New England Fishery Management Council
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E.F. "Terry" Stockwell III, *Chairman* | Thomas A. Nies, *Executive Director*

MEMORANDUM

DATE: April 8, 2015

TO: Habitat Committee

FROM: Habitat Plan Development Team

SUBJECT: **Analyses requested at February 24, 2015 Committee Meeting**

Please see attached background information and analyses prepared by the Habitat Plan Development Team in response to the following tasks identified by the Habitat Committee:

- Summarize public comments on management alternatives in a way that conveys how many and which individuals supported a particular approach
- Evaluate how OHA2 and Northeast Multispecies Framework Adjustment 53 measures, in combination, address OHA2 groundfish spawning objectives
- Evaluate scientific literature and information, including grey literature and analyses developed by the public, referenced in public comments. Identify whether analyses have already been used in the DEIS and supporting materials, whether or not they change the conclusions of existing analyses in the DEIS, and what their peer review status is.
- Discuss approaches to better evaluate the magnitude of realized adverse effects within Habitat Management Areas (HMAs)
- Analyze and determine the need to minimize adverse impacts within Habitat Areas of Particular Concern
- Develop a work plan for improving the practicability analysis
- Assess how lobster/scallop gear conflict and lobster resource impacts analyses could be improved upon
- Identify potential high energy sand clam-dredge exemption areas within HMAs
- Re-evaluate the winter flounder EFH designation, especially egg lifestage
- Discuss how the amendment complies with the prey information requirement of the EFH regulations and how adverse effects on prey component of EFH were evaluated during development of the SASI model
- Analyze management alternatives modified by the Committee on February 24

Public comments summary

Task: Summarize of the public comments in a manner that indicates how many individuals support a particular alternative.

Status: Completed.

Summary of work: The following products will help the Committee and Council to understand and evaluate the range of public comments received.

- Public comments summary report – comments grouped by topic, for more general comments, or by alternative. All comment letters related to each point of view are listed. This was provided to the Committee in advance of their February 24 meeting.
- Summary spreadsheet that tallies the comments in two ways. The spreadsheet is most useful in electronic format.
    - By alternative type and sub-region
    - By comment letter
- A table with the number of supporters/signatures by alternative was added to the comments summary report for distribution at the Council meeting.

Groundfish spawning

Task: Evaluate how OHA2 and Northeast Multispecies Framework Adjustment 53 measures, in combination, address OHA2 groundfish spawning objectives

Status: Completed.

Information:

OHA2 DEIS, Volume 3

- Section 2.2, page 96 – Descriptions of the spawning alternatives.
- Section 4.1.3.2, page 176 – Methods for evaluating the impacts of the spawning alternatives on large mesh groundfish resources
- Section 4.3.2, page 503 – Analysis of the impacts of the spawning alternatives on large mesh groundfish resources

Framework Adjustment 53 to the Northeast Multispecies FMP

- Section 4.2.1.3.2, page 51 – Option 2: Gulf of Maine Cod Protection Measures
- Section 7.1.2.1.3, page 205 – Analysis of impacts of the GOM Cod Protection Measures on groundfish resources
- Appendix II – Includes four separate Groundfish PDT analyses:
    - M. Dean. 2014. Estimating the Conservation Benefit of Gulf of Maine (GOM) Cod Protection Measures- Revised Commercial Groundfish Fishery Rolling Closures- to Spawning Cod.
    - S. Sherman and J. Cournane. 2015. Examining Gulf of Maine (GOM) Cod Spawning Activity in the Coastal Waters of Maine and New Hampshire.
    - P. Nitschke and J. Cournane. 2015. Examination of seven spring spawning groundfish stocks in the NEFSC bottom trawl survey for comparison to spatial management measures under consideration in Framework Adjustment 53.

- P. Nitschke, M. Palmer, and J. Cournane. 2015. Examining the mortality objective of the Gulf of Maine cod protection measures using fishery-dependent data

Discussion: At the Habitat Committee meeting on February 24, 2015, the PDT was tasked "to evaluate whether spawning alternatives in OHA2 in combination with Framework 53 cod protection measures would meet the goals and objectives of OHA2[1]." This analysis highlights the differences between OHA2 Spawning Alternative 1 for the Gulf of Maine and the proposed FW 53 cod protection measures, comparing the two sets of measures relative to the goals and objectives of OHA2. The following questions are discussed:

- Do changes proposed in FW 53 raise concerns relative to groundfish spawning?
- When and where do various groundfish stocks spawn relative to existing and proposed management areas?

The Council may wish to consider this information when selecting their final preferred alternative for spawning protection in the Gulf of Maine.

Background: OHA2 includes alternatives to meet the following objectives: "[i]mproved groundfish spawning protection; including protection of localized spawning contingents or sub-populations of stocks" and "[i]mproved access to both the use and non-use benefits arising from closed area management across gear types, fisheries, and groups."[2] The Council has selected two preferred alternatives for spawning protection in OHA2, Alternative 1 and Alternative 3. Alternative 3 is the Massachusetts Bay Cod Spawning Protection Area. Alternative 1, identified as 'No Action' in the OHA2 DEIS, includes the following areas:

- Western Gulf of Maine Closure Area and Cashes Ledge Closure Area
  - Closed year-round to all gears, except exempted gears, certain exempted fisheries, and party/charter vessels with a letter of authorization
- Gulf of Maine Rolling Closures Areas that apply to sector and common pool vessels (party/charter fishing allowed with a letter of authorization)
  - March: Blocks 121,122,123 for common pool vessels;
  - April: Blocks 121-133 for common pool vessels, and Blocks 124,125,132,133 for sector vessels;
  - May: 124-140 for common pool vessels, and Blocks 132,133,138,139,140 for sector vessels;
  - June: Blocks 132,133,139-147,152 for common pool vessels, and Blocks 139,140,145,146,147,152 for sector vessels;
  - October: Blocks 124 and 125 for common pool vessels
  - November: Blocks 124 and 125 for common pool vessels
- Gulf of Maine Cod Spawning Protection Area, commonly referred to as the 'Whaleback', closed April 1 – June 30 to all gears capable of catching groundfish

Framework 53 (proposed rule dated 3/9/15) includes cod protection measures that modify the existing Gulf of Maine rolling closures. These changes include the elimination of April rolling

[1] New England Fishery Management Council, Habitat Committee Meeting Summary, Mansfield, MA, February 24, 2015.
[2] Omnibus Habitat Amendment 2, DEIS, Volume 3, Page 96.

closure blocks and the addition of winter closures in November through January. The rationale for the Framework 53GOM cod protection measures is as follows:

> *"This measure would modify the existing rolling closure to use seasonal closures in the commercial groundfish fishery to protect GOM cod at times and in areas where spawning is known to occur in the winter and spring, and reduce fishing mortality in these times and areas on the stock while providing opportunity for the groundfish fishery to prosecute healthy stocks in other times and areas. The intent of this measure is to increase protection for GOM cod in the winter months by adding the winter closures, and to create more economic opportunities in the spring by opening up the April closure."*

Table 1 compares the OHA2 Alternative 1 rolling closures and Alternative 3 Massachusetts Bay Area (shaded in yellow) to the Framework 53 cod protection closures (blue). Overlapping times and thirty minute blocks (or portions of blocks) are shown in green. The Gulf of Maine Cod Spawning Protection Area (Whaleback) is retained by both Alternatives 1 and 2 in OHA2 and by Framework 53. Also, both actions include proposals for blocks 124 and 125 between November and January. Alternative 3 in OHA2 provides additional fishing gear restrictions within the Massachusetts Bay Area, which covers a portion of each of these blocks. Changes to the year-round groundfish closures are not contemplated in the framework, so the focus here is on comparing the seasonal closures in the two actions.

