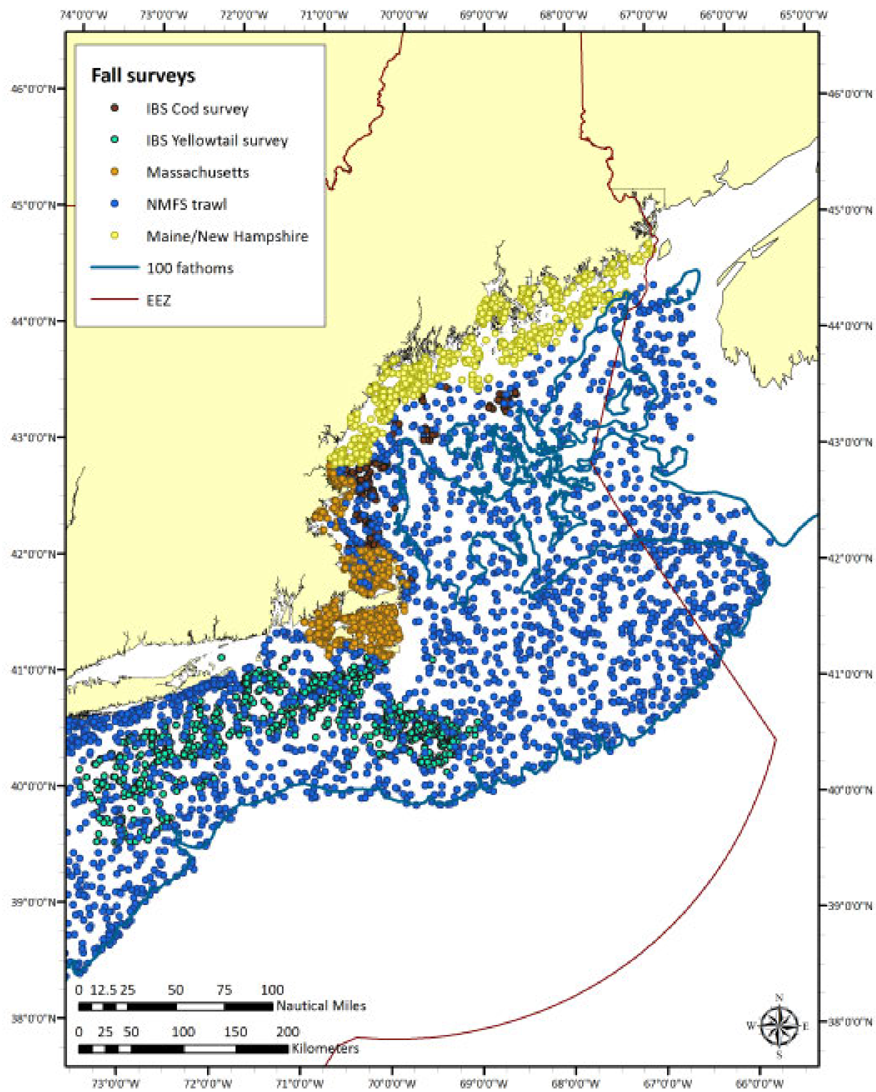
Map 123 – Domain of spring survey tows used for the hotspot analysis, by survey type. Tows used in analysis were made between fall 2002 and spring 2012.



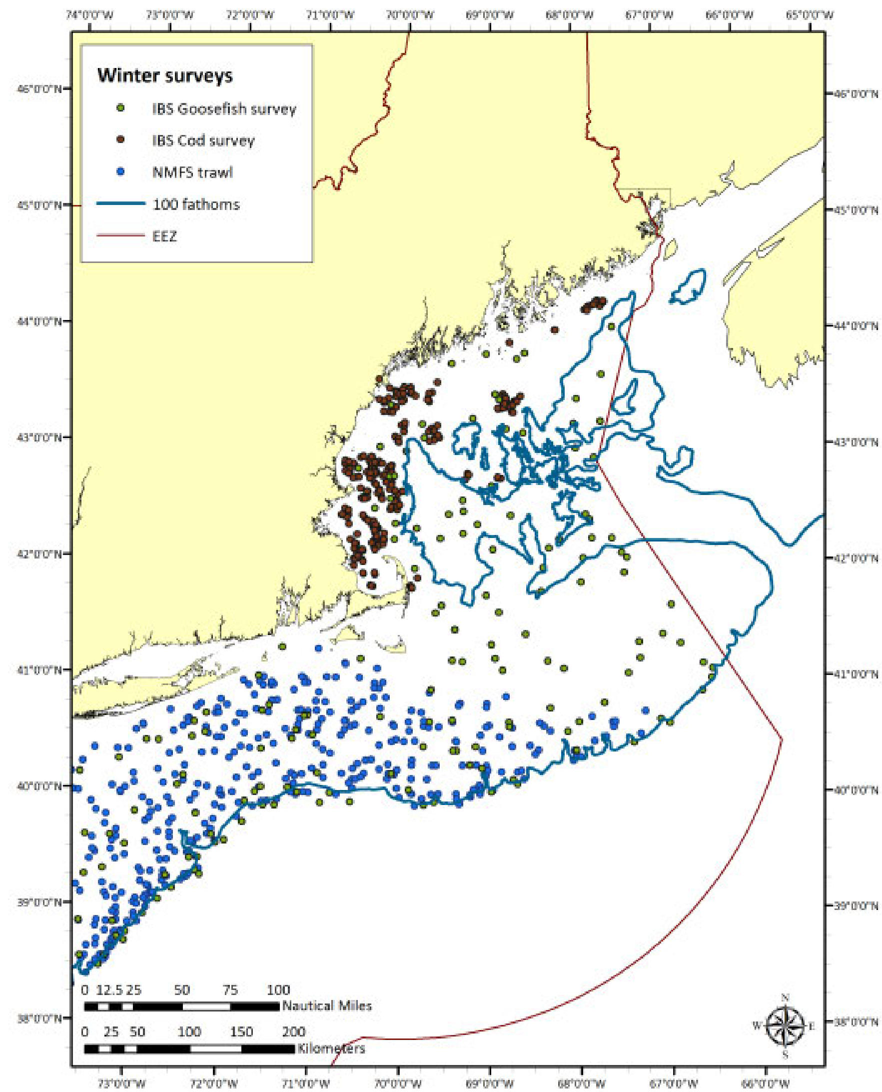
Map 124 – Domain of summer survey tows used for the hotspot analysis, by survey type. Tows used in analysis were made between fall 2002 and spring 2012.



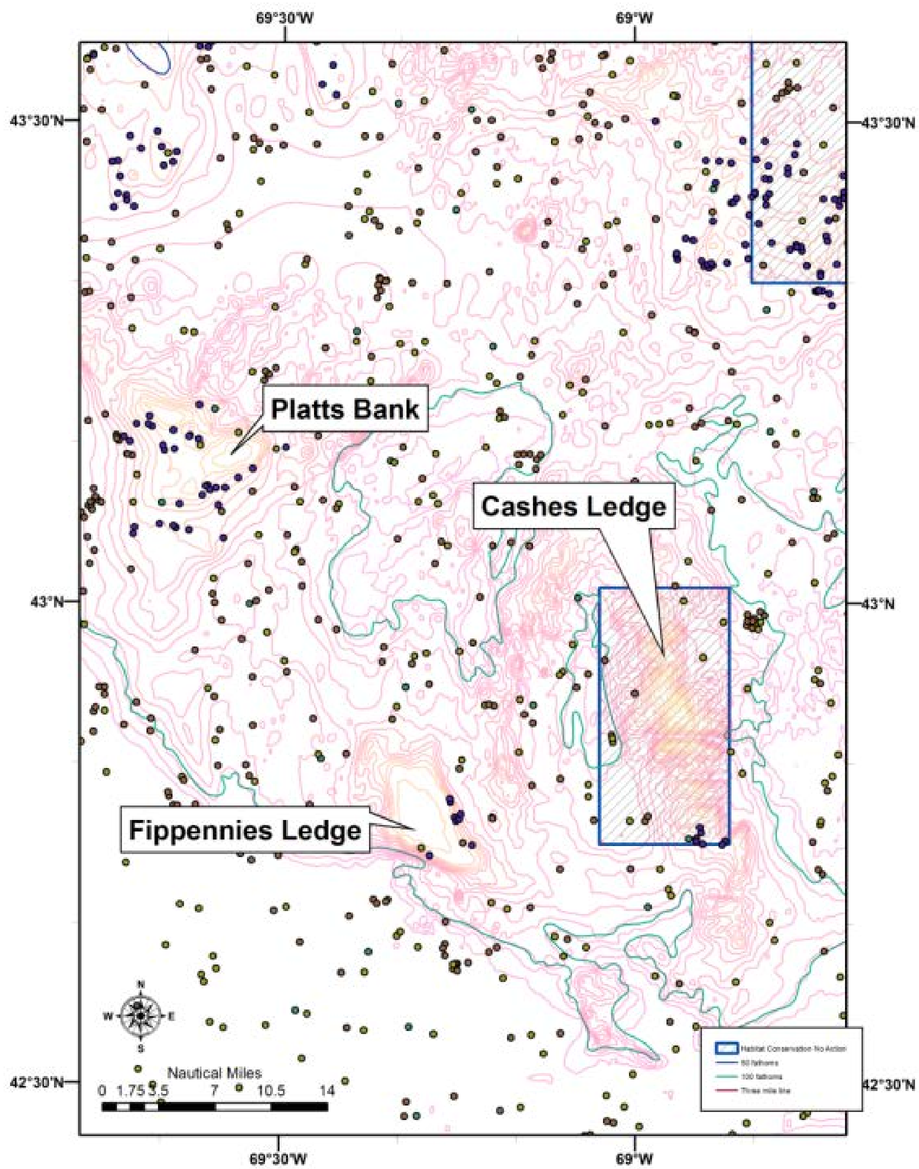
Map 125 – Domain of fall survey tows used for the hotspot analysis, by survey type. Tows used in analysis were made between fall 2002 and spring 2012.



Map 126 – Domain of winter survey tows used for the hotspot analysis, by survey type. Tows used in analysis were made between fall 2002 and spring 2012.



Map 127 – Survey tows taken by NEFSC trawl surveys in the vicinity of Platts Bank, Fippennies Ledge, Cashes Ledge during Fall 2002 to Spring 2012.



Map 128 – Survey tows taken by NEFSC trawl and MADMF trawl surveys in the vicinity of Nantucket Shoals during Fall 2002 to Spring 2012.

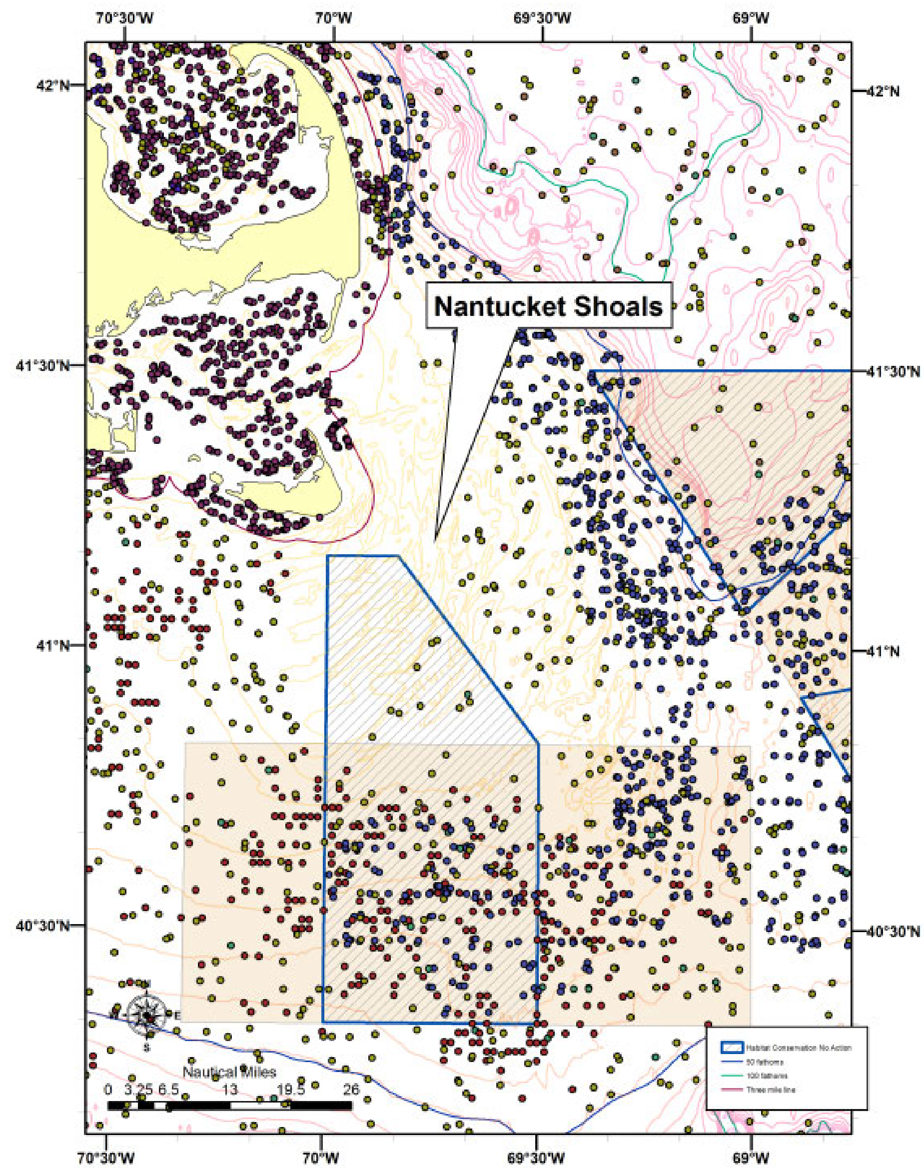


Table 31 – Number of random and non-random survey tows used in age 0 and 1 and large spawner groundfish hotspot analysis by survey type, season, and month of sampling.

	SPRING						SUMMER				FALL				WINTER						Grand Total
Row Labels	2	3	4	5	6	7	6	7	8	9	9	10	11	12	1	2	3	4	11	12	
IBS Monkfish		**45**	**63**	**105**	**16**											**78**	**104**	**16**			**427**
2004		45	63	105	16																229
2009																78	104	16			198
IBS cod	**54**	**80**	**139**	**176**									**71**	**104**	**124**	**71**	**12**		**18**	**49**	**898**
2003													5	38							43
2004		2	82	65									39	23	35	51	12				309
2005	23	40	57	50											36	8			18	49	281
2006				61									27	43							131
2007	31	38													53	12					134
IBS yellowtail flounder			**566**								**89**	**605**	**15**								**1275**
2003												207									207
2004			271									268									539
2005			295								89	130	15								529
NMFS trawl	**19**	**1857**	**1424**	**126**							**1673**	**1446**	**282**	**12**		**636**	**23**				**7498**
2002		151	141								154	144				131	11				732
2003		153	124								120	170				77	2				646
2004		173	119								150	134				124					700
2005		146	121								147	122	23			87					646
2006		197	109								203	122				101	5				737
2007		201	127								146	161				116	5				756
2008		148	147	14							165	140	12								626
2009	3	162	129	48							133	99	94								668
2010	8	179	162	7							135	121	59	12							683
2011		195	101	43							153	107	49								648
2012	8	152	144	14							167	126	45								656
MA DMF trawl				**936**							**685**	**29**									**1650**
2002				83							63										146
2003				74							64										138
2004				84							33	29									146
2005				85							65										150
2006				86							61										147
2007				78							65										143
2008				92							78										170
2009				86							62										148
2010				94							69										163
2011				86							58										144
2012				88							67										155
NMFS shrimp								**364**	**313**												**677**
2002								44	7												51
2003								16	36												52
2004								17	32												49
2005								31	32												63
2006								11	28												39
2007								29	39												68
2008								23	35												58
2009								54	19												73
2010								58	12												70
2011								54	20												74
2012								27	53												80
NMFS scallop dredge				**491**	**756**	**73**	**152**	**1873**	**1247**	**42**											**4634**
2002								189	268												457
2003								52	338	42											432
2004								427	78												505
2005								341	151												492
2006								283	199												482
2007								360	151												511
2008							152	221	62												435
2009				158	212	12															382
2010				182	266																448
2011				151	141																292
2012					137	61															198

Table 32 – Weighting factors applied to juvenile groundfish hotspot data to sum hotspots across species and develop area management options. The final weighting sum was applied to the gridded hotspots for species shaded in red. Grey shaded rows designate species not allocated to sectors.

Stock (Red cells indicate selected stocks for Option 3)	Juvenile size threshold Age 0 and 1 length (90th %ile, cm)	Length at 20% female maturity (cm) re-estimated by CATT	Vulnera-bility of species (Bmsy/B)[1]	Sub-populations[2]	Residency[3]	Substrate[4]	Final Weighting Sum
GB cod	24 (Sp), 34 (Fa)	36	14.11	2	1	3	20.11
GOM cod	24 (Sp), 34 (Fa)	36	5.53	3	1	3	12.53
GB yellowtail flounder	13 (Sp), 15 (Fa)	25	9.39	1	2	1	13.39
CC/GOM yellowtail flounder	13 (Sp), 15 (Fa)	25	4.21	1	2	1	8.21
SNE/MA yellowtail flounder	13 (Sp), 15 (Fa)	25	0.77	1	2	1	4.77
GOM winter flounder	18 (Sp), 28 (Fa)	27	UNK	UNK	2	1	10.04
GB winter flounder	18 (Sp), 28 (Fa)	27	1.22	3	2	1	7.22
SNE/MA winter flounder	18 (Sp), 28 (Fa)	27	6.17	3	2	1	12.17
White hake	34 (Sp), 39 (Fa)	25	1.21	UNK	2	1	6.04
GOM haddock	24 (Sp), 34 (Fa)	28	1.71	1	1	3	6.71
GB haddock	24 (Sp), 34 (Fa)	28	0.75	1	1	3	5.75
Witch flounder	20 (Sp), 19 (Fa)	28	2.45	3	2	1	8.45
American plaice	12 (Sp), 18 (Fa)	24	1.70	UNK	1	1	5.54
Pollock	23 (Sp), 32 (Fa)	39	0.46	2	2	2	6.46
Acadian redfish	14 (Sp), 13 (Fa)	19	0.76	1	2	3	6.76
Atlantic halibut	see winter fl.	NA	28.82	UNK	2	2	34.66
Ocean pout	29	29[6]	12.05	UNK	1	2	16.88
N. windowpane	see yellowtail	18	3.48	UNK	2	1	8.31
S. windowpane	see yellowtail	18	0.69	UNK	2	1	5.52
Atlantic wolffish	47	47[7]	3.48	UNK	UNK	2	8.99
Sum							208.52
Mean			**5.21**	**1.83**	**1.68**	**1.70**	**10.43**

1 Either SSBMSY/SSB or BMSY/B used depending on what is reported in the assessment

2 Derived from Table 81 in Framework 48 or from NEFSC biological data. 1=no subpopulations, 2=some evidence, 3=known subpopulations

3 Based on information in literature. 1=less resident, more migratory; 2=more resident, less migratory

4 Based on information in literature. 1=almost exclusively in mud or sand substrates, 2=occur in a variety of substrates including gravels, 3=strong affinity for coarse or hard substrates

5 Sums include a mean value for unknowns

6 From O'Brien et al. (1993)

7 From Templeman (1986)

Management-weighted and unweighted hotspots were summarized for existing EFH closed areas (No Action) and for various areas under consideration for habitat management (via gear modification or closure) in this amendment. Gridded (100-km^2 resolution) hotspot summaries by season and species for age 0 and 1 fish are presented below, along with these management area summaries. The number of hotspots in specific areas vary by season due to seasonal variations in geographic distribution as well as the amount and extent of surveys conducted during each season (see sampling summary in the above section). Therefore no attempt was made to rank or grade areas by summing weighted or unweighted hotspots across seasons.

4.4.1.1 By species

Hotspot distribution maps for age 0/1 or small juvenile fish are described below for the large mesh groundfish, small mesh groundfish, and other associated species that are common in the Gulf of Maine and on Georges Bank. Additional generalized additive model results (detailed in Appendix F) are discussed for cod and yellowtail flounder.

Acadian redfish

Age 0/1 redfish hotspots were prevalent in the spring and summer surveys in depths generally greater than 100 fathoms from the center of the Western Gulf of Maine Closure Area to Jeffreys Bank (Map 133). The distribution of the hotspots from the summer survey catches overlapped Platts Bank and extended toward but did not reach Cashes Ledge. The fall hotspot distribution was nearly the same as it was in the spring, but extended to the north and east into the Jordan Basin and included areas around Fippennies and Cashes Ledges.

American plaice

Large areas of age 0/1 American plaice hotspots were detected in the western Gulf of Maine, shallower than 100 fathoms from off Scituate, Massachusetts to off Mt. Desert Island, Maine (Map 134). The area with age 0/1 plaice hotspots was nearly the same in the spring and fall surveys. The summer shrimp survey had plaice hotspots in the same area in the western Gulf of Maine, but also had plaice hotspots near Platts Bank and Cashes Ledge. No plaice hotspots were detected in winter survey catches.

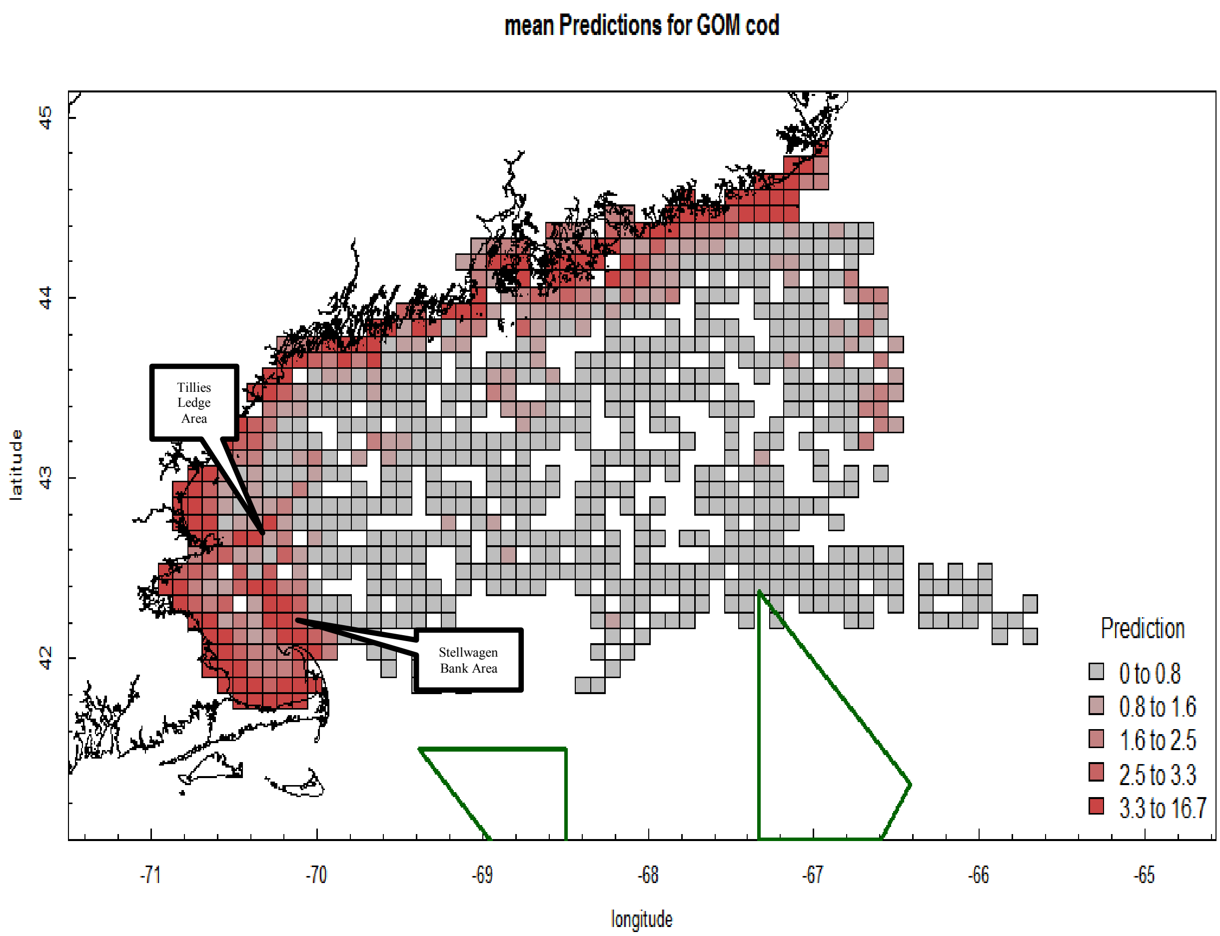
Atlantic cod

Cod are caught throughout the region, including the Gulf of Maine, Georges Bank, and Southern New England. Two stocks are recognized, Gulf of Maine and Georges Bank/Southern New England (Map 135). Using survey age-length keys, age 0 and 1 cod are less than 24 cm in the spring and 34 cm in the fall, rounded up to 25 and 35 cm respectively for the hotspot analysis. Hotspots of age 0/1 cod were identified mainly in the western Gulf of Maine in the spring and fall surveys, mostly in Massachusetts Bay, inshore of Stellwagen Bank and in the southern portion of the Bigelow Bight, north of Cape Ann, Massachusetts. The summer surveys for shrimp and scallops did not cover areas where there were concentrations of abundant age 0/1 cod. The winter trawl and IBS cod surveys found concentrations of age 0/1 cod in Massachusetts Bay, partly overlapping the Stellwagen Bank area, but inshore of the Western Gulf of Maine Closure Area. Close examination of the age 0/1 cod survey catch distributions and the identified hotspots indicate that small juvenile cod are more abundant west and south (i.e., inshore) of Stellwagen Bank in the spring, and offshore of it in the fall, but that these fish are concentrated inshore of the Western Gulf of Maine Closure Area regardless of season. During the summer scallop dredge survey, it is common to find clusters of high abundances of age 0/1 cod on the far eastern portion of Georges Bank, in Canadian waters.

The cod hotspots are consistent with a habitat suitability model developed for the Council by Samuel Truesdell, a PhD candidate at the University of Maine, Orono ("Modeling Juvenile Atlantic cod and yellowtail flounder abundance on Georges Bank and in the Gulf of Maine using 2-stage generalized additive models" by Samuel Truesdell, 2013, Appendix F). A two-stage General Additive Model (GAMs) was developed using analytical methods previously used in a lobster habitat suitability model. The cod model estimated the association of age 0/1 cod with various environmental factors that included seabed form, sediment type, depth, and temperature. Control variables included in the model included season, survey (accounting for differences in catchability between surveys), and zenith angle (accounting for diel variations in catchability).

According to the model results, the habitat and oceanic conditions most suitable to small juvenile cod, independent of stock size and fishing, were located along the shallower inshore portions of the Gulf of Maine, from Cape Cod to northern Maine (Map 129). The grids with the highest predicted cod abundance in the western Gulf of Maine were well inshore of the Western Gulf of Maine Closure Area and the Western Gulf of Maine Habitat Closure Area. The model also predicts high age 0/1 cod abundance for areas north of Cape Cod, Massachusetts, on Stellwagen Bank, off Cape Ann, Massachusetts, and on Tillies Bank. There also appear to be above average predicted abundance for some of the higher relief features in the central Gulf of Maine, such as Platts Bank, Cashes Ledge, and Jeffreys Bank.

Map 129 – Mean predicted age 0/1 cod abundance in the Gulf of Maine.



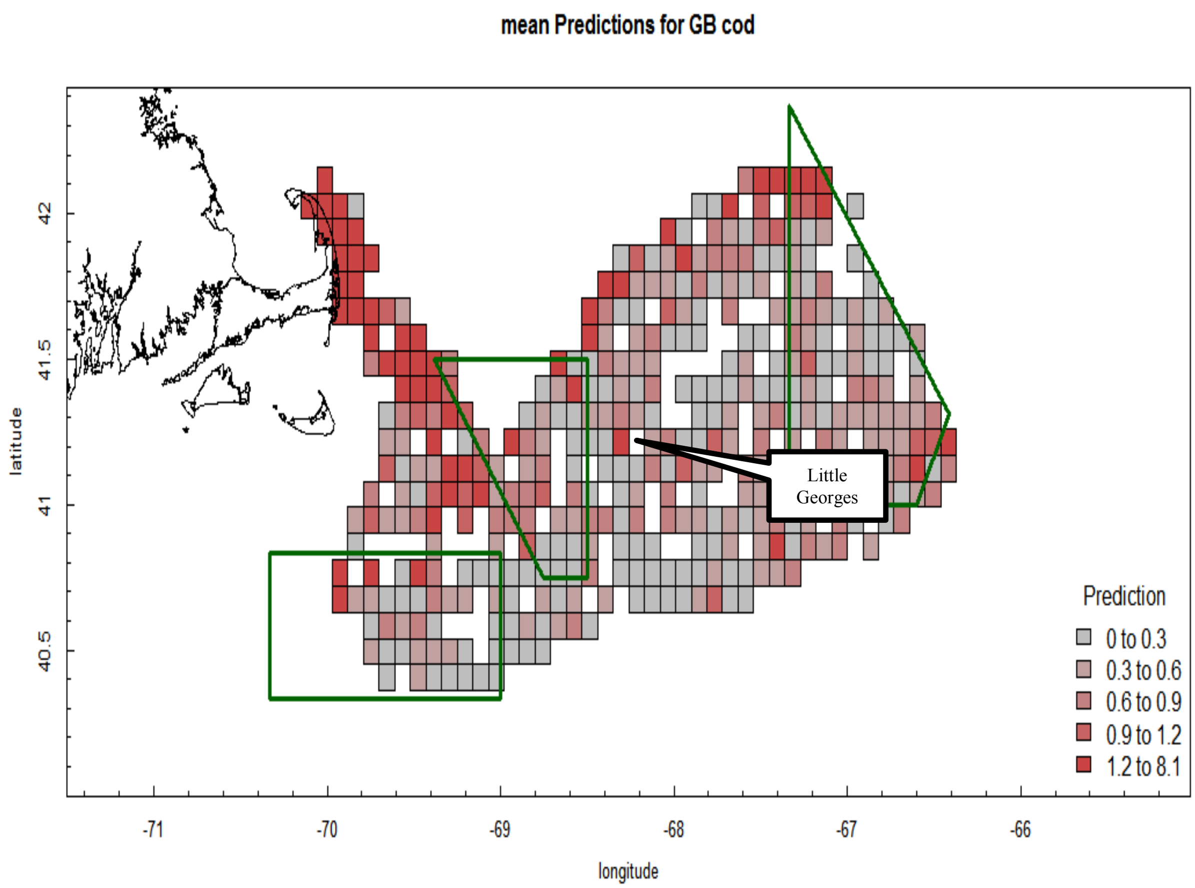
A GAMs model was also developed for Georges Bank cod, which estimated the association of age 0/1 cod with various habitat and oceanographic variables, including seabed form, dominant sediment, sediment coarseness, sheer stress (a measure of wave and current energy), temperature, and depth. Control variables included in the analysis were season, survey type, and zenith angle.

Based on habitat and oceanographic conditions, the GAMs analysis predicted high abundance along the Great South Channel from off Cape Cod, Massachusetts and past the western edge of Closed Area I, with notable predictions of high abundance in the center and northern portions of the Nantucket Lightship Area, which also overlaps the Nantucket Lightship Area EFH closure (Map 130). It is important to recognize that high juvenile cod abundance was predicted in these areas yet cod catches from the 2002-2012 surveys were not above average and no age 0/1 cod hotspots were detected in this area. Over a longer 1963-2008 period, this area was very important for cod and had high abundance of age 0/1 cod (Lough 2010). The implication is that conditions are good for juvenile cod, but recent abundance is low and there were few hotspots identified in this area due to other factors, including fishing.

High cod abundance was also predicted along the northern margin of Georges Bank, including areas within Closed Area II. Unlike the Perry and Smith (1994) results for the Scotian Shelf, the

Georges Bank GAMs analysis indicated suitable habitat on the shallower areas of Georges Bank, including near an area called Little Georges Bank, east of Closed Area I. Age 0/1 cod were predicted to have high abundance in the shallower areas of the Bank during the spring and along the deeper margins of Georges Bank in the fall.

Map 130 – Mean predicted age 0/1 cod abundance for Georges Bank and the Great South Channel.



Atlantic halibut

Although occasional catches occur elsewhere, age 0/1 halibut hotspots were detected only in a cluster in the Machias, Maine area during the spring (Map 136). These catches were made by the ME/NH trawl survey.

Haddock

Hotspots for age 0/1 haddock catches in spring surveys were scattered broadly across southern Georges Bank, both inside and outside of Closed Area II (Map 137). No hotspots were detected on the Northern Edge during the spring surveys. Clusters of hotspots were however identified in the western Gulf of Maine, immediately north of Cape Cod, in the deeper waters of Ipswich Bay, and offshore of Cape Elizabeth, Maine. Another cluster of hotspots occurred in northern Maine, near Machias. A few haddock hotspots appeared near Cashes Ledge.

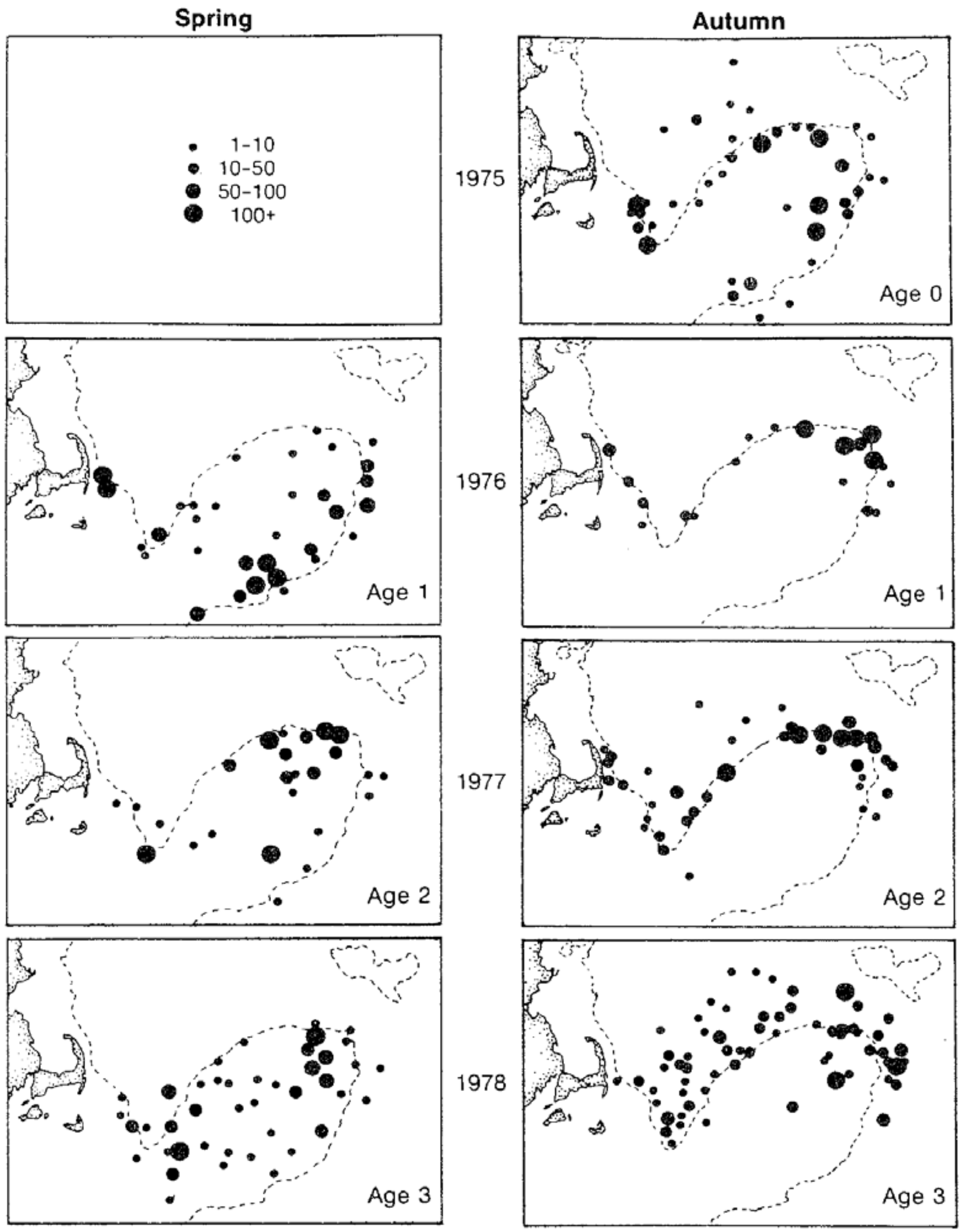
During the summer, a strong cluster of hotspots was identified on the southern part of Georges Bank, mostly within the southern part of Closed Area II, spilling over into Canadian waters. This area was shown to have dense concentrations of amphipod tubes (Vitaliano et al. 2013) and may be an important nursery and feeding area for juvenile haddock. A few hotspots of age 0/1 haddock were also identified in the southern portion of the Great South Channel, south of and partly overlapping the southern part of Closed Area I.

In the fall surveys, the hotspot analysis detected a strong presence of age 0/1 haddock along the northern edge of Georges Bank from the boundary of the habitat closure east into Canada. This distribution of hotspots extended into the deeper edges in the Southeast Part of Georges Bank. Fewer hotspots were detected in the Gulf of Maine than in the spring surveys, but were in the same general areas, including the inshore areas around Machias, Maine. Six hotspots were also detected on the southern part of Jeffreys Ledge, inside of the Western Gulf of Maine closed area.

Age 0/1 haddock hotspots were also detected in the central Gulf of Maine, around Cashes and Fippennies Ledges. These results are from the IBS cod survey and hotspots may therefore also occur near the offshore banks and ledges in the central Gulf of Maine, if surveys occurred there during the winter.

Although it was anticipated that there would be more juvenile haddock hotspots on the Georges Bank Northern Edge, these hotspot results are very consistent with a previous analysis of the spring and autumn trawl survey data by Overholtz (1985). The Overholtz analysis examined the geographic distribution of the abundant 1975 and 1978 year classes by age. Age 0 haddock in autumn and age 1 haddock in spring were broadly dispersed across the shallower areas of Georges Bank (Map 131). As the haddock aged beginning with age 1 in the fall survey, they became concentrated in the deeper margins of the bank, first in the Canadian and eastern portion of Georges Bank and then further west on the Northern Edge into the Cod HAPC and Closed Area II, until age 3 in the spring. A hotspot analysis of age 2 and 3 haddock probably would have identified more hotspots on the northern edge in U.S. waters.

Map 131 – Georges Bank distribution of the 1975 haddock year class by age in spring and autumn trawl surveys (Overholtz 1985).



Ocean pout

Age 0/1 ocean pout hotspots were detected in the Bigelow Bight, off New Hampshire and southern Maine from spring and fall trawl survey catches (Map 138). These hotspots were generally shallower than 100 fathoms, north and west of the Western Gulf of Maine Closure Area. One winter hotspot was detected in southern New England waters.

Pollock

Very few age 0/1 pollock hotspots were detected, mainly scattered north and west of the Western Gulf of Maine Closure Area in the spring (Map 139). The lack of hotspots is probably due to the wide variation of catches on survey tows.

Red hake

Like silver hake, age 0/1 red hake hotspots appear to be broadly distributed, but strongly identified in various areas within the Gulf of Maine, Georges Bank, and southern New England (Map 140). During the spring, red hake hotspots were identified in Cape Cod Bay, Ipswich Bay, off southern Maine, in the Machias region and south and east of Cashes Ledge, as well as in deeper water offshore of the Western Gulf of Maine Closure Area. A few hotspots were found in deep water north of Georges Bank and in the center of the Nantucket Lightship Area, as well as off Buzzards Bay.

Fall hotspots were similar, but aggregated in six broad areas. Areas of strong aggregations of hotspots were in Cape Cod Bay to off Scituate, Massachusetts; and off New Hampshire and southern Maine. Other broad areas of age 0/1 red hake hotspots included an area around Jeffreys Bank and Toothaker Ridge off central Maine, across the northern part of Georges Bank, the southeast part of Georges Bank, and the Mud Hole area in southern New England. Age 0/1 red hake hotspots were sporadic and dispersed in the summer and winter surveys.

Like silver hake, juvenile red hake may be an important food source for piscivorous groundfish. Red hake are also not known to be associated with hard substrates, preferring sandy, silty, or muddy bottom.

Silver hake

Age 0/1 silver hake hotspots are common and widely dispersed in a swath of moderate depths off Cape Cod Bay, Massachusetts nearly to the Machias, Maine area, generally between 50 and 100 fathoms (Map 141). A similar distribution of hotspots occurs in the summer surveys, but these are limited by the extent of the shrimp trawl survey. During the fall and winter trawl surveys, a patch of silver hake hotspots was detected around the Mud Hole in southern New England. Juvenile (and adult) silver hake are an important prey species for piscivorous fish like cod. While silver hake are not known to be strongly associated with hard substrates, their presence near these areas may serve as an important food source for large juvenile and adult fish.

White hake

Less is known about the distribution of juvenile white hake in relation to oceanographic features in the Gulf of Maine than information on cod, haddock, and winter flounder. White hake hotspots are scattered mostly in the northern Gulf of Maine in the spring, from moderate depths along the coast to deeper depths in the eastern Gulf of Maine (Map 142). In the summer shrimp trawl survey, age 0/1 white hake hotspots were distributed broadly in moderate depths off central and southern Maine, and on both sides of the Jeffreys Bank Habitat Closure Area. Hotspots further east might be found in the summer, but it is outside the sampling range of this survey. Hotspots for age 0/1 white hake were also found in the IBS cod survey data, clustered in Ipswich Bay and off Casco Bay. This survey has a restricted sampling region, however, and age 0/1 winter flounder hotspots may occur elsewhere in the inshore portions of the Gulf of Maine.

Windowpane flounder

Age 0/1 windowpane flounder hotspots were identified mainly around Penobscot Bay and coastal areas just to the east (Map 143). A few scattered windowpane flounder hotspots were identified during the spring, fall, and winter surveys across Georges Bank and southern New England, northwest of the Nantucket Lightship Closed Area.

Winter flounder

Age 0/1 hotspots for winter flounder were detected along the coastline from southern New England to northern Maine in the spring. The hotspot analysis for age 0/1 winter flounder revealed several important areas with clusters of high winter flounder abundance in the spring, ranging from the shallow coastal areas in Rhode Island Sound, Cape Cod Bay, Massachusetts Bay, Ipswich Bay, Casco Bay, off Mt. Desert Island, Maine, and in Northern Maine, near Machias (Map 144). In the fall, hotspots were identified in slightly deeper water off central and northern Maine, but not in the Massachusetts Bay area. In winter, clusters of hotspots of age 0/1 winter flounder appear in Massachusetts Bay and overlap Stellwagen Bank, but are inshore of the Western Gulf of Maine Closure Area. A few hotspots are located inshore in Ipswich Bay as well. No hotspots were identified in the summer shrimp survey data, but some occur in the summer scallop dredge survey on the Northern Edge of Georges Bank.

Although DeCelles and Cadrin (2010) focused on the distribution and movement of adult winter flounder in coastal and estuarine waters of the southern Gulf of Maine, these hotspots results are adjacent to the identified spawning locations and may show areas that serve as important nursery areas.

Witch flounder

Age 0/1 witch flounder hotspots were detected in the Gulf of Maine along and slightly deeper than the 100 fathom isobaths, generally from offshore of Casco Bay, Maine to the Machias area, from spring to fall (Map 145). A few hotspots were detected on the southern portion of Jeffreys Ledge, inshore of the Western Gulf of Maine Closure Area. Only one hotspot was detected in the winter surveys, primarily due to their limited sampling range.

Yellowtail flounder

Catches of age 0/1 yellowtail flounder appear to be more broadly dispersed than catches of cod, and fewer hotspots were detected in any season (Map 146). Yellowtail flounder hotspots in the spring were located mainly in the shallower portions of Massachusetts Bay, much of them from the MADMF survey in state waters. These hotspot results are not surprising, since yellowtail flounder are less concentrated and more strongly associated with sand and mud substrates. A few scattered hotspots of age 0/1 yellowtail flounder were found in the summer and fall survey catches, but no hotspots were detected in the winter survey (which was designed to sample flatfish).

Age 0/1 yellowtail flounder hotspots were less numerous than they were for cod. Since yellowtail flounder occupy more widely dispersed sandy habitats, this result is unsurprising. Another factor that might influence the outcome is stock size. Depending on how species respond to changes in stock abundance, density can remain constant across space or increase as a proportion of the total abundance. For total abundance, Periera et al. (2012) found that yellowtail flounder densities are consistent with the constant density and basin models. Their results were based on total catch per tow of all sizes. Based on the Periera et al. (2012) results, hotspots should be more prevalent at low stock size as they are now[7]. The hotspot analysis, however, focuses on age 0/1 flounder. Fish of this size range may respond differently to density dependent factors than large and adult fish, particularly if there is age truncation due to high fishing mortality.

In the spring, hotspots were identified in Ipswich Bay, Massachusetts Bay, and Cape Cod Bay in the western Gulf of Maine. These hotspots are in the Cape Cod yellowtail flounder stock area. During the summer and fall, sporadic hotspots were identified in the Great South Channel and on Georges Bank. Despite the type of survey gear that is designed to catch flatfish in the winter trawl survey, no yellowtail flounder hotspots were identified from the 2002-2007 data.

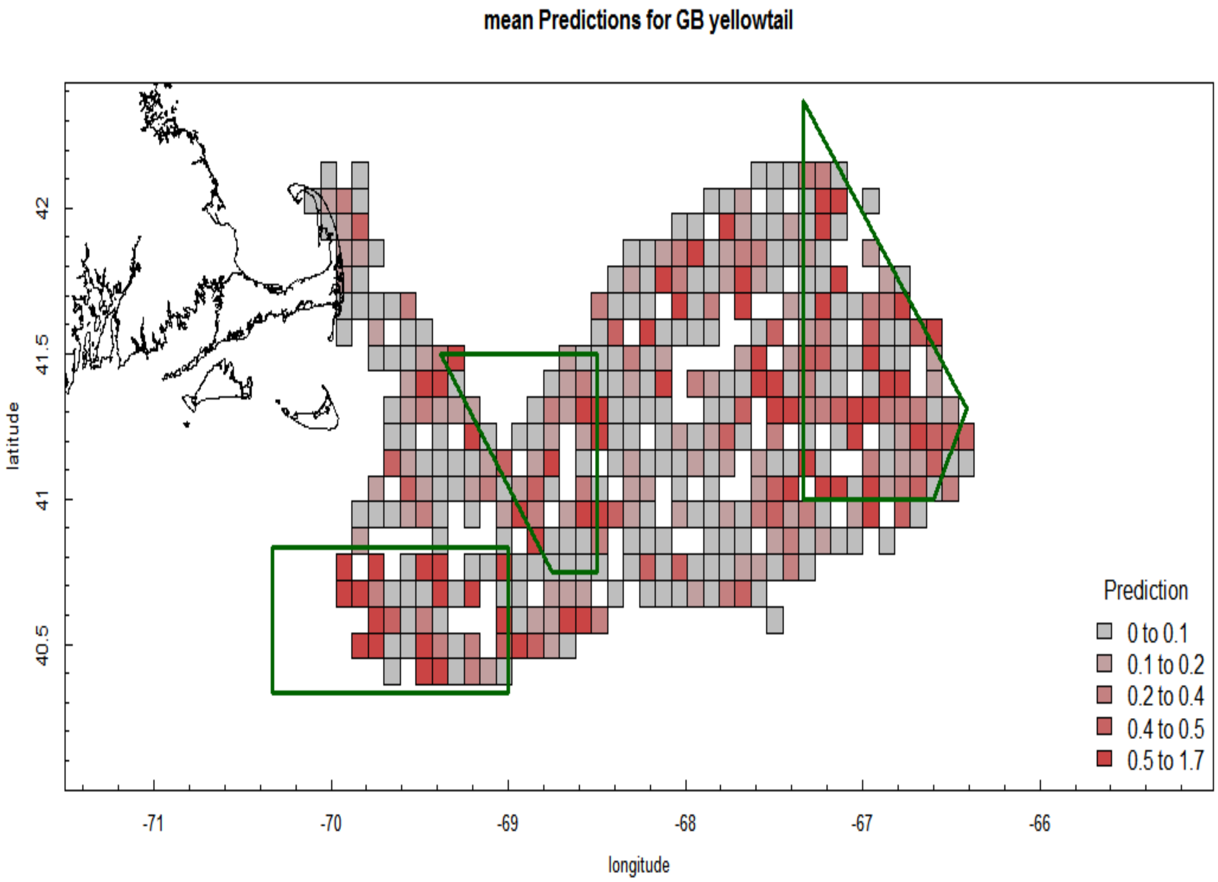
A GAMs model for Georges Bank yellowtail flounder estimated the association of age 0/1 yellowtail flounder with various habitat and oceanographic variables, including seabed form, dominant sediment, sediment coarseness, sheer stress (a measure of wave and current energy), temperature, and depth. Control variables included in the analysis were season, survey type, and zenith angle.

The predicted abundance is shown in Map 132. Clusters of high abundance based on the GAMs analysis are generally in the Nantucket Lightship Area and on Eastern Georges Bank, mostly visible in the spring but more random in the fall. Clusters of high abundance elsewhere are more scattered through the Great South Channel and western Georges Bank.

The higher predicted juvenile abundance in the Nantucket Lightship Area suggests that it may play an important role for a yellowtail flounder nursery area. The Nantucket Lightship Area may, however, play a less important role for adult yellowtail flounder since it was not found to contribute to yellowtail flounder biomass rebuilding (DeCelles et al. 2012; Kerr et al. 2012).

[7] The ratio of B_{MSY} to current biomass is 9.39 for Georges Bank yellowtail flounder and 4.21 for Cape Cod yellowtail flounder.

Map 132 – Mean predicted age 0/1 yellowtail flounder abundance for Georges Bank and the Great South Channel.



Monkfish

A few scattered hotspots of age 0/1 monkfish were detected in the spring and winter in the western Gulf of Maine and in southern New England (Map 147). In the summer shrimp trawl and scallop dredge surveys, denser clusters of age 0/1 monkfish hotspots were detected off southern Maine and northeast of the Western Gulf of Maine Closure Area, as well as immediately off the tip of Cape Cod and in the south central part of the Nantucket Lightship Area. During the fall surveys, monkfish hotspots were detected in the same area off southern Maine as in the spring, but also near the Cashes Ledge area and in waters deeper than 100 fathoms off the tip of Cape Cod.

Barndoor skate

Although the trawl surveys that sample Georges Bank and Southern New England catch small barndoor skate, no hotspots were detected despite higher levels of total abundance in the last decade compared to previously collected data. The summer dredge survey, however, had clusters of tows with significantly above average catches in a narrow swath ranging from southwestern Georges Bank to Southern New England, into the Nantucket Lightship Area (Map

148). Although some of these hotspot areas are open to fishing, a considerable number of them occur in the Nantucket Lightship Area which may provide considerable conservation benefit. Some of the hotspots in the Nantucket Lightship Area are in the scallop access area, specifically the portion that is most intensively fished.

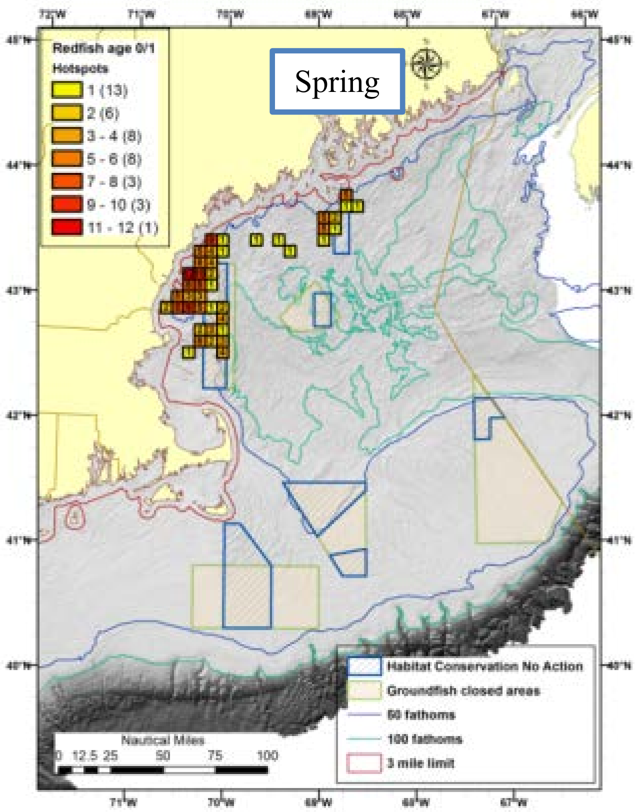
Atlantic herring

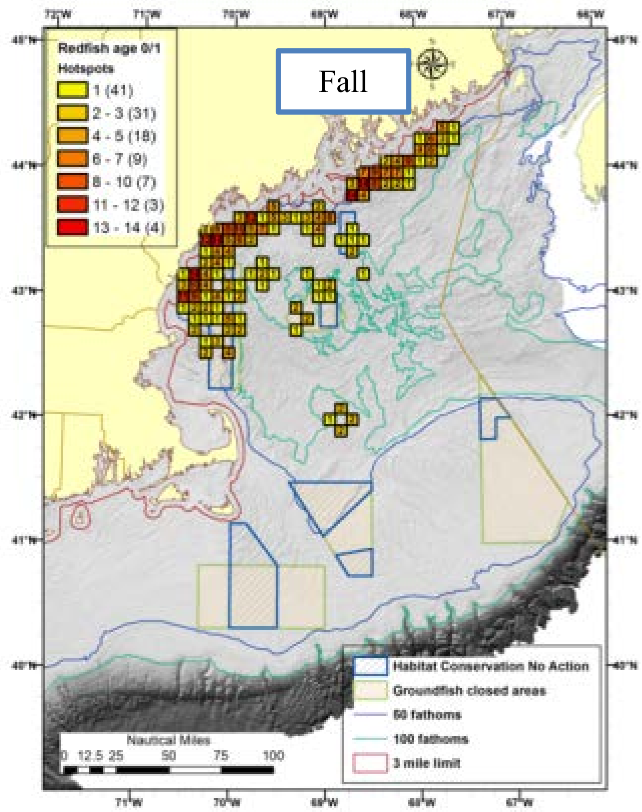
Sporadic and dispersed juvenile herring hotspots were detected along the Maine coastline in the spring survey catch data (Map 149). No hotspots were detected in the summer, fall, and winter survey catch data.

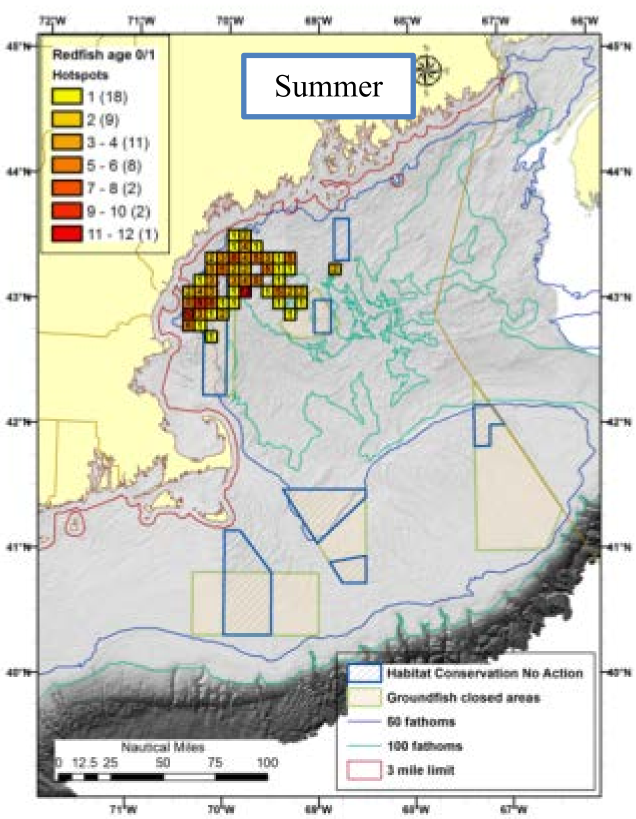
Alewife

Juvenile alewife hotspots were detected in the spring and fall ME/NH survey data along the central to eastern Maine coastline (Map 150), generally in depths less than 100 fathoms and often less than 50 fathoms. Strong aggregations of fall hotspots occur further inshore than they do in the spring, particularly notable in Penobscot Bay and around Mt. Desert Island, Maine. No hotspots were detected in the summer and winter survey catch data.

Map 133 – Seasonal distribution of age 0-1 Acadian redfish hotspots from 2002-2012 survey abundance.



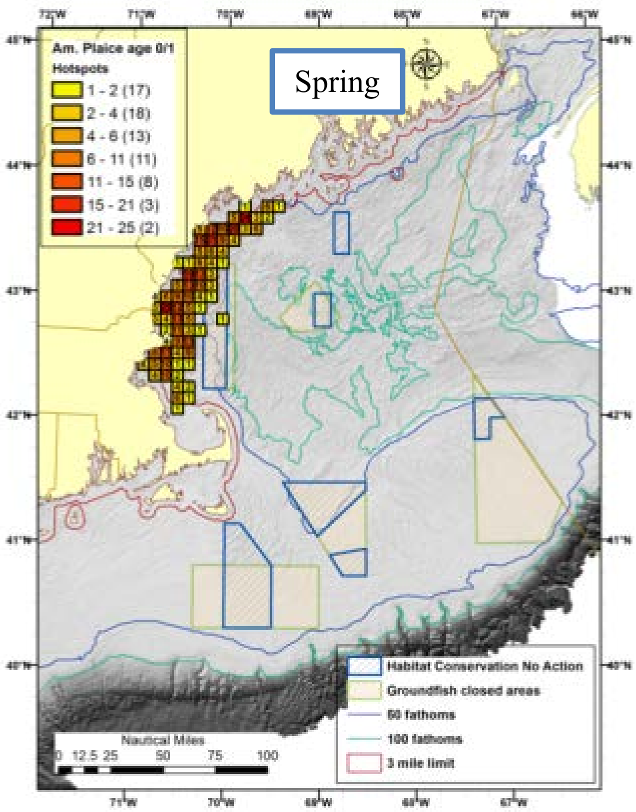


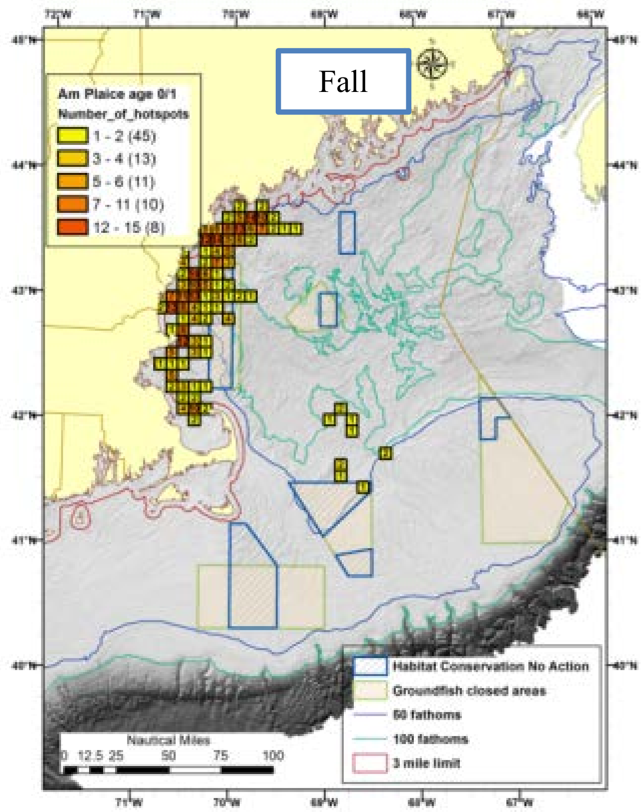


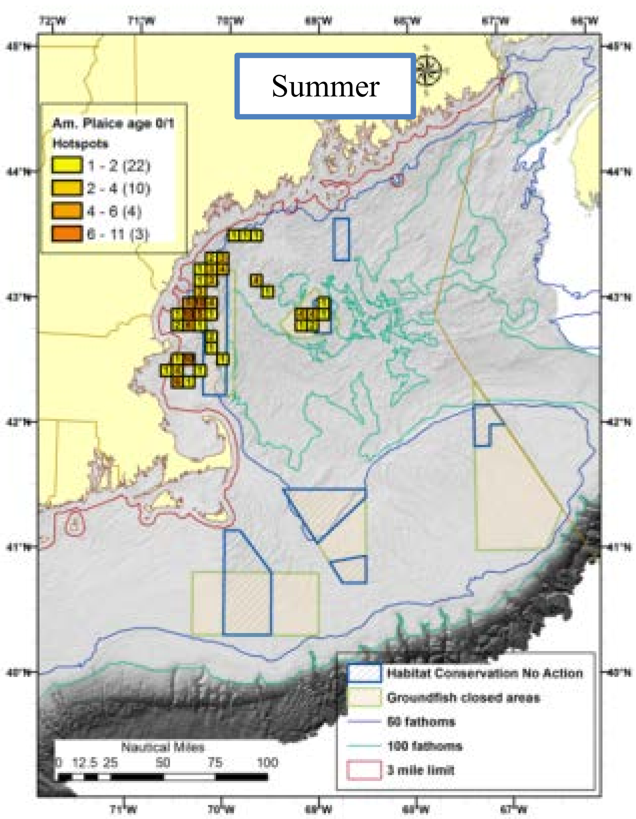
Winter

No hotspots detected

Map 134 – Seasonal distribution of age 0-1 American plaice hotspots from 2002-2012 survey abundance.



