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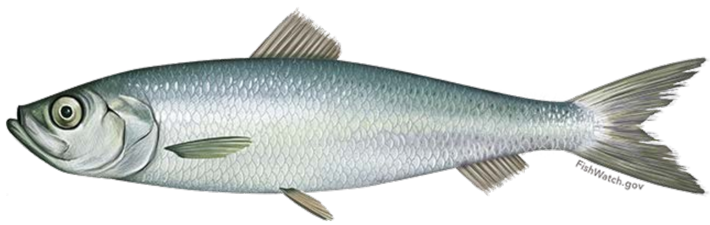
AMENDMENT 8
to the
Atlantic Herring Fishery Management Plan



Including a

Draft Environmental Impact Statement (DEIS)

Volume I

Prepared by the

New England Fishery Management Council

in cooperation with the

National Marine Fisheries Service

Council approval of DEIS: December 5, 2017

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Cover Image: *Downloaded from FishWatch, www.FishWatch.gov .*

NOAA Fisheries website with up-to-date information on U.S. seafood.

AMENDMENT 8 TO THE ATLANTIC HERRING FISHERY MANAGEMENT PLAN

Proposed Action: Propose a long-term Acceptable Biological Catch (ABC) control rule for the Atlantic herring fishery that may explicitly account for herring's role in the ecosystem and to address the biological and ecological requirements of the Atlantic herring resource. Propose measures to address potential localized depletion and user conflicts with possible detrimental biological and socioeconomic impacts on predators of herring and other user groups.

Type of Statement: Draft Environmental Impact Statement (DEIS)

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Abstract: The New England Fishery Management Council, in consultation with NOAA's National Marine Fisheries Service, has prepared draft Amendment 8 to the Atlantic Herring Fishery Management Plan (FMP), which includes a draft environmental impact statement (DEIS). The DEIS presents the range of alternatives to achieve the goals and objectives of the amendment. The proposed alternatives focus on measures related to the ABC control rule and potential localized depletion of the herring resource and user conflicts. The document describes the affected environment and valued ecosystem components and analyzes the impacts of the alternatives on both. It addresses the requirements of the National Environmental Policy Act (NEPA), the Magnuson Stevens Fishery Conservation and Management Act (MSA), the Regulatory Flexibility Act (RFA), and other applicable laws.

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Executive Summary

This draft amendment document and draft environmental impact statement (DEIS) presents and evaluates management alternatives and measures to achieve specific goals and objectives for the Atlantic herring fishery. This document was prepared by the New England Fishery Management Council and its Herring Plan Development Team (PDT), in consultation with the National Marine Fisheries Service (NMFS, NOAA Fisheries), the Atlantic States Marine Fisheries Commission (ASMFC), and the Mid-Atlantic Fishery Management Council (MAFMC). This amendment is being developed in accordance with the Magnuson-Stevens Fishery Conservation and Management Act (MSFCMA, M-S Act) and the National Environmental Policy Act (NEPA).

This document also includes a preliminary evaluation of impacts relative to the Regulatory Flexibility Act (RFA) and other applicable laws. This document provides the background and context for Amendment 8 (Affected Environment), describes in detail all of the management alternatives under consideration, updates information about all of the components of the ecosystem and fishery potentially affected by the alternatives, evaluates the potential impacts of the management alternatives under consideration, addresses the alternatives with respect to other applicable laws, provides the public and the Council with adequate information about the measures and their impacts to ultimately inform decision-making following the public comment period.

The primary purpose of Amendment 8 is to modify the fishery management plan for the Atlantic herring fishery by:

- Proposing a long-term ABC control rule for the Atlantic herring fishery that may explicitly account for herring's role in the ecosystem and to address the biological and ecological requirements of the Atlantic herring resource.
- Proposing measures to address potential localized depletion of Atlantic herring to minimize possible detrimental biological impacts on predators of herring and associated socioeconomic impacts on other user groups.

The purposes and needs for this amendment are expected to advance the goals and objectives of the herring management program, as modified in Section 1.4 of this document. The management measures under consideration are intended to achieve both the goals and objectives of the management program, in addition to the primary purposes of this action. The management measures under consideration in this amendment include:

- Acceptable Biological Catch (ABC) control rules that specify a formulaic approach for establishing an annual limit or target fishing level that is based on the best available scientific information. It provides guidance to the Science and Statistical Committee (SSC) regarding how to specify the ABC for Atlantic herring based on scientific uncertainty, stock status, and the Council's risk tolerance. The Council included Management Strategy Evaluation (MSE) to develop and analyze various ABC control rule alternatives.
- Specific measures to address concerns raised by some stakeholders about potential localized depletion causing negative biological and socioeconomic impacts on other user groups that depend on herring as forage in the ecosystem. The range of localized depletion measures considered include: area closures, gear prohibition areas, modifications to management area boundaries and various seasonal restrictions.

The Affected Environment is described in this document based on valued ecosystem components (VECs) that are identified specifically for Amendment 8. The VECs for consideration in Amendment 5 include: Atlantic Herring; Non-Target Species (Bycatch); Predator species; Protected Resources; Physical Environment and Essential Fish Habitat (EFH); and Human Communities including the herring fishery, the mackerel fishery, lobster fishery, bluefin tuna fishery, Groundfish fishery, other recreational fisheries, ecotourism businesses, and fishing communities. VECs represent the resources, areas, and human communities that may be affected by the management measures under consideration in this amendment. VECs are the focus of an EIS since they are the "place" where the impacts of management actions are exhibited. The sections of the Affected Environment are therefore divided into the six VECs.

The impacts of the alternatives/options under consideration in Amendment 8 on each of the VECs are generally summarized below. Much of the detailed analyses to support the development of the alternatives/options under consideration in Amendment 8 were provided by the Herring PDT and form the basis for determining the potential impacts of the measures on each of the VECs. The complete analyses and supporting technical documents are included in Section 5.0 of this document and the appendices to the Amendment 8 (Volume II). The No Action alternative represents status quo conditions for the Atlantic herring fishery management program and forms the basis for comparison and assessment of all management options/alternatives under consideration.

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Appendix Number	Title
Appendix I	Summary of Scoping Comments for Amendment 8
Appendix II	Background on ABC control rules and Management Strategy Evaluation (MSE) process used in New England
Appendix III	Technical Details of Herring MSE models
Appendix IV	MSE Peer Review Final Report
Appendix V	NEFMC MSE User Guide
Appendix VI	Supplemental Herring Plan Development Team (PDT) Analyses Relative to Localized Depletion
Appendix VII	Technical Report of Herring PDT Fishery Overlap Analysis
Appendix VIII	Localized Depletion Literature Review

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Acronymns

ABC	Acceptable Biological Catch
ABC CR	ABC Control Rule
ACL	Annual Catch Limit
AM	Accountability Measure
ASMFC	Atlantic States Marine Fisheries Commission
B	Biomass
CC	Cape Cod
CZMA	Coastal Zone Management Act
DEIS	Draft Environmental Impact Statement
EA	Environmental Assessment
EEZ	Exclusive Economic Zone
EFH	Essential Fish Habitat
EIS	Environmental Impact Statement
E.O.	Executive Order
ESA	Endangered Species Act
F	Fishing Mortality Rate
FEIS	Final Environmental Impact Statement
FGSA	Fixed Gear Set-Aside
FMP	Fishery Management Plan
FW	Framework
FY	Fishing Year
GB	Georges Bank
GOM	Gulf of Maine
M	Natural Mortality Rate
MA	Mid-Atlantic
MADMF	Massachusetts Division of Marine Fisheries
MAFMC	Mid-Atlantic Fishery Management Council
MEDMR	Maine Department of Marine Resources
MMPA	Marine Mammal Protection Act
MSA	Magnuson-Stevens Fishery Conservation and Management Act
MSE	Management Strategy Evaluation
MSFCMA	Magnuson-Stevens Fishery Conservation and Management Act
MSY	Maximum Sustainable Yield
mt	Metric Tons
NEFMC	New England Fishery Management Council
NEFSC	Northeast Fisheries Science Center
NEPA	National Environmental Policy Act
NMFS	National Marine Fisheries Service
NOAA	National Oceanic and Atmospheric Administration
NSGs	National Standard Guidelines
OFL	Overfishing Limit
OY	Optimum Yield
PDT	Plan Development Team
PS/FG	Purse Seine/Fixed Gear
RFA	Regulatory Flexibility Act

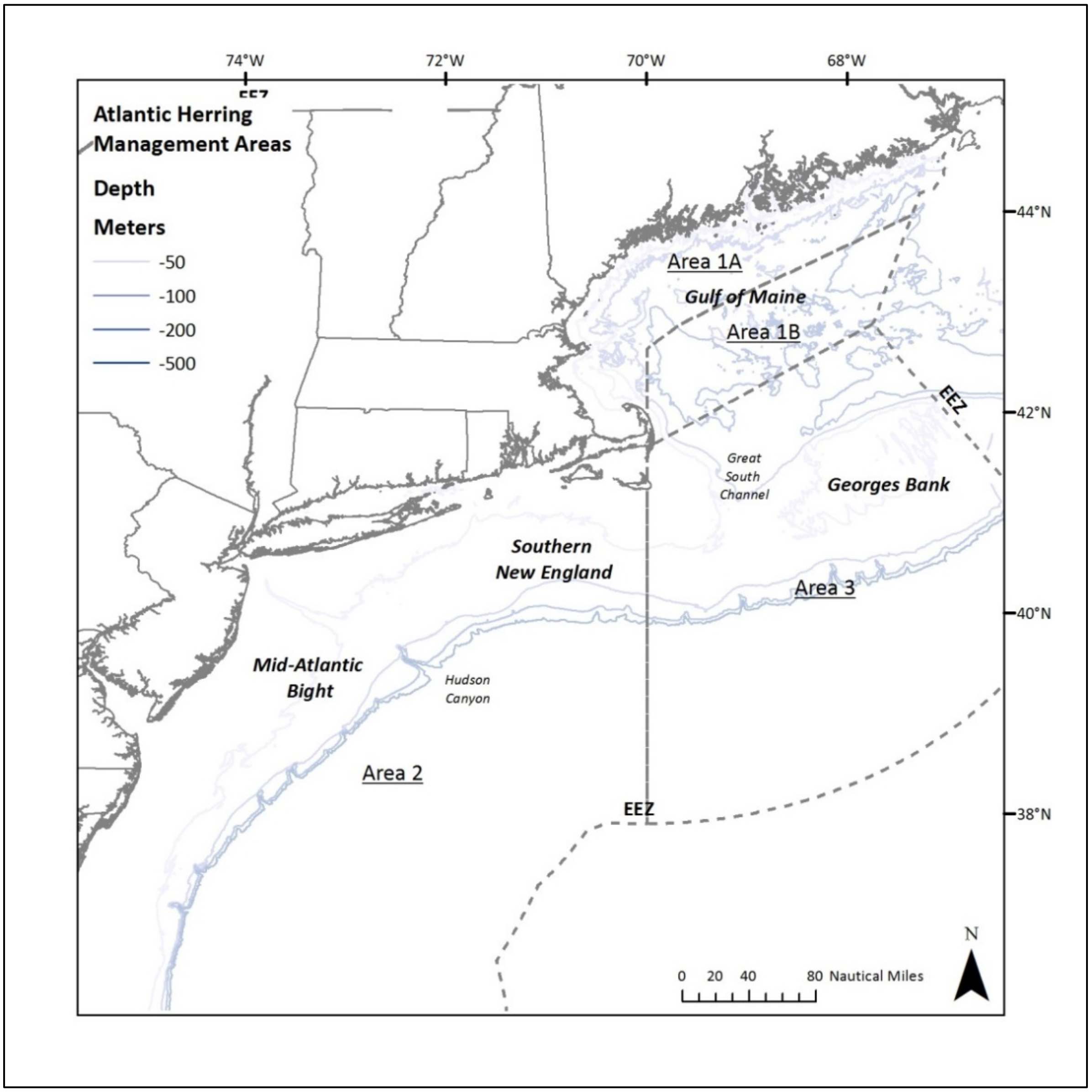
RFFA	Reasonably Foreseeable Future Action
RH/S	River Herring/Shad
RIR	Regulatory Impact Review
RSA	Research Set-Aside
SARC	Stock Assessment Review Committee
SAW	Stock Assessment Workshop
SNE	Southern New England
SSB	Spawning Stock Biomass
SSC	Scientific and Statistical Committee
SFA	Sustainable Fisheries Act
SNE/MA	Southern New England/Mid-Atlantic
TC	Technical Committee
TRT	Take Reduction Team
VMS	Vessel Monitoring System
VTR	Vessel Trip Report

1.0 INTRODUCTION

1.1 EXISTING MANAGEMENT SYSTEM

More details and background information is at http://www.nefmc.org. The Atlantic herring (*Clupea harengus*) fishery specifications are currently set every three years. Due to the spatial structure of the Atlantic herring stock complex (multiple stock components that separate to spawn and mix during other times of the year), the total annual catch limit for Atlantic herring (stock-wide ACL/OY) is divided and assigned as sub-ACLs to four management areas (Figure 1). The best available information is used about the proportion of each spawning component of the Atlantic herring stock complex in each area/season and minimizing the risk of overfishing an individual spawning component to the extent practicable.

Figure 1 - Atlantic herring management areas (current boundaries in place since Amendment 1, 2007)



1.2 ACCEPTABLE BIOLOGICAL CATCH CONTROL RULE

An acceptable biological catch (ABC) control rule is a formulaic approach for setting annual ABCs. For Atlantic herring and other stocks for which there is a defined overfishing limit (OFL), the ABC is based on the OFL reduced by scientific uncertainty such that that the OFL will not be exceeded. The ABC control rule, which the Council may choose based on the Councils risk tolerance for not exceeding the OFL and which may use the level of stock abundance to determine an ABC, provides guidance to the Science and Statistical Committee (SSC) for recommending annual ABCs based on current scientific information about stock status.

The ABC control rule used in the Atlantic Herring FMP has been modified over time and Appendix II summarizes the details of different rules used including the current interim rule, as well as ABC control rules used for other species in New England and other forage species for comparison. Appendix II also includes more detail on lawsuits related to the Atlantic herring specifications.

1.3 LOCALIZED DEPLETION

Localized depletion has been discussed at Council herring meetings for over 15 years dating back to Amendment 1 to the Atlantic Herring FMP, which excluded midwater trawl (MWT) gears from management Area 1A from June-September starting in 2007. Since that time there has been limited research on whether and to what extent the Atlantic herring fishery causes localized depletion. Appendix VIII summarizes the literature available on this topic and examples where localized depletion has been addressed in fisheries management, including other potentially relevant examples of how user conflicts have been addressed and precautionary measures taken to ensure prey availability. The Council has recommended that localized depletion be included in the research priorities for 2019-2021 to potentially help ensure more research is conducted on this subject.

During the original scoping period for Amendment 8 (February 26-April 30, 2015), many commenters were concerned about localized depletion of Atlantic herring and therefore, the Council expanded the focus of Amendment 8 and a supplemental scoping period was scheduled in August 21-September 30, 2015 to explicitly solicit comment on that topic. Appendix I includes a summary of the scoping comments that were received, including both oral and written comments.

After scoping ended the Council developed goals and objectives for Amendment 8 including measures to address localized depletion - a working definition of localized depletion and problem statement about the need for these measures (Section 1.4). As the Council developed the problem statement, it became more clear that the concerns voiced by many stakeholders were not just about the biological impacts of removing herring in discrete areas on predators, but also the potentially negative economic impacts on businesses that rely on those predators. These user conflicts, or competing interests in terms of utilizing herring for the directed fishery versus maintaining herring in the ecosystem for predators, are also part of the more socioeconomic objectives for this action.

Information about herring consumption by predators, fishing effort maps and trends, potential correlations between catches of herring and predator fisheries, as well as fishery overlap analysis is in Appendix VI and VII. No direct evidence of localized depletion was found from concentrated herring fishing activity events and subsequent predator fishery events; however, there are data limitations and caveats with the analysis.

1.4 PURPOSE AND NEED FOR ACTION

A purpose of Amendment 8 is to propose a long-term ABC control rule for the Atlantic herring fishery that may explicitly account for herring's role in the ecosystem and to address the biological and ecological requirements of the Atlantic herring resource. A long-term control rule is needed to provide guidance to the SSC regarding how to specify an annual ABC to account for scientific uncertainty, stock status, and the Council's risk tolerance to maintain a sustainable Atlantic herring stock that includes consideration of herring as a forage species. This action was also needed to address concerns raised by the SSC during the development of the 2013-2015 Atlantic herring specifications related to the special ecosystem status of herring as important forage (Appendix II has more background).

Additionally, a purpose of Amendment 8 is to propose measures to address potential localized depletion of Atlantic herring. The corresponding need is to minimize possible detrimental biological impacts or socioeconomic impacts on other user groups (commercial, recreational, ecotourism) who depend upon adequate local availability of Atlantic herring to support business and recreational interests both at sea and on shore.

To better demonstrate the link between the purpose and need for this action, the following table summarizes the need for the action and corresponding purposes.

Table 1 – Summary of the purpose and need for Amendment 8

<table>
<tr><th>Need</th><th>Purpose</th></tr>
<tr><td>To provide guidance to the SSC regarding how to specify an annual ABC to account for scientific uncertainty, stock status, and the Council's risk tolerance to maintain a sustainable Atlantic herring stock that includes consideration of herring as a forage species.</td><td rowspan="2">Propose a long-term ABC control rule for the Atlantic herring fishery that may explicitly account for herring's role in the ecosystem and to address the biological and ecological requirements of the Atlantic herring resource.</td></tr>
<tr><td>To address concerns raised by the SSC during the development of the 2013-2015 Atlantic herring specifications, when the SSC was asked by the Council to examine some alternative control rules that recognize the special ecosystem status of herring as important forage.</td></tr>
<tr><td>To minimize possible detrimental biological impacts or socioeconomic impacts on other user groups (commercial, recreational, ecotourism) who depend upon adequate local availability of Atlantic herring to support business and recreational interests both at sea and on shore.</td><td>Propose measures to address potential localized depletion of Atlantic herring.</td></tr>
</table>

1.5 GOALS AND OBJECTIVES

1.5.1 Goals and Objectives of the Atlantic Herring FMP

The goals and objectives of the Atlantic Herring FMP remain as identified through Amendment 1 (NEFMC 2006) and will continue to frame the long-term management of the resource and fishery.

Goal

- Manage the Atlantic herring fishery at long-term sustainable levels consistent with the National Standards of the Magnuson-Stevens Fishery Conservation and Management Act.

Objectives

- Harvest the Atlantic herring resource consistent with the definition of overfishing contained in the Herring FMP and prevent overfishing.
- Prevent the overfishing of discrete spawning components of Atlantic herring.
- Avoid patterns of fishing mortality by age which adversely affect the age structure of the stock.
- Provide for long-term, efficient, and full utilization of the optimum yield from the herring fishery while minimizing waste from discards in the fishery. Optimum yield is the amount of fish that will provide the greatest overall benefit to the Nation, particularly with respect to food production and recreational opportunities, taking into account the protection of marine ecosystems, including maintenance of a biomass that supports the ocean ecosystem, predator consumption of herring, and biologically sustainable human harvest. This includes recognition of the importance of Atlantic herring as one of many forage species of fish, marine mammals, and birds in the Northeast Region.
- Minimize, to the extent practicable, the race to fish for Atlantic herring in all management areas.
- Provide, to the extent practicable, controlled opportunities for fishermen and vessels in other Mid-Atlantic and New England fisheries.
- Promote and support research, including cooperative research, to improve the collection of information in order to better understand herring population dynamics, biology and ecology, and to improve assessment procedures.
- Promote compatible U.S. and Canadian management of the shared stocks of herring.
- Continue to implement management measures in close coordination with other Federal and State FMPs and the Atlantic States Marine Fisheries Commission (ASMFC) management plan for Atlantic herring, and promote real-time management of the fishery.

1.5.2 Goals and Objective of Amendment 8 to the Atlantic Herring FMP

The Council has identified three goals and one objective for this action.

Goals

1. To account for the role of Atlantic herring within the ecosystem, including its role as forage.
2. To stabilize the fishery at a level designed to achieve optimum yield.
3. To address localized depletion in inshore waters.

Objective

1. Develop and implement an ABC control rule that manages Atlantic herring within an ecosystem context and addresses the goals of Amendment 8.

1.5.3 Problem statement related to localized depletion for Amendment 8

The Council approved a problem statement in April 2016 to help frame the development of alternatives in Amendment 8. This problem statement was incorporated into the purpose and need of this action.

> *"Scoping comments for Amendment 8 identified concerns with concentrated, intense commercial fishing of Atlantic herring in specific areas and at certain times that may cause detrimental socioeconomic impacts on other user groups (commercial, recreational, ecotourism) who depend upon adequate local availability of Atlantic herring to support business and recreational interests both at sea and on shore. The Council intends to further explore these concerns through examination of the best available science on localized depletion, the spatial nature of the fisheries, reported conflicts amongst users of the resources and the concerns of the herring fishery and other stakeholders."*

1.6 PUBLIC SCOPING

1.6.1 Notice of Intent and Scoping Process

At the request of the Council, NMFS published a Notice of Intent (NOI) on February 26, 2015 (80 FR 10458), to announce its intent to develop Amendment 8 and prepare an Environmental Impact Statement (EIS) to analyze the impacts of the management alternatives under consideration. The announcement stated that Council proposed Amendment 8 to further consider long-term harvest strategies for herring, including an allowable biological catch (ABC) control rule that addresses the biological needs of the herring resource and explicitly accounts for herring's role in the ecosystem. The public scoping period was February 26 – April 30, 2015. During this time, oral and written comments were received at three in-person hearings and a webinar. Written comments were also submitted directly to the (Council). A number of concerns were raised during scoping about localized depletion of Atlantic herring. In June 2015, upon preliminary review of scoping comments, the Council developed goals for Amendment 8 that expanded the scope of this action to include consideration of the spatial and temporal availability of Atlantic herring. A supplemental scoping period was held August 21 -September 30, 2015. Comments were received in writing and at one in-person hearing.

Localized depletion was defined in the Council's public supplemental scoping document for Amendment 8 as:

> *"In general, localized depletion is when harvesting takes more fish than can be replaced either locally or through fish migrating into the catch area within a given time period."*

The occurrence of localized Atlantic herring depletion suggests that the removal of herring from a given area would either leave its relatively immobile predators (e.g., monkfish) with insufficient prey for some time, or that relatively mobile predators (e.g., cod, tuna) would leave the area in search of alternative prey.

1.6.2 Scoping Comments

Comments were received from a variety of stakeholders, including nonprofit organizations, individual fishermen, fishing corporations, government agencies, and other interested citizens. Through the 290 comments (i.e., 29 oral and 261 written), 468 people gave input (duplicates removed) on Amendment 8, in addition to the 28,000 people (duplicates possible) who signed the three large form letters. All written comments and summaries of hearings are provided at www.nefmc.org as well as Appendix I of this action. Most of the comments supported addressing concerns about localized depletion and developing an approach for managing herring that explicitly accounts for its role in the ecosystem. Many thanked the Council for undertaking Amendment 8. Comments spoke of a need for precaution to ensure sufficient supply of herring as predators and prey in the ecosystem to, in part, benefit all fisheries that depend on herring (e.g., groundfish, tuna, as well as herring). Several commenters included fishery related research on localized depletion of Atlantic herring and the potential impacts on predators. These references, along with other research completed by the Herring PDT are in Appendix VIII.

2.0 ALTERNATIVES UNDER CONSIDERATION

2.1 ATLANTIC HERRING ABC CONTROL RULE

The following section describes the alternatives considered by the Council for setting a long-term ABC control rule. Background information about ABC control rules and the work completed to support the development and analysis of ABC control rules in Amendment 8 is in Appendices II, III, IV, V, and VI).

The Council declined to identify a preferred alternative for this section of Amendment 8. Additional analysis of the ABC control rule alternatives is in Section 5.0 of this document, as well as Appendix II, III, IV, and V.

The specific parameters that define the range of control rule alternatives considered in this action are summarized Table 2 and Figure 2 (p. 39). This action considers a wide range of values for each of these control rule parameters. The primary elements of the control rule alternatives considered are:

1. The value used for the "lower biomass parameter", or the value where a control rule shape crosses the x-axis for the ratio of estimated spawning stock biomass (SSB) to the estimate of the spawning stock biomass that produces maximum sustainable yield (SSB_{MSY}). ABC is set to zero when biomass reaches this value.
2. The value used for the "upper biomass threshold", the inflection point of a control rule shape, which specifies the ratio of SSB/SSB_{MSY} where a control rule begins to reduce fishing mortality, or the maximum fishing mortality rate used for each rule.
3. Whether the rule includes a fishery cutoff, or level of biomass where ABC is set to zero (fishery closure of ABC set to zero).

2.1.1 Alternatives for ABC control rule

2.1.1.1 No Action Control Rule – Policy used in recent specification setting processes (fishing years 2013-2018) (*No Action*)

Under No Action, the current ABC control rule used for the last two specification cycles, or six fishing years (2013-2018), would remain in place. This rule has been called "interim" or "status quo" or "default" and it is a biomass based control rule. The ABC is set at the same level for three years equivalent to the catch that is projected to produce a ≤50% probability of exceeding F_{MSY} in the third year. Note that in practice, the Council has decided to set ABC *equal to* the catch projected to produce a 50% probability of exceeding F_{MSY} in the third year, and not less than 50%, but the current definition does provide that flexibility. To compare to other alternatives in this action, the No Action control rule does not include a fishery cutoff, the lower biomass parameter = 0, so fishing would not be closed unless the biomass was zero.

Rationale: This control rule has been used in the last two specification setting processes (fishing years 2013-2018), and has successfully prevented overfishing and herring abundance has increased under this policy. ABCs have been very stable for the last six years - 111,000 mt in 2016-2018 and 114,000 in 2013-2015.

2.1.1.2 Alternative 1: Control rule that would resemble the interim control rule as approximated by its average performance in recent years (*Strawman A*)

Under Alternative 1 (referred to as Strawman A in the management strategy evaluation), ABC would be set using the following parameters:

- A maximum fishing mortality rate equal to 90% of F_{MSY};
- Upper biomass parameter equal to 0.5 for the ratio of SSB/SSB_{MSY}; and
- No fishery cutoff, i.e., lower biomass parameter = 0, such that ABC=0 only when biomass is zero.
- If the fishery enters a rebuilding plan under this control rule, the linear decline in F between the upper and lower biomass parameters included in this alternative may be insufficient to meet rebuilding requirements. In such cases, deviations from the linear decline in F will be required, and projections will have to be completed to determine the ABC that will achieve rebuilding (equivalent to what is currently done to specify ABC in rebuilding plans). If the linear decline in F between the upper and lower biomass parameters *is* sufficient to meet rebuilding requirements, then the control rule should be adhered to and the F produced by the linear decline should be used to specify ABC.

Rationale: Alternative 1 was developed to identify a control rule that would function like the interim control rule (No Action), but would be applicable in all cases, regardless of whether abundance is increasing or decreasing. Furthermore, it was not feasible to complete the MSE analysis for the current/interim control rule, because it is not a long term policy (3 years at a time) and does not include all parameters needed for MSE models (i.e., maximum fishing mortality rate). Therefore, Alternative 1 (Strawman A) is intended to perform as the No Action ABC control rule has performed on average over the last six years (i.e., 2 specification cycles), but it a distinct alternative in this action and could be selected as an alternative to No Action. While Alternative 1 is very similar to No Action and was designed to be a proxy for the No Action ABC control rule to compare to other alternatives in the MSE process, it has different characteristics that enable it to be used in both increasing and decreasing abundance, and it has control rule parameters that can be analyzed with MSE models (i.e., maximum fishing mortality rate, upper and lower biomass thresholds).

2.1.1.3 Alternative 2: Maximum fishing mortality of 50% F_{MSY} and fishery cutoff when biomass less than 1.1 of SSB/SSB_{MSY} (*Strawman B*)

Under Alternative 2 (referred to as Strawman B in the management strategy evaluation), ABC would be set using the parameters described in the bullets below. Similar to Alternative 3 below, this alternative is based on defining the numeric parameters of the control rule in advance, rather than identifying the desired performance of specific objectives a control rule and using the MSE model to isolate the numeric parameters of control rules that meet those objectives (as is the case with Alternative 4).

- Upper biomass parameter equals 2.0 for ratio of $SSB/SSB_{MSY.}$
- The maximum fishing mortality would be set at 50% of $F_{MSY.}$
- Fishery cutoff, or lower biomass parameter equals 1.1 for ratio of SSB/SSB_{MSY}.
- If the fishery enters a rebuilding plan under this control rule, the linear decline in F between the upper and lower biomass parameters included in this alternative may be

insufficient to meet rebuilding requirements. In such cases, deviations from the linear decline in F will be required, and projections will have to be completed to determine the ABC that will achieve rebuilding (equivalent to what is currently done to specify ABC in rebuilding plans). If the linear decline in F between the upper and lower biomass parameters *is* sufficient to meet rebuilding requirements, then the control rule should be adhered to and the F produced by the linear decline should be used to specify ABC.

Rationale: Alternative 2 was developed based on input from stakeholders at the public workshops held during the MSE who supported expanding the range of alternatives considered in this action. These stakeholders supported including alternatives that prioritize herring predator forage needs and limit catch more than traditional control rules used in this region. Some research from outside the New England region has shown that limiting fishing mortality to 50% of F_{MSY} is expected to help maintain forage fish biomass and prevent negative impacts on dependent predators (Pikitch *et al.* 2012). Furthermore, setting the upper biomass parameter for SSB/SSB_{MSY} relatively high (2.0) would reduce fishing mortality further if biomass falls below a level that is twice the theoretical B_{MSY}. For Alternative 2, the maximum fishing mortality rate that can be applied is 0.5 F_{MSY}, and that is reduced when biomass falls below 2* SSB_{MSY}. In addition, Alternative 2 includes a fishery cutoff (closure at 1.1* SSB_{MSY}) if biomass falls below that level. ABC would be set to zero, and no herring fishing would be allowed until biomass increases above 1.1* SSB_{MSY}.

The targets and limits used in Alternative 2 may account for the uncertain population dynamics of forage fish and their important role in the ecosystem for predators such as marine birds, marine mammals and larger fish. These targets and limits were suggested based on research from outside this region, so their benefit may not apply to herring off the Northeast U.S. For example, the MSE suggests that other alternatives would not increase risk to dogfish survival, or tuna growth, and bird reproduction rates would only be marginally improved. However, maintaining higher herring biomass may provide other benefits to the ecosystem that were not explicitly considered in the MSE. Overall, Alternative 2 was identified to maintain lower rates of fishing mortality to maintain higher levels of forage fish biomass, compared to more conventional approaches that generally allow higher maximum fishing mortality rates and fishery cutoffs at lower biomass levels (i.e., 20%). Alternative 2 includes a fishery cutoff of 1.1, neither No Action nor Alternative 1 include a fishery cutoff. In addition, Alternative 2 has a more conservative upper biomass parameter of 2.0, compared to 0.5 for Alternative 1, reducing fishing mortality at higher biomass levels than the other alternatives under consideration.

Alternatives 2 to 4 perform similarly and relatively well for the predator metrics in the MSE, but such results are uncertain and do not address all ecosystem/forage concerns. Alternatives that leave more herring biomass in the ecosystem would be risk-averse and may better address unquantified ecosystem needs, relative to Alternative 1, but at the expense of other metrics (e.g., yield).

2.1.1.4 Alternative 3: Control rule parameters defined upfront

Alternative 3 is based on defining the numeric parameters of the control rule in advance, rather than identifying the desired performance of specific objectives a control rule and using the MSE model to isolate the numeric parameters of control rules that meet those objectives (as is the case with Alternative 4). The recommended values for this alternative are: 0.3 for the lower biomass parameter, 0.7 for the upper biomass parameter, and setting the maximum fishing mortality at 0.9, or 90% of F_{MSY}.

Under Alternative 3, ABC would be set using the following parameters:

- Upper biomass parameter equals 0.7 for ratio of $SSB/SSB_{MSY.}$
- Maximum fishing mortality is set at 90% of $F_{MSY.}$
- Fishery cutoff, or lower biomass parameter equals 0.3 for ratio of SSB/SSB_{MSY}.
- If the fishery enters a rebuilding plan under this control rule, the linear decline in F between the upper and lower biomass parameters included in this alternative may be insufficient to meet rebuilding requirements. In such cases, deviations from the linear decline in F will be required, and projections will have to be completed to determine the ABC that will achieve rebuilding (equivalent to what is currently done to specify ABC in rebuilding plans). If the linear decline in F between the upper and lower biomass parameters *is* sufficient to meet rebuilding requirements, then the control rule should be adhered to and the F produced by the linear decline should be used to specify ABC.

Rationale: Alternative 3 was developed to include an alternative with fishing mortality limits similar to how the current, interim control rule performs on average in recent years (90% of F_{MSY}), but would include explicit control rule parameters to better account for the important role herring has in the ecosystem as a prey species. Including an upper biomass parameter of 0.7 would reduce fishing mortality to less than 90% of F_{MSY} when biomass falls below 70% of $SSB_{MSY.}$ This parameter, in addition to the fishery cutoff when biomass falls below 30% of SSB_{MSY}, would reduce fishing pressure when biomass levels decline below certain thresholds. Alternative 3 includes a fishery cutoff of 0.3; neither No Action nor Alternative 1 include a fishery cutoff. In addition, this alternative has a more conservative upper biomass parameter (0.7) than Alternative 1 (0.5). Overall, these parameters are considered more conservative than Alternative 1 (Strawman A), i.e. max fishing mortality is lower, it includes a fishery cutoff, and the upper biomass parameter is higher, so fishing mortality begins to decline at higher biomass levels than Alternative 1 (Strawman A).

Alternatives 2 to 4 perform similarly and relatively well for the predator metrics in the MSE, but such results are uncertain and do not address all ecosystem/forage concerns. Alternatives that leave more herring biomass in the ecosystem would be risk-averse and may better address unquantified ecosystem needs, relative to Alternative 1, but at the expense of other metrics (e.g., yield).

2.1.1.5 Alternatives 4a – 4f: Control rule alternatives based on desired performance of specific metrics identified in the Management Strategy Evaluation process

Alternative 4 includes six control rule alternatives based on the desired performance of four primary metrics identified by the Council, selected from a longer list of metrics identified by stakeholders who participated in the MSE process. The different parameters and graphic depictions for these alternatives are in Table 2 and Figure 2 (p. 39). Over 15 different metrics were identified at a public workshop and accepted by the Council as important fishery objectives that could be evaluated in the MSE. The range of metrics was diverse including: biomass relative to B_{MSY}, biomass relative to unfished biomass, frequency overfished, tuna condition, annual variation in yield, net revenue, frequency of fishery closure, tern productivity, etc.

The Council reviewed the metrics identified by stakeholders and used in the MSE and identified a subset of primary metrics that would be used to identify a range of performance based control rules. The subset of metrics and desired performance includes:

1. Setting the proportion of MSY at 100%, with an acceptable level as low as 85%;
2. Setting the variation in annual yield <10%, with an acceptable level as high as 25%;
3. Setting the probability of overfished 0%, with an acceptable level as high as 25%;
4. Setting the probability of herring fishery closure (ABC=0) between 0-10%.

These primary metrics, with desired performance values, produce over 70 different control rule variations. The Council then reduce the range to six alternatives by:

1. Removing shapes that have an upper biomass parameter <0.5, as these may not respond to declining stock sizes before separate rebuilding requirements would be required. Control rules that have an upper biomass parameter $\geq$ 50% SSB_{MSY} should reduce the likelihood of a stock becoming overfished and needing a rebuilding plan. These control rules are therefore more likely to achieve rebuilding requirements and are more consistent with the goal to avoid an overfished status.
2. Setting probability of overfished equal to zero; because having a low probability of overfished was a common objective for most if not all stakeholders; and
3. Setting proportion of MSY to be 88% of greater, rather than 85%, to be even more consistent with the Committee's desired performance of a control rule that provides an ABC of 100% of MSY.

If the fishery enters a rebuilding plan under any of these six control rule alternatives, the linear decline in F between the upper and lower biomass parameters may be insufficient to meet rebuilding requirements. In such cases, deviations from the linear decline in F will be required, and projections will have to be completed to determine the ABC that will achieve rebuilding (equivalent to what is currently done to specify ABC in rebuilding plans). If the linear decline in F between the upper and lower biomass parameters *is* sufficient to meet rebuilding requirements, then the control rule should be adhered to and the F produced by the linear decline should be used to specify ABC.

Rationale: Rather than identify the values for control rule parameters upfront, Alternative 4 options identify the desired performance of a handful of metrics, and the MSE model then isolated the control rule shapes to meet those standards. The MSE model results were used more directly to inform the types of control rule alternatives to consider. At the first stakeholder workshop, over a dozen potential metrics were identified based on participant input. The Council reviewed that list and narrowed the number of primary metrics to four: 1) % MSY; 2) variation in yield; 3) probability of overfished; and 4) probability of herring closure (ABC = 0). The Council also identified the desired values for each metrics in terms of performance (i.e., variation in annual yield set at a preferred level <10%, and acceptable level as high as 25%).

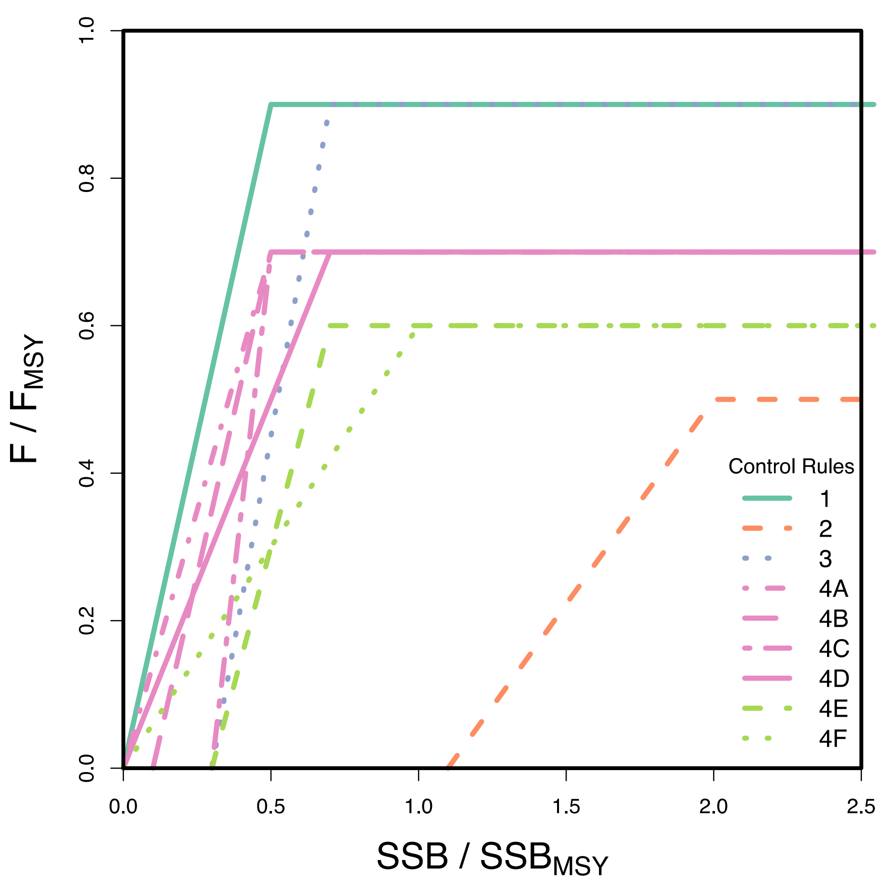
These six alternatives all maintain higher herring biomass, but provide less yield, relative to No Action and Alternative 1/Strawman A, with lower maximum fishing mortality rates, either 60% or 70% of F_{MSY}, compared to 90% used in Alternative 1. Half of these alternatives include a fishery cutoff at 0.3 or 0.1, and half do not have a fishery cutoff. Finally, half of these shapes use the same upper biomass parameter of 0.5 as Alternative 1 for the point where fishing mortality begins to decline, and the other half use a more conservative value of 0.7 or 1.0.

Alternatives 2 to 4 perform similarly and relatively well for the predator metrics in the MSE, but such results are uncertain and do not address all ecosystem/forage concerns. Alternatives that leave more herring biomass in the ecosystem would be risk-averse and may better address unquantified ecosystem needs, relative to Alternative 1, but at the expense of other metrics (e.g., yield).

Table 2 – Summary of control rule parameters for the potential range of alternatives

	Upper Biomass Parameters	Lower Biomass Parameters	Max F
Alt1. No Action	N/A	N/A	N/A
Alt 1a. Strawman A	0.5	0.0	0.9
Alt 2. Strawman B	2.0	1.1	0.5
Alt 3. Parameters upfront	0.7	0.3	0.9
Alt 4a. MeetCriteria1	0.5	0.0	0.7
Alt 4b. MeetCriteria2	0.5	0.1	0.7
Alt 4c. MeetCriteria3	0.5	0.3	0.7
Alt 4d. MeetCriteria4	0.7	0.0	0.7
Alt 4e. MeetCriteria5	0.7	0.3	0.6
Alt 4f. MeetCriteria6	1.0	0.0	0.6

Figure 2 – Range of ABC control rule alternatives considered in Amendment 8



Alt.1 Strawman A

(Aqua)

Alt.3 Parameters defined upfront

(Blue dotted)

Alt. 4 Range of performance based alternatives (6 Total)

(Pink and Green)

Alt. 2 Strawman B

(Orange dashed)

Lower biomass parameter *– Point where rule intersects x-axis (ratio of SSB/SSBmsy where ABC set to zero).*

Upper biomass parameter *– Specifies the ratio of SSB/SSBmsy where fishing mortality begins to decline (inflection point from maximum fishing mortality rate).*

2.1.2 Alternatives for setting three-year ABCs

2.1.2.1 Alternative 1 – Set ABC for three years at the same level for each year (*No Action*)

If Alternative 1 in this section is selected, the ABC control rule adopted in Section 2.1.1 would be used to set ABC at the same level for three years (consistent value in mt for three years at a time). Specifications would be set for three years at a time using the most recent herring stock assessment information available. In terms of timing, this is similar to how herring specifications are set now, every three years (e.g., ABC for FY2019-2021 would be set for three years at a time, and the ABC would be set at the same value (in mt)).

If the No Action control rule alternative is selected from Section 2.1.1, then the ABC for the three years would be equal to the ABC that produces a ≤50% probability of exceeding F_{MSY} in year three of the specifications cycle (see above). Again, however, this would only be applicable to cases where abundance is declining through time.

For all other alternatives, Alternatives 1-4, ABC for year one of the specifications cycle would be specified by applying the chosen control rule via projections from the terminal year of the stock assessment (as is currently done for all ABC specifications for all fisheries with age-based assessments). The ABC in years two and three would be set to the same ABC value from year one. If the ABC in any of the years would have a greater than 50% probability of exceeding F_{MSY}, then the ABC in all years would equal that required to achieve a probability of 50% in any one year (i.e., the ABC in all years equals that of the most restrictive year).

The model used in this MSE did not include projections with the same ABC value for three years, but rather applied a control rule to the terminal year estimate from the assessment and used the resultant ABC in the subsequent three years. The effect of using the terminal year versus doing projections for year one are expected to be negligible.

Rationale: This is similar to how ABC is set in this fishery currently, the same value for three years at a time. It provides stability in the fishery with positive economic impacts from a business planning perspective for both herring harvesters and industries that rely on herring as bait. Based on the results of the MSE, setting ABC at the same level for three years, compared to annually, does have some economic cost from lower yields, but they are relatively minimal (Figure 12).

2.1.2.2 Alternative 2 – Set ABC for three years with annual application of control rule

If Alternative 2 is selected, the ABC control rule selected in Section 2.1.1 would be used to set ABC every three years, but ABC would not necessarily be the same value. Each year, the ABC value could change. ABC would be set each year based on the most recent herring assessment and short-term projections. The short-term projections would apply the selected ABC control rule in each projected year. This process is essentially identical to what is done for specification setting in many other fisheries in the region. For example, some groundfish stocks not in rebuilding plans use 75% F_{MSY} in short-term projections to specify annually varying ABCs.

Rationale: The PDT initially recommended this approach replace an alternative (Section 2.3.1.3) that would set ABC annually based on annually updated assessments and specifications, because current human resources and financial resources preclude annual assessment and specification processes. This alternative would have similar performance to an annual process, but ABC values for year 2 and 3 would rely on short-term projections rather than updated assessments. Using projections rather than updated assessments would not be expected to provide significantly different ABCs, because the age of 50% selectivity for the mobile gear fishery is age-4, with full selection at age-5. These cohorts are relatively well estimated by the assessment, as opposed to age-1 (i.e., recruits), for which few data points are available to inform the assessment. Age-1 fish, however, would be a relatively smaller fraction of the catches over the three-year specifications cycle than the age-2 and older cohorts that are better estimated and would contribute relatively more to catches. Inter-annual catch may vary more with this alternative compared to one that sets ABC at the same value for three years, but this would be more responsive to model projections that may suggest ABC vary from year to year.

2.1.3 FMP provisions that may be changed through a framework adjustment

During development of ABC CR alternatives, the Council clarified that future changes to the ABC CR could be made by amendment or framework, and modifications to the ABC CR would be added to the list of frameworkable measures (management measures that may be changed through a framework adjustment). The Council does not think the specifications setting process gives adequate public notice and opportunity for comment to modify the control rule. This section does not have alternatives; it clarifies that future changes to any ABC CR selected in this action could be modified by Amendment or Framework, but not via a specification package.

Examples of potential modifications that could be considered by future amendment or framework are: modifications to ABC CR parameters such as F_{max}, modifications if a quantitative assessment is not available, if the MSE model is producing ABCs that are not justified or consistent with the state of knowledge about the system, or if the stock enters into a rebuilding program under the proposed control rule (if biomass falls below 50% of SSB), then the ABC would deviate from the control rule. The specific examples listed above are explained in more detail below.

First, this amendment evaluates the potential impacts of a wide range of alternatives for each parameter of a control rule (i.e., F_{max}, upper and lower biomass threshold). Therefore, since those potential impacts have been considered, relatively minor changes to the ABC control rule could be modified by future amendment or framework action.

Second, in the event that the assessment gets rejected and the selected ABC control rule cannot be applied as intended, another method would be used to specify the ABC. But if an acceptable assessment emerges in the future, then the selected control rule would once again be applied.

Third, the MSE used multiple operating models to represent a range of uncertainties in herring biology, herring's relationship to some predators, and the management system. These operating models were conditioned on data, meaning the ranges of uncertainties they represent are consistent with the state of knowledge about the system. In the future, changes may occur such that the dynamics of the system are no longer bounded by the uncertainties represented by the operating models, and so the selected control rule may not behave as anticipated based on results of the MSE. The Council may schedule periodic reviews (e.g., every 5-10 years) of the models used in this MSE so that the latest data and modeling can be evaluated to determine whether the operating models still sufficiently represent the dynamics of the system. If the operating models no longer sufficiently represent the system, then the Council should consider whether an interim control rule should be used until such time that the MSE can be updated, and the control rule alternatives re-evaluated. The details of the process would be determined and implemented through another action.

Fourth, if the stock enters into a rebuilding program under the proposed control rule because for some reason it becomes overfished (biomass falls below 50% of SSB_{MSY}), then the ABC probably would deviate from the control rule. For example, the model used for these control rules has included a linear decline of F when biomass falls below 0.5 SSB_{MSY}, but if a rebuilding plan is initiated, $F_{rebuild}$ probably would need to deviate from the control rule F based on updated projections.

If any or all of these issues arise in the future, the Council could consider modifying the ABC control rule by an amendment or framework adjustment.

2.2 POTENTIAL LOCALIZED DEPLETION AND USER CONFLICTS

This section describes the alternatives considered by the Council for measures to address potential localized depletion and user conflicts. During the scoping period for this action many commenters spoke of a need for precaution to ensure sufficient supply of herring as forage in the ecosystem. A supplemental scoping period was scheduled to solicit additional comments specific to concerns about potential localized depletion and the potentially negative biological and social and economic impacts on other users (e.g., groundfish, tuna, and whale watching businesses). Summary background information about localized depletion is found in Section 1.3, and several appendices contain more information used to support the development and analysis of the measures to address potential localized depletion in Appendix VI. VII, and VIII.

The Council declined to identify a preferred alternative for this section of Amendment 8. Additional analyses supporting this section of Amendment 8 is in Section 5.0 of this document, as well as Appendices VI – VIII. Table 3 summarizes the range of alternatives considered in this amendment to address potential localized depletion and user conflicts.

The Council clarified that if any measures are selected in this section they would be additive to the existing measure in place to address potential localized depletion of herring in Area 1A, the seasonal prohibition of midwater trawl gear from June 1 – September 30 (from Amendment 1).

Furthermore, RSA compensation fishing is currently exempt from seasonal closures (January – May for Area 1A and January – April for Area 1B), as well as any closures after a sub-ACL is reached for a herring management area. However, RSA compensation fishing with MWT gear is *not* exempt from the prohibition of MWT gear in Area 1A (from June-September), the No Action alternative in Amendment 8. The Council clarified that if any measures are selected in this section RSA fishing would be exempt from these restrictions, regardless of gear type. Specifically, RSA compensation fishing could take place in the area and season adopted by this alternative. RSA compensation fishing trips are authorized under an exempted fishing permit (EFP). While the exemption from the localized depletion measure(s) is an overarching exemption from the restrictions, it does not mean that EFPs will be without restriction. Terms and conditions of the EFP must be consistent with the Magnuson-Stevens Fishery Conservation and Management Act, applicable law, the Herring FMP, and other FMPs. The Regional Administrator would consider whether additional terms and conditions should be required for the compensations fishing EFPs to ensure these consistencies are met, and additional terms and conditions may restrict compensation fishing.

The Council discussed that any existing or new closures approved to address potential localized depletion and user conflicts could be modified via Amendment or framework action. The list of frameworkable items already includes changes to closed areas, which would include closures or gear prohibition areas implemented to address potential localized depletion and user conflicts.

2.2.1 Alternative 1: No Action

Under Alternative 1 (No Action), vessels fishing for herring with midwater trawl gear would continue to be excluded from fishing in Herring Management Area 1A from June 1 through September 30 (Figure 3). This measure was implemented in Amendment 1 in 2007 to establish a seasonal purse seine/fixed gear-only area to address growing concerns about localized depletion of the inshore Gulf of Maine stock as well as the importance of herring as a forage species.

Rationale: The primary rationale for this measure when it was implemented was that, " there is significant and growing concern about the status of the inshore component of the herring resource and the potential impacts of midwater trawl fishing effort, which can be highly concentrated at times, in the inshore Gulf of Maine." In addition, the Council noted that given the importance of herring as forage and its role in the Gulf of Maine ecosystem, proactive measures should be taken to prevent overfishing in a very important area for both the fishery and predators.

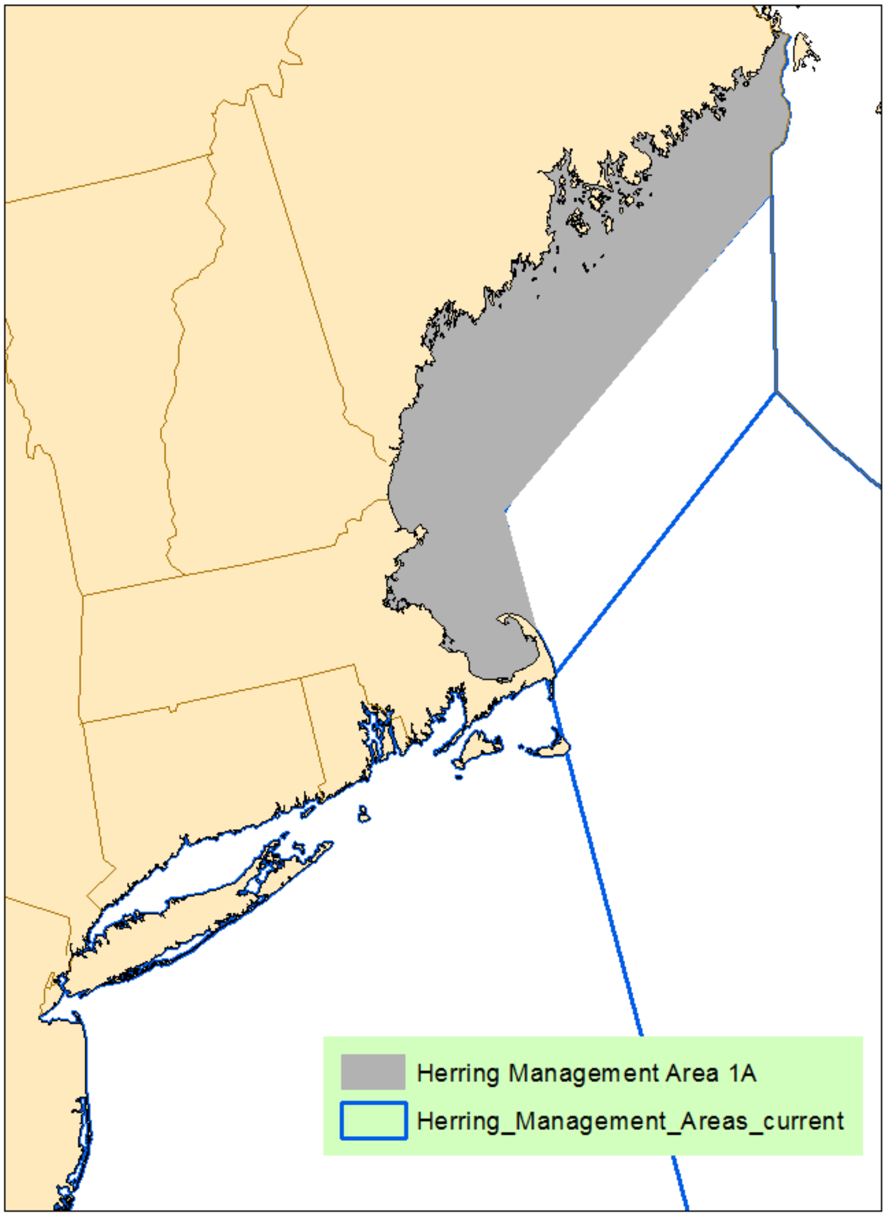
In addition, a prohibition on trawl effort during the summer was also expected to help ensure access to herring for purse seine and fixed gears. During development of Amendment 1, some purse seiners suggested that midwater trawl gear disperses herring schools, making it difficult to purse seine, while fixed gear participants argued that midwater trawl gear keeps herring schools from coming inshore, limiting opportunities for that gear type. While there was no specific data available to link midwater trawling to localized depletion and overall declines in herring abundance, this measure was expected to reduce overall fishing effort on herring since MWT was the primary gear type used to catch herring during the peak months of the season, which also happens to be spawning months for this stock component (late summer). Although there may have been several reasons fixed gear fisheries in the inshore GOM declined over the years, gear conflicts between purse seine and MWTs were cited as one of the primary reasons the Council considered and approved this purse seine/fixed gear only area.

The gear prohibition was also expected to reduce risks to some marine mammal species that are present in the GOM in the summer (primarily harbor porpoise, harbor seals, gray seals, and possibly other seal species) as well as reduce bycatch of groundfish species in the GOM. In addition, the measure was cited as an opportunity to improve scientific information to potentially observe differences in catch rates inside and outside of the area and any short-term/long-term changes in the ecosystem within the area where MWT gear is restricted. Finally, Amendment 1 references substantial public testimony from other stakeholders (i.e., whale watching community, commercial and recreational tuna fishermen, and other recreational users) that midwater trawl gear is too efficient, and is causing negative economic impacts on income for those businesses. This measure was, in part, developed to help mitigate these conflicts.

From Amendment 1:

> *The information presented during the development of this amendment, the testimony received during public hearings, the numerous concerns expressed about the health of the inshore stock and the impact of midwater trawling on the resource and the ecosystem, the importance of herring as a forage species, the need to improve ecological information and move towards ecosystem-based management, and the general need to improve information about fisheries-related impacts* ***<u>all</u>*** *support a precautionary approach to managing a high-volume fishery for this important keystone species. The Council believes that the long-term benefits of this measure to the herring resource and the Gulf of Maine ecosystem far outweigh the short-term costs to the industry, particularly midwater trawl vessels, the vast majority of which are able to fish farther offshore and travel to other fishing grounds in a safe manner.*

Figure 3 – Alternative 1 (No Action) to address localized depletion and user conflicts – Area 1A closed to midwater trawl gear June 1 – Sept 30



2.2.2 Alternative 2: Closure within 6 nautical miles from shore in Area 114 to all vessels fishing for Atlantic herring (all gear types)

Under Alternative 2, waters within 6 nautical miles from shore in the thirty minute square 114 would be closed to all vessels fishing for herring, regardless of gear type or herring permit type (Figure 4). If a vessel has any herring permit (limited access or open access), and is in possession of herring, it is not permitted to fish in this area. This alternative includes a two-year sunset provision from the date of implementation. During the time the closure is in place the Council should continue analysis into defining localized depletion and determining whether it exists in the Atlantic herring fishery. For example, if Amendment 8 is implemented on June 1, 2018 this provision would be effective until May 30, 2020, unless a subsequent action is taken by the Council to extend the closure.

Rationale: The scale of this alternative was limited to only encompass the area that was believed to be the primary area of concern - coastal waters off the east of Cape Cod in Area 114. This alternative would apply to all herring fishing, to address the concern that the removal or depletion of herring is what causes potential negative impacts on other users, not the impacts of a specific gear type. A sunset clause is included in this alternative to potentially alleviate current tensions between users, the measure is temporary in nature to help ensure the Council more thoroughly analyzes and defines localized depletion in the herring fishery. When that research is done to define localized depletion and document that it is occurring, then more permanent closures or restrictions could be considered and adopted.

To some extent, this measure is expected to address the potential localized depletion and user conflicts that were raised during the scoping process. This measure is expected to provide a seasonal closure when interactions would be most expected between the herring fishery and both recreational and commercial small vessel activity. This alternative is specific to waters east of Cape Cod, an area that was identified during scoping. In addition, this alternative helps to maintain optimum yield by minimizing the impacts on both the herring and lobster fisheries compared to other options discussed in this action. Furthermore, it was discussed that this alternative would support fair and equitable allocation of fishery access by minimizing the extent of closed areas.

2.2.2.1 Seasonal options (only one sub-option will apply)

2.2.2.1.1 Sub-option A - June 1 – August 31 (3 months)

Under Sub-option A, the 6 nm closure would be applicable June 1 – August 31.

Rationale: This closed season was identified as the time of year when the highest level of interactions would be expected between the herring fishery and other users in both recreational and commercial activities in this area. Summer months generally have increased levels in both recreational and some commercial fishing operations in nearshore waters. If the primary concern of other user groups is concentrated removals of herring, eliminating herring fishing in the time and place other users fish should have beneficial impacts on the predators of herring in that area, and address reported negative socioeconomic impacts on other users. This sub-options season was limited to three months to still provide some opportunity and flexibility to the herring fishery to fish in that area and minimize economic impacts of seasonal closures.

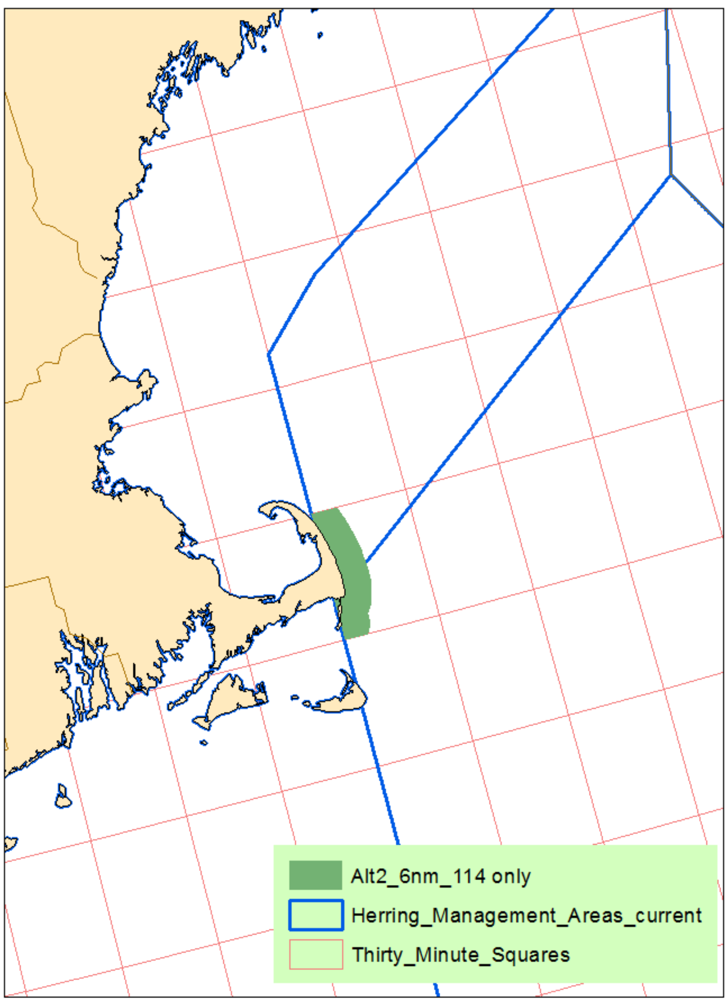
2.2.2.1.2 Sub-option B - June 1 – October 31 (5 months)

Under Sub-option B, the 6 nm closure would be applicable June 1 – October 31.

This sub-option is two months longer than the previous sub-option and was included to further address potential user conflicts in this area by preventing all herring fishing for an extended time period.

Rationale: Extending the seasonal closure into the early fall could have beneficial impacts on the predator commercial and recreational fisheries in that area, in particular groundfish and tuna fisheries east of Cape Cod. If the seasonal closure to herring fishing helps to protect herring in that area, and keeps them from dispersing to other areas, there could be beneficial impacts on predators that forage in this area.

Figure 4 – Alternative 2 to address localized depletion and user conflicts - 6 nm closure in Area 114

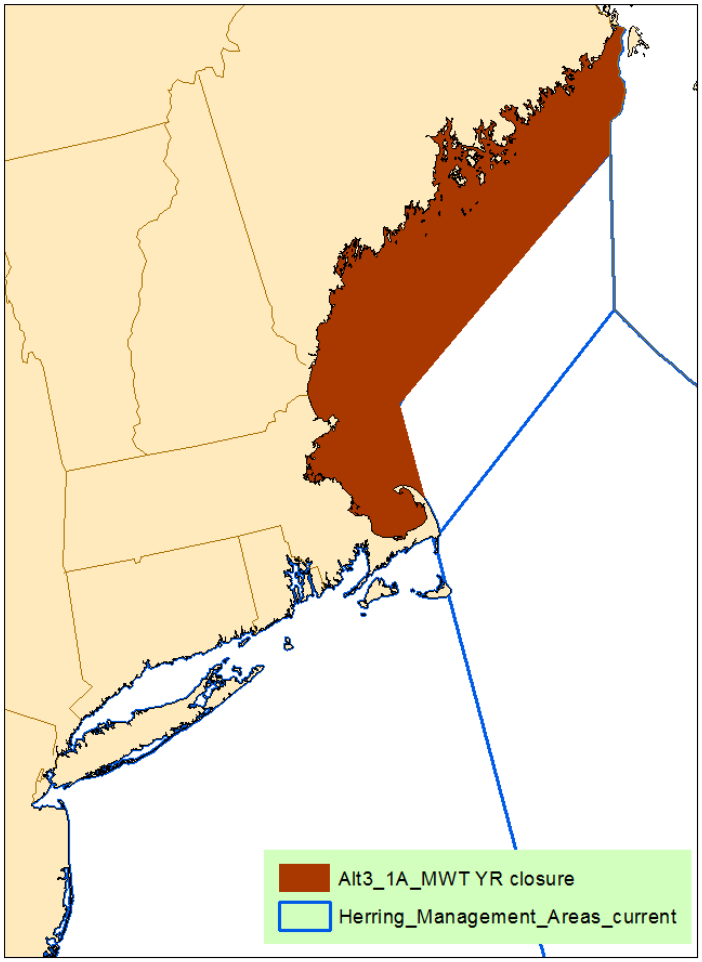


2.2.3 Alternative 3: A year-round prohibition of midwater trawl gear in Herring Management Area 1A

Under Alternative 3, the prohibition of midwater trawl gear in Area 1A from June 1 through September 30 would be extended to be a year-round restriction (Figure 5). Vessels using other gear types would still be permitted to fish for herring, i.e., purse seine or fixed gears. Vessels that currently use midwater trawl gear would be permitted to convert to other gear types allowed in the area.

Rationale: To some extent, this measure addressed the potential localized depletion and user conflicts raised during the scoping process. This alternative expands the current measure in place to address concerns about potential localized depletion by making the midwater trawl gear prohibition in Area 1A year-round. Some stakeholders have argued that there are additional months that could use similar protections from concentrated herring removals that would have beneficial impacts on the GOM ecosystem. For example, if whale migrations south do not start until October or later, limiting herring fishing in the GOM longer into early fall could have beneficial impacts on whales and other marine mammals that consume herring. In addition, commercial tuna fishing takes place in the GOM in months outside of the current MWT prohibition in Area 1A (June – September). Therefore, if reducing herring effort by MWT vessels has positive impacts on tuna (and tuna fishing), expanding the season of the current prohibition on MWT gear in that area could have beneficial impacts on tuna, as well as positive impacts on tuna fisheries.

Figure 5 – Alternative 3 to address localized depletion and user conflicts - closure of Area 1A year-round



2.2.4 Alternative 4: Prohibit midwater trawl gear inside of 12 nautical miles south of Area 1A

Under Alternative 4, waters within 12 nautical miles south of Herring Management Area 1A would be closed to midwater trawl gear (either throughout Herring Management Areas 1B, 2 and 3 or throughout Herring Management Areas 1B and 3 – depending on the Area sub-option selected AND either year round or between June 1 through September 30 – depending on the sub-option selected). If adopted, vessels with any Atlantic herring permit (limited or open access) could not use, deploy, or fish with midwater trawl gear in this area and season. A vessel with midwater trawl gear on board may transit the area, provided such midwater trawl gear is stowed and not available for immediate use. Vessels approved to use other gear types would still be permitted to fish for herring, i.e., purse seine or fixed gears, and small mesh bottom gear (only with approved gears and under specific regulations for small mesh exemption areas). Vessels that currently use midwater trawl gear would be permitted to convert to other gear types if they want to fish for herring in this area. Figure 6 depicts Alternative 4, 5 and 6.

Rationale: To some extent, this measure addresses the potential localized depletion and user conflicts raised during the scoping process. This alternative would focus on relatively nearshore areas, within 12 nautical miles along the coast south of Herring Management Area 1A, because there are measures in place already to address concerns of potential localized depletion and user conflicts for Area 1A. The intent of this alternative is to reduce concentrated removals of herring from MWT fishing gear to provide conservation benefits for inshore ecosystems. Herring plays an important role in the ecosystem as forage, and this alternative is designed to address concerns raised about nearshore localized depletion and user conflicts throughout the range of the herring resource.

2.2.4.1 Area options (only one sub-option will apply)

2.2.4.1.1 Sub-option A – Herring Management Areas 1B, 2 and 3

This sub-option would include all areas south of Herring Management Area 1A. Because there is a seasonal prohibition on midwater trawl gear in Area 1A already, this option was developed to focus on coastal waters that do not already have measures in place to reduce the potential of negative impacts on other users that depend on herring for forage.

Rationale: This option would consider measures similar to the one already in place for Area 1A that prohibits the use of midwater trawl gear in nearshore waters. The intent is to extend that measure throughout the range of the resource, and not just Area 1A.

2.2.4.1.2 Sub-option B - Herring Management areas 1B and 3 only

This sub-option would limit the gear prohibition to Areas 1B and 3; there would not be any gear prohibitions in Herring Management Area 2. Most of the concerns raised during this process have been focused around the backside of the Cape and farther north. Therefore, this sub-option would not include any gear prohibitions for the southernmost Herring Management Area (Area 2).

Rationale: Concerns about localized depletion have primarily been focused on the GOM and the back side of Cape Cod. Therefore, this sub-option was developed to consider an option that would exclude any restrictions on MWT fishing in Area 2 since that has not been identified as an area of concern where concentrated herring fishing has caused negative impacts from localized depletion. Area 2 has been identified as an area of concern for river herring bycatch, but that is not a goal or objective for the measures being identified in this action. The potential impacts of all measures on river herring are evaluated in this action in terms of impacts on non-target species or bycatch, but the alternatives were not designed to specifically reduce impact on river herring.

2.2.4.2 Seasonal options (only one sub-option will apply)

2.2.4.2.1 Sub-option A – Year round (12 months)

This sub-option would prohibit the use of midwater trawl gear within 12 nautical miles year-round.

Rationale: Banning the use of midwater trawl gear in coastal waters year-round was an idea raised during the scoping process for Amendment 8. Prohibiting that gear was identified as a way to reduce the potential negative impacts on other users that use herring as forage. A year-round closure would provide the maximum potential benefit to predators that forage on herring in that area by restricting herring removals during all seasons.

2.2.4.2.2 Sub-option B – June 1 – September 30 (4 months)

This sub-option would limit the season of the gear prohibition to June 1 – September 30, instead of being a year-round restriction. Under this sub-option, midwater trawl gear would not be permitted to fish for herring in the proposed area for those four consecutive months. Midwater trawl gear would be permitted to fish for herring in the proposed area during the remaining months (October – May). This sub-option was developed to potentially refine the restriction to the time of year when potential impacts with other user groups may be higher. Specifically, during the summer/early fall when herring fishing in these areas is typically higher, and other users are more active (i.e., predation by marine mammals and other predators as well as associated fishing and whale watching businesses, etc.).

Rationale: This sub-option was included to focus on the months when interactions with other user groups were expected to be highest, summer and early fall. This season is consistent with the current measure in place to address potential concerns of localized depletion in Area 1A. Limiting the seasonal prohibition is expected to minimize economic impacts on herring and lobster fisheries, and reduce unintended consequences of MWT effort shifts that could occur from longer seasonal restrictions.

2.2.5 Alternative 5: Prohibit midwater trawl gear inside of 25 nautical miles in areas south of Herring Management Areas 1A

Under Alternative 5, waters within 25 nautical miles south of Herring Management Area 1A would be closed to midwater trawl gear (either throughout Herring Management Areas 1B, 2 and 3 or throughout Herring Management Areas 1B and 3 – depending on the Area sub-option selected AND either year round or between June 1 through September 30 – depending on the sub-option selected). If adopted, vessels with any Atlantic herring permit (limited or open access) would not be allowed to use, deploy, or fish with midwater trawl gear in this area and season. A vessel with midwater trawl gear on board may transit the area, provided such midwater trawl gear is stowed and not available for immediate use. Vessels approved to use other gear types would still be permitted to fish for herring, i.e., purse seine or fixed gears, and small mesh bottom gear (only with approved gears and under specific regulations for small mesh exemption areas). Vessels that currently use midwater trawl gear would be permitted to convert to other gear types if they want to fish for herring in this area. Figure 6 depicts Alternative 4, 5 and 6.

Rationale: This alternative was included as part of a suite of measures, some suggested by scoping comments. The Council also discussed an alternative at 35 miles based on input from scoping comments, but that suggestion was replaced with two alternatives instead, this alternative at 25 miles, and another alternative that extends to 50 miles. To some extent, this measure is expected to address the potential localized depletion and user conflicts that were raised during the scoping process. This alternative focuses on relatively nearshore areas, but extends farther than the 12 nautical mile alternative, primarily to encompass more area where herring MWT fishing overlaps with other users of herring, both predators foraging on herring, and predator fisheries (i.e., groundfish and tuna).

This alternative does not include Area 1A, because there are measures in place already to address concerns of potential localized depletion and user conflicts for that management area. The intent of this alternative is to reduce concentrated removals of herring from MWT fishing gear to provide conservation benefits for inshore ecosystems. Herring plays an important role in the ecosystem as forage, and this alternative is designed to address concerns raised about nearshore localized depletion and user conflicts throughout the range of the herring resource.

2.2.5.1 Area options (only one sub-option will apply)

2.2.5.1.1 Sub-option A – Herring Management Areas 1B, 2 and 3

This sub-option would include all areas south of Herring Management Area 1A. Because there is a seasonal prohibition on midwater trawl gear in Area 1A already, this option was developed to focus on coastal waters that do not already have measures in place to reduce the potential of negative impacts on other users that depend on herring for forage.

Rationale: This option would consider measures similar to the one already in place for Area 1A that prohibits the use of midwater trawl gear in nearshore waters. The intent is to extend that measure throughout the range of the resource, and not just Area 1A.

2.2.5.1.2 Sub-option B - Herring Management areas 1B and 3 only

This sub-option would limit the gear prohibition to Areas 1B and 3; there would not be any gear prohibitions in Herring Management Area 2. Most of the concerns raised during this process have been focused around the backside of the Cape and farther north. Therefore, this sub-option would not include any gear prohibitions for the southernmost Herring Management Area (Area 2).

Rationale: Concerns about localized depletion have primarily focused on the GOM and east of Cape Cod. Therefore, this sub-option was developed to consider an option that would exclude any restrictions on MWT fishing in Area 2 since that has not been identified as an area of concern where concentrated herring fishing has caused negative impacts from localized depletion. Area 2 has been identified as an area of concern for river herring bycatch, but that is not a goal or objective for the measures being identified in this action. The potential impacts of all measures on river herring are evaluated in this action in terms of impacts on non-target species or bycatch, but the alternatives were not designed to specifically reduce impact on river herring.

2.2.5.2 Seasonal options (only one sub-option will apply)

2.2.5.2.1 Sub-option A – Year round (12 months)

This sub-option would prohibit the use of midwater trawl gear within 25 nautical miles year-round.

Rationale: Banning the use of midwater trawl gear in coastal waters was identified during the scoping process for Amendment 8. Prohibiting that gear was identified as a way to reduce the potential negative impacts on other users that use herring as forage.

2.2.5.2.2 Sub-option B – June 1 – September 30 (4 months)

This sub-option would limit the season of the gear prohibition to June 1 – September 30, instead of being a year-round restriction. If this sub-option is adopted, midwater trawl gear would not be permitted to fish for herring in the proposed area for those four consecutive months. Midwater trawl gear would be permitted to fish for herring in the proposed area during the remaining months (October – May). This sub-option was developed to potentially refine the restriction to the time of year when potential impacts with other user groups may be higher. Specifically, during the summer/early fall when herring fishing in these areas is typically higher, and other users are more active (i.e., predation by marine mammals and other predators as well as associated fishing and whale watching businesses, etc.).

Rationale: This sub-option was included to focus on the months when interactions with other user groups were expected to be highest, summer and early fall. This season is consistent with the current measure in place to address potential concerns of localized depletion in Area 1A. Limiting the seasonal prohibition is expected to minimize economic impacts on herring and lobster fisheries, and reduce unintended consequences of MWT effort shifts that could occur from longer seasonal restrictions.

2.2.6 Alternative 6: Prohibit midwater trawl gear inside of 50 nautical miles in waters south of Herring Management Areas 1A

Under Alternative 6, waters within 50 nautical miles south of Herring Management Area 1A would be closed to midwater trawl gear (either throughout Herring Management Areas 1B, 2 and 3 or throughout Herring Management Areas 1B and 3 – depending on the Area sub-option selected AND either year round or between June 1 through September 30 – depending on the sub-option selected). If adopted, vessels with any Atlantic herring permit (limited or open access) would not be allowed to use, deploy, or fish with midwater trawl gear in this area and season. A vessel with midwater trawl gear on board may transit the area, provided such midwater trawl gear is stowed and not available for immediate use. Vessels approved to use other gear types would still be permitted to fish for herring, i.e., purse seine or fixed gears, and small mesh bottom gear (only with approved gears and under specific regulations for small mesh exemption areas). Vessels that currently use midwater trawl gear would be permitted to convert to other gear types if they want to fish for herring in this area. Figure 6 depicts Alternative 4, 5 and 6.

Rationale: The Council added this alternative as part of a suite of measures, some of which were suggested by scoping comments. The Council also discussed an alternative at 35 miles based on input from scoping comments, but that suggestion was replaced with two alternatives instead, this alternative at 50 miles, and another alternative at 25 miles. To some extent, this measure is expected to address the potential localized depletion and user conflicts that were raised during the scoping process. A 50 mile buffer was recommended for consideration from a variety of stakeholders, and the Council decided to include this alternative to be responsive to that input and to consider a wide range of alternatives.

This alternative does not include Area 1A, because there are measures in place already to address concerns of potential localized depletion and user conflicts for that management area. The intent of this alternative is to reduce concentrated removals of herring from MWT fishing gear to provide conservation benefits for inshore ecosystems. Herring plays an important role in the ecosystem as forage, and this alternative is designed to address concerns raised about nearshore localized depletion and user conflicts throughout the range of the herring resource.

2.2.6.1 Area options (only one sub-option will apply)

2.2.6.1.1 Sub-option A – Herring Management Areas 1B, 2 and 3

This sub-option would include all areas south of Herring Management Area 1A. Because there is a seasonal prohibition on midwater trawl gear in Area 1A already, this option was developed to focus on coastal waters that do not already have measures in place to reduce the potential of negative impacts on other users that depend on herring for forage.

Rationale: This option would consider measures similar to the one already in place for Area 1A that prohibits the use of midwater trawl gear in nearshore waters. The intent is to extend that measure throughout the range of the resource, and not just Area 1A.

2.2.6.1.2 Sub-option B - Herring Management areas 1B and 3 only

This sub-option would limit the gear prohibition to Areas 1B and 3; there would not be any gear prohibitions in Herring Management Area 2. Most of the concerns raised during this process have been focused around the backside of the Cape and farther north. Therefore, this sub-option would not include any gear prohibitions for the southernmost Herring Management Area (Area 2).

Rationale: Concerns about localized depletion have primarily focused on the GOM and east of Cape Cod. Therefore, this sub-option was developed to consider an option that would exclude any restrictions on MWT fishing in Area 2 since that has not been identified as an area of concern where concentrated herring fishing has caused negative impacts from localized depletion. Area 2 has been identified as an area of concern for river herring bycatch, but that is not a goal or objective for the measures being identified in this action. The potential impacts of all measures on river herring are evaluated in this action in terms of impacts on non-target species or bycatch, but the alternatives were not designed to specifically reduce impact on river herring.

2.2.6.2 Seasonal options (only one sub-option will apply)

2.2.6.2.1 Sub-option A – Year round (12 months)

This sub-option would prohibit the use of midwater trawl gear within 50 nautical miles year-round.

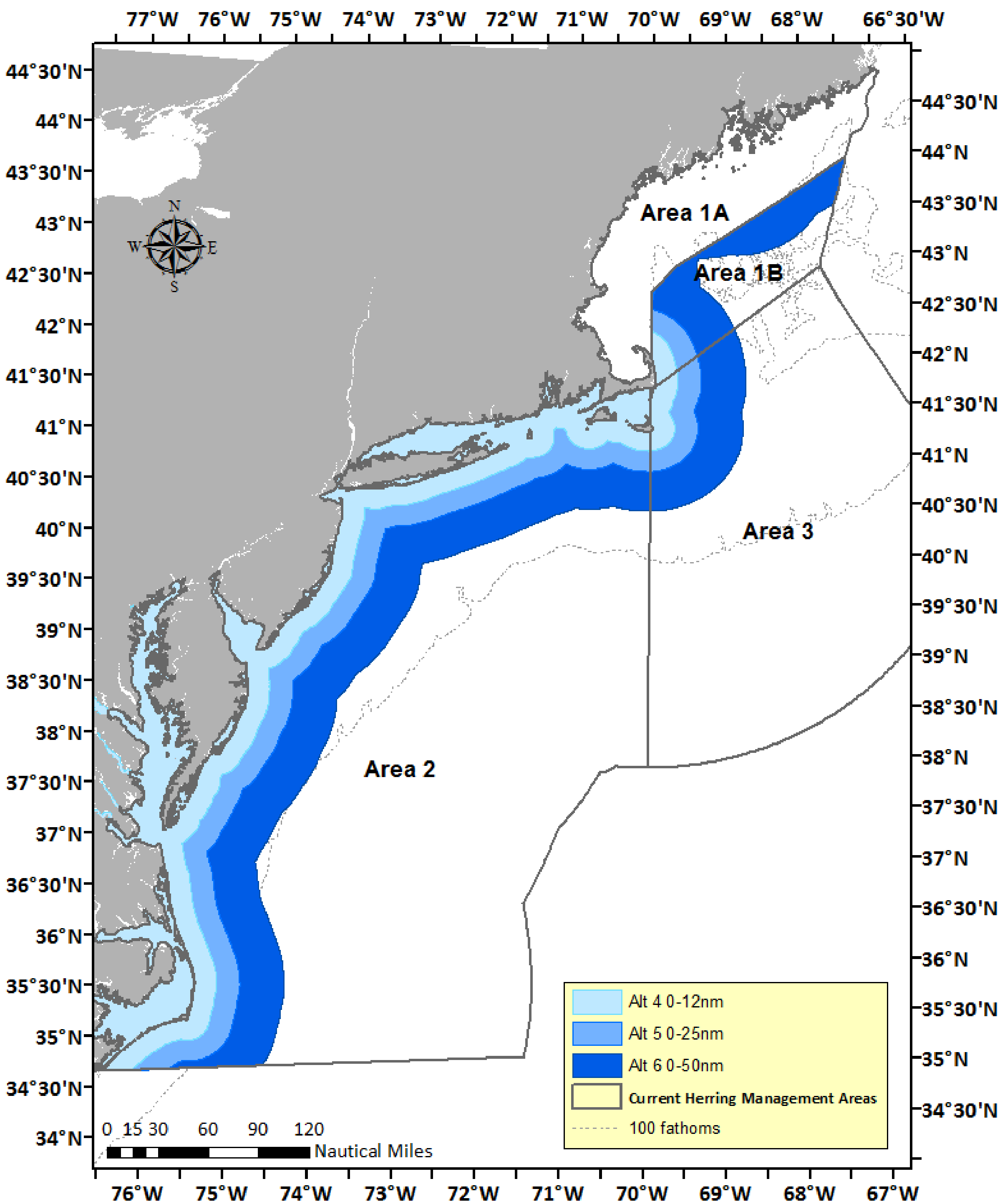
Rationale: Banning the use of midwater trawl gear in coastal waters was identified during the scoping process for Amendment 8. Prohibiting that gear was identified as a way to reduce the potential negative impacts on other users that use herring as forage.

2.2.6.2.2 Sub-option B – June 1 – September 30 (4 months)

This sub-option would limit the season of the gear prohibition to June 1 – September 30, instead of being a year-round restriction. If this sub-option is adopted, midwater trawl gear would not be permitted to fish for herring in the proposed area for those four consecutive months. Midwater trawl gear would be permitted to fish for herring in the proposed area during the remaining months (October – May). This sub-option was developed to potentially refine the restriction to the time of year when potential impacts with other user groups may be higher. Specifically, during the summer/early fall when herring fishing in these areas is typically higher, and other users are more active (i.e., predation by marine mammals and other predators as well as associated fishing and whale watching businesses, etc.).

Rationale: The Council included this sub-option to focus on the months when interactions with other user groups were expected to be highest, summer and early fall. This season is consistent with the current measure in place to address potential concerns of localized depletion in Area 1A. Limiting the seasonal prohibition is expected to minimize economic impacts on herring and lobster fisheries, and reduce unintended consequences of MWT effort shifts that could occur from longer seasonal restrictions.

Figure 6 – Alternatives 4, 5, and 6 (12, 25, and 50 nautical mile prohibition on MWT gear south of Area 1A) to address localized depletion and user conflicts (Effective throughout the extent of Herring Management Areas 1B, 2 and 3, U.S. EEZ waters south of Area 1A to the NC/SC border)



2.2.7 Alternative 7: Prohibit midwater trawl gear within thirty minute squares off Cape Cod (99, 100, 114, 115 and 123)

Under Alternative 7, vessels with midwater trawl gear would be prohibited to fish within several thirty minute squares (Areas 99, 100, 114, 115, and 123) with several area and seasonal options included (Figure 7). If adopted, vessels with any Atlantic herring permit (limited or open access) would not be allowed to use, deploy, or fish with midwater trawl gear in this area and season. A vessel with midwater trawl gear on board may transit the area, provided such midwater trawl gear is stowed and not available for immediate use. Vessels approved to use other gear types would still be permitted to fish for herring, i.e., purse seine or fixed gears, and small mesh bottom gear (only with approved gears and under specific regulations for small mesh exemption areas). Vessels that currently use midwater trawl gear would be permitted to convert to other gear types if they want to fish for herring in this area. Figure 7 depicts Alternative 7.

Rationale: This alternative was included as part of a suite of measures, some suggested by scoping comments. This alternative is focused on waters around Cape Cod, an area that was cited during scoping that has experienced negative impacts from localized depletion and user conflicts. The boundaries of this alternative use thirty minute squares instead of distances from the coast, so the boundaries are more regular in shape. The core area in the center, Area 114, is the square that has the highest amount of herring fishing activity. The eastern most boundary of this alternative is about 20 nautical miles from the coastline. Additional thirty minute squares were added around Area 114 to be precautionary and add additional conservation benefits around the core area of herring fishing off the back side of Cape Cod. The intent of this alternative is to reduce concentrated removals of herring from MWT fishing gear to provide conservation benefits for inshore ecosystems. Herring plays an important role in the ecosystem as forage, and this alternative is designed to address concerns raised about potential nearshore localized depletion and user conflicts throughout the range of the herring resource.

2.2.7.1 Area options (only one sub-option will apply)

2.2.7.1.1 Sub-option A – all five thirty minute squares within Herring Management Areas 1B, 2 and 3

This sub-option would include all five thirty minute squares identified within Herring Management Area 1B, 2 and 3 (Areas 99, 100, 114, 115, and 123) (Figure 7).

Rationale: This option would consider measures similar to the one already in place for Area 1A that prohibits the use of midwater trawl gear in nearshore waters. The intent is to consider a similar measure for waters around Cape Cod, an area that was identified during scoping that experiences negative impacts of localized depletion of herring on other users that depend on herring as forage.

2.2.7.1.2 Sub-option B – subset of thirty minute squares within Herring Management areas 1B and 3 only (Areas 99, 114, and 123 only)

This sub-option would limit the gear prohibition to the thirty minute squares within Areas 1B and 3 only (Areas 99, 114, and 123 only), it would exclude Areas 115 and 100 that are within Area 2. Most of the concerns raised during this process have been focused in waters east of Cape Cod and farther north. Therefore, this sub-option would not include any gear prohibitions for the southernmost Herring Management Area (Area 2; Figure 7).

Rationale: Concerns about localized depletion have primarily focused on the GOM and east of Cape Cod. Therefore, this sub-option was developed to consider an option that would exclude any restrictions on MWT fishing in Area 2 since that has not been identified as an area of concern where concentrated herring fishing has caused negative impacts from localized depletion. Area 2 has been identified as an area of concern for river herring bycatch, but that is not a goal or objective for the measures being identified in this action. The potential impacts of all measures on river herring are evaluated in this action in terms of impacts on non-target species or bycatch, but the alternatives were not designed to specifically reduce impact on river herring.

2.2.7.2 Seasonal options (only one sub-option will apply)

2.2.7.2.1 Sub-option A – Year round (12 months)

This sub-option would prohibit the use of midwater trawl gear in the specified thirty-minute squares year-round.

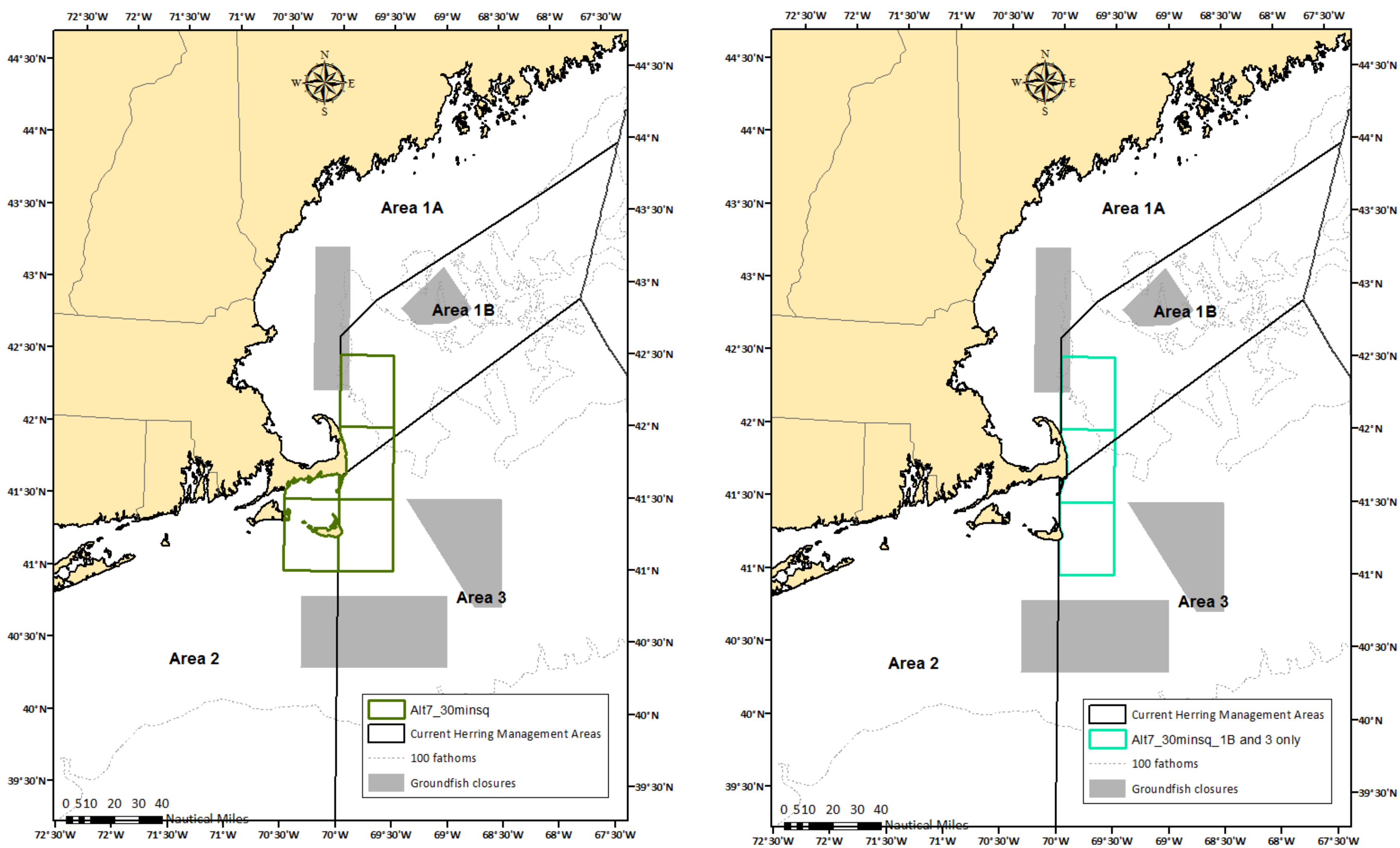
Rationale: Banning the use of midwater trawl gear in coastal waters was identified during the scoping process for Amendment 8. Prohibiting that gear was identified as a way to reduce the potential negative impacts on other users that use herring as forage.

2.2.7.2.2 Sub-option B – June 1 – September 30 (4 months)

This sub-option would limit the season of the gear prohibition to June 1 – September 30, instead of being a year-round restriction. If this sub-option is adopted, midwater trawl gear would not be permitted to fish for herring in the proposed area for those four consecutive months. Midwater trawl gear would be permitted to fish for herring in the proposed area during the remaining months (October – May). This sub-option was developed to potentially refine the restriction to the time of year when potential impacts with other user groups may be higher. Specifically, during the summer/early fall when herring fishing in these areas is typically higher, and other users are more active (i.e., predation by marine mammals and other predators as well as associated fishing and whale watching businesses, etc.).

Rationale: The Council included this sub-option to focus on the months when interactions with other user groups were expected to be highest, summer and early fall. This season is consistent with the current measure in place to address potential concerns of localized depletion in Area 1A. Limiting the seasonal prohibition is expected to minimize economic impacts on herring and lobster fisheries, and reduce unintended consequences of MWT effort shifts that could occur from longer seasonal restrictions.

Figure 7 – Alternative 7 Area sub-option A (LEFT) (midwater trawl gear restriction in thirty minute squares 99, 100, 114, 115, and 123) and Alternative 7 Area Sub-option B (RIGHT) (midwater trawl gear restriction in thirty minute squares 99, 114, and 123 only)

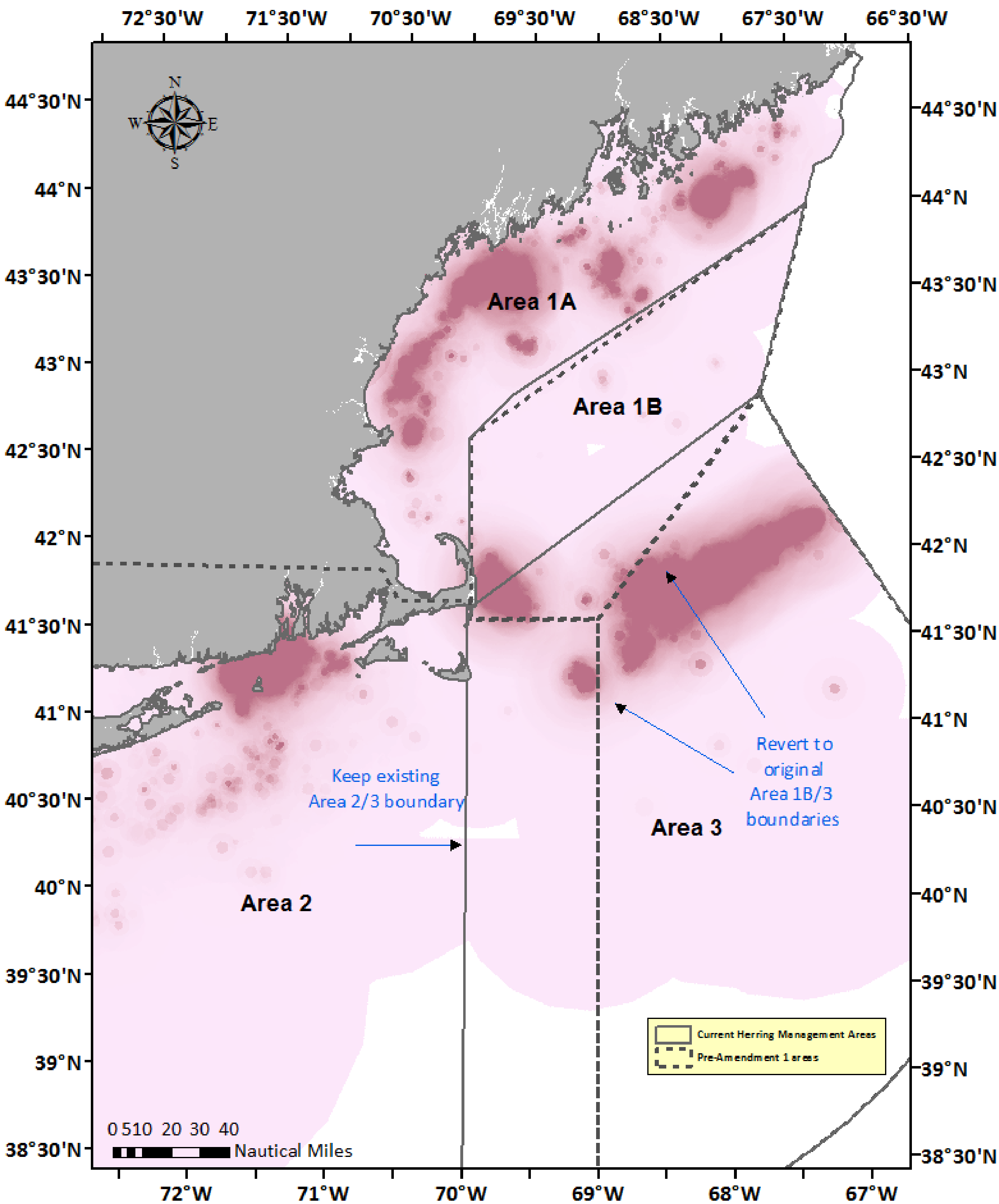


2.2.8 Alternative 8: Revert the boundary between Herring Management Areas 1B and 3 back to original boundary

Under Alternative 8, the Herring Management Area boundaries between Area 1B and 3 would be reverted back to what they were under the original Herring FMP, maintaining the current boundary between Areas 2 and 3. The boundaries were changed in Amendment 1 (effective June 1, 2007) based on recommendations from the 2003 TRAC meeting to better reflect spawning distributions and movement of spawning concentrations. For this action, the boundaries would be changed for a different reason. By moving the boundary between 1B and 3 farther offshore the measure is expected to prevent Area 3 catch from being caught relatively close to shore, east of Cape Cod. The intended result of this measure is to consider an alternative that would still reduce the total herring removals east of Cape Cod, but not using an area closure or gear restriction to do so. If herring removals from the area of concern are managed under the Area 1B TAC only, and not both the Area 1B and Area 3 TAC, total removals may be lower, reducing potential impacts of localized depletion and user conflicts. To be clear, if this alternative is adopted the area specific sub-ACLs will not be recalculated in this action, but a subsequent action may adjust them.

Rationale: The intent of this alternative is to support the goal of Amendment 8 to address localized depletion by modifying the boundaries to maintain adequate forage and afford protection to marine ecosystems. It was argued that since the management boundaries have changed, the fishing communities on Cape Cod, Barnstable County in particular, have faced a disproportionate increase in herring removals from the coastal fishing areas near those communities. Reverting the boundaries back to what they were before Amendment 1 changed them would prevent Area 3 catch from being harvested closer to shore. This alternative does not use area closures to address this concern. Instead, if the boundary reverts back to where it was, Area 3 effort would need to take place farther offshore, potentially addressing concerns about localized depletion and user conflicts in nearshore areas.

Figure 8 – Summary of herring landings from FY2011-2015 compared to current herring management area boundaries (bold) versus original (dashed) management area boundaries



2.2.9 Alternative 9: Remove seasonal closure of Area 1B

Under Alternative 9, the seasonal closure in Area 1B that currently exists from January 1 – April 30 would be removed. Framework 2 to the Herring FMP allowed sub-ACLs to be split seasonally to provide more flexibility by reducing derby fishing and distributing catch throughout the year. That action also included fishery specifications for FY2013-2015, which allocated 0% of the ACL for January 1 – April 30. That seasonal closure was primarily implemented to boost herring landings when the bait market needed it most, right before the summer lobster fishery. Before the seasonal closure was used, herring could be caught from Area 1B starting in January. Another reason cited in the plan is to reduce impacts on river herring bycatch, which is generally higher in the winter months in this area.

Rationale: This action would remove the sub-ACL allocation of 0% for those months, essentially removing the seasonal closure that currently exists from January 1 through April 31 as a measure to reduce potential localized depletion and user conflicts. In recent years Area 1B has opened May 1 and in many cases the TAC is caught relatively quickly in a matter of weeks, concentrating effort in the late spring when other users are in the area. If the 0% ACL restriction for January 1 through April 30 is removed, herring fishing in that area may spread out and shift earlier when potential concerns about localized depletion and user conflicts may be less.

Table 3 – Summary of the alternatives under consideration in Amendment 8 to address potential localized depletion and user conflicts

Alternative	Description	Section #
1	**No Action**	**2.2.1**
2	**Closure within 6nm from shore in Area 114 to ALL vessels fishing for herring**	**2.2.2**
	• Seasonal Sub-option A (Jun1-Aug31)	2.2.2.1.1
	• Seasonal Sub-option B (Jun1-Oct31)	2.2.2.1.2
3	**Prohibit MWT in Area 1A (year round)**	**2.2.3**
4	**Prohibit MWT inside of 12nm south of Area 1A**	**2.2.4**
	• Area Sub-option A (Areas 1B, 2 and 3)	2.2.4.1.1
	• Area Sub-option B (Areas 1B and 3)	2.2.4.1.2
	• Seasonal Sub-option A (year round)	2.2.4.2.1
	• Seasonal Sub-option B (Jun1-Sept30)	2.2.4.2.2
5	**Prohibit MWT inside of 25nm south of Area 1A**	**2.2.5**
	• Area Sub-option A (Areas 1B, 2 and 3)	2.2.5.1.1
	• Area Sub-option B (Areas 1B and 3)	2.2.5.1.2
	• Seasonal Sub-option A (year round)	2.2.5.2.1
	• Seasonal Sub-option B (Jun1-Sept30)	2.2.5.2.2
6	**Prohibit MWT inside of 50nm south of Area 1A**	**2.2.6**
	• Area Sub-option A (Areas 1B, 2 and 3)	2.2.6.1.1
	• Area Sub-option B (Areas 1B and 3)	2.2.6.1.2
	• Seasonal Sub-option A (year round)	2.2.6.2.1
	• Seasonal Sub-option B (Jun1-Sept30)	2.2.6.2.2
7	**Prohibit MWT within 30minute squares off Cape Cod (99, 100, 114, 115, and 123)**	**2.2.7**
	• Area Sub-option A (All squares in Areas 1B, 2, and 3)	2.2.6.1.1
	• Area Sub-option B (All squares in Areas 1B and 3)	2.2.6.1.2
	• Seasonal Sub-option A (year round)	2.2.6.2.1
	• Seasonal Sub-option B (Jun1-Sept30)	2.2.6.2.2
8	**Revert boundary between Areas 1B and 3 to original boundary**	**2.2.8**
9	**Remove seasonal closure of Area 1B**	**2.2.9**

2.3 CONSIDERED BUT REJECTED AALTERNATIVES

During development of this action, the Council considered a handful of alternatives that were rejected for a variety of reasons. This section briefly describes the considered but rejected alternatives, including the primary rationale for not including them in the final range of alternatives for full consideration in this document.

2.3.1 Atlantic Herring ABC control rule

2.3.1.1 Constant catch control rule

A 'constant catch' control rule harvests the same amount of fish regardless of abundance. Consequently, as abundance declines, the fishing mortality rate (i.e., catch divided by abundance) increases, because the fishery is removing a larger proportion of the stock. This control rule type was identified as the first stakeholder workshop as a potential alternative to explore. Analysts included a constant catch control rule in the initial analyses completed during the MSE. A variant of constant catch, conditional constant catch, was also included in which a maximum fishing mortality rate of 50%Fmsy was imposed to prevent relative high fishing mortality at low abundance, as would occur under strict constant catch. Those results were presented at the second stakeholder workshop and the overwhelming majority of input from participants in attendance was to remove further consideration of constant catch alternatives.

Rationale for Rejection: While a constant catch strategy can provide stability in allowable catch, overall the performance of this control rule compared to others examined was inferior. For example, for a constant catch strategy to provide stable catches for the longer term, it must sacrifice yield, or have an ABC with a lower ratio of yield to MSY. Figure 9 shows that the two constant catch alternatives examined, 'CC' and 'CCC', had relatively low variation in yield, less than 20% for all of the runs, but that came at a cost of achieving higher yields, the ratio of yield to MSY was never greater than 80%. When stakeholders were presented with these tradeoffs, the potential benefits of stable catches did not seem to outweigh the costs of lower yields.

Similarly, the performance of predator metrics were generally inferior for constant catch strategies compared to others evaluated. There were some constant catch strategies that performed well for predators, but only with a relatively large reduction in yield.

Figure 10 shows the frequency with which tuna weight was greater than average for the operating model that assumes high natural mortality and fast growth of herring. When herring are assumed to have high recruitment and growth, the median tuna weight is above average (>1.0) for all of runs for most of the control rules examined. However, for the constant catch control rule, there are some runs that have poor tuna weights (<1.0). The same is true for the tern model results. Figure 11 shows that the frequency with which term production was ≥ 1.0 (i.e., terms able to maintain replacement) was generally about 85% or higher for all of the biomass based control rule runs, but the constant catch alternative had some runs that produced lower tern production and lower herring biomass.

In summary, the constant catch control rule alternative had poor performance for several of the metrics considered compared to other control rule alternatives.

Figure 9 – MSE tradeoff plot for median yield relative to MSY versus interannual variation in yield

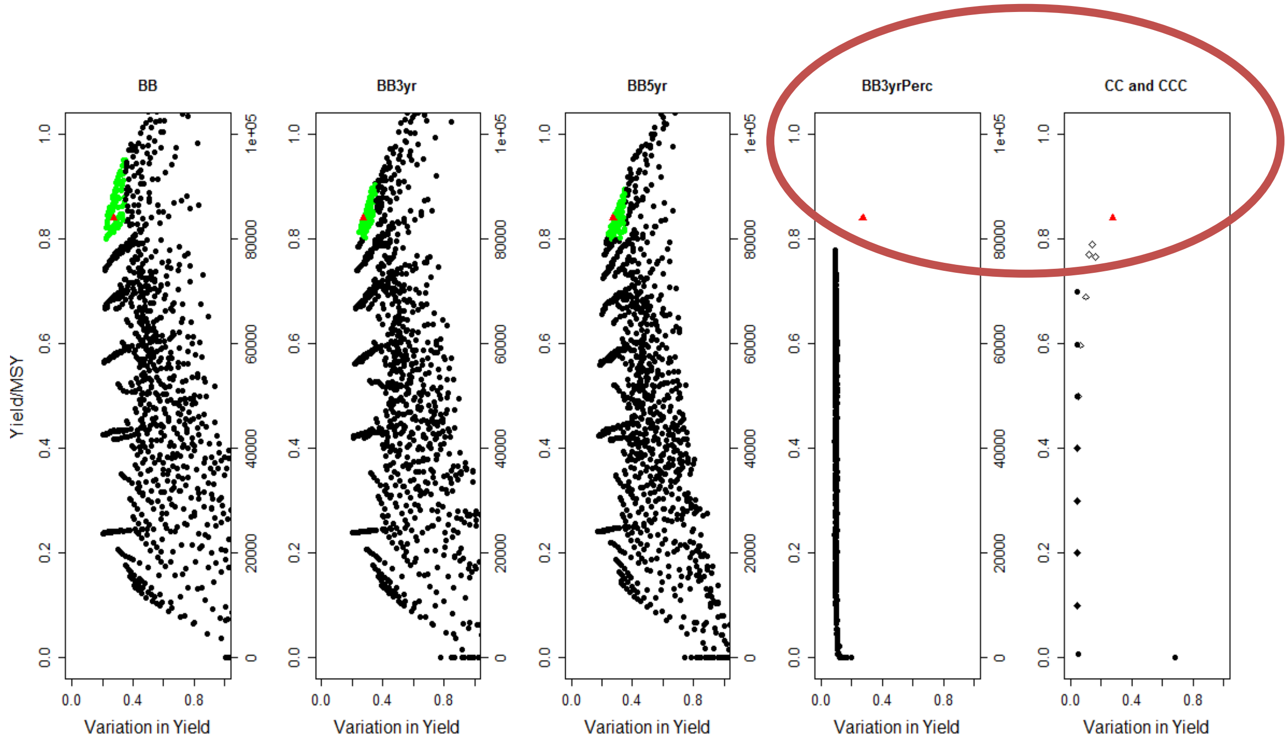


Figure 10 – MSE tradeoff plot for median frequency with which tuna weight was greater than average (Prob Wt>Avg) versus SSB relative to unfished SSB

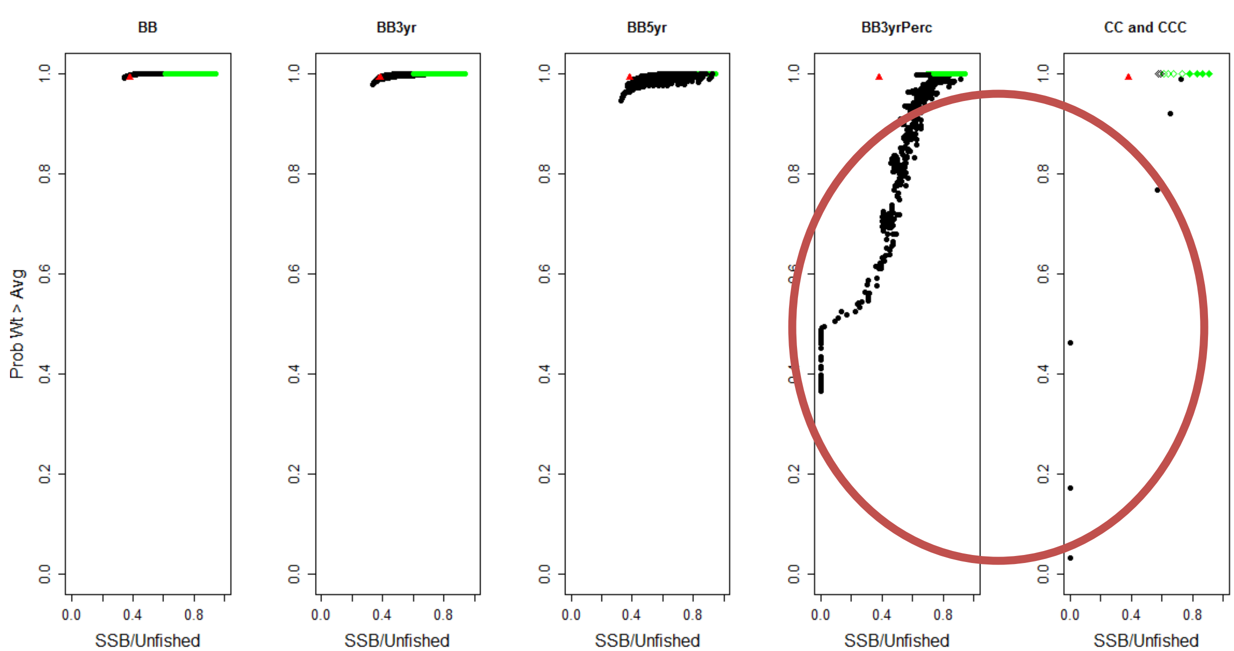
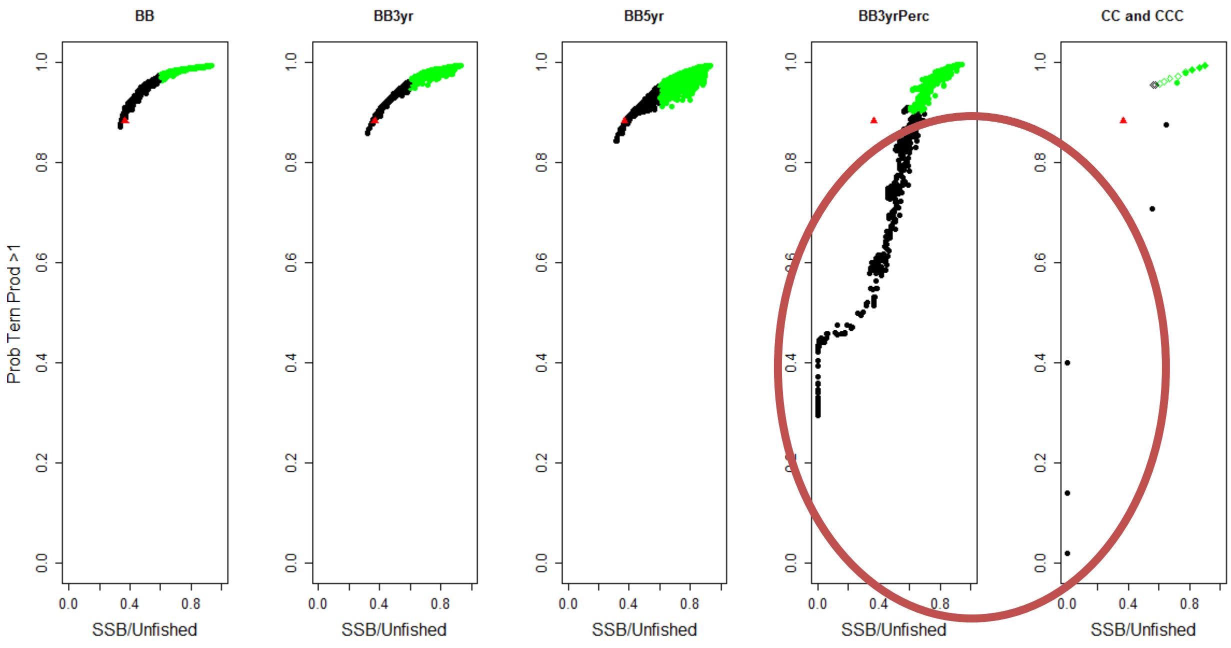


Figure 11 – MSE tradeoff plot for median frequency with which tern production was greater than average (Prob Tern Produt>1) versus SSB relative to unfished SSB



2.3.1.2 Biomass-based with 15% restriction on annual yield

A biomass-based control rule adjusts the fishing mortality used to specify an ABC in response to changes in herring biomass. This responsiveness, however, can lead to relatively large changes in ABC from year to year. Analysts developed a biomass-based control rule that restricted the change in ABC between any two years to no more than 15% based on input that some stakeholders desired increased stability in catches. Those results were presented at the second stakeholder workshop and the overwhelming majority of input from participants in attendance was to remove further consideration of both constant catch alternatives.

Rationale for Rejection: While a 15% restriction on annual changes in the ABC can provide stability in allowable catch, overall the performance of this control rule compared to others examined was inferior. For example, for this strategy to provide stable catches for the longer term, it must sacrifice yield, or have an ABC with a lower ratio of yield to MSY. This alternative (BB3yrPerc) had relatively low variation in yield (Figure 9), less than 20% for most of the runs, but that came at a cost of achieving higher yields, the ratio of yield to MSY was never greater than 80%. When stakeholders were presented with these tradeoffs, the potential benefits of stable catches did not seem to outweigh the costs of lower yields.

Similarly, the performance of predator metrics were inferior for most biomass based options with a 15% restriction on annual changes in ABC when compared to others evaluated.

Figure 10 shows the frequency with which tuna weight was greater than average for the operating model that assumes high natural mortality and fast growth of herring. When herring are assumed to have high recruitment and growth, the median tuna weight is above average (>1.0) for all of runs for most of the control rules examined. However, for the biomass based rule with a 15% restriction, there were more runs that had poor tuna weights (<1.0) than biomass based alternatives without the 15% restriction. The same is true for the tern model results. The frequency with which term production was ≥ 1.0 (i.e., terms able to maintain replacement) was generally about 85% or higher for all of the biomass based control rule runs (Figure 11), but the 15% restriction had more runs that produced lower tern production and lower herring biomass.