Note that as of this writing, Alternative 1 in OHA2 is perhaps more appropriately considered the current 'status quo', at least through the end of April 2015, while the framework measures represent what would happen if the Council were to take 'no action' during habitat amendment final action on the rolling closures, assuming the cod protection measures are implemented via the Framework 53 final rule later this month.

Assuming that the cod protection measures become the 'new' no action beginning May 1, 2015, the Council should clearly articulate during OHA2 final action if they wish to implement any additional time/area closures for spawning protection relative to what was implemented via Framework 53. This could include selection of OHA2 Alternative 3, the Massachusetts Bay Area, which has different restrictions vs. the overlapping cod protection closures. This could also include closures of thirty minute blocks in April, which were removed via Framework 53.

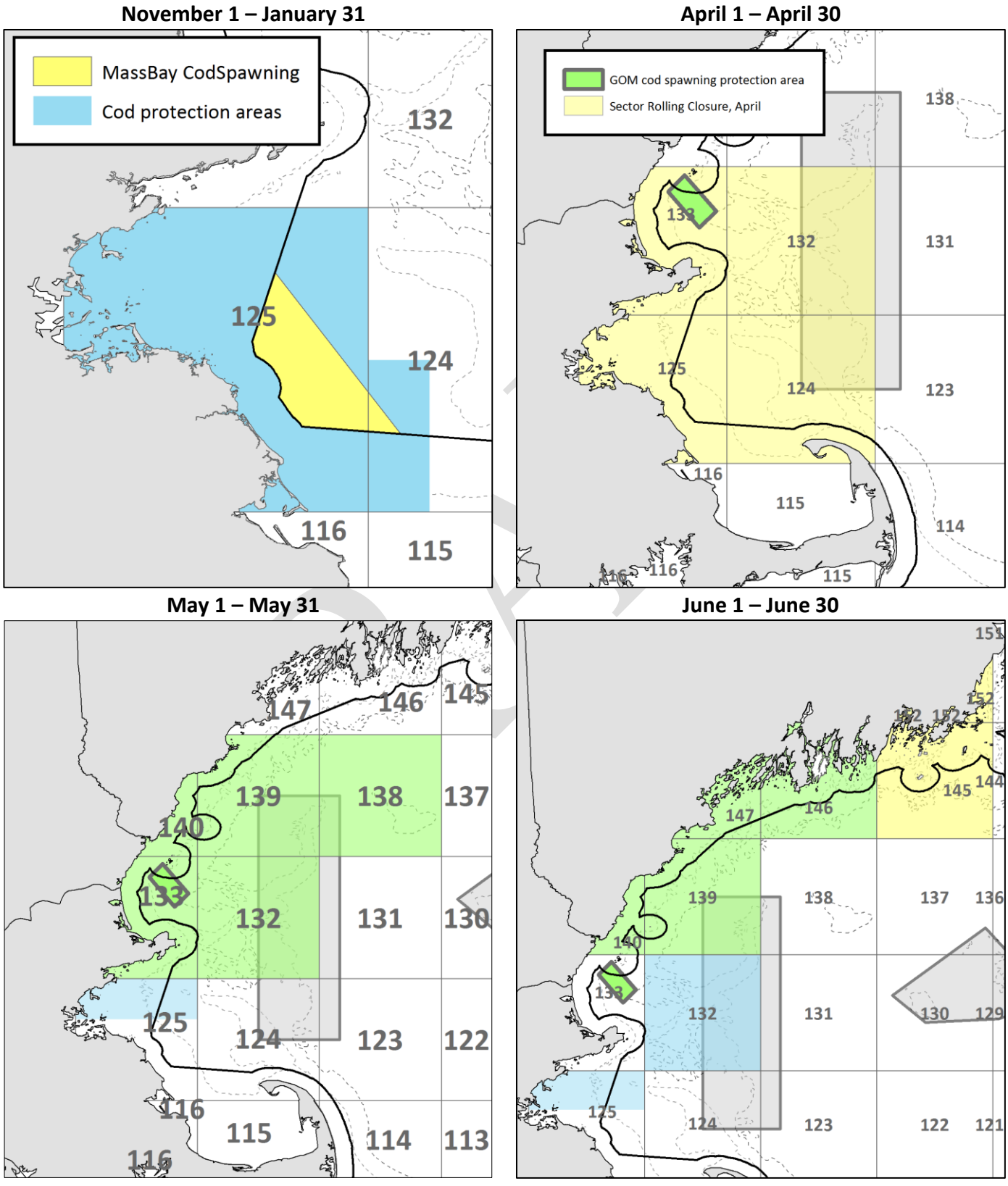
Table 1 – Comparison between the proposed Framework 53 to the status quo

- Yellow = OHA2 Alternative 1 rolling closures and Alternative 3 Massachusetts Bay
- Blue = FW 53 cod protection measures
- Green = same for FW 53 and OHA2 Alternative 1 and OHA2 Alternative 3

Block	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.
124	1, 2										1, 2	1, 2
125	2				3	3					2	2
132												
133				4	4	4						
138												
139												
140												
145												
146												
147												
152												

1. Cod protection measures (FW53) include an area of 124 defined by the following coordinates:
   42°22’ N … 70°30’ W
   42°00’ N … 70°24’ W
   42°15’ N … 70°24’ W
   42°15’ N … 70°30’ W
2. Massachusetts Bay Spawning Protection Area is a subset of these two blocks between November 1 and January 31
3. Cod protection measures (FW53) include Block 125 north of 42°20’ during May and June
4. GOM Cod Spawning Protection Area (Whaleback) is a subset of this block April 1 and June 30

Figure 1 – Visual comparison of the current sector rolling closures and Massachusetts Bay Area (OHA2) with the Cod Protection Closures (FW53). Yellow = OHA2, Blue = FW53, Green = both actions.



Comparison of objectives – GOM cod protection measures vs. OHA2

It is important to remember that the objectives associated with the two actions are slightly different. The GOM cod protection measures (FW 53) are intended to increase protection of GOM cod (spawning and mortality), while providing opportunities for the groundfish industry to prosecute healthy stocks in other times and areas.[3] The OHA2 objectives are to improve groundfish productivity and spawning protection generally, not only for cod, and to improve the use and non-use benefits of area closures.

Framework 53 analyses: Appendix II to the Framework 53 Environmental Assessment includes four working papers that were used to evaluate the cod protection closures. One of these, Nitschke and Cournane, *Examination of seven spring spawning groundfish stocks in the NEFSC bottom trawl survey for comparison to spatial management measures under consideration in Framework Adjustment 53*, analyzed spawning activity of several groundfish stocks based on information provided in the Northeast Fisheries Science Center Spring bottom trawl survey (generally the last two weeks of April and first two weeks of May), using 2009, 2011, 2012, 2013, and 2014 survey years[4]. This analysis included a visual inspection of the spatial/temporal patterns for mature and spawning condition fish observed in the spring survey. Two sets of maps were generated for each species.

- Distribution of Mature Fish Index: number of fish per tow greater than the length at 50% maturity[5] at each location (Table 1 provides the L50s by stock which are results from O'Brien et al.'s 1993 work on species maturation).
- Spawning Fish Index: Mature Fish Index multiplied by the proportion of fish in spawning condition in that tow (i.e., ripe, ripe and running, or spent).
- Maps also included tows where mature or spawning fish were not present.