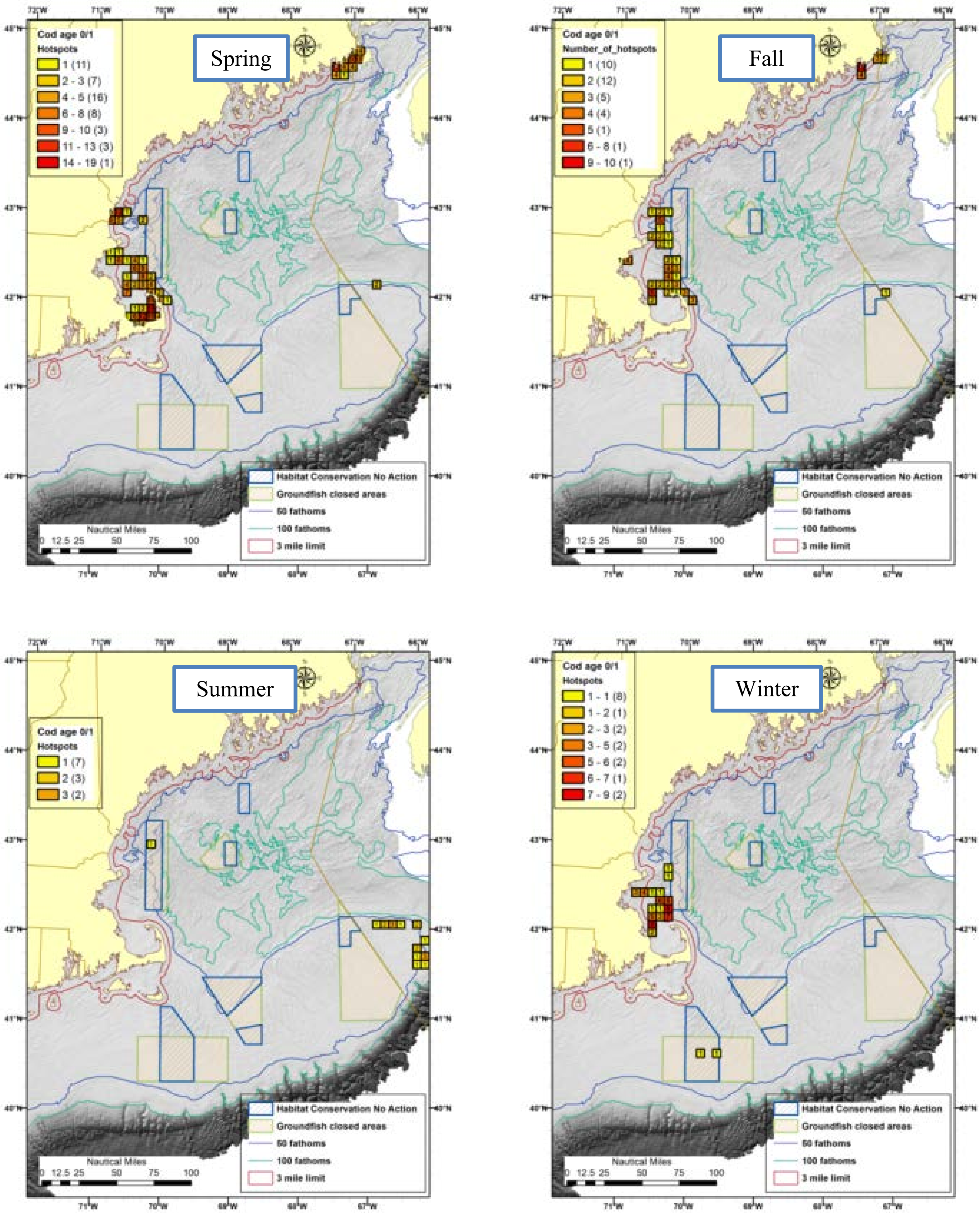




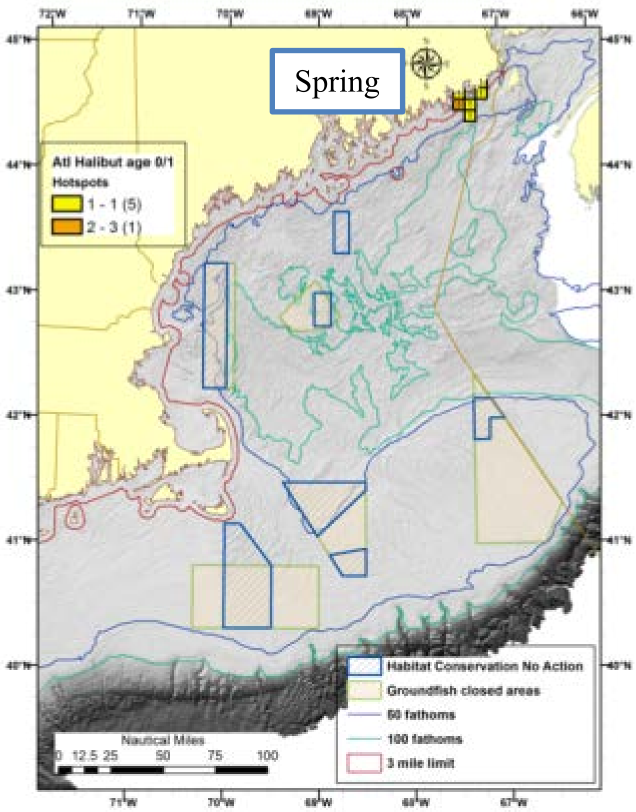
Winter

No hotspots detected

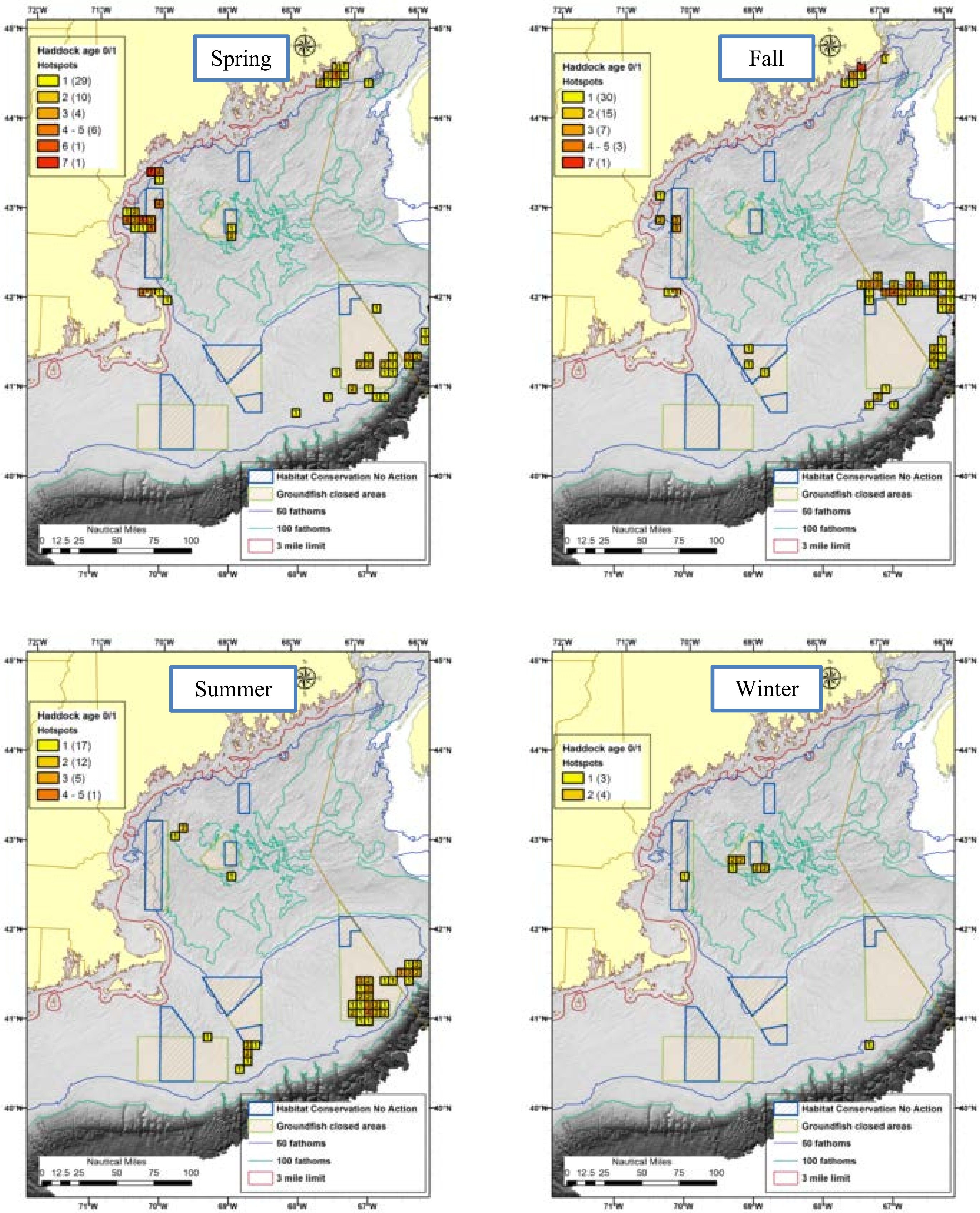
Map 135 – Seasonal distribution of age 0-1 Atlantic cod hotspots from 2002-2012 survey abundance.



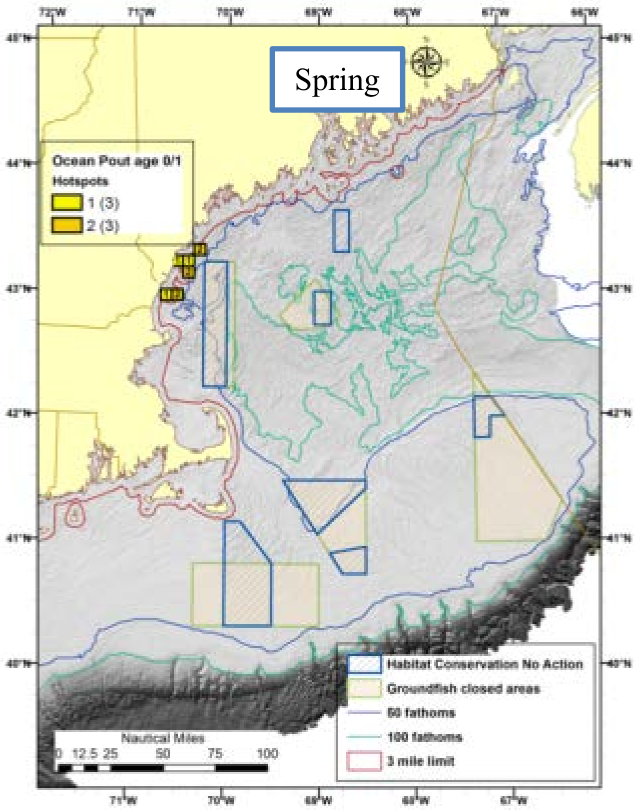
Map 136 – Seasonal distribution of age 0-1 Atlantic halibut hotspots from 2002-2012 survey abundance. Only spring hotspots detected.

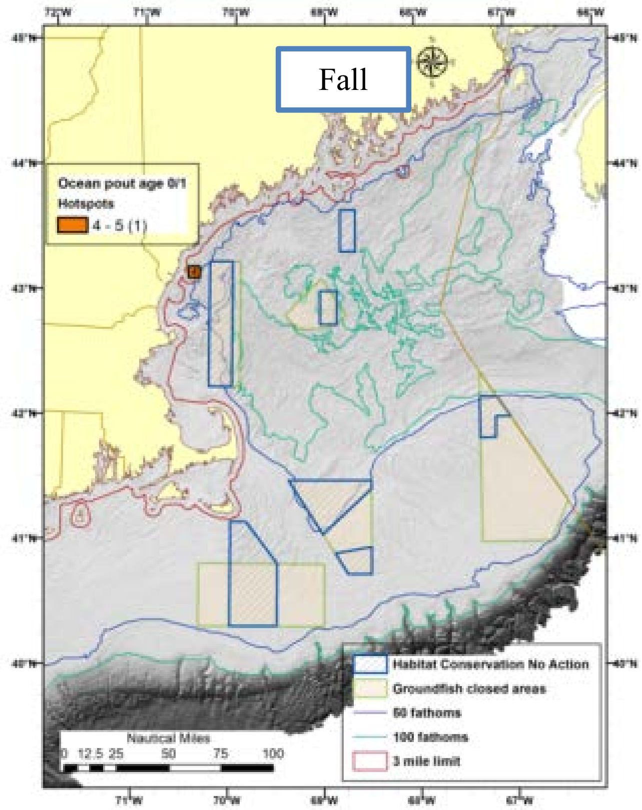


Map 137 – Seasonal distribution of age 0-1 haddock hotspots from 2002-2012 survey abundance.



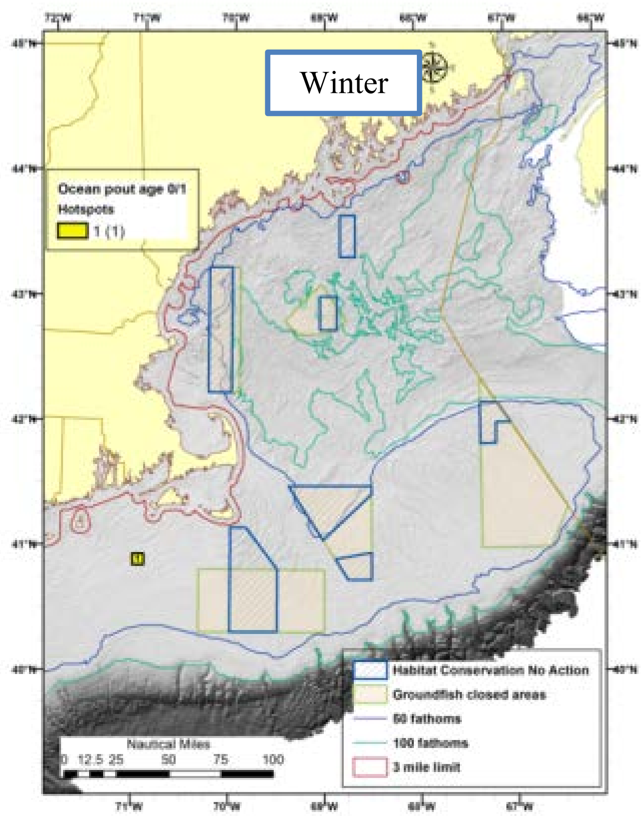
Map 138 – Seasonal distribution of age 0-1 ocean pout hotspots from 2002-2012 survey abundance.



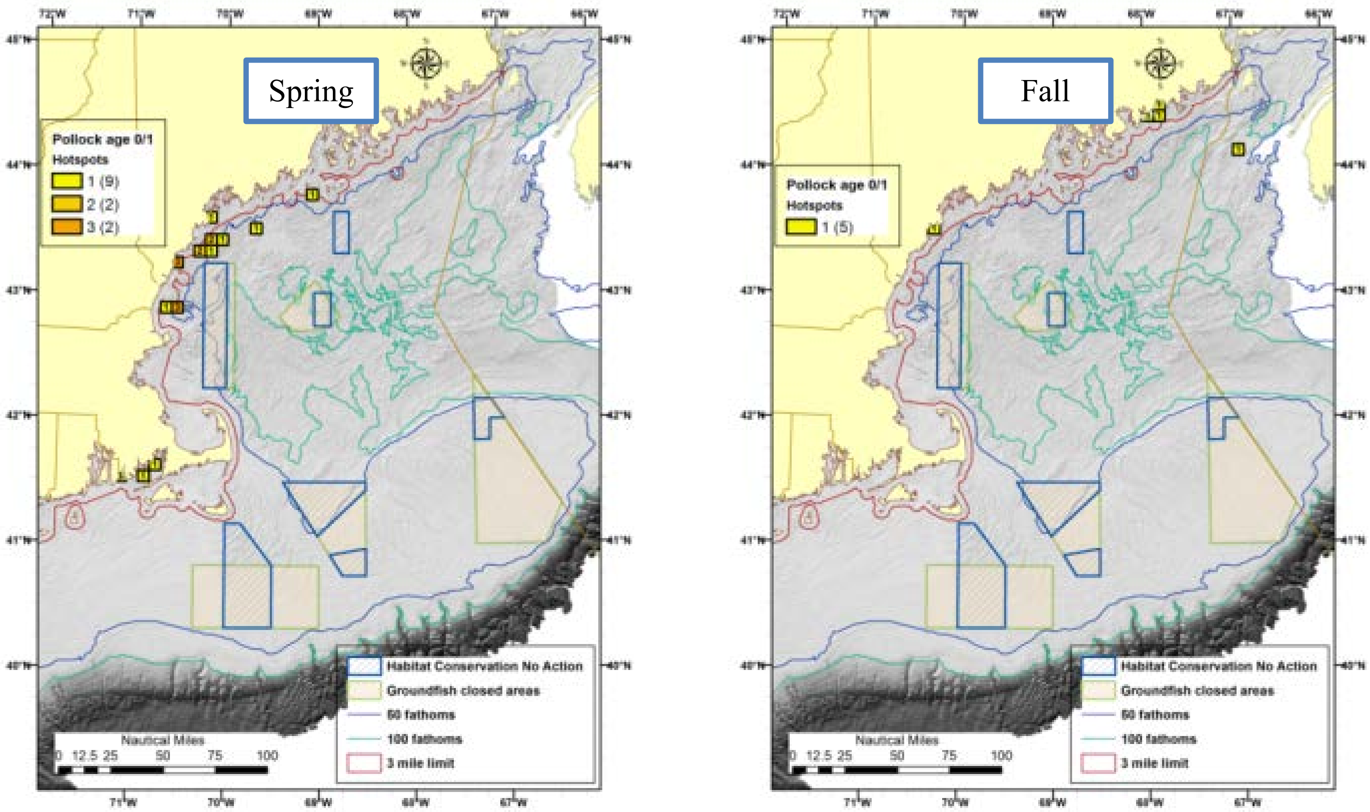


Summer

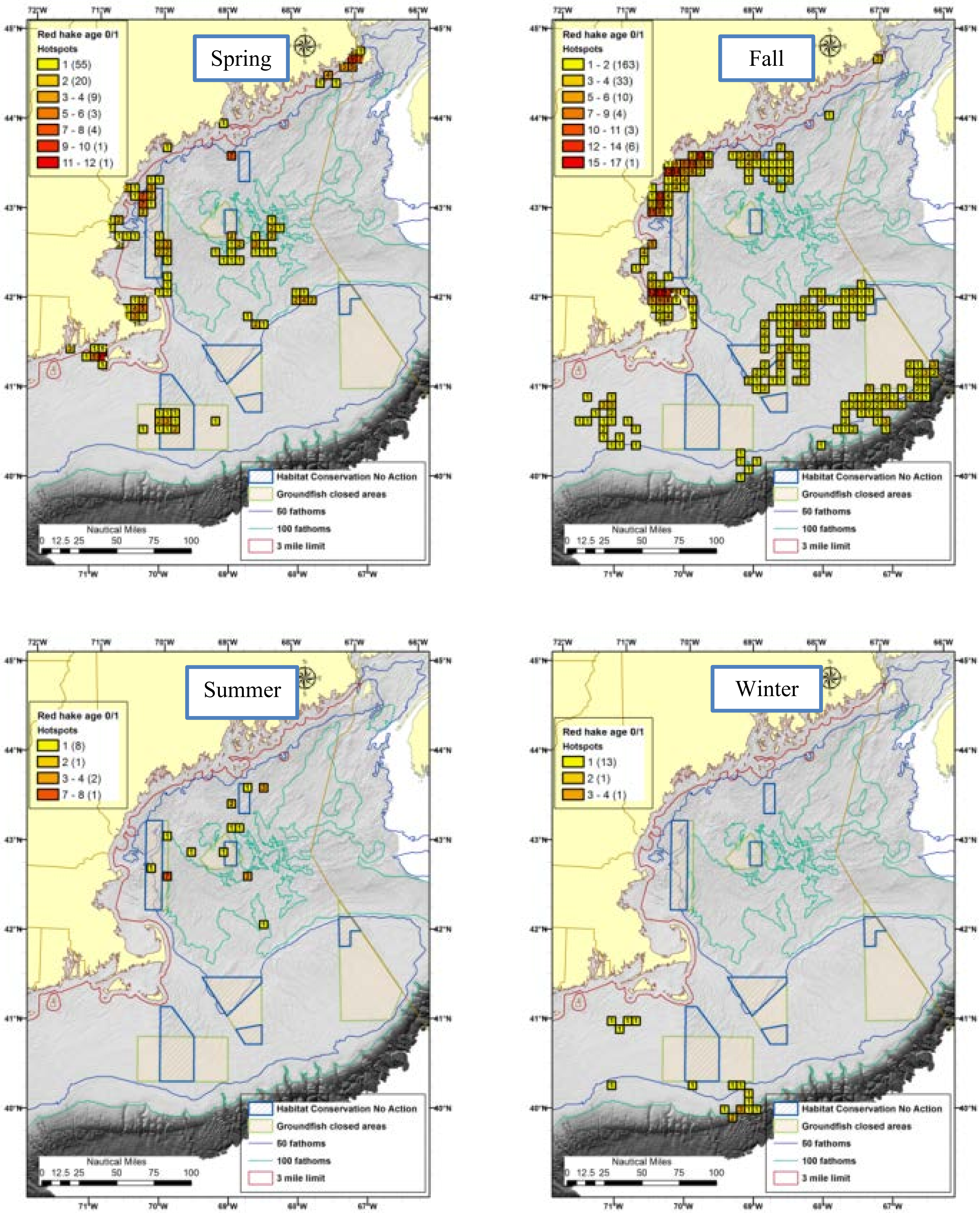
No hotspots detected



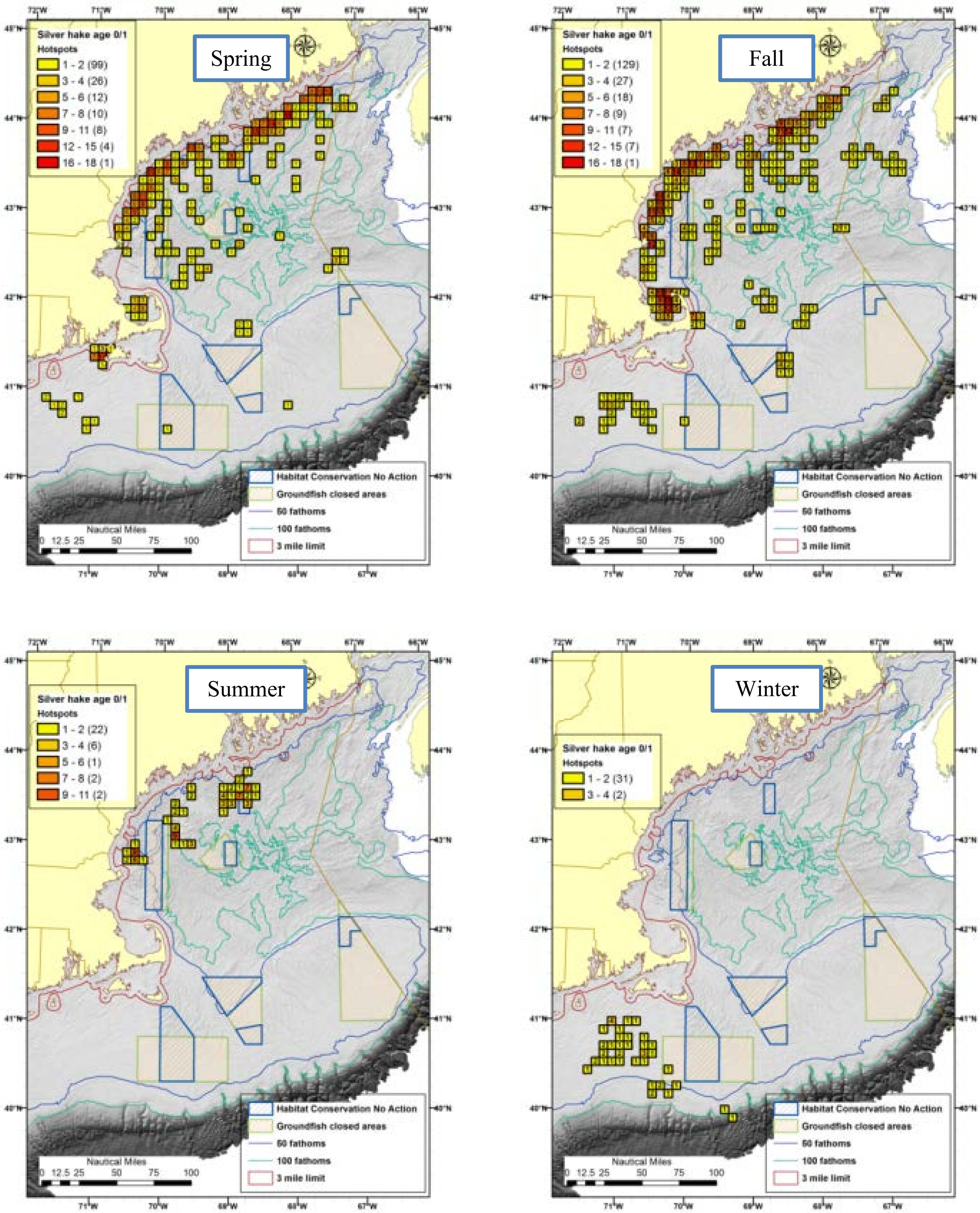
Map 139 – Seasonal distribution of age 0-1 pollock hotspots from 2002-2012 survey abundance. Only spring and fall hotspots detected.



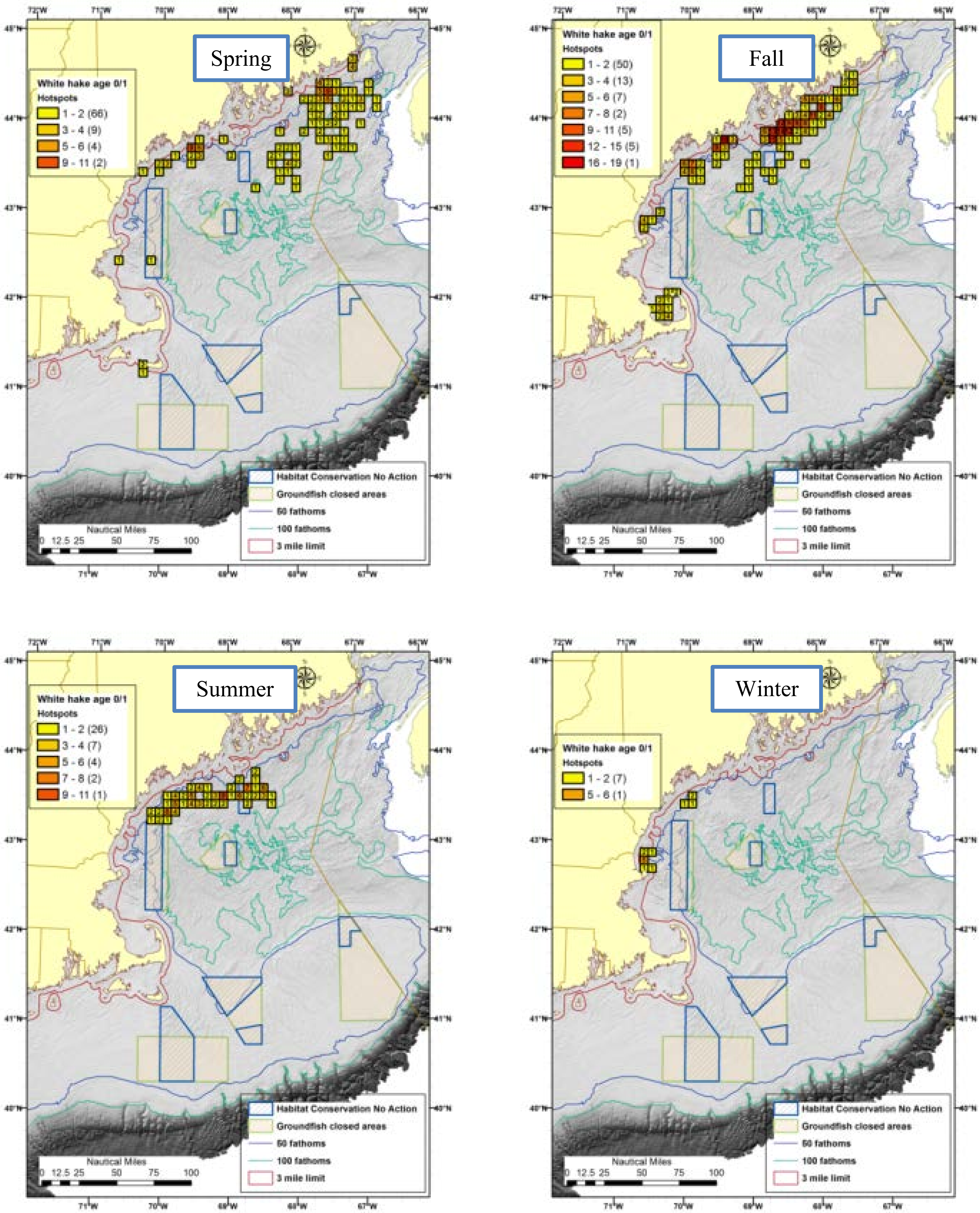
Map 140 - Seasonal distribution of age 0-1 red hake hotspots from 2002-2012 survey abundance.



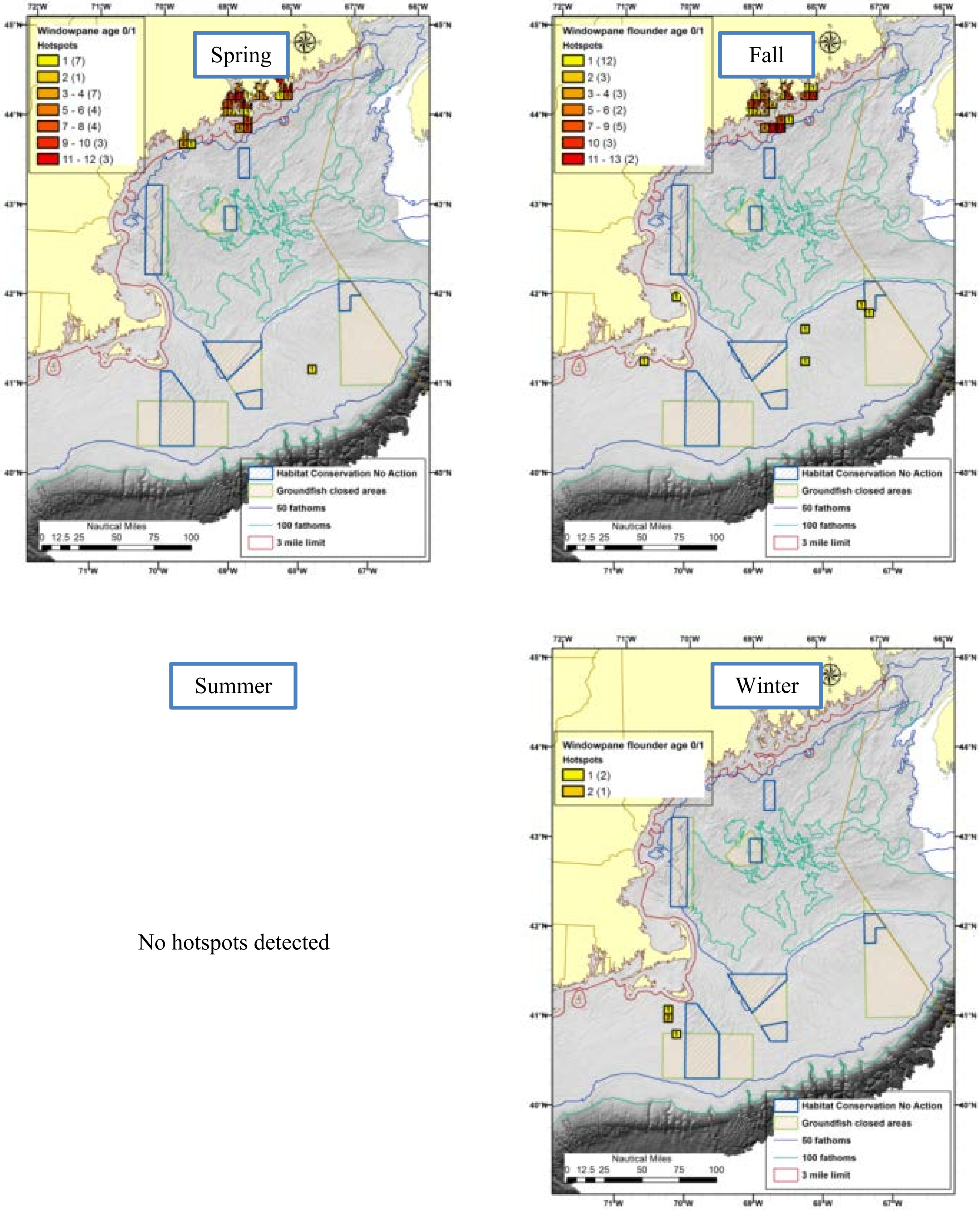
Map 141 - Seasonal distribution of age 0-1 silver hake hotspots from 2002-2012 survey abundance.



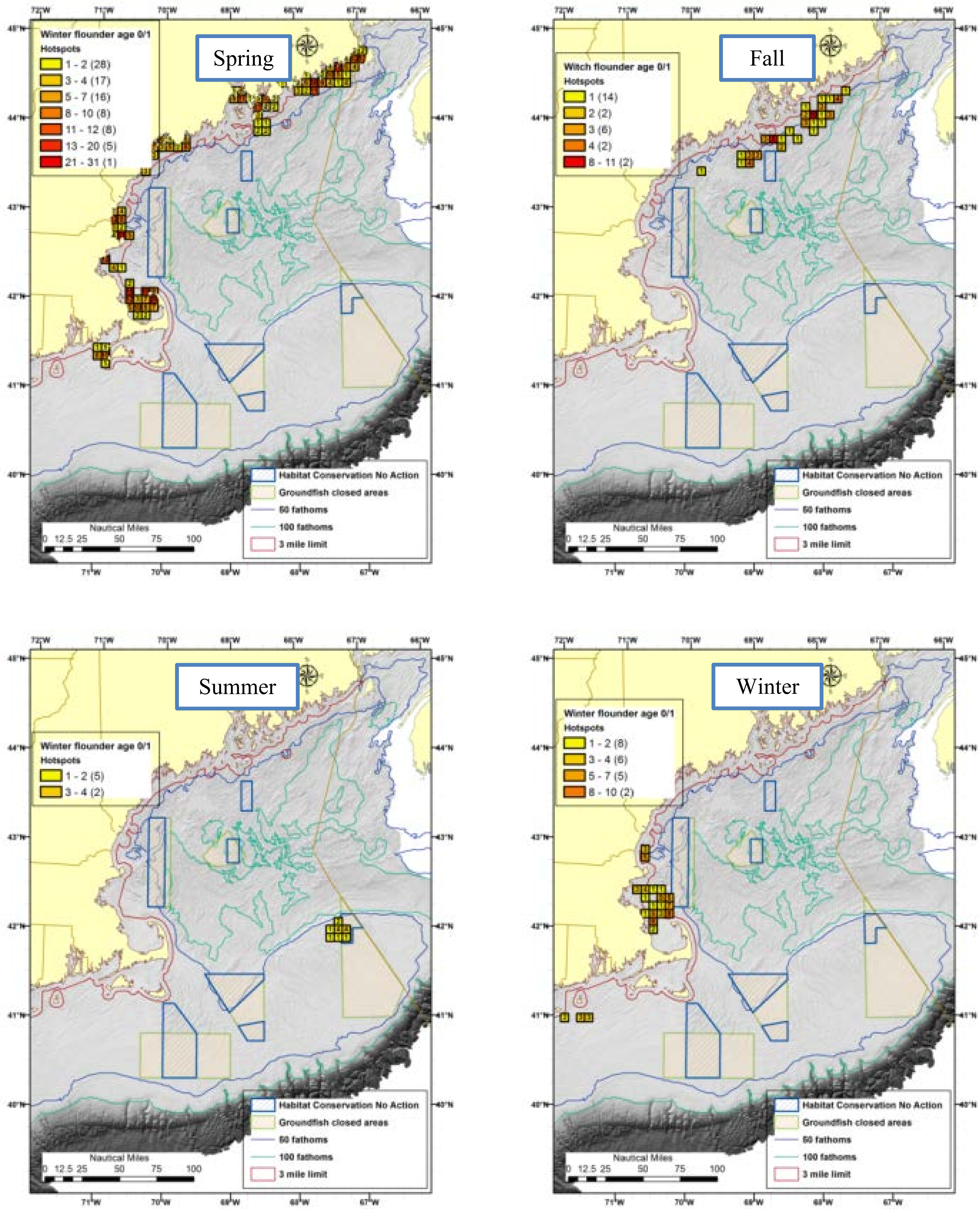
Map 142 – Seasonal distribution of age 0-1 white hake hotspots from 2002-2012 survey abundance.



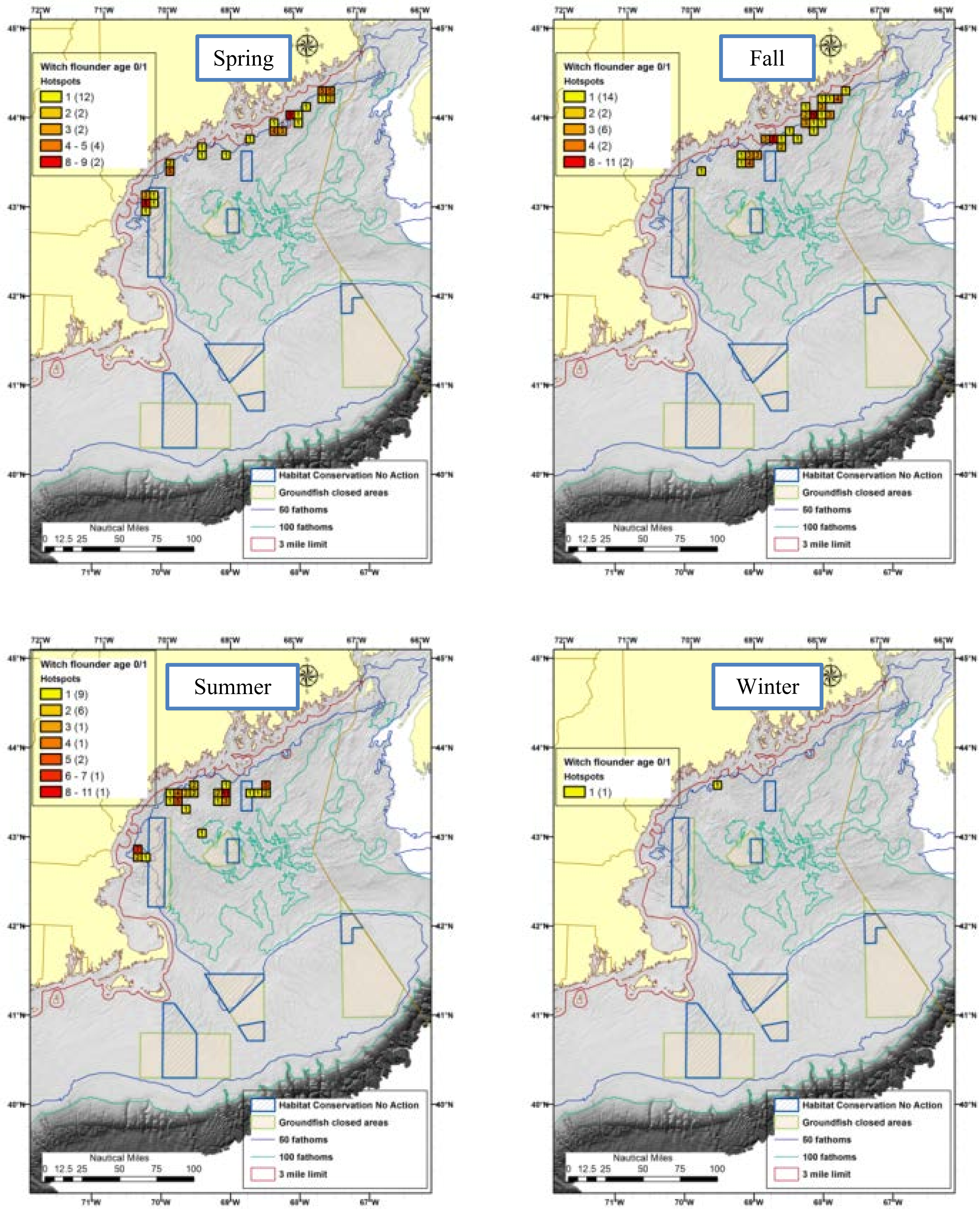
Map 143 – Seasonal distribution of age 0-1 windowpane flounder hotspots from 2002-2012 survey abundance.



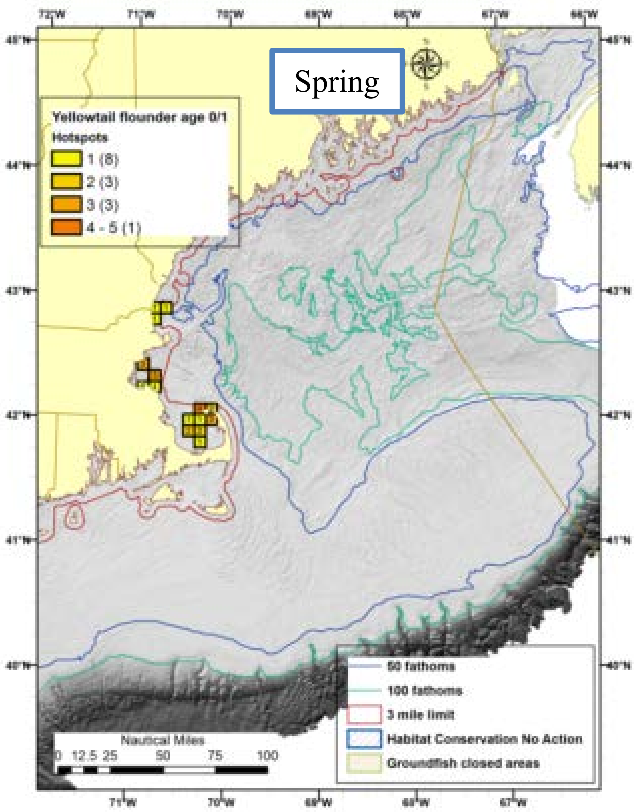
Map 144 – Seasonal distribution of age 0-1 winter flounder hotspots from 2002-2012 survey abundance.

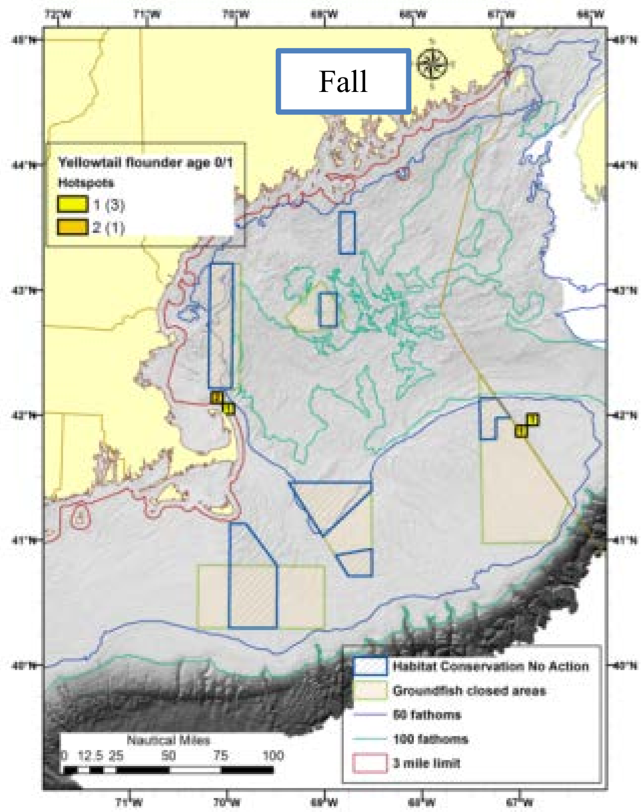


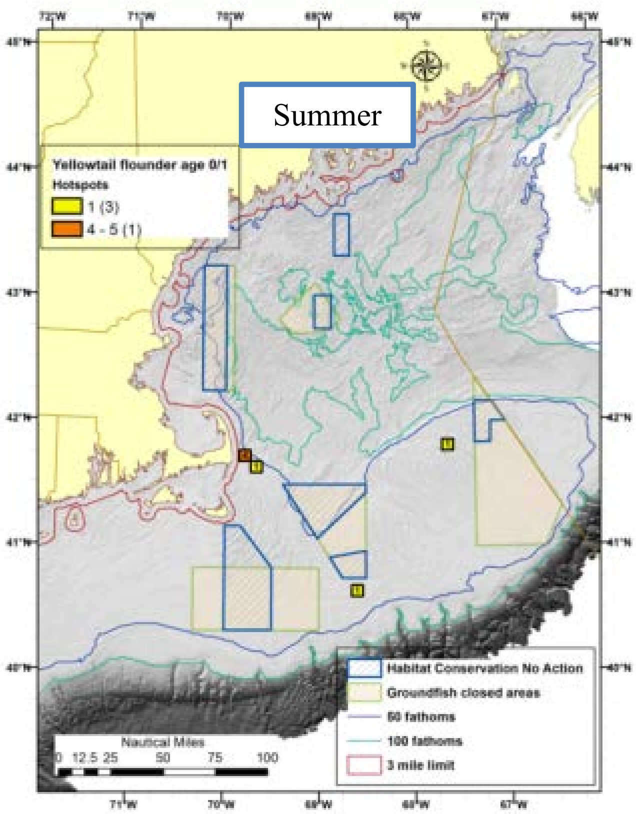
Map 145 – Seasonal distribution of age 0-1 witch flounder hotspots from 2002-2012 survey abundance.



Map 146 – Seasonal distribution of age 0-1 yellowtail hotspots from 2002-2012 survey abundance.



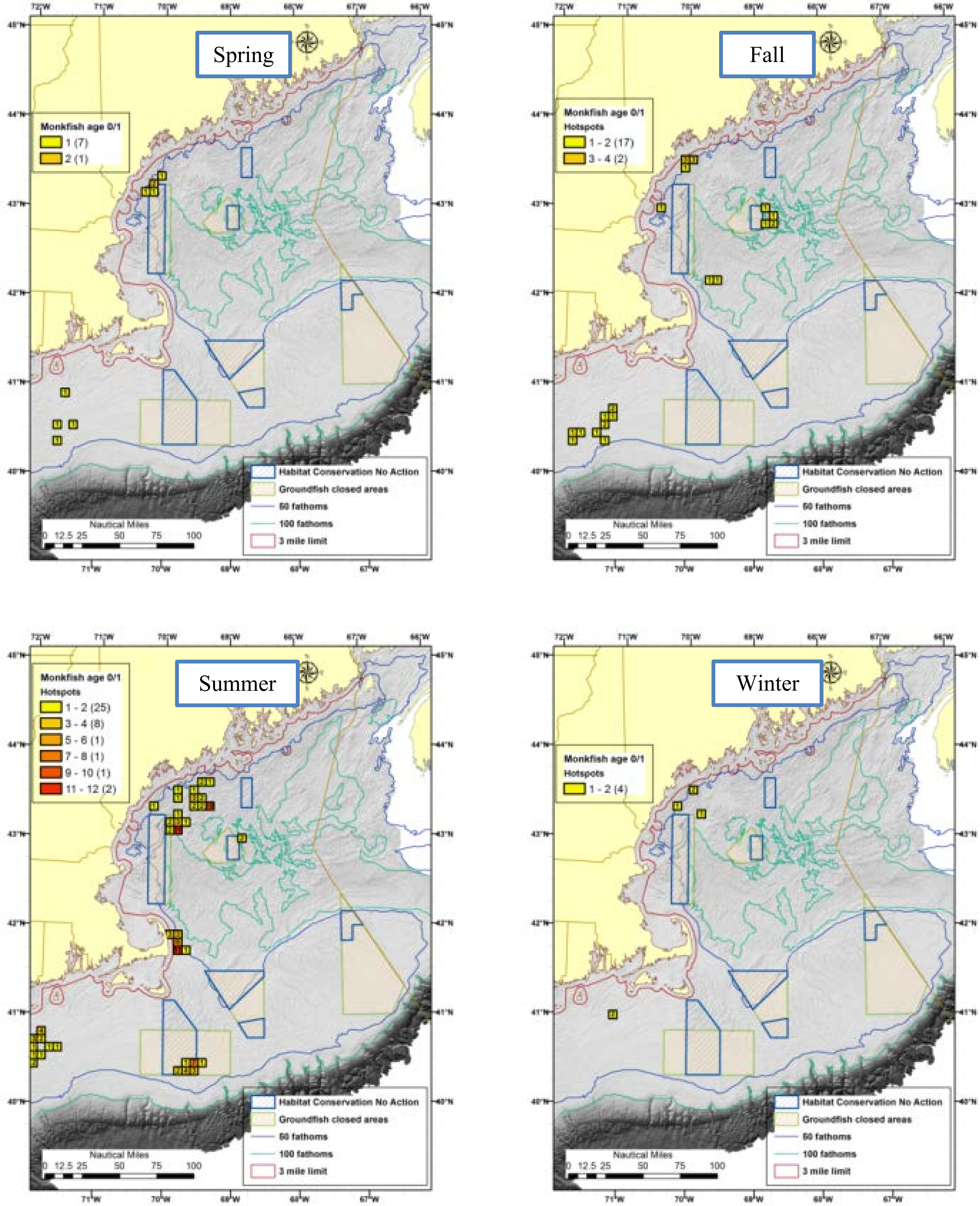




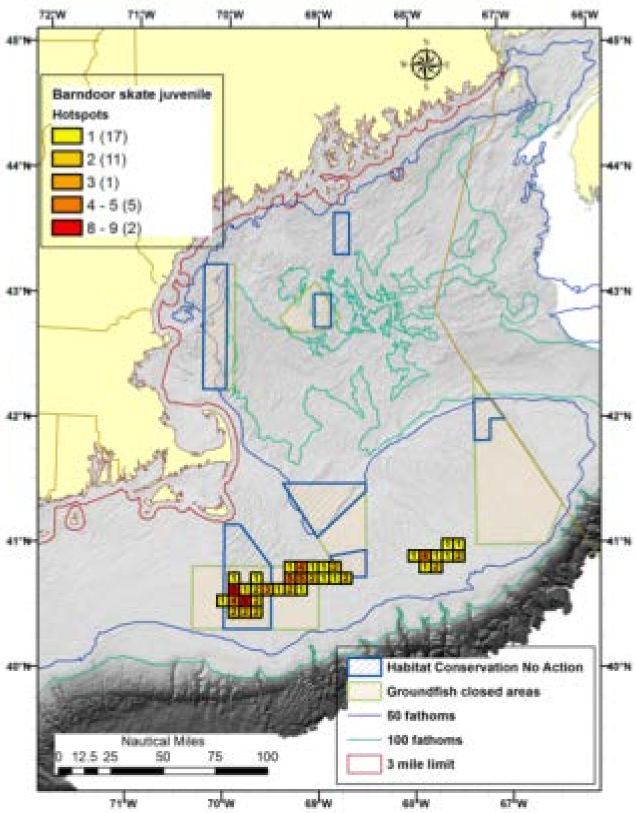
Winter

No hotspots detected

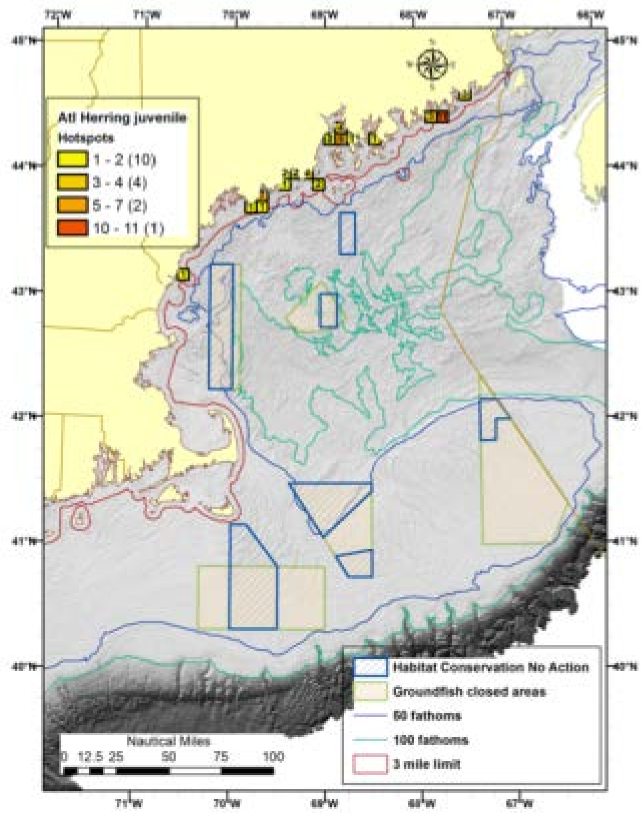
Map 147 – Seasonal distribution of age 0-1 monkfish hotspots from 2002-2012 survey abundance.



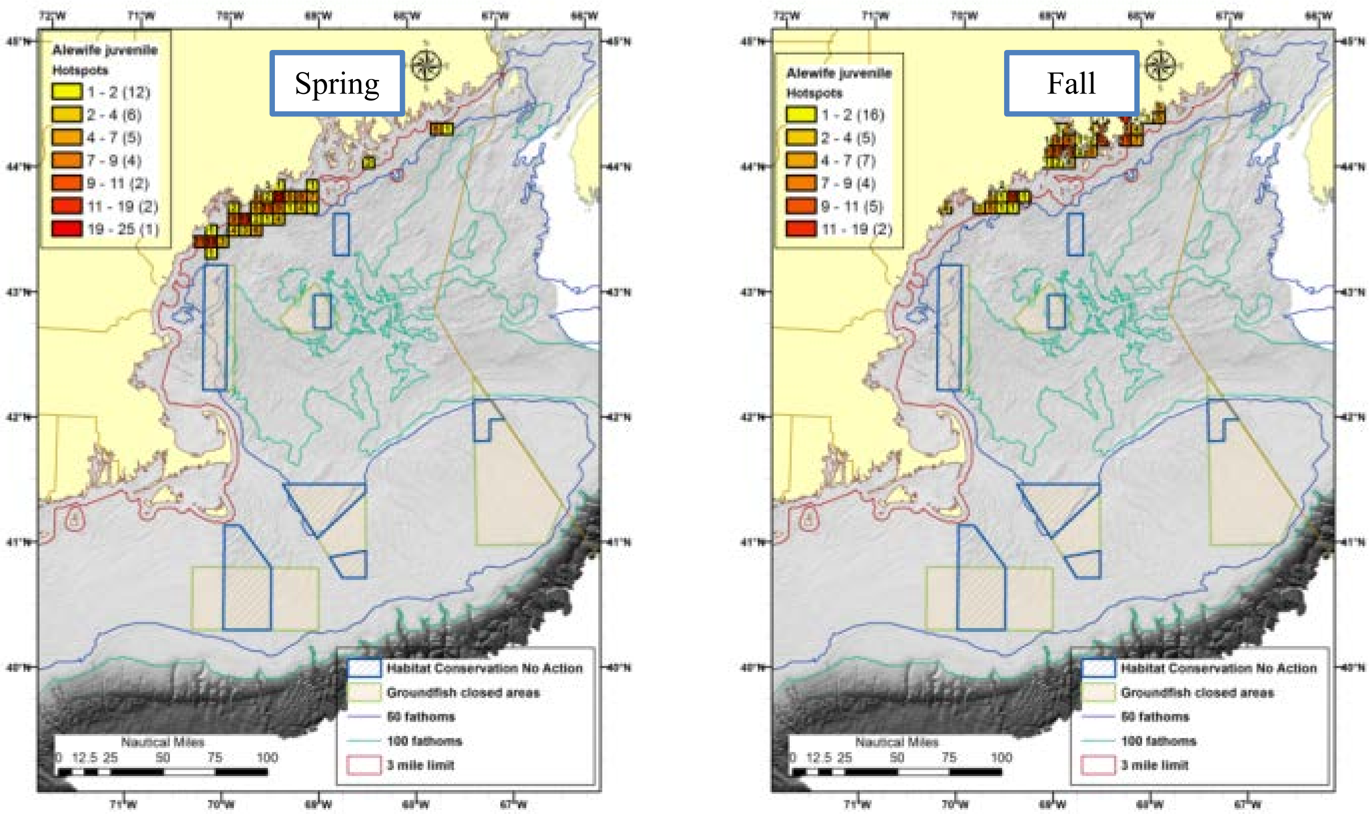
Map 148 – Seasonal distribution of age 0-1 barndoor skate hotspots from 2002-2012 survey abundance. Only summer hotspots detected.



Map 149 - Seasonal distribution of age 0-1 Atlantic herring hotspots from 2002-2012 survey abundance. Only spring hotspots detected.



Map 150 – Seasonal distribution of age 0-1 alewife hotspots from 2002-2012 survey abundance. Only spring and fall hotspots detected.



4.4.1.2 By area

This section summarizes the age 0/1 groundfish hotspot results by management area, including current EFH closures to mobile bottom tending gears, current year-round closures to all gears capable of catching groundfish[8], and potential new areas included in the habitat management alternatives (Table 34 and 35). Total area and management categories are listed in the table below.

[8] Portions of the year-round groundfish closures are open in certain situations with specific gears or seasons, including selective gear special access programs (SAPs) in Closed Area II, a longline SAP in Closed Area I, and scallop dredge access programs in the Nantucket Lightship Closed Area, Closed Area I, and Closed Area II.

Table 33 – Size and location of status quo and proposed habitat management areas.