In summary, restricting annual changes in the ABC to ≤15% had poor performance for several of the metrics considered compared to other control rule alternatives.

2.3.1.3 Control rule timeframe of one year

During the stakeholder workshops it was discussed that setting ABC annually would enable use of the best available science, if there was time and resources available to update the assessment and set regulations to set ABC every year, as is currently done in the Multispecies and Scallop FMPs. Analysts explored alternatives that would set ABC annually, every three years, and every five years. Those results were presented at the second stakeholder workshop and the differences in performance between annual and three-year specifications were not substantially different.

Rationale for Rejection: An annual biomass based control rule would set ABC one year at a time, based on an updated assessment of the herring stock. This approach requires more resources than are currently available to the herring assessment and management process. Each year herring biomass would be estimated based on updated fishery and available data. Based on the updated estimates, the Council would develop annual specifications. The PDT recommended the Council reject this alternative at this time because it is not feasible given current resources. A modified alternative was recommended by the PDT instead, a three-year biomass based approach that uses an annual application based on the most recent herring assessment and short-term projections. The Council agreed to reject inclusion of an annual ABC control rule alternative, and instead included a timeframe alternative that would set ABC for three years based on an annual application of short-term projections.

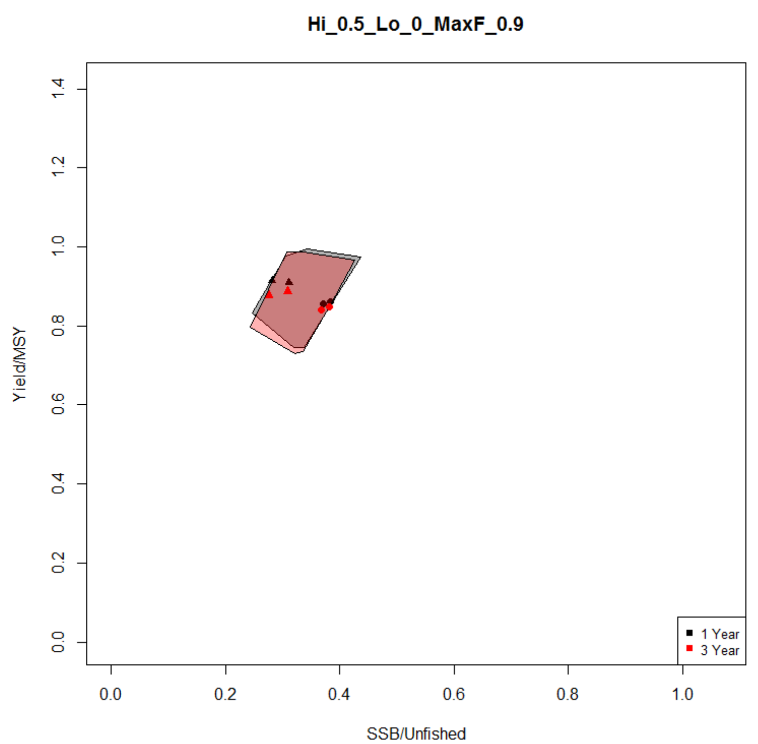
The Council reviewed the initial analysis of annual ABC versus setting ABC every three years and the performance was not very different to justify the additional resources required. The performance of several examples from the MSE has shown that most control rules perform similarly when using an annual biomass based control rule or a three-year control rule. Generally, the performance for most metrics slightly degrades when switching from an annual to a three application, with the slight costs of using a three-year application coming to the benefit of short-term fishery stability. Given the robust nature of the control rules to annual or three-year applications, the Council could choose the general control rule shape (i.e., a set of biomass based control rule parameters) in Amendment 8, but then choose separately whether to apply the control rule annually or in three-year blocks during each specifications cycle. The long-term performance of switching between annual or three-year application would likely fall within the combined range of uncertainty for the annual and three-year block performance for the given control rule in the MSE. For example, the minor differences are displayed in Figure 12 for Strawman A and Strawman B.

2.3.1.1 Control rule timeframe of five years

During the stakeholder workshops, it was discussed that it may be useful to evaluate an option that would set ABC for a longer time period to potentially improve business planning and stability in the fishery, i.e., five years. Analysts explored alternatives that would set ABC every five years. Those results were presented at the second stakeholder workshop.

Rationale for Rejection: Initial results were presented at the second stakeholder workshop and overall participants both in the fishery and other stakeholders agreed that waiting five years to review information to set ABC may be too long. This is a fast growing, relatively short-lived species, and a lot can change in five years in this ecosystem. Larger changes in ABC were expected if information was not reviewed more frequently, and the plan may not be responsive enough to changes if ABC is not re-evaluated every few years. Overall, the potential benefits of short-term stability in the fishery did not outweigh the potential costs of not updating ABC more frequently based on new information about the resource and ecosystem. The current process of a benchmark assessment every three years followed by setting fishery specifications seems to be working, so stakeholders and the Council were most comfortable with status quo, in terms of timing for setting ABC. The results for the five-year option did not perform as well for some of the metrics, frequency stock becomes overfished was higher and yield as a fraction of MSY was lower than the scenarios that set ABC for one or three years (Figure 13).

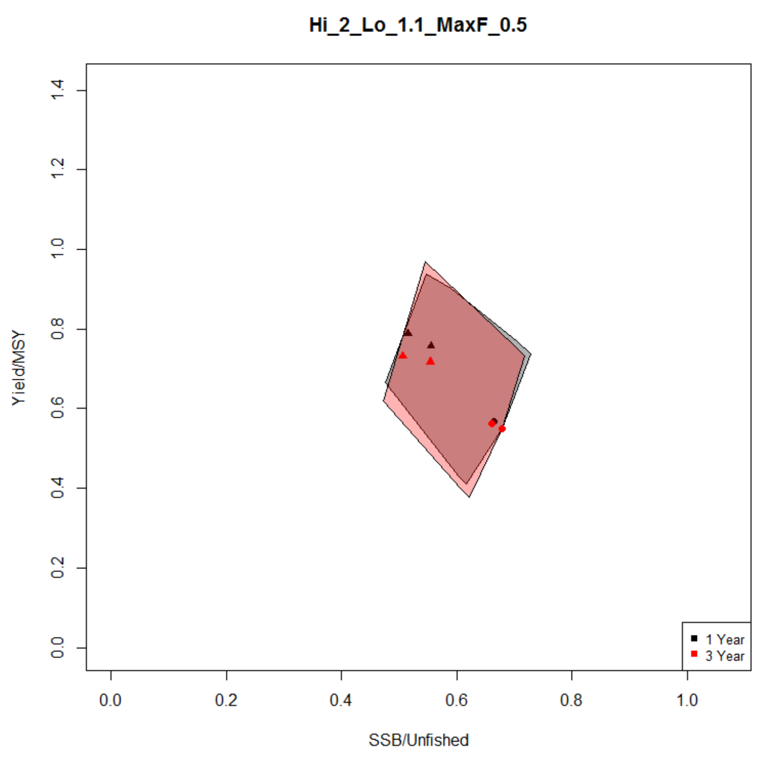
Figure 12 – Comparison of using annual (black) or three-year (red) biomass based control rules for Strawman A (top) and Strawman B (bottom)



1 vs. 3 year (Strawman A)

Minor differences in tradeoff of yield vs. biomass

Some reduction in yield for 3 year compared to some addition of biomass for 1 year option.

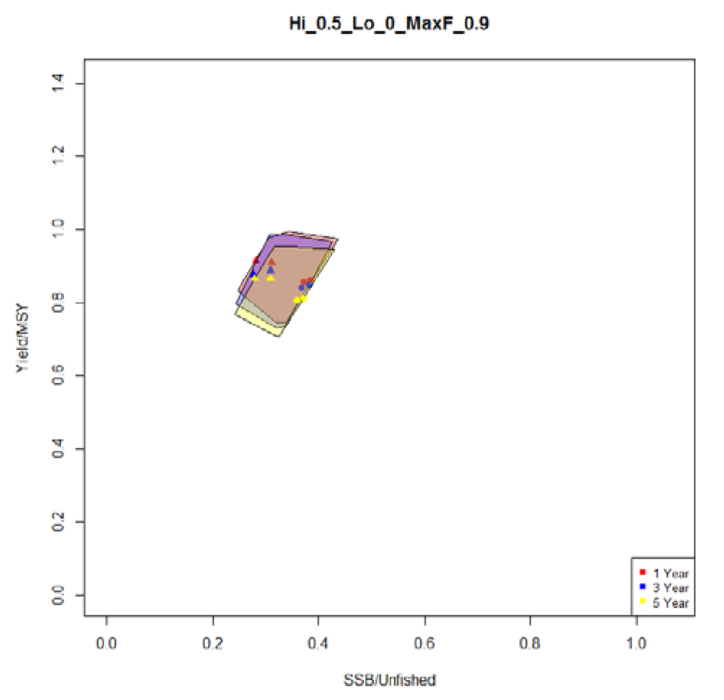


1 vs. 3 year (Strawman B)

Minor differences in tradeoff of yield vs. biomass

Some reduction in yield for 3 year compared to some addition of biomass for 1 year option.

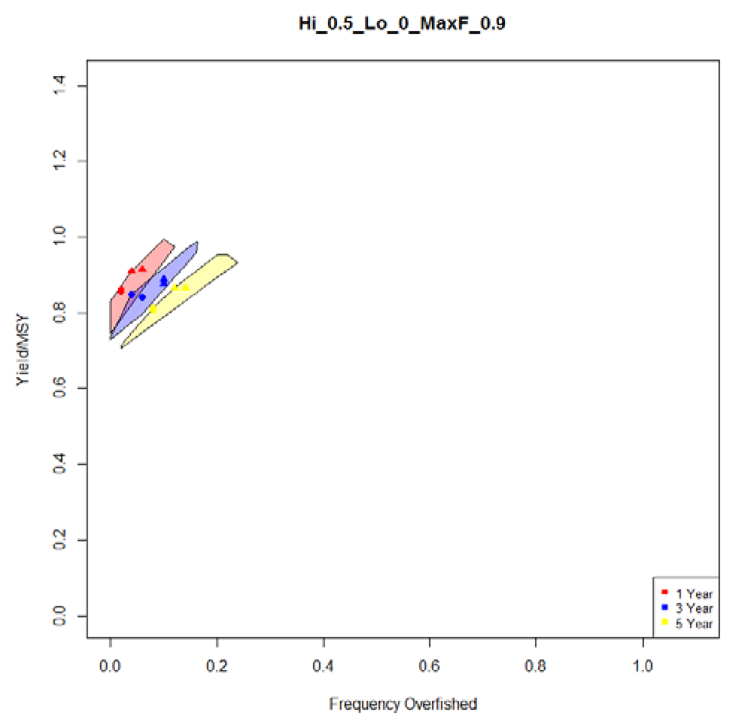
Figure 13 – Tradeoff plots comparing annual (red), three-year (blue), or five-year (yellow) biomass based control rules for Strawman A for several metrics (SSB/unfished compared to Yield/MSY (top) and Frequency overfished compared to Yield/MSY (bottom)).



1 vs. 3 vs. 5 year

Minor differences in tradeoff of yield vs. biomass

Greater reduction in yield for 5 year compared to some addition of biomass for 1 year option.



1 vs. 3 vs. 5 year

Five-year option has the greatest proportion of years when the stock may become overfished, and does not have higher yields as a fraction of MSY; therefore, the Council did not recommend including this alternative.

2.3.2 Potential localized depletion and user conflicts

During the scoping process for this action many concerns and potential recommendations were provided by the public related to the negative impacts of localized depletion of herring on other user groups such as the whale watching industry and commercial and recreational fisheries of predator fisheries (i.e., tuna and striped bass). A variety of potential management options were discussed during development of this action based on input from scoping comments, as well as discussions at both the Herring Advisory Panel and Herring Committee meetings. If a proposal passed by motion or consensus at the Herring Committee it was forwarded to the full Council. The majority of the recommendations from the Herring Committee to include as alternatives for measures to address potential localized depletion and user conflicts were included by the Council for full consideration in this action. One alternative that was originally recommended by the Herring Committee that was not included in the DEIS is described below.

2.3.2.1 Prohibit midwater trawl gear inside 35 nautical miles in Herring Management Areas 1B, 2, and 3 year-round

This alternative would have considered a prohibition of midwater trawl gear in waters within 35 nautical miles south of Herring Management Area 1A year-round (throughout Herring Management Areas 1B, 2 and 3). Vessels approved to use other gear types would still be permitted to fish for herring, i.e., purse seine or fixed gears, and small mesh bottom gear in some areas. Vessels that currently use midwater trawl gear would be permitted to convert to other gear types.

Rationale for Rejection: The Herring Committee originally recommended the Council include a range of buffer alternatives including 12 and 50 nautical miles. At the Council level it was discussed that including an alternative between 12 and 50 miles would be useful as well, but the Council did not think it was necessary to consider both 25 and 35 nautical miles. The differences between 25 and 35 nautical miles were not expected to be substantial, in terms of both possible benefits to predator fisheries as well as economic costs to the herring fishery. Therefore, the Council decided to include another alternative in Amendment 8 that would be between 12 and 50 miles, 25 nautical miles (Alternative 5), and not both 25 and 35 miles.

3.0 AFFECTED ENVIRONMENT

The Affected Environment is described in this document based on valued ecosystem components (VECs), including: target species, non-target species, predator species, physical environment and Essential Fish Habitat (EFH), protected resources, and human communities. VECs represent the resources, areas and human communities that may be affected by the alternatives under consideration in this amendment. VECs are the focus, since they are the “place” where the impacts of management actions are exhibited.

3.1 TARGET SPECIES (ATLANTIC HERRING)

This section describes the life history and stock population status for Atlantic herring, as well as herring’s role as forage in the ecosystem. The Council manages the Atlantic herring fishery under the Atlantic Herring FMP. A complete description of the Atlantic herring resource is in Section 7.1 of the FEIS for Amendment 1 to the Herring FMP. Updated information is in the Amendment 5 EIS and Framework 2 to the Herring FMP (which includes the 2013-2015 Atlantic herring fishery specifications). The following subsections update information through 2013/2014 where possible and summarize the stock status and recent biological information for Atlantic herring. Based on the best available science, the Atlantic herring resource is ***neither overfished nor subject to overfishing*** (the stock is considered ***rebuilt***).

3.1.1 Distribution and Life History

The Atlantic herring, *Clupea harengus*, is widely distributed in continental shelf waters of the Northeast Atlantic, from Labrador to Cape Hatteras. Herring occur in every major estuary from the northern Gulf of Maine to the Chesapeake Bay. They are most abundant north of Cape Cod and become increasingly scarce south of New Jersey (Kelly & Moring 1986) with the largest and oldest fish found in the southern most portion of the range (Munroe 2002). Adult Atlantic herring are found in shallow inshore waters, 20 meters deep, to offshore waters up to 200 meters deep (Munroe 2002; NEFMC 1999), but seldom migrate to depths more than 50 fathoms (300 ft or 91.4 m; Kelly & Moring 1986). They prefer water temperatures of 5^o – 9^o C (Munroe 2002; Zinkevich 1967), but may overwinter at temperatures as low as 0^o C (Reid *et al.* 1999).

Spawning occurs in the summer and fall, starting earlier along the eastern Maine coast and southwest Nova Scotia (August – September) than in the southwestern Gulf of Maine (early to mid-October in the Jeffreys Ledge area) and Georges Bank (as late as November – December; Reid *et al.* 1999). Herring are synchronous spawners, with mature fish producing eggs once a year. Male and female herring grow at about the same rate and become sexually mature beginning at age 2, with most maturing by age 4 (Munroe 2002; O'Brien *et al.* 1993). Growth rates vary greatly from year to year, and to some extent from stock to stock, and appear to be influenced by many factors, including temperature, food availability, and population size.

3.1.2 Migration

In general, GOM herring migrate from summer feeding grounds along the Maine coast and on GB to SNE/MA areas during winter, with larger individuals tending to migrate farther distances. Migration. Tagging experiments provide evidence of intermixing of Gulf of Maine, Georges Bank, and Scotian Shelf herring during different phases of the annual migration, which is described in greater detail in Amendment 1 (NEFMC 2006).

For example, in 2009, Maine DMR worked on a tagging project that showed seasonal movements of Atlantic herring from SNE in the winter to Nova Scotia in the summer (Kanwit & Libby 2009). The tag recoveries showed a clear pattern of short-term residency during the summer feeding and spawning period, which was then followed by a long distance migration through time. Most were recaptured close to the point of release close to a year later in the GOM (only six recoveries were after one year at large, however). In comparison, those tagged in SNE during the winter feeding time period did not stay in the area for as long, but were back in the same area quicker than those released in the GOM. This study concurs with several other studies in similar areas at similar times.

3.1.3 Stock Definition

In the past, the herring resource along the east coast of the United States was divided into the Gulf of Maine and Georges Bank stocks (Anthony & Waring 1980). Currently, however, no methods are available to identify stock of origin for fish caught in the mixed stock fishery or during fishery-independent surveys. Consequently, herring from the Gulf of Maine and Georges Bank are combined for assessment and management purposes into a single stock complex, although three spawning stock components occupy three fairly distinct locations: in the Gulf of Maine, southwest Nova Scotia-Bay of Fundy, and Georges Bank. A more detailed description of this stock definition is in Amendment 1.

Bolles (2006) used morphometrics to investigate mixing rates between these three spawning components during spawning times. Truss network analysis, a systematic set of morphometric distances, was used in combination with image analysis and multivariate procedures to build on work done by Cadrin and Armstrong in 2001. Canadian herring were sampled using commercial purse seines, and Gulf of Maine and Georges Bank were sampled using mid water trawls. Sampling took place during the 2003 and 2004 summer and autumn spawning periods. Results showed that Canadian herring could be more correctly classified than Gulf of Maine and Georges Bank herring. Some differences in morphological variables were observed between the eastern and western Gulf of Maine herring. The models produced by this work could be used in future research to better determine the mixing rates of the three spawning stock components in non-spawning times. This information may be reviewed if stock structure, as a larger topic, is explored in future benchmark stock assessments for herring (Bolles 2006).

3.1.4 Trends in Abundance and Biomass

The Atlantic herring stock was last assessed as a benchmark during the 54th Stock Assessment Workshop using data through 2011 (NEFSC 2012). Data were updated through 2014 for an operational assessment in 2015. The three surveys used as indices of abundance are the NMFS spring, fall and summer shrimp bottom trawl survey. The spring survey has dropped since the 2011 all-time high, the fall survey has varied without trend near the average, and the summer survey has been near or below the average for some time (Figure 14). Trends in SSB, recruitment and fishing mortality from the assessment update are in Figure 15. SSB generally declined from 1965 to a time series low of 56,509 mt in 1978. SSB generally increased from 1978 through the mid-90s SSB declined from 1997 to 347,675 mt in 2010, but then increased to the time series high of 1,041,500 mt in 2014. The point estimate of unexploited SSB equaled 845,176 mt. Age-1 recruitment in 2009 was estimated to be the largest in the time series, followed by 2012 age-1 recruitment. Finally, fishing mortality was reported to be stable and low since 2009, equaling the time series low of 0.10 in 2014.

Figure 14 – NMFS spring, fall and summer shrimp bottom trawl survey indices for Atlantic herring (plus/minus 1 standard deviation). The dashed line is the average value from 1985-2014 for each survey

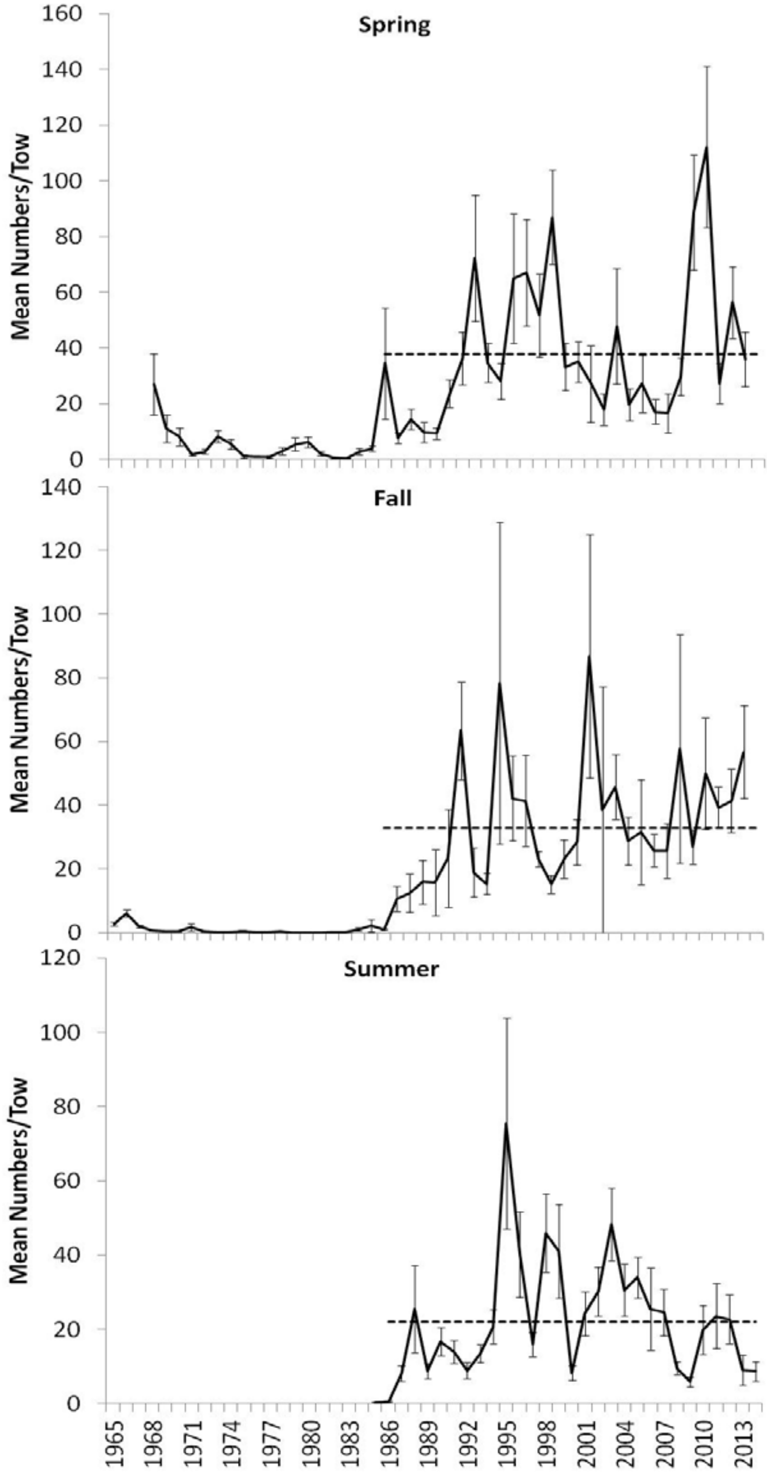
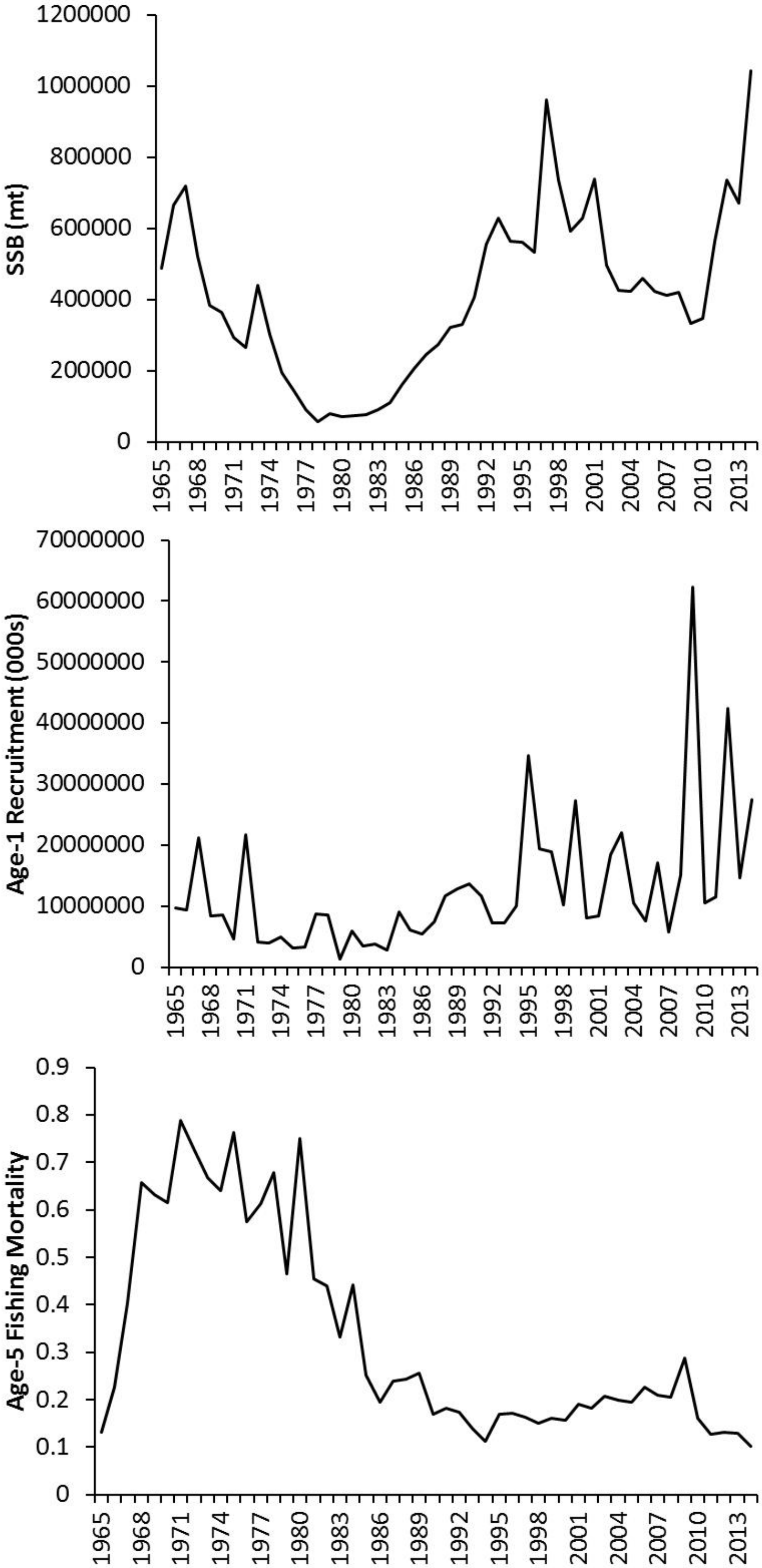


Figure 15 – Atlantic herring estimated SSB, age-1 recruitment, and age-5 fishing mortality (NEFSC 2015)



3.1.5 Spawning

While Atlantic herring reproduce in the same general season each year, the onset, peak and duration of spawning may vary by several weeks annually (Winters & Wheeler 1996) due to changing oceanographic conditions (e.g., temperature, plankton availability, etc.). Atlantic herring are believed to return to natal spawning grounds (Figure 16) throughout their lifetime to spawn (NEFMC 2006; Ridgeway 1975; Sinderman & Iiles 1985).

Spawning occurs at specific locations in the Gulf of Maine in depths of 20-50 m (about 60-160 feet), on coastal banks such as Jeffreys Ledge and Stellwagen Bank located 8-40 km offshore, along the eastern Maine coast between the U.S.-Canada border and at various other locations along the western Gulf of Maine (Figure 16). Some spawning sites are used repeatedly, sometimes more than once a year (NEFMC 2006; Stevenson 1989). Jeffreys Ledge may be the most important spawning ground in the Gulf of Maine based on the number of spawning and near-spawning adults found there (Boyar *et al.* 1973). Figure 16 summarizes the general locations of major herring spawning areas in the GOM and GB.

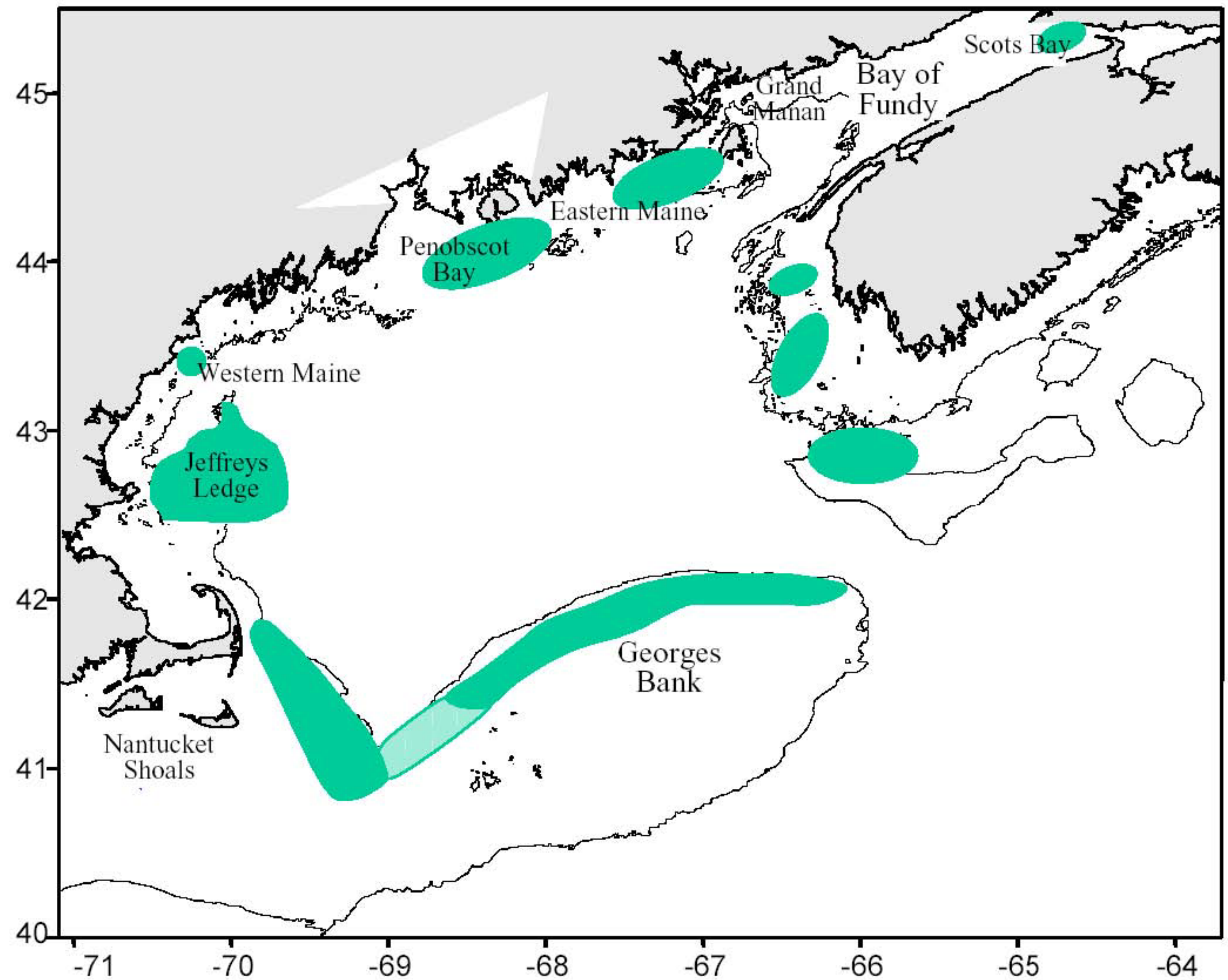
Herring also spawn on Nantucket Shoals and Georges Bank, but not further south. In Canada, spawning occurs south of Grand Manan Island (in the entrance of the Bay of Fundy) and on various banks and shoals south of Nova Scotia (Figure 16). Spawning occurs in the summer and fall, starting earlier along the eastern Maine coast and southwest Nova Scotia (August-September) than in the southwestern Gulf of Maine (early to mid-October in the Jeffreys Ledge area and as late as November-December on Georges Bank; NEFMC 2006; Reid *et al.* 1999). Eggs are laid in layers and form mats as thick as 4-5 cm. Herring in the Gulf of Maine region usually reproduce at relatively high temperatures (10-15°C) and at high salinities (NEFMC 2006). Herring do not spawn in brackish water.

Atlantic herring spawn on the bottom in discrete locations by depositing adhesive eggs that stick to any stable bottom substrate, including lobster pots and anchor lines. Eggs are laid in layers and form mats or carpets. In the Gulf of Maine region, egg mats as thick as 4-5 cm have been observed in discrete egg beds that have varied in size from 0.3-1.4 km^2. One very large egg bed surveyed on Georges Bank in 1964 covered an area of about 65 km^2 (Noskov & Zinkevich 1967).

Atlantic herring are synchronous spawners, producing eggs once a year after they reach maturity. Depending on their size and age, female herring can produce from 55,000 to 210,000 eggs (Kelly & Stevenson 1983). Once they are laid on the bottom, herring eggs are preyed upon by a number of fish species, including cod, haddock, red hake, sand lance, winter flounder, smelt, tomcod, cunner, pollock, sculpins, skates, mackerel and even herring themselves (Munroe 2002; NEFMC 2006). Egg predation and adverse environmental conditions often result in high egg mortalities.

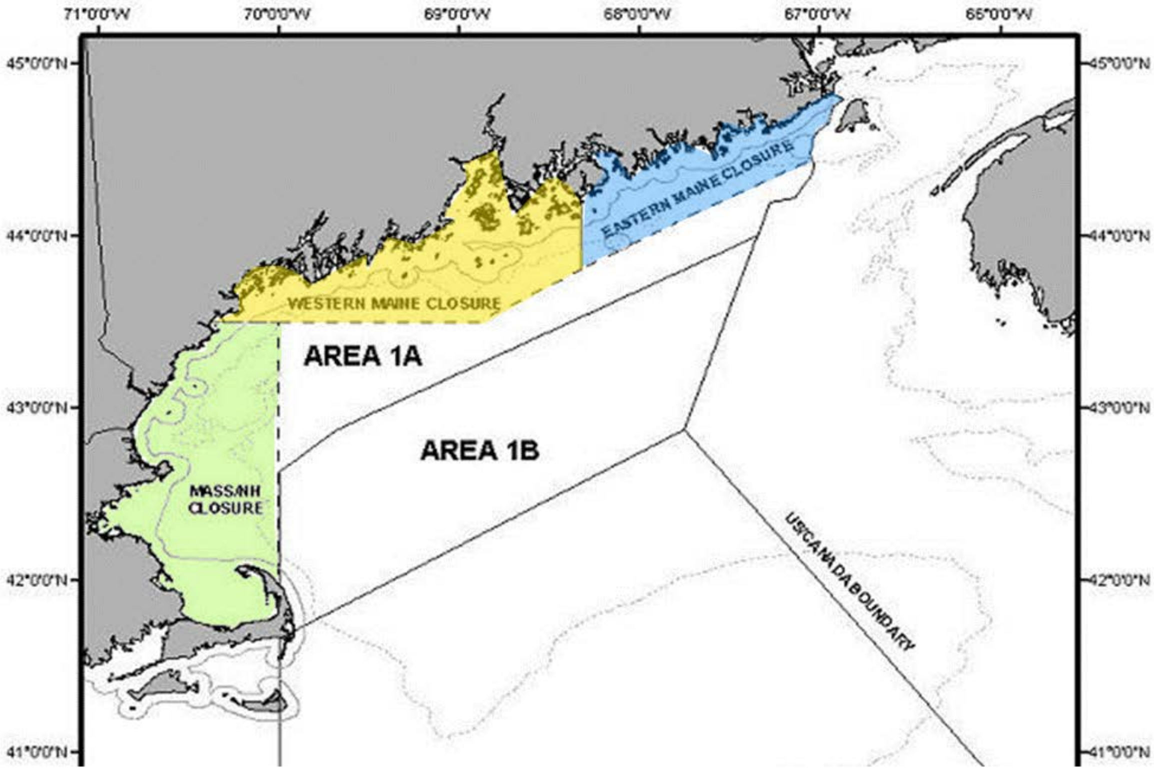
Spawning closures. Amendment 3 to the ASMFC plan for Atlantic herring (ASMFC 2016b) implemented three seasonal spawning closures within Area 1A that vary based on the observation of spawning fish (Figure 17; http://www.massmarinefisheries.net/herring/). Starting in 2016, samples of herring are collected in the summer and fall from the commercial fishery and processed to record individual length and gonadal somatic index (GSI) of maturing females. Once sufficient samples have been processed showing a significant increase in GSI30, the area closes for four weeks. If there is insufficient data (< 3 samples) to forecast a closure date, a default closure date will apply, either August 28 or October 4, depending on the area. If additional samples show greater than 25% of fish in spawning condition once an area re-opens, the area will re-close for an additional two weeks.

Figure 16 - Generalized view of the current major herring spawning areas in the GOM and on GB



Source: Overholtz *et al.* (2004).

Figure 17 - Atlantic herring spawning closures implemented by ASMFC



Source: ASMFC.

Table 4 - Closure dates for the Atlantic herring spawning closures

Area	Eastern Maine	Western Maine	Massachusetts/ New Hampshire
Default date	Aug. 28 – Sept. 24	Oct. 4 – Oct. 31	Oct. 4 – Oct. 31
2016 closure date	Aug. 28 – Sept. 24	Sept. 18 – Oct. 15	Oct. 2 – Oct. 29
2017 closure date	Aug. 28 – Oct. 30	Sept. 26 – Oct. 23	Oct. 1 – Nov. 11
Source: ASMFC			

3.1.6 Atlantic Herring Stock Status

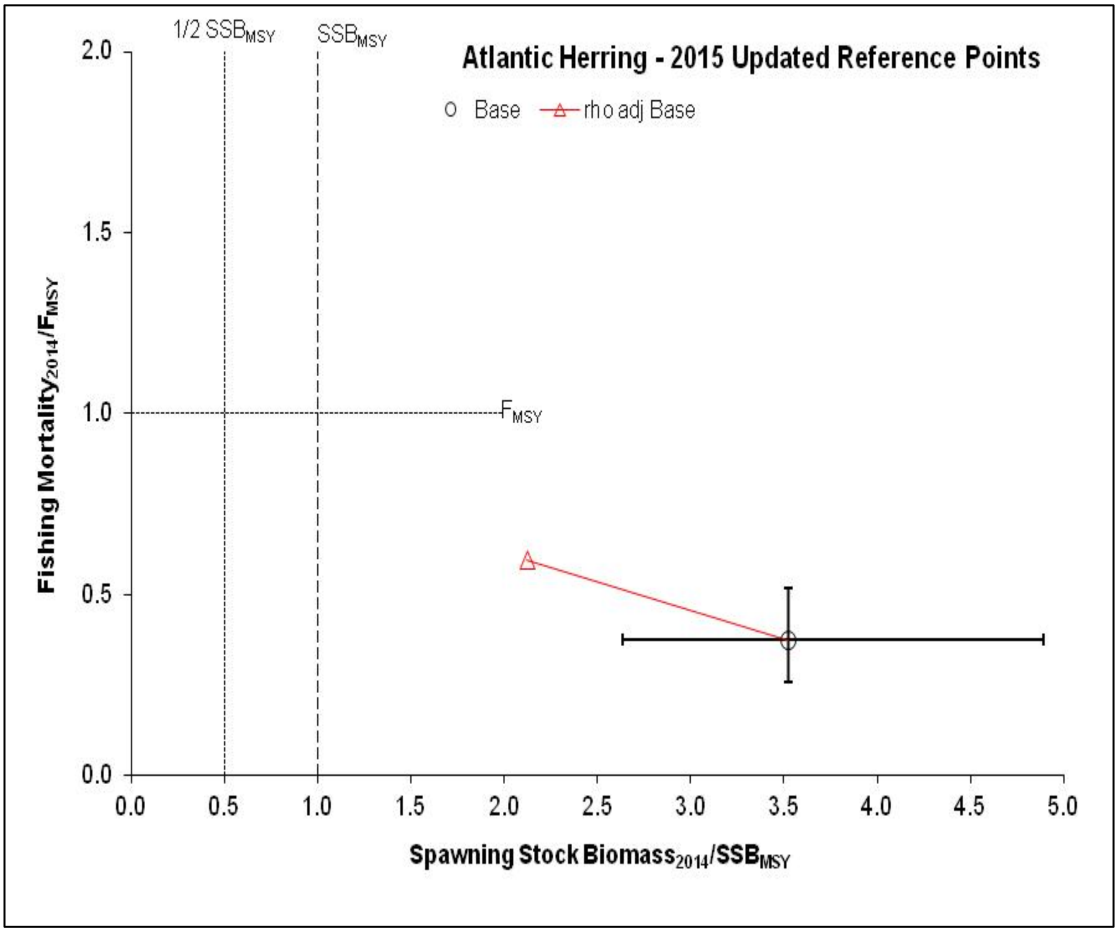
The Atlantic herring operational (update) assessment meeting was held in Woods Hole, MA on April 8-9, 2015 (Deroba 2015). This assessment served as an update to the SAW/SARC 54 benchmark assessment conducted in 2012. A new benchmark assessment is under development and is expected to be completed in summer 2018.

Overall, the updated assessment indicates that the Atlantic herring resource continues to remain well above its biomass target (rebuilt), and fishing mortality remains well below the F_{MSY} threshold. Atlantic herring is ***neither overfished nor subject to overfishing.*** A retrospective pattern re-emerged when updating the assessment model, which suggests that Atlantic herring spawning stock biomass (SSB) is likely to be overestimated and fishing mortality (F) is likely to be underestimated in the terminal year of the assessment. Resolution of a technical error in the contribution of recruitment to the objective function (i.e., negative log-likelihood) of the assessment model also affected the severity of the retrospective pattern. As a result, the assessment review panel applied a retrospective adjustment to the SSB and F values for the terminal year (2014) using Mohn's Rho. The retrospective adjustments resulted in about a 40% decrease in the terminal year (2014) SSB estimate and a 60% increase in the 2014 F estimate. Even with the retrospective adjustments, the Atlantic herring stock complex remains above the biomass target and below the fishing mortality threshold (Table 5, Figure 18).

Table 5 - Atlantic herring reference points and terminal year SSB/F estimates from the Benchmark Assessment (2012) and Update Assessment (2015)

	2012 SAW 54 Benchmark	**2015 Update (Non-Adjusted)**	**2015 Update (Retro-Adjusted)**
Terminal Year SSB	518,000 mt (2011)	1,041,500 mt (2014)	**622,991 mt (2014)**
Terminal Year F	0.14 (2011)	0.10 (2014)	**0.16 (2014)**
SSB_{MSY}	157,000 mt	311,145 mt	
F_{MSY}	0.27	0.24	
MSY	53,000 mt	77,247 mt	

Figure 18 - Atlantic herring operational assessment: 2014 fishing mortality and SSB relative to F_{MSY} and SSB_{MSY} reference points, including retrospective adjustment (red line)



Note: Error bars represent 10th and 90th percentiles of 2014 F/SSB estimates.

The results of the 2015 operational assessment form the basis of the SSC and Council recommendations for the 2016-2018 specifications of OFL and ABC. The operational assessment report and the May 20, 2015 SSC report contain more detailed information.

3.1.7 Considerations Related to Scientific Uncertainty

With respect to the 2015 Atlantic herring operational assessment, the re-emerging retrospective pattern, assumptions about natural mortality (M), and the mismatch between implied consumption and estimated consumption appear to be the primary sources of uncertainty (see discussion in following subsections). The size/strength of the 2011 year class and other sources of uncertainty were also identified in the assessment report. However, signals related to the 2011 year class (possibly the second-largest on record) are similar to those for the 2008 year class that were noted in the 2012 Atlantic herring benchmark stock assessment. The update assessment indicates that the 2008 year class has persisted through the fishery as the strongest on record.

3.1.7.1 Retrospective Pattern

Since the benchmark assessment, an issue with the contribution of recruitment to the negative log likelihood in the assessment framework, ASAP, was discovered. This issue was resolved for the operational assessment. Differences in results and diagnostics between the benchmark and the update are partially attributable to the likelihood issue. Resolving the likelihood issue had the effect of changing the scale of estimates (e.g., increasing abundance estimates), particularly in recent years. Regardless of the likelihood issue, diagnostic problems (e.g., retrospective patterns) were present in the update assessment. Resolving the likelihood issue only amplified these diagnostic problems (e.g., worsening retrospective patterns). To account for retrospective bias, the assessment review panel made a retrospective adjustment to the terminal year (2014) estimates of SSB (40%) and F (60%). The retrospective-adjusted estimates of SSB, F, and numbers-at-age are utilized for the short-term (2016-2018) catch projections. No retrospective adjustment was applied to the benchmark terminal year (2011) biomass and fishing mortality estimates that were utilized in the projections for the 2013-2015 Atlantic herring fishery specifications.

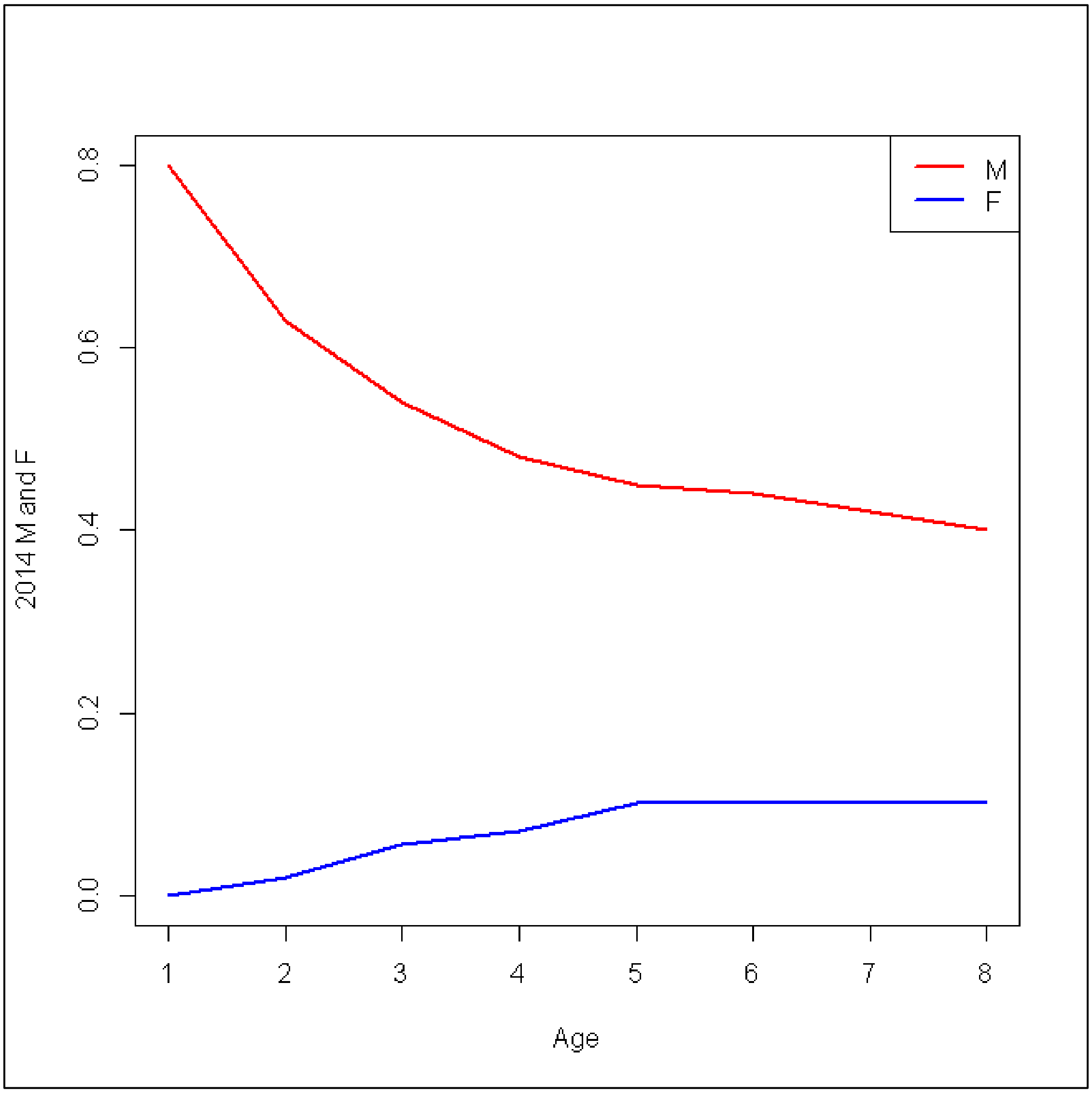
The reemergence of the retrospective pattern suggests a fundamental diagnostic problem with the assessment model that remains a cause for concern. However, it appears that the stock would remain above the biomass target and below the fishing mortality thresholds even if the 80% confidence intervals (i.e., 90th and 10th percentiles) associated with the terminal year estimates of F and SSB (Figure 18, p. 80) are applied to the retrospective-adjusted estimates. Thus, stock status would not change, 2014 F would remain below the threshold, and 2014 SSB would remain above the target.

3.1.7.2 Natural Mortality and Consumption

Additional uncertainty is associated with the treatment of natural mortality (M) in the assessment model and the divergence between NMFS’ consumption estimates (based on stomach content data) and levels of consumption implied by the input M values in the assessment model. The mismatch between estimated and implied consumption became apparent when the assessment model was updated. This may not be of significant concern because of the possible inaccuracy of consumption estimates derived from the food habits data. These data can be extremely sensitive to presence/absence of herring in just a few stomach samples. While food habits data are used to estimate consumption by teleost predators (fish), estimates of consumption by marine mammals, seabirds, and some larger predators (e.g., tuna) are derived from prior research and assumed to be constant in recent years; these data may not be complete. Moreover, consumption of Atlantic herring and other species may change due to factors other than M (e.g., herring abundance, spatial overlap).

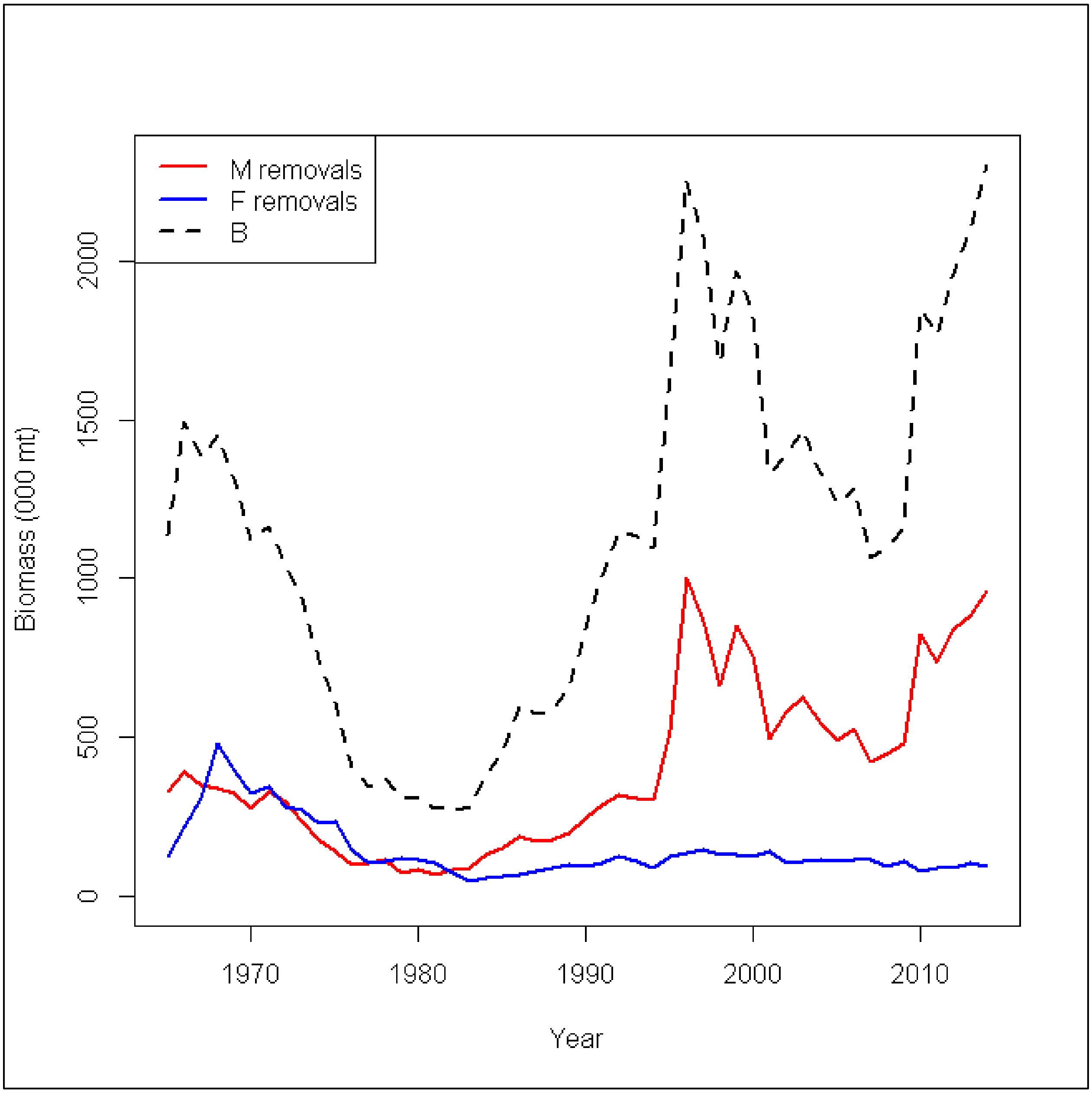
The assessment model assumes a significant amount of natural mortality on Atlantic herring, particularly at younger ages, before the fish experience mortality from the fishery. Figure 19shows how the assessment model treats natural mortality (red line) and fishing mortality (blue line) by age class in 2014. Thus, the model assumes that M is a much higher fraction of total mortality than fishing mortality. Figure 20 illustrates removals from fishing mortality and natural mortality estimated from the assessment model relative to total biomass over the entire time series.

Figure 19 - Atlantic Herring Operational Assessment: 2014 estimated natural mortality (M) and fishing mortality (F) by age



Source: Atlantic Herring Operational Assessment Meeting, April 8-9, 2015.

Figure 20 - Atlantic Herring Operational Assessment: Estimated removals from natural mortality (M) and fishing mortality (F) relative to total estimated biomass (B)



Source: Atlantic Herring Operational Assessment Meeting, April 8-9, 2015.

3.1.8 Importance of Herring as Forage

Atlantic herring play an important role as forage in the Northeast U.S. shelf ecosystem. They are eaten by a wide variety of fish, marine mammals, birds, and (historically) by humans in the region. The structure of the Northeast U.S. shelf ecosystem features multiple forage species rather than a single dominant forage species. Herring share the role of forage here with many other species including sandlance, mackerels, squids, and hakes, although herring are distinguished by a high energy density (caloric content) relative to other pelagic prey in the ecosystem. This diversity of forage options leads to a complex and diverse food web supporting many different predators. The relative importance of herring as forage varies by predator group, due to differences in predator life history, foraging style, and bioenergetics. Therefore, predator responses to changing herring populations vary, and depend on the extent to which other forage is available.

In the Northeast Fisheries Science Center fish food habits database, Atlantic herring are found most often in the stomachs of spiny dogfish, Atlantic cod, and silver hake. Although these three species most commonly have herring in their diets, herring make up no more than 20% of the diet composition for any of these predators; these are generalist predators (Link & Almeida 2000; Smith & Link 2010). Similarly, diet estimates for marine mammals show that herring are important, but not dominant, generally comprising 10-20% of diets for baleen whale, toothed whales, and pinnipeds (Smith *et al.* 2015). Juvenile hake and herring are important forage for puffins in the Gulf of Maine, along with sandlance, and recently, juvenile haddock and redfish (Kress *et al.* 2016). Common and Arctic tern chicks in the Gulf of Maine were fed primarily juvenile herring and juvenile hake in equal amounts, followed by sandlance, and other fish (Hall *et al.* 2000). Endangered Species Act-listed Atlantic salmon, as adults at-sea, feed on forage fishes such as herring, mackerel, sandlance, and capelin (off Greenland; Renkawitz *et al.* 2015). Large adult bluefin tuna are one of the few potentially herring-dependent predators (~half of the diet is herring) in the Northeast U.S. shelf ecosystem (Chase 2002; Logan *et al.* 2015). However, recent studies suggest that bluefin tuna may require large herring, rather than abundant herring, to maintain body condition (Golet *et al.* 2015).

In some ecosystems, pelagic schooling fishes are major predators of the pelagic eggs and larvae of other fish. However, fish eggs and larvae appear to be only a small component of Atlantic herring diet in federal waters of the Northeast U.S. shelf. Invertebrates (copepods, krill, amphipods, and other zooplankton) make up the majority (68%) of identified herring prey in the NEFSC food habits database, while fish larvae, eggs, and all other vertebrates combined are under 5% of herring diet (27% of stomach contents could not be identified). These data reflect mainly adult herring food habits on the continental shelf of the Northeast U.S. from 1992-the present. Limited information also suggests that juvenile herring primarily eat invertebrates and only rarely fish eggs and larvae in nearshore Gulf of Maine waters (Sherman & Perkins 1971).

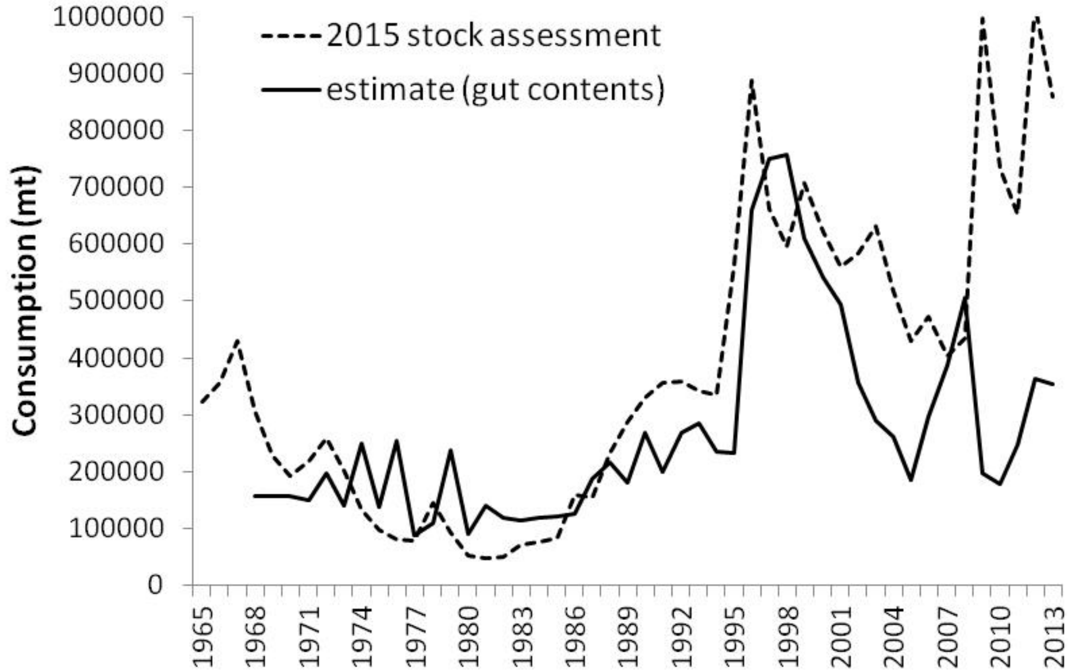
Climate and environmental conditions can be major drivers of pelagic fish dynamics. In the Northeast U.S., Atlantic herring and other pelagics have lower biological sensitivity to climate risks than other species in the region due to high mobility, but as a result, have a high potential to change distribution. Overall, the impact of climate change on Atlantic herring in this ecosystem is negative to neutral relative to other Northeast species. All Northeast U.S. species have high or very high exposure to climate change risks, as this ecosystem is changing more rapidly than much of the world ocean (Hare *et al.* 2016).

In the Atlantic herring stock assessment, the amount of herring assumed to be taken by predators (e.g., piscivorous fish, seabirds, highly migratory species, marine mammals) has varied annually (Figure 1, dashed line). The 2015 stock assessment assumed that, during 2009-2013, an annual average of 852,000 mt of Atlantic herring was eaten by predators, which equaled 44% of average total biomass (1.92M mt) over the same period. The amount of herring assumed to be consumed by predators in the assessment is based on natural mortality rates and estimates of herring consumption largely based on gut contents data, which also vary annually (Figure 1, solid line), with an annual average of 268,000 mt during that time. The gut contents data are from NMFS surveys, and are highly imprecise and likely biased. The short-term projections used to provide catch advice (overfishing limit, acceptable biological catch) assume a similar amount of herring are consumed as assumed in the stock assessment. More information is available in the 2015 Atlantic Herring Operational Assessment report (Deroba 2015).

The Ecosystem-Based Fishery Management PDT report on scientific advice for accounting for ecosystem forage requirements (NEFMC 2015) and assessment reports (e.g., Deroba 2015) contain estimates of predator consumption. Recently, marine mammal consumption of herring has been similar to commercial fishery landings, averaging 105,000 mt/year. Bluefin tuna and blue sharks have recently consumed 20-25,000 mt/year. Seabirds consume a relatively small amount of herring, conservatively estimated at about 3-5 mt/year. Herring constitutes about 20% of the diet of cod and spiny dogfish (NEFSC diet data). There is also some evidence which suggests it is not just the volume of herring available, but the age structure of that forage base that is important in the energy budgets of predators (Diamond & Devlin 2003; Golet *et al.* 2015).

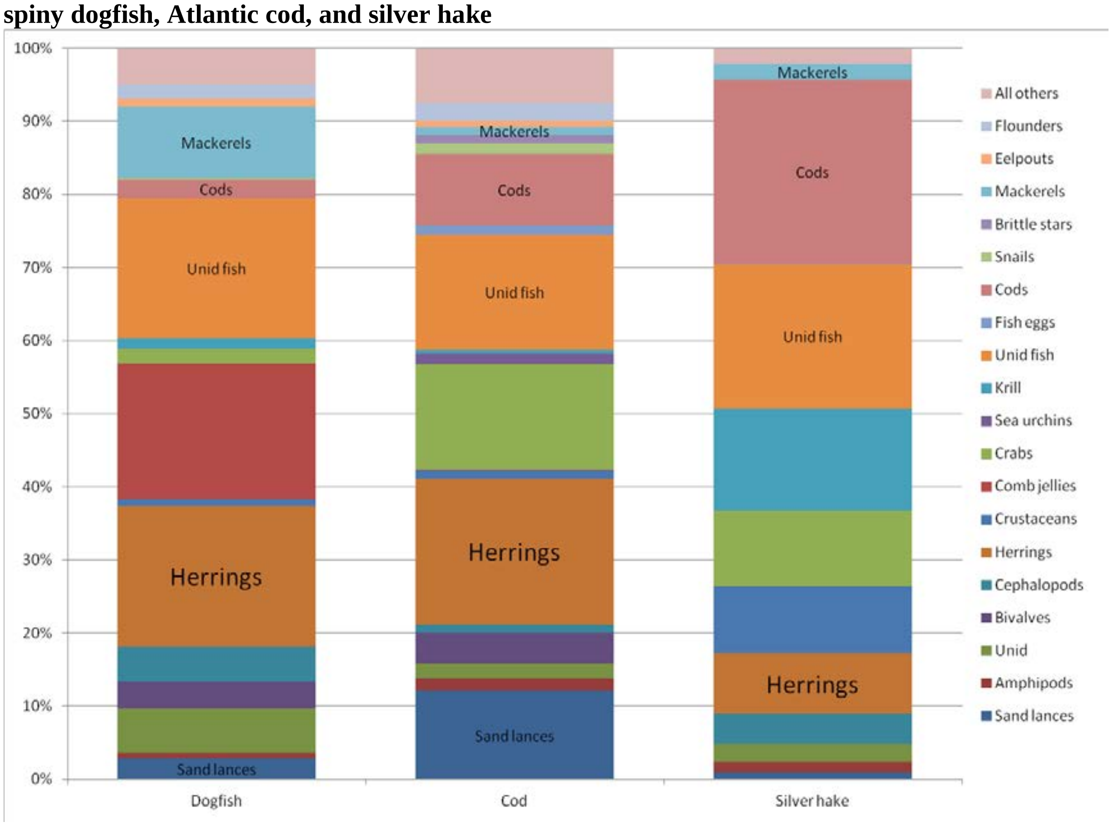
The amount of Atlantic herring needed for forage is the amount below which predators are negatively impacted. Estimates of this need do not currently exist and would vary by the abundance of predators and other prey. To summarize, consumption estimates can be generated, but that is different than what is necessary – which is a difficult question to answer definitively.

Figure 21 - Atlantic herring consumption by predators



Source: Deroba (2015).

Figure 22 - Estimated diet from Gulf of Maine, Georges Bank, and southern New England combined for spiny dogfish, Atlantic cod, and silver hake



Source: NEFSC diet database, 1973-2012.

3.2 NON-TARGET SPECIES (BYCATCH)

Non-target species refers to species other than Atlantic herring which are caught/landed by federally permitted vessels while fishing for herring. The MSA defines *bycatch* as fish that are harvested in a fishery, but are not retained (sold, transferred, or kept for personal use), including economic discards and regulatory discards (16 U.S.C. § 1802(2)). The MSA mandates the reduction of *bycatch*, as defined, to the extent practicable (16 U.S.C.§ 1851(a)(9)). Incidental catch, on the other hand, is typically considered to be non-targeted species that are harvested while fishing for a target species and is retained and/or sold. In contrast to bycatch, there is no statutory mandate to reduce incidental catch. When non-target species are encountered in the Atlantic herring fishery, they are either discarded (bycatch) or they are retained and sold as part of the catch (incidental catch). The majority of catch by herring vessels on directed trips is Atlantic herring, with extremely low percentages of bycatch (discards). Atlantic mackerel is targeted in combination with Atlantic herring during some times of the year in the southern New England and Mid-Atlantic areas and is therefore not considered a non-target species.

Due to the high-volume nature of the Atlantic herring fishery, non-target species, including river herring (blueback herring and alewives), shad (hickory shad and American shad), and some groundfish species (particularly haddock), are often retained once the fish are brought on board (NEFMC 2012, p. 173). The catch of non-target species in the directed Atlantic herring fishery can be identified through sea sampling (observer) data collected by the Northeast Fisheries Observer Program (NEFOP). Portside sampling data collected by MADMF and MEDMR can be used to estimate catch of any non-target species that are landed. Dealer and VTR data can be used to identify/cross-check incidental landings of some non-target species that may be separated from Atlantic herring.

The primary non-target species in the directed Atlantic herring fishery are **groundfish (particularly haddock)** and the **river herring/shad (RH/S) species**. There are accountability measures in place for both haddock and river herring/shad if area and gear specific catch cap is exceeded. Dogfish, squid, butterfish, Atlantic mackerel are also common non-target species in the directed Atlantic herring fishery (mackerel and some other non-target species catch is often landed and sold). Comprehensive information about the catch of these species in the Atlantic herring fishery is in Section 5.2 of Amendment 5 and Sections 3.2 and 3.3 of Framework 3 to the Atlantic Herring FMP.

3.2.1 Haddock

Population status: Haddock has two stocks, Gulf of Maine and Georges Bank. As of the 2017 groundfish operational assessments, GOM haddock is ***neither overfished nor subject to overfishing***, with 2016 SSB estimated to be at 47,821 mt, which is 706% of the biomass target. The GOM haddock stock has experienced several large recruitment events since 2010. The population biomass is currently at an all-time high and overall, the population is experiencing low mortality). The GB haddock stock is also ***neither overfished nor subject to overfishing***. There has been a steady increase in SSB from ~15,000 mt in the early 1990s, to about 252,000 mt in 2007. The dramatic increase 2005 - 2007 is due to the exceptionally large 2003 year class reaching maturity. From 2007 - 2010, SSB decreased 35% as that 2003 year class decreased due to natural and fishing mortality. The fishing mortality rate for this stock has been low in recent years. The retrospective adjusted 2016 SSB was estimated to be at 290,324 mt, which is 278% of the biomass target. The GB haddock stock shows a broad age structure, and broad spatial distribution. This stock has produced several exceptionally strong year classes in the last 15 years, leading to record high SSB in recent years. While indices support the finding that this stock is at an all-time high, weights at age have been declining since the large 2003 year class, and show further declines with the most recent data (NEFSC 2017a).

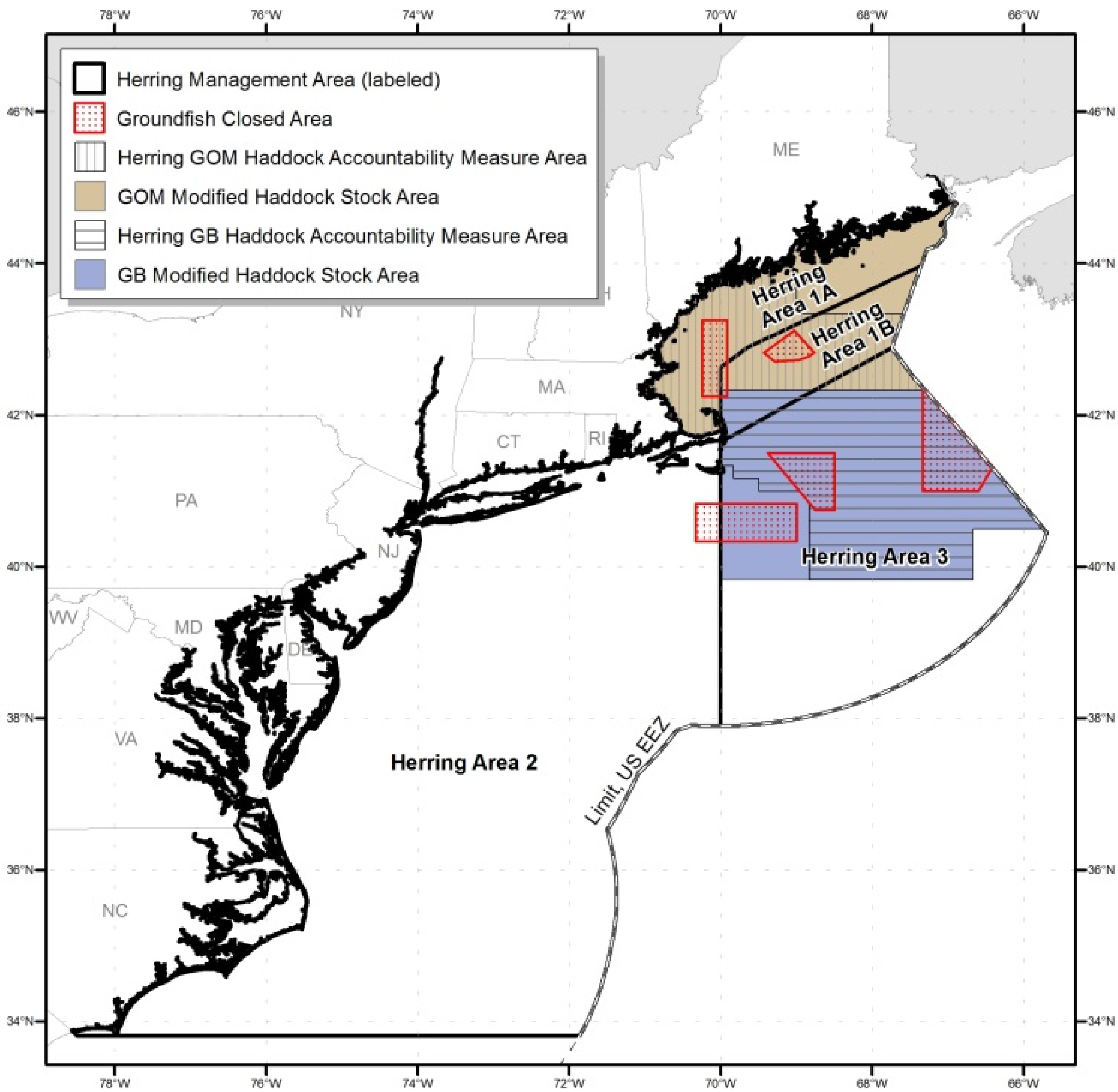
Management: Haddock is managed by the NEFMC under the Northeast Multispecies FMP. Framework Adjustment 56 to the Northeast Multispecies FMP increased the midwater trawl Atlantic herring fishery sub-ACL for Georges Bank haddock to 1.5% (up from 1%) and maintained the GOM haddock sub-ACL of 1% (NEFMC 2017). When the haddock incidental catch cap for a particular haddock stock (GOM or GB) has been caught, all herring vessels fishing with midwater trawl gear are prohibited from fishing for, possessing, or landing, more than 2,000 lb of herring in the respective haddock accountability measure area for the remainder of the multispecies fishing year (Figure 23). There is also a pound-for-pound payback for any overages. This aims to incentivize the midwater trawl fleet to minimize the incidental catch of GB haddock to the extent practicable, while providing the opportunity for the fleet to fully harvest its herring sub-ACL for Herring Management Areas 1B and 3. The measure would reduce the potential for negative impacts on the herring and Atlantic mackerel fisheries caused by reductions in fishing opportunities in Areas 1B and 3, and avoid potential market interruptions for the supply of herring as bait for the lobster fishery. GOM haddock catches have been relatively low; therefore, the focus of potential impacts on haddock is relative to GB haddock. Table 6 has recent allocations and catches of GB haddock in the MWT herring fishery. Accountability measures were triggered in 2015, closing most of GB to the herring fleet for a large portion of the fishing year. Notably, observer coverage was much lower in 2015 than previous years.

Table 6 – Summary of recent catches (mt) of Georges Bank haddock by the midwater trawl Atlantic herring fishery, groundfish FY 2010- FY 2016

	Midwater Trawl- Georges Bank Haddock						
Groundfish FY	**Sub-ACL**	**Landings**	**Discards**	**Catch**	**Percentage of sub-ACL**	**CV on Catch**	**Observer Coverage % Trips**
2010	84	69.2	0	69.2	82.3%		
2011	318	101.8	0	101.8	32.0%	17.6%	41.7%
2012	286	271.9	16.7	288.6	100.9%	12.3%	62.9%
2013	273	272.7	17.2	290	106.2%	21.3%	35.6%
2014	162	113.5	0	113.5	70.1%	20.5%	27.2%
2015	227	235.0	0.6	235.5	103.9%	61.4%	4.9%
2016	512	115.3	3.6	118.9	23.2%	42.9%	20.1%

Sources: Groundfish FY2010 – FY2015 final year-end catch reports, FY2016 preliminary in-season report through 3/8/2017, GARFO, and CV and observer coverages rates for FY 2011- FY 2016 from GARFO personal communication November 3, 2017.

Figure 23 – GOM and GB haddock stock areas (shaded) with Herring MWT accountability measures (hatched)



3.2.2 River herring / Shad

Population status: In 2017, there was an updated river herring assessment that concluded, that the coastwide meta-complex of river herring stocks on the U.S. Atlantic coast remains ***depleted*** to near historic lows. There is evidence for declines in abundance due to several factors, but their relative importance could not be determined. The ***overfished and overfishing status is unknown*** for the coastwide stock complex, as estimates of total biomass, fishing mortality rates and corresponding reference points could not be developed. While status on a coastwide basis remains unchanged, there are some positive signs of improvement for some river systems, with increasing abundance trends for several rivers in the Mid-Atlantic throughout New England region. While abundance in these river systems are still at low levels, dam removals and improvements to fish passage have had a positive impact on run returns (ASMFC 2017d).

The primary concern about river herring/shad and the Atlantic herring fishery is the incidental catch of river herring during fishery operations. In addition, there are concerns that Atlantic herring also play an important role as forage, and if more Atlantic herring is available in the system, it can be an important buffer for other prey such as migrating diadromous fish species. For example, Atlantic salmon smolts and young of the year (YOY) shad and river herring are preyed upon in coastal waters near mouths of rivers. A larger forage base can reduce pressure on these prey species that are rebuilding (Stephen Gephart, personal communication). More information about predator swamping, or maintaining high levels of prey to mitigate impacts on other prey species, is in Ims [1990], Furey et al [2016], Turner et al [2017], and Saunders [2006].

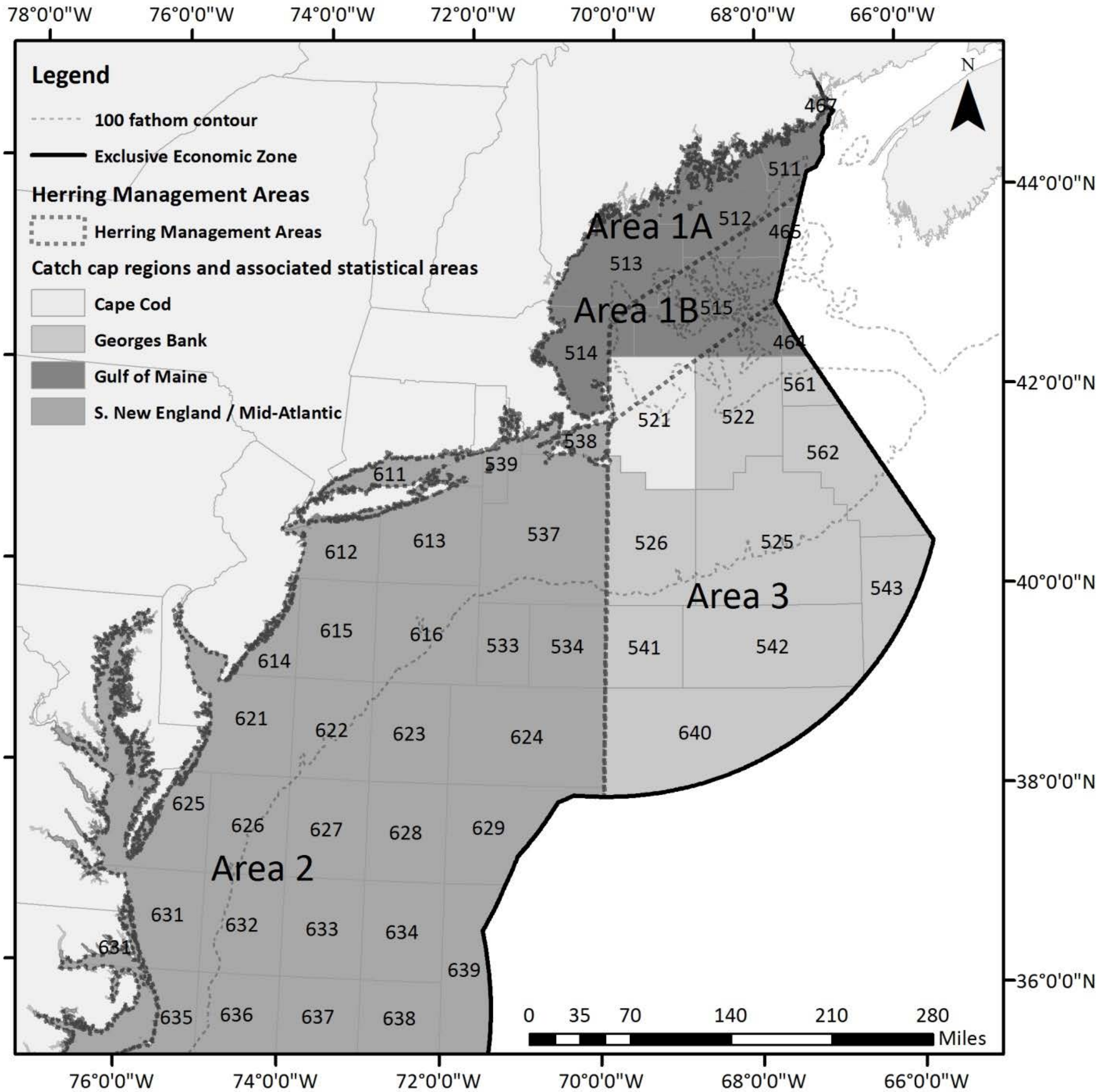
Management: River herring is primarily managed under Amendment 2 (ASMFC 2009) to the ASMFC FMP for Shad and River Herring, which addresses concerns regarding declining river herring populations. Like shad, states and jurisdictions had to develop Sustainable Fishery Management Plans (SFMPs) to maintain a commercial and/or recreational river herring fishery past January 2012. By 2016, the only approved River Herring SFMPs in effect were: Maine, New Hampshire, Massachusetts, New York, and South Carolina. The remaining states and jurisdictions have closed their commercial and recreational fisheries.

There are several federal management measures in place to manage river herring intended to reduce commercial fisheries interactions in federal waters. The types of management measures currently in place or being considered fall into five general categories:

1. Limitations on total river herring and shad catch;
2. Improvements to at-sea sampling by fisheries observers;
3. River herring avoidance program;
4. Increased monitoring of Atlantic herring and mackerel fisheries; and
5. Including river herring in a Federal fishery management plan.

In December 2014, NMFS implemented river herring and shad catch caps for the Atlantic herring fishery for 2014 and 2015 (Figure 24). Catch of river herring and shad on fishing trips that land more than 6,600 lb of herring count towards the caps. Caps are area and gear specific. If NMFS determines that 95% of a river herring and shad cap has been harvested, a 2,000 lb herring possession limit for that area and gear will become effective for the remainder of the fishing year. This low possession limit essentially turns the area into a closed area for directed herring fishing until the start of the next fishing year. The river herring catch caps for 2017 are: 32.4 mt for Cape Cod MWT cap, 76.7 mt for GOM MWT cap, 122.3 mt for SNE BT cap, and 129.6 mt for SNE MWT cap. Bycatch is monitored and reported on the GARFO website: https://www.greateratlantic.fisheries.noaa.gov/aps/monitoring/riverherringshad.html .

Figure 24 - Atlantic Herring Management Areas and RH/S Catch Cap Areas



3.2.3 Observer data

Fishery bycatch is monitored primarily using Federal fishery observers, though observer rates have varied annually and by fishery. Calculating an observer rate by gear type within the Atlantic herring fishery is difficult due to the overlaps with other fisheries (e.g., overlap with squid and whiting in the small mesh bottom trawl (SMBT) fishery). Thus, the data in Table 7 was pulled in a more general approach and included all trips by the three main gear types used in the Atlantic herring fishery. Observed purse seine and midwater trawl trips are predominantly targeting Atlantic herring, while non-herring trips are included in the SMBT coverage rates reported here.

Table 7 - Midwater trawl, purse seine, and small mesh bottom trawl observer coverage rates, 2012-2016

Gear	2012	2013	2014	2015	2016
Midwater Trawl	40.2%	20.9%	24.4%	4.7%	16.1%
Purse Seine	5.2%	5.8%	3.9%	2.1%	2.2%
Small Mesh Bottom Trawl	4.5%	8.0%	9.5%	9.1%	10.5%

Source: DMIS and OBDBS databases as of December 21, 2017.
Notes: Includes other fisheries using these gear types, **not** just herring and mackerel fisheries. Midwater Trawl includes both single and paired midwater trawl gears. Purse seine excludes tuna purse seine trips. Small mesh bottom trawl includes bottom trawl gear with codend mesh size less than 5.5" except bottom otter twin trawl, scallop and shrimp trawl trips. Rate includes observer trips with at least one observed haul divided by VTR trips reporting kept catch.

Table 8 summarizes all the bycatch species recorded from at-sea observers for the midwater trawl fishery that listed herring as target species 1 or 2. There are a handful of species with relatively larger amounts of total estimated bycatch (over 5,000 pounds in one year), but the bycatch rates are not very high, due to the large volume nature of this fishery (shaded rows in Table 8). The species with the highest bycatch rates are: haddock, whiting, and mackerel, and fish unknown. Table 9 has similar data for purse seine vessels, and Table 10 is a summary of the observed bycatch for bottom trawl vessels that landed at least 6,600 lbs of herring per trip.

Note about Table 8- Table 10: *Catch ratio calculated using observed total catch of each species (kept and discarded) divided by the total kept catch weight (K_{ALL}) for the year. Records for Fish, NK were not included. "Fish,NK" used to categorize catch that could not be sampled by the observer, species mix unknown.*

Table 8 – Summary of bycatch for herring MWT vessels, 2014-2016

	2014			2015			2016		
Species	Lbs Disc	Lbs Kept	Ratio	Lbs Disc	Lbs Kept	Ratio	Lbs Disc	Lbs Kept	Ratio
ALEWIFE	4	4,975	0.00010255	3	1,369	0.00027883	47	4,232	0.00023205
BUTTERFISH	0	705	0.00001452	0	534	0.00010852	23	963	0.00005347
COD, ATLANTIC	0	149	0.00000307	0	0	0.00000000	0	4	0.00000022
DEBRIS	20	0	0.00000041	2,000	0	0.00040643	60	0	0.00000325
DOGFISH	2,353	4	0.00004856	2,489	1,240	0.00075780	8,615	0	0.00046714
DORY, BUCKLER (JOHN)	0	0	0.00000000	0	0	0.00000000	2	0	0.00000013
EEL, SAND LANCE, NK	0	0	0.00000000	0	0	0.00000000	9	0	0.00000047
FISH, NK	563,933	58,284	0.01281545	2,432	0	0.00049422	264,334	80,000	0.01867216
FLOUNDER, AMERICAN PLAICE	1	0	0.00000002	0	0	0.00000000	0	0	0.00000000
HAKE, RED (LING)	2	0	0.00000003	0	0	0.00000000	33	0	0.00000179
HADDOCK	0	153,039	0.00315207	51	21,938	0.00446836	1,570	58,888	0.00327841
HAKE, NK	0	71	0.00000146	0	0	0.00000000	0	0	0.00000000
HAKE, SILVER (WHITING)	3	151,816	0.00312692	0	8,020	0.00162980	267	34,976	0.00191112
HERRING, ATLANTIC	3,565	46,921,000	0.96647878	296	4,866,907	0.98910011	18,814	17,251,248	0.93650181
HERRING, BLUEBACK	619	8,666	0.00019124	3	2,153	0.00043820	2	7,606	0.00041254
HERRING, NK	0	0	0.00000000	225	0	0.00004572	0	0	0.00000000
JELLYFISH, NK	0	0	0.00000000	0	0	0.00000000	12	0	0.00000067
LAMPREY, NK	1	0	0.00000003	0	0	0.00000000	0	0	0.00000000
MACKEREL, ATLANTIC	16	1,223,457	0.02519918	23	16,643	0.00338678	33	989,976	0.05368510
MENHADEN, ATLANTIC	12,047	476	0.00025792	0	0	0.00000000	15	6,822	0.00037073
MONKFISH (GOOSEFISH)	7	47	0.00000111	0	11	0.00000232	0	0	0.00000000
POLLOCK	84	48	0.00000273	240	0	0.00004871	51	53	0.00000565
RAVEN, SEA	4		0.00000007	0	0	0.00000000	0	0	0.00000000
REDFISH, NK (OCEAN PERCH)	641	20,433	0.00043404	24	1,403	0.00028997	2	2,293	0.00012446
SHAD, AMERICAN	3	1,355	0.00002798	0	0	0.00000000	34	678	0.00003861
SQUID, ATL LONG-FIN	0	587	0.00001209	0	603	0.00012254	0	1,636	0.00008872
SQUID, SHORT-FIN	0	6,978	0.00014373	0	19	0.00000386	14	1,659	0.00009074
GRAND TOTAL	583,303	48,552,091		7,786	4,920,840		293,936	18,441,034	

Table 9 – Summary of bycatch for herring PS vessels, 2014-2016

	2014			2015			2016		
Species	Lbs Disc	Lbs Kept	Ratio	Lbs Disc	Lbs Kept	Ratio	Lbs Disc	Lbs Kept	Ratio
ALEWIFE	0	0	0.00000000	0	8	0.00000321	0	0	0.00000000
DOGFISH, SPINY	556	0	0.00014197	0	0	0.00000000	239	0	0.00008000
HAKE, RED (LING)	0	0	0.00000000	0	20	0.00000782	0	0	0.00000000
HAKE, SILVER (WHITING)	0	275	0.00007022	0	1,627	0.00063639	0	3,122	0.00104415
HERRING, ATLANTIC	7	3,915,757	0.99986089	75	2,549,525	0.99726016	4	2,984,135	0.99804240
HERRING, BLUEBACK	0	0	0.00000000	0	0	0.00000000	1	120	0.00004030
LOBSTER, AMERICAN	0	0	0.00000000	15	0	0.00000598	0	0	0.00000000
MACKEREL, ATLANTIC	0	194	0.00004964	1	5,425	0.00212227	2	2,615	0.00087532
SAURY, ATLANTIC	0	0	0.00000008	0	0	0.00000000	0	0	0.00000000
SQUID, SHORT-FIN	1	83	0.00002135	0	0	0.00000000	0	0	0.00000000
GRAND TOTAL	565	3,916,309		92	2,556,605		246	2,989,992	

Table 10 – Summary of bycatch for herring BT vessels, 2014-2016

	2014			2015			2016		
Species	Lbs Disc	Lbs Kept	Ratio	Lbs Disc	Lbs Kept	Ratio	Lbs Disc	Lbs Kept	Ratio
ALEWIFE	7,224	4,104	0.00434897	2,958	7,175	0.01064078	712	7,336	0.00981009
BLUEFISH	10	0	0.00000372	0	0	0.00000000	0	0	0.00000000
BOARFISH, DEEPBODY	18	0	0.00000703	149	0	0.00015647	0	0	0.00000000
BUTTERFISH	209	6,868	0.00271693	270	212	0.00050576	18	53	0.00008655
COD, ATLANTIC	52	13	0.00002496	3	3	0.00000578	1	2	0.00000414
CRAB, HORSESHOE	2	0	0.00000077	0	0	0.00000000	0	0	0.00000000
CRAB, JONAH	7	9	0.00000614	0	0	0.00000000	0	0	0.00000000
CRAB, SPIDER, NK	103	0	0.00003954	0	0	0.00000000	0	0	0.00000000
DEBRIS, FISHING GEAR	235	0	0.00009022	330	0	0.00034655	20	0	0.00002438
DEBRIS, NK	0	0	0.00000000	1,500	0	0.00157525	0	0	0.00000000

	2014			2015			2016		
Species	Lbs Disc	Lbs Kept	Ratio	Lbs Disc	Lbs Kept	Ratio	Lbs Disc	Lbs Kept	Ratio
DOGFISH, CHAIN	0	0	0.00000000	132	0	0.00013862	0	0	0.00000000
DOGFISH, SMOOTH	200	0	0.00007679	0	0	0.00000000	0	0	0.00000000
DOGFISH, SPINY	55	0	0.00002092	4,573	0	0.00480198	15,128	60	0.01851452
DORY, BUCKLER (JOHN)	448	0	0.00017192	223	289	0.00053716	0	0	0.00000000
DRUM, BLACK	0	0	0.00000000	31	0	0.00003287	0	0	0.00000000
EEL, NK	0	0	0.00000000	3	1	0.00000441	0	0	0.00000000
EGGS, ELASMOBRANCH, NK	0	0	0.00000000	0	3	0.00000315	0	0	0.00000000
FISH, NK	51,366	8,000	0.02279219	6,870	1,500	0.00879018	150	10,200	0.01261689
FLOUNDER, FOURSPOT	12	0	0.00000445	636	0	0.00066790	0	0	0.00000000
FLOUNDER, SAND DAB (WINDOWPANE)	25	0	0.00000941	0	2	0.00000210	0	0	0.00000000
FLOUNDER, SUMMER (FLUKE)	9	0	0.00000349	32	2,140	0.00228106	0	0	0.00000000
FLOUNDER, WINTER (BLACKBACK)	7	3	0.00000376	3	0	0.00000284	0	13	0.00001585
FLOUNDER, WITCH (GREY SOLE)	0	0	0.00000000	43	0	0.00004516	0	0	0.00000000
HADDOCK	149	443	0.00022713	0	0	0.00000032	0	0	0.00000000
HAKE, NK	0	0	0.00000000	90	0	0.00009451	0	0	0.00000000
HAKE, RED (LING)	1	0	0.00000046	0	0	0.00000000	0	28	0.00003413
HAKE, SILVER (WHITING)	1,539	663	0.00084541	225	706	0.00097802	13	433	0.00054429
HAKE, SPOTTED	8	0	0.00000292	45	50	0.00009924	1	0	0.00000061
HERRING, ATLANTIC	5,101	2,572,217	0.98950114	1,544	873,571	0.91901423	31	713,237	0.86948983
HERRING, BLUEBACK	3,646	104	0.00143973	221	13,678	0.01459643	1,074	1,814	0.00351993
HERRING, NK	26	2,547	0.00098784	42	0	0.00004411	0	0	0.00000000
JELLYFISH, NK	0	0	0.00000000	0	0	0.00000000	1	0	0.00000061
LOBSTER, AMERICAN	0	0	0.00000000	0	2	0.00000158	2	0	0.00000244
MACKEREL, ATLANTIC	236	611	0.00032492	970	49,896	0.05341741	4	85,093	0.10373567
MENHADEN, ATLANTIC	5	0	0.00000196	0	934	0.00098085	144	1,243	0.00169018
MONKFISH (GOOSEFISH)	32	0	0.00001232	6	92	0.00010250	0	0	0.00000000
OCEAN POUT	0	0	0.00000000	1	0	0.00000116	0	0	0.00000000
SCULPIN, LONGHORN	22	0	0.00000833	5	0	0.00000525	0	49	0.00005973

SCUP	30	0	0.00001163	7	75	0.00008611	0	17	0.00002121
SEA BASS, BLACK	1	0	0.00000035	3	24	0.00002793	0	0	0.00000000
SEA ROBIN, ARMORED	5	0	0.00000196	144	0	0.00015122	0	0	0.00000000
SEA ROBIN, NORTHERN	3	0	0.00000107	1	0	0.00000147	0	0	0.00000000
SEAWEED, NK	17	0	0.00000653	0	10	0.00001050	0	0	0.00000000
SHAD, AMERICAN	174	45	0.00008420	1	291	0.00030654	5	158	0.00019907
SHELL, NK	4	0	0.00000154	0	0	0.00000000	0	0	0.00000000
SILVERSIDE, NK	0	0	0.00000000	0	0	0.00000000	0	3	0.00000366
SKATE, BARNDOOR	19	0	0.00000729	587	0	0.00061645	0	0	0.00000000
SKATE, LITTLE	23	55	0.00002995	2	20	0.00002342	1	12	0.00001585
SKATE, NK	0	30	0.00001152	0	0	0.00000000	0	0	0.00000000
SKATE, ROSETTE	1	0	0.00000031	52	0	0.00005461	0	0	0.00000000
SKATE, SMOOTH	2	0	0.00000077	0	0	0.00000000	0	0	0.00000000
SPONGE, NK	1	0	0.00000038	0	0	0.00000000	0	0	0.00000000
SKATE, WINTER (BIG)	0	0	0.00000000	0	0	0.00000000	4	0	0.00000500
SPONGE, NK	0	0	0.00000000	0	0	0.00000000	0	3	0.00000366
SQUID, ATL LONG-FIN	723	8,715	0.00362338	0	1,441	0.00151308	30	575	0.00073775
SQUID, SHORT-FIN	284	237	0.00019983	0	0	0.00000000	0	0	0.00000000
STARFISH, SEASTAR,NK	0	1	0.00000046	0	0	0.00000000	0	0	0.00000000
TILEFISH, BLUELINE	0	0	0.00000000	0	11	0.00001166	0	0	0.00000000
TILEFISH, GOLDEN	2	0	0.00000088	138	97	0.00024637	0	0	0.00000000
TRIGGERFISH, NK (LEATHERJACKET)	0	0	0.00000012	0	0	0.00000000	0	0	0.00000000
WEAKFISH (SQUETEAGUE SEA TROUT)	0	0	0.00000000	3	14	0.00001733	0	0	0.00000000
GRANT TOTAL	72,033	2,604,664		21,845	952,233		17,339	820,329	

3.3 NON-PROTECTED PREDATOR SPECIES THAT FORAGE ON HERRING

This section includes a description of the life history and stock population status for the major predators of Atlantic herring which are not protected under the Endangered Species Act and/or the Marine Mammal Protection Act, including tuna, some species managed under the Groundfish FMP, and striped bass. Section 3.4 summarizes the life history and stock status information for species that are protected under various environmental laws including marine mammals, protected fish species, sea turtles, and seabirds.

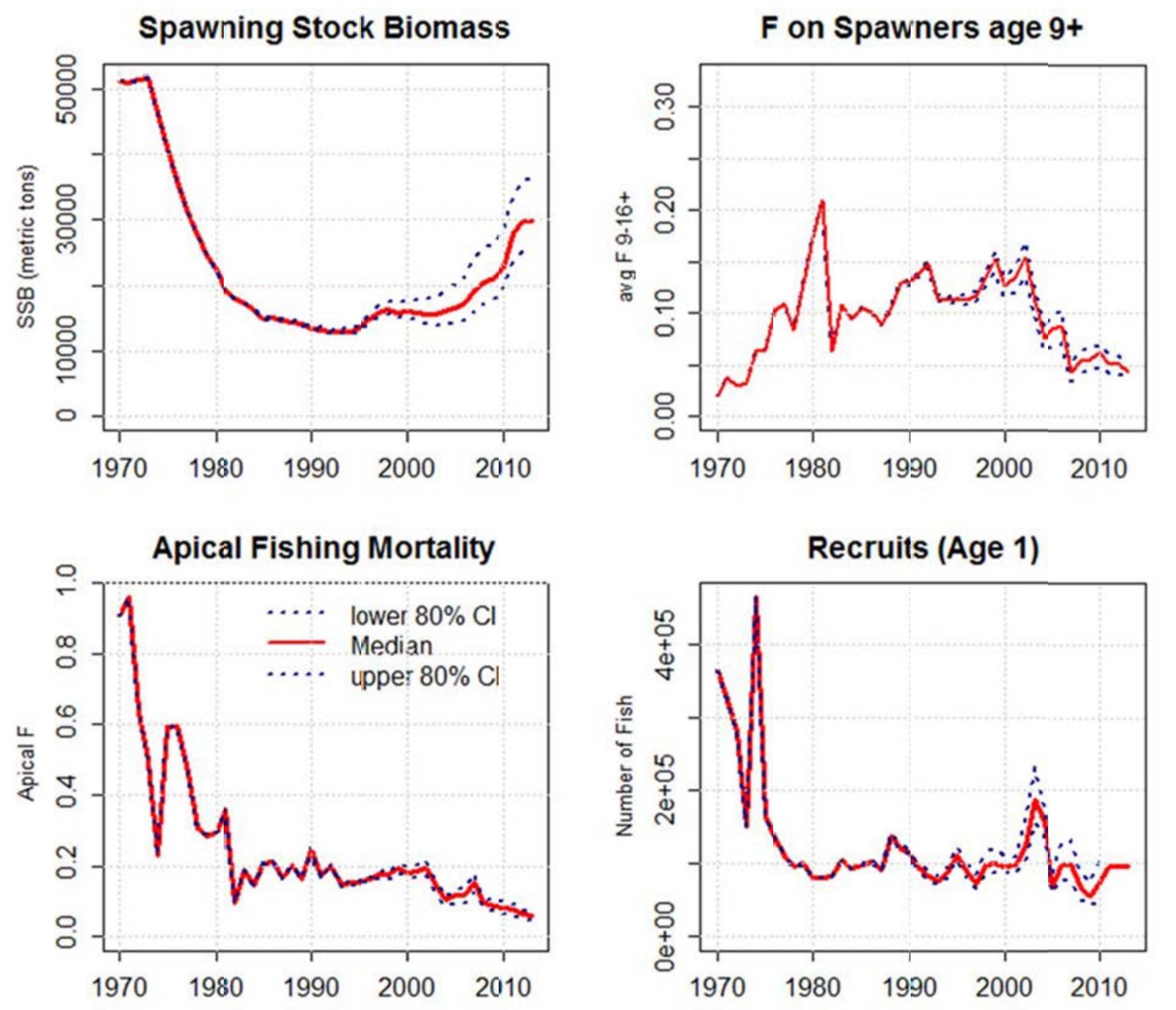
3.3.1 Bluefin Tuna

Population status: Atlantic bluefin tuna (*Thunnus thynnus*) is both a commercially and recreationally important species across the temperate waters of the Atlantic Ocean. They are long lived (up to 40 years) and large, reaching 13 ft long and weighing up to 2000 lb. Bluefin tuna are pelagic. Although they spend most of their time near the ocean surface, they can dive to depths over 1000 m. They are found in Atlantic waters from the Gulf of Mexico north to Newfoundland, and west to the Mediterranean Sea, and are able to thrive in a wide range of conditions, partly because they maintain a consistent body temperature across cold and warm water temperatures (SCRS 2013).

Bluefin tuna are opportunistic feeders with a diet that consists of various species of fish, crustaceans, mollusks, jellyfish, planktonic tunicates, and sponges. Juveniles tend to rely heavily on crustaceans, fish, and cephalopods, while adults primarily eat available baitfish. During spawning season in the Gulf of Mexico (April-June), bluefin feed on both passive (tunicates) and active (fishes, mollusks, crustaceans) prey. When bluefin enter the Gulf of Maine in May and June, their diet centers on Atlantic herring and other fish including sand lance (Chase 2002), while more northerly individuals rely heavily on herring and Atlantic mackerel (Pleizier *et al.* 2012). Sharks, large fish, and marine mammals prey upon bluefin tuna (NMFS 2014c).

Recruitment estimates for bluefin were very high in the early 1970s (Figure 25). From about 1977 to 2011, recruitment varied without trend, except for exceptionally large classes in 2002-03. Stock assessment results indicate the SSB for bluefin tuna peaked at over 300,000 mt in the late 1950s and early 1970s. SSB steadily declined until the early 1990, where it stabilized at between 25-30% of 1970 levels until 2002. Stocks rebounded upon implementation of the rebuilding plan in 1998/1999. Beginning in 2003, there was a steady rise from about 32% of the 1970 SSB to about 55% in 2013. By 2015, bluefin SSB has risen by over 70% since the rebuilding plan began in 1998. Additionally, fishing mortality on both juveniles (age 2-5) and large spawners (age 9+) is down substantially since 2003.

Figure 25 - Bluefin tuna biomass, fishing mortality, and recruitment, 1970-2012



Notes: Median estimates of spawning biomass (age 9+), fishing mortality on spawners, apical fishing mortality (F on the most vulnerable age class) and recruitment for the base VPA model from the 2014 stock assessment. The 80% confidence intervals are indicated with dotted lines. The recruitment estimates for the last three years of the VPA are considered unreliable and have been replaced by the median levels corresponding to the low recruitment scenario (SCRS 2016, with 1970-2014 data).

Management measures for bluefin tuna have been based on the premise that there are two Atlantic bluefin stocks (eastern and western), which are divided by the 45°W meridian. Bluefin tuna are oviparous and iteroparous batch spawners, and females may produce up to 10 M eggs per year. Eastern bluefin stocks are thought to mature at around 25 kg, which generally occurs around age 4. The stock assessments used in developing management measures assume that western bluefin mature around 145 kg (age 9), spawn only in the Gulf of Mexico and Florida Straits, and demonstrate spawning site fidelity. Although a recent study by Richardson *et al.* (2016, detailed at the bottom of this section) disproves some of these assumptions, a new model has not been developed to account for bluefin life history as is currently understood. Thus, this section provides information based on knowledge at the time of the 2014 stock assessment.

Notably, ICCAT and NMFS apply different thresholds for stock status determination of bluefin tuna as follows:

- Overfishing to be occurring when: a) ICCAT: $F_{year}/F_{MSY} > 1.0$; or b) NMFS: $F_{year} > F_{MSY}$. These two definitions are functionally equal.
- Stocks to be overfished when: a) ICCAT: $SSB_{current}/SSB_{MSY} < 1$; or b) NMFS: $SSB_{current}/SSB_{MSY} < 0.86$.

In 2014, the SCRS updated the 2012 stock assessments for both the western and eastern BFT stocks using data collected through 2013. A key factor in determining BFT stock status is the estimation of maximum sustainable yield (MSY)-related benchmarks, which depend largely on the relationship between spawning stock biomass (SSB) and recruitment. There are two competing stock-recruitment relationships that are currently considered for western BFT: the two-line (low recruitment potential) scenario and the Beverton-Holt (high recruitment potential) scenario. Like prior western BFT stock assessments and updates, the SCRS presented status and projection information based on the two divergent stock recruitment scenarios and stated that it has insufficient evidence to favor either scenario over the other. The SCRS' findings did not permit specification of a single MSY level. Generally, under the low recruitment scenario, it is assumed that the stock is not as productive as it once was (i.e., prior to the 1970s) and therefore the MSY is fairly low. Under the high recruitment scenario, it is assumed that the stock can be much more productive as it recovers and the MSY target is much higher. It is important to note that the estimate of current and past SSB is independent of the recruitment scenario. Note that the recruitment assumption (low vs. high recruitment) only affects future SSB projections.

The SSB trends estimated in the 2014 update were consistent with previous analyses in that SSB declined steadily from 1970 to 1992 and has since fluctuated around 25 to 30% of the 1970 level for about the next decade. In recent years, however, there appears to have been a gradual increase in SSB from 32% of the 1970 level in 2003 to an estimated 55% in 2013, with a more rapid increase in recent years. Since 1998, when the rebuilding plan was adopted, the SSB has increased by 70%. The stock has experienced different levels of fishing mortality over time, depending on the size of fish targeted by various fleets. Fishing mortality on spawners (ages 9 and older) declined markedly after 2003.

Since 1977, recruitment has varied from year to year without trend, except for strong year-classes in 2002 and 2003. The 2014 assessment suggests that both the 2002 and 2003 year classes were large; but the estimate of a strong 2002 year class may be an artifact of the lack of direct observations of the age of fish in the catch and recent regulations in the United States that limited the take of fish in that size range. Under the current maturity assumptions (age 9 and older), the 2002/2003 year classes started to contribute to the spawning biomass in 2011/2012. The SCRS noted that the strong 2002/2003 year classes and recent reduction in fishing mortality have contributed to the more rapid increase in SSB in recent years.

Under the low recruitment scenario, the fishing mortality rate (F) for 2010-2012 was 36% of F_{MSY} and the SSB for 2013 was 225% of the SSB that can support maximum sustainable yield (SSB_{MSY}). The MSY estimate was 3,050 mt, with an SSB_{MSY} of 13,226 mt. This means the stock is ***neither overfished nor subject to overfishing***, the current SSB > SSB_{MSY}, and substantial growth in TAC levels cannot happen.

Under the high recruitment scenario, the fishing mortality rate (F) for 2010-2012 was 88% of F_{MSY} and the SSB for 2013 was 48% of SSB_{MSY}. The MSY estimate was 5,316 mt, with an SSB_{MSY} of 63,102 mt. This means that the stock is ***not subject to overfishing, but is overfished***. The stock would not rebuild by the end of the rebuilding period even with no catch. Once rebuilt, however, future TACs could be much higher than under the low recruitment scenario.

This was the first assessment in which the stock was estimated to not be undergoing overfishing under both recruitment scenarios. The SCRS advised that annual catches of below 2,250 mt would have a 50% probability of allowing the SSB to be at or above its current (2013) level by 2019. Maintaining current catch levels (1,750 mt) is expected to allow the SSB to increase more quickly, which may help resolve the issue of low and high recruitment potential. SCRS advised that annual catches of 2,000 mt would continue to allow for stock growth under both recruitment scenarios.

As in the past, the SCRS noted that management actions taken for the eastern Atlantic and Mediterranean stock likely will impact the recovery of the western BFT stock, given evidence that indicates that the productivity of western BFT fisheries is linked to the eastern Atlantic and Mediterranean stock. The SCRS continues to caution that the conclusions of the western BFT assessment do not fully capture the degree of uncertainty in the assessments and projections (e.g., mixing, maturity at age, recruitment, natural mortality, lack of representative samples of otoliths, conflicting and/or biologically implausible abundance indices). The next full stock assessment was delayed from 2015 to 2017, to conduct the necessary preparatory work to incorporate new data and methodologies. Further, to help support the next stock assessment, western harvesters are planning to collaborate in the development of combined indices of abundance.

Taking this information into consideration and following protracted negotiations, ICCAT adopted a two-year measure that increased the TAC to 2,000 mt and maintained key provisions of the previous recommendation, including the allocations to Contracting Parties. This TAC is expected to allow for continued stock growth under both low and high stock recruitment scenarios. A new SCRS stock assessment was conducted in 2017; it is expected to incorporate new data from the research conducted by the Atlantic-wide BFT Research Program and related activities, and to utilize new methodologies and an assessment peer review process.

As mentioned above, Richardson *et al.* (2016) provided evidence that the stock assessment premises were flawed. It found unequivocal evidence that western stocks also spawn in the Slope Sea, an area on the Atlantic coast north of the Gulf Stream and northeast of the U.S. continental shelf. In addition to finding a substantial number of larval bluefin in this area, endocrine testing of tuna caught in the Gulf of Maine and adjacent Slope Sea indicated that all bluefin greater than 131 cm FL (age-5) were fully mature. The study also found that spawning area was likely partitioned by size, with larger bluefin (500 lb+) generally spawning in the Gulf of Mexico and smaller fish (80-500 lb) spawning in the Slope Sea. The study suggested that bluefin may alternately spawn in the Slope Sea and the Gulf of Mexico in different years. In addition, this study indicated that the population structure of bluefin tuna is likely more complex than previously thought, as spawners from the Slope Sea may originate from both the western and eastern population stocks. Stable isotope analysis has demonstrated that while little mixing occurs in bluefin found in the Gulf of Mexico or in the Mediterranean Sea, other areas (e.g., North Carolina winter fishing grounds, Canadian Maritimes, Central North Atlantic) showed a substantial amount of stock mixing (Secor 2015). Recent and ongoing studies are attempting to better understand stock structure and mixing, which may improve fishing mortality estimates.

There is a great deal of uncertainty associated with the state of bluefin stocks. The amount of mixing that occurs between eastern and western stocks is not well understood and varies based on the type of data used in mixing estimations (e.g., tagging, isotope analysis) and the modeling assumptions. The assumptions used in estimating mixing, spawning age and potential, and recruitment are uncertain, which likely skews estimates used in stock assessments. In addition, many indices used in the 2014 stock assessment update show conflicting trends, and individual indices may unduly influence estimates. In some cases, removal of just one of the indices may shift the overall biomass estimate for a stock by up to 33% (SCRS 2013). Collection of more data and incorporation of recently collected data into future stock assessment is necessary to improve estimates of parameters used in bluefin management.

Management: U.S. Atlantic bluefin tuna fisheries are managed under the 2006 Consolidated Highly Migratory Species (HMS) Fishery Management Plan (FMP) and regulations at 50 CFR part 635, pursuant to the authority of the Magnuson-Stevens Act, and Atlantic Tunas Convention Act (ATCA). Under ATCA, the Secretary of Commerce shall promulgate such regulations as may be necessary and appropriate to carry out International Commission for the Conservation of Atlantic Tunas (ICCAT) recommendations. ICCAT is an intergovernmental fishery organization responsible for the conservation of tunas and tuna-like species in the Atlantic Ocean and its adjacent seas.

The Convention entered formally into force in 1969, and there are currently 48 Contracting Parties, including the U.S., Canada, and various other nations from the U.N., Africa, and Asia. ICCAT coordinates research and develops scientific-based management advice on behalf of its members for tuna and tuna-like species. In accordance with the Convention, ICCAT also compiles bycatch information caught during tuna fishing in the Convention area (http://www.iccat.es/en/introduction.htm).

In 1998, ICCAT adopted a 20-year international recovery plan to rebuild stocks of bluefin tuna and in 1999, NOAA implemented the recovery plan into an FMP. The rebuilding plan continued under the 2006 Consolidated HMS FMP. The rebuilding plan considers scientific uncertainties associated with the status of the bluefin stock. Most recently, NOAA implemented Amendment 7 to the HMS FMP with the following objectives:

1) Prevent overfishing and rebuild bluefin tuna, achieve on a continuing basis optimum yield, and minimize bluefin bycatch to the extent practicable by ensuring that domestic bluefin tuna fisheries continue to operate within the overall TAC set by ICCAT consistent with the existing rebuilding plan;
2) Optimize the ability for all permit categories to harvest their full bluefin quota allocations; account for mortality associated with discarded bluefin in all categories; maintain flexibility of the regulations to account for the highly variable nature of the bluefin fisheries; and maintain fairness among permit/quota categories;
3) Reduce dead discards of bluefin tuna and minimize reductions in target catch in both directed and incidental bluefin fisheries to the extent practicable

4) Improve the scope and quality of catch data through enhanced reporting and monitoring to ensure that landings and dead discards do not exceed the quota and to improve accounting for all sources of fishing mortality;
5) Adjust other aspects of the 2006 Consolidated HMS FMP as necessary and appropriate.

ICCAT manages bluefin tuna through a quota system. Quotas are divided between eastern and western bluefin stocks, and the U.S. receives 54% of the western bluefin tuna quota. U.S. regulations further subdivide the quota into recreational and commercial categories, and by gear types (Table 11). Catch in bluefin fisheries is managed by gear restrictions, minimum fish sizes, closed areas, trip limits, and other tools.

Table 11 - U.S. bluefin tuna quota subdivision among recreational and commercial categories.

U.S. Bluefin Tuna Quota*	Recreational Category	Commercial Categories					
	Angling	General	Longline	Purse Seine	Harpoon	Trap	Reserve
Percentage	19.7	47.1	8.1	18.6	3.9	0.1	2.5
MT	195.2	466.7	80.3 + 68 + 25 = 173.3	184.3	38.6	1.0	24.8
*Based on an annual quota of 1,058 mt, where 68 mt is subtracted and allocated to the Longline category before percentages are applied. An additional 25 mt is also allocated to the Longline category to account for catches in the vicinity of the East/West management boundary.							

Tuna Reliance on Herring: Important linkages do exist between bluefin tuna and herring (Golet *et al.* 2013; Golet *et al.* 2015). Aggregations of bluefin and herring are associated with each other, though not all herring aggregations have bluefin present (Schick *et al.* 2004; Schick & Lutcavage 2009). The bluefin tuna fishery is located throughout the entire Gulf of Maine, which is an important tuna foraging ground (Mather *et al.* 1995). The large bluefin tuna that are targeted in commercial fisheries generally enter the Gulf of Maine beginning in May and June of each year. Bluefin spend up to six months in this area feeding on high energy prey such as Atlantic herring (Chase 2002). Historically, large catches of bluefin have been landed in the Kettle, Cape Cod Bay, Stellwagen Bank, Jeffreys Ledge, Great South Channel, Ipswich Bay, Platts Bank, Cashes Ledge, Georges Bank, Wilkinson's Basin, and the Schoodic Ridges. This is not a comprehensive list, rather a highlight of some of the areas which have yielded large landings.