The discussion of the maps focused on blocks 124, 125, 132, and 133, which are part of the long-standing April rolling closure that was removed via Framework 53. During April and May, these blocks have provided spawning protection for cod, winter flounder, yellowtail flounder, American plaice, haddock, and to a lesser extent, witch flounder and windowpane flounder. Thus, the Framework 53 impacts analysis concluded that the cod protection measures adopted by the Council would have mixed impacts for groundfish stocks other than cod as compared to the long-standing rolling closures. These included low negative impacts on winter flounder, yellowtail flounder, American plaice, and haddock, and to a lesser extent witch flounder and windowpane flounder. Compared to the current rolling closures, the Framework 53 impacts analysis found that the cod protection measures may have a low positive impact for ocean pout because they spawn in the fall and the winter and therefore the closure of 124 and 125 between November and January might provide some protection.

[3] Framework Adjustment 53 Proposed Rule, 80 Federal Register 12394. (March 9, 2015).

[4] Technical analysis by Cournane and Nitschke did not utilize 2010 survey data due to lack of sampled inshore strata. Most of the sampling is in April and May. See Framework 53, Appendix II (page AII-41) for rationale.

[5] L50 is the median length at maturity for at least 50 percent of females.

Additional information highlighted by the Habitat PDT: Additional information is provided below about peak spawning times (see Appendix B of the OHA 2 DEIS) and current stock status (see FW 53 EA Table 92: Cumulative effects assessment baseline conditions of the VECs).

American Plaice: American plaice spawn from March through June, with peak spawning during April and May. According to the maps prepared by Nitschke and Cournane, blocks 124, 125, 132, 133, and 139 contain high numbers of spawning condition American plaice during the spring survey, with spawning condition fish distributed broadly throughout other parts of the Gulf as well. According to the 2014 Status of the Stocks[6], the Gulf of Maine American plaice stock is not experiencing overfishing and is not overfished. In 2014, National Marine Fisheries Service implemented a second rebuilding plan for this stock due to inadequate progress in its initial rebuilding plan.

Atlantic Cod: Atlantic cod spawn throughout much of the year, with peak spawning in the Gulf of Maine, from January through May. According to the maps prepared by Nitschke and Cournane, blocks 124, 125, 132, and 133 contain relatively high numbers of spawning condition cod. As noted by the Groundfish Plan Development Team, Gulf of Maine cod exhibit high site fidelity[7]. The Gulf of Maine Cod stock is experiencing overfishing and the stock is overfished.

Winter Flounder: GOM winter flounder spawn between February and May, with peak spawning in April. According to the maps prepared by Nitschke and Cournane, spawning condition winter flounder are concentrated in blocks 115, 116, 124, 125, 132, and 133 during the spring survey. The Gulf of Maine winter flounder stock is not experiencing overfishing, but it remains unknown whether the biomass is above or below the threshold to sustain a healthy stock size.

Yellowtail Flounder: Cape Cod/GOM yellowtail flounder spawn between March and August, with peak spawning between April and June. According to the maps prepared by Nitschke and Cournane, spawning condition yellowtail flounder are concentrated in blocks 115, 124, 125, 132, and 133 during the spring survey. The GOM/Cape Cod yellowtail stock is overfished and experiencing overfishing. This stock is in Year 11 of a 19-year rebuilding plan. Based on the current stock status, more spawning protection during peak spawning activity could be beneficial for this species.

Witch Flounder: Witch flounder spawn throughout much of the year, including four peak spawning months during May through August. According to the maps prepared by Nitschke and Cournane, spawning condition witch flounder appear to be broadly distributed in the spring survey. The witch flounder stock is overfished and is currently experiencing overfishing.

Windowpane Flounder: Windowpane flounder also spawn throughout much of the year, from March through September, with no particular month identified as peak spawning activity. Windowpane flounder are not especially abundance in the Gulf of Maine, with their distribution centered further south. The Gulf of Maine/Georges Bank windowpane flounder stock is experiencing overfishing and is currently overfished. The stock is in year five of a seven year rebuilding plan.

[6] National Marine Fisheries Service. *4th Quarter 2014:* Update *Summary of Stock Status for FSSI Stocks*. www.nmfs.noaa.gov/sfa/fisheries_eco/status_of_fisheries/archive/2014/fourth/q4_2014_stock_status_tables.pdf

[7] Groundfish PDT Analysis II for FW 53 - Micah Dean and Steven J. Correia. October 31, 2014

Haddock: Haddock spawn from February through May, with peak spawning activity between February and April). According to the maps prepared by Nitschke and Cournane, spawning condition haddock are concentrated in blocks 124, 125, 132, and 133 during the spring survey. The Gulf of Maine haddock stock is not overfished and is not experiencing overfishing.

Conclusions: The information presented here, in combination with the analyses in Framework 53, can be used to evaluate the questions raised in the introduction.

- Do changes proposed in FW 53 raise concerns relative to groundfish spawning?
- When and where do various groundfish stocks spawn relative to existing and proposed management areas?

The new rolling closures that will go into effect on May 1, 2015 (assuming the final rule is similar to the proposed rule) result in changes from the current sets of closures. In particular, the changes increase winter protection between November and January in blocks 124 and 125, eliminate blocks 124, 125, 132, and 133 during April, add part of block 125 in May, and add part of block 125 and all of block 132 in June, removing two blocks further north (145 and 152).

Implementing the Massachusetts Bay area via OHA2 Alternative 3 does not cover additional times or areas as compared to the fall/winter closures proposed as a result of Framework 53, and in fact the Massachusetts Bay area is smaller in size. However, the measures in the Massachusetts Bay area are slightly more restrictive relative to those associated with the framework. Thus, it may make sense for the Council to adopt both sets of November to January closures in combination via selection of OHA2 Alternative 3. Both sets of areas increase winter protection for spawning fish, and were developed based on information about winter spawning cod in particular. Pollock and ocean pout are also winter spawners, but the research that supports the designation of the Massachusetts Bay Area does not address these stocks. Given the poor stock status of GOM cod, this increased winter spawning protection is certainly important, but it does not diminish the need for spawning protection during other times of year.

In the spring, the major difference between the two sets of areas is the elimination of all rolling closure blocks in April under Framework 53. Except for pollock and ocean pout, which are winter spawners, and GB/GOM white hake, which are not known to spawn in the GOM, most of the GOM groundfish stocks are spring spawners. These include American plaice, cod, halibut, haddock, redfish, windowpane, winter flounder, witch flounder, and yellowtail flounder. Of these, plaice, cod, haddock, winter flounder, and yellowtail are thought to be in the peak of their spawning season during April. The spawning condition fish maps prepared by Nitschke and Cournane indicate that the western Gulf of Maine, where the existing rolling closure blocks are located, is a center of abundance for some stocks, with others distributed more evenly throughout the region during the spring survey.

Certainly the spatial and temporal overlap between the April rolling closures and fish in spawning condition raises concerns, and the groundfish PDT concluded that the changes associated with Framework 53 would lead to slight negative impacts for many of these spring spawning stocks. However, these concerns are likely not large in magnitude. Changes to the rolling closures, if implemented on May 1, are within an environment of overall catch limits that constrain effort. In the near-term, very low cod catch limits will act as a general constraint on fishing effort in the Gulf of Maine. That being said, one objective in OHA2 is to improve spawning protection, and for spring spawning groundfish, longer duration and larger time/area

closures might help to achieve that objective. Another objective is to "improve access to both the use and non-use benefits arising from closed area management across gear types, fisheries, and groups". As discussed in Framework 53, adjusting the spring rolling closures is intended to improve access to stocks other than cod.