Management area	Area (km^2)	Area (nm^2)	Type	Region	Sub_region
Alternate Roller Gear Restricted Area	4,147	1,209	Habitat Management Area	Gulf of Maine	Western GOM
Ammen Rock	15	4	Habitat Management Area	Gulf of Maine	Central GOM
Cashes Ledge Closed Area	1,373	400	Groundfish closure	Gulf of Maine	Central GOM
Cashes Ledge Habitat Closure	443	129	EFH closure	Gulf of Maine	Central GOM
Closed Area I	3,939	1,148	Groundfish closure	Georges Bank/Southern New England	Georges Bank
Closed Area I N Habitat Closure	1,937	565	EFH closure	Georges Bank/Southern New England	Georges Bank
Closed Area I S Habitat Closure	584	170	EFH closure	Georges Bank/Southern New England	Georges Bank
Closed Area II	6,862	2,001	Groundfish closure	Georges Bank/Southern New England	Georges Bank
Closed Area II Habitat Closure	641	187	EFH closure	Georges Bank/Southern New England	Georges Bank
Cox Ledge 1	143	42	Habitat Management Area	Georges Bank/Southern New England	Southern New England
Cox Ledge 2	70	20	Habitat Management Area	Georges Bank/Southern New England	Southern New England
EFH Expanded 1	1,152	336	Habitat Management Area	Georges Bank/Southern New England	Georges Bank
EFH Expanded 2	804	234	Habitat Management Area	Georges Bank/Southern New England	Georges Bank
EFH South MBTG	278	81	Habitat Management Area	Georges Bank/Southern New England	Georges Bank
Fippennies Ledge	45	13	Habitat Management Area	Gulf of Maine	Central GOM
Georges Shoal 1 MBTG	926	270	Habitat Management Area	Georges Bank/Southern New England	Georges Bank
Georges Shoal 2 MBTG	1,025	299	Habitat Management Area	Georges Bank/Southern New England	Georges Bank
Georges Shoal GMA	1,073	313	Habitat Management Area	Georges Bank/Southern New England	Georges Bank
Great South Channel	2,566	748	Habitat Management Area	Georges Bank/Southern New England	Southern New England
Great South Channel East	3,356	979	Habitat Management Area	Georges Bank/Southern New England	Southern New England
Great South Channel GMA	2,301	671	Habitat Management Area	Georges Bank/Southern New England	Southern New England
Inshore Roller Gear Restricted Area	11,327	3,302	Habitat Management Area	Gulf of Maine	Western GOM
Jeffreys Bank Habitat Closure	499	145	EFH closure	Gulf of Maine	Central GOM
Jeffreys Ledge	733	214	Habitat Management Area	Gulf of Maine	Western GOM
Large Bigelow Bight	1,691	493	Habitat Management Area	Gulf of Maine	Western GOM
Large Eastern Maine	1,692	493	Habitat Management Area	Gulf of Maine	Eastern GOM
Large Stellwagen	1,177	343	Habitat Management Area	Gulf of Maine	Western GOM
Machias	334	97	Habitat Management Area	Gulf of Maine	Eastern GOM
Modified Cashes Ledge EFH	324	94	Habitat Management Area	Gulf of Maine	Central GOM
Modified Jeffreys Bank EFH	494	144	Habitat Management Area	Gulf of Maine	Central GOM
Nantucket Lightship Closed Area	6,248	1,822	Groundfish closure	Georges Bank/Southern New England	Southern New England
Nantucket Lightship Habitat Closure	3,387	987	EFH closure	Georges Bank/Southern New England	Southern New England
Nantucket Shoals	2,350	685	Habitat Management Area	Georges Bank/Southern New England	Southern New England
Nantucket Shoals West	2,952	861	Habitat Management Area	Georges Bank/Southern New England	Southern New England
Northern Edge	476	139	Habitat Management Area	Georges Bank/Southern New England	Georges Bank
Northern Georges GMA	6,838	1,994	Habitat Management Area	Georges Bank/Southern New England	Georges Bank
Northern Georges MBTG	4,788	1,396	Habitat Management Area	Georges Bank/Southern New England	Georges Bank
Platts Bank 1	31	9	Habitat Management Area	Gulf of Maine	Central GOM
Platts Bank 2	41	12	Habitat Management Area	Gulf of Maine	Central GOM
Small Bigelow Bight	561	164	Habitat Management Area	Gulf of Maine	Western GOM
Small Eastern Maine	483	141	Habitat Management Area	Gulf of Maine	Eastern GOM
Small Stellwagen	670	195	Habitat Management Area	Gulf of Maine	Western GOM
Toothaker Ridge	700	204	Habitat Management Area	Gulf of Maine	Eastern GOM
Western Gulf of Maine Closed Area	3,030	883	Groundfish closure	Gulf of Maine	Western GOM
Western Gulf of Maine Habitat Closure	2,272	662	EFH closure	Gulf of Maine	Western GOM
WGOM Shrimp Trawl Exemption Area	422	123	Habitat Management Area	Gulf of Maine	Western GOM

In the **Gulf of Maine**, the existing habitat closures (Western Gulf of Maine, Cashes Ledge, and Jeffreys Bank) contained 92 spring hotspots, 104 summer hotspots, 101 fall hotspots, and 5 winter hotspots. Total weighted hotspots that account more heavily for stocks with low biomass (i.e. vulnerable stocks) and average or above substrate affinity were 288.1 in the spring, 175.0 in the summer, 386.8 in the fall, and 33.6 in the winter. The majority of age 0/1 groundfish hotspots in existing habitat areas were in the Western Gulf of Maine Habitat Closure Area, with 70 spring, 32 summer, 56 fall, an 1 winter[9] hotspot. Of the 160 total hotspots in the Western Gulf of Maine Habitat Closure Area, 66 were for redfish, 33 for plaice, 20 for silver hake, and 19 for haddock. The remaining 41 hotspots were for cod (8), monkfish (1), red hake (9), white hake (1), winter

[9] The winter hotspot was from the IBS cod survey. The NMFS winter trawl survey was not conducted in this area.

flounder (1), and witch flounder (2). Total weighted hotspots in this closure were 261.1, 128.4, 265.2, and 6.7 respectively.

The winter hotspots were limited mainly by the spatial extent of the IBS cod (conducted only in portions of the western Gulf of Maine) and winter trawl (primarily surveying Georges Bank and southern New England) surveys. Much of the Gulf of Maine has not been surveyed for fish abundance during the winter. Generally, the number of hotspots in the existing and proposed habitat management areas is a function of both the distribution of age 0/1 groundfish hotspots and the size of each area. Naturally, a smaller area that is a subset of a larger area will contain fewer hotspots.

For newly developed or modified areas, in the spring, the greatest number of hotspots were in the Inshore Roller Gear Restricted Area (1050), followed by the Large Bigelow Bight Area (462), and the Small Bigelow Bight Area (150) and then the Large Eastern Maine Area (115). On the basis of hotspots weighted for stock vulnerability, subpopulation presence, residency, and substrate affinity, being the largest area in the western Gulf of Maine the Inshore Roller Gear Restricted Area had the highest rank (2686.9), followed by the Large Bigelow Bight Area (826.3) which overlaps it. The next areas in rank order of spring weighted hotspots were the Small Bigelow Bight Area (351.7), the Machias Area (187.7) and the Jeffreys Ledge Area (127.8). The weighted hotspots from spring surveys in other areas were 47.3 for the Large Eastern Maine Area, 0.0 for the Small Eastern Maine Area, 81.1 for the Toothaker Ridge Area, 112.9 for the Large Stellwagen Area, and 38.6 for the Small Stellwagen Area. Ammen Rock, Cashes Ledge, Fippennies Ledge, and Platts Bank Areas had zero or low number of age 0/1 groundfish hotspots, but this result is generated by the low number of survey tows in the vicinity of these areas.

Although small in size, the Machias Area ranked high for weighted hotspots due to the cluster of high ME/NH survey catches of cod (13 hotspots), haddock (7 hotspots), and winter flounder (15 hotspots). The mix of age 0/1 groundfish species that contributed to the high weighted hotspot scores for the Inshore Roller Gear Restricted Area, and the Large and Small Bigelow Bight Areas were similar, since the areas overlap. They include redfish (72 in the Small Bigelow Bight Area), plaice (137), cod (12), haddock (11), and winter flounder (20). It should be noted that the Small Bigelow Bight Area also has a high number (62) of age 0/1 silver hake hotspots where a small mesh fishery targeting this species takes place.

The fall hotspot results are similar to those from the spring surveys, with larger management areas in the western Gulf of Maine ranking higher than other areas, both in total number of age 0/1 groundfish hotspots and in weighted hotspots. The Inshore and Alternative Roller Gear Areas have 1018 (1886.8 weighted) and 2270 (4579.7 weighted) hotspots, respectively, followed by the Large Bigelow Bight Area (483; 844.6 weighted) which overlaps the roller gear areas.

Unlike surveys in the spring, the age 0/1 fall hotspots tend to more heavily favor areas in the central Gulf of Maine. Next in ranked order of weighted hotspots are the Large Eastern Maine Area (263; 500.2 weighted), the Small Eastern Maine Area (110; 229.8 weighted), the Small Bigelow Bight Area (153; 270.1 weighted), the Toothaker Ridge Area (69; 128.4 weighted), the Large Stellwagen Area (17; 123.5 weighted), the Jeffreys Ledge Area (28; 107.9 weighted), the

Machias Area (11, 91.5 weighted), the Small Stellwagen Area (9; 82.9 weighted), and the Jeffreys Bank Modified Area (15; 27.0 weighted). It is notable that the Machias and Small Stellwagen Areas have a relatively high weighted hotspot ranking compared with the total number of unweighted hotspots, because the hotspots are mostly redfish and cod in the Small Stellwagen Area and cod, haddock, and winter flounder in the Machias Area.

Summer and winter age 0/1 hotspots are not as comparable across Gulf of Maine areas as they are elsewhere, because surveys in these seasons do not cover the entire Gulf of Maine. The winter data are mainly from the IBS cod survey and cover parts of the Western Gulf of Maine. The summer shrimp survey is somewhat broader in scope but does not survey the eastern Gulf of Maine or the inshore strata in Massachusetts Bay. It is useful, however, for evaluation of the hotspot species composition in the western and central Gulf of Maine.

Age 0/1 hotspots were less numerous in the **Georges Bank and southern New England** region than they were in the Gulf of Maine, mainly composed of hotspots for monkfish, haddock, red hake, and winter flounder. Monkfish and red hake are not large mesh groundfish and were therefore given zero weight. The existing habitat closures on Georges Bank within Closed Area I and Closed Area II contained 5 summer (0.0 weighted) and 14 fall (23.0 weighted) hotspots. No hotspots were detected in the spring and winter seasonal surveys. The most numerous habitat closure hotspots were for red hake (9), winter flounder (5), and haddock (4).

Hotspots of age 0/1 groundfish were more numerous in the year-round groundfish closed areas, both due to their location and larger size. Closed Area I had 35 hotspots (17.3 weighted) in the fall survey, comprised mainly of red hake (23) and silver hake (8) hotspots. Closed Area II had 11 hotspots in the spring (63.3 weighted), 39 in the summer (195.5 weighted), 16 in the fall (28.8 weighted), and none in the winter. These hotspots were comprised mainly of haddock (50) and red hake (10). The proposed habitat management areas include the Large Georges Shoal Gear Modification Area which has a higher number of hotspots than the existing habitat closure, but fewer than neighboring Closed Area II, a year-round groundfish closed area.

In southern New England, the larger Nantucket Lightship Closed Area had more hotspots than the smaller but overlapping habitat closure (Table 33), mostly of species that were given zero weight. The Nantucket Lightship Closed Area had 10 spring (0.0 unweighted), 54 summer (0.0 unweighted), 0 fall, and 2 winter (40.2 weighted) hotspots. These hotspots were mainly monkfish (17) and red hake (9). The proposed habitat management areas in southern New England had fewer hotspots, and none with a non-zero weight. The Great South Channel Gear Modification Area, for example, had only 12 hotspots in the fall survey, mostly winter flounder, and no weighted hotspots (winter flounder has low affinity for complex substrates).

Table 34 – Summary of number of age 0 and 1 groundfish hotspots and hotspots weighted to account for stock status, existence of sub-populations, degree of residency, and substrate affinity in existing and proposed Gulf of Maine Habitat Management Areas. Data included numbers per tow caught by seasonal NEFSC, state, and industry-based surveys during 2002-2012. Hotspots were assigned weights by stock based on factors listed in Table 28.

	Spring		Summer		Fall		Winter	
	Total hotspots	Total weighted hotspots	Total hotspots	Total weighted hotspots	Total hotspots	Total weighted hotspots	Total hotspots	Total weighted hotspots
Gulf of Maine								
EFH closure								
Western Gulf of Maine Habitat Closure	70	261.1	32	128.4	56	265.2	1	6.7
Cashes Ledge Habitat Closure	1	6.7	2	0.0	2	6.8	0	0.0
Jeffreys Bank Habitat Closure	7	20.3	39	0.0	22	33.8	0	0.0
Groundfish closure								
Western Gulf of Maine Closed Area	84	261.1	49	162.2	67	305.7	1	6.7
Cashes Ledge Closed Area	1	6.7	16	13.5	12	47.3	4	26.8
Habitat Management Area								
Alternate Roller Gear Restricted Area	549	1518.2	90	189.3	562	1263.9	67	357.6
Ammen Rock	0	0.0	1	0.0	0	0.0	0	0.0
Fippennies Ledge	0	0.0	0	0.0	0	0.0	2	13.4
Inshore Roller Gear Restricted Area	1050	2686.9	213	500.2	1018	1886.8	133	720.9
Jeffreys Ledge	26	127.8	5	27.0	28	107.9	0	0.0
Machias	35	187.7	0	0.0	11	91.5	0	0.0
Platts Bank 2	0	0.0	0	0.0	1	6.8	0	0.0
Toothaker Ridge	43	81.1	33	0.0	69	128.4	0	0.0
Large Bigelow Bight	462	826.3	77	155.5	483	844.6	11	0.0
Modified Cashes Ledge EFH	1	6.7	2	0.0	2	6.8	0	0.0
Small Bigelow Bight	150	351.7	51	114.9	153	270.1	6	0.0
Small Stellwagen	5	38.6	1	0.0	9	82.9	0	0.0
Large Stellwagen	24	112.9	6	6.8	17	123.5	1	6.7
WGOM Shrimp Trawl Exemption Area	20	20.3	21	94.6	11	33.8	0	0.0
Modified Jeffreys Bank EFH	0	0.0	5	0.0	15	27.0	0	0.0
Large Eastern Maine	115	47.3	4	0.0	263	500.2	0	0.0
Small Eastern Maine	41	0.0	0	0.0	110	229.8	0	0.0

	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								
EFH closure								
Closed Area I N Habitat Closure	0	0.0	0	0.0	10	11.5	0	0.0
Closed Area II Habitat Closure	0	0.0	5	0.0	4	11.5	0	0.0
Nantucket Lightship Habitat Closure	10	0.0	54	0.0	0	0.0	2	40.2
Groundfish closure								
Closed Area II	11	63.3	39	195.5	16	28.8	0	0.0
Closed Area I	0	0.0	0	0.0	35	17.3	0	0.0
Nantucket Lightship Closed Area	16	0.0	79	5.8	1	0.0	4	40.2
Habitat Management Area								
Great South Channel	0	0.0	0	0.0	6	0.0	0	0.0
Nantucket Shoals	0	0.0	0	0.0	1	0.0	0	0.0
Northern Edge	0	0.0	0	0.0	8	34.5	0	0.0
Great South Channel East	0	0.0	0	0.0	9	0.0	0	0.0
Nantucket Shoals West	0	0.0	0	0.0	1	0.0	0	0.0
Northern Georges GMA	6	0.0	15	0.0	33	11.5	0	0.0
EFH Expanded 2	0	0.0	13	0.0	10	5.8	0	0.0
Northern Georges MBTG	6	0.0	15	0.0	35	40.3	0	0.0
EFH Expanded 1	0	0.0	13	0.0	12	11.5	0	0.0
EFH South MBTG	0	0.0	1	0.0	0	0.0	0	0.0
Georges Shoal 2 MBTG	0	0.0	0	0.0	1	0.0	0	0.0
Great South Channel GMA	0	0.0	0	0.0	12	0.0	0	0.0
Georges Shoal GMA	0	0.0	1	0.0	4	0.0	0	0.0

Table 35 – Total number of age 0 and 1 hotspots by species and season in existing and proposed Habitat Management Areas. Data included numbers per tow caught by seasonal NEFSC, state, and industry-based surveys during 2002-2012.

	Acadian redfish	Alewife	American plaice	Atlantic halibut	Atlantic herring	Cod	Goosefish	Haddock	Ocean pout	Pollock	Red hake	Silver hake	White hake	Windowpane flounder	Winter flounder	Witch flounder	Yellowtail flounder	Grand Total
Gulf of Maine																		
Eastern GOM																		
Habitat Management Area																		
Machias	0	0	0	2	0	13	0	7	0	0	5	0	4	0	15	0	0	46
Toothaker Ridge	31	1	0	0	0	0	0	0	0	0	25	47	17	0	0	24	0	145
Large Eastern Maine	81	0	0	0	0	0	0	0	0	0	2	143	94	13	5	44	0	382
Small Eastern Maine	34	0	0	0	0	0	0	0	0	0	0	62	36	13	3	3	0	151
Central GOM																		
EFH closure																		
Cashes Ledge Habitat Closure	1	0	2	0	0	0	0	1	0	0	0	1	0	0	0	0	0	5
Jeffreys Bank Habitat Closure	8	0	0	0	0	0	0	0	0	0	8	31	20	0	0	1	0	68
Groundfish closure																		
Cashes Ledge Closed Area	9	0	13	0	0	0	1	5	0	0	1	4	0	0	0	0	0	33
Habitat Management Area																		
Ammen Rock	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
Fippennies Ledge	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	2
Platts Bank 2	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
Modified Cashes Ledge EFH	1	0	2	0	0	0	0	1	0	0	0	1	0	0	0	0	0	5
Modified Jeffreys Bank EFH	4	0	0	0	0	0	0	0	0	0	4	7	5	0	0	0	0	20
Western GOM																		
EFH closure																		
Western Gulf of Maine Habitat Closure	66	0	33	0	0	8	1	19	0	0	9	20	1	0	1	2	0	160
Groundfish closure																		
Western Gulf of Maine Closed Area	77	0	35	0	0	8	5	19	0	0	24	30	1	0	1	2	0	202
Habitat Management Area																		
Alternate Roller Gear Restricted Area	242	45	371	0	0	98	13	38	9	9	113	206	41	0	63	17	3	1268
Inshore Roller Gear Restricted Area	354	33	706	0	2	214	9	64	13	13	226	348	39	0	350	24	20	2415
Jeffreys Ledge	21	0	10	0	0	0	0	18	0	0	0	10	0	0	0	0	0	59
Large Bigelow Bight	198	45	353	0	0	12	13	19	9	9	106	191	40	0	20	17	1	1033
Small Bigelow Bight	72	0	137	0	0	12	1	11	0	4	23	62	10	0	20	7	1	360
WGOM Shrimp Trawl Exemption Area	22	0	19	0	0	1	1	0	0	0	3	5	0	0	0	2	0	53
Small Stellwagen	5	0	1	0	0	7	0	0	0	0	0	0	1	0	1	0	0	15
Large Stellwagen	23	0	4	0	0	7	0	1	0	0	6	5	1	0	1	0	0	48

	Acadian redfish	Alewife	American plaice	Atlantic halibut	Atlantic herring	Cod	Goosefish	Haddock	Ocean pout	Pollock	Red hake	Silver hake	White hake	Windowpane flounder	Winter flounder	Witch flounder	Yellowtail flounder	Grand Total
Georges Bank/Southern New England																		
Georges Bank																		
EFH closure																		
Closed Area I N Habitat Closure	0	0	1	0	0	0	0	2	0	0	7	0	0	0	0	0	0	10
Closed Area II Habitat Closure	0	0	0	0	0	0	0	2	0	0	2	0	0	0	5	0	0	9
Groundfish closure																		
Closed Area II	0	0	0	0	0	0	0	50	0	0	10	0	0	1	5	0	0	66
Closed Area I	0	0	1	0	0	0	0	3	0	0	23	8	0	0	0	0	0	35
Habitat Management Area																		
Northern Edge	0	0	0	0	0	0	0	6	0	0	2	0	0	0	0	0	0	8
Northern Georges GMA	0	0	0	0	0	0	0	2	0	0	34	1	0	2	14	0	1	54
Northern Georges MBTG	0	0	0	0	0	0	0	7	0	0	32	0	0	2	14	0	1	56
EFH Expanded 1	0	0	0	0	0	0	0	2	0	0	9	0	0	1	13	0	0	25
EFH Expanded 2	0	0	0	0	0	0	0	1	0	0	8	0	0	1	13	0	0	23
EFH South MBTG	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	1
Georges Shoal GMA	0	0	0	0	0	0	0	0	0	0	4	0	0	0	0	0	1	5
Georges Shoal 2 MBTG	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	1
Southern New England																		
EFH closure																		
Nantucket Lightship Habitat Closure	0	0	0	0	0	2	17	0	0	0	9	1	0	0	0	0	0	29
Groundfish closure																		
Nantucket Lightship Closed Area	0	0	0	0	0	2	18	1	0	0	15	3	0	1	0	0	0	40
Habitat Management Area																		
Great South Channel	0	0	0	0	0	0	0	0	0	0	0	0	0	0	6	0	0	6
Nantucket Shoals	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	1
Great South Channel GMA	0	0	0	0	0	0	0	0	0	0	2	0	0	0	10	0	0	12
Great South Channel East	0	0	0	0	0	0	0	0	0	0	0	0	0	0	9	0	0	9
Nantucket Shoals West	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	1

Juvenile groundfish hotspots in proposed dedicated habitat research areas (Table 36) were also summarized. The Georges Bank DHRA (overlapping the southern part of Closed Area I) had no hotspots for small juvenile groundfish (Table 37). More age 0/1juvenile groundfish hotspots were found in the DHRAs in the Gulf of Maine (Table 37 – total number and weighted hotspots, Table 38 – hotspots by species). The Eastern Maine DHRA contained 41 spring (0.0 weighted) and 110 fall (229.8 weighted) hotspots, comprised mainly of silver hake (62), white hake (36) and redfish (34).The entire Stellwagen DHRA contained 24 spring (112.9 weighted), 6 summer (6.8 weighted), 17 fall (123.5 weighted) and 1 winter (6.7 weighted) hotspots, comprising mainly of redfish (23), red hake (6), and cod (5). Two spring (25.1 weighted) and two fall (12.5 weighted) hotspots were found in the southern Stellwagen DHRA reference area (reference area 1), comprised mainly of cod (2 spring, 1 fall). The northern reference area (reference area 2) contained fall hotspots only, for cod (3).

Table 36 – Size and location of existing and proposed DHRA management areas. Reference area 1 is the southern area, and reference area 2 is the northern area.

Management area	Area (km^2)	Area (nm2	Region	Sub_region
Eastern Maine DHRA	483	141	Gulf of Maine	Eastern GOM
Georges Bank DHRA	584	170	Georges Bank/Southern New England	Georges Bank
Stellwagen DHRA	1,177	343	Gulf of Maine	Western GOM
Stellwagen DHRA, reference area 1	191	56	Gulf of Maine	Western GOM
Stellwagen DHRA, reference area 2	190	56	Gulf of Maine	Western GOM

Table 37 – Number of age 0 and 1 groundfish hotspots and hotspots weighted to account for stock status, existence of sub-populations, degree of residency, and substrate affinity in proposed Dedicated Habitat Research Areas (DHRA). Data included numbers per tow caught by seasonal NEFSC, state, and industry-based surveys during 2002-2012. Reference area 1 is the southern area, and reference area 2 is the northern area.

	Total hotspots	Total weighted hotspots
Eastern Maine DHRA	151	229.8
Spring	41	0.0
Summer	0	0.0
Fall	110	229.8
Winter	0	0.0
Stellwagen DHRA2	48	249.9
Spring	24	112.9
Summer	6	6.8
Fall	17	123.5
Winter	1	6.7
Stellwagen DHRA, reference area 1	4	37.6
Spring	2	25.1
Summer	0	0.0
Fall	2	12.5
Winter	0	0.0
Stellwagen DHRA , reference area 2	3	37.6
Spring	0	0.0
Summer	0	0.0
Fall	3	37.6
Winter	0	0.0
Georges Bank DHRA	0	0.0
Spring	0	0.0
Summer	0	0.0
Fall	0	0.0
Winter	0	0.0

Table 38 –Number of age 0 and 1 groundfish hotspots by species and season in proposed DHRAs. Analyzed data included numbers per tow caught by seasonal NEFSC, state, and industry-based surveys during 2002-2012. Reference area 1 is the southern area, and reference area 2 is the northern area.

	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
Stellwagen DHRA	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
Stellwagen DHRA, reference area 1	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
Stellwagen DHRA, reference area 2	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
Georges Bank DHRA	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

4.4.2 Large spawner hotspot analysis

In addition to improving habitat protection for juvenile groundfish and other species, other alternatives in this amendment focus on improving protection of groundfish spawning activity. The existing year-round groundfish closed areas provide some protection of spawning fish as they migrate to or aggregate in areas where they customarily spawn. These areas may or may not be ideally located with respect to aggregations of spawning fish, and exist for much longer than necessary to protect spawning, which does not occur at a consistent rate throughout the year. The CATT analyzed the seasonal distribution of large groundfish to evaluate how to improve spawning protection and mitigate the impact of the potential removal of the year-round groundfish closed areas.

There are two main factors to consider when designing spawning management areas. One is the aggregation of fish on spawning grounds. Although catching fish when they are aggregated for spawning may reduce fishing costs, fishermen preferentially target the largest fish. This may reduce total spawning potential of the aggregation as larger fish are more fecund and often produce larger, more viable eggs (Lough et al. 2008, Palakovich and Kaufman 2009, and Vallin and Nissling 2000, Tripple et al. 1997). The second factor to consider is that fishing on the aggregation may disrupt actual spawning activity, i.e. courtship displays and other fish behavior that enhances spawning success of the fittest indivduals. Such cod spawning behavior has been observed in laboratory settings (e.g. Nordeide and Folstad 2000, Hutchings et al. 1999) and lately *in situ* using acoustic tags (Dean et al 2014).

While there are observations of groundfish spawning activity and behavior in the region, there is no systematic collection of such data on a year-round, region-wide, basis. Little or no biological data (other than lengths) are obtained during commercial or recreational fishing activity. Even then, the groundfish closed areas and seasonal rolling closures would prevent observations in these important areas. Specifically, the sector and common pool rolling closures in the western Gulf of Maine occur in the spring, when cod and other groundfish often are spawning, and Closed Area I and II on Georges Bank were originally implemented as spring closures to protect spawning cod and haddock.

Biological data, including maturation stages, are collected on NEFSC and state trawl surveys, but their timing can miss peak spawning activity in specific areas. For example, the spring trawl surveys are likely to capture cod spawning on Georges Bank and in parts of the western Gulf of Maine, but probably miss peak spawning in Masschusetts Bay during the winter and off coastal Maine during late spring and early summer (which may be earlier than the annual summer shrimp trawl survey). Industry based surveys for cod, yellowtail flounder, and monkfish also collected biological data, but have occurred sporadically and many times targeted specific areas with non-random tows.

The surveys do sample large female spawning fish (sometimes called ‘mega-spawners’), even if the timing of these surveys misses their peak spawning condition. Thus, in the absence of more targeted observations of spawning fish, aggregations, or hotspots, of these large fish during appropriate seasons when spawning occurs can be used as an indicator of a spawning, or pre-spawning, aggregation. The analysis presented below and in Appendix E attempts to identify when and where these spawning and pre-spawinging aggregations of large fish occur. We focus on the largest animals because it is generally known that fish fecundity and mature spawning behavior improves with age. Older females tend to produce larger, more viable fish eggs (for example, see Lough et al. 2008, Carr and Kaufman 2009, and Vallin and Nissling 2000). Furthermore, Tripple et al.1997 showed that cod eggs and larvae were larger when produced by larger mothers. Tripple et al. 1999 showed that repeat spawners with larger larvae also have improved hatching success. The analysis includes all large fish (i.e. both sexes), specifically the largest fish that comprised 20% of total biomass for each groundfish stock during 2002-2012. Males and females were analyzed together because only a fraction of the animals sampled in any given survey are sexed.

Several biological considerations that led to these choices about survey data used in the analysis included the following:

- Recent data more accurately reflected current and potentially future spawning distributions, particularly in the face of generally increasing water temperature that has been observed in the northeast region.
- Less than 10 years of survey data would be insufficient to identify many clusters of significantly high biomass. The spring and fall surveys each take about 300-400 tows per year, so 10 years of survey data includes observations for 3000-4000 tow locations.
- Larger spawners are more fecund, so protection of these large spawning fish could have more positive population impacts.
- Larger spawners are more likely to exhibit mature spawning behavior and therefore be easier to detect.

The survey data that covers broad areas of the Gulf of Maine and Georges Bank/southern New England regions have some biological data that might be used to identify spawning activity, including maturity stage and sex ratios. However, survey tows typically are about a nautical mile long and probably cannot detect the fine-scale biological characteristics that can be identified in localized studies, such as the MADMF study described below. The observed maturity stage of a subset of the groundfish caught on survey tows is also available, but as noted above, the surveys may or may not coincide with key spawning times that may only last a week or so in a specific area. For example, CATT members thought that the spring trawl surveys were too early to detect spawning activity off southern Maine and around Closed Area I. The winter trawl survey (which was terminated in 2007) would be ideal to identify winter cod spawning, but the sampling domain did not extend far into Massachusetts Bay (see Map 126).

Similar to the juvenile hotspots, the spawner hotspots were weighted to account for management concerns and the expected seasonality of spawning for each stock. The CATT assigned weights to the number of hotspots for each stock (Table 39), based on seasons when spawning occurred for that species, stock status (a ratio of B_{MSY} to current biomass), and whether the species exhibited a higher degree of residency and/or formed sub-populations. Atlantic halibut (32.7) and ocean pout (14.9) were assigned relatively high weights (compared to an 8.73 average weight), but few hotspots were identified for these species. Georges Bank cod (17.1) and Georges Bank yellowtail flounder (12.4) were assigned relatively high weights mainly due to low stock biomass relative to the target biomass. Haddock (2.7-3.7) and redfish (3.8) were given low weights in the aggregate totals. Red and silver hake were not included in the aggregate totals, since they are not considered to be large-mesh groundfish and therefore were not the focus of the spawning closure alternatives. A seasonal multiplier of either zero or one was used to zero out hotspots found during seasons when a particular stock is not known to be spawning.

The CATT compared the results of the spawner hotspot analyses to spawning distributions described in the scientific literature. Although there are some published studies that describe groundfish spawning locations, these analyses focused either in a specific area and season (e.g. Dean et al. 2013) or a specific species (e.g. cod, winter flounder, and haddock, see individual species headings under section 4.2.2). The most comprehensive analysis to identify location and seasonal spawning activity was the Ames (2004) analysis that focused on cod spawning along the Maine and New Hampshire coastline. The Ames study identified historic cod spawning grounds based primarily on interviews with fishermen.

Since specific location-based information on groundfish spawning was limited, the Council undertook a broad-based and seasonal analysis of groundfish large spawning aggregations, or hotspots, using all available survey data, including NEFSC spring, fall, and winter trawl surveys, MADMF spring and fall trawl surveys, ME-NH spring and fall trawl surveys, Industry Based Surveys (IBS) for cod, yellowtail flounder, and monkfish (which also measured and recorded catches of other groundfish), the NEFSC shrimp trawl survey, and the NEFSC scallop dredge survey. Other surveys were considered, but were either unavailable for a compatible analysis or did not measure the characteristics of interest (especially fish size in photographic/video surveys).

Some ad hoc industry surveys, such as the Closed Area II scallop dredge survey by VIMS and Coonamessett Farms were also analyzed separately, but generally provided localized information about a specific area. Although the research focused on relative changes in scallop and yellowtail flounder CPUE, the results were helpful in identifying peak spawning of yellowtail flounder occurring in June to August.

MADMF has been conducting targeted surveys and acoustic tagging experiments, focusing on inshore cod spawning. These results characterize cod spawning activity in the study area, including where the behavior of mature male and female cod have specific diel cycles during spawning. This research focused on an area in Northern Massachusetts Bay, south of Gloucester, and is now protected by a spring closure in state waters. Similar characteristics have been observed by others in the Whaleback region of Ipswich Bay, which is now protected by a late spring spawning closure in Federal waters, the Gulf of Maine Cod Spawning Protection Area.

A third area is currently being investigated by MADMF and Sector X fishermen off Scituate, Massachusetts, straddling State and Federal waters. Acoustic tagging work began in November 2013 and results should be available during 2014. This area also was identified in the CATT's hotspot analysis as one that holds high concentrations of both juvenile and spawning size cod. These preliminary results led the Council to include an alternative that proposes a winter cod spawning closure in this area, i.e. the Massachusetts Bay Spawning Management Area.

Summaries of aggregated weighted groundfish hotspots as well as distributions of large spawner hotspots for individual species are presented in the following two sections.

Table 39 – Weighting factors applied to large spawner groundfish hotspots.The 'final weighting sum' was applied to the gridded hotspots for each species and season shaded in red. Grey shaded rows designate species that are not allocated to sectors.

Stock	Large spawner threshold (20% of total biomass)	Length at 80% female maturity (cm) (re-estimated by CATT)	Vulnerability of species (Bmsy/B)[1]	Sub-populations[2]	Residency[3]	Final weighting Sum[4]	Spring multiplier	Summer multiplier	Fall multiplier	Winter multiplier
GB Cod	75	52	14.11	2	1	17.1	1	1	0	1
GOM Cod	75	52	5.53	3	1	9.5	1	1	0	1
GB Yellowtail Flounder	40	30	9.39	1	2	12.4	1	0	0	0
CC/GOM Yellowtail Flounder	40	30	4.21	1	2	7.2	1	0	0	0
SNE/MA Yellowtail Flounder	40	30	0.77	1	2	3.8	1	0	0	0
GOM Winter Flounder	45	31	UNK	UNK	2	9.0	1	0	0	1
GB Winter Flounder	45	31	1.22	3	2	6.2	1	0	0	1
SNE/MA Winter Flounder	45	31	6.17	3	2	11.2	1	0	0	1
White Hake	75	45	1.21	UNK	2	5.0	1	0	0	0
GOM Haddock	50	40	1.71	1	1	3.7	1	0	0	0
GB Haddock	50	40	0.75	1	1	2.7	1	0	0	0
Witch Flounder	45		2.45	3	2	7.5	1	1	1	0
American Plaice	40	32	1.70	UNK	1	4.5	1	0	0	0
Pollock	75	52	0.46	2	2	4.5	0	0	0	1
Acadian Redfish	30	25	0.76	1	2	3.8	1	1	0	0
Atlantic Halibut	45	NA	28.82	UNK	2	32.7	1	1	1	1
Ocean Pout	60	NA	12.05	UNK	1	14.9	0	1	1	1
Northern (GOM-GB) Windowpane Flounder	30	24	3.48	UNK	2	7.3	1	1	1	1
Southern (SNE-MA) Windowpane Flounder	30	24	0.69	UNK	2	4.5	1	1	1	1
Atlantic Wolffish	45	NA	3.48	UNK	UNK	7.0	1	0	0	0
Sum						174.5	18	8	5	10
Mean			**5.21**	**1.83**	**1.68**	**8.73**				

[1]Either SSBmsy/SSB or Bmsy/B used depending on what is reported in the assessment
2Derived from Table 81 in Framework 48 or from NEFSC biological data. 1=no subpopulations, 2=some evidence, 3=known subpopulations
3Based on information in literature. 1=less resident, more migratory; 2=more resident, less migratory
4Sums include a mean value for unknowns

4.4.2.1 Gulf of Maine region

The total number of hotspots and weighted hotspots summed over all groundfish species for Gulf of Maine spawning management areas is summarized below (Table 40). Weighted hotspots exclude species not spawning in a given season according to the multipliers in Table 39. The totals in the shaded rows include some duplicated hotspots because the seasonal rolling closures overlap. Nonetheless, the total weighted large spawner hotspots are most numerous in the spring, particularly in the April and May Sector Rolling Closure Areas. Hotspots were also detected in these areas during the winter survey, but are much less numerous than in the spring. Some of these management areas do not correspond to locations where winter surveys were conducted.

Table 40 – 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[10].

	Winter		Spring		
	Total hotspots	Total weighted hotspots	Total hotspots	Total weighted hotspots	Area (nm^2)
Gulf of Maine	70	149.7	1027	2478.2	6,104
Groundfish closure	19	28.5	111	406.4	1,284
Cashes Ledge GF			7	15.0	400
Western Gulf of Maine GF	19	28.5	104	391.4	883
Spawning area	51	121.2	916	2071.8	4,820
GOM cod spawning protection area			7	14.1	33
Sector Rolling Closure, April	28	74.8	265	949.4	2,120
Sector Rolling Closure, June			290	256.6	2,043
Sector Rolling Closure, May	23	46.3	354	851.6	2,436

The distribution of the weighted hotspots (all species combined) for the spring, fall, summer, and winter seasons are shown in Map 151. Generally, the weighted hotspots are distributed from Massachusetts Bay through southern Maine during the spring. Notable areas include waters off the north shore of Massachusetts, overlapping the MADMF winter and spring spawning protection areas, inshore in the Bigelow Bight overlapping the Gulf of Maine Cod Spawning Protection (Whaleback) Area, an area in the center of the Western Gulf of Maine closed area, and an area on the southern boundary of the Western Gulf of Maine closed area north of Cape Cod. A smaller number of weighted hotspots were identified near and east of Cashes Ledge.

There are few hotspots in the Gulf of Maine during the fall survey season (Map 151). This is largely because only windowpane flounder, witch flounder, and ocean pout appear to spawn in the fall. During the summer shrimp survey, clusters of weighted hotspots were identified mainly northwest and northeast of the Cashes Ledge Closure Area and a few on the northern tip of Jeffreys Ledge. During the winter survey season, hotspots were detected in Massachusetts Bay off Scituate, and around Tillies Bank at the western edge of the Western Gulf of Maine Closure Area.

Table 41 and Map 152 summarize the number and distribution of large spawner hotspots by species during seasons when spawning occurs. Generally, there are many more hotspots for red

[10] The sum of spawning areas in the Gulf of Maine accounts for the overlap of the individual Sector Rolling Closures, as well as the GOM cod spawning protection area.

and silver hake than there are for other species (these stocks are given a zero weight in the aggregated hotspot distribution because they are not large mesh species).

Redfish hotspots were found mainly surrounding the Cashes Ledge and Fippenies Ledge areas in the summer (Map 152). American plaice hotspots were primarily distributed in the western Gulf of Maine during the spring surveys, with a strong signal in the Tillies Bank area.

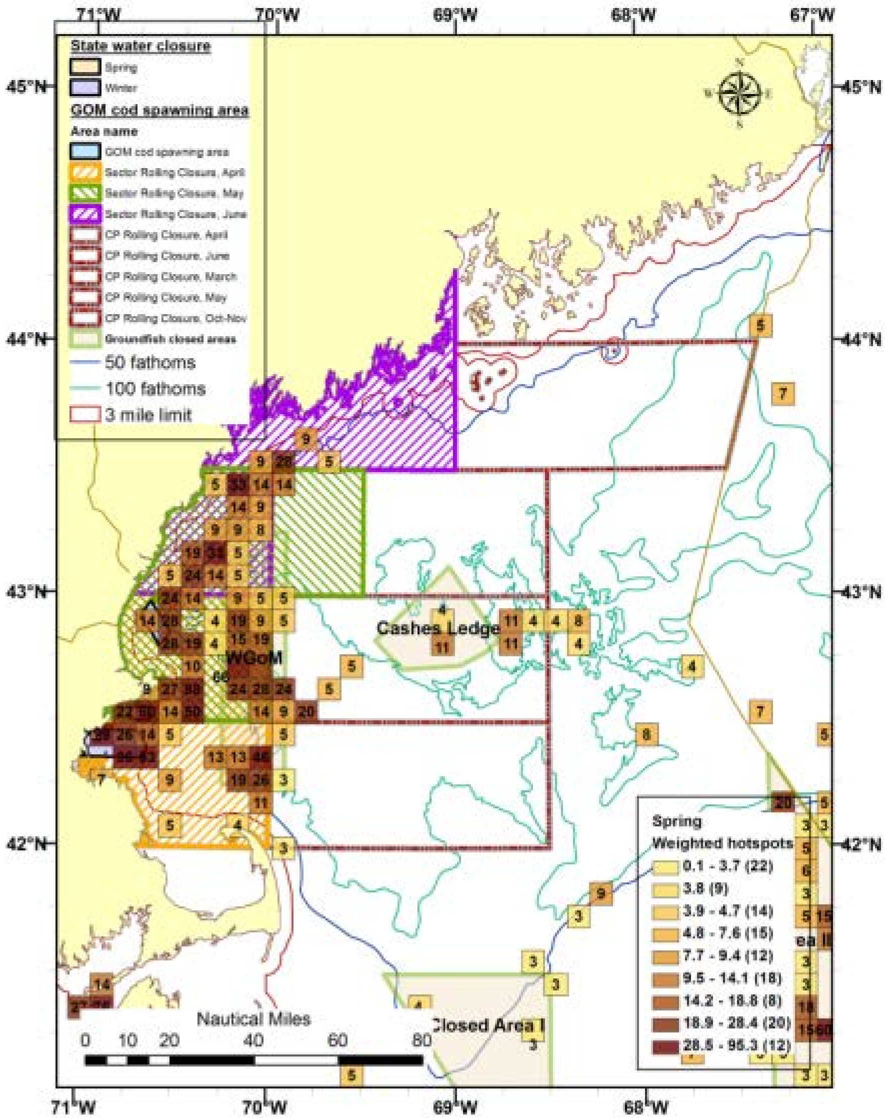
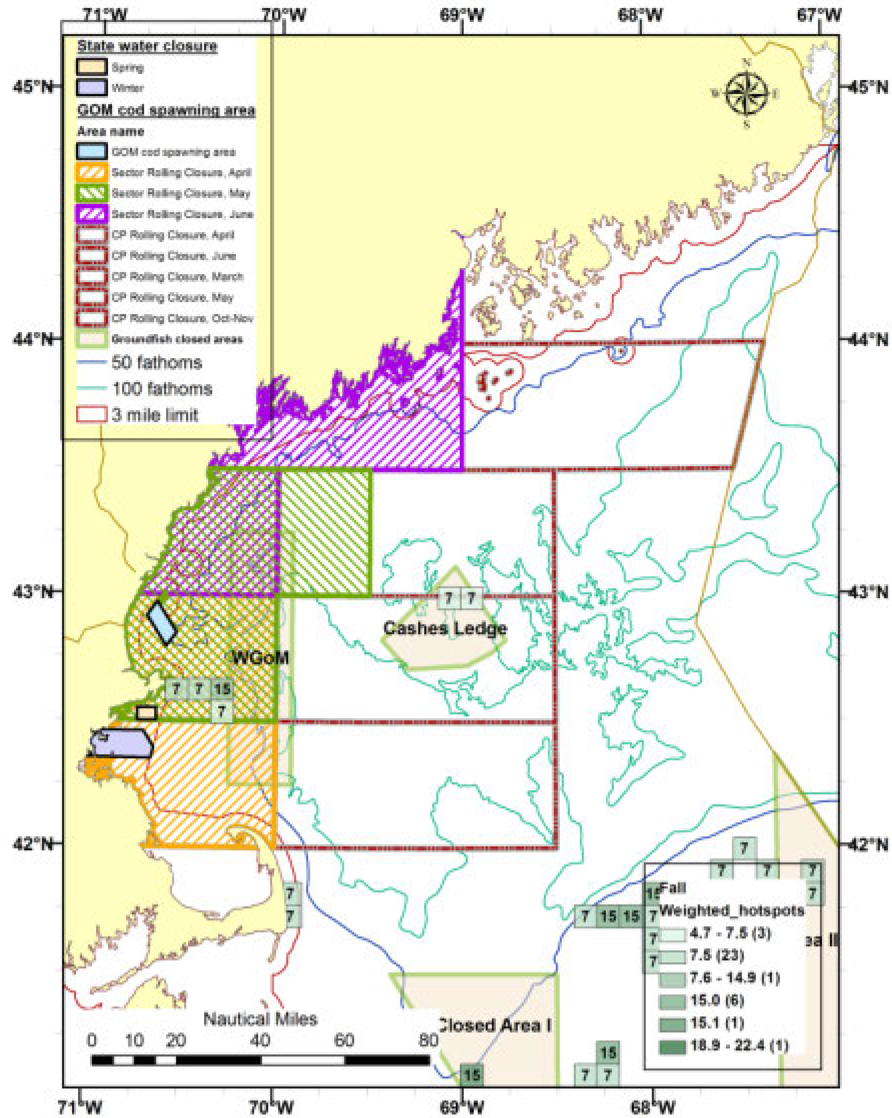
Cod hotspots were more numerous in the spring: 28 in the April rolling closure and 17 in the May rolling closure. Most of the hotspots were identified in the April and May Sector Rolling Closure areas, primarily offshore on Stellwagen and Tillies Banks (Map 152). Some hotspots were also identified in the Ipswich Bay area, near the Gulf of Maine Cod Spawning Protection (Whaleback) Area in the spring, and off Scituate, Massachusetts in the winter. A short discussion about the distribution of cod in spawning condition and the relative distribution of large and small mature cod with respect to proposed spawning alternatives is given in the groundfish impacts of spawning alternatives section of Volume 3.

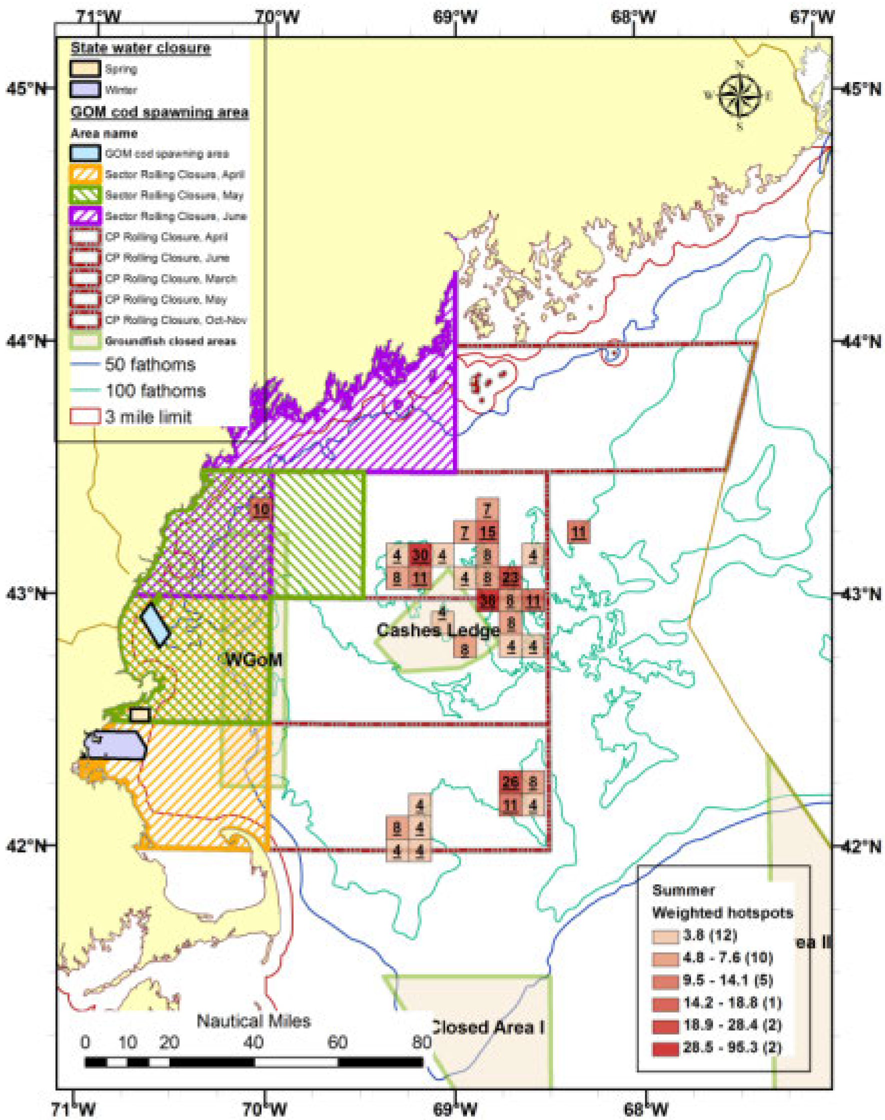
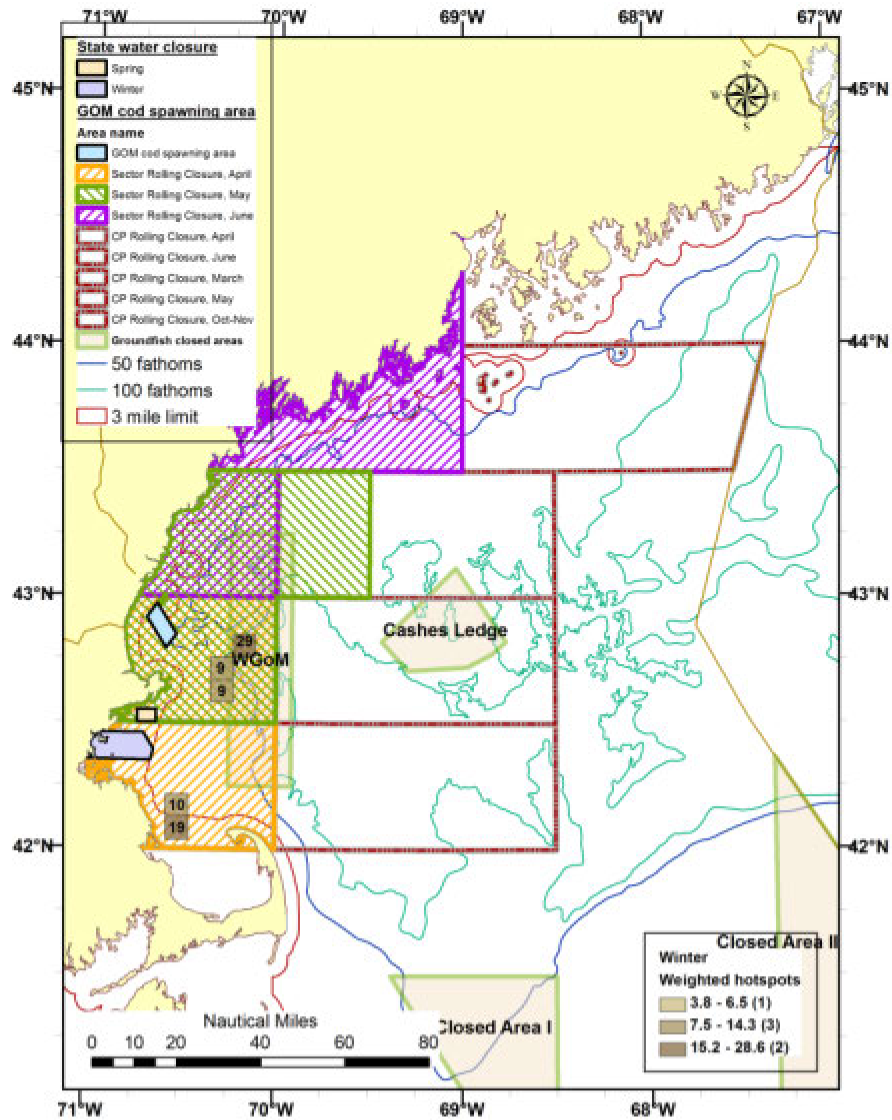
Haddock hotspots were more associated with Jeffreys Ledge and on the offshore side of Stellwagen Bank (Map 152) in the spring. No ocean pout hotspots and only 4 pollock hotspots were identified in the Gulf of Maine (Map 152). (A large number of ocean pout hotspots were detected in the spring off the northern point of Cape Cod, but ocean pout are not known to spawn during the spring. Further investigation of this area for ocean pout spawning would be warranted). As mentioned above, red and silver hake hotspots were much more numerous than those for other species, but were more broadly distributed throughout the Gulf of Maine in the spring and fall trawl seasons, although red hake hotspots in the spring tended to be in relatively deep water (Map 152). Four white hake hotspots from spring surveys were identified by the analysis in deep water of the Gulf of Maine, and five windowpane flounder hotspots were identified off Gloucester, Massachusetts in the spring and fall, and off Cape Cod in the spring (Map 152). No winter flounder hotspots were identified in the Gulf of Maine, and a handful of witch flounder hotspots were identified in deep water from the spring, summer, and fall surveys (Map 152).

Table 41 – Total number of large spawner hotspots by species, management area, and survey season in the Gulf of Maine region.

	Acadian redfish	Alewife	American plaice	Atlantic herring	Cod	Haddock	Ocean pout	Pollock	Red hake	Silver hake	White hake	Windowpane flounder	Witch flounder	Yellowtail flounder	Grand Total
Gulf of Maine															
Groundfish closure	13		31	1	32	36		13	89	17	13		4	21	270
Cashes Ledge GF	13								6				2		21
Spring	4								3						7
Summer	3														3
Fall	6								3				2		11
Western Gulf of Maine GF			31	1	32	36		13	83	17	13		2	21	249
Spring			30	1	21	10		1	23	16			2	14	118
Summer			1			8			21						30
Fall					8	5		12	39	1	13			4	82
Winter					3	13								3	19
Spawning area	91	143	237	240	91	105	35	30	519	334	14	6	8	510	2363
Sector Rolling Closure, April	23		71	60	57	59	35	15	172	101	7	3	5	272	880
Spring	4		69	28	27	33	35	1	17	19		1	2	265	501
Summer						7			52						59
Fall	19			32	24	6		10	103	82	7	2	3	4	292
Winter			2		6	13		4						3	28
Sector Rolling Closure, June	23	135	55	68	1				84	89				58	513
Spring	2	116	53	50					14	55				58	348
Summer					1				19						20
Fall	21	19	2	18					51	34					145
Sector Rolling Closure, May	45	8	111	112	33	46		15	263	144	7	3	3	180	970
Spring	6	8	107	72	17	23		1	26	83		1		173	517
Summer					1	6			116						123
Fall	39		2	40	12	6		10	121	61	7	2	3	4	307
Winter			2		3	11		4						3	23

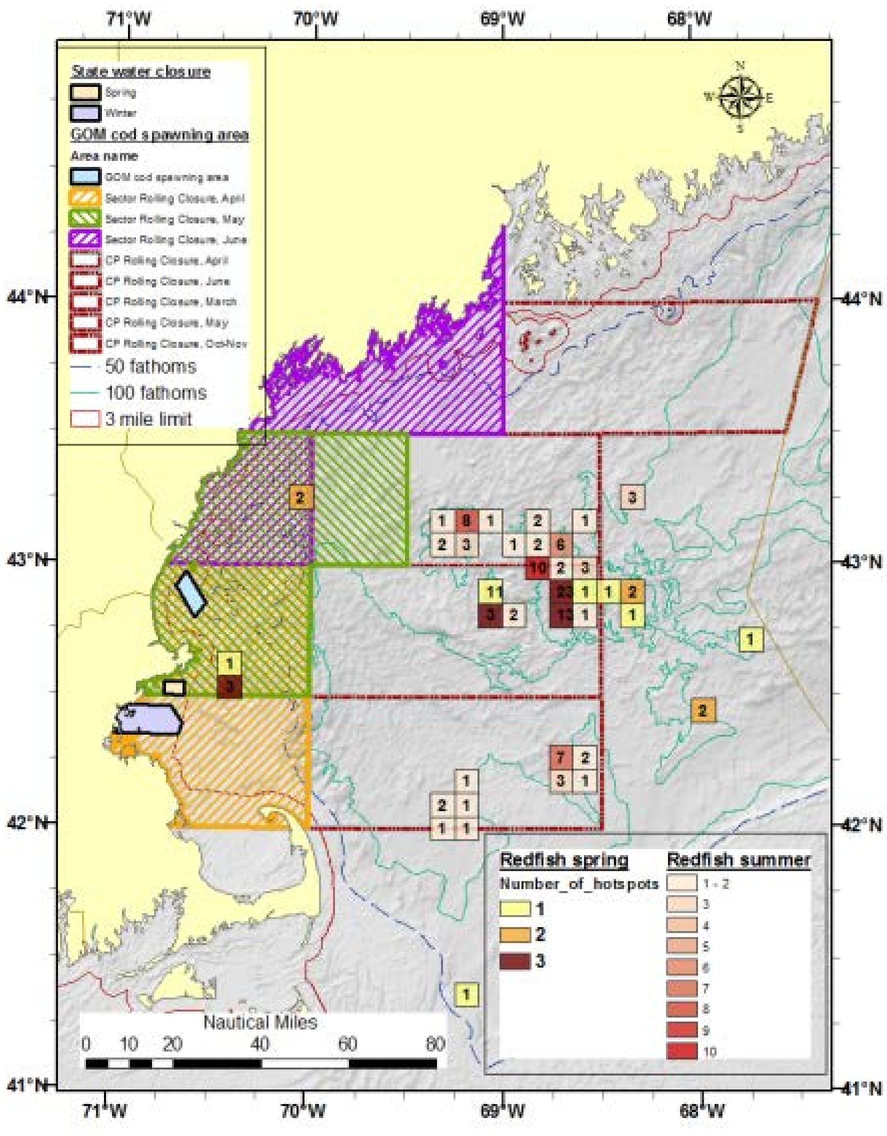
Map 151 – Distribution of weighted large spawner groundfish hotspots in the Gulf of Maine by season, derived from 2002-2012 NEFSC, MADMF, ME-NH, and IBS survey data. Continued on the next page.