Bluefin rely on herring for a substantial portion of their diet and come to the Gulf of Maine specifically to feed on herring as a lipid source (Golet *et al.* 2013; Logan *et al.* 2015). They are highly dependent upon herring, which comprises up to an estimated 70% of their diet (Logan *et al.* 2015). Bluefin body condition has historically increased during this feeding period (Rodriguez-Marin *et al.* 2015). Recently, a trend has emerged in which these tuna have difficulty in acquiring the lipids needed to improve body condition late in the season. Thus, they are often found in relatively lean condition. Golet *et al.* (2015) found that in spite of high herring abundance, bluefin body condition was low. The authors asserted that a shift in the size structure of Atlantic herring with fewer older and larger fish was to blame for the decline in bluefin condition, and suggested that bluefin body condition is sensitive to the size (and thus, lipid content) of prey even when prey is abundant.

Declines in herring weight and size-at-age have been drastic recently, as average herring weight has declined by 55% between 1981 and 2010. The herring population in the Gulf of Maine show a strong inverse relationship between the number of adult herring and mean length-at-age, with indications that this relationship is a function of overall herring stock numbers (Melvin & Stephenson 2007). In addition, Greene *et al.* (2013) found that bottom-up changes in Gulf of Maine ecosystems may be impacting herring growth. Low rates of fishing mortality (Deroba 2015) and historic changes in herring harvest patterns by fleet indicate that changes in the weight and size-at-age for herring are due to population level changes, not fleet selectivity (Golet *et al.* 2015).

The decline in bluefin condition in the Gulf of Maine may have wide-ranging impacts ecologically. Because bluefin fecundity is influenced by weight, smaller bluefin body conditions may result in decreased egg production and reproductive potential (Medina *et al.* 2002). In addition, fewer large bluefin may remain in the Gulf of Maine because the smaller herring in this area may not improve or maintain body condition. Instead, these fish may forage in areas where herring body condition has not declined and thus, larger herring are more prevalent (e.g., Scotian Shelf, Gulf of St. Lawrence). In this manner, the herring condition decline has changed the historical distribution of bluefin tuna (Golet *et al.* 2015). The decline in bluefin condition may also negatively affect users of the bluefin resource economically. Because of the decline in bluefin condition, foreign and domestic buyers and consumers may find smaller, leaner bluefin less desirable, resulting in a decline in ex-vessel values from captured tuna. In addition, fishers may have to travel greater distances to fishing grounds to capture the larger, fattier, more profitable tuna that no longer forage in the Gulf of Maine.

3.3.2 Large Mesh Multispecies (Groundfish)

There are 13 species managed under the Northeast Multispecies Fishery Management Plan (FMP) as large mesh (groundfish) species, based on fish size and type of gear used to harvest the fish: American plaice, Atlantic cod, Atlantic halibut, Atlantic wolffish, haddock, pollock, redfish, ocean pout, yellowtail flounder, white hake, windowpane flounder, winter flounder, and witch flounder. Several large mesh species are managed as two or more stocks based on geographic region. The NMFS food habits data indicate that herring contributes to diet of several groundfish species: Atlantic cod, haddock, white hake, pollock, Atlantic halibut (<10% per species; Smith & Link 2010). The commercial fishery catches all of these species, but the recreational fishery focuses on GOM cod and GOM haddock (NEFMC 2017).

Population status: Of the seven groundfish stocks for which Atlantic herring is an important prey item, ***three are considered overfished and one is subject to overfishing*** as of the 2017 stock assessment (Table 12)(NEFSC 2017a).

Management: Groundfish has been managed since 1977 with the adoption of a groundfish plan for cod, haddock, and yellowtail flounder. This plan first relied on hard quotas, but the quota system ended in 1982 with the adoption of the Interim Groundfish Plan, which controlled fishing mortality with minimum fish sizes and codend mesh regulations. The Northeast Multispecies FMP replaced this plan in 1986, initially continuing to control fishing mortality with gear restrictions and minimum mesh size, and used biological targets based on a percentage of maximum spawning potential. The FMP has had many revisions in subsequent years. Since 2010, most of the fishery has been managed with a catch share program, in which self-selected groups of commercial fishermen (i.e., sectors) are allocated a portion of the available catch.

Table 12 – Status of selected Northeast groundfish stocks for FY2017

Stock	2017 Assessments	
	Overfishing?	Overfished?
Georges Bank cod	Unknown	Yes
Gulf of Maine cod	Yes	Yes
Georges Bank haddock	No	No
Gulf of Maine haddock	No	No
White hake	No	No
American plaice	No	No
Pollock	No	No
Atlantic halibut	Unknown	Yes
Source: NEFSC (2017a).		

3.3.3 Atlantic Striped Bass

The NMFS food habits database does not always have sufficient samples of striped bass stomach contents to fully assess the contribution of herring in their diet. For example, there were no observations of herring in striped bass stomachs until 1993. Nonetheless, striped bass is among the top predators of Atlantic herring from the database, number 11 overall (NEFSC, 2015). Appendix VI of this document includes more information on striped bass fisheries, and information on herring as diet for striped bass, including estimates of about 10% coastwide, and as high as 30% in some areas and seasons (SEDAR, 2015).

Population status: The 2016 Atlantic striped bass stock assessment indicates the resource is ***neither overfished nor subject to overfishing*** relative to the biological reference points. Although the stock is not overfished, female spawning stock biomass (SSB) has declined since 2004, and in 2015 was estimated at 129M pounds. This is just above the SSB threshold of 127M pounds, and below the SSB target of 159M pounds. Total fishing mortality (F) was estimated at 0.16 in 2015, a value below both the $F_{threshold}$ and F_{target} levels (0.22 and 0.18, respectively; ASMFC 2016a).

Management: Atlantic striped bass is managed by the ASMFC through Amendment 6 to the Interstate Fishery Management Plan for Atlantic Striped Bass and its subsequent addenda (Addendum I-IV). The management program includes target and threshold biological reference points and sets regulations aimed at achieving the targets. Required regulatory measures include recreational and commercial minimum size limits, recreational creel limits, and commercial quotas. States can implement alternative management measures that are deemed to be equivalent to the preferred measures in Amendment 6 through the conservation equivalency process.

3.4 PROTECTED SPECIES: FISH, SEA TURTLES, MARINE MAMMALS, SEABIRDS

Protected species are those afforded protections under the Endangered Species Act (ESA; species listed as threatened or endangered under the ESA) and/or the Marine Mammal Protection Act (MMPA). Table 13 lists protected species that occur in the affected environment of the Atlantic herring FMP and the potential for the fishery to impact the species, specifically via interactions with Atlantic herring fishing gear. The life history and stock status of seabirds is given in Section 3.4.4. Some seabirds are protected under the ESA, and others are not, but are predators of Atlantic herring. Because Atlantic herring is an important prey species of some seabirds in this ecosystem, this VEC includes seabirds that prey on Atlantic herring in this region. The related human communities (i.e., birdwatching ecotourism) are described in Section 3.6.2.7 (p. 191).

Table 13 - Species protected under the ESA and/or MMPA that may occur in the affected environment of the herring FMP

Species	**Status**[2]	***Potential to interact with Atlantic herring fishing gear?***
Cetaceans		
North Atlantic right whale (Eubalaena glacialis)	***Endangered***	***No***
Humpback whale, West Indies DPS, (*Megaptera novaeangliae*)	Protected (MMPA)	Yes
Fin whale (Balaenoptera physalus)	***Endangered***	***Yes***
Sei whale (Balaenoptera borealis)	***Endangered***	***Yes***
Blue whale (Balaenoptera musculus)	***Endangered***	***No***
Sperm whale (Physeter macrocephalus	***Endangered***	***No***
Minke whale (*Balaenoptera acutorostrata*)	Protected (MMPA)	Yes
Pilot whale (Globicephala spp.)[3]	***Protected (MMPA)***	***Yes***
Pygmy sperm whale (*Kogia breviceps*)	Protected (MMPA)	No
Dwarf sperm whale (*Kogia sima*)	Protected (MMPA)	No
Risso's dolphin (*Grampus griseus*)	Protected (MMPA)	Yes
Atlantic white-sided dolphin (*Lagenorhynchus acutus*)	Protected (MMPA)	Yes
Short Beaked Common dolphin (*Delphinus delphis*)	Protected (MMPA)	Yes
Atlantic Spotted dolphin (*Stenella frontalis*)	Protected (MMPA)	No
Striped dolphin (*Stenella coeruleoalba*)	Protected (MMPA)	No
Beaked whales (*Ziphius and Mesoplodon spp*)[4]	Protected (MMPA)	No
Bottlenose dolphin (Tursiops truncatus)[5]	***Protected (MMPA)***	***Yes***
Harbor porpoise (*Phocoena phocoena*)	Protected (MMPA)	Yes
Pinnipeds		
Harbor seal (*Phoca vitulina*)	Protected (MMPA)	Yes
Gray seal (*Halichoerus grypus*)	Protected (MMPA)	Yes
Harp seal (*Phoca groenlandicus*)	Protected (MMPA)	Yes

Species	**Status**[2]	***Potential to interact with Atlantic herring fishing gear?***
Hooded seal (*Cystophora cristata*)	Protected (MMPA)	No
Sea Turtles		
Leatherback sea turtle (*Dermochelys coriacea*)	Endangered	Yes
Kemp's ridley sea turtle (*Lepidochelys kempii*)	Endangered	Yes
Green sea turtle, North Atlantic DPS (*Chelonia mydas*)	Threatened	Yes
Loggerhead sea turtle (*Caretta caretta*), Northwest Atlantic Ocean DPS	Threatened	Yes
Hawksbill sea turtle (*Eretmochelys imbricate*)	Endangered	No
Fish		
Atlantic salmon	Endangered	Yes
Atlantic sturgeon *(Acipenser oxyrinchus)*		
Gulf of Maine DPS	Threatened	Yes
New York Bight DPS, Chesapeake Bay DPS, Carolina DPS & South Atlantic DPS	Endangered	Yes
Cusk *(Brosme brosme)*	Candidate	Yes
Alewife *(Alosa pseudoharengus)*	Candidate	Yes
Blueback herring *(Alosa aestivalis)*	Candidate	Yes
Critical Habitat		
Northwest Atlantic DPS of Loggerhead Sea Turtle	ESA (Protected)	No
North Atlantic Right Whale Critical Habitat	ESA (Protected)	No

Notes: Marine mammal species (cetaceans and pinnipeds) in bold italics are considered MMPA strategic stocks.[1] Shaded rows indicate species who prefer continental shelf edge/slope waters (i.e., >200 m).

[1] A strategic stock is defined under the MMPA as a marine mammal stock for which: (1) the level of direct human-caused mortality exceeds the potential biological removal level; (2) based on the best available scientific information, is declining and is likely to be listed as a threatened species under the ESA within the foreseeable future; and/or (3) is listed as a threatened or endangered species under the ESA, or is designated as depleted under the MMPA (Section 3 of the 1972 MMPA).

[2] Status is defined by whether the species is listed under the ESA as endangered (i.e., at risk of extinction) or threatened (i.e., at risk of endangerment), or protected under the MMPA. Marine mammals listed under the ESA are also protected under the MMPA. Candidate species are those species for which ESA listing may be warranted.

[3] There are two species of pilot whales: short finned (*G. melas melas*) and long finned (*G. macrorhynchus*). Due to the difficulties in identifying the species at-sea, they are often referred to as *Globicephala spp*.

[4] There are multiple species of beaked whales in the Northwest Atlantic. They include the cuvier's (*Ziphius cavirostris*), blainville's (*Mesoplodon densirostris*), gervais' (*Mesoplodon europaeus*), sowerbys' (*Mesoplodon bidens*), and trues' (*Mesoplodon mirus*) beaked whales. Species of *Mesoplodon* are difficult to identify at-sea, therefore, much of the available characterization for beaked whales is to the genus level only.

[5] This includes the Western North Atlantic Offshore, Northern Migratory Coastal, and Southern Migratory Coastal Stocks of Bottlenose Dolphins.

Cusk, alewife, and blueback herring are NMFS "candidate species" under the ESA, a petitioned species for which NMFS has determined that listing may be warranted under the ESA and has initiated an ESA status review through an announcement in the *Federal Register*. If a species is proposed for listing, the conference provisions under Section 7 of the ESA apply (50 CFR 402.10). However, candidate species receive no substantive or procedural protection under the ESA. As a result, cusk will not be discussed further in this and the following sections; however, NMFS recommends that project proponents consider implementing conservation actions to limit the potential for adverse effects on candidate species from any proposed action (http://www.nmfs.noaa.gov/pr/species/esa/candidate.htm).

3.4.1 Protected Species and Critical Habitat Unlikely to be Affected (via interactions with gear or destruction of essential features of critical habitat) by the Atlantic Herring FMP

Based on available information, it has been determined that this action is unlikely to affect (via interactions with gear or destruction of essential features of critical habitat) multiple ESA listed and/or marine mammal protected species or any designated critical habitat (Table 13). This determination has been made because either the occurrence of the species is not known to overlap with the area primarily affected by the action and/or there have never been documented interactions between the species and the primary gear type used to prosecute the Atlantic herring fishery (i.e., purse seine, bottom otter trawl (small mesh), midwater (including pair) trawl; Hayes *et al.* 2017; NEFSC 2015; 2016b; Waring *et al.* 2014a; 2015; Waring *et al.* 2016). In the case of critical habitat, this determination has been made because operation of the Atlantic herring fishery will not affect the essential physical and biological features of North Atlantic right whale or loggerhead turtle (NWA DPS) critical habitat and therefore, will not result in the destruction or adverse modification of any species critical habitat (NMFS 2014a; 2015).

3.4.2 Protected Species Potentially Affected by the Proposed Action

3.4.2.1 Sea Turtles

Kemp's ridley, leatherback, the North Atlantic DPS of green and the Northwest Atlantic DPS of loggerhead sea turtle are the four ESA-listed species of sea turtles that occur in the affected environment of the Atlantic herring fishery. Three of the four species are hard-shelled turtles (i.e., green, loggerhead, and Kemp's ridley). Additional background information on the range-wide status, descriptions, and life histories of these four species is in several published documents, including sea turtle status reviews and biological reports (Conant *et al.* 2009; Hirth 1997; NMFS & USFWS 1995; 2007a; b; 2013; 2015; Seminoff *et al.* 2015; TEWG 1998; 2000; 2007; 2009), and recovery plans for the loggerhead sea turtle (Northwest Atlantic DPS; NMFS & USFWS 2008), leatherback sea turtle (NMFS & USFWS 1992; 1998b), Kemp's ridley sea turtle (NMFS & USFWS 2011), and green sea turtle (NMFS & USFWS 1991; 1998a).

A general overview of sea turtle occurrence and distribution in waters of the Northwest Atlantic Ocean is provided below to assist in understanding how the Atlantic herring fishery overlaps in time and space with sea turtles. Maps depicting the range wide distribution and occurrence of sea turtles in the Greater Atlantic Region is at:
https://www.greateratlantic.fisheries.noaa.gov/protected/section7/listing/index.html; http://marinecadastre.gov/; and http://seamap.env.duke.edu/.

Hard-Shelled Sea Turtles: In U.S. Northwest Atlantic waters, hard-shelled turtles commonly occur throughout the continental shelf from Florida to Cape Cod, Massachusetts, although their presence varies with the seasons due to changes in water temperature (Braun-McNeill *et al.* 2008; Braun & Epperly 1996; Epperly *et al.* 1995a; Epperly *et al.* 1995b; Mitchell *et al.* 2003; Shoop & Kenney 1992; TEWG 2009). While hard-shelled turtles are most common south of Cape Cod, MA, they are known to occur in the Gulf of Maine. Loggerheads, the most common hard-shelled sea turtle in the Greater Atlantic Region, feed as far north as southern Canada. Loggerheads have been observed in waters with surface temperatures of 7 °C to 30 °C, but water temperatures ≥11 °C are most favorable (Epperly *et al.* 1995b; Shoop & Kenney 1992). Sea turtle presence in U.S. Atlantic waters is also influenced by water depth. While hard-shelled turtles occur in waters from the beach to beyond the continental shelf, they are most commonly found in neritic waters of the inner continental shelf (Blumenthal *et al.* 2006; Braun-McNeill & Epperly 2002; Griffin *et al.* 2013; Hawkes *et al.* 2006; Hawkes *et al.* 2011; Mansfield *et al.* 2009; McClellan & Read 2007; Mitchell *et al.* 2003; Morreale & Standora 2005).

Hard-shelled sea turtles occur year-round in waters off Cape Hatteras, North Carolina and south. As coastal water temperatures warm in the spring, loggerheads begin to migrate to inshore waters of the southeast United States and also move up the Atlantic Coast (Braun-McNeill & Epperly 2002; Epperly *et al.* 1995a; Epperly *et al.* 1995b; Epperly *et al.* 1995c; Griffin *et al.* 2013; Morreale & Standora 2005), occurring in Virginia foraging areas as early as late April and on the most northern foraging grounds in the Gulf of Maine in June (Shoop & Kenney 1992). The trend is reversed in the fall as water temperatures cool. The large majority leave the Gulf of Maine by September, but some remain in Mid-Atlantic and Northeast areas until late fall. By December, sea turtles have migrated south to waters offshore of NC, particularly south of Cape Hatteras, and further south (Epperly *et al.* 1995b; Griffin *et al.* 2013; Hawkes *et al.* 2011; Shoop & Kenney 1992).

Leatherback Sea Turtles: Leatherbacks, a pelagic species, are known to use coastal waters of the U.S. continental shelf and to have a greater tolerance for colder water than hard-shelled sea turtles (Dodge *et al.* 2014; Eckert *et al.* 2006; James *et al.* 2005; Murphy *et al.* 2006; NMFS & USFWS 2013). Leatherback sea turtles engage in routine migrations between northern temperate and tropical waters (Dodge *et al.* 2014; James *et al.* 2005; James *et al.* 2006; NMFS & USFWS 1992). They are found in more northern waters (i.e., Gulf of Maine) later in the year (i.e., similar time frame as hard-shelled sea turtles), with most leaving the Northwest Atlantic shelves by mid-November (Dodge *et al.* 2014; James *et al.* 2005; James *et al.* 2006).

3.4.2.2 Large Whales

Humpback, fin, sei, and minke whales are found throughout the waters of the Northwest Atlantic Ocean. In general, these species follow an annual pattern of migration between low latitude (south of 35ºN) wintering/calving grounds and high latitude spring/summer foraging grounds (primarily north of 41N; Hayes *et al.* 2017; NMFS 1991; 2010a; b; Waring *et al.* 2014a; 2015; Waring *et al.* 2016). This, however, is a simplification of whale movements, particularly as it relates to winter movements. It remains unknown if all individuals of a population migrate to low latitudes in the winter, although, increasing evidence suggests that for some species (e.g., humpback whales), some portion of the population remains in higher latitudes throughout the winter (Clapham *et al.* 1993; Hayes *et al.* 2017; Swingle *et al.* 1993; Vu *et al.* 2012; Waring *et al.* 2014a; 2015; Waring *et al.* 2016). Although further research is needed to provide a clearer understanding of large whale movements and distribution in the winter, the distribution and movements of large whales to foraging grounds in the spring/summer is well understood. Movements of whales into higher latitudes coincide with peak productivity in these waters. As a result, the distribution of large whales in higher latitudes is strongly governed by prey availability and distribution, with large numbers of whales coinciding with dense patches of preferred forage (Hayes *et al.* 2017; Payne *et al.* 1986; Payne *et al.* 1990; Schilling *et al.* 1992; Waring *et al.* 2014a; 2015; Waring *et al.* 2016). For additional information on the biology, status, and range-wide distribution of each whale species, refer to: Waring *et al.* (2014a), Waring *et al.* (2015), Waring *et al.* (2016), Hayes *et al.* (2017); and NMFS (1991; 2010a; 2011a).

To further assist in understanding how the Atlantic herring fishery may overlap in time and space with the occurrence of large whales, a general overview of species occurrence and distribution in the area of the Atlantic herring fishery is provided in Table 14.

Table 14 - Large whale occurrence in the affected environment of the Atlantic herring fishery

Species	Prevalence and Approximate Months of Occurrence
Humpback	• Distributed throughout all continental shelf waters of the Mid-Atlantic (Southern New England included), Gulf of Maine, and Georges Bank throughout the year. • New England waters (Gulf of Maine and Georges Bank regions) = **Foraging Grounds** (about March-November). • Mid-Atlantic waters: Migratory pathway to/from northern (high latitude) foraging and southern (West Indies) calving grounds. • Increasing evidence of whales remaining in mid- and high- latitudes throughout the winter. Specifically, increasing evidence of wintering areas (for juveniles) in Mid-Atlantic (e.g., waters near Chesapeake and Delaware Bays; peak presence about January through March) and Southeastern coastal waters.
Fin	• Distributed throughout all continental shelf waters of the Mid-Atlantic (Southern New England included), Gulf of Maine, and Georges Bank throughout the year. • Mid-Atlantic waters: o Migratory pathway to/from northern (high latitude) foraging and southern (low latitude) calving grounds; and o Possible offshore calving area (about October-January). • New England (Gulf of Maine and Georges Bank/ Southern New England) waters = **Foraging Grounds** (greatest densities spring through summer; lower densities fall through winter). Important foraging grounds include: o Massachusetts Bay (esp. Stellwagen Bank); o Great South Channel; o Waters off Cape Cod (~40-50 meter contour); o Gulf of Maine; Perimeter (primarily eastern) of Georges Bank; and o Mid-shelf area off the east end of Long Island. • Evidence of wintering areas in mid-shelf areas east of New Jersey Stellwagen Bank; and eastern perimeter of Georges Bank.

Species	Prevalence and Approximate Months of Occurrence
Sei	• Uncommon in shallow, inshore waters of the Mid-Atlantic (SNE included), Georges Bank, and Gulf of Maine; however, occasional incursions during peak prey availability and abundance. • Primarily found in deep waters along the shelf edge, shelf break, and ocean basins between banks. • Spring through summer, found in greatest densities in offshore waters of the Gulf of Maine and Georges Bank; sightings concentrated along the northern, eastern (into Northeast Channel) and southwestern (around Hydrographer Canyon) edge of Georges Bank.
Minke	• Widely distributed throughout continental shelf waters (<100m deep) of the Mid-Atlantic (Southern New England included), Gulf of Maine, and Georges Bank. • Most common in the EEZ from spring through fall, with greatest abundance found in New England waters; fall through spring widespread and common in deep-ocean waters.
Sources: NMFS (1991; 2010a; 2011a), Hain *et al.* (1992), Payne *et al.* (1984; 1990), CETAP (1982), Clapham *et al.* (1993), Swingle *et al.* (1993), Vu *et al.* (2012), Risch *et al.* (2013), Waring *et al.* (2014a; 2015; 2016), Hayes *et al.* (2017).	

3.4.2.3 Small Cetaceans and Pinnipeds

Small cetaceans occur throughout the year in waters of the Northwest Atlantic Ocean (Hayes 1983; Waring *et al.* 2014a; 2015; Waring *et al.* 2016), though there are seasonal shifts in species distribution and abundance. Pinnipeds are found in nearshore, coastal waters of the Northwest Atlantic Ocean throughout the year or seasonally from New Jersey to Maine. However, some species (e.g., harbor seals) may be extending their range seasonally into waters as far south as Cape Hatteras, North Carolina (35oN; Hayes *et al.* 2017; Waring *et al.* 2007; Waring *et al.* 2014a; 2015; Waring *et al.* 2016).

To further assist in understanding how Atlantic herring fishery may overlap in time and space with the occurrence of small cetaceans and pinnipeds, a general overview of species occurrence and distribution in the affected environment of this amendment is provided in **Table 15**.

Table 15 - Small cetacean and pinniped occurrence in the affected environment of the Atlantic herring fishery

Species	Prevalence and Approximate Months of Occurrence
Atlantic White-Sided Dolphin	• Distributed throughout the continental shelf waters (primarily to 100 m isobath) of the Mid-Atlantic (north of 35°N), Southern New England, Georges Bank, and Gulf of Maine; however, most common in continental shelf waters from Hudson Canyon (~ 39°N) to Georges Bank, and into the Gulf of Maine. • **January-May**: low densities found from Georges Bank to Jeffreys Ledge. • **June-September**: large densities found from Georges Bank through the Gulf of Maine.

Species	Prevalence and Approximate Months of Occurrence
	• **October-December**: intermediate densities found from southern Georges Bank to southern Gulf of Maine. • South of Georges Bank (Southern New England and Mid-Atlantic), low densities found year round, with waters off Virginia and NC representing southern extent of species range during winter months.
Short-Beaked Common Dolphin	• Regularly found throughout the continental shelf-edge-slope waters (primarily between the 100-2,000 m isobaths) of the Mid-Atlantic, Southern New England, and Georges Bank (esp. in Oceanographer, Hydrographer, Block, and Hudson Canyons). • Less common south of Cape Hatteras, NC, although schools have been reported as far south as the Georgia /South Carolina border. • **January-May**: occur from waters off Cape Hatteras, NC, to Georges Bank (35^{o} to 42^{o}N). • **Mid-summer-fall**: occur primarily on Georges Bank with small numbers present in the Gulf of Maine; Peak abundance found on Georges Bank in the autumn.
Risso's Dolphin	• **Spring through fall**: Distributed along the continental shelf edge from Cape Hatteras, NC, to Georges Bank. • **Winter**: distributed in the Mid-Atlantic Bight, extending into oceanic waters. • Rarely seen in the Gulf of Maine; primarily a Mid-Atlantic continental shelf edge species (occur year round).
Harbor Porpoise	• Distributed throughout the continental shelf waters of the Mid-Atlantic (north of 35^{o}N), Southern New England, Georges Bank, and Gulf of Maine. • **July-September**: concentrated in the northern Gulf of Maine (waters < 150 meters); low numbers occur on Georges Bank. • **October-December**: widely dispersed in waters from NJ to Maine; seen from the coastline to deep waters (>1,800 meters). • **January-March**: intermediate densities in waters off NJ to NC; low densities found in waters off NY to Gulf of Maine. • **April-June**: widely dispersed from NJ to ME; seen from the coastline to deep waters (>1,800 meters).
Bottlenose Dolphin	**<u>Western North Atlantic Offshore Stock</u>** • Distributed primarily along the outer continental shelf and continental slope in the Northwest Atlantic from Georges Bank to FL. • Depths of occurrence: ≥40 meters **<u>Western North Atlantic Northern Migratory Coastal Stock</u>** • Warm water months (e.g., July-August): distributed from the coastal waters from the shoreline to about the 25 m isobats between the Chesapeake Bay mouth and Long Island, NY.

Species	Prevalence and Approximate Months of Occurrence
	• Cold water months (e.g., January-March): stock occupies coastal waters from Cape Lookout, NC, to the NC/VA border. **Western North Atlantic Southern Migratory Coastal Stock** • **October-December**: stock occupies waters of southern NC (south of Cape Lookout) • **January-March**: stock moves as far south as northern FL. • **April-June**: stock moves north to waters of NC. • **July-August**: stock is presumed to occupy coastal waters north of Cape Lookout, NC, to the eastern shore of VA.
Pilot Whales: *Short- and Long-Finned*	**Short-Finned Pilot Whales** • Except for area of overlap (see below), primarily occur south of 40ºN • May through December (about): distributed primarily near the continental shelf break of the Mid-Atlantic and Southern New England; beginning in the fall, individuals appear to shift to southern waters (i.e., 35ºN and south). **Long-Finned Pilot Whales** • Except for area of overlap (see below), primarily occur north of 42ºN. • Winter to early spring: primarily distributed along the continental shelf edge-slope. • Late spring through fall (: movements and distribution shift onto/within Georges Bank, the Great South Channel, and Gulf of Maine. **Area of Species Overlap:** between about 38ºN and 41ºN.
Harbor Seal	• Primarily distributed in waters from NJ to ME; however, increasing evidence indicates that their range is extending into waters as far south as Cape Hatteras, NC (35ºN). • **Year Round**: waters of ME • **September-May**: waters from New England to NJ.
Gray Seal	• Distributed in waters from NJ to ME. • Year Round: waters from ME to MA. • September-May: waters from Rhode Island to NJ.
Harp Seal	• Winter-Spring (about January-May): waters from ME to NJ.
Hooded Seal	• Winter-Spring (about January-May): waters of New England.
Notes: Information in table is representative of small cetacean occurrence in the Northwest Atlantic continental shelf waters out to 2,000 m depth. *Sources*: Waring *et al.* (2007; 2014a; 2015; 1992; 2016), Hayes *et al.* (2017), Payne and Heinemann (1993), Payne *et al.* (1984), Jefferson *et al.* (2009).	

3.4.2.4 Atlantic Sturgeon

The marine range of U.S. Atlantic sturgeon extends from Labrador, Canada, to Cape Canaveral, Florida. Atlantic sturgeon from all five DPSs can be anywhere in this marine range (ASSRT 2007; Dadswell 2006; Dadswell *et al.* 1984; Dovel & Berggren 1983; Dunton *et al.* 2012; Dunton *et al.* 2015; Dunton *et al.* 2010; Erickson *et al.* 2011; Kynard *et al.* 2000; Laney *et al.* 2007; O'Leary *et al.* 2014; Stein *et al.* 2004a; Waldman *et al.* 2013; Wirgin *et al.* 2015a; Wirgin *et al.* 2015b; Wirgin *et al.* 2012). Based on fishery-independent and dependent data, as well as data collected from tracking and tagging studies, in the marine environment, Atlantic sturgeon primarily occur inshore of the 50 m depth contour (Dunton *et al.* 2010; Erickson *et al.* 2011; Stein *et al.* 2004a; b); however, Atlantic sturgeon are not restricted to these depths, as excursions into deeper continental shelf waters have been documented (Collins & Smith 1997; Dunton *et al.* 2010; Erickson *et al.* 2011; Stein *et al.* 2004a; b; Timoshkin 1968). Data from fishery-independent surveys and tagging and tracking studies indicate that Atlantic sturgeon may move seasonally along the coast (Dunton *et al.* 2010; Erickson *et al.* 2011; Wipplehauser & Squires 2012). Satellite-tagged adult sturgeon from the Hudson River concentrated in the southern part of the Mid-Atlantic Bight, at depths >20 m, during winter and spring, while in the summer and fall, concentrations shifted to the northern Mid-Atlantic Bight at depths <20 m (Erickson *et al.* 2011).

Within the marine range of Atlantic sturgeon, several aggregation areas have been identified adjacent to estuaries and/or coastal features formed by bay mouths and inlets along the U.S. eastern seaboard (i.e., waters off North Carolina, Chesapeake Bay, and Delaware Bay; New York Bight; Massachusetts Bay; Long Island Sound; and Connecticut and Kennebec River Estuaries); depths in these areas are generally no greater than 25 m (Bain *et al.* 2000; Dunton *et al.* 2010; Erickson *et al.* 2011; Laney *et al.* 2007; O'Leary *et al.* 2014; Oliver *et al.* 2013; Savoy & Pacileo 2003; Stein *et al.* 2004a; Waldman *et al.* 2013; Wipplehauser 2012; Wipplehauser & Squires 2012). Although additional studies are still needed to clarify why these particular sites are chosen by Atlantic sturgeon, they may serve as thermal refuge, wintering sites, or marine foraging areas (Dunton *et al.* 2010; Erickson *et al.* 2011; Stein *et al.* 2004a).

3.4.2.5 Atlantic Salmon

The wild populations of Atlantic salmon are listed as endangered under the ESA. Their freshwater range occurs in the watersheds from the Androscoggin River northward along the Maine coast to the Dennys River, while the marine range of the Gulf of Maine DPS extends from the Gulf of Maine (primarily northern portion of the Gulf of Maine) to the coast of Greenland (Fay *et al.* 2006; NMFS & USFWS 2005; 2016). In general, smolts, post-smolts, and adult Atlantic salmon may be present in the Gulf of Maine and coastal waters of Maine in the spring (beginning in April), and adults may be present throughout the summer and fall months (Baum 1997; Fay *et al.* 2006; Hyvarinen *et al.* 2006; Lacroix & Knox 2005; Lacroix & McCurdy 1996; Lacroix *et al.* 2004; NMFS & USFWS 2005; 2016; Reddin 1985; Reddin & Friedland 1993; Reddin & Short 1991; Sheehan *et al.* 2012; USASAC 2004). For additional information on the on the biology, status, and range-wide distribution of the Gulf of Maine DPS of Atlantic salmon refer to NMFS and USFWS (2005; 2016) and Fay *et al.* (2006).

3.4.3 Gear Interactions with Protected Species

Several protected species are vulnerable to interactions with various types of fishing gear. Interaction risks vary by gear type, quantity, and soak or tow time. Available information on gear interactions with a given protected species (or species group) is provided in the sections below.

These sections are not a comprehensive review of all fishing gear types known to interact with a given species, but focus on interaction risks associated with purse seines, bottom (small mesh) trawls, or midwater trawls, the primary gears used in the Atlantic herring fishery.

3.4.3.1 Gear Interactions with Sea Turtles

Bottom Otter Trawl. Sea turtle interactions with bottom trawl gear have been observed on Georges Bank and in the Mid-Atlantic, but mostly in the Mid-Atlantic (Murray 2015; Warden 2011a; b). As no sea turtle interactions with bottom trawl gear have been observed in the Gulf of Maine, and just few interactions have been observed on Georges Bank, there is insufficient data to conduct a robust model-based analysis on sea turtle interactions with bottom trawl gear in these regions or produce a bycatch estimate for these regions. Thus, the bycatch estimates and discussion below are for bottom trawl gear in the Mid-Atlantic.

Bottom trawl gear poses an injury and mortality risk to sea turtles, specifically due to forced submergence (Sasso & Epperly 2006). Green, Kemp's ridley, leatherback, loggerhead, and unidentified sea turtles have been documented interacting (e.g., bycaught) with bottom trawl gear; however, none of the observed bottom trawl interactions have been attributed to the herring fishery. Although multiple species of sea turtles have been observed in bottom trawl gear, bycatch estimates are available only for loggerhead sea turtles. Warden (2011a; b) estimated that from 2005-2008, the average annual loggerhead interactions in bottom trawl gear in the Mid-Atlantic[1] was 292 (CV=0.13, 95% CI=221-369), with an additional 61 loggerheads (CV=0.17, 95% CI=41-83) interacting with trawls, but released through a Turtle Excluder Device (TED).[2] The 292 average annual observable loggerhead interactions equates to about 44 adult equivalents (Warden 2011a; b). Most recently, Murray (2015) estimated that from 2009-2013, the total average annual loggerhead interactions in bottom trawl gear in the Mid-Atlantic[3] was 231 (CV=0.13, 95% CI=182-298); this equates to about 33 adult equivalents. Bycatch estimates provided in Warden (2011a) and Murray (2015) are a decrease from the average annual loggerhead bycatch in bottom otter trawls during 1996-2004, which Murray (2008) estimated at 616 sea turtles (CV=0.23, 95% CI over the nine-year period: 367-890). This decrease is likely due to decreased fishing effort in high-interaction areas (Warden 2011a; b).

Midwater Trawl: NEFOP and ASM observer data from 1989 to 2015 show five leatherback sea turtle interactions with midwater trawl gear; the primary species landed during these interactions was tuna (NEFSC 2015; 2016b). These takes were in the early 1990s in an experimental HMS fishery that no longer operates. No takes have been documented in other MWT fisheries in the Greater Atlantic Region. Based on the best available information, sea turtle interactions with MWT gear in the Greater Atlantic Region are expected to be ***rare***.

Purse Seine: Sea turtle interactions with purse seines are possible; however, based on available information (NEFSC 2015; 2016b), the risk of a sea turtle interacting with purse seine is

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[1] Warden (2011a) defined the Mid-Atlantic as south of Cape Cod, Massachusetts, to about the North Carolina/South Carolina border.

[2] TEDs allow sea turtles to escape the trawl net, reducing injury and mortality resulting from capture. Approved TEDs are required in the shrimp and summer trawl fishery (50 CFR 223.206 and 68 FR 8456 (February 21, 2003).

[3] Murray (2015b) defined the Mid-Atlantic as the boundaries of the Mid-Atlantic Ecological Production; roughly waters west of 71°W to the North Carolina/South Carolina border.

expected to be ***low***. Sea turtles may be captured in the net and become entangled in the mesh. Captured turtles can be released alive, if they are quickly retrieved and removed from the net.

3.4.3.2 Gear Interactions with Atlantic Sturgeon

Bottom Otter Trawl: Atlantic sturgeon interactions (i.e., bycatch) with bottom trawl gear have been observed since 1989; however, none of the observed bottom trawl interactions have been attributed to the herring fishery (NEFSC 2015; 2016b). Three documents, covering three time periods, that use data collected by the Northeast Fisheries Observer Program to describe bycatch of Atlantic sturgeon in bottom trawl gear are: Stein *et al.* (2004b) for 1989-2000; ASMFC (2007) for 2001-2006; and Miller and Shepard (2011) for 2006-2010; none of these documents provide estimates of Atlantic sturgeon bycatch by Distinct Population Segment. Miller and Shepard (2011), the most recent of the three documents, analyzed fishery observer data and VTR data to estimate the average annual number of Atlantic sturgeon interactions in otter trawl in the Northeast Atlantic that occurred from 2006 to 2010. This timeframe included the most recent, complete data and as a result, Miller and Shepard (2011) is considered to be the most accurate predictor of annual Atlantic sturgeon interactions in the Northeast bottom trawl fisheries (NMFS 2013a).

Based on the findings of Miller and Shepard (2011), NMFS (2013a) estimated that the annual bycatch of Atlantic sturgeon in bottom trawl gear to be 1,342 sturgeon. Miller and Shepard (2011) reported observed Atlantic sturgeon interactions in trawl gear with small (< 5.5 in) and large (≥ 5.5 in) mesh sizes and concluded that, based on NEFOP observed sturgeon mortalities, relative to gillnet gear, bottom trawl gear posed less risk of mortality to Atlantic sturgeon. Estimated mortality rates in gillnet gear were 20.0%, while those in otter trawl gear were 5.0% (Miller & Shepard 2011; NMFS 2013a). Similar conclusions were reached in Stein *et al.* (2004b) and ASMFC (2007) reports; after review of observer data from 1989-2000 and 2001-2006, both studies concluded that observed mortality is much higher in gillnet gear than in trawl gear. Importantly, observed mortality is considered a minimum of what actually occurs, and therefore, the conclusions reached by Stein *et al.* (2004b), ASMFC (2007), and Miller and Shepard (2011) are not reflective of the total mortality associated with either gear type. To date, total Atlantic sturgeon mortality associated with gillnet or trawl gear remains uncertain.

Midwater Trawl: To date, there have been no observed/documented interactions with Atlantic sturgeon in midwater trawl gear (NEFSC 2015; 2016b). Thus, MWT gear is not expected to pose interaction risk to Atlantic sturgeon and therefore, is ***not expected to be a source of injury or mortality*** to this species.

Purse Seine: Capture of sturgeon in purse seines is possible; however, interactions have been extremely rare over the past 26 years. NEFOP and ASM observer data from 1989-2015 show two Atlantic sturgeon interactions with purse seine gear targeting Atlantic herring in the Gulf of Maine (NEFSC 2015; 2016b); these interactions were in 2004 and 2005, prior to the listing of Atlantic sturgeon under the ESA. Thus, although Atlantic sturgeon interactions with purse seine gear are possible, the risk of an interaction is expected to be ***low***.

3.4.3.3 Gear Interaction with Atlantic Salmon

Bottom Otter Trawl: Atlantic salmon interactions (i.e., bycatch) with bottom trawl have been observed since 1989; however, none of the observed bottom trawl interactions have been attributed to the herring fishery (NEFSC 2015; 2016b). According to the Biological Opinion issued by NMFS Greater Atlantic Regional Fisheries Office on December 16, 2013, NMFS Northeast Fisheries Science Center's Northeast Fisheries Observer and At-Sea Monitoring Programs documented 15 individual salmon incidentally caught on more than 60,000 observed commercial fishing trips from 1989 through August 2013 (Kocik *et al.* 2014; NMFS 2013a); of those 15 salmon, four were observed caught in bottom trawl gear (Kocik (NEFSC), pers. comm. (February 11, 2013) in NMFS (2013a)). The genetic identity of these captured salmon is unknown; however, the NMFS 2013 Biological Opinion considers all 15 fish to be part of the Gulf of Maine Distinct Population Segment, although some may have originated from the Connecticut River restocking program (i.e., those caught south of Cape Cod, Massachusetts). Since 2013, no additional Atlantic salmon have been observed in bottom trawl gear (NEFSC 2015; 2016b). Thus, bottom trawl interactions with Atlantic salmon are likely rare (Kocik *et al.* 2014; NMFS 2013a).

Purse Seine and Midwater Trawl: To date, there have been no observed/documented interactions with Atlantic salmon and midwater trawls or purse seines (NEFSC 2015; 2016b). Thus, MWTs and purse seines are not expected to pose an interaction risk to Atlantic salmon and therefore, are ***not expected to be a source of injury or mortality*** to this species.

3.4.3.4 Gear Interactions with Marine Mammals

Depending on species, marine mammal interactions have been observed in bottom trawl, purse seine, and/or midwater trawl gear. Pursuant to the MMPA, NMFS publishes a List of Fisheries (LOF) annually, classifying U.S. commercial fisheries into one of three categories based on the relative frequency of incidental serious injuries and/or mortalities of marine mammals in each fishery (i.e., Category I=frequent; Category II=occasional; Category III=remote likelihood or no known interactions). In the Northwest Atlantic, the 2017 LOF (82 FR 3655 (January 12, 2017)) categorizes the Gulf of Maine herring purse seine fishery as a Category III fishery and commercial bottom trawl (Northeast and Mid-Atlantic) and midwater trawl fisheries (Northeast or Mid-Atlantic) as Category II fisheries.

3.4.3.4.1 Large whales

Bottom Otter and Midwater Trawls: With the exception of one species, there have been no observed interactions with large whales and trawl (bottom or midwater) gear. The one exception is minke whales, which have been observed seriously injured and killed in both types of trawl gear. Over the past 10 years, there have been two observed minke whales incidentally taken in MWT gear. These occurred in 2009 and 2013. The 2009 incident was an entanglement in NOAA research MWT (whale was released alive, but seriously injured). The 2013 incident was an entanglement in a Northeast MWT pair trawl fishing vessel (whale was dead, moderately decomposed; http://www.nefsc.noaa.gov/fsb/take_reports/nefop.html) (Henry *et al.* 2015; Waring *et al.* 2016). Based on the latter incident, reported in Waring *et al.* (2016), the estimated annual average minke whale mortality and serious injury from the Northeast MWT (including pair trawl) fishery from 2009 to 2013 is 0.2; Hayes *et al.* (2017) provided the same estimated annual average minke whale mortality and serious injury from the Northeast MWT (including pair trawl) fishery from 2010 to 2014.

For bottom trawl gear, interactions have only been observed in Northeast fisheries. From 2008-2012, the estimated annual mortality attributed to this fishery was 7.8 minke whales for 2008 and zero minke whales from 2009-2012. No serious injuries were reported during this time. Thus, from 2008-2012, the estimated annual average minke whale mortality and serious injury attributed to the Northeast bottom trawl fishery was 1.6 (CV=0.69) whales (Waring *et al.* 2015). From 2008-2013, mean annual serious injuries and mortalities from the Northeast bottom trawl fishery were 1.40 (CV=0.58) minke whales (Lyssikatos 2015). Serious injury and mortality records for minke whales in U.S. waters from 2010-2014 showed zero interactions with bottom trawl (Northeast or Mid-Atlantic) gear (Hayes *et al.* 2017; Henry *et al.* 2016).

Thus, trawl gear is likely to pose a ***low*** interaction risk to any large whale species. An interaction could pose serious injury or mortality; however, relative to other gear types discussed below (i.e., fixed gear), trawl gear represents a low source serious injury or mortality to any large whale.

Purse Seine: Since 2008, three humpback whales and one fin/sei whale have been documented as interacting with purse seines operating in the Gulf of Maine targeting Atlantic herring. All interactions, however, resulted in the animals being released from the nets unharmed (http://www.nefsc.noaa.gov/fsb/take_reports/nefop.html) (Hayes *et al.* 2017; Henry *et al.* 2015; Waring *et al.* 2016). Thus, although interactions are possible with large whales, purse seines are ***not expected to be a source of injury or mortality*** to them.

3.4.3.4.2 Small cetaceans and pinnipeds

Bottom and Midwater Trawl: Small cetaceans and pinnipeds are vulnerable to interactions with bottom and midwater trawl gear (82 FR 3655 (January 12, 2017); Hayes *et al.* 2017; Read *et al.* 2006; Waring *et al.* 2014a; 2015; Waring *et al.* 2016). As provided in Section 4.5.2.1, small cetacean and pinnipeds have been observed incidentally taken by vessels using midwater and bottom trawl gear to target herring. For additional information on small cetacean and pinniped interactions, see: http://www.nmfs.noaa.gov/pr/sars/region.htm. Based on the most recent five years of observer data (2010-2014), Table 16 lists species that have been observed (incidentally) seriously injured and/or killed by List of Fisheries Category II trawl fisheries that operate in the affected environment of the Atlantic herring fishery (Hayes *et al.* 2017; 82 FR 3655 (January 12, 2017)).

In 2006, based on observed midwater trawl interactions with long-finned pilot whales, short - finned pilot whales, common dolphins, and white sided dolphins, the Atlantic Trawl Gear Take Reduction Team (ATGTRT) was convened to address the incidental mortality and serious injury of these species incidental to bottom and midwater trawl fisheries operating in both the New England and Mid-Atlantic regions. Because none of the marine mammal stocks of concern to the ATGTRT are classified as a "strategic stock", nor do they currently interact with a Category I fishery,[4] it was determined that ***development of a take reduction plan was not necessary***. Instead, the ATGTRT agreed to develop an Atlantic Trawl Gear Take Reduction Strategy (ATGTRS), identifying informational and research tasks, as well as education and outreach needs the ATGTRT believes are necessary to provide the basis for decreasing mortalities and serious injuries of marine mammals to insignificant levels approaching zero. The ATGTRS also identifies several voluntary measures that can be adopted by certain trawl fishing sectors to potentially reduce the incidental capture of marine mammals. For additional information on small cetacean and pinniped interactions, see: http://www.nmfs.noaa.gov/pr/sars/region.htm.

[4] Category I fisheries have frequent incidental mortality and serious injury of marine mammals.

Table 16 - Small cetacean and pinniped species observed seriously injured and/or killed by Category II trawl fisheries in the affected environment of the Atlantic herring fishery

Fishery	Category	Species Observed or reported Injured/Killed
Mid-Atlantic Midwater Trawl-Including Pair Trawl	II	White-sided dolphin
		Gray seal
		Harbor seal
Northeast Midwater Trawl-Including Pair Trawl	II	Short-beaked common dolphin
		Long-finned pilot whales
		Gray seal
		Harbor seal
Northeast Bottom Trawl	II	Harp seal
		Harbor seal
		Gray seal
		Long-finned pilot whales
		Short-beaked common dolphin
		White-sided dolphin
		Harbor porpoise
		Bottlenose dolphin (offshore)
		Risso's dolphin
Mid-Atlantic Bottom Trawl	II	White-sided dolphin
		Short-beaked common dolphin
		Risso's dolphin
		Bottlenose dolphin (offshore)
		Gray seal
		Harbor seal
Sources: Hayes *et al.* (2017); MMPA LOF 82 FR 3655 (January 12, 2017).		

Purse Seine: There have been no observed small cetacean interactions with purse seines used to prosecute any Greater Atlantic Region fishery (primarily Gulf of Maine Atlantic herring). As a result, this gear type is not expected to pose an interaction risk with small cetacean species, and therefore, is ***not expected to be a source of serious injury or mortality*** to any small cetacean.

Purse seines; however, specifically those operating in the Gulf of Maine targeting Atlantic herring, are known to interact with pinniped species. Since 2004, pinniped species have been observed in purse seine gear, but none of these interactions have resulted in mortality or confirmed serious injury to the seal (Table 17) (Hayes *et al.* 2017; Waring *et al.* 2014b) (http://www.nefsc.noaa.gov/fsb/take_reports/nefop.html). Thus, although interactions are possible with seals, purse seines are not expected to pose serious injury or mortality risk to these species. This conclusion is further supported by the fact that the List of Fisheries has identified the Gulf of Maine Atlantic herring purse seine fishery as a Category III fishery, that is, a fishery that causes a remote to no likelihood of causing serious injury or mortality to marine mammals.

Table 17 - 2004-2014 Observed gray and harbor seal interactions with the Gulf of Maine Atlantic herring purse seine fishery

Seal Species	Number of Observed Interactions	Released Alive (No Serious Injury or Mortality)
Unknown	16	Yes
Harbor Seal	21	Yes
Gray Seal	114	Yes

3.4.4 Seabirds

This action includes more emphasis on seabirds as an element of the protected species valued ecosystem component than previous herring management actions due to specific concerns raised during scoping for this action. Over 20 species of seabirds in the northeast rely on herring as prey during parts of their lifecycle. Some of these species are also known to be caught incidentally during herring fishing operations (Hatch 2017; Hatch *et al.* 2016)and Section 4.5.2.2). Seabird ecotourism is an important element of the human community in terms of tourism and recreational opportunities throughout the Northeast and Mid-Atlantic (Section 3.6.2.7).

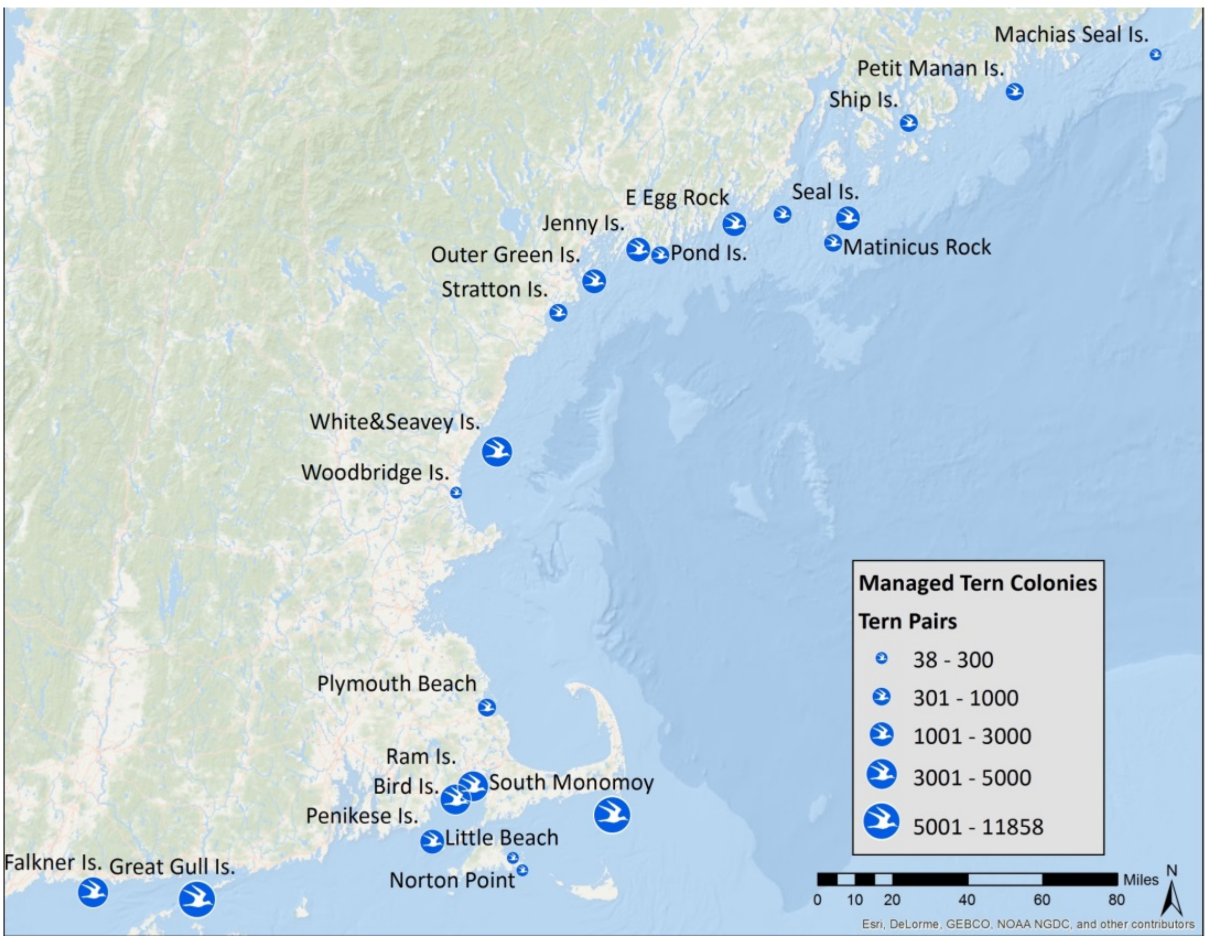
Seabirds may be opportunistic in their foraging, capitalizing on whatever prey species is available at a given time. Therefore, it is likely that, while herring makes up a portion of many species' diets, the proportion is variable. However, such plasticity in seabird food requirements depends on several geographic and temporal factors that are not well understood. Seabirds require access to reliable sources of forage fish throughout the year. Therefore, localized depletion of herring stocks could have a significant impact on their populations and reproductive success, when they are unable to shift to other high-quality prey. While non-breeding seabirds can move around northeast and mid-Atlantic US waters in search of food, nesting seabirds are closely tied to their breeding colonies throughout the nesting season. Breeding seabirds must locate food within commuting distance from the colony, to successfully raise chicks. In recent years, the US Fish and Wildlife Service (USFWS) and their conservation partners have observed declines of 60-80% in tern and puffin productivity when preferred forage fish are not available to nesting birds. The USFWS has documented that breeding Arctic and common terns make 10-15 foraging trips per day, so any factor that increases search time or distance to forage fish could influence seabird productivity rates.

The USFWS also estimates that Arctic terns may fly up to 80 km / trip, demonstrating that these birds are already working for much of the available daylight hours to feed their chicks. While some birds have increased foraging effort, it has not been sufficient to compensate for decreased availability of forage fish in some years, and tern chick productivity remains extremely low in many areas, such as the Gulf of Maine (USFWS unpub data). Research conducted at other tern colonies in the northeast has shown that terns routinely fly 20-40 km to access forage fish (Black 2006, Heinemann 1992, Loring 2016, and Rock et al 2007). The USFWS also tagged razorbills breeding on Matinicus Rock (Matinicus Isle, ME) with satellite tags and determined that the birds were traveling over 30km from the colony to forage. Atlantic puffins and razorbills tagged on Machias Seal Island traveled 32km and 22 km, respectively, from the colony to forage for their chicks (Symons and Diamond, UNB, unpub data).

In the Northeast, terns arrive at the breeding colonies in early to mid-May (Figure 26), peak hatch is early June (CT and MA) and mid-June (ME and NB), with tern chicks fledging mid to late July. Common and roseate terns (~45,000 pairs) stage (rest and refuel) on Cape Cod for 4-6 weeks in late summer and early fall, before continuing their migration to South America. Terns are considered surface feeders, and therefore are unable to access prey that may be located deeper in the water column. Atlantic puffins also arrive at the breeding colonies in early May, chicks hatch in late June - early July, and they remain in their burrows until fledging in mid-August. Puffins can pursue prey underwater and can dive to a depth of 60 meters. Razorbills also begin nesting in May, but their chicks depart the breeding colonies in mid-late July. Razorbills are also pursuit divers and have been documented diving to depths of 120 meters.

During the breeding season, seabirds trying to raise chicks must be able to successfully locate and capture prey within commuting distance of the breeding colony. Once the breeding season has been completed, they have more flexibility in searching out more productivity feeding grounds since they no longer need to return to the colonies. Puffins and Razorbills remain in the Gulf of Maine and adjacent waters of the northwest Atlantic throughout the year. As pursuit divers, these species also can access prey items deeper in the water column than surface feeders like terns.

Figure 26 – Location of tern colonies in the Northeast with active management



Source: USFWS unpub. data

Within the affected environment of the Atlantic herring fishery, few data are available on the composition of seabird diets. A notable exception are the seabird colonies in the Gulf of Maine which have been extensively monitored for decades. Most herring fed to seabird chicks in the Gulf of Maine are <14 cm, so the seabirds are utilizing fish smaller than those targeted for commercial harvest. On Machias Seal Island from 1995-2002, the breeding success of Arctic and common terns, puffins, and razorbills, fluctuated in concert with the fat content of herring in the diet (Devlin and Diamond 2003). In general, seabird chicks fed high-lipid fish grow fast, fledge earlier, and have larger fat reserves and better post-fledging survival than chicks fed poorer quality food (Eilertsen et. al. 2008).

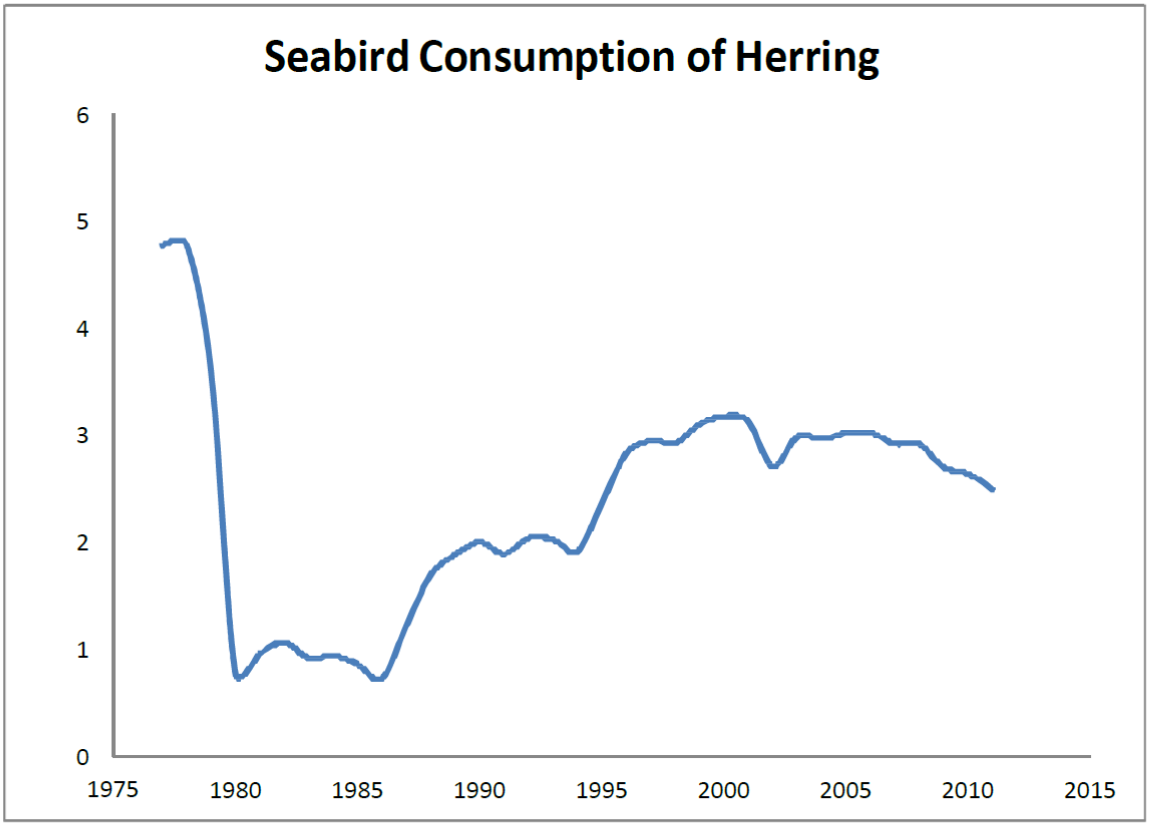
Deleterious effects of decreased proportions of herring fed to seabird chicks on colonies in the Gulf of Maine are highlighted here. Between 1998-2009, the USFWS documented that common terns nesting on Petit Manan Island (Steuben ME) fed their chicks an average of 61% herring (range: 40-95%) and productivity was 1.06 chicks / pair (USFWS unpub data). In more recent years, (2010-2017), the amount of herring that common terns fed their chicks declined to an average of 231% herring (range: 11-38%) and their productivity declined by 14% (average of 0.89 chicks / pair). The Petit Manan tern colony has been able to provide their chicks with hake in recent years, therefore productivity rates have remained stable despite the decline in herring availability.

Atlantic puffin colonies in Maine have experienced similar declines in amount of herring fed to chicks and annual productivity. Since 2010, the amount of herring fed to puffin chicks has declined by approximately 60% while average productivity has declined by 24% (USFWS and National Audubon Society unpub data). On Machias Seal Island (Maine / NB border), terns, Atlantic puffins, and razorbills fed their chicks a diet that averaged 60-90% herring from 1995-2000. By 2000, the amount of herring in the seabirds' diets declined to less than 40%. In recent years, the amount of herring that is fed to chicks has continued to decline and now represents only 10-20%, or less, of the seabird diet (Lauren Scopel, University of New Brunswick, pers comm.). These findings somewhat contradict with the overall increasing trends of herring biomass in the GOM in recent years. However, many seabirds are surface feeders, so prey must be in upper portions of the water column. Furthermore, prey needs to be relatively close to shore and within commuting distance to nests. Therefore, it is possible that herring biomass can be relatively high, but if schools are deeper in the water column or farther offshore, birds may not have sufficient access to support successful forage and productivity.

Herring may also constitute an important food resource for non-breeding seabirds. For example, herring have been found regularly to make up a substantial component of the diet of Great Shearwaters at sea after post-breeding dispersal (Ronconi, et al. 2010). In the Gulf of Maine, the tremendous diversity of non-breeding (i.e. great shearwaters) and migratory seabirds (i.e. northern gannets) far exceeds the number of seabirds that breed here (Diamond 2012). The area supports the majority, if not all, of the North American population of razorbills (est. 52,000 pairs) in the winter, and nationally and internationally significant populations of Arctic terns and Atlantic puffins (USFWS unpub data). These seabirds require persistent aggregations of high quality forage fish to meet the energetic demands of their annual life cycle.

Quarterly estimates of seabird numbers, daily ration, and the proportion of herring in seabird diets were estimated with an uncertainty framework in SAW 54 (NEFSC 2012). This work is an extension of the Overholtz et al. (2008) and Overholtz and Link (2007) methods. Results indicated that, on average, these seabirds consume a relatively small amount herring per year, on the order 3-5 mt (Figure 27). This should be viewed as a lower bound estimate as several factors, namely seabird abundance, are understood to be conservative values.

Figure 27 - Annual estimates of consumption of Atlantic herring by seabirds



Since 2010 several systematic seabird surveys have been conducted in this area, largely by aircraft, by the Atlantic Marine Assessment Program for Protected Species (AMAPPS; https://marinecadastre.gov/espis/#/search/study/100019). These data have been integrated into NOAA abundance and distribution models incorporated into the Northeast Ocean Data Portal (http://www.northeastoceandata.org). These models are summarized in mapping tools characterizing the predicted distribution and abundance for 40 bird species, 29 marine mammal species, and the surveyed biomass of 82 fish species (see Figure 28 for example).

The United States Fish and Wildlife Service (USFWS) is responsible for the conservation and management of seabirds, and works with state agencies and NGO's to manage seabird colonies along the entire eastern seaboard. In 1918, the Migratory Bird Treaty Act was signed into law to protect migratory birds from extinction. A digest of the Act and how US Fish and Wildlife Service implements the Act is at: https://www.fws.gov/laws/lawsdigest/MIGTREA.HTML , and the list of protected species under the Act is at https://www.fws.gov/birds/management/managed-species/migratory-bird-treaty-act-protected-species.php. In recent years, state agencies have identified Species of Greatest Conservation Need (SGCN) as part of their State Wildlife Action Plans. Factors such as risk of extirpation, recent population trends, regional conservation concerns, and vulnerability to climate change were all considered during the species evaluation process. As a result, 14 species of seabirds that consume herring have been listed by the states from Maine to North Carolina, the regulatory range of the Herring FMP. The Atlantic Marine Bird Cooperative (AMBC), a USFWS-coordinated international partnership of agency, NGO, and academic , marine bird experts, has also developed a priority list of seabirds for state wildlife action planning efforts that includes an additional six species beyond those already listed as SGCN by individual states. All these species require robust populations of forage fish to complete their annual breeding cycle and annual migrations. Partners at USFWS have identified a subset of this priority list that are known to consume herring. These species are in Table 18.

Table 18 - Species of Greatest Conservation Need (by State) and Marine Bird Species Priority List

High Conservation Concern	Medium Conservation Concern
Least Tern (ME, NH, MA, RI, CT, NY, NJ, DE,MD,VA))	Arctic Tern (ME,MA)
Roseate Tern (ME, NH, MA, RI, CT, NY)	Common Tern (ME, NH, MA, RI, CT, NY NJ, DE,MD,VA))
Black Skimmer (NY, NJ, DE,MD,VA)	Black-legged Kittiwake (AMBC)
Northern Gannet (AMBC)	Great Shearwater (AMBC)
Red-throated Loon (AMBC)	Manx Shearwater (ME & MA)
Common Loon (AMBC)	Cory's Shearwater (AMBC)
Atlantic Puffin (ME)	Great Cormorant (ME)
Razorbill (ME & NY)	Double-crested Cormorant (ME, NH, MA, RI, CT, NY)
Common Murre (ME)	Herring Gull (ME, NH, MA, CT, NY, DE)
Audubon’s Shearwater (AMBC)	Great Black-backed Gull (ME, NH, MA, RI, CT, NY, DE)
	Low Conservation Concern
	Laughing Gull - (ME, NH, MA, CT, NY)
	Ring-billed gull (ME)
	Gull-Billed Tern (NY NJ, DE,MD,VA))
	Forster’s Tern (NY NJ, DE,MD,VA))
Source: Adapted from the AMBC Priority List by USFWS experts in August 2017.	

As indicated above, the nesting period is a particularly critical life stage when specific high quality forage fish species, such as herring, are relied upon. Estimated numbers of nesting pairs of many of SGCN and AMBC species that consume herring are listed in Table 19. It is important to note, that many of the species in Table 18 do not breed in this region, but would represent tens of thousands of additional seabirds utilizing this area for a portion of the year. While non-breeding seabirds can travel large distances to find forage fish, since they are not geographically limited to foraging near breeding colonies, they still require adequate prey resources to meet the energetic demands of their migration and wintering activities. Therefore, even though these species are not nesting in this ecosystem, they are spending a portion of their life cycle in this area and access to high quality forage fish is important to their overall health and productivity.

Table 19 - Estimated numbers of marine birds breeding in two sectors of the eastern United States and the Bay of Fundy

Species	[1]Gulf of Maine/ Bay of Fundy	[2]Mid-Atlantic Bight	Total
Manx Shearwater	0	0	0
Northern Gannet	9	–	9
Great Cormorant	190	0	190
Double-crested Cormorant	37,000	6100	46,100
Black-legged Kittiwake	25	–	25
Laughing Gull	2000	130,000	132,000
Ring-billed Gull	0	0	0
Herring Gull	57,000	36,000	93,000
Lesser Black-backed Gull	0	–	0
Great Black-backed Gull	37,000	13,000	50,000
Least Tern	2500	9200	11,700
Gull-billed Tern	–	280	280
Roseate Tern	180	3300	3480
Common Tern	15,000	36,000	51,000
Arctic Tern	5400	2	5400
Forster's Tern	0	7200	7200
Black Skimmer	3	2600	2600
Common Murre	120	–	120
Razorbill	1000	–	1000
Atlantic Puffin	4000	–	4000
TOTAL	161,427	243,682	405,109

All numbers in nesting pairs; data are from 1994–95 and are derived from the USGS database for those years, unless otherwise noted. – indicates never recorded breeding in the sector, while 0 indicates a known breeder but not in 1994–95. Numerical estimates are rounded to two significant figures and most are thought to be reliable to ±10–20%.
Source: modified from Nisbet et al (2011).

Life history information for several of these seabirds from the alcid family (seabirds with webbed feet that can fly), has been included in the tables below as background (Table 20 and Table 21). Common tern was identified at the MSE stakeholder workshops as the recommended seabird herring predator because it has more extensive data available and a generally higher proportion of herring in its diet based on that data (Scopel *et al.* 2017). Relative abundance of common terns during summer months, as illustrated in the Northeast Ocean Data Portal (Figure

28), indicate that there are several hotspots along the Northeast coast where common terns congregate before they begin their southward migration.

Table 20 – Alcid life history summary

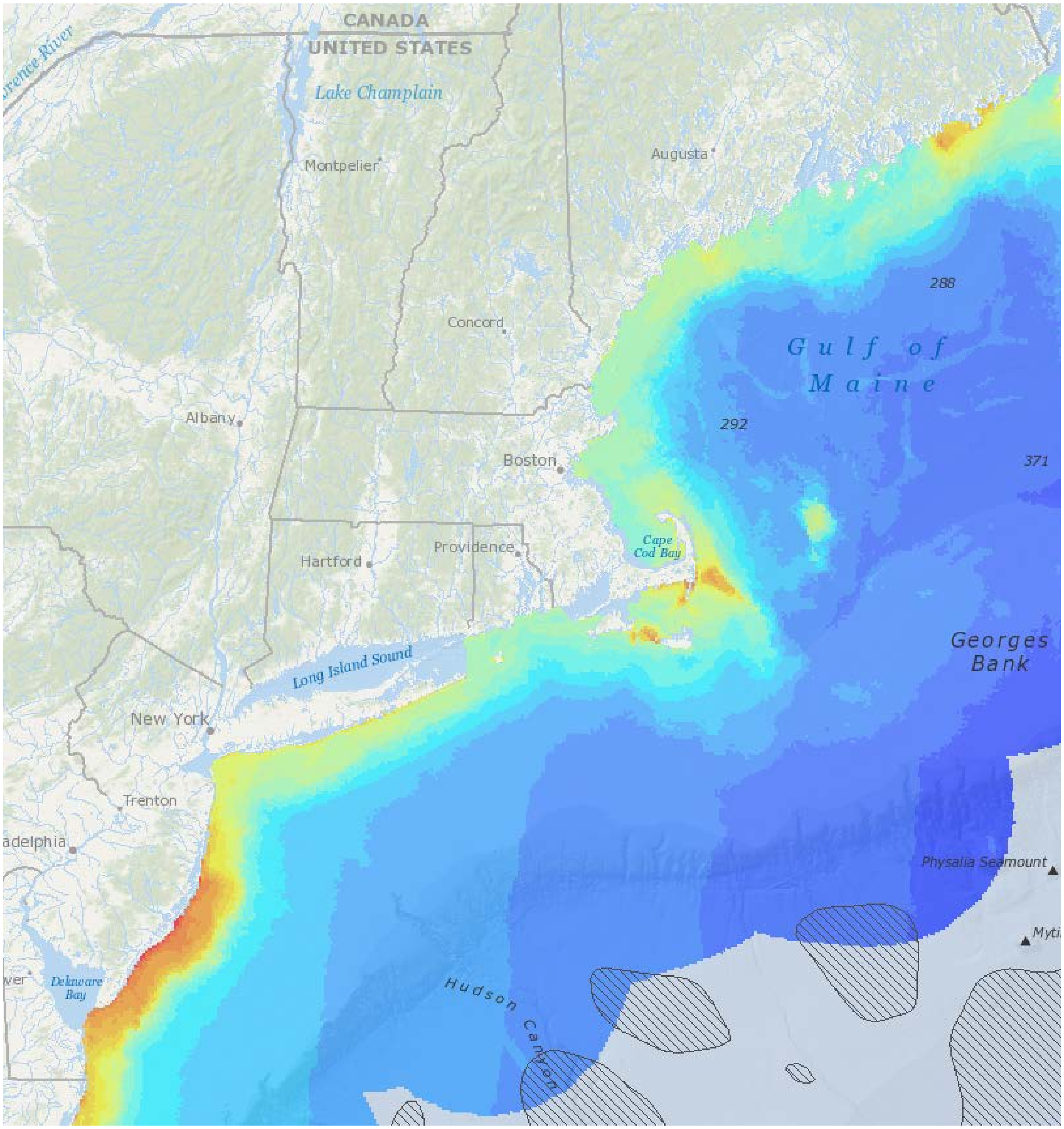
	Razorbill	Atlantic Puffin
North American Breeding Range	Boreal & sub-Arctic waters of Atlantic	Offshore islands from Maine to Greenland, and across the Atlantic to Europe
North American population size	500,000 -700,000 (worldwide)	11.8 million worldwide (6% in eastern North America)
Gulf of Maine Population	3,575 pairs	6,500 pairs
Winter Range	waters off of Newfoundland, Nova Scotia, New Brunswick, and the Gulf of Maine (major area near Grand Manan)	- far offshore, rarely seen during winter - large population off of Newfoundland
Life Span	unknown	30+ years
Adult Survival	~90%	~90-95%
Size of Adults	~720g	~390g (males) ~360g (females) males slightly larger, especially the bill
Colony size	up to 750,000 (NW Iceland)	up to 225,000 pairs (Witless Bay, Newfoundland)
Juvenile Survival	~ 40%	30 - 40%
Age at first breeding	4-5 years	as early as 3 years, but normally 6 years
Breeding Habitat	crevices on cliffs or among boulders and talus	Nests among boulders or in sod burrows (on islands with sufficient soil)

Table 21 – Tern life history summary

	Common Tern	Arctic Tern	Roseate Tern
North American Breeding Range	Coastal Newfoundland to Caribbean, and inland (esp. Great Lakes)	MA to insular Newfoundland, and northwest through Canadian Arctic to Bering Sea	- 2 discrete populations: Nova Scotia to Long Island, and Caribbean
Northeast (ME-NY) population size	41,500 pairs	2,360 pairs	4,085 pairs
Winter Range	Caribbean, South America to Brazil, occasionally Argentina	edge of Antarctic pack ice	Caribbean and South America to Brazil
Migration	Many stage on Cape Cod for 4-6 weeks in late summer, fly south over open ocean through Caribbean to South America	Flies northeast to Nova Scotia, crosses over to western Europe, south to western Africa, south to Antarctic - returns via South America (89,000 km round trip)	travels mainly over ocean, probably migrates with common terns
Life Span	up to 30 years	34 years	up to 30 years
Adult Survival	> 80%	85-90%	~75- 80%
Size of Adults	100 - 130g	100 - 120g	95-130g
Colony size	up to 10,000 pairs	up to 2,250 pairs	up to 1,500 pairs
Age at first breeding	3 (rarely 2)	3-4 years	3-4 years
Breeding Habitat	fresh & saltwater beaches and marshes, treeless islands & barrier beaches	sandy & rocky islands, sand or gravel beaches, dunes ,and tundra	almost exclusively on islands, uses sand, rock and tall vegetation - always with COTE
Nest	simple scrape to intricate nest (> 90% visible from above) frequently adjacent to vegetation or rock	scrape to bare rock; generally less architecture than COTE	Sheltered site in tall vegetation with shallow scape, shrubs, or rock (<30% visible from above)
Clutch size	up to 3 eggs	2-3 eggs (usually 2)	1- 4 eggs (usually 1)
Parental care	both parents share in incubation and feeding	both parents share in incubation and feeding	both parents share in incubation and feeding

	Common Tern	Arctic Tern	Roseate Tern
Incubation period	21 -29 days, depending on disturbance (usually 22)	usually 21 days	usually 21 days
Chick diet	small pelagic schooling fish, and some invertebrates	small pelagic schooling fish, and some crustaceans	small pelagic schooling fish
Age at fledging	27 - 30 days	21 - 24 days	22-30 days (mobile at 2-4 days)
Breeding success	0 - 2.1 chicks / pair	0 - 1.7 chicks / pair	avg = 1.1 chicks /pair
Adult foraging strategy	plunge diving from 1- 6 meters	plunge diving from 1-6 meters	plunge diving or surface dipping, tends to fly into wind, hover, & dive (Usually from 1-6m)
Foraging habitat	usually shallow, inshore waters 20-40 km from breeding colony (average distance = 5.5km)	May forage 20-40 km from colony, averaging foraging distance = 3km, forage in a variety of habitats including: deep water, along rocky shores, and tide rips	Forages over shallow sandbars, tide rips, or shoals for schooling fish. May feed closer to shore than COTE. May travel 25-30km to forage.

Figure 28 – Relative abundance of common tern (during the summer only)



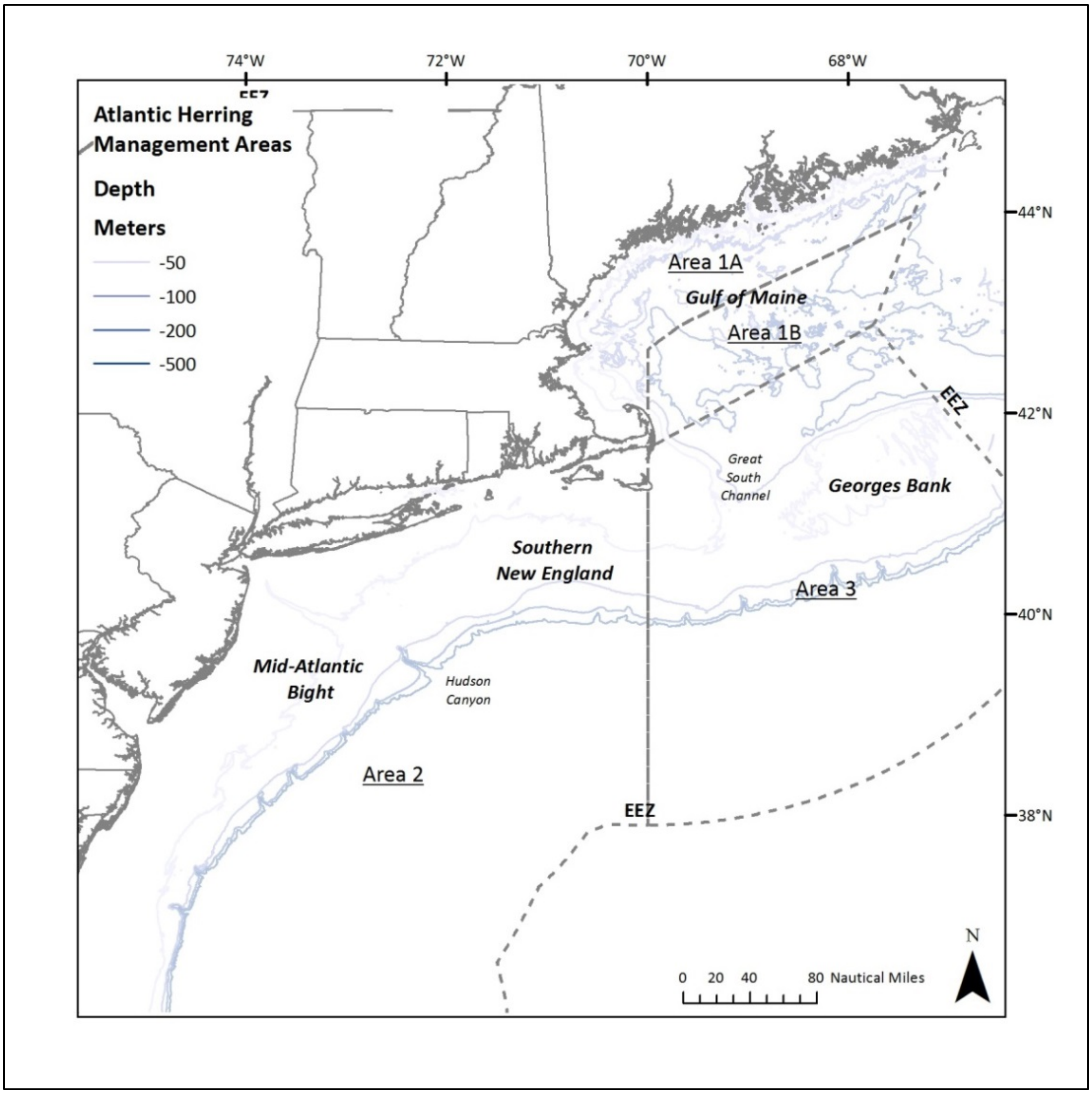
Source: NOAA National Centers for Coastal Ocean Science (NCCOS); http://www.northeastoceandata.org/data-explorer/?birds

3.5 PHYSICAL ENVIRONMENT AND ESSENTIAL FISH HABITAT

3.5.1 Physical Environment

The Atlantic herring fishery occurs in four areas defined as Areas 1A, 1B, 2, and 3 (Figure 29). These areas collectively cover the entire Northeast U.S. shelf ecosystem, which has been defined as the Gulf of Maine south to Cape Hatteras, North Carolina, extending from the coast seaward to the edge of the continental shelf, including offshore to the Gulf Stream (Sherman *et al.* 1996). Three distinct sub-regions, the Gulf of Maine, Georges Bank, and the southern New England/Mid-Atlantic region, were described in the Affected Environment section of Amendment 5 to the Atlantic Herring FMP, based on a summary compiled for the gear effects technical memo authored by Stevenson *et al.* (2004). Roughly, Areas 1A and 1B cover the Gulf of Maine, Area 2 covers southern the New England/Mid-Atlantic region, and Area 3 covers Georges Bank.

Figure 29 – Atlantic Herring Management Areas and the Northeast U.S. shelf ecosystem



3.5.2 Essential Fish Habitat

3.5.2.1 Essential Fish Habitat for Atlantic Herring

The original EFH designation for Atlantic herring was developed as part of EFH Omnibus Amendment 1 in 1998. The final rule for Omnibus Habitat Amendment 2 (OHA2), which includes updates to the EFH designation for herring, published on April 9, 2018 and is now effective (NOAA 2018)(83 FR 15240). New designations for adults and juveniles identify nearly the entire Gulf of Maine as EFH, and designate additional areas on the southern half of Georges Bank. The updated larval designation is similar to the original one. The updated egg designation is the most different from the original, with many additional areas identified as EFH based on the distribution of very small larvae. The updated EFH designation for herring are below. Interactive maps of EFH for each species and life stage are available on NOAA EFH Mapper: http://www.habitat.noaa.gov/protection/efh/efhmapper/index.html. The mapper will be updated to reflect changes from OHA2 after the amendment is published. Other details are in Volume 2 (designations), Appendix A (designation methods), and Appendix B (supplementary information) of OHA2 (http://www.nefmc.org/library/omnibus-habitat-amendment-2).

Eggs: Inshore and offshore benthic habitats in the Gulf of Maine and on Georges Bank and Nantucket Shoals in depths of 5-90 m on coarse sand, pebbles, cobbles, and boulders and/or macroalgae (Figure 30). Eggs adhere to the bottom, often in areas with strong bottom currents, forming egg “beds” that may be many layers deep.

Larvae: Inshore and offshore pelagic habitats in the Gulf of Maine, on Georges Bank, and in the upper Mid-Atlantic Bight (Figure 31), and in the bays and estuaries listed in Table 22. Atlantic herring have a very long larval stage, lasting 4-8 months, and are transported long distances to inshore and estuarine waters where they metamorphose into early stage juveniles (“brit”) in the spring.

Juveniles: Intertidal and sub-tidal pelagic habitats to 300 m throughout the region (Figure 32), including the bays and estuaries listed in Table 22. One and two-year old juvenile herring form large schools and make limited seasonal inshore-offshore migrations. Older juveniles usually occur in water temperatures of 3-15°C in the northern part of their range and as high as 22°C in the Mid-Atlantic. Young-of-the-year juveniles tolerate low salinities, but older juveniles avoid brackish water.

Adults: Sub-tidal pelagic habitats with maximum depths of 300 m throughout the region (Figure 33), including the bays and estuaries listed in Table 22. Adults make extensive seasonal migrations between summer and fall spawning grounds on Georges Bank and the Gulf of Maine and overwintering areas in southern New England and the Mid-Atlantic region. They seldom migrate below 100 m depths and – unless they are preparing to spawn – usually remain near the surface. They generally avoid water temperatures above 10°C and low salinities. Spawning takes place on the bottom, generally in depths of 5-90 m on a variety of substrates (see eggs).

Table 22 – Atlantic herring EFH designation for estuaries and embayments

Estuaries and Embayments	Larvae	Juveniles	Adults
Passamaquoddy Bay	S,M	S,M	S,M
Englishman/Machias Bay	S,M	S,M	S,M
Narraguagus Bay	S,M	S,M	S,M
Blue Hill Bay	S,M	S,M	S,M
Penobscot Bay	S,M	S,M	S,M
Muscongus Bay	S,M	S,M	S,M
Damariscotta River	S,M	S,M	S,M
Sheepscot River	S,M	S,M	S,M
Kennebec / Androscoggin	S,M	S,M	S,M
Casco Bay	S,M	S,M	S
Saco Bay	S,M	S,M	S
Wells Harbor	S,M	S,M	S
Great Bay	S,M	S,M	S
Hampton Harbor*	S,M	S,M	S
Merrimack River	M	M	
Plum Island Sound*	S,M	S,M	S
Massachusetts Bay	S	S	S
Boston Harbor	S	S,M	S,M
Cape Cod Bay	S	S	S
Buzzards Bay		S,M	S,M
Narragansett Bay	S	S,M	S,M
Long Island Sound		S,M	S,M
Gardiners Bay		S	S
Great South Bay		S	S
Hudson River / Raritan Bay	S,M	S,M	S,M
Barnegat Bay		S,M	S,M
New Jersey Inland Bays		S,M	S,M
Delaware Bay		S,M	S
Chesapeake Bay			S

S = The EFH designation for this species includes the seawater salinity zone of this bay or estuary (salinity > 25.0‰).
M = The EFH designation for this species includes the mixing water / brackish salinity zone of this bay or estuary (salinity 0.5-25.0‰).
* This water body was not included in the original ELMR reports, but it was included in the salinity zone maps that were appended to all the relevant fishery management plans and amendments which implemented the no action EFH designations; EFH designations were inferred in these locations if there were ELMR-based designations in the adjacent north and south locations.

Figure 30 – Atlantic herring egg EFH

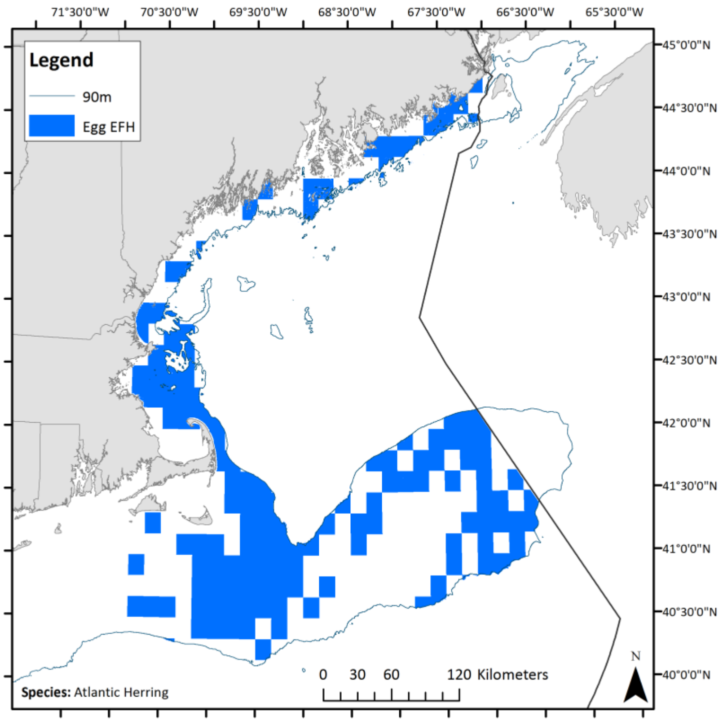


Figure 31 - Atlantic herring larval EFH

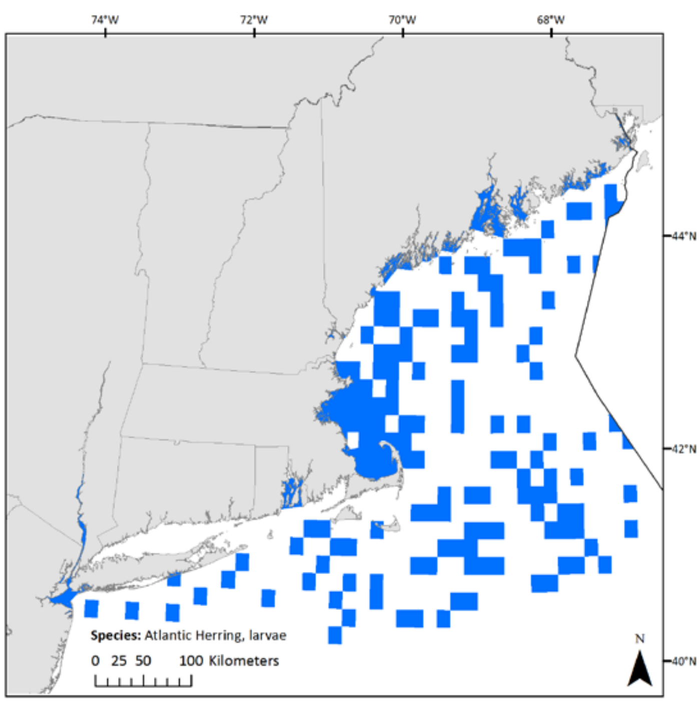


Figure 32 - Atlantic herring juvenile EFH

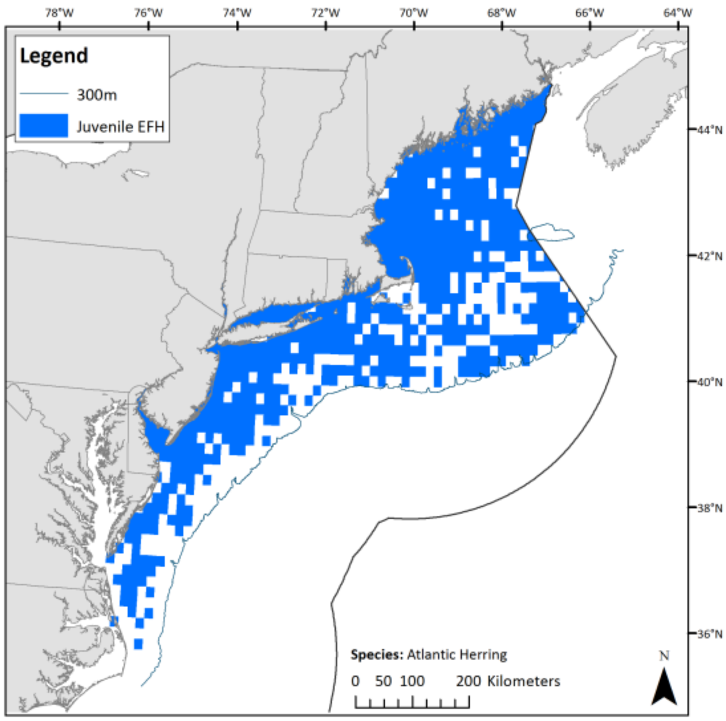
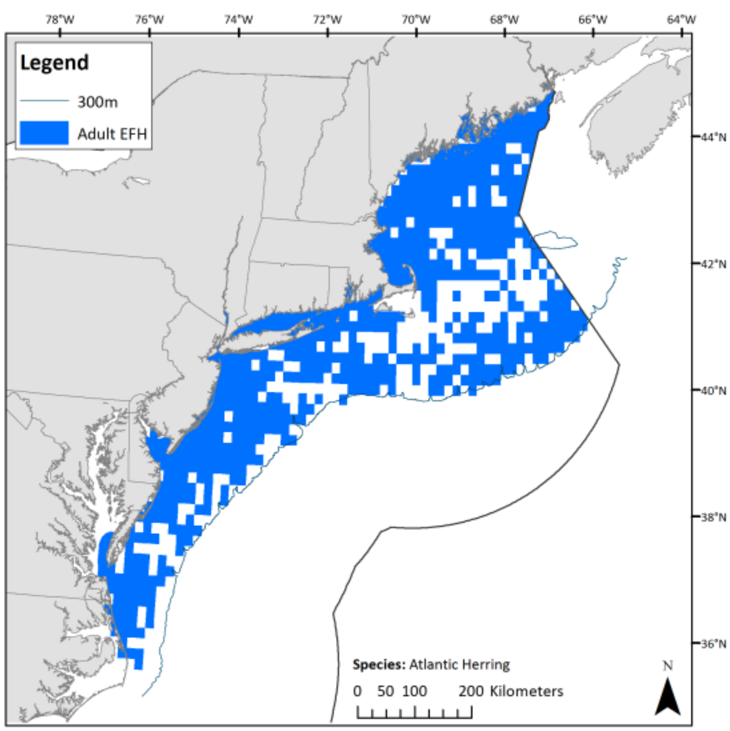


Figure 33 - Atlantic herring adult EFH



3.5.2.2 Essential Fish Habitat for Other Species

The environment that could potentially be affected by the Proposed Action has been identified as EFH for the benthic life stages of the species listed in Table 23. Additional information is in the FMP document that most recently updated each species' EFH designation (last column in Table 23), or on the EFH mapper referenced above. Note that the Mid-Atlantic Fishery Management Council is currently reviewing their EFH designations, but that action is not expected to be completed during the Amendment 8 timeline.

Table 23 - Sources for current EFH designation information

Species	Authority	Plan Managed Under	Last update
Monkfish	NEFMC, MAFMC	Monkfish	OHA2
Atlantic herring	NEFMC	Atlantic Herring	OHA2
Atlantic salmon	NEFMC	Atlantic salmon	OHA2
Atlantic sea scallop	NEFMC	Atlantic Sea Scallop	OHA2
American plaice	NEFMC	NE Multispecies	OHA2
Atlantic cod	NEFMC	NE Multispecies	OHA2
Atlantic halibut	NEFMC	NE Multispecies	OHA2
Atlantic wolffish	NEFMC	NE Multispecies	OHA2
Haddock	NEFMC	NE Multispecies	OHA2
Ocean pout	NEFMC	NE Multispecies	OHA2
Offshore hake	NEFMC	NE Multispecies	OHA2
Pollock	NEFMC	NE Multispecies	OHA2
Red hake	NEFMC	NE Multispecies	OHA2
Redfish	NEFMC	NE Multispecies	OHA2
Silver hake	NEFMC	NE Multispecies	OHA2
White hake	NEFMC	NE Multispecies	OHA2
Windowpane flounder	NEFMC	NE Multispecies	OHA2
Winter flounder	NEFMC	NE Multispecies	OHA2
Witch flounder	NEFMC	NE Multispecies	OHA2
Yellowtail flounder	NEFMC	NE Multispecies	OHA2
Barndoor skate	NEFMC	NE Skate Complex	OHA2
Clearnose skate	NEFMC	NE Skate Complex	OHA2
Little skate	NEFMC	NE Skate Complex	OHA2
Rosette skate	NEFMC	NE Skate Complex	OHA2
Smooth skate	NEFMC	NE Skate Complex	OHA2
Thorny skate	NEFMC	NE Skate Complex	OHA2
Winter skate	NEFMC	NE Skate Complex	OHA2
Red crab	NEFMC	Red Crab	OHA2
Spiny dogfish	MAFMC/NEFMC	Spiny Dogfish	Original FMP
Atlantic surfclam	MAFMC	Atlantic Surfclam Ocean Quahog	Amendment 12
Ocean quahog	MAFMC	Atlantic Surfclam Ocean Quahog	Amendment 12
Bluefish	MAFMC	Bluefish FMP	Amendment 1
Atlantic mackerel	MAFMC	Squid, Mackerel, Butterfish	Amendment 11
Butterfish	MAFMC	Squid, Mackerel, Butterfish	Amendment 11
Longfin squid	MAFMC	Squid, Mackerel, Butterfish	Amendment 11
Shortfin squid (*Illex*)	MAFMC	Squid, Mackerel, Butterfish	Amendment 11
Black sea bass	MAFMC	Summer Flounder, Scup, and Black Sea Bass	Amendment 12
Scup	MAFMC	Summer Flounder, Scup, and Black Sea Bass	Amendment 12
Summer flounder	MAFMC	Summer Flounder, Scup, and Black Sea Bass	Amendment 12
Tilefish	MAFMC	Tilefish	Amendment 1
Note: OHA2 = Omnibus Habitat Amendment 2			

3.6 HUMAN COMMUNITIES

Amendment 8 considers and evaluates the effect management alternatives may have on people's economy, way of life, traditions, and community. These social and economic impacts may be driven by changes in fishery flexibility, opportunity, stability, certainty, safety, and/or other factors. While it is possible that social and economic impacts could be solely experienced by individuals, it is more likely that impacts would be experienced across communities, gear types, and/or vessel size classes.

Summarized here are the fisheries and human communities most likely to be impacted by the Alternatives under Consideration. Social, economic and fishery information presented herein is useful in describing the response of the fishery to past management actions and predicting how the Amendment 8 alternatives may affect human communities. Additionally, this section establishes a descriptive baseline for the fishery with which to compare actual and predicted future changes that result from management actions.

MSFCMA Section 402(b), 16 U.S.C. 1881a(b) states that no information gathered in compliance with the Act can be disclosed, unless aggregated to a level that obfuscates the identity of individual submitters. The fishery data in this amendment are thus aggregated to at least three reporting units, to preserve confidentiality. Additional standards are applied to reporting the fishing activity of particular states or fishing communities. To report landings activity to a specific geographic location, the landings have been attributed to at least three fishing permit numbers and the landings must be sold to three dealer numbers. However, the dealers do not necessarily have to be located in the same specific geographic location.

3.6.1 Herring Fishery

3.6.1.1 Introduction

Atlantic herring has been integral to New England's industry and culture since at least the 1700s (Smylie 2004, p. 76-84). Today, the U.S. Atlantic herring fishery occurs over the Northwest Atlantic shelf region from Cape Hatteras to Maine, including an active fishery in the inshore Gulf of Maine and seasonally on Georges Bank (Figure 24, p. 91). Atlantic herring is managed as one stock complex, but this stock is thought to be comprised of inshore and offshore components that segregate during spawning. In recognition of the spatial structure of the herring resource, the Atlantic herring Annual Catch Limit (ACL) is divided into sub-ACLs and assigned to four herring management areas. Area 1 is the Gulf of Maine (GOM) divided into an inshore (Area 1A) and offshore section (Area 1B); Area 2 is located in the coastal waters between MA and NC (generally referred to as southern New England/Mid-Atlantic), and Area 3 is on Georges Bank (GB).

The Atlantic herring fishery generally occurs south of New England in Area 2 during the winter (January-April), and oftentimes as part of the directed mackerel fishery. There is 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) generally occurs throughout the GOM in Areas 1A, 1B and in Area 3 (GB) as fish are available. Restrictions in Area 1A have pushed the fishery in the inshore GOM 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 sub-ACL split (0% January-May) and the purse seine-fixed gear only area (all of Area 1A) that is effective June-September.

A sub-ACL split for Area 1B (0% January – April, 100% May – December) is effective for all vessels during the 2014 and 2015 fishing years.

Fall and winter fishing (September-December) tends to be more variable and dependent on fish availability; the Area 1A sub-ACL is always fully used, and the inshore GOM fishery usually closes around November. As the 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 is also caught in state waters and in the New Brunswick weir fishery.

3.6.1.2 Current Specifications

The Atlantic herring ABC for 2016-2018 is at the level recommended by the SSC (111,000 mt, Table 24, Table 25) and maintains the 2013-2015 specification of management uncertainty for 2016-2018. The management uncertainty buffer is 6,200 mt to account for catch in the New Brunswick weir fishery. All other Atlantic herring fishery specifications for 2016-2018 are unchanged, including set-asides and the seasonal (monthly) distribution of sub-ACLs (Table 2). Under certain conditions, 1,000 mt of Atlantic herring may be returned to the Area 1A fishery from the management uncertainty buffer.

These specifications include the Council's recommendations for river herring/shad catch caps in the Atlantic herring fishery for the 2016-2018 fishing years (Table 26). The RH/S catch caps continue to apply to midwater trawl vessels in the Gulf of Maine and Cape Cod Catch Cap Areas, and to both MWT and small mesh bottom trawl vessels in the southern New England/Mid-Atlantic Catch Cap Area (see RH/S Catch Cap Areas, Figure 24, p. 91) on all trips landing over 6,600 lbs. of Atlantic herring. No GB RH/S catch cap is in place.

3.6.1.3 Atlantic Herring Catch

The Atlantic herring stock-wide ACL and management area sub-ACLs are tracked/ monitored based on the ***total catch – landings and discards***, which is provided and required by herring vessels through the vessel monitoring system (VMS) catch reports and vessel trip reports (VTRs) as well as through Federal/state dealer data. Atlantic herring harvesters are required to report discards in addition to landed catch through these independent reporting methods.

NMFS' catch estimation methods for the Atlantic herring fishery are described in detail in both Framework Adjustment 2 and Framework Adjustment 3 to the Atlantic Herring FMP (Section 3.6.1 of Framework 3, NEFMC 2014b). The following bullets briefly describe how catch estimates have been derived:

- 2004-2006 Atlantic herring catch estimates are provided from quota management implemented by NMFS through the Atlantic Herring FMP and are based on interactive voice reporting (IVR) data from the call-in system used to monitor TACs. Reported herring discards are included in the totals.
- 2007-2009 Atlantic herring catch estimates are based on IVR data supplemented with dealer data. Reported herring discards are included in the totals.
- 2010-current Atlantic herring catch estimates are based on a comprehensive methodology developed by NMFS in response to Amendment 4 provisions and the need to better monitor sub-ACLs. Catch estimates are based on landings data obtained from dealer

reports (Federal and State), supplemented with VTRs and VMS catch reports (Federal and State of Maine) with the addition of discard data from extrapolated observer data.

Table 24 - 2016-2018 Atlantic herring fishery specifications

Specification	2016-2018
OFL	2016 – 138,000 2017 – 117,000 2018 – 111,000
ABC	111,000
Management Uncertainty	6,200 (Value in 2015)
ACL/OY	104,800[1]
DAH	104,800
DAP	100,800
USAP	0
BT	4,000
Area 1A Sub-ACL (28.9%)	30,300
Area 1B Sub-ACL (4.3%)	4,500
Area 2 Sub-ACL (27.8%)	29,100
Area 3 Sub-ACL (39%)	40,900
RSA	3%
FGSA	295

[1]***NB Weir Payback Provision –*** If, by considering landings through ***October 1,*** NMFS determines that under 4,000 mt has been caught in the NB weir fishery, NMFS will allocate an additional 1,000 mt to the Area 1A sub-ACL to be made available to the directed herring fishery as soon as possible, through the remainder of the fishing year (until the AM is triggered). If this occurs, the stock-wide Atlantic herring ACL would increase to **105,800 mt**.

Table 25 - Seasonal (monthly) sub-ACL divisions, 2016-2018

Area	Seasonal sub-ACL division
1A	0% January-May; 100% June-December
1B	0% January-April; 100% May-December

Table 26 - River herring/shad catch caps, 2016-2018

RH/S Catch Cap Area	2016-2018 RH/S Catch Cap (mt)
GOM	Midwater Trawl – 76.7
CC	Midwater Trawl – 32.4
SNE/MA	Midwater Trawl – 129.6 Bottom Trawl – 122.3
GB	0

The vast majority of the Atlantic herring resource is harvested in Federal waters (Table 27). Catch by Federal permit holders in State waters is counted against the sub-ACLs. Catch by state-only permit holders is monitored by the ASMFC and is not large enough to substantially affect management of the Federal fishery and the ability to remain under the sub-ACLs (Section 3.6.1.3.1). Catch in the New Brunswick weir fishery is accounted for under the management uncertainty buffer (Section 3.6.1.3.1).

Atlantic herring catch has been variable from 2004-2016, averaging 90,000 mt, with the highest catch in 2009 (103,943 mt) and lowest in 2016 (64,801 mt;

Table **28**; Figure 34). However, the quota allocated to the fishery (stock-wide ACL) has decreased during this time. Consequently, the Atlantic herring fishery has become more fully used in recent years, with the exception of 2015 when the fishery became constrained by the Georges Bank Haddock catch cap accountability measure. Total catch is substantially lower today than during the late 1960s to mid-1970s, during the years of foreign fishing (peak at 477,767 mt in 1968; Deroba 2015).

There has been a marked change in removals by area (Figure 35). Post 2007 catches in the offshore areas (Areas 2 & 3) increased while catches inshore decreased. This is likely due to several factors, including the reduction in Area 1A quota from ~60,000 mt in 2005 to ~27,000 by 2010. The temporal and spatial variability of the Atlantic herring fishery may be understood by examining the quota use in each management area monthly over the course of the fishing year. In general, the fishery concentrates in Area 2 during the first few months of the year (BT and MWT effort in Dec-Mar), then effort shifts towards Area 1A through the summer and fall (purse seine gear June through October and MWT gear in Oct and Nov). Midwater vessels also fish in Area 3 in May through October, and Area 1B primarily in May when the area first opens, but more traditionally that area was fished in the fall. These trends have changed to some degree over time as more seasonal access limitations have been implemented; the long term trends are illustrated in Figure 36, which shows average quarterly catch by management area during the years 2000-2006 and 2007-2016, respectively.

Table 27 - Atlantic herring catch (mt), 1970-2014

Year	U.S. Catch			NB weir	Total catch
	Mobile	Fixed	Total		
1970	302,107	4,316	**306,423**	15,070	**321,493**
1971	327,980	5,712	**333,692**	12,136	**345,828**
1972	225,726	22,800	**248,526**	31,893	**280,419**
1973	247,025	7,475	**254,500**	19,053	**273,553**
1974	203,462	7,040	**210,502**	19,020	**229,522**
1975	190,689	11,954	**202,643**	30,816	**233,459**
1976	79,732	35,606	**115,338**	29,207	**144,545**
1977	56,665	26,947	**83,612**	19,973	**103,585**
1978	52,423	20,309	**72,732**	38,842	**111,574**
1979	33,756	47,292	**81,048**	37,828	**118,876**
1980	57,120	42,325	**99,445**	13,526	**112,971**
1981	26,883	58,739	**85,622**	19,080	**104,702**

Year	U.S. Catch			NB weir	Total catch
	Mobile	Fixed	Total		
1982	29,334	15,113	**44,447**	25,963	**70,410**
1983	29,369	3,861	**33,230**	11,383	**44,613**
1984	46,189	471	**46,660**	8,698	**55,358**
1985	27,316	6,036	**33,352**	27,864	**61,216**
1986	38,100	2,120	**40,220**	27,885	**68,105**
1987	47,971	1,986	**49,957**	27,320	**77,277**
1988	51,019	2,598	**53,617**	33,421	**87,038**
1989	54,082	1,761	**55,843**	44,112	**99,955**
1990	54,737	670	**55,407**	38,778	**94,185**
1991	78,032	2,133	**80,165**	24,574	**104,739**
1992	88,910	3,839	**92,749**	31,968	**124,717**
1993	74,593	2,288	**76,881**	31,572	**108,453**
1994	63,161	539	**63,700**	22,242	**85,942**
1995	106,179	6	**106,185**	18,248	**124,433**
1996	116,788	631	**117,419**	15,913	**133,332**
1997	123,824	275	**124,099**	20,551	**144,650**
1998	103,734	4,889	**108,623**	20,092	**128,715**
1999	110,200	654	**110,854**	18,644	**129,498**
2000	109,087	54	**109,141**	16,830	**125,971**
2001	120,548	27	**120,575**	20,210	**140,785**
2002	93,176	46	**93,222**	11,874	**105,096**
2003	102,320	152	**102,472**	9,008	**111,480**
2004	94,628	96	**94,724**	20,685	**115,409**
2005	93,670	68	**93,738**	13,055	**106,793**
2006	102,994	1,007	**104,001**	12,863	**116,864**
2007	81,116	403	**81,519**	30,944	**112,463**
2008	84,650	31	**84,681**	6,448	**91,129**
2009	103,458	98	**103,556**	4,031	**107,587**
2010	67,191	1,263	**68,454**	10,958	**79,412**
2011	82,022	421	**82,443**	3,711	**86,154**
2012	87,164	9	**87,173**	504	**87,677**
2013	95,182	9	**95,191**	6,431	**101,622**
2014	92,651	518	**93,169**	2,149	**95,318**
Source: Deroba (2015). *Note:* The NB weir catch includes the shutoff fishery.					

Table 28 - Atlantic herring sub-ACL allocations and catch by year and management area, 2004-2016

Year	Sub-Area	sub-ACL (mt)	Catch (mt)	% Harvested
2004	1A	60,000	60,095	100%
	1B	10,000	9,044	90%
	2	50,000	12,992	26%

Year	Sub-Area	sub-ACL (mt)	Catch (mt)	% Harvested
	3	60,000	11,074	18%
2005	1A	60,000	61,102	102%
	1B	10,000	7,873	79%
	2	30,000	14,203	47%
	3	50,000	12,938	26%
2006	1A	60,000	59,989	100%
	1B	10,000	13,010	130%
	2	30,000	21,270	71%
	3	50,000	4,445	9%
2007	1A	50,000	49,992	100%
	1B	10,000	7,323	73%
	2	30,000	17,268	58%
	3	55,000	11,236	20%
2008	1A	43,650	42,257	97%
	1B	9,700	8,671	89%
	2	30,000	20,881	70%
	3	60,000	11,431	19%
2009	1A	43,650	44,088	101%
	1B	9,700	1,799	19%
	2	30,000	28,032	93%
	3	60,000	30,024	50%
2010	1A	26,546	28,424	107%
	1B	4,362	6,001	138%
	2	22,146	20,831	94%
	3	38,146	17,596	46%
2011	1A	29,251	30,676	105%
	1B	4,362	3,530	81%
	2	22,146	15,001	68%
	3	38,146	37,038	97%
2012	1A	27,668	24,302	88%
	1B	2,723	4,307	158%
	2	22,146	22,482	102%
	3	38,146	39,471	103%
2013	1A	29,775	29,820	100%
	1B	4,600	2,458	53%
	2	30,000	27,569	92%
	3	42,000	37,833	90%
2014	1A	33,031	32,898	100%
	1B	2,878	4,399	153%
	2	28,764	19,626	68%
	3	39,415	36,323	92%
2015	1A	30,580	29,406	96%

Year	Sub-Area	sub-ACL (mt)	Catch (mt)	% Harvested
	1B	4,922	2,889	59%
	2	32,100	15,214	47%
	3	44,910	33,256	74%
2016	1A	30,524	27,831	91%
	1B	2,844	3,657	129%
	2	31,227	13,463	43%
	3	42,765	18,631	44%

Note: Shaded rows are sub-ACL overages. *Source:* GARFO

Figure 34 – Atlantic herring sub-ACLs (solid lines) and catch (dashed lines) by year and management area, 2004-2016

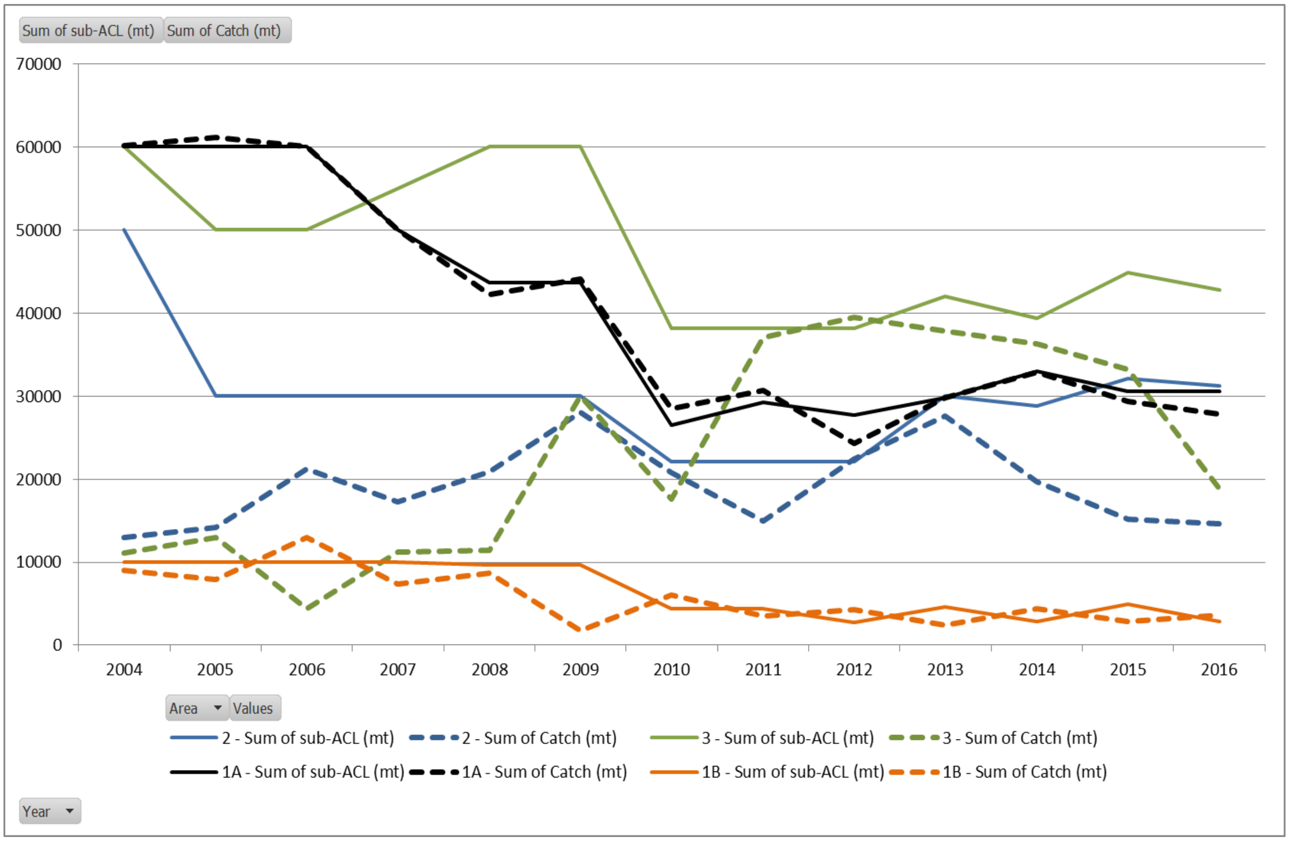


Figure 35 – Atlantic herring catch by year and management area, 2004-2016

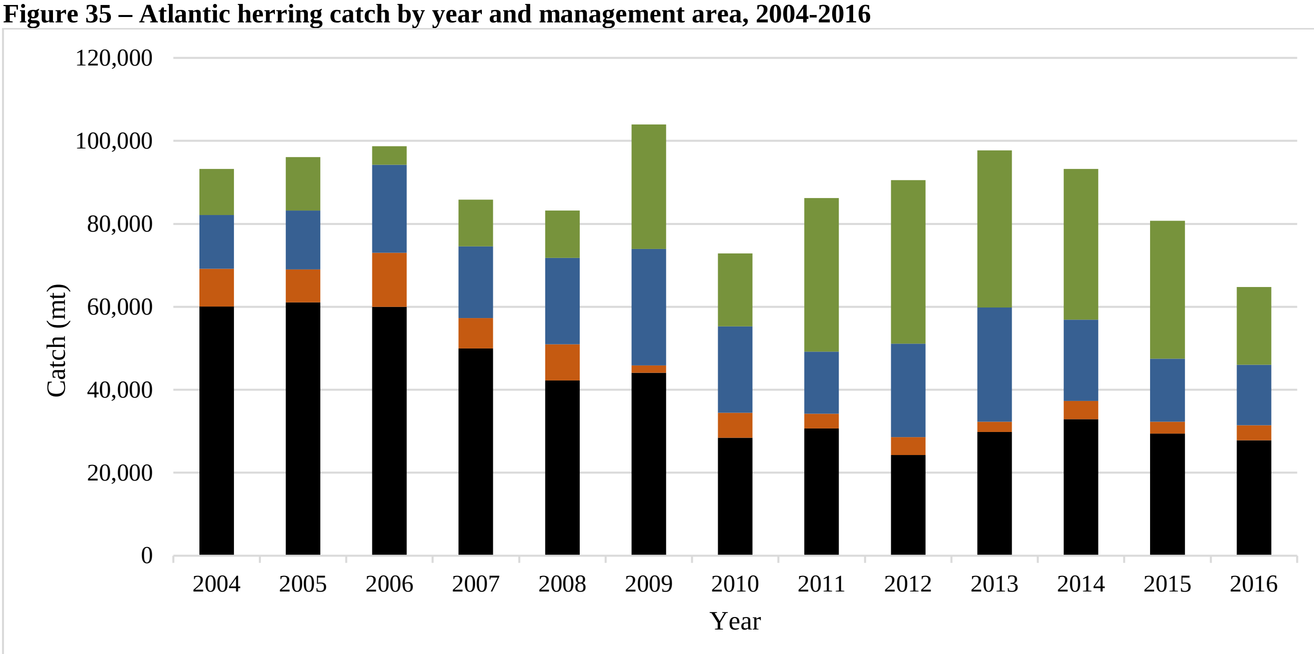
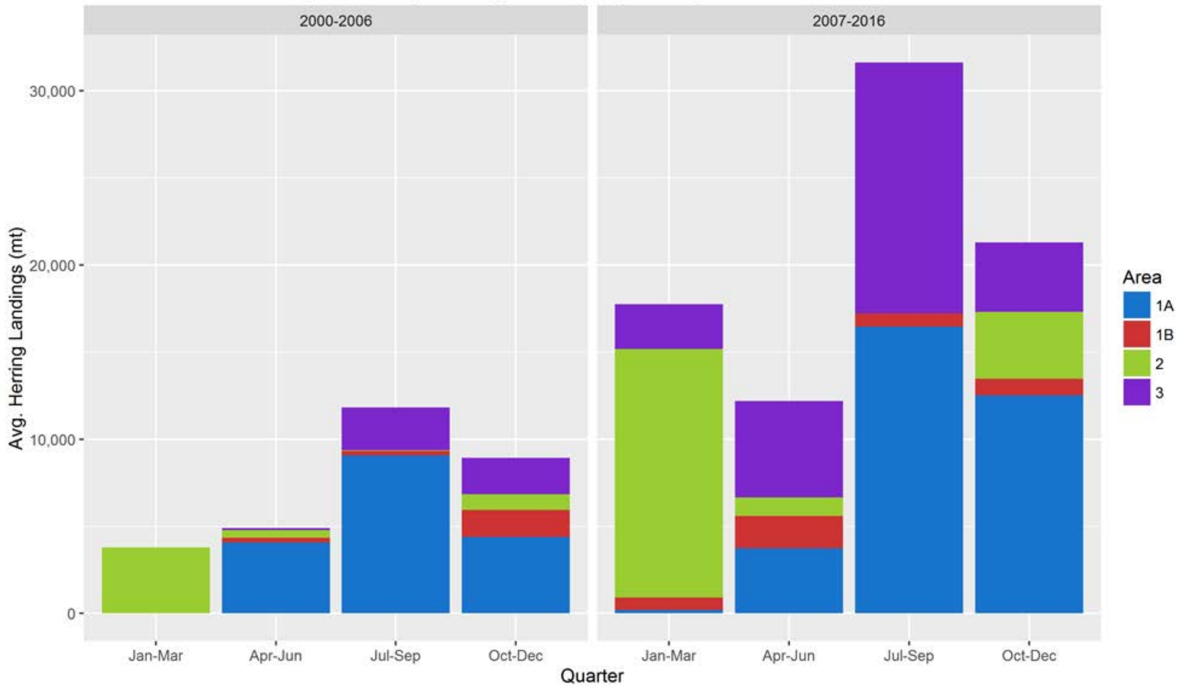


Figure 36 - Average quarterly Atlantic herring landings by management area, 2000-2016



Source: GARFO VTR database, queried 12/27/2017.