Scientific information cited in public comments

Task: Evaluate scientific literature and information, including grey literature and analyses developed by the public, referenced in public comments. Identify whether analyses have already been used in the DEIS and supporting materials, whether or not they change the conclusions of existing analyses in the DEIS, and what their peer review status is (see figure below).

Status: In progress. GARFO staff and PDT members have gone through the public comments and identified all scientific information referenced therein. This list was compared to the DEIS and DEIS appendices to determine which studies and data have already been incorporated into the analysis.

Next step During completion of the FEIS, the PDT will continue to work with this list to determine if any of the information referenced should be added to the document.**s:**

Incorporation of realized adverse effects estimates into analysis and decision making

Task: Determine whether and how realized adverse effects estimates generated by the SASI model (Z-realized) can be incorporated into the evaluation of the costs and benefits of habitat management areas. In the absence of Z-realized values for the most recent calendar years, can another effort metric be used? Should Z-realized values for recent calendar years be updated?

Status: At the March 23-24 Committee meeting, the PDT did not recommend updating the Z-realized information to include additional years of data, and there was no particular disagreement from the Committee.

Discussion: One output of the Swept Area Seabed Impact Model (SASI) is a realized adverse effect estimate, Z-realized. This data product is described in the DEIS, Volume 1, section 4.2.2.2, with details in Appendix D:

> 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. (DEIS Vol. 1, page 144)

As an example, the 2009 Z-realized map (or underlying data table) shows the impacts of 2009 fishing effort combined with the residual impacts of effort that occurred between 1999 and 2008. Over time, recovery occurs, and previous impacts in a grid cell are assumed to dissipate fully after 10 years. These estimates are presented by gear type, but could be summed across gear

types as Z is always expressed in km^2 units. Realized adverse effects estimates can be used to understand trends in impacts over time and space. However, care needs to be taken in understanding the results, because these trends are heavily influenced by the regulatory environment, which has shaped the distribution of past effort through year-round, seasonal, and rotational closures, catch limits, and other measures. For a particular area of interest, the time series of Z-realized for each gear type gives an annual snapshot of the magnitude of habitat impacts within the area, but it is important to understand what is happening in other locations throughout the region. If overall effort from a particular gear type has increased or decreased over time, the Z-realized maps and tables will reflect this. Because impacts can take ten years to decay to zero, there will be lags in the realized adverse effects maps as effort shifts in space or declines.

The PDT considered the possibility of updating the dataset for the SASI realized z-scores (adverse effects, currently available for 1996-2009) help to inform the Committee when they consider recommendations for habitat management alternatives. This information was summarized in the affected environment section of the DEIS (Volume 1) using maps, graphs, and tables, by gear type over time. The PDT had a robust discussion of this issue prior to, during, and after the meeting. Team membered disagreed about exactly how useful the estimates were in understanding the relative benefits associated with different habitat management areas. Some members felt that it was important to understand past levels of impacts in a candidate closure, in order to know what benefits might be realized if an area were to close. The idea was that you could potentially realize more benefits from closing an area that had seen greater impacts and fishing effort in the past. The counter argument to this is that if consistently fished areas are closed, then there is greater potential for effort displacement to other habitats. Given the interconnectedness of areas within and among sub-regions, it is important to think about net effects on a region-wide basis.

Additionally, these estimates should be considered with caution because their distribution is dependent on fishery resource distribution, existing closed areas, and other existing and past regulations. Thus, the past distribution of adverse effects cannot be taken at face value. Also, a point previously raised during discussion of the SASI model was reiterated here. Specifically, the does not explicitly differentiate between existing closures where recovery may have occurred and currently open areas, except through differences in area swept.

However, the PDT agreed that given the large number of caveats about the interpretation of these results, data through 2009 would be sufficient to understand the general distribution of habitat impacts throughout the region. They agreed that updating the data set to include additional years of data would be interesting, to see more recent trends, but was not going to be worth the effort required to do so. The team discussed that updating the estimates would require a few weeks of someone's time at the NEFSC SSB.

HAPC adverse effects evaluation

Task: Analyze and determine the need to minimize adverse impacts within Habitat Areas of Particular Concern

Status: In progress. A formal written evaluation will be included with the FEIS.

Background and discussion: Background information about the rationale for the northern edge HAPC specifically is provided in a memorandum from the Executive Director.

Early in the process of developing OHA2, the Council solicited HAPC proposals and these were reviewed by the PDT, the Committee, and finally the Council in order to select the preferred alternatives identified in the October 2014 DEIS. Because many of these HAPCs overlap with other fishery management areas already being evaluated within the DEIS, a separate analysis was not done at the draft stage. Below is a list of the various HAPCs with some information about overlap with management areas and other analyses.

Atlantic Salmon HAPC: This HAPC includes various rivers in the GOM. Federally-managed fisheries impacts to these habitats are not an issue given the location of the HAPC.

Inshore GOM HAPC: Includes waters to 20 meters in the GOM. As above, Federally-managed fisheries impacts to these habitats are not expected to be a major issue given the location of the HAPC. Early on in the development of the SASI model, the PDT evaluated whether substantial federally managed fishing activities occur in state waters, and concluded that given the limited federally managed fishing activity occurring very close to shore, it was reasonable to eliminate state waters from the SASI analysis. The inshore GOM HAPC is a subset of state waters and therefore adverse impacts from federally managed fisheries are not expected to be an issue.

Cashes Ledge HAPC: This HAPC has the same boundaries as the Cashes Ledge Habitat Closed Area, so adverse effects were assessed in that context. Note that other boundary options for this HAPC were considered during Phase I of OHA2.

Stellwagen/Jeffreys Ledge HAPC: This HAPC has the same boundaries as the Western Gulf of Maine Habitat Closed Area, so adverse effects were assessed in that context. Note that other boundary options for this HAPC were considered during Phase I of OHA2.

Northern Edge HAPC: This HAPC has the same boundaries as the Closed Area II Habitat Closed Area, so adverse effects were assessed in that context. Note that other boundary options for this HAPC were considered during Phase I of OHA2.

Great South Channel HAPC: Most of this HAPC is within the SASI model domain, such that fishing impacts and habitat vulnerability were assessed as part of the development of the SASI analyses and subsequent PDT and Committee work. There is some overlap between the HAPC and the Great South Channel region Habitat Management Areas.

Canyon and seamount HAPCs: After these HAPCs were identified as preferred alternatives, the Council began development of coral protection zones under the Magnuson Stevens Act discretionary authority. This work in on hold pending completion of the habitat amendment, but will include a comprehensive analysis of fishing impacts in these general locations, as well as measures to minimize impacts. There is currently no fishing on the seamounts, and fishing occurs in the shallower waters of the various canyon HAPCs. The Mid-Atlantic Fishery Management Council is also developing measures to protect corals in their region, which overlap with some of the NEFMC HAPCs further south.

Practicability analysis

Task: Improve the practicability analysis in Volume 4 of the DEIS

Status: In progress. The practicability analysis will be updated for the FEIS.

Discussion: Practicability analysis should lay out the results of the impacts analysis, describe uncertainty in the results, and be clear about short- vs. long-term outcomes. Analysis should not include concluding statements such as "X alternative is practicable compared to Y alternative".