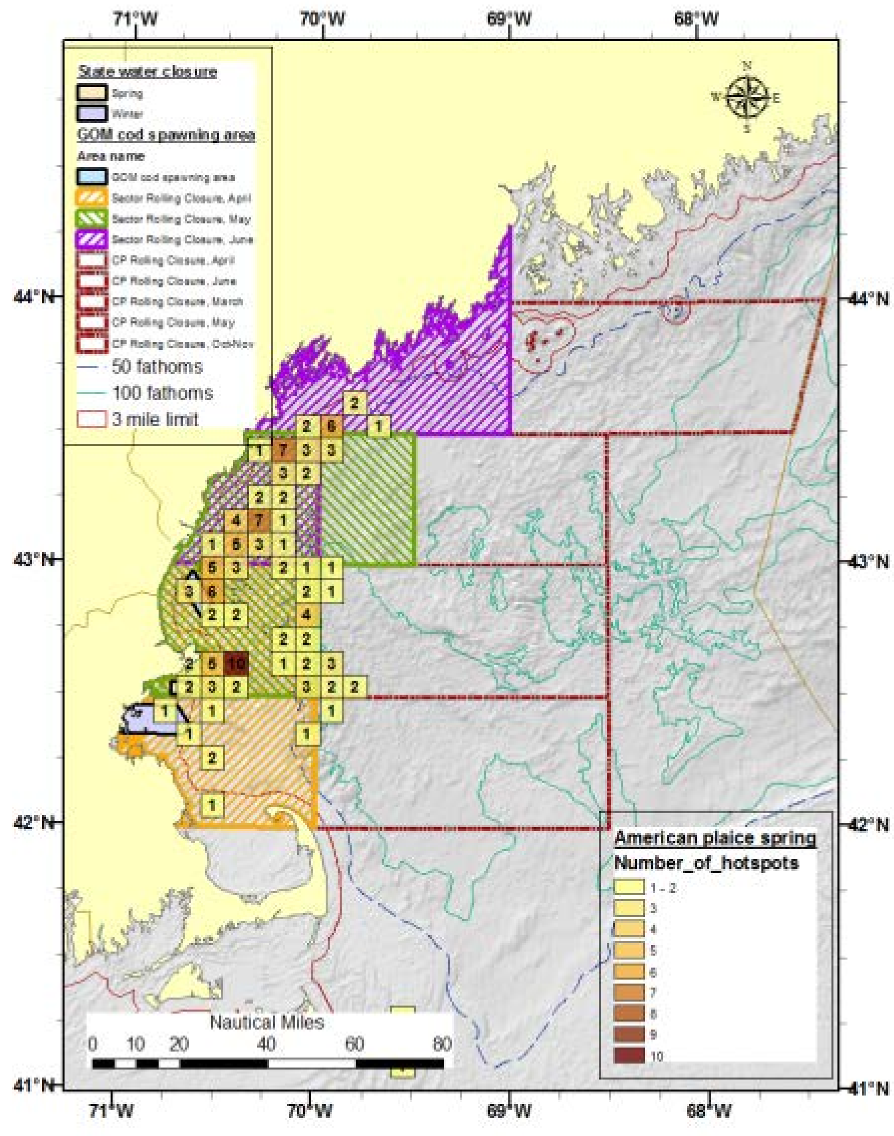
Spring	Fall
	

Summer	Winter
	

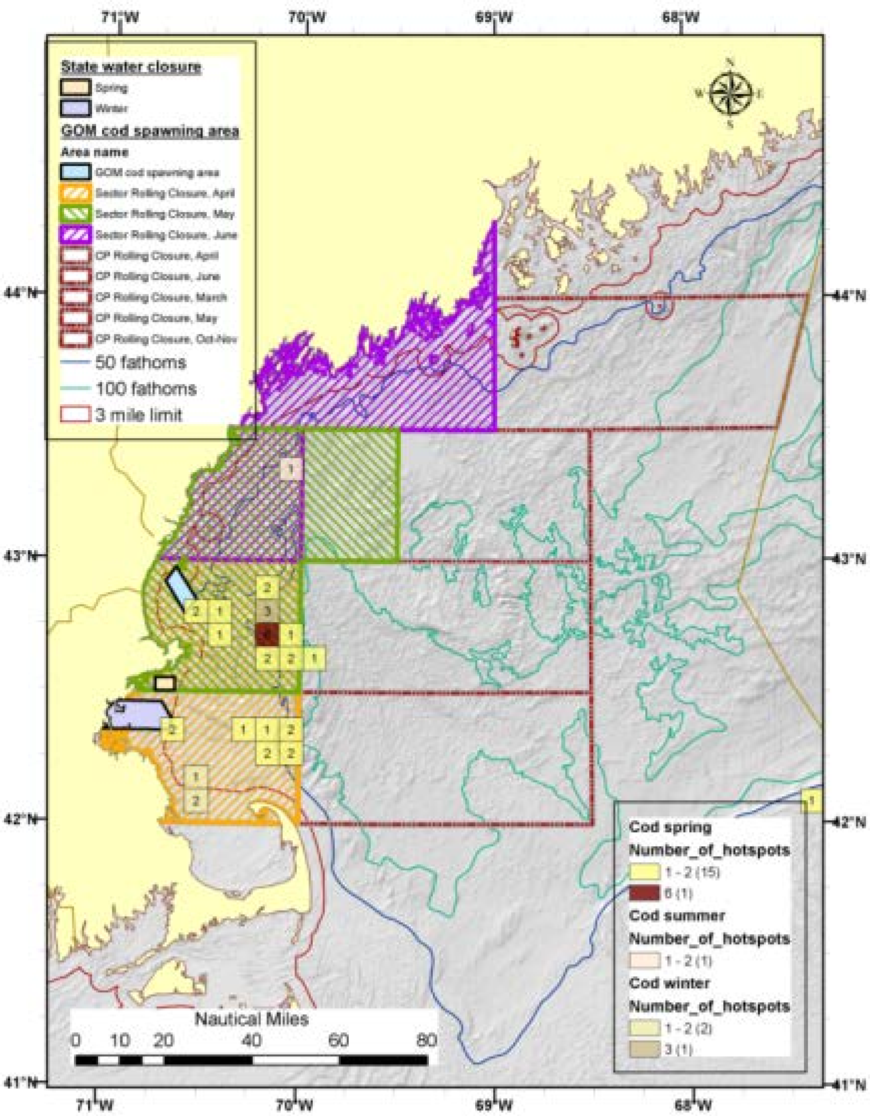
Map 152 – Seasonal distribution of large spawner hotspots for individual groundfish species in the Gulf of Maine region identified from 2002-2012 NEFSC, MADMF, ME-NH, and IBS trawl surveys. **Continued on the following 6 pages.**

Acadian redfish	American plaice

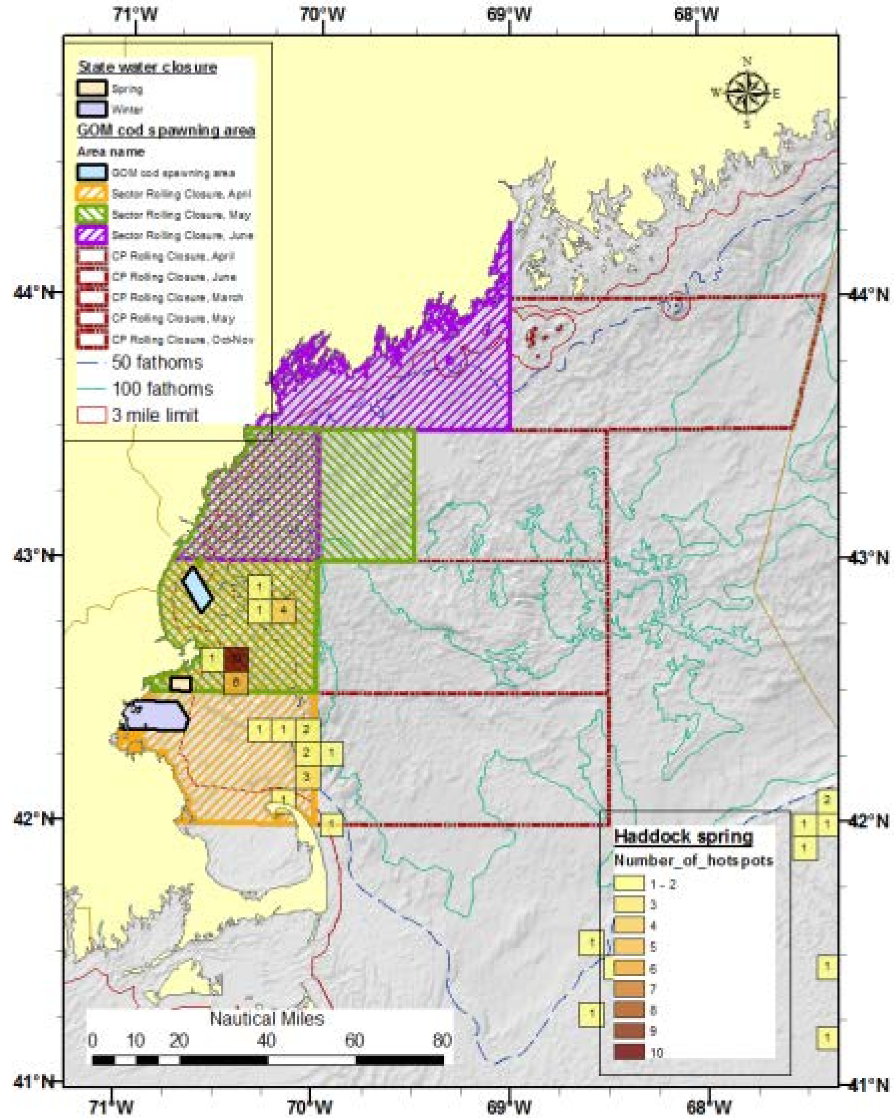




Cod	Haddock

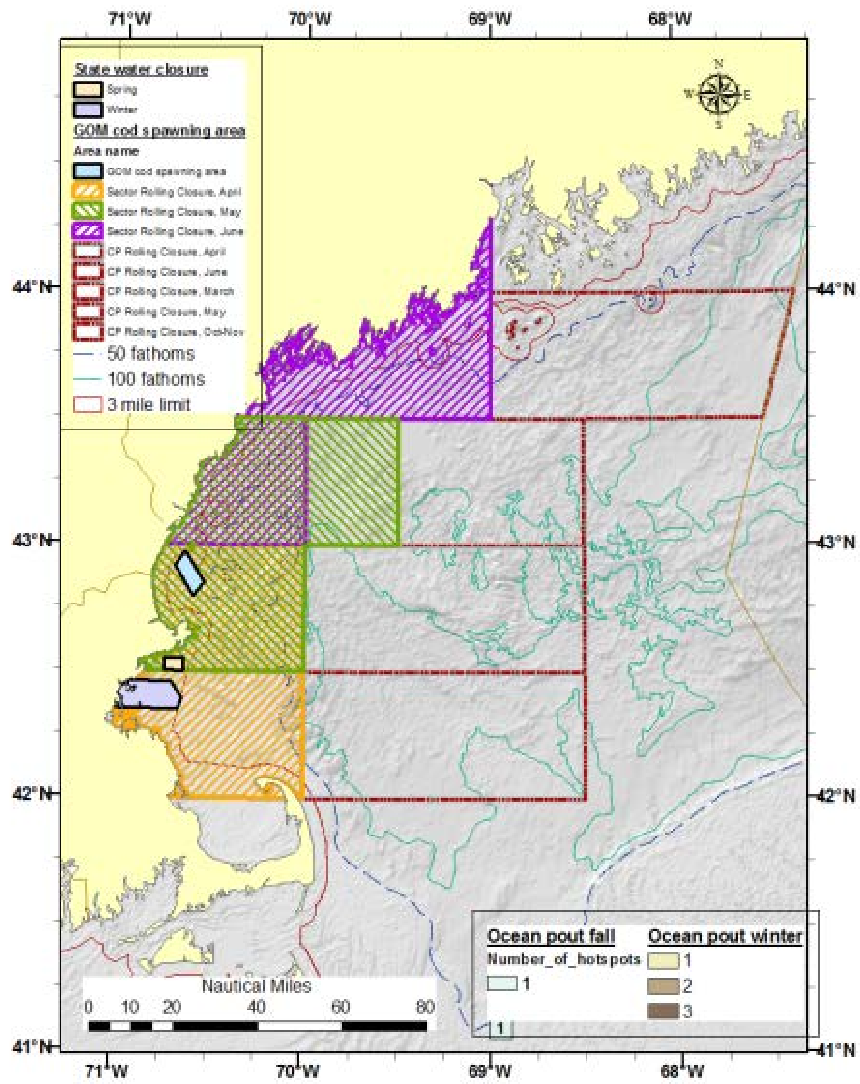


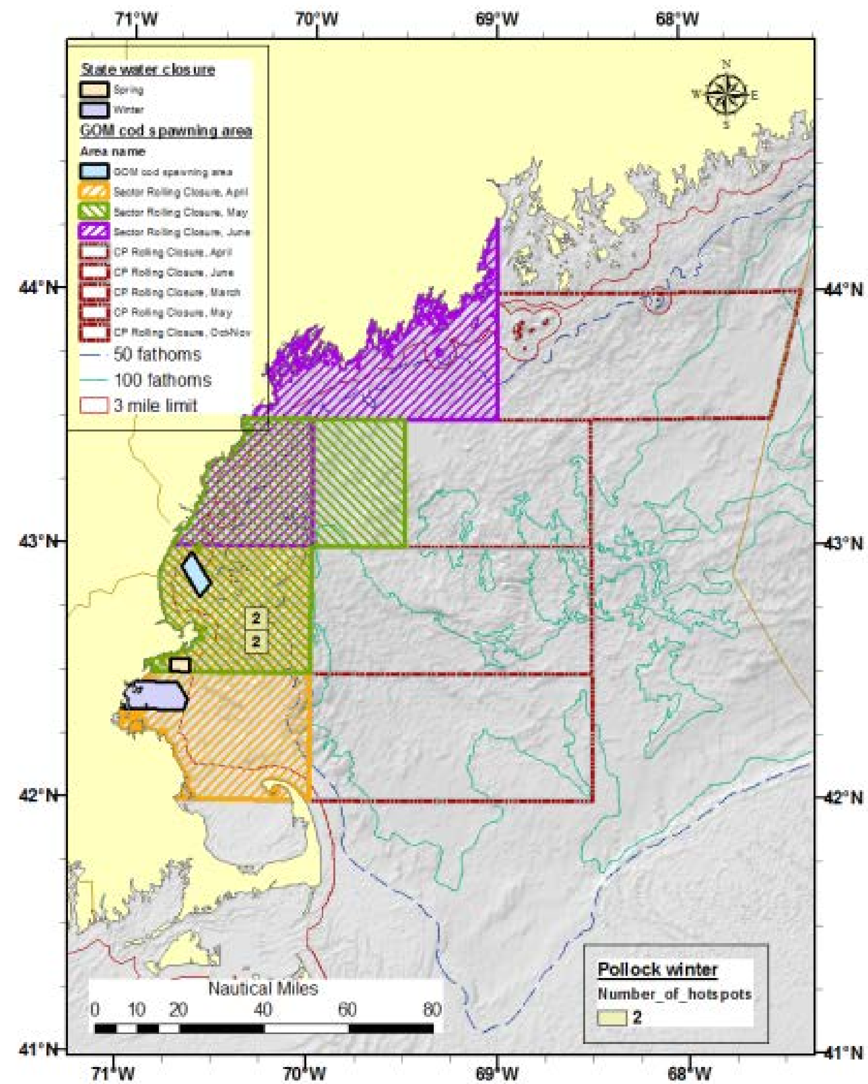
71°W
70°W
69°W
68°W
44°N
43°N
42°N
41°N
State water closure
Spring
Winter
GOM cod spawning area
Area name
GOM cod spawning area
Sector Rolling Closure, April
Sector Rolling Closure, May
Sector Rolling Closure, June
CP Rolling Closure, April
CP Rolling Closure, June
CP Rolling Closure, March
CP Rolling Closure, May
CP Rolling Closure, Oct-Nov
50 fathoms
100 fathoms
3 mile limit
Cod spring
Number_of_hotspots
1 - 2 (15)
6 (1)
Cod summer
Number_of_hotspots
1 - 2 (1)
Cod winter
Number_of_hotspots
1 - 2 (2)
3 (1)
Nautical Miles
0 10 20 40 60 80



71°W
70°W
69°W
68°W
44°N
43°N
42°N
41°N
State water closure
Spring
Winter
GOM cod spawning area
Area name
GOM cod spawning area
Sector Rolling Closure, April
Sector Rolling Closure, May
Sector Rolling Closure, June
CP Rolling Closure, April
CP Rolling Closure, June
CP Rolling Closure, March
CP Rolling Closure, May
CP Rolling Closure, Oct-Nov
50 fathoms
100 fathoms
3 mile limit
Haddock spring
Number_of_hotspots
1 - 2
3
4
5
6
7
8
9
10
Nautical Miles
0 10 20 40 60 80

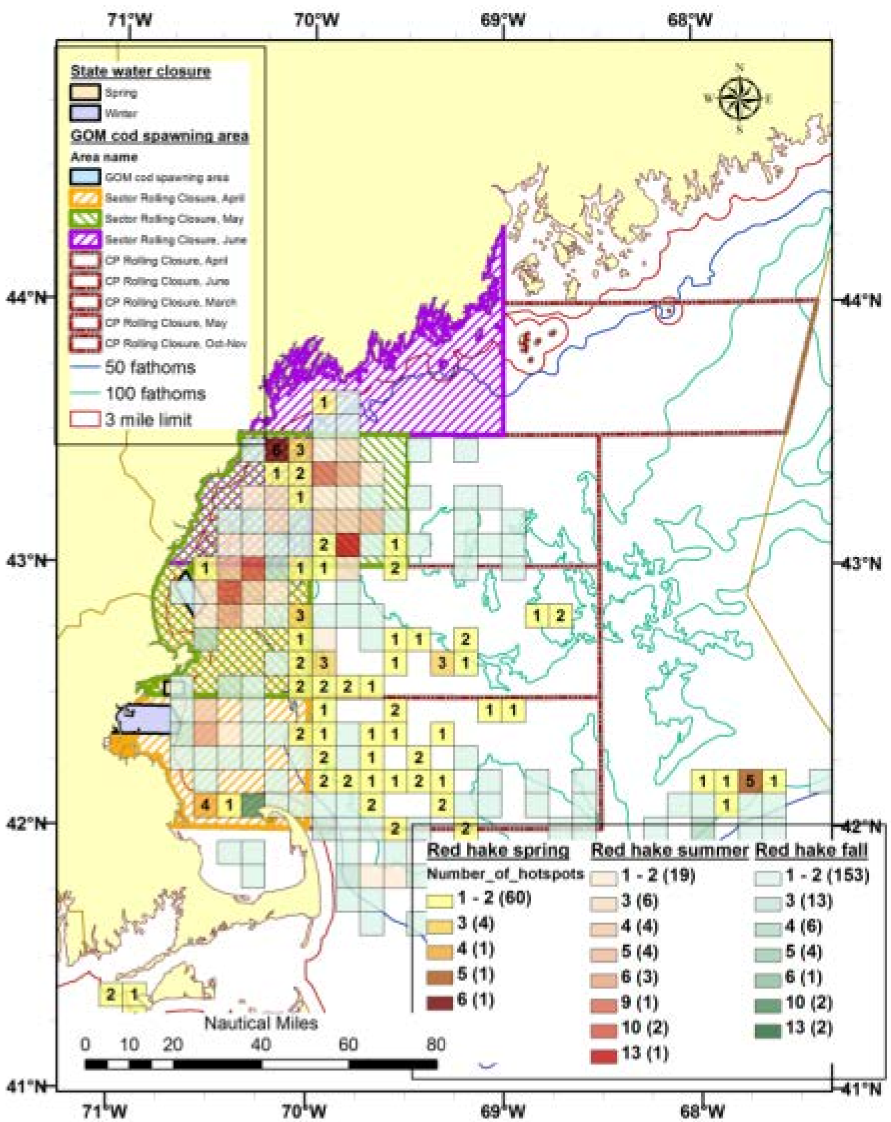
Ocean pout[11]	Pollock

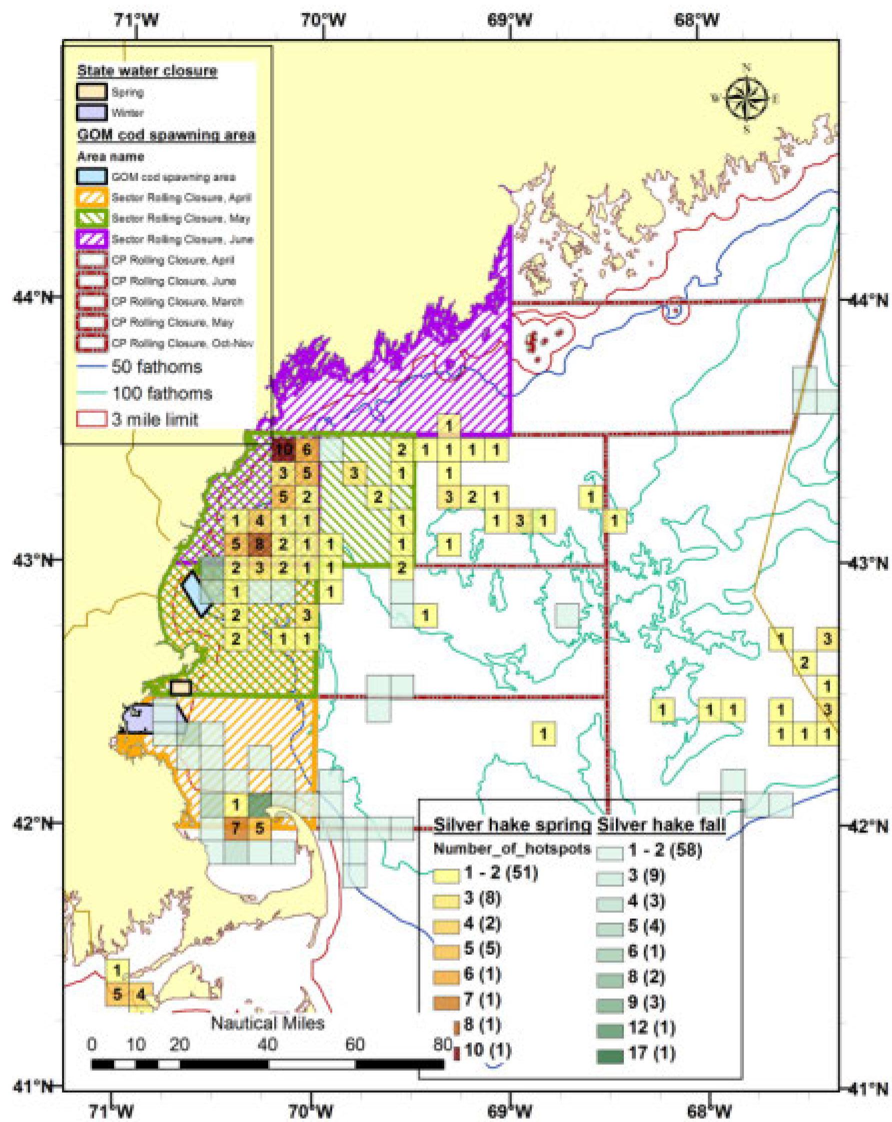




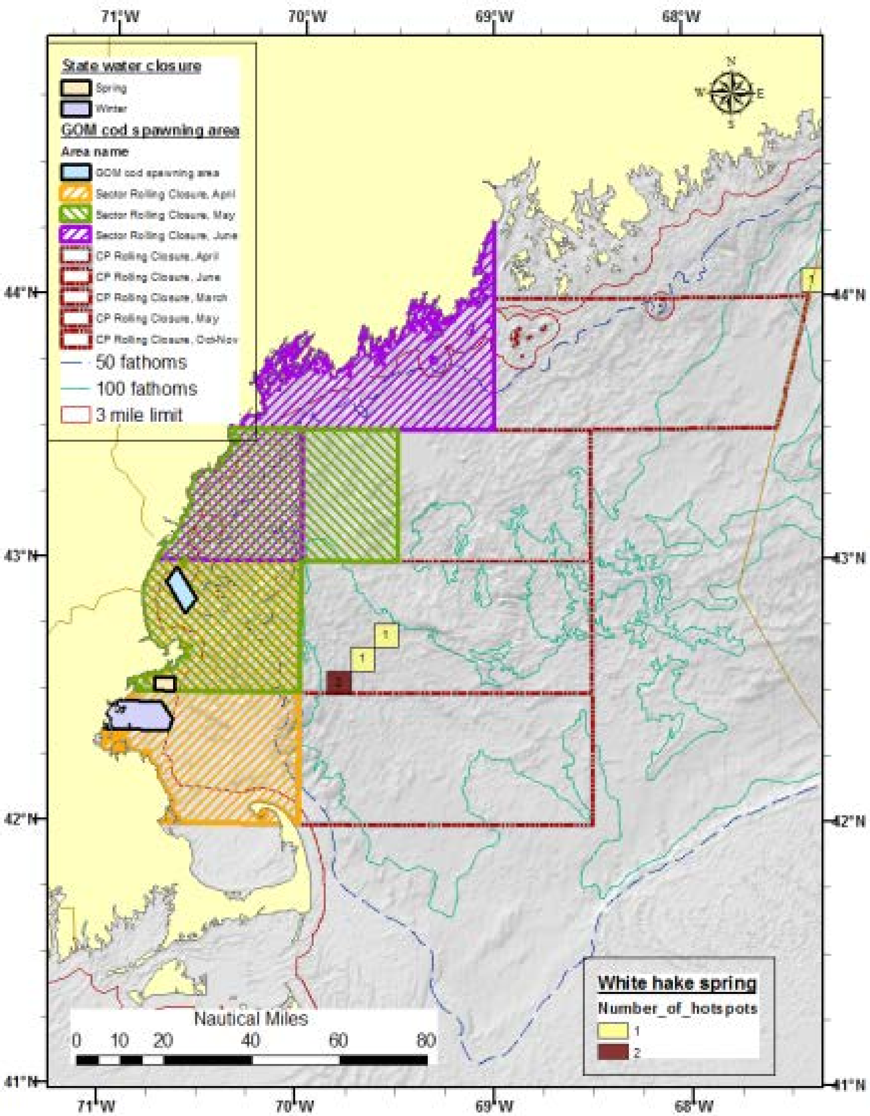
[11] Ocean hotspots are located in the Georges Bank and Southern New England regions and are obscured by legends. No ocean pout hotspots occur within the Gulf of Maine region.

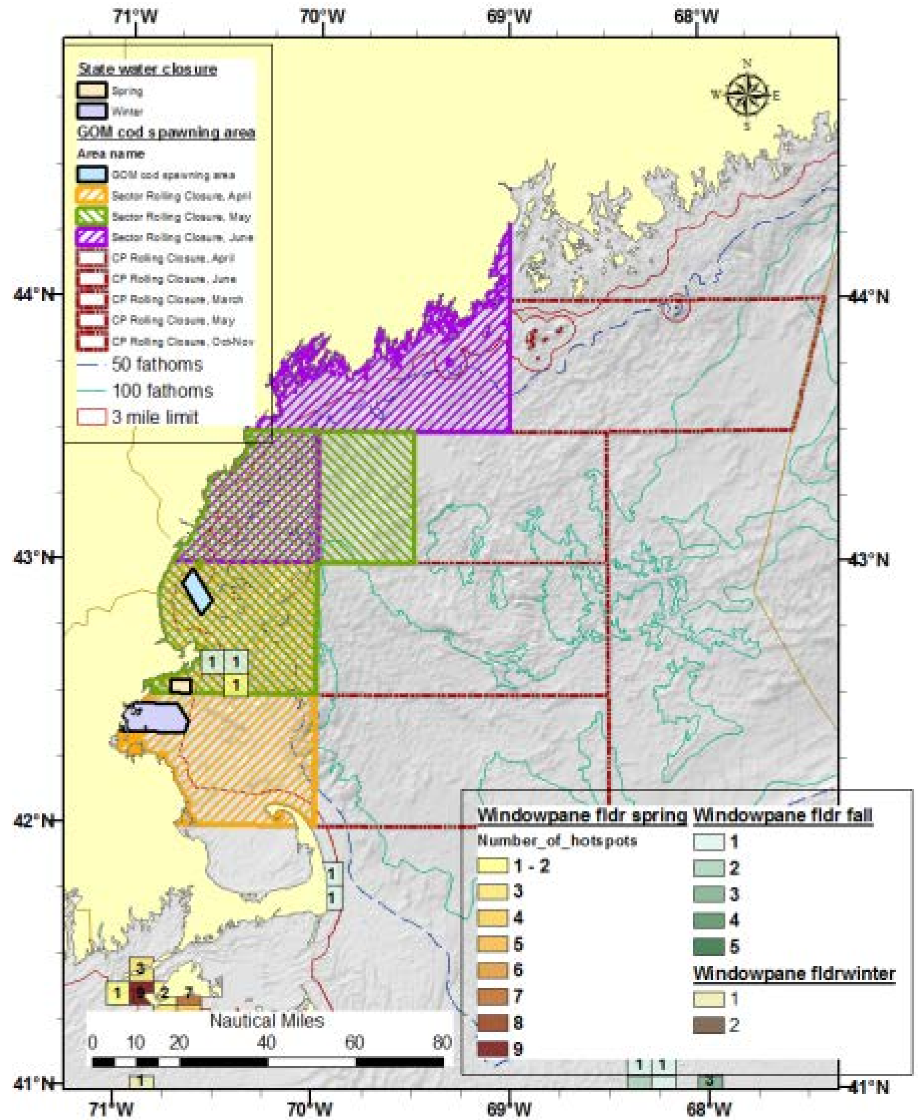
Red hake	Silver hake



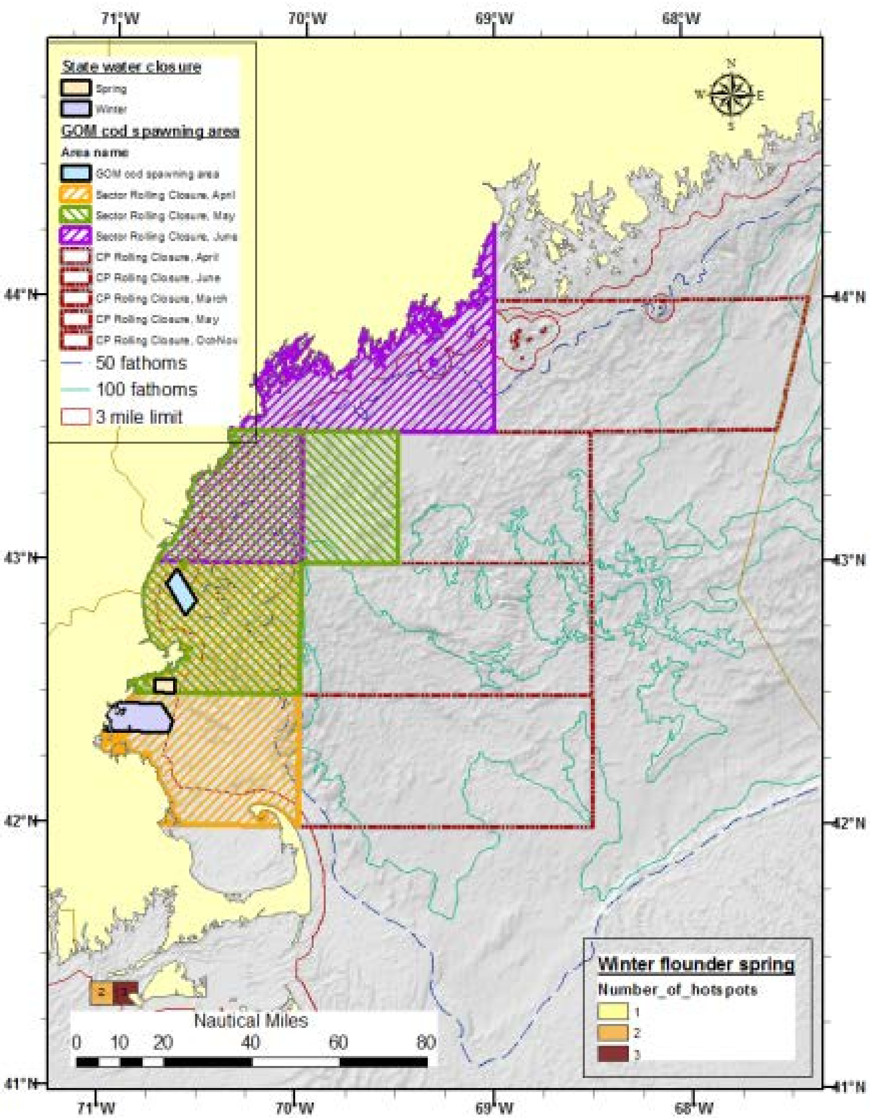


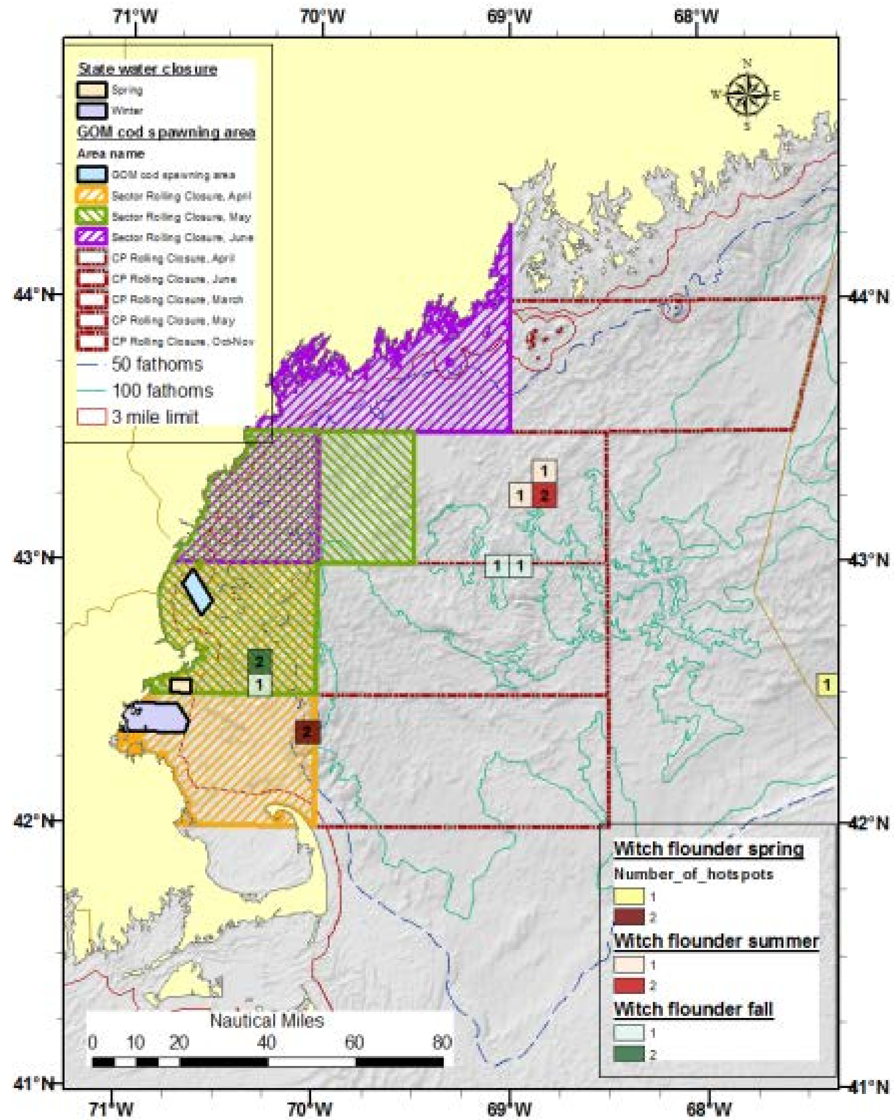
White hake	Windowpane flounder



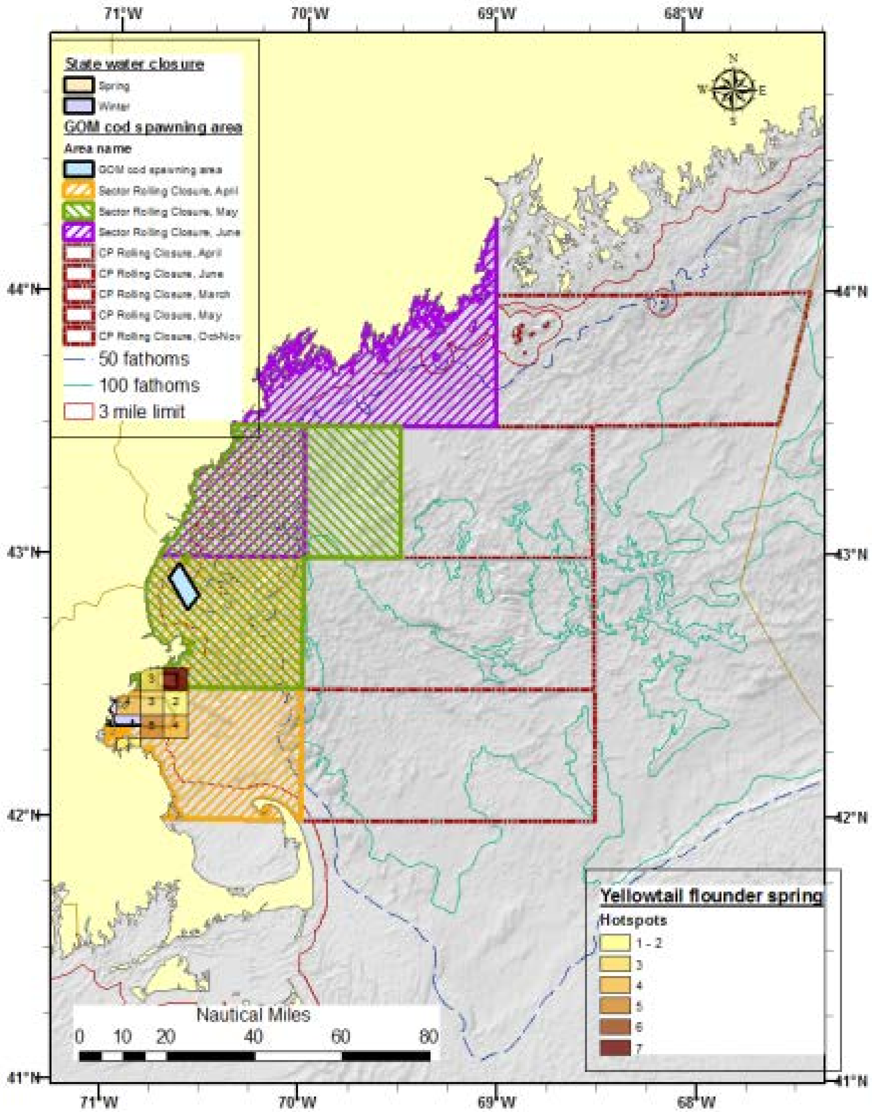


Winter flounder	Witch flounder





Yellowtail flounder



4.4.2.2 Georges Bank/Southern New England region

Table 42 summarizes the total number of hotspots and weighted hotspots summed over all groundfish species for No Action management areas on Georges Bank and in southern New England. Weighted hotspots are most numerous in the spring, particularly in Closed Area II. Some hotspots were identified (weighted value 62.2) in the Georges Bank Seasonal Closure Area, but the spring trawl survey occurs a few months before this area is closed in May and the summer dredge survey occurs a few months after. A few hotspots were identified in the Nantucket Lightship Closed Area (weighted value 15.0), but these hotspots were from windowpane flounder catches, not cod.

Table 42 – Total unweighted and weighted groundfish large spawner hotspots from 2002-2007 winter and 2002-2011 spring surveys by management area in the Georges Bank/Southern New England region.

	Winter		Spring		
	Total hotspots	Total weighted hotspots	Total hotspots	Total weighted hotspots	Area (nm^2)
Georges Bank/Southern New England	11	43.1	139	618.4	11344.5
Groundfish closure	9	28.1	99	556.2	4970.7
Closed Area I GF			2	6.5	1148.4
Closed Area II GF	3	0.0	97	549.8	2000.7
Nantucket Lightship GF	6	28.1			1821.6
Spawning area	2	15.0	40	62.2	6373.9
Georges Bank Seasonal Closure Area	2	15.0	40	62.2	6373.9

The distribution of the weighted hotspots during spring, fall, summer, and winter is shown on Map 153. Generally, the weighted large spawner groundfish hotspots are clustered in Closed Area II during the spring, primarily from haddock and yellowtail flounder (Map 154). Closed Area II appears to be well sited to reduce the impacts on fishing on spawning haddock and yellowtail flounder, but since Scallop Framework Adjustment 25 the southern part of this area is open to fishing by scallop dredges during the spring. In the fall survey, large spawner hotspots were identified on the northern portion of Georges Bank and in the Cultivator Shoals area east of Closed Area I (Map 153), almost entirely from windowpane flounder (Map 154). The timing of windowpane flounder spawning is not well-defined.

No large spawner groundfish hotspots were identified in the summer dredge survey data (Map 153), although if they occurred, non-zero weights would have applied to cod, witch flounder, redfish, Atlantic halibut, ocean pout, and windowpane flounder (Table 43). The lack of large spawner hotspots is probably the result of low catchability of large fish in the noisy and relatively narrow lined scallop dredge.

Hotspots were identified from winter survey data in the southern portion of the Great South Channel, south of Closed Area I and east of the Nantucket Lightship Closed Area (Map 153). These hotspots were mainly the result of the presence of high biomass levels for windowpane flounder.

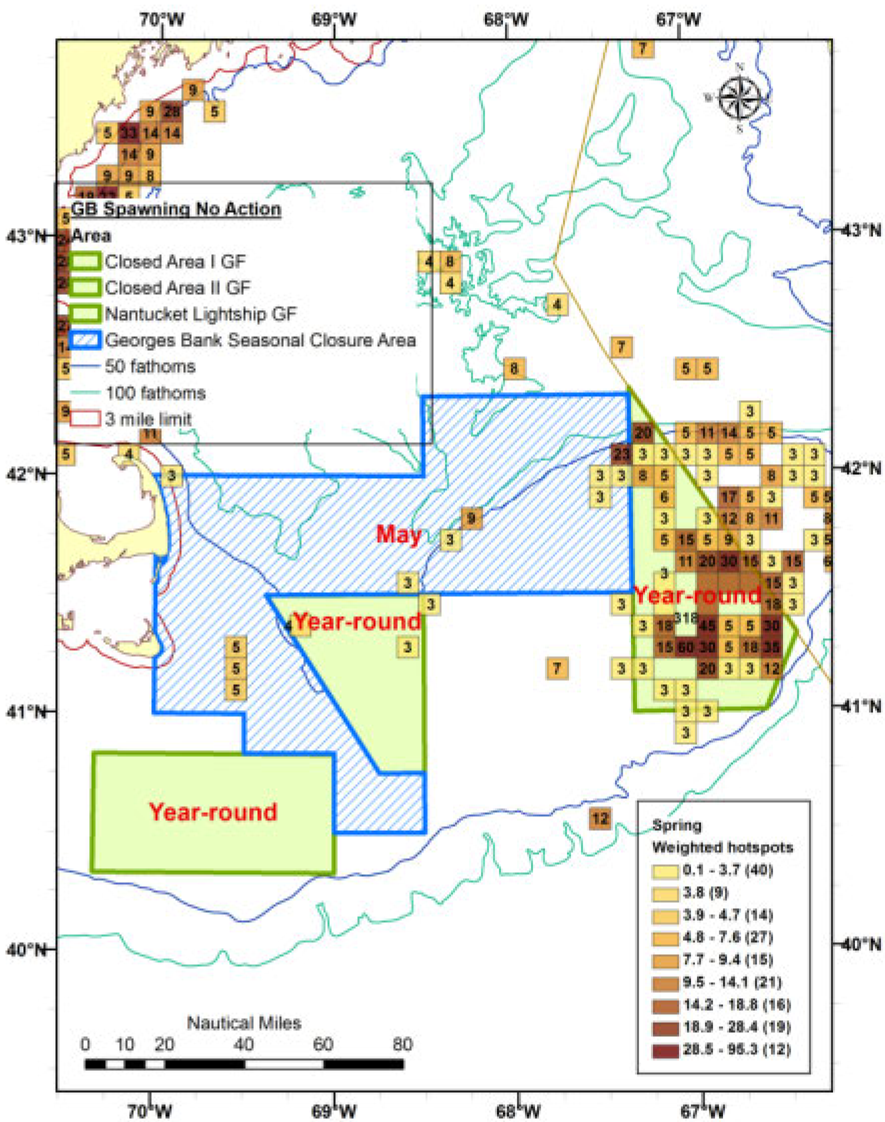
Hotspots in the Georges Bank/southern New England region for other groundfish species were relatively sparse, including hotspots from cod catches. Only two cod hotspots were identified on the northern edge (Map 154), although a broader distribution of mature size cod are caught in the spring survey (Map 155). 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 155). Past observations indicated that cod and haddock spawn in this area during the spring, and 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 156). However, a considerable proportion of haddock were 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 157).

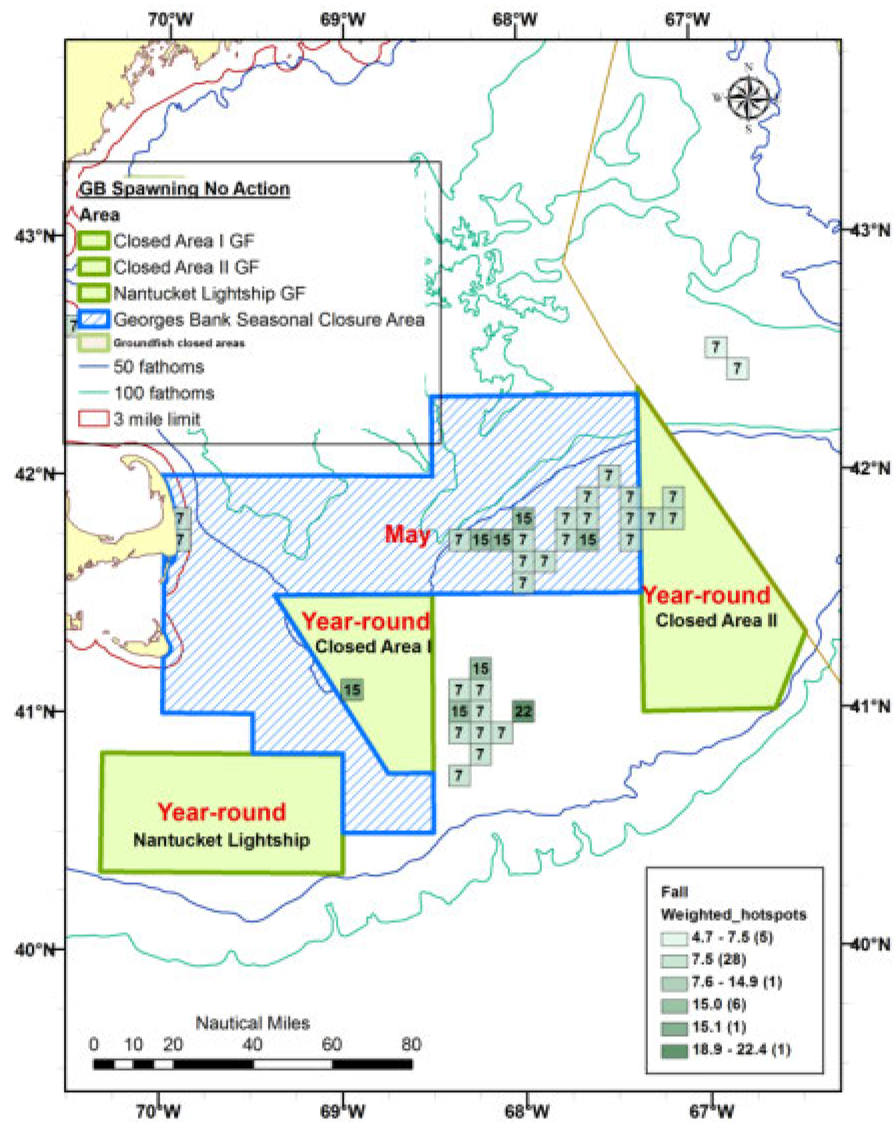
Table 43 – Total number of large spawner hotspots by species, management area, and survey season in the Georges Bank/Southern New England region.

	Acadian redfish	American plaice	Atlantic herring	Cod	Goosefish	Haddock	Ocean pout	Red hake	Silver hake	Windowpane flounder	Winter flounder	Yellowtail flounder	Grand Total
Georges Bank/Southern New England													
Groundfish closure	2	1	1	1		84	1	8	6	10	23	96	233
Closed Area I GF	2	1	1			8	1	7	6		14		40
Spring	1					1							2
Summer						1					14		15
Fall	1	1	1			6	1	7	6				23
Closed Area II GF				1		74		1		4	9	96	185
Spring				1		66				1	2	46	116
Summer											7	17	24
Fall						5		1		3		33	42
Winter						3							3
Nantucket Lightship GF						2				6			8
Summer						2							2
Winter										6			6
Spawning area	15	5	41	1	1	15		119	44	25	3		269
Georges Bank Seasonal Closure Area	15	5	41	1	1	15		119	44	25	3		269
Spring		5	5	1		8		21					40
Summer	2				1	2		2			3		10
Fall	13		36			5		96	44	23			217
Winter										2			2

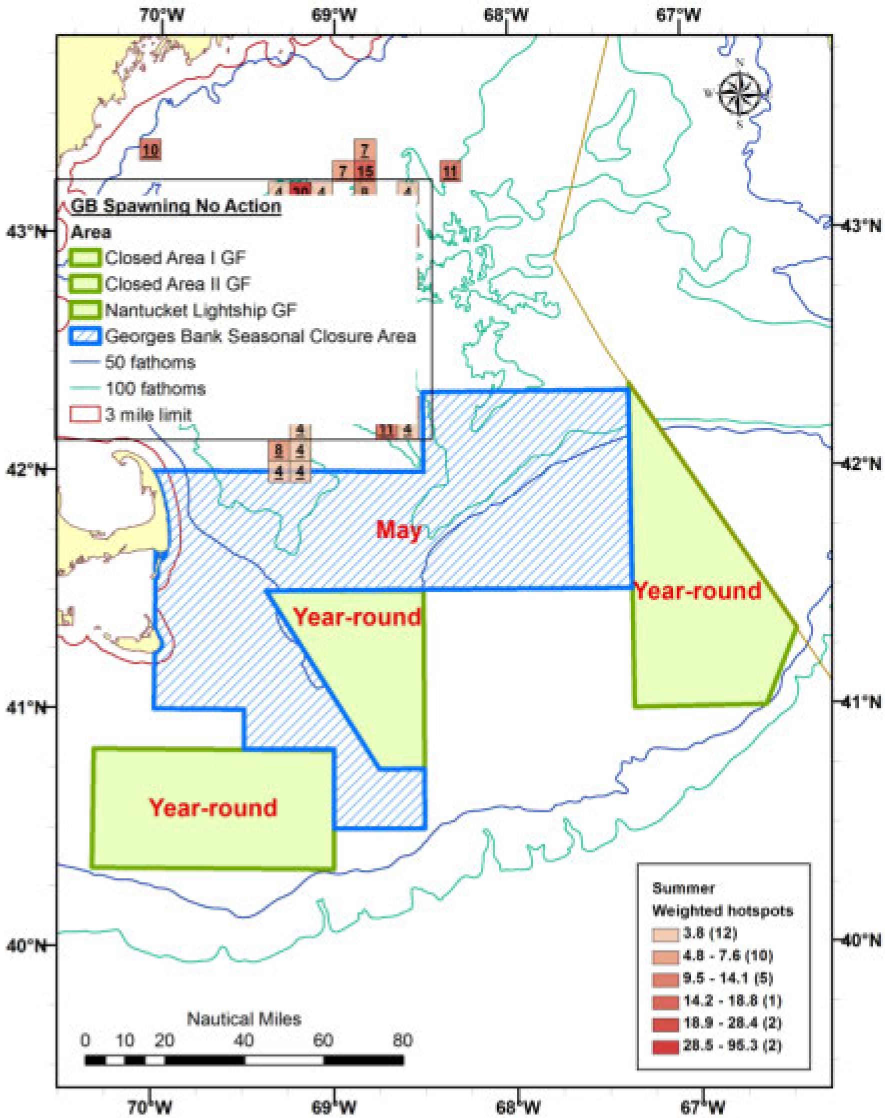
Map 153 – Distribution of weighted large spawner groundfish hotspots in the Georges Bank/Southern New England region by season, derived from 2002-2012 NEFSC, MADMF, and IBS survey data. Continued on the next page.

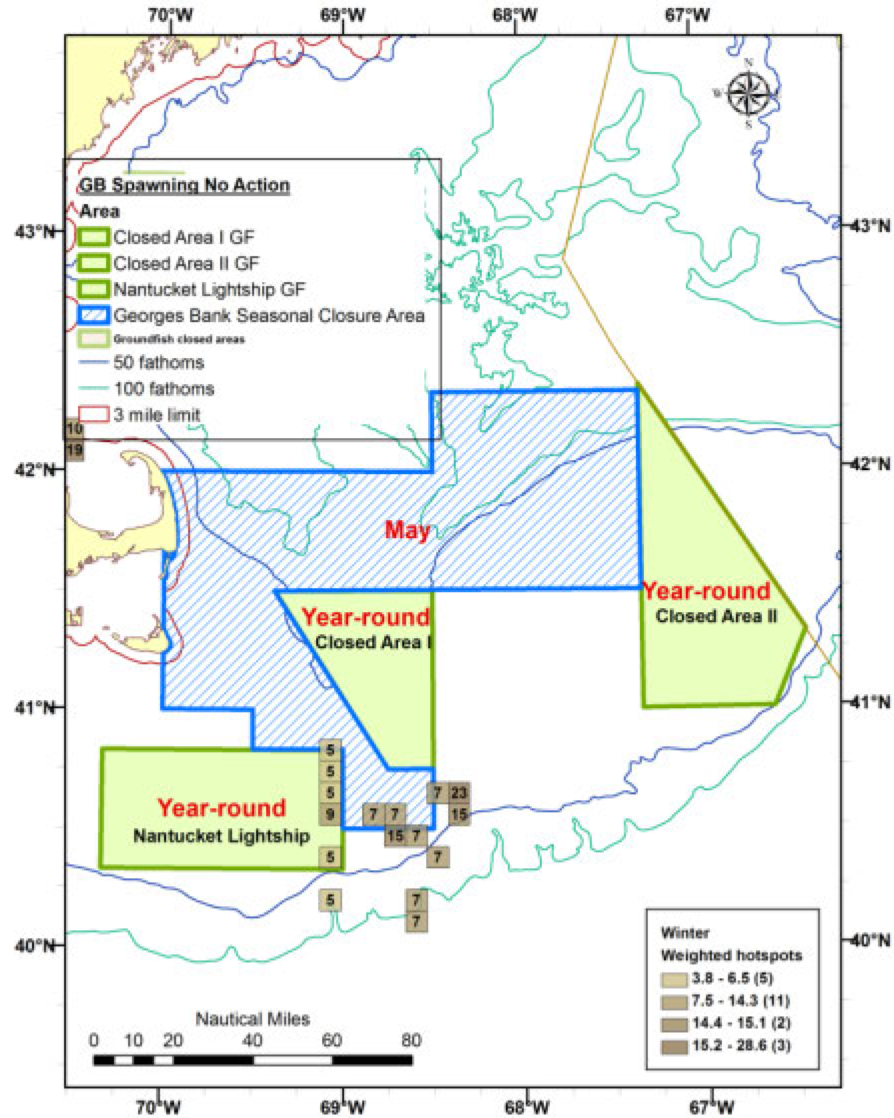
Spring	Fall



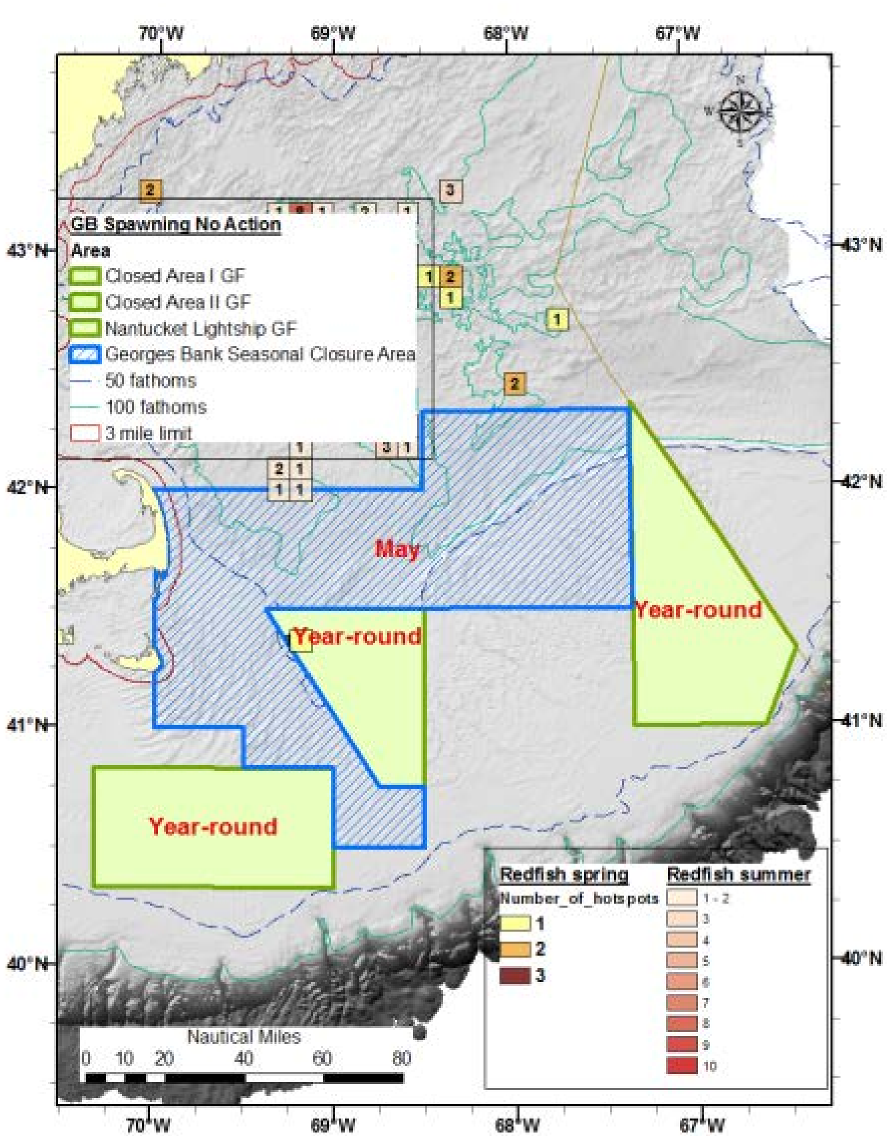
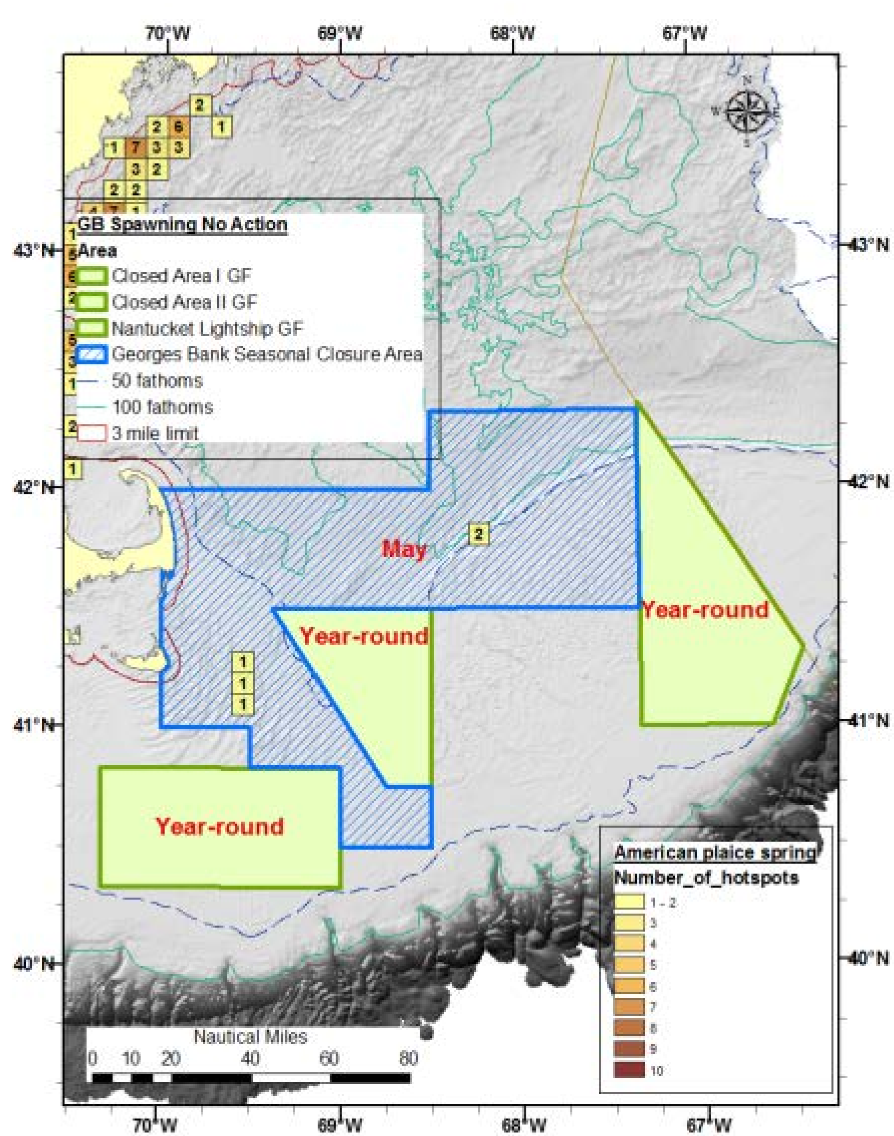


Summer	Winter

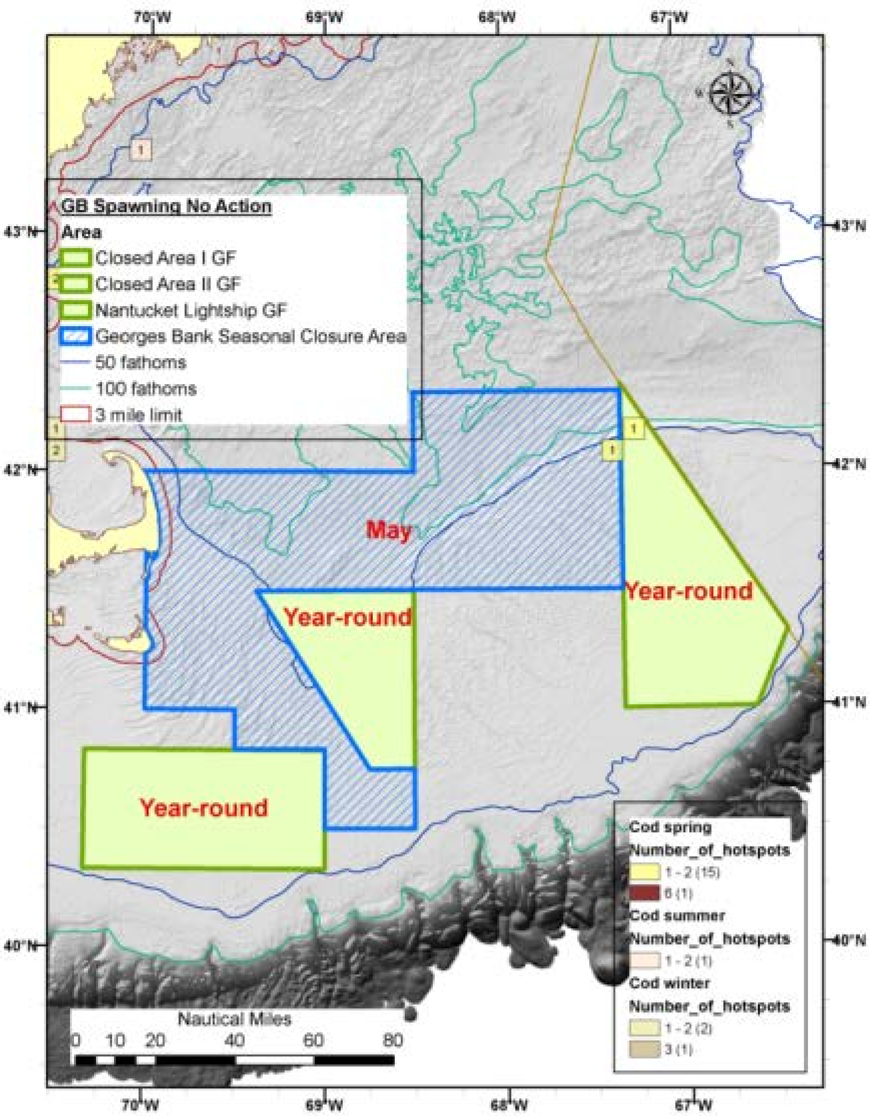


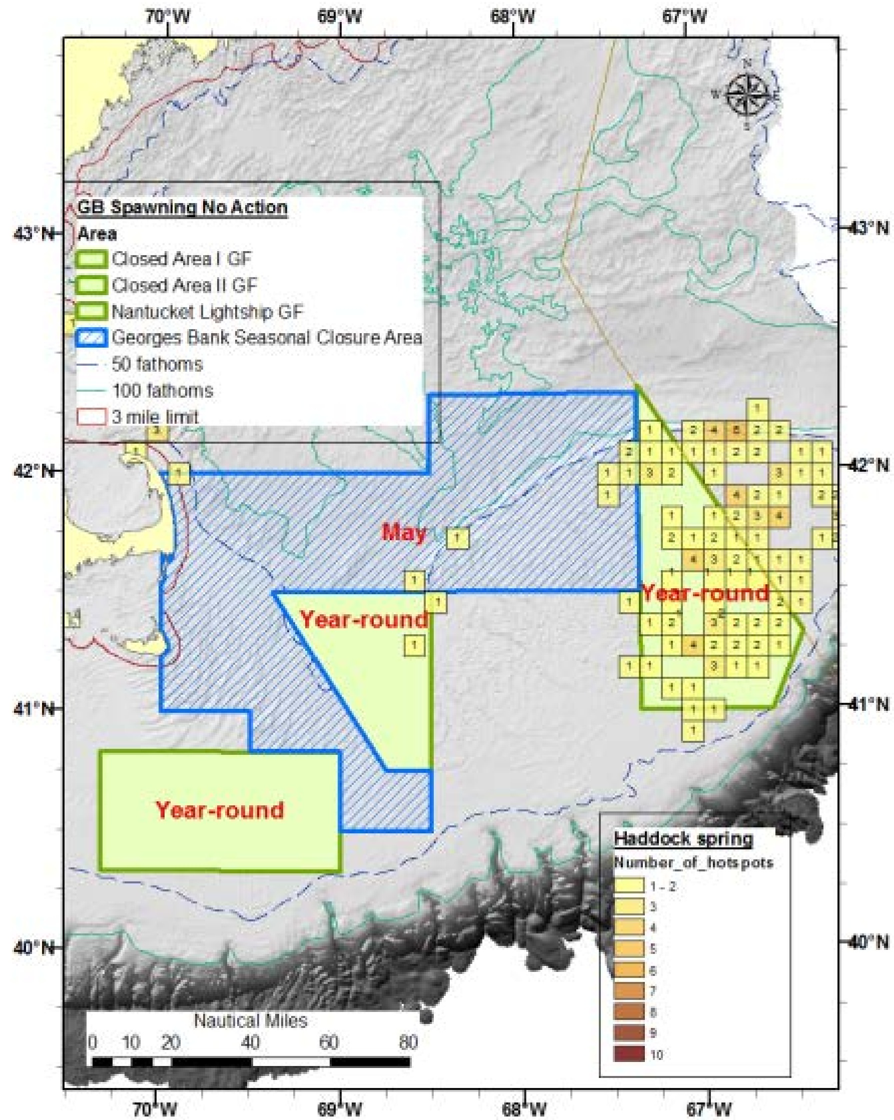


Map 154 – Seasonal distribution of large spawner hotspots for individual groundfish species in the Georges Bank/Southern New England region identified from 2002-2012 NEFSC, MADMF, ME-NH, and IBS trawl surveys. Continued on the following 6 pages.