Notes: Data are from VTR only (not DMIS) due to the time-series back to 2000. Herring area was determined by the lat/lon on the VTR. Thus, the annual landings will not exactly match herring quota monitoring, which uses a combination of data sources (Dealer, VMS, VTR). The data were aggregated by quarter due to confidentiality reasons. Averages were calculated by summing the total mt in each area for each time period and dividing the total mt by the number of years in the period.

3.6.1.3.1 State Waters Catch of Atlantic Herring

The vast majority of the Atlantic herring resource is harvested in Federal waters. Catch by Federal permit holders that occurs in State waters is reported and counted against the sub-ACLs. Catch by state-only permit holders is monitored by the ASMFC and is not large enough to substantially affect management of the Federal fishery and the ability to remain under the sub-ACLs (Table 29). Total Atlantic herring catch by vessels fishing in state waters was about 19 mt in 2015. The recent state-only permitted commercial landings of Atlantic herring are by fishermen in Maine, about three using fixed gear and about three using purse seines.

The Council specifies a set-aside for West of Cutler fixed gear fishermen (FGSA), currently 295 mt. The unused portion of the FGSA is returned to the Area 1A fishery after November 1. The ASMFC's requirement that fixed gear fishermen must report through IVR (and therefore have catch counted against the sub-ACL) has reduced any management uncertainty associated with State waters landings to an unsubstantial amount. Additionally, MEDMR requires the Maine state commercial fixed gear fishermen to comply with the federal IVR weekly reporting requirements and regulations as well as reporting monthly to MEDMR.

Table 29 - Atlantic herring landings from fixed gear fishery, before and after November 1 rollover date

Year	Area 1A Sub-ACL		Cumulative Catch (mt) by Dec 31	Fixed Gear Landings (mt)	
	Closure Date	mt		Jan-Oct	Nov-Dec
2004	11/19/2004	60,000	60,095	49	0
2005	12/2/2005	60,000	61,102	53	0
2006	10/21/2006	50,000	59,989	528	0
2007	10/25/2007	50,000	49,992	392	0
2008	11/14/2008	43,650	42,257	24	0
2009	11/26/2009	43,650	44,088	81	0
2010	11/17/2010	26,546	28,424	823	0
2011	10/27/2011	29,251	30,676	23	0
2012	11/5/2012	27,668	24,302	0	0
2013	10/15/2013	29,775	29,820	6	0
2014	10/26/2014	33,031	32,898	8	0
2015	11/2/2015	30,580	29,406	15	0
2016	10/18/2016	30,524	27,831	21	0
Source: GARFO, ASMFC.					

3.6.1.3.2 Canadian Catch of Atlantic Herring

Catch of the Atlantic herring stock complex in Canadian waters consists primarily of fish caught in the New Brunswick (NB) weir fishery. During the benchmark stock assessment for Atlantic herring (2012), the SARC 54 Panel noted that the contribution of the Atlantic herring stock on the Scotian Shelf region is unknown. It is generally assumed that juvenile fish (age 1 and 2) caught in the NB weir fishery are from the inshore (GOM) component of the Atlantic herring stock complex, while adult fish (age 3+) caught in the NB weir fishery are from the SW Nova Scotia stock complex (4WX). NB weir fishery catch is not tracked in-season against the U.S. Atlantic herring ACL. Rather, the annual expected catch in the NB weir fishery is estimated and then subtracted from the ABC, as an element of the management uncertainty buffer, to calculate the stock-wide Atlantic herring ACL for the U.S. fishery. The NB weir catch estimates only include weir catch and not catch from the shutoff fishery. Catch from shutoffs is a small component of the total NB weir fishery catch.

The overall trend in landings since 1990 has been downward (Table 27), and landings from 2000 have dropped from 20,209 mt in 2001 to 4,031 mt in 2009, but increased in 2010 back to 10,958 mt. The fishery has bounced between 1,000 to over 5,000 mt since then, and the number of weirs has declined as well from almost 50 in 2013 to just over 10 in 2017. The same trend can also be seen in the NB weir landings from 1964 to 2011 (Table 30).

The NB weir fishery catch is quite variable and dropped below 1,000 mt in 2013 and 2015, but was above 30,000 in 2007.

- The most recent five-year average of NB weir landings (2013-2017) is about 5,000 mt, and even lower for the last 3 years, about 1,500 mt.

Landings from the NB weir fishery since 1978 have always been somewhat variable (Table 31); however, the fishery occurs primarily during the late summer and fall (June-October), dependent on many factors including weather, fish migration patterns, and environmental conditions. Catch from this fishery after October has averaged under 4% of the yearly total.

Table 30 - Number of active weirs and the catch per weir in the New Brunswick, Canada fishery, 1978-2017

Year	NB Weir Catch (mt)	No. Active Weirs	Catch Per Weir (mt)
1978	33,570	208	162
1979	32,477	210	155
1980	11,100	120	92
1981	15,575	147	102
1982	22,183	159	140
1983	10,594	143	88
1984	8,374	116	72
1985	26,724	156	171
1986	27,515	105	262
1987	26,622	123	216
1988	32,554	191	200
1989	43,475	171	255
1990	38,224	154	258
1991	23,713	143	166
1992	31,899	151	212
1993	31,431	145	216
1994	20,622	129	160
1995	18,198	106	172
1996	15,781	101	156
1997	20,416	102	200
1998	19,113	108	181
1999	18,234	100	191
2000	16,472	77	213
2001	20,064	101	199
2002	11,807	83	142
2003	9,003	78	115
2004	20,620	84	245
2005	12,639	76	166
2006	11,641	89	131
2007	30,145	97	311
2008	6,041	76	79
2009	3,603	38	95
2010	10,671	77	139
2011	2,643	37	71
2012	494	4	124
2013	5,902	49	120
2014	1,571	26	60
2015	146	11	13
2016	2,777	26	107
2017	1732	11	157
Long-Term Average	17,409	103	158
3-Year Average	1,552	16	92
5-Year Average	4,923	38	102
10-Year Average	4,545	40	101

Source: Department of Fisheries and Oceans Canada.

Table 31 - Monthly weir landings (mt) for weirs located in New Brunswick, 1978-2016

	MONTH												Year
YEAR	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Total
1978	3	0	0	0	512	802	5,499	10,275	10,877	4,972	528	132	33,599
1979	535	96	0	0	25	1,120	7,321	9,846	4,939	5,985	2,638	74	32,579
1980	0	0	0	0	36	119	1,755	5,572	2,352	1,016	216	0	11,066
1981	0	0	0	0	70	199	4,431	3,911	2,044	2,435	1,686	192	14,968
1982	0	17	0	0	132	30	2,871	7,311	7,681	3,204	849	87	22,181
1983	0	0	0	0	65	29	299	2,474	5,382	3,945	375	0	12,568
1984	0	0	0	0	6	3	230	2,344	2,581	3,045	145	0	8,353
1985	0	0	0	0	22	89	4,217	8,450	6,910	4,814	2,078	138	26,718
1986	43	0	0	0	17	0	2,480	10,114	5,997	6,233	2,564	67	27,516
1987	39	21	6	12	10	168	2,575	10,893	6,711	5,362	703	122	26,621
1988	0	12	1	90	657	287	5,993	11,975	8,375	8,457	2,343	43	38,235
1989	0	24		95	37	385	8,315	15,093	10,156	7,258	2,158	0	43,520
1990	0	0	0	0	93	20	4,915	14,664	12,207	7,741	168	0	39,808
1991	0	0	0	0	57	180	4,649	10,319	6,392	2,028	93	0	23,717
1992	0	0	0	15	50	774	5,477	10,989	9,597	4,395	684	0	31,981
1993	0	0	0	0	14	168	5,561	14,085	8,614	2,406	470	10	31,328
1994	0	0	0	18	0	55	4,529	10,592	3,805	1,589	30	0	20,618
1995	0	0	0	0	15	244	4,517	8,590	3,956	896	10	0	18,228
1996	0	0	0	0	19	676	4,819	7,767	1,917	518	65	0	15,781
1997	0	0	0	8	153	1,017	6,506	7,396	5,316	0	0	0	20,396
1998	0	0	0	0	560	713	3,832	8,295	5,604	525	0	0	19,529
1999	0	0	0	0	690	805	5,155	9,895	2,469	48	0	0	19,063
2000	0	0	0	0	10	7	2,105	7,533	4,940	1,713	69	0	16,376
2001	0	0	0	0	35	478	3,931	8,627	5,514	1,479	0	0	20,064
2002	0	0	0	0	84	20	1,099	6,446	2,878	1,260	20	0	11,807
2003	0	0	0	0	257	250	1,423	3,554	3,166	344	10	0	9,003
2004	0	0	0	0	21	336	2,694	8,354	8,298	913	3	0	20,620
2005	0	0	0	0	0	213	802	7,145	3,729	740	11	0	12,639
2006	0	0	0	0	8	43	1,112	3,731	3,832	2,328	125	462	11,641
2007	182	0	20	30	84	633	3,241	11,363	7,637	6,567	314	73	30,145
2008	0	0	0	0	0	81	1,502	2,479	1,507	389	49	32	6,041
2009	0	0	0	0	5	239	699	1,111	1,219	330	0	0	3,603
2010	0	0	0	6	64	1,912	2,560	3,903	1,933	247	46	0	10,671
2011	0	0	0	0	0	250	656	1,097	500	140	0	0	2,643
2012	0	0	0	0	29	140	5	5	98	217	0	0	494
2013	0	0	0	0	7	612	1,517	1,797	1,051	919	0	0	5,902
2014	0	0	0	0	0	70	130	147	449	774	0	0	1,571
2015	0	0	0	0	12	32	28	36	5	33	0	0	146
2016	0	0	0	0	3	0	102	1,034	1,153	485	0	0	2,777
NB Average Catch (t)	21	4	1	7	99	338	3,065	6,903	4,661	2,455	473	37	18,064
NB Minimum Catch (t)	0	0	0	0	0	0	5	5	5	0	0	0	146
NB Maximum Catch (t)	535	96	20	95	690	1,912	8,315	15,093	12,207	8,457	2,638	462	43,520

3.6.1.4 Atlantic Herring Permits and Vessels

Amendment 1 to the Herring FMP established a limited access program in the herring fishery with three limited access (A, B, C) and one open access (D) permit categories (Table 32). The Vessels that have not been issued a limited access herring permit, but have been issued a limited access mackerel permit, are eligible for a Category E permit, a category established through Amendment 5 (implemented March 2014).

Table 32 - Atlantic herring permit categories

	Category	Description
Limited Access	A	Limited access in all management areas.
	B	Limited access in Areas 2 and 3 only.
	C	Limited access in all management areas, with a 25 mt (55,000 lb) Atlantic herring catch limit per trip and one landing per calendar day.
Open Access	D	Open access in all management areas, with a 3 mt (6,600 lb) Atlantic herring catch limit per trip and one landing per calendar day.
	E	Open access in Areas 2 and 3 only, with a 9 mt (20,000 lb) Atlantic herring catch limit per trip and landing per calendar day.

The following describes the vessels participating in the Atlantic herring fishery from 2008-present, including nominal revenues for herring trips. Here, an active herring trip is defined liberally as any trip in which at least one pound of Atlantic herring is retained. Since 2008, the number of vessels with an Atlantic herring permit has decreased annually (Table 33). This includes a decrease in the limited access directed fishery vessels (Categories A and B), with 36 permitted in 2016. In 2016 41% of the limited access vessels were active (defined broadly as landing at least one pound of Atlantic herring during the fishing year).

Many of the Category A, B, and C vessels are also active in the Atlantic mackerel fishery (managed by the MAFMC). For the open access vessels, just 3-5% of the Category D permits have been active since 2008. The Category E permit was implemented during permit year 2013 (May-April). In 2014, there were 53 E permits issued, mostly to vessels with a D permit as well. About 11% of the E permits were active that year.

Although there have been far fewer active limited access versus open access vessels, the limited access vessels account for about 97% of annual Atlantic herring landings and revenues (Table 34).

Table 33 - Fishing vessels with federal Atlantic herring permits, permit years 2008-2016 (May-April)

		Atlantic Herring Permit Year (May-April)								
Permit Category		2008	2009	2010	2011	2012	2013	2014	2015	2016
Limited Access	A	47 (57.4%)	46 (63%)	43 (60.5%)	42 (59.5%)	42 (57.1%)	39 (66.7%)	40 (62.5%)	42 (50%)	39 (56.4%)
	BC	5 (60%)	4 (75%)	4*	4*	4*	4 (75%)	4*	4*	4*
	C	53 (18.9%)	51 (31.4%)	50 (28%)	47 (23.4%)	47 (31.9%)	44 (29.5%)	42 (23.8%)	41 (26.8%)	41 (24.4%)
	Total	**105 (38.1%)**	**101 (47.5%)**	**97 (43.3%)**	**93 (40.9%)**	**93 (44.1%)**	**87 (48.3%)**	**86 (43%)**	**87 (39.1%)**	**84 (40.5%)**
Open Access	D	2408 (3.6%)	2393 (3.8%)	2307 (3.9%)	2147 (3.9%)	2065 (3.5%)	1957 (3.3%)	1838 (3.6%)	1762 (3.4%)	1776 (2.9%)
	DE						6*	52 (9.6%)	54 (5.6%)	53 (5.7%)
	E						0	1*	1*	1*
	Total	**2408 (3.6%)**	**2393 (3.8%)**	**2307 (3.9%)**	**2147 (3.9%)**	**2065 (3.5%)**	**1963 (3.3%)**	**1891 (3.8%)**	**1817 (3.5%)**	**1830 (3%)**

Source: GARFO Permit database and DMIS as of November 13, 2017.
() Percent active vessels listed in parentheses
*Confidential vessel activity data

Table 34 – Percent contribution of herring vessels by permit category to total landings, 2013-2016 (Jan.-Dec.)

Permit Category		Fishing Year (Jan-Dec)			
		2013	2014	2015	2016
Limited Access	A and BC	96.9%	98.0%	99.0%	98.7%
	C	2.6%	1.7%	0.9%	1.0%
	D, DE, and E	0.1%	0.1%	0.1%	0.2%

Source: GARFO Permit database and DMIS as of 2017-11-13.

Limited Access Category A Vessels. Category A vessels comprise the majority of fishery landings (Table 34). In 2016, these vessels ranged in length from 21' to 146' (including inactive vessels), and 72% are over 80' (Table 35).

Table 35 - Vessel length for vessels with a Category A herring permit, 2014-2016

Year		2013	2014	2015	2016
Vessel length	<60	2	3	5	2
	60-80	7	8	8	8
	>80	30	29	29	26
	Total	**39**	**40**	**42**	**36**

Source: NMFS Permit database, as of September 2016: https://www.greateratlantic.fisheries.noaa.gov/aps/permits/data/index.html.

Limited Access Category B/C and C Vessels. In 2016, vessels with a Category B/C or C permit ranged in length from 34' to 94' (including inactive vessels), and just 15% are over 80', primarily in the 60-80' range (Table 36). There are no vessels currently with just a Category B permit. Vessels either carry a B/C combination or just a C permit (limited access incidental catch). Thus, other fisheries are important to these vessels, more so than the Category A vessels.

Table 36 - Vessel length for vessels with a Category B/C or C herring permit, 2013-2016

Year		2013	2014	2015	2016
Vessel length	<60	17	16	16	14
	60-80	26	24	23	21
	>80	5	5	6	6
	Total	**48**	**45**	**45**	**41**

Source: NMFS Permit database, as of September 2016: https://www.greateratlantic.fisheries.noaa.gov/aps/permits/data/index.html.

Open Access Category Vessels (D and E). In 2016, vessels with a Category D and/or E permit ranged in length from 6' to 159' (including inactive vessels), and just 15% are over 80', primarily in the 60-80' range (Table 36). Other fisheries are important to these vessels, more so than the limited access vessels. Unlike Categories A-C, Category D and E vessels (open access incidental catch) are numerous and participate in a wide variety of fisheries throughout the Northeast region. Category D vessels only land a small amount of herring.

Table 37 - Vessel length for vessels with a Category D and/or E herring permit, 2013-2016

Year		2013	2014	2015	2016
Vessel length	<60	1,383	1,324	1,259	1,139
	60-80	348	346	338	329
	>80	210	200	205	202
	Total	**1,941**	**1,870**	**1,802**	**1,670**

Source: NMFS Permit database, as of September 2016: https://www.greateratlantic.fisheries.noaa.gov/aps/permits/data/index.html.

3.6.1.5 Effort in Herring Fishery

Trips, areas, gear type. Atlantic herring vessels primarily use purse seines, single or paired midwater trawls. The midwater pair trawl fleet has harvested the majority of landings since 2008 (Table 38, Table 39). 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), though Areas 1A and 1B account for less of their overall landings in recent years. The purse seine fleet fishes primarily in Area 1A and to a lesser extent, Areas 1B and Area 2, though in recent years, purse seines have not been active in Area 2. Single MWT vessels have been most active in Area 3. Small mesh bottom trawl vessels comprise 5% of herring landings since 2008; other gear types (e.g., pots, traps, shrimp trawls, hand lines) comprise under 0.5% of the fishery.

Table 38 - Atlantic herring landings by fishing gear type and area, 2008-2011

Gear Type	Area 1A (mt)	Area 1B (mt)	Area 2 (mt)	Area 3 (mt)	Total
Bottom Trawl	463 (0.3%)	1 (0%)	14,288 (16%)	117 (0.1%)	**14,869 (4%)**
Midwater Trawl (Single and Pair)	63,109 (47%)	15,858 (81%)	73,222 (82%)	91,348 (99.9%)	**243,537 (73%)**
Purse Seine	69,074 (52%)	3,696 (19%)	2,221 (2%)	0 (0%)	**74,991 (22%)**
Other	817 (0.6%)	0 (0%)	17 (0%)	1 (0%)	**834 (0.2%)**
Total	**133,463 (100%)**	**19,555 (100%)**	**89,748 (100%)**	**91,466 (100%)**	**334,231 (100%)**

Source: VTR database. September 2012.
Note: Data include all vessels that landed one pound or more of Atlantic herring.

Table 39 - Atlantic herring landings by fishing gear type and area, 2012-2014

Gear Type	Area 1A (mt)	Area 1B (mt)	Area 2 (mt)	Area 3 (mt)	Total
Bottom Otter Trawl	534 (1%)	16,967 (64%)	0 (0%)	267 (0%)	**17,768 (7%)**
Midwater Trawl (Single and Pair)	14,677 (18%)	9,068 (34%)	44,746 (100%)	110,227 (100%)	**178,718 (67%)**
Purse Seine	68,409 (82%)	310 (1%)	0 (0%)	0 (0%)	**68,719 (26%)**
Other	3 (0%)	0 (0%)	3 (0%)	0 (0%)	**6 (0%)**
Total	**83,623 (100%)**	**26,345 (100%)**	**44,749 (100%)**	**110,494 (100%)**	**265,211 (100%)**

Source: VTR database. August 2015.
Note: Data include all vessels that landed one pound or more of Atlantic herring. Single and pair midwater trawl data are combined due to data confidentiality restrictions.

In recent years, Atlantic herring catch per day for the purse seine fishery has been higher than for the midwater trawl fishery, and trip length was lower (Table 40). Costs per day have been lower for purse seines.

Table 40 - Average daily catch, trip length and costs for the purse seine and midwater trawl fleets, 2011-2015

Year	Catch (mt/day)	Trip length (days)	Cost per day			Trips	
			Low	High	Raw	Observed	VTR
Purse seine fleet							
2011	65.5	0.9	$1,454	$1,927	$1,667	79	264
2012	77.5	1.1	$1,149	$1,520	$1,290	40	278
2013	91.7	0.8	$1,115	$1,500	$1,279	50	312
2014	99.4	1.1	$1,156	$1,556	$1,330	24	316
2015	105.4	1.1	$1,068	$1,437	$811	14	243
ALL	**87.5**	**1.0**	**$1,249**	**$1,664**	**$1,396**	**207**	**1,413**
Midwater trawl fleet							
2011	69.9	2.6	$4,011	$5,232	$4,520	149	354
2012	64.8	3.0	$4,108	$5,287	$4,608	179	392
2013	53.9	3.5	$3,364	$4,472	$3,954	103	470
2014	66.1	2.4	$3,672	$4,865	$4,182	123	409
2015	55.2	2.5	$3,904	$5,124	$3,001	19	380
ALL	**61.4**	**2.9**	**$3,833**	**$5,009**	**$4,315**	**573**	**2,005**
Source: Catch and trip length from VTR data. Costs from observer data.							

Carrier vessels. A carrier vessel is one that has received herring from another vessel and will not report that catch as its own on its Federal Vessel Trip Report. A carrier vessel can have no gear on board capable of catching or processing fish, and it cannot transport species other than herring or groundfish. Since Amendment 5, a vessel can declare (via VMS) what activity it will be engaging in on a trip-by-trip basis.

Using a Letter of Authorization (LOA) issued by NMFS, transfers may occur: (a) from herring catcher vessels to carriers; (b) between federally permitted herring vessels; and (c) from herring catcher vessels to non-permitted vessels for personal use as bait. Purse seine vessels are required to report what amount of catch is transferred to a carrier vessel, so those landings can be attributed to purse seine. It is difficult to determine if MWT vessels are the primary carrier vessels for purse seines. Carrier trips are no longer required to report on a VTR, and also gear is not static for each fishing vessels.

Although Federal regulations do not limit the amount of herring that can be transferred at-sea (up to the permitted amount), the ASMFC has, as of May 2017, allowed the Atlantic Herring Section members from Maine, New Hampshire and Massachusetts to annually determine any landings restrictions on transfers at-sea, by permit category and/or gear type (ASMFC 2017a). As of September 2017, a harvester vessel can make only one at-sea transfer per week, and U.S. carriers can only receive a transfer from one harvester vessel per week and land up to 120,000 lbs. (~54 mt) per week (ASMFC 2017c).

In 2010, 50 vessels received a LOA carrier exemption, doubling the number issued in 2006 (Table 41). Carrier activity, as reported in VTRs, was down though, from 58 reports in 2009 to

49 in 2010 (Table 42). Vessels can be issued both exemption types within one fishing year. The list of vessels wanting to engage in carrier activities will change from year to year, and some of the Category D permit vessels may already have VMS required by multispecies and scallop permits. The number of D vessels with LOAs increased from 11 in 2008 to 21 in 2010. These tables also illustrate the number of smaller vessels (under 50 feet) already have VMS, required by the herring permit that they possess.

Table 41 - Total herring vessels that received a letter of authorization by year and type of exemption

Year	Transfer at-sea LOA (#)	Carrier LOA (#)	Total LOA
2006	19	6	25
2007	27	16	43
2008	26	13	39
2009	23	18	41
2010	35	15	50
2011	40	18	58
2012	44	16	60
2013	42	19	61
2014	39	22	61
2015	35	19	54
2016	44	19	63

Note: Herring carrier vessels identified by Herring Carrier LOA issuance prior to 2014, or combination of LOA issuance and VMS declaration for 2014 and beyond.
Source: NMFS permit data.

Table 42 - Total VTR herring carrier reports by year, 2007-2013

Year	Total VTR reports
2007	46
2008	33
2009	56
2010	30
2011	38
2012	80
2013	109

Note: The implementation of Amendment 5 in March, 2014 eliminated VTR reporting requirements on carrier trips, precluding accurate activity counts for 2014-2016.

3.6.1.6 Border Transfer

"Border Transfer" is U.S.-caught herring shipped to Canada via Canadian carrier vessels and used for human consumption. This specification is not a set-aside; rather, it is a maximum amount of Atlantic herring caught from Area 1A that can be transshipped to Canadian vessels for human consumption. GARFO tracks BT use through a separate dealer code. Specification of BT has remained at 4,000 mt since the implementation of the Atlantic Herring FMP. Border transfer decreased from 1994-2013 (Table 43), with 2011 using 838 mt (21% of 4,000 border transfer mt). No BT occurred from 2008-2010, but some amount occurred in 2011-2013.

Table 43 - Herring catch in Area 1A shipped to Canada via Canadian carrier vessels (i.e., border transfer), 1994 – 2003 [update]

Year	Border transfer (mt)	Year	Border transfer (mt)
1994	2,456	2004	184
1995	2,117	2005	169
1996	3,690	2006	653
1997	1,280	2007	53
1998	1,093	2008	0
1999	839	2009	0
2000	1,546	2010	0
2001	445	2011	946
2002	688	2012	788
2003	1,311	2013	838
Source: NMFS.			

3.6.1.7 Fishery Economics

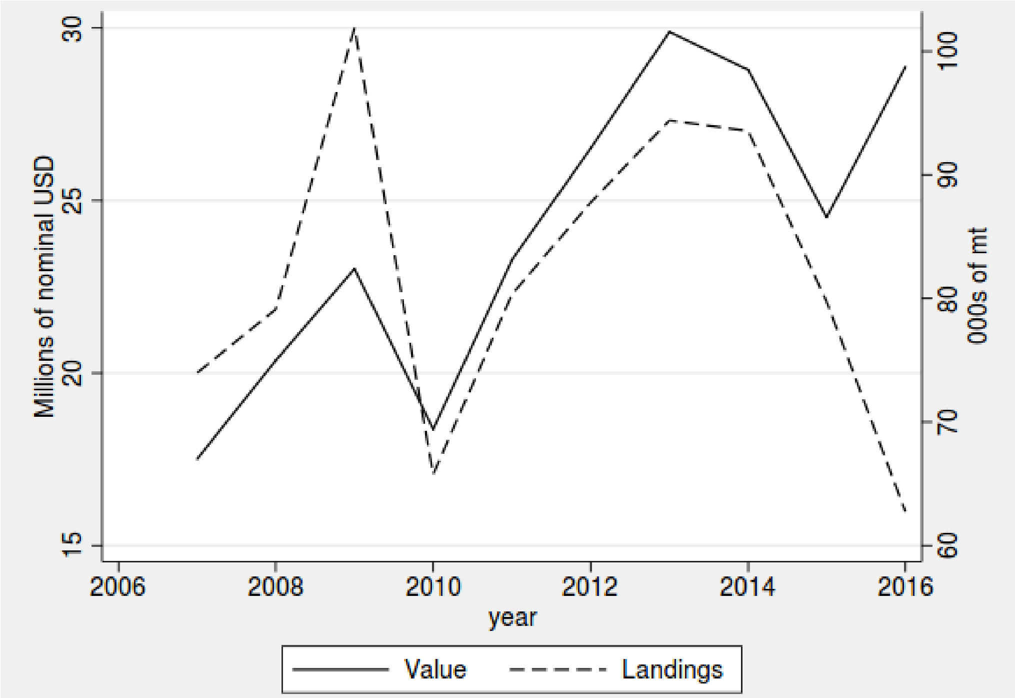
Price of herring. Between 2007 and 2016, the annual average price of Atlantic herring has ranged between $238 per mt in 2007 and $426 in 2016, generally increasing through the time series (Figure 38). Atlantic herring caught in the Northeast U.S. is primarily used as lobster bait, but is also eaten by consumers worldwide (Section 3.6.1.9). As there are substitutes for both uses, prices are generally insensitive to quantity changes (e.g., 2016 is an exception). If good substitutes are available, then prices will not be sensitive to changes in quantity supplied. However, if good substitutes are not available, then prices will be quite sensitive to changes in quantity supplied.

Prices tend to be cyclical higher in the summer months and lower during the winter. This may be related to demand for herring as bait in the lobster fishery. During 2007-2016, the price of herring was lowest in January-March (about $230-260/mt) and highest in July and August (about $340/mt).

Fishery revenue. From 2007-2016, 2016 had the lowest annual landings of Atlantic herring, but nominal value was relatively high (Figure 37). Fishery value peaked in 2013 at about $30M, and has been above $20M per year since 2011.

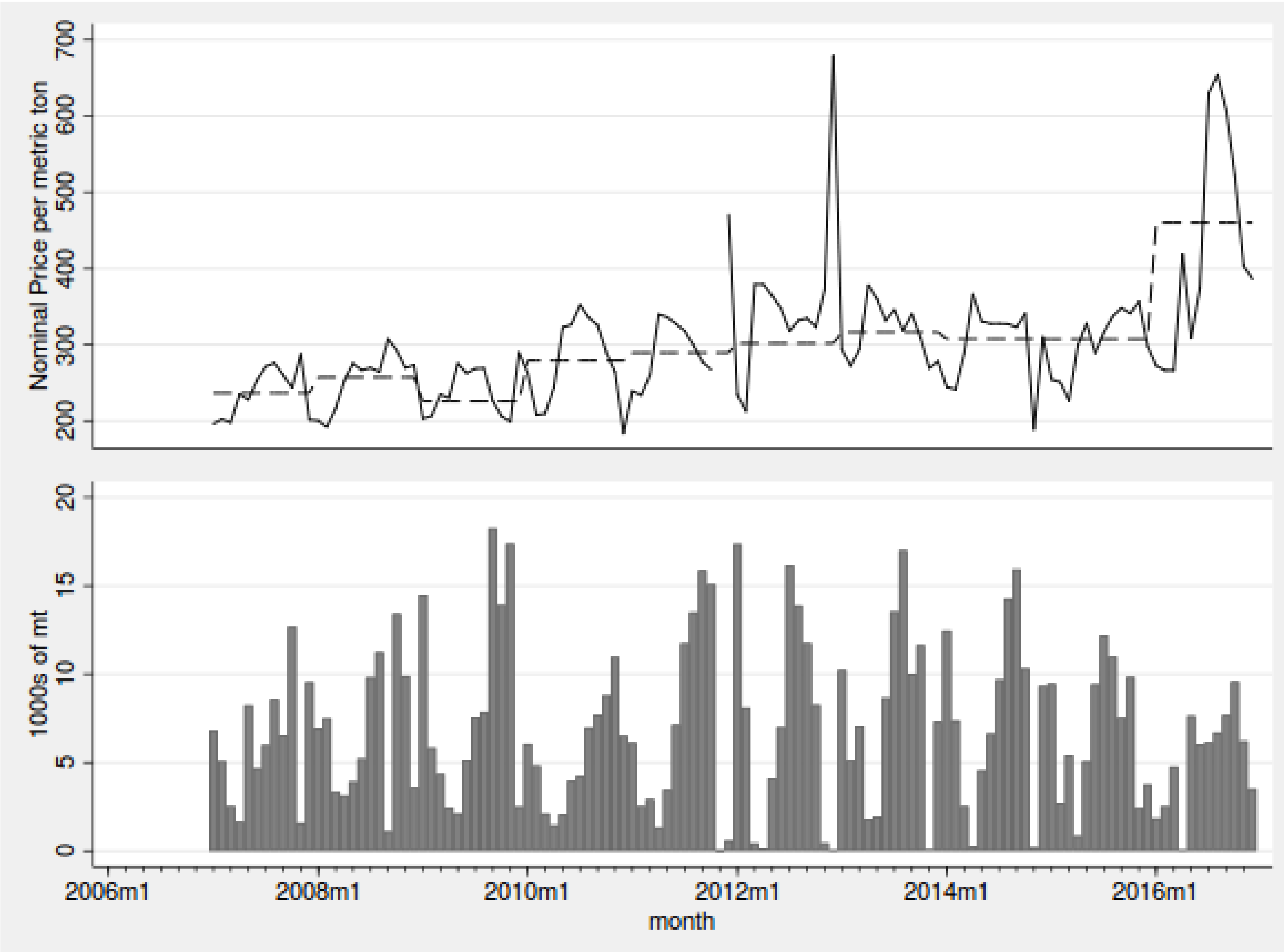
Crew share. As in most fisheries in the country, the crew members of vessels do not receive a set wage; instead, they are compensated through the share system. In 2014, the crew share, as the percent of gross revenue, was 28% on average for herring and mackerel vessels (MAFMC 2017). The split between owner and crew had been more even in the past (NEFMC 2012).

Figure 37 - Total annual landings (thousands of mt) and value of herring ($M of nominal USD), 2007-2016



Source: Dealer data

Figure 38 - Total landings (thousands of mt) and average price (nominal price per mt), 2007 – 2016



Source: NMFS dealer data.

3.6.1.8 Dependence on Herring

Permits in other fisheries. In 2016, 14 vessels were active in the Atlantic herring midwater trawl fishery, all of which have limited access permits in the Atlantic mackerel fishery (Table 44, SMB Tiers 1-3). These vessels also have a variety of other permits under 14 other fishery management plans (e.g., bluefish (BLU), dogfish (DOG), tilefish (TLF)). Vessels are not necessarily active in all fisheries in which permits are held due to management or logistical constraints.

Table 44 – Permits held by midwater trawl vessels active in the Atlantic herring fishery (n=14), 2016 only

Permit Category	Fishery Management Plan															
	BLU	BSB	DOG	FLS	HRG	LGC	LO	MNK	MUL	OQ	RCB	SCP	SF	SKT	SMB	TLF
1	14	6	14	5								6	8	8	6	12
3															7	
5															4	
6										8						
A									4		7					
A, B or C					14											
A1 or 1							6									
B or C						6										
D or F								3								
E								8								
HB									5							
K									8							
T1															11	
T2 or T3															3	

Source: GARFO Permit Database as of December 21, 2017.
Note: The count for each permit plan/category indicates how many of the 14 active midwater herring vessels hold that specific permit. Does not include HMS or Incidental HMS Squid Trawl permits. The data are for permit year 2016 (May 2016-April 2017).

Dependence by permit category. Table 45 has percentage of total revenue from Atlantic herring for each permit category from 2008-2011 for trips landing Atlantic herring, showing the contribution of Atlantic herring revenues to those trips. Category A vessels catching Atlantic herring in Areas 1A, 1B, and 3 are catching herring almost exclusively (e.g., Category A vessels in Area 1A derived 98% of revenue from herring when landing herring). However, when these vessels catch herring in Area 2, a substantial portion of revenues (nearly 40%) are attributable to other species. Category C and D vessels have derived relatively small amounts of revenue from herring trips. The remainder of the revenue for these vessels is derived from other species (e.g., whiting). Categories A and B vessels specialize in small pelagics (herring, mackerel, and squid) while most of the C and D vessels catch herring either incidentally or seasonally in smaller amounts. For 2012-2014, Category A vessels caught Atlantic herring almost exclusively in all areas (Table 46), more so than in 2008-2011. Area 2 continued to be important for Category B and C vessels. The open access permit vessels (Category D and E) derive relatively little revenue from Atlantic herring (14% overall).

Table 45 - Percent of total revenue from Atlantic herring by total revenue for each permit category and management area for trips landing Atlantic herring, 2008-2011

	Category A	Category B/C	Category C	Category D
Area 1A	99.9%		55.1%	32.8%
Area 1B	99.7%			
Area 2	61.6%	94.8%	6.7%	2.5%
Area 3	96.8%			1.2%
Total	**86.4%**	**94.8%**	**30.3%**	**11.2%**

Table 46 - Importance of Atlantic herring for each permit category and management area, 2012-2014

<table>
<tr><th></th><th>Category A</th><th>Category B or C</th><th>Category D or E</th></tr>
<tr><td>Area 1A</td><td>98%</td><td>42%</td><td>26%</td></tr>
<tr><td>Area 1B</td><td colspan="2">85%</td><td>minimal*</td></tr>
<tr><td>Area 2</td><td>85%</td><td>77%</td><td>9%</td></tr>
<tr><td>Area 3</td><td colspan="2">92%</td><td>minimal*</td></tr>
<tr><td>Total</td><td>92%</td><td>69%</td><td>14%</td></tr>
<tr><td colspan="4">Note: “Importance” measured as the percentage of total revenue derived from Atlantic herring for trips that retained herring.
* There was a very small amount of herring revenue for the D/E vessels in these areas.</td></tr>
</table>

Dependence by gear type: The dependence of vessels on Atlantic herring by gear type is illustrated in (Table 47), which reports the revenue by species for the three primary gear types from 2012 to 2016. Herring is the primary source of revenue for the purse seine vessels, a major source of revenue for midwater trawls, and a minor revenue source for bottom trawls, though herring fishing enables participation in other fisheries.

Table 47 – Revenue (in thousands $) by gear type for vessels that land Atlantic herring, 2012-2016

Area	Species	2012	2013	2014	2015	2016
Midwater trawl	Herring	$18,116	$18,864	$17,881	$15,908	$13,998
	Mackerel	$935	$2,205	$2,938	$1,920	$3,111
	Menhaden	$0	$0	$388	$141	$50
	Squid	$0	$0	$0	$0	$0
	Other	$674	$127	$134	$50	$64
Bottom trawl	Herring	$1,783	$3,537	$1,551	$1,177	$1,280
	Mackerel	$2,963	$316	$361	$1,340	$510
	Menhaden	$0	$0	$56	$56	$0
	Squid	$20,884	$13,808	$20,781	$21,991	$35,012
	Other	$22,839	$26,560	$46,227	$43,320	$37,455
Purse Seine	Herring	$6,655	$7,890	$9,486	$7,793	$14,571
	Mackerel	$0	$0	$0	$0	$0
	Menhaden	c	c	c	c	$1,656
	Squid	$0	$0	$0	$0	$0
	Other	$0	$0	$0	$0	$0
Other	Herring	$0	$0	$0	$0	$0
	Mackerel	$0	$0	$10	$0	$0
	Menhaden	$0	$0	$0	$0	$0
	Squid	$0	c	$56	$14	$52
	Other	$24,874	$20,056	$36,445	$38,763	$46,692
Total	**Herring**	**$26,554**	**$30,291**	**$28,918**	**$24,878**	**$29,849**
	Mackerel	**$3,898**	**$2,521**	**$3,309**	**$3,260**	**$3,261**
	Menhaden	**c**	**c**	**>$444**	**>$197**	**$1,822**
	Squid	**$20,884**	**>$13,808**	**$20,837**	**$22,005**	**$35,064**
	Other	**$48,387**	**$46,743**	**$82,806**	**$82,133**	**$84,211**

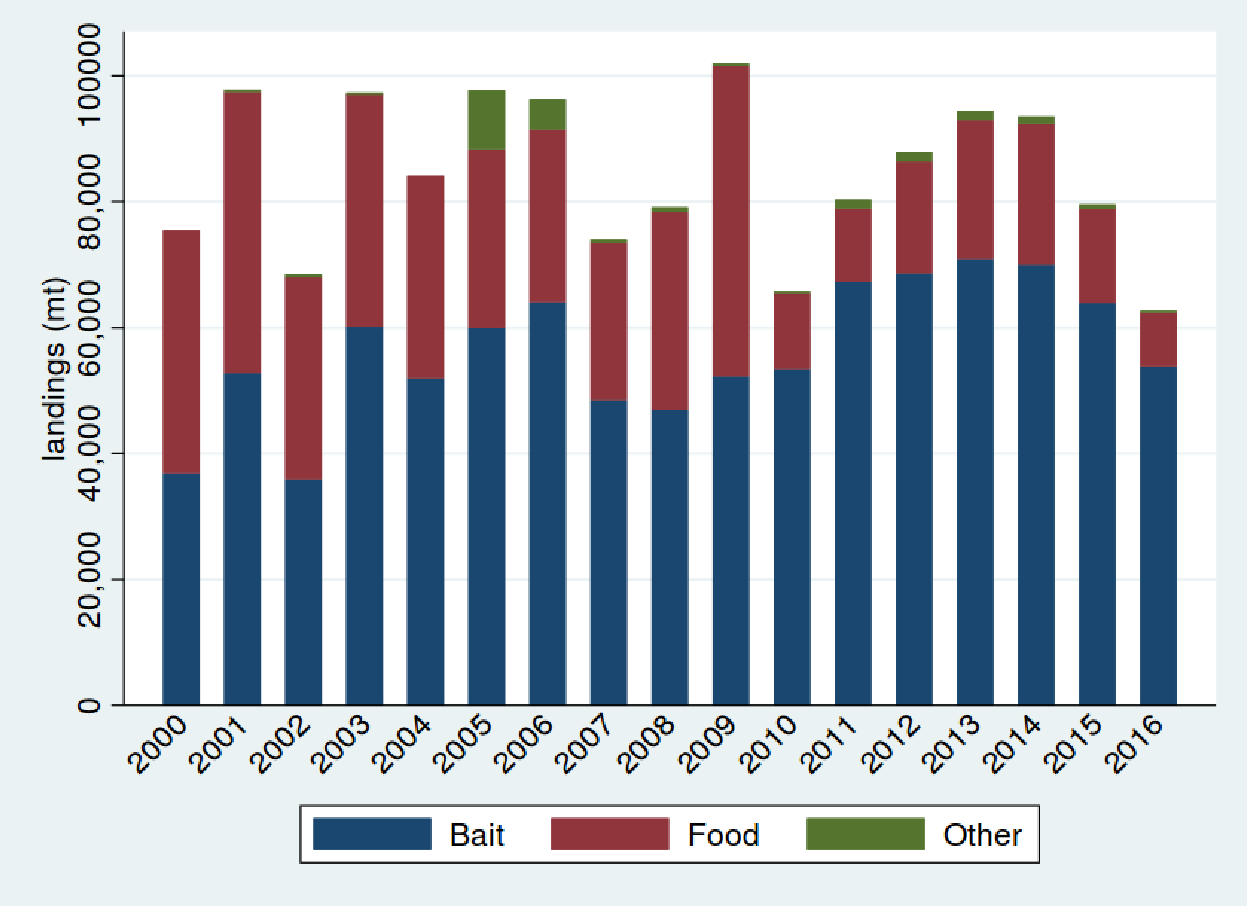
Source: NMFS VTR data
C = confidential

3.6.1.9 Use of Atlantic Herring and Substitute Goods

Used as bait. A large proportion of herring catch is used as bait. Figure 39 has the percentage of reported herring landings used for bait, food, and other uses from the dealer database during 2000-2016. Since 2001, over 50% of herring landings are sold for bait, and the amount used for bait has generally increased over time. Other uses of herring include aquaculture feed, canned pet food, livestock food, and industrial and biomedical purposes.

Herring is used as bait for many fisheries, such as lobster, tuna, and various recreational fisheries. Historically, Atlantic herring is used for bait by smaller inshore vessels more than larger offshore vessels, because it is typically less expensive; in addition, alternative bait options like skates tend to be preferred for longer soaks in offshore waters. Generally, the herring used for bait goes through a large wholesale dealer to smaller dealers and lobster wharfs along the coast. The wholesale dealers generally have facilities where they sort, barrel, freeze and store bait for redistribution. The locations and processing and selling techniques also vary. Amendments 1 and 5 have more description of herring as bait and some the ways in which herring is processed and sold.

Figure 39 - Herring landings reported for bait, food, and other uses, 2000-2016



Source: NMFS dealer data

In the bait market, Atlantic menhaden, managed by the Atlantic States Marine Fisheries Commission, is one substitute for Atlantic herring. Use of menhaden for bait has increased in importance relative to fish meal and oil. Between 2001 and 2012, the percent of total menhaden landings that were used for bait rose from 13% to a high of 28% in 2012 (63,540 mt). In 2013, bait harvest was about 22% of the total menhaden harvest. Menhaden landings for bait have recently dipped due to reductions in allowable catch; landings in 2013 were 35,043 mt, 34% below the average landings during 2010-2012 (52,900 mt; ASMFC 2015c). During 2008-2011, *ex-vessel* menhaden prices ranged from $139-$169 per mt. This is about 33-50% lower than *ex-*

vessel herring prices. If the quantity of Atlantic herring supplied into the bait market declines dramatically, more menhaden may be used as bait, moderating the increases in herring prices. Menhaden is primarily used to produce fish meal and oil. However, the Atlantic Herring FMP prohibits use of herring for fish meal, so herring is not a substitute in the production of those goods.

Used as food. Limited amounts of Atlantic herring are consumed as food domestically. In the world market, there is likely one substitute: European herring. U.S. production of Atlantic herring is quite small relative to the worldwide production. Since total U.S. landings of Atlantic herring have been near 100,000 mt annually, while total worldwide landings of Atlantic herring are near 2,000,000 mt. Therefore, U.S. producers of herring as human food are likely to be price takers on the world market. This means that moderate changes in the quantity of herring produced for food are unlikely to have an effect on price of herring.

3.6.1.10 Atlantic Herring Dealers and Processors

The number of Atlantic herring dealers remained fairly constant between 2012 and 2016, ranging between 282 and 296, and between 71 and 95 (24-33%) of them were active (Table 48). Dealer permits can be issued and cancelled throughout the year, so at any given time, the number of active dealer permits could fluctuate from the totals reported. Most of the Atlantic herring dealers are based in Maine, Massachusetts, Rhode Island, New York, and New Jersey.

Processing, with respect to the Atlantic herring fishery, is defined in the regulations as *the preparation of Atlantic herring to render it suitable for human consumption, bait, commercial uses, industrial uses, or long-term storage, including but not limited to cooking, canning, roe extraction, smoking, salting, drying, freezing, or rendering into meat or oil.* The definition of processing does not include trucking and/or transporting fish.

The businesses summarized here provide a snapshot of typical business involved in dealing and/or processing Atlantic herring. This information has been voluntarily provided by the businesses and has not been verified by the Herring PDT through any independent sources of information. Information was provided between November 2016 and May 2017.

BBS Lobster Trap Co. (Machiasport, ME). Established in 1972 in Bourne, MA, Lobster Trap is a wholesale seafood distributor with facilities in Bourne, MA, Machiasport and Steuben, ME, as well as various storage locations in Canada. The subsidiary BBS Lobster Trap Company (http://www.lobstertrap.com/bbslobster) owns four lobster pounds and two buying stations in Machiasport and Steuben. The Maine locations service more than 40 lobster boats providing bait, fuel, and supplies. While considered secondary to their primary purpose, bait is a large operation, with storage capacity of 2 million pounds. Fresh and frozen whole herring, cuttings, and other varieties are sold in both retail and wholesale quantities (D. Walsh, pers. comm., 2017).

Table 48 - Atlantic herring dealer permits issued, 2012-2016

		2012	2013	2014	2015	2016
United States	ME	76	84	85	86	79 (1)*
	NH	8	7	7	8	8
	MA	57	61	60	65	71 (1)*
	RI	35	32	27	26	24 (1)*
	CT	2	2	3	3	4
	VT	1	1	1	1	1
	NY	52	50	50	53	53 (1)*
	NJ	26	26	26	28 (1)*	29
	PA	2	2	2	2	4
	DE	1	0	1	1	1
	MD	3	3	3	2	2
	VA	7	7	8	8	7
	NC	9	8	8	8	8 (1)*
	FL	0	0	0	1	0
	GA	1	1	0	0	0
Canada	NB	1	1	1	1	1
	NS	1	3	3	3	3
Total		**282**	**288**	**285**	**296 (1)***	**295 (5)***
Active		**85 (30%)**	**95 (33%)**	**95 (33%)**	**88 (30%)**	**71 (24%)**

Source: GARFO permit database as of December 22, 2017.
Notes: Individual entities may possess more than one permit type, so total permits issued does not necessarily equal total number of dealers. Active means that any amount of herring was purchased.
* At-sea dealer permits.

Cape Seafoods (Gloucester, MA). Largely family-owned and operated, Cape Seafoods was established in 2001 specifically to process herring and mackerel. The products include frozen food grade herring and mackerel (blast frozen, whole round), sold domestically and internationally. In addition, Cape Seafoods' wholesale bait shop makes fresh, salted and frozen bait available, primarily for lobstermen but also tuna fishermen. The company's semi-automatic equipment packs whole round 20kg boxes. It has blast freezing capacity for up to 250 mt per day, cold-storage for about 4,000 pallet spaces, and a facility to store 300 tons of salted herring for bait. Bait is trucked all over and the drivers tend to be from Gloucester or nearby.

Prior to the drop in quotas, Cape Seafoods typically handled 25,000-30,000 tons of both species per year, but now only about 13,000 tons. Prior to the seasonal closure (January-April) of Area 1B, a substantial percentage of the year's herring was landed January through March, though February weather could constrain vessels, and in March, the herring could start getting "feedy." The vessels target mackerel in March, but haddock accountability measures constrain their searches for mackerel. Herring from Georges Bank (Area 3) is usually caught in May until the quota is harvested (typically by mid-summer). In October and November, the vessels fish in Area 1A and in December in Area 2.

Employee numbers range from 25 to 50, depending on the volume of fish received. There are usually 24 seasonal employees supplied by an agency. When work was more predictable, many of the same employees would return each year.

In 1998, Cape Seafoods' partner company, Western Sea Fishing, owned three fishing vessels that fished half the year as scallopers and half as midwater trawlers. After Cape Seafoods opened in 2001, one vessel was sold and the other two enlarged to carry 450mt per vessel. Since then, these vessels have worked exclusively as herring and mackerel midwater trawlers. A third vessel was built due to market demand, strong quotas, and access to fish. With the three vessels, Western Sea employed 25 full-time, year-around. With the series of regulatory changes, one vessel was sold, the Cape Seafoods facility was down-sized, staff was substantially reduced, catch dropped at least 50%, the company lost market share and has been operating at a loss. For the first time, survival of Cape Seafoods Inc. and Western Sea Fishing Company, along with their employees and infrastructure, is truly threatened.

Channel Fish Co., Inc. (East Boston, MA). For more than 50 years, Channel Fish Company (http://channelfishco.com/) has been supplying the seafood industry with fresh and frozen fish products. A family-owned business, Channel Fish employs nearly 100 people in East Boston (MA), where it produces seafood for many markets, including frozen and salted fish for human consumption, animal feed, and lobster bait. Today, they are a leading supplier of frozen fish products to the pet food industry. Some of the major species processed are Atlantic herring, Atlantic mackerel, Atlantic menhaden, and Loligo squid. Channel Fish's pumping station on the Chelsea Creek in Boston Harbor is currently the only active pier in Boston for unloading small pelagic species. Channel Fish also trucks fresh herring and other species to its facility from points ranging from Downeast Maine to Cape May (NJ).

Connor Brothers (Blacks Harbour, NS). In the late 1800's, two brothers fished from an open skiff off Blacks Harbour, then built a fishing weir to catch sardine-sized herring. A few years later, they started canning the small herring, eventually becoming the world's largest producer of canned sardines. Today, Connors Bros. Clover Leaf Seafoods Company produces a variety of shelf-stable seafood, most of which is sold under the Brunswick label (T. Hooper, pers. comm., 2017).

Lund's Fisheries, Incorporated (Cape May, NJ). This family-owned company, established in 1954, purchases, produces and distributes nearly 75 M lbs. of fresh and frozen fish annually. Currently, the company concentrates on mackerel, herring, illex and loligo squid and menhaden, although scup, butterfish, black sea bass, summer flounder, sea scallops, croaker, sea trout, bluefish and monkfish are also produced.

Herring comprises about 10% of their production today, a percentage that has declined in recent years due to several regulatory challenges that have limited landings. The fish are landed primarily between October and April, 75% of which is sold fresh for lobster bait or in blast or sea-frozen packs for lobster and other bait. Lund's herring is used in the King crab fishery and longline fishery on the West coast and the blue crab and crawfish fisheries on the East coast and Gulf of Mexico. Food for zoos and aquariums comprises about 5% of the production and about 10% is usually sold for pet food. Fresh and frozen seafood is sold for human consumption both domestically and internationally. Africa, in particular, is a potential market, with demand for herring, menhaden or chub mackerel if sufficient quota is available for export. In fact, it has been estimated that 60,000 people survived for a year on the million pounds of chub mackerel that

Lund's exported to Africa in a recent year. All of these markets, regardless of the intended use, demand high quality, food-grade herring.

The company employs about 200 people (about 100 full-time including the employees in the affiliated freezer facility, the rest part-time). Despite paying higher than minimum wage, the plant relies on companies that also supply temporary workers for local farms, to hire individuals willing to work in the processing plant and cold storage facility.

Lund's owns 15 vessels, another 15 typically deliver a variety of species of seafood to the facility year-round. Though the majority are home-ported in Cape May, other independently-owned vessels land in Rhode Island, New York, Virginia and North Carolina. Seven company-owned tractors and trailers deliver seafood from Maine to Texas.

While herring, mackerel and squid vessels use refrigerated seawater (RSW), Lund's ice plant produces 40 tons daily with a storage capacity of 100 tons for use by the vessels for other species. Lund's has a daily freezing capacity of 500 metric tons. An affiliated company, Shoreline Freezers in Bridgeton (NJ) can store up to 12,000 tons of frozen products. Lund's also has a West Coast production facility that freezes 5 to 15 M lbs. of loligo squid annually, which is primarily exported to Asia.

The company long ago diversified, which has contributed to its ability to stay viable. Its location in the Mid-Atlantic has helped since vessels can target both cold and warmer water species. The company's forward-thinking culture has also contributed to its resilience with their investment in up-graded processing equipment and the pursuit of both Fair Trade and MSC (Marine Stewardship Council) certification. The company is a founding member of the Science Center for Marine Fisheries, a National Science Foundation industry-government-academic partnership funding applied science to minimize uncertainty in fish stock assessments.

Nevertheless, herring management continues to challenge the company. The MWT trawl fishery on Georges Bank is shut down if 1.5% of the haddock quota is landed (other small-mesh fisheries on GB can land up to 5% of the haddock quota). However, only 3.5% of the total haddock quota for Georges Bank was landed by the directed fisheries last year. Because of the potential for early closures in the herring fishery, Lund's boats sought squid instead this summer, leading to some tightening of the lobster bait market. In addition, herring fishing in the groundfish closed areas requires 100% observer coverage, but no observers are available to the herring boats because the NOAA Fisheries has insufficient funding to pay their share of the cost. Substantial amounts of herring were in these areas, and inaccessible, during the 2017 summer fishery.

The Northern Pelagic Group (NORPEL, New Bedford, MA). NORPEL was established in 2002 as a pelagic processing plant, focusing primarily on herring (70%) and mackerel (30%). Herring is processed year around, while mackerel is primarily January-April. NORPEL owns one fishing vessel, though it is not currently fishing. In addition, a variety of other boats deliver to the facility. NORPEL exports herring to Nigeria for human consumption and provides herring for the bait market. Customers for bait include local lobstermen and tuna fishermen, but occasionally an unanticipated market opens to fulfill an emergency need for herring or mackerel. In the last year, the company started grinding a specific combination of fish species to supply a pet food company, and bought one reefer truck to accommodate the grinding operation.

The company employs about 70 individuals when freezing herring and mackerel (including full and part time positions). Most seasonal employees are of Central American descent. Six to eight engineers and managers work for the processing plant full-time. Processing capacity is 320 mt per day; freezing 2,240 mt per week in 40 vertical plate freezers. For a time, the company processed 30,000 to 40,000 mt annually; however, last year only 5,500 mt was frozen, due to the regulations that lead to the loss of several herring boats and the abundance of haddock that is a "choke" species for herring fishermen. On-site storage capacity of fresh fish in RSW holding tanks was about 600 mt, but now only 240 mt can be held in the tanks. There is additional cold storage available in an adjacent facility.

Purse Line Bait (Sebasco Estates, ME). Purse Line Bait has been purchasing Atlantic herring for lobster bait since about 1993. Herring is purchased from purse seiners and trawl vessels landing in Maine and Massachusetts, pogies from New Jersey, and redfish and other species from around New England. The fish is trucked to their main facility in Sebasco Estates (ME) where it is salted and barreled, then sold to about 40 lobster buyers between Harpswell and Rockland (ME). Purse Line has two freezer facilities, in Sebasco and Harpswell, where about 2M pounds of product can be stored for the times when no product is coming in. Americold Cold Storage in Portland (ME) is used for overflow. Eighty-five percent of their sales are to lobster buyers, with the remainder sold off dump trucks. Of about 20M pounds in overall sales per year, 12M are herring, 5M are pogies, and 3M are redfish and other species. In addition to purchasing from herring vessels, Purse Line Bait also purchases herring from Cape Seafoods in Gloucester (MA), O'Hara Corporation in Rockland (ME) and from other sources. Purse Line Bait owns 10 trucks, employs about 8 or 9 people full-time, year around and 4 or 5 more seasonally.

Seafreeze, Ltd. (N. Kingstown, RI). Seafreeze was established in 1984 by two fishermen. The company fishes and freezes at-sea herring, mackerel, illex and loligo squid, and butterfish. Two high-capacity freezer trawlers, with 350 mt holding capacity, together can freeze about 110 mt of seafood per day in their plate freezers. While herring is primarily a back-up fishery, since it is available year around; most of the other species have a season. Mackerel's season is usually December to May, illex is May to October, loligo is September to April and butterfish is December to March. Seafreeze sells frozen product domestically (30%) and internationally (70%), including bait to longline fleets. Eastern Europe and Asia purchase from Seafreeze; Canada purchases mackerel for bait; illex is used domestically for bait in groundfish, swordfish and tuna fisheries, as well as in the lobster and crab fisheries. Zoos and aquariums also purchase Seafreeze products. The company's cold storage facility capacity is 12,000 mt. The plant employs 60 full-time people including 10 administrative and managerial staff; 20 fishing vessel crew working rotating shifts; and 15 individuals in the storage facility. Regulatory changes in the loligo fishery and groundfish have required shifts among the fisheries. The company has found it essential to diversify so that they are not too dependent on any one species. They have also increased their cold storage facility, allowing them to operate as a public cold storage facility.

3.6.1.11 Shoreside Support

Beaver Enterprises Inc. (Rockland, ME). In 2009, Beaver Enterprises Inc., founded in 1975, sold their plant to Linda Bean, a lobster dealer. Beaver is no longer in the lobster bait business, but instead focuses on selling salt to herring operations all over the region including in Rockland and Kittery, ME, Gloucester, MA and Rhode Island. The salt business is easier than the herring business, because salt "keeps" whereas herring deteriorates quickly.

Beaver is probably the largest salt purveyor in the region for the fishing industry. The owner started small, but was able to grow large enough quickly enough to develop "buying power". He buys directly from the three largest producers, Morton, Cargill's and U.S. Salt. Beaver Enterprises averages deliveries of two trailer-truck loads per day of salt.

Without herring, Beaver Enterprises would be out of business. Herring fishermen have always salted their product. Typically, of 400 pounds of barreled herring, 80 pounds is salt (i.e., 20% of herring bait weight is salt). The ASMFC landing days restrictions has increased salt demand.

The cost of overhead is higher than it was in the past with the need for cold storage, plus bait is more expensive, as is the cost of fuel. It is harder for the "little guys," who used to be able to make a day's pay with one truckload of fish, for example.

Beaver Enterprises does do some fish hauling. For example, they recently transported a ton of pogies (22 vats) from Lund's (Cape May, NJ) to O'Hara's (Rockland, ME), spending $1000 in fuel. (Wayne Stinson 2011, personal communication)

Maritime International (New Bedford, MA). Much of the processed product from NORPEL (Section 3.6.1.10) is shipped overseas via Maritime International Inc.) http://www.maritimeinternational.org/), with a facility adjacent to NORPEL in New Bedford. Overseas shipment occurs in high cube refrigerated containers designed to hold the product at the optimal temperature of –18°F (0°C) to ensure freshness. Maritime International can arrange for either containerized cargo shipments or bulk/tramper carriage of nearly 4,000 mt per shipment.

During the scoping process for Amendment 1, Maritime International provided estimates of financial expenditures associated with NORPEL cargo vessel loading operations - based on one cargo vessel remaining in port for three days and spending money in the community for transportation, restaurants and entertainment, doctors, propane suppliers, and other associated industries. Estimates of expenditures associated with pilot boat operators, vessel agents, customs agents, lift trucks, courier services, and other items required to prepare the cargo ship for transport were also provided. With a potential of 15 cargo vessels per year, Maritime International estimated expenditures of at least $3.2M, in addition to those associated with processing, storage, container shipments, and local distribution.

3.6.1.12 Atlantic Herring Research Set-Aside Program

Research Set-Aside programs are unique to Federal fisheries in the Greater Atlantic Region. No Federal funds are provided to support the research. Instead, research funds are generated through the sale of set-aside allocations for quota managed or days-at-sea (DAS) managed fisheries. The NEFMC and MAFMC set aside quota or DAS, which is awarded through a competitive grant process managed by the NEFSC. Money generated by the sale of the awarded RSA quota or DAS fund the proposed research.

RSA priorities are established by the Councils. Solicitations for RSA proposals are posted at www.grants.gov, and distributed widely through Councils' and other NMFS public relations channels. Incoming proposals are reviewed and ranked based on both technical merit and management relevance. With competitive grants awarded through this process, different entities will apply. Projects funded under an RSA allocation must enhance understanding of the fishery resource and/or contribute to the body of information which management decisions are made.

The Herring RSA program was established in 2007 under Amendment 1 to the Herring FMP (NEFMC 2006, Section 4.8). That action authorizes the Council, in consultation with the ASMFC, to allocate 0-3% of the Herring ACL from each management area to pay for research. Set-aside amounts are specified by area and tracked/monitored separately, but they may be used to support herring-related research in any management area(s) consistent with the research priorities identified by the Council.

GARFO issues an Exempted Fishing Permit to participants that includes two exemptions from herring regulations: 1) participating vessels are exempt from the January-May Area 1A seasonal closure; and 2) participating vessels are exempt from the 2,000 lb possession limit that takes effect when/if a herring management area closes due to harvest of the sub-ACL. Participating vessels are subject to all other herring fishery regulations.

The first Herring RSA award was allocated in 2008, and the program has been active each year since, except 2010-2012 when no RSA was allocated, and 2013, which was a transition year to the 2013-2015 specifications. The 2013-2015 Atlantic herring fishery specifications deducted a 3% RSA from the ACL for all management areas and identified river herring bycatch avoidance and portside sampling as top priorities for cooperative research to be funded by herring RSA in 2014 and 2015. For the 2016-2018, the RSA remained at 3% (Table 24, p. 138).

Top Priorities for Cooperative Research, 2016-2018

In January 2015, the Council recommended the following four research priorities under any RSAs that may be allocated in the 2016-2018 Atlantic herring fishery specifications (without ranking, i.e., equally-important):

1. Portside sampling
2. River herring bycatch avoidance
3. Electronic monitoring
4. Research to support/enhance Atlantic herring stock assessments

In addition, the Council unanimously passed a motion to request input from the NEFSC regarding the fourth cooperative research priority. The NEFSC identified four research projects that would support or enhance the Atlantic herring assessment, while at the same time being appropriate for Atlantic herring RSA. These topics include: stock structure/spatial management; availability and detectability; fishery acoustic indices; and volume-to-weight conversion. The NEFSC provided some additional information to the Council regarding the applicability of these research topics to the Atlantic herring RSA program.

Previously funded Herring RSA Projects

Thus far, four Herring RSA projects have been funded (Table 49). Several of the programs have been multi-year and focused on bycatch issues. Two final reports have been approved.

Table 49 –Herring RSA projects funded to date

Year	Project Category	Title	Funding Level	State	Organization
2016	Bycatch Reduction	Sustaining, improving, and evaluating portside sampling and river herring incidental catch reduction in the Atlantic herring midwater trawl fishery*	$408,004	MA	University of Massachusetts - Dartmouth
2016	Tagging, Other	Coastwide Stock Structure of Atlantic Herring using DNA Analyses to determine the degree of mixing between stocks and spawning aggregations*	$257,554	NY	Cornell Cooperative Extension
2014	Conservation Engineering, Trawl	Characterizing and Reducing River Herring Incidental Catch in the Atlantic Herring Midwater Trawl	$1,046,160	MA	University of Massachusetts - Dartmouth
2008	Resource Dynamics	Effects of Fishing on Herring Aggregations*	$666,600	ME	Gulf of Maine Research Institute
*Final report available at: https://www.nefsc.noaa.gov/coopresearch/projects_search_setup.html.					

3.6.2 Other Managed Resources and Fisheries

In addition to Atlantic herring, many other fisheries could be impacted by the Alternatives under Consideration. The mackerel and herring fisheries are often prosecuted in conjunction, and the lobster fishery is highly dependent on herring as bait. Herring is either a fishery bait source and/or a natural prey item for bluefin tuna, groundfish, and striped bass, which have commercial and recreational fisheries associated with them. Herring is also a prey for whales, other marine mammals, and sea birds, which have ecotourism industries associated with them.

3.6.2.1 Atlantic Mackerel Fishery

Population status**:** The Atlantic mackerel stock was most recently assessed in 2017, with 2016 as the terminal year of data. Fishing mortality (F) in 2016 was estimated to be 0.47, so ***overfishing*** was occurring in 2016. The 2016 spawning stock biomass (SSB) was estimated to be 43,519 metric tons (MT), or 22% of the SSB target so mackerel is "***overfished***" (below 50% of the target). The MAFMC is working on a rebuilding program for mackerel, which will be developed in the specifications being developed for 2019-2021.

Management: Many vessels that participate in the Atlantic herring fishery are also active in the Atlantic mackerel fishery managed by the Mid-Atlantic Fishery Management Council through the Atlantic Mackerel, Squid, and Butterfish (MSB) Fishery Management Plan. More information about mackerel management is at: http://www.mafmc.org/msb.

Fishery: There are three commercial limited access Atlantic mackerel permit categories. When the directed fishery is open, there are no trip limits for Tier 1, Tier 2 has a 135,000 lb. trip limit and Tier 3 has a 100,000 lb. trip limit, which is reduced to 20,000 lb. if it catches 7% of the commercial quota. Open access incidental permits have a 20,000 lb. trip limit. There is also a smaller recreational fishery for mackerel (including private/rental and party/charter).

The directed fishery is primarily comprised of Tier 1 vessels. In 2016, there were 30 Tier 1 vessels (Table 50), 24 of which also had an Atlantic herring Category A permit (67% of all Herring Category A vessels also had a Tier 1 Mackerel permit in 2016). The Tier 1 vessels are primarily (70%) over 80' in length (Table 51). In 2017, 48 vessels had both limited access mackerel and limited access herring permits.

Total landings of Atlantic mackerel (foreign and domestic) peaked at about 400,000 mt in 1973, but have been under 100,000 mt per year since 1977. Except for a peak in the early 2000s of about 40,000-55,000 mt, U.S. domestic landings have generally been under 30,000 mt since the 1960s (MAFMC 2015) and under 10,000 mt since 2011 (Table 52). Mackerel catches since 2008 have generally been under 50% of the total mackerel quota (NEFSC 2016a). Revenue from the mackerel fishery has been under $5M per year since 2010 (MAFMC 2016c). Most landings are on MWT gear vessels and some bottom trawl vessels (Figure 40).

Table 50 - Number of vessels with Atlantic mackerel permits stratified by Atlantic herring permit category, 2016

Mackerel Permit Category	Herring permit categories							
	A	B/C	C	D	D/E	E	none	Total
Tier 1	24	0	5	0	1	0	0	**30**
Tier 2	2	1	5	2	14	0	0	**24**
Tier 3	1	2	11	25	38	1	1	**79**

Source: NMFS Permit database: https://www.greateratlantic.fisheries.noaa.gov/aps/permits/data/index.html. Data as of September 2016.

Table 51 - Vessel length for vessels with a limited access Atlantic mackerel permit, 2016

		Tier 1	Tier 2	Tier 3	Total
Vessel length	<60	1	2	22	**25**
	60-80	8	13	50	**71**
	>80	21	9	7	**37**
	Total	**30**	**24**	**79**	**133**

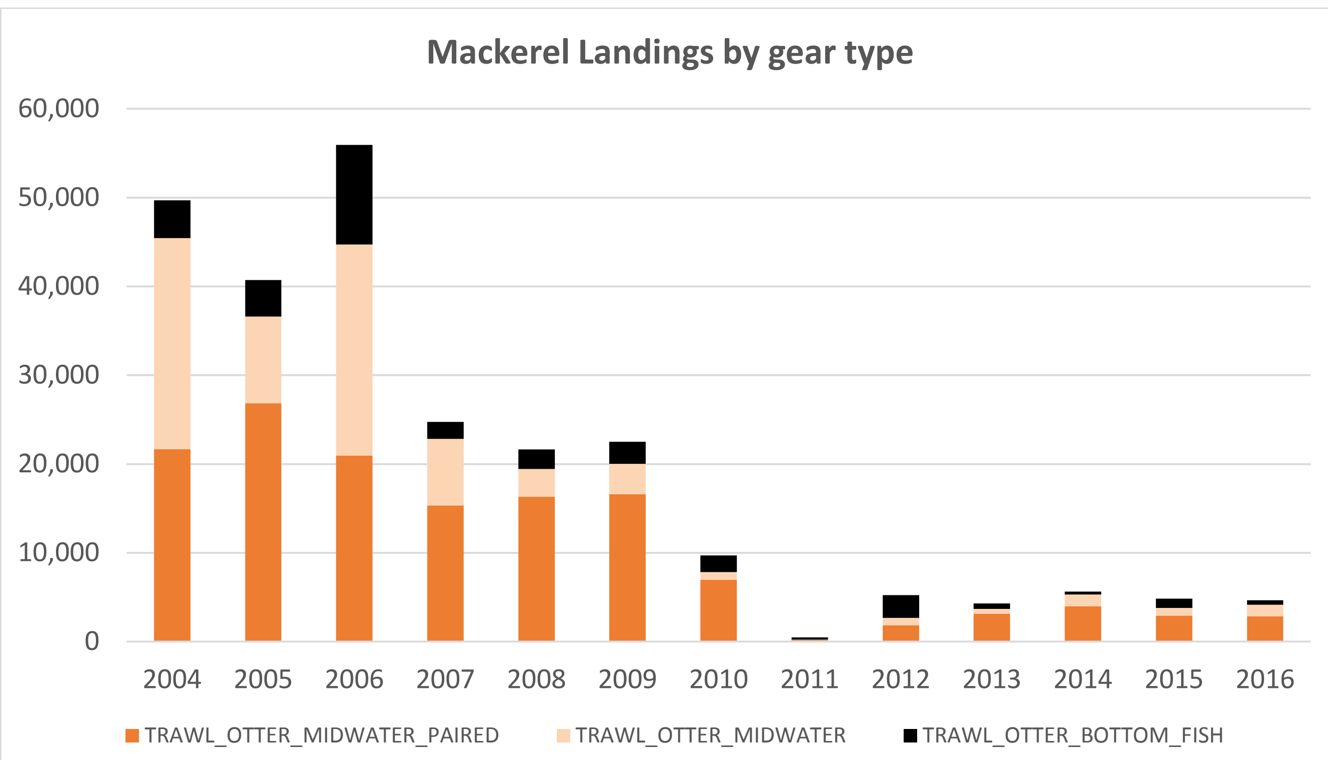
Source: NMFS Permit database: https://www.greateratlantic.fisheries.noaa.gov/aps/permits/data/index.html. Data as of September 2016.

Table 52 – Atlantic mackerel catch (mt) and quota 2005-2015

Year	U.S. Domestic			Canadian Landings	Total Catch	Quota (U.S. + Canada)	% Quota Caught (US + Canada)
	Commercial Landings	Commercial Discards	Recreational Landings + Discards (Mostly Landings)				
2005	42,209	1,083	1,029	55,282	99,603	335,000	30%
2006	56,640	135	1,690	53,960	112,425	335,000	34%
2007	25,546	159	633	53,394	79,732	238,000	34%
2008	21,734	747	857	29,671	53,009	211,000	25%
2009	22,634	125	684	42,232	65,675	211,000	31%
2010	9,877	97	938	38,736	49,648	211,000	24%
2011	533	38	1,042	11,534	13,147	80,000	16%
2012	5,333	33	767	6,468	12,601	80,000	16%
2013	4,372	20	951	9,017	14,360	80,000	18%
2014	5,905	52	1,142	6,872	13,971	80,000	17%
2015*	5,616	13	1,384	4,937	11,950	40,165	30%

Source: NEFSC (2016a, Tables 1 & 2).
* preliminary

Figure 40 – Mackerel landings by gear type for 2004-2016



There is no resource sharing agreement between Canada and the U.S. for Atlantic mackerel. The U.S. sets an upper limit on total catch, and simply deducts expected Canadian catch from the total catch. This has not caused issues to date but at the current low quotas, if Canada raises its quota/catches, then the U.S. may be shut out of the fishery under the current FMP.

In 2013, the first year that the mackerel fishery became limited access, there were 149 vessels issued a limited access mackerel permit (Tier 1-3). Of those, 45 (30%) had over 1% of their total revenue from mackerel, but just 9 (6%) had over 25% of their total revenue from mackerel. Generally, mackerel is a primary fishery for a small handful of vessels (MAFMC 2015).

During 2005-2009, when annual domestic mackerel landings were 23,000-58,000 mt, the fishery was primarily focused in the waters of Mid-Atlantic and Southern New England, though there was fishing in the Gulf of Maine and the southern flank of Georges Bank (Figure 42). In more recent years, with much lower landings, the fishery has been less concentrated in the Mid-Atlantic, and waters of Rhode Island and in the Gulf of Maine have continued to be important, as have both the northern and southern flank of Georges Bank.

Members of the MAFMC MSB Advisory Panel reported in May 2016 that shifting of thermal habitat suitability is likely impacting the distribution and/or productivity of MSB species, a topic that was discussed in the 2017 mackerel assessment. The AP also noted that Atlantic herring management limits mackerel fishing, such as the summer closure of Herring Management Area 1A to midwater trawl gear, herring spawning closures, and recently, the Georges Bank haddock catch cap accountability measure, which closed most of Georges Bank to herring fishing October 22, 2015 to April 30, 2016 (MAFMC 2016a).

Herring and mackerel are often caught together, and many trips that land herring also land mackerel. For this action, the PDT evaluated the distribution of herring and mackerel catches for MWT vessels since some alternatives may restrict the use of MWT gear in certain areas and seasons. Overall, about a dozen MWT vessels are active in these fisheries and the average percent of herring per trip has varied over time (from 2011 through 2016). About half of MWT herring trips had over 90% herring, and only a small fraction, about 10%, had over 90% mackerel landings. Many trips had more mixed trips of herring and mackerel (Table 53, Figure 41).

Table 53 – Herring and Mackerel landings in the MWT fishery (2011-2016)

Year	Permits	Trips	Trips Landing Herring	Trips Landing ≥90% Herring	Herring Live Pounds	Mackerel Live Pounds	Avg. Herring Percent per Trip[2]
2011	12	24	23	16	6,496,623	673,915	87.7%
2012	12	41	36	15	9,145,718	5,877,851	52.2%
2013	16	58	57	33	13,853,901	8,118,382	74.0%
2014	11	55	52	15	19,068,466	11,691,912	54.8%
2015	11	67	59	29	15,855,332	8,445,115	57.4%
2016	11	90	85	41	20,637,136	9,550,445	65.8%

Source: GARFO DMIS Database, as of 2017-11-02.
[1]Includes all midwater trips landing > 0 pounds of Atlantic mackerel that filed a VTR. Excludes CARRIER and PARTY/CHARTER trips.
[2]Average percentage of herring from combined Atlantic mackerel and Atlantic herring landings for each trip.

Figure 41 – Histogram of MWT trips landing herring and mackerel (2011-2016)

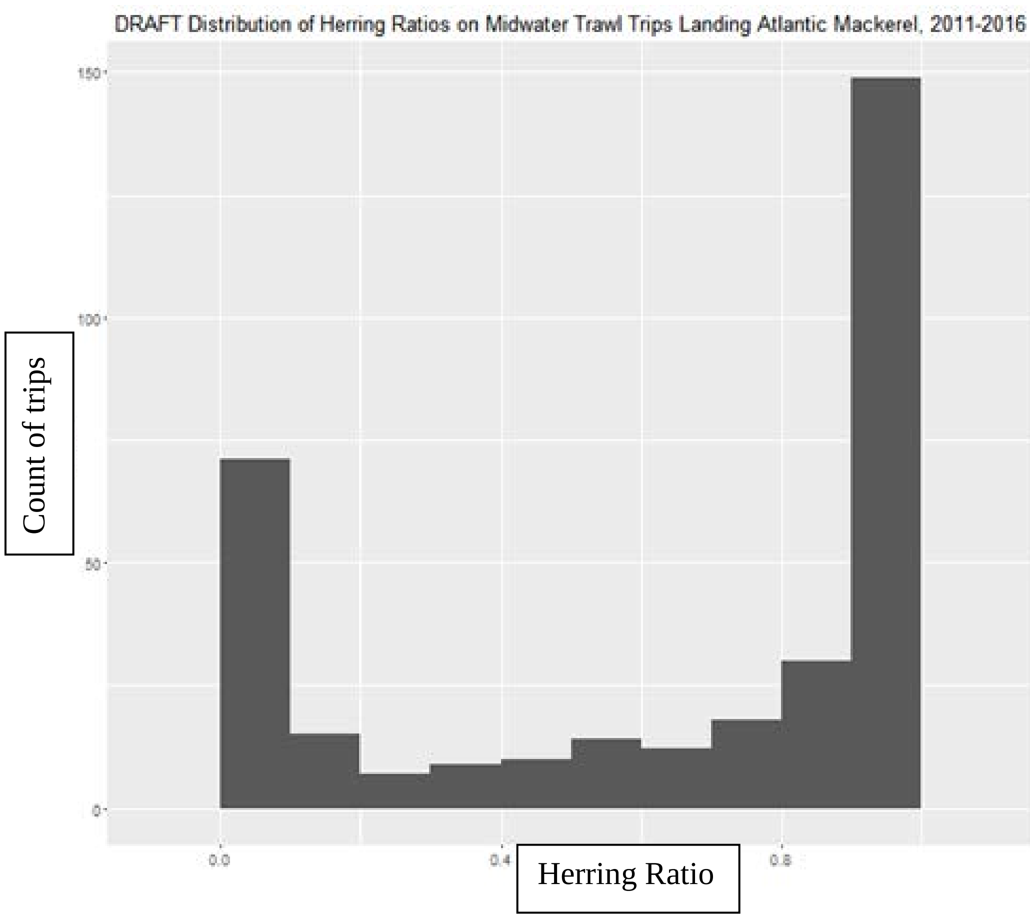
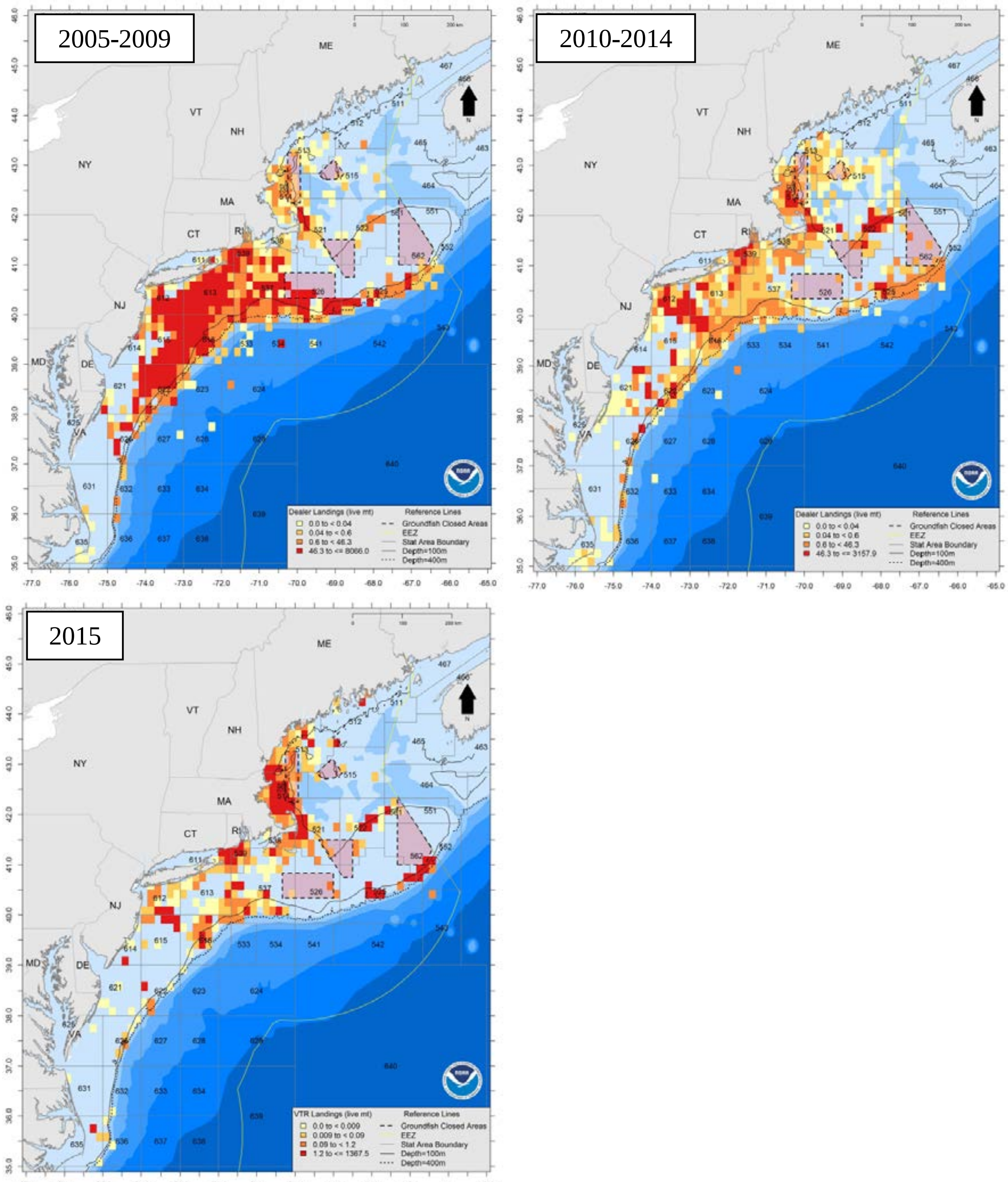


Figure 42 - Atlantic mackerel commercial landings, 2005-2015



Source: NEFSC (2016a). NMFS Dealer data for 2005-2014, VTR data for 2015.

3.6.2.2 American Lobster Fishery

Population status: American lobsters (*Homarus americanus*) are benthic crustaceans found in U.S. waters from Maine to New Jersey inshore and Maine to North Carolina offshore. Lobsters tend to be solitary, territorial, and exhibit a relatively small home range of 5-10 km^2, although large mature lobsters living in offshore areas may migrate inshore seasonally to reproduce, and southern inshore lobsters may move to deeper areas to seek cooler temperatures on a seasonal or permanent basis.

The 2015 peer-reviewed stock assessment report (ASMFC 2015a) indicated a mixed picture of the American lobster resource, with record high stock abundance throughout most of the Gulf of Maine (GOM) and Georges Bank (GBK) and record low abundance and recruitment in Southern New England (SNE). The assessment used a new model which incorporated lobster size and a broader range of data. GOM and GBK were previously assessed as separate stock units; however, due to evidence of seasonal migrations by egg-bearing females between the two stocks, the areas were combined into one biological unit.

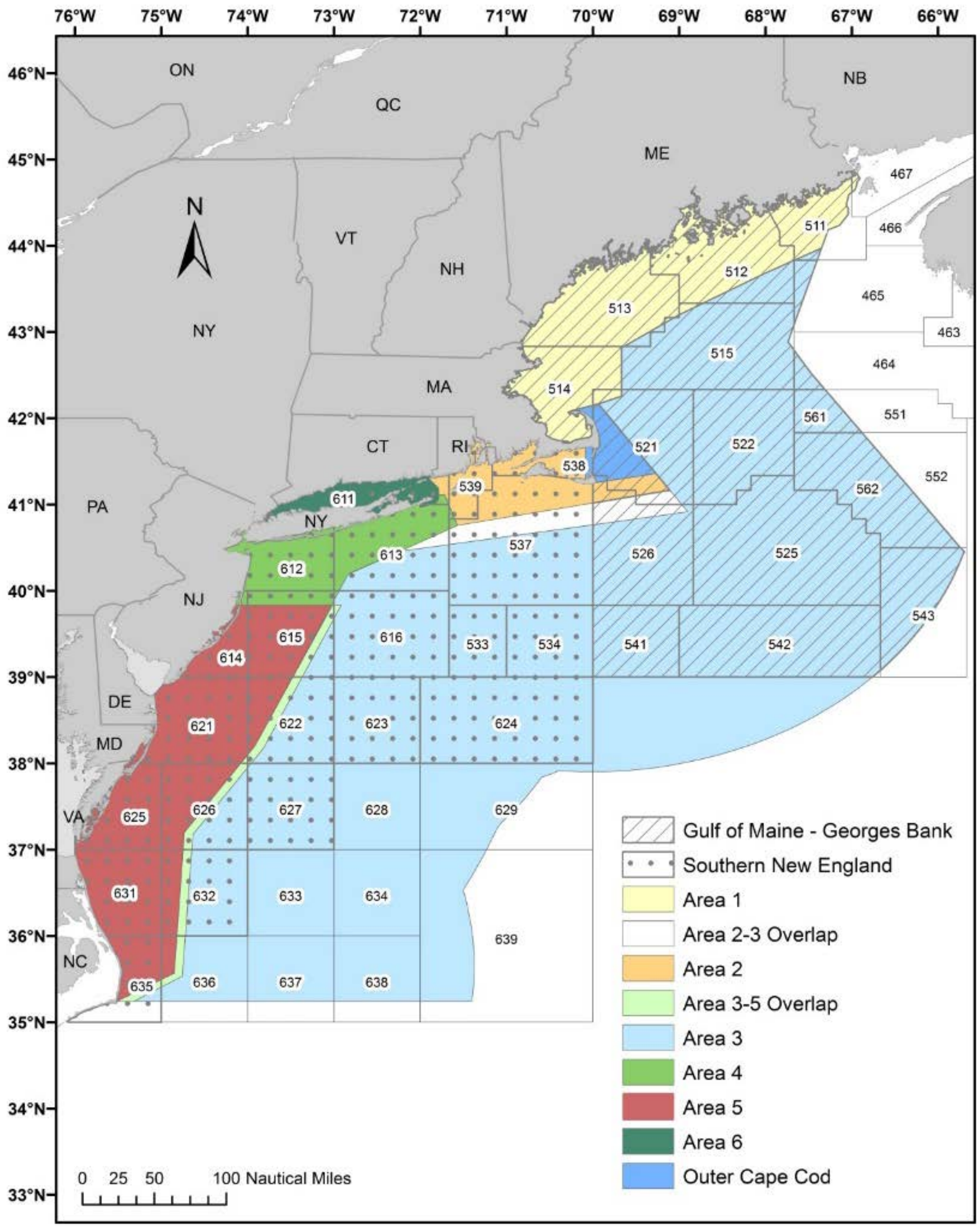
The assessment found the ***GOM/GBK stock*** was experiencing record stock abundance and recruitment (***not overfished, not experiencing overfishing***). While model results show a dramatic overall increase in stock abundance in the GOM/GBK, population indicators show young-of-year estimates are trending downward. This indicates a potential decline in recruitment in the coming years, and the Panel recommended that the ASMFC be prepared to impose restrictions should recruitment decline. The Panel also noted that productivity has been lower in the past, and warned that current levels of fishing would not be sustainable if recruitment were to decline again.

Conversely, the assessment found the ***SNE stock is severely depleted, though overfishing was not occurring***. Abundance indices were determined to be at or near time-series lows. Recruitment indices show the stock has continued to decline and is in recruitment failure. However, the overfishing determination for SNE may be misleading and unreliable, because the methods used to estimate fishing mortality are not designed for such low biomass situations. The inshore portion of the SNE stock is in particularly poor condition with surveys showing a contraction of the population. This decline is expected to impact the offshore portion of the stock, which is dependent on recruitment from inshore. Landings in SNE are expected to decline since the extremely poor year classes which have settled since 2008 have yet to recruit to the fishery (ASMFC 2015a). The distress experienced by the SNE stock had been examined in 2010, and it was found that the stock was continuing to fall lower than the assessment. It was suggested that a combination of environmental and biological changes, as well as continued fishing was leading the stock to experience a recruitment failure. This recruitment failure was in turn preventing the stock from rebuilding (ASMFC 2010).

Management: Lobster is jointly managed, by the Atlantic States Marine Fisheries Commission in state waters (0-3 nm from shore) and by NMFS in federal waters (3-200 mi from shore). The fishery occurs within the three stock units: Gulf of Maine, Georges Bank, and Southern New England, each with an inshore and offshore component. Today, American lobster is managed under Amendment 3, which provides the flexibility to make changes to the management program through addenda, allowing resource and fishery concerns to be addressed promptly. Seven lobster management areas (LMAs; Figure 43) were created through Amendment 3, as well as a Lobster Conservation Management Team (LCMT) for each management area. Made up of industry representatives, the LCMTs are responsible for recommending changes to their management plans. The documents for each addenda are at: www.asmfc.org.

The fishery is managed using minimum and maximum carapace length; limits on the number and configuration of traps; possession prohibitions on egg-bearing (berried) and v-notched female lobsters, lobster meat, or lobster parts; prohibitions on spearing lobsters; and limits on non-trap landings and entry into the fishery (ASMFC 2015a). The most recent addendum, Addendum XVIII, reduces trap allocations by 50% for LCMA 2 and 25% for LCMA 3.

Figure 43 - ASMFC lobster management areas



Fishery: The American lobster fishery has seen incredible expansion in effort and landings over the last 40 years and is now one of the top fisheries on the U.S. Atlantic coast. In the 1920s, lobster landings were about 11M lbs. Landings were fairly stable between 1950 and 1975, around 30M pounds; however, from 1976 – 2008, landings tripled, reaching 92M pounds in 2006. Landings continued to increase and peaked in 2013 at over 150M pounds. Landings leveled off, but remained high at 147M pounds in both 2014 and 2015 (Table 54), but again jumped to over 158M pounds (over $660 M) in 2016. The largest contributors to the fishery are Maine and Massachusetts, with 83% and 11% of the recent landings, respectively. Landings, in descending order, also occurred in New Hampshire, Rhode Island, New Jersey, Connecticut, New York, Maryland, Delaware, and Virginia (ASMFC 2017b).

Table 54 - Total lobster landings (lbs) by state, 2009-2015

	ME	NH	MA	RI	CT	NY	NJ + south[a]	Total
2009	81,175,847	2,985,166	11,781,490	3,174,618	451,156	731,811	238,267	**100,538,355**
2010	95,506,383	3,658,894	12,768,448	3,258,221	432,491	813,513	692,480	**117,130,430**
2011	104,693,316	3,917,461	13,717,192	2,513,255	191,594	344,232	689,000	**126,066,050**
2012	125,759,424	4,236,740	14,917,238	2,932,388	236,846	275,220	978,767	**149,336,623**
2013	127,773,264	3,822,844	15,738,792	2,149,266	133,008	248,267	756,494	**150,621,935**
2014	124,440,799	4,939,310	15,060,352	2,387,321	141,988	216,630	619,565	**147,805,965**
2015	122,212,133	4,716,084	16,418,796	2,879,874	158,354	146,624	505,985	**147,037,850**
Average	**111,651,595 (83%)**	**4,039,500 (3.0%)**	**14,343,187 (11%)**	**2,756,420 (2.1%)**	**249,348 (0.19%)**	**396,614 (0.30%)**	**640,080 (0.48%)**	**134,076,744 (100%)**

Source: ASMFC lobster data warehouse (M. Cieri, pers. comm., 2017).
[a] "South" includes Delaware, Maryland and Virginia.

Landings typically occur from inshore areas, and lobsters are most abundant inshore from Maine through New Jersey, with abundance declining from north to south. Offshore, lobsters occur from Maine through North Carolina. Area 1 (inshore Gulf of Maine) has the highest landings, 80% of total harvest between 1981 and 2012. This is followed by LCMA 3 (offshore), 9% of total landings. Dramatic declines in the catch from inshore SNE since 1999 have been attributed to waters increasingly exceeding the lobster thermal stress threshold of 20°C (ASMFC 2015a).

In Maine, the fishery is most active during the months of July to November. For the years 2004-2016, about 85% of the pounds landed were landed in those months (Table 55). Just 4% of landings occurred in the months of January to April (www.maine.gov).

There was an average of 8,315 vessels issued commercial lobster permits for the fishery in state waters each year between 2009 and 2013, and 3,080 vessels were issued federal permits (Table 56), though in most cases, a vessel holding a federal permit also holds a state permit. Thus, there are about 8,300 vessels in the lobster fishery. The State of Maine has issued the largest number of state permits, recently averaging 5,163 (62%). For Maine, about 85% of the permits are active (~4,400). For New Hampshire, about 70% of the permits issued were active during 2009-2013.

Table 55 - Average Maine commercial lobster landings (pounds and value) by month, 2004-2016

	Average pounds		Average value	
January	1,308,027	1%	$5,975,882	2%
February	570,693	1%	$3,225,004	1%
March	561,699	1%	$3,577,798	1%
April	1,102,204	1%	$6,478,832	2%
May	2,471,323	3%	$11,669,067	3%
June	4,218,268	4%	$18,237,197	5%
July	14,296,658	15%	$47,888,908	14%
August	20,949,668	22%	$67,362,446	19%
September	18,286,093	19%	$63,786,998	18%
October	18,086,518	19%	$64,513,527	18%
November	11,101,952	11%	$39,496,026	11%
December	4,322,768	4%	$16,618,840	5%
Total	**97,275,872**	**100%**	**$348,830,527**	**100%**
Source: www.maine.gov, accessed July 2017. Note: 2016 data are preliminary.				

Table 56 – Commercial lobster licenses issued by jurisdiction, 2009-2013

Year	ME	NH	MA	RI	CT	NY	NJ	State total	NMFS	Total
2009	5,376	365	1,314	979	220	375	109	**8,738**	3,176	**11,914**
2010	5,226	347	1,278	948	206	360	109	**8,474**	3,141	**11,615**
2011	5,155	333	1,245	922	180	344	109	**8,288**	3,119	**11,407**
2012	5,079	334	1,214	905	161	334	109	**8,136**	3,003	**11,139**
2013	4,979	322	1,188	874	142	326	109	**7,940**	2,963	**10,903**
Average	**5,163**	**340**	**1,248**	**926**	**182**	**348**	**109**	**8,315**	**3,080**	**11,396**
Source: ASMFC (2015a).										

Reliance on herring as bait: The lobster industry depends greatly on herring bait to sustain itself. Between 1981 and 2013, 96% of all lobster landed was harvested using traps (ASMFC 2015a). Small-scale truckers, bait shop owners, and related business all participate in the commercial bait venture. Bait can be delivered dockside via trucks. In the past, trucks picked up the bait from canneries and community sites up and down the coast to service smaller bait shops or lobster fishing 'gangs' (Acheson 1987). The canneries are gone now, but herring is still delivered to important lobster communities. Island-bound and isolated lobster fishermen may also pick up bait directly off herring vessels, or have it brought out on ferries. In recent years, the shift has been towards herring vessels landing directly in island ports (e.g., Vinalhaven). A small proportion of lobster bait has been supplied by the freezer plants in Massachusetts (Cape Seafoods, NORPEL). While bait choices vary with individual fishermen's preferences and fishery, lobster vessels in the State of Maine are perhaps the most dependent on herring for bait. Recently, however, pogies (menhaden) have also proved popular. Major dealers in Maine offer herring, pogies, redfish and flounder, haddock, carp racks, tuna heads, and Pacific rockfish, with prices ranging from $0.15 - $0.44. In part due to the ASMFC limits on landing days, much of the herring is salted and frozen. Initially, lobstermen found the frozen product to be difficult to handle, but according to reports from dealers, they have adjusted. Lobster vessels in Massachusetts and New Hampshire also depend on herring for bait, but this dependency on herring decreases in more southern areas.

Herring is commonly used in the Gulf of Maine and Southern New England lobster fleets, less so in the offshore and Mid-Atlantic fleets (Table 57). Federal fishery observers collect data on two primary baits used during lobster pot/trap fishery hauls. Additional kinds of bait are recorded as a comment. In 2012-2017, 40% of the observed hauls within Lobster Management Area 1 (LMA; inshore Gulf of Maine; Figure 43) had Atlantic herring as one of the two primary baits used. The percentage is substantially lower in all other areas. Note that observer coverage of the lobster fleets operating in LMA 5, the LMA 2_3 overlap, and Outer Cape Cod is low relative to the other LMAs.

Table 57 - Observed use of Atlantic herring in the federal American lobster fishery, 2012-2017

LMA	% Hauls Herring Used
1	40%
2	25%
3	3%
4	4%
5	0%
6	12%
2_3	0%
OC	12%
Source: NEFOP data.	

The Maine lobster industry is particularly dependent on herring as a bait source, though it depends on price and availability. A 2008 survey of 6,832 lobster license holders in Maine revealed that 58% of respondents answered “very much” to the question “Could the supply or price of herring for bait impact your decisions on how to fish?” (MEDMR 2008). For lobstermen surveyed from Maine, New Hampshire and Massachusetts who harvest in Lobster Conservation Management Area A (inshore Gulf of Maine), herring is the predominant bait source (Table 58). South of Massachusetts, lobstermen tend to use skate or other bait, as herring tends to break down in warmer water.

Table 58 - Bait use in the inshore Gulf of Maine lobster fishery

	Maine							NH	MA
	Zone A	Zone B	Zone C	Zone D	Zone E	Zone F	Zone G		
Herring	90%	86%	73%	73%	84%	37%	75%	60%	76%
Pogies	3%	2%	0%	15%	14%	39%	11%	4%	13%
Redfish	1%	8%	12%	4%	1%	19%	8%	0%	0%
Racks	1%	2%	1%	2%	0%	1%	1%	26%	6%
Alewives	1%	1%	0%	1%	0%	0%	0%	0%	0%
Other	4%	2%	13%	5%	0%	4%	4%	9%	4%
Source: Dayton *et al.* (2014).									

New Hampshire lobster vessels may be less dependent on herring as a bait source than the aforementioned survey indicates. Atlantic herring is a small percentage of the bait used by these vessels (Table 59), ranging between 1.8% in 2010 and 4.6% in 2005. In terms of herring per trap just in Lobster Management Area (LMA) 1, the most used was in 2005 and the least in 2010. This correlates with overall high and low points in the percent of herring bait used.

Table 59 - Bait use in the lobster fishery in New Hampshire, 2005-2011

Year	Herring Bait (lbs)	Other Bait (lbs)	Total Bait (lbs)	% Herring of all Bait	# Types of Bait	Herring Per Trap LMA 1 (lbs)
2005	8,200	169,725	177,925	4.6%	11	0.33
2006	9,700	293,125	302,825	3.2%	13	0.20
2007	8,300	226,350	234,650	3.5%	10	0.18
2008	7,658	247,000	254,658	3.0%	12	0.16
2009	8,825	189,690	198,515	4.4%	11	0.25
2010	3,350	181,728	185,078	1.8%	11	0.14
2011	6,100	249,900	256,000	2.4%	9	0.21
Source: NH Fish & Game Department.						

3.6.2.3 Bluefin Tuna Fishery

Section 3.3.1 summarizes the population status and management of bluefin tuna.

Bluefin tuna in are known to feed on herring, and the tuna fishery is dependent upon herring for bait. In 2016, about 7,000 commercial and 21,000 bluefin tuna permits were issued (Table 16). The bluefin tuna fishery (recreational and commercial combined) landed an average of 862.3 mt between the years 2012 and 2016, with the majority of catch coming from the commercial rod and reel and longline fisheries in the northwest Atlantic (Table 61). The importance of the bluefin tuna fishery to the U.S. in 2015 can be seen in Table 62. A total of over 856 mt was caught by commercial vessels in U.S. waters, with revenues of $8,820,000.

Recreational Bluefin Fishery: The bluefin tuna recreational fishery targets school, large school and small medium, (27 >73” curved fork length) bluefin tuna, and provides for a small trophy fishery on bluefin ≥73”. The fishery generally occurs off of North Carolina from December through January, and becomes active off of Cape Cod and in the Gulf of Maine in summer and early fall. The recreational fishery requires use of handgear (i.e., rod and reel, handline), with the exception that charter and headboats may also fish with bandit gear (vertical hook and line gear attached to vessel; retrieved by manual, electric, or hydraulic reels) or a green-stick (actively trolled mainline elevated above surface of water with up to 10 hooks or gangions).

HMS Charter/Headboat permitted vessels may fish under either the recreational or the commercial handgear size/retention limits on a given trip. The rules are based on the size category of the first bluefin retained on each trip, and whether that tuna fits under the size limit of the recreational or General category commercial fishery. Landings on charter/headboats are counted toward the corresponding quota category determined by the size of fish landed on that trip.

Table 60 - Bluefin tuna permits issued and vessels with landings, 2016

Permit category	Permits issued in 2016 (#)	Vessels with 2016 commercial landings
Commercial		
Longline/Trap	275/5	n.d.
Harpoon	17	7
Purse seine	5	n.d.
General category (rod & reel, handline, harpoon)	3,100	439
Charter/Headboat	3,600	263
Recreational		
Angling	21,000	n/a
Source: NMFS HMS office.		

Table 61 - U.S. landings (mt) of Atlantic bluefin tuna by area and gear, 2012-2016

Area	Gear	2012 (%)	2013 (%)	2014 (%)	2015 (%)	2016
NW Atlantic	Longline	189.4 (20.9)	153.0 (16.9)	171.7 (19.0)	70.1 (7.8)	80.1
	Handline	1.3 (0.1)	0.5 (0.1)	0.0 (0)	0.0 (0)	1.1
	Purse seine	1.7(0.2)	42.5 (4.7)	41.8 (4.6)	38.8 (4.3)	0.0
	Harpoon	52.3 (5.8)	45.0 (5.0)	67.5 (7.5)	77.1 (8.5)	52.9
	Commercial Rod and reel	419.5 (46.4)	249.5 (27.6)	378.9 (41.9)	581.4 (64.3)	722.1
	Recreational rod and reel	148.7 (16.4)	131.4 (14.5)	99.6 (11.0)	112.9 (12.5)	143.7
	Trawl	0.0 (0)	0.0 (0)	0.0 (0)	0.0 (0)	
Gulf of Mexico	Longline	101.2 (11.2)	33.5 (3.7)	41.3 (4.6)	9.3 (0.8)	10.6
	Recreational rod and reel	0.0	0.0	0.0	0.0	1.7
NC Area 94a	Longline	3.9 (0.4)	3.5 (0.4)	8.9 (1.0)	8.3 (0.9)	12.7
Caribbean	Longline	0.9 (0.1)	0.4 (<0.1)	0.0 (0)	0.0 (0)	0.2
All areas	**All gears**	**919.0**	**658.9**	**810.0**	**898.2**	**1,025.0**
Source: NMFS (2017).						

Table 62 – U.S. commercial landings and revenue of bluefin tuna by catch location, 2015

	0 - 3 mi. from U.S. coast	3 - 200 mi. from U.S. coast	High Seas or off foreign coasts	Total U.S. Landings
Landings (mt)	16	840	0	856
Revenue ($ thousands)	$31	$8,789	$0	$8,820
Source: NOAA (2015).				

Commercial Bluefin Fishery: Commercial handgear vessels that wish to sell catch must obtain one of the three types of commercial handgear permits. These include Atlantic Tunas General (rod and reel, harpoon, handline, bandit gear), Atlantic Tunas Harpoon (harpoon only), and HMS Charter/Headboat. Any catch sold by these vessels must be sold to permitted Atlantic tuna dealers, and must comply with Coast Guard regulations and regulations for the state in which catch is landed.

The commercial bluefin fishery is predominantly in New England, however, a winter fishery has solidified in southern states including North Carolina and Virginia. Vessels commonly use bait and fish anywhere from 8 to 200 km from shore. The fleet is largely composed of privately owned vessels that are over 7 m in length. Preferred bluefin baits include herring, mackerel, mullet, butterfish, squid, whiting, ballyhoo, and menhaden. Fishing area and catch rates are highly variable due to bluefin abundance and distribution, which is influenced by oceanographic and ecological conditions, including forage availability.

Commercial bluefin tuna fishermen work off an annual quota which is divided up among the three categories. The general category receives the largest allocation (466.7 mt) and has seasonal subquotas (Table 63). If the catch limit is reached before the end of a time period, the fishery will close and reopen again in at the start of the next time period. Inseason transfers can be made from the Reserve following criteria identified at 50 CFR 635.27(a)(8). Prior to closures in 2017, the fishery had not closed due to reaching any of these within season quotas since the 1990s. The bluefin season occurs when there are ample fish to catch, but generally runs from June through October or November off New England, and December – March off North Carolina.

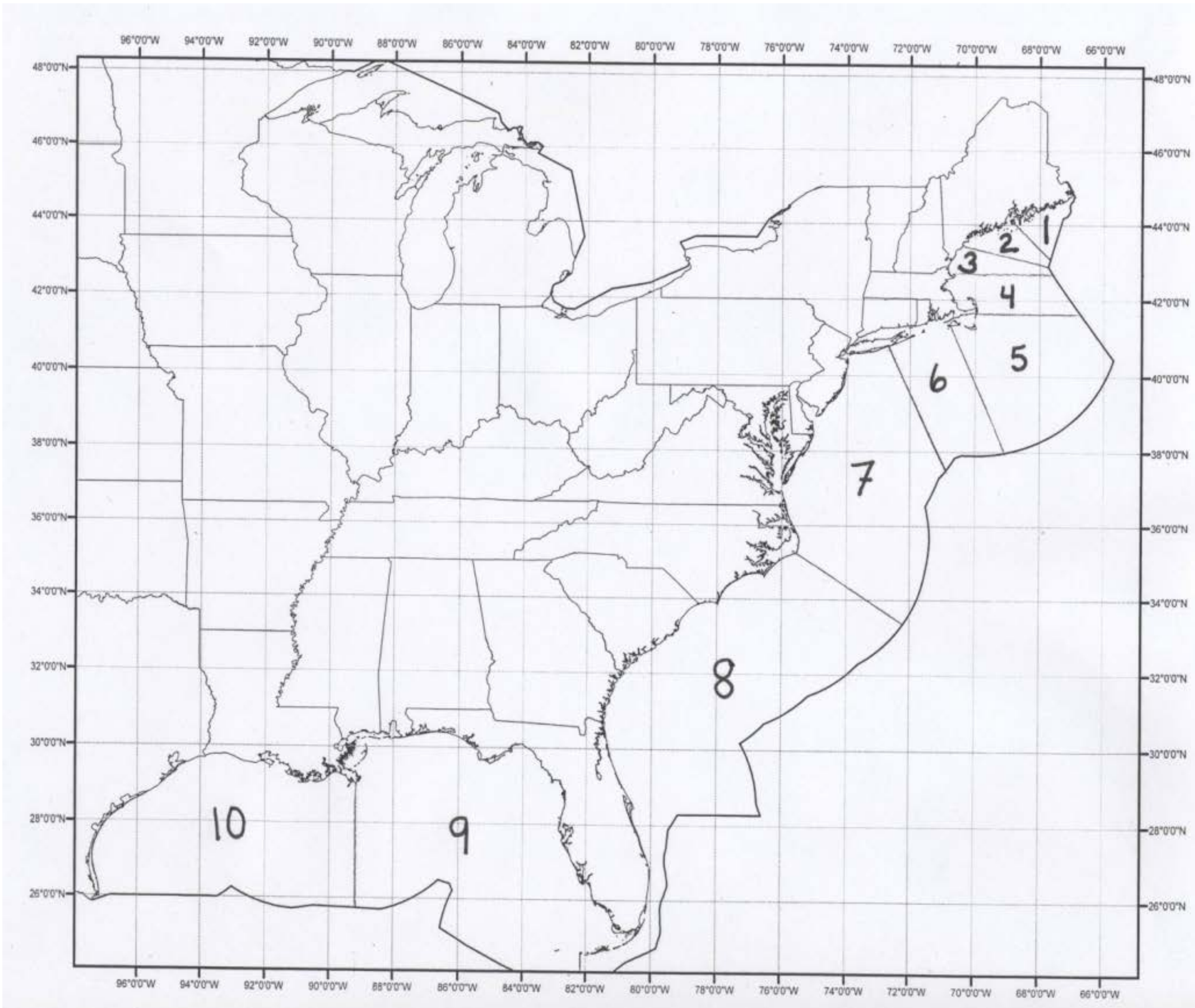
Table 63 - General category time period subquotas.

Time Period	January	June-August	September	October – November	December	TOTAL
Subquotas (MT)	34.4	233.3	123.0	60.0	16.0	466.7

Bluefin Tuna and Herring Fishery Overlaps: Of the ten U.S. Atlantic HMS reporting areas (Figure 44), Areas 1 to 7 fall overlap with the Atlantic herring stock area (Figure 24, p. 91). Since 1996, 93% of all U.S. bluefin tuna landings are from these areas (Table 64). Areas 4 and 5 are the areas with the highest proportion of total landings during this time period, 27% and 36%, respectively. These are the areas to the east and southeast of Massachusetts.

The two months with the highest bluefin tuna landings from 1996-2015 are September (26%) and October (25%; Table 65). From only HMS Area 4, July (24%) and September (28%) had the highest landings, though since 2011, September and October had the highest landings (Table 66). However, in Areas 1-3 to the north, the fishery occurs primarily in July-September; October landings were just 8% of the total from 1996-2015 (Table 67).

Figure 44 - Highly Migratory Species reporting areas



Source: NMFS Highly Migratory Species (HMS) office.