Lobster analyses

Task: Evaluate whether additional analysis can be conducted on the magnitude of potential lobster trap/scallop dredge conflicts should Closed Area II reopen. Consider potential economic impacts as well as potential impacts on the lobster resource impacts.

Status: In progress. The FEIS will be updated to include additional discussion of lobster resource impacts as appropriate.

Background: Currently, Closed Area II (CAII) is closed to mobile bottom tending gear, with the exception of regular rotational scallop fishery access below 41° 30' N. A lobster fishery has developed in this area since the closure was enacted year round in 1994, with effort concentrated in the summer months. OHA2 includes proposals that would open CAII except during a February 1 – April 15 spawning closure, as well as proposals that could remove or adjust the boundaries of the Closed Area II Habitat Closure in the northern part of the area. Scallop vessels could potentially be exempted from the spawning closure but would likely be restricted from any habitat closure as they are a mobile bottom-tending gear type.

Public comments mentioning this issue: The lobster industry and the Atlantic States Marine Fisheries Commission (ASMFC) have raised concerns about the potential for fishing with scallop dredges to negatively impact lobster pot gear and fishing operations. In addition, concerns have been raised about the potential for negative impacts on the lobster resource via mobile bottom-tending gear interactions with the substantial number of egg-bearing female lobsters present in the area during the summer months. In addition, a draft area sharing agreement and associated emails have been distributed and discussed at various meetings this spring.

DEIS references: The DEIS discusses these issues in the human community impacts sections (see Volume 3) and the lobster resource and fishery impacts section (see Volume 3).

Additional discussion and information: This issue was discussed at the March 11 PDT meeting. The PDT agreed that some of the information in the public comments could be incorporated into the FEIS, for example details about the distribution of egg bearing females and connectivity between the Georges Bank and Gulf of Maine lobster stocks. Gear conflict resolution is not an issue the PDT can help to resolve with additional discussion or analysis – based on discussions among the parties at the PDT meeting, it seems that coming to an agreement is a matter of timing in terms of spring access for the scallop fishery.

Clam dredge exemption

Task: Identify potential high energy sand clam-dredge exemption areas within HMAs

Status: In progress. See recommendation at the conclusion of this section. Additional maps and information will be presented at the Committee meeting.

Background: Option 2 proposes to exempt hydraulic clam dredges from HMA restrictions. MAFMC motion and comment letter suggested that NEFMC should identify specific exemption areas of high energy sand.

Discussion: The Habitat Committee requested that the PDT identify candidate hydraulic clam dredge exemption areas within habitat closures. The general intention was to identify areas with high energy sand that are currently fished with clam dredges, generally on Nantucket and Georges Shoals. The fishery also operates on Cultivator Shoals but this is west of the proposed habitat closure boundaries. Currently, the OHA2 DEIS includes a blanket exemption option (Option 2) for this gear type, whereas the exemption area approach would consider specific sub-areas where dredging for clams would be permitted, with the rest of the habitat management area off limits to the gear. It was noted that the Swept Area Seabed Impact model assumes that clam dredges can fish in sand and granule-pebble-sized sediments.

In theory, it should be possible to identify high energy sand habitats where clam fishing occurs that can be developed into reasonably sized and shaped exemption areas. However, there are a number of reasons why this has proven difficult to do. The PDT explored the issue further at our March 11, meeting, with no resolution. Clam fishing effort appears to be very broadly distributed, with only a small subset of areas identified where fishing is not really feasible. The clam dredge industry provided a chart before the PDT meeting, and attendees from that industry provided some explanation of this chart to the PDT. Basically, they identified broad areas where fishing occurs, and also identified sub-areas where fishing would be prohibited. The PDT discussed that this was actually the opposite of the Committee request to identify exemption areas where fishing would be allowed.

The PDT asked the industry to identify key fishing areas and to continue work to identify closure areas. The idea was that if we understood where both the most important fishing areas and the impossible to fish areas within habitat management areas were located, that exemption area boundaries could be developed more easily. The PDT investigated whether VMS data could be used to map clam fishing effort, but VMS data for this fishery have not been processed for fishing/not fishing and there is not currently a model available to do so. However, the VTR confidence interval analysis used in the DEIS (summarized in DePiper 2014) produces effort heat maps that provide a general overview of where fishing effort occurs.

Following the PDT meeting, the clam industry provided charts with individual tows to show in detail how fishing effort is distributed in the Nantucket Shoals region. These charts were reviewed during the Habitat AP meeting, March 23-24 Committee meeting, and during a PDT conference call on April 2. The charts indicate that fishing occurs throughout areas mapped by the PDT as cobble-dominated, and that fishing does not occur in highly dynamic sand shoal areas. The PDT concluded during their call that they remain concerned about the use of hydraulic clam dredges in cobble-dominated habitats. A preferable approach would be to designate habitat management areas in locations with less overlap with the clam fishery, such that exemption

would not be required. For example, two of the four original Great South Channel habitat areas identified by the PDT have little overlap with clam dredging activity. These areas appear to have higher overlap with scallop dredging and trawling, however.

Winter flounder EFH designation

Task: Re-evaluate the winter flounder egg EFH designation

Status: In progress. See recommendation at the conclusion of this section, with maps to be provided at the Committee meeting.

Background: EFH for winter flounder was first designated via Omnibus EFH Amendment 1 in 1999. There are separate but very similar maps for eggs/larvae, and juveniles/adults. The only difference in the maps is that the southern limit of the egg and larval designation occurs at Delaware Bay, and the southern limit of the juvenile and adult designations occurs at Chincoteague Bay. The no action maps for all lifestages are generally based on the distribution of adults.

The occurrence of winter flounder egg EFH is often cited as a reason for requiring conservation measures when NMFS conducts EFH consultations on various federally permitted projects in nearshore waters. For this reason, there is public interest in revision the egg EFH designation, and four comment letters speak directly to this issue. An argument has been made that the southern boundary of the designation extends too far south into waters with few winter flounder, and also that areas with high siltation rates, e.g. manmade harbors that require regular maintenance dredging, do not actually provide suitable egg habitat. Generally, conservation recommendations take the form of seasonal restrictions on dredging, during the time periods when winter flounder are expected to move inshore to deposit their eggs.

During 2010, the Habitat PDT and Committee had extensive discussions about the maximum depth of winter flounder egg EFH in southern New England and Mid-Atlantic waters, reviewing data collected in NY harbor to evaluate whether the designation should extend into deeper waters, to 20m, rather than the current depth of 5m. The recommendation of the PDT, which the Committee agreed with, was to keep the maximum depth at 5m. The southern extent of the designation was not a topic of discussion at that time, or at least was not raised as a major issue.

Changes from the no action to preferred alternative egg designation are discussed in the DEIS, Volume 2, preferred EFH alternatives section:

> "The proposed designation for winter flounder eggs defines EFH south of Cape Cod to be sub-tidal coastal waters from the shoreline to a maximum depth of 5 meters (relative to mean low water) from Cape Cod to Delaware Bay, and from the shoreline to a maximum depth of 70 meters in the Gulf of Maine and on Georges Bank. The proposed designation would also include the bays and estuaries identified in the ELMR program where winter flounder eggs or larvae are "common" or "abundant."