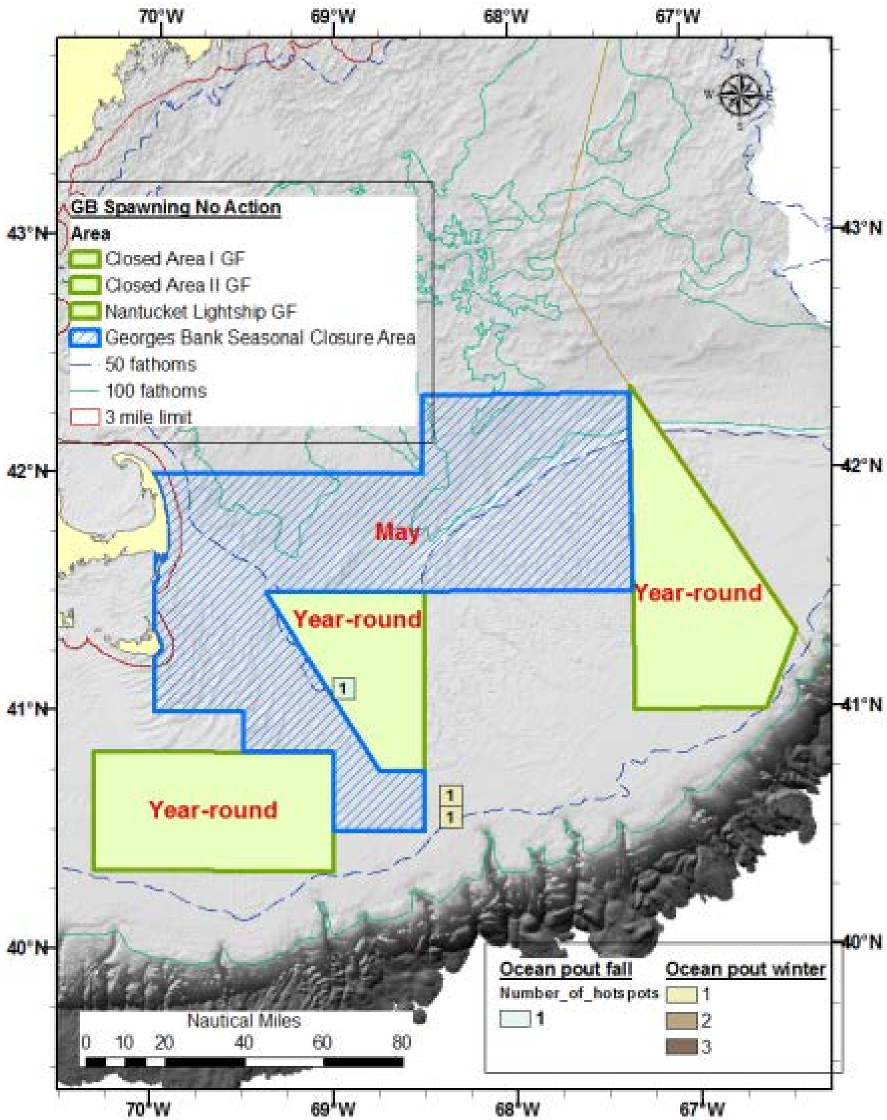
Acadian redfish	American plaice
	

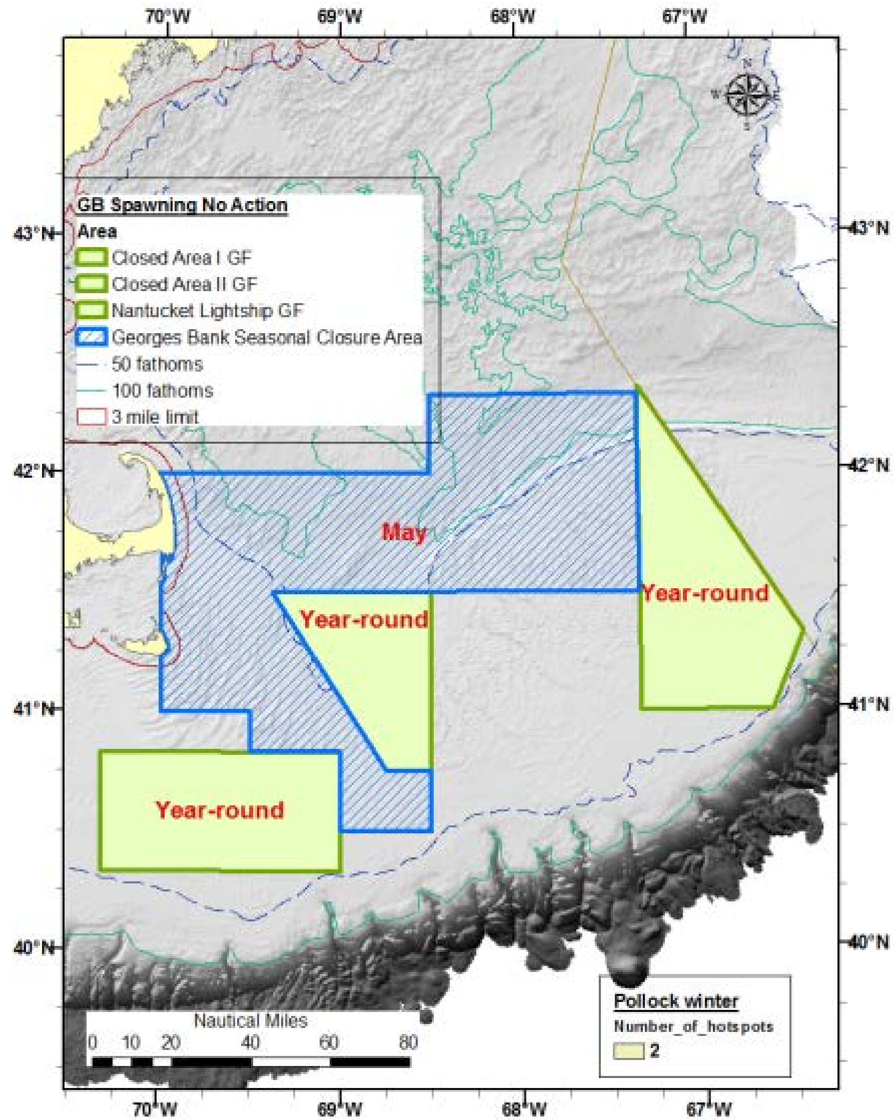
Cod	Haddock


70°W
69°W
68°W
67°W
43°N
42°N
41°N
40°N
GB Spawning No Action
Area
Closed Area I GF
Closed Area II GF
Nantucket Lightship GF
Georges Bank Seasonal Closure Area
50 fathoms
100 fathoms
3 mile limit
May
Year-round
Year-round
Year-round
Cod spring
Number_of_hotspots
1 - 2 (15)
6 (1)
Cod summer
Number_of_hotspots
1 - 2 (1)
Cod winter
Number_of_hotspots
1 - 2 (2)
3 (1)
Nautical Miles
0 10 20 40 60 80

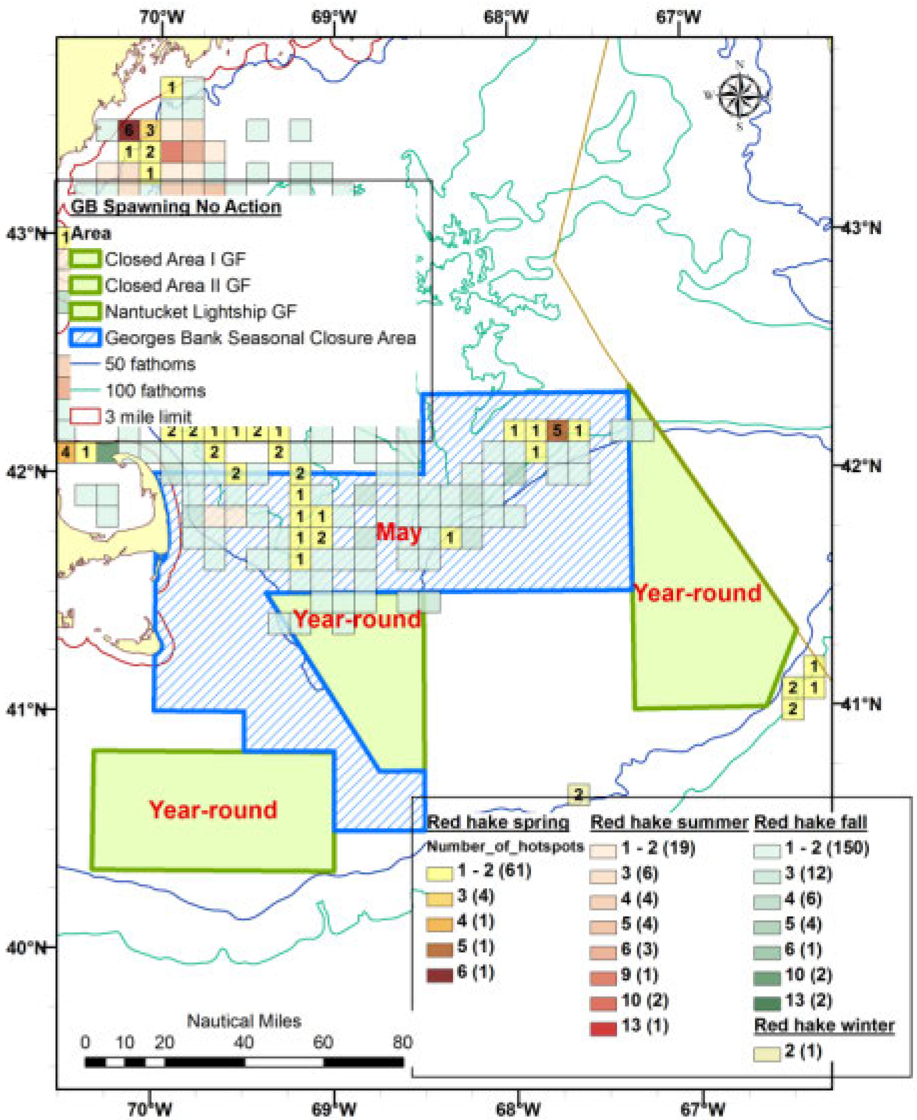

70°W
69°W
68°W
67°W
43°N
42°N
41°N
40°N
GB Spawning No Action
Area
Closed Area I GF
Closed Area II GF
Nantucket Lightship GF
Georges Bank Seasonal Closure Area
50 fathoms
100 fathoms
3 mile limit
May
Year-round
Year-round
Year-round
Haddock spring
Number_of_hotspots
1 - 2
3
4
5
6
7
8
9
10
Nautical Miles
0 10 20 40 60 80

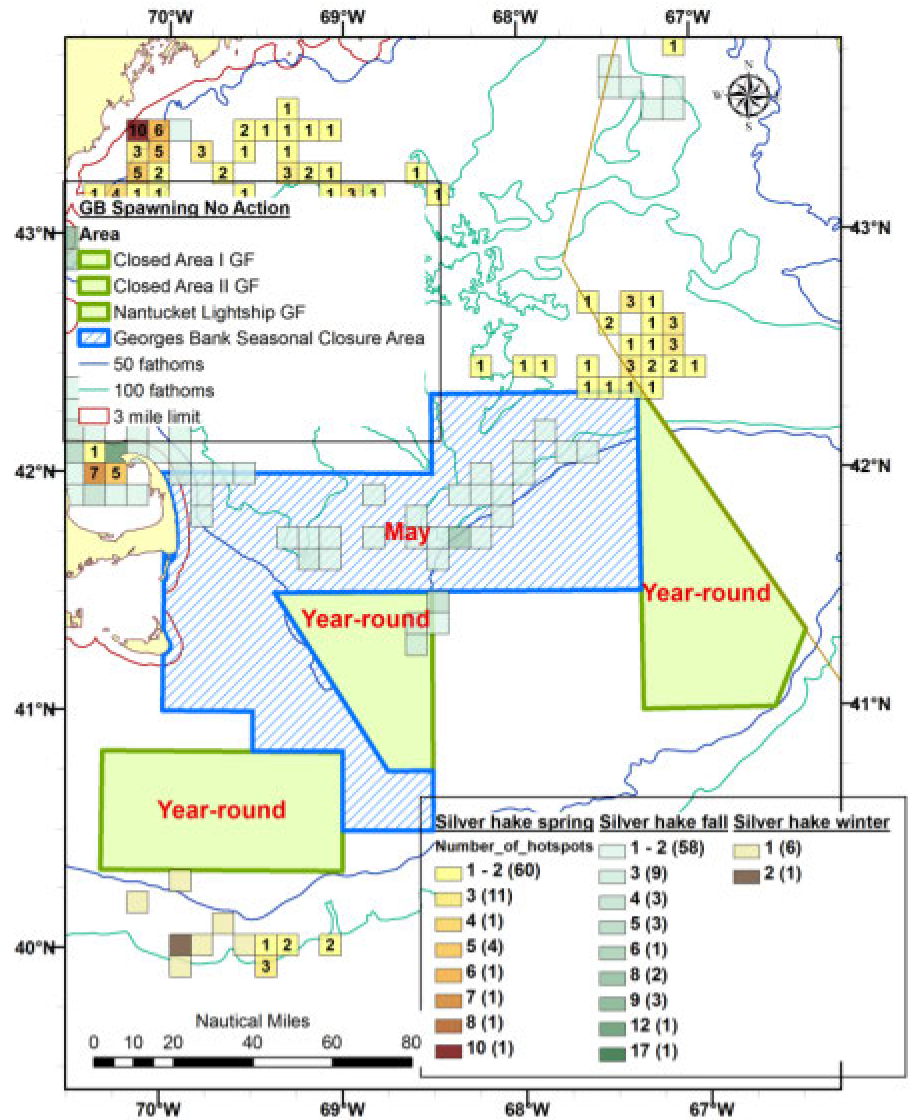
Ocean pout	Pollock



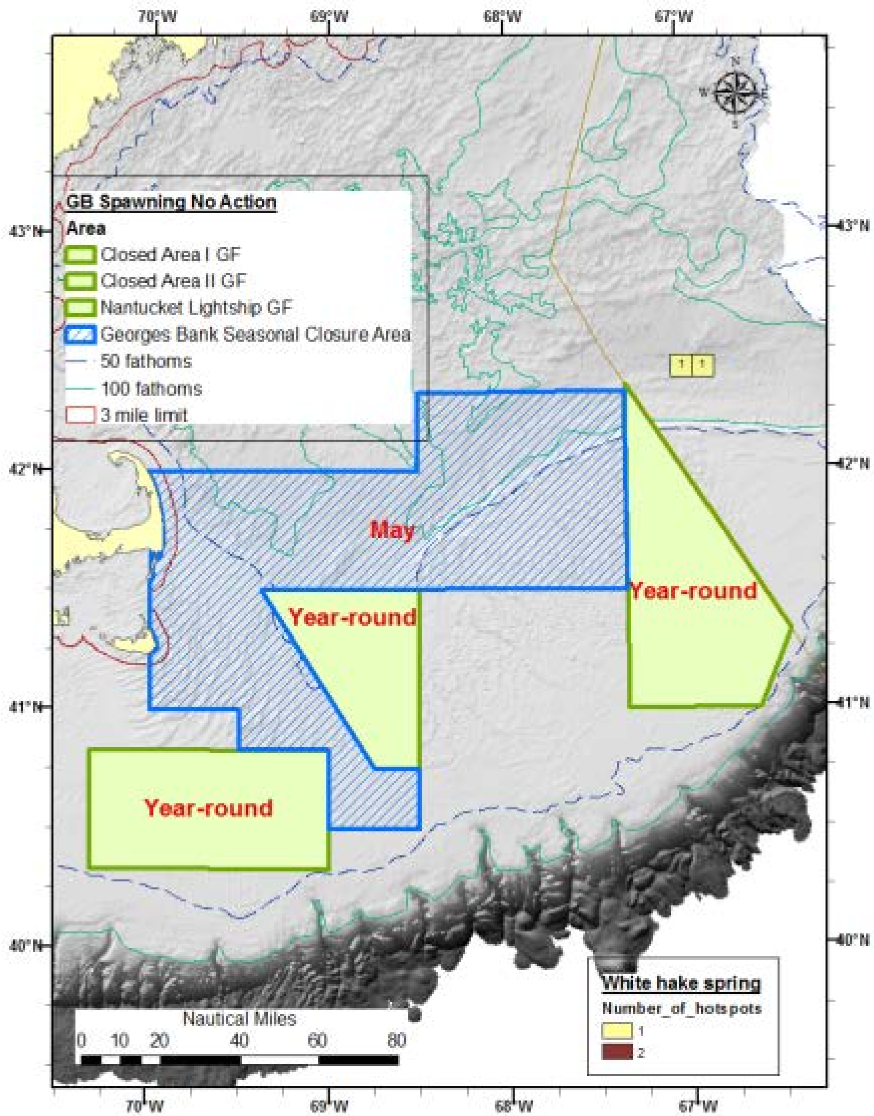


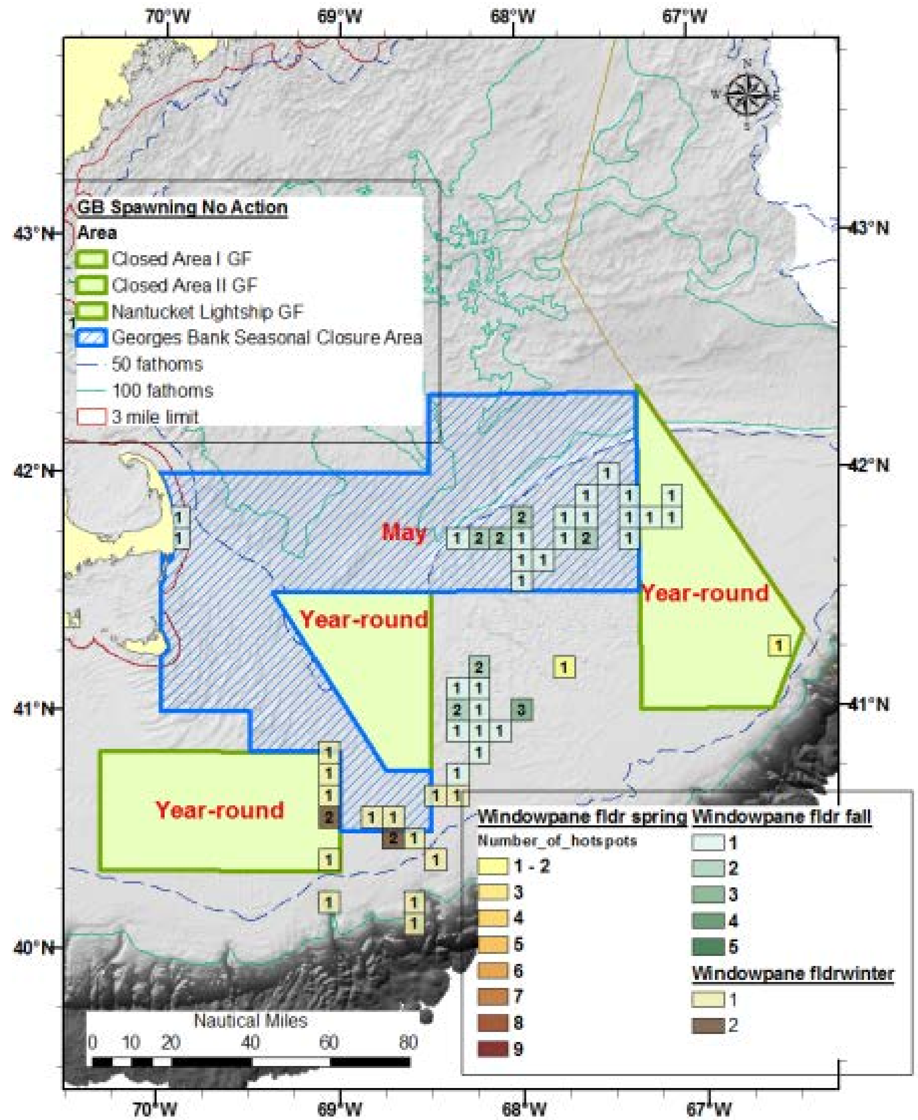
Red hake	Silver hake



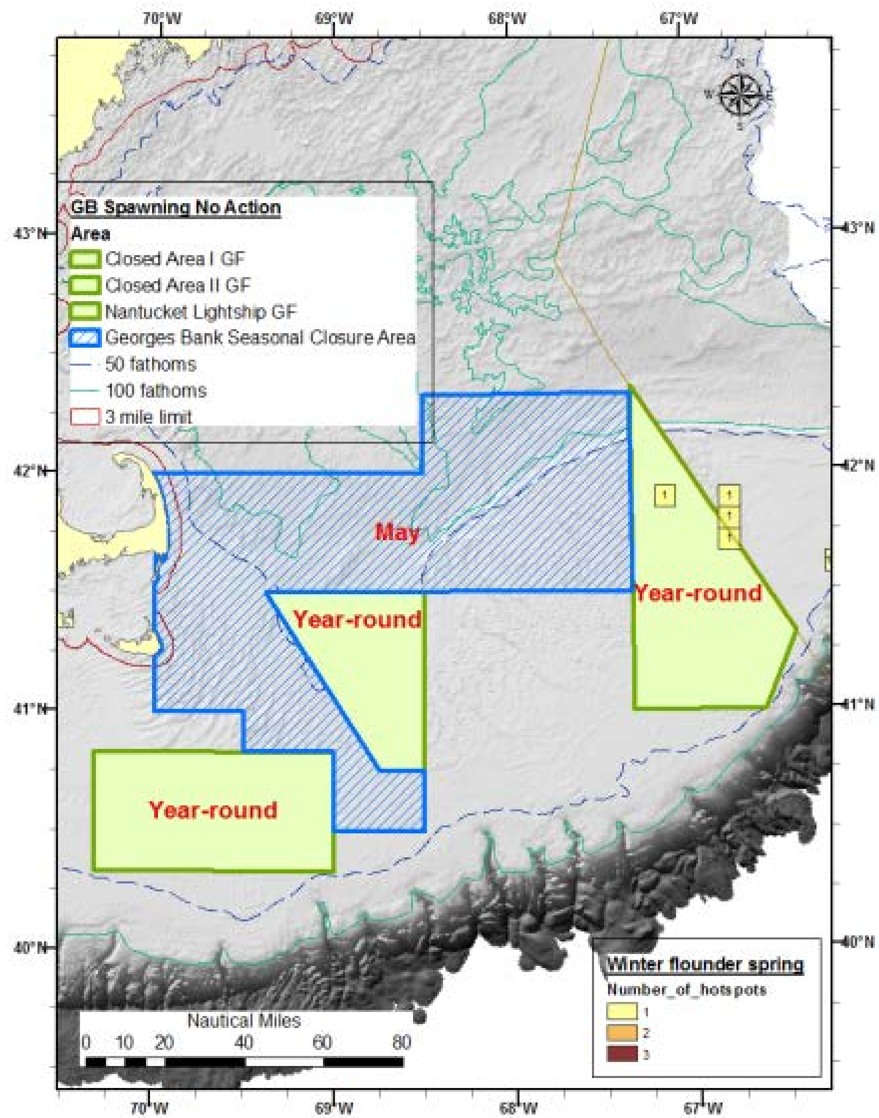


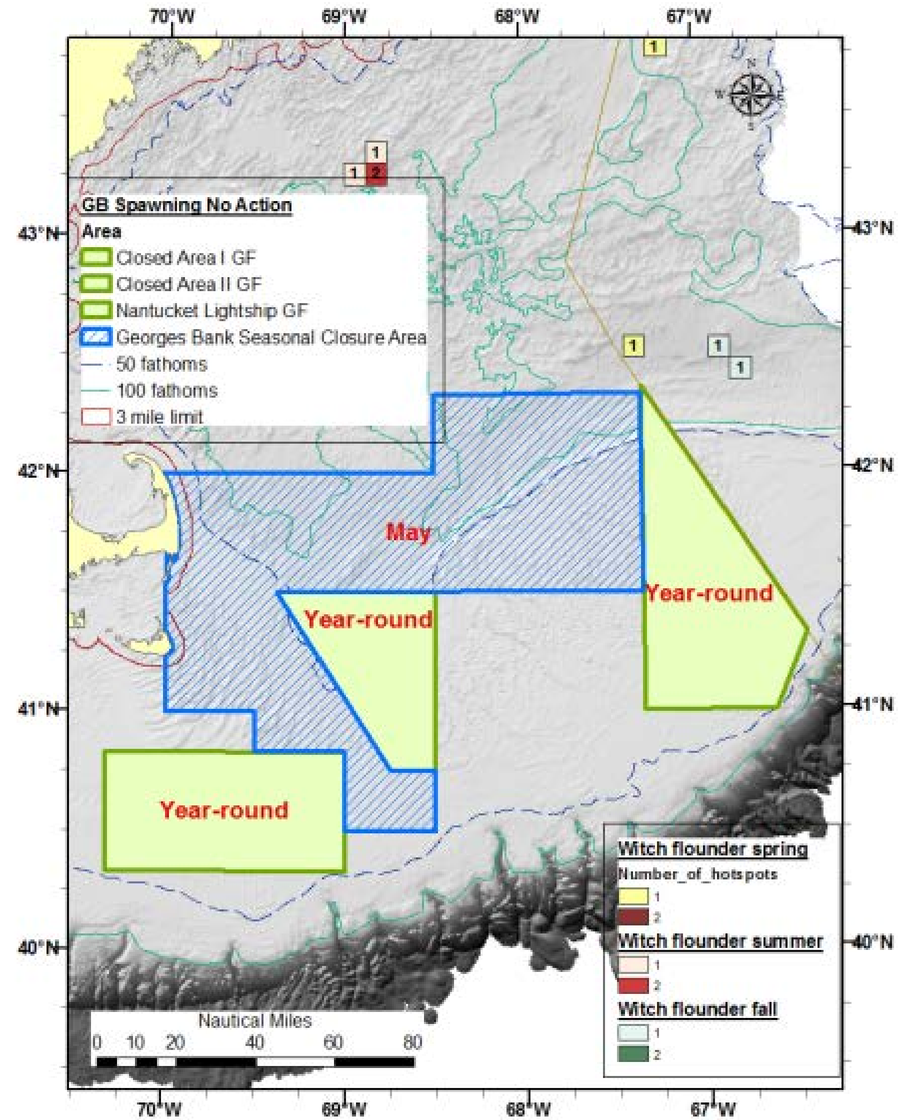
White hake	Windowpane flounder



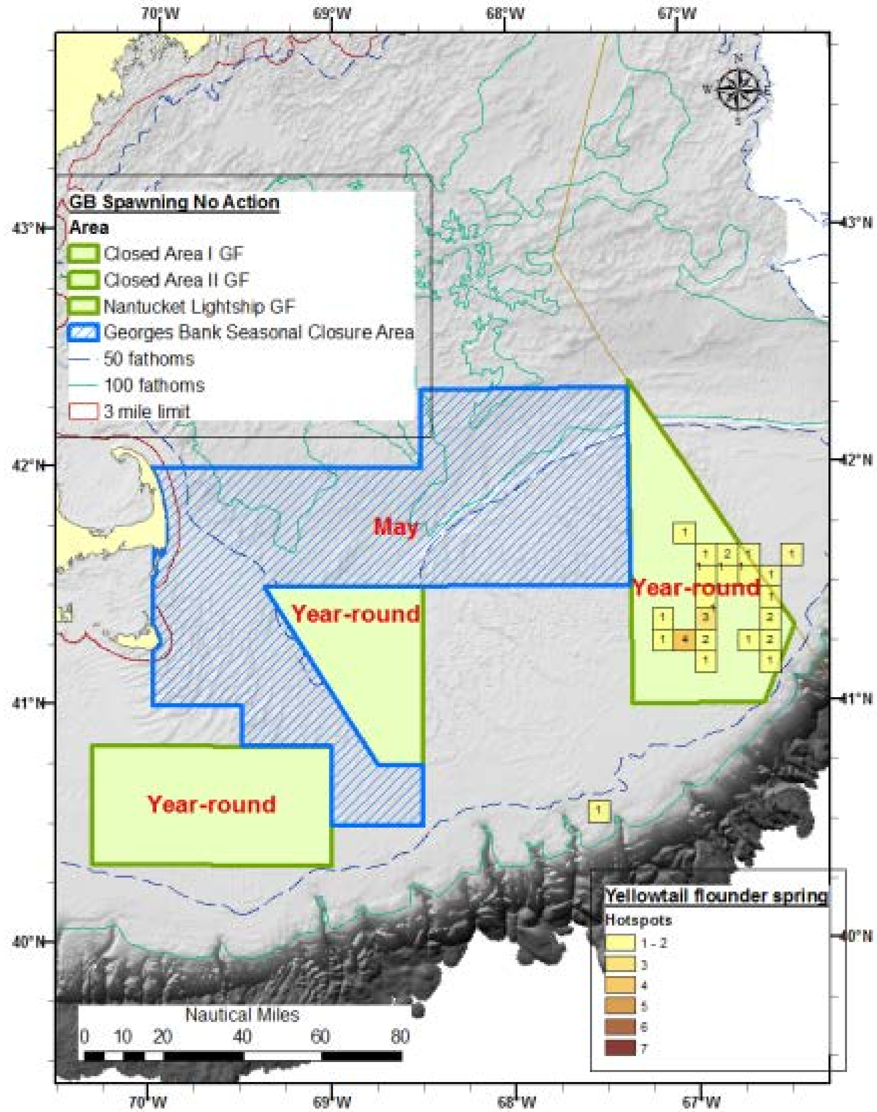


Winter flounder	Witch flounder

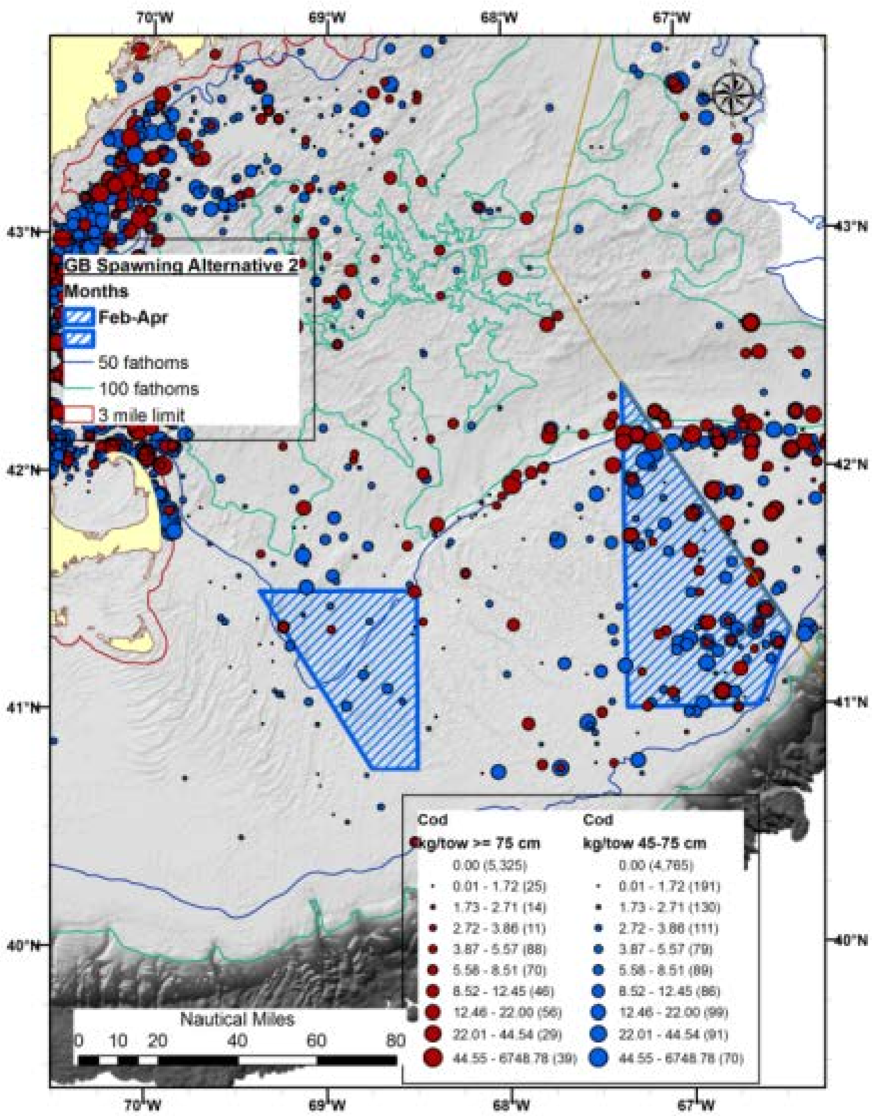


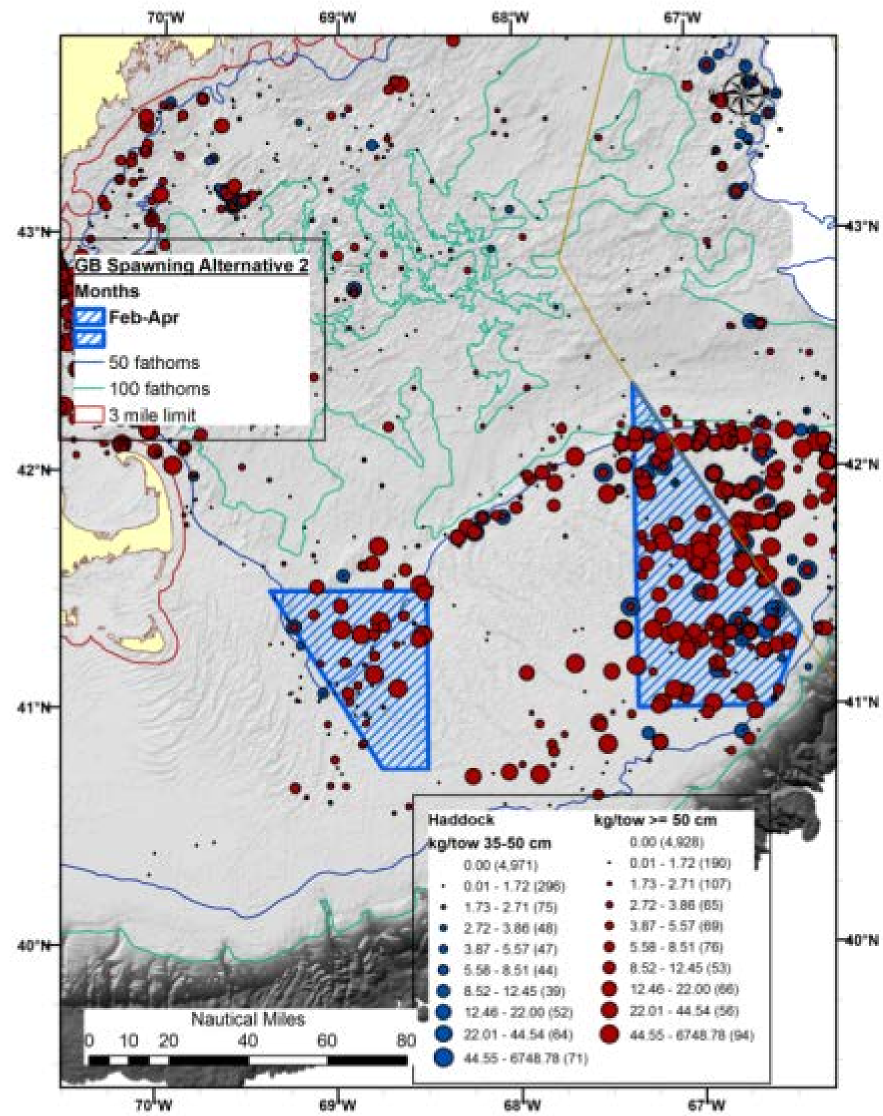


Yellowtail flounder

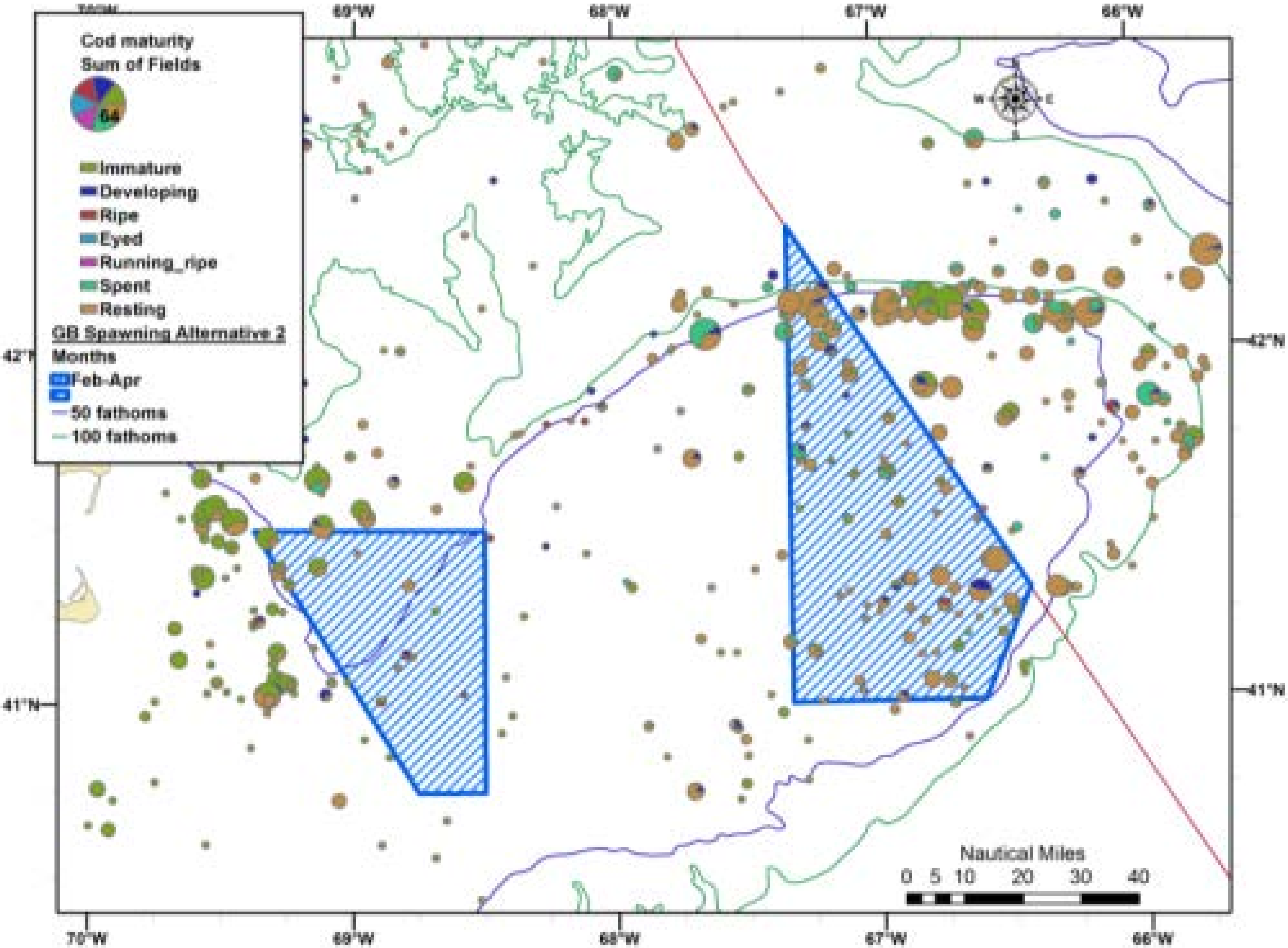


Map 155 – Distribution of cod (left) and haddock (right) by small and large mature fish size classes during spring and summer surveys of Georges Bank during 2002-2011.

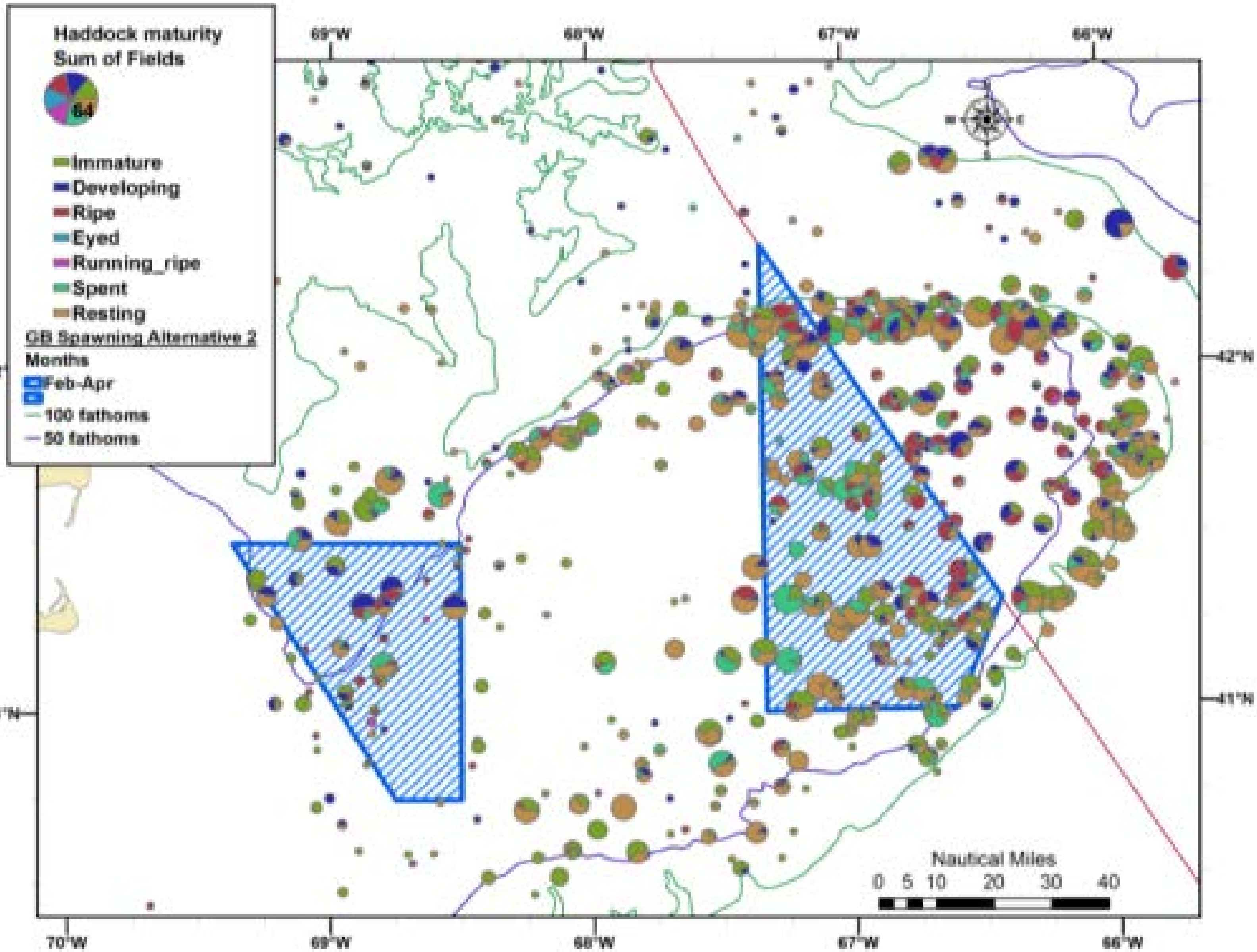




Map 156 – Distribution of cod by maturity stage during 2002-2011 surveys.



Map 157 – Distribution of hadock by maturity stage during 2002-2011 surveys.



4.5 Comparison of vessel trip report and sea sampling data with dealer-reported landings

Three sources of fishery distribution data were used in various parts of this document: dealer reported landings data, vessel trip reports (VTR), and sea sampling[12]. A summary of fishery data from these three sources was compiled, comparing 2005-2012 reporting and sampling frequency by the ratio of landings, revenue[13], number of vessels[14], number of dealers[15], trips[16], and where possible, days fished[17]. These comparisons are made for each major gear category in the tables below and in the discussion that follows. Landings made by vessels fishing in the Mid-Atlantic region (statistical areas > 600) were excluded (Map 158), since this amendment proposes no management changes in the Mid-Atlantic region.

Assuming that dealer-reported landings provide a complete picture of landings by gear type, the question these tables attempt to answer is what fraction of those landings are represented in the VTR or sea sampling data. This answer helps to put the economic analyses into context because VTR data, which can be used to locate fishing effort within specific management areas, are used to estimate potential revenue displacement under potential management scenarios. Secondarily, sea sampling data are presented in various parts of this document and the fraction of effort represented by sea sampled trips is important for putting conclusions from sea sampling data in context.

Landings and other information about commercial fishing trips are reported by federally and state permitted dealers, via either electronic or manual report submission. State permitted dealers usually report to their respective state agencies, which aggregate the monthly landings information for the dealer-reported landings data maintained by the NEFSC. Other sources of landings (e.g. IVR (Interactive Voice Response)/quota reports and law enforcement confiscations) also work their way into these landings data. Collectively, these data are considered to be the complete truth (and nothing but) for assessment and monitoring purposes, although we know that some landings do not appear in dealer reports (e.g., over the side sales by fishing vessels and sales to non-traditional entities). By themselves, these landings data do not include much information about location fished and are not useful for analyzing impacts of specific and relatively small management areas. These data are the appropriate and only source of information about prices paid to fishermen. All dealer data were used in the summaries and

[12] Sea sampling includes data from the observer and at-sea monitoring programs.
[13] Revenue for VTRs was estimated by applying the appropriate price per pound derived from landings reported by dealers, applied to the VTR hail weights assigned to reported fishing locations.
[14] Number of unique vessels landing at each dealer, number of vessels making VTR reports, or number of unique vessels sampled in a calendar year, depending on the data source.
[15] Number of dealers reporting landings, number of unique dealers sold fish on VTR reports, number of dealers sold fish on observed trips, depending on the data source.
[16] Trips are defined as a landings by a vessel on a unique date in dealer data (landings are multiple dealers are counted once if they occur on a common date), or defined as the number of unique trip identifiers on VTR reports, or by the number of observed trips, depending on the data source.
[17] Days fished are assigned to dealer landings data based on reports with matching VTR serial numbers, by the total hours towed/fished reported on VTRs, or on actual set and retrieval times of individual tows on observed trips.

comparisons made in the following sections, regardless of whether or not the data matched reported VTR trips.

Vessel trip reports (VTRs) are required for all trips by federally permitted vessels in most regulated fisheries. However, some fisheries occurring in Federal waters do not require vessel trip reports if the vessel only holds a Federal permit for that fishery. Examples include vessels operating only in the lobster and shrimp fisheries in Federal waters. However, if the vessel holds other Federal fishery permits, submission of a VTR on these trips is required. Other fishery data reports are made through other systems, such as the IVR system for the surf clam and ocean quahog fishery.

Ideally, landings from the VTRs should match the dealer-reported landings with some allowance for errors in estimating hail weight, or changes in fish weight while in the fish hold. The ratio of VTR landings to dealer reported landings should equal one. In practice, however, the VTR data is usually close to the dealer reported landings but differences exist. Some landings may occur without being reported by dealers. The form of landings or hail weight (i.e. whole, gutted, dressed, etc.) may not be reported consistently between vessels and dealers. Some types of vessels may furthermore not be required to submit VTRs if they hold no other types of Federal fishing permits that do have this requirement. Another factor is the quality or existence of location fished information. VTR data with invalid latitude/longitude pairs were excluded from the analyses in this document, because the questions being asked related to the amount of fishing within or near specific management areas. In general reports without specific coordinates are relatively infrequent. Alternatively, landings from state waters may not be reported by dealers participating in the Federal SAFIS system. These landings may or may not be reported by fishermen on VTRs.

VTRs that account for 80+ percent of dealer reported landings are considered to be a good representation of the total amount of activity in a particular fishery. Lower proportions for some fisheries exist due to differences in reporting requirements. Even if the VTR data account for only 50-80% of total dealer reported landings they may still be representative; however, there could be biases by vessel size or other factors. It is thought that vessels fishing in state waters or in fisheries not regulated by Council FMPs would be underrepresented by the VTR data, but the VTRs may still adequately represent fishing activity in Federal waters, where most of the proposed management areas are located. Exceptions to this theory may be the offshore lobster trap fishery and the northern shrimp fishery. Some vessels in these fisheries do not have other Federal fishing permits and are therefore not required to submit VTRs regardless of whether they are fishing inshore or offshore.

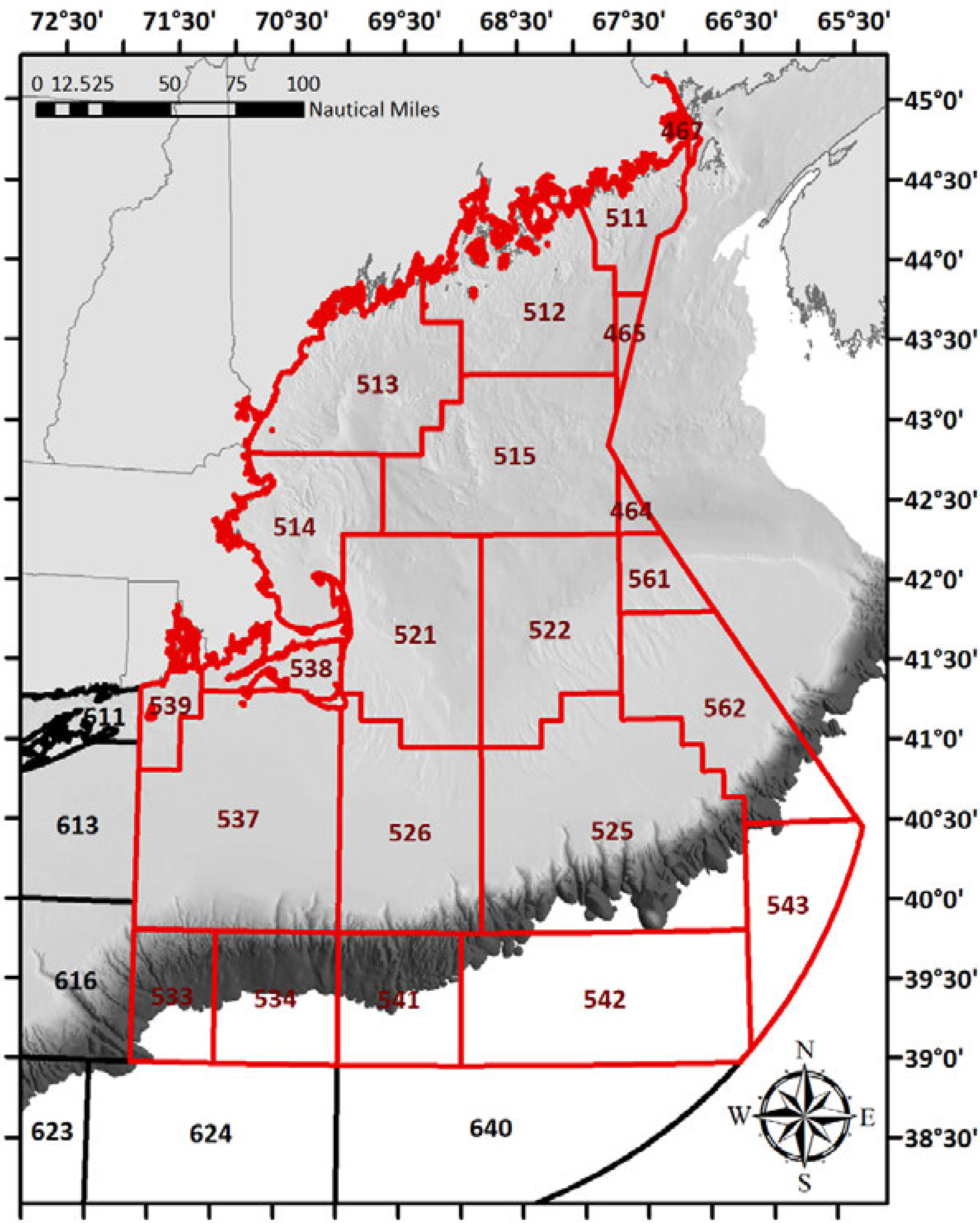
VTR data were used in this document in a variety of ways, including plotting and analyzing the location of fishing activity by fishermen using gears that would be restricted or prohibited in Habitat Management Areas, Spawning Management Areas, and Dedicated Habitat Research Areas. The data were also used in various ways in this amendment to characterize fishing activity with respect to substrate and groundfish hotspot distributions. Finally, VTR data were used to characterize the general distribution of effort in a particular fishery, especially when sea sampling did not adequately represent locations where fishing is known to occur.

By itself, VTR fishing location data is relatively imprecise for an individual trip, but can give a general picture of activity when aggregated over many fishing trips during a year. Fishermen are instructed to submit a gear report to represent fishing activity within a three digit statistical area (Map 158) using a single type of gear. This instruction can result in multiple reports for a single trip that fishes in more than one statistical area or uses more than one type of gear (e.g., mesh size changes would require a new VTR). Analysis of observed trips has shown that trips with longer durations frequently cover a wider area and fish in more statistical areas as compared to shorter trips. For the analysis of economic impacts, a statistical model was developed to estimate the probability of fishing with distance around the single point locations submitted in VTR data. This model is described in the introduction to the environmental impacts of spatial management alternatives section of the document.

Sea sampling data (observer and at-sea monitoring) are more spatially precise than VTRs, but only a fraction of total trips are sampled, an amount that varies by gear type, fishery, and season, following an algorithm and procedure from the Standard Bycatch Reporting Methodology (50 CFR §648.11). In most federally regulated fisheries, the sampling frequency is adequate to characterize the catch and fishing activity. For these fisheries, the SBRM procedures are designed to make sampling representative of the fishery as a whole to provide accurate and satisfactorily precise estimates of bycatch. Trips in some fisheries are sampled infrequently, however, because the fishery rarely interacts with marine mammals and/or has relatively low bycatch of other managed species.

For fisheries with low sampling frequencies of a percent or two, it would be difficult to make a case that the sea sampling is representative of the fishery as a whole, and furthermore, there may be biases in location and levels of catch related to vessel size and the frequency of trips. Smaller vessels fishing closer to shore and who may take less frequent trips may be undersampled, even though according to the SBRM procedures these trips should be sampled as frequently as other trips. On the other hand, many Federal fisheries are sampled at rates (measured by the proportion of total landings observed) that are 15 percent or more. In these fisheries, the sea sampling data is considered to be representative of the fishery.

Map 158 – Statistical reporting areas used to characterize fishing activity in VTR data. Areas shown in red were included; those in black were excluded.



4.5.1 Bottom trawls

Standard bottom trawls are used to target a relatively wide variety of species in many areas, including regulated large-mesh groundfish, monkfish, silver hake (whiting), and skates. Some landings from trips using this gear are from state-permitted vessels fishing in state waters, which do not have VTR submission requirements and are unlikely to be sampled by the Federal observer program. Excluded from this analysis were vessels using shrimp trawls. Also excluded were trips reported to be using Ruhle or separator trawls, whether or not the vessel was fishing in a SAP. VTR reporting and sea sampling frequency for these gears are summarized and analyzed in other sections below.

During 2012, dealers and states reported 118.3 million pounds of landings, 9.2 million pounds by vessels < 50 feet, 33.7 million pounds by vessels between 50 and 70 feet, and 75.5 million pounds by vessels ≥ 70 feet. Total revenue paid to vessels was reported to be $116.1 million for 12,764 reported trips.

Based on the proportion of reported landings, trips reported via VTRs accounted for 85.5 percent of landings reported by dealers and states, ranging from 82.3 to 86.5 percent by vessel size (Table 44). The proportion of total landings represented by VTRs has been relatively constant since 2005. VTR reports also accounted for 77.0 percent of vessels with landings reported by dealers and 88.5 percent of dealers reporting landings by vessels using bottom trawls.

Sea sampling of trips using bottom trawls was also fairly good during 2012. Sampled trips represented 17.5 percent of dealer-reported landings. Sampling was, however, about 50 percent more frequent on trips made by vessels ≥ 70 feet (19.9 percent) than for trips made by vessels < 50 feet (12.6 percent). Vessels that were sampled represented 42.6 percent of the total number of vessels with landings reported by dealers and landings on sampled trips were made at 25.3 percent of reporting dealers. These results suggest some bias toward more frequent sampling on larger vessels landing at more active dealers. Sampling frequency on observed trips declined from 2005 levels, but has since steadily risen until 2011 with a slight decline in 2012.

Although it appears that there could be a bias in sea sampling data that underrepresents smaller vessels (which often take shorter trips closer to port) and both sea sampling and VTRs miss some landings by state-permitted vessels, the analysis suggests that both types of data are sufficient for use in the spatial analyses in this document. Using VTR reported landings, the potentially displaced bottom trawl revenue from habitat, spawning, and research areas may be underestimated by about 20 percent.

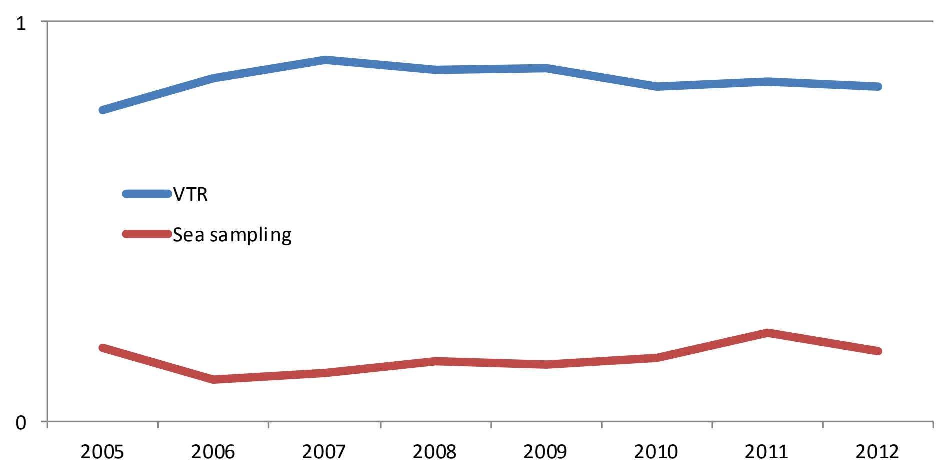
Table 44 – <u>Bottom trawls</u>: Ratio of Federal VTR reports and observed trips (OBDBS & ASM) to dealer reported data during the 2012 calendar year for trips fishing in statistical areas 464-465 and 511-562 (Gulf of Maine, Georges Bank, and Southern New England), with trends in VTR reported landings and landings from observed hauls to dealer landings ratios from 2005-2012.