Table 64 – Bluefin tuna landings (dressed weight, lbs) by HMS reporting area, 1996-2015

Area	1996-2000		2001-2005		2006-2010		2011-2015		Total	
1	54,010	1%	13,139	0%	2,416	0%	80,823	2%	150,388	1%
2	899,461	14%	485,765	9%	207,718	8%	657,995	16%	2,250,939	12%
3	1,408,474	22%	506,456	9%	321,435	12%	443,337	11%	2,679,702	14%
4	1,826,228	28%	788,045	14%	918,798	34%	1,643,206	39%	5,176,277	27%
5	2,149,052	33%	3,122,402	55%	778,324	29%	870,192	21%	6,919,970	36%
6	32,830	1%	50,687	1%	44,305	2%	83,042	2%	210,864	1%
7	22,143	0%	184,607	3%	37,221	1%	292,713	7%	536,684	3%
Other	97,880	2%	495,940	9%	354,318	13%	100,132	2%	1,048,270	6%
Total	**6,490,078**	**100%**	**5,647,041**	**100%**	**2,664,535**	**100%**	**4,171,440**	**100%**	**18,973,094**	**100%**
Source: NMFS/GARFO/HMS office. Data as of October 2016.										

Table 65 – Bluefin tuna landings (dressed weight, lbs) by month, 1996-2015

Month	1996-2000		2001-2005		2006-2010		2011-2015		Total	
June	371,237	6%	200,947	4%	170,300	6%	345,587	8%	1,088,071	6%
July	1,645,787	25%	635,682	11%	229,511	9%	626,707	15%	3,137,687	17%
Aug.	1,257,806	19%	645,229	11%	392,388	15%	516,404	12%	2,811,827	15%
Sept.	2,006,236	31%	1,210,802	21%	666,003	25%	1,096,067	26%	4,979,108	26%
Oct	1,091,708	17%	2,247,095	40%	551,757	21%	801,267	19%	4,691,827	25%
Nov.	54,732	1%	138,323	2%	279,619	10%	340,650	8%	813,324	4%
Dec.	62,572	1%	462,541	8%	214,214	8%	187,716	5%	927,043	5%
Jan.-May	0	0%	106,422	2%	160,743	6%	257,042	6%	524,207	3%
Total	**6,490,078**	**100%**	**5,647,041**	**100%**	**2,664,535**	**100%**	**4,171,440**	**100%**	**18,973,094**	**100%**

Table 66 – Bluefin tuna landings (dressed weight, lbs) by month in HMS Area 4, 1996-2015

Month	1996-2000		2001-2005		2006-2010		2011-2015		Total	
June	158,669	9%	56,360	7%	75,697	8%	153,110	9%	443,836	9%
July	641,452	35%	185,828	24%	105,677	12%	296,916	18%	1,229,873	24%
Aug.	361,261	20%	212,621	27%	168,200	18%	211,271	13%	953,353	18%
Sept.	494,086	27%	158,571	20%	300,019	33%	476,433	29%	1,429,109	28%
Oct	170,216	9%	149,282	19%	224,704	24%	373,026	23%	917,228	18%
Nov.-Jan.	544	0%	25,383	3%	44,501	5%	132,450	8%	202,878	4%
Total	**1,826,228**	**100%**	**788,045**	**100%**	**918,798**	**100%**	**1,643,206**	**100%**	**5,176,277**	**100%**

Table 67 – Bluefin tuna landings (dressed weight, lbs) by month in HMS Areas 1-3, 1996-2015

Month	1996-2000		2001-2005		2006-2010		2011-2015		Total	
June	171,849	7%	109,158	11%	80,903	15%	101,174	9%	463,084	9%
July	772,334	33%	311,437	31%	109,088	21%	251,428	21%	1,444,287	28%
Aug.	598,242	25%	335,977	33%	177,978	33%	264,473	22%	1,376,670	27%
Sept.	686,993	29%	173,736	17%	133,617	25%	354,697	30%	1,349,043	27%
Oct	132,527	6%	74,062	7%	28,128	5%	163,260	14%	397,977	8%
Nov.-May	0	0%	990	0%	1,855	0%	47,123	4%	49,968	1%
Total	**2,361,945**	**100%**	**1,005,360**	**100%**	**531,569**	**100%**	**1,182,155**	**100%**	**5,081,029**	**100%**

3.6.2.4 Large Mesh Multispecies (Groundfish)

The overall trend since the start of sector management through 2014 has been a decline in groundfish landings and revenue ($55M in FY2014) and the number of vessels with revenue from at least one groundfish trip (273 in FY2014). The groundfish fishery has had a diverse fleet of vessels sizes and gear types. Over the years, as vessels entered and exited the fishery, the typical characteristics defining the fleet changed as well. The decline in active vessels has occurred across all vessel size categories. Since FY2009, the 30' to < 50' vessel size category, which has the largest number of active groundfish vessels, experienced a decline from 305 to 145 active vessels. The <30' vessel size category, containing the least number of active groundfish vessels, experienced the largest reduction since FY2009 (34 to 14 vessels; Murphy *et al.* 2015; NEFMC 2017).

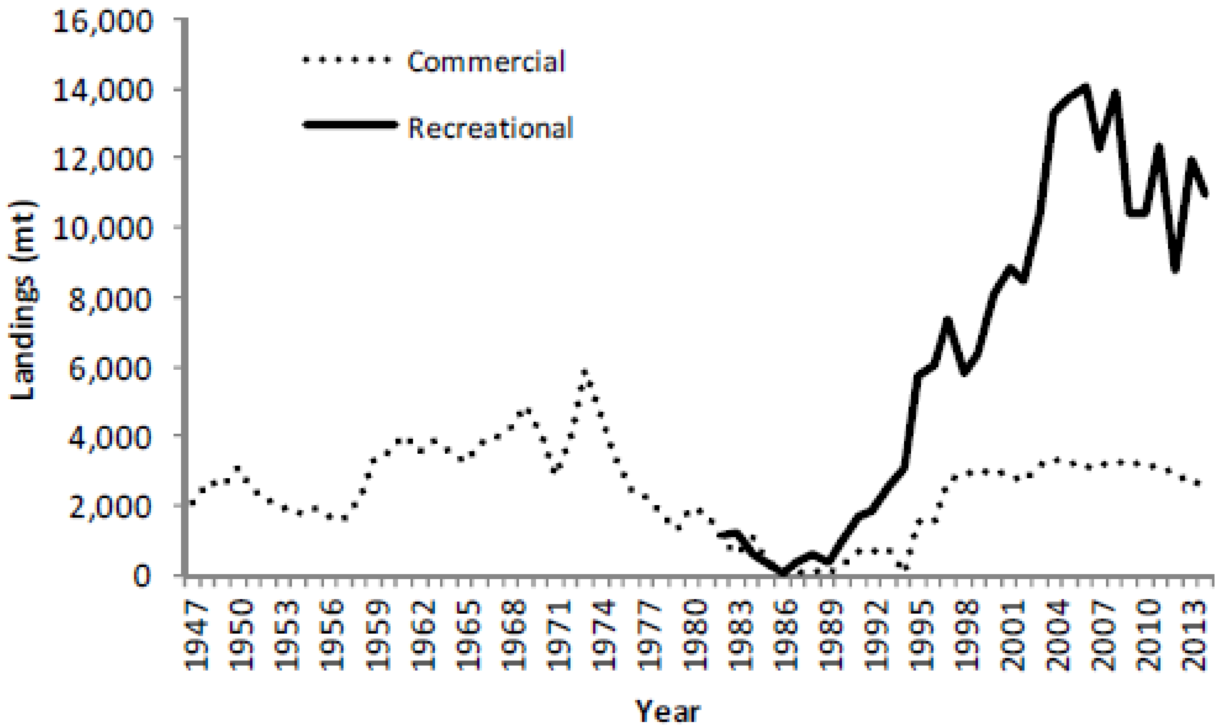
3.6.2.5 Striped Bass Fishery

The striped bass fishery occurs from Maine to North Carolina. The recreational fishery for striped bass has increased from 1982 through 2014 (1,010 mt in 1990) with a peak in 2006 (14,082 mt; Figure 45). The recreational fishery has occurred since the 1990s in Maine, New Hampshire, Massachusetts, Rhode Island, Connecticut, New York, New Jersey, Delaware, Maryland, Virginia, and North Carolina (no NC harvest in 2012 -2014). In 2014, the three states with the most recreational striped bass harvested (by numbers) were Maryland (33%), New York (23%), and Massachusetts (15%; ASMFC 2015b).

For the commercial striped bass fishery, it has occurred since the 1990s in Massachusetts, Rhode Island, New York, Delaware, Maryland, Virginia, North Carolina (no NC harvest in 2013 and 2014), and the Potomac River Fisheries Commission. Total commercial landings harvest from 2005 to 2014 averaged 3,162 mt, with a slight decline in recent years. The commercial harvest mainly occurs in Maryland and states to its south. In 2014, 7.9% of the commercial striped bass harvested (by numbers) occurred in Massachusetts, 1.4% in Rhode Island, and 6.9% in New York (ASMFC 2015b).

For the recreational fishery, the only data are collected through the Marine Recreational Information Program (MRIP). However, MRIP includes no spatial data for catch locations.

Figure 45 - Coast-wide commercial and recreational striped bass harvest, 1940s - present



Source: ASMFC (2015b).

Table 68 - 2014 commercial and recreational harvest (numbers) of striped bass by state

State	Commercial		Recreational	
	(#)	(% total)	(#)	(% total)
ME			20,750	1.2%
NH			6,415	0.4%
MA	60,619	7.9%	277,138	15.5%
RI	10,468	1.4%	103,516	5.8%
CT			86,763	4.8%
NY	52,903	6.9%	409,342	22.9%
NJ			225,910	12.6%
DE	14,894	1.9%	8,774	0.5%
MD	370,661	48.4%	583,028	32.6%
PRFC	81,429	10.6%	n/a	
VA	175,324	22.9%	67,486	3.8%
NC	0	0.0%	0	0.0%
Total	**766,298**	100.0%	**1,789,122**	100.0%

Source: ASMFC (2015b).
Note: MA commercial includes fish for personal consumption.

The Massachusetts Division of Marine Fisheries manages the fishery using 14 statistical areas within state waters. Figure 46 and Figure 47 map the landings and CPUE (pounds per fishing hours) within each area from 2010 to 2014. Area 9, to the east of Cape Cod, has had relatively high landings throughout the time series, and areas to the east and south of Cape Cod have had relatively high CPUE. Figure 48 tracks the landings and CPUE over time each year, showing that most of the landings have occurred between mid-July and mid-August. Decreased CPUE over the length of the season could be an indicator of decreased striped bass availability, but the landings data do not show consistent increases or decreases in CPUE across seasons.

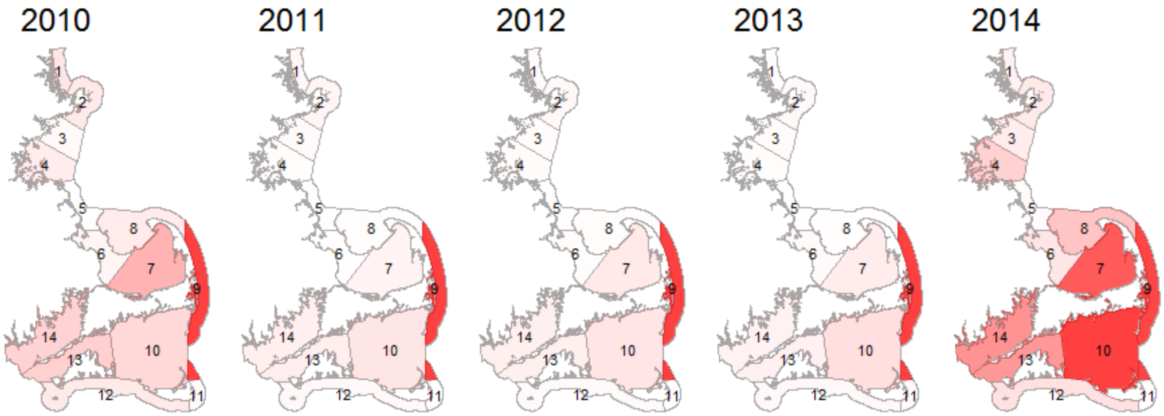
Striped bass are typically present in Massachusetts waters between May and October, yet the commercial fishery (the only source of spatial fishery-dependent data) occurs over a much narrower timeframe (Kneebone *et al.* 2014b). Prior to 2014, the commercial striped bass fishery began each year on July 11 and closed when the quota was exhausted, which was typically in 5-7 weeks. In 2013, the fishery closed after 5 weeks, and then reopened for an additional two weeks in late August, after it became evident that there was quota remaining. In 2014, regulations changed the fishery start date to June 23rd, and a reduced trip limit led to a more protracted season (11 weeks).

Neither recreational nor commercial striped bass fishing is allowed outside of state waters, per federal law. However, striped bass are abundant in federal waters and frequently cross this state/federal jurisdictional boundary (Kneebone *et al.* 2014a). Coast-wide, the recreational fishery accounts for 60-70% of total removals in recent years. In Massachusetts, the recreational/commercial ratio is about 85%/15%.

As part of an effort to estimate the predation mortality of striped bass on Atlantic menhaden, all available data sources for diet composition of striped bass were assembled and summarized (SEDAR 2015). A total of 28 data sources were identified that included over 40,000 individual stomachs examined. On a coast-wide and annual basis, herring species comprise <10% of striped bass diets. At specific times and regions (e.g., Gulf of Maine in summer/fall), Atlantic herring may comprise up to 30% of the diet.

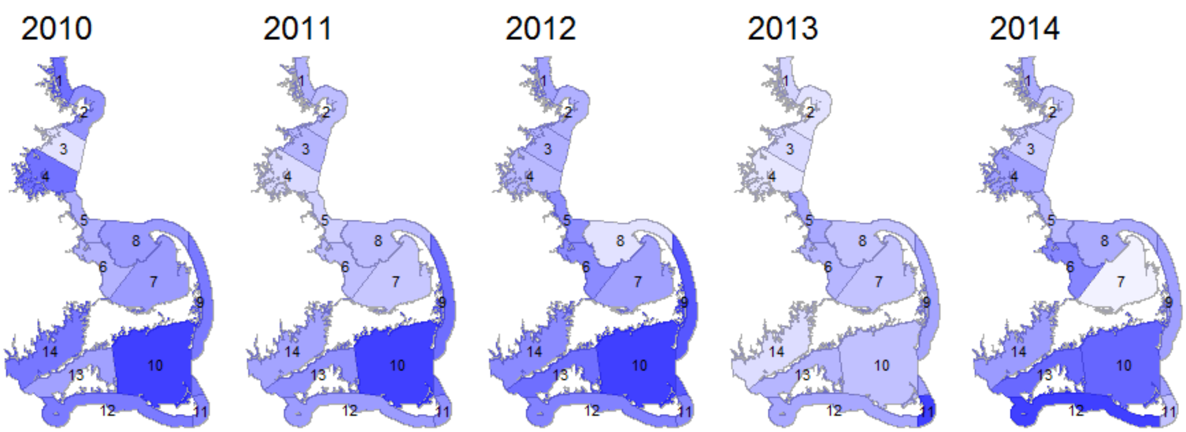
While there are no specific rules that explicitly prevent midwater trawling for herring in Massachusetts state waters, there are regulations that effectively prohibit this activity: 1) There is no exemption from the 6" minimum mesh size for herring fishing (as there is for the whiting and squid fisheries); and 2) A "coastal access permit" is required to fish with mobile gear in MA state waters, which has a maximum vessel length of 72 feet. There are very few coastal access permits (CAP), and there has been a moratorium on issuing new CAP permits since 1995.

Figure 46 - Spatial pattern in landings (pounds) for Massachusetts striped bass commercial fishery, 2010-2014



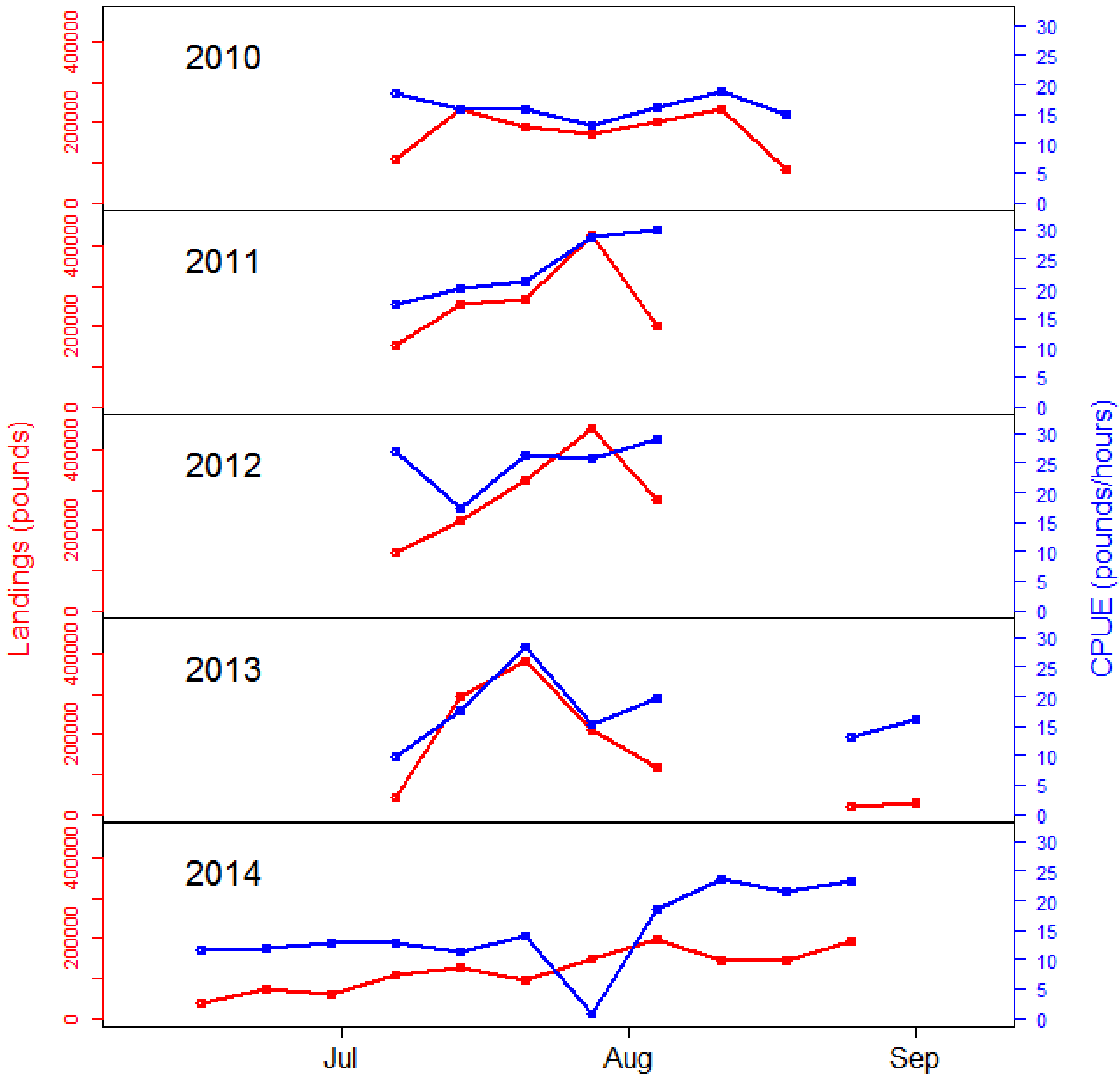
Source: MADMF (2016).

Figure 47 - Spatial pattern in CPUE (pounds / fishing-hours) for Massachusetts striped bass commercial fishery, 2010-2014



Source: MADMF (2016).

Figure 48 - Seasonal profile of Massachusetts commercial striped bass fishery, 2010-2014



Source: MADMF (2016).

3.6.2.6 Other Recreational Fisheries

Many recreational fisheries exist in the Northeast, and several depend on herring as a source of bait as well as a source of food for the fish that they target. The following review of recreational fisheries comes from the fisheries of the United States, which offers a comprehensive overview of recreational fisheries in the U.S. A full breakdown of the different recreationally fished species by year and weight is offered therein, as well as by distance from shore and by number of live releases.

The recreational fisheries serve many purposes for the residents of the Atlantic Coast states. In 2009, there were close to 44M trips that caught over 198M fish, trips which serviced nearly 6.4M residents. Over 31% of those trips were made in the waters managed by the NEFMC. Commonly caught fish on the trips that occurred in federally managed waters include black sea bass, summer flounder, Atlantic cod, dolphinfish, and bluefish. 62% of all the prior mentioned trips were ones in which the fishing was done mostly in inland waters.

States stand to benefit from recreational activity as well. In 2009, the state of New Jersey, New York, and Massachusetts had the most number of angler trips, with 5,444 trips; 4,917 trips, and 3,603 trips, respectively. Connecticut had 1,462 trips; while Maine had 1,014, and Rhode Island 1,042. The state of New Hampshire had the fewest, with 414 trips. The numbers of trips taken in 2008 were similar in magnitude by state. The trend in states is similarly mimicked in the number of finfish both harvested and released by recreational fishermen in 2008 and 2009, however, Connecticut was much closer in ranking to Massachusetts.

Due to the eclectic nature of the fisheries entailed in the recreational community, there is no one management body that oversees all recreational fisheries. Instead, there is a mixture of management from the NMFS, NEFMC, MAFMC, ASMFC, and state agencies that are not divided by the value of the resource. For instance, black sea bass is managed by the ASMFC, with recreational catches of 1,022 and 1,269 mt in 2008 and 2009, respectively. Atlantic cod are managed under the NEFMC’s Groundfish FMP, with recreational catches of 1,905 mt in 2008 and 1,677 mt in 2009. The MAFMC manages bluefish, with recreational catches of 8,717 mt in 2008 and 6,290 mt in 2009. There are a wide range of bodies that assess the health and status of the stocks that are recreationally fished as well.

There are multiple forms of data on recreational fisheries available. Data are gathered through state and regional logbook programs, a coastal household telephone survey, a telephone survey of for-hire fishing vessel operators, and a field intercept survey of completed angler fishing trips. Amendment 16 to the Groundfish FMP used data that came from the Marine Recreational Information Program (MRIP, formerly the MRFSS) and recreational party/charter logbook data. The party/charter mode logbook data can be used to characterize numbers of participating vessels, trips, and passengers.

The MRIP is a source for catch statistics including harvested and released catch, distance from shore, size distribution of harvested catch, catch class (numbers of fish per angler trip), and seasonal distribution of harvested catch. The MRIP is a relatively new initiative from NMFS, focused on counting and reporting marine recreational catch and effort. MRIP aims to provide the detailed, timely, scientifically sound estimates that fisheries managers, stock assessors and marine scientists need to ensure the sustainability of ocean resources, as well as address public concerns about the reliability and credibility of recreational fishing catch and effort estimates.

3.6.2.7 Ecotourism Industries

Atlantic herring is a forage species for whales, other marine mammals and birds in the Northeast. Thus, the whale and bird watching industries have an interest in the health of the Atlantic herring population. Fewer marine mammals or birds in the area available for customers to observe could lead to fewer boats and tours for specific operators. Furthermore, whales and some seabirds are known to respond to prey availability, and may become increasingly difficult to find if local sources of herring are reduced. For example, if these predators move farther offshore to find more plentiful sources of prey, that could have negative impacts on ecotourism industries that rely on more nearshore observations of marine mammals and seabirds. The number of marine mammals and birds needed to support the industries is unknown, but limited economic data on the whale watching industry does exist.

Whale watching: The whale watching season runs from April to October, occasionally into November, with fin, humpback, and minke whales being the key species of interest. Humpback whales are known to feed on herring, particularly in the Gulf of Maine, but also sand lance and other small fish. Humpbacks feed during the spring, summer and fall in the western North Atlantic (Waring *et al.* 2015). Their distribution in this region is largely correlated with prey, though behavior and bathymetry are factors as well (Payne *et al.* 1986; Payne *et al.* 1990).

Whales tend to congregate on large oceanographic features, which often cause prey items to aggregate in response to the upwelling. A good portion of a whale-watching trip involves finding the whales, which results in spent fuel. If schools of herring were to stop schooling or reduce in number and whales subsequently stopped congregating at these congregated feeding areas, this could result in increased effort and fuel to locate the dispersed whales (Lee 2010).

O'Conner *et al.* (2009) characterized the whale watching industry in 2008 as attracting 910,071 passengers participating boat-based trips by 31 operators from ports in Maine, New Hampshire, Massachusetts and Rhode Island, with $35M total direct revenue in 2008 (Table 69). Including indirect expenditures, the total expenditures was estimated to be $126M. This snapshot represents a decline in the number of passengers and operators, but an increase in revenue from a similar snapshot in 1998. Ticket prices in 2008 were about $40 for adults and $30 for children on a 4-hour cruise. Up to 400 passengers can fit on some vessels. The industry was estimated to employ 730 people.

Table 69 - New England whale watching, 1998 and 2008

Year	Whale watchers (#)	Operators (#)	Direct expenditure	Indirect expenditure	Total expenditure
1998	1,240,00	36	$30,600,000	$76,650,000	$107,250,000
2008	910,07	31	$35,000,000	$91,000,000	$126,000,000
Source: O'Conner et al (2009).					

AS of 2017, there are 22 dedicated whale watching companies with 34 vessels from Maine to New Jersey and several in Delaware and Virginia (Table 70). There are roughly 30 smaller, charter whale watch operations as well in the Northeast (GARFO). Important ports for whale watching in the Gulf of Maine include Bar Harbor, Maine; Rye, New Hampshire; and Gloucester, Boston, and Provincetown, Massachusetts (Lee 2010).

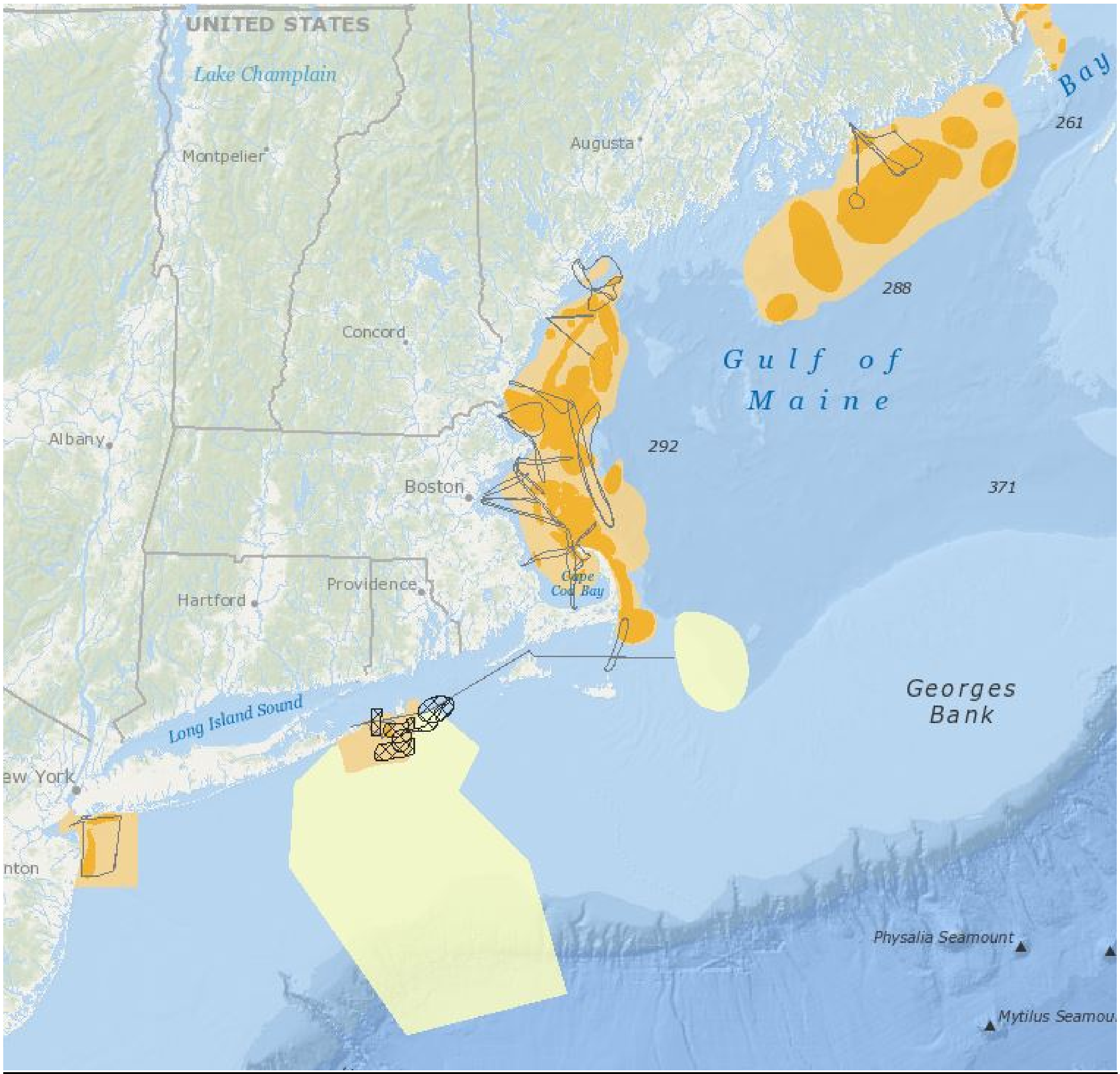
Whale watch companies do not report to NMFS where they go and what protected species they see. However, many, if not all, whale watch vessels carry naturalists on board to collect data. The naturalists are from research or conservation organizations. The Bar Harbor Whale Watch (BHWW) Company has been collecting data (e.g., number of humpbacks and finbacks, location and date) since the 1990s, but in 2003, started carrying scientists from Allied Whale on every trip. Their data are digitized, and BHWW has offered to help obtain the data. The Blue Ocean Society, The Whale and Dolphin Conservation, Provincetown Center for Coastal Studies, and College of the Atlantic also provide scientists for trips by other companies that do excursions to Jeffries Ledge, Stellwagen Bank, and other areas (Z. Klyver, pers. comm., 2015).

Table 70 - Whale watching companies in the Northeast U.S., 2017

State	Company name	Port	Number of vessels
ME	Bar Harbor Whale Watch	Bar Harbor	2
	Boothbay Harbor Capt. Fish's Whale Watch	Boothbay Harbor	3
	First Chance Whale Watch	Kennebunk	1
	Odyssey Whale Watch	Portland	1
NH	Atlantic Fleet Whale Watch	Rye	1
	Granite State Whale Watch	Rye	1
MA	Boston Harbor Cruises/New England Aquarium	Boston	4
	Cape Ann Whale Watch	Gloucester	1
	Capt Bill and Sons Whale Watch	Gloucester	1
	Captain John Boats	Plymouth	2
	Dolphin Fleet of Provincetown	Provincetown	4
	Hyannis Whale Watch Cruises	Barnstable	1
	Newburyport Whale Watch	Newburyport	1
	Seven Seas Whale Watch	Gloucester	1
	Shearwater Excursions Whale Watch	Nantucket	1
RI	Frances Fleet	Narragansett	2
	Seven B's V	Narragansett	1
NY	American Princess Fleet	Neponset	1
	Viking Fleet	Montauk	1
	Joseph DiLiberto	Montauk	1
NJ	Cape May Whale Watcher	Cape May	1
	Cape May WW & Research Center & Starlight Fleet	Cape May	2
Source: GARFO			

Figure 49 shows commercial whale watching areas as mapped by whale watch industry participants in the Northeast Coastal and Marine Recreational Use Characterization Study conducted by SeaPlan, the Surfrider Foundation, and Point 97 under the direction of the Northeast Regional Planning Body. Whale watch owners, operators, naturalists, and data managers attended participatory mapping workshops to map areas where whale watching takes place in the region, while also providing information about seasonality, species, and overall industry trends.

Figure 49 - Map of commercial whale watching areas



Source: Northeast Ocean Data Explorer, http://www.northeastoceandata.org/data-explorer/.

Legend:

- **Light orange = General use areas.** The full footprint of whale watch activity in 2010 – 2014.
- **Dark orange = Dominant use areas.** Areas routinely used by most users.
- **Lines = Transit routes.** Areas used for transit to and from general or dominant use areas.
- **Yellow = Supplemental areas.** Areas used for closely-related activities and infrequent specialty trips.
- **Hatched = RI Ocean Special Area Management Plan areas.** Areas that are part of the Rhode Island Ocean Special Area Management plan and are symbolized separately to reflect different data collection methodologies.

Seabird watching: New England is a primary destination for seabird watching, with trips concentrated in New Hampshire (e.g., Rye, Hampton), Massachusetts (Newburyport, Gloucester, and Provincetown - often in conjunction with whale watching), and Maine ports. In Maine, popular seabird watching destinations include Petit Manan and Machias Seal Island, within the Maine Coastal Islands National Wildlife Refuge (off the coast of Steuben and Cutler), and Eastern Egg Rock (St George). The seabird tourism industry in Maine generally runs May-early August, when most seabirds come to land to nest. However, opportunities to view non-breeding or migratory seabirds such as northern gannets and shearwaters continue until October. According to a 2005 USFWS report, 120 companies were identified as providing recreational seabird viewing in Maine, with about two thirds located in the Penobscot Bay area or to the east. Seabird viewing is a primary focus of 10-15% of these companies; it is an incidental service for the remainder. Trip prices ranged from $36 for a one to four hour excursion to $425 for multi-day excursions. It was estimated that 5,000-7,500 trips were taken annually with seabird viewing as a primary purpose and 350,000 to 450,000 trips with seabird viewing as a secondary purpose (e.g., whale watching trips). The value of seabird tourism in Maine was estimated at $5 to $10 million in 2001.

Since that time, seabird-based ecotourism has continued to increase in New England, particularly in Maine. During summer 2013, over 24,000 people paid for boat trips to watch Atlantic puffins; one of Maine's most popular wildlife attractions. For example, the Project Puffin Visitor Center, a popular tourist attraction in Rockland, Maine engages approximately 8,500 visitors each season in both the conservation and recreational aspects of seabirds and seabird-watching. It generates about $100,000 in sales of puffin-related merchandise and artwork, and sponsors weekly evening seminars on wildlife, photography, and seabirds. The Hog Island Audubon Camp in Bremen offers approximately ten residential sessions each summer, mostly to adults, on the topics of birds, bird watching, conservation based service-learning, and environmental education. According to the Maine Office of Tourism (2012), 6 million of Maine's 22 million annual visitors came for "leisure activities," spending $173 million on "recreation." This is in addition to more than two billion dollars spent by this group of visitors, on lodging, food, transportation, retail goods, etc. Of these "overnight" tourists, 50% said they visited "to enjoy the coastline," 36% said they visited to "enjoy nature as the primary purpose of their visit," and 13% were in Maine for "wildlife and bird watching". This equates to approximately 780,000 people. The Friends of Maine Coastal Islands National Wildlife Refuge website has links to 17 seabird tour boat operators in Downeast and Midcoast Maine (Table 71; https://mainecoastislands.org).

Commercial seabird watching also takes place in the mid-Atlantic, with activities concentrated at ports in Brooklyn, NY; Belmar and Cape May, NJ; Lewes, DE; Virginia Beach, VA; and Wanchese and Hatteras, NC. According to Conservation Community Consulting, a Maryland-based organization specializing in nature tourism promotion and assessment, there are only a few seabird watch operators with dedicated boats in this area (J. Rapp, pers. comm., but see http://paulagics.com/, http://www.patteson.com/). These operators range in price from $125 per person for an 8h trip to $250 per person for an 18-22 h trip. Several bird tour operators and birding clubs charter smaller recreational fishing and tour boats for seabird watches. These trips range from $55 per person for a half-day, to $75 per person for a full day ((J. Rapp, pers. comm.). As many mid-Atlantic seabird watches focus on non-breeding species in the open ocean, the most popular months are December through February, though spring and summer trips are also common. When this document was drafted, information on the total economic value generated by mid-Atlantic seabird watching was not readily available. However, based on the number of trips taking place, and associated costs, it is likely that the industry generates hundreds of thousands of dollars per year.

Table 71 – Seabird watching companies in Maine, 2017

Region	Port	Company names
Downeast	Bar Harbor	Bar Harbor Whalewatch
	Cutler	Bold Coast Charter
	Milbridge	Downeast Coastal Cruises; Robertson Sea Tour Adventures
	Stonington	Old Quarry Ocean Adventures; The Mail Boat
Midcoast	Rockland	Breakwater Kayak; Maine Windjammer Association; Matinicus Excursions
	Boothbay	Cap’n Fish Whale Watch Cruises; Maine Kayak; Tidal Transit Kayak
	New Harbor	Hardy Boat Cruises
	Bath	Long Reach Cruises
	Damariscotta	Midcoast Kayak
	Port Clyde	Monhegan Boat Line
	Bremen	Sail Muscongus

Source: Friends of Maine Coastal Islands National Wildlife Refuge (mainecoastislands.org, accessed July 2017).

3.6.4 Fishing Communities

3.6.4.1 Introduction

Consideration of the economic and social impacts on fishing communities from proposed fishery regulations is required by the National Environmental Policy Act (NEPA 1970) and the Magnuson-Stevens Fishery Conservation and Management Act (MSFCMA 2007).

National Standard 8 of the MSFCMA (16 U.S.C. § 1851(a)(8)) 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.*

A "fishing community" is defined in the MSFCMA (16 U.S.C. § 1802(17)), 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.*

Determining which fishing communities are "substantially dependent" on and "substantially engaged" in the Atlantic herring fishery can be difficult. Although it is useful to narrow the focus to individual communities in the analysis of fishing dependence, there are several potential issues with the confidential nature of the information. 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 ports that may only have a small number of active vessels.

To gain a better perspective on the nature of the Atlantic herring fishery and the character of the affected human environment, a broader interpretation of fishing community has been applied to include almost all communities with a substantial involvement in or dependence on the Atlantic herring fishery. In terms of National Standard 8 (NS 8), some of the communities identified in this section may not fit the strict interpretation of the criteria for substantial dependence on fishing. The fishing communities that meet the legal definition (as promulgated through NS 8) are likely to be considered a subset of the broader group of communities of interest that are engaged in the herring fishery and identified in this document.

Because Atlantic herring is widely used as bait for the lobster fishery, especially in Maine, it is impractical to identify every community with substantial involvement in the lobster fishery (and consequently some level of dependence on the herring fishery) for assessment in this document. Instead, some of the communities of interest are selected, in part, because of their involvement in or dependence on the lobster fishery; assessment of the impacts of measures on these communities should provide enough context to understand the potential impacts on any community with substantial involvement in the lobster fishery. Parallels can be drawn between the communities that are identified in this section and other similar communities engaged in the lobster fishery.

National Standard 8 requires the Council to consider the importance of fishery resources to affected communities and provide those communities with continuing access to fishery resources, but it does not allow the Council to compromise the conservation objectives of the management measures. "Sustained participation" is interpreted as continued access to the fishery within the constraints of the condition of the resource.

3.6.4.2 Communities of Interest

3.6.4.2.1 Atlantic Herring Fishery

There have been over 150 communities that have been a homeport or landing port to one or more active Atlantic herring fishing vessels since 1997. These ports primarily occur from Maine to Virginia. The level of activity in the herring fishery has varied across time. This section seeks to identify the communities for which Atlantic herring is particularly important, including communities active in the Atlantic herring fishery, and those dependent on herring as a bait source or prey item in the ecosystem. While these data describe a community's dependence on the Atlantic herring fishery, it is important to remember that at least some of the individual vessels therein are even more dependent on Atlantic herring. In some cases, the groups of communities identified above have been disaggregated so that information specific to certain communities can be provided and so that important details about individual communities are not lost.

Engagement in and reliance on the Atlantic herring fishery: Using the NMFS Community Vulnerability Indicators give a broader view of the degree of involvement of communities in fisheries than simply using pounds or revenue of landed fish (Jepson & Colburn 2013). The indicators portray the importance or level of dependence of commercial or recreational fishing to coastal communities, and are used to help identify the Atlantic herring *Communities of Interest* for this action. The degree of engagement in or reliance on the Atlantic herring fishery is based on multiple sources of information, averaged over five years, 2011-2015, using dealer data.

- *The engagement index* incorporates the pounds and value of landed Atlantic herring, the number of herring dealers buying fish in that community, and the number of vessels with herring landings.
- *The reliance index* is a per capita measure using the same data as the engagement index, but divided by total population in the community.

Using a principal component and single solution factor analysis, each community receives a factor score, which is translated into a ranking of low, medium, medium-high, or high. A score of 1.0 or more places the community at 1 standard deviation above the mean (or average) and is considered highly engaged or reliant. Communities with scores of 0.0-0.49 have low engagement. More information about the indicators may be found at: http://www.st.nmfs.noaa.gov/humandimensions/social-indicators/index

The indicators reveal that there are 71 communities that have an Atlantic herring fishery engagement and reliance index in the range of low to high. Reported in Table 72 are the 19 communities that have a ranking of at least medium for either engagement or reliance. In general, the fishing communities with low populations (e.g., in eastern Maine) have a medium to low engagement index, but a relatively higher reliance index. Portland, Gloucester, and New Bedford are highly engaged in the Atlantic herring fishery, but have high populations, so have lower reliance indices. Just one community scores high on both engagement and reliance indices: Rockland, Maine.

Table 72 – Atlantic herring fishing community engagement and reliance indicators

State	Community	Community Index	
		Engagement	Reliance
ME	Machiasport	Low	Medium
	Jonesport	Low	High
	Gouldsboro	Medium	High
	Stonington	Medium	High
	Rockland	High	High
	Vinalhaven	Low	High
	Matinicus	Low	Med-High
	Friendship	Low	Medium
	South Bristol	Low	High
	Portland	High	Medium
MA	Gloucester	High	Med-High
	New Bedford	High	Low
RI	N. Kingstown	Medium	Low
	Narragansett/Pt. Judith	High	Medium
NY	Montauk	Med-High	Med-High
	Hampton Bays/Shinnecock	Med-High	Low
NJ	Belford	Low	Medium
	Barnegat Light	Low	Med-High
	Cape May	Medium	Medium
Source: http://www.st.nmfs.noaa.gov/humandimensions/social-indicators/index.			

Community of Interest Criteria. The *Communities of Interest* (primary ports) for the Atlantic herring fishery meet at least one of the following criteria:

1. Atlantic herring landings of at least 10M pounds (4,536 mt) per year from 2007-2016, or anticipated landings above this level based on interviews and documented fishery-related developments.
2. Port infrastructure dependent in part or whole on Atlantic herring (e.g., herring dealers, pump stations).
3. Dependence on herring as bait (e.g., for lobster and/or tuna fisheries).
4. Geographic isolation in combination with some level of dependence on the Atlantic herring fishery.
5. Use of Atlantic herring for value-added production.
6. A ranking of "medium-high" or "high" for engagement in or reliance on the Atlantic herring fishery, according to the NMFS Community Vulnerability Indicators.

Updates to these criteria since their use in Amendment 5 are: a) updating the timeframe for herring landings in Criterion #1 (from 1997-2008 to 2007-2016); and b) adding Criterion #6, as the information for which has since become available from the NEFSC/Social Sciences Branch.

Communities identified. There are 18 communities that meet one or more of these criteria (Table 73). For Criteria #3, as there are well over 5,000 vessels landing lobster in ports from Maine to Virginia, a subset of representative ports are included here. Herring is used as bait primarily in ports from Maine to Massachusetts. Ports with landings over 10M lbs (4,536 mt) each year from 1997-2008, a criterion in Amendment 5, is included for comparison purposes. The communities meeting this criterion are unchanged, with the exception of New Bedford, which meets the criterion under the more recent time period. In Amendment 5, Lubec/Eastport, Maine was a *Community of Interest*, but this community is not included in Table 73, as the value-added production plant (for pearl essence) that was located there is now closed. Of these 17 communities, 11 have non-confidential landings and are described further in Section 3.6.4.3.

Table 73 - *Communities of Interest* (primary ports) in the Atlantic herring fishery

State	Community	Landings >10M lbs.		Infra-struct.	Bait	Isolation	Value-added	Rank
		(97-08)	(07-16)					
ME	Jonesport			√	L	√		√
	Gouldsboro			√	L	√		√
	Stonington			√	L	√		√
	Rockland	√	√	√	L			√
	Vinalhaven			√	L	√		√
	Matinicus			√	L	√		√
	South Bristol			√	L			√
	Sebasco			√	L			
	Portland	√	√	√	L			√
MA	Gloucester	√	√	√	L,T			√
	New Bedford		√	√	L,T		√	√
RI	Newport			√	L			
	N. Kingstown			√				
	Narragansett/ Pt. Judith			√	L		√	√
NY	Montauk			√	T			√
	Hampton Bays/ Shinnecock			√				√
NJ	Barnegat Light			√	T			√
	Cape May			√	T			

L = port reliant on herring bait for the lobster fishery.
T = port identified as a Highly Migratory Species community in the HMS FMP. A portion of the tuna fishery uses herring as bait.

States and Landing Ports. During the period 2007-2016, Atlantic herring was landed in eight states (not including confidential states), with the most landings occurring in Maine and Massachusetts, averaging 82M lbs. (37K mt) and 79M lbs. (36K mt), respectively, per year (Table 74). Within these states, Atlantic herring was landed in 130 ports. Gloucester and Portland have been the top two landing ports during this time period.

Table 74 – Annualized Atlantic herring landings to states and Atlantic herring *Communities of Interest*, 2007-2016

State/Port	Top port ranking	2007-2016 Avg. landings (mt)	Herring permits [a]	Herring dealers [a]
Maine		37,278	62	103
Portland	#2	16,986	33	80
Rockland	#4	13,319	20	67
Stonington	#6	2,359	12	33
Vinalhaven	#10	928	8	7
Jonesport	#12	763	8	13
S. Bristol	#19	231	6	4
Other (n=35)*		2,692	39	72
New Hampshire		829	26	32
Massachusetts		35,988	66	97
Gloucester	#1	19,892	39	83
New Bedford	#3	14,694	28	63
Other (n=11)		1,402	29	45
Rhode Island		5,326	58	35
Point Judith	#5	3,227	171	29
Newport	#13	612	12	8
Other (n=8)		1,487	9	7
Connecticut		6	11	6
New York		40	73	30
Montauk	#39	10	45	16
Hampton Bays/ Shinnecock	#37	13	29	16
Other (n=12)		17	14	13
New Jersey		2,150	56	12
Maryland		5	11	3
Confidential state(s)		307	9	7
Total	**130**	**81,930**	**291**	**190**

[a] Totals may not equal the sum of the parts, because permits can land in multiple ports/states.
*Prospect Harbor, Maine is the ninth port in terms of landings during this time period (12Kmt total), yet it does not qualify as an Atlantic herring *Community of Interest*.
Source: Dealer data, accessed July 2017.

Home Ports. Of the Atlantic herring *Communities of Interest*, Gloucester and New Bedford, Southern RI, and Cape May are homeports with largest concentrations of vessels that have Atlantic Herring limited access directed fishery permits, Categories A and B (Table 75). Mid-Coast ME, Portland and Seacoast NH also are home to a few of these permit holders. Beyond the communities of interest, a few Category A and B permit holders have homeports in Bath, Cundys Harbor, Hampden, and Matinicus ME; Boston and Woods Hole MA; and Wanchese NC. For the most part, these vessels use a community of interest as a landing port. The distribution of important homeports for Atlantic herring vessels is largely unchanged between 2011 and 2016, particularly for the limited access vessels.

Table 75 - Distribution of vessels with herring permits which have an Atlantic herring community of interest as a homeport, 2011 and 2016

Homeport		Atlantic Herring Permit Category					
		Limited Access (A, B, C)		Open Access (D, E)		Total	
		2011	2016	2011	2016	2011	2016
ME	Portland	3	3	37	33	40	36
	Rockland	1	1	2	2	3	3
	Stonington/Deer Isle	1	0	1	2	2	2
	Vinalhaven	0	0	2	3	2	3
	Lubec/Eastport	0	0	2	1	2	1
	Sebasco Estates	0	0	3	2	3	2
	Maine, other	11	7	213	150	224	159
NH	Seacoast	6	4	104	94	110	98
MA	Gloucester	8	6	191	116	199	122
	New Bedford	12	10	210	183	222	193
	Massachusetts, other	10	8	407	329	417	337
RI		15	14	124	112	139	126
NJ	Cape May	14	12	100	77	114	89
	New Jersey, other	0	0	207	173	207	173
Other		12	12	521	393	533	405

Source: NMFS permit database: https://www.greateratlantic.fisheries.noaa.gov/aps/permits/data/index.html. Accessed September 2016.

3.6.4.2.2 Other Fisheries/Ecotourism

There are several other fisheries, as well as the ecotourism industry, that are potentially impacted by this action. Summarized below are the key port communities that are important to each of these fisheries, as identified by the lead management entity for each. Where the management entity has not previously identified the relevant communities, a method was developed through this action and explained below. Many ports have coexisting fisheries, including the Atlantic herring fishery. In all, about 140 communities have been identified as potentially impacted (Table 78).

Atlantic Mackerel: Many vessels that participate in the Atlantic herring fishery are also active in the Atlantic mackerel fishery. Primary ports identified in the Mackerel, Squid, Butterfish FMP had at least $100,000 in ex-vessel revenues from mackerel during 2012-2014 (combined) included (from more mackerel dollars to less): North Kingstown, RI; Gloucester, MA; New Bedford, MA; Portland, ME; Cape May, NJ; Marshfield, MA; Provincetown, MA; and Point Judith, RI (Table 78) (MAFMC 2016b). For purposes of this action, these are considered the primary mackerel ports. There are 11 other ports that are either a homeport or a primary landing port for ≥1 Atlantic mackerel vessel(s) (MAFMC 2015), and these are considered secondary ports here. Section 3.6.2.1 contains more information about the mackerel fishery.

American Lobster: The American lobster fishery is the primary end user of Atlantic herring as bait. American lobster is landed in many port communities on the Atlantic coast. The ASMFC does not identify key ports in the FMP for this fishery. In 2015, 18 of the top 20 ports for lobster landed value were in Maine (primarily midcoast to eastern Maine), and two were in Massachusetts (Table 76). For purposes of this action, these 20 top ports are considered the primary lobster ports. Also in 2015, there were 2,297 federal lobster licenses issued to vessels from 279 home ports (15 states) and 273 primary landing ports (12 states). Of these, there were 63 ports that were either the home port or primary landing port to at least 10 federal lobster vessels (Table 78), and these are considered secondary ports here. Since roughly 8,000 state waters-only lobster licenses are issued annually, it is likely that many more ports have over 10 lobster licenses issued per port. Section 3.6.2.2 contains more information about the lobster fishery.

Bluefin Tuna: Atlantic herring is important to tuna as a prey item in the ecosystem as well as a bait source for a subset of the fishery. NMFS has identified 28 fishing communities important to the Highly Migratory Species fishery (including 53 species of tunas, swordfish, sharks, etc.) defined by the proportion of HMS landings in the town, the relationship between the geographic communities and the fishing fleets, socioeconomic research, community studies, and input from advisory bodies. The communities in Maine to New Jersey are: Gloucester and New Bedford, MA; Wakefield RI; Montauk, NY; and Brielle, Barnegat Light, and Cape May, NJ (NMFS 2011b). For purposes of this action, these 7 top ports are considered the primary tuna ports (Table 78). As of October, 2017, there were 6,620 current tuna permits issued (GARFO 2017), 4,009 (61%) of which were in states from Maine to New Jersey. Within these states, 82 communities have ≥10 bluefin tuna vessels as its principal port, and these are considered secondary ports here. Section 3.6.2.3 contains more information about the tuna fishery.

Commercial Groundfish: Atlantic herring is important to groundfish as a prey item in the ecosystem as well; it is a bait source for a very minor subset of the commercial fishery (more important for recreational bait). There are over 400 communities that have been the homeport or landing port to one or more commercial Northeast groundfish fishing vessels since 2008. Of these, 10 ports have been identified as primary commercial groundfish port communities (and 22 secondary ports), based on the level of commercial groundfish activity in the port (Table 78). Primary ports have, during FY 2009-FY 2013, at least $100,000 average annual revenue (for all species, not just groundfish) and are in the top ten ranking in regional quotient or local quotient (confidential ports excluded). For purposes of this action, these 10 top ports are considered the primary commercial groundfish ports. Secondary ports are in the top 11-30 ranking in regional or local quotient (same revenue threshold; NEFMC 2017). Section 3.6.2.4 contains more information about the groundfish fishery.

Table 76 – Top 20 landing ports by lobster revenue, 2015, Maine to New Jersey (Source: ACCSP, Aug.2017)

State	Port	Top 20 landing port for lobster revenue		
		Revenue	# of vessels	# of dealers
ME	Jonesport	$9.8M	178	6
	Beals	$20M	234	5
	Milbridge	$11M	76	13
	Steuben	$9.4M	71	11
	Winter Harbor	$8.4M	39	3
	Southwest Harbor	$11M	109	8
	Bass Harbor	$11M	91	7
	Swans Island	$11M	93	4
	Stonington	$62M	367	10
	Rockland	$13M	163	4
	Vinalhaven	$39M	222	12
	Owls Head	$10M	71	4
	S. Thomaston/Spruce Head	$17M	130	10
	Port Clyde	$10M	103	10
	Tenants Harbor	$9.7M	92	11
	Cushing	$9.1M	68	9
	Friendship	$21M	165	10
	Portland	$17M	230	21
MA	Gloucester	$16M	202	24
	New Bedford/Fairhaven	$8.3M	91	22

Recreational: Atlantic herring is important to recreational fisheries as a prey item in the ecosystem as well as a bait source for a subset of the fishery. The relevant recreational fisheries are primarily tuna, striped bass, and groundfish. In the fishery management plans for these fisheries, criteria for identifying key recreational fishing communities have not been identified. For this action, a community is considered a recreational fishing community if it is (Table 77):

- If the community has a high level of engagement or reliance in recreational fishing using the NMFS Community Vulnerability Indicators, which portray the importance or level of dependence on recreational fishing by coastal communities (Jepson & Colburn 2013). *The engagement index* incorporates the number of recreational fishing trips in 2011-2015 by fishing mode (private boat, charter boat, shore fishing) originating in the community (using MRIP data). *The reliance index* is a per capita measure using the same data as the engagement index, but divided by total population in the community.
- Located on or near the coast in a coastal state from Maine to New Jersey. *These are the states adjacent to the Atlantic herring stock area.*

Between 2011-2015, there were 191 fishing communities between Maine and New Jersey identified as the principal port for the 571 vessels with Northeast multispecies charter/party permits (Category I). Montauk, NY had the most number of permits (annual average of 52). There were 12 ports with an annual average of ten or more permits that also met the above criteria. For this action, these are considered the primary recreational communities (Table 78), others are considered secondary ports.

Ecotourism: The Friends of the Maine Coastal Island National Wildlife Refuge lists several seabird watching businesses, and they are located in 11 communities in Maine. GARFO records indicate there are currently 17 whale watching businesses, in communities from Maine to New Jersey (Section 3.6.2.7; Table 78).

Table 77 – Ports with a "high" recreational fishing community engagement or reliance indicator and number of party/charter permits on average in 2011-2015 (if ≥10)

State	Community	Community Index		# of vessels with party/charter permits
		Engagement	Reliance	
ME	Biddeford	High	Low	
NH	Hampton	High	Medium	12
	Seabrook	High	Medium	
MA	Salisbury	High	Med-High	
	Newburyport	High	Medium	11
	Gloucester	High	Medium	20
	Plymouth	High	Low	11
	Marshfield (Green Harbor-Cedar Crest/ Marshfield Hills/Ocean Bluff-Brant Rock)	High	Medium	27
	Sandwich (E. Sandwich/Forestdale)	High	Medium	
	Barnstable	High	Medium	
	Yarmouth (S. Yarmouth/W. Yarmouth/ Yarmouth Port)	High	Low	
	Dennis	High	High	
	Chatham	Med-High	High	
	Harwich Port	Med-High	High	
	Falmouth	High	High	
	Bourne	High	High	
	Wareham (W. Wareham/Onset)	High	Low	
	Nantucket	High	Med-High	
	Westport	High	Medium	
RI	Tiverton	High	Low	
	Bristol	High	Low	
	Jamestown	High	Medium	
	Warwick	High	Low	
	Narragansett (Point Judith)	High	Med-High	22
	S. Kingstown (Kingston/Wakefield-Peacedale)	High	Low	
	Charlestown (Carolina)	High	Medium	
CT	Stonington (Mystic/Pawcatuck)	High	Medium	
	Groton	High	Medium	
	Waterford	High	Medium	
	East Lyme (Niantic)	High	Medium	
	Old Lyme	High	Medium	
	Old Saybrook	High	Med-High	
	Milford	High	Low	

State	Community	Community Index		# of vessels with party/charter permits
		Engagement	Reliance	
NY	Northport	High	Medium	
	Port Jefferson	High	Medium	
	Mt. Sinai	High	Medium	
	Moriches	High	High	
	Shirley	High	Low	
	Mastic Beach	High	Low	
	Orient	High	High	
	Montauk	High	High	52
	Hampton Bays	High	High	
	Babylon	High	High	
	Oak Beach-Captree	Low	High	
	Wantagh	High	Medium	
	Point Lookout	High	High	
	Long Beach	High	Low	
	Brooklyn (Sheepshead Bay)	High	Low	12
	Queens	High	Low	
NJ	Keyport	High	Med-High	
	N. Middletown	High	Medium	
	Port Monmouth	High	Medium	
	Leonardo	High	High	
	Atlantic Highlands	High	High	
	Belmar (South Belmar)	High	High	15
	Manasquan	High	Medium	
	Brielle	High	Med-High	
	Pt. Pleasant	High	Med-High	15
	Berkeley (Bayville)	High	Low	
	Barnegat Light	High	High	10
	Port Republic	Med-High	High	
	Brigantine	High	Medium	
	Abesecon	High	Medium	
	Margate City	High	Med-High	
	Somers Point	High	Medium	
	Ocean City	High	Medium	
	Sea Isle City	High	High	
	Stone Harbor	High	High	
	Wildwood	High	High	
	Lower (Erma/North Cape May/Villas)	High	Low	
	Cape May	High	High	29
	Maurice River (Leesburg)	High	Medium	
	Downe (Fortesque)/Newport	High	High	

Table 78 – Primary and secondary port communities for the herring fishery and other fisheries/industries potentially impacted by Amendment 8, Maine to New Jersey

State	Port	Herring	Mackerel	Lobster	Tuna	Groundfish	Recreational	Ecotourism
ME	Cutler			L				B
	Machiasport	H						
	Bucks Harbor			L				
	Jonesport	H*		L*				
	Beals			L*				
	Addison			L				
	Harrington			L				
	Milbridge			L*				B
	Steuben			L*				
	Gouldsboro (Corea)	H*		L				
	Winter Harbor			L*				
	Bar Harbor			L				B/W
	Southwest Harbor			L*				
	Bass Harbor			L*				
	Swans Island			L*				
	Stonington	H*		L*				B
	Deer Isle			L				
	Rockland	H*	M	L*				B
	Vinalhaven	H*	M	L*				
	Owls Head			L*				
	Matinicus	H*						
	S. Thomaston (Spruce Head)			L*		G		
	Port Clyde			L*		G		B
	Tenants Harbor			L*				
	Cushing			L*	T			
	Friendship	H		L*	T			
	Bremen							B
	New Harbor			L	T			B
	South Bristol	H*		L				
	Damariscotta							B
	Boothbay (Boothbay Harbor)			L	T	G		B/W
	Bath		M					B
	Phippsburg (Sebasco)	H*		L	T			
	Harpswell (Bailey Island/Cundy's Harbor)		M	L	T	G		
	Portland	H*	M*	L*	T	G*		W
	South Portland				T			
	Saco				T	G		

	Biddeford				T		R	
	Kennebunkport (Cape Porpoise)			L	T	G		W
	Wells				T			
	Ogunquit			L	T			
	York							
	Kittery			L	T			
	Elliot				T			
	Portsmouth			L	T	G*		
	New Castle				T			
	Newington		M	L	T			
NH	Dover				T			
	Rye			L	T	G*		B/W
	Hampton			L	T	G	R*	B/W
	Seabrook			L	T	G*	R	
	Salisbury				T		R	
	Newburyport				T	G	R*	B/W
	Rockport			L	T	G*		B
	Gloucester	H*	M*	L*	T*	G*	R*	W
	Manchester (Manchester-By-The-Sea)				T			
	Beverly			L	T			
	Salem				T			
	Marblehead			L				
	Winthrop				T			
	Boston		M	L	T	G*		B/W
	Quincy				T			
	Hingham				T			
	Scituate			L	T	G*		B/W
	Marshfield (Green Harbor/Cedar Crest)		M*	L	T	G	R*	B
	Plymouth				T	G	R*	B/W
MA	Sandwich (East Sandwich/Forestdale)				T	G	R	
	Barnstable (Osterville)				T	G	R	W
	Yarmouth (S. Yarmouth/W. Yarmouth/ Yarmouth Port)						R	
	Dennis (East Dennis)				T	G	R	
	Provincetown		M*	L	T	G		W
	Truro				T			
	Wellfleet				T			
	Bass River				T			
	Orleans				T			
	Chatham			L	T	G*	R	B
	Harwich (Harwich Port)				T	G*	R	
	Hyannis				T			
	Falmouth				T		R	
	Woods Hole		M			G		
	Bourne				T		R	

	Wareham (W. Wareham/Onset)						R	
	Nantucket				T	G*	R	W
	Edgartown				T			
	Menemsha			L				
	New Bedford/Fairhaven	H*	M*	L*	T*	G*		
	Westport			L			R	
RI	Tiverton		M				R	
RI	Bristol						R	
RI	Portsmouth				T			
RI	Newport	H*		L	T	G		
RI	Jamestown						R	
RI	Warwick				T		R	
RI	N. Kingstown (Davisville)	H*	M*					
RI	Narragansett (Pt. Judith)	H*	M*	L	T	G*	R*	W
RI	South Kingstown (Kingston/Wakefield-Peacedale)				T		R	
RI	Charlestown (Carolina)						R	
CT	Stonington (Mystic/Pawcatuck)			L	T	G	R	
CT	Groton (Noank)				T		R	
CT	New London				T			
CT	Waterford						R	
CT	East Lyme (Niantic)				T		R	
CT	Old Lyme						R	
CT	Old Saybrook				T		R	
CT	Milford						R	
NY	Northport						R	
NY	Brookhaven (Port Jefferson/Mt. Siani/ Moriches/Shirley/Mastic Beach)						R	
NY	Greenport		M					
NY	Orient						R	
NY	Montauk	H*	M	L	T*	G	R*	W
NY	Hampton Bays/Shinnecock	H*			T		R	
NY	Bay Shore				T			
NY	Babylon (Oak Beach-Captree)				T		R	
NY	Hempstead (Freeport/Wantagh/Pt. Lookout)				T		R	
NY	Long Beach						R	
NY	New York(Brooklyn (Sheepshead Bay)/ Queens (Neponset))			L			R*	W
NJ	Keyport						R	
NJ	Middletown (N. Middleton/Port Monmouth/ Belford/Leonardo)	H		L			R	
NJ	Atlantic Highlands						R	
NJ	Highlands				T			
NJ	Neptune				T			

	Belmar (South Belmar)				T		R*	
	Manasquan				T		R	
	Brielle				T*		R	
	Point Pleasant			L	T		R*	
	Brick				T			
	Berkeley (Bayville)						R	
	Forked River				T			
	Waretown				T			
	Barnegat Light	H*		L	T*		R*	
	Beach Haven				T			
	Port Republic						R	
	Brigantine						R	
	Abesecon						R	
	Atlantic City				T			
	Margate City						R	
	Somers Point						R	
	Ocean City				T		R	
	Sea Isle City						R	
	Stone Harbor						R	
	Wildwood		M		T		R	
	Lower (Erma/N. Cape May/Villas)						R	
	Cape May	H*	M*	L	T*		R*	W
	Maurice River (Leesburg)						R	
	Downe (Fortesque)/Newport						R	

H = herring; M = mackerel; L = lobster; T = tuna; G = groundfish; B = seabird watching; W = whale watching
* = primary port.

3.6.4.3 Port Descriptions

Described here are the 11 fishing communities that have a "high" Atlantic herring fishery engagement and/or reliance index (Section 3.6.4.2.1). Information in this section is largely based on demographic data collected by the U.S. Census and fishery data collected by NMFS, much of which are available on the NEFSC website (NEFSC 2017b). Clay *et al.* (2007) has a detailed profile of each port, including important social and demographic information.

3.6.4.3.1 Maine ports

Jonesport, ME

General: Jonesport is a fishing community in Washington County, ME. In 2016, Jonesport had a population of 1,241, a 9% decrease from the year 2010 (1,370). In 2012-2016, 26% of the civilian employed population aged 16 years and over worked in agriculture, forestry, fishing, hunting, and mining occupations in Jonesport; the poverty rate was 16%; and the population was 97% white, non-Hispanic (U.S. Census 2018). The commercial fishing engagement and reliance indices for Jonesport are both high (Jepson & Colburn 2013). In 2015, Jonesport was the homeport and primary landing port for 60 and 66 federal fishing permits, respectively (GARFO 2017). Total landings in Jonesport were valued at over $11M, 2% of the state-wide total ($591M). American lobster accounted for $9.8M, 89% of the 2015 landings in Jonesport, landed by 157 vessels and sold to 6 dealers (Table 79; ACCSP, 2017).

Herring fishery: Since 2007, Jonesport has been the 12th highest port in terms of Atlantic herring landings (763 mt/year; 1% of total; Table 74). These landings are attributed to eight Atlantic herring federal permits, sold to 13 dealers. In 2015, Jonesport was the homeport and primary landing port for four and five Category D federal fishing permits, respectively (GARFO 2017). Thus, Jonesport is likely not the primary port for several herring vessels. Jonesport is involved in the Atlantic herring fishery primarily through its dependence on herring for lobster bait and for its geographic isolation (Section 3.6.4.2.1). Jonesport shares characteristics with many other small, somewhat isolated communities in Maine dependent on herring for lobster bait. The Atlantic herring fishing engagement and reliance indices are low and high, respectively, for Jonesport (Jepson & Colburn 2013).

Other fisheries/ecotourism: Jonesport is a primary port for the lobster fishery (Table 78).

Table 79 - Top five species landed by value in Jonesport ME, 2015

Species	Revenue ($)	Vessels	Dealers
American lobster	$9.8M	157	6
Sea scallop	$0.89M	94	3
Sea mussel	$0.55M	7	3
Atlantic halibut	$0.071M	34	3

Note: Data for one of the five top species landed are confidential.
Source: ACCSP, as of August 2017.

Stonington, ME

General: Stonington is a fishing community in Hancock County, ME. In 2016, Stonington had a population of 1,138, a 9% increase from the year 2010 (1,043). In 2012-2016, 23% of the civilian employed population aged 16 years and over worked in agriculture, forestry, fishing, hunting, and mining occupations in Stonington; the poverty rate was 17%; and the population was 97% white, non-Hispanic (U.S. Census 2018). The commercial fishing engagement and reliance indices for Stonington are both high (Jepson & Colburn 2013). In 2015, Stonington was the homeport and primary landing port for 89 and 90 federal fishing permits, respectively (GARFO 2017). Total landings in Stonington were valued at over $63M, 11% of the state-wide total ($591M). American lobster accounted for $62M, 98% of the 2015 landings in Stonington, landed by 372 vessels and sold to 10 dealers (Table 80; ACCSP, 2017). Shoreside support services and fishing-related organizations based in Stonington include the Maine Center for Coastal Fisheries (coastalfisheries.org), the Stonington Lobster Cooperative (http://www.stoningtonlobstercoop.com), Island Fishermen's Wives Association (http://islandfishermenswivesassociation.org), and Commercial Fisheries News (www.fish-news.com/cfn/).

Herring fishery: Since 2007, Stonington has been the 6th highest port in terms of Atlantic herring landings (2,359 mt/year; 3% of total; Table 74). These landings are attributed to 12 Atlantic herring federal permits, sold to 33 dealers. In 2015, Stonington was the homeport for no Atlantic herring federal fishing permits and the primary landing port listed for two Category D permits (GARFO 2017). Thus, Stonington is likely not the primary port for several herring vessels. Stonington is involved in the Atlantic herring fishery primarily through its dependence on herring for lobster bait and for its geographic isolation (Section 3.6.4.2.1). Stonington shares characteristics with many other small, somewhat isolated communities in Maine dependent on herring for lobster bait. The Atlantic herring fishing engagement and reliance indices are medium and high, respectively, for Stonington (Jepson & Colburn 2013).

Other fisheries/ecotourism: Stonington is a primary port for the lobster fishery (Table 78). It is a bird watching destination, with two companies located in town: Old Quarry Ocean Adventures (www.oldquarry.com) and The Mail Boat (isleauhautferryservice.com; Table 71).

Table 80 - Top five species landed by value in Stonington ME, 2015

Species	Revenue ($)	Vessels	Dealers
American lobster	$62M	372	10
Sea scallop	$0.48M	38	11
Atlantic halibut	$0.23M	39	5
Atlantic rock crab	$0.034M	33	5
Note: Data for one of the five top species landed are confidential. *Source:* ACCSP, as of August 2017.			

Rockland, ME

General: Rockland is a fishing community in Knox County, ME. In 2016, Rockland had a population of 7,220, a 1% decrease from the year 2010 (7,297). In 2012-2016, 4% of the civilian employed population aged 16 years and over worked in agriculture, forestry, fishing, hunting, and mining occupations in Rockland, the poverty rate was 14%; and the population was 95% white, non-Hispanic (U.S. Census 2018). The commercial fishing engagement and reliance indices for Rockland are high and medium, respectively (Jepson & Colburn 2013). In 2015, Rockland was the homeport and primary landing port for 14 and 12 federal fishing permits, respectively (GARFO 2017). Total landings in Rockland were valued at over $18M, 3% of the state-wide total ($591M). American lobster accounted for $13M, 72% of the 2015 landings in Rockland, landed by 141 vessels and sold to 4 dealers (Table 81; ACCSP, 2017).

Herring fishery: Since 2007, Rockland has been the 4th highest port in terms of Atlantic herring landings (average 29M/year; 16% of total; Table 74). In 2015, herring was one of the top five species landed in Rockland, valued at $4.4M, landed by 6 vessels and sold to 31 dealers (Table 81; ACCSP, 2017). Rockland meets Criterion #1 for an Atlantic herring *Community of Interest*: having at least 10M pounds of landings per year from 2007-2016. These landings are attributed to 20 Atlantic herring federal permits, sold to 67 dealers. In 2015, Rockland was the homeport for no Atlantic herring federal fishing permits and the primary landing port listed for two Category A and two Category D permits (GARFO 2017). Thus, Rockland is likely not the primary port for several herring vessels.

Rockland is also involved in the Atlantic herring fishery in its dependence on herring for lobster bait (Section 3.6.4.2.1). Shoreside support services based in Rockland include several lobster bait dealers, large and small, and a pumping station for offloading herring, which is trucked to other ports. In addition, there are freezer facilities to store lobster bait and ice services in Rockland. The Atlantic herring fishing engagement and reliance indices are high and high, respectively, for Rockland (Jepson & Colburn 2013)

Other fisheries/ecotourism: Rockland is a primary port for the lobster fishery and a secondary port for the mackerel fishery (Table 78). Rockland is a bird watching destination, with three companies located in town: Breakwater Kayak, Maine Windjammer Assoc., and Matinicus Excursions (Table 71).

Table 81 - Top five species landed by value in Rockland ME, 2015

Species	Revenue ($)	Vessels	Dealers
American lobster	$13M	141	4
Atlantic herring	$4.4M	6	31
Note: Data for three of the five top species landed are confidential. *Source:* ACCSP, as of August 2017.			

Vinalhaven, ME

General: Vinalhaven is an island fishing community in Knox County, MM. In 2016, Vinalhaven had a year-round population of 1,155 (swells in the summer), a 1% decrease from the year 2010 (1,165). In 2012-2016, 34% of the civilian employed population aged 16 years and over worked in agriculture, forestry, fishing, hunting, and mining occupations in Vinalhaven, the poverty rate was 12%; and the population was 98% white, non-Hispanic (U.S. Census 2018). The commercial fishing engagement and reliance indices for Vinalhaven are high and medium-high, respectively (Jepson & Colburn 2013). In 2015, Vinalhaven was the homeport and primary landing port for 49 and 51 federal fishing permits, respectively (GARFO 2017). Total landings in Vinalhaven were valued at over $40M, 7% of the state-wide total ($591M). American lobster accounted for $39M, 98% of the 2015 landings in Vinalhaven, landed by 221 vessels and sold to 12 dealers (Table 82; ACCSP, 2017).

Herring fishery: Since 2007, Vinalhaven has been the 10th highest port in terms of Atlantic herring landings (average 2.0M/year; 1% of total; Table 74). These landings are attributed to eight Atlantic herring federal permits, sold to seven dealers. In 2015, Vinalhaven was the homeport for no Atlantic herring federal fishing permits and the primary landing port listed for two Category A and five Category D permits (GARFO 2017). Thus, the Atlantic herring vessels that offload on Vinalhaven are primary based on the mainland. There is a public ferry service from Rockland, but its storage capacity is too small to satisfy the bait market.

Vinalhaven is also involved in the Atlantic herring fishery in its dependence on herring for lobster bait and its geographic isolation (Section 3.6.4.2.1). Shoreside support services based in Vinalhaven include the Vinalhaven Fishermen's Cooperative, locally owned by lobstermen and supplying the island with bait and fuel and distributing their lobsters to customers globally (vinalhavencoop.com). There are several lobster wholesale and packaging companies operating on Vinalhaven. There is little on-island bait storage capacity, so islanders are dependent on deliveries by herring vessels. Bait dealers on Vinalhaven pay a higher price for bait than dealers on the mainland, as there is limited bait storage capacity on the island and insufficient space on the ferry that transports goods and people from the mainland to make regular bait transshipments during the height of the lobster season. The Atlantic herring fishing engagement and reliance indices are low and high, respectively, for Vinalhaven (Jepson & Colburn 2013).

Other fisheries: Vinalhaven is a primary port for the lobster fishery and a secondary port for the mackerel fishery (Table 78).

Table 82 - Top five species landed by value in Vinalhaven, ME, 2015

Species	Revenue ($)	Vessels	Dealers
American lobster	$39M	221	12
Sea scallop	$0.064M	7	3
Atlantic halibut	$0.018M	10	3
Atlantic rock crab	$0.016M	53	8
Note: Data for one of the five top species landed are confidential. *Source:* ACCSP, as of April 2017.			

South Bristol, ME:

General: South Bristol is a fishing community in Lincoln County, ME. In 2016, South Bristol had a population of 995, a 12% increase from the year 2010 (892). In 2012-2016, 3% of the civilian employed population aged 16 years and over worked in agriculture, forestry, fishing, hunting, and mining occupations in South Bristol; the poverty rate was 8%; and the population was 98% white, non-Hispanic (U.S. Census 2018). The commercial fishing engagement and reliance indices for South Bristol are both medium-high (Jepson & Colburn 2013). In 2015, South Bristol was the homeport and primary landing port for 26 and 27 federal fishing permits, respectively (GARFO 2017). Total landings in South Bristol were valued at over $5.9M, 1% of the state-wide total ($591M). American lobster accounted for $5.9M of the 2015 landings in South Bristol, landed by 77 vessels and sold to 4 dealers (Table 83; ACCSP, 2017).

Herring fishery: Since 2007, South Bristol has been the 19th highest port in terms of Atlantic herring landings (average 0.5M/year; 0.3% of total; Table 74). These landings are attributed to six Atlantic herring federal permits, sold to four dealers. In 2015, South Bristol was the homeport for two Category C and six Category D Atlantic herring federal fishing permits and the primary landing port listed for one Category A permit, two category C permits, and six Category D permits (GARFO 2017). Thus, the Atlantic herring vessels that offload in South Bristol may primarily be based in South Bristol.

South Bristol is also involved in the Atlantic herring fishery in its dependence on herring for lobster bait (Section 3.6.4.2.1). Shoreside support services based in South Bristol include the South Bristol Fisherman's Cooperative, which was created in the 1970s and has a current membership of over 35 fishermen, supplying the community with bait and fuel and distributing their lobsters (e.g., packing and shipping) to customers (www.southbristolcoop.com). The Atlantic herring fishing engagement and reliance indices are low and high, respectively, for South Bristol (Jepson & Colburn 2013).

Other fisheries/ecotourism: South Bristol is a primary port for the lobster fishery (Table 78).

Table 83 - Top five species landed by value in South Bristol ME, 2015

Species	Revenue ($)	Vessels	Dealers
American lobster	$5.9M	77	4
Note: Data for four of the five top species landed are confidential. *Source:* ACCSP, as of August 2017.			

Portland, ME

General: Portland is a fishing community in Cumberland County, ME. In 2016, Portland had a population of 66,649, a 0.7% increase from the year 2010 (66,194). In 2012-2016, 0.5% of the civilian employed population aged 16 years and over worked in agriculture, forestry, fishing, hunting, and mining occupations in Portland; the poverty rate was 19.2%; and the population was 82% white, non-Hispanic (U.S. Census 2018). The commercial fishing engagement and reliance indices for Portland are high and low, respectively (Jepson & Colburn 2013). In 2017, Portland was the homeport and primary landing port for 76 and 98 federal fishing permits (i.e., vessels), respectively (GARFO 2018). Total landings in Portland were valued at $35M, 6% of the state-wide total ($591M). American lobster accounted for $17M, 49% of the 2015 landings in Portland, landed by 218 vessels and sold to 21 dealers (Table 84; ACCSP, 2017).

Herring fishery: Since 2007, Portland has been the 2nd highest port in terms of Atlantic herring landings (average 37M/year; 20% of total; Table 74). Portland meets Criterion #1 for an Atlantic herring *Community of Interest*: having at least 10M pounds of landings per year from 2007-2016. These landings are attributed to 33 Atlantic herring federal permits, sold to 80 dealers. In 2015, Portland was the homeport for two Category A, one Category C, 30 Category D, and one Category D/E Atlantic herring federal fishing permits. Portland was the primary landing port listed for three Category A permits, one category C permit, and 30 Category D permits, and one Category D/E permits (GARFO 2017). Thus, more Atlantic herring vessels offload in Portland than are based there.

Portland is also involved in the Atlantic herring fishery in its dependence on herring for lobster bait (Section 3.6.4.2.1). Shoreside support services based in Portland include several dealers, processors, and other infrastructure that supports the herring fishery. Opening in 1986, the Portland Fish Exchange is America's first all-display seafood auction (www.pfex.org). In addition to serving as a herring dealer, it rents space to store salted herring. Several lobster bait dealers and a pumping station for offloading herring are located in Portland. Several facilities in Portland process lobsters including Cozy Harbor Seafood, Inc. (www.cozyharbor.com), and Inland Seafood (www.inlandseafood.com). Portland's infrastructure includes major highways, shipping terminals, and an airport. The port also provides many additional fishing-related services including ice, fuel, and vessel maintenance/repair services. The Atlantic herring fishing engagement and reliance indices are high and medium, respectively (Jepson & Colburn 2013).

Other Fisheries/Ecotourism: Portland is a primary port for the mackerel, lobster, and groundfish fisheries and a secondary port for the tuna fishery (Table 78). Recreational fishing companies based in Portland (or South Portland) include: Go Fish! Charters (www.gofishmaine.com), Fishing with Matt and Josh (www.mainecharterfishing.com), and Morning Flight Charters (www.morningflightcharters.com). Portland is a whale watching destination, home to one whale watching company, Odyssey Whale Watch (Table 70).

Table 84 - Top five species landed by value in Portland ME, 2015

Species	Revenue ($)	Vessels	Dealers
American lobster	$17M	218	21
Atlantic herring	$8.1M	8	50
Pollock	$1.9M	32	5
White hake	$0.90M	27	3
Goosefish (monkfish)	$0.58M	27	4
Source: ACCSP, as of August 2017.			

3.6.4.3.2 Massachusetts ports

Gloucester, MA

General: Gloucester is a fishing community in Essex County, MA. In 2016, Gloucester had a population of 29,546, a 3% increase from the year 2010 (28,789). In 2012-2016, 2% of the civilian employed population aged 16 years and over worked in agriculture, forestry, fishing, hunting, and mining occupations in Gloucester; the poverty rate was 8.2%; and the population was 95% white, non-Hispanic (U.S. Census 2018). The commercial fishing engagement and reliance indices for Gloucester are high and medium, respectively (Jepson & Colburn 2013). In 2017, Gloucester was the homeport and primary landing port for 200 and 213 federal fishing permits, respectively (GARFO 2018). In 2015, total landings in Gloucester were valued at $44M, 8% of the state-wide total ($524M). American lobster accounted for $16M, 36% of the 2015 landings in Gloucester, landed by 199 vessels and sold to 24 dealers (Table 85; ACCSP, 2017).

Herring fishery: Since 2007, Gloucester has been the highest port in terms of Atlantic herring landings (average 44M/year; 24% of total; Table 74). Gloucester meets Criterion #1 for an Atlantic herring *Community of Interest*: having at least 10M pounds of landings per year from 2007-2016. These landings are attributed to 39 Atlantic herring federal permits, sold to 83 dealers. In 2015, Gloucester was the homeport for five Category A, three Category C, and 128 Category D Atlantic herring federal fishing permits. Gloucester was the primary landing port listed for four Category A permits, three category C permit, and 137 Category D permits (GARFO 2017). Thus, more Atlantic herring vessels register their vessels (are based) in Gloucester than have actively landed there.

Gloucester is also involved in the Atlantic herring fishery in its dependence on herring for lobster bait (Section 3.6.4.2.1). Shoreside support services based in Gloucester include several dealers, processors, and other infrastructure that supports the herring fishery. Several lobster bait dealers and a pumping station for offloading herring are located in Gloucester. The port also provides many additional fishing-related services including ice, fuel, and vessel maintenance/repair services. Cape Seafoods, one of the largest processors of herring for frozen export, is located at the State Pier and owns several dedicated pelagic fishing vessels. The Atlantic herring fishing engagement and reliance indices are high and medium-high, respectively, for Gloucester (Jepson & Colburn 2013).

Other Fisheries/Ecotourism: Gloucester is a primary port for the mackerel, lobster, tuna, groundfish and recreational fisheries (Table 78). Gloucester is a whale watching destination, home to three whale watching companies: Cape Ann Whale watch, Capt. Bill and Sons Whale Watch, and Seven Seas Whale Watch (Table 70).

Table 85 - Top five species landed by value in Gloucester MA, 2015

Species	Revenue ($)	Vessels	Dealers
American lobster	$16M	199	24
Atlantic herring	$5.3M	9	25
Haddock	$3.8M	70	13
Goosefish (monkfish)	$2.5M	70	9
Acadian redfish	$2.5M	55	12
Source: ACCSP, as of August 2017.			

New Bedford, MA

General: New Bedford is a fishing community in Bristol County, Massachusetts. In 2016, New Bedford had a population of 94,988, a 0.1% decrease from the year 2010 (95,072). In 2012-2016, 2% of the civilian employed population aged 16 years and over worked in agriculture, forestry, fishing, hunting, and mining occupations in New Bedford; the poverty rate was 23.5%; and the population was 65% white, non-Hispanic (U.S. Census 2018). The commercial fishing engagement and reliance indices for New Bedford are high and medium, respectively (Jepson & Colburn 2013). In 2017, New Bedford was the homeport and primary landing port for 220 and 239 federal fishing permits (i.e., vessels), respectively (GARFO 2018). Total landings in New Bedford were valued at $322M, 62% of the state-wide total ($524M). Sea scallops accounted for $245M, 76% of the 2015 landings in New Bedford, landed by 276 vessels and sold to 28 dealers (Table 86; ACCSP, 2017).

Herring fishery: Since 2007, New Bedford has been the 3rd highest port in terms of Atlantic herring landings (average 32M/year; 18% of total; Table 74). New Bedford meets Criterion #1 for an Atlantic herring *Community of Interest*: having at least 10M pounds of landings per year from 2007-2016. These landings are attributed to 28 Atlantic herring federal permits, sold to 63 dealers. In 2015, New Bedford was the homeport for eight Category A, three Category C, 174 Category D, and nine Category D/E Atlantic herring federal fishing permits. New Bedford was the primary landing port listed for eight Category A permits, two category C permits, and 189 Category D permits, and nine Category D/E permits (GARFO 2017). Thus, New Bedford is the homeport and primary landing port for the largest number of permits in the fishery.

New Bedford is also involved in the Atlantic herring fishery in its dependence on herring for lobster bait (Section 3.6.4.2.1). Shoreside support services based in New Bedford include several dealers, processors, and other infrastructure that supports the herring fishery. Several lobster bait dealers and a pumping station for offloading herring are located in New Bedford. NORPEL, one of the largest processors of herring for frozen export, is located in New Bedford. New Bedford's infrastructure includes shipping terminals (Maritime International, Section 3.6.1.10) and access to major highways and nearby airports. The port provides many fishing-related services including ice, fuel, and vessel maintenance/repair services. The Atlantic herring fishing engagement and reliance indices are high and low, respectively, for New Bedford (Jepson & Colburn 2013).

Other Fisheries/Ecotourism: New Bedford is a primary port for the mackerel, lobster, tuna, and groundfish fisheries (Table 78). Recreational fishing companies based in New Bedford include: Captain Leroy's Deep Sea Fishing, Mac-atac Sportfishing, Viking Fleet, and Walsh's Deep Sea Fishing (www.portofnewbedford.org). Viking Fleet also offers whale watching trips.

Table 86 - Top five species landed by value in New Bedford MA, 2015

Species	Revenue ($)	Vessels	Dealers
Sea scallop	$245M	276	28
Atlantic surfclam	$12M	18	11
American lobster	$8.3M	103	22
Haddock	$6.4M	50	9
Winter flounder	$5.7M	57	8
Source: ACCSP, as of August 2017.			

3.6.4.3.3 Rhode Island ports

Narragansett/Point Judith

General: Point Judith is a fishing community in the town of Narragansett, in Washington County, RI. In 2016, Narragansett had a population of 15,672, a 1% decrease from the year 2010 (15,868). In 2012-2016, 2% of the civilian employed population aged 16 years and over worked in agriculture, forestry, fishing, hunting, and mining occupations in Narragansett; the poverty rate was 16.3%; and the population was 95% white, non-Hispanic (U.S. Census 2018). The commercial fishing engagement and reliance indices for Narragansett/Point Judith are high and medium, respectively (Jepson & Colburn 2013). In 2017, Point Judith was the homeport and primary landing port for 117 and 140 federal fishing permits (i.e., vessels), respectively (GARFO 2018). Total landings in Point Judith were valued at $46M, 56% of the state-wide total ($82M). Many of Point Judith's vessels are active in fisheries managed by the MAFMC. Inshore longfin squid accounted for $13M (29%) of the 2015 landings in Point Judith, landed by 98 vessels and sold to 17 dealers (Table 87; ACCSP, 2017).

Herring fishery: Since 2007, Point Judith has been the 5th highest port in terms of Atlantic herring landings (average 7.1M/year; 4% of total; Table 74). These landings are attributed to 171 Atlantic herring federal permits (the most of any *Community of Interest*), sold to 29 dealers. In 2015, Point Judith was the homeport for two Category A, two Category B/C permits, seven Category C, 54 Category D, and eight Category D/E Atlantic herring federal fishing permits. Point Judith was the primary landing port listed for two Category A permits, three Category B/C permits, seven category C permits, 60 Category D permits, and 12 Category D/E permits (GARFO 2017). Thus, the Atlantic herring vessels that offload in Point Judith may primarily be based in Point Judith.

Shoreside support services based in Point Judith include several dealers, processors, and other infrastructure that supports the herring fishery. Several lobster bait dealers and a pumping station for offloading herring are located in Point Judith. The port also provides many additional fishing-related services including ice, fuel, and vessel maintenance/repair services. Herring is also trucked to Maine for processing. The Atlantic herring fishing engagement and reliance indices are high and medium, respectively, for Point Judith (Jepson & Colburn 2013).

Other Fisheries/Ecotourism: Point Judith is a primary port for the mackerel, groundfish, and recreational fisheries and a secondary port for the lobster and tuna fisheries (Table 78). Recreational fishing companies based in Point Judith include: L'il Toot Charters (tuna, July – October; cod, April – November) and Captain Sheriff's Fishing Charters (tuna, cod). Point Judith is a whale watching destination; at least two whale watch companies are based there.

Table 87 - Top five species landed by value in Point Judith, RI, 2015

Species	Revenue ($)	Vessels	Dealers
Inshore longfin squid	$13M	98	17
American lobster	$7.0M	109	14
Sea scallop	$5.7M	36	14
Summer flounder	$5.3M	326	20
Scup	$3.6M	254	21
Source: ACCSP, as of August 2017.			

3.6.4.3.4 New York ports

Montauk

General: Montauk is a fishing community in the town of East Hampton in Suffolk County, on Long Island, NY. In 2016, Montauk had a population of 3,510, a 6% increase from the year 2010 (3,326). In 2012-2016, 4% of the civilian employed population aged 16 years and over worked in agriculture, forestry, fishing, hunting, and mining occupations in Montauk; the poverty rate was 11.5%; and the population was 81% white, non-Hispanic (U.S. Census 2018). The commercial fishing engagement and reliance indices for Montauk are both high (Jepson & Colburn 2013). In 2017, Montauk was the homeport and primary landing port for 122 and 136 federal fishing permits (i.e., vessels), respectively (GARFO 2018). In 2015, total landings in Montauk were valued at over $12M, 24% of the state-wide total ($51M). Many of Montauk's vessels are active in fisheries managed by the MAFMC. Inshore longfin squid accounted for $3.5M of the 2015 landings in Montauk, landed by 50 vessels and sold to 21 dealers (Table 88; ACCSP, 2017).

Herring fishery: Since 2007, Montauk has been the 38th highest port in terms of Atlantic herring landings (average 0.0M/year; >1% of total; Table 74). These landings are attributed to 45 Atlantic herring federal permits, sold to 16 dealers. In 2015, Montauk was the homeport and primary landing port for one Category A, four Category C, 78 Category D, and four Category D/E Atlantic herring federal fishing permits (GARFO 2017). Thus, the Atlantic herring vessels that offload in Montauk may primarily be based in Montauk. Though landings are minor in Montauk, there are several vessels participating in the fishery.

Shoreside support services based in Montauk include several dealers, processors, and other infrastructure that supports the herring fishery. The port also has other fishing-related services including ice, fuel, and vessel maintenance/repair services. The Long Island Commercial Fishermen's Association is based in Montauk. Inlet Seafood Restaurant is owned by six commercial fishermen and opened in 2006 as an offshoot of Montauk Inlet Seafood, which claims to be the largest packer/shipper of fresh seafood in New York (www.inletseafood.com). The Atlantic herring fishing engagement and reliance indices are medium-high for Montauk (Jepson & Colburn 2013).

Other Fisheries/Ecotourism: Montauk is a primary port for the tuna and recreational fisheries and a secondary port for the mackerel, lobster and groundfish fisheries (Table 78). Charter fishing companies based in Montauk tend to focus on tuna, striped bass and include Double D Charters and Montauk Fishing Charters. Montauk is a whale watching destination; at least two whale watch companies are based there (Table 70).

Table 88 - Top five species landed by value in Montauk, NY 2015

Species	Revenue ($)	Vessels	Dealers
Longfin inshore squid	$3.5M	50	21
Tilefish	$3.2M	7	10
Scup	$2.6M	117	18
Summer flounder	$1.7M	98	23
Silver hake	$1.3M	37	15
Source: ACCSP, as of August 2017.			

Hampton Bays/Shinnecock

General: Hampton Bays and Shinnecock here are considered to be the same community. Shinnecock is a fishing port in the hamlet of Hampton Bays in Suffolk County, on Long Island, NY. Shinnecock is on the barrier island next to Shinnecock Inlet, and does not actually refer to a geopolitical entity. Fishermen use either port name in reporting their catch, but they are considered to be the same physical place. In 2016, Hampton Bays had a population of 13,040, a 4% decrease from the year 2010 (13,603). In 2012-2016, 0.6% of the civilian employed population aged 16 years and over worked in agriculture, forestry, fishing, hunting, and mining occupations in Hampton Bays; the poverty rate was 7.5%; and the population was 68% white, non-Hispanic and 30% Hispanic or Latino (of any race; U.S. Census 2018). The commercial fishing engagement and reliance indices for Hampton Bays/Shinnecock are high and medium, respectively (Jepson & Colburn 2013). In 2017, Hampton Bays/Shinnecock was the homeport and primary landing port for 34 and 33 federal fishing permits (i.e., vessels), respectively (GARFO 2018). In 2015, total landings in Hampton Bays and Shinnecock were valued at over $4M and over $0.38M, respectively. Collectively, this accounts for 8% of the state-wide total ($51M). Many of Hampton Bays and Shinnecock's vessels are active in fisheries managed by the MAFMC. Inshore longfin squid accounted for $1.9M of the 2015 landings in Hampton Bays and Shinnecock, landed by at least 39 vessels and sold to 13 dealers (Table 89, Table 90; ACCSP, 2017).

Herring fishery: Since 2007, Hampton Bays/Shinnecock has been the 37th highest port in terms of Atlantic herring landings (average 0.0M/year; >1% of total; Table 74). These landings are attributed to 29 Atlantic herring federal permits, sold to 16 dealers. In 2015, Hampton Bays/Shinnecock was the homeport and primary landing port for 27 and 28 Category D Atlantic herring federal fishing permits, respectively (GARFO 2017). Thus, the Atlantic herring vessels that offload in Hampton Bays/Shinnecock may primarily be based in Hampton Bays/Shinnecock. Though landings are minor in Hampton Bays/Shinnecock, there are several vessels participating in the fishery. The Atlantic herring fishing engagement and reliance indices are medium-high and low for Hampton Bays/Shinnecock, respectively (Jepson & Colburn 2013).

Other Fisheries/Ecotourism: Hampton Bays/Shinnecock is a secondary port for the tuna and recreational fisheries (Table 78). Charter fishing companies based in Hampton Bays/Shinnecock tend to focus on cod, porgies, bluefish, tuna, and striped bass and include Shinnecock Star and Outlaw Charters.

Table 89 - Top five species landed by value in Hampton Bays, NY 2015

Species	Revenue ($)	Vessels	Dealers
Longfin inshore squid	$1.8M	39	13
Goosefish (monkfish)	$0.73M	29	14
Sea scallop	$0.56M	6	7
Summer flounder	$0.53M	34	18
Scup	$0.17M	37	15
Source: ACCSP, as of August 2017.			

Table 90 - Top five species landed by value in Hampton Bays/Shinnecock, NY 2015

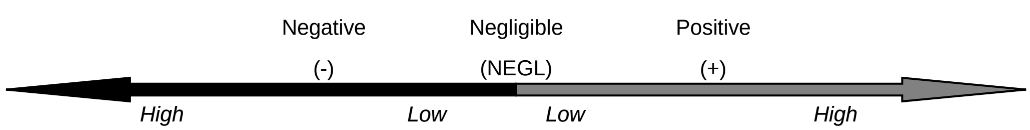
Species	Revenue ($)	Vessels	Dealers
Summer flounder	$0.15M	19	11
Longfin inshore squid	$0.090M	9	7
Scup	$0.051M	13	9
Bluefish	$0.51M	21	10
Goosefish (monkfish)	$0.30M	13	10
Source: ACCSP, as of August 2017.			

4.0ENVIRONMENTAL IMPACTS OF ALTERNATIVES

In this section, the impacts of the alternatives under consideration are evaluated relative to each of the valued ecosystem components (VECs) described in the Affected Environment (Section 3.0). To enhance clarity and maintain consistency, the terms defined in are used to summarize the impacts of each alternative/option on the VECs in this document. In some instances, impacts on a VEC may be characterized as neutral, particularly if there may be both positive and negative impacts resulting from a management measure. If impacts are determined to be neutral, the reasons for making such a determination are in the discussion.

Table 91 - Terms used to summarize impacts on VECs

Impact Definition			
	Direction		
VEC	**Positive (+)**	**Negative (-)**	**Neutral**
Atlantic Herring; Non-Target Species; Predator Species; 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 and 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	To a lesser degree		
High	To a substantial degree (not significant unless indicated as such)		
Likely	Some degree of uncertainty associated with the impact		



4.1 APPROACH TO IMPACTS ANALYSIS

Section 4.1.1 summarizes the methods for evaluating the ABC control rule alternatives, primarily the Management Strategy Evaluation that the Council completed for this action. This includes a summary of the methods, data and results for all metrics and alternatives considered. Section 4.1.2 summarizes the methods for evaluating the measures to address potential localized depletion and user conflicts. In Sections 4.2 - 4.7, the impacts of all the alternatives are summarized by valued ecosystem component, so the impacts can be considered separately in terms of potential impacts on each segment of the ecosystem (herring resource, predators, etc.). Several appendices describe the methods and results in more detail. Finally, Section 4.8 includes overall summary tables with impacts across VECs for all of the alternatives considered.

4.1.1 Analysis of ABC control rule alternatives

4.1.1.1 Summary of technical methods used in MSE models

The management strategy evaluation includes three models: a Gulf of Maine/Georges Bank Atlantic herring model, a model of Atlantic herring predators, and an economic model. This section briefly describes the methods used for these models to help inform the discussion of results. A more detailed description of the technical methods is in Appendix III. The Northeast Fisheries Science Center developed these models using all available data on herring and other species in this region. While there are limitations on what data could be included in the models, this MSE was reviewed by an external panel of experts, " that deemed the Atlantic herring MSE represents the *best available science* at this time for evaluating the performance of herring control rules and their potential impact on key predators." The peer review final report is in Appendix IV.

Herring models: Multiple age-structured herring operating models, eight in all, were created to evaluate the effects of the uncertainties identified through the first workshop: herring recruitment (high or low?), natural mortality (high or low?), growth (good or poor?), assessment error/bias (yes or no?; Table 92). Operating models, or states of nature, were created to help describe the uncertainty in this system, eight separate operating models were developed. Each varies in terms of assumptions about herring growth, assessment bias, and productivity of herring.

Several basic control rule categories were evaluated first (i.e., constant catch, biomass based, etc.), as well as several variations in the time frame applied (i.e., annual, 3 year blocks, etc.). For each combination of control rule shapes and operating model, 100 simulations were conducted, each for 150 years, and the results are presented for the last 50 years (e.g., proportion of years overfishing occurs).

Predator models: The predator modelling was shaped by public input at the first workshop, as well as the scope and timeline specified by the Council – an annual, stock-wide control rule that considered herring's ecological role as forage, and that the MSE be completed in one year. The primary predator types identified at the workshop were highly migratory species (tuna), groundfish, seabirds, and marine mammals. The time constraint of this MSE did not permit development of integrated multispecies models, or spatial and seasonal models accounting for migrations of wide-ranging predators in and out of this ecosystem. Through this MSE, three predator population models (for bluefin tuna, common tern, and spiny dogfish) were developed and an existing food web model (for marine mammals) was used, with several noted data limitations and assumptions for each. For example, the predator models were not fully age structured (unlike the herring models). A purpose here was to help compare the relative performance of control rules, not necessarily to create perfect population models for the predators. This MSE identifies how a predator may react to having different amounts of herring in the ecosystem, based on how a given control rule performs. Not all of the predator metrics reacted to the control rules, in some cases because of data/model limitations and in other cases there was evidence to support that they would not react.

Economic models: The initial ("Base Price") economic model, which was subject to peer review, evaluated three economic metrics: net revenue, interannual variability of net revenue, and stationarity of net revenue (i.e., long-term temporal stability).[5]

Subsequent to the peer review, a "New Price" model was created that improved the herring price and fishery cost data and improved methods to assess stationarity. Results with the New Price model (Table 103 to Table 106) are generally higher than under the Base Price model.

Table 92 – Operating models used in Herring MSE to evaluate uncertainties

Operating Model	Growth	Assessment Bias	Productivity	
			Mortality	Steepness
A	Old	Biased	High	Low
B	Recent	Biased	High	Low
C	Old	Unbiased	High	Low
D	Recent	Unbiased	High	Low
E	Old	Biased	Low	High
F	Recent	Biased	Low	High
G	Old	Unbiased	Low	High
H	Recent	Unbiased	Low	High

[5] Other metrics that primarily regard herring and predator performance can also inform impacts analysis.

4.1.1.2 Format of MSE results

The MSE produced a large volume of results to compare alternatives. These have been synthesized in two main ways.

Results by metric: Decision support tables (e.g., **Figure 59**) help in comparing control rule alternatives for an individual subject or metric across the operating models (potential resource conditions).

Section 4.1.1.3 provides results for 15 metrics. In each table, control rule Alternatives 1, 2, 3, and 4a-4f are listed across the top row, and the eight operating models are listed down the far left column (A through H). The numeric results for each alternative/model is included in the individual bar charts, and the alternatives are ranked from highest to lowest with dark green representing the highest ranked alternative compared to the others. The taller the bar, the better that alternative/model performed for that metric.

The bottom row of each table sums the rank of each alternative for all eight operating models. This row is a sum of the rank for an alternative compared to the other alternatives; it is not related to the data for a particular metric (value that dictates the rank). The best possible ranking (performs the best across all operating models) would be a total score of 72 (score of 9 for each operating model: 9*8 = 72), and the worst possible ranking (performs the worst across all operating models) would be a total score of 8 (1*8 OM = 8). Section 4.1.1.4 includes a summary table of all the results and rankings for each metric individually (Table 93). Each metric has one or more icons on the top right corner; they identify the part of the ecosystem that metric is related to. For example, herring fishery, predator fishery, ecotourism, etc.

Results (Sections 4.1.1.3 and 4.1.1.4) are in terms of the median. Additional results for the 25th and 75th percentiles were developed, however, no differences from results using just the median were detected, except for a few changes in rankings of alternatives. These results were not included, since they do not substantially affect the general findings or overall rankings of alternatives.

Results by VEC: Section 4.1.1.5 summarizes the associated tradeoffs across the valued ecosystem component (VEC) to help identify potential impacts under requirements of the Magnuson Stevens Act (MSA) and the National Environmental Protection Act (NEPA). Rather than consider the impacts individually, radar plots or web diagrams have been developed to help evaluate the potential effects of control rule alternatives across VECs, or on several aspects of the ecosystem at once. Finally, Section 4.1.1.6 summarizes the potential short-term impacts of the control rule alternatives, compared to the previous results which are long-term.

In Sections 4.2 to 4.7, all of the short- and long-term (MSE) results are summarized by VEC. For each VEC, a few representative metrics have been selected, and the results have been combined to produce an overall summary of potential impacts to the VEC. For example, the results for several metrics that represent potential impacts on the herring resource have been combined, as well as protected resources and ecotourism, predator species, herring fishery impacts including mackerel and lobster fisheries, and predator fisheries.

4.1.1.3 MSE Results: Metric by Metric

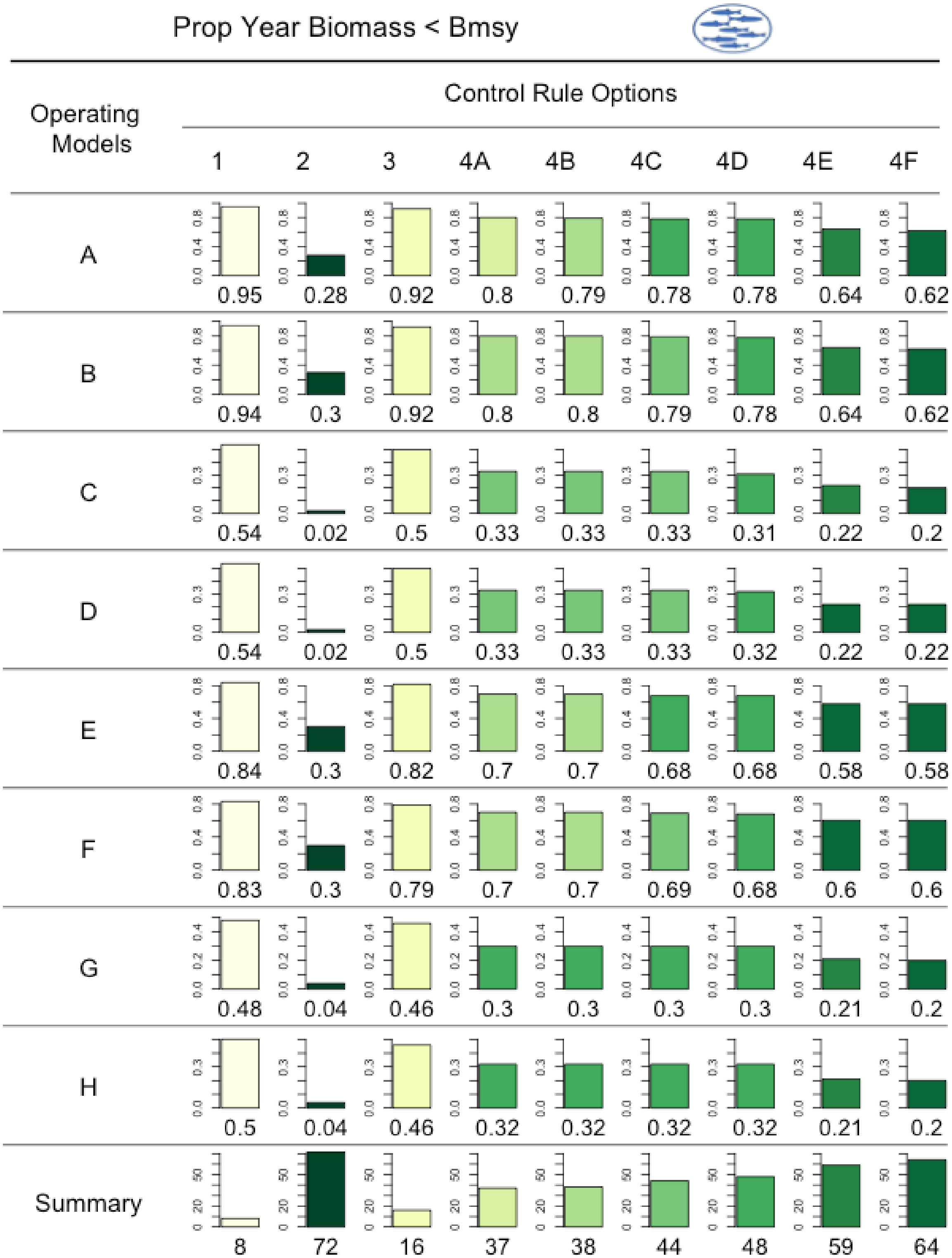
The first handful of metrics below are related to the herring resource (e.g., biomass metrics, metrics related to overfished, etc.), followed by a handful of metrics associated with the economics of the herring fishery (e.g., yield, interannual variation in yield, revenue etc.), and finally several metrics focused on predators (e.g., tuna weight status, tern production, etc.).

4.1.1.3.1 Proportion of years biomass less than B_{MSY}

- ***Metric defined***: The model estimates the proportion of years the ABC control rule causes biomass to fall below B_{MSY}. For this metric, the *lower* the value the better the performance; lower values mean the proportion of years that biomass is projected to be lower than B_{MSY} is small.
- ***Individual rankings***: Overall, Alternative 2 (Strawman B) ranks the best across all operating models, and for many operating models, the proportion of years that biomass is projected to be below B_{MSY} is less than 5%. It is only 30% for operating models A and B which have low productivity and a biased assessment.
- The difference between the results for Alternative 2 and all the other alternatives is notable. In some cases, Alternative 2 has a very low proportion of years that biomass may fall below B_{MSY}, while many of the other alternatives have high results, well over 50%.
- Alternatives 4E and 4F rank next with results that range from about 20% - 60% in terms of the number of years that biomass could be less than B_{MSY}. Alternatives 4A – 4D follow next with results between 30% for operating models C, D, G and H and 70-80% for operating models A, B, E and F when the assessment is assumed to be biased.
- Alternative 3 and Alternative 1 (Strawman A) rank the worst, with estimates of 50% to 95% depending on the operating model.
- ***Overall ranking***: Alternative 2 ranks the highest overall with a total score of 72/72, and Alternative 4F is the next ranked alternative with 64/72.

Figure 50 – Summary results for metric "<u>Proportion of years biomass greater than B_{MSY}</u>" for ABC control rule alternatives across all eight operating models developed for Herring Amendment 8 MSE

Units are in terms of proportion of years that average biomass is less than B_{MSY}, a value of 0.50 means that average biomass is estimated to be 50% of B_{MSY}.

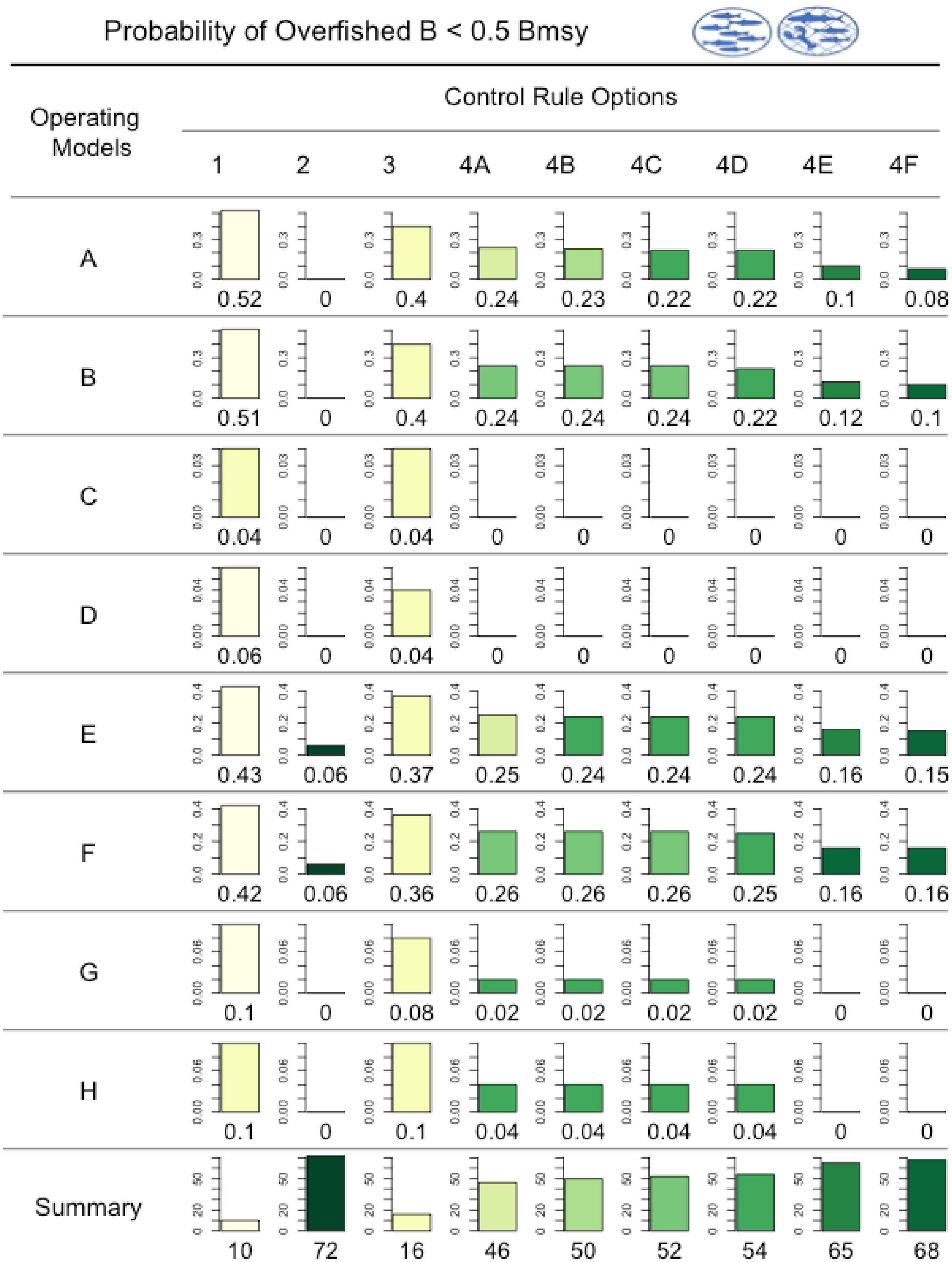


4.1.1.3.2 Probability of Overfished (B< 0.5 B_{MSY})

- ***Metric defined***: The model estimates the probability that biomass would fall below 0.5 B_{MSY}, or the level of biomass that defines when a stock is considered overfished. For this metric, the *lower* the value the better the performance; lower values mean the probability that a control rule alternative will lead to the stock being overfished is low.
- ***Individual rankings***: Overall, Alternative 2 (Strawman B) ranks the highest across all operating models. This alternative has essentially a zero chance of causing the stock to be overfished except under the two operating models (E and F), which assume the assessment is biased and the stock productivity is high, and those results are very low as well, about 6%.
- For the operating models that assume the assessment is unbiased (C, D, G and H), essentially all of the control rule alternatives have zero or very little chance of causing the stock to be overfished (less than 10%).
- Alternatives 4E and 4F rank next with results that are 0% for half the operating models, and 8-16% for the other half. And Alternatives 4A – 4D follow next with low values for probability of overfished for half of the operating models, and about 25% for the operating models that assume the assessment is biased (A, B, E, and F). It is not surprising that most of the Alternative 4 options perform relatively well for this topic, because this is one of the four primary metrics the Council selected to identify alternative control rule shapes for Alternative 4. The Council recommended that alternatives be considered with a probability of overfished equal to zero, but could increase to 25% under certain conditions. Therefore, most of the results under various operating models for the Alternative 4 options fall between 0-25%.
- Alternative 3 and Alternative 1 (Strawman A) rank the lowest, with generally similar results overall, but Alternative 3 consistently scoring a little better than Alternative 1 across the board. For some of the operating models, the probability of overfished is low for both alternatives (less than 10%) and for some it is 40-50%. Therefore, the range of results across operating models is relatively large for both Alternative 1 and 3 for this metric.
- ***Overall ranking***: Alternative 2 ranks the highest overall with a total score of 72/72, and Alternative 4F is the next ranked alternative with 68/72.

Figure 51 – Summary results for metric "Probability of overfished" for ABC control rule alternatives across all eight operating models developed for Herring Amendment 8 MSE

Units are in terms of the probability the stock becomes overfished, or biomass is less than 0.5 of B_{MSY}, a value of 0.50 means that average biomass is estimated to be 50% of B_{MSY}.