The maximum depth in southern New England and the Mid-Atlantic is the same as in the no action designation for the entire coast. It was not changed because data collected during a series of benthic winter flounder egg surveys by the U.S. Army Corps of Engineers in the New York Harbor area in recent years indicate that many more eggs are deposited on the bottom in shallow water areas, not in the deeper shipping channels. Based on this information, the Council concluded that the shoal water areas in New York harbor were the primary habitat for winter

flounder eggs. Evidence from recent research studies in the southwestern Gulf of Maine (see Appendix B) show that winter flounder spawn in deeper water as well as in coastal estuaries. Based on this information, the Council decided to extend EFH for winter flounder eggs to 70 meters – the maximum depth identified in the original Bigelow and Schroeder edition of Fishes of the Gulf of Maine for spawning winter flounder on Georges Bank – north of Cape Cod and on Georges Bank.

Current proposed designation: The proposed EFH designation for winter flounder eggs would maintain the no action depth range of 0-5 meters south of Cape Cod, but extend EFH into much deeper water (70 meters) north of Cape Cod while reducing the maximum depth from 90 to 70 meters on Georges Bank. It also would add submerged aquatic vegetation to the list of egg substrates.

Because the no action EFH maps are all based on the distribution of adults, they are all the same. Compared to the no action map, the proposed map for eggs is much more limited in terms of area, especially south of Cape Cod and on Nantucket Shoals. Because it is not possible to show the 5 meter depth contour, the map actually extends to 20 meters even though EFH would be limited to 5 meters; thus, the actual geographic extent of EFH for winter flounder eggs would be less than is shown on the map. Modification of the EFH designation for winter flounder eggs – a reduction in the maximum depth from 20 to 5 meters along the coast south of Cape Cod and an increase from 20 to 70 meters north of the cape – added a significant amount of benthic habitat in the Gulf of Maine and removed a lot in southern New England and the Mid-Atlantic."

Many species have inshore EFH map designations that are based on a 10 percent frequency of occurrence threshold in state surveys. In other words, within the ten minute squares overlapping state survey data, if at least 10 percent of the tows caught any number of the species and lifestage, the area is designated EFH. In some cases, another lifestage is used as a proxy. In this instance, the occurrence of adult winter flounder in at least 10% of state survey tows is used to map inshore EFH for eggs. In general, this results in a 'generous' EFH designation, as 10% is a fairly low threshold, but the result is that potentially important habitats in inshore areas are not missed on the maps.

In addition, the maps also designate EFH in embayments and estuaries evaluated in the Estuarine Living Marine Resource reports as having a species and lifestage as common or abundant. These ELMR reports were published in the mid-1990s, based on data from decades prior to that. Due to the age of these reports and their associated data, it is at least possible that the common/abundant classifications in the ELMR reports no longer reflect current conditions. This could be an especially important consideration when climate change mediated range shifts are occurring such that recolonization of former habitats is extremely unlikely to occur.

Recommendation: Revisions to all three maps (eggs, juveniles, and larvae/adults) need to be considered that would modify EFH at the southern end of the species range. Trawl survey data show that winter flounder are much less abundant in southern New Jersey and Delaware Bay than they are in northern New Jersey. Also, increasing water temperatures in the Mid-Atlantic and increased predation of juveniles by summer flounder – which are also moving north as climate changes – are causing a northward shift in the distribution of the population. Improving the accuracy of winter flounder EFH is a primary concern to NMFS/GARFO Habitat Conservation Division because of the importance of this species when making conservation

recommendations aimed at protecting shallow inshore habitats from the adverse effects of non-fishing activities such as maintenance dredging of harbors and shipping channels.

Compliance with prey information requirements

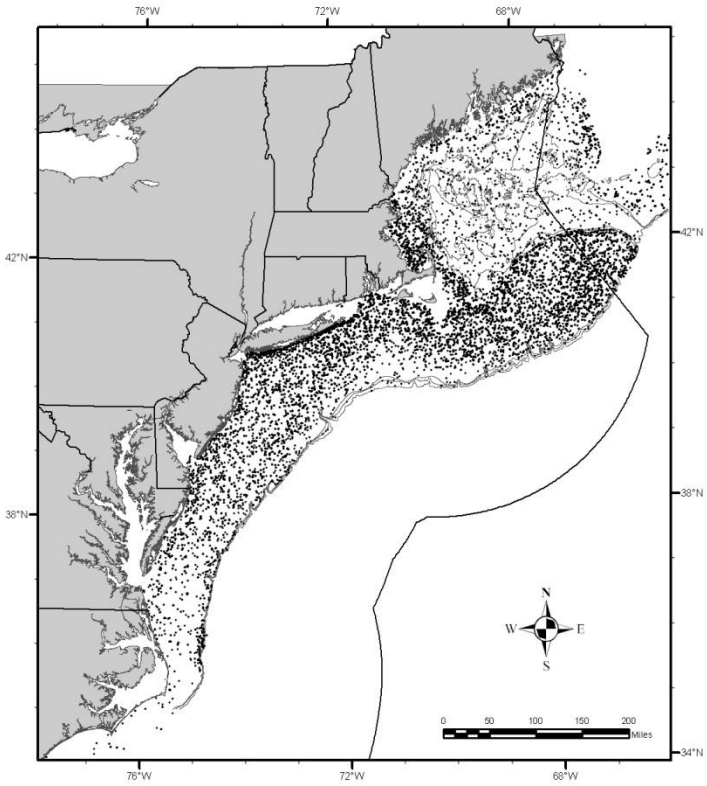
Task: Discuss how the amendment complies with the prey information requirement of the EFH regulations and how adverse effects on prey component of EFH were evaluated during development of the SASI model

Discussion: Prey is a component of EFH. According to the EFH regulations, the impacts of fishing on prey of managed species should be included in fishing effects analyses.

> Loss of prey may be an adverse effect on EFH and managed species because the presence of prey makes waters and substrate function as feeding habitat, and the definition of EFH includes waters and substrate necessary to fish for feeding. Therefore, actions that reduce the availability of a major prey species, either through direct harm or capture, or through adverse impacts to the prey species' habitat that are known to cause a reduction in the population of the prey species, may be considered adverse effects on EFH if such actions reduce the quality of EFH. FMPs should list the major prey species for the species in the fishery management unit and discuss the location of prey species' habitat. Adverse effects on prey species and their habitats may result from fishing and non-fishing activities.

The 2007 Phase 1 DEIS listed major prey species for each managed species in an appendix, and included maps of principal prey taxa. Appendix B to the current DEIS folded these detailed descriptions of principal types of prey eaten by each managed species into the EFH supplementary information tables. The supplemental tables provide a level of detail that goes beyond the EFH text descriptions. The prey maps were left out of current DEIS and appendices because they were thought to not be especially informative. An example prey map is provided below. Many of the prey types are broadly distributed, similar to this map.

Figure 2 Sample gammarid amphipod map from Phase 1 DEIS



On a number of occasions, the PDT discussed the inclusion of a prey component in the SASI model. Ultimately, the group decided not to include a prey component in addition to the geological structure and biological structure components. In lieu of modeling the impacts of fishing on prey, an appendix describing the results of studies looking at effects of fishing gears used in New England region on prey types/species was prepared. This appendix was left out of the current DEIS. The introduction summarizes why the prey component was not included in the SASI analysis:

> Ideally, the SASI model would spatially resolve fishing effects across all components of habitat. In particular, the prey of managed fish species is an important component of fish habitat that is potentially affected by fishing gears. While the PDT recognized the importance of incorporating prey vulnerability into the assessment of the adverse effects of fishing on EFH, including prey as another habitat component in SASI would have further decoupled the model results from local spatial empirics because prey features, like biological habitat features, would need to be inferred to substrate/energy regimes. When the spatial distributions of all feature classes (geological, biological, and prey) are better known, it may be appropriate to include prey in the vulnerability assessment and make SASI regionally specific, thereby reducing errors in vulnerability estimates at the local level. As an interim step, this document describes prey species found in the region, and their vulnerability to fishing gear impacts.