	Vessel length	Reported total landings (live, million lb)	Reported total revenue	Individual dealers	Individual vessels	Reported trips	Days fished
Dealer (CFDBS/SAFIS /State, all sources)	**All**	**118.3**	**116.1**	**1727**	**2423**	**12,764**	**13,620**
	< 50 ft	9.2	11.1	420	677	5,863	3,353
	50-70 ft	33.7	32.0	563	678	4,288	3,386
	>= 70 ft	75.5	73.0	744	1068	2,613	6,882

	Vessel length	Reported landings (%)	Estimated revenue (%)	Reported dealers (%)	Reporting vessels (%)	Reported trips (%)	Reported days fished (%)
VTR, good position information	**All**	**85.5%**		**88.5%**	**77.0%**	**102.4%**	**84.3%**
	< 50 ft	82.3%		76.7%	52.0%	75.8%	94.4%
	50-70 ft	86.5%		93.8%	82.0%	102.5%	104.7%
	>= 70 ft	82.8%		84.8%	87.5%	158.4%	67.9%

	Vessel length	Landings sampled (%)		Dealers sampled (%)	Vessels sampled (%)	Trips sampled (%)
Sea sampling	**All**	**17.5%**		**25.3%**	**42.6%**	**22.0%**
	< 50 ft	12.6%		17.9%	23.3%	11.9%
	50-70 ft	13.7%		26.8%	41.6%	20.2%
	>= 70 ft	19.9%		28.2%	55.2%	47.4%

Trend in ratio of landings to dealer data



4.5.2 SAP bottom trawls

In about 2005, vessels began using a special type of modified bottom trawl to target species like haddock while avoiding capture of other groundfish species, particularly flounders and cod in the Northeast Multispecies FMP Special Access Programs (SAP). Since 2008, fishermen and dealers have used a unique gear code on VTRs to report trips using this type of gear. Fishing using this gear type has been analyzed separately in several portions of this document because the fishery footprint is much different (and generally more offshore using large vessels) than the bottom trawl fishery summarized above.

During 2012, dealers reported landings of 1.6 million pounds with a value of $2.1 million by vessels using SAP bottom trawls on 61 trips (Table 45). Nearly all of the landings were by vessels greater than 70 feet. Overall, VTR landings represented 74.0 percent of dealer reported landings. Caution should be used when comparing the VTR data to dealer reported data in this case because gear codes may not have been consistently used (i.e., SAP trawl landings were reported as bottom trawl by dealers or fishermen on VTRs).

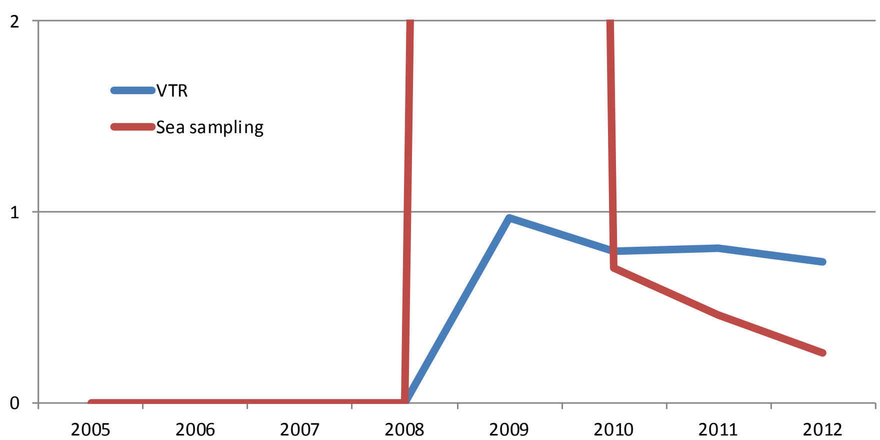
The landings on observed trips accounted for 26.5 percent of dealer reported landings. Here again, the comparison should be interpreted with caution, not only because dealers may have reported SAP trawl landings as bottom trawls, but also gears that did not meet the technical criteria as a SAP trawl were coded as a standard bottom trawl by observers (but yet may have been reported as a SAP trawl by dealers).

To the extent the data have allowed, the VTR data and sea sampling data appear to give a fair representation of SAP trawl fishing activity, although reporting inconsistencies add some degree of uncertainty to the results. Although we know that SAP trawl use occurred as early as 2005, the information does not appear in the various data sets until 2008. Therefore, total revenue from fishing that could be affected by the alternatives in this amendment would be underrepresented before 2008 and possibly since then, but this fishing activity was mixed into the standard bottom trawl reports and sampling described in the previous section.

Table 45 – SAP bottom trawls: Ratio of Federal VTR reports and observed trips (OBDBS & ASM) to dealer reported data during the 2012 calendar year for trips fishing in statistical areas 464-465 and 511-562 (Gulf of Maine, Georges Bank, and Southern New England), with trends in VTR reported landings and landings from observed hauls to dealer landings ratios from 2005-2012.[18]

	Vessel length	Reported total landings (live, million lb)	Reported total revenue	Individual dealers	Individual vessels	Reported trips	Days fished
Dealer (CFDBS/SAFIS /State, all sources)	**All**	**1.6**	**2.1**	**55**	**54**	**61**	**217**
	< 50 ft	0.0	0.0	1	1	1	1
	50-70 ft	0.1	0.1	11	8	15	16
	>= 70 ft	1.6	2.0	43	45	45	200
	Vessel length	**Reported landings (%)**	**Estimated revenue (%)**	**Reported dealers (%)**	**Reporting vessels (%)**	**Reported trips (%)**	**Reported days fished (%)**
VTR, good position information	**All**	**74.0%**		**132.7%**	**137.0%**	**269.1%**	**56.6%**
	< 50 ft	153.1%		200.0%	100.0%	100.0%	20.1%
	50-70 ft	29.3%		118.2%	112.5%	113.3%	90.1%
	>= 70 ft	75.9%		134.9%	142.2%	324.8%	54.0%
	Vessel length	**Landings sampled (%)**		**Dealers sampled (%)**	**Vessels sampled (%)**	**Trips sampled (%)**	
Sea sampling	**All**	**26.5%**		**90.9%**	**120.4%**	**124.7%**	
	< 50 ft	0.0%		0.0%	0.0%	0.0%	
	50-70 ft	52.2%		90.9%	100.0%	73.3%	
	>= 70 ft	25.4%		93.0%	126.7%	144.6%	

Trend in ratio of landings to dealer data



[18] The high ratio of sea sampling to dealer data prior to 2010 results from incomplete reporting of the use of this gear type in the dealer database when this gear was first being used. Since 2010, the ratios are more consistent with expectations, with most landings represented in the VTR data, and a smaller fraction represented in the sea sampling data.

4.5.3 Scallop dredges

Fishermen use scallop dredges to target sea scallops in the Mid-Atlantic region and on Georges Bank. Some scallop fishing with dredges also occurs in the Gulf of Maine. The greatest amount of landings comes from large vessels that have limited access permits, often staying at sea for several days to a week or more. There are also a considerable number of 'day-boat' scallop vessels that use small dredges under a limited access general category permit or in the Northern Gulf of Maine area, where fishing is subject to a lower daily catch limit. Dredges are considered to be mobile bottom-tending gear and as such could be directly affected by the proposed habitat, spawning, and/or research areas proposed by alternatives in this amendment.

During 2012, dealers reported landings of 257.7 million pounds worth $306.5 million (Table 46). These totals are converted to live weight and include non-target species that scallop vessels land. Over 500 dealers reported landings by 1,202 scallop dredge vessels from 4,909 trips accounting for 6,711 days fished. The total number of vessels and dealers may be overestimated in this summary due to landings being reported as coming from multiple statistical areas or vessels making landings in more than one state.

The VTR data appears to agree well with the dealer-reported data, accounting for 96.5 percent of total landings and 96.3 percent of vessels. A higher number of individual dealers (101.7 percent) and trips (106.6 percent) are associated with the VTR data as compared to the dealer data. Days fished appear to be reported differently in the VTR and dealer data. There does not appear to be much, if any, bias in VTR reporting by vessel size. Landings data on 2005-2012 VTRs also appear to accurately track dealer-reported landings.

The scallop dredge fishery also appears to be moderately well sampled by at-sea observers and monitors, with these data accounting for 7.4 percent of dealer-reported landings, 7.3 percent of the trips, with observed trips on 26.7 percent of the vessels with landings reported by dealers. Observed trips landed scallops and other species at 21.9 percent of the dealers reporting landings from vessels using scallop dredges. Smaller vessels (i.e., less than 50 feet) appear to be underrepresented in the sea sampling data, accounting for only 2.0 percent of the 8.9 million pounds reported by dealers. However, there is no reasons to suspect that the sampled vessels fish differently than unsampled vessels in this group, which represents only 3.5 percent of total landings by scallop dredge vessels. Observed trips account for 1.0 percent of trips by vessels under 50 feet, 4.6 percent of trips by vessels between 50 and 70 feet, and 17.7 percent of trips by vessels over 70 feet. Also, most or nearly all vessels in the fishery have VMS equipment and, subject to interpretation of when vessels are fishing, VMS can be used to characterize fishing effort distributions.

In summary, it appears that the VTR data with good location fished (position) information is representative of the fishery and, subject to the precision of the location information, can be used to fairly represent the distribution of fishing activity and the value of fishing effort that could be displaced by the various habitat, spawning, and research areas proposed by this amendment.

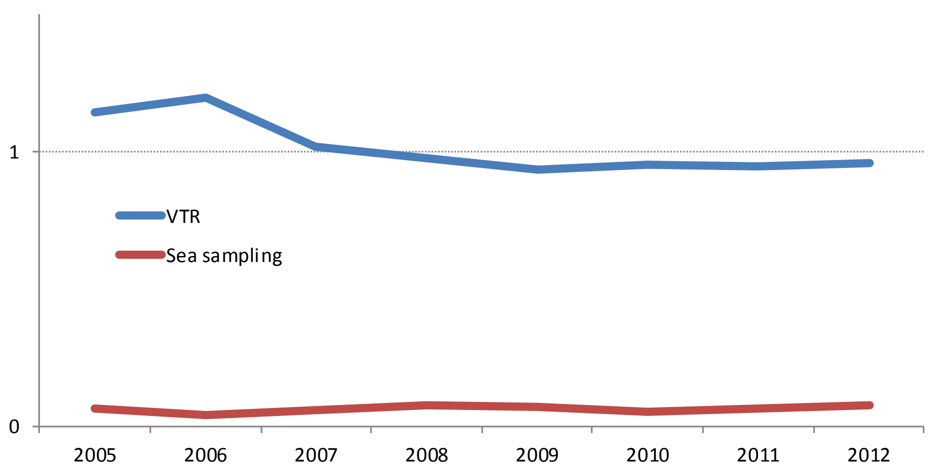
Table 46 – Scallop dredges: Ratio of Federal VTR reports and observed trips (OBDBS & ASM) to dealer reported data during the 2012 calendar year for trips fishing in statistical areas 464-465 and 511-562 (Gulf of Maine, Georges Bank, and Southern New England), with trends in VTR reported landings and landings from observed hauls to dealer landings ratios from 2005-2012.

	Vessel length	Reported total landings (live, million lb)	Reported total revenue	Individual dealers	Individual vessels	Reported trips	Days fished
Dealer (CFDBS/SAFIS /State, all sources)	**All**	**257.7**	**306.5**	**544**	**1202**	**4,909**	**6,711**
	< 50 ft	8.9	11.1	141	146	2,297	522
	50-70 ft	20.0	23.6	127	137	979	586
	>= 70 ft	228.8	271.8	276	919	1,633	5,603

	Vessel length	Reported landings (%)	Estimated revenue (%)	Reported dealers (%)	Reporting vessels (%)	Reported trips (%)	Reported days fished (%)
VTR, good position information	**All**	**96.5%**		**101.7%**	**96.3%**	**106.6%**	**3.4%**
	< 50 ft	97.0%		112.8%	97.9%	106.1%	16.1%
	50-70 ft	104.1%		82.7%	90.5%	102.2%	5.6%
	>= 70 ft	95.5%		98.9%	95.6%	93.6%	1.8%

	Vessel length	Landings sampled (%)		Dealers sampled (%)	Vessels sampled (%)	Trips sampled (%)
Sea sampling	**All**	**7.4%**		**21.9%**	**26.7%**	**7.3%**
	< 50 ft	2.0%		2.8%	5.5%	1.0%
	50-70 ft	8.7%		19.7%	29.2%	4.6%
	>= 70 ft	7.5%		32.6%	29.7%	17.7%

Trend in ratio of landings to dealer data



4.5.4 Shrimp trawls

Vessel using shrimp trawls target northern shrimp in the western Gulf of Maine, off the coasts of Maine, New Hampshire, and Massachusetts. Typically, most of the vessels are smaller and the majority of the 4.5 million pounds of landings worth $4.0 million in 2012 were from vessels under 50 feet (Table 47). Shrimp trawls are considered a mobile bottom-tending gear and as such could be directly affected by the habitat, spawning, and research areas proposed by the alternatives in this amendment, depending on the management options selected by the Council and approved by NMFS.

VTR data in 2012 accounted for 82.1 percent of total landings by 70.1 percent of the vessels at 88.6 percent of the dealers reporting landings by vessels using shrimp trawls. There appears to be some reporting bias by vessel size. Data for vessels under 50 feet appear to be less representative of dealer-reported landings than data from vessels in the larger size categories.

Sea sampling frequency is relatively low, accounting for only 1.0 percent of landings and 1.3 percent of trips reported by dealers. There also appears to be some bias by vessel size, with smaller vessels under 50 feet being sampled less frequently than vessels in the larger size classes.

The fraction of landings reported on VTRs has declined relative to landings reported by dealers, not so much because VTR reporting has deteriorated, but because landings coming into the dealer reported data has improved. VTR landings from 2005 to 2010 were considerably above dealer landings, but were around 80-85 percent of dealer landings in 2011 and 2012. It is probable that reporting from aggregate state landings and non-traditional buyers has improved over time. This apparent trend is not due to an increasing proportion of matches between dealer and VTR data using the VTR serial number. All dealer data were summarized regardless of VTR matches.

VTR data with good fishing location information is therefore a relatively accurate, although somewhat imprecise (for reasons noted in this section's introduction), representation of the distribution of fishing activity. In fact, in earlier years, it may be better than the dealer reported data (which of course has no fishing location information other than statistical area).

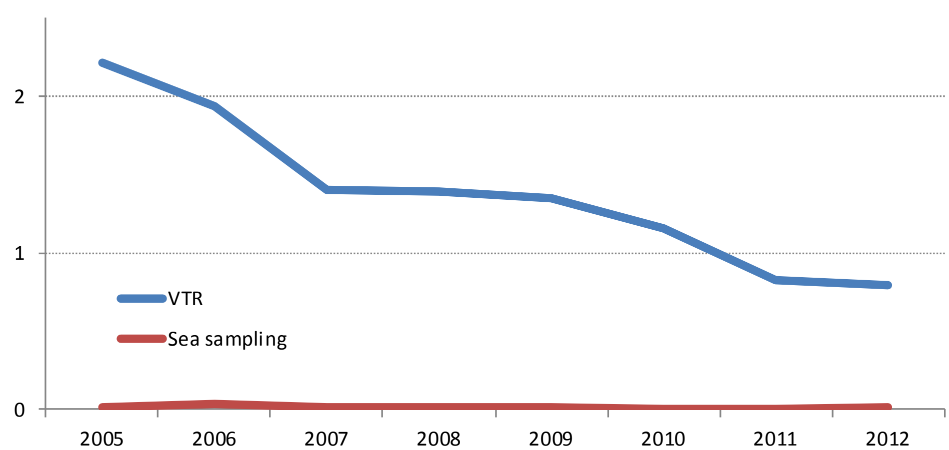
Table 47 – Shrimp trawls: Ratio of Federal VTR reports and observed trips (OBDBS & ASM) to dealer reported data during the 2012 calendar year for trips fishing in statistical areas 464-465 and 511-562 (Gulf of Maine, Georges Bank, and Southern New England), with trends in VTR reported landings and landings from observed hauls to dealer landings ratios from 2005-2012.

	Vessel length	Reported total landings (live, million lb)	Reported total revenue	Individual dealers	Individual vessels	Reported trips	Days fished
Dealer (CFDBS/SAFIS /State, all sources)	All	4.5	4.0	158	254	1,972	642
	< 50 ft	2.9	2.7	111	201	1,587	536
	50-70 ft	1.3	1.0	41	48	351	97
	>= 70 ft	0.2	0.2	6	5	34	10

	Vessel length	Reported landings (%)	Estimated revenue (%)	Reported dealers (%)	Reporting vessels (%)	Reported trips (%)	Reported days fished (%)
VTR, good position information	All	82.1%		88.6%	70.1%	77.0%	35.5%
	< 50 ft	74.1%		78.4%	65.2%	66.3%	30.6%
	50-70 ft	88.9%		100.0%	79.2%	101.0%	47.9%
	>= 70 ft	99.9%		100.0%	80.0%	135.3%	75.2%

	Vessel length	Landings sampled (%)		Dealers sampled (%)	Vessels sampled (%)	Trips sampled (%)
Sea sampling	All	1.0%		13.9%	8.3%	1.3%
	< 50 ft	0.9%		10.8%	5.5%	0.9%
	50-70 ft	1.2%		17.1%	14.6%	2.3%
	>= 70 ft	1.6%		50.0%	60.0%	8.8%

Trend in ratio of landings to dealer data



4.5.5 Sink gillnets

Fishermen use sink gillnets to target a wide variety of species on Georges Bank and in the Gulf of Maine, including cod, haddock, flounders, monkfish, and skates. Most vessels have Federal fishing permits in one or more fisheries and are thus required to submit VTRs. Some state-permitted vessels fish for these species in state waters and are not required to submit Federal VTRs, but their landings may appear in (and should be incorporated into) dealer (and state aggregated) reported landings.

Sink gillnets are relatively non-mobile and are not considered to be a mobile bottom-tending gear. Fishing with this gear would not be directly affected by most of the habitat areas proposed by alternatives in this amendment, but it would likely be regulated in the spawning areas and in some research areas. Fishermen using these gears may also experience secondary or indirect effects, either by mobile gear vessels fishing in new areas that were once fished primarily with gillnets, or by new areas becoming open to fishing by sink gillnets, but not by mobile bottom-tending gears such as trawls and dredges.

During 2012, dealers reported sink gillnet landings of 48.8 million pounds, valued at $38.2 million from 9,523 trips (Table 48). Ninety-five (95) percent of landings and trips were from vessels under 50 feet.

Landings from VTRs accounted for 63.7 percent of dealer-reported landings made by 70.5 percent of dealers and originating from 43.0 percent of vessels. The VTRs accounted for 103.3 percent of trips in dealer data, suggesting that quite a few of the dealer reports were for aggregated trips of one or more landings and/or vessels. The proportion of VTR landings that came from vessels between 50 and 70 feet (52.1 percent) was a little less than average, but this is probably not a meaningful difference given the relatively low amount of trips and landings from vessels falling in this size category. No dealer or VTR data were reported for vessels over 70 feet.

A relatively high proportion of landings (11.3 percent) and trips (19.3 percent) were made from observed trips during 2012, only second to the proportion of observed pair trawl and bottom trawl trips. There appears to be some clustering of sampling on vessels (14.1 percent of vessels with dealer-reported landings) and at more active dealers (15.7 percent of reporting dealers). The fraction of landings from observed trips on vessels between 50 and 70 feet (8.6 percent) is somewhat less than the average, but again this is probably not a meaningful difference.

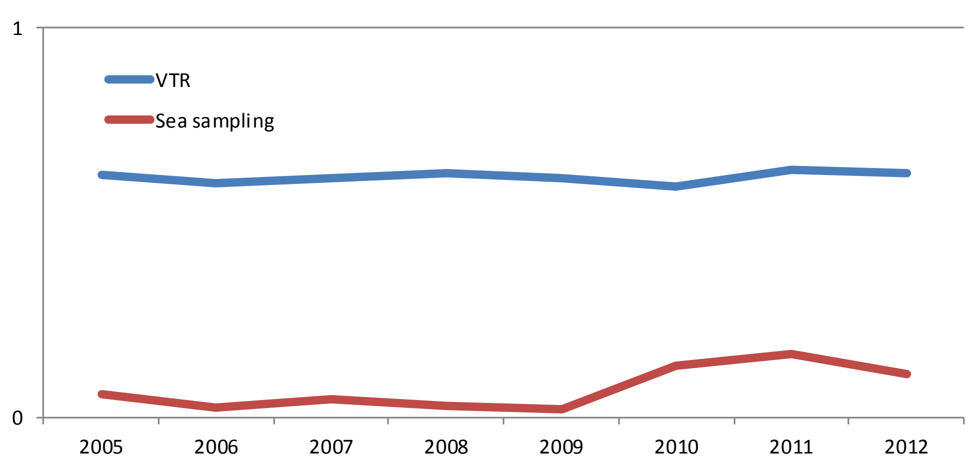
The fraction of dealer-reported landings made on VTRs has remained relatively constant from 2005-2012, a rather surprising result if dealer-reported landings are improving as suggested in other fisheries with a high degree of landings in state waters. Nonetheless, the fraction of landings having associated VTR data with good fishing location data represents the majority of trips and landings and should be fairly representative of the distribution of the fleet's fishing activity, particularly in Federal waters.

Since 2010, sea sampling is also relatively good and does not seem to have any substantial bias with respect to vessel size. From 2005-2009, however, the fraction of landings from observed trips was much lower. Therefore, fishing activity represented by sea sampling haul locations is relatively good since 2010, but less so prior to that year.

Table 48 – Sink gillnets: Ratio of Federal VTR reports and observed trips (OBDBS & ASM) to dealer reported data during the 2012 calendar year for trips fishing in statistical areas 464-465 and 511-562 (Gulf of Maine, Georges Bank, and Southern New England), with trends in VTR reported landings and landings from observed hauls to dealer landings ratios from 2005-2012.

	Vessel length	Reported total landings (live, million lb)	Reported total revenue	Individual dealers	Individual vessels	Reported trips	Days fished
Dealer (CFDBS/SAFIS /State, all sources)	**All**	**48.8**	**38.2**	**645**	**1288**	**9,523**	**19,285**
	< 50 ft	46.3	36.0	577	1235	9,032	17,934
	50-70 ft	2.6	2.2	68	53	490	1,352
	>= 70 ft	0.0	0.0	0	0	-	-
	Vessel length	Reported landings (%)	Estimated revenue (%)	Reported dealers (%)	Reporting vessels (%)	Reported trips (%)	Reported days fished (%)
VTR, good position information	**All**	**63.7%**		**70.5%**	**43.0%**	**103.3%**	
	< 50 ft	63.4%		67.2%	41.5%	103.3%	
	50-70 ft	52.1%		57.4%	37.7%	70.6%	
	>= 70 ft						
	Vessel length	Landings sampled (%)		Dealers sampled (%)	Vessels sampled (%)	Trips sampled (%)	
Sea sampling	**All**	**11.3%**		**15.7%**	**14.1%**	**19.3%**	
	< 50 ft	11.5%		15.3%	13.9%	19.6%	
	50-70 ft	8.6%		16.2%	15.1%	14.7%	
	>= 70 ft						

Trend in ratio of landings to dealer data



4.5.6 Longlines

Vessels use baited longlines to target certain species of groundfish, such as cod. Similar to gillnets, longlines are relatively non-mobile and are not considered to be a mobile bottom-tending gear. As such fishing with this gear would not be directly affected by most of the habitat areas proposed by alternatives in this amendment, but it would likely be regulated in the spawning areas and in some research areas. Fishermen using these gears may also experience secondary or indirect effects associated with changes in mobile-bottom tending gear restrictions.

During 2012, dealers reported landings of 7.7 million pounds, worth $16.9 million, mostly by smaller vessels less than 50 feet (Table 49). Overall, reported landings on VTRs accounted for 74.1 percent of landings reported by dealers. VTR reports accounted for dealer reported landings at 75.4 percent of the dealers and for 62.8 percent of vessels with reported landings at dealers. Sea sampled trips accounted for 6.2 percent of landings reported by dealers, and all of the observed trips were made by vessels less than 50 feet.

The trend in VTR reports and observed trips both varied without trend since 2005, when compared to dealer-reported landings. The landings on VTRs appear to have declined (or dealer landings increased) since 2009 when they were close to 90 percent of dealer reported landings.

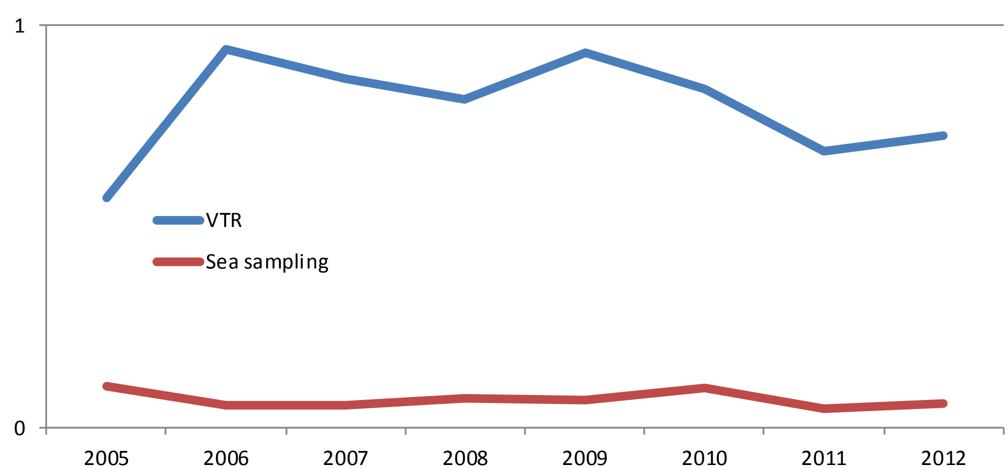
Table 49 – Longlines: Ratio of Federal VTR reports and observed trips (OBDBS & ASM) to dealer reported data during the 2012 calendar year for trips fishing in statistical areas 464-465 and 511-562 (Gulf of Maine, Georges Bank, and Southern New England), with trends in VTR reported landings and landings from observed hauls to dealer landings ratios from 2005-2012.

	Vessel length	Reported total landings (live, million lb)	Reported total revenue	Individual dealers	Individual vessels	Reported trips	Days fished
Dealer (CFDBS/SAFIS /State, all sources)	All	7.7	16.9				
	< 50 ft	6.5	13.0				
	50-70 ft	0.8	2.4				
	>= 70 ft	0.5	1.5				

	Vessel length	Reported landings (%)	Estimated revenue (%)	Reported dealers (%)	Reporting vessels (%)	Reported trips (%)	Reported days fished (%)
VTR, good position information	All	74.1%					
	< 50 ft	63.0%					
	50-70 ft	92.7%					
	>= 70 ft	167.2%					

	Vessel length	Landings sampled (%)	Dealers sampled (%)	Vessels sampled (%)	Trips sampled (%)
Sea sampling	All	6.2%			
	< 50 ft	7.4%			
	50-70 ft	0.0%			
	>= 70 ft	0.0%			

Trend in ratio of landings to dealer data



4.5.7 Lobster and other pots

Pots are mainly used to target lobster in the Gulf of Maine, on Georges Bank, and in Southern New England. Vessels that also have other Federal fishing permits are required to submit VTRs, but other vessels that fish in Federal waters only for lobster are not required to submit VTRs. Likewise state-permitted vessels fishing in state waters are not required to submit VTRs and may land lobsters at dealers that do not have a Federal dealer permit. These landings can make their way into the Federal data through state agency channels, but this source may have improved the amount of data submitted to the Federal government over time.

Since pots are considered to be non-mobile gear (at least when not moved by storms or other fishing activity), and many types of pots catch few groundfish, fishing with trap and pot gears would generally not be directly restricted by alternatives proposed by this amendment. There may be some secondary or incidental affects, however, including a greater degree of adverse interactions with mobile gear in areas that are now closed to fishing for groundfish, or potential increases in fishing effort using pots in areas that become closed to mobile bottom-tending gears.

During 2012, 1,717 dealers reported landings of 47.2 million pounds, worth $123.1 million, from 3,445 vessels making 58,622 trips (Table 50). The number of reporting dealers and vessels in this summary table may be inflated by dealers landing lobster trips from and vessels fishing in multiple statistical areas.

Landings reported on VTRs accounted for 58.2 percent of dealer-reported landings. A lower proportion of landings (40.5 percent) were reported on VTRs by fishermen on smaller vessels, less than 50 feet. It is more likely that smaller vessels would fish inshore, often in state waters, and may not be required to not submit VTRs. Vessels between 50 and 70 feet reported 120.3 percent of dealer-reported landings, while vessels over 70 feet reported 89.1 percent. Some variation in the 50 to 70 feet vessel category is due to the relatively small number of trips and lobster landings made by vessels in the medium length category.

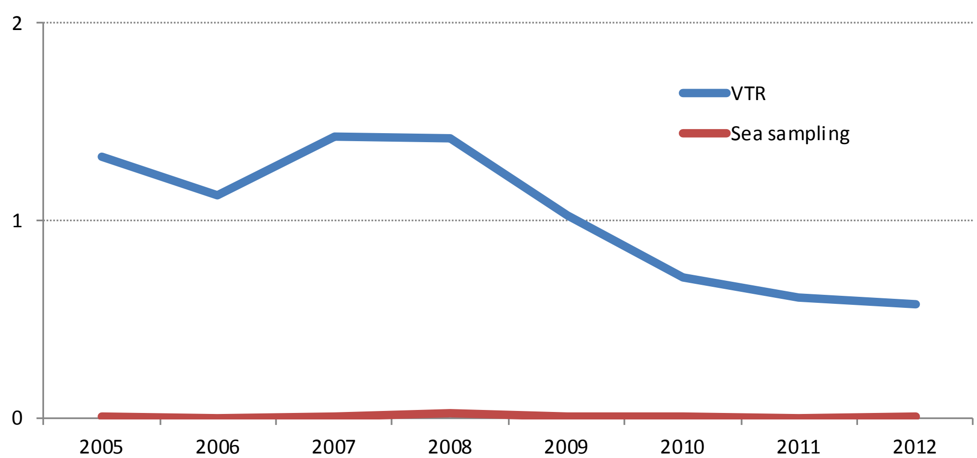
Sea sampling on observed trips is very low, accounting for only 0.1 percent of dealer-reported landings. Sea sampling on trips by larger vessels is somewhat higher because these vessels tend to fish more frequently in Federal waters and are more likely to have other Federal fishing permits (and therefore be chosen for sea sampling). During 2012, the sea sampled trips were observed on 10.4 percent of the 70+ feet vessels, landing at 7.1 percent of the dealers reporting landings from vessels using pots. Like some other cases described for other gears, the sea sampling appears to be biased toward larger vessels that frequently fish further offshore on longer trips.

From 2005 to 2008, the amount of landings reported on VTRs by vessels using pots exceeded the amount reported by dealers. This trend appears to be related to improvements in the amount of landings reported by non-Federal dealers over time. Sea sampling since 2005 has been consistently low at less than 1 percent of dealer reported landings. This low rate taken together with a bias toward sampling large vessels means that fishing activity derived from sea sampling data is not very representative of total fishing activity.

Table 50 – Lobster and other pots: Ratio of Federal VTR reports and observed trips (OBDBS & ASM) to dealer reported data during the 2012 calendar year for trips fishing in statistical areas 464-465 and 511-562 (Gulf of Maine, Georges Bank, and Southern New England), with trends in VTR reported landings and landings from observed hauls to dealer landings ratios from 2005-2012.

	Vessel length	Reported total landings (live, million lb)	Reported total revenue	Individual dealers	Individual vessels	Reported trips	Days fished
Dealer (CFDBS/SAFIS /State, all sources)	**All**	**47.2**	**123.1**	**1717**	**3445**	**58,622**	**194,373**
	< 50 ft	33.1	87.7	1409	3189	57,099	182,317
	50-70 ft	3.9	7.3	126	93	807	5,255
	>= 70 ft	10.3	28.1	182	163	716	6,801
	Vessel length	**Reported landings (%)**	**Estimated revenue (%)**	**Reported dealers (%)**	**Reporting vessels (%)**	**Reported trips (%)**	**Reported days fished (%)**
VTR, good position information	**All**	**58.2%**		**54.3%**	**29.4%**	**51.1%**	**112.1%**
	< 50 ft	40.5%		48.0%	26.0%	48.9%	102.5%
	50-70 ft	120.3%		57.9%	47.3%	66.6%	209.9%
	>= 70 ft	89.1%		80.8%	69.9%	137.7%	239.0%
	Vessel length	**Landings sampled (%)**		**Dealers sampled (%)**	**Vessels sampled (%)**	**Trips sampled (%)**	
Sea sampling	**All**	**0.1%**		**1.2%**	**0.8%**	**0.0%**	
	< 50 ft	0.0%		0.6%	0.3%	0.0%	
	50-70 ft	0.0%		0.0%	0.0%	0.0%	
	>= 70 ft	0.6%		7.1%	10.4%	2.4%	

Trend in ratio of landings to dealer data



4.5.8 Mid-water trawls

Mid-water trawls are primarily used to target small pelagic fish, such as herring, menhaden, and mackerel. These trawls would generally not be restricted in habitat or research areas, but might be excluded from spawning areas depending on the options the Council recommends.

During 2012, dealers reported 125.4 million pounds of landings, worth $16.7 million pounds on 100 trips (Table 51). In this summary, the total number of dealers and vessels are probably double counted when landings come from more than one statistical area, or partial landings by single trips were reported by more than one dealer in different states. Nonetheless, the vast majority of landings were made by large vessels, greater than 70 feet.

Overall, VTR data was very good, accounting for 100.3 percent of landings reported by dealers. Sea sampling frequency was also very high, 60.6 percent of landings made by 64.1 percent of vessels with landings reported by dealers, but only at 17.3 percent of the dealers reporting landings. This suggests that sea sampling of trips occurred more frequently on vessels landing at the more active dealers. The number of trips sampled compared to the number of trips landed by dealers is inconsistent, suggesting the summary from one or the other should be adjusted.

Trends in landings reported by VTRs since 2005 also are troubling, since the VTR reported landings exceed dealer reported landings by a significant degree from 2005 and 2006, and to a lesser extent from 2007 to 2010. This outcome does not suggest an isolated reporting issue, but rather that the dealer landings may have improved over time. The proportion of landings on observed trips has also increase over time, from 2007 to 2010, then declining a little in 2011.

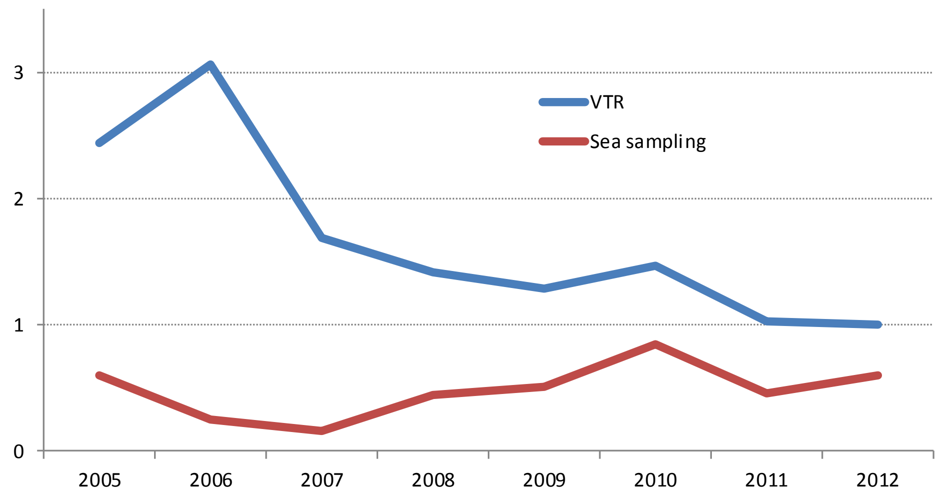
Table 51 – Mid-water trawls: Ratio of Federal VTR reports and observed trips (OBDBS & ASM) to dealer reported data during the 2012 calendar year for trips fishing in statistical areas 464-465 and 511-562 (Gulf of Maine, Georges Bank, and Southern New England), with trends in VTR reported landings and landings from observed hauls to dealer landings ratios from 2005-2012.

	Vessel length	Reported total landings (live, million lb)	Reported total revenue	Individual dealers	Individual vessels	Reported trips	Days fished
Dealer (CFDBS/SAFIS/State, all sources)	All	125.4	16.7	283	67	100	32
	< 50 ft	0.0	0.0	0	0	0	0
	50-70 ft	1.3	0.2	6	3	36	5
	>= 70 ft	124.1	16.6	277	64	64	27

	Vessel length	Reported landings (%)	Estimated revenue (%)	Reported dealers (%)	Reporting vessels (%)	Reported trips (%)	Reported days fished (%)
VTR, good position information	All	100.3%		121.9%	144.8%	438.1%	
	< 50 ft						
	50-70 ft	67.0%		66.7%	66.7%	108.4%	
	>= 70 ft	100.6%		122.7%	146.9%	621.3%	

	Vessel length	Landings sampled (%)	Dealers sampled (%)	Vessels sampled (%)	Trips sampled (%)
Sea sampling	All	60.0%	17.3%	62.7%	196.6%
	< 50 ft				
	50-70 ft	4.8%	16.7%	33.3%	5.6%
	>= 70 ft	60.6%	17.3%	64.1%	303.6%

Trend in ratio of landings to dealer data



4.5.9 Purse seines

Purse seines are used to mostly target herring and are not considered to be a mobile bottom-tending gear. The alternatives in this amendment are unlikely to affect fishing activity using this gear, although they could be restricted in spawning areas.

During 2012, dealers reported landings of 42.6 million pounds, worth $6.5 million on 284 trips (Table 52). Overall, landings reported on VTRs accounted for 99.9 percent of dealer reported landings. The reports accounted for 88.5 percent of the number of vessels with dealer-reported landings and for 92 percent of reporting dealers. The number of VTR trips is higher than those reported by dealers, probably because some dealer (and state) reported landings are for more than one trip. No trips on vessels using purse seines were observed in 2005-2012.

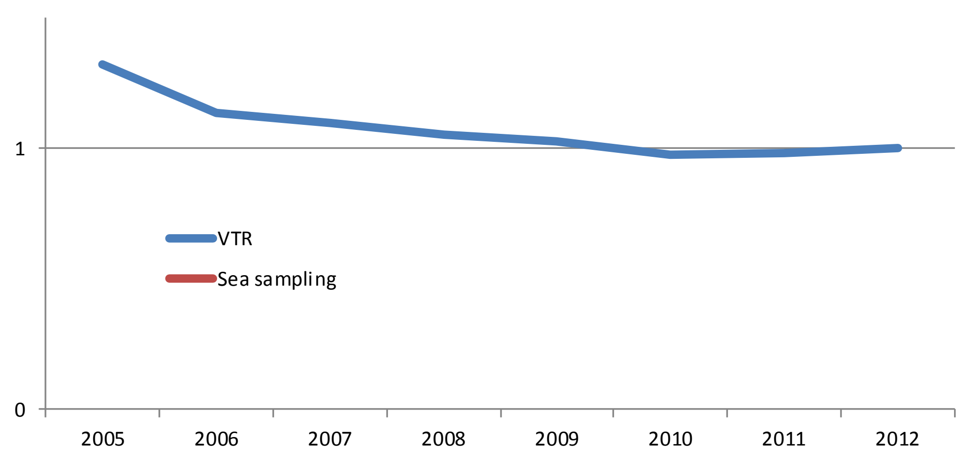
Except for 2005, when VTR reported landings were somewhat greater than dealer-reported landings, the VTR reports are fairly consistent with the dealer reports.

The VTR data appear to be a good representation of the fishery, subject to limits on the quality of location data noted in this section's introduction. Sea sampling data cannot of course be used to characterize the distribution of fishing effort.

Table 52 – Purse seines: Ratio of Federal VTR reports and observed trips (OBDBS & ASM) to dealer reported data during the 2012 calendar year for trips fishing in statistical areas 464-465 and 511-562 (Gulf of Maine, Georges Bank, and Southern New England), with trends in VTR reported landings and landings from observed hauls to dealer landings ratios from 2005-2012.

	Vessel length	Reported total landings (live, million lb)	Reported total revenue	Individual dealers	Individual vessels	Reported trips	Days fished
Dealer (CFDBS/SAFIS /State, all sources)	**All**	**42.6**	**6.5**	**261**	**52**	**284**	**35**
	< 50 ft	1.8	0.4	20	19	87	22
	50-70 ft	17.0	2.6	145	19	87	6
	>= 70 ft	23.7	3.5	96	14	110	7
	Vessel length	Reported landings (%)	Estimated revenue (%)	Reported dealers (%)	Reporting vessels (%)	Reported trips (%)	Reported days fished (%)
VTR, good position information	**All**	**99.9%**		**92.0%**	**88.5%**	**124.9%**	
	< 50 ft	112.8%		95.0%	94.7%	136.8%	
	50-70 ft	100.9%		93.1%	78.9%	112.5%	
	>= 70 ft	98.2%		89.6%	92.9%	125.3%	
	Vessel length	Landings sampled (%)		Dealers sampled (%)	Vessels sampled (%)	Trips sampled (%)	
Sea sampling	**All**	**0.0%**		**0.0%**	**0.0%**	**0.0%**	
	< 50 ft	0.0%		0.0%	0.0%	0.0%	
	50-70 ft	0.0%		0.0%	0.0%	0.0%	
	>= 70 ft	0.0%		0.0%	0.0%	0.0%	

Trend in ratio of landings to dealer data



4.6 Fishing communities

This amendment will impact communities and ports throughout the coastal northeast and mid-Atlantic. Consideration of the social impacts on these communities from proposed fishery regulations is required as part of the National Environmental Policy Act (NEPA) of 1969 and the Magnuson Stevens Fishery Conservation and Management Act (Magnuson Stevens Act) of 1976. Before any agency of the Federal government may take "actions significantly affecting the quality of the human environment," that agency must prepare an Environmental Assessment (EA) that includes the integrated use of the social sciences (NEPA Section 102(2)(C)). National Standard 8 of the MSA stipulates that "conservation and management measures shall, consistent with the conservation requirements of this Act (including the prevention of overfishing and rebuilding of overfished stocks), take into account the importance of fishery resources to fishing communities in order to (A) provide for the sustained participation of such communities, and (B) to the extent practicable, minimize adverse economic impacts on such communities" (16 U.S.C. § 1851(a)(8)).

A "fishing community" is defined in the Magnuson-Stevens Act, as amended in 1996, as "a community which is substantially dependent on or substantially engaged in the harvesting or processing of fishery resources to meet social and economic needs, and includes fishing vessel owners, operators, and crew and United States fish processors that are based in such community" (16 U.S.C. § 1802(17)). For detailed descriptions of the affected human communities and fisheries affected by the Omnibus Amendment refer to the respective FMPs available from the New England and Mid-Atlantic Councils and the Atlantic States Marine Fisheries Commission.

Given the geographic scope of this action and the fact that it will influence fishing with various different gear types, these alternatives will impact numerous fishing communities. Identifying specific communities that will be impacted is difficult and uncertain, particularly for the communities which will be impacted by opening or modifying current area closures. Because these areas are currently closed and have been for some time, there is no baseline information regarding the recent history of effort in these areas and communities that are most likely to be impacted. Due to changes in behavior, fishing strategy and other adaptations that have occurred since the original implementations of these closures, it is unlikely that effort will revert to the original condition prior to the implementation of the closures. Additionally there are a number of potential issues with the confidential nature of the information used to narrow the focus to individual communities in the analysis of fishing dependence. There are privacy concerns with presenting the data in such a way that proprietary information (landings, revenue, etc.) can be attributed to an individual vessel or a small group of vessels. This is particularly difficult when presenting information on small ports and communities that may only have a small number of vessels and that information can easily be attributed to a particular vessel or individual.

The communities that are likely to experience significant impacts from the alternatives under consideration include those currently fishing in areas proposed to be closed, those fishing near current closed areas which are proposed to be opened, and those fishing with gear types that are allowed in currently closed areas that are proposed to be opened to other gear types. Given the scope of the Omnibus Amendment, these criteria identify more port groups than is practical to identify as *communities of interest* for this assessment. Additionally, it is difficult to determine which ports are likely to be most impacted by the opening of currently closed areas. For these reasons, the specific communities of interest were identified through the economic analysis of vessel trips most likely to be impacted by the addition of new closed areas (see the economic impacts sections in Volume 3, Section 4). Communities listed in Table 53 are either the port of landing or the city where the permit is registered for trips by at least three vessels using mobile bottom-tending gears in 2012 in areas that are proposed for closure in this amendment. It is important to note that this is not an exhaustive list of communities that will be impacted. It is necessary to consider the impacts of the proposed alternatives across all communities, particularly those identified as communities of interest in their respective FMPs.

Table 53 also includes Social Indicators of Fishing Community Vulnerability and Resilience for these communities. Social indicators are useful in understanding the context with which these communities will be affected by regulatory change. These indicators were developed for three categories of vulnerability: 1) social indices, which represent general vulnerability to a community that exists regardless of the importance of fishing in that community, 2) gentrification indices, which represent factors which may introduce threats to working waterfront and shoreside infrastructure, and 3) fishing dependence, which represent the importance of and dependence on fishing in that community. Within each category separate indices are calculated. These indices were selected based on literature and previous research and correspond to different components of vulnerability that will affect communities. Each indicator is scored from low to high vulnerability (1=Low, 2=Moderate, 3=High). These levels are calculated from the standard deviation of each community's individual vulnerability score. Standard deviations less than 0.499 are scored as low (1), standard deviations of 0.500-0.999 are scored as moderate (2) and standard deviations >1.000 above the mean are scored as high (3). For more information on the development and use of Social Indicators see Jepson and Colburn, 2013 or http://www.st.nmfs.noaa.gov/humandimensions/social-indicators/index. Table 54 provides a summary of total landings by weight and value by community and state.

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

Table 53 – Communities (port of landing or city of registration) associated with mobile bottom tending gear trips or recreational trips by 3 or more vessels in 2012 in currently open areas potentially affected by new closure management alternatives. Some information is omitted due to privacy concerns (*).

	Level affected		Social Vulnerability Indices					Gentrification Indices				Commercial Fishing Dependence		Recreational Fishing	
State, Community	Port	City	Personal Disruption	Population Composition	Poverty	Labor Force Structure	Housing Characteristics	Housing Disruption	Retiree Migration	Urban Sprawl	Natural Amenities	Com. Fishing Reliance	Com. Fishing Engagement	Rec. Fishing Reliance	Rec. Fishing Engagement
Connecticut	**x**	**x**													
New London	x		3	3	3	1	2	1	1	1	2	1	2	1	1
Stonington	x		2	1	1	1	1	1	1	1	1	1	2	1	1
Massachusetts	**x**	**x**													
Barnstable	x		1	1	1	1	1	1	1	1	1	1	2	1	3
Boston	x	x	3	3	3	1	1	1	1	3	1	1	3	1	3
Chatham	x	x	1	1	1	3	1	3	3	2	3	3	3	3	3
Chilmark	x		1	1	1	3	1	1	1	3	3	3	2	1	1
Fairhaven	x	x	2	1	2	1	2	1	1	1	1	1	3	1	3
Falmouth	x		1	1	1	3	2	1	3	1	2	1	1	3	3
Gloucester	x	x	1	1	1	1	1	1	1	1	1	3	3	1	3
Harwich		x	1	1	1	1	1	2	2	1	1	1	1	1	1
Harwichport	x	x	1	1	1	3	2	1	3	1	3	2	1	3	3
Hyannis	x		1	1	1	1	1	1	1	1	1	1	2	1	3
Marshfield	x	x	1	1	1	1	1	2	1	2	1	1	1	1	1
Mattapoisset	x		1	1	1	2	1	1	2	1	1	1	1	1	1
Nantucket	x		1	1	1	1	1	3	1	2	3	1	3	2	3
New Bedford	x	x	3	3	3	1	2	2	1	1	1	2	3	1	2
Newburyport	x		1	1	1	1	1	1	1	2	1	1	2	1	3
Peabody		x	1	1	1	1	1	1	1	2	1	1	1	1	1
Plymouth	x		2	1	1	1	1	1	1	1	1	1	3	1	1

	Level affected		Social Vulnerability Indices					Gentrification Indices				Commercial Fishing Dependence		Recreational Fishing	
State, Community	**Port**	**City**	**Personal Disruption**	**Population Composition**	**Poverty**	**Labor Force Structure**	**Housing Characteristics**	**Housing Disruption**	**Retiree Migration**	**Urban Sprawl**	**Natural Amenities**	**Com. Fishing Reliance**	**Com. Fishing Engagement**	**Rec. Fishing Reliance**	**Rec. Fishing Engagement**
Provincetown	x		1	1	1	1	2	1	1	1	3	2	2	2	3
Rockport	x	x	1	1	1	2	1	1	2	1	3	1	2	1	1
Sandwich	x		1	1	1	1	1	2	1	1	1	1	2	1	1
Salisbury	x		1	1	1	1	2	1	1	1	2	1	1	1	3
Scituate	x		1	1	1	1	1	1	1	2	1	1	3	1	1
South Dartmouth[1]		x	1	1	1	1	1	1	1	1	1	1	1	1	1
Swampscott		x	1	1	1	1	1	1	1	2	1	1	1	1	1
Westport		x	1	1	1	1	1	1	1	1	1	1	3	1	3
Woods Hole	x	x	1	1	1	3	1	1	3	2	3	1	1	2	1
Maine	**x**	**x**													
Addison		x													
Beals		x	1	1	3	3	3	1	1	1	3	3	3	1	1
Boothbay Harbor	x		1	1	1	3	2	1	3	1	3	3	3	1	1
Bremen		x	1	1	1	2	3	1	2	1	3	3	1	1	1
Bucks Harbor	x		1	1	2	2	3	1	1	1	3	3	2	1	1
Cundys Harbor[2]	x		1	1	3	3	1	1	3	1	3	3	3	1	1
Friendship	x	x	1	1	2	3	3	1	3	1	3	3	3	1	1
Harpswell[2]	x	x	1	1	3	3	1	1	3	1	3	3	3	1	1
Jonesport	x	x	2	1	3	3	3	1	1	1	3	3	3	1	1
Machiasport	x	x	1	1	2	2	3	1	1	1	3	3	2	1	1
New Harbor[3]	x		1	1	1	3	2	1	3	1	3	3	2	1	1
Northeast Harbor															
Ogunquit		x	1	1	1	3	1	3	3	1	3	1	1	2	1
Port Clyde[4]	x	x	1	1	2	3	2	2	3	1	3	3	3	1	1
Portland	x	x	2	1	3	1	2	1	1	1	2	1	3	1	1

	Level affected		Social Vulnerability Indices					Gentrification Indices				Commercial Fishing Dependence		Recreational Fishing	
State, Community	**Port**	**City**	**Personal Disruption**	**Population Composition**	**Poverty**	**Labor Force Structure**	**Housing Characteristics**	**Housing Disruption**	**Retiree Migration**	**Urban Sprawl**	**Natural Amenities**	**Com. Fishing Reliance**	**Com. Fishing Engagement**	**Rec. Fishing Reliance**	**Rec. Fishing Engagement**
Rockland	x														
Saco	x		1	1	1	1	2	1	1	1	1	1	1	1	3
South Bristol	x	x	1	1	1	3	2	1	3	1	3	3	3	1	1
Stonington	x	x	1	1	1	3	3	1	1	1	3	3	3	1	1
Tennants Harbor[4]	x	x	1	1	2	3	2	2	3	1	3	3	3	1	1
Vinalhaven	x	x	1	1	1	2	3	3	1	1	3	3	3	1	1
Wells	x		1	1	1	1	3	1	1	1	3	1	1	1	1
Westbrook		x	1	1	3	1	2	1	1	1	1	1	1	1	1
Winter Harbor		x	1	1	3	3	3	1	1	1	3	3	2	1	1
North Carolina	x	x													
Bayboro		x	2	2	2	3	3	1	3	1	1	1	1	1	1
Beaufort	x		3	1	3	2	3	1	1	1	1	2	2	3	3
Hobucken		x	1	1	1	3	3	1	3	1	2	3	1	1	1
New Bern		x	3	2	3	2	3	1	1	1	1	1	2	1	1
Newport		x	2	1	1	1	3	1	1	1	1	1	1	1	2
Oriental		x	1	1	1	3	1	2	3	1	2	3	2	3	3
Wanchese		x	1	1	1	1	3	1	2	1	1	3	3	3	3
New Hampshire	**x**	**x**													
Hampton		x	1	1	1	1	1	1	1	1	2	1	2	1	1
Hampton Falls		x	1	1	1	1	1	1	1	1	1	1	1	1	1
Newington	x		1	1	1	1	1	1	1	2	3	2	2	1	1
Portsmouth	x		1	1	1	1	1	1	1	1	1	1	3	1	2
Rye	x		1	1	1	1	1	1	1	2	3	1	2	1	2
Seabrook	x	x	1	1	1	1	3	1	1	1	1	1	2	1	3
New Jersey	**x**	**x**													

	Level affected		Social Vulnerability Indices					Gentrification Indices				Commercial Fishing Dependence		Recreational Fishing	
State, Community	**Port**	**City**	**Personal Disruption**	**Population Composition**	**Poverty**	**Labor Force Structure**	**Housing Characteristics**	**Housing Disruption**	**Retiree Migration**	**Urban Sprawl**	**Natural Amenities**	**Com. Fishing Reliance**	**Com. Fishing Engagement**	**Rec. Fishing Reliance**	**Rec. Fishing Engagement**
Atlantic City		x													
Barnegat/ Barnegat Light	x	x	1	1	1	1	1	3	1	1	1	1	1	1	1
			1	1	1	3	1	1	3	2	3	3	3	3	3
Cape May	x	x	1	1	1	3	1	3	3	1	3	3	3	3	3
Cape May Courthouse		x	1	1	1	1	1	2	1	1	1	1	1	1	1
Manahawkin		x	1	1	1	1	1	2	1	1	1	1	1	1	1
Point Pleasant	x		1	1	1	1	1	1	1	1	1	1	3	1	3
New York	**x**	**x**													
Hampton Bays[5]		x	1	1	1	1	1	3	1	3	1	1	3	1	3
Montauk	x	x	1	1	1	2	1	3	1	2	3	3	3	3	3
Rhode Island	**x**	**x**													
Charlestown[6]		x	1	1	1	1	1	1	1	1	2	1	1	1	3
Newport	x		1	1	1	1	1	2	1	1	1	1	3	1	3
North Kingstown[7]		x	1	1	1	1	1	1	1	1	1	1	3	1	1
Point Judith/ Narragansett[8]	x	x	1	1	1	2	1	1	1	1	1	1	1	1	3
South Kingstown		x	1	1	1	1	1	1	1	1	1	1	1	1	3
Wakefield[9]		x	1	1	1	1	1	1	1	1	1	1	3	1	1
West Kingston[10]		x	1	1	1	1	1	1	1	1	1	1	1	1	3
Westerly		x	1	1	1	1	1	1	1	1	3	1	1	1	1
Virginia	**x**	**x**													
Chincoteague	x		1	1	3	2	3	1	2	1	3	2	2	3	3
Gloucester[11]		x	1	1	2	3	1	1	3	1	1	1	1	1	1
Hampton	x	x	2	2	2	1	2	1	1	1	2	1	3	1	3
Newport News	x	x	2	2	2	1	2	1	1	1	1	1	3	1	3

	Level affected		Social Vulnerability Indices					Gentrification Indices				Commercial Fishing Dependence		Recreational Fishing	
State, Community	Port	City	Personal Disruption	Population Composition	Poverty	Labor Force Structure	Housing Characteristics	Housing Disruption	Retiree Migration	Urban Sprawl	Natural Amenities	Com. Fishing Reliance	Com. Fishing Engagement	Rec. Fishing Reliance	Rec. Fishing Engagement
Seaford[12]	x	x	1	1	1	1	1	1	1	1	1	1	3	1	1

1 indicators were developed for Dartmouth, MA

2 indicators were developed for Harpswell/Bailey Island, ME (Cundy's Harbor is a village within Harpswell)

3 indicators were developed for Bristol/New Harbor/Pemaquid, ME

4 indicators were developed for Saint George/Port Clyde-Tenants Harbor/Spruce Head, ME

5 indicators were developed for Hampton Bays/Shinnecook, NY

6 indicators were developed for Charlestown/Carolina, RI

7 indicators were developed for North Kingstown/Saunderstown, RI

8 indicators were developed for Narragansett Pier, RI

9 indicators were developed for Wakefield-Peacedale, RI

10 indicators were developed for South Kingstown, RI (West Kingstown is a village within the town of South Kingstown)

11 indicators were developed for Gloucester Courthouse, VA

12 indicators were developed for Grafton/Seaford, VA

Table 54 – Total landings by weight and value by community and state, for those communities and states referenced in the table above. The top four valued species and their percentage of landed value are also identified. Blank cells indicate data omitted due to confidentiality requirements. Species/species group abbreviations are LM GF (large-mesh groundfish), SM GF (small-mesh groundfish), M/S/B (mackerel, squid, butterfish), SF/S/BSB (summer flounder, scup, black sea bass), and SC/OC (surfclam, ocean quahog).