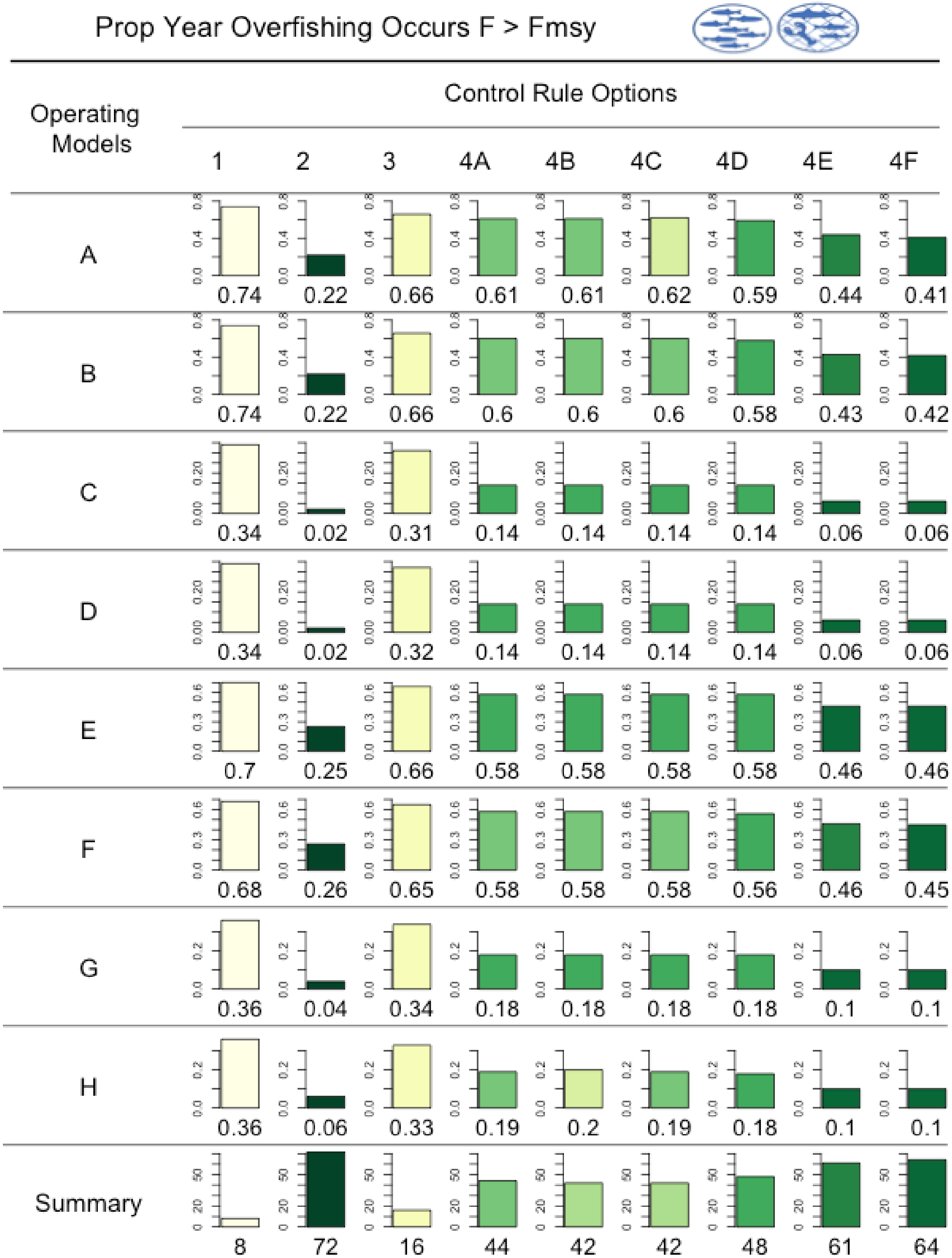


4.1.1.3.3 Probability of Overfishing (F > F_{MSY})

- ***Metric defined***: The model estimates the probability that fishing mortality would fall below the fishing mortality rate associated with F_{MSY}, the rate that is estimated to produce B_{MSY} on a continual basis. If fishing mortality falls below $F_{MSY,}$ overfishing is occurring. For this metric, the *lower* the value the better the performance; lower values mean the probability that a control rule alternative will lead to overfishing is low.
- ***Individual rankings***: Overall, Alternative 2 (Strawman B) ranks the highest across all operating models. This alternative has a very low probability of causing overfishing for half of the operating models, and a relatively low probability for the other half (about 22-26% proportion of years).
- For half of the operating models that assume the assessment is unbiased (C, D, G and H), essentially all of the control rule alternatives have very little or well below a 50% probability of causing overfishing; the Alternative 4 options are between 6-20% for these operating models, and that increases to about 40-60% for the other operating models that assume the assessment is biased (A, B, E, and F). The ranked order of the Alternative 4 options is generally the same, Alternative 4F performs slightly better than Alternative 4E, followed by Alternatives 4A-4D, which are about the same.
- Alternative 3 and Alternative 1 (Strawman A) rank the lowest, and have very similar results, with Alternative 3 consistently scoring a little better than Alternative 1 for all operating models. For the operating models that assume the assessment is unbiased, the estimated probability of overfishing for these alternatives is about 35%, and for the other operating models that assume the assessment is biased, that increases to about 65-75% depending on the alternative and operating model.
- Some of the alternatives (i.e., 2 and 4E) are below 50% even where there is bias in the assessment; therefore, the risk of overfishing is likely very low.
- ***Overall ranking***: Alternative 2 rank the highest overall with a total score of 72/72, and Alternative 4F is the next ranked alternative with 64/72.

Figure 52 – Summary results for metric "<u>Probability of overfishing</u>" for ABC control rule alternatives across all eight operating models developed for Herring Amendment 8 MSE

Units are in terms of the probability of overfishing, of when fishing mortality is greater than F_{MSY}, a value of 0.50 means that average fishing mortality is estimated to be 50% of F_{MSY}.

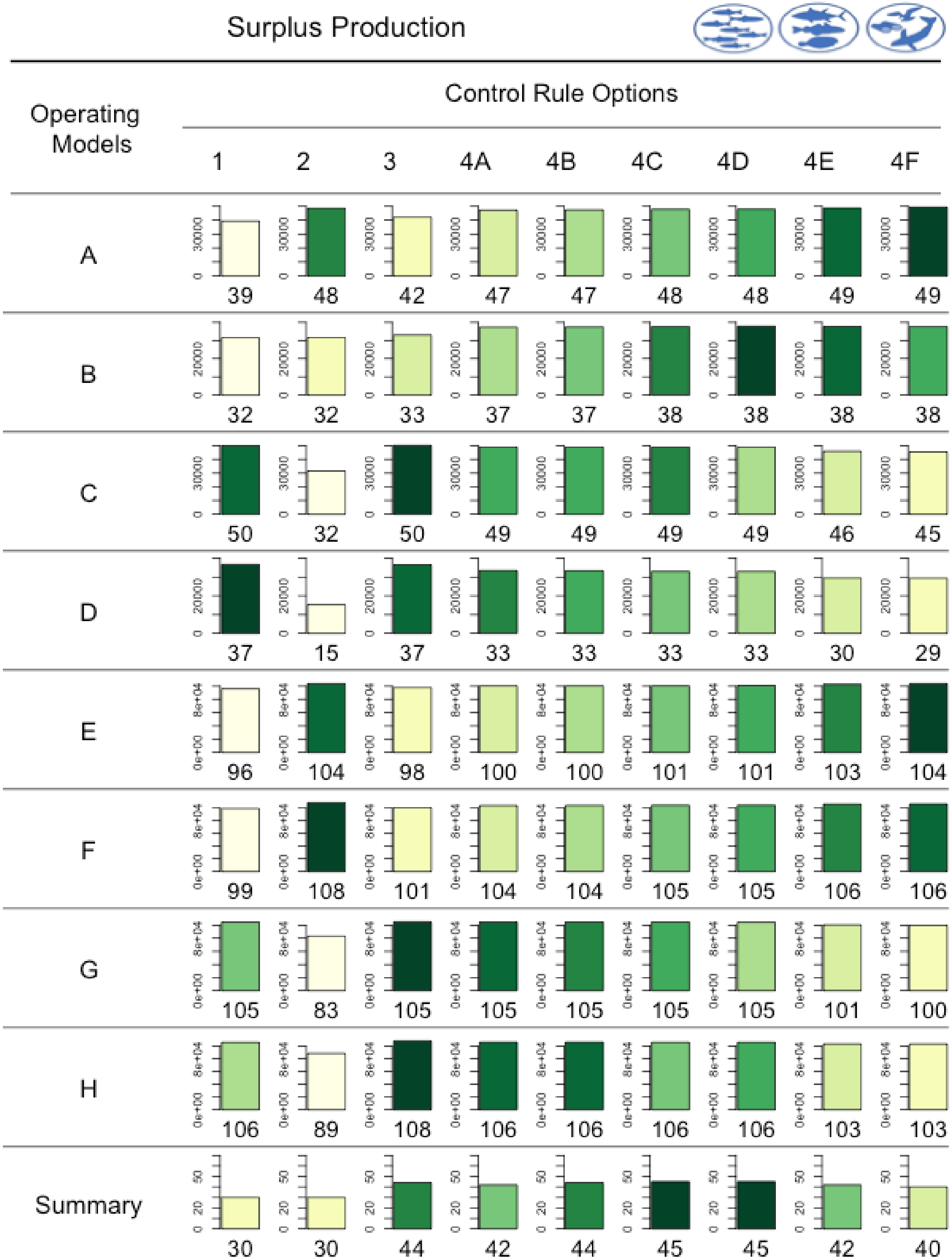


4.1.1.3.4 Surplus Production

- ***Metric defined***: Surplus production is the amount of biomass produced by a stock over and above the level required to maintain the total stock biomass overtime. For this metric, the *higher* the value the better the performance; higher values mean the control rule alternative produces higher surplus production, or biomass above the amount needed to sustain a population.
- ***Individual rankings***: Overall, Alternative 4D ranks the highest across all operating models; however, for the most part, the results are very similar across all alternatives and the differences are very small; differences primarily due to different productivity scenarios.
- The operating model drives differences in total surplus production more than the control rule alternative. For example, all the alternatives produce about 1 million mt of biomass under high production operating models (E, F, G, and H), but much lower estimated surplus production for operating models with low production (A, B, C, and D).
- When the results for all operating models are combined, the only alternative with noticeably lower results is Alternative 2, because its estimated surplus production is substantially lower for some of the operating models alternatives (C and D) relative to others.
- All the Alternative 4 options are relatively close (5.8 million mt) when results for all operating models are combined. The results are essentially the same for Alternatives 4A – 4D, and Alternatives 4E and 4F are close behind. Alternative 3 ranks jut lower than Alternative 4 (5.74 million mt), followed by Alternative 1 (Strawman A) at 5.63 million mt, and finally Alternative 2 at 5.11 million mt.
- ***Overall ranking***: Alternatives 4C and 4D rank the highest overall with a total score of 45/72, and Alternatives 3 and 4B are not far behind with 44/72.

Figure 53 – Summary results for metric “<u>Surplus Production</u>” for ABC control rule alternatives across all eight operating models developed for Herring Amendment 8 MSE

Units are in terms of estimated herring biomass in 1,000 metric tons (mt), values range from under 50,000 mt to over 1,000,000 mt for the same control rule alternative under different operating models.

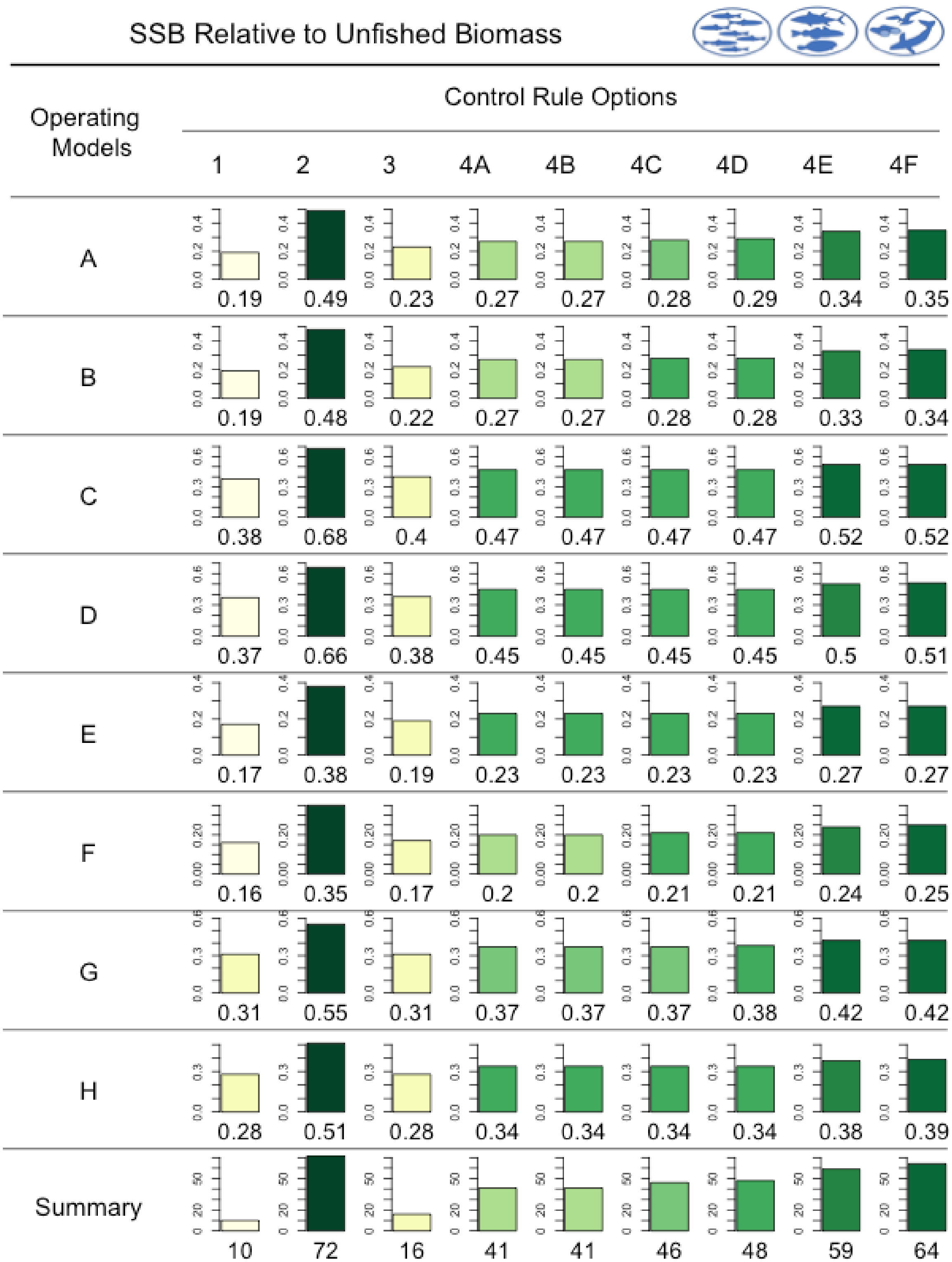


4.1.1.3.5 SSB relative to unfished biomass (SSB / SSB_0)

- ***Metric defined***: Unfished biomass is the size of a fish stock without fishing. For this metric, the *higher* the value the better the performance; higher values mean the estimated spawning stock biomass (SSB) relative to unfished biomass (SSB_0), or biomass level with no directed fishery, is high. For example, a value of 0.3 means that the biomass is 30% of what a biomass would be without fishing pressure.
- ***Individual rankings***: Overall, Alternative 2 ranks the highest and consistently has the highest results for all operating models. The estimates are between 35 to just under 70% SSB relative to unfished SSB.
- Overall, this metric has very stable results across alternatives and operating models; no alternative jumps out of order across operating models. The results are similar for Alternatives 4A-4F, ranging from 20-50% of unfished biomass depending on the operating model.
- Alternatives 1 and 3 rank the lowest, having similar results with Alternative 3 slightly ahead of Alternative 1 in all cases; average results range between about 20-40% of unfished biomass.
- ***Overall ranking***: Alternative 2 rank the highest overall with a total score of 72/72, and Alternative 4F is the next ranked alternative with 64/72.

Figure 54 – Summary results for metric "SSB relative to unfished biomass" for ABC control rule alternatives across all eight operating models developed for Herring Amendment 8 MSE

Units are in terms of estimated biomass relative to the estimate of unfished biomass for that operating model, a value of 0.40 means that estimated biomass is about 40% of unfished biomass.



4.1.1.3.6 Proportion of years biomass is greater than 30% of unfished biomass and less than 75% of unfished biomass (B_0)

- ***Metric defined***: The model approximates the proportion of years biomass is estimated to fall between 30-75% of unfished biomass. This range was discussed at the MSE stakeholder workshops as a potentially useful metric to help evaluate the performance of control rules in terms of producing a biomass that consistently falls within a range that does not allow biomass to fall too low (<40% unfished), or increase to levels that are not expected to have additional benefits to the ecosystem (>75%). For this metric, the *higher* the value the better the performance; higher values mean herring biomass is expected to be a relatively high fraction of unfished biomass in most years, but not more than 75% of unfished biomass (B_0), which is not expected to have additional benefits to the ecosystem.
- ***Individual rankings***: Overall, Alternative 4F ranks the highest with Alternative 4E and 2 not far behind. For most operating models, Alternative 4F maintains herring biomass within 30%-75% of B_0 over 60% of the time. It falls to closer to 40% under operating models E and F.
- Alternative 2 ranks very high for this metric, except for operating models C and D, which pull the overall rank of Alternative 2 behind Alternatives 4F and 4E.
- ***Overall ranking***: Alternative 1 ranks the lowest across most operating models for this metric, and its estimated biomass is outside the target range of B_0 in the majority of years.

- This metric was evaluated in another way as well, the proportion of years that biomass is greater than 75% of B_0 (**Figure 56**). For this figure the *higher* the value the better the performance, a value of zero means that no runs produced a biomass greater than 75% of B_0. Alternative 2 is the only CR alternative that has some portion of runs with biomass above 75% unfished, but not across all operating models. Several alternatives have 5-10% of runs with biomass above 75% unfished, but only under unbiased, highly productive operating models (C and D).

Figure 55 – Summary results for metric "% years biomass between 30-75% unfished biomass" for ABC control rule alternatives across all eight operating models developed for Herring Amendment 8 MSE

Units are in terms of estimated biomass relative to the estimate of unfished biomass for that operating model, a value of 0.20 means that estimated biomass is expected to be above 30% of unfished 20% of the time.

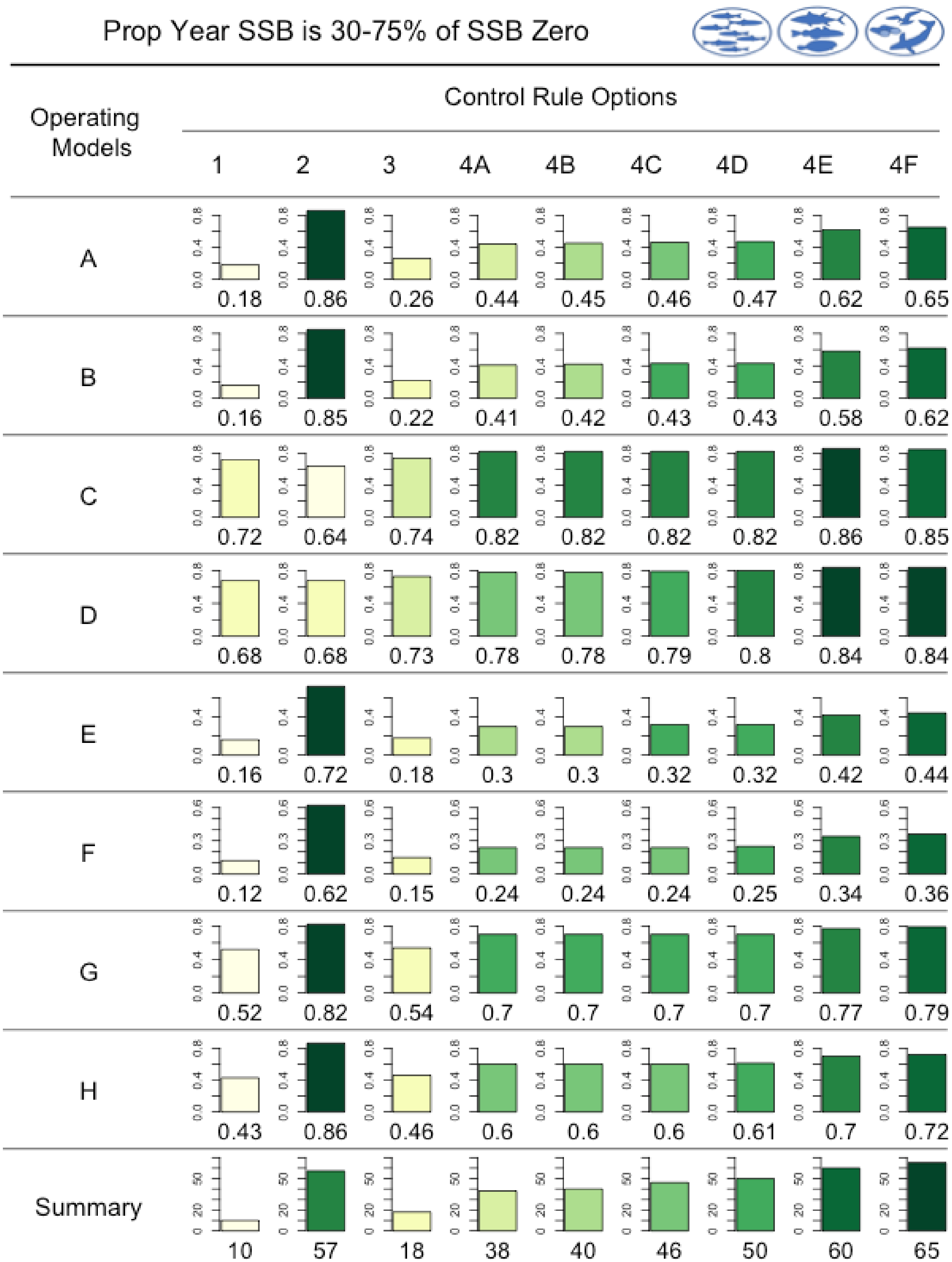
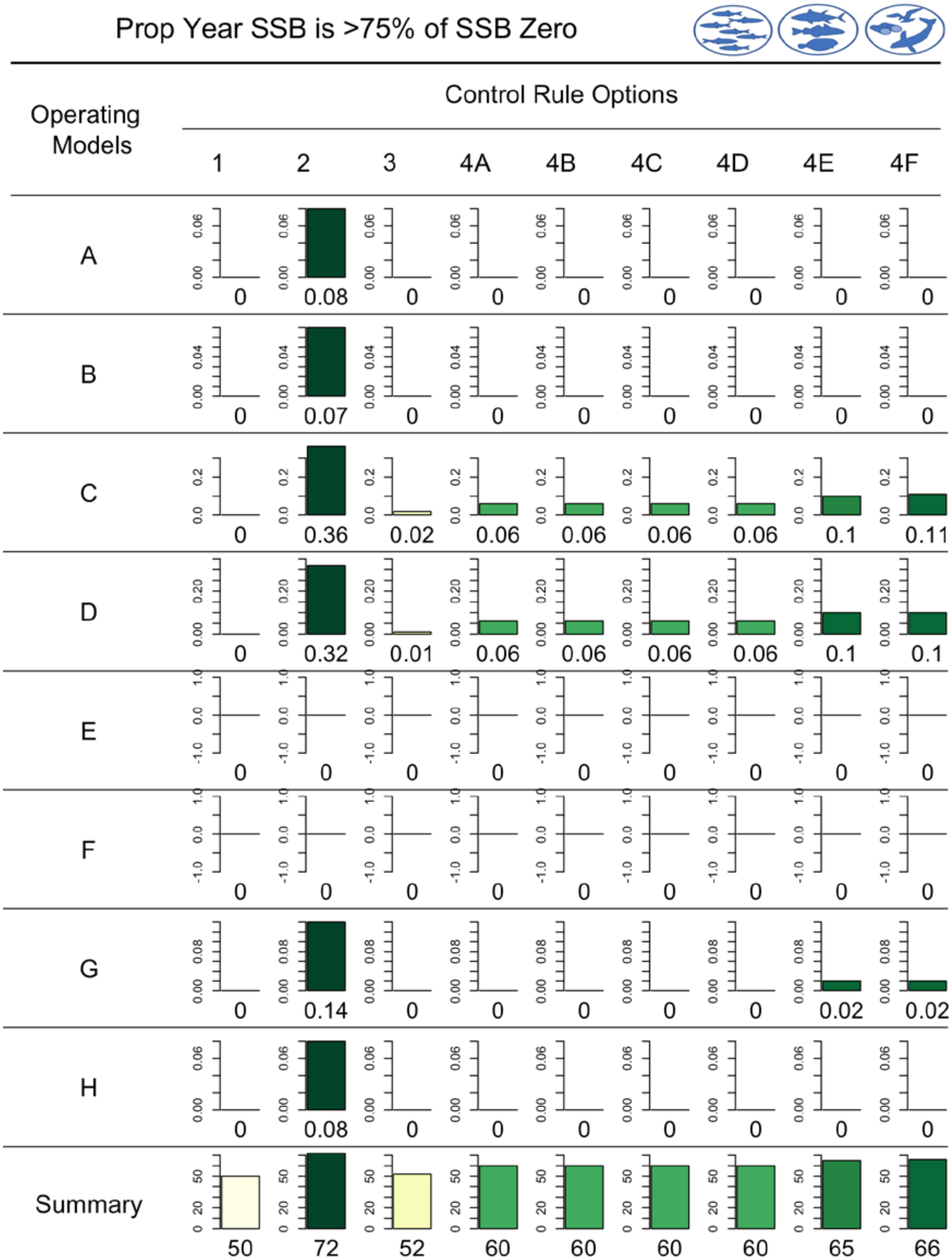


Figure 56 – Summary results for metric "<u>% years biomass is greater than 75% unfished biomass</u>" for ABC control rule alternatives across all eight operating models developed for Herring Amendment 8 MSE

Units are in terms of estimated biomass relative to the estimate of unfished biomass for that operating model, a value of 0.08 means that estimated biomass is expected to be above 75% unfished 8% of the time.

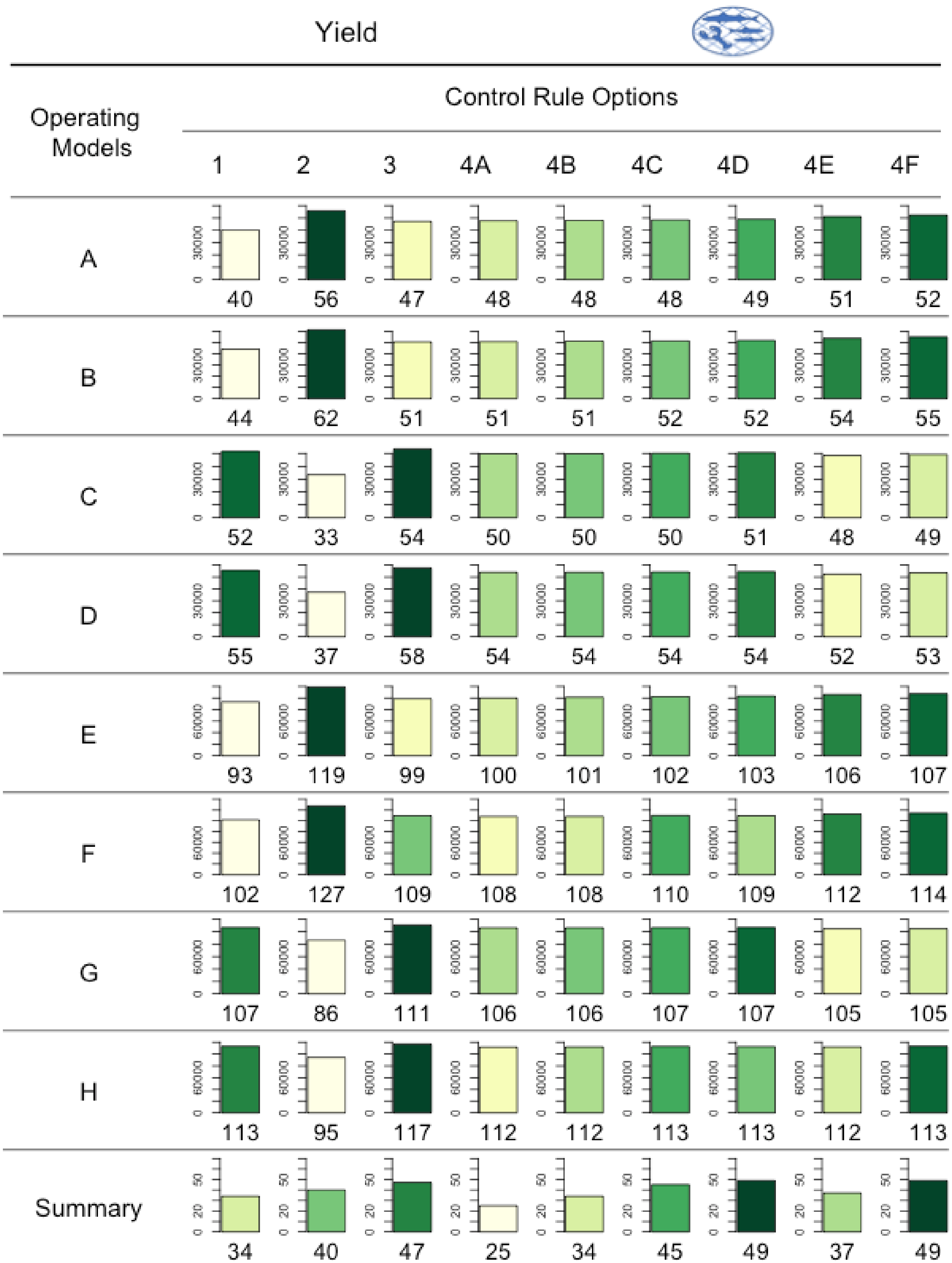


4.1.1.3.7 Absolute Yield

- ***Metric defined***: The model estimates total yield, or ABC, in metric tons. For this metric, the *higher* the value the better the performance; higher values mean projected yields are higher for the herring fishery. The units are in 1,000 mt.
- ***Individual rankings***: Overall, Alternatives 4F and 4D rank highest across operating models, and the results are essentially the same as they were for the metric "yield relative to MSY." Alternative 3 is ranked second, followed by the Alternatives 4A-4E.
- Alternative 3 ranks second, because it is the highest performer for some of the operating models with an unbiased assessment (C, D, G and H), but falls behind most of the Alternative 4 options for the other operating models.
- Alternative 1 is generally similar to Alternative 3, but consistently has about 5,000 mt less yield than Alternative 3.
- Alternative 2 again ranks the highest for some of the operating models, 111-127,000 mt, but falls well behind the others for other operating models. It ranks #8 out of 9 overall, because it projects about 20,000 mt less yield than the other alternatives using some of the operating models. Also, while some of the options for Alternative 4 rank behind Alternative 2 for some of the operating models, in some cases, it is not by much in terms of absolute yields.
- The operating model drives differences in absolute yields more than the control rule alternative. The four high productivity operating models (models E, F, G, and H) have higher yield estimates, well over 100,000 mt for all alternatives. The operating models with low productivity (models A, B, C, and D) have much lower yields for all control rule alternatives, about 40-55,000 mt.
- ***Overall ranking***: Alternatives 4F and 4D rank the highest overall with a total score of 49/72, and Alternative 3 is not far behind with 47/72.

Figure 57 – Summary results for metric "<u>Absolute Yield</u>" for ABC control rule alternatives across all eight operating models developed for Herring Amendment 8 MSE

Units are in terms of average annual yield in 1,000 metric tons (mt), values range from 33,000 mt to 127,000 mt for the same control rule alternative under different operating models.



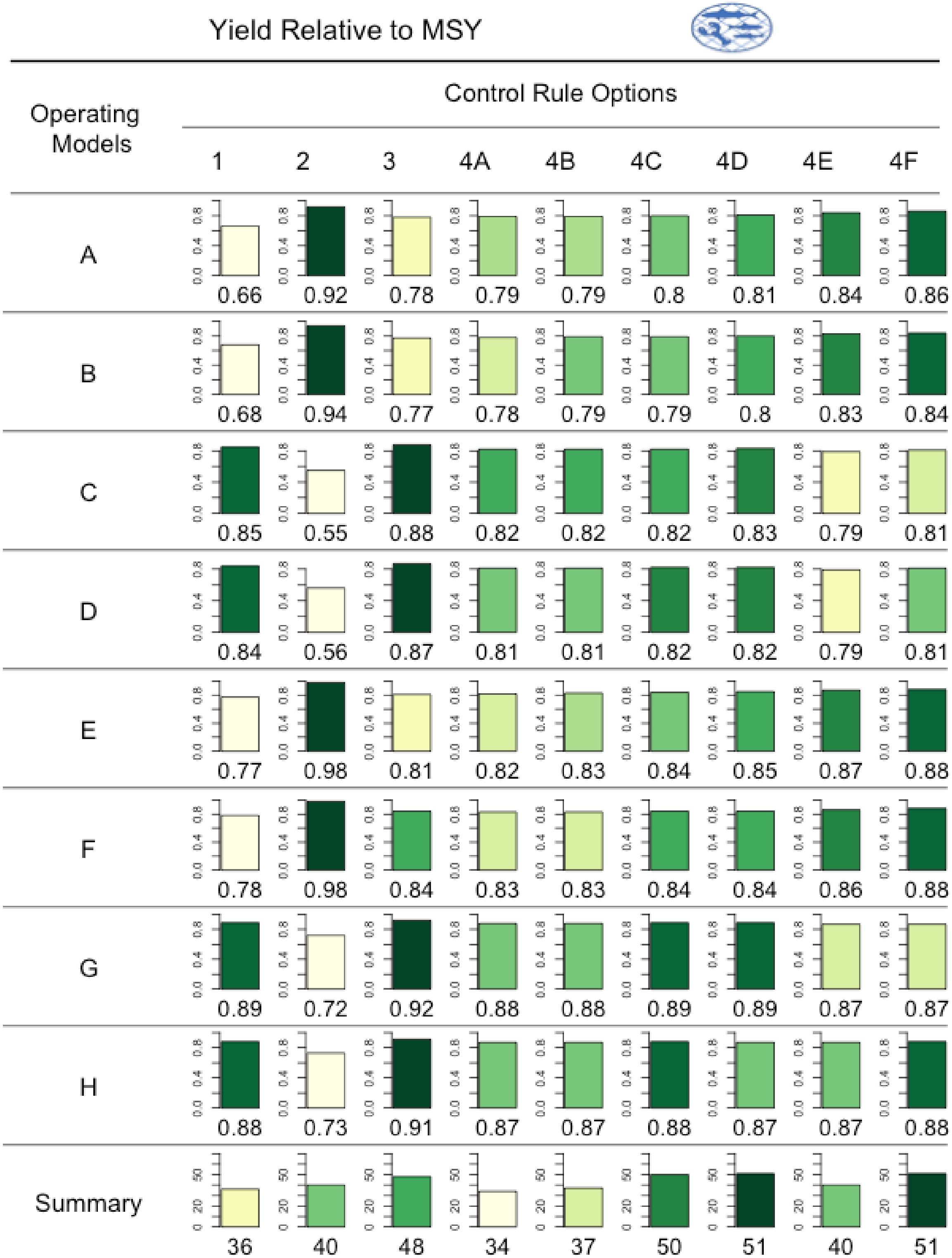
Operating Models	1	2	3	4A	4B	4C	4D	4E	4F
A	40	56	47	48	48	48	49	51	52
B	44	62	51	51	51	52	52	54	55
C	52	33	54	50	50	50	51	48	49
D	55	37	58	54	54	54	54	52	53
E	93	119	99	100	101	102	103	106	107
F	102	127	109	108	108	110	109	112	114
G	107	86	111	106	106	107	107	105	105
H	113	95	117	112	112	113	113	112	113
Summary	34	40	47	25	34	45	49	37	49

4.1.1.3.8 Yield relative to MSY

- ***Metric defined***: The model estimated the ratio of estimated yield compared to MSY. For this metric, the *higher* the value the better the performance; higher values mean fishery yields are projected to be closer to MSY (the maximum catch that is expected to produce a sustainable resource long-term).
- ***Individual rankings***: Overall, Alternatives 4F and 4D rank the highest across all operating models, but for the most part, Alternative 3 and the other Alternative 4 options have similar results for projected long-term yields relative to MSY. It is not surprising that most of the Alternative 4 options perform relatively well for this topic, because this is one of the four primary metrics the Council selected to identify alternative control rule shapes for Alternative 4. The Council recommended that alternatives be considered that set yield at 100% MSY, with an acceptable level as low as 85%. Therefore, for most cases the results for all Alternative 4 options have values over 85% for this metric, except for a few of the operating models where yield relative to MSY falls closer to 80% (i.e., operating models with high natural mortality – models A, B, C and D).
- Alternative 3 performs the best for this metric (about 90%) under some of the operating models (i.e., Models C, D, G and H that assume the assessment is unbiased), but worse for the other operating models. Therefore, it ranks second overall when the results for all operating models are combined, because it ranks on the higher end for some, but not as low as others for remaining operating models.
- The results for Alternative 1 (Strawman A) are similar to Alternative 3; they are relatively high for some operating models (almost 90% of MSY), but fall under 70% for operating models that assume the assessment is biased (A and B), while Alternative 3 remains closer to 80% under those conditions. Overall, Alternative 1 does *not* perform well under operating models with a biased assessment.
- Conversely, Alternative 2 ranks the highest for some of the operating models, and lowest for others. The results vary the greatest for this metric, ranging from about 55% for operating models C and D (which assume the assessment is unbiased) to 98% for operating models E and F that assume the assessment is biased. Alternative 2 is relatively sensitive to operating model for this metric.
- ***Overall ranking***: Alternatives 4F and 4D rank the highest overall, with a total score of 51/72, and Alternative 4C is not far behind with 50/72.

Figure 58 – Summary results for metric "<u>Yield relative to MSY</u>" for ABC control rule alternatives across all eight operating models developed for Herring Amendment 8 MSE

Units are in terms of average yield as a proportion of maximum sustainable yield, or the fraction of MSY that ABC would be set at, a value of 0.90 means that on average ABC would be set at 90% of MSY.

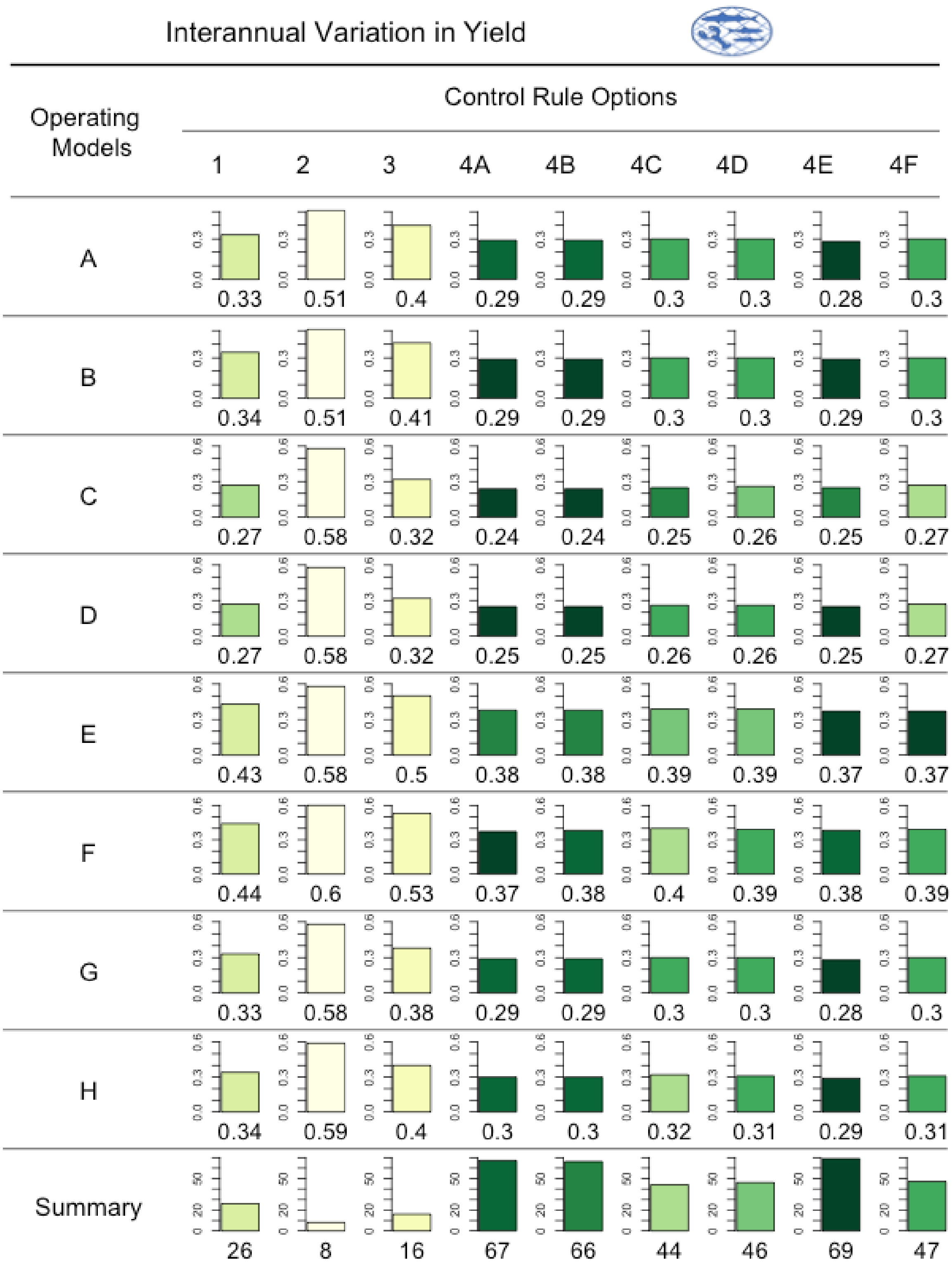


4.1.1.3.9 Interannual variation in yield

- ***Metric defined:*** Interannual variation in yield (IAV) is the year to year change in the Atlantic herring ABC. For this metric, the *lower* the value the better the performance; lower values translate into lower variation in fishery yields from year to year which is considered to be positive for the fishery and businesses that rely on herring as bait to help stabilize the supply.
- ***Individual rankings:*** For most of the operating models (6 out of 8 operating models), Alternative 4E ranks highest, with IAV between 25-30%. It is not surprising that most of the Alternative 4 options perform relatively well for this topic, because this is one of the four primary metrics the Council selected to identify alternative control rule shapes for Alternative 4. The Council recommended that annual variation in yield should ideally be less than 10%, but if necessary as high as 25%; therefore, most of the results for Alternative 4 will fall in that range for most of the operating models. Alternative 4E ranks first, with variation in annual yield between 25-30%. Alternatives 1 and 3 have 30-40% variation in yield for most of the operating models, but a few for Alternative 3 reach 50%, so the overall rank for Alternative 3 is lower than Alternative 1.
- On average, Alternative 2 estimates 50-60% variation in yield across operating models; therefore, ranks consistently last for this metric.
- ***Overall ranking***: Alternatives 4A-4F rank the best, have the smallest IAV. Alternative 1 (Strawman A) ranks second, then Alternative 3, and finally Alternative 2 ranks last. Alternative 4E ranks the highest overall with a total score of 69/72, and Alternatives 4A and 4B are not far behind.

Figure 59 – Summary results for metric "Interannual variation in yield (IAV)" for ABC control rule alternatives across all eight operating models developed for Herring Amendment 8 MSE

Units are in terms of average variation in herring yields from one year to the next, a value of 0.25 means that on average ABC could change up to 25% from one year to the next.

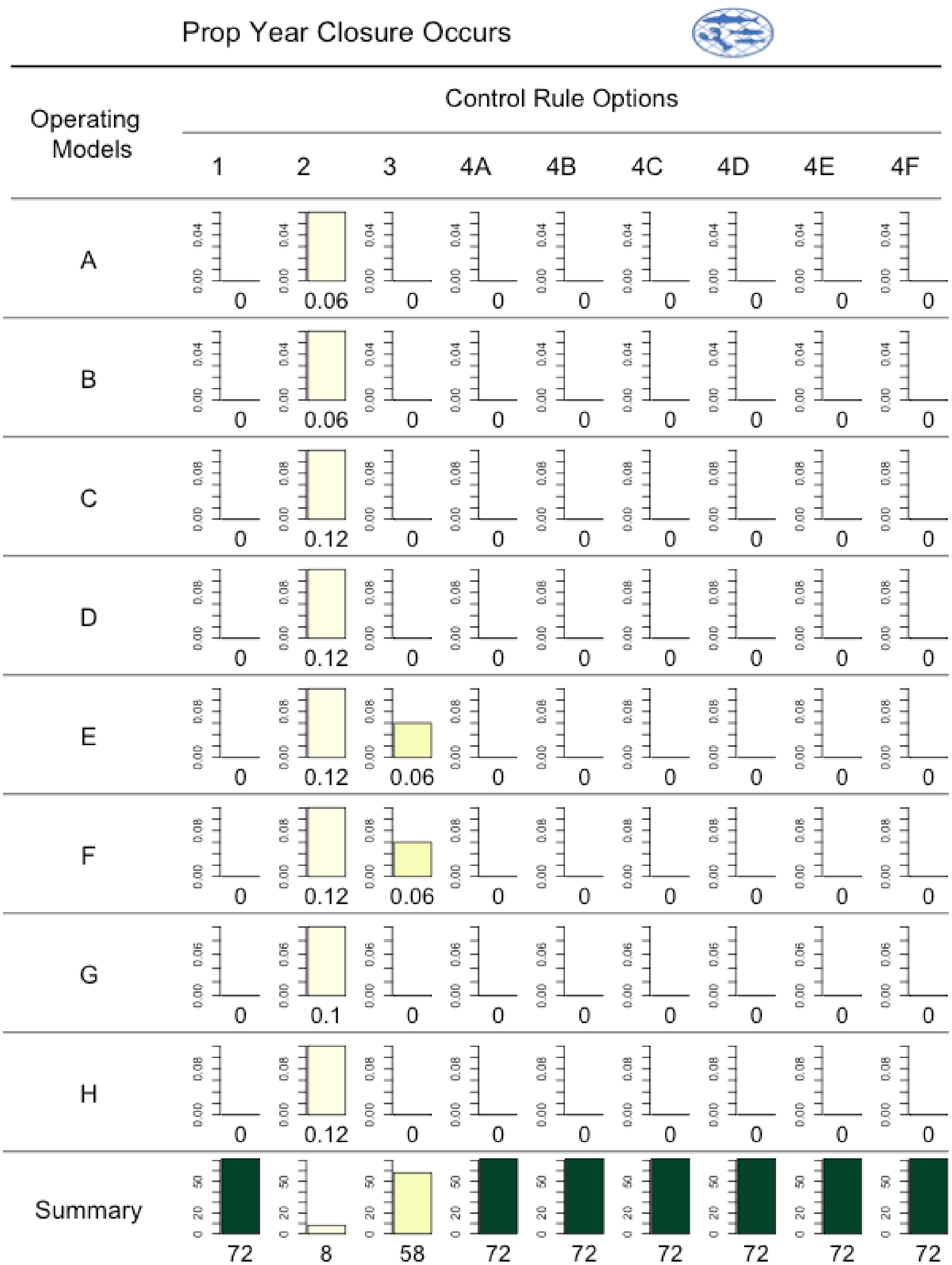


4.1.1.3.10 Proportion of years a fishery closure occurs (ABC=0)

- ***Metric defined***: This metric evaluates the proportion of years an ABC control rule would need to set ABC = 0, or no allocation would be available for the herring fishery, a "fishery closure". For this metric, the *lower* the value the better the performance; lower values mean the probability that a control rule alternative will lead to a fishery closure (the need to set ABC equal to zero) is low.
- ***Individual rankings***: For this metric, the frequency of years ABC would potentially be set at zero is generally very low. It is not surprising that the results for the Alternative 4 options perform relatively well for this topic (fishery closure = 0), since this is one of the metrics the Council used to define the parameters of Alternative 4 control rule options. Therefore, Alternatives 4A-4F are zero for all operating models. Even though two of the six options for Alternative 4 include a fishery cutoff, the likelihood of biomass falling below the level that would set SBC=0 is essentially zero.
- The results for Alternative 1 (Strawman A) are also zero for all operating models; there is essentially no chance of a fishery closure under this alternative for any of the operating models.
- For Alternative 3, there is only one set of operating models that has a relatively small chance of causing a fishery closure; operating models E and F are estimated to cause ABC to equal zero 6% of the time, or about 3 times out of 50 years.
- Alternative 2 ranks last for this metric, but the number of years that ABC is estimated to equal zero is also relatively small, ranging from 6% to 12% depending on the operating model, or 3 to 6 times in fifty years.
- ***Overall ranking***: Many alternatives tie for the highest rank for this metric; Alternative 1 and all options of Alternative 4 rank the highest overall with a total score of 72/72, and Alternative 3 is next behind them with 58/72.

Figure 60 – Summary results for metric "Proportion of years the fishery would be closed (ABC=0)" for ABC control rule alternatives across all eight operating models developed for Herring Amendment 8 MSE

Units are in terms of the proportion of years biomass would be low enough that ABC would be set to zero and the fishery would be closed, a value of 0.1 means that the model estimates that the fishery would be closed about 10% of the years under that control rule alternative.

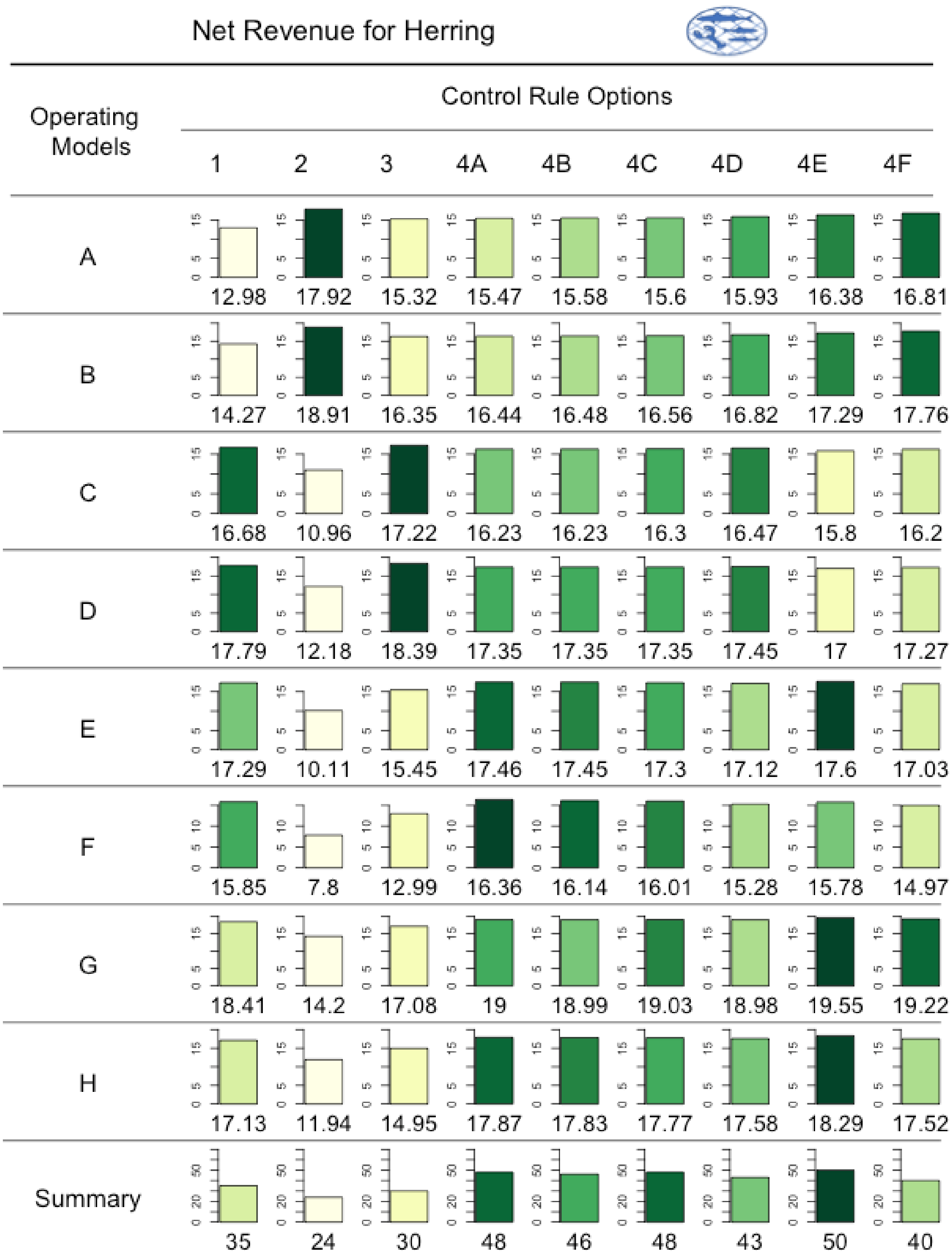


4.1.1.3.11 Net revenue for herring fishery

- ***Metric defined***: For this metric, the *higher* the value the better the performance; higher values mean the control rule alternative produces higher estimates of net revenue for the herring fishery.
- ***Individual rankings***: Overall, Alternative 4E ranks the highest across all operating models; however, for the most part the results are very similar across all alternatives and the differences are very small, except for Alternative 2, which is ranked last and has the lowest results under all scenarios except when the operating model is biased and high productivity (A and B operating models). For Alternative 4E, it ranks very high under most operating models, except models C and D when it falls second to last.
- Alternative 2 (Strawman B) has the highest estimated net revenues than all the other alternatives for operating models A and B (biased, high mortality, low steepness). However, this alternative ranks last for all the other operating models. On average, Alternative 2 is estimated to have \$3-6 million less in annual net revenues under most control rules and operating models, and \$1-5 million higher net revenues under operating models A and B.
- The overall differences between Alternative 1, Alternative 3, and Alternatives 4A-4F are relatively small.
- ***Overall ranking***: Alternative 4E ranks the highest overall with a total score of 50/72, and Alternatives 4A and 4C are close behind with scores of 48/72.

Figure 61 – Summary results for metric "<u>Net revenue for herring</u>" for ABC control rule alternatives across all eight operating models developed for Herring Amendment 8 MSE

Units are estimated average net revenue for the herring fishery in millions of dollars, a value of 16.0 means the model estimates that average annual net revenue would be 16 million dollars for the fishery overall.

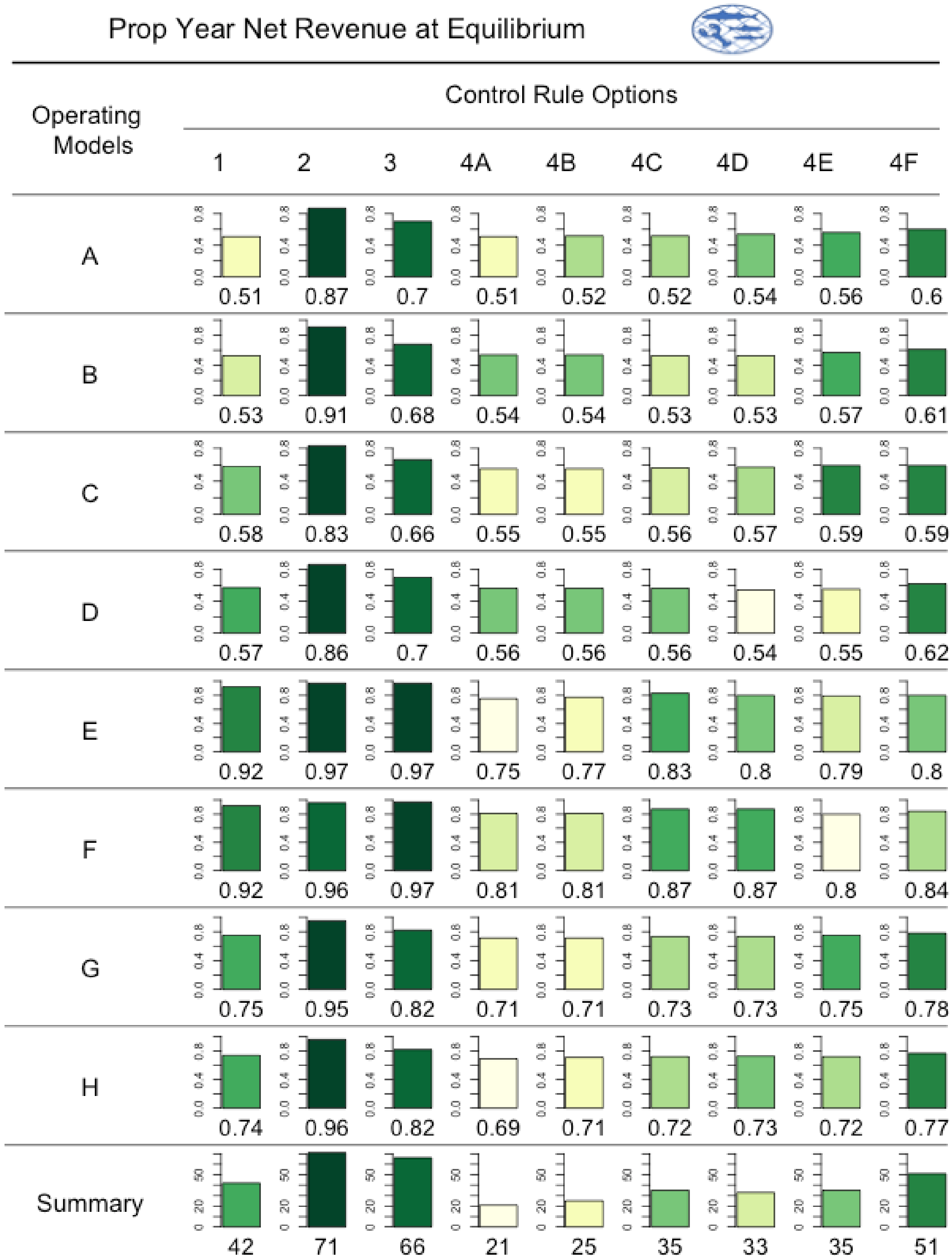


4.1.1.3.12 Stationarity (streakiness of net revenues)

- ***Metric defined***: For this metric, the *higher* the value the better the performance; higher values mean the system is in a stable equilibrium – a good revenue year is equally likely to be followed by a good or bad year. A lower value implies the system is not is a stable equilibrium, a good year is more likely to be followed by a good year, and a bad year is more likely to be followed by a bad year.
- ***Individual rankings***: Overall, the performance is somewhat similar across alternatives, within 10-20% in most cases across operating models.
- ***Overall ranking***: Overall, Alternative 2 ranks the highest; revenue generated from one year less likely to be influenced by yields from the previous year.

Figure 62 – Summary results for metric "<u>stationarity</u>" for ABC control rule alternatives across all eight operating models developed for Herring Amendment 8 MSE

Units are in terms of proportion of years the system is in a stable equilibrium.

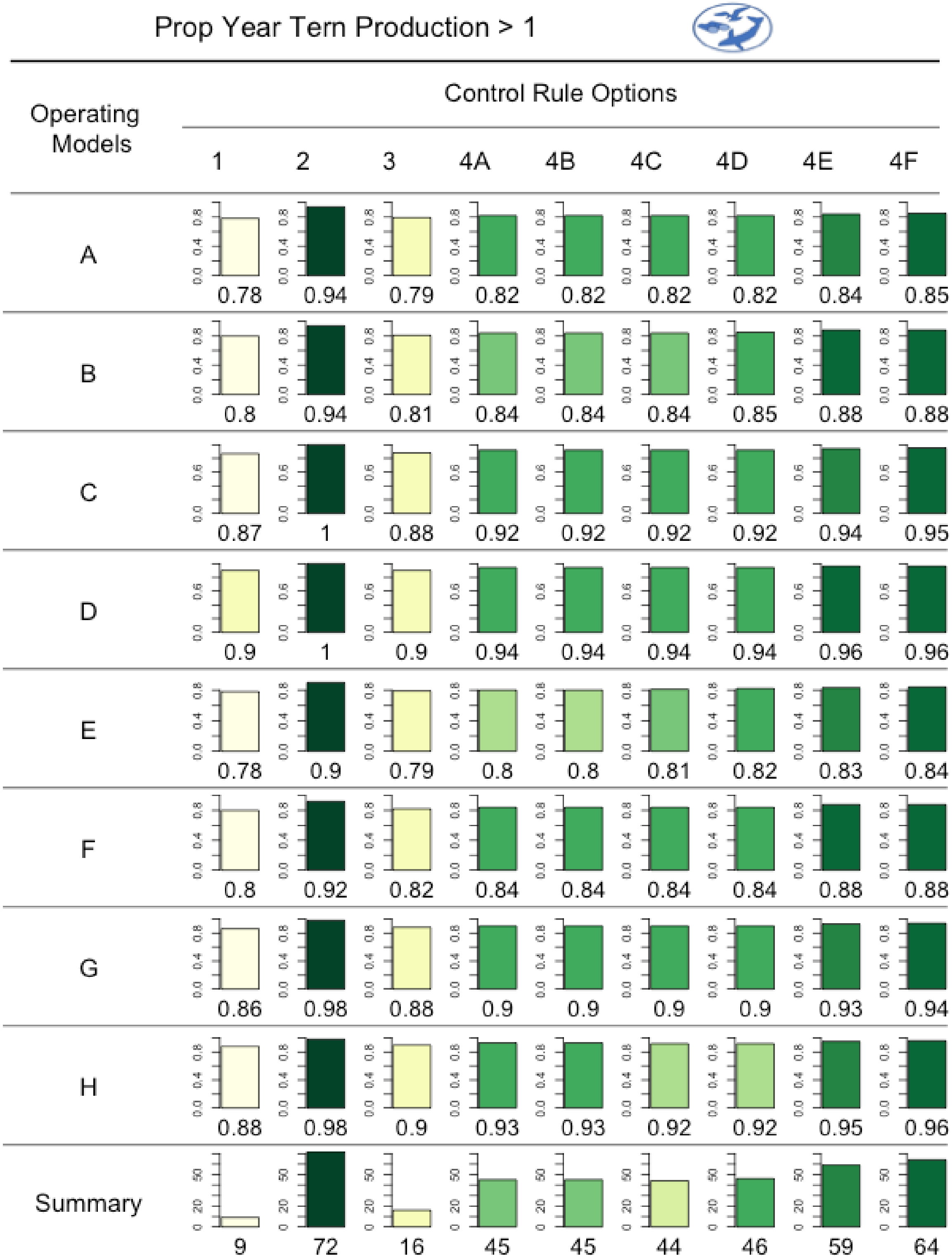


4.1.1.3.13 Tern productivity

- ***Metric defined***: For this metric, the *higher* the value the better the performance; higher values mean the likelihood that tern productivity (i.e., the ability for one tern to replace itself) is high. A threshold of 0.8 was recommended at the stakeholder workshop as a possible target to evaluate control rules. When that threshold was used essentially all of the ABC control rule alternatives ranked very high and it was difficult to see any differences. Therefore, for these analyses the threshold was increased from 0.8 to a target of 1.0, or 100% tern productivity, productivity of 1.0 means roughly that the populations can replace itself. When a threshold of 1.0 is used some variation among control rule alternatives is detected, but the differences are still relatively small.
- ***Individual rankings***: In general, all control rules maintain tern productivity above the threshold of 0.8 the majority of the time. All of the ABC control rule alternatives rank very high and have minimal differences.
- Overall, Alternative 2 ranks the highest and consistently has the highest results for all operating models.
- Alternative 4F is not very far behind, and for the most part, all of the control rule alternatives score very high for this metric, with over 90% success rate for tern production under all operating models. The results fall a bit lower under the operating models that assume the assessment is biased, but even in those cases, the results are at or above the threshold that was recommended at the stakeholder workshop by seabird experts, 80%.
- ***Overall ranking***: Alternative 2 ranks the highest overall, with a total score of 72/72, and Alternative 4F is the next ranked alternative with 64/72. While other alternatives rank lower, for this metric the differences are relatively small, thus even the last ranked alternative (9/72) still performs well for this metric, tern production > 0.8.

Figure 63 – Summary results for metric "tern production" for ABC control rule alternatives across all eight operating models developed for Herring Amendment 8 MSE

Units are in terms of proportion of years tern production is >1.0 or 100% tern productivity – terns are able to replace themselves in the ecosystem.

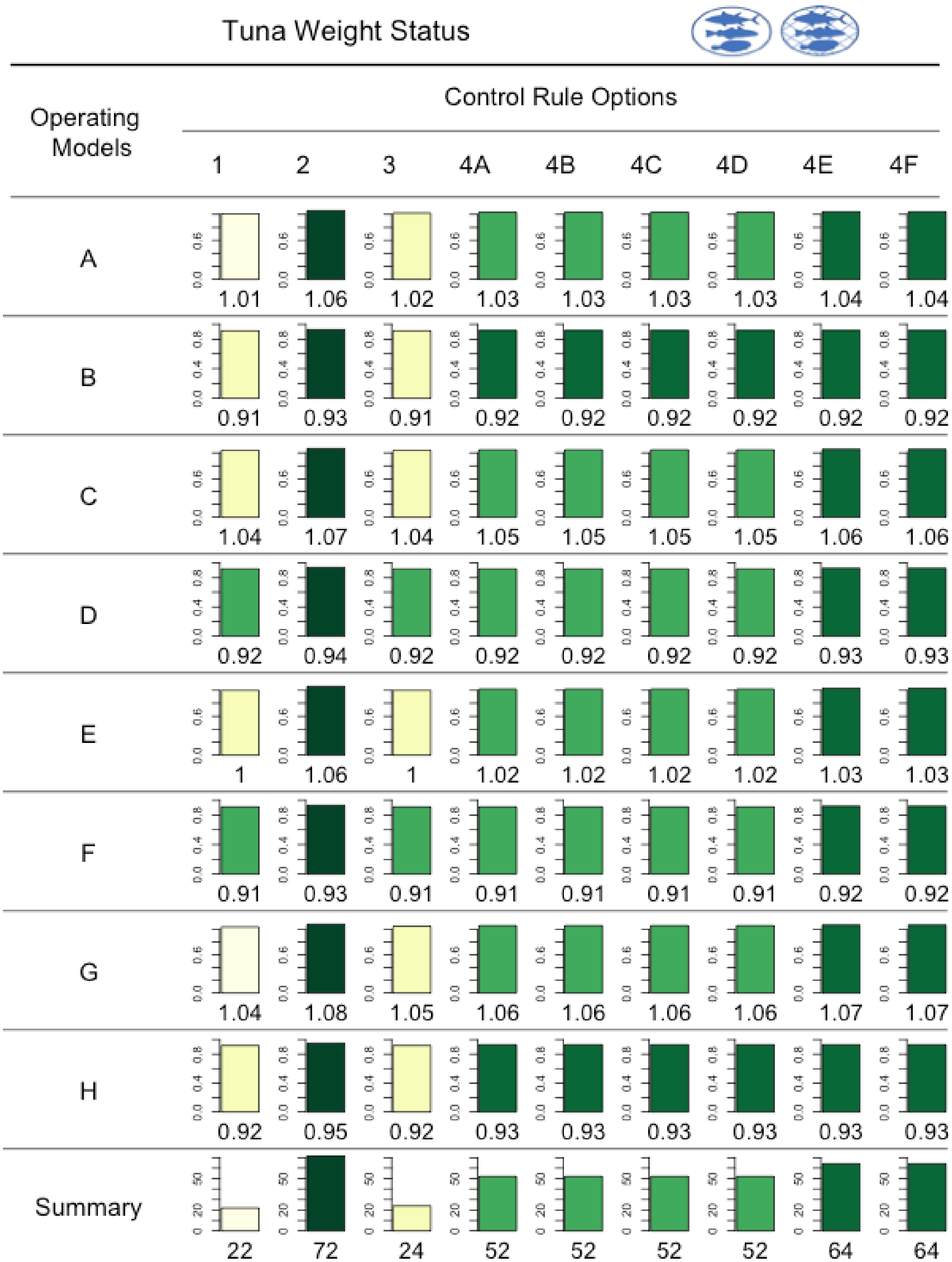


4.1.1.3.14 Tuna weight

- ***Metric defined***: For this metric, the *higher* the value the better the performance; higher values mean estimated tuna weight is higher than the threshold weight, a value of 1.0 means estimated tuna weight is equal to threshold weight. Values greater than 1.0 would have expected positive impacts for tuna growth.
- ***Individual rankings***: Overall, Alternative 2 ranks the highest and consistently has the highest results for all operating models. However, the differences among alternatives are relatively minor.
- The range of values across all control rule alternatives and operating models is 0.92 to 1.08. This is a relatively narrow range in terms of performance. Therefore, even under poor herring conditions (i.e., operating models B and D have recent (slow) growth and low productivity), tuna weights are lower than threshold values (about 0.92), but not drastically lower. Furthermore, even under the best herring conditions (operating model E), the highest ratio of tuna weight is 1.06, or 6% higher than threshold values.
- ***Overall ranking***: Alternative 2 rank the highest overall, with a total score of 72/72, and Alternatives 4E and 4F are next with 64/72. While other alternatives rank lower, for this metric the differences are relatively small, thus even the last ranked alternative (22/72) still performs well for this metric, tuna weight near 1.0, value where estimated tuna weight is equal to threshold weights.

Figure 64 – Summary results for metric "<u>tuna weight</u>" for ABC control rule alternatives across all eight operating models developed for Herring Amendment 8 MSE

Units are in terms of estimated tuna weight compared to threshold weight, so ideally values close to 1 are ideal for tuna growth, a value of 1.0 means that estimated tuna weight is equal to threshold weights.

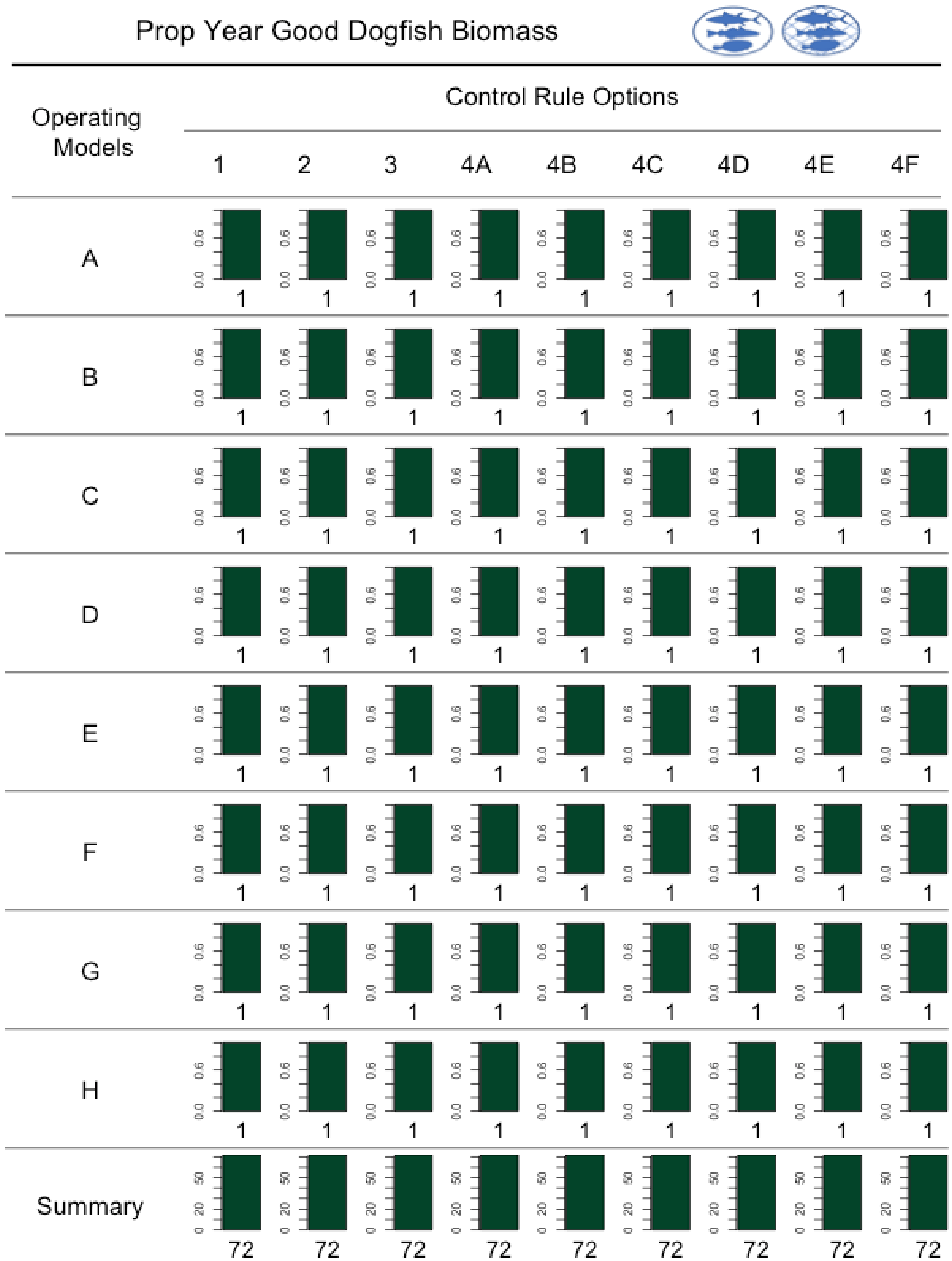


4.1.1.3.15 Dogfish biomass

- ***Metric defined***: For this metric, the *higher* the value the better the performance; higher values mean estimated dogfish biomass, a proxy for groundfish biomass, is higher than B_{MSY} for dogfish. A value of 1.0 means estimated dogfish biomass is equal to B_{MSY} for dogfish.
- ***Individual rankings***: Dogfish biomass equals B_{MSY} under all alternatives across all operating models. Therefore, there is essentially no impact detected of the alternatives on estimated dogfish populations (i.e., no differences between alternatives).
- ***Overall ranking***: All alternatives have the same overall rank. Since none of them are expected to cause negative impacts on dogfish biomass, the score overall for all alternatives is 72/72.

Figure 65 – Summary results for metric "<u>dogfish biomass</u>" for ABC control rule alternatives across all eight operating models developed for Herring Amendment 8 MSE

Units are in terms of estimated dogfish biomass compared to B_{MSY} for dogfish, a value of 1.0 means that estimated dogfish biomass is about B_{MSY} for dogfish.



4.1.1.4 MSE Results: Summary of Metric by Metric results

Table 93 includes the overall ranking for each metric across operating models for each alternative, i.e., the bottom row of each individual metric table (Figure 50 to Figure 65) is brought into Table 93. It is very important to note that simply looking at the overall rank of alternatives by metric can be misleading, because in many cases the individual scores for alternatives are very close, and while one may rank first with a score of 72, and another last with a score of 8, the relative performance across alternatives may actually be very similar. Therefore, it is important to review the actual mean values provided for each metric, not just the summary ranking score.

Table 93 – Summary of MSE results by metric and rank of Amendment 8 ABC control rule alternatives

Performance Summary

Performance Metrics	Control Rule Options: 1	2	3	4A	4B	4C	4D	4E	4F
Prop Year Biomass < Bmsy	8	72	16	37	38	44	48	59	64
Probability of Overfished B < 0.5 Bmsy	10	72	16	46	50	52	54	65	68
SSB Relative to Unfished Biomass	10	72	16	41	41	46	48	59	64
Prop Year SSB is 30-75% of SSB Zero	10	57	18	38	40	46	50	60	65
Surplus Production	30	30	44	42	44	45	45	42	40
Tuna Weight Status	22	72	24	52	52	52	52	64	64
Prop Year Good Dogfish Biomass	72	72	72	72	72	72	72	72	72
Prop Year Overfishing Occurs F > Fmsy	8	72	16	44	42	42	48	61	64
Yield Relative to MSY	36	40	48	34	37	50	51	40	51
Yield	34	40	47	25	34	45	49	37	49
Prop Year Closure Occurs	72	8	58	72	72	72	72	72	72
Net Revenue for Herring	35	24	30	48	46	48	43	50	40
Prop Year Net Revenue at Equilibrium	42	71	66	21	25	35	33	35	51
Interannual Variation in Yield	26	8	16	67	66	44	46	69	47
Prop Year Tern Production > 1	9	72	16	45	45	44	46	59	64

4.1.1.5 MSE Results: Tradeoff Analysis

A benefit of MSE is the ability to compare results of different metrics. While the quantitative results are in different units, the models enable comparisons of results across the same time frames and conditions. Radar plots or web diagrams are often used in MSEs to help compare a handful of metrics at once (Figure 66). These plots are useful to see how alternatives stack up against each other for a handful of metrics at once. The information in Section 4.1.1.3 can be displayed in web diagrams. For some readers, it is easier to compare alternatives when the data are displayed in figures, rather than tables. Figure 67 displays the tradeoffs for several herring fishery-related metrics with several more ecosystem-related metrics across four separate operating models. The performance of some alternatives vary based on the operating model and the overall ranking changes in some cases.

Figure 66 – Example of web diagram displaying MSE results

Good performance has vertex toward the edge of web, and poor performance has vertex toward the center: (1) Similar results fall under each other; (2) consistent performance has same gradient across alternatives; and (3) variable performance occurs when gradient changes across alternatives – illustrating tradeoffs.

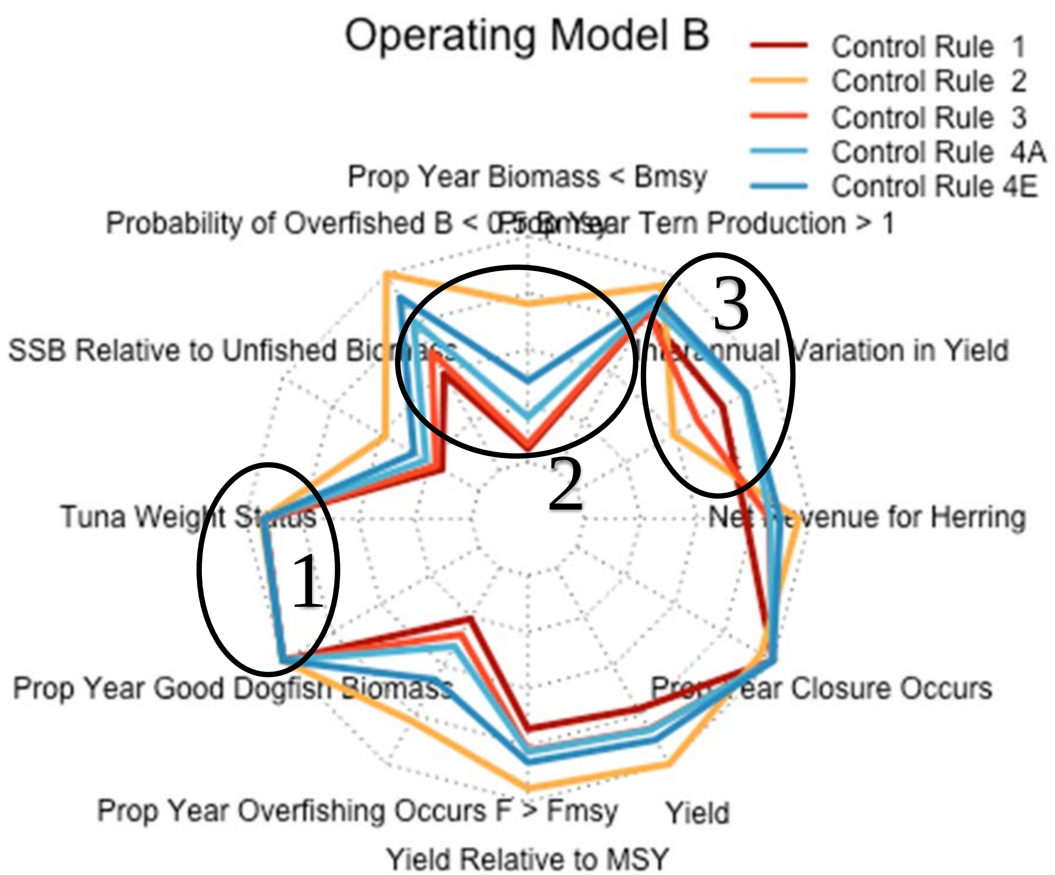
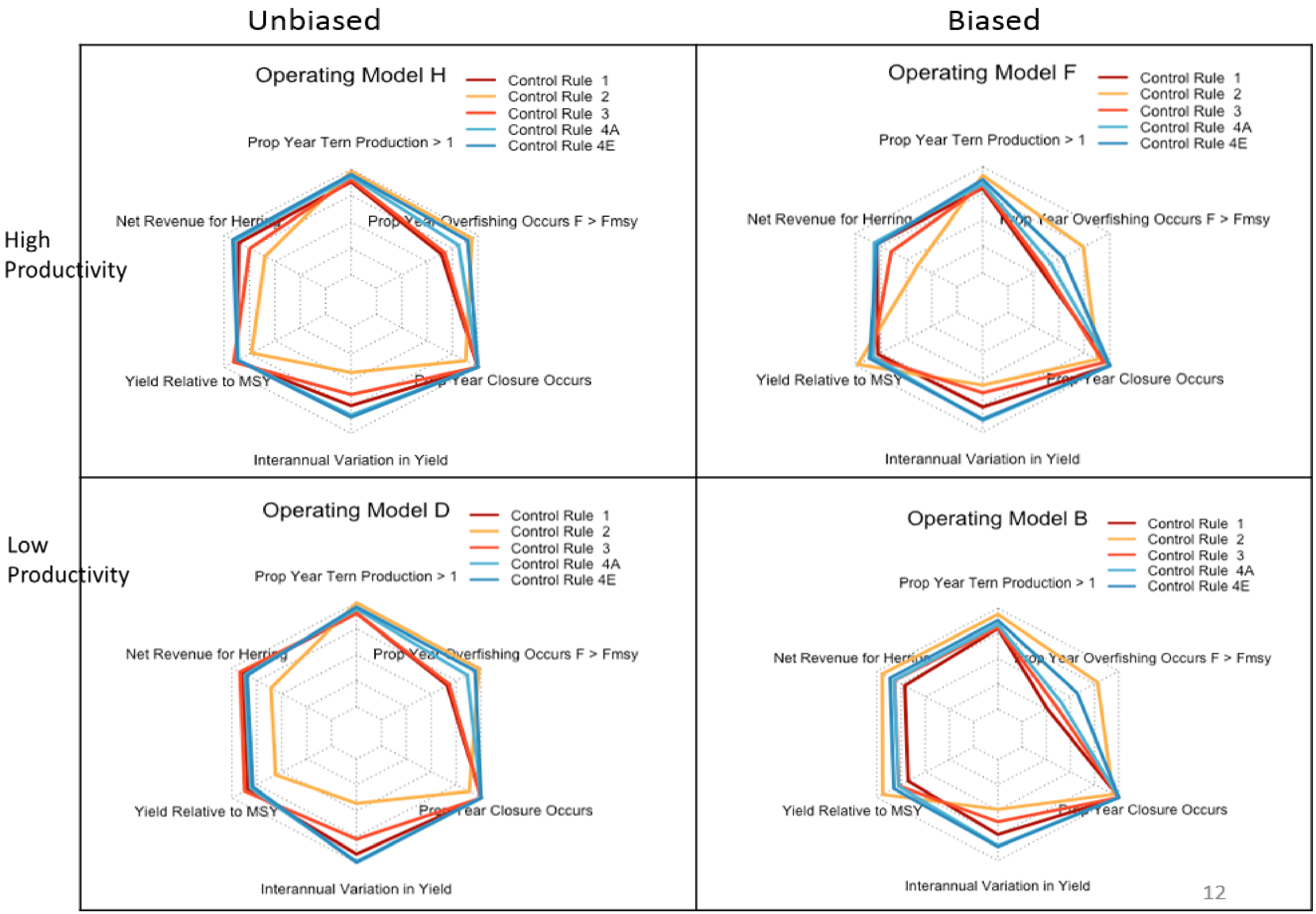


Figure 67 – Tradeoff plots for several metrics across operating models



4.1.1.6 Short-term analysis

MSE analyses focus on the potential long-term impacts; they are designed to consider impacts over a wide variety of resource conditions and time. The models developed for this MSE were run for 150 years, and the results are reported as the median of the last 50 years. Therefore, the potential impacts concentrate on long-term effects. It is also important to consider the short-term effects of control rules, i.e., the expected impacts over the next several years. These analyses include two shorter-term analyses. First, four different herring biomass levels were selected that have been observed in the past and a single-year estimate of biomass and catch was produced for the various ABC control rule alternatives. Second, for each alternative, data from the last assessment (Deroba 2015) were used to prepare three-year projections of herring biomass and ABC. These analyses give a sense of how the various ABC CR alternatives would have performed in terms of shorter-term catch and biomass if they were used in the last specifications (FY2016-2018).

4.1.1.6.1 Single-year estimates

The numbers of herring at age from the last assessment (2015), as well as three other times in the past were used to give a range of possible short-term impacts. Because it is relatively uncertain what the herring resource conditions will be in the next several years, a range of possible resource conditions were evaluated to illustrate the range of possible short-term biomass and yield estimates that would result from the various ABC alternatives. “High (recent)” is the 2015 numbers at age, which is about 2.0*B_{MSY}, “Poor (1980)” was selected to reflect potential biomass and yield estimates for when the herring resource was at very low numbers (about 0.16*B_{MSY}), and two “medium” years were selected as well, 1986 (0.5*B_{MSY}) and 1995 (1.24*B_{MSY}). These different levels of biomass are used as starting points, and the fishing mortality rates from each control rule alternative was applied to those biomass values. The High (recent) biomass scenario is most likely to be in effect in the near future. The results from the other biomass scenarios provide some insight into the sensitivity of the outcomes relative to changes in biomass. The MSE models used to simulate long-term conditions were *not* used in these analyses; these are single-year estimates.

Spawning stock biomass (SSB) is essentially the estimate of biomass after ABC is removed. These estimates also include an adjustment for the retrospective pattern that was observed in the recent stock assessment. Estimates of biomass for each control rule alternative under the four different scenarios are in Figure 68, and estimates of ABC in Figure 69. Overall, biomass is somewhat similar for many of the alternatives, but in some cases, Alternative 2 is higher, especially using 1995 numbers at age. The short-term estimates of ABC are quite variable based on the estimate of herring abundance. When herring abundance is high, as it has been in recent years, the ABC for all the alternatives is 75K to well over 100K mt, except for Alternative 2 which limits fishing mortality at 0.5. Because the upper biomass parameter for Alternative 2 is set at 2.0, fishing mortality reduces before other control rules that do not start reducing fishing mortality until biomass falls below 1.0 or lower (0.5-0.7 for other alternatives). The alternatives with fishery cutoffs show zero ABC when herring resource conditions are poor (1980), and Alternative 2 has zero ABC under 1986 as well because the lower biomass parameter is higher than the other alternatives (set at 1.1 compared to 0.1 or 0.3 for some of the other alternatives).

Short-term gross and net revenue under each of the control rules (Figure 70 and Figure 71) was constructed using the same method as for long-run revenues, except that the New Price model was used. Under the High biomass scenario, the short-term outcomes for the herring fishery are similar for all alternatives except Alternative 2, which results in net revenues that are $2.4-5.8M less than all the other alternatives. Under the Medium biomass scenario, the short-term outcomes for the herring fishery are also similar for all alternatives except Alternative 2, which results in net revenues that are about $20M less than all the other alternatives. Under the Medium B biomass scenario, there is a good deal of variability in outcomes, although revenues in all scenarios are well below historical averages. Under the Poor biomass scenario, short-term outcomes are similar and reflect nearly no herring fishing under all alternatives.

Figure 68 – Estimate of spawning stock biomass (SSB) under four different herring resource conditions for the control rules under consideration in Amendment 8

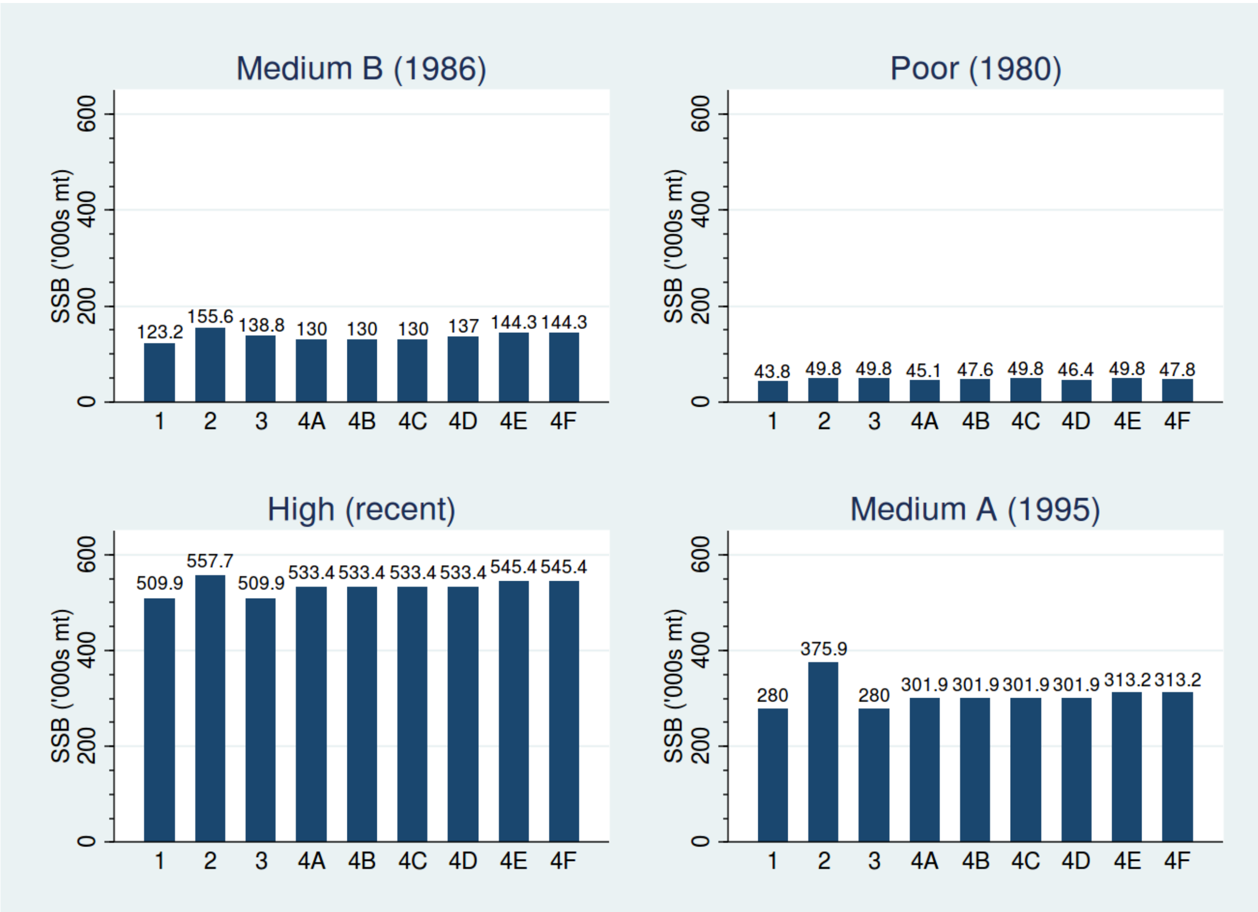


Figure 69 – Estimate of short-term ABC under four different herring resource conditions for the control rules under consideration in Amendment 8

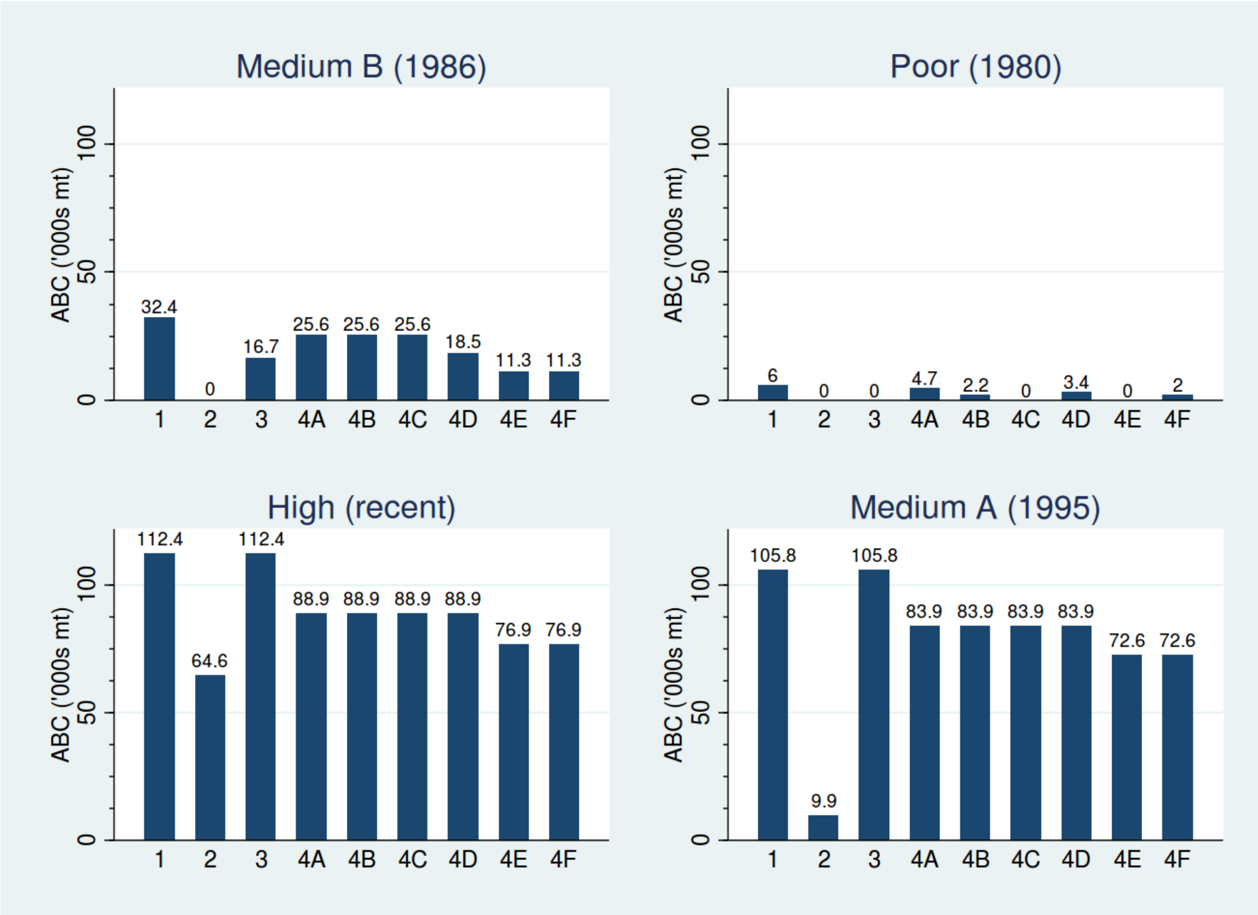


Figure 70 – Estimate of short-term gross revenue under four different herring resource conditions for the control rules under consideration in Amendment 8, using the New Price economic model

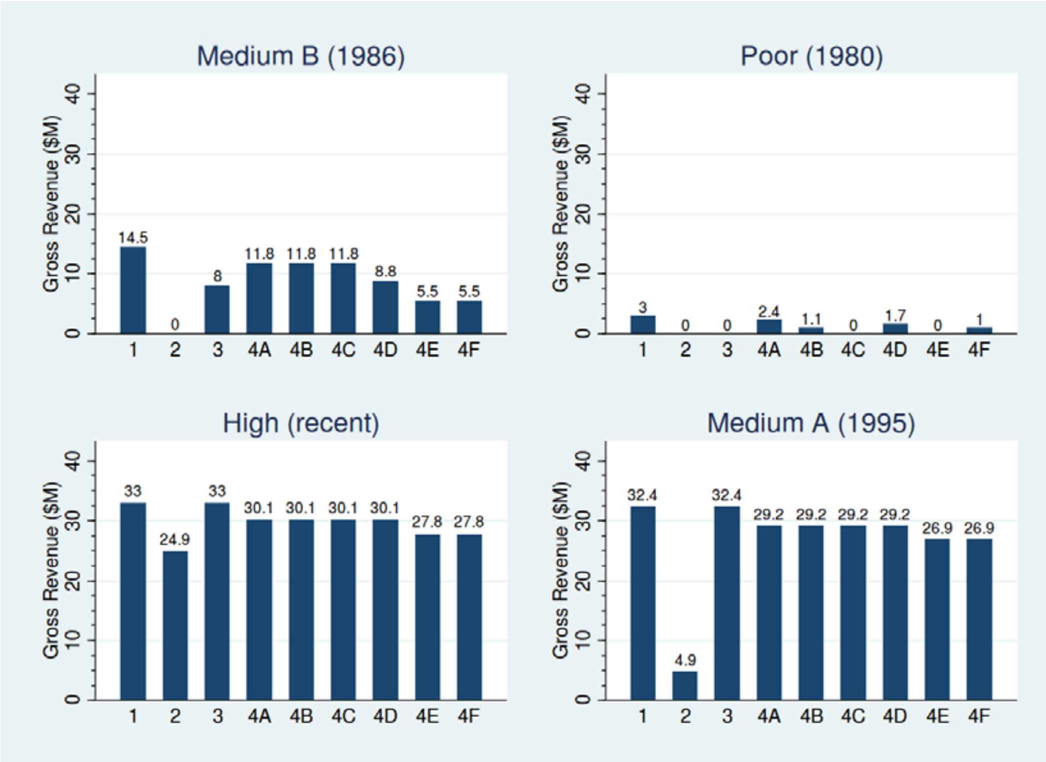
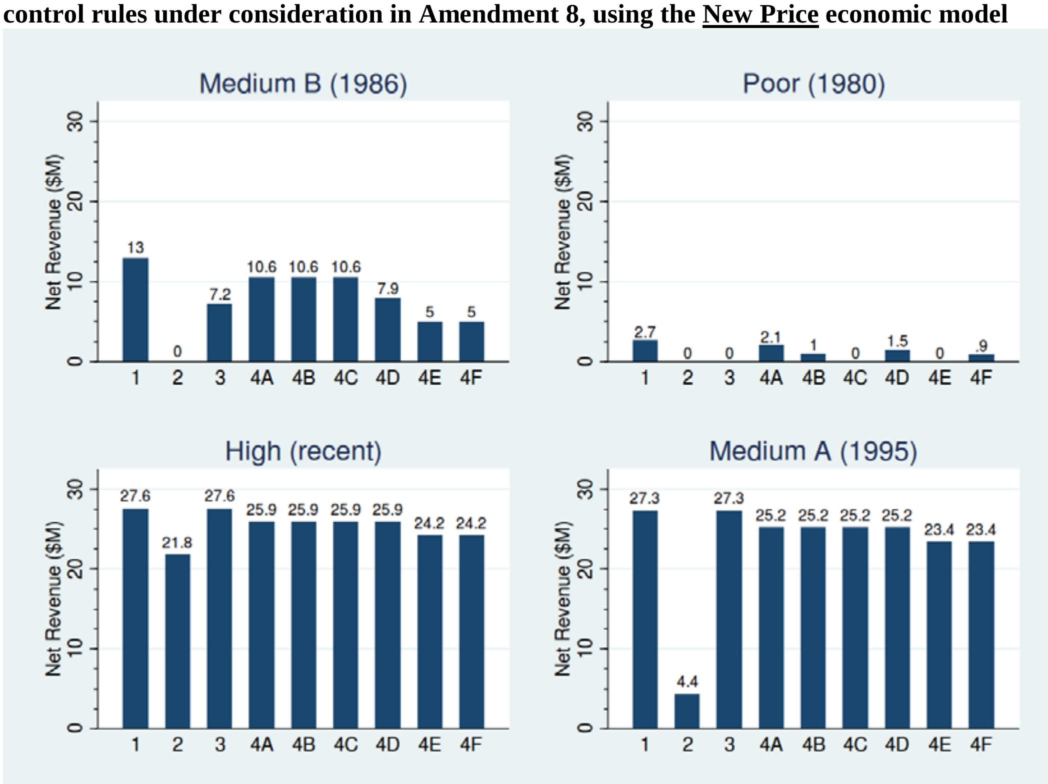


Figure 71 – Estimate of short-term net revenue under four different herring resource conditions for the control rules under consideration in Amendment 8, using the New Price economic model



4.1.1.6.2 Three-year projections

During review of the draft impacts, the members of the herring industry commented that it would be useful to understand how the ABC CR alternatives would function in reality; specifically, what the recent specifications would have been under different control rules. Therefore, the PDT revisited the last specifications document prepared for FY2016-2018, and produced example specifications by applying various fishing mortality rates (0.5 – 0.9) to the most recent (2015) estimate of herring biomass. The other elements of the CR were unnecessary to incorporate (upper and lower biomass thresholds – or inflection points in the CR shapes, because herring biomass is well above B_{MSY}). Table 94 gives the median fishing mortality rates, ABC (catch), and biomass levels as if these CR alternatives were used in the last specifications. This table includes the estimates of ABCs for both alternatives for multiple year ABCs (Section 2.1.2). The No Action multiyear ABC method, the alternative that would use one consistent value for a three-year period is in the column farthest to the right (3-year). Results for the annual alternative that would set ABC at varying levels over the three-year period is the catch associated with each year (2016-2018).

Under the No Action control rule, the constant catch CR that sets ABC at the value that produces 50% probability of $F>F_{MSY}$ in year 3, used in the last specifications package, the ABC was 111,000 mt. Under Alternative 1 and Alternative 3, both with a fishing mortality max of 0.9, the 3-year ABC is also about 111,000 for the 3-year ABC alternative, and under the annual ABC alternative, the ABCs would vary between 123,000 and 98,000 mt. This is the only alternative under consideration where the ABC from year 1 could not be used for all three years, because it would produce an ABC in year 3 with > 50% probability of $F>F_{MSY}$. All the CRs under consideration in this action state that if ABC is projected to have more than a 50% probability of $F>F_{MSY}$, then ABC has to be reduced. Therefore, under Alternative 1 and 3 combined with the 3-year ABC alternative, ABC would need to be reduced to a value between 123,000 and 98,000. In this case, that is about 111,000 mt so that the median F in year 3 did not have more than a 50% probability of exceeding F_{MSY} (estimated at 0.24 in the last assessment). Based on these results, an ABC of 111,000 mt produces an F of 0.24 in 2018. For Alternative 2, which has a max fishing mortality rate of 0.5, the 3-year ABC would equal 73,000 and the annual ABC would range between 73,000 and 64,000 mt. Alternatives 4a-4d (max F = 0.7) range between 100,000 and 84,000 mt, and finally Alternatives 4e and 4f (max F = 0.6) range between 74,000 and 86,000.

Alternatives 1 and 3 produce essentially the same ABC in the short term as No Action (111,000 mt) under current biomass conditions from the last specification package. If the annual ABC alternative is used, the total ABC over the three years is slightly lower than under the 3-year approach (324,000 vs. 333,000), but the probability that biomass is less than B_{MSY} is also lower for the annual ABC approach. The ABC under Alternatives 2, 3 and 4 are all lower than No Action, for both the 3-year and annual approaches. These alternatives use lower maximum fishing mortality limits; therefore, the probability of biomass being less than B_{MSY} are all lower for these alternatives compared to No Action, as well as Alternatives 1 and 3.

Table 94 – Example specification projections for all ABC CR alternatives for FY2016-2018, as well as both alternatives under consideration for setting three-year ABC (annual and 3-year alternatives)

	No Action (Constant Catch that Produces Prob $F>F_{MSY}$ = 0.50 in 2018)			3-year
	2016	2017	2018	
Median F	0.19	0.23	0.24	
Median Catch mt	111,000	111,000	111,000	111,000
Median SSB mt	557,000	458,000	427,000	
Prob SSB < SSBMSY	0.06	0.16	0.24	
Prob SSB < $0.5SSB_{F=0}$	0.24	0.41	0.49	
Prob SSB < $0.75SSB_{F=0}$	0.63	0.80	0.82	
	Alts. 1 and 3 ($0.9F_{MSY}$)			3-year
	2016	2017	2018	
Median F	0.22	0.22	0.22	
Median Catch mt	123,000	103,000	98,000	*~ 111,000**
Median SSB mt	547,000	457,000	433,000	
Prob SSB < SSBMSY	0.04	0.07	0.13	
Prob SSB < $0.5SSB_{F=0}$	0.22	0.39	0.47	
Prob SSB < $0.75SSB_{F=0}$	0.65	0.86	0.88	
	Alt. 2 ($0.5F_{MSY}$)			3-year
	2016	2017	2018	
Median F	0.12	0.12	0.12	
Median Catch mt	73,000	64,000	64,000	73,000
Median SSB mt	584,000	517,000	506,000	
Prob SSB < SSBMSY	0.02	0.03	0.04	
Prob SSB < $0.5SSB_{F=0}$	0.17	0.24	0.27	
Prob SSB < $0.75SSB_{F=0}$	0.60	0.75	0.76	
	Alts. 4a,4b,4c,4d ($0.7F_{MSY}$)			3-year
	2016	2017	2018	
Median F	0.17	0.17	0.17	
Median Catch mt	100,000	86,000	84,000	100,000
Median SSB mt	565,000	484,000	466,000	
Prob SSB < SSBMSY	0.03	0.04	0.08	
Prob SSB < $0.5SSB_{F=0}$	0.19	0.33	0.38	
Prob SSB < $0.75SSB_{F=0}$	0.63	0.81	0.83	
	Alts. 4e, 4f ($0.6F_{MSY}$)			3-year
	2016	2017	2018	
Median F	0.15	0.15	0.15	
Median Catch mt	86,000	75,000	74,000	86,000
Median SSB mt	574,000	501,000	486,000	
Prob SSB < SSBMSY	0.03	0.03	0.06	
Prob SSB < $0.5SSB_{F=0}$	0.18	0.28	0.32	
Prob SSB < $0.75SSB_{F=0}$	0.61	0.78	0.80	

** Because F estimate is close to Fmsy for year 3 for this alternative, it is likely that ABC will not be set at year 1 value, (123,000).*
That would voliate ABC CR definition; ABC cannot have greater than 50% probability of exceeding Fmsy.
Therefore, in this case, the ABC in year 1 needs to be reduced to something less than 123,000, but something higher than 98,000.
The 3-year allocation would likely be about 111,000 mt for alternatives 1 and 3 in this example to be set at F < 0.24 (Fmsy).

When considering these ABC projections, it is also important to keep in mind that in the Herring FMP there are reductions taken from the ABC before catch levels, or ACLs are allocated to the fishery. A buffer for management uncertainty is removed first, followed by a set amount of ABC to support the Herring RSA program. In the last specifications, the management uncertainty buffer was set at 6,200 mt, and 3% of the ABC was set-aside for the RSA program (NEFMC 2016). Additionally, the ACL is divided into sub-ACLs by management area. In the last specifications, those allocations were as follows: 28.9% for Area 1A, 4.3% for Area 1B, 27.8% for Area 2, and 39% for Area 3. There are different restrictions in place that limit which vessels and gears can access each herring management area, including seasonal restrictions. Specifically, Area 1A is closed to all fishing from Jan – May, and in June-Sept Area 1A is only open to purse seine gear with 72.8% of the Area 1A sub-ACL, and from Oct-Dec the remaining 27.2% of the Area 1A TAC is available to all gear types.

To further evaluate the potential impacts of these ABC CR alternatives on the herring fishery, the short-term ABCs from above were sub-divided into sub-ACLs, according to the method in the 2016-2018 specifications (Table 95). This example is for the 3-year ABC CR alternative only, but the same idea would apply to the annual ABC alternative, similar reductions and sub-ACLs would be applied to those ABCs as well, but the allocations would vary every year, compared to being consistent for three years. Overall, the ACL and subsequent sub-ACLs are again lower for Alternatives 2, 3, and 4; the allocations are the same for Alternatives 1 and 3, as well as No Action, since the starting ABC is identical.

Table 95 – Example ABC and ACL allocations for FY2016-2018

	No Action	**Alt. 1 and 3**	**Alt. 2**	**Alt. 4a-4d**	**Alt. 4e-4f**
Example 3-year ABC	**111,000**	**111,000**	**73,000**	**100,000**	**86,000**
Management uncertainty	**6,200**	**6,200**	**6,200**	**6,200**	**6,200**
RSA (3%)	**3,330**	**3,330**	**2,190**	**3,000**	**2,580**
ACL	**101,470**	**101,470**	**64,610**	**90,800**	**77,220**
Area 1A (28.9%)	**29,325**	**29,325**	**18,672**	**26,241**	**22,317**
Area 1B (4.3%)	**4,363**	**4,363**	**2,778**	**3,904**	**3,320**
Area 2 (27.8%)	**28,209**	**28,209**	**17,962**	**25,242**	**21,467**
Area 3 (39%)	**39,573**	**39,573**	**25,198**	**35,412**	**30,116**
Area 1A					
Jan-May (0%)	**0**	**0**	**0**	**0**	**0**
Jun-Sept (72.8%)	**21,348**	**21,348**	**13,593**	**19,104**	**16,246**
Oct-Dec (27.2%)	**7,976**	**7,976**	**5,079**	**7,138**	**6,070**

4.1.2 Analysis of measures to address potential localized depletion and user conflicts

The PDT defined localized depletion as described in the Council's public scoping document for Amendment 8:

> *"In general, localized depletion is when harvesting takes more fish than can be replaced either locally or through fish migrating into the catch area within a given time period."*

The occurrence of localized depletion suggests that the removal of prey from a given area would either leave relatively immobile predators (e.g., monkfish) with insufficient prey for some time, or that relatively mobile predators (e.g., cod, tuna) would leave the area in search of alternative prey.

To the degree that temporal and spatial fishery catch data are available, it is relatively simple to describe where and when fishing has occurred for predator fisheries. As described below, this may not be so straight forward for tuna fisheries and perhaps striped bass fisheries. It is challenging to identify if and how other fisheries have been impacted by herring catches. There are many constraints that determine where and when a fishery is prosecuted (e.g., area closures, weather windows, mobility of fish) that need to be understood in an investigation of whether there is causality to any correlations.

In Amendment 1 and more recently, much attention has been given to midwater trawls as the gear responsible for causing localized depletion. The method of removal, however, should not be relevant to the evaluation of localized depletion. If predators are responding only to herring abundance in an area, then given the same amount of catch, the same level of depletion occurs regardless of gear type and would subsequently have the same effect on predators. That said, as a relatively large and mobile gear, midwater trawls likely have different effects on predators than other gears commonly used to harvest similar amounts of herring (e.g., purse seines). Both gear types can be used to fish in a concentrated fashion. Issues of gear conflict should be kept distinct from issues of localized depletion. Are herring predators responding to depletion of herring (which should not depend on the gear used to remove herring), or are the predators responding to a trawl gear passing through an area (and would respond the same way regardless of herring depletion)? The former is localized depletion while the latter is not. These issues are also not mutually exclusive. Conducting field research would help determine if correlations indicate causality and avoid speculation. To date, there has not been research in this area to directly assess the potential impacts of different fishing gears on herring abundance and potential related effects of localized depletion on predators on herring.

While the Herring Committee explored localized depletion and developed alternatives, it requested multiple analyses from the Herring PDT. First, the PDT summarized what is known about the role of herring as forage in this ecosystem. To identify potential user conflicts, the PDT developed mapping tools to describe the footprint of the herring fishery and key predator fisheries. In addition, the PDT completed an overlap analysis of these fisheries to identify the areas and seasons that have been most important and quantify the degree of overlap, or potential user conflict. The PDT also evaluated if there is a correlation between herring fishery removals and negative impacts on predator fisheries based on available data. Finally, the PDT worked with industry advisors to help identify possible effort shifts that may result from area closures. This work is summarized here, and additional information is in Appendix IV, as well as within the impacts discussion (Sections 4.2 to 4.7).

4.1.2.1 Herring as forage

In the Atlantic herring stock assessment, the amount of herring assumed to be ***taken*** by predators (e.g., piscivorous fish, seabirds, highly migratory species, marine mammals) has varied annually (**Figure 21**, dashed line). The 2015 stock assessment assumed that, during 2009-2013, an annual average of 852,000 mt of Atlantic herring was eaten by predators, which equaled 44% of average total biomass (1.92 million mt) over the same period. The amount of herring assumed to be consumed by predators in the assessment is based on natural mortality rates and estimates of herring consumption largely based on gut contents data, which also vary annually (**Figure 21**, solid line), with an annual average of 268,000 mt during that time. The gut contents data are from NMFS surveys, and are highly imprecise and likely biased because the samples are limited. The short-term projections used to provide catch advice (overfishing limit, acceptable biological catch) assume a similar amount of herring are consumed as assumed in the stock assessment. More information is available in the 2015 Atlantic Herring Operational Assessment report (Deroba 2015).

The Ecosystem-Based Fishery Management PDT report on scientific advice for accounting for ecosystem forage requirements (NEFMC 2015) and assessment reports (e.g., Deroba 2015) may be referenced for sample estimates of predator consumption. In recent years, marine mammal consumption of herring is similar to commercial fishery landings, averaging 105,000 mt/year. Bluefin tuna and blue sharks have recently consumed 20-25,000 mt/year. Seabirds consume a relatively small amount of herring, conservatively estimated at about 3-5 mt/year. According to the NEFSC diet database, herring constitutes roughly 20% of the diet of cod and spiny dogfish. There is also some evidence which suggest it is not just volume of herring available, but the age structure of that forage base that is important in the energy budgets of predators (Diamond & Devlin 2003; Golet *et al.* 2015).

During development of this action, the Herring Committee asked the PDT to estimate forage needs of herring in the ecosystem. The PDT assumes that the amount of Atlantic herring ***needed*** for forage is the amount below which predators are negatively impacted. Estimates of this need do not currently exist and would vary by the abundance of predators and other prey. To summarize, consumption estimates can be generated, but that is different than what is necessary – which is a difficult question to answer definitively.

4.1.2.2 Footprint of herring and other fisheries

Two tools that include map products were used to understand the footprint of the Atlantic herring fishery and other fisheries potentially impacted by this action. Many caveats are needed to understand the maps. For example, fishery locations and intensity should not be confused as measures of abundance (or depletion) given the numerous regulations constraining a fishery (e.g., catch limits, time/area closures).