Next steps: The PDT and Council/GARFO staff have discussed how the prey information in the FEIS can be improved.

The PDT will review prey vulnerability appendix, identify any new literature that should be incorporated into the analysis, and include the appendix with the FEIS. Also, the PDT will

include prey species maps and descriptions of the distribution of prey in either Appendix B with the supplementary tables, or in the prey vulnerability appendix, as seems appropriate.

Finally, the FEIS will include additional discussion of prey species issues in two locations. In the EFH designation volume (Volume 2), the introduction will reference the prey species supplementary tables in Appendix B, and explain how this information will be incorporated into the EFH consultation process, which is primarily undertaken by GARFO Habitat Conservation Division. In the habitat impacts analysis (Volume 3), the introduction will discuss the prey vulnerability appendix, and how that information relates to the impacts determinations for each alternative. In general, most fish species consume varied types of prey on an opportunistic basis, such that loss of prey was not a major consideration when drafting the impacts analysis originally. However, if prey resources in a particular location warrant special consideration in the impacts analysis, this will be noted in the write up for that alternative and accounted for in the final determination of habitat impacts for that alternative, as appropriate.

Analysis of modified management alternatives

Task: Analyze modified management alternatives identified by the Committee

Description of alternatives: Three modified alternatives are as follows:

- In the GSC/SNE sub-region, separate the Cox Ledge HMA from the Great South Channel/Nantucket Shoals HMAs Alternatives 3-6 into a standalone alternative
- In the western GOM sub-region, add an alternative that includes the Small Stellwagen and Jeffreys Ledge HMAs only
- In the western GOM sub-region, add an alternative that modifies the eastern boundary of the WGOM Closure Area to make it consistent with the WGOM Habitat Closure Area

The first two alternatives above are subsets of existing alternatives. If these, or other mix and match alternatives are selected by the Council during final action, the FEIS will be rewritten to reflect the differences between the alternatives selected and those already analyzed. The remainder of this section focuses on the Western Gulf of Maine boundary change, because this alternative represents a greater departure from what has already been analyzed in the DEIS.

The boundary change for the Western Gulf of Maine Closure Area (the groundfish mortality closure) was confirmed as the Committee's preferred alternative on March 23, 2015. The alternative would adjust the eastern boundary of the closure to make it the same as the existing Western Gulf of Maine Habitat Closure Area boundary, eliminating a portion of the groundfish closure that is roughly 5 nautical miles wide east to west and 60 nautical miles long north to south.

The concept of an exemption area for this same easternmost section of the groundfish closure was analyzed in Framework Adjustment 48 to the Northeast Multispecies FMP, and the analyses developed for that framework assessed the potential biological, habitat, and economic impacts associated with allowing sector groundfish vessels access to fish in the area. Note that Framework 48 evaluated this area as a sector exemption area, while the proposal here is to change the boundary and allow any types of fishing into the area, subject to other overlapping management areas and constraints. While via Framework 48 the Council approved the

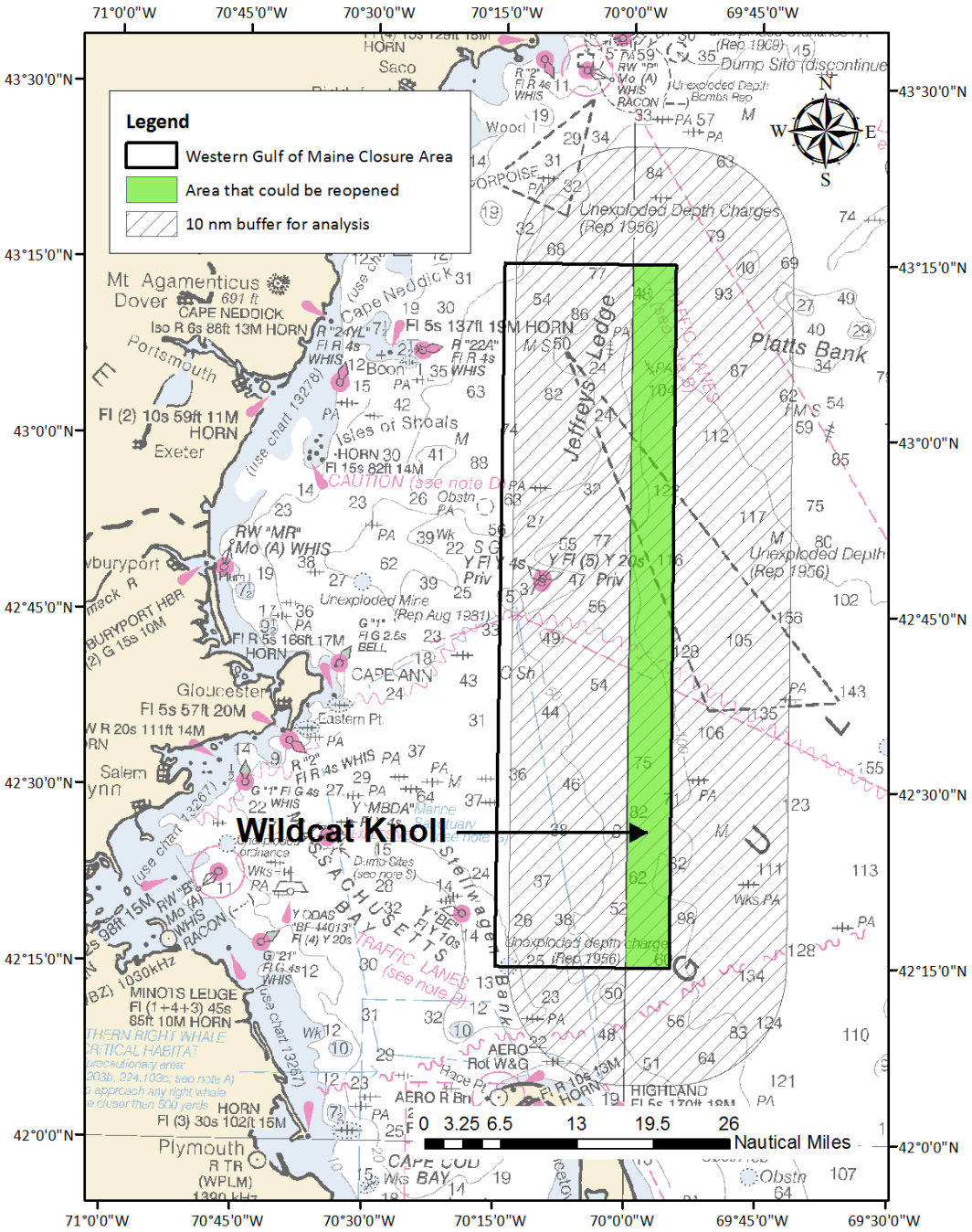
exemption areas as exemptions that could be requested by sectors, sector fishing activities within this particular exemption area have not been authorized to date in the annual sector regulations.