State	2012 Landings		Percent of landings value by top four species or species groups							
Community	Value	Lbs	Species 1	%	Species 2	%	Species 3	%	Species 4	%
Connecticut	**$ 21,432,347**	**8,381,236**								
New London	$ 7,138,598	3,578,601	scallops	48	M/S/B	14	SM GF	13	monkfish	11
Stonington	$ 12,126,105	3,674,200	scallops	70	SF/S/BSB	9	M/S/B	6		
Massachusetts	**$ 613,057,787**	**275,652,568**								
Barnstable	$ 8,647,609	1,426,395	other	50	lobster	32	scallops	14	SF/S/BSB	2
Boston	$ 18,726,770	11,520,973	LM GF	66	lobster	12			other	9
Chatham	$ 16,648,927	10,726,709	other	37	scallops	17	lobster	15	LM GF	8
Chilmark	$ 1,267,709	251,199	other	49	lobster	43	SF/S/BSB	6	LM GF	1
Fairhaven	$ 25,065,515	7,096,357	scallops	68	other	25			lobster	1
Falmouth	$ 1,489,220	312,974	other	87			SF/S/BSB	3	bluefish	1
Gloucester	$ 56,758,715	77,398,771	LM GF	46	lobster	21	herring	11	scallops	8
Harwichport	$ 3,423,954	955,996	other	60	lobster	20	scallops	13		
Hyannis										
Marshfield	$ 2,681,211	2,502,469	lobster	77			LM GF	4	scallops	4
Mattapoisset	$ 319,379	195,054	SF/S/BSB	61	other	39			LM GF	
Nantucket	$ 2,712,606	449,624	other	67			SF/S/BSB	12	lobster	3
New Bedford	$ 407,366,943	133,902,861	scallops	82	LM GF	6	SC/OQ	5	lobster	2
Newburyport	$ 924,924	288,756	lobster	63			other	8	LM GF	4
Plymouth	$ 4,031,312	1,821,381	lobster	83	other	7			M/S/B	2
Provincetown	$ 6,108,947	1,890,793	scallops	47	lobster	31	other	10	LM GF	4
Rockport	$ 796,794	230,669	lobster	99	other	1				
Sandwich										
Salisbury	$ 5,524,274	2,791,940	lobster	40	other	30	scallops	21	LM GF	3
Scituate	$ 4,519,702	3,253,876	lobster	43	LM GF	40	dogfish	8	scallops	4
Woods Hole	$ 2,771,733	1,352,844	M/S/B	23	SF/S/BSB	23	other	21	LM GF	15
Maine	**$ 529,559,487**	**288,302,577**								
Beals	$ 11,463,226	5,035,395	lobster	94	other	4	scallops	2		

State	2012 Landings		Percent of landings value by top four species or species groups							
Community	**Value**	**Lbs**	**Species 1**	**%**	**Species 2**	**%**	**Species 3**	**%**	**Species 4**	**%**
Boothbay Harbor	$ 4,663,088	1,710,569	lobster	90	other	8	LM GF	1		
Cundys Harbor										
Friendship	$ 14,179,324	5,816,154	lobster	94	other	6				
Harpswell	$ 17,986,181	6,710,242	lobster	91	other	7	LM GF	1		
Jonesport	$ 12,696,660	17,800,984	lobster	65	other	14	SC/OQ	14		
New Harbor	$ 3,727,306	1,794,881	lobster	86						
Port Clyde	$ 9,625,855	6,075,059	lobster	91	other	3	LM GF	3		
Portland	$ 33,565,377	58,643,014	lobster	33	other	25	herring	22	LM GF	18
Rockland	$ 14,754,927	35,154,608			herring	32				
Saco	$ 436,456	378,490	lobster	42	LM GF	30	other	18		
South Bristol	$ 6,204,061	3,290,724	lobster	67	other	29	herring	3		
Stonington	$ 47,217,453	22,232,499	lobster	96	other	2	herring	1	scallops	1
Vinalhaven	$ 28,291,930	13,446,137	lobster	97			other	1		
Wells										
North Carolina	**$ 30,845,218**	**20,597,665**								
Beaufort	$ 4,809,443	2,352,085	other	84	SF/S/BSB	13				
New Hampshire	**$ 23,261,842**	**11,414,633**								
Portsmouth	$ 5,674,278	2,753,325	lobster	65	LM GF	26	other	4		
Rye	$ 2,084,685	1,834,168	LM GF	42	lobster	27	other	16		
Seabrook	$ 2,346,150	1,879,911	LM GF	49						
New Jersey	**$ 192,128,847**	**240,210,579**								
Barnegat/Barnegat Light	$ 30,010,778	6,443,562	scallops	74	other	13	monkfish	7		
Cape May	$ 74,866,105	74,271,810	scallops	81	M/S/B	11	other	5	SF/S/BSB	2
Point Pleasant	$ 28,675,177	25,066,710	scallops	48	SC/OQ	20	SF/S/BSB	13	lobster	9
New York	**$ 43,800,906**	**28,231,715**								
Montauk	$ 23,105,671	14,426,314	M/S/B	22	SF/S/BSB	20	tilefish	15	other	11
Rhode Island	**$ 78,513,456**	**81,241,913**								
Newport	$ 10,561,749	8,582,400	lobster	37	scallops	33	other	10	skates	6
Point Judith/ Narragansett	$ 42,701,304	43,912,198	M/S/B	73	scallops	11	other	7	herring	7
Virginia	**$ 176,793,054**	**453,871,518**								
Chincoteague	$ 9,143,896	4,479,025	other	62	SF/S/BSB	23				

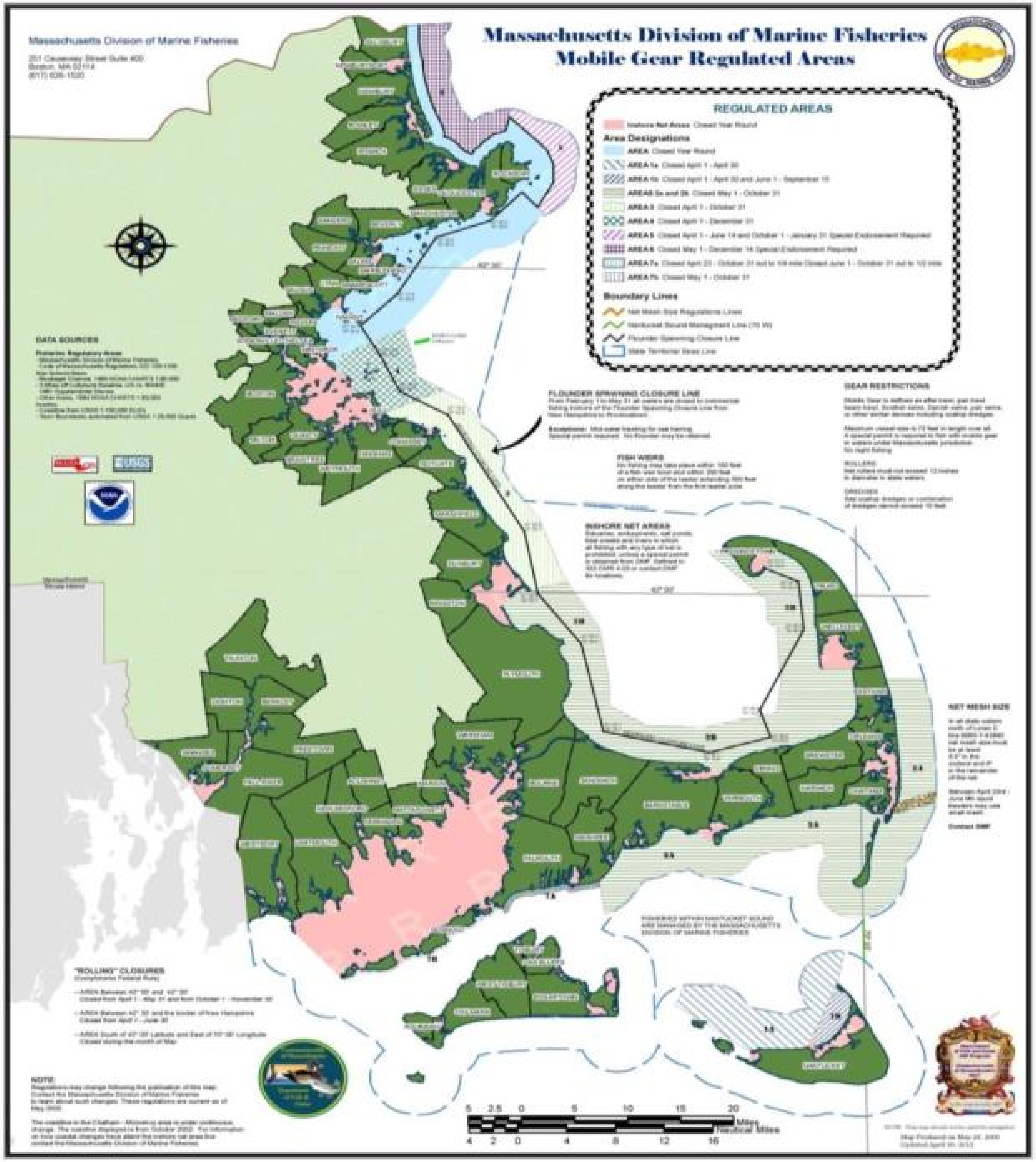
State	2012 Landings		Percent of landings value by top four species or species groups							
Community	Value	Lbs	Species 1	%	Species 2	%	Species 3	%	Species 4	%
Hampton	$ 14,072,645	5,591,189			SF/S/BSB	25	other	13	bluefish	1
Newport News	$ 31,083,344	5,527,009	scallops	84	SF/S/BSB	13	other	2		
Seaford	$ 19,457,920	2,025,932								

4.7 Complementary state regulations

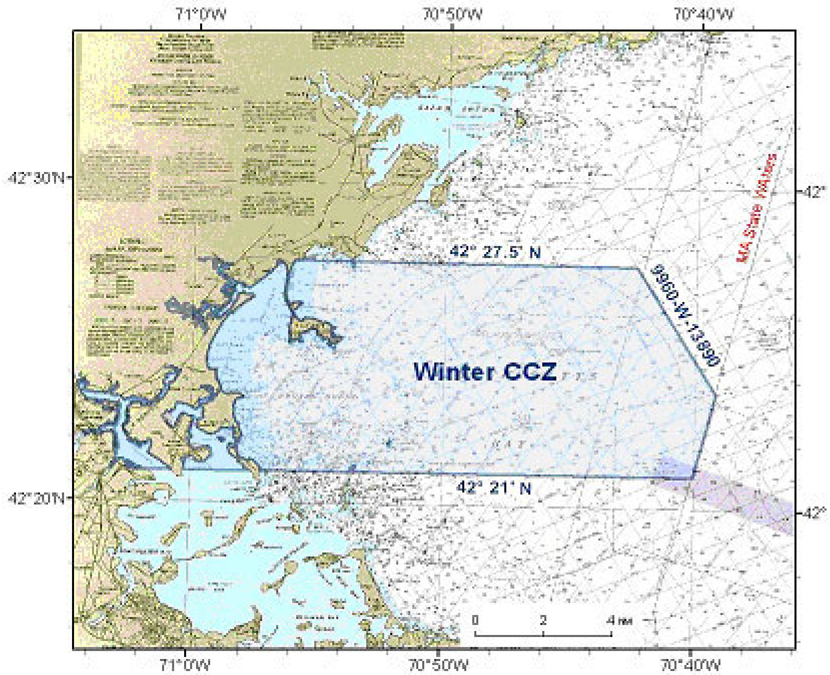
Four of the New England states have regulations pertaining to the use of mobile gear or gear capable of catching groundfish, either seasonally or year-round, within their state waters. The state of New Hampshire has a complete ban on mobile gear in state waters. In addition, gillnets in New Hampshire state waters are prohibited in April, May, and June, and they must comply with the Federal northeast multispecies gillnet requirements (see the New Hampshire Marine Fishing Rules, Sections 602.06 and 602.07). The State of Maine has a seasonal, inshore closure from November until February in Sheepscot Bay (Maine Department of Marine Resources Regulations, Chapter 8). The State of Rhode Island limits rollers, rockhoppers, and discs to a maximum of 12 inches in diameter (R.I. Gen. Laws Title 20 Part X).

The Commonwealth of Massachusetts has several restrictions on mobile gear (Map 159). The waters north of Boston to the New Hampshire state line are closed to mobile gear year-round, with two exceptions. A portion of this closed area north of Rockport, Massachusetts is open to mobile gear from December 15 – March 31, and the "whiting area" off of Rockport is open in the months of February and March; however, no roller gear are allowed and there are restrictions on other aspects of the gear and vessels. The Outer Boston Harbor Area is closed to mobile gear from April through December. Moving south, there are several seasonal closures: (1) From Hull to Plymouth is closed April through October; (2) Plymouth to Provincetown and Eastham to Mashpee are closed May through October; (3) the north shore of Nantucket is closed in April; and (4) Great Point to Nantucket Harbor is closed June through mid-September. There are additional shoreline closures around Falmouth, from late April through October. In addition, there is a 12-inch maximum allowed for roller, disk, or rockhopper size, and a vessel size restriction (maximum of 90 ft) for all trawl fishing in state waters. There are further closures specific to spawning protection for flounders in the nearshore waters from Provincetown to the New Hampshire state line from February through May. There are two "Cod Conservation Zones": a winter closure (Map 160) that is closed from November 15 through January 31, and a spring closure (Map 161) that is closed from April 16 through July 21. Both of these areas are closed to any gear capable of catching cod, including gillnets, otter trawls, mid-water trawls, seines, and all hook and line gears (Mass. Gen. Laws. 322 CMR § 3.02 and § 8.01 through 8.15).

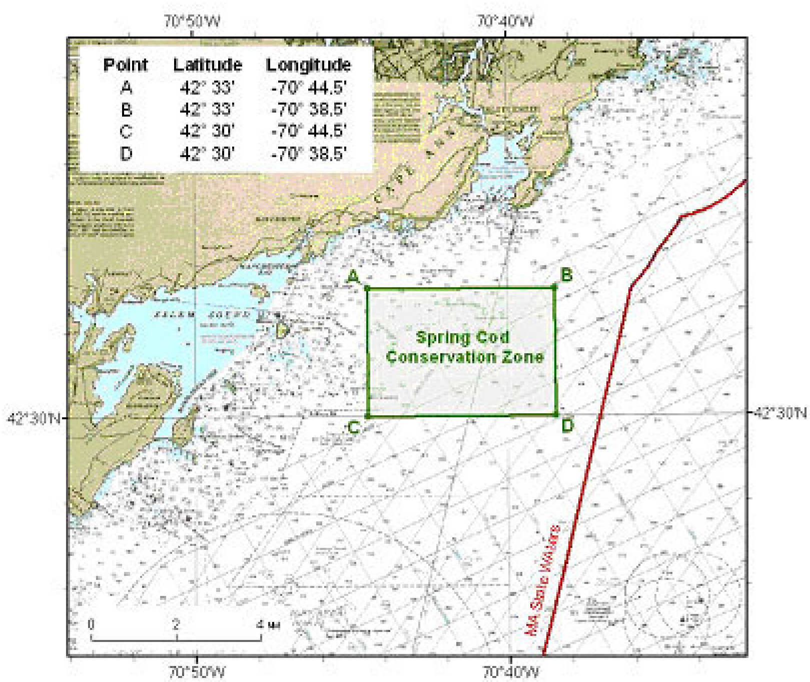
Map 159 Massachusetts Mobile Gear Regulated Areas



Map 160 Massachusetts Winter Cod Conservation Zone



Map 161 Massachusetts Spring Cod Conservation Zone



4.8 Protected resources

Numerous protected species inhabit the environment within the jurisdiction of the New England Fishery Management Council. Therefore, many protected species potentially occur in the operations area of the Council's fisheries. These species are under NMFS jurisdiction and are afforded protection under the Endangered Species Act of 1973 (ESA) and/or the Marine Mammal Protection Act of 1972 (MMPA). Non ESA-listed species protected by the MMPA that utilize this environment and have no documented interaction with Council-managed fisheries will not be discussed in this section.

The following protected resources information was compiled with assistance from NMFS and provided in other NMFS and/or Council documents. These summaries provide the best available information on protected species and the likely effects of the action.

4.8.1 Species present in the area

Table 55 lists the species, protected either by the ESA, the MMPA, or both, that may be found in the areas utilized by Council fisheries. Table 55 also includes one candidate fish species, as identified under the ESA. Candidate species are those petitioned species that are actively being considered for listing as endangered or threatened under the ESA, as well as those species for which NMFS has initiated an ESA status review that it has announced in the Federal Register. Candidate species receive no substantive or procedural protection under the ESA; however, NMFS recommends that project proponents consider implementing conservation actions to limit the potential for adverse effects on candidate species from any proposed project. NMFS has initiated a review of recent stock assessments, bycatch information, and other information for these candidate and proposed species. The results of those efforts are needed to accurately characterize recent interactions between fisheries and the candidate/proposed species in the context of stock sizes. Any conservation measures deemed appropriate for these species will follow the information reviews. Once a species is proposed for listing the conference provisions of the ESA apply (see 50 CFR 402.10), which require consultation with the responsible agency on any action which is likely to jeopardize the continued existence of any proposed species or result in the destruction or adverse modification of proposed critical habitat.

Cusk (*Brosme brosme*) and Dusky Shark (*Carcharhinus obscurus*) are NMFS "species of concern," as well as a "candidate species" under the ESA as NMFS is currently conducting a review of the species. NMFS initiated a status review due to concerns over the status of and threats to cusk, particularly bycatch. NMFS is involved in various proactive conservation initiatives to obtain more information on this data poor species to assess its status and further conservation efforts. These initiatives involve cooperative efforts with industry, scientists, and other partners to learn more about cusk. NMFS is especially interested in the investigation and identification of methods to reduce bycatch or discard mortality of cusk, and, in particular, studies of how to alleviate barotrauma effects in released cusk are of high interest. In the northeastern U.S., cusk are predominantly caught in the Gulf of Maine in commercial bottom trawl, bottom longline, gillnet, lobster trap, and handline/rod and reel gears, as well recreational handline gear (O'Brien, 2010; GMRI, 2012).

NMFS determined that two petitions requesting listing of Dusky shark presented "substantial scientific or commercial information indicating that the petitioned action may be warranted for the Northwest Atlantic and Gulf of Mexico population of dusky shark." However, NMFS determined that this was not applicable range-wide. As a result, a status review of the Northwest Atlantic and Gulf of Mexico population of dusky shark has been initiated to determine if the listing is warranted. (Proposed Rule, May 17, 2013; 78 FR 29100).

Additional information regarding candidate species can be found at http://www.nero.noaa.gov/protected/pcp/index.html.

Table 55 – Status of protected resource species present in the area

Species	Status
Cetaceans	
North Atlantic right whale (*Eubalaena glacialis*)	Endangered
Humpback whale (*Megaptera novaeangliae*)	Endangered
Fin whale (*Balaenoptera physalus*)	Endangered
Sei whale (*Balaenoptera borealis*)	Endangered
Blue whale (*Balaenoptera musculus*)	Endangered
Sperm whale (*Physeter macrocephalus)*	Endangered
Minke whale (*Balaenoptera acutorostrata*)	Protected
Long-finned pilot whale (*Globicephala melas*)	Protected
Short-finned pilot whale (*Globicephala macrorhynchus*)	Protected
Risso's dolphin (*Grampus griseus*)	Protected
Atlantic white-sided dolphin (*Lagenorhynchus acutus*)	Protected
Common dolphin (*Delphinus delphis*)	Protected
Spotted dolphin (*Stenella frontalis*)	Protected
Bottlenose dolphin (*Tursiops truncatus*)[a]	Protected
Harbor porpoise (*Phocoena phocoena*)	Protected
Sea Turtles	
Leatherback sea turtle (*Dermochelys coriacea*)	Endangered
Kemp's ridley sea turtle (*Lepidochelys kempii*)	Endangered
Green sea turtle (*Chelonia mydas*)[b]	Endangered[c]
Loggerhead sea turtle (*Caretta caretta*), Northwest Atlantic DPS	Threatened
Hawksbill sea turtle (*Eretmochelys imbricate*)	Endangered
Fish	
Shortnose sturgeon (*Acipenser brevirostrum*)	Endangered
Atlantic salmon (*Salmo salar*)	Endangered
Atlantic sturgeon *(Acipenser oxyrinchus)*	
Gulf of Maine DPS	Threatened
New York Bight DPS, Chesapeake Bay DPS, Carolina DPS & South Atlantic DPS	Endangered
Cusk (*Brosme brosme*)	Candidate

Species	Status
Dusky shark (*Carcharhinus obscurus*)	Candidate
Pinnipeds	
Harbor seal (*Phoca vitulina*)	Protected
Gray seal (*Halichoerus grypus*)	Protected
Harp seal (*Phoca groenlandicus*)	Protected
Hooded seal (*Cystophora cristata*)	Protected

[a] Bottlenose dolphin (*Tursiops truncatus*), Western North Atlantic coastal stock is listed as depleted.
[b]Green turtles in U.S. waters are listed as threatened except for the Florida breeding population which is listed as endangered. Due to the inability to distinguish between these populations away from the nesting beach, green turtles are considered endangered wherever they occur in U.S. waters.

4.8.2 Species potentially affected

Council-managed fisheries have the potential to affect the sea turtle, cetacean, pinniped, and fish species discussed below. A number of documents contain background information on the range-wide status of sea turtle and marine mammal species that occur in the area and are known or suspected of interacting with fishing gear (demersal gear including trawls, gillnets, and bottom longlines). These include:

- Sea turtle status reviews and biological reports (Conant et al. 2009; NMFS and USFWS 1995, 2007a, 2007b, 2007c, 2007d; Hirth 1997, Turtle Expert Working Group (TEWG) 1998, 2000, 2007, 2009);
- Recovery plans for Endangered Species Act-listed sea turtles and marine mammals (NMFS 1991a, 1991b; NMFS and USFWS 1991c, 1991d, 2008; NMFS et al. 2011; USFWS and NMFS 1992; NMFS 2005b);
- Marine mammal stock assessment reports (e.g., Waring et al. 2013); and
- Other publications (e.g., Clapham et al. 1999; Perry et al. 1999; Wynne and Schwartz 1999; Best et al. 2001; Perrin et al. 2002).
- Additional background information on the Gulf of Maine Distinct Population Segment of Atlantic salmon and the five distinct population segments of Atlantic sturgeon can be found in the respective status reviews (Fay et al. 2006; ASSRT 2007) and listing determinations for Atlantic salmon (NMFS 2009a (74 FR 29344; June 19, 2009)) and Atlantic sturgeon (77 FR 5880 and 77 FR 5914; February 3, 2012).

4.8.2.1 Sea turtles

Loggerhead, leatherback, Kemp's ridley, and green sea turtles occur seasonally in southern New England and Mid-Atlantic continental shelf waters north of Cape Hatteras, North Carolina. Turtles generally move up the coast from southern wintering areas as water temperatures warm in the spring (Braun-McNeill and Epperly 2004, Morreale and Standora 1998, Musick and Limpus 1997, Shoop and Kenney 1992, Keinath et al. 1987). A reversal of this trend occurs in the fall when water temperatures cool. Turtles pass Cape Hatteras by December and return to more southern waters for the winter (James et al. 2005, Morreale and Standora 2005, Braun-McNeill and Epperly 2004, Morreale and Standora 1998, Musick and Limpus 1997, Shoop and Kenney 1992, Keinath et al. 1987). Hard-shelled sea turtles are more commonly observed south of Cape Cod, but may occur in the Gulf of Maine. The more cold-tolerant leatherbacks range farther north than other sea turtles, feeding as far north as Canadian waters. Sightings per unit effort data can be used to visualize the seasonal distributions of loggerheads (Map 162), leatherbacks (Map 163), and green sea turtles (Map 164). (Shoop and Kenney 1992, STSSN database http://www.sefsc.noaa.gov/seaturtleSTSSN.jsp).

On March 16, 2010, NMFS and USFWS published a proposed rule (75 FR 12598) to divide the worldwide population of loggerhead sea turtles into nine DPSs, as described in the 2009 Status Review. Two of the DPSs were proposed to be listed as threatened and seven of the DPSs, including the Northwest Atlantic Ocean DPS, were proposed to be listed as endangered. NMFS and the USFWS accepted comments on the proposed rule through September 13, 2010 (June 2, 2010, 75 FR 30769). On March 22, 2011 (76 FR 15932), NMFS and USFWS extended the date by which a final determination on the listing action would be made to no later than September 16, 2011. This action was taken to address the interpretation of the existing data on status and trends and its relevance to the assessment of risk of extinction for the Northwest Atlantic Ocean DPS, as well as the magnitude and immediacy of the fisheries bycatch threat and measures to reduce this threat. New information or analyses to help clarify these issues were requested by April 11, 2011.

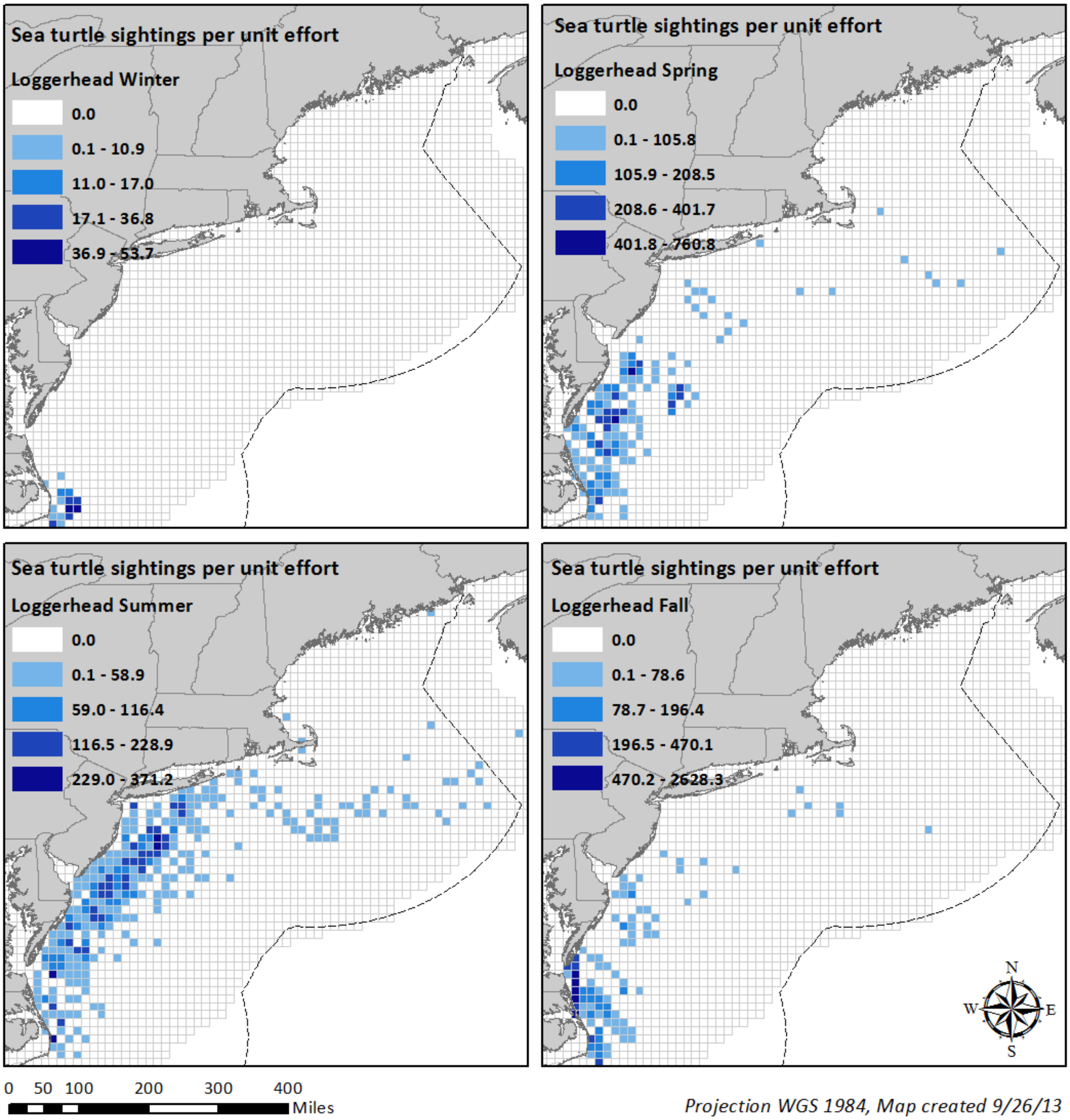
On September 22, 2011, NMFS and USFWS issued a final rule (76 FR 58868), determining that the loggerhead sea turtle is composed of nine DPSs (as defined in Conant et al., 2009) that constitute species that may be listed as threatened or endangered under the ESA. Five DPSs were listed as endangered (North Pacific Ocean, South Pacific Ocean, North Indian Ocean, Northeast Atlantic Ocean, and Mediterranean Sea), and four DPSs were listed as threatened (Northwest Atlantic Ocean, South Atlantic Ocean, Southeast Indo-Pacific Ocean, and Southwest Indian Ocean). Note that the Northwest Atlantic Ocean (NWA) DPS and the Southeast Indo-Pacific Ocean DPS were original proposed as endangered. The NWA DPS was determined to be threatened based on review of nesting data available after the proposed rule was published, information provided in public comments on the proposed rule, and further discussions within the agencies. The two primary factors considered were population abundance and population trend. NMFS and USFWS found that an endangered status for the NWA DPS was not warranted given the large size of the nesting population, the overall nesting population remains widespread, the trend for the nesting population appears to be stabilizing, and substantial conservation efforts are underway to address threats.

The September 2011 final rule also noted that critical habitat for the two DPSs occurring within the U.S. (NWA DPS and North Pacific DPS) will be designated in a future rulemaking. A proposed rule for loggerhead critical habitat was published on July 18, 2013 (78 FR 43005). Information from the public related to the identification of critical habitat, essential physical or biological features for this species, and other relevant impacts of a critical habitat designation was solicited.

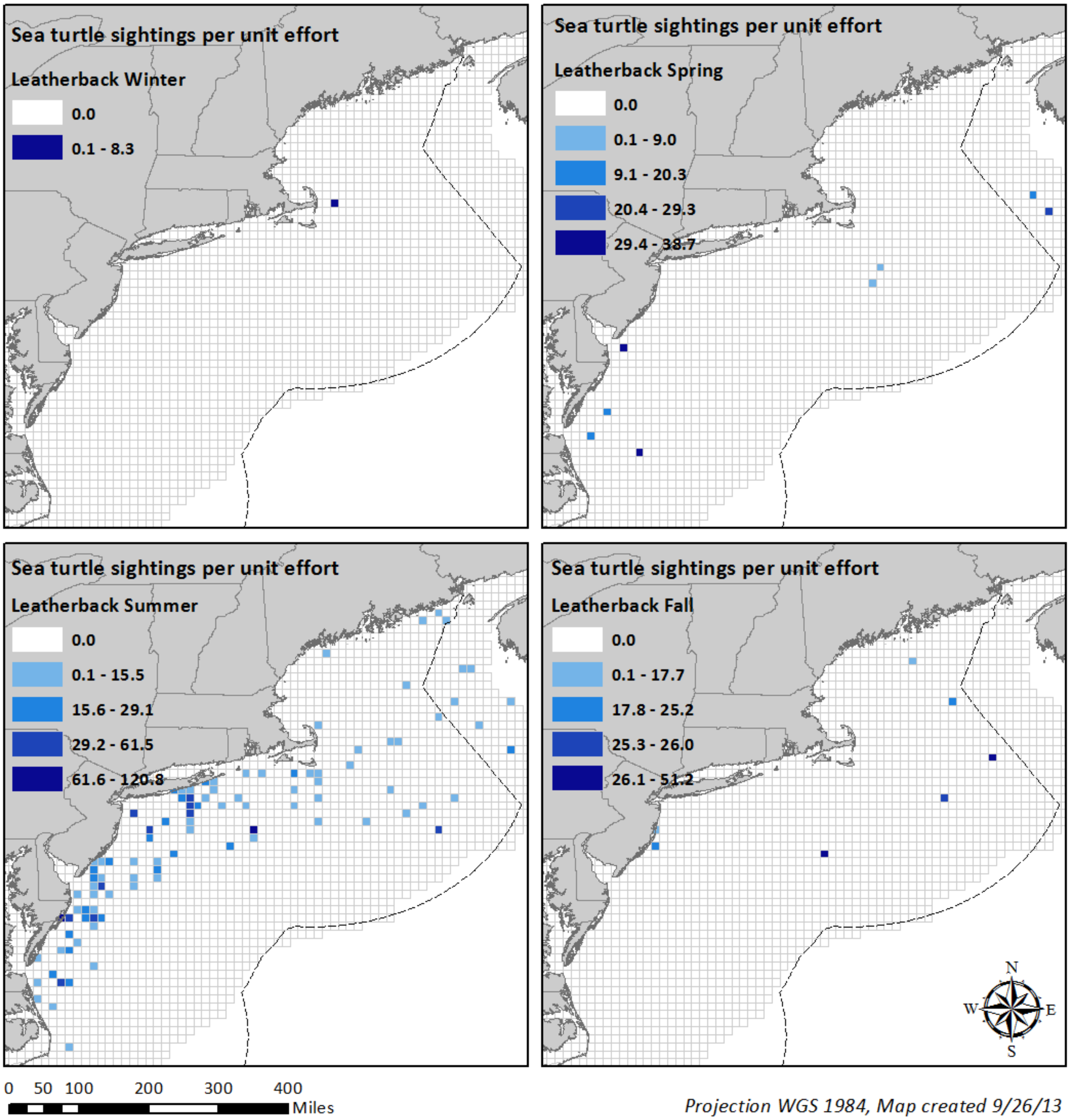
This Amendment would only occur in the Atlantic Ocean. As noted in Conant et al. (2009), the range of the four DPSs occurring in the Atlantic Ocean are as follows: NWA DPS – north of the equator, south of 60° N latitude, and west of 40° W longitude; Northeast Atlantic Ocean (NEA) DPS – north of the equator, south of 60° N latitude, east of 40° W longitude, and west of 5° 36' W longitude; South Atlantic DPS – south of the equator, north of 60° S latitude, west of 20° E longitude, and east of 60° W longitude; Mediterranean DPS – the Mediterranean Sea east of 5° 36' W longitude. These boundaries were determined based on oceanographic features, loggerhead sightings, thermal tolerance, fishery bycatch data, and information on loggerhead distribution from satellite telemetry and flipper tagging studies. Sea turtles from the NEA DPS are not expected to be present over the North American continental shelf in U.S. coastal waters, where the actions proposed in this amendment would occur (NMFS 2014 Sector Environmental Assessment). Previous literature (Bowen et al. 2004) has suggested that there is the potential, albeit small, for some juveniles from the Mediterranean DPS to be present in U.S. Atlantic coastal foraging grounds. These data should be interpreted with caution however; as they may be representing a shared common haplotype and lack of representative sampling at Eastern Atlantic rookeries. Given that updated, more refined analyses are ongoing and the occurrence of Mediterranean DPS juveniles in U.S. coastal waters is rare and uncertain, if even occurring at all, for the purposes of this assessment we are making the determination that the Mediterranean DPS is not likely to be present in the action area. Sea turtles of the South Atlantic DPS do not inhabit the action area of this subject fishery (Conant et al. 2009). As such, the remainder of this assessment will only focus on the NWA DPS of loggerhead sea turtles, listed as threatened.

In general, sea turtles are a long-lived species and reach sexual maturity relatively late (NMFS SEFSC 2001; NMFS and USFWS 2007a, 2007b, 2007c, 2007d). Sea turtles are injured and killed by numerous human activities (NRC 1990; NMFS and USFWS 2007a, 2007b, 2007c, 2007d). Nest count data are a valuable source of information for each turtle species since the number of nests laid reflects the reproductive output of the nesting group each year. A decline in the annual nest counts has been measured or suggested for four of five western Atlantic loggerhead nesting groups through 2004 (NMFS and USFWS 2007a), however, data collected since 2004 suggests nest counts have stabilized or increased (TEWG 2009). Nest counts for Kemp's ridley sea turtles as well as leatherback and green sea turtles in the Atlantic demonstrate increased nesting by these species (NMFS and USFWS 2007b, 2007c, 2007d).

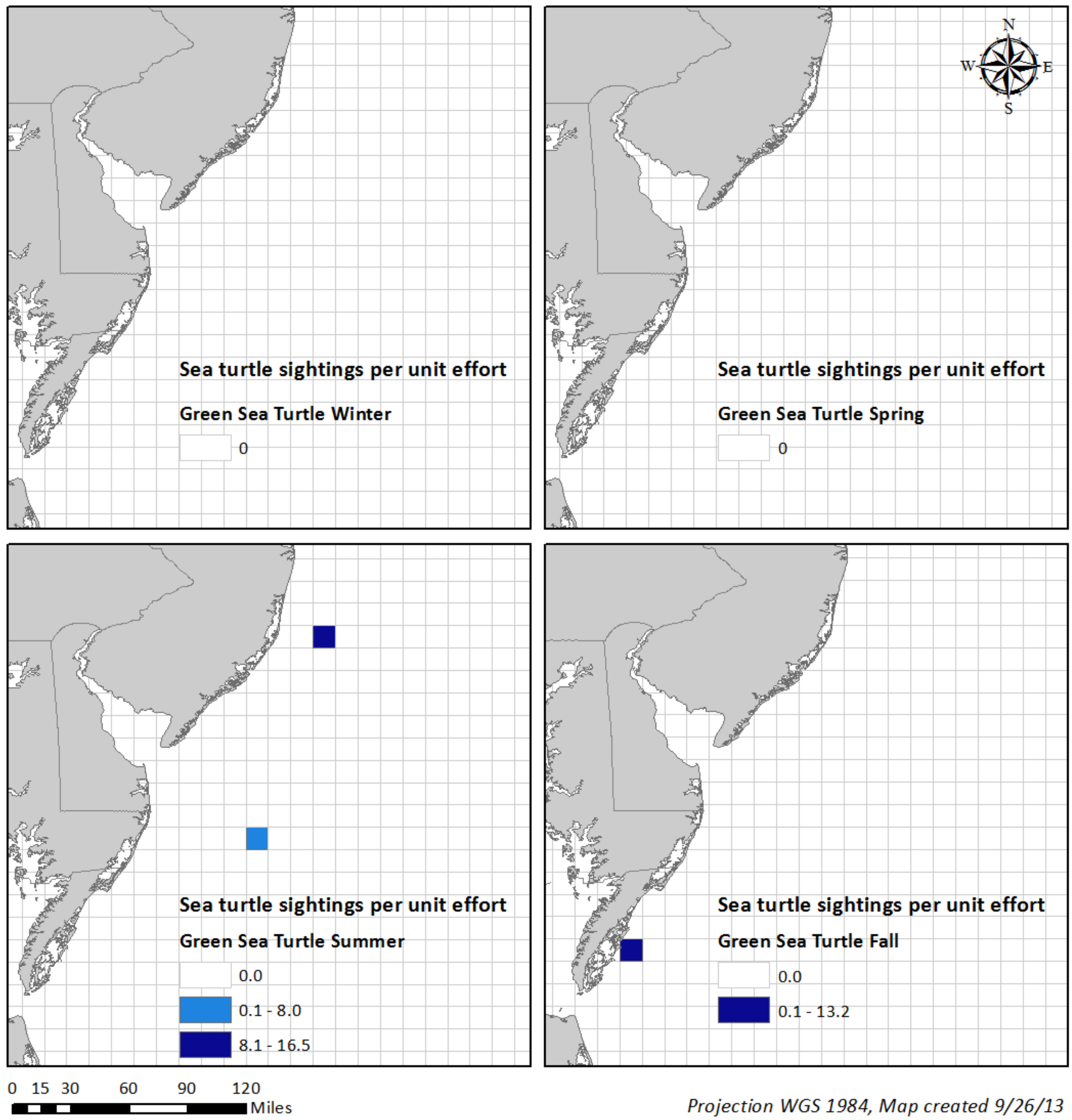
Map 162 – Loggerhead sea turtle sightings per unit effort 1979-2007 (source – TNC NAMERA)



Map 163 – Leatherback sea turtle sightings per unit effort 1979-2007 (source – TNC NAMERA)



Map 164 - Green sea turtle sightings per unit effort 1979-2007 (source – TNC NAMERA)



4.8.2.2 Large cetaceans

The most recent Marine Mammal Stock Assessment Report (SAR) (Waring et al. 2013) reviewed the current population trend for each of these cetacean species within U.S. EEZ. The SAR also estimated annual human-caused mortality and serious injury. Finally, it described the commercial fisheries that interact with each stock in the U.S. Atlantic. The following paragraphs summarize information from the SAR.

The western North Atlantic baleen whale species (North Atlantic right, humpback, fin, sei, and minke whales) follow a general annual pattern of migration. They migrate from high latitude summer foraging grounds, including the Gulf of Maine and Georges Bank, to low latitude winter calving grounds (Perry et al. 1999, Kenney 2002). However, this is a simplification of species movements as the complete winter distribution of most species is unclear (Perry et al. 1999, Waring et al. 2013). Studies of some of the large baleen whales (right, humpback, and fin) have demonstrated the presence of each species in higher latitude waters even in the winter (Swingle et al. 1993, Wiley et al. 1995, Perry et al. 1999, Brown et al. 2002). Blue whales are most often sighted along the east coast of Canada, particularly in the Gulf of St. Lawrence. They occur only infrequently within the U.S. EEZ (Waring et al. 2013).

Available information suggests that the North Atlantic right whale population increased at a rate of 2.6 percent per year between 1990 and 2009. The total number of North Atlantic right whales is estimated to be at least 444 animals in 2009 (Waring et al. 2013). The minimum rate of annual human-caused mortality and serious injury to right whales in U.S. waters averaged 2.4 mortality or serious injury incidents per year during 2006 to 2010 (Waring et al. 2013). Of these, U.S. fishery interactions resulted in an average of 1.6 mortality or serious injury incidents per year.

The North Atlantic population of humpback whales is conservatively estimated to be 7,698 (Waring et al. 2013). The best estimate for the Gulf of Maine stock of humpback whale population is 823 whales (Waring et al. 2013). Based on data available for selected areas and time periods, the minimum population estimates for other western North Atlantic whale stocks are 3,522 fin whales, 357 sei whales (Nova Scotia stock), 1,593 sperm whales, and 20,741 minke whales (Waring et al. 2013). Current data suggest that the Gulf of Maine humpback whale stock is steadily increasing in size (Waring et al. 2013). Insufficient information exists to determine trends for these other large whale species.

The most recent revisions to the Atlantic Large Whale Take Reduction Plan (72 FR 57104, October 5, 2007) addressed entanglement risk of large whales (right, humpback, and fin whales, and acknowledge benefits to minke whales) in commercial fishing gear. The revisions seek to reduce the risk of death and serious injury from entanglements that occur in groundlines of commercial gillnet and trap/pot gear. On June 27, 2014 (79 FR 36586), NMFS published a final rule to revise the Atlantic Large Whale Take Reduction Plan to address the entanglement risks to large whales posed by vertical lines on commercial trap/pot gear. Additional information can be found at http://www.nero.noaa.gov/Protected/whaletrp/.

More details on fisheries interactions with these species, as well as management actions in place to reduce entanglement risk, can be found in Section 4.8.4, below.

4.8.2.3 Small cetaceans

There is fishing related mortality of numerous small cetacean species (dolphins, pilot whales, and harbor porpoises) associated with New England-based fishing gear. Seasonal abundance and distribution of each species off the coast of the Northeast U.S. varies with respect to life history characteristics. Some species such as white-sided dolphins and harbor porpoises primarily occupy continental shelf waters. Other species such as the Risso's dolphin occur primarily in continental shelf edge and slope waters. Still other species like the common dolphin and the spotted dolphin occupy all three habitats. Waring et al. (2013) summarizes information on the distribution and geographic range of western North Atlantic stocks of each species.

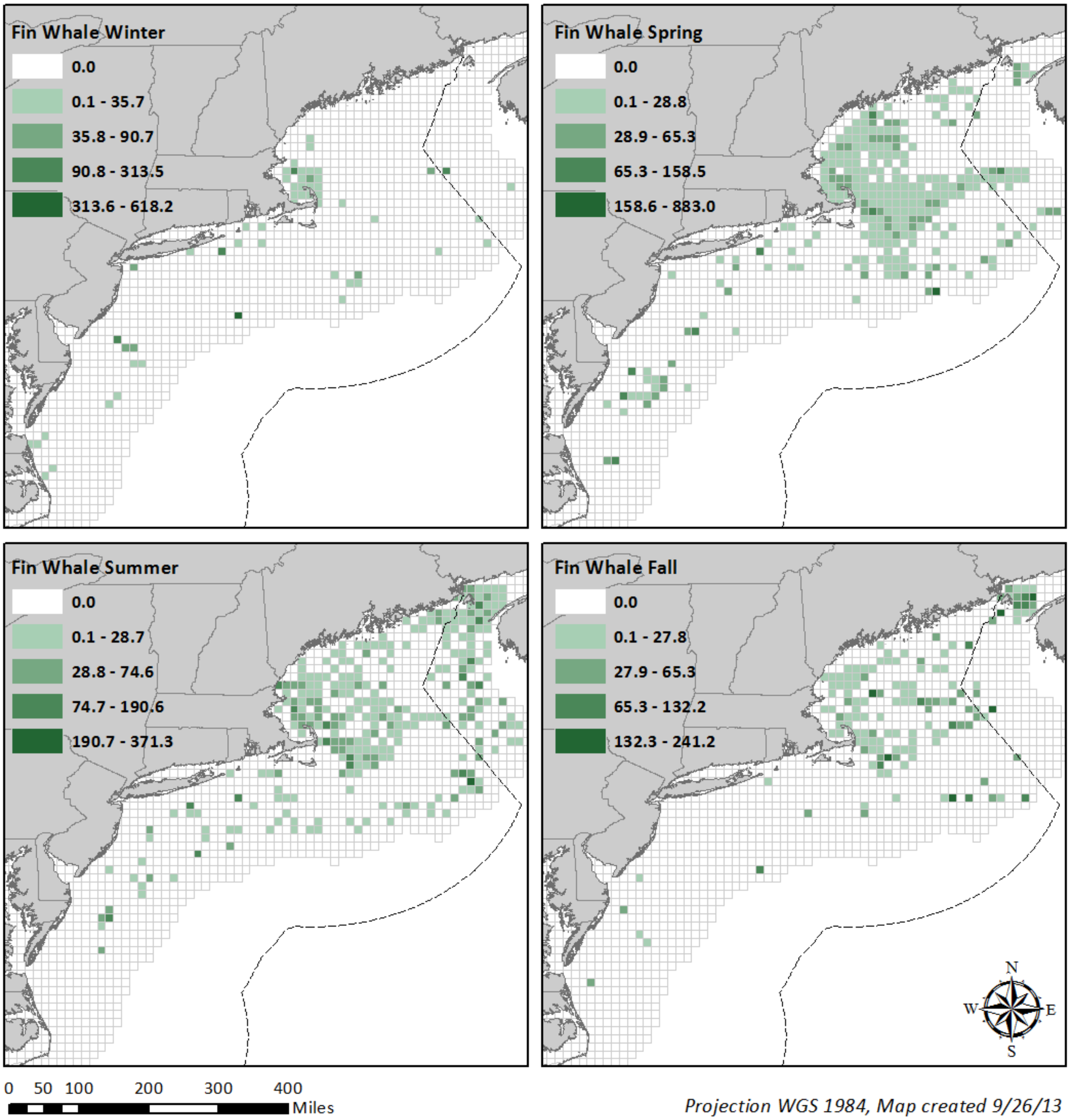
The most commonly observed small cetaceans recorded as bycatch in multispecies (i.e., groundfish, monkfish, or skate) fishing gear (e.g., gillnets and trawls) are harbor porpoises, white-sided dolphins, common dolphins, and long- and short-finned pilot whales. Harbor porpoises are found seasonally within New England and Mid-Atlantic waters. In the Mid-Atlantic, porpoises are present in the winter/spring (typically January through April) and in southern New England waters from December through May. In the Gulf of Maine, porpoises occur largely from the fall through the spring (September through May) and in the summer are found in northern Maine and through the Bay of Fundy and Nova Scotia area.

White-sided dolphin distribution shifts seasonally, with a large presence from Georges Bank through the Gulf of Maine from June through September, with intermediate presence from Georges Bank through the lower Gulf of Maine from October through December. Low numbers are present from Georges Bank to Jeffrey's Ledge from January through May (Waring et al. 2013). Common dolphins are widely distributed over the continental shelf from Maine through Cape Hatteras, North Carolina. From mid-January to May they are dispersed from North Carolina through Georges Bank, and then move onto Georges Bank and the Scotia shelf from the summer to fall. They are occasionally found in the Gulf of Maine (Waring et al. 2013).

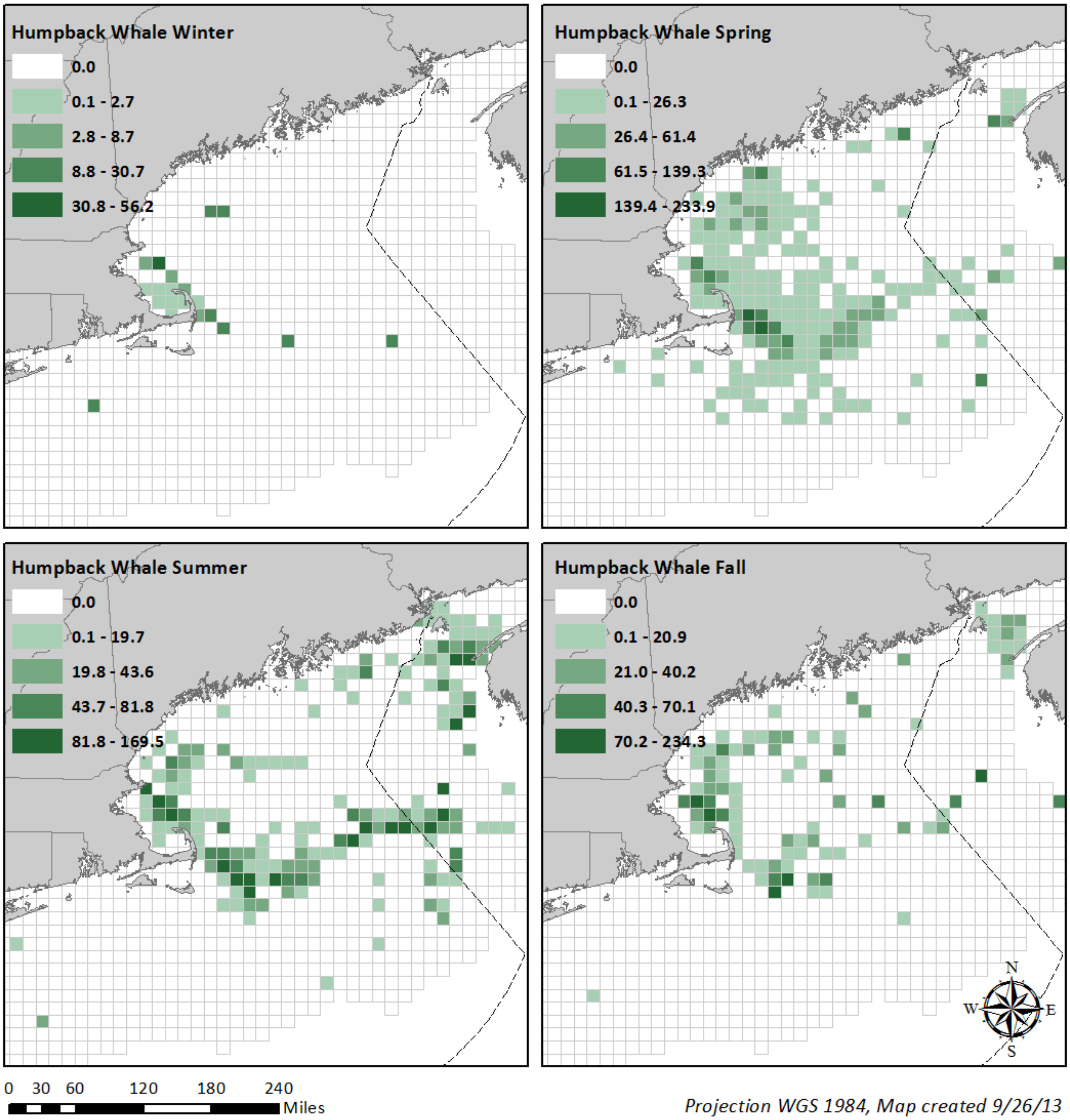
Pilot whales are generally distributed along the continental shelf edge off the northeastern U.S. coast in the winter and early spring. In late spring, they move onto Georges Bank and into the Gulf of Maine and remain until late fall. They do occur along the Mid-Atlantic shelf break between Cape Hatteras, North Carolina and New Jersey (Waring et al. 2013). Since pilot whales are difficult to differentiate at sea, they are generally considered *Globicephala* sp. when they are recorded at sea (Waring et al. 2013).

Sightings per unit effort data can be used to visualize the seasonal distributions of fin whales (Map 165), humpback whales (Map 166), sei whales (Map 167), minke whales (Map 168), right whales (Map 169), sperm whales (Map 170), and harbor porpoises (Map 171).

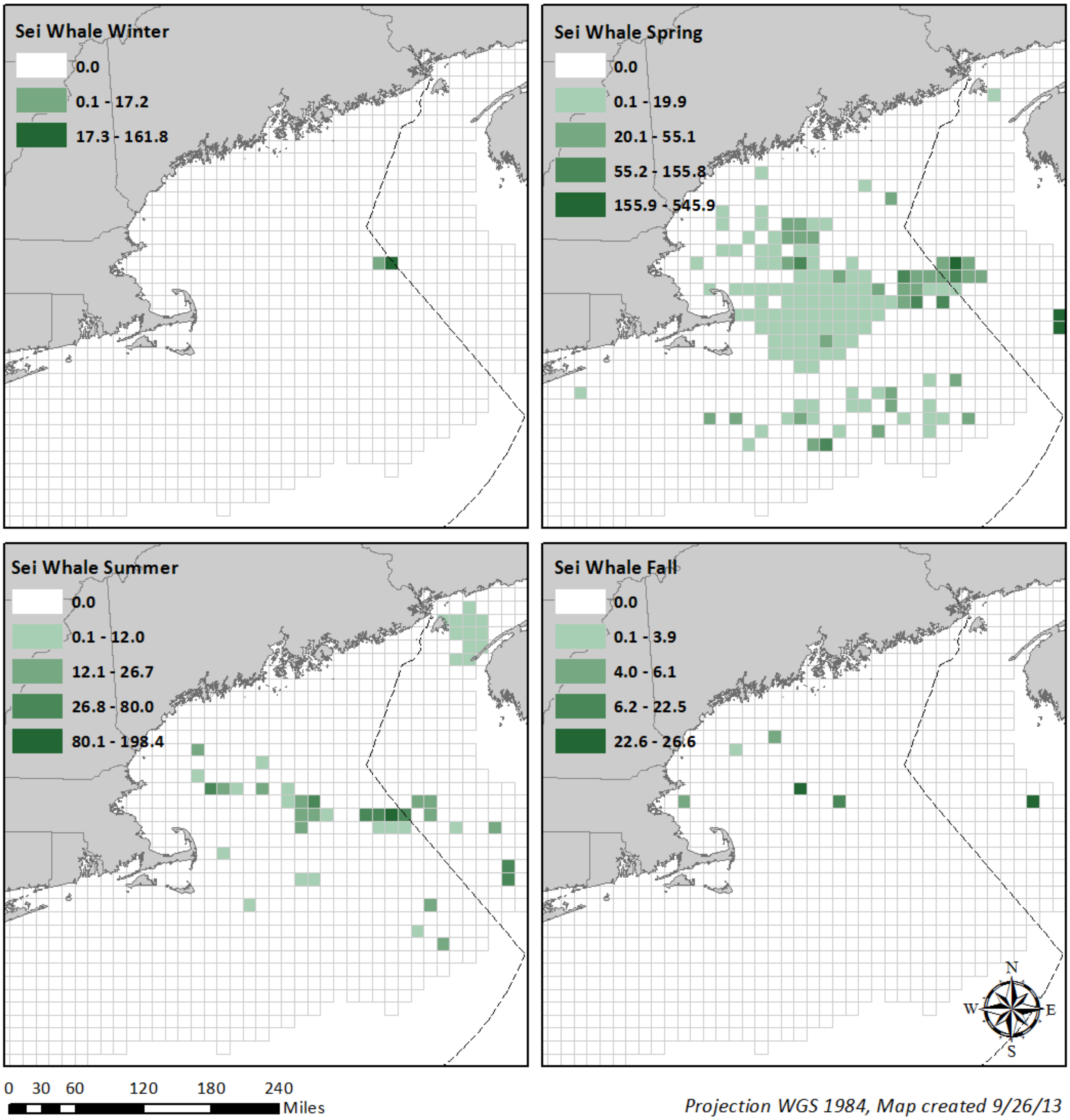
Map 165 – Fin whale sightings per unit effort 1979-2007 (source – TNC NAMERA)



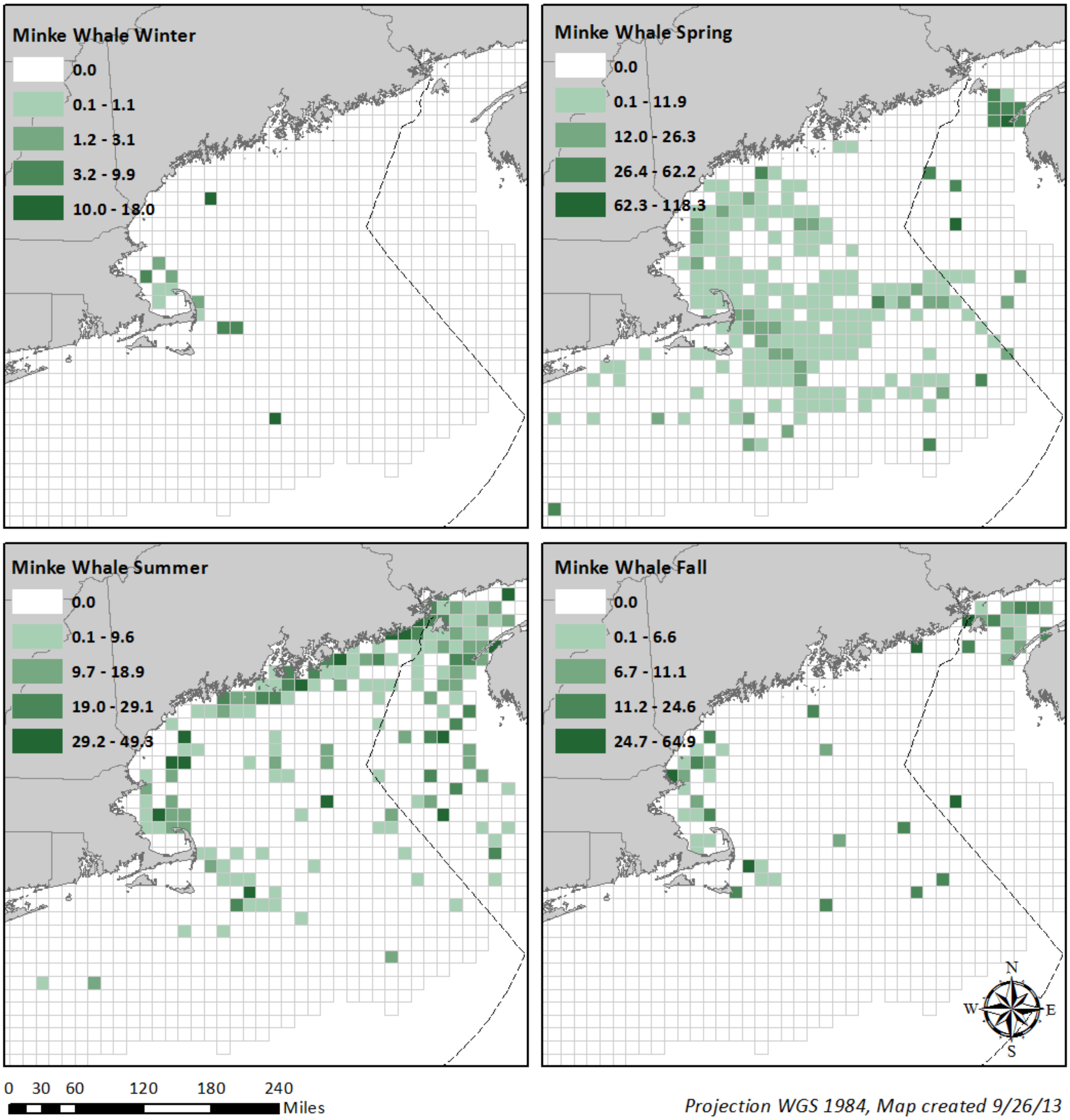
Map 166 – Humpback whale sightings per unit effort 1979-2007 (source – TNC NAMERA)



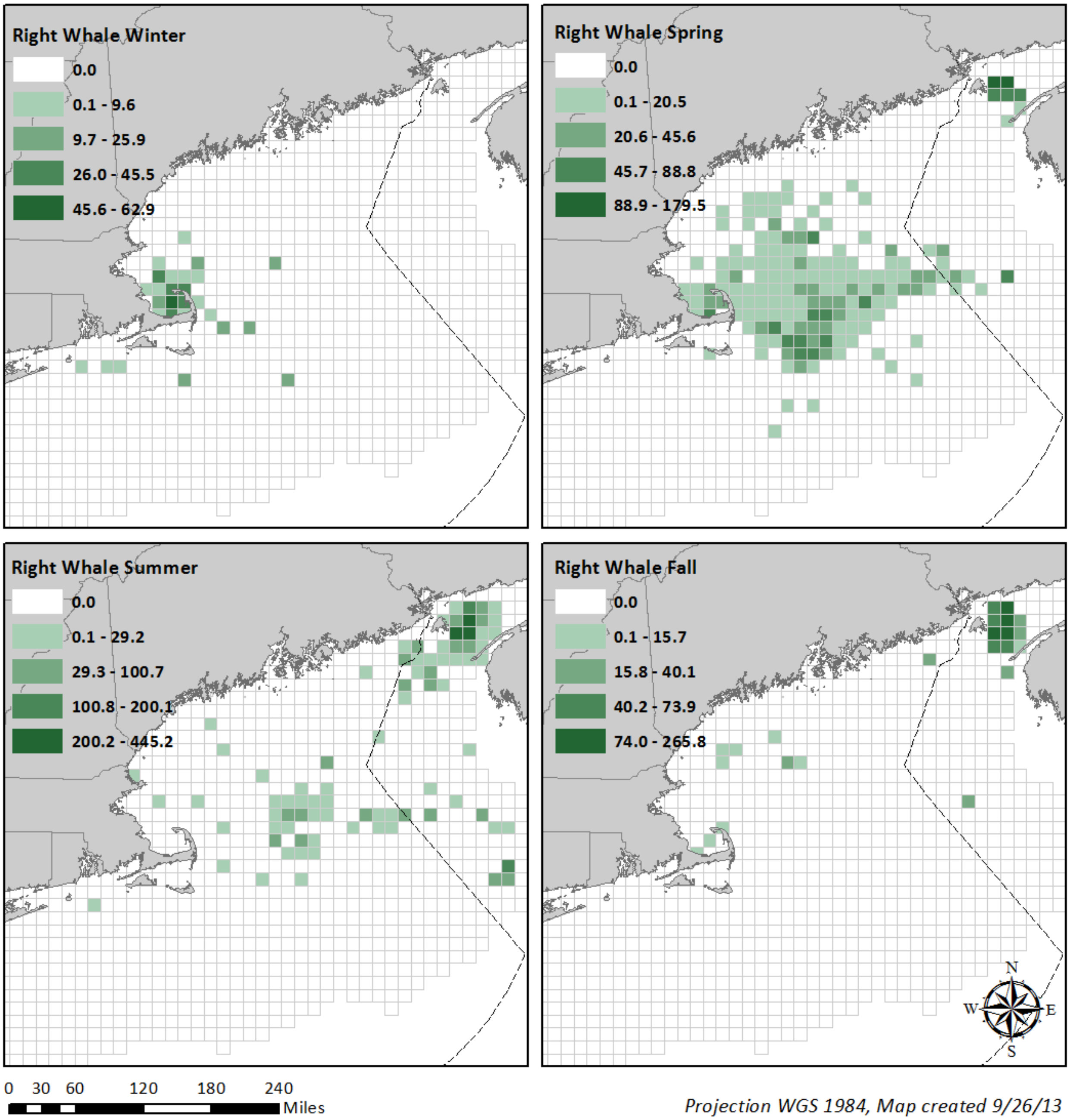
Map 167 – Sei whale sightings per unit effort 1979-2007 (source – TNC NAMERA)



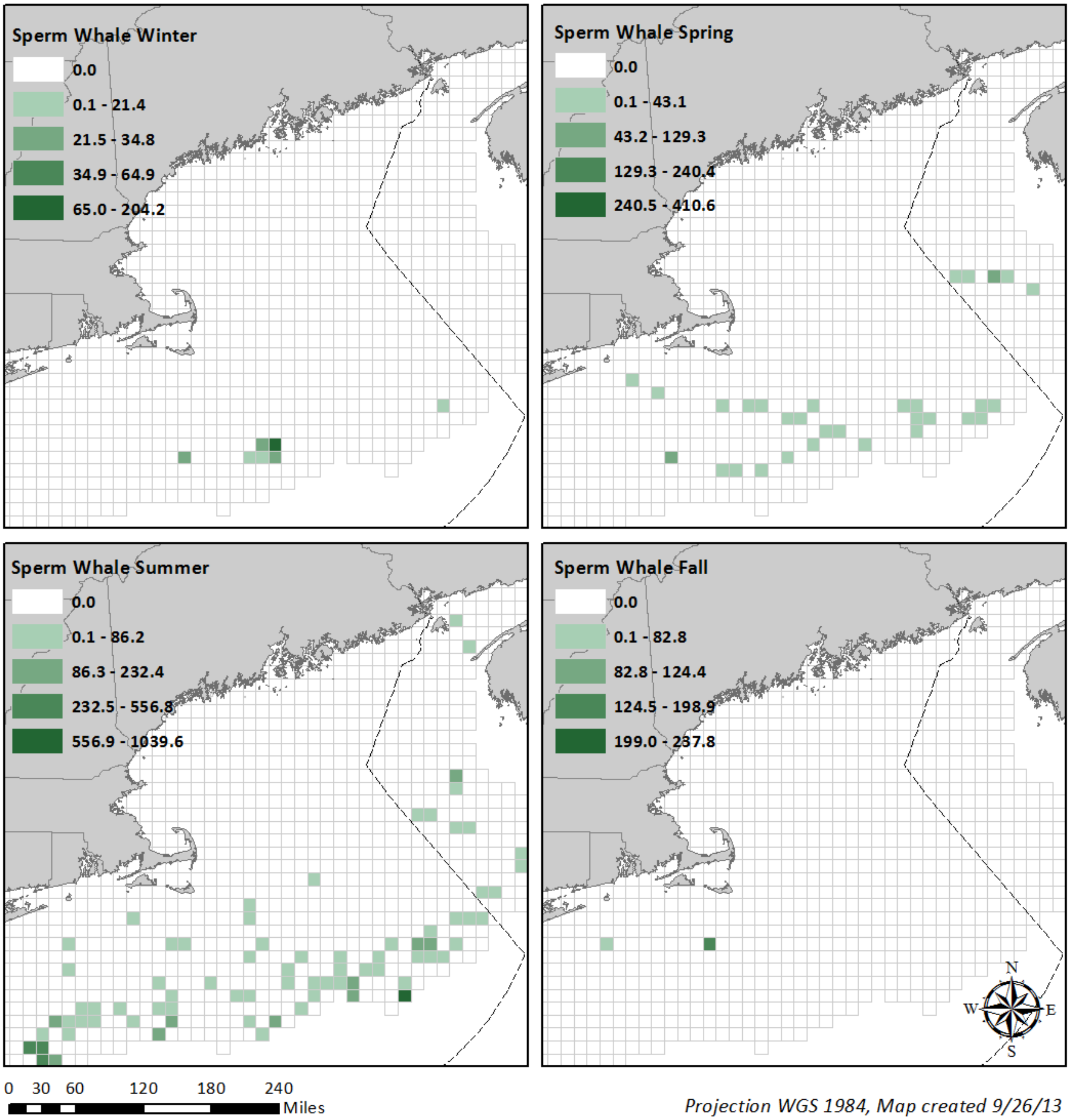
Map 168 – Minke whale sightings per unit effort 1979-2007 (source – TNC NAMERA)



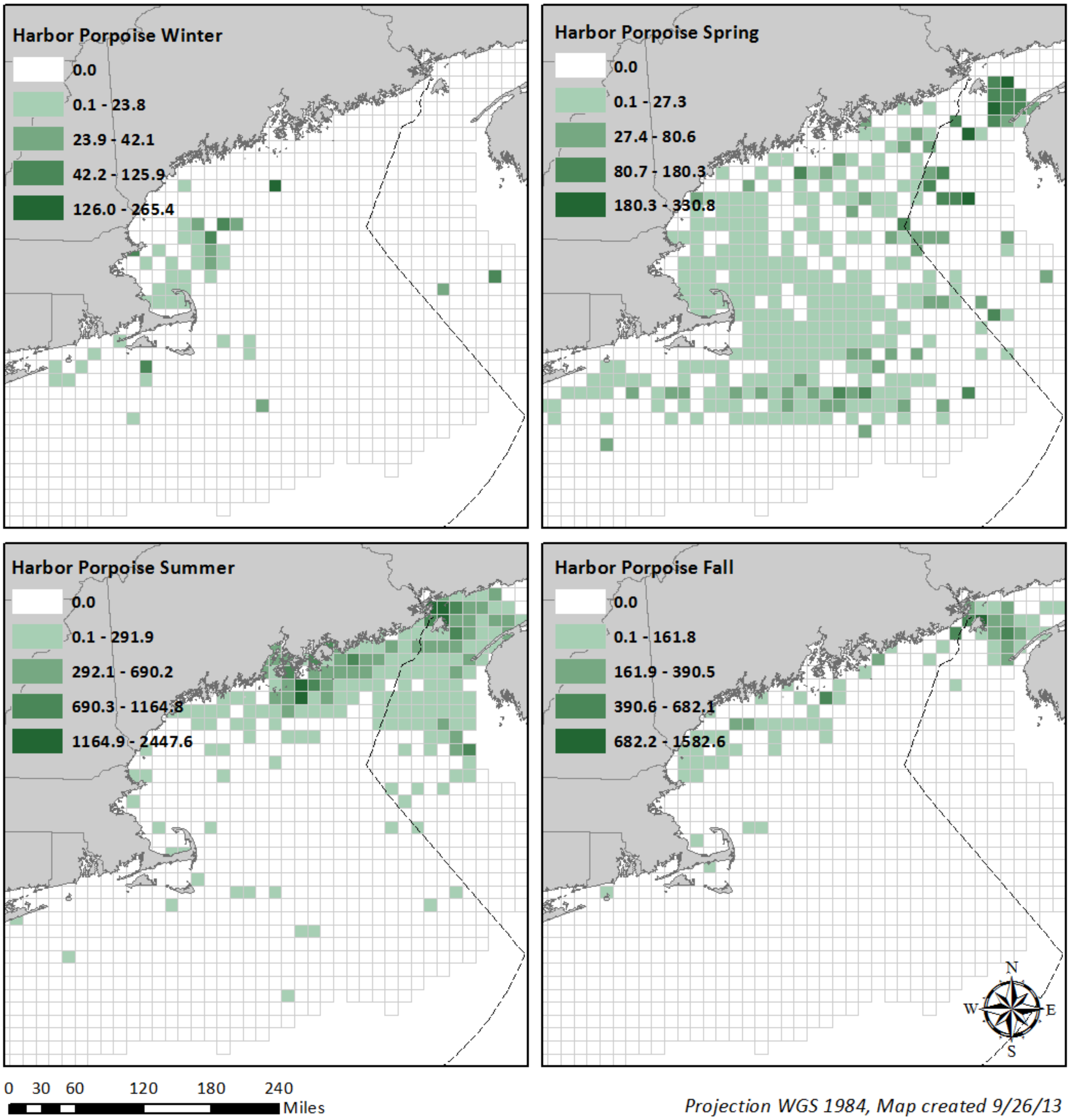
Map 169 – Right whale sightings per unit effort 1979-2007 (source – TNC NAMERA)



Map 170 – Sperm whale sightings per unit effort 1979-2007 (source – TNC NAMERA)



Map 171 - Harbor porpoise sightings per unit effort 1979-2007 (source – TNC NAMERA)



4.8.2.4 Pinnipeds

Harbor seals have the most extensive distribution of the four species of seal expected to occur in the area. Harbor seal sightings have occurred far south as 30° N (Katona et al. 1993, Waring et al. 2013). Their approximate year-round range extends from Nova Scotia, through the Bay of Fundy, and south through Maine to northern Massachusetts (Waring et al. 2013). Their more seasonal range (September through May) extends from northern Massachusetts south through southern New Jersey, and stranding records indicate occasional presence of harbor seals from southern New Jersey through northern North Carolina (Waring et al. 2013).