VTR analysis: Vessel trip reports (VTR) and observer data are the primary sources of data used here to understand herring fishing location, landings/revenue, and number of vessels and ports that might be affected by a particular alternative. VTRs are required for all vessels fishing with a federal permit (unless the only federal permit is lobster). For a trip where VTR is required, the vessel must submit a VTR for each gear type used and/or statistical area fished in, including a single point location for where fishing occurred relative to that VTR. However, previous studies indicate that this self-reporting underreports switches in gear type and statistical area (Palmer & Wigley 2007; 2009). Furthermore, and perhaps more importantly, given that commercial fishing trips can be quite long, a single spatial point is unlikely to adequately represent the actual footprint of fishing. Because of this, a statistical approach was used, referred in this action as the "VTR analysis," to better represent the footprint of fishing (DePiper 2014). This analysis was developed for the Omnibus Habitat Amendment (NEFMC 2014c) and used in several actions of the NEFMC and MAFMC since. This is the best approach to identifying the locations of Atlantic herring fishing and is briefly summarized here.

Briefly, VTR data are matched to observer data. A statistical model is then estimated to explain the distance between hauls and the corresponding VTR coordinate. Days absent and gear used are major explanatory factors. The results are used to expand the VTR coordinate to a circular region. Fourth, portions of circular regions that cannot be fished (such as land or areas closed to fishing) are removed and landings or fishing time from the VTR data are assigned to the remaining region. Finally, the individual trips are aggregated to the appropriate level.

Using this method, the PDT developed the tables estimating the amount of landings harvested from the various areas/seasons considered under the alternatives. Note that the model output is the location of herring landings rather than catch. However, for the Atlantic herring fishery, landings generally approximate catch, as Atlantic herring discards represent a very small fraction of total Atlantic herring catch (generally <0.3%). Because the landings data are model outputs, the data should be considered estimates. The PDT also overlaid herring fishing effort by gear type with the range of alternatives considered for years before Amendment 1, as well as more recent years **Figure 72** and **Figure 73**.

Interactive map: The Greater Atlantic Regional Fisheries Office (GARFO) has an online "story map" describing current management areas for the scallop fishery. To support the development of this action, a similar interactive map product was developed for the Atlantic herring fishery. Herring fishery locations are mapped using the VTR analysis (DePiper 2014). Many reference layers are available including herring management areas, spawning areas, depth, catch cap areas to name a few. The fishery data include annual summaries for both herring and mackerel landings, as well as several key predators that forage on herring and are subject to VTR reporting requirements (cod, dogfish, and pollock). Examples are in Figure 74, but the website is live and the maps show how these fisheries have overlapped over time. The map is available at: http://noaa.maps.arcgis.com/apps/webappviewer/index.html?id=5d3a684fe2844eedb6beacf1169ca854

Figure 72 – Herring catch for all gear types combined (left) and MWT only (right), 2001-2005 (Pre-A1)

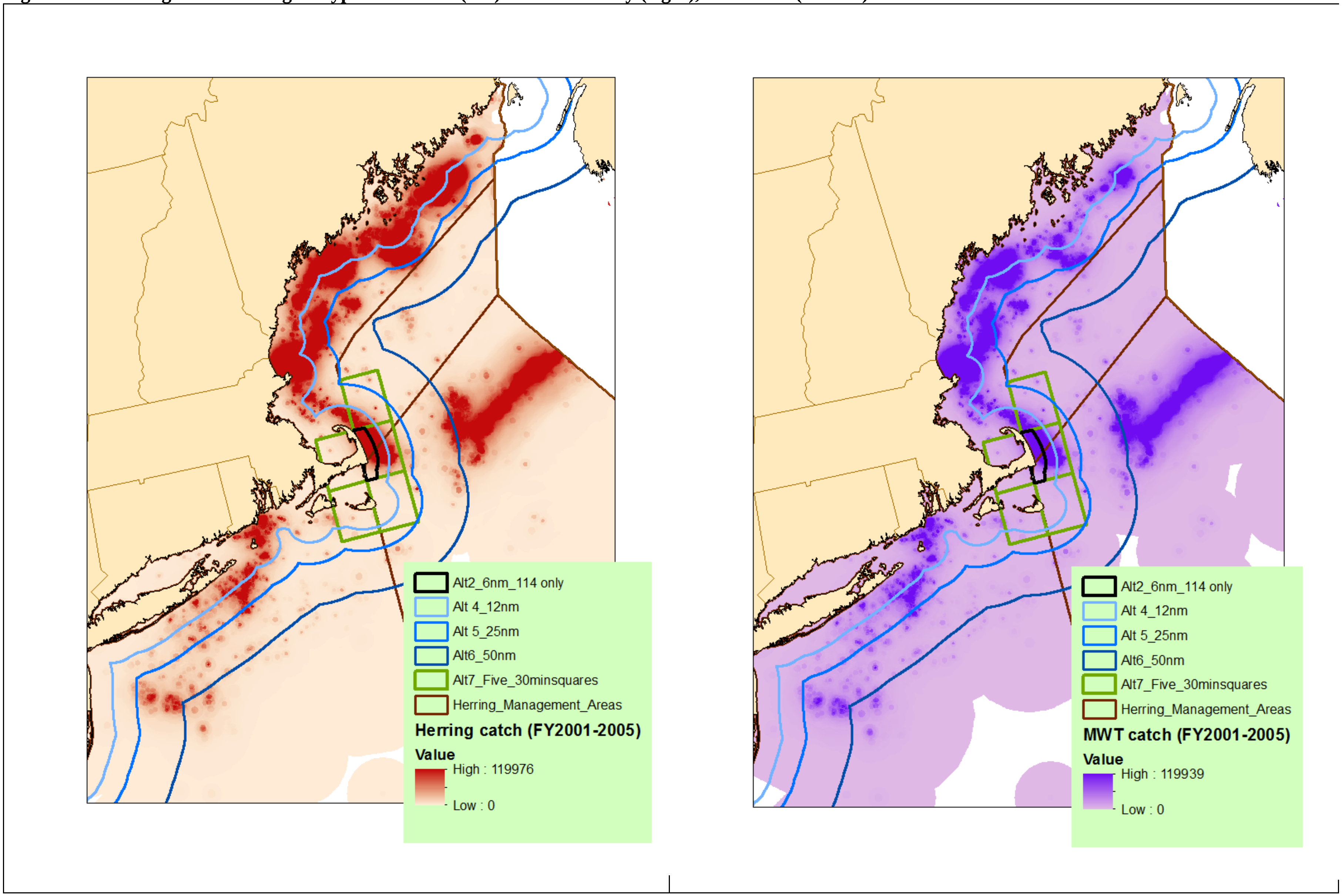


Figure 73 – Herring catch for all gear types combined (left) and MWT only (right), 2011-2015

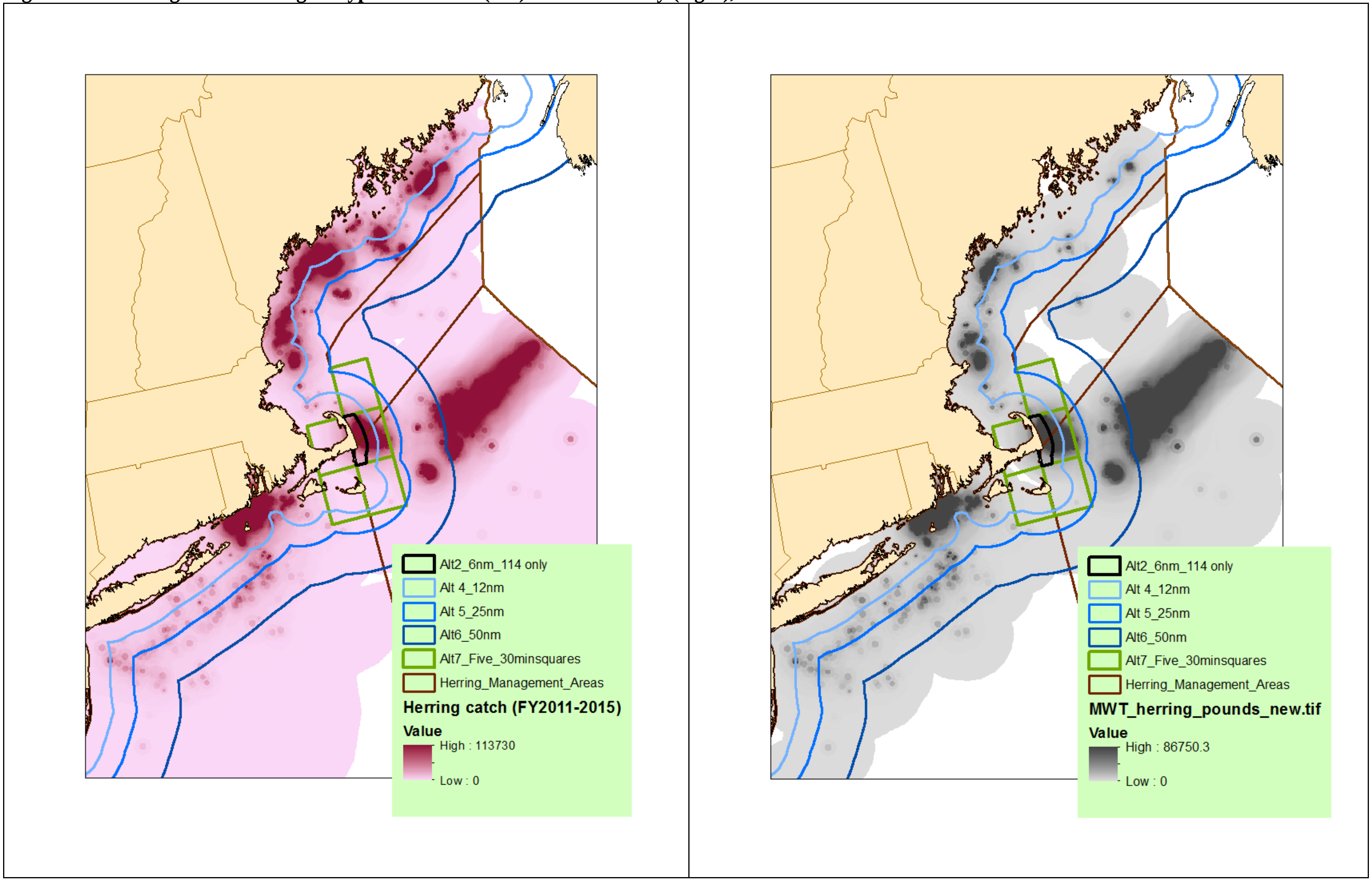
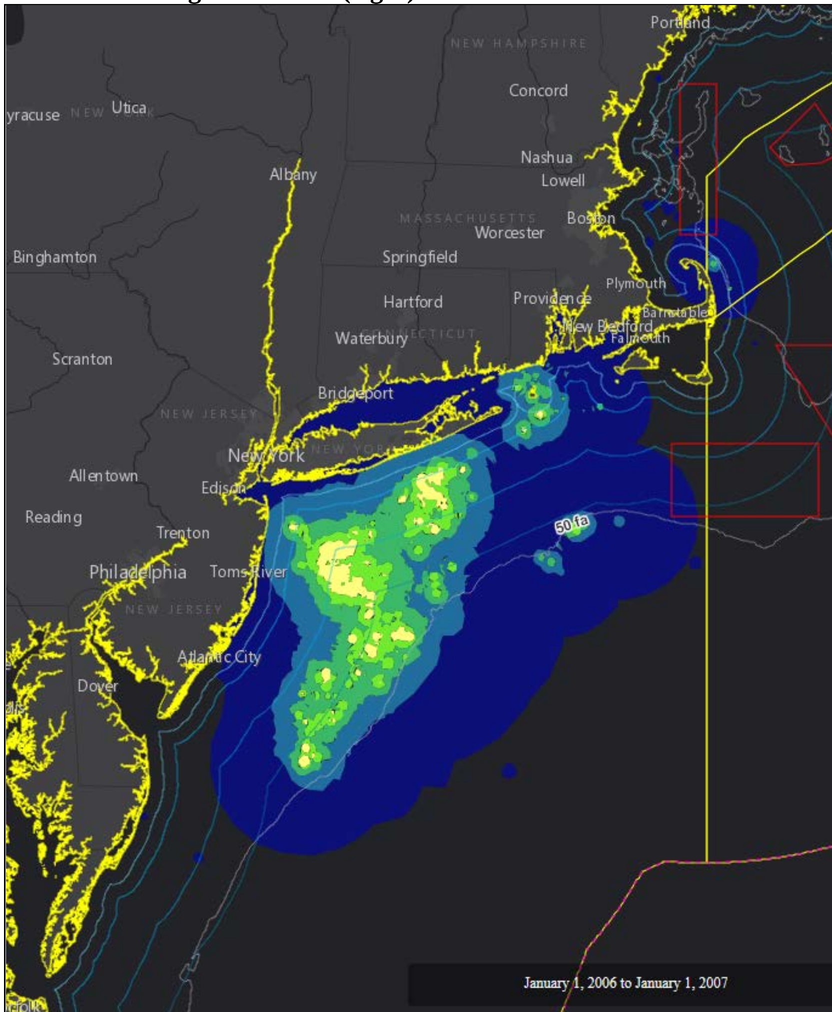
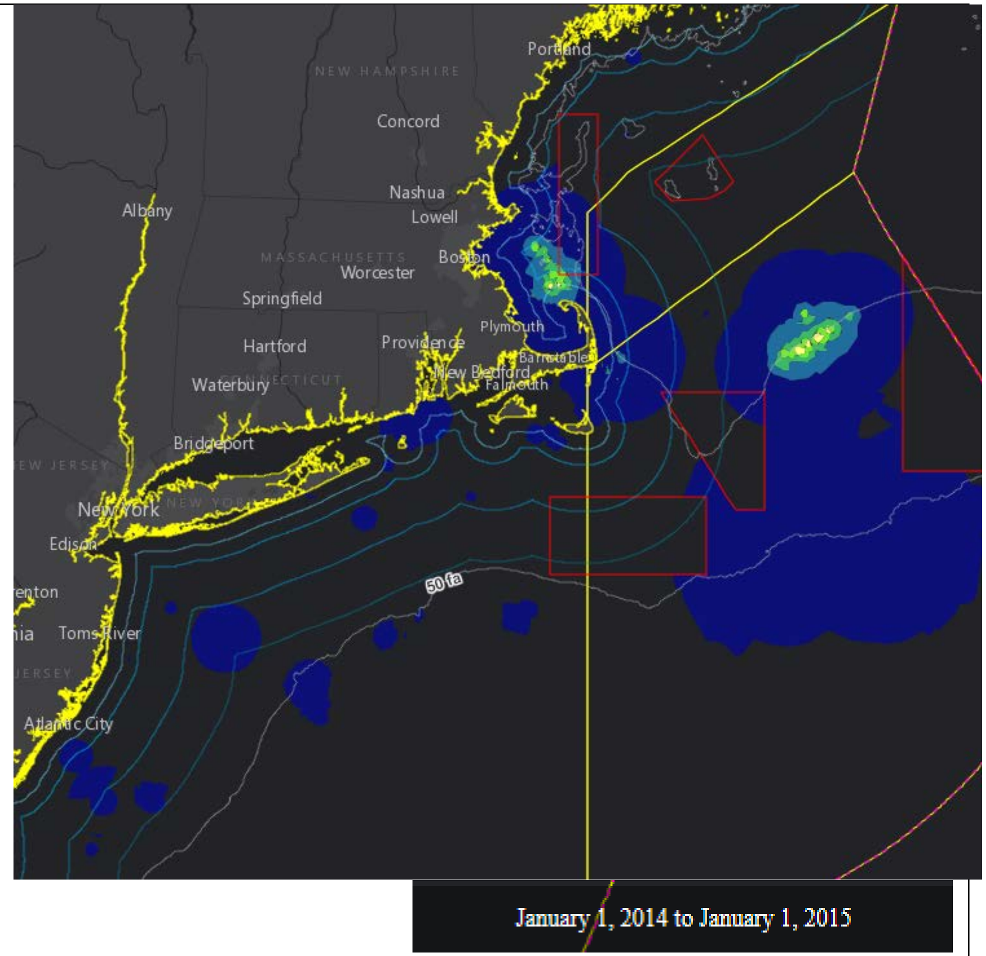


Figure 74 – Example of annual landings web app developed by GARFO to support development of Amendment 8 (Mackerel landings from 2006 (left) and mackerel landings from 2014 (right)





4.1.2.3 Overlaps of fisheries

An analysis was conducted to identify the seasons and areas that have been important to the herring midwater trawl fishery, the commercial fisheries for groundfish and bluefin tuna, and the commercial whale watching industry (Figure 75; Appendix VII and figures therein). Spatial, monthly overlaps were identified between the predator user groups and the herring MWT fishery under three different time periods: 1) pre-Amendment 1 (2000-2006); 2) post-Amendment 1 (2007-2015); and 3) recent (2013-2015).

Summary of overlaps: The level of overlap between the herring MWT fishery and all other predator users analyzed dropped significantly in 2007 with the passing of Amendment 1 (Figure 76). The seasonal profile of overlap has also changed since 2007 (Figure 77), with less overlap in summer months in recent years. These changes in seasonal overlap are due, in part, to Amendment 1, but also to changes in the distribution of landings in the predator fisheries caused by modifications to the spatial measures for those fisheries.

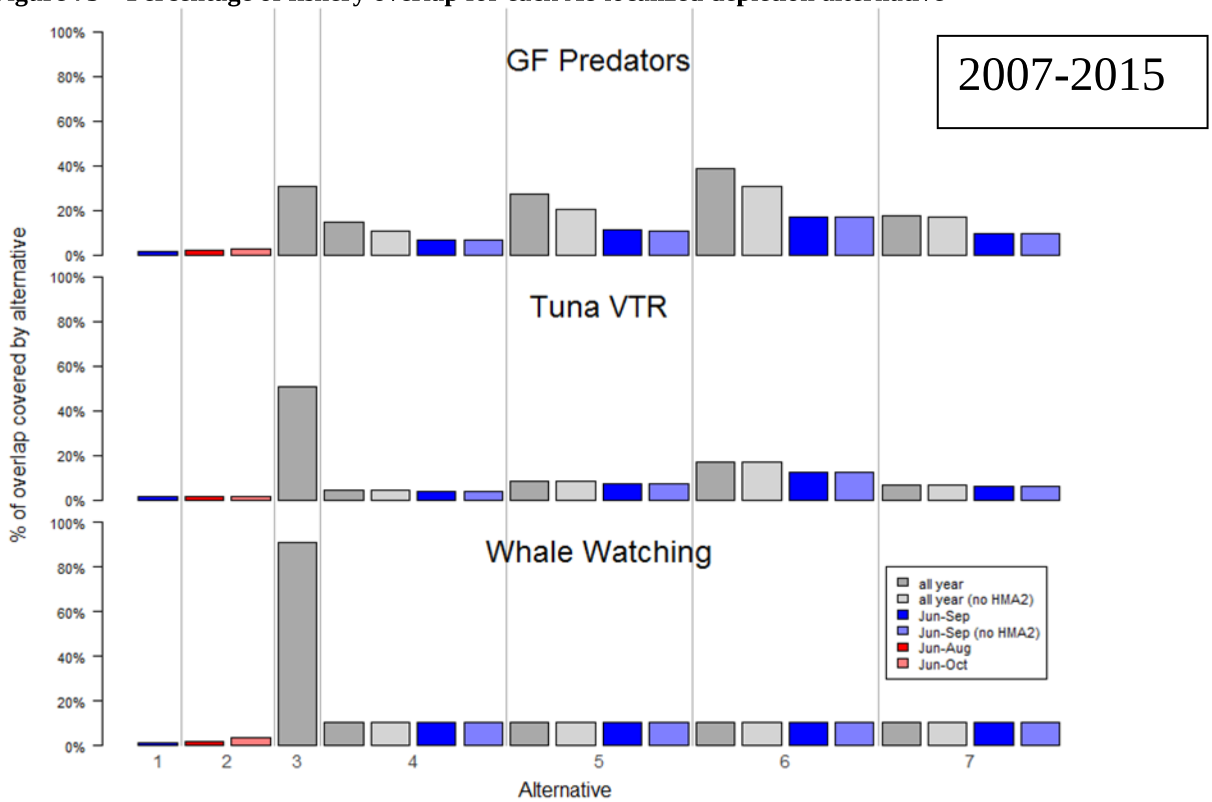
Overlap with commercial groundfish fishery: In all three time periods, the greatest amount of overlap between the herring MWT and groundfish predator fisheries occurred near Cape Ann in October-November. Prior to Amendment 1, significant overlap also occurred in this area during the summer months; however, this interaction has been minimal since 2007. In the recent time period, the most important herring-groundfish overlap *outside of* Area 1A occurred along the northern edge of Georges Bank in May, off outer Cape Cod in July-August, the Great South Channel in September, and near Block Island in December-January.

Overlap with bluefin tuna fishery: In all three time periods, the overlap between the herring MWT and bluefin tuna fisheries is greatest during October near Cape Ann. Prior to Amendment 1, overlap between these two fisheries also occurred in Area 1A during July-September. More recently, there has also been relatively high overlap along the northern edge of Georges Bank during November.

Overlap with the whale watch industry: Prior to Amendment 1, the greatest overlap between the herring MWT herring MWT fishery and commercial whale watch operators occurred in several areas within Area 1A from May-November. As with the other user groups focused on herring predators, the summer Area 1A overlap no longer exists, and currently the area with the greatest overlap is near Cape Ann during October-November. Notably, any inference about the change over time in overlap with whale watching comes entirely from the herring MWT dataset, as the spatial/seasonal pattern for whale watching was assumed time-invariant.

Overlap relative to the alternatives: Alternative 3 (year-round prohibition of herring MWT fishing in Area 1A) and the widest shoreline buffer alternatives (Alt 5 and Alt 6) with the year-round sub-option encompassed the largest portion of overlap with the groundfish predator fisheries (up to 20-45%). For the commercial tuna fishery, Alternative 3 by far encompassed the greatest portion overlap with the herring MWT fishery (50-60%), with all other alternatives covering <20%. Similarly, Alternative 3 encompassed >90% of the overlap with the whale watching industry, with all other alternatives covering <10%.

Figure 75 – Percentage of fishery overlap for each A8 localized depletion alternative



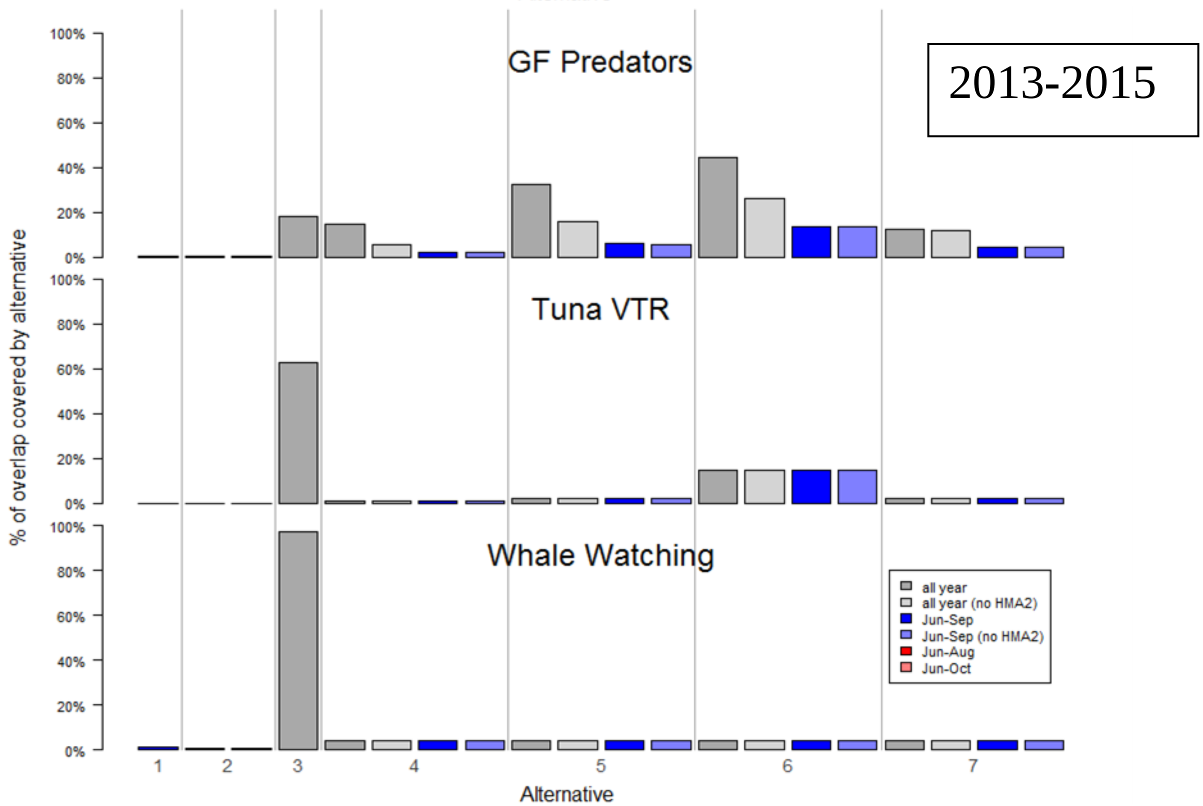


Figure 76 – Annual index of overlap between the herring MWT fishery and other predator-focused user groups, 2000-2015

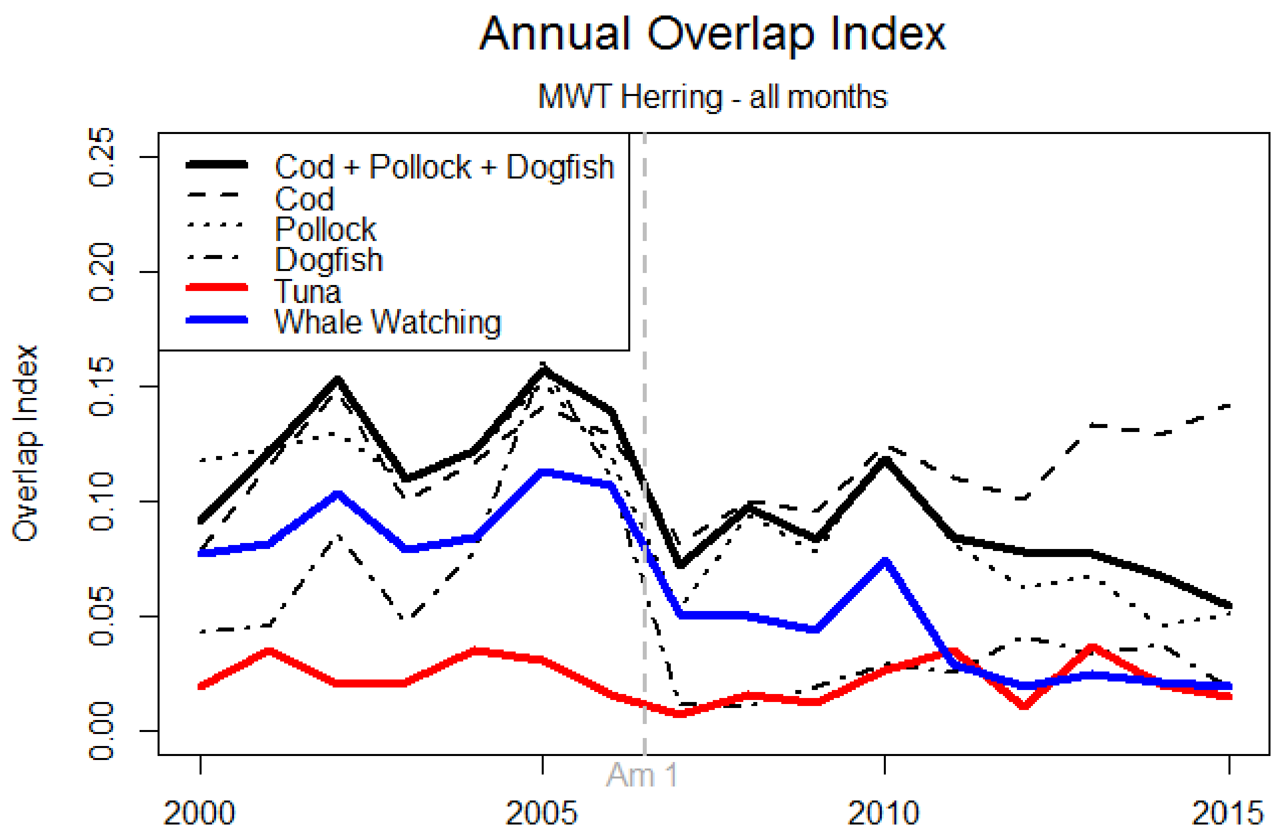
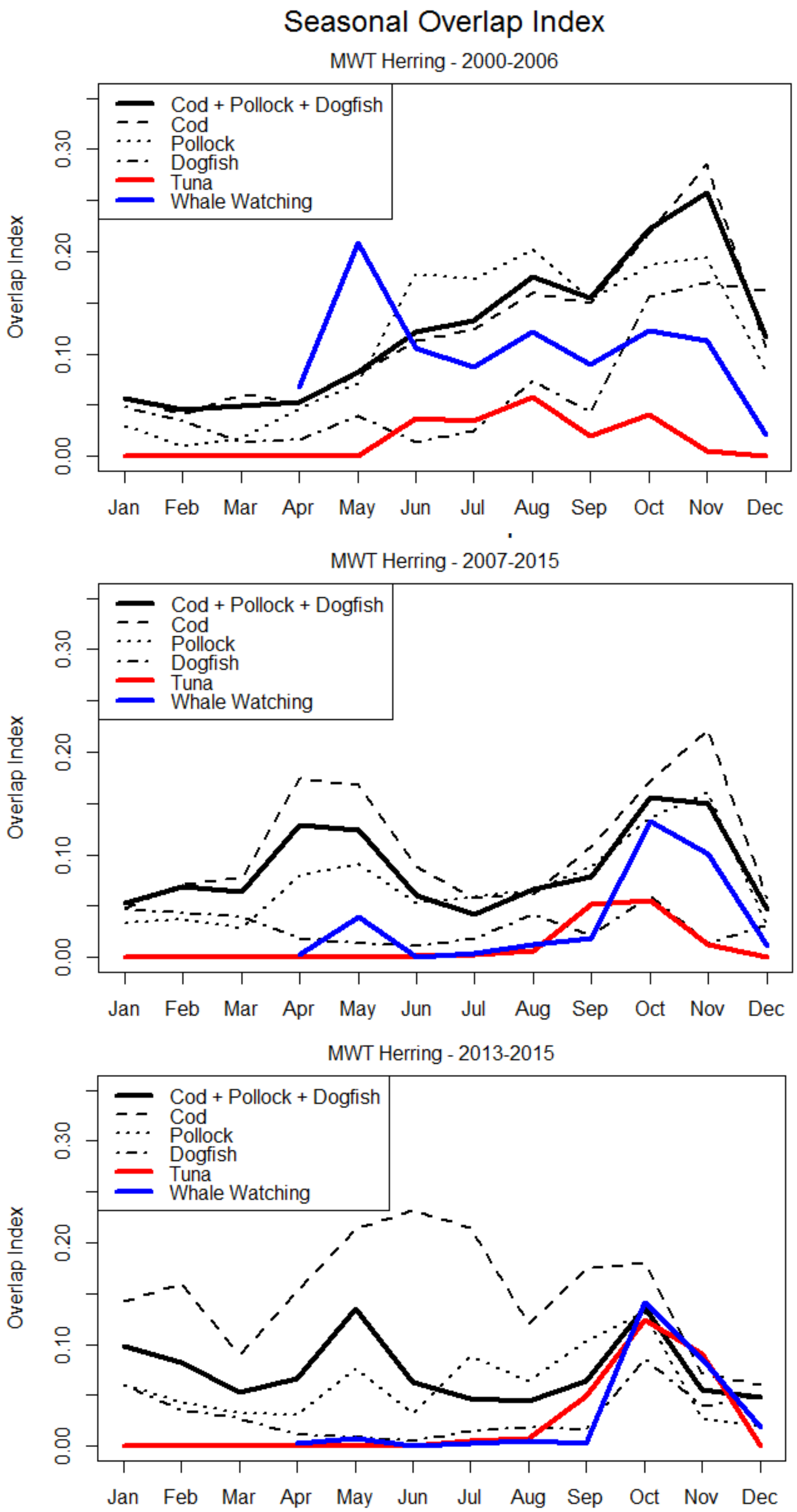


Figure 77 – Seasonal index of overlap between the herring MWT fishery and other predator-focused user groups, under three different time periods



4.1.2.4 Correlation between catches of herring and predator fisheries

The Herring PDT completed a preliminary analysis attempting to inform the discussion on localized depletion of herring for components of the groundfish fishery in early 2016 (Appendix VI). The analysis was intended to test if predator fisheries move after herring MWT fishing occurs, is there a tendency for predators to vacate an area in search of better foraging grounds after herring MWT fishing activity. In this analysis, herring catch was compared to the reported catch per trip of Atlantic cod, pollock, and spiny dogfish in both the week following herring catch and two weeks following herring catch (similar spatial catch data do not exist for other important predator fisheries such as tuna and striped bass). The data were taken from statistical areas contained in each of Herring Management Areas 1A, 2, and 3 (Stat Areas 511, 512, 513, 514, 522, 537, 539, and 613) between 1996 and 2014. The analysis did not find any evidence of localized depletion. However, the finding of this analysis comes with many caveats, including that the data are only applicable to spatial and temporal resolution of the analyses and to the predators included.

In addition, localized depletion was examined on the scale of statistical area and week. So, if conditions within a statistical area were unchanged after one or two weeks, then no evidence of localized depletion would be found. This analysis also focused on three predators and combined them for analysis, but different predators may respond differently to the removal of herring. Conducting analysis by individual predator or groups of predators thought to react similarly to herring removals should likely be considered in the future. Likewise, varying the temporal and spatial scale of analysis by predator might also be considered, and other predators of interest could be examined. This analysis also used VTR data, which is self-reported and may contain errors (e.g., incorrect spatial assignments). Other data sources might be considered in the future. This method assumes that catch per tow is an index of predator abundance.

Finally, data from all times of year were combined in this analysis, but perhaps analysis by season may have had different results. Herring migrate during certain times of year, so localized depletion is unlikely to occur during these times because the herring will be in a different location in the near future regardless of catches. Analysis of a time of year when herring are likely to be confined in a single region might be more appropriate (summer feeding grounds or fall spawning). However, having included data from all times of year in this analysis would only increase the chances of finding a negative correlation, which may support the occurrence of localized depletion. In summary, these analyses did not find evidence of localized depletion from the data available and how the data were summarized.

4.1.2.5 Potential effort shifts

The alternatives under consideration could result in several potential scenarios for how herring fishery effort may change, from shifting gears and/or seasons to potentially precluding fishing altogether – which would have follow-on impacts across all the VECs (e.g., protected resources, habitat). For example, Alternative 2 is a seasonal closure that would impact all herring gear types in a relatively small area 6 miles east of Cape Cod. Therefore, potential effort shifts from Alternative 2 are less than other alternatives, likely shifting effort to areas just beyond that closure, or to other times of year within that area. On the other hand, all the other alternatives are MWT gear only prohibitions. Therefore, vessels would have the option to switch gear types if they do not want to be displaced by the closure.

The likelihood of a vessel converting gear type depends on the alternative selected, as well as the individual set up and business plan per vessel. A few vessels currently switch gears between purse seine and MWT to maintain access in Area 1A during the current MWT prohibition from June 1 through September 30. Other MWT vessels have large barriers to switch gear type and have no intention of switching gear types. It is very expensive to invest in new gear and time consuming to convert a vessel from one gear to another. However, a LD measure that prohibits MWT fishing in a large area or for a long period of time would increase the incentives to change.

The impacts analysis was informed not only by fishery data, but by the Herring PDT's understanding of the general impacts of area closures (Section 4.7.3.1.1, p. 398) and its working knowledge of the herring fishery. To supplement this knowledge, the PDT requested, through the Herring Committee Chairman, that the Herring Advisory Panel discuss the potential for effort shifts (areas, seasons, gear type) as well as potential costs associated with possible fishing behavior changes that may occur because of the alternatives. On November 20, 2017, these topics were discussed by the AP, with public input, and individual responses were later received from five AP members who represent active herring fishing companies. The input is summarized below. Statements have not necessarily been confirmed independently by the PDT.

Activity in Area 1A since Amendment 1

- The majority of the Area 1A sub-ACL is caught by four purse seine vessels, and it seems they prefer to fish in summer and early fall, when bait is in high demand.
- There has been more spatial concentration of effort in Area 1A, since the areas that PS vessels can fish is more limited (e.g., shallower) than midwater trawl vessels.
- Bait dealers have adapted, though there was an adjustment period. Their greater constraint is the overall catch limit.
- PS vessels have increased in length, and two MWT vessels have been reconfigured to also fish with PS, so they can access Area 1A during the season it is closed to MWT gear.
- Before A1, the PS vessels used to land early in the week and the MWT towards the end, which would make for smooth operations getting product to market. Without the MWT vessels, and with the ASMFC limits on landing days, landings tend to stack up. There are not always enough trucks to handle the influx, so it is difficult to have consistent markets. Because of the reduced landing days, there are many more bait dealers to try to handle the influx (to the detriment to long-time dealers). It is more difficult for the herring boats to be loyal to their best customers. The nature of the business has changed.
- There are concerns that the recent ASMFC limits on transferring fish to carrier vessels (Section 3.6.1.5) may have increased PS discards.

Potential for MWT vessels to act as carriers

- New weekly carrier limits (Section 3.6.1.5) make it uneconomical for most MWT vessels to become carriers. There are concerns that, since the carrier limits are for U.S. vessels only, the use of Canadian carriers may continue/expand.
- Even without the new limits, it is not economical for a MWT vessel to only act as a carrier. Fishing revenue is necessary to stay in business. When acting as a carrier, the landings revenue is generally shared 50/50 or 40/60 with the harvester vessel.

Potential to switch areas/seasons

- Herring are migratory; there is no area with a resident, year-round population. Concerns were voiced that there are not many areas left open at present where the fishery can consistently look for fish. The recent spawning closures (Section 3.1.5) are pushing the Trimester 3 opening of Area 1A to later and later in the fall. The groundfish closures require 100% observer coverage, and it is difficult to get an observer, essentially keeping those areas off the table. Excluding vessels from an area (e.g., Area 114 in summer) does not mean that vessels can just fish in other areas (e.g., Area 2 in summer, which only has herring in the winter).

Potential to switch gears

- AP members commented that there are three vessels that are primarily MWT vessels currently equipped to also fish with PS gear. They primarily convert to PS to fish in Area 1A when MWTs are restricted.
- It is very difficult for a MWT vessel to rig over to PS.
  - The cost for a MWT vessel to convert so that it can also fish with PS is estimated to be $1-3M, requiring booms, cranes, winch modifications or replacements, PS gear and deck reconfigurations.
  - MWT gear worth $300K-500K would need to be discarded or stored, and there is a cost to storing PS gear when not in use.
  - The conversion could impact the vessel righting moment, making vessels unsafe.
  - PS is a completely different way of fishing, so there may be a year or two of lost income and fuel expenses to learn how to fish with a PS. New crew may need to be hired with PS experience.
  - Fishing with PS requires more crew, a cost increase.
  - Once the vessel is converted, it takes 3-5 days to switch from one gear to the other, sometimes with $20,000-30,000 in conversion costs.
- A vessel owner that has made a MWT vessel able to also fish with PS gear said that it took about seven years to recoup the $3M spent on converting.
- AP members explained that it is not possible to fish with a PS outside Area 1A, not consistently anyway. The dedicated PS vessels are too small to fish much more than 12 nm offshore. When it has been tested in the past it has not been very successful.
- There is greater potential for a MWT vessel to rig over to using small-mesh bottom trawls than to PS.
  - The conversion cost is ~$100,000-$250,000 per boat, requiring a high-rise bottom trawl net, pelagic doors, reconfigured winches, and greater wire capacity.
  - AP members estimate that the time to convert the vessel and train the crew would be about two weeks; existing crew could be used.
  - In GOM/GB, could only fish in the small-mesh exemption areas that have specific seasonal restrictions as well. For example, the small mesh exemption area east of Cape Cod is only open to small mesh gear in September – December.
- It is not possible for a vessel to be able to rig for all three gear types.

Impacts of establishing a buffer zone (Alternatives 2-7)

- Some AP input was that Alternatives 2-7 would force vessels to switch from MWT gears.
- Vessels may opt to relocate to West Coast fisheries where larger vessels are in demand.

- Replacing MWT effort (low discard rates) with SMBT (higher discard rates) may increase bycatch and discards and have negative unintended consequences.
- Increasing SMBT effort would make fishing within the SMBT bycatch caps more difficult, negatively impacting current SMBT vessels.
- Fishing in the SMBT areas in GOM/GB may increase user conflicts with whiting boats, and result in increased bycatch of whiting, red hake and other species.
- In the south, a shift into the ilex fishery (some of the current MWT vessels have ilex permits) could negatively impact current participants.
- For one vessel, the 3-12 nm zone comprise, 60% and 85% of its total herring and mackerel catch in Area 3 and 1B, respectively.
- Buffer zones will further truncate available areas; having a range of areas is very important for a highly migratory fishery.

Alternative 9

- Some AP members felt that the Area 1B seasonal closure started/magnified user conflicts. Removing it would reduce conflicts with the recreational fishery.
- Now the entire MWT fleet descends on Area 1B as soon as it opens, May 1.
- Removing the Area 1B seasonal closure could:
    - Impact the bait market, but since Area 1A opens to PS vessels in June, the market disturbance would be low.
    - Enable the mackerel fishery far more opportunity.
    - Likely shift the derby fishery in Area 1B from May to January; the fear that other fishermen might fish out the sub-ACL would likely weigh a desire to wait until prices improve in summer.

Preference for herring as bait

- Herring and menhaden remain the preferred bait for the lobster fishery, despite increasing availability of frozen alternatives.
- Herring has been preferred for 100 years, since sardine cannery cuttings were available and inexpensive.
- Salted herring holds up well in bait bags.
- Herring oil helps lobsters feed and grow while in the traps.
- A herring-menhaden combo is preferred; menhaden holds up better in the bags and also has oils.
- Bait price is a large factor in selection of bait.
- Frozen bait ensures year-round supply, but lobstermen do not like frozen bait. It is expensive to keep frozen and takes time to thaw out.
- Some bait preferences are spatial and seasonal. Menhaden is in Casco Bay, Maine, in the summer, but herring is preferred when the lobster fishery moves offshore. Lobstermen east of Rockland, Maine, do not like menhaden, but it is unclear why. Two of the biggest herring PS operations live on Vinalhaven, so there may be a preference to stick with local bait suppliers, “the home boys.”

4.2 IMPACTS ON TARGET SPECIES (ATLANTIC HERRING)

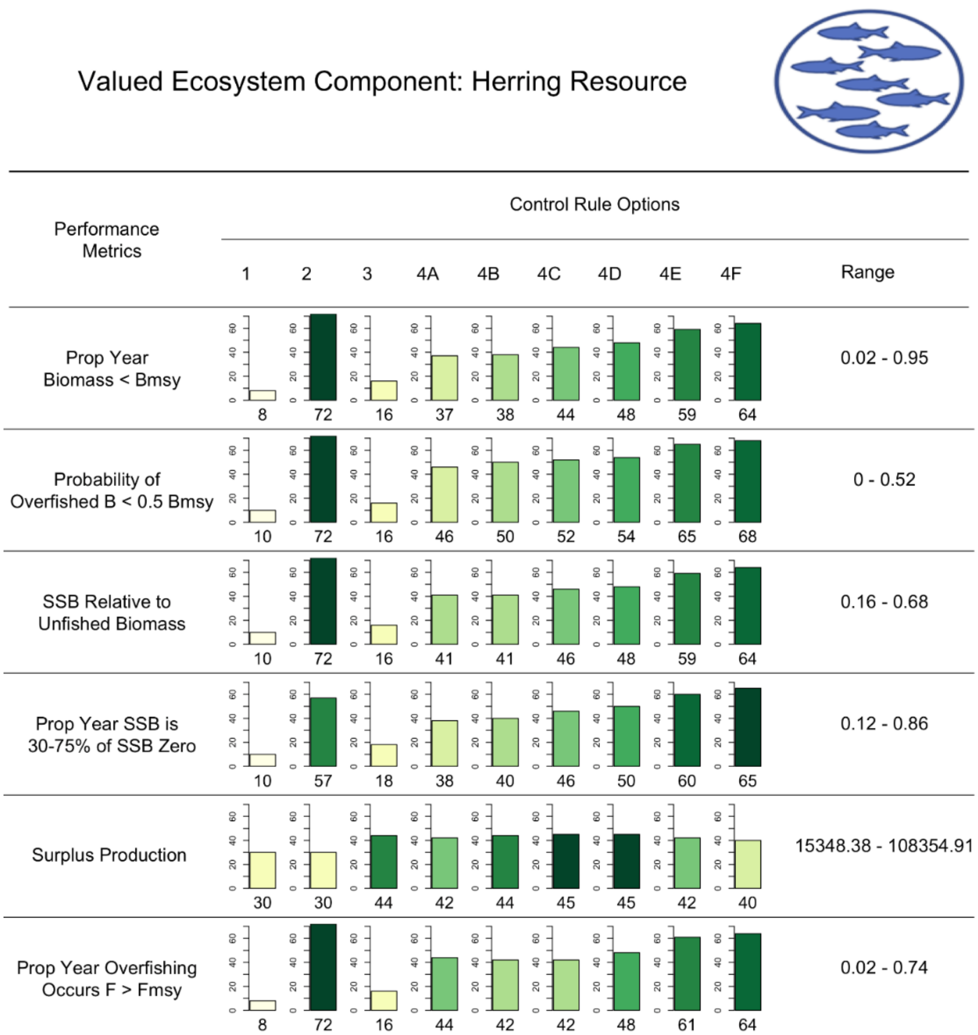
4.2.1 Atlantic Herring ABC Control Rule

4.2.1.1 Alternatives for ABC control rule

The biological impacts of the ABC control rule alternatives on the herring resource can be evaluated using the summary table of MSE results for the herring resource VEC (Figure 78). The metrics that have been identified to best represent the herring resource are: Proportion of years $B<B_{MSY}$, Probability of overfished, SSB relative to unfished biomass, proportion of years biomass is 30-75% of unfished biomass, surplus production, and proportion of years overfishing occurs.

Figure 78 – Summary of the metrics that are indicators of potential impacts on the valued ecosystem metric – <u>herring resource</u>

Herring Resource Metrics: Proportion of years $B<B_{MSY}$, Probability of overfished, SSB relative to unfished biomass, surplus production, and proportion of years overfishing occurs.



4.2.1.1.1 No Action: Interim Control Rule – Policy used in recent specification setting processes (fishing years 2013-2018)

Under No Action, the ABC control rule used for the last two specification cycles, or six fishing years (2013-2018), would be used. The interim or sometimes called "status quo" or "default" control rule is biomass based, but the ABC is set at the same level for three years. ABC is set at the catch that is projected to produce a ≤50% probability of exceeding F_{MSY} in the third year.

Overall, the No Action ABC control rule is expected to have generally ***positive impacts*** on the herring resource. For the last six years, it has prevented overfishing, the stock is not overfished, and it has helped maintain sufficient biomass to support above average recruitment in recent years. Estimated biomass is well above B_{MSY}; the most recent updated stock assessment estimated biomass at over 600,000 mt, about twice the SSB_{MSY} of 311,145 mt. As with most fisheries, there is some uncertainty in the assessment and fishery projections; therefore, the impacts may be low positive if the assessment is overly optimistic and biomass is actually lower than estimated levels. A retrospective pattern re-emerged when updating the assessment model in 2015, which suggests that Atlantic herring spawning stock biomass (SSB) is likely to be overestimated and fishing mortality (F) is likely to be underestimated in the terminal year of the assessment. As a result, the assessment review panel applied a retrospective adjustment to the SSB and F values for the terminal year, and even with those adjustments, the Atlantic herring stock complex remains above the biomass target and below the fishing mortality threshold (Deroba 2015).

The interim control rule has been used on a relatively short-term scale, three years at a time. The ***long-term benefits of this control rule for the herring resource are more uncertain***, and may not be as positive under other scenarios (i.e., when abundance is decreasing). Compared to other alternatives under consideration, the long-term benefits on the herring resource of this alternative are estimated to be lower.

It is important to note that the status of the herring resource is not exclusively generated by the ABC control rule used. There are other factors that likely have an even greater influence on herring biomass, including environmental factors such as primary production, water temperature, etc., that are unaffected by the ABC control rule used to set fishery catch levels. These factors will continue to play a large part in the overall herring abundance, regardless of the ABC control rule established. For example, the current resource conditions with biomass over two times B_{MSY} are not likely to persist, regardless of the control rule selected. There is a high degree of variability in this system. The MSE analyses prepared for this action does consider a wide range of operating models, or potential states of nature, to help evaluate the uncertainties in the system. These analyses enable the Council to assess the performance of different control rule alternatives under various assumptions of natural mortality, growth, and overall assessment bias. While a wide range of operating models have been considered, they still may not reflect the range of actual states of nature.

The MSE analyses do provide direct quantitative information about the potential long-term impacts of different control rule alternatives on the herring resource, as well as other valued ecosystem components (VECs). Because the interim control rule as defined does not have parameters that enable it to be included in the MSE model (i.e., not fishing mortality limit or defined biological parameters), it could not be integrated into the MSE model. Therefore, a modified control rule was developed to approximate the average performance of the No Action interim control rule in recent years (Strawman A). Strawman A is a proxy for the No Action

ABC control rule, and for analysis purposes, the other ABC control rule alternatives in this action are compared to that option to illustrate how other control rules compare to the average performance of the No Action ABC control rule.

4.2.1.1.2 Alternative 1: Control rule that would resemble the interim control rule as approximated by its average performance in recent years (*Strawman A*)

Under Alternative 1, the control rule would be modified (the interim control rule where ABC is set at a value that has a ≤50% probability of exceeding F_{MSY} in year three) with a control rule that uses an upper biomass parameter equal to 0.5 for the ratio of SSB/SSB_{MSY}, a maximum fishing mortality rate equal to 90% of F_{MSY}, and no fishery cutoff. These parameters were selected to perform as the No Action ABC control rule has performed on average over the last six years, but are more compatible with MSE modeling and long-term projections compared to No Action. Application of the Interim Control Rule, No Action, over the last six fishing years (2013-2018) has resulted in an average annual fishing mortality rate equal to 90% of F_{MSY}.

Section 4.2.1.1 summarizes the potential long-term impacts of the ABC CR alternatives on Atlantic herring (Figure 78). For the most part, Alternative 1 does not perform as well as the other alternatives for these metrics. For example, the proportion of years that the resource is expected to be overfished or experience overfishing is higher for this alternative compared to the others. Under some resource conditions, the probability of the herring resource being overfished is 5-10%, but under other conditions it is as high as 50%. The proportion of years that overfishing may occur is higher, about 35-75% of the time using this control rule under a variety of resource conditions. This alternative does not perform as well as other alternatives for the metrics related to unfished biomass or surplus production.

In the short-term, there is not much difference between the ABC CR alternatives in terms of the estimates of herring SSB (Figure 68 and Table 94). Alternative 1 (Strawman A) does have lower estimated SSB than the other alternatives considered, but the differences are relatively small. SSB is more affected by the level of recruitment, compared to which ABC CR is used; SSB is very high under recent conditions for all the ABC CR alternatives, and SSB is very low for all of the alternatives when recruitment is poor (1980). Overall, the relative differences in estimated SSB between the ABC CR alternatives is small. Alternative 2 (Strawman B) has slightly higher estimates than the other alternatives for SSB under all of the recruitment scenarios, and higher under medium recruitment (1995 conditions). While Alternative 1 is very similar to No Action and was designed to be a proxy for the No Action ABC control rule to compare to other alternatives in the MSE process, it has different characteristics that enable it to be used in both increasing and decreasing abundance. It also has control rule parameters that can be analyzed with MSE models (i.e., maximum fishing mortality rate, upper and lower biomass thresholds).

In summary, ***low positive impacts on the herring resource are expected from Alternative 1 in the long term***, but the positive impacts are not as high as some of the other alternatives under consideration. ***In the short term, Alternative 1 is expected to have low positive impacts*** on the herring resource, but again, not as high as other alternatives under consideration.

4.2.1.1.3 Alternative 2: Maximum fishing mortality of 50% F_{MSY} and fishery cutoff when biomass less than 1.1 of SSB/SSB_{MSY} (*Strawman B*)

Under Alternative 2, ABC is set as a function of biomass (biomass based), the upper biomass parameter equals 2.0 for the ratio of SSB/SSB_{MSY}, maximum fishing mortality is set at 50% of

F_{MSY}, and this control rule includes a fishery cutoff when biomass is less than 1.1 for the ratio of SSB/SSB_{MSY}.

Alternative 2 constrains ABC more than all the other alternatives under consideration because the values used to define the control rule parameters. A lower biomass parameter of 1.1 means that there is no fishery (ABC=0) unless estimated biomass is greater than SSB_{MSY}. Alternative 2 also constrains fishing mortality so that it is never more than 0.5, or 50% of F_{MSY}; furthermore, fishing mortality can only reach 0.5 if biomass is twice SSB_{MSY} (similar to the level of biomass estimated in the last assessment). Otherwise, fishing mortality rates are lower than 0.5. In general, this control rule alternative is expected to have positive impacts on the herring resource compared to No Action and Strawman A, especially if biomass is overestimated (biased assessment).

Section 4.2.1.1 summarizes the potential long-term impacts of the ABC CR alternatives for the herring resource valued ecosystem component (Figure 78). For the most part, Alternative 2 ranks the highest in terms of performance for the metrics that illustrate potential impacts on the herring resource. Except for the metric that evaluates surplus production, Alternative 2 consistently ranks the highest across all operating models for lower probabilities of overfished and overfishing, and higher proportion of biomass relative to unfished biomass. The models estimate that this control rule has less than a 5% chance of overfishing under some operating models, and 20-25% under other conditions. The probability of the stock becoming overfished is essentially zero, up to only 6% for one of the operating models. Similarly, the proportion of years that biomass is expected to be less than B_{MSY} is relatively low across all operating models. In addition, Alternative 2 ranks the highest for the metric that measures SSB relative to unfished biomass; it consistently has the highest results for all operating models, about 35 – 70% SSB relative to unfished SSB.

The PDT discussed that there is likely a limit to the potentially positive impacts of high herring biomass. Herring biomass has been relatively high recently and there is some evidence of reduced herring size at age (NEFSC 2012, Figure A1-9, Table A1-13, Table A1-14). Declines in herring weight and size-at-age have been drastic recently, as average herring weight has declined by 55% between 1981 and 2010. The herring population in the Gulf of Maine show a strong inverse relationship between the number of adult herring and mean length-at-age, with indications that this relationship is a function of overall herring stock numbers (Melvin & Stephenson 2007). If herring biomass nears carrying capacity there could be potentially negative biological impacts on the ecosystem as well, including impacts on the herring stock itself, other prey that compete with herring, and some predator species that rely on herring condition, not just herring abundance (e.g., tuna). This issue may be investigated further at the upcoming herring assessment in 2018. In the meantime, the positive impacts of higher herring biomass may be limited, and may not increase indefinitely with increasing biomass.

In the short-term, there is not much difference between the ABC CR alternatives in terms of the estimates of herring SSB (Figure 68 and Table 94). SSB is more affected by the level of recruitment, compared to which ABC CR is used; SSB is very high under recent conditions for all the ABC CR alternatives, and SSB is very low for all of the alternatives when recruitment is poor (1980). Overall, the relative differences between the ABC CR alternatives is small in terms of estimated SSB. Alternative 2 (Strawman B) has slightly higher estimates than the other alternatives for SSB under all of the recruitment scenarios, and higher under medium recruitment (1995 conditions).

In summary, ***positive impacts on the herring resource are expected from Alternative 2 in the long term***, and for this VEC, Alternative 2 out performs the other alternatives under consideration. ***In the short term, Alternative 2 is expected to have positive impacts*** on the herring resource, and again has higher estimates of SSB than the other alternatives under consideration.

4.2.1.1.4 Alternative 3: Control rule parameters defined upfront

Alternative 3 is based on defining the parameters that dictate the shape of the control rule upfront. The recommended values are: 0.3 for the lower biomass parameter, 0.7 for the upper biomass parameter, and setting the maximum fishing mortality at 0.9, or 90% of F_{MSY}. Compared to Alternative 1 (developed to perform as the No Action control rule has on average in recent years), Alternative 3 has the same maximum fishing mortality (90% F_{MSY}), but other parameters are generally more conservative including a fishery cutoff at 0.3 and an upper biomass threshold that starts to reduce F when biomass falls below 70% of B_{MSY}. While these two elements were added to provide additional constraints on ABC if biomass falls below certain levels, these modifications do not seem to have much effect on the long-term biological impacts, thus the impacts are generally neutral compared to Strawman A and No Action.

Section 4.2.1.1 summarizes the potential long-term impacts of the ABC CR alternatives for the herring resource valued ecosystem component (Figure 78). For the most part, Alternative 3 does not perform as well as the other alternatives for these metrics; it performs slightly better than Alternative 1 for most of the metrics that highlight potential impacts on the herring resource. For example, the proportion of years that the resource is expected to be overfished or experience overfishing is generally higher for Alternative 3compared to the others, and Alternative 3 ranks slightly better than Alternative 1. Under some resource conditions, the probability of the herring resource being overfished is 4-10%, but under other conditions it is as high as 40%. The proportion of years that overfishing may occur is higher, about 30-65% of the time using this control rule under a variety of resource conditions. Alternative 3 does not perform as well as other alternatives for the metrics related to unfished biomass or surplus production.

In the short-term, there is not much difference between the ABC CR alternatives in terms of the estimates of herring SSB (Figure 68 and Table 94). Alternative 3 does have lower estimated SSB than most of the other alternatives considered, but the differences are relatively small. SSB is more affected by the level of recruitment, compared to which ABC CR is used; SSB is very high under recent conditions for all the ABC CR alternatives, and SSB is very low for all of the alternatives when recruitment is poor (1980). Overall, the relative differences between the ABC CR alternatives is small in terms of estimated SSB. Alternative 3 has slightly higher estimates than Alternative 1 (Strawman A) for one of the medium biomass estimates (1986), but essentially the same for the other resource scenarios. For the most part, the biomass estimates for Alternative 3 are lower than all the other alternatives under consideration (Alternatives 1, 2, and 4).

In summary, ***low positive impacts on the herring resource are expected from Alternative 3 in the long term***, but the positive impacts are not as high as some of the other alternatives under consideration. Overall, the expected impacts are likely similar to Alternative 1 (Strawman A), as well as the No Action alternative. As a reminder, Alternative 1(Strawman A) is very similar to No Action and was designed to be a proxy for the No Action ABC control rule to compare to other alternatives in the MSE process. Alternative 1 has different characteristics that enable it to be used in both increasing and decreasing abundance, and it has control rule parameters that can be analyzed with MSE models (i.e., maximum fishing mortality rate, upper and lower biomass thresholds). Therefore, in many of the analyses, alternatives are compared to Alternative 1, and not No Action. ***In the short term, Alternative 3 is expected to have low positive impacts*** on the herring resource, but again not as high as other alternatives under consideration (Alternative 2 followed by Alternative 4) and short-term biomass does not seem to be very affected by the ABC CR applied.

4.2.1.1.5 Alternative 4: Control rule alternatives based on desired performance of specific metrics identified in the Management Strategy Evaluation process

Alternative 4 contains sub-options based on the desired performance for a handful of primary metrics identified by the Council. The primary metrics used to identify this range of six performance based alternatives are: 1) constrain %MSY to be 100%, with an acceptable level as low as 85%; 2) variation in annual yield set at a preferred level <10%, acceptable level as high as 25%; 3) probability of overfished set at 0%, with an acceptable level as high as 25%; and 4) probability of herring closure (ABC=0) set between 0-10%.

These control rules fall between Alternative 1 (Strawman A), the alternative developed to perform as the No Action control rule has on average in recent years, and Alternative 2 (Strawman B). The overall performance of these six control rules, in terms of potential biological impacts on the herring resource, is positive, and the overall impacts are similar to each other. They may have slightly more positive impacts than Strawman A, and in some cases slightly less positive impacts on the herring resource compared to Alternative 2 (Strawman B).

Section 4.2.1.1 summarizes the potential long-term impacts of the ABC CR alternatives for the herring resource valued ecosystem component (Figure 78). For the most part, the six control rules under Alternative 4 (4A – 4F) perform better than some alternatives (Alternative 1 and 3) and not as high as Alternative 2. After Alternative 2, Alternative 4F ranks next in terms of performance of metrics that illustrate potential impacts on the herring resource. Alternative 4E and 4F have a lower maximum fishing mortality rate than Alternatives 4A – 4D, 0.6 compared to 0.7. Alternative 4F starts to reduce fishing mortality earlier than Alternative 4E, when biomass is equal to B_{MSY} compared to 70% of B_{MSY} for Alternative 4E. These aspects of the shape likely lead to slightly better performance for metrics that focus on herring resource impacts.

The proportion of years that the resource is expected to be overfished or experience overfishing is generally higher for this series of alternatives compared to Alternative 2, but lower compared to Alternatives 1 and 3. Alternatives 4E and 4F have zero probability for overfished under half of the operating models, and relatively low probability for the other half, 8-16%. The proportion of years that overfishing may occur is higher, about 20-60% for Alternatives 4E and 4F, and 30-80% for Alternatives 4A- 4D. The results for biomass relative to unfished biomass are very similar for these alternatives and stable across operating models, ranging from 20-50% depending on assumed resource conditions. Alternative 4D actually ranks higher than all other alternatives for the surplus production metric, but overall the results are very similar for this metric and are more driven by operating model than control rule alternative.

In the short-term, there is not much difference between the ABC CR alternatives in terms of the estimates of herring SSB (Figure 68 and Table 94). Alternatives 4E and 4F have slightly higher estimates of SSB than Alternatives 4A-4D, but the differences are very small, and generally similar to the other alternatives under consideration. SSB is more affected by the level of recruitment, compared to which ABC CR is used; SSB is very high under recent conditions for all the ABC CR alternatives, and SSB is very low for all of the alternatives when recruitment is poor (1980). Overall, the relative differences between the ABC CR alternatives is small in terms of estimated SSB. Alternatives 4A-4F have slightly higher estimates than Alternatives 1 (Strawman A) and Alternative 3, and equal or slightly lower estimates of SSB compared to Alternative 2.

In summary, ***positive impacts on the herring resource are expected from Alternatives 4A – 4F in the long term,*** and the positive impacts are not as high as Alternative 2 in some cases, and generally higher than both Alternatives 1 and 3. Alternatives 4E and 4F may have slightly higher positive impacts than Alternatives 4A – 4D for some metrics, but the differences are relatively small. ***In the short term, Alternatives 4A – 4F are expected to have positive impacts*** on the herring resource, again potentially not as high as Alternative 2, and potentially slightly higher than Alternatives 1 and 3 but short-term biomass does not seem to be very affected by the ABC CR applied.

4.2.1.2 Alternatives for setting three-year ABCs

4.2.1.2.1 Multiyear ABC Method Alternative 1: Set ABC at the same level for three years (*No Action*)

Under Alternative 1, the ABC control rule would be used to set ABC at the same level for three years (consistent value in mt for three years at a time). In general, the primary impacts of setting ABC at the same value for three years, compared to allowing ABC to fluctuate annually is that there is obviously more stability in yields from year to year when the ABC is kept the same. However, ABC may need to be adjusted by more when the next three-year cycle is set. With more stability, there is usually a cost in annual yields, ABCs are generally a bit lower when set three years at a time compared to setting ABCs annually.

This MSE considered several different options for the method used for setting multiyear ABCs; annual ABCs, setting ABC at the same level for three years, and setting ABC at the same level for five years. The Council decided to only consider annual and 3-year ABC timeframe alternatives, so the results for 5 years are not important to consider in this action, but are shown in the figures below. Overall, the impacts on the herring resource are relatively small when setting ABC for one year versus three. Figure 79 shows that for ABC CR Alternative 1 (Strawman A) and Alternative 2 (Strawman B), between setting ABC annually (red) to three years at once (blue), there is a slight reduction in the ratio of SSB to unfished biomass, but there is essentially no difference. The mean results for two operating models with high herring production (circles), and two with low herring production (triangles) are shown in the figures below. The operating model has a larger effect on the ratio of SSB/unfished biomass than the ABC timeframe of one or three years (distance between the circles and triangles is larger than the difference between the red and blue box).

The results are a bit more pronounced for the metric that evaluates the frequency SSB falls below 30% of unfished biomass. Figure 80 shows the frequency SSB falls below 30% unfished for Alternative 1 (left) and Alternative 2 (right) for the different time periods – setting ABC annually (red), three years (blue), and five years (yellow). The results are again relatively similar in terms of changes in frequency that SSB falls below 30%, especially for Alternative 1. When

Alternative 2 is set for 5 years at a time the frequency biomass falls below 30% unfished is increased from about zero to almost 20% for some of the operating models.

Tradeoff plots for some of the MSE metrics have been developed to compare the potential impacts of setting ABC with annual application, or a stable value for three years at one time. Figure 81 compares the performance of Control rule 4a (selected as an example, all the CRs had similar patterns) for the two time period alternatives: one year versus three years. The only metric with some level of variation is IAV, interannual variation in yield, which is not surprising since catch is held constant for the three-year alternative, and is allowed to vary for the annual application alternative.

Overall, the impacts on the herring resource may be ***slightly low negative when ABC is set at the same value for three years at once compared to setting ABC annually, but the differences are relatively small***.

Figure 79 – Example tradeoff plot comparing annual (red), three-year (blue), and five-year (yellow) ABC control rule options for Alternative 1 (Strawman A) on left and Alternative 2 (Strawman B) on right.

Metrics compared: ratio of yield/MSY and biomass/unfished biomass

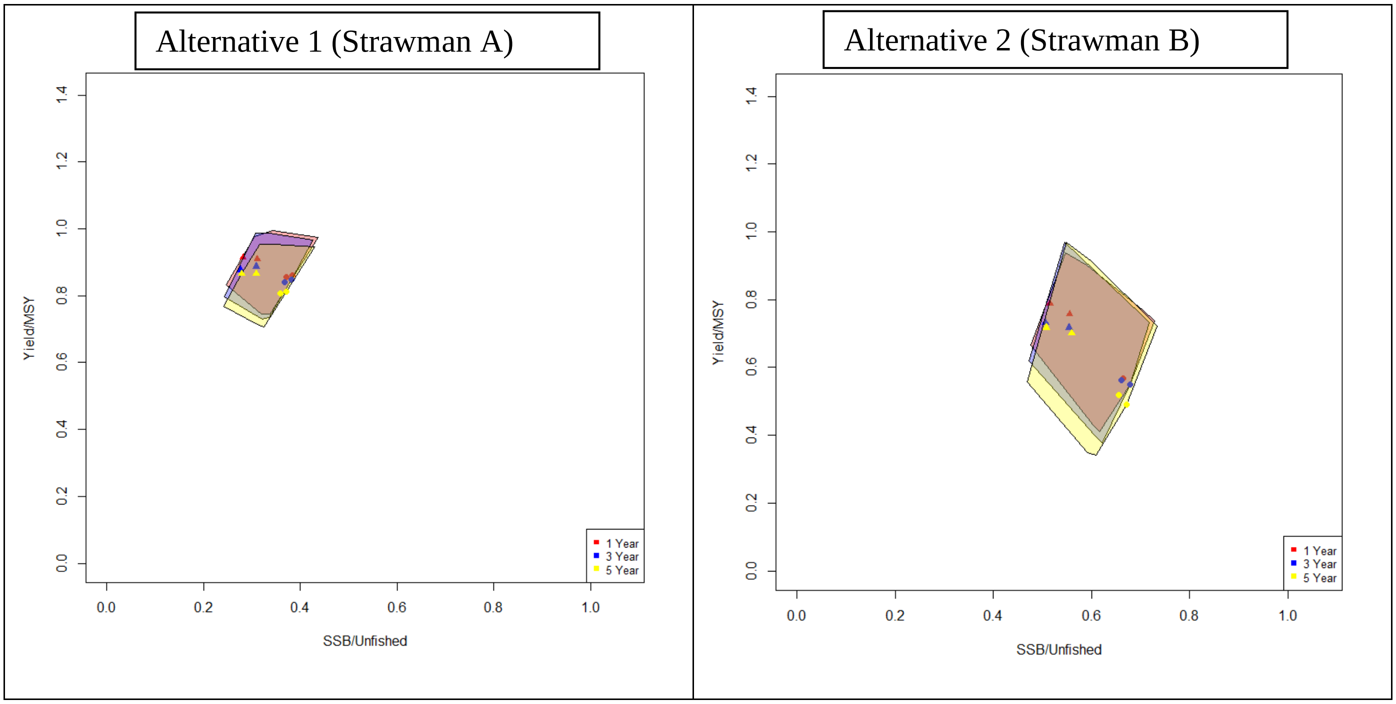


Figure 80 – Example tradeoff plot comparing annual (red), three-year (blue), and five-year (yellow) ABC control rule options for Alternative 1 (Strawman A) on left and Alternative 2 (Strawman B) on right.

Metrics compared: ratio of yield/MSY and frequency SSB falls below 30% unfished biomass

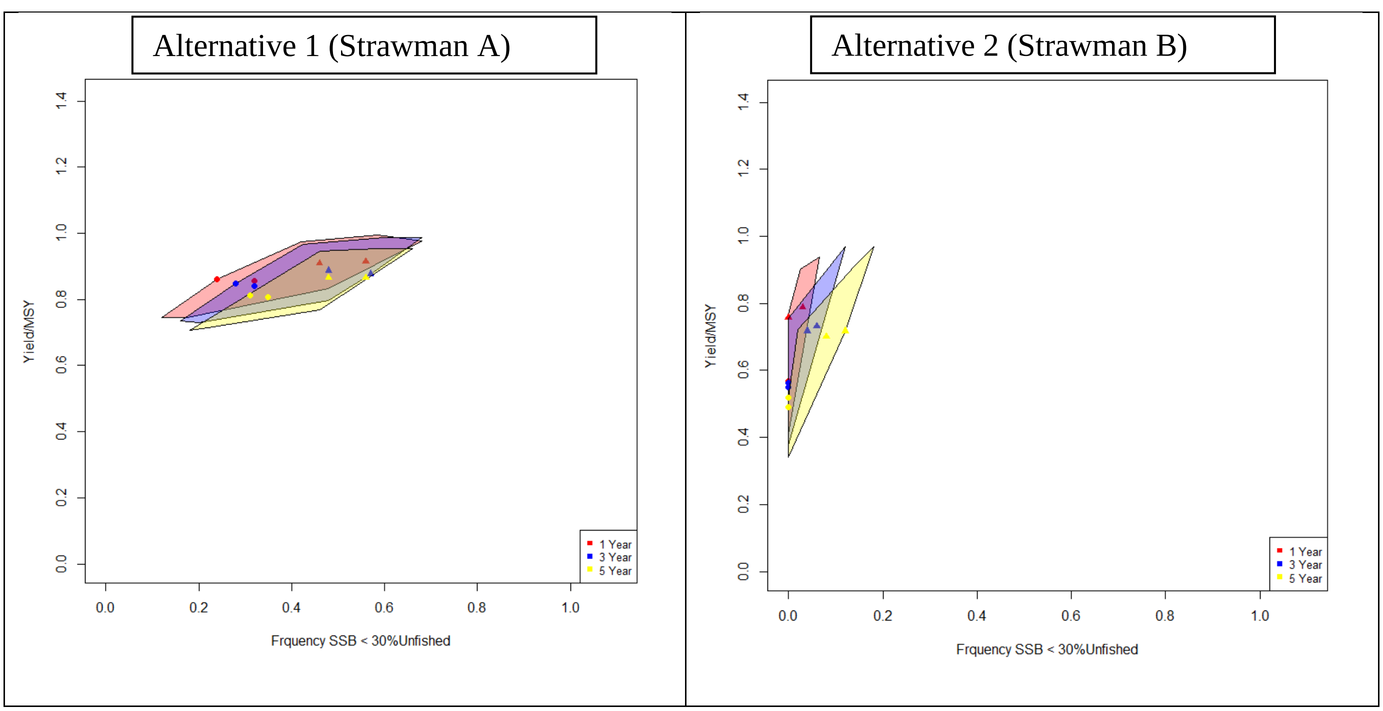


Figure 81 – Tradeoff web diagram comparing performance across several metrics for one-year application of control rule compared to three-year application of control rule (using Alternative 4A as an example)

4.2.1.2.2 Multiyear ABC method Alternative 2: Set ABC for three years with annual application of control rule

Under Alternative 2, the ABC control rule would be used to set ABC every three years, but ABC would not be the same value. Each year the ABC value could change. ABC would be set each year based on the most recent herring assessment and short-term projections. Figure 79 and Figure 80 illustrate that there ***may be very small positive impacts on the herring resource by setting ABC annually*** compared to No Action (Alternative 1); the frequency that biomass falls below 30% unfished is slightly lower for the annual alternative (red) compared to three years (blue). The ratio of SSB/unfished SSB is essentially the same for both alternatives whether ABC is set for 1 or 3 years. Any positive impacts are expected to be minor, because the differences between the alternatives are very small.

4.2.1.3 FMP provisions that may be changed through a framework adjustment

The Council recommends that future modifications to the ABC CR could be made by amendment or framework, but not through specifications. This recommendation is administrative, and would have ***no direct impacts on the herring resource, positive or negative***.

4.2.2 Potential Localized Depletion and User Conflicts

4.2.2.1 Alternative 1 (No Action: prohibit MWT gear in Area 1A from June – September)

Under No Action, vessels fishing for herring with midwater trawl gear are excluded from fishing in Area 1A June 1 through September 30. This is the one measure implemented through Amendment 1 to address concerns of potential localized depletion.

The impacts on the Atlantic herring resource of No Action in isolation are expected to be ***neutral***. The resource is still experiencing similar levels of herring removals during this season, just by a different gear type. However, Amendment 1 implemented a handful of actions, when combined together, have likely had beneficial impacts on the herring resource over the years. Furthermore, ASMFC has also implemented actions in recent years that have likely contributed to overall positive impacts on the herring resource, especially in Area 1A. However, it is very difficult to tease out the potential benefits of one measure independently. In reality, it is more likely that the combination of many measures implemented simultaneously have collectively had positive benefits overall (i.e. limited entry, TAC reductions, seasonal closures, spawning closures, etc.).

Since Amendment 1 was implemented in 2007, the herring resource has increased, and based on the last assessment, is in healthy condition and is far from an overfished status (Section 3.1.3). Amendment 1 implemented a handful of measures that have likely helped with improved resource conditions. The measure that has likely had the greatest direct positive impacts on the herring resource in Area 1A is the output control, or the overall ACL. Before Amendment 1 was implemented, the Area 1A sub-ACL was 60,000 mt, and since then, it has hovered near 30,000 mt, a 50% reduction in a relatively short amount of time (

Table 28, p. 140). In addition, the number of participants has decreased substantially since pre-Amendment 1, so fewer vessels could mean less incidental mortality if the number of trips has remained

Generally, protecting spawning fish is thought to have positive impacts on fishery resources, or at a minimum neutral impacts, but certainly not negative impacts. Herring typically spawn in late summer through the fall (Section 3.1.5). The No Action alternative does overlap with a portion of the spawning season within the GOM (September); however, peak spawning often occurs in October and even into November. There are separate ASMFC spawning closures within the GOM that are triggered when observations of female herring eggs indicate spawning is imminent (Figure 17). These spawning closures are thought to have potentially beneficial impacts on the herring resource, because they overlap better with peak spawning time periods, and they prohibit all herring fishing, not just MWT gear; compared to the No Action alternative that is only a June-September prohibition for MWT gear.

The Council is not aware of any research available in this region that evaluates direct impacts of fishing activity on spawning Atlantic herring, or whether there are any differential impacts by gear type, (i.e., one gear type having more negative impacts than another). Therefore, in terms of impacts on spawning fish, the No Action alternative was not primarily designed to reduce potential impacts on spawning fish, and is expected to have no direct positive or negative impacts on spawning fish.

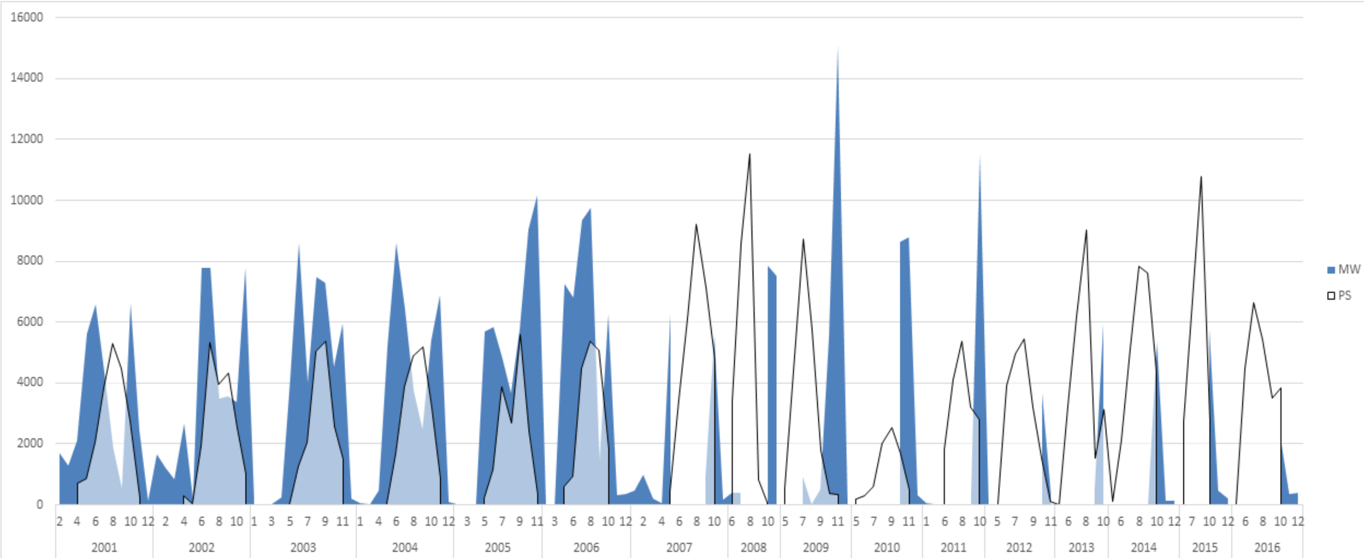
Section 6.5 of Amendment 1 reviewed the Council rationale at that time for supporting the No Action alternative that prohibited MWT gear in Area 1A from June 1 – September 30. It was a precautionary approach to restrict a high-volume fishery that targets an important prey species in the ecosystem. Addressing potential localized depletion concerns was not the only element considered; there were concerns about the health of the inshore GOM stock, impacts of MWT gear on the resource and ecosystem, importance of herring as forage, and potential research opportunities. In summary, Amendment 1 stated that the long-term benefits to the herring resource and GOM ecosystem far outweighed the short-term costs to the industry, particularly MWT vessels, which are better able to fish father offshore and travel to other grounds in a safe manner.

The No Action alternative has been in place for about ten years. While herring resource conditions have improved over that time, those benefits cannot be directly linked back to this measure exclusively. Reducing ACLs has likely had the most direct positive benefits on the herring resource. Furthermore, the herring resource is still assessed on a stock-wide basis, and to date, the status of the herring resource is not evaluated based on smaller sub-components (e.g., GOM, GB). Thus, it is not possible to evaluate the impacts of a localized closure when the resource is assessed on a stock-wide level.

Furthermore, while MWT vessels are not allowed in the area from June – September, the purse seine fleet is, and similar levels of herring are still being removed, just from another gear type. Similar to impacts on spawning fish, there is no research available that evaluates whether there are differential impacts on the herring resource based on gear type. There are no studies available in this area that have compared the biological impacts of fishing for Atlantic herring with different gear types when overall removals are similar. The PDT has discussed that vessel capacity is really the limiting factor; a smaller purse seine vessel that works with a carrier, or in some cases two carriers, can have similar capacity to a much larger MWT vessel.

Generally, herring fishing methods are efficient, regardless of gear type, and can catch large amounts of fish in a relatively short amount of time. When thinking about depletion, it is important to consider the overall rate of removals from a particular area. Since Amendment 1, the fishery in Area 1A has become more truncated. Before Amendment 1, herring catches were spread out over a longer time period, and now most catch from Area 1A takes place June through November (Figure 82). Many management measures and changing conditions have contributed to this trend including that Area 1A is now closed to all fishing January – May, and MWT gear is prohibited in June – September (the No Action alternative for Amendment 8). While ASMFC has implemented several effort control measures designed to slow removals and extend the fishing season, in many cases, herring removals in some months are greater now than before. This increase in the rate of removals over shorter time periods is further compounded by ASMFC spawning closures that further limit when vessels can fish. Both before and after Amendment 1 prohibited MWT gear from June – Sept, about 70% of the Area 1A sub-ACL was caught before the end of Trimester 2. However, the gear type landing these fish has changed from mixed gear types to all purse seine.

Figure 82 – Area 1A herring landings by month and gear type (MW and PS) for 2001-2016 (VTR data including all federal and ME state permitted vessels)

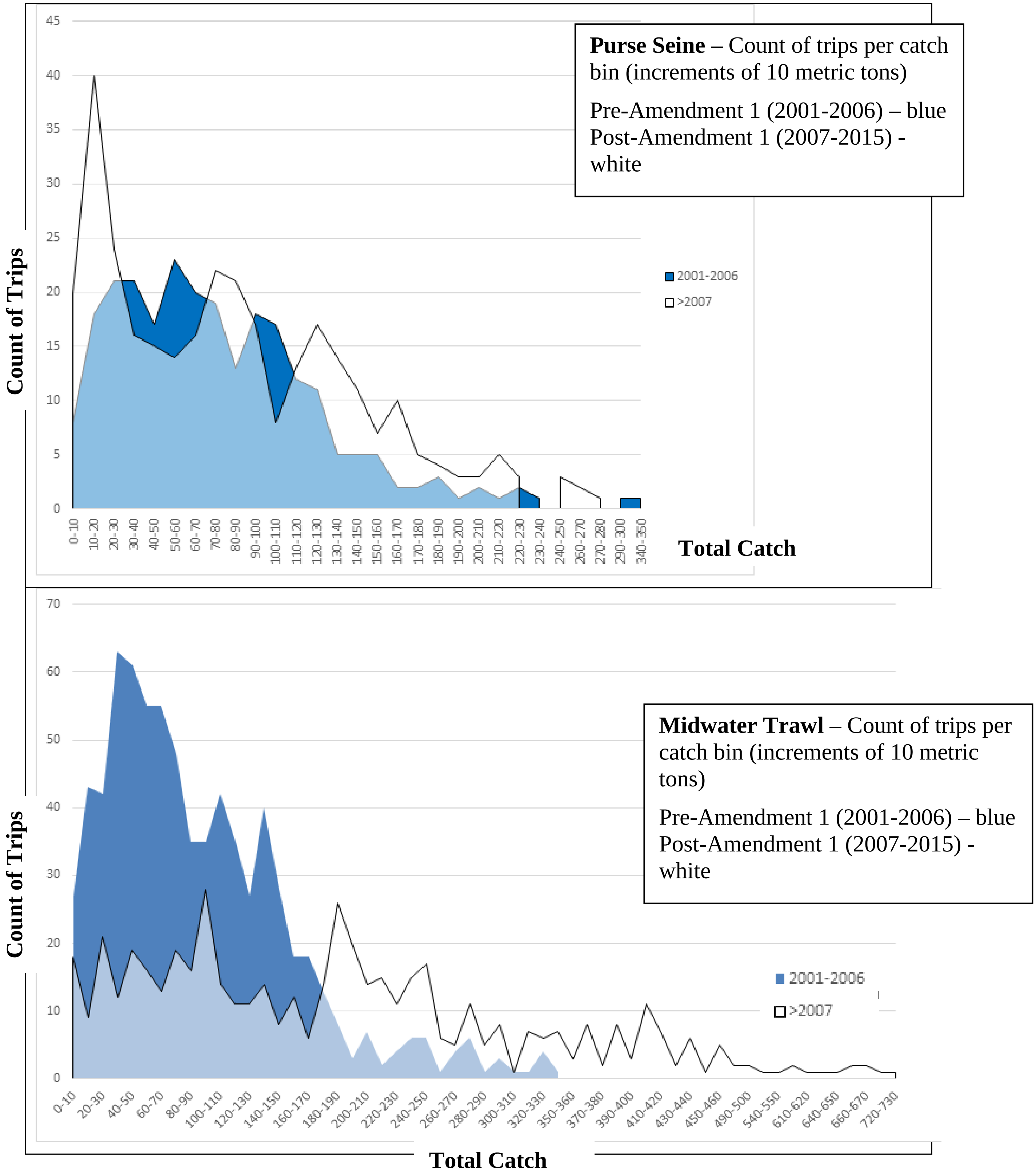


On average, larger catches now occur for both gear types in more recent years compared to pre-Amendment 1 (**Figure 83**). Prior to Amendment 1, there were more MWT trips in Area 1A and the majority were less than 200,000 pounds per trip. Post Amendment 1, there are fewer MWT trips overall, but the trips are larger, 300K-700K pounds. This is not surprising, because of all the different measures in place that constrain when MWT vessels can access Area 1A. The total potential season is now three months, October through December, and when spawning closures are implemented as well as days out measures, the number of potential fishing days is greatly reduced. At the same time, the number of PS trips and the total catch per trip has increased as well, but still not as high as some of the MWT catches per trip. The No Action alternative alone has not caused these shifts in fishing effort. The combination of many measures, as well as changes in storage capabilities and ability to freeze product have collectively played a part in these changes in fishing effort over time.

Finally, when this measure was adopted in Amendment 1 it was discussed that implementing a seasonal prohibition on MWT fishing would create an opportunity to evaluate the potential localized depletion impacts of that activity. One study was funded through the RSA program in 2008, but due to logistical and budget constraints, efforts were re-focused and the project was limited in scope and that aspect of the project was not completed (Stockwell *et al.* 2011). Therefore, there has not been any direct research on defining and evaluating localized depletion in Area 1A since adoption of this measure.

In summary, it is not possible to determine whether the No Action alternative for Amendment 8 has had direct beneficial impacts in isolation of all the other measures that have been adopted. ***Because total removals of herring are controlled by a sub-ACL for the area, the direct impacts of the No Action alternative are likely neutral; the same amount of herring is being removed from the area, regardless of the gear type landing the fish.***

Figure 83 – Number of trips by landings category (in 10mt bins) and gear type (MW on bottom and PS on top) pre Amendment 1 (2001-2006) compared to post Amendment 1 (2007-2015) in Area 1A for Trimester 3 (October-December)



4.2.2.2 Alternative 2 (Closure within 6 nm in Area 114 to all vessels fishing for herring)

Alternative 2 is expected to have no positive or negative impacts on the herring resource. Because this area is relatively small, and does not overlap a primary herring fishing area, it is expected to have no major impacts, and would likely not prevent the fishery from harvesting the full ACL. Whether the fish are caught in this area or just outside of this area, there is an overall ACL, so there is a limit on harvest, which controls direct impacts on the herring resource. ***Therefore, the impacts of Alternative 2 on the herring resource are expected to be neutral.*** Furthermore, this area is primarily a migratory corridor for Atlantic herring. Therefore, a seasonal closure would not help protect spawning fish. Table 111 (p. 409) summarizes the potential herring revenues impacted by Alternative 2, which gives a sense of the fraction of landings that could be impacted by this alternative. If selected, this alternative would be added to Alternative 1 (No Action). The combined impacts are still neutral, since this alternative is not expected to have direct impacts on the resource, negative or positive. Compared to No Action, this alternative again has neutral impacts on the resource because it would not impact a primary herring fishing area for most years in the time series evaluated.

4.2.2.2.1 Seasonal sub-options (A: June – August or B: June – October)

Neither of these seasonal sub-options are expected to have direct impacts on the herring resource. Alternative 2 is expected to have neutral impacts regardless of the seasonal sub-option of three months (Option A) or five months (Option B). While the longer seasonal sub-option extends through October, a time of year when herring typically spawn, this is not an area that is important for spawning herring. ***Therefore, the impacts on the herring resource are neutral from both seasonal sub-options under consideration.***

4.2.2.3 Alternative 3 (Prohibit MWT gear in Area 1A year-round)

As described under the No Action alternative, the most direct impact on the herring resource in Area 1A is the Sub-ACL for the area, which is broken out by trimester: 0% for January-May, about 70% for June – September, and about 30% for October - December. If this measure is adopted, it would effectively eliminate access to Area 1A for MWT gear in Area 1A for the entire year, since other measures already prohibit access the remaining months (Jan-Sept). Any fishing in Area 1A by MWT vessels is already constrained to these three months (October-December), unless the vessel is fishing under the RSA program.

If MWT gear is prohibited from the area year-round, the Area 1A sub-ACL is still expected to be harvested. There would still be sufficient capacity among the vessels that fish with purse seine gear to harvest the full sub-ACL. If the full sub-ACL was not harvested it is possible there could be low positive impacts on the resource if more herring remains in the ecosystem, but in this case the Area 1A sub-ACL would still likely be harvested by existing vessels using purse seine gear, and potentially some vessels with MWT gear would convert to purse seine gear to access Area 1A. ***Therefore, Alternative 3 is expected to have neutral direct impacts on the herring resource.*** It is not expected to prevent the full ACL from being harvested; the same amount of herring would likely be harvested from the area, just with a different gear type, which is not expected to have differential impacts on the herring resource. Table 116 summarizes the potential herring revenues impacted by Alternative 3, which gives a sense of the fraction of landings that could be impacted by this alternative. Compared to Alternative 1 (No Action) and Alternative 2, this alternative has similar generally neutral impacts because the same amount of total herring removals would be expected.

It should be noted, there are other measures in place under ASMFC that would control weekly removals of herring catch (e.g., days out, weekly catch limits, and possession limits). These effort control measures could and do extend into the late fall and winter if necessary.

4.2.2.4 Alternative 4 (Prohibit MWT gear inside 12 nm south of Area 1A)

As described under the No Action alternative, the measure in the herring plan that has the most direct impact on the herring resource is the sub-ACL by management area. That measure ultimately dictates and controls how much herring is allowed to be removed from an area. Therefore, alternatives that prohibit one gear type, but allow another gear type that likely have similar biological impacts on the herring resource, would not be expected to have differential impacts on a resource that is managed under an overall quota. Because Alternative 4 includes portions of several herring management areas (Areas 1B, 2 and 3), it could have different impacts on the ability to harvest one sub-ACL depending on the degree of overlap within each management area.

For Area 1B, Alternative 4 could make it difficult to catch the sub-ACL for that area. The Area 1B sub-ACL is relatively small, about 4,000 mt in recent years, and it is typically caught within 30-minute square 114 off the back side of the Cape in relatively nearshore waters by MWT gear only. If this alternative was adopted and MWT vessels could no longer fish within 12 nm, it would become more difficult for the fishery to harvest the Area 1B sub-ACL. This could have low positive impacts on the herring resource if the sub-ACL is not harvested and more fish are left in the water. MWT vessels may shift fishing efforts just outside of 12 nm within Area 1B and still harvest the sub-ACL, but most fishing in Area 1B is currently inside of 12 nm. Overall, Area 1B is a small fraction of the total ACL; therefore, any low positive impacts from unutilized Area 1B catch, would likely have minimal impacts on the resource overall.

As for Area 3, the majority of catch for that management area is outside of 12 nm, so the fishery has more ability to harvest the sub-ACL for Area 3. A portion of Area 3 landings is consistently caught within 12 nm that would be impacted, mostly east of Cape Cod. If adopting Alternative 4 makes it more difficult to harvest the sub-ACL for Area 3, there could be low positive impacts on the herring resource because more fish would be left in the water. However, since the majority of Area 3 fishing takes place farther offshore, this alternative may have more neutral impacts if the fishery can harvest the sub-ACL from waters farther offshore.

In addition, fishing takes place closer to shore in Area 2 compared to Area 3; therefore, the potential impact of this measure in terms of making it difficult to harvest the area sub-ACL is greater. Notably, the fishery has not utilized the full area sub-ACLs for Areas 2 and 3 in recent years; therefore, implementing this measure could make it even more difficult. Furthermore, it is uncertain if underutilizing sub-ACLs would have measurable benefits on the overall resource anyway. The herring resource is currently well above biomass thresholds; therefore, relatively small amounts of additional herring may not have any measurable benefits overall.

Finally, any potential low positive impacts from less fish being harvested by the MWT fishery could be neutralized if other allowable gear types increase effort. For example, if bottom trawl activity increased as a result of less MWT effort in an area, then the overall impacts would be neutral – same level of catch controlled by the areas sub-ACL, just landed by a vessel using a different gear type. *In the end, this measure could make it more difficult for the fishery to harvest area sub-ACLs, which can have* ***low positive impacts on the resource****. However, if the fishery is able to change gear type, or catch the same amount of herring in a different area or season,* ***any***

potential low positive impacts could be neutralized. In addition, some of the seasonal and spatial sub-options under consideration for this alternative could reduce some of the potential low positive impacts by maintaining more of the current access MWT vessels have to fish. There is one sub-option to reduce the length of time an area is closed, and another sub-option to reduce the overall footprint of the potential restriction. More details about the potential impacts of the sub-options are described below. Table 119 summarizes the potential herring revenues impacted by this alternative, which gives a sense of the fraction of landings that could be impacted during the time and area within this alternative. For more recent years (2007-2015), the average percent of MWT catch within this alternative for all areas and all years is about 20%. Including the sub-options to exclude Area 2 and limit the season to June-September brings the average percent of MWT catch to about 4%. Compared to Alternatives 1, 2 and 3, this alternative may have low positive impacts on the resource if this measure makes it difficult for the sub-ACLs to be harvested, potentially leaving more herring in the ecosystem. However, compared to the current large estimated biomass of herring, these restrictions may not have direct impacts on the overall herring resource.

4.2.2.4.1 Area sub-options (A: Areas 1B, 2 and 3 or B: Areas 1B and 3 only)

There are two sub-options for spatial boundaries for Alternative 4: Option A includes Area 1B, 2 and 3; and Option B includes Areas 1B and 3 only. The potential impacts of this alternative overall are low positive (if more difficult to harvest sub-ACL s) to neutral (fishery able to harvest the ACL despite the LD measure). When the spatial sup-option to remove Area 2 is added, any low positive impacts are potentially more neutralized. Because a large portion of MWT effort in Area 2 is within 12 nm, restricting this measure to Area 1B and 3 only would have lower potential impacts in terms of preventing the fishery from harvesting the sub-ACL.

4.2.2.4.2 Seasonal sub-options (A: year-round or B: June-September)

This action is considering two sub-options for seasonal prohibitions of MWT gear: Option A that would prohibit MWT gear year round; and Option B that would prohibit MWT gear June – September (4 months). The potential impacts of this alternative overall are ***low positive*** (if more difficult to harvest sub-ACLs) ***to neutral*** (fishery able to harvest sub-ACL despite LD measure). When the seasonal sup-option to limit the prohibition to June-September is added, any low positive impacts are potentially more neutralized, because the fishery is more likely to harvest the sub-ACLs. Furthermore, if both sub-options are adopted, not include Area 2 and limit the prohibition to June – September, the combined impacts likely neutralize any potentially low positive impacts on the resource.

4.2.2.5 Alternative 5 (Prohibit MWT gear inside 25 nm south of Area 1A)

The potential biological impacts of Alternative 5 are generally similar to the potential impacts described above for Alternative 4, except the likelihood of this measure inhibiting the ability for the fishery to harvest the sub-ACLs for Areas 1B, 3 and 2 may be greater since it covers more area that is traditionally fished by the MWT fishery. A larger fraction of total MWT effort occurs within 25 nm, compared to 12 nm. It is possible that vessels could increase fishing effort in waters farther offshore, but it may be more difficult to harvest the sub-ACL. Table 119 summarizes the potential herring revenues impacted by this alternative, which gives a sense of the fraction of landings that could be impacted during the time and area within this alternative. For more recent years (2007-2015), the average percent of MWT catch within this alternative for all areas and all year is about 28%, and including the sub-options to exclude Area 2 and limit the season to June-September brings the average percent of MWT catch to about 5%. In general, this measure would only have low positive impacts on the resource if vessels are not able to harvest the sub-ACL; if vessels are able to harvest the sub-ACL in waters farther offshore this will have neutral impacts on the resource.

As described under Alternative 4, this alternative includes portions of several herring management areas (Areas 1B, 2 and 3), it could have different impacts on the ability to harvest one sub-ACL depending on the degree of overlap within each management area. Essentially all of Area 1B fishing takes place within 25 nm, so this alternative would make it very difficult to harvest that sub-ACL, unless the seasonal sub-option is adopted, or vessels are able to successfully convert to purse seine gear, which is unlikely. The fishery may be able to catch more of the Area 3 sub-ACL relative to other management areas, because more of the fishing activity is farther offshore, but a substantial amount is within 25 nm as well. Fishing the full Area 2 sub-ACL would be more difficult if the first 25 nm were closed to MWT gear.

Finally, any potential low positive impacts from less fish being harvested by the MWT fishery could be neutralized if other allowable gear types increase effort. For example, if bottom trawl activity increased as a result of less MWT effort in an area, then the overall impacts would be neutral – same level of catch controlled by the areas sub-ACL, just landed by a vessel using a different gear type. *In the end, this measure could make it more difficult for the fishery to harvest area sub-ACLs, which can have* ***low positive impacts on the resource.*** *However, if the fishery is able to change gear type, or catch the same amount of herring in a different area or season, any* ***low positive impacts would be neutralized.*** Compared to Alternatives 1, 2, 3, and 4 this alternative may have low positive impacts on the resource if this measure makes it difficult for the sub-ACLs to be harvested, potentially leaving more herring in the ecosystem. However, compared to the current large estimated biomass of herring, these restrictions may not have direct impacts on the overall herring resource.

In addition, some of the seasonal and spatial sub-options under consideration for this alternative could reduce some of the potential low positive impacts by maintaining more of the current access MWT vessels have to fish. There is one sub-option to reduce the length of time an area is closed, and another sub-option to reduce the overall footprint of the potential restriction. More details about the potential impacts of the sub-options are described below.

4.2.2.5.1 Area sub-options (A: Areas 1B, 2 and 3 or B: Areas 1B and 3 only)

This action is considering two sub-options for spatial boundaries for this alternative: Option A that includes Area 1B, 2 and 3; and Option B that includes Areas 1B and 3 only. The potential impacts of this alternative overall are low positive (if more difficult to harvest sub-ACL s) to neutral (fishery able to harvest sub-ACL despite LD measure). When the spatial sup-option to remove Area 2 is added, any low positive impacts are potentially more neutralized. Because a large portion of MWT effort in Area 2 is within 25 nm, restricting this measure to Area 1B and 3 only would have lower potential impacts in terms of preventing the fishery from harvesting the sub-ACL.

4.2.2.5.2 Seasonal sub-options (A: year-round or B: June-September)

This action is considering two sub-options for seasonal prohibitions of MWT gear: Option A that would prohibit MWT gear year round; and Option B that would prohibit MWT gear in this area

June – September (4 months). The potential impacts of this alternative overall are low positive (if more difficult to harvest sub-ACL s) to neutral (fishery able to harvest sub-ACL despite LD measure). When the seasonal sup-option to limit the prohibition to June-September is added, any low positive impacts are potentially more neutralized, because the fishery is more likely to harvest the sub-ACLs. Furthermore, if both sub-options are adopted, not include Area 2 and limit the prohibition to June – September, the combined impacts likely neutralize any potentially low positive impacts on the resource.

4.2.2.6 Alternative 6 (Prohibit MWT gear inside 50 nm south of Area 1A)

The potential biological impacts of Alternative 6 are generally similar to the potential impacts described above for Alternative 4 and 5, except the likelihood of this measure inhibiting the ability for the fishery to harvest the sub-ACLs for Areas 1B, 3 and 2 is greater. A larger fraction of total MWT effort occurs within 50 nm, compared to 12 nm and 25 nm. Table 119 summarizes the potential herring revenues impacted by this alternative, which gives a sense of the fraction of landings that could be impacted during the time and area within this alternative. For more recent years (2007-2015), the average percent of MWT catch within this alternative for all areas and all year is over 40%, and including the sub-options to exclude Area 2 and limit the season to June-September brings the average percent of MWT catch to about 20%. In general, because this measure overlaps with more area where MWT fishing currently takes place, closing the area to that gear type would make it much more difficult to harvest the sub-ACL, and more likely the sub-ACL would be underutilized, leaving more fish in the water, with potentially low positive impacts on the resource.

As described under Alternative 4, this alternative includes portions of several herring management areas (Areas 1B, 2 and 3), it could have different impacts on the ability to harvest one sub-ACL depending on the degree of overlap within each management area. There is little to no fishable areas for MWT gear outside of 50 nm, based on historical fishing locations. Therefore closing this area to MWT gear would make it very difficult to harvest that sub-ACL, unless the seasonal sub-option is adopted, or vessels are able to successfully convert to purse seine gear, which is unlikely. The fishery may be able to catch more of the Area 3 sub-ACL relative to other management areas, because more of the fishing activity is farther offshore, but a substantial amount is within 50 nm as well. Fishing the full Area 2 sub-ACL would also be much more difficult if the first 50 nm were closed to MWT gear.

Finally, any potential low positive impacts from less fish being harvested by the MWT fishery could be neutralized if other allowable gear types increase effort. For example, if bottom trawl activity increased as a result of less MWT effort in an area, then the overall impacts would be neutral – same level of catch controlled by the areas sub-ACL, just landed by a vessel using a different gear type. ***In the end, this measure could make it more difficult for the fishery to harvest area sub-ACLs, which can have low positive impacts on the resource. However, if the fishery is able to change gear type, or catch the same amount of herring in a different area or season, any low positive impacts could be neutralized.*** Compared to Alternatives 1 through 5 this alternative may have low positive impacts on the resource if this measure makes it difficult for the sub-ACLs to be harvested, potentially leaving more herring in the ecosystem. Because this alternative could impact a large fraction of current herring landings, 20-over 40% of total herring/mackerel average revenues, it may be more difficult for vessels to make up that revenue.

In addition, some of the seasonal and spatial sub-options under consideration for this alternative could reduce some of the potential low positive impacts by maintaining more of the current access MWT vessels have to fish. There is one sub-option to reduce the length of time an area is closed, and another sub-option to reduce the overall footprint of the potential restriction. More details about the potential impacts of the sub-options are described below.

4.2.2.6.1 Area sub-options (A: Areas 1B, 2 and 3 or B: Areas 1B and 3 only)

This action is considering two sub-options for spatial boundaries for this alternative: Option A that includes Area 1B, 2 and 3; and Option B that includes Areas 1B and 3 only. The potential impacts of this alternative overall are low positive (if more difficult to harvest sub-ACL s) to neutral (fishery able to harvest sub-ACL despite LD measure). When the spatial sup-option to remove Area 2 is added, any low positive impacts are potentially more neutralized. Because a large portion of MWT effort in Area 2 is within 50 nm, restricting this measure to Area 1B and 3 only would have lower potential impacts in terms of preventing the fishery from harvesting the sub-ACL.

4.2.2.6.2 Seasonal sub-options (A: year-round or B: June-September)

This action is considering two sub-options for seasonal prohibitions of MWT gear: Option A that would prohibit MWT gear year round; and Option B that would prohibit MWT gear in this area June – September (4 months). The potential impacts of this alternative overall are low positive (if more difficult to harvest sub-ACL s) to neutral (fishery able to harvest sub-ACL despite LD measure). When the seasonal sup-option to limit the prohibition to June-September is added, any low positive impacts are potentially more neutralized, but for this alternative a larger fraction of MWT catch is harvested during the summer, so it may be more difficult for the fishery to harvest the sub-ACLs. If both sub-options are adopted, not include Area 2 and limit the prohibition to June – September, the combined impacts may neutralize any potentially low positive impacts on the resource, but it may be difficult to make up all the herring catch within 50 nm of shore during the summer from Areas 3 and 1B.

4.2.2.7 Alternative 7 (Prohibit MWT gear in thirty minute squares off Cape Cod)

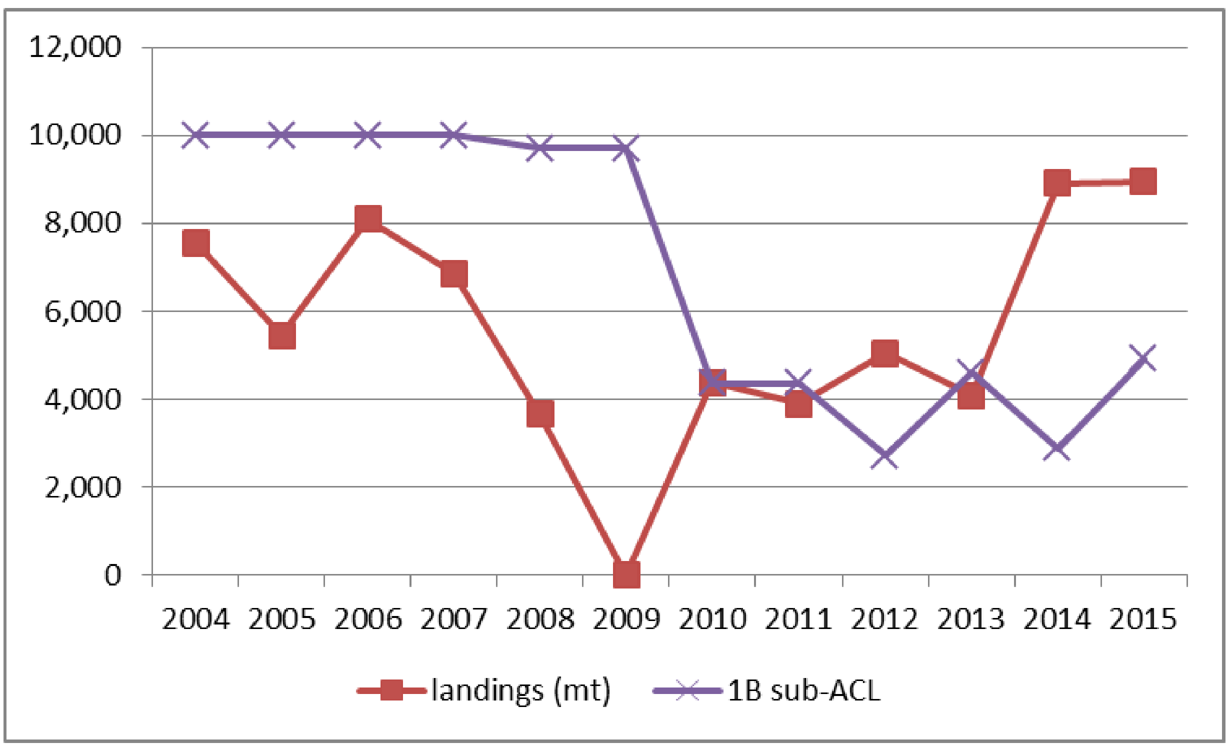
Alternative 7 is not expected to have positive or negative impacts on the herring resource overall. This alternative includes essentially the entire area MWT fishing currently effort takes place in Area 1B; therefore, if adopted it would be very difficult for the fishery to harvest the sub-ACL for that area, unless a seasonal component was also adopted, or vessels switched gear type. Even if the entire Area 1B quota was underutilized, any potential low positive impacts on the herring resource from more fish being left in the water is somewhat uncertain. The herring resource is currently well above biomass thresholds; therefore, relatively small amounts of additional herring potentially underutilized from Area 1B may not have any measurable benefits on the herring resource overall. In addition, the Area 1B quota is a relatively minor component of the overall fishery, representing less than 5% of the overall ACL.

Several herring management areas are included in this region, fishing within this region can either be part of Area 1B, Area 3 and Area 2. By far the area that has the most herring fishing activity is Area 114 west of Chatham, which is split between Area 1B and 3. Before Amendment 1 changed the boundaries, Area 114 was completely within Area 1B. Overall all sub-ACLs have declined in recent years, so the Area 1B sub-ACL has gone from 10,000mt to about 5,000 mt. Over the last ten years total removals form Area 114 declined at first, but are now higher than they were pre-Amendment 1 (Figure 84). Since part of Area 114 is in Herring Management Area 3, catch from that portion of the 30-minute square is under the Area 3 sub-ACL, which is much larger.

While catches from this area are similar to pre-Amendment 1 levels, or slightly higher even, there are still neutral impacts on the herring resource overall. Whether the fish are caught in this area or just outside of this area, there is an overall sub-ACL for both Area 1B and Area 3, so there is a limit on harvest, which controls direct impacts on the herring resource. ***Therefore, the overall direct impacts of Alternative 7 on the herring resource are expected to be neutral.*** Furthermore, this area is primarily a migratory corridor for Atlantic herring. Therefore, this seasonal area closure alternative would not have any potential benefits related to protection of spawning fish. Table 134 summarizes the potential herring revenues impacted by this alternative, which gives a sense of the fraction of landings that could be impacted during the time and area within this alternative.

Compared to the other alternatives in this section, Alternative 7 has neutral impacts because it is not expected to have substantial impacts on the herring resource. Several other measures may have low positive impacts on the herring resource compared to this alternative (i.e. Alternatives 4, 5, and 6), but most are expected to have generally neutral impacts on the herring resource.

Figure 84 – Herring landings from 30-minute square 114 off the backside of Cape Cod (red) compared to Area 1B sub-ACL (purple)

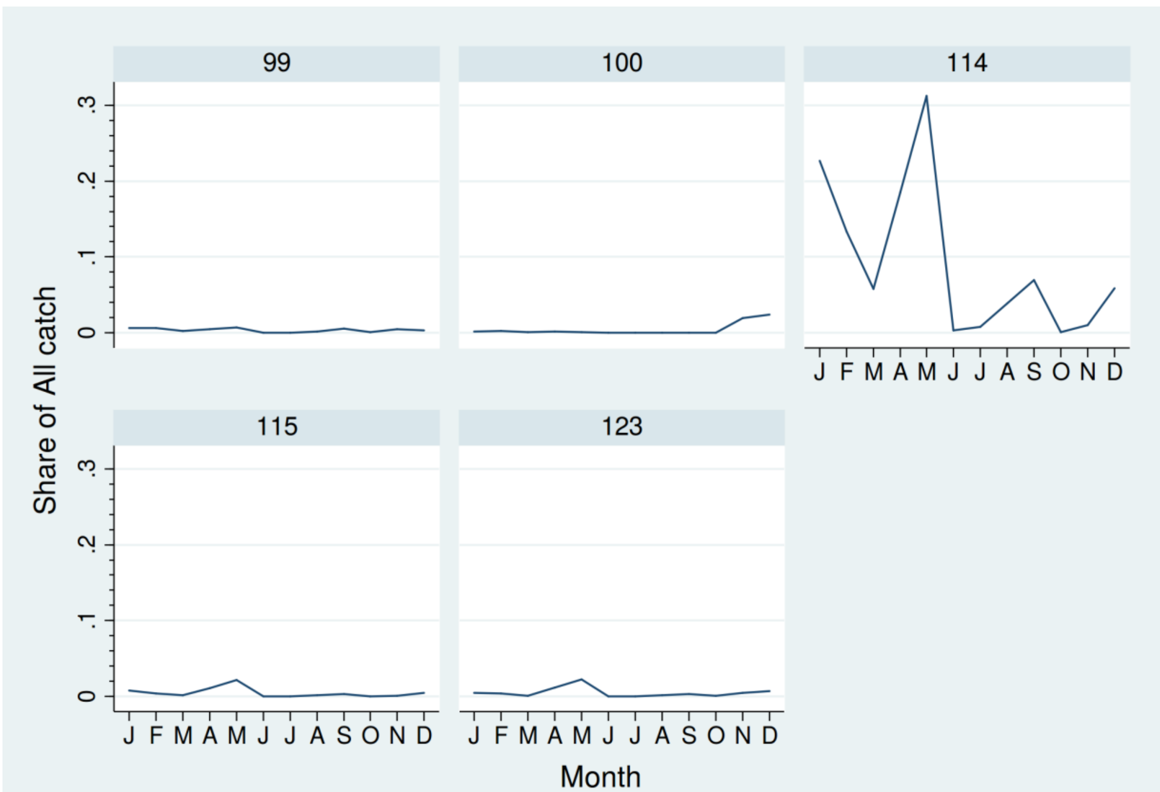


Note: Area 114 is split between herring management areas 1B and 3. Therefore, landings above the sub-ACL for Area 1B do not necessarily mean the fishery exceeded the sub-ACL, a portion of those landings are from the western half of Area 114, which is part of Area 3.

4.2.2.7.1 Area sub-options (A: five 30-minute squares in Areas 1B, 2 and 3 or three 30-minute squares in Areas 1B and 3 only)

This action is considering two sub-options for spatial boundaries for this alternative: Option A that includes Area 1B, 2 and 3; and Option B that includes Areas 1B and 3 only. The potential impacts of this alternative overall are neutral, and there are no essentially no differences between the area sub-options in terms of potential impacts on the herring resource. Very little herring fishing effort currently takes place within the 30-minute squares that are within Area 2 (areas 100 and 115); ***therefore, there are essentially no differences between these area sub-options in terms of potential impacts on the herring resource, which are neutral overall*** (Figure 85).

Figure 85 – Herring landings (2010-2015) by 30-minute square, share of all catch from within Alternative 7



4.2.2.7.2 Seasonal sub-options (A: year-round or B: June-September)

This action is considering two sub-options for seasonal prohibitions of MWT gear: Option A that would prohibit MWT gear year round; and Option B that would prohibit MWT gear in this area June – September (4 months). The potential impacts of this alternative overall are expected to be neutral. Adding the seasonal sup-option to limit the prohibition to June-September could help enable the fishery better utilize the sub-ACL; however, the majority of herring fishing takes place in this area during other months, mostly in May when the area now reopens after the January-April closure of Area 1B. Therefore, under current fishing patterns, adding the seasonal sub-option would not have any measurable differences in terms of potential impacts on the resource, compared to closing the area year-round.

4.2.2.8 Alternative 8 (Revert boundary between Area 1B and 3 back to original boundary)

The change in the management boundaries under Amendment 1 were intended, in part, to better reflect the distribution of the spawning components of the stock. Therefore, if the boundaries change back there may be increased risk of fishing one spawning component harder than another, which could have low negative impacts on that segment of the overall resource. This is supported by hydroacoustic sampling of the offshore component of the resource that was done before Amendment 1 was implemented (Figure 86, Figure 87).