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

At least two questions are of importance in evaluating the impacts of reopening this area to fishing. First, what habitat types are included within the area and how might those habitats be impacted by fishing activities should the area open? Second, what fishery resources might be harvested within the area? The answer to the second question can be used to evaluate both the potential biological impacts of reopening the area, as well as the potential economic impacts. Both questions were addressed in the impacts analysis prepared for Framework 48 (see the Framework 48 Environmental Assessment (EA), http://www.nefmc.org/library/framework-48, sections 7.1.2.6 (pages 423-433, biological impacts), 7.2.2.6 (pages 447-451, habitat impacts), and 7.4.3.5 (pages 504-525, economic impacts).

Biological impacts on groundfish stocks were evaluated as mixed In the Framework 48 EA, depending on the exemption area and stock under consideration. Habitat impacts were not expected to be significant, 'except perhaps in discrete locations where bottom trawling could impact complex bottom habitats to a greater degree than they are already affected by natural factors' (page 447). Within the eastern portion of the WGOM Closure Area, Wildcat Knoll was listed as an area of complex habitat more vulnerable to the impacts of fishing. This location of this area is highlighted on Figure 3, which shows the area that could open under this boundary change, as well as a 10 nautical mile buffer around that area generated for analytical use.

Figure 3 – Western Gulf of Maine Closure Area, eastern sliver that could be reopened, and 10 nautical mile buffer.



The tables in the economic impacts section of the framework are updated below to include just the buffer area shown above, rather than using a buffer around the entire Western Gulf of Maine Closure Area. This was done to remove tows west of the closure, which are likely to be less similar to tows in areas east of the 'sliver' area. For practical purposes, in assessing fishing effort in areas adjacent to the 'sliver' area, the portion of the buffer inside the Western Gulf of Maine Closure Area has been closed for many years to various types of fishing effort, so the tables shown below summarize revenues from areas to the north, south, and east of the sliver only. The

results of this analysis are presented below for species that, on average across all months, comprised 5% or more of revenues in any gear type. Blue and green shading is used to show the gradient of values from low (white) to high (blue or green) revenue or percent of revenue per haul.

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

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

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

Given that the low Gulf of Maine cod TAC proposed as part of Framework 53 is likely to severely restrict groundfish fishing in the area surrounding the WGOM sliver, the economic benefits afforded by fishermen's access to this area of the ocean are likely to be small to negligible. A two tailed test for the proportion of hauls catching cod on the east versus the west side of the WGOM closure is significant at the 5% level for bottom trawl (p-value = 0.00), but not for gillnet hauls (p-value = 0.81) This means that catch rates of cod are significantly lower on the eastern versus western side of the WGOM closure for observed bottom trawl trips, but not for gillnet trips. A nonparametric two-tailed Wilcoxon rank-sum test indicates that, at the 5% level, the median value derived from cod on hauls on the western side of the closure is significantly higher than the eastern side for both bottom trawls (p-value = 0.00) and gillnet hauls (p-value = 0.00). This means that cod is a higher proportion of the landed revenue on the western side of the closure than the eastern side of the closure. This analysis indicates that, given the constraining role cod is likely to play in the groundfish fishery for the foreseeable future, there is some benefit to opening areas with a lower catch rate of cod, versus other species, to fishermen. Nevertheless, as previously stated, the economic benefit would likely be small to negligible in magnitude.

Table 2 – Average revenue per haul by species and gear type within a 10 nm buffer around the eastern sliver of the WGOM Closure Area, time period 2007-2012.

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

Figure 4 – Spatial distribution of bottom trawl VTR revenues near the WGOM Closure Area, 2007-2012. Revenue distribution around each VTR point was generated using the approach outlined in DePiper 2014.

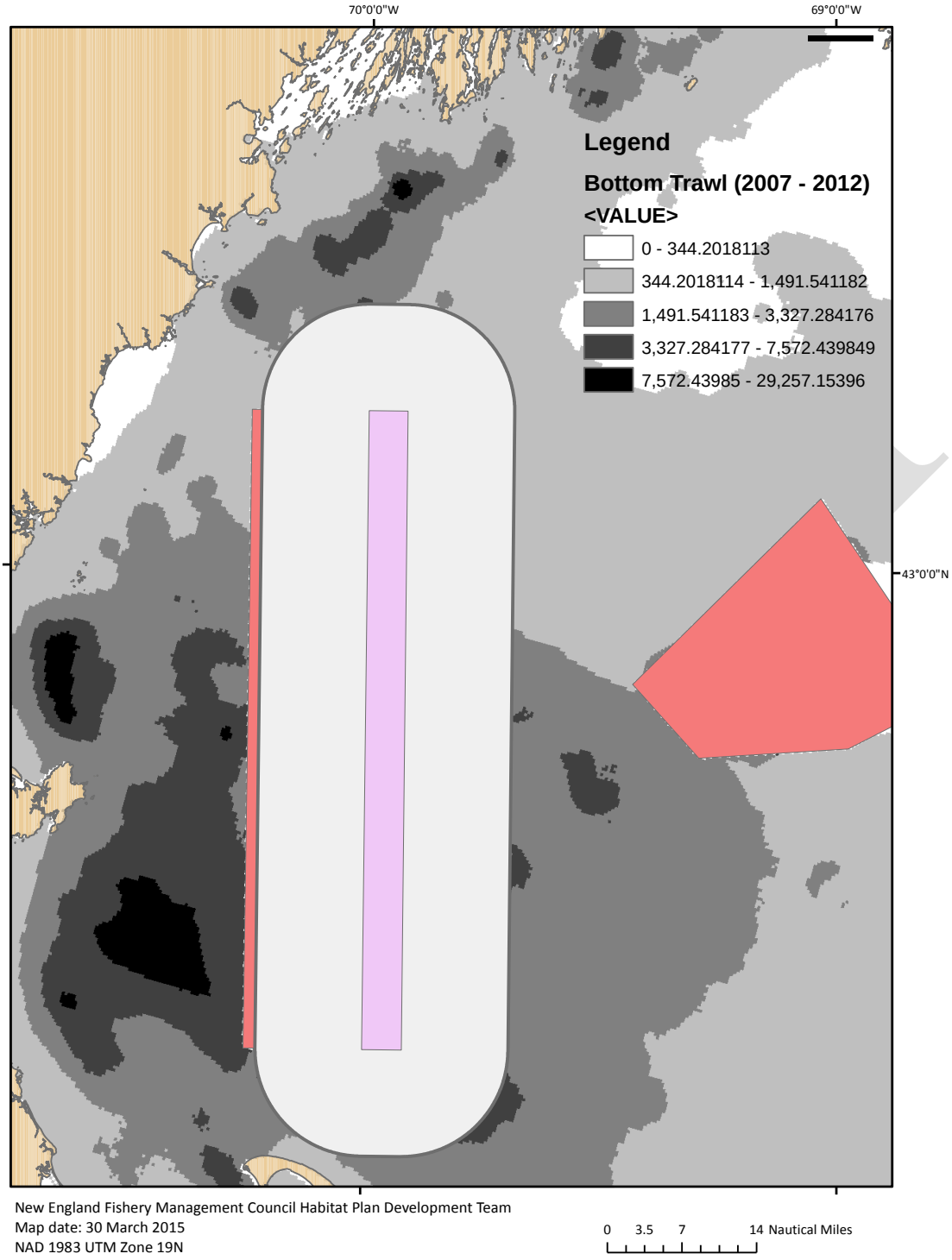


Figure 5 – Spatial distribution of sink and floating gillnet VTR revenues near the WGOM Closure Area, 2007-2012. Revenue distribution around each VTR point was generated using the approach outlined in DePiper 2014.