Gray seals are the second most common seal species in U.S. EEZ waters. They occur from Nova Scotia through the Bay of Fundy and into waters off of New England (Katona et al. 1993; Waring et al. 2013) year-round from Maine through southern Massachusetts (Waring et al. 2013). A more seasonal distribution of gray seals occurs from southern Massachusetts through southern New Jersey from September through May. Similar to harbor seals, occasional presence from southern New Jersey through northern North Carolina indicate occasional presence of gray seals in this region (Waring et al. 2013). Pupping for both species occurs in both U.S. and Canadian waters of the western North Atlantic. The majority of harbor seal pupping is thought to occur in U.S. waters. While there are at least three gray seal pupping colonies in U.S., the majority of gray seal pupping likely occurs in Canadian waters. Observations of harp and hooded seals are less common in U.S. EEZ waters. Both species form aggregations for pupping and breeding off eastern Canada in the late winter/early spring. They then travel to more northern latitudes for molting and summer feeding (Waring et al. 2013). Both species have a seasonal presence in U.S. waters from Maine to New Jersey, based on sightings, stranding, and fishery bycatch information (Waring et al. 2013).

4.8.2.5 Atlantic sturgeon

As described in the Biological Opinion on the Continued Implementation of Management Measures for the Northeast Multispecies, Monkfish, Spiny Dogfish, Atlantic Bluefish, Northeast Skate Complex, Atlantic Mackerel, Squids, and Butterfish, and Summer Flounder, Scup, and Black Sea Bass FMPs (NMFS 2013), often referred to as the "Batch Biological Opinion", Atlantic sturgeon is an anadromous species that spawns in relatively low salinity, river environments, but spends most of its life in the marine and estuarine environments from Labrador, Canada to the Saint Johns River, Florida (Holland and Yelverton 1973, Dovel and Berggen 1983, Waldman et al. 1996, Kynard and Horgan 2002, Dadswell 2006, ASSRT 2007). Tracking and tagging studies have shown that subadult and adult Atlantic sturgeon that originate from different rivers mix within the marine environment, utilizing ocean and estuarine waters for life functions such as foraging and overwintering (Stein et al. 2004a, Dadswell 2006, ASSRT 2007, Laney et al. 2007, Dunton et al. 2010). Fishery-dependent data as well as fishery-independent data demonstrate that Atlantic sturgeon use relatively shallow inshore areas of the continental shelf; primarily waters less than 50 m (Stein et al. 2004b, ASMFC 2007, Dunton et al. 2010). The data also suggest regional differences in Atlantic sturgeon depth distribution with sturgeon observed in waters primarily less than 20 m in the Mid-Atlantic Bight and in deeper waters in the Gulf of Maine (Stein et al. 2004b, ASMFC 2007, Dunton et al. 2010). Information on population sizes for each Atlantic sturgeon DPS is very limited. Based on the best available information, NMFS has concluded that bycatch, vessel strikes, water quality and water availability, dams, lack of regulatory mechanisms for protecting the fish, and dredging are the most significant threats to Atlantic sturgeon.

Since the ESA listing of Atlantic sturgeon, the NEFSC has completed new population estimates using data from the Northeast Area Monitoring and Assessment (NEAMAP) survey (Kocik et al. 2013). Atlantic sturgeon are frequently sampled during the NEAMAP survey. NEAMAP has been conducting trawl surveys from Cape Cod, Massachusetts to Cape Hatteras, North Carolina in nearshore waters at depths to 18.3 meters (60 feet) during the fall since 2007 and depths up to 36.6 meters (120 feet) during the spring since 2008 using a spatially stratified random design with a total of 35 strata and 150 stations per survey. The information from this survey can be directly used to calculate minimum swept area population estimates during the fall, which range from 6,980 to 42,160 with coefficients of variation between 0.02 and 0.57 and during the spring, which range from 25,540 to 52,990 with coefficients of variation between 0.27 and 0.65. These are considered minimum estimates because the calculation makes the unlikely assumption that the gear will capture 100% of the sturgeon in the water column along the tow path. Efficiencies less than 100% will result in estimates greater than the minimum. The true efficiency depends on many things including the availability of the species to the survey and the behavior of the species with respect to the gear. True efficiencies much less than 100% are common for most species. The NEFSC's analysis also calculated estimates based on an assumption of 50% efficiency, which reasonably accounts for the robust, yet not complete sampling of the Atlantic sturgeon, oceanic temporal and spatial ranges, and the documented high rates of encounter with NEAMAP survey gear and Atlantic sturgeon. For the most recent analysis conducted in the Batch Biological Opinion (NMFS Northeast Region 2013), the best available scientific information for the status of Atlantic sturgeon were the population estimates derived from NEAMAP swept area biomass (Kocik et al. 2013) because the estimates were derived directly from empirical data with few assumptions. In addition, this analysis used the median value of the 50% efficiency as the best estimate of the Atlantic sturgeon ocean population is most appropriate at this time. This results in a total population size estimate of 67,776 fish. This estimate is the best available estimate of Atlantic sturgeon abundance at the time of this analysis. The Atlantic States Marine Fisheries Commission has begun work on a benchmark assessment for Atlantic sturgeon to be completed in 2014, which would be expected to provide an updated population estimate and stock status. The Commission is currently collecting public submissions of data for use in the assessment: http://www.asmfc.org/press_releases/2013/pr20AtlSturgeonStockAssmtPrep.pdf.

4.8.2.6 Atlantic salmon (Gulf of Maine DPS)

As described in the Monkfish Fishery Management Plan Framework Adjustment 8 Environmental Assessment (NEFMC 2014), Atlantic salmon may be affected by the actions described in this amendment. The wild populations of Atlantic salmon are listed as endangered under the ESA. Their freshwater range occurs in the watersheds from the Androscoggin River northward along the Maine coast to the Dennys River. Juvenile salmon in New England rivers typically migrate to sea in spring after a one- to three-year period of development in freshwater streams. They remain at sea for two winters before returning to their U.S. natal rivers to spawn (Kocik and Sheehan 2006). The marine range of the Gulf of Maine DPS extends from the Gulf of Maine, throughout the Northwest Atlantic Ocean, to the coast of Greenland. Results from a 2001-2003 post-smolt trawl survey in the nearshore waters of the Gulf of Maine indicate that Atlantic salmon post-smolts are prevalent in the upper water column throughout this area in mid to late May (Lacroix, Knox, and Stokesbury 2005). The trend in abundance of Atlantic salmon in the Gulf of Maine DPS has been low and either stable or declining over the past several decades. The number of returning naturally reared adults continues at low levels due to poor marine survival.

Adult Atlantic salmon may be present in the action area year-round, however they are rarely captured in the marine environment. Northeast Fisheries Observer Program (NEFOP) data from

1989 through August 2013 show records of incidental Atlantic salmon bycatch in 7 of 24 years, with a total of 15 individuals caught. Of the observed incidentally caught Atlantic salmon, 10 were listed as "discarded," which is assumed to be a live discard (Kocik, pers comm, Feb 11, 2013). Five of the 15 were listed as mortalities. The incidental takes of Atlantic salmon occurred using sink gillnets (11) and bottom otter trawls (4). Observed captures occurred in November (6), June (3), March (2), April (2), August (1) and May (1). The most recent data, from 2004 through August 2013, show incidental captures in the multispecies and monkfish fisheries during the spring months in areas offshore (statistical areas 522 and 525) and in the spring and summer months in the Gulf of Maine (statistical areas 513, 514, and 515).

4.8.3 Species not likely to be affected

The actions being considered in this EIS are not likely to adversely affect shortnose sturgeon, hawksbill sea turtles, blue whales, or sperm whales, all of which are listed as endangered under the ESA. The following discussion provides the rationale for these determinations.

Shortnose sturgeon are benthic fish that mainly occupy the deep channel sections of large rivers. They occupy rivers along the western Atlantic coast from St. Johns River in Florida, to the Saint John River in New Brunswick, Canada, although the species is possibly extirpated from the Saint Johns River system. Shortnose sturgeon are anadromous in the southern portion of its range (i.e., south of Chesapeake Bay), while some northern populations are amphidromous (NMFS 1998), meaning that they return to freshwater for breeding and also at other times. Since the fisheries managed via this action would not operate in or near the rivers where concentrations of shortnose sturgeon are most likely found, it is highly unlikely that changes in their management would affect shortnose sturgeon.

The hawksbill turtle is uncommon in the waters of the continental U.S. Hawksbills prefer coral reefs, such as those found in the Caribbean and Central America. Hawksbills feed primarily on a wide variety of sponges, but also consume bryozoans, coelenterates, and mollusks. The Culebra Archipelago of Puerto Rico contains especially important foraging habitat for hawksbills. Nesting areas in the western North Atlantic include Puerto Rico and the Virgin Islands. There are accounts of hawksbills in south Florida and individuals have been sighted along the east coast as far north as Massachusetts; however, east coast sightings north of Florida are rare (NMFS 2009b). Operations of Council-managed fisheries would not occur in waters that are typically used by hawksbill sea turtles. Therefore, it is highly unlikely that fishery operations would affect this turtle species.

Blue whales do not regularly occur in waters of the U.S. EEZ (Waring et al. 2013). In the North Atlantic region, blue whales are most frequently sighted from April to January (Sears 2002). No blue whales were observed during the Cetacean and Turtle Assessment Program surveys of the mid- and North Atlantic areas of the outer continental shelf (Cetacean and Turtle Assessment Program 1982). Calving for the species occurs in low latitude waters outside of the area where the sectors would operate. Blue whales feed on euphausiids (krill) that are too small to be captured in fishing gear. There were no observed fishery-related mortalities or serious injuries to blue whales between 1996 and 2000 (Waring et al. 2013). The species is unlikely to occur in areas where Council-managed species typically operate, and fishery operations would not affect the availability of blue whale prey or areas where calving and nursing of young occurs. Therefore, the proposed action would not be likely to adversely affect blue whales.

Unlike blue whales, sperm whales do regularly occur in waters of the U.S. EEZ. However, the distribution of the sperm whales in the U.S. EEZ occurs on the continental shelf edge, over the continental slope, and into mid-ocean regions (Waring et al. 2013). Sperm whale distribution is typically concentrated east-northeast of Cape Hatteras in winter and shifts northward in spring when whales are found throughout the Mid-Atlantic Bight (Waring et al. 2013). Distribution extends further northward to areas north of Georges Bank and the Northeast Channel region in summer and then south of New England in fall, back to the MA Bight (Waring et al. 2013). In contrast, the subject fisheries in this action operate primarily in continental shelf waters. The average depth over which sperm whale sightings occurred during the Cetacean and Turtle Assessment Program surveys was 5,879 ft (1,792 m) (Cetacean and Turtle Assessment Program 1982). Female sperm whales and young males almost always inhabit open ocean, deep water habitat with bottom depths greater than 3,280 ft (1,000 m) and at latitudes less than 40° N (Whitehead 2002). Sperm whales feed on large squid and fish that inhabit the deeper ocean regions (Perrin et al. 2002). There were no observed fishery-related mortalities or serious injuries to sperm whales between 2001 and 2005 (Waring et al. 2013). Sperm whales are unlikely to occur in water depths where Council-managed fisheries, including the deep-sea red crab fishery, typically operate, and fishery operations would not affect the availability of sperm whale prey or areas where calving and nursing of young occurs. Therefore, this amendment would not be likely to adversely affect sperm whales.

Although marine turtles and large whales could be potentially affected through interactions with fishing gear, NMFS has determined that the continued authorization of the monkfish, multispecies (large and small mesh), skate, herring, scallop, and red crab fisheries, and, therefore, the preferred alternative, would not have any adverse effects on the availability of prey for these species. Sea turtles feed on a variety of plants and animals, depending on the species. However, none of the turtle species are known to feed upon monkfish or groundfish. Right whales and sei whales feed on copepods (Horwood 2002, Kenney 2002). Council-managed fisheries will not affect the availability of copepods for foraging right and sei whales because copepods are very small organisms that will pass through fishing gear, even small-mesh, rather than being captured in it. Humpback whales and fin whales also feed on krill as well as small schooling fish such as sand lance, herring and mackerel (Aguilar 2002, Clapham 2002). The majority of the fishing gear in the Council's jurisdiction operates on or very near the bottom. Fish species caught in fishing gear are species that live in benthic habitat (on or very near the bottom) such as flounders, groundfish, and skates. As a result, this gear does not typically catch schooling fish such as herring and mackerel that occur within the water column. Humpback whales and fin whales feed on krill as well as small schooling fish (e.g., sand lance, herring, mackerel) (Aguilar 2002, Clapham 2002). The Transboundary Resource Assessment Committee Status Report of 2006 suggests that although predator consumption estimates have increased since the mid-1980s, the productive potential of the herring stock complex has improved in recent years. The management measures that govern the herring fishery may provide a benefit to the protected resources by providing a greater quantity of food available. Therefore, the continued authorization of the multispecies (large and small mesh), skate, herring, scallop, and red crab fisheries or the approval of the preferred alternative will not affect the availability of prey for foraging humpback or fin whales.

4.8.4 Interactions between gear and protected resources

4.8.4.1 Marine mammals

NMFS categorizes commercial fisheries based on a two-tiered, stock-specific fishery classification system that addresses both the total impact of all fisheries on each marine mammal stock as well as the impact of individual fisheries on each marine mammal stock. NMFS bases the system on the numbers of animals per year that incur incidental mortality or serious injury due to commercial fishing operations relative to a marine mammal stock's PBR level. Tier 1 takes into account the cumulative mortality and serious injury to marine mammals caused by commercial fisheries. Tier 2 considers marine mammal mortality and serious injury caused by the individual fisheries. This EIS uses Tier 2 classifications to indicate how each type of gear typically used by New England fisheries may affect marine mammals (NMFS 2009c). Table 56 identifies the classifications used in the final List of Fisheries for FY 2013 (78 FR 53336; August 29, 2013; NMFS 2013a), which are broken down into Tier 2 Categories I, II, and III.

Table 56 – Descriptions of the Tier 2 fishery classification categories (50 CFR 229.2)

Category	Category Description
Category I	A commercial fishery that has frequent incidental mortality and serious injury of marine mammals. This classification indicates that a commercial fishery is, by itself, responsible for the annual removal of 50 percent or more of any stock's PBR level.
Category II	A commercial fishery that has occasional incidental mortality and serious injury of marine mammals. This classification indicates that a commercial fishery is one that, collectively with other fisheries, is responsible for the annual removal of more than 10 percent of any marine mammal stock's PBR level and that is by itself responsible for the annual removal of between 1 percent and 50 percent, exclusive of any stock's PBR.
Category III	A commercial fishery that has a remote likelihood of, or no known incidental mortality and serious injury of marine mammals. This classification indicates that a commercial fishery is one that collectively with other fisheries is responsible for the annual removal of: a. Less than 50 percent of any marine mammal stock's PBR level, or b. More than 1 percent of any marine mammal stock's PBR level, yet that fishery by itself is responsible for the annual removal of 1 percent or less of that stock's PBR level. In the absence of reliable information indicating the frequency of incidental mortality and serious injury of marine mammals by a commercial fishery, the Assistant Administrator would determine whether the incidental serious injury or mortality is "remote" by evaluating other factors such as fishing techniques, gear used, methods used to deter marine mammals, target species, seasons and areas fished, qualitative data from logbooks or fisher reports, stranding data, and the species and distribution of marine mammals in the area or at the discretion of the Assistant Administrator.

Interactions between gear and a given species occur when fishing gear overlaps both spatially and trophically with the species' niche. Spatial interactions are more "passive" and involve inadvertent interactions with fishing gear when the fishermen deploy gear in areas used by protected resources. Trophic interactions are more "active" and occur when protected species attempt to consume prey caught in fishing gear and become entangled in the process. Spatial and trophic interactions can occur with various types of fishing gear used by the multispecies fishery through the year. Many large and small cetaceans and sea turtles are more prevalent within the operations area during the spring and summer. However they are also relatively abundant during the fall and would have a higher potential for interaction with sector activities that occur during these seasons. Although harbor seals may be more likely to occur in the operations area between fall and spring, harbor and gray seals are year-round residents. Therefore, interactions could occur year-round. The uncommon occurrences of hooded and harp seals in the operations area are more likely to occur during the winter and spring, allowing for an increased potential for interactions during these seasons.

This discussion assumes the potential for entanglements to occur is higher in areas where more gear is set and in areas with higher concentrations of protected species.

Table 57 lists the marine mammals known to have had interactions with gear used by New England fisheries. The gear used in the Northeast multispecies, monkfish, and skate fisheries gear includes sink gillnets, traps/pots, bottom trawls, and bottom longlines within the northeast multispecies region, as excerpted from the List of Fisheries for FY 2013 (NMFS 2013, also see Waring et al. 2013). Sink gillnets have the greatest potential for interaction with protected resources, followed by bottom trawls. There are no observed reports of interactions between bottom longline gear used in the multispecies fishery and marine mammals in FY 2009 through FY 2011. However, interactions between the pelagic longline fishery and both pilot whales and Risso's dolphins led to the development of the Pelagic Longline Take Reduction Plan. Although interactions between protected species and gear deployed by the multispecies fishery would vary, interactions generally include:

- becoming caught on hooks (bottom longlines)
- entanglement in mesh (gillnets and trawls)
- entanglement in the float line (gillnets and trawls)
- entanglement in the groundline (traps/pots, gillnets, trawls, and bottom longlines)
- entanglement in anchor lines (gillnets and bottom longlines), or
- entanglement in the vertical lines that connect gear to the surface and surface systems (gillnets, traps/pots, and bottom longlines).

The herring fishery is prosecuted by midwater trawl gear (single), paired midwater trawls, purse seines, stop seines and weirs. A full description of the gear used in the fishery is provided in the Amendment 1 FEIS. Only the first three are considered to be primary gears in the Atlantic herring fishery. Weirs and stop seines are responsible for a only a small fraction of herring landings (see Amendment 1 FEIS), operate exclusively within state waters and are not regulated by the Federal FMP, and therefore will not be discussed further in this document relative to protected species. It should be noted, however, that both gear types have accounted for interactions with protected species, notably minke whales and harbor porpoise, as well as harbor and gray seals. Animals, particularly pinnipeds, may be released alive.

Atlantic Large Whale Take Reduction Plan is a program to reduce the risk of serious injury to or mortality of large whales due to incidental entanglement in U.S. commercial fishing gear. The plan is required by the MMPA and has been developed by NMFS, and focuses on the critically endangered North Atlantic right whale, but is also intended to reduce entanglements of endangered humpback and fin whales and to benefit non-endangered minke whales. For the purposes of the plan, the red crab fishery is considered part of the Atlantic Mixed Species Trap/Pot fishery, and takes place primarily in the Offshore Trap/Pot Area. Regulations pertaining to this area, in addition to the universal requirements, include gear marking and weak links, which are designed to reduce injury should an interaction occur. The red crab fishery is considered a Category II fishery under the MMPA, which means occasional incidental interactions and serious injury may occur, however, given the small scale of the fleet and the management measures that restrict the number of traps a vessel may use, interaction with protected species is rare.

According to the 2013 List of Fisheries, there have been no documented marine mammal species interactions with either the sea scallop dredge fishery or the Atlantic shellfish bottom trawl fishery; therefore, the scallop fishery is considered a Category III fishery under the MMPA (i.e., a remote likelihood or no known incidental mortality and serious injuries of marine mammals).

Table 57 – Marine Mammal Species and Stocks Incidentally Killed or Injured Based on New England Fishing Areas and Gear Types (based on 2013 List of Fisheries)

Fishery		Estimated Number of Vessels/Persons	Marine Mammal Species and Stocks Incidentally Killed or Injured
Category	Type		
Category I	Mid-Atlantic gillnet	5,509	Bottlenose dolphin, Northern Migratory coastal [a]
			Bottlenose dolphin, Southern Migratory coastal [a]
			Bottlenose dolphin, Northern NC estuarine system [a]
			Bottlenose dolphin, Southern NC estuarine system [a]
			Bottlenose dolphin, WNA offshore
			Common dolphin, WNA
			Gray seal, WNA
			Harbor porpoise, Gulf of Maine/Bay of Fundy
			Harbor seal, WNA
			Harp seal, WNA
			Humpback whale, Gulf of Maine
			Long-finned pilot whale, WNA
			Minke whale, Canadian east coast
			Risso's dolphin, WNA

Fishery		Estimated Number of Vessels/Persons	Marine Mammal Species and Stocks Incidentally Killed or Injured
Category	Type		
			Short-finned pilot whale, WNA
			White-sided dolphin, WNA
	Northeast sink gillnet	4,375	Bottlenose dolphin, WNA, offshore
			Common dolphin, WNA
			Fin whale, WNA
			Gray seal, WNA
			Harbor porpoise, Gulf of Maine/Bay of Fundy
			Harbor seal, WNA
			Harp seal, WNA
			Hooded seal, WNA
			Humpback whale, Gulf of Maine
			Long-finned Pilot whale, WNA
			Minke whale, Canadian east coast
			North Atlantic right whale, WNA
			Risso's dolphin, WNA
			Short-finned Pilot whale, WNA
			White-sided dolphin, WNA
Category II	Mid-Atlantic bottom trawl	631	Bottlenose dolphin, WNA offshore
			Common dolphin, WNA [a]
			Gray seal, WNA
			Harbor seal, WNA
			Long-finned pilot whale, WNA a
			Risso's dolphin, WNA
			Short-finned pilot whale, WNA [a]
			White-sided dolphin, WNA
	Northeast bottom trawl	2,987	Bottlenose dolphin, WNA offshore
			Common dolphin, WNA
			Gray seal, WNA
			Harbor porpoise, Gulf of Maine/ Bay of Fundy
			Harbor seal, WNA
			Harp seal, WNA
			Long-finned pilot whale, WNA
			Minke whale, Canadian East Coast
			Short-finned pilot whale, WNA
			White-sided dolphin, WNA [a]
	Atlantic mixed species trap/pot [c]	3,467	Fin whale, WNA
			Humpback whale, Gulf of Maine
	Mid-Atlantic midwater trawl	669	Bottlenose dolphin, WNA offshore
			Common dolphin, WNA

Fishery		Estimated Number of Vessels/Persons	Marine Mammal Species and Stocks Incidentally Killed or Injured
Category	Type		
	(including pair trawl)		Long-finned pilot whale, WNA
			Risso's dolphin, WNA
			Short-finned pilot whale, WNA
			White-sided dolphin, WNA
	Northeast midwater trawl (including pair trawl)	887	Harbor seal, WNA
			Long-finned pilot whale, WNA
			Short-finned pilot whale, WNA
			White-sided dolphin, WNA
	Gulf of Maine Atlantic herring purse seine	>6	Harbor seal, WNA
			Gray Seal, WNA
	Gulf of Maine herring and Atlantic mackerel stop seine/weir	Unknown	Gray seal, Northwest North Atlantic
			Harbor porpoise, GME/BF
			Harbor seal, WNA
			Minke whale, Canadian East Coast
			White-sided dolphin, WNA
Category III	Northeast/Mid-Atlantic bottom longline/hook-and-line	1,207	None documented in recent years
	Gulf of Maine, U.S. Mid-Atlantic sea scallop dredge	>403	None documented in recent years

Marine mammals are taken in gillnets, trawls, and trap/pot gear used in the New England fisheries area. Documented marine mammal interactions in Northeast sink gillnet and Mid-Atlantic gillnet fisheries include harbor porpoise, white-sided dolphin, harbor seal, gray seal, harp seal, hooded seal, pilot whale, bottlenose dolphin (various stocks), Risso's dolphin, and common dolphin.

Table 58 and Table 59 summarize the estimated mean annual mortality of small cetaceans and seals that are taken in the Northeast sink gillnet and Mid-Atlantic gillnet fisheries according to the most recent Stock Assessment Report for each particular species.

Documented marine mammal interactions with Northeast and Mid-Atlantic bottom trawl fisheries include minke whale, harbor porpoise, white-sided dolphin, harbor seal, gray seal, harp seal, pilot whale, and common dolphin.

Table 60 and Table 61 provide the estimated mean annual mortality of small cetaceans and seals that are taken in the Northeast and Mid-Atlantic bottom trawl fisheries, based on the most recent SAR for each particular species. The data in these tables are based on takes observed by fishery observers as part of the Northeast Fisheries Observer Program (NEFOP).Given the target species of the herring fishery and because herring is a primary prey species for seals, porpoises and some whales, levels of protected species interactions with the fishery are likely for the midwater and pair trawl. The NOAA Fisheries Northeast Fisheries Science Center incidental take reports are published on the Northeast Fisheries Science Center website - http://www.nefsc.noaa.gov/femad/fishsamp/fsb/. A number of takes have occurred in the past four years by the midwater trawl fishery, as indicated in Table 62.

Table 58 – Estimated marine mammal mortalities in the Northeast sink gillnet fishery

Species	Years Observed	Mean Annual Mortality (CV)	Total PBR
Harbor porpoise	06-10	511 (0.17)	706
Atlantic white-sided dolphin	06-10	38 (0.46)	304
Common dolphin (short-beaked)	06-10	30 (0.42)	529
Western North Atlantic Offshore bottlenose dolphin	06-10	Unknown+	566
Harbor seal	06-10	280 (0.17)	Undetermined
Gray seal	06-10	794 (0.13)	Undetermined
Harp seal	06-10	218 (0.20)	Undetermined
Hooded seal	06-10	25 (0.82)	Undetermined

Source: Waring et al. (2013)
+While there have been documented interactions between the Western North Atlantic Offshore bottlenose dolphin stock and the Northeast sink gillnet fishery during the five year time period, estimates of bycatch mortality in the fishery have not been generated.

Table 59 – Estimated marine mammal mortalities in the Mid-Atlantic gillnet fishery

Species	Years Observed	Mean Annual Mortality (CV)	Total PBR
Harbor porpoise	06-10	275 (0.29)	706
Common dolphin (short-beaked)	06-10	8.4 (0.55)	529
Risso's dolphin	06-10	6.6 (0.73)	95
Bottlenose dolphin - Western North Atlantic Northern Migratory Coastal stock	06-10	5.27 (0.19) min; 6.02 (0.19) max	71
Bottlenose dolphin - Western North Atlantic Southern Migratory Coastal stock	06-10	5.71 (0/31 min; 41.91 (0.14) max	96
Bottlenose dolphin - Northern North Carolina Estuarine System stock	06-10	2.39 (0.25) min; 18.99 (0.11) max	Undetermined
Bottlenose dolphin - Southern North Carolina Estuarine System stock	06-10	0.61 (0.30) min; 0.92	16
Bottlenose dolphin - Western North Atlantic Offshore stock	06-10	(0.21) max Unknown+	566

Species	Years Observed	Mean Annual Mortality (CV)	Total PBR
Harbor seal	06-10	63 (0.46)	Undetermined
Harp seal	06-10	57 (0.5)	Undetermined

Source: Waring et al. (2013)
[+]While there have been documented interactions between the Western North Atlantic Offshore bottlenose dolphin stock and the Mid-Atlantic gillnet fishery during the five year time period, estimates of bycatch mortality in the fishery have not been generated.

Table 60 – Estimated marine mammal mortalities in the Northeast bottom trawl fishery

Species	Years Observed	Mean Annual Mortality (CV)	Total PBR
Minke whale	06-10	3.5 (0.34)	69
Harbor porpoise	06-10	4.5 (0.30)	706
Atlantic white-sided dolphin	06-10	142 (0.15)	304
Common dolphin (short-beaked)	06-10	20 (0.13)	529
Pilot whales*	06-10	12 (0.14)	93 (long-finned); 172 (short-finned)
Harbor seal	06-10	0.8 (n/a)	Undetermined
Gray seal	06-10	6 (n/a)	Undetermined
Harp seal	06-10	0.2 (n/a)	Undetermined

Source: Waring et al. (2013).
*Total fishery-related serious injuries and mortalities to pilot whales (*Globicephala* sp.) cannot be differentiated to species due to uncertainty in species identification by fishery observers (Waring et al. 2013). However, separate PBRs have been calculated for long-finned and short-finned pilot whales.

Table 61 – Estimated marine mammal mortalities in the Mid-Atlantic bottom trawl fishery

Species	Years Observed	Mean Annual Mortality (CV)	Total PBR
Atlantic white-sided dolphin	06-10	20 (0.09)	304
Common dolphin (short-beaked)	06-10	103 (0.13)	529
Risso's dolphin	06-10	3 (n/a)	95
Harbor seal	06-10	0.2 (n/a)	Undetermined
Pilot whales*	06-10	30 (0.16)	93 (long-finned); 172 (short-finned)

Source: Waring et al. (2013).
*Total fishery-related serious injuries and mortalities to pilot whales (*Globicephala* sp.) cannot be differentiated to species due to uncertainty in species identification by fishery observers (Waring et al. 2013). However, separate PBRs have been calculated for long-finned and short-finned pilot whales.

Table 62 – Number of mid-water trawl incidental takes recorded by fisheries observers

	2011 (To August)	2010	2009	Total
Gray Seal	10	5	1	6
Harbor Seal	3	4	1	5
Common Dolphin		1		1
Unknown dolphin		1		1
Unknown mammal		1		1
Unknown seal	8	1		1

Takes of large whales are typically not documented within observer records as large whales are typically entangled in fixed fishing gear and the chances of observing an interaction are small. Although large whales can become anchored in gear, they more often swim off with portions of the fishing gear; therefore, documentation of their incidental take is based primarily on the observation of gear or markings on whale carcasses, or on whales entangled and observed at-sea. Even if a whale is anchored in fishing gear, it is extremely difficult to make any inferences about the nature of the entanglement event and initial interaction between the whale and the gear. Frequently, it is difficult to attribute a specific gear type to an entangled animal based on observed scars or portions of gear remaining attached to whales or their carcasses; however, gillnet gear has been identified on entangled North Atlantic right whales, humpback whales, fin whales, and minke whales. Minke whales have been observed to be taken in the Northeast bottom trawl fishery by fishery observers. At this time, there is no evidence suggesting that other large whale species interact with trawl gear fisheries.

One interaction between a large whale and scallop fishing gear is known to have occurred. In 1983, a humpback whale became entangled in the cables of scallop dredge gear off of Chatham, Massachusetts. This was a unique and very rare event that is extremely unlikely to reoccur given that large whales have the speed and maneuverability to get out of the way of oncoming scallop fishing gear. Also, observer coverage of many fishing trips using dredge gear has shown that this gear types do not pose a reasonable risk of entanglement or capture for large whales. Therefore, it is generally believed that large whales are not likely to interact with gear used in the scallop fishery.

A number of marine mammal management plans are in place along the U.S. east coast to reduce serious injuries and deaths of marine mammals due to interactions with commercial fishing gear. All fishing vessels are required to adhere to measures in the Atlantic Large Whale Take Reduction Plan, which manages from Maine through Florida, to minimize potential impacts to certain cetaceans. The plan was developed to address entanglement risk to right, humpback, and fin whales, and to acknowledge benefits to minke whales in specific Category I or II commercial fishing efforts that utilize traps/pots and gillnets. It calls for the use of gear markings, area restrictions, weak links, and sinking groundline. Fishing vessels are required to comply with the Atlantic Large Whale Take Reduction Plan in all areas where applicable.

Fishing vessels are also required to comply, where applicable, with the requirements of the Bottlenose Dolphin Take Reduction Plan, which manages coastal waters from New Jersey through Florida, and Harbor Porpoise Take Reduction Plan, which manages coastal and offshore waters from Maine through North Carolina. The dophin plan spatially and temporally restricts night time use of gillnets and requires net tending in the Mid-Atlantic gillnet region. The porpoise plan aims to reduce interactions between harbor porpoises and gillnets in the Gulf of Maine, southern New England, and Mid-Atlantic regions. In New England waters, the Harbor Porpoise Take Reduction Plan implements seasonal area closures and the seasonal use of pingers (acoustic devices that emit a sound) to deter harbor porpoises from approaching the nets (Map 172). In Mid-Atlantic waters, it implements seasonal area closures and the seasonal use of gear modifications for large mesh (7-18 in) and small mesh (<5 to >7 in) gillnets to reduce harbor porpoise bycatch (Map 173).

Map 172 – Harbor Porpoise Take Reduction Plan management areas in New England

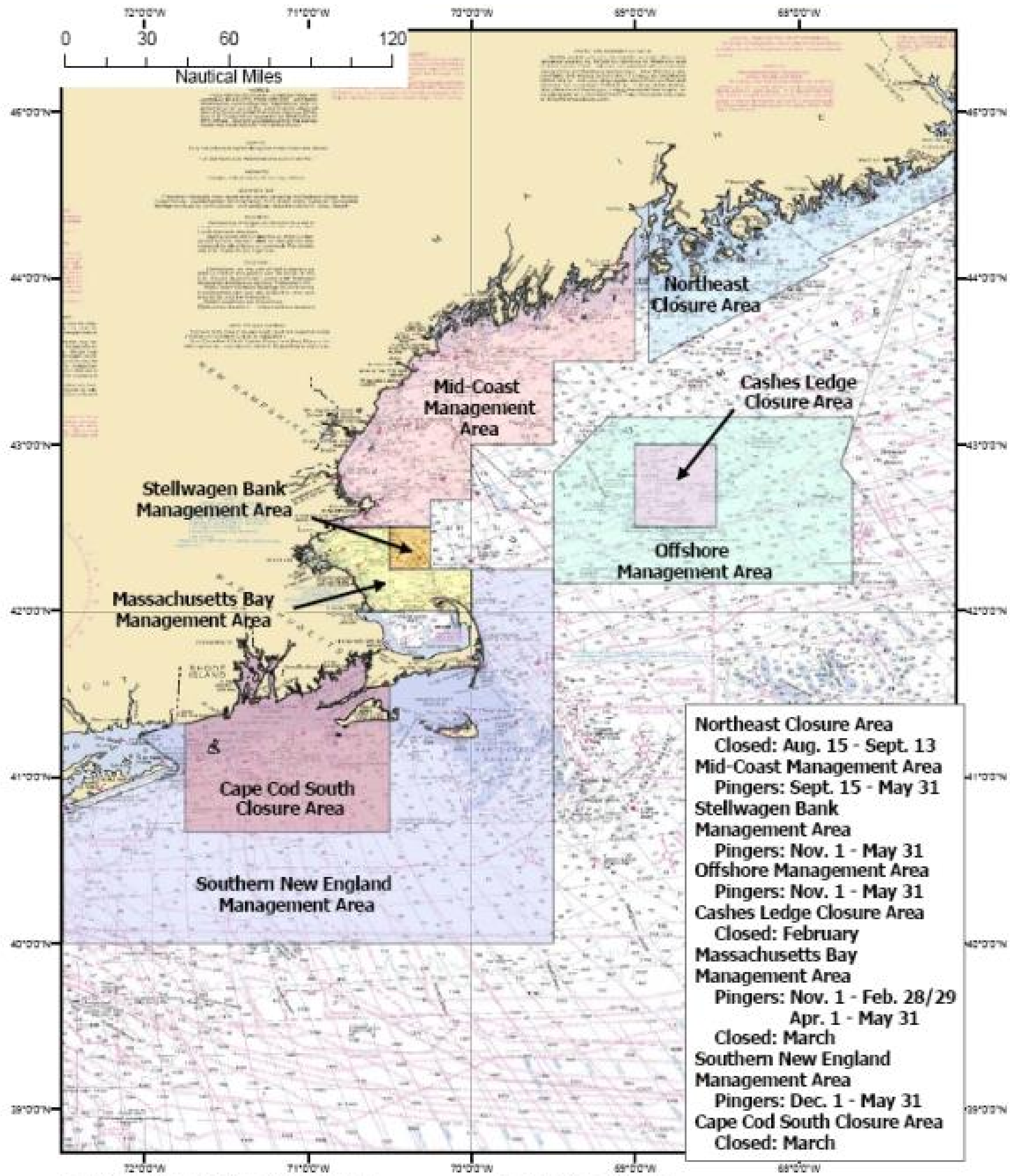
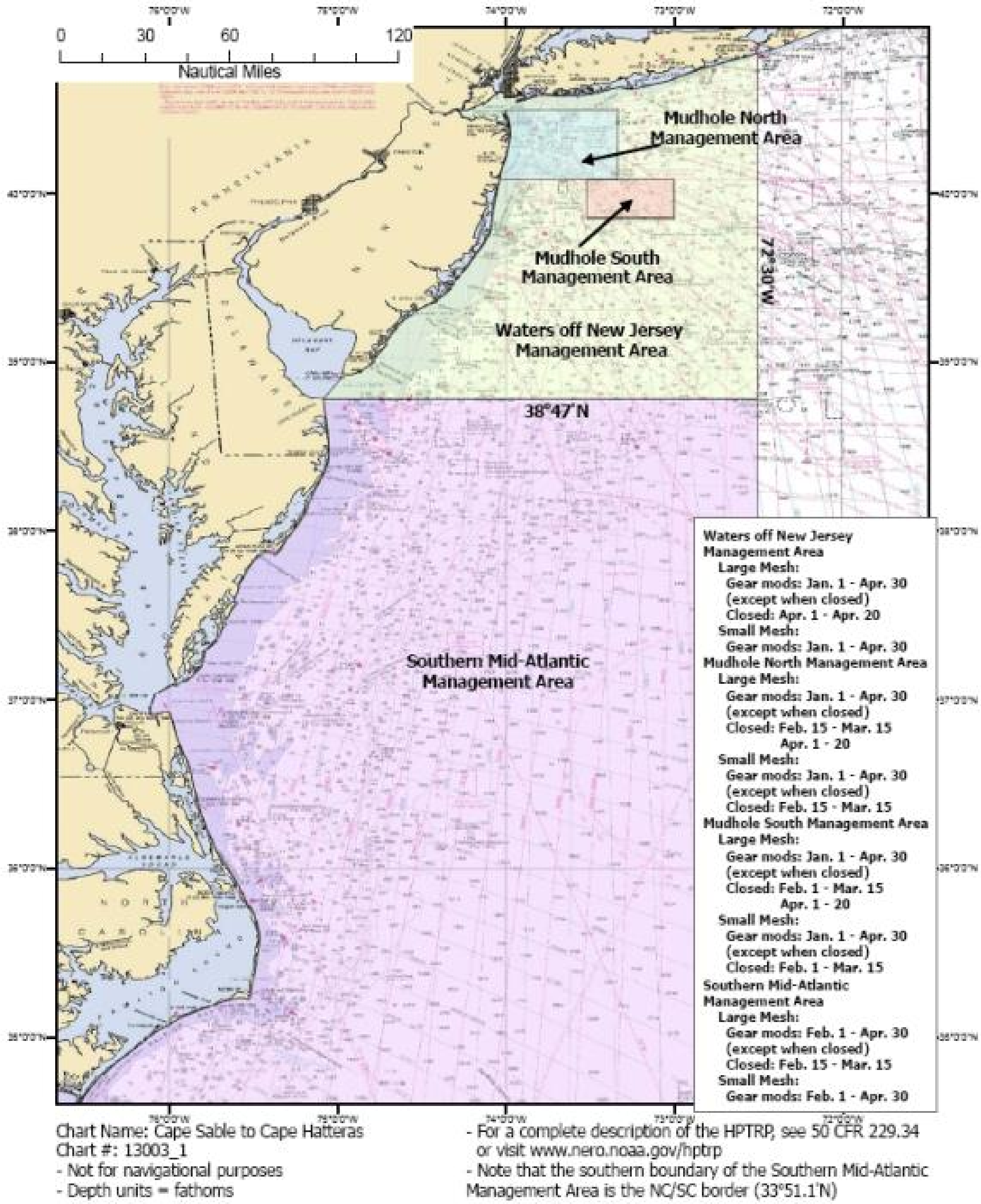


Chart Name: Cape Sable to Cape Hatteras
Chart #: 13003_1
- Not for navigational purposes

- Depth units = fathoms
- For a complete description of the HPTRP, see 50 CFR 229.33 or visit the HPTRP web site at www.nero.noaa.gov/hptrp

Map 173 – Harbor Porpoise Take Reduction Plan management areas in the mid-Atlantic



An Atlantic Trawl Gear Take Reduction Team was formed in 2006 to address the bycatch of white-sided and common dolphins and pilot whales in Northeast and Mid-Atlantic trawl gear fisheries. While a take reduction plan with regulatory measures was not implemented (bycatch levels were not exceeding allowable thresholds under the MMPA), a take reduction strategy was developed that recommends voluntary measures to be used to reduce the chances for interactions between trawl gear and these marine mammal species. The two voluntary measures that were recommended are: 1) reducing the number of turns made by the fishing vessel and tow times while fishing at night; and 2) increasing radio communications between vessels about the presence and/or incidental capture of a marine mammal to alert other fishermen of the potential for additional interactions in the area.

4.8.4.2 Sea turtles

Sea turtles have been caught and injured or killed in multiple types of fishing gear, including dredges, gillnets, trawls, and hook and line gear. However, impact due to inadvertent interaction with trawl gear is almost twice as likely to occur when compared with the other gear types (NMFS 2009d). Interaction with trawl gear is more detrimental to sea turtles than other groundfishing gear as they can be caught within the trawl itself and will drown after extended periods underwater. A study conducted in the Mid-Atlantic region showed that bottom trawling accounts for an average annual take of 616 loggerhead sea turtles, although Kemp's ridleys and leatherbacks were also caught during the study period (Murray 2006). Impacts to sea turtles may still occur under this action, even though sea turtles generally occur in more temperate waters than those in the Council area.

In addition to potential interactions with multispecies gear, the 2012 consultation (Endangered Species Act Section 7 Consultation on the Atlantic Sea Scallop Fishery Management Plan, July 12, 2012) on the scallop fishery, concluded that the continued operation of the scallop fishery may adversely affect, but is not likely to jeopardize the continued existence of loggerhead, leatherback, Kemp's ridley, or green sea turtles, or any other ESA-listed species under NMFS jurisdiction. NMFS anticipates the incidental take of ESA-listed species as follows:

- for the Northwest Atlantic Ocean DPS of loggerhead sea turtles, we anticipate (a) the annual average take of up to 161 individuals in dredge gear, of which up to 129 per year may be lethal in 20l2 and up to 46 per year may be lethal in2013 and beyond,[19] and (b) the annual average take of up to 140 individuals in trawl gear, of which up to 66 per year may be lethal;
- for leatherback sea turtles, we anticipate the annual lethal take of up to two individuals in dredge and trawl gear combined;
- for Kemp's ridley sea turtles, we anticipate the annual take of up to three individuals in dredge and trawl gear combined (for 2012, up to three takes are anticipated to be lethal, while for 2013 and beyond, up to two takes are anticipated to be lethal);
- for green sea turtles, we anticipate the annual lethal take of up to two individuals in dredge and trawl gear combined;
- for Atlantic sturgeon, we anticipate the annual take of up to one individual from either the Gulf of Maine, New York Bight, Chesapeake Bay, Carolina, or South Atlantic DPS in trawl gear; once every 20 years this take is expected to result in mortality.

[19] The estimated mortality numbers presented in the Biological Opinion for scallop dredges with chain mats in 2012 are conservative in that they are overestimates of actual mortalities. Mortality rates used for 2012 are based on those estimated for observed turtle takes (e.g., turtles captured in the dredge and brought on deck), yet a percentage of the estimated takes are not observed (e.g., interactions where turtles were excluded by the chain mat) and these takes are considered to have a lower mortality rate.

NMFS is still required to minimize these takes so several Reasonable and Prudent Measures have been identified. Terms and conditions are included to specify how the measures should be implemented. Both the measures and terms and conditions are non-discretionary and must be implemented by NMFS.

Reasonable and Prudent Measures (RPM)

1. NMFS must annually monitor and assess the distribution of fishing effort in the Mid-Atlantic scallop dredge fishery during the period of known sea turtle overlap (May through November) to ensure that there are no increases in the likelihood of interactions with sea turtles that may result from increased effort.
2. NMFS must continue to investigate and implement, within a reasonable time frame following sound research, modifications to gears used in these fisheries to reduce incidental takes of sea turtles and Atlantic sturgeon and the severity of the interactions that occur.
3. NMFS must continue to review available data to determine whether there are areas or conditions within the action area where sea turtle and Atlantic sturgeon interactions with fishing gear used in the scallop fishery are more likely to occur.
4. NMFS must continue to quantify the extent to which chain mats and turtle deflection devices reduce the number of serious injuries/deaths of sea turtles that interact with scallop dredge gear.
5. NMFS must continue to research the extent to which sea turtle interactions with scallop dredge gear occur on the bottom versus within the water column.
6. NMFS must ensure that any sea turtles incidentally taken in scallop dredge or trawl gear and any Atlantic sturgeon incidentally taken in scallop trawl gear are handled in a way as to minimize stress to the animal and increase its survival rate.
7. NMFS must seek to ensure that monitoring and reporting of any sea turtles and Atlantic sturgeon encountered in scallop fishing gear: (1) detects any adverse effects such as injury or mortality; (2) detects whether the anticipated level of take has occurred or been exceeded; and (3) collects data from individual encounters.
8. NMFS must continue to engage in outreach efforts with commercial fishermen regarding the proper installation and use of chain mats on their scallop dredges.

Terms and Conditions

1. To comply with RPM #1 above, NMFS must continue to monitor dredge hours in the Mid-Atlantic scallop dredge fishery during the months of May through November when sea turtle interactions are most likely to occur. NMFS must collect and review effort data as stipulated under the monitoring plan below (i.e.,two-year running averages) to determine if dredge effort in the Mid-Atlantic is on the rise, and, if needed, re-evaluate the monitoring plan methodology annually in the event more refined methods become available through discussions within the agency or with the Council or scallop industry. The calculation and comparison of two-year running averages should also be performed on an annual basis, wtth 2007-2008 serving as the baseline efforl levels post-chain mats.
2. To comply with RPM #2 above, NMFS must continue to investigate modifications to scallop dredge and trawl gear to further minimize adverse effects on sea turtles due to

collisions with and/or entrainment in the gear. Through continued experimental gear trials from or by any source (e.g., through the Scallop RSA program), NMFS and its partners must review all data collected from those trials, determine the next appropriate course of action (e.g., expanded gear testing, further gear modification, rulemaking to require the gear modification), and initiate management action based on the determination. These trials may include further refinements of and improvements to the TDD as well as continued testing and evaluation of modified trawls (e.g. trawls with TEDs, topless trawls).

3. To comply with RPM #3 above, NMFS must continue to review all available data on the incidental take of sea turtles in the scallop fishery (observable plus unobservable, quantifiable) and other suitable information (e.g., data on observed sea turtle interactions with other trawl fisheries, sea turtle distribution information, or fishery surveys in the area where the scallop fishery operates) to assess whether correlations with environmental conditions (e.g., depth, SST, salinity) or other drivers of incidental take (e.g., gear configuration) can be made for some or all portions of the action area. If additional analysis is deemed appropriate, within a reasonable amount of time after completing the review, NMFS must take action, if appropriate, to reduce sea turtle interactions and/or their impacts.
4. To comply with RPM #4 above, NMFS must continue to use available and appropriate technologies to quantify the extent to which chain mats and TDDs reduce the number of serious injuries/deaths of sea turtles that interact with scallop dredge gear. This information is necessary to better determine the extent to which these two gear modifications reduce injuries leading to death for sea turtles and may result in further modifications of the fishery to ensure sea turtle interactions, including those causing serious injuries and mortalities are minimized.
5. To comply with RPM#5 above, NMFS must continue to use available and appropriate technologies to better determine where (on the bottom or in the water column) and how sea turtle interactions with scallop dredge gear are occurring. Such information is necessary to assess whether further gear modifications in the scallop dredge fishery will actually provide a benefit to sea turtles by either reducing the number of interactions or the number of interactions causing serious injury and mortality.
6. To comply with RPM #6 above, NMFS must ensure that all Federal permit holders in the scallop fishery possess handling and resuscitation guidelines for sea turtles and Atlantic sturgeon. For sea turtles, all Federally-permitted fishing vessels should have the handling and resuscitation requirements listed in 50 CFR 223.206(d)(1) and reproduced in Appendix C. For Atlantic sturgeon, NMFS must instruct fishermen and observers to resuscitate any individuals that may appear to be dead by providing a running source of water over the gills.
7. To also comply with RPM #6 above, NMFS must continue to develop and distribute training materials for commercial fishermen regarding the use of recommended sea turtle and Atlantic sturgeon release equipment and protocols. Such training materials would be able to be brought onboard fishing vessels and accessed upon incidental capture (e.g., CD that could be used in on-board computer, placard, etc.).
8. To comply with RPM #7 above, NMFS must continue to place observers onboard scallop dredge and trawl vessels to document and estimate incidental bycatch of sea turtles and Atlantic sturgeon, Monthly summaries and an annual report of observed sea turtle takes

in gears primarily landing scallops must be provided to the NERO Protected Resources Division. A similar data reporting plan must be developed for Atlantic sturgeon.

9. To also comply with RPM #7 above, NMFS must continue to instruct observers to tag and take tissue samples from incidentally captured sea turtles as stipulated under their ESA section 10 permit. The current NEFOP protocols are to tag any sea turtles caught that are larger than 26 centimeters in notch-to-tip carapace length and to collect tissue samples for genetic analysis from any sea turtles caught that are larger than centimeters in notch-to-tip carapace length. NMFS must continue to instruct observers to send any genetic samples of sea turtles taken to the NEFSC. NMFS must further instruct observers to take fin clips from all incidentally captured Atlantic sturgeon and send them to NMFS for genetic analysis. Fin clips must be taken according to the procedures outlined in appendix D and prior to preservation of other fish parts or whole bodies.
10. To also comply with RPM #7 above, NMFS must continue to reconvene the Sea Turtle Injury Working Group in order to better assess and evaluate injuries sustained by sea turtles in scallop dredge and trawl gear, and their potential impact on sea turtle populations. New data should be reviewed on an annual basis.
11. To comply with RPM #8 above, NMFS must distribute information to scallop permit holders specifying the chain mat and TDD regulations and be prepared to provide them assistance to resolve issues that may cause chain mats or any components of the TDD to be rigged improperly or malfunction.

4.8.4.3 Atlantic sturgeon

Atlantic sturgeon are known to be captured in sink gillnet, drift gillnet, and otter trawl gear (Stein et al. 2004a, ASMFC TC 2007). Of these gear types, sink gillnet gear poses the greatest known risk of mortality for bycaught sturgeon (ASMFC TC 2007). Sturgeon deaths were rarely reported in the otter trawl observer dataset (ASMFC TC 2007). However, the level of mortality after release from the gear is unknown (Stein et al. 2004a). In a review of the Northeast Fishery Observer Program (NEFOP) database for the years 2001-2006, observed bycatch of Atlantic sturgeon was used to calculate bycatch rates that were then applied to commercial fishing effort to estimate overall bycatch of Atlantic sturgeon in commercial fisheries. This review indicated sturgeon bycatch occurred in statistical areas abutting the coast from Massachusetts (statistical area 514) to North Carolina (statistical area 635) (ASMFC TC 2007). Based on the available data, participants in an ASMFC bycatch workshop concluded that sturgeon encounters tended to occur in waters less than 50 m throughout the year, although seasonal patterns exist (ASMFC TC 2007). The Commission analysis determined that an average of 650 Atlantic sturgeon mortalities occurred per year (during the 2001 to 2006 timeframe) in sink gillnet fisheries. Stein et al. (2004a), based on a review of the NMFS Observer Database from 1989-2000, found clinal variation in the bycatch rate of sturgeon in sink gillnet gear with lowest rates occurring off of Maine and highest rates off of North Carolina for all months of the year.

The NEFSC prepared an estimate of the number of encounters of Atlantic sturgeon in fisheries authorized by northeast FMPs (NEFSC 2013). The analysis estimates that from 2006 through 2010, there were averages of 1,239 and 1,342 encounters per year in observed gillnet and trawl fisheries, respectively, with an average of 2,581 encounters combined annually. Mortality rates in gillnet gear were approximately 20%. Mortality rates in otter trawl gear observed are generally lower, at approximately 5%. The highest incidence of sturgeon bycatch in sink gillnets is associated with depths of <40 meters, larger mesh sizes, and the months April-May. Sturgeon bycatch in ocean fisheries is actually documented in all four seasons with higher numbers of interactions in November and December in addition to April and May. Mortality is also correlated to higher water temperatures, the use of tie-downs, and increased soak times (>24 hours). Most observed sturgeon deaths occur in sink gillnet fisheries. For otter trawl fisheries, Atlantic sturgeon bycatch incidence is highest in depths <30 meters and in the month of June.

However, as described in the 2012 Scallop Biological Opinion, scallop dredge gear is much more rigid, has a lower profile while on being fished on the ocean bottom, and is hauled up more vertically than trawl gear. As a result, dredge gear does not pose a threat of bycatch to Atlantic sturgeon on the bottom or in the water column as trawl gear. In addition, there is no documented bycatch of Atlantic sturgeon in midwater trawls and herring purse-seine gear, which makes up the majority of the herring fishing effort. There is also no documented bycatch of Atlantic sturgeon in red crab pot/trap gear from 2001-2010. In addition, red crab traps are set much deeper (400-800 m) than sturgeon's preferred water depth (up to 50 m) (ASMFC TC 2007).

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