Overall, ***neutral*** impacts are expected on the herring resource stock-wide. If sub-ACL s remain the same as they are now despite the boundary shifting then there could be positive impacts on the nearshore herring resource if the boundary is pushed farther offshore and the Area 1B sub-ACL remains at the current level. But if the Area 1B sub-ACL increases as a result of a boundary change, then impacts may be more neutral since similar fishery removals would be expected overall from the same general area. A future specifications document would set the specific sub-ACL s per area, not Amendment 8. Regardless, whether the sub-ACL for Area 1B increases as a result of this boundary shift, or if it remains at current levels, the likelihood of this change having direct measurable impacts on the resource overall are minimal. However, ***if future sub-ACLs are set too high for Area 1B and fishing pressure is higher on one sub-component there could be low negative impacts on the resource***. But again, there is currently not sufficient information available for this region that has documented the direct impacts of fishing activity on spawning Atlantic herring.

Compared to the other alternatives in this section, Alternative 8 has neutral impacts because it is not expected to have substantial impacts on the herring resource. Several other measures may have low positive impacts on the herring resource compared to this alternative (i.e. Alternatives 4, 5, and 6), but most are expected to have generally neutral impacts on the herring resource.

4.2.2.9 Alternative 9 (Remove seasonal closure of Area 1B from January – April)

In general, when herring are in this area there is a mixture of inshore and offshore fish moving. If the existing seasonal closure was removed and vessels could fish that area earlier in the year it is possible effort would shift. There are fish in that area in the winter and fishing used to take place in Area 1B during those months. However, managers implemented the existing closure primarily to prevent the Area 1B sub-ACL from being harvested too quickly at the start of the fishing year. This measure was not put in place for biological reasons, it was primarily an allocation issue, and having the quota available later in the year does provide more time to determine if there were any overages or underages from the previous year before the final sub-ACL is known.

Whether the area is open or closed during these months, there would still be a sub-ACL for the area that would control direct impacts on the herring resource; therefore, generally ***neutral*** impacts are expected from this alternative. This is not an important area for spawning. Compared to the other alternatives in this section, Alternative 9 has neutral impacts because it is not expected to have substantial impacts on the herring resource. Several other measures may have low positive impacts on the herring resource compared to this alternative (i.e. Alternatives 4, 5, and 6), but most are expected to have generally neutral impacts on the herring resource.

Figure 86 - Results of 2000 NMFS Hydroacoustic Survey superimposed on the boundaries of current management areas and those under Alternative 9

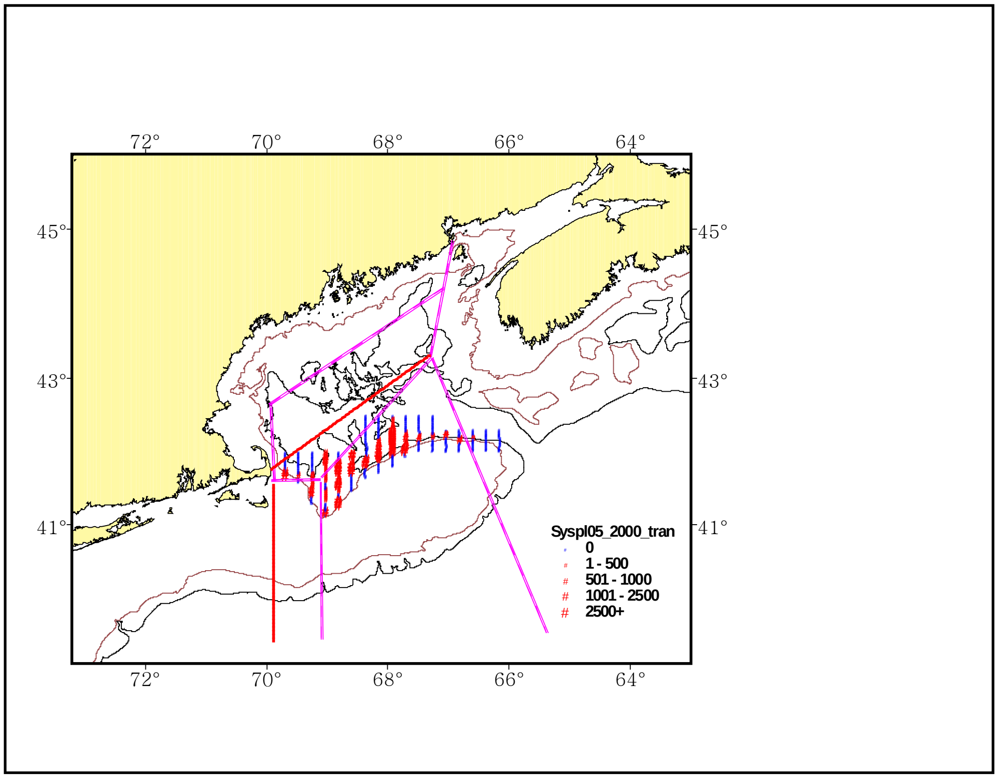
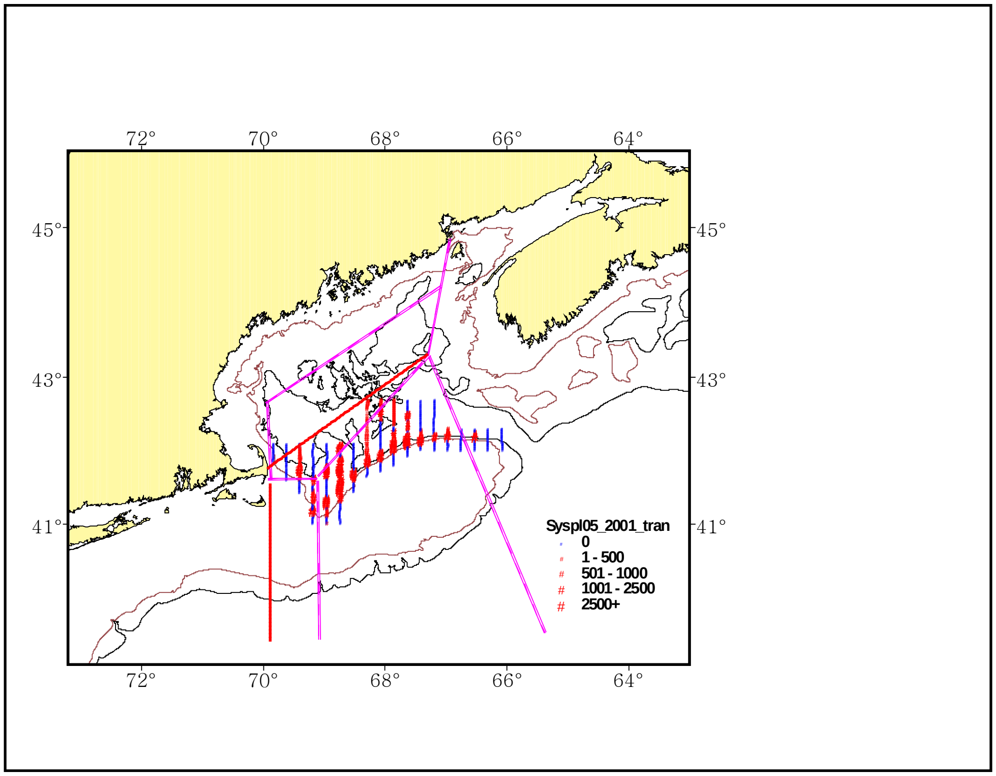


Figure 87 Results of 2001 NMFS Hydroacoustic Survey superimposed on the boundaries of current management areas and those under Alternative 9



4.3 IMPACTS ON NON-TARGET SPECIES (BYCATCH)

Non-target species refers to species other than Atlantic herring which are caught/landed by federally permitted vessels while fishing for herring. The majority of catch by herring vessels on directed trips is Atlantic herring, with extremely low percentages of bycatch (discards). Atlantic mackerel is targeted in combination with Atlantic herring during some times of the year in the southern New England and Mid-Atlantic areas and is therefore not considered a non-target species. The primary non-target species in the directed Atlantic herring fishery are **groundfish (particularly haddock)** and the **river herring/shad (RH/S) species**. Dogfish, squid, butterfish, Atlantic mackerel are also common non-target species in the directed Atlantic herring fishery (mackerel and some other non-target species catch is often landed and sold). Section 3.2 has more information about non-target species in the herring fishery. Different gear types and seasonal fishing activity have different potential impacts on non-target species. This section focuses on the biological impacts on species caught incidentally in the herring fishery, Section 4.4 considers the potential impacts on non-protected species that forage on herring (e.g., groundfish and tuna).

With respect to Amendment 8, most of the alternatives are not expected to cause major changes in the amount of harvest or areas that herring vessels fish. The alternatives under consideration that may impact herring fishing patterns directly are identified, and potential impacts are described. Impact analysis on non-target species as bycatch are largely qualitative and based on whether alternatives under consideration are expected to shift effort to areas that may have increased interactions, or change gear types that can have differential impacts on bycatch rates.

4.3.1 Atlantic herring ABC control rule

These alternatives specify the formulaic approach, or control rule, used for determining acceptable biological catch (ABC) levels in the herring fishery, including the method for setting ABCs for multiple years. The focus in this section is on the potential effects of the control rule alternatives on non-target species in terms of bycatch.

In general, alternatives related to the ABC control rule are not expected to have substantial impacts to non-target species or bycatch, positive or negative, because the overall range of alternatives under consideration has relatively small differences in projected catches. Figure 68 summarizes the range of projected short-term yields and herring biomass estimates under several different herring conditions. Catch levels vary, hence the potential for interaction with bycatch varies, but the overall magnitude of differences is small, especially in the long term.

4.3.1.1 Alternatives for ABC control rule

There are four ABC control rule alternatives (in addition to No Action) with several sub-options; each one varies in terms of the parameters that drive the overall shape of each CR, or the mathematical relationship between biomass estimates and catch advice. These approaches are:

- **No Action/Interim Control Rule.** This is the policy used in recent specification setting processes during fishing years 2013-2018. Under this control rule, the ABC is projected to produce a probability of exceeding F_{MSY} in the third year that is less than or equal to 50%. The same ABC is used for three years.
- **Alternative 1** would implement a rule that is similar to the interim control rule as approximated by its average performance in recent years. This alternative was developed

to identify a control rule that would function like the interim control rule, but would be applicable in all cases, regardless of whether abundance is increasing or decreasing.

- **Alternative 2** sets the ABC based on available biomass (SSB), and would identify the ABC associated with a maximum fishing mortality of 50% F_{MSY}. The maximum allowable ABC occurs when the SSB is two times SSB_{MSY}. The fishery is not prosecuted (ABC=0) when SSB/SSB_{MSY} falls below 1.1 times SSB_{MSY}.
- **Alternative 3** is also biomass-based. If SSB is at or about 70% of SSB_{MSY}, fishing mortality is set at 90% of F_{MSY}. Below this SSB value, F decreases. If SSB reaches 30% of SSB_{MSY} (or less), the fishery is not prosecuted (ABC=0). This alternative is closer to No Action in terms of F rates, but includes a fishery cutoff, which is conceptually similar to Alternative 2, although not triggered until a lower biomass value is reached.
- **Alternative 4** is also biomass-based, but accounts for other objectives as well. Specifically, Alternative 4 would set the ABC to achieve specific metrics (or objectives) identified in the Management Strategy Evaluation process. Six distinct ABC control rule sub-options are part of this alternative. The primary metrics used to identify this range of six performance based alternatives are: 1) set %MSY to be 100%, with an acceptable level as low as 85%; 2) set variation in annual yield at <10%, with an acceptable level as high as 25%; 3) set the probability of overfished at 0%, with an acceptable level as high as 25%; and 4) set the probability of a fishery closure (ABC=0) between 0-10%.

It is difficult to quantify specific positive or negative impacts on non-target species that may result from different ABC control rules, because bycatch impacts are primarily driven by changes in fishing behavior that are uncertain. In general, alternatives that allow for higher Atlantic herring catch may increase interactions with non-target species, but the impacts, whether positive or negative, will depend on changes in patterns in the Atlantic herring fishery (timing/effort) as well as the distribution/ abundance of non-target species. Variability associated with these factors prevents specific predictions regarding impacts. Overall, bycatch in the Atlantic herring fishery is relatively low, and no new risks are expected, because the overall range of ABC control rule alternatives have similar or lower projected yields for the fishery. Therefore, the range of ABC control rule alternatives may have generally neutral to low positive impacts to non-target bycatch species in this region since fishing levels are expected to be similar or lower depending on the alternative selected. Furthermore, when the stock-wide ACL is applied across the four management areas there is relatively little change in the management area sub-ACLs for many of the alternatives (Table 94 and Table 95). Therefore, the impacts on non-target species bycatch are not expected to change much form current levels under No Action.

The potential for bycatch impacts could be higher under Alternatives 1 and 3 compared to Alternative 4, and especially Alternative 2, because the projected ABCs are generally lower for Alternatives 4 and 2. However, all of the ABC CR alternatives have similar or lower levels of yield compared to current activity under No Action. Because interactions with the primary non-target species in the Atlantic herring fishery (haddock and RH/S) will continue to be managed through catch caps, the impacts of all the ABC CR alternatives on non-target species are expected to be ***neutral***. Even if ABC values increase or decrease as a result of this action, the fishery is limited to sub-ACLs for primary bycatch species with accountability measures that help reduce bycatch during the fishing year and trigger in-season closures if bycatch caps are reached, as well as sub-ACL reductions in future years if bycatch caps are exceeded.

4.3.1.2 Alternatives for setting three-year ABCs

There are two alternatives associated with the method used for setting ABCs in a multiyear specification process.

- **Alternative 1/No Action** would set the same ABC for all three years of a specification cycle.
- **Alternative 2** would also set the ABC for three years, but with annual application of a control rule based on the most recent herring assessment and short-term projections.

Regardless of the alternative selected, three years of ABC values will be set with each specification action, as is currently done. Alternative 2 would allow the ABC and ACLs to vary annually, according to biomass projections and the control rule alternative selected in this action. Neither of these alternatives have direct or indirect impacts on non-target species as bycatch, because the alternatives do not affect the spatial distribution or intensity of fishing activities. The ABC values themselves may vary slightly under Alternative 1 and 2 in this section, but the differences are expected to be minimal and relatively stable over the three-year time frame. Therefore, the length of time an ABC is in place has essentially no direct or indirect impact on non-target bycatch, ***neutral impacts*** expected overall for both alternatives.

4.3.1.3 FMP provisions that may be changed through a framework adjustment

The Council recommends that future modifications to the ABC CR could be made by amendment or framework. This section does not have any alternatives; this recommendation is administrative, and would have ***no direct impacts on non-target species, positive or negative***.

4.3.2 Potential localized depletion and user conflicts

The primary analyses prepared by the PDT to assess the potential impacts of these measures on bycatch are an estimate of bycatch ratios inside versus outside each area, general maps of bycatch events compared to LD alternative boundaries, and general qualitative discussion about possible effort shifts from the alternatives that could have different impacts on bycatch compared to No Action. The bycatch ratio analyses are based on at-sea observer data for fishing years 2010-2016 for all MWT trips that identified Atlantic herring as the first or second target species. The focus of these analyses are on the species with bycatch sub-ACLs: alewife and blueback herring (collectively river herring) and haddock.

The PDT has also developed bycatch maps that overlay observed bycatch events with the range of alternatives under consideration. The maps summarize hauls with catch of relevant bycatch species for observed trips where the target species (1 or 2) was Atlantic herring, as well as identify locations with very low amounts of bycatch of that species (Figure 90 - Figure 96). These maps have been completed for the primary bycatch species with sub-ACLs, as well as several additional maps that are more relevant for Amendment 8 including: individual animal log (IAL) species (sharks, tunas, swordfish, and rays) and birds. Seasonal maps help in evaluating the seasonal sub-options under consideration.

In most cases, there are too many unknowns in future bycatch rates, and how the herring fishery will respond to these measures, to draw conclusions about potential direct impacts on bycatch. If the fleet responds one way the impacts on bycatch may be “x”, but if the fleet responds another way, the impacts could be “y”. Furthermore, there could be positive impacts on one bycatch species, but effort shifts could lead to increased negative impacts on a different bycatch species.

While these analyses include some measure of potential relative effects of shifting effort from one area to another, they need to be considered with great caution in terms of the actual impacts on bycatch. For alternatives that encompass all or most of the areas known to have higher bycatch, then there could be potential benefits. Many of the alternatives close only a portion of the area known to have higher bycatch interactions, and depending on where that effort shifts, the impacts could be neutralized, or even negative if effort shits to an area/season with higher bycatch rates.

In very general terms, the PDT discussed that any measures that have the potential to shift effort into Area 2 in the winter could have negative impacts on river herring compared to No Action, and any measures that likely shift effort to GB in the fall, could have negative impacts on GB haddock compared to No Action. Overall, if measures reduce flexibility for the fleet, and close areas that include more efficient fishing, or fishing with lower bycatch, it is possible that there could be unintended consequences of increased bycatch if vessels are more limited to fish in areas that have higher bycatch rates, if more desirable areas or seasons with lower bycatch rates are not accessible to the fishery.

The PDT also notes that the herring fishery does not currently target herring in all areas where herring exist, so there is some uncertainty in what impacts there would be on bycatch if effort shifts to a currently unfished area. Furthermore, the herring MWT fishery is under two hard sub-ACLs for bycatch of haddock and river herring. Thus, current fishing behavior is already influenced by bycatch caps; therefore, maps based on previous fishing locations may already be more concentrated in areas that do not overlap with highest bycatch levels since the fishery already has incentives to avoid bycatch to remain under existing bycatch caps. Ultimately, the existing caps control the impact of this fishery on bycatch, so there is a hard limit on the impact of the herring fishery on bycatch species that have sub-ACLs, regardless of any LD measures that may be adopted through this action.

It is important to note that the alternatives under consideration were not specifically designed to minimize bycatch or address bycatch concerns directly. Some alternatives may have potentially positive or negative impacts on bycatch species, but the intent of these measures is to address potential localized depletion and user conflicts. The Magnuson Stevens Fishery and Conservation Act does require that all management measures minimize the potential impacts on bycatch, to the extent practicable. However, the main driver behind development of these measures was to address potential concerns of localized depletion and user conflicts, not to directly reduce bycatch.

Bycatch rates within and outside of alternatives under consideration

Bycatch ratios have been calculated based on catches from observed trips from vessels using MWT gear targeting herring in 2012-2016. The ratios inside and outside of each Amendment 8 LD spatial alternative have been calculated. Table 96 summarizes the ratios for several bycatch species: alewife, blueback herring, and haddock. For the most part, the bycatch ratios for alewife and blueback are higher within the alternatives compared to outside areas, and for haddock the results are reversed; the bycatch ratios for haddock are always higher outside of the areas under consideration.

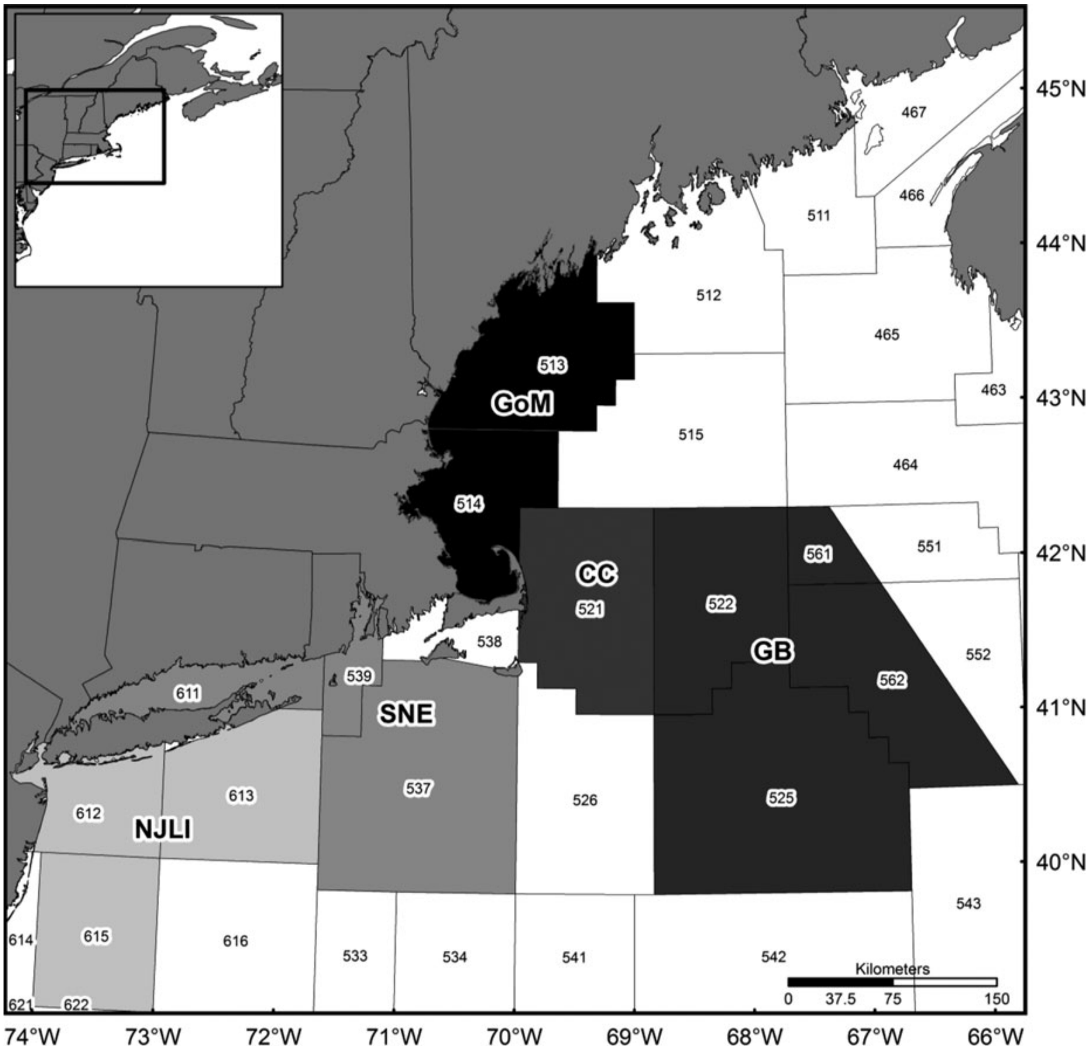
Table 96 – Ratios of bycatch from observed MWT herring trips (2012-2016)

	Inside Ratio			Outside Ratio		
Alternative	Alewife	Blueback	Haddock	Alewife	Blueback	Haddock
2	0.004965	0.005658	0.000008	0.000217	0.000588	0.004424
3	0.000052	0.000149	0.000060	0.000404	0.000820	0.004817
4	0.001841	0.003894	0.000124	0.000049	0.000073	0.005177
5	0.001637	0.003455	0.000271	0.000031	0.000035	0.005340
6	0.000992	0.002065	0.001541	0.000024	0.000029	0.005778
7	0.001980	0.002182	0.000422	0.000116	0.000525	0.004881

Annual bycatch ratios can be misleading, since bycatch varies by season and observer coverage may not be consistent throughout the year or across years. Bethoney et al. (2014) showed there is interannual, interspecies, and intraspecies differences in bycatch of river herring among and within different areas along the coast. Alewife and blueback herring bycatch were analyzed in four nearshore areas (Gulf of Maine (GOM), Cape Cod (CC), Southern New England (SNE), and New Jersey and Long Island (NJLI); Figure 88). Based on federal observer data from 2000-2012, over 95% of all river herring bycatch came from those nearshore areas, and over 80% of that bycatch occurred during discrete seasons. Bethoney et al found that most river herring bycatch observed in this fishery in the Mid-Atlantic and SNE occurs between January and March (Table 97). The higher bycatch season is slightly longer off Cape Cod, (Dec – Mar), and earlier in the year in the GOM (Oct-Nov).

These seasonal differences are important to keep in mind when considering potential impacts of seasonal restrictions on fishing effort. Furthermore, the size of river herring bycatch varied by area; this study found that river herring caught in the GOM were larger and more mature than other nearshore areas farther south. In addition, there are regulations that drive when MWT vessels harvest herring, and that can have large effects on associated bycatch. The PDT evaluated more recent years of observer data (2010-2016) and found river herring bycatch from similar areas and seasons, with some differences (Figure 89). There are more constraints on the MWT fishery in more recent years compared to the earlier data set, and those management measures affect when and where observed trips have occurred. Therefore, bycatch ratios and patterns from the past may not necessarily be good indicators of future bycatch ratios.

Figure 88 – Areas used in Bethoney et al. (2014) to summarize river herring bycatch

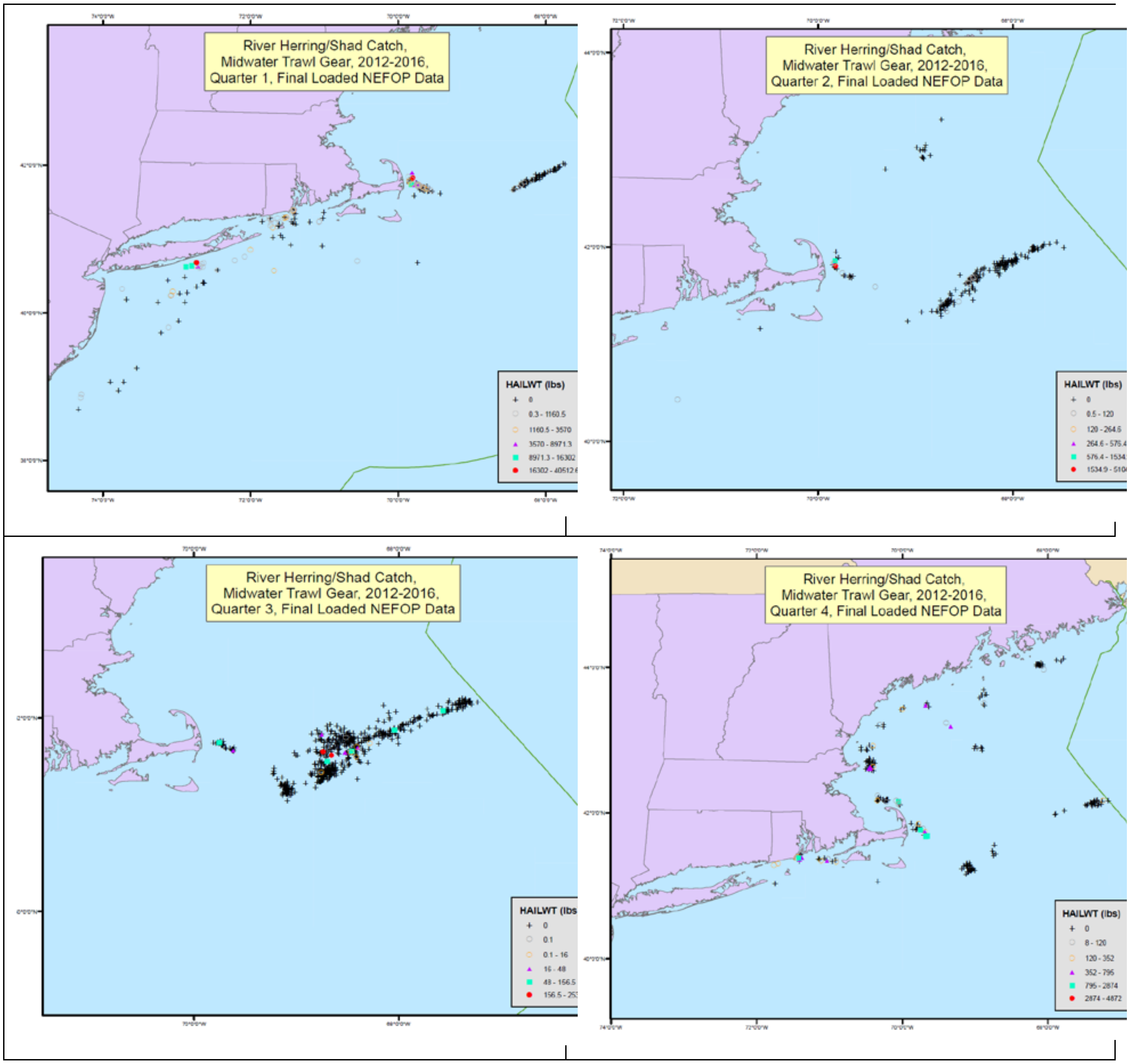


Note: GoM = western Gulf of Maine; CC = east of Cape Cod; SNE = southern New England; NJLI = New Jersey and Long Island; GB = Georges Bank. Numbered areas are NOAA statistical areas.

Table 97 – Within four nearshore areas, the range of months in which river herring bycatch by weight is highest in the Atlantic herring and mackerel MWT fisheries, 2000-2012

Area	Period	Percent of bycatch
NJLI	Jan-Mar	99
SNE	Jan-Mar	81
CC	Dec-Mar	95
GoM	Oct-Nov	99
Source: Bethoney et al (2014)		

Figure 89 – Observed RH/S bycatch in the MWT herring fishery by quarter (2010-2016 NEFOP data)



Bycatch Maps for Amendment 8 Alternatives

Maps of observer bycatch of several species help characterize the potential impacts on bycatch from the alternatives under consideration. The maps include all records for seven fishing years combined, 2010-2016, as well as seasonal maps for June – September, to evaluate some of the seasonal sub-options under consideration. This season does not correspond with all the sub-options, but it reflects the majority of the time period under consideration for the seasonal sub-options under consideration.

<u>River Herring/Shad</u>

As expected, the majority of hauls with observed river herring catch were in nearshore areas (Figure 90). There are some hauls with RH offshore on GB as well, but all tows with larger amounts of RH were from more nearshore areas. However, when the data are summarized for the summer and early fall only, the season under consideration in some of the sub-options in Amendment 8, most RH bycatch is offshore where the herring fishery is primarily operating (note the scales are different for the annual and seasonal maps; Figure 91). There are some observed tows of RH east of Cape Cod during this season, but higher bycatch tows were observed in that area in other months of the year.

<u>Haddock</u>

The vast majority of observed haddock bycatch is offshore on GB (Figure 92). There are some observed tows of haddock east of Cape Cod during the summer and early fall, but the majority of bycatch is along the northern flank of Georges Bank outside the boundaries of the LD alternatives under consideration (Figure 93). Haddock bycatch is also summarized by quarter (Figure 94). For haddock, there are observations in all four quarters, with smaller tows observed in Quarter 4 compared to earlier seasons.

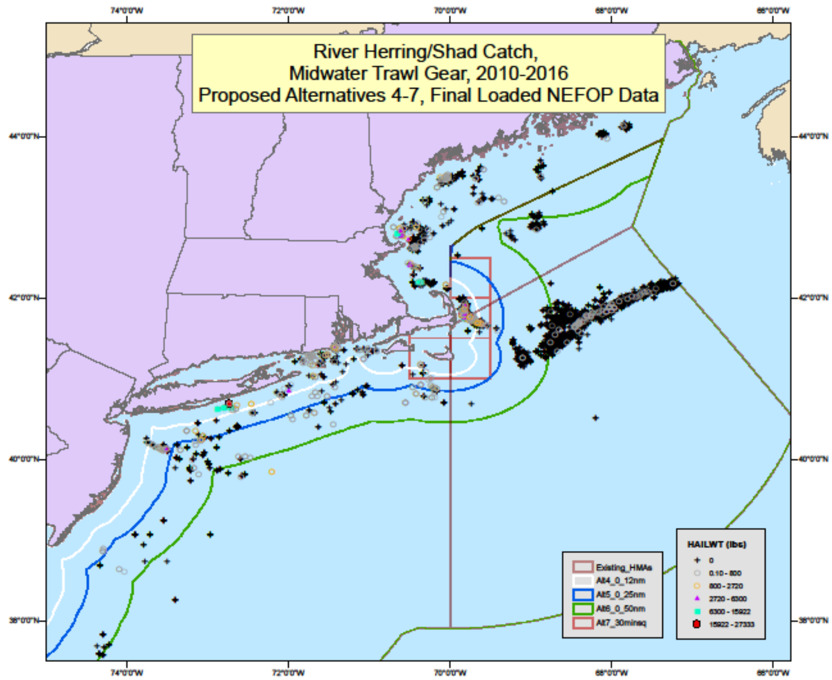
<u>Individual species (tuna, sharks, swordfish, rays)</u>

There is some interaction between the herring MWT fishery and individual species such as tuna, swordfish, shark and rays (Figure 95). Not surprisingly, when the MWT fishery is excluded from Area 1A, the interactions are limited to GB only. The interactions that have occurred east of Cape Cod have not been during the summer and early fall, those events were observed other months of the year.

<u>Seabirds</u>

Most observations of seabird bycatch in the herring MWT fishery, from 2010-2016, have been on GB with a handful in more nearshore areas (Figure 96). The nearshore observations were not during the summer and early fall.

Figure 90 – All observed hauls of river herring/shad bycatch in the herring MWT fishery (2010-2016) overlayed with Amendment 8 alternatives. Entire fishery on TOP and zoomed in on BOTTOM.



Note the scales are different for annual vs. seasonal bycatch

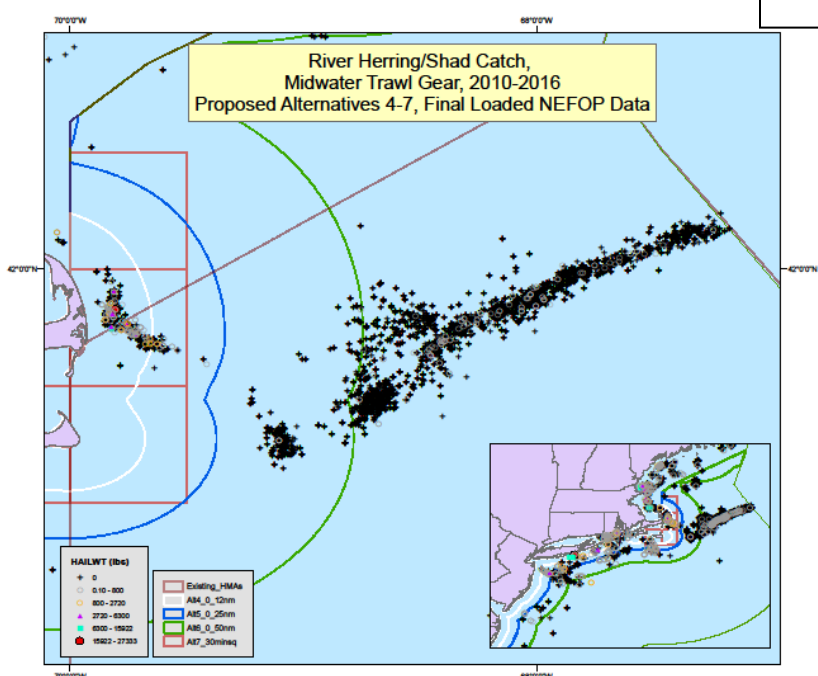
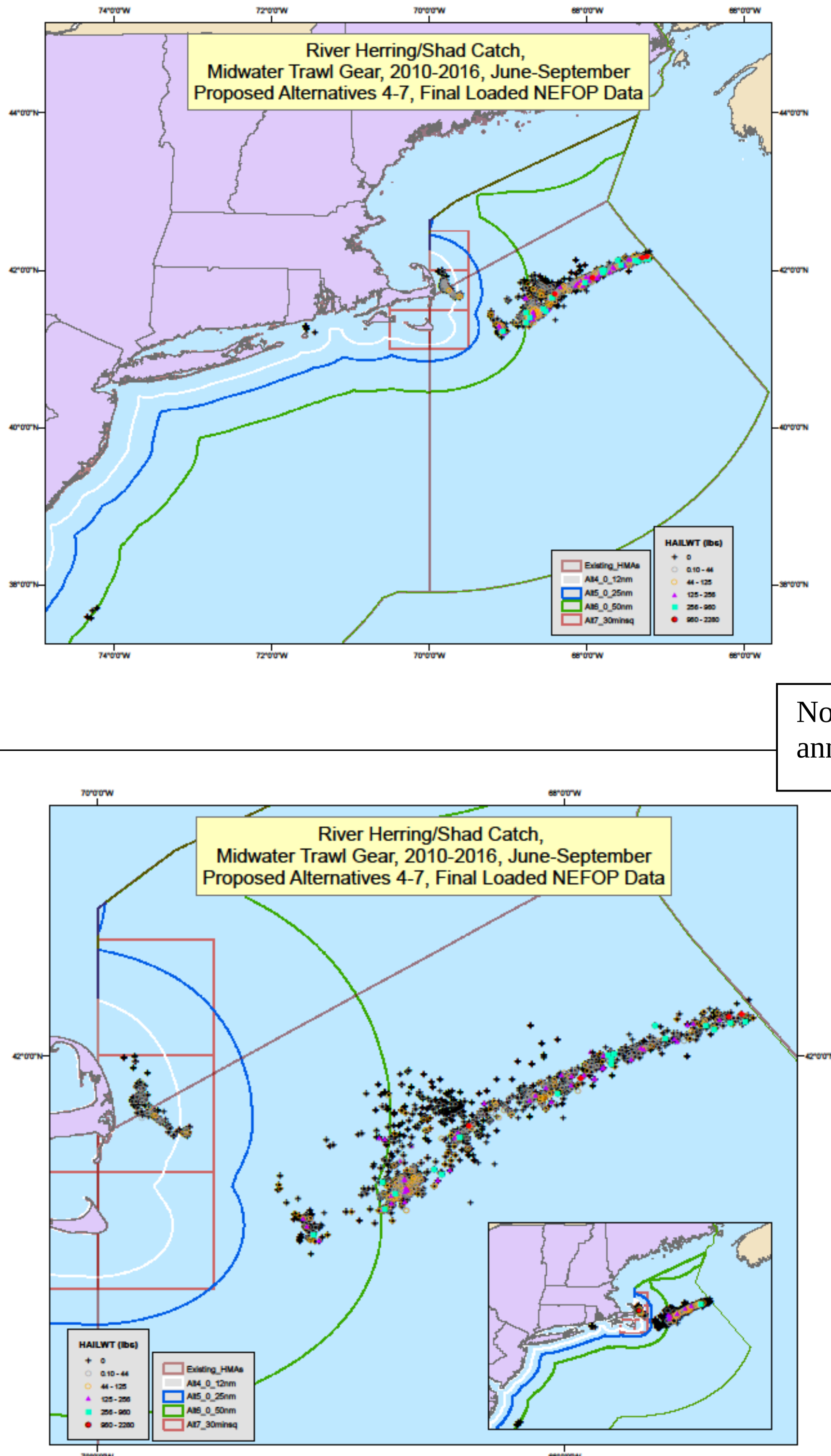
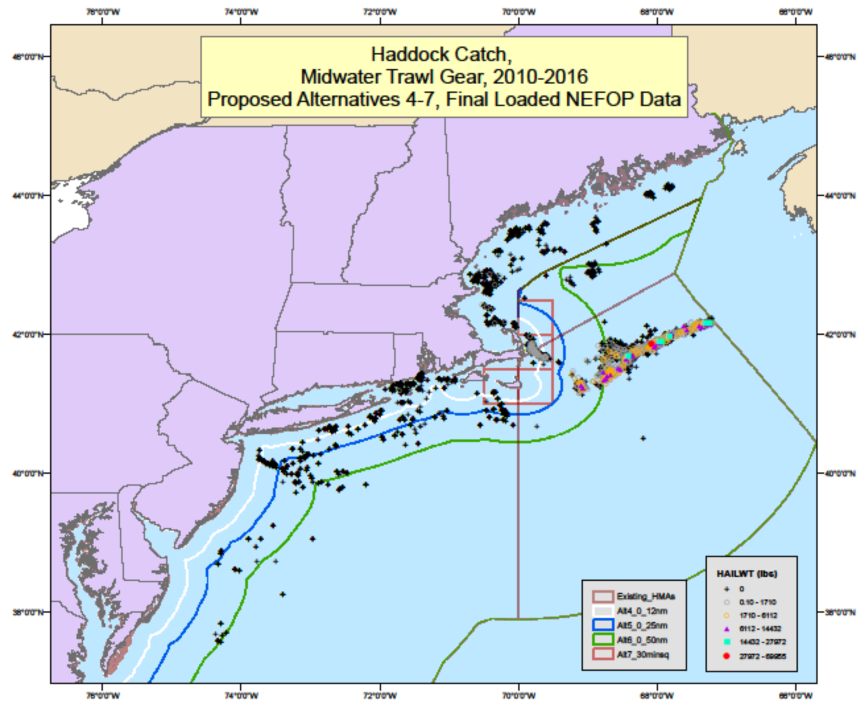


Figure 91 – Observed hauls from June – September of river herring/shad bycatch in the herring MWT fishery (2010-2016) overlayed with Amendment 8 alternatives. Entire fishery on TOP and zoomed in on BOTTOM.



Note the scales are different for annual vs. seasonal bycatch

Figure 92 – All observed hauls of haddock bycatch in the herring MWT fishery (2010-2016) overlayed with Amendment 8 alternatives. Entire fishery on TOP and zoomed in on BOTTOM.



Note the scales are different for annual vs. seasonal bycatch

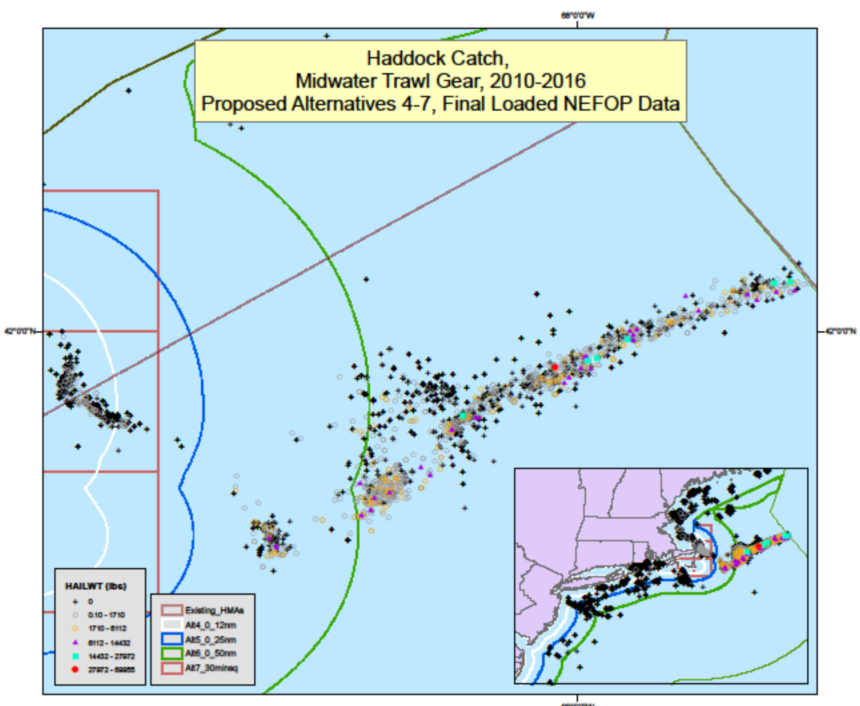
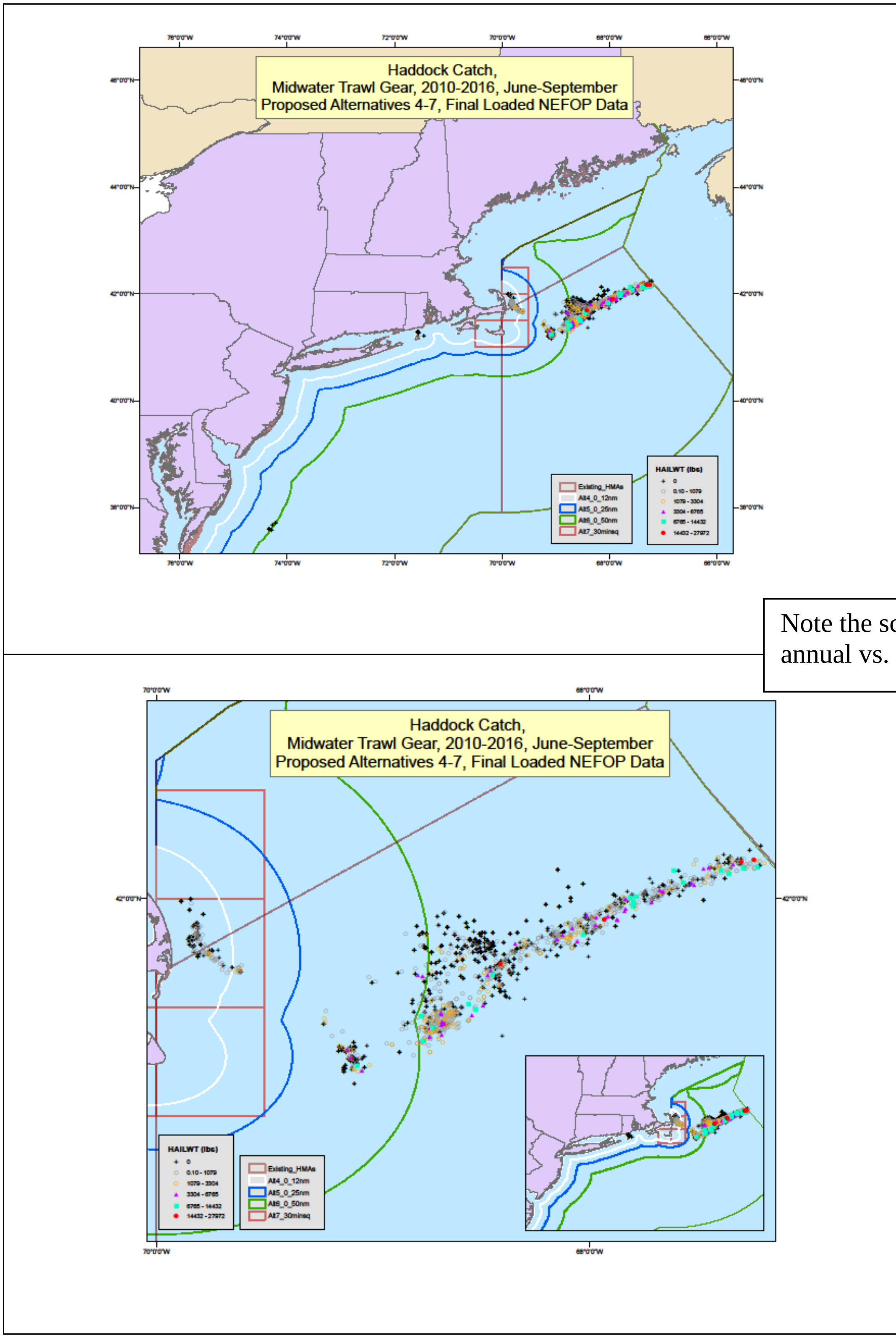


Figure 93 – Observed hauls from June – September of haddock bycatch in the herring MWT fishery (2010-2016) overlayed with Amendment 8 alternatives. Entire fishery on TOP and zoomed in on BOTTOM.



Note the scales are different for annual vs. seasonal bycatch

Figure 94 – Observed haddock bycatch in the MWT herring fishery by quarter (2010-2016 NEFOP data)

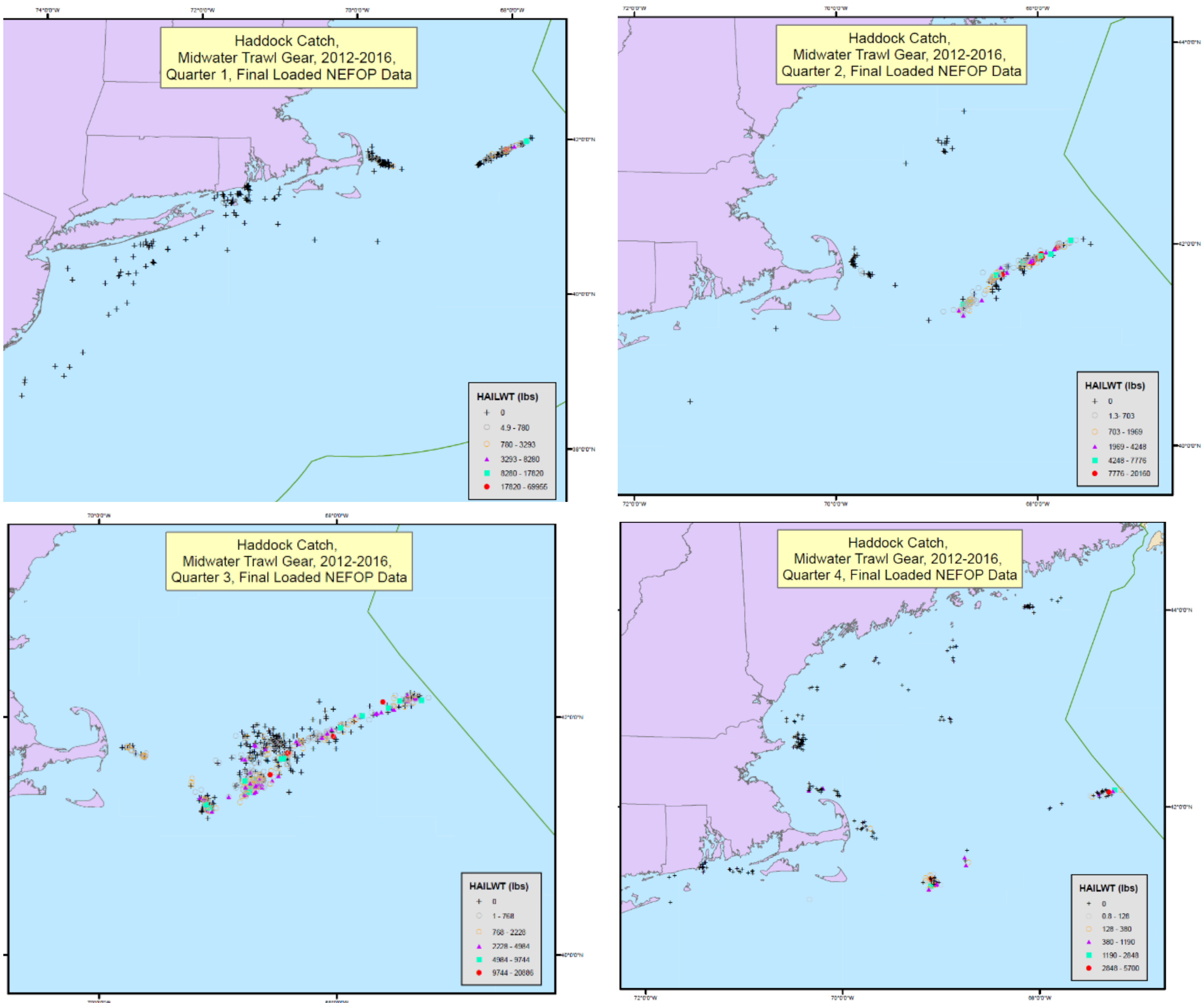


Figure 95 – All observed hauls of shark, tuna, and ray bycatch from the individual animal log (IAL) in the herring MWT fishery (2010-2016) overlayed with Amendment 8 alternatives. Year round data on LEFT and seasonal data for June-Sept on RIGHT.

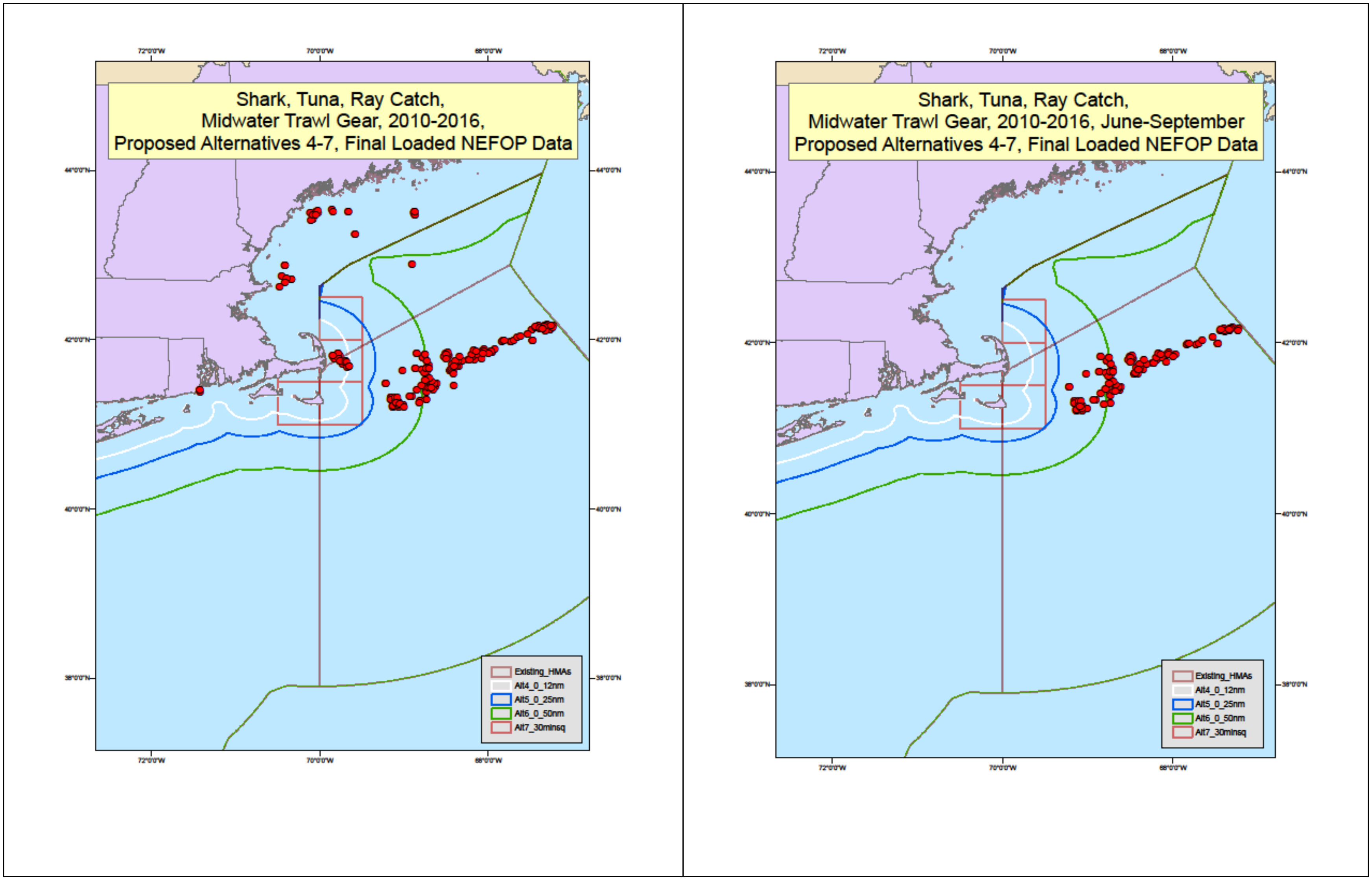
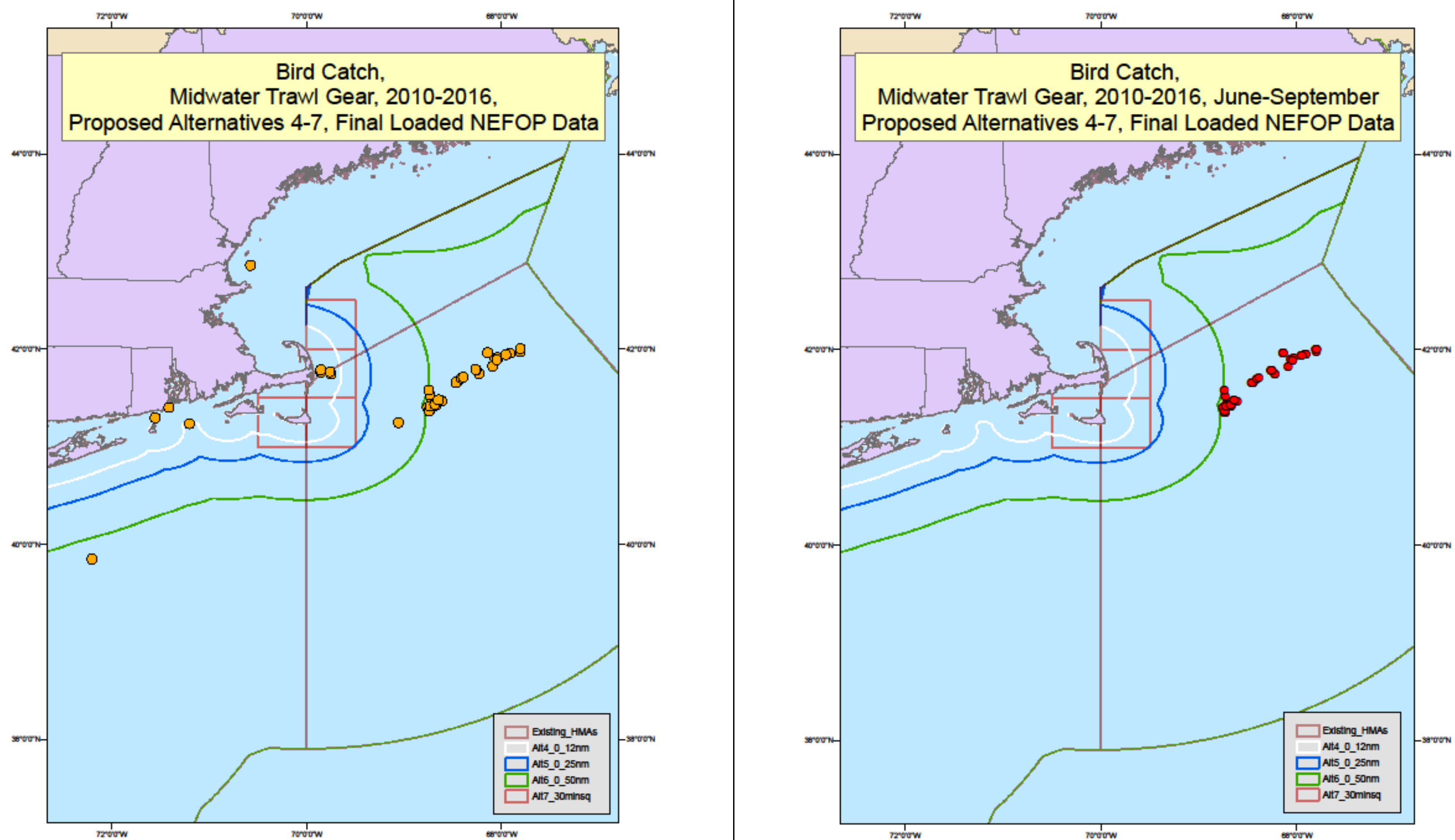


Figure 96 – All observed hauls of seabird bycatch in the herring MWT fishery (2010-2016) overlayed with Amendment 8 alternatives. Year round data on LEFT and seasonal data for June-Sept on RIGHT.



4.3.2.1 No Action - prohibit MWT gear in Area 1A from June – September

To assess the potential impacts of No Action on bycatch, the bycatch occurring on MWT vessels in Area 1A before Amendment 1 could be compared to bycatch levels now. However, it is not possible to connect any direct impacts back to this measure in isolation of all the other measures that have likely contributed to changes in fishing effort, thus bycatch in this fishery (as in Section 4.2.2.1). Multiple measures collectively impact when and where vessels fish, and that changes each season, sometimes due to natural variations in fishing conditions, and often due to management measures that restrict when and where vessels can fish by both NMFS and actions taken by ASMFC. Furthermore, the observer coverage rates have been very variable over the years, making it difficult to evaluate if there have been actual changes in bycatch interactions. Finally, the primary bycatch species in this fishery are managed under a hard bycatch cap; therefore, there is a hard limit in place that will cap the total impact on bycatch in this fishery. Thus, regardless of measures that may or may not impact bycatch, in the end the total amount of mortality from this fishery is capped; therefore, other measures may have more indirect impacts on bycatch, but the bycatch caps in place will limit the overall impact of this fishery on species with sub-ACLs (river herring and haddock).

If most MWT effort from June – Sept in Area 1A pre-Amendment 1 moved to other areas outside of the GOM, it is possible that impacts on GOM haddock bycatch have reduced under No Action. However, if effort shifted to GB, then impacts on GB haddock have potentially increased under No Action. As for river herring, bycatch is usually higher inshore, and rates are highest in Area 2 and east of Cape Cod. If MWT effort has moved from Area 1A to these inshore areas, it is possible that bycatch impacts on river herring have increased under No Action. In reality, total herring fishing effort has declined in all areas since Amendment 1, so overall bycatch interactions are likely lower than pre-Amendment 1.

Thus, there are too many uncertainties in how effort shifts from year to year to determine if total bycatch will be higher or lower under No Action. However, the bycatch caps in place are intended to control impacts on bycatch. Impacts are expected to be ***neutral*** under No Action.

4.3.2.2 Alternative 2 (Closure within 6nm in Area 114 to all vessels fishing for herring)

The impacts on non-target species of Alternative 2 are expected to be ***neutral***. In a very qualitative sense, river herring bycatch is generally higher in nearshore areas, especially east of Cape Cod (Figure 90). Therefore, if MWT effort is removed from this area, it is possible that impacts on river herring bycatch could be reduced. However, if effort shifts just outside of this closure, bycatch rates are likely to be very similar, which would have generally neutral impacts. If effort shifts from the summer/fall to other times of the year but in the same area, then bycatch of river herring could increase if it is more concentrated in the time of year river herring bycatch rates are generally higher (i.e., winter). Overall, it is not possible to know how vessels will respond, so the impacts on bycatch are uncertain. In this case, this area does not overlap with a large fraction of herring fishing activity, so any shifts would be minor, and are not likely to change overall bycatch impacts. Compared to No Action this alternative is not expected to have direct impacts since this alternative does not overlap with a concentrated herring fishing area.

4.3.2.2.1 Seasonal sub-options (A: June – August or B: June – October)

The impacts on non-target species of either seasonal sub-option are expected to be ***neutral***. The sub-options focus on either the summer (Option A) or the summer and early fall (Option B), which are generally lower bycatch seasons for river herring (Figure 90). Again, if effort shifts from the summer/fall to other times of the year but in the same area, then bycatch of river herring could increase, if it is more concentrated in the time of year river herring bycatch rates are generally higher (i.e., winter). But this area does not overlap with a large fraction of herring fishing activity, so any shifts would be minor, and are not likely to change overall bycatch impacts.

4.3.2.3 Alternative 3 (Prohibit MWT gear in Area 1A year-round)

If the MWT fishery is excluded from Area 1A for the entire year, the purse seine fleet would likely still harvest the entire sub-ACL. MWT effort would be constrained to Area 1B, Area 2, and Area 3. Bycatch interactions from MWT gear would be lower for species within Area 1A, but many of those species are also found in other herring management areas. Therefore, any positive impacts from less effort in Area 1A, could be somewhat neutralized if bycatch interactions increase in other areas. There may be some positive impacts on river herring from rivers within the GOM, but there could be increased fishing pressure in nearshore areas for other rivers (i.e., SNE and the Mid-Atlantic). If effort shifts to Area 3, especially in the fall, it is possible that impacts on GB haddock would increase. Again, there is an overall bycatch cap, so the sub-ACL for GB haddock will limit the total level of impact from the MWT fishery. Overall, the bycatch caps for both river herring and haddock will help neutralize any potential increased impacts on bycatch resulting from effort shifts; therefore, when the caps are combined with this alternative, the overall impacts on bycatch are generally ***neutral***. Since overall impacts are potentially neutral, the impacts compared to Alternative 1 and 2 are neutral.

4.3.2.4 Alternative 4 (Prohibit MWT gear inside 12 nm south of Area 1A)

Herring MWT landings within 12 nm are highest during the months of November – February; therefore, the highest impact of a closure on the fishery would be the winter months, especially December and January (Figure 120). If there is an area closure during those months effort will likely shift spatially or temporally. The PDT discussed that effort shifts can have different impacts on bycatch species, especially river herring and shad because they are typically found in nearshore areas. For example, a buffer closure could have negative fence effects that could shift all inshore effort and concentrate it just outside the boundary, if that boundary happens to overlap an important ocean feature, the impacts could be intensified, e.g., the Great South Channel. The timing of the closure could have very different impacts on bycatch and other fisheries as well.

Based on the bycatch ratio analysis presented in Table 96, river herring bycatch rates are higher inside 12 nm compared to areas fished outside, and the reverse is true for haddock. As the document explains, there are seasonal differences and rates vary from year to year. The bycatch maps also show that more river herring interactions occur within 12-nautical miles compared to areas farther offshore. The vast majority of river herring bycatch has been observed in areas within 12 nautical miles. However, the direct impacts on bycatch in this fishery are controlled by the existing bycatch caps, and the effort shifts this alternative may cause are uncertain. Therefore, the potential impacts on bycatch are ***neutral*** due to the existing bycatch caps, ***and somewhat uncertain*** due to unknown effort shifts that may have positive or negative impacts on various bycatch species. Also, compared to the other alternatives under consideration, this alternative is expected to have neutral and somewhat uncertain impacts.

4.3.2.4.1 Area sub-options (A: Areas 1B, 2 and 3 or B: Areas 1B and 3 only)

If Area 2 is excluded (Option B), MWT effort may shift into that area if those vessels are excluded from Area 1B and nearshore areas of Area 3. If effort shifts to nearshore waters in Area 2, especially in the winter, impacts on river herring could be increased. Again, there are bycatch caps in place that will limit the total impact on river herring, regardless of any LD measure adopted. If nearshore waters throughout the range are closed to MWT fishing (Option A) MWT effort will likely shift farther offshore. The species that could face increased impacts would be GB haddock. Those potential increased impacts would have a maximum since there is a bycatch cap for GB haddock. Therefore, the potential impacts on bycatch are ***neutral*** due to the existing bycatch caps, ***and somewhat uncertain*** due to unknown effort shifts that may have positive or negative impacts on various bycatch species.

4.3.2.4.2 Seasonal sub-options (A: year-round or B: June-September)

The year-round sub-option ***(Option A) may have more positive impacts on river herring***, especially if paired with the sub-option that includes Area 2 because that would encompass the areas and times when river herring bycatch are highest. While river herring is caught farther offshore than 12 nm, the largest observed tows of river herring bycatch have all been inshore of 12nm (Figure 90) and the majority of observed bycatch has been within this alternative. If the yearlong option (Option A) and Area sub-option A is selected it is more likely that river herring bycatch caps will not be exceeded by the herring fishery, potentially reducing overall impacts on river herring.

The seasonal option that would restrict this gear prohibition to June-September, is expected to have more ***neutral impacts on river herring***, but interactions could be lower in waters east of Cape Cod based on recent observer data. Alternatively, if more MWT effort is pushed father offshore, impacts on haddock could increase, but there is a limit to those potential increased impacts because there is a bycatch cap in place. Therefore, impacts could be ***low negative to neutral on haddock*** depending on the degree of potential effort shifts.

4.3.2.5 Alternative 5 (Prohibit MWT gear inside 25 nm south of Area 1A)

Overall, Alternative 5 has similar impacts to Alternative 4 described above, except that it more completely encompasses areas with observed river herring bycatch. Because this area extends even farther offshore it is even more likely that river herring bycatch caps will not be exceeded, having potentially positive impacts on river herring. However, if effort shifts farther offshore there may be increased impacts on haddock. Overall, the potential impacts on bycatch are ***neutral*** due to the existing bycatch caps, ***and somewhat uncertain*** due to unknown effort shifts that may have positive or negative impacts on various bycatch species. Also, compared to the other alternatives under consideration, this alternative is expected to have neutral and somewhat uncertain impacts.

4.3.2.5.1 Area sub-options (A: Areas 1B, 2 and 3 or B: Areas 1B and 3 only)

If Area 2 is excluded (Option B), MWT effort may shift into that area if those vessels are excluded from Area 1B and nearshore areas of Area 3. If effort shifts to nearshore waters in Area 2, especially in the winter, impacts on river herring could be increased. Again, there are bycatch caps in place that will limit the total impact on river herring, regardless of any LD measure adopted. If nearshore waters throughout the range are closed to MWT fishing (Option A) MWT effort will likely shift farther offshore. The species that could face increased impacts would be

GB haddock. Those potential increased impacts would have a maximum since there is a bycatch cap for GB haddock. Therefore, the potential impacts on bycatch are ***neutral*** due to the existing bycatch caps, ***and somewhat uncertain*** due to unknown effort shifts that may have positive or negative impacts on various bycatch species.

4.3.2.5.2 Seasonal sub-options (A: year-round or B: June-September)

The year-round sub-option ***(Option A) may have more positive impacts on river herring***, especially if paired with the sub-option that includes Area 2 because that would encompass the areas and times when river herring bycatch are highest. While river herring is caught farther offshore than 12 nm, the largest observed tows of river herring bycatch have all been inshore of 12nm (Figure 90) and the majority of observed bycatch has been within this alternative. If the yearlong option (Option A) and Area sub-option A is selected it is more likely that river herring bycatch caps will not be exceeded by the herring fishery, potentially reducing overall impacts on river herring.

The seasonal option that would restrict this gear prohibition to June-September, is expected to have more ***neutral impacts on river herring***, but interactions could be lower in waters east of Cape Cod based on recent observer data. Alternately, if more MWT effort is pushed father offshore, impacts on haddock could increase, but there is a limit to those potential increased impacts because there is a bycatch cap in place. Therefore, impacts could be ***low negative to neutral on haddock*** depending on the degree of potential effort shifts.

4.3.2.6 Alternative 6 (Prohibit MWT gear inside 50 nm south of Area 1A)

Overall this alternative has similar impacts to Alternative 4 and 5 described above, except the alternative basically includes all areas with observed river herring bycatch and some of the areas where haddock bycatch has been observed as well. Because this area extends even farther offshore than Alternatives 4 and 5 it is even more likely that the river herring bycatch caps will not be exceeded, having potentially positive impacts on bycatch. However, if effort shifts farther offshore there may be increased impacts on haddock since effort will be more constrained in when and where MWT effort could take place. The likelihood of reaching or exceeding the haddock catch caps may be increased if vessels have less flexibility to fish in areas and seasons to avoid haddock bycatch. Overall, the potential impacts on bycatch are ***neutral*** due to the existing bycatch caps, ***and somewhat uncertain*** due to unknown effort shifts that may have positive or negative impacts on various bycatch species. Also, compared to the other alternatives under consideration, this alternative is expected to have neutral and somewhat uncertain impacts.

4.3.2.6.1 Area sub-options (A: Areas 1B, 2 and 3 or B: Areas 1B and 3 only)

If Area 2 is excluded (Option B), MWT effort may shift into that area if those vessels are excluded from Area 1B and nearshore areas of Area 3. If effort shifts to nearshore waters in Area 2, especially in the winter, impacts on river herring could be increased. But again, there are bycatch caps in place that will limit the total impact on river herring, regardless of any LD measure adopted. If nearshore waters throughout the range are closed to MWT fishing (Option A) MWT effort will likely shift farther offshore. The species that could face increased impacts would be GB haddock. Those potential increased impacts would have a maximum since there is a bycatch cap for GB haddock. Therefore, the potential impacts on bycatch are ***neutral*** due to the existing bycatch caps, ***and somewhat uncertain*** due to unknown effort shifts that may have positive or negative impacts on various bycatch species.

4.3.2.6.2 Seasonal sub-options (A: year-round or B: June-September)

The year-round sub-option ***(Option A) may have more positive impacts on river herring***, especially if paired with the sub-option that includes Area 2 because that would encompass the areas and times when river herring bycatch are highest. While river herring is caught farther offshore than 12 nm, the largest observed tows of river herring bycatch have all been inshore of 12nm (Figure 90) and the majority of observed bycatch has been within this alternative. If the yearlong option (Option A) and Area sub-option A is selected it is more likely that river herring bycatch caps will not be exceeded by the herring fishery, potentially reducing overall impacts on river herring.

The seasonal option that would restrict this gear prohibition to June-September, is expected to have more ***neutral impacts on river herring***, but interactions could be lower in waters east of Cape Cod based on recent observer data. Alternatively, if more MWT effort is pushed father offshore, impacts on haddock could increase, but there is a limit to those potential increased impacts because there is a bycatch cap in place. However, the more constraints on the fishery the less flexibility it has to fish in times and areas with lower bycatch, which can have negative unintended consequences on bycatch. Therefore, impacts could be ***low negative to neutral on haddock*** depending on the degree of potential effort shifts.

4.3.2.7 Alternative 7 (Prohibit MWT gear in thirty minute squares off Cape Cod)

The vast majority of landings that are removed from this area, essentially 100%, is with herring MWT gear (Table 134). Total landings from this area are not very high compared to the total fishery removals, but in some years, for some vessels this can be an important component of their annual income, about 7-9% of total MWT revenue since 2000. If MWT vessels are excluded from this area they may shift effort offshore, which could have low positive impacts on river herring (especially Cape Cod river herring stocks), and low negative impacts on haddock. Based on the bycatch ratio analysis presented in Table 96, river herring bycatch rates are higher inside Alternative 7 compared to areas fished outside, and the reverse is true for haddock. But as the document explains, there are seasonal differences and rates vary from year to year.

The bycatch maps also show that essentially all observed river herring interactions east of Cape Cod have occurred within the boundaries of Alternative 7. However, the direct impacts on bycatch in this fishery are controlled by the existing bycatch caps, and the effort shifts this alternative may cause are uncertain. For example, if effort from this area shifts to a nearshore area in Area 2, those river herring stocks could be impacted. The haddock bycatch that has been observed east of Cape Cod could be reduced if this alternative is adopted, but if effort shifts farther offshore there could be greater impacts on that portion of the same overall stock of GB haddock. Also, if effort shifts to similar nearshore areas but in other areas, i.e. southern New England, there could be increased impacts on RH/S in those areas. Therefore, the potential impacts on bycatch are ***neutral*** due to the existing bycatch caps, ***and somewhat uncertain*** due to unknown effort shifts that may have positive or negative impacts on various bycatch species. Also, compared to the other alternatives under consideration, this alternative is expected to have neutral and somewhat uncertain impacts; it may not impact as much potential effort as some alternatives (Alternatives 5 and 6), but more than others (Alternatives 2, 3, and 4).

4.3.2.7.1 Area sub-options (A: five 30-minute squares in Areas 1B, 2 and 3 or three 30-minute squares in Areas 1B and 3 only)

There is very little herring effort in the portion of this alternative that is within Area 2. Therefore, if MWT vessels can no longer fish in that area, there are likely to be ***neutral*** impacts on bycatch since very little, if any, effort would shift.

4.3.2.7.2 Seasonal sub-options (A: year-round or B: June-September)

The year-round sub-option ***(Option A) may have more positive impacts on river herring***. Since this alternative includes the entire area that observed tows of river herring have been observed (Figure 90), it is more likely to have positive impacts on river herring stocks around Cape Cod. ***Option B is expected to have more neutral impacts on river herring*** because the season with higher bycatch is outside of that closure period. **Table 97** shows that river herring bycatch is primarily observed in the nearshore waters around Cape Cod in the months of December through March; therefore, a closure in June – September could increase impacts if effort shifts from that season to a time of year with higher river herring catch rates. In addition, if more MWT effort is pushed father offshore, impacts on haddock could increase, but there is a limit to those potential increased impacts because there is a bycatch cap in place. However, the more constraints on the fishery the less flexibility it has to fish in times and areas with lower bycatch, which can have negative unintended consequences on bycatch. Therefore, impacts could be ***low negative to neutral on haddock*** depending on the degree of potential effort shifts.

4.3.2.8 Alternative 8 (Revert boundary between Area 1B and 3 back to original boundary)

The impacts of Alternative 8 on bycatch are expected to be neutral, since the existing Atlantic herring sub-ACLs and accountability measures in place limit the overall impact of this fishery on non-target species such as river herring and haddock (Figure 24 and Figure 23). Separate to Amendment 8, a future action would determine future distributions of the Atlantic herring ACL between sub ACLs for Areas 1B and 3 if the boundary changes under Amendment 8. If Area iB increases in size (offshore), while the 1B sub-ACL remains the same, bycatch of nearshore species (e.g., river herring) may be reduced. If the Area 1B sub-ACL increases (e.g., in response to an increase in the size of Area 1B), it is possible that there may be increased impacts on bycatch of nearshore species. Still, the hard sub-ACL and accountability measures in place would limit the overall impacts so they would not increase above levels already determined to be acceptable.

Furthermore, if the size of Area 3 is reduced as a result of this boundary shift, the Area 3 sub-ACL would be harvested from a smaller, more offshore area. Thus, potential impacts on offshore bycatch species could increase. For GB haddock, the sub-ACL creates a ceiling on any increase in bycatch. Therefore, while the boundary shift could impact fishing efforts levels (increase or decrease compared to current levels), the bycatch caps in place would prevent increased impacts on bycatch; therefore, overall impacts are likely to be ***neutral***. Compared to the other alternatives under consideration, this alternative is expected to have neutral impacts; it is not expected to shift as much effort as other alternatives under consideration (i.e. Alternatives 3, 4, 5 6, and 7), and the shift would likely go from inshore to offshore if sub-ACLs are adjusted in a future action (keeping Area 1B lower and not increasing the sub-ACL completely for the adjusted boundary).

4.3.2.9 Alternative 9 (Remove seasonal closure of Area 1B from January – April)

The area with the highest concentration of river herring bycatch from the herring MWT fishing is east of Cape Cod, and then south of Rhode Island. If the current seasonal closure of Area 1B was lifted, and vessels shifted from mostly fishing in that area in May to earlier in the year (January/February as well as the end of the year November/December), it is possible that river herring bycatch impacts could increase. Interactions are generally higher in December through March (Table 97, Figure 89). River herring bycatch rates are generally higher in the winter compared to the spring. This measure is not expected to have any differential impacts on haddock since most haddock bycatch is observed farther offshore, and the seasonal differences of haddock bycatch in this area are not as distinct (Figure 94).

If Area 1B opens earlier in the year it is possible that MWT fishing that typically takes place in Area 2 in the winter could shift to Area 1B instead. Therefore, bycatch of river herring in Area 2 could decrease, but impacts on river herring father north could increase. Conversely, if Area 2 effort remains what it is, but effort that takes place in Area 1B (typically in May in recent years) shifts earlier in the year, there could be increased risks to river herring because winter typically has higher bycatch rates. However, in the end, the bycatch caps control total impacts on non-target species. If bycatch rates of river herring increase in the winter as a result of the seasonal closure being lifted, then the caps would still be in place and would restrict fishing if estimated bycatch exceeded the sub-ACL by implementing in-seasonal closures (Figure 23). In summary, because there are bycatch caps in place, any increased risk of impacting bycatch is somewhat neutralized because there is a limit on the potential impact. Therefore, the overall impacts of this alternative are expected to be ***neutral***.

Compared to the other alternatives under consideration, this alternative is expected to have neutral impacts; it is not expected to shift as much effort as all the other alternatives under consideration, just the season that fishing is allowed to occur in this area.

4.4 IMPACTS ON NON-PROTECTED PREDATOR SPECIES THAT FORAGE ON HERRING (TUNA, GROUNDFISH, STRIPED BASS)

4.4.1 Atlantic herring ABC Control Rule

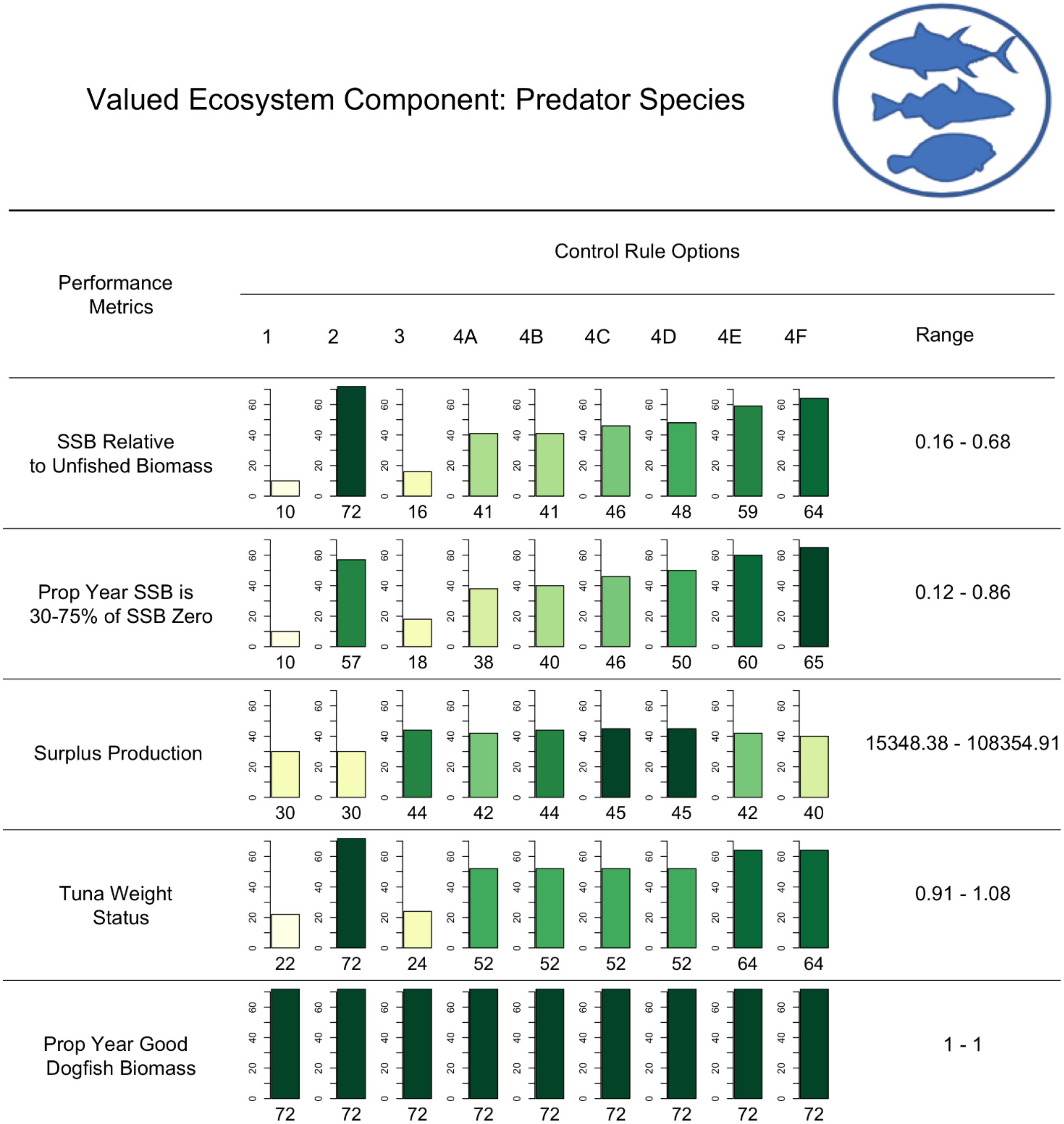
There are species in this region that forage on herring that are not included in the list of protected species under the Endangered Species Act (ESA; species listed as threatened or endangered under the ESA) and/or the Marine Mammal Protection Act (MMPA). During development of Amendment 8, the public raised concerns that measures should be taken to consider the important role herring has as forage in the ecosystem, including tuna, groundfish, and other recreational species like striped bass. A summary of the life history of these species and potential reliance on herring as forage is in Section 3.3.

Discussion of potential impacts on prey availability is largely qualitative and based on whether alternatives under consideration are expected to change overall fishing patterns or shift effort to areas that may have increased interactions, or change gear types that may have differential impacts on protected resources. However, some quantitative analyses were prepared in the MSE model to evaluate the potential effects of changes in herring biomass on the health or potential productivity of several predator species. Models were developed for tuna and dogfish (a proxy for groundfish because relationships were difficult to establish for herring-cod, in part, due to declining cod populations).

The biological impacts of the ABC control rule alternatives on non-protected species that forage on herring can be evaluated using the summary table of MSE results for the predator species VEC (**Figure 97**). The metrics that have been identified to best represent potential impacts on these predator species are: SSB relative to unfished biomass, proportion of years SSB is 30-75% of unfished biomass, surplus production, tuna weight status, and proportion of years that dogfish biomass is above average.

Figure 97 – Summary of the metrics that are indicators of potential impacts on the valued ecosystem metric – <u>predator species</u>

Predator species Metrics: SSB relative to unfished biomass, surplus production, tuna weight, and dogfish biomass.



These alternatives specify the formulaic approach, or control rule, used for determining annual target fishing levels (ABCs) in the herring fishery, including the method that would be used for setting ABCs for multiple years. This section focuses on the potential effects of the control rule alternatives on non-protected resource predators in terms of herring availability as forage for these species.

In general, alternatives related to the ABC control rule are not expected to have substantial impacts on non-protected species that forage on herring (e.g., tuna and groundfish), positive or negative, because the overall range of alternatives under consideration has relatively small differences in projected catches. **Figure 68** summarizes the range of projected short-term yields and herring biomass estimates under several different herring conditions. While catch levels vary, hence the amount of herring available for predators in the ecosystem varies, the overall magnitude of differences is small in terms of fraction of the estimated total biomass, especially in the long term.

In terms of potential long-term impacts, this MSE process did evaluate a handful of metrics directly related to potential impacts on species that forage on herring. Two of the three species included in the predator modeling are non-protected species – tuna and dogfish. It is important to recognize that these predator models are evaluated over a stock-wide basis; an annual ABC is applied for the entire stock area; they are not spatially explicit and do not address local availability of herring for certain species on smaller spatial scales.

Bluefin tuna: Simulated tuna biomass, numbers, and recruitment were similar across all herring operating models and control rule alternatives. The range of values across all control rule alternatives and operating models was close to 1.0, or projected tuna weights equaling threshold weights. Some performed slightly better than others, but larger differences were observed across operating models compared to control rule alternatives.

While the MSE models did not detect large differences from stock-wide changes in herring biomass, bluefin rely on herring for a substantial portion of their diet and come to the Gulf of Maine to feed on herring as a lipid source (Golet *et al.* 2013; Logan *et al.* 2015). They are highly dependent upon herring, which comprises up to an estimated 70% of their diet (Logan *et al.* 2015). Bluefin body condition has historically increased during this feeding period (Rodriguez-Marin, et al. 2015). Recently, a trend has emerged in which these tuna have difficulty in acquiring the lipids needed to improve body condition late in the season. Thus, they are often found in relatively lean condition. Golet *et al.* (2015) found that in spite of high herring abundance, bluefin were unable to improve body condition by feeding on them, thus bluefin body condition is sensitive to the size (and thus lipid content) of prey even when prey is abundant.

The decline in bluefin condition in the Gulf of Maine may have wide-ranging impacts ecologically. Because bluefin fecundity is influenced by weight, smaller bluefin body conditions may result in decreased egg production and reproductive potential (Medina *et al.* 2002). In addition, fewer large bluefin may remain in the Gulf of Maine because the smaller herring in this area may not improve or maintain body condition. Instead, these fish may forage in areas where herring body condition has not declined and thus larger herring are more prevalent (e.g., Scotian Shelf, Gulf of St. Lawrence). In this manner, the herring condition decline may influence the historical distribution of bluefin tuna (Golet *et al.* 2015). The decline in bluefin condition may also negatively affect users of the bluefin resource economically. Because of the decline in bluefin condition, foreign and domestic buyers and consumers may find smaller bluefin less desirable, resulting in a decline in income from captured tuna. In addition, fishers may have to travel greater distances to fishing grounds to capture the larger, more profitable tuna that no longer forage in the Gulf of Maine.

Dogfish, proxy for groundfish: Based on the NEFSC food habits database, spiny dogfish, Atlantic cod, and silver hake are the top three groundfish predators of herring. Dogfish was deemed the best species to use as a proxy for other groundfish predators because positive relationships with herring biomass were found. Simulated dogfish population metrics showed less variation across operating models and CR alternatives than for tuna and terns. These one to one relationships are difficult to find in the analyses because most predators in this ecosystem are opportunistic, and prey on multiple species when available. In the end, the dogfish metric was not very informative in terms of showing differential impacts of the alternatives, because they essentially all preformed the same, dogfish biomass was not negatively impacted by any of the CR alternatives considered, under any of the operating models tested.

4.4.1.1 Alternatives for ABC control rule

There are four ABC control rule alternatives (in addition to No Action) with several sub-options; each one varies in terms of the parameters that drive the overall shape of each CR, or the mathematical relationship between biomass estimates and catch advice. These approaches are summarized below.

- **No Action/Interim Control Rule.** This is the policy used in recent specification setting processes during fishing years 2013-2018. Under this control rule, the ABC is projected to produce a probability of exceeding F_{MSY} in the third year that is less than or equal to 50%. The same ABC is used for three years.
- **Alternative 1** would implement a rule that is similar to the interim control rule as approximated by its average performance in recent years. This alternative was developed to identify a control rule that would function like the interim control rule, but would be applicable in all cases, regardless of whether abundance is increasing or decreasing.
- **Alternative 2** sets the ABC based on available biomass (SSB), and would identify the ABC associated with a maximum fishing mortality of 50% F_{MSY}. The maximum allowable ABC occurs when the SSB is two times SSB_{MSY}. The fishery is not prosecuted (ABC=0) when SSB/SSB_{MSY} falls below 1.1 times SSB_{MSY}.
- **Alternative 3** is also biomass-based. If SSB is at or about 70% of SSB_{MSY}, fishing mortality is set at 90% of F_{MSY}. Below this SSB value, F decreases. If SSB reaches 30% of SSB_{MSY} (or less), the fishery is not prosecuted (ABC=0). This alternative is closer to No Action in terms of F rates, but includes a fishery cutoff, which is conceptually similar to Alternative 2, although not triggered until a lower biomass value is reached.
- **Alternative 4** is also biomass-based, but accounts for other objectives as well. Specifically, Alternative 4 would set the ABC to achieve specific metrics (or objectives) identified in the Management Strategy Evaluation process. Six distinct ABC control rule sub-options are part of this alternative. The primary metrics used to identify this range of six performance based alternatives are: 1) set %MSY to be 100%, with an acceptable level as low as 85%; 2) set variation in annual yield at <10%, with an acceptable level as high as 25%; 3) set the probability of overfished at 0%, with an acceptable level as high as 25%; and 4) set the probability of a fishery closure (ABC=0) between 0-10%.

The range of ABC control rule alternatives are expected to have generally ***neutral to low positive*** impacts to predator species in this region. Overall, all of the ABC control rule alternatives have similar or lower projected yields for the fishery, so fishing levels are expected to be similar or lower depending on the alternative selected. ABCs are expected to be similar or lower, and when the stock-wide ACL is distributed across the four management areas there is very little change in the management area sub-ACLs. Even if the ABC is reduced to some extent, the potential positive impacts on predator species are limited because the change in yields are generally small, and many predators are opportunistic. In the long term, there were essentially no differences between the alternatives relative to the dogfish biomass metric, and minimal differences for the tuna metric.

In the short term, the range of ABC control rule alternatives have very similar estimates of projected herring biomass; therefore, minimal impacts on predator species are expected from any of the alternatives in the short term. In general, more herring left in the ecosystem unfished could have positive impacts on resources that prey on herring. However, relatively small differences in overall ABC may not have measurable differences in overall impacts on a predator, and many predators in this region are opportunistic. In addition, analyses were conducted on a stock-wide basis and did not include spatial considerations. Therefore, it is possible that herring ABC control rules could maintain generally high overall herring biomass, but other measures or factors could cause herring biomass to be lower in some areas compared to others since herring is migratory and not evenly distributed throughout the region. Therefore, the direct impacts of control rule alternatives 1, 2, 3, and 4a-4e on predator species are expected to be similar, ranging between neutral to low positive, with minimal differences between the alternatives overall. There could be some low positive impacts if more herring are available for predators, but there are many factors involved, so impacts could be somewhat neutral since relatively small changes in herring catches may not directly change the overall population of predators positively or negatively.

When the EBFM PDT considered various control rules for the herring fishery earlier in this process, their report concluded that this system is comparatively complex and unlike many of the ecosystems analyzed in other reports. It is not an upwelling system with strong linkages between primary prey species and predators. Many of the herring predators are generalists, so it is important to consider the effect that the abundance and nutritional value of alternative prey species (e.g., sand lance, squid, silver hake) could have. In addition to prey abundance, availability of prey is an important element of overall predator health, and the EBFM PDT commented that the spatial and temporal aspects of herring availability as prey is not addressed most effectively through a control rule. Spatial and temporal management could be refined or modified to address local ecosystem issues better (NEFMC 2015).

4.4.1.2 Alternatives for setting three-year ABCs

There are two alternatives associated with the method used for setting ABCs in a multiyear specification process.

- **Alternative 1/No Action** would set the same ABC for all three years of a specification cycle.
- **Alternative 2** would also set the ABC for three years, but with annual application of a control rule based on the most recent herring assessment and short-term projections.

Regardless of the alternative selected, three years of ABC values will be set with each specification action, as is currently done. Alternative 2 would allow the ABC and ACLs to vary annually, according to biomass projections and the control rule alternative selected in this action. Neither of these alternatives have direct or indirect impacts on predator species. The ABC values themselves may vary slightly under Alternative 1 and 2 in this section, but the differences are expected to be minimal and relatively stable over the three year time frame. Therefore, the method used to set multiyear ABCs has essentially no direct or indirect impact on predator species, ***neutral impacts*** expected overall for both alternatives.

4.4.1.3 FMP provisions that may be changed through a framework adjustment

The Council recommends that future modifications to the ABC CR could be made by amendment or framework. This section does not have any alternatives; this recommendation is administrative, and would not have any ***direct impacts on predator species, positive or negative***.

4.4.2 Measures to Address Potential Localized Depletion and User Conflicts

During development of this action the Atlantic Herring PDT became aware of five cases in which hypotheses related to localized depletion of Atlantic herring were examined (Appendix VIII). Some negative correlations between herring fishing activity and predator abundance (or whale watch search times) have been identified. However, additional research is still necessary to determine if and how the herring fishery (or midwater trawls specifically) is causing localized depletion of herring to the detriment of predators.

In 2008, the Atlantic Herring Research-Set-Aside Program funded a project to address the RSA priority to define localized depletion of herring on a spatial and temporal scale. Stockwell et al. (2011) attempted a before-after-control-impact study in 2009 based on pilot work in 2008. However, the project was hampered by logistical and budget constraints that resulted in low sample sizes, seriously hampering the results and ability of the project to meet the stated objectives. The project focus shifted to methods development, evaluating the use of acoustics on commercial fishing boats for assessing the possible impacts of midwater trawling on herring aggregations, but no direct results on potential localized depletion were developed (Stockwell *et al.* 2013).

Dr. Walt Golet (GMRI/UMO) has done a substantial amount of research on bluefin migration and diet, and has identified correlations between Atlantic herring and bluefin tuna schools, but that research has not examined localized depletion questions specifically. Golet has been given access by tuna fishermen and dealers to their logbooks, which has spatial catch data at a finer resolution than what is submitted to NMFS. However, these data are proprietary and not readily available to the PDT. He indicated that an investigation of localized depletion would be possible, but would need to draw on many areas of expertise and involve using acoustics, vessels, and the logbook data, be a long-term project, and involve a diverse array of investigators to ensure that causality is appropriately attributed (e.g., tuna fishermen are constrained by weather windows). The biggest concern is study design; this would have to be carefully thought out and by a diverse team. Such an open process is critical for the transparency of results, the most efficient use of any funds which may be available to support this work, and for proper study design (e.g., to ensure causality is correctly identified). Given the complexities of this proposed study, the Council does not expect any information to be available for this action.

Analysis of localized depletion of herring in the tuna fishery is a complex problem. Data clearly show that herring abundance and condition impact the condition and behavior of bluefin tuna. What is not clear is if or how the herring fishery, and specifically the MWT fleet, contributes to this. The lack of precise spatial data available to the PDT from the tuna fishery limits the amount analysis that can be performed on both the scientific and economic impacts of localized depletion due to the herring fishery. These impacts are especially difficult to quantify given the relatively high recent catch rates in the commercial General and Harpoon category bluefin fishery, even during periods of overlap with herring MWT fisheries.

Due to the limited data available on direct assessments of the biological impacts of herring fishing on predators, these analyses are primarily qualitative. There are more detailed analyses of the potential impacts on predator fisheries, and the industries that rely on predators of herring from an economic perspective (Section 4.7), but there is limited information on the direct biological impacts on predators from herring fishing, in particular with MWT gear. Overall, if a measure is expected to shift effort there could be positive impacts on predators in that area, and negative impacts on predators in areas that efforts shifts to. Under some alternatives, the amount of potential effort shift is minimal (i.e. Alternative 2), so generally neutral impacts on predators are expected. In some cases, the alternatives may be very limiting to one gear type (MWT), so vessels may change gear types (i.e. Alternatives 4-6). If vessels convert gear type and herring fishery removals are similar, the impacts on predators would be neutral, but if herring removals are lower as a result of a MWT prohibition, then impacts on predators in that area may be positive, and possibly negative in other areas if effort levels increase in other areas. Some measures are not expected to have direct impacts on predators, such as Alternative 2, thus neutral impacts expected.

4.4.2.1 Alternative 1 (No Action: prohibit MWT gear in Area 1A from June – September)

Under Alternative 1/No Action, vessels fishing for herring with midwater trawl gear are excluded from fishing in Herring Management Area 1A June 1 through September 30. This gear prohibition has likely shifted midwater trawling effort from the Gulf of Maine to Georges Bank during this time period.

This alternative would maintain status quo conditions, which have primarily shifted MWT effort from GOM to GB during the summer (Figure 72 and Figure 73). If it is assumed that this shift has had positive impacts on the predators within the GOM, those positive impacts are expected to continue under No Action. On the other hand, if effort has increased on GB as a result of the No Action alternative, there may have been increased impacts on predators on GB compared to years before the seasonal closure to MWT gear in Area 1A was implemented. However, any increased effort levels on GB are not expected to increase above recent levels, 2011 to present. Overall, ***potentially positive impacts on predators in the GOM are somewhat negated by potentially negative impacts on predators on GB*** from MWT effort shifting from GOM to GB. However, both areas are managed under herring catch limits, so the total level of herring removals is limited. Hard limits help minimize impacts on predators by limiting removals.

4.4.2.2 Alternative 2: Closure within 6 nautical miles from shore in Area 114 to all vessels fishing for Atlantic herring (all gear types)

Under Alternative 2, waters within 6 nm from shore in thirty-minute square 114 off Cape Cod would be closed to all vessels fishing for herring, regardless of gear type or herring permit type. This closure would sunset two years after implementation, unless extended by the Council. Sub-option A would close the area between June 1 and August 31, and sub-option B would close the area for an additional two months, through October 31. This alternative is expected to shift herring fishing with any gear type away from this area. Since midwater trawl gear is already prohibited in Area 1A during the Sub-option A timeframe, under this sub-option, midwater trawl gear use is likely to shift further east onto Georges Bank.

As discussed under Alternative 1, there could be potentially positive impacts on predators that are in this area if effort shifts farther east, but some of those benefits would likely be somewhat neutralized by potentially negative impacts on predators that are distributed in other areas. This area is not typically fished very hard by herring vessels, so the magnitude of potential effort shift is relatively small. Herring fishing effort in this area is higher in some years than others, but on average it is a small fraction of total herring effort (Table 111). Therefore, the ***direct impacts of this alternative on predators is likely neutral***, especially for the shorter seasonal option (Option A) compared to the longer seasonal option (Option B). Therefore, compared to Alternative 1, No Action, the impacts are generally neutral since the amount of potential effort shifting is relatively small.

4.4.2.3 Alternative 3: Year-round prohibition of midwater trawl gear in Herring Management Area 1A

If adopted, this alternative would extend the midwater trawl gear prohibition in Area 1A to be a year-round restriction (Figure 5). Midwater trawls would be allowed to convert to other gear types (purse seine, small mesh bottom trawl) to target herring.

Area 1A is an important fishing ground for the midwater trawl fleet during certain seasons, and a year-round restriction under Alternative 3 would likely provide incentives for vessels to switch gears. Shifting to use of a bottom trawl would likely be easier than shifting to use of purse seine gear, given that midwater trawl vessels and their crews are already configured for mobile gear use. However, bottom trawl use in Area 1A is restricted under habitat and groundfish regulations, with year-round closures in the Western Gulf of Maine habitat and groundfish closure areas (which overlap one another), and seasonal closures associated with the cod protection closures and cod spawning protection areas. In addition, small mesh bottom trawls can only be used in certain exemption areas. Given the extensive restrictions on the use of small mesh bottom trawls in the Gulf of Maine, vessels would convert purse seine gear or decide not to fish in Area 1A. Overall, Alternative 3 would likely have ***neutral*** impacts on predators if vessels convert to purse seine gear and remove the same levels of herring from Area 1A.

If MWT vessels do not convert to purse seine gear and stop fishing in Area 1A altogether, it is likely that existing purse seine vessels plus MWT vessels that already convert to purse seine gear, would be able to harvest the full Area 1A TAC; therefore, neutral impacts on predators are expected since the same amount of herring would be removed from the area. That said, purse seine and MWT vessels operate differently, and removals of herring may be more spread out if fewer vessels are targeting the entire Area 1A quota with purse seine gear only. If that is the case there could be low positive impacts on predators in Area 1A if herring fishing is more spread out in the fall. MWT vessels will want to make up that lost revenue in Area 1A so may increase effort in other herring management areas, with potentially increased negative impacts on predators in other areas (GB and SNE/MA). Both of those areas currently have underutilized sub-ACLs, so effort could increase, compared to Area 1B that is already fully harvested. When all the different possible scenarios are considered, the overall impacts of this alternative ***range from low negative to low positive*** on predators, some could experience increased impacts if effort shifts to an area where that predator is more prevalent (i.e. haddock on GB), or low positive impacts on predators within Area 1A if removals of herring are lower per week if fewer vessels fish in that area as a result of this measure.

Compared to Alternative 2 and Alternative 1, this measure has low negative to low positive impacts depending on how fishing behavior changes as a result of this measure.

4.4.2.4 Alternative 4: Prohibit midwater trawl gear inside of 12 nautical miles south of Area 1A

If this alternative is adopted, waters within 12 nm from shore and south of Herring Management Area 1A would be closed to midwater trawl gear. Various area and season options were considered. Area options include sub-option A, Herring Management Areas 1B, 2, and 3, while sub-option B includes 1B and 3 only. Seasonal options include sub-option A, year-round, and sub-option B, June 1-September 30.

The area due east of Cape Cod and the area immediately off Rhode Island are consistently fished by midwater trawl gears, and this effort would be shifted out of these areas under Alternative 4. Effort east of Cape Cod would be displaced under either area sub-option, while effort in both areas would be displaced only if sub-option A is selected. Year-round restrictions would have a greater effect of effort shifts than seasonal prohibitions. Because the seasonal prohibition is the same as the 1A closure, under area sub-option A, nearly all midwater trawl effort would shift onto Georges Bank, beyond 12 nm from shore. Under area sub-option B, midwater trawls could be used on Georges Bank or in Area 2.

Depending on the response of the vessels, impacts to predator species will vary. If vessels primarily shift to areas just outside the 12nm boundary, effort may remain similar to current conditions in these general areas or, it may decrease due to the vessels inability to access nearshore waters needed to attain the respective management area TAC. Under these circumstances, ***impacts to predators may be somewhat neutral, with less impacts in nearshore waters, but greater impacts just outside 12nm***, where many predators are still present.

There is a sub-option that excludes Area 2, and if vessels shift to that area, impacts on predators could increase in Area 2, with positive impacts on predators in Areas 1B and 3. In this case, MWT vessels that once fished within the nearshore waters (within 12nm) of Areas 1B and 3 would also potentially shift effort to offshore waters within Area 3, where there is more ability to harvest the area TAC due to the accessibility to the herring resource. Depending on the number of vessels operating in Area 3 at a specific time, effort in this management area has the potential to increase or remain similar to current operating conditions. Should effort increase in offshore areas within herring Management Area 3, there is the potential for increased impacts on predators in that area, possibly negating some of the benefits to predators in nearshore areas.

This alternative could create incentives for MWT vessels to convert to bottom trawl gear in order to attain the Management Area TAC allocated to Area 1B, 2, and 3, but less incentive than

Alternatives 5 and 6, which prohibit MWT gear in larger areas (25 and 50 nm respectively). Combined with existing bottom trawls already operating in these herring management areas, should this scenario occur, bottom trawl effort in the nearshore waters could increase. If this scenario occurs there may be more neutral impacts on predators, if similar amounts of herring are removed from the ecosystem just by a different gear type.

The overall impacts on predators are somewhat uncertain because it is unclear how vessels will respond to these relatively large gear restriction areas. Taking into consideration the above scenarios, Alternative 4 has the potential to result in impacts ranging from ***low negative to low positive*** on predators depending on how the fleet responds to this alternative. Relative to the No action (Alternative 1), Alternative 4 has the potential to result in impacts that range from low negative on predators farther offshore if more effort shifts to those areas to low positive on predators in nearshore areas if effort reduces as a result of this alternative.

4.4.2.5 Alternative 5: Prohibit midwater trawl gear inside of 25 nautical miles in areas south of Herring Management Areas 1A

If this alternative is adopted, waters within 25nm from shore and south of Herring Management Area 1A would be closed to midwater trawl gear. Various area and season options were considered. Area options include sub-option A, Herring Management Areas 1B, 2, and 3, while sub-option B includes 1B and 3 only. Seasonal options include sub-option A, year-round, and sub-option B, June 1-September 30.

Effort shifts are expected to be similar to those for Alternative 4, but with midwater trawls shifted further offshore. Shifts in midwater trawl effort alone are likely to have ***low positive*** impacts on predators in nearshore areas ***and low negative*** impacts on predators in offshore areas if effort shifts fishing activity farther offshore.

There is a sub-option that excludes Area 2, and if vessels shift to that area, impacts on predators could increase in Area 2, with positive impacts on predators in Areas 1B and 3. In this case, MWT vessels that once fished within the nearshore waters (within 25nm) of Areas 1B and 3 would also potentially shift effort to offshore waters within Area 3, where there is more ability to harvest the area TAC due to the accessibility to the herring resource. Depending on the number of vessels operating in Area 3 at a specific time, effort in this management area has the potential to increase or remain similar to current operating conditions. Should effort increase in offshore areas within herring Management Area 3, there is the potential for increased impacts on predators in that area, possibly negating some of the benefits to predators in nearshore areas.

This alternative could create incentives for MWT vessels to convert to bottom trawl gear in order to attain the Management Area TAC allocated to Area 1B, 2, and 3, more incentive than Alternative 4, but less than Alternative 6, which prohibits MWT gear within 50 nm of shore. Combined with existing bottom trawls already operating in these herring management areas, should this scenario occur, bottom trawl effort in the nearshore waters could increase. If this scenario occurs there may be more neutral impacts on predators, if similar amounts of herring are removed from the ecosystem just by a different gear type.

The overall impacts on predators are somewhat uncertain because it is unclear how vessels will respond to these relatively large gear restriction areas. Taking into consideration the above scenarios, Alternative 5 has the potential to result in impacts ranging from ***low negative to low positive*** on predators depending on how the fleet responds to this alternative. Relative to the No action (Alternative 1), Alternative 5 has the potential to result in impacts that range from low negative on predators farther offshore if more effort shifts to those areas to low positive on predators in nearshore areas if effort reduces as a result of this alternative.

4.4.2.6 Alternative 6: Prohibit midwater trawl gear inside of 50 nautical miles in waters south of Herring Management Areas 1A

If this alternative is adopted, waters within 50 nm from shore and south of Herring Management Area 1A would be closed to midwater trawl gear. Various area and season options were considered. Area options include sub-option A, Herring Management Areas 1B, 2, and 3, while sub-option B includes 1B and 3 only. Seasonal options include sub-option A, year-round, and sub-option B, June 1-September 30.

Effort shifts are expected to be similar to those for Alternative 4 and 5, but with midwater trawls shifted further offshore. Shifts in midwater trawl effort alone are likely to have ***low positive*** impacts on predators in nearshore areas ***and low negative*** impacts on predators in offshore areas if effort shifts fishing activity farther offshore.

There is a sub-option that excludes Area 2, and if vessels shift to that area, impacts on predators could increase in Area 2, with positive impacts on predators in Areas 1B and 3. In this case, MWT vessels that once fished within the nearshore waters (within 50nm) of Areas 1B and 3 would also potentially shift effort to offshore waters within Area 3, where there is more ability to harvest the area TAC due to the accessibility to the herring resource. Depending on the number of vessels operating in Area 3 at a specific time, effort in this management area has the potential to increase or remain similar to current operating conditions. Should effort increase in offshore areas within herring Management Area 3, there is the potential for increased impacts on predators in that area, possibly negating some of the benefits to predators in nearshore areas.

This alternative could create incentives for MWT vessels to convert to bottom trawl gear in order to attain the Management Area TAC allocated to Area 1B, 2, and 3, especially since large fractions of total herring landings have occurred within 50 nm all herring management areas. If MWT vessels decide to convert to BT to maintain access to nearshore areas than bottom trawl effort in the nearshore waters is likely to increase. If this scenario occurs there may be more neutral impacts on predators, if similar amounts of herring are removed from the ecosystem just by a different gear type.

The overall impacts on predators are somewhat uncertain because it is unclear how vessels will respond to these relatively large gear restriction areas. Taking into consideration the above scenarios, Alternative 6 has the potential to result in impacts ranging from ***low negative to low positive*** on predators depending on how the fleet responds to this alternative. Since this alternative overlaps more herring fishing areas, vessels may be more likely to convert gear type rather than shift fishing areas. Relative to the No action (Alternative 1), Alternative 6 has the potential to result in impacts that range from low negative on predators farther offshore if more effort shifts to those areas, to low positive on predators in nearshore areas if effort reduces inshore as a result of this alternative. But again, if vessels convert to bottom trawl gear to maintain access to nearshore areas, the impacts on predators will be more neutralized.

4.4.2.7 Alternative 7: Prohibit midwater trawl gear within thirty minute squares 99, 100, 114, 115 and 123

If this alternative is adopted, vessels with midwater trawl gear would be prohibited from fishing within several thirty minute squares (Areas 99, 100, 114, 115, and 123). Various area and seasonal options were considered. Area options include sub-option A, Herring Management Areas 1B, 2, and 3 (all 30-minute squares), while sub-option B includes 1B and 3 only (30-minute squares 99, 114, and 123). Seasonal options include sub-option A, year-round, and sub-option B, June 1-September 30.

Alternative 7 would have fewer effects on fishing effort than Alternative 6 (50 nm), potentially similar to Alternatives 4 and 5 with the sub-options that focus just on Areas 1B and 3, and likely less than Alternatives 2 and 3. Area 114 in particular is the portion of this alternative that is fished by midwater trawls. Fishing effort off RI and in the Great South Channel would not be affected by Alternative 7.

Depending on the response of the vessels, impacts to predator species will vary. If vessels primarily shift to areas just outside Alternative 7, effort may remain similar to current conditions in these general areas or, it may decrease due to the vessels inability to access nearshore waters needed to attain the respective management area TAC. Under these circumstances, ***impacts to predators may be somewhat neutral, with less impacts in nearshore waters surrounding Cape Cod, but greater impacts just outside these boundaries***, where many predators are still present.

In general, the magnitude of effort shift that may happen as a result of this action is lower than others under consideration. Alternative 7 has the potential to result in impacts ranging from ***low negative to low positive*** on predators depending on how the fleet responds to this alternative. Relative to the No action (Alternative 1), Alternative 7 has the potential to result in impacts that range from low negative on predators farther offshore if more effort shifts to those areas to low positive on predators in nearshore areas if effort reduces as a result of this alternative. There is a sub-option that excludes Area 2, and if vessels shift to that area, impacts on predators could increase in Area 2, with positive impacts on predators in Areas 1B and 3.

4.4.2.8 Alternative 8: Revert the boundary between Herring Management Areas 1B and 3 back to original boundary

This alternative would revert the Herring Management Area boundaries between Area 1B and 3 back to what they were under the original Herring FMP, but maintain the current boundary between Areas 2 and 3. This action alone would reduce the allowable fishing effort east of Cape Cod because the TAC for Area 1B is relatively low, and Area 3 fishing that currently takes place east of Cape Cod would be shifted farther offshore to GB. This could have ***beneficial impacts on predators that feed on herring east of Cape Cod, and potentially low negative impacts on predators that are on GB***. However, a future action may adjust the Area 1B and 3 TACs if the boundaries change in this action. If that is the case then overall impacts on predators would be more ***neutralized*** if overall fishing pressure is similar when TACs are adjusted. Therefore, the direct impacts on predators are ***somewhat uncertain*** and depend on whether future TACs are adjusted, which would be fully analyzed in a future action.

Overall this measure has neutral impacts compared to No Action, especially if TACs are adjusted in a future action and overall fishing patterns are similar, or similar amounts of herring expected to be removed from similar areas. However, if the boundary changes and the TACs do not change then less herring would be available from the area that is currently part of Area 3, but would become part of Area 1B under this alternative.

4.4.2.9 Alternative 9: Remove seasonal closure of Area 1B

This alternative would remove the existing January 1 – April 30 closure in Area 1B. Given prior fishery use of the area, effort would potentially extend over a longer period of time and begin earlier in the year, compared to a relatively short season extending only several weeks in May.

If the seasonal restriction is removed it is assumed that effort would return to fishing patterns before the closure was in place, but that may not be the case. If herring fishing returns to more of a winter fishery for this area with effort more spread out it is possible ***there could be benefits to predators*** in this region, compared to possible negative effects if larger amounts of herring are removed from a relatively small area rather quickly, i.e. matter of weeks in some cases. That said, this action does not direct when and where fishing occurs within Area 1B, and conditions change every year; the area may still be fished in the spring and relatively quickly if fishing conditions support that. Therefore, there could be some benefits on some predators if fishing patterns change as a result of this action, ***but the impacts are not certain*** because fishing patterns could also remain similar if this alternative is selected.

4.5 IMPACTS ON PROTECTED SPECIES (FISH, SEA TURTLES, MARINE MAMMALS, SEABIRDS)

Protected species are those afforded protections under the Endangered Species Act (ESA; species listed as threatened or endangered under the ESA) and/or the Marine Mammal Protection Act (MMPA). Section 3.4 lists protected species that occur in the affected environment of the Atlantic herring FMP and the potential for the fishery to impact the species, specifically via interactions with Atlantic herring fishing gear. Some species of seabirds are protected under the ESA, and others are not but are predator species of Atlantic herring. Because Atlantic herring was identified as an important predator species of some seabirds in this ecosystem during development of this action, this VEC was expanded to include information about seabirds that prey on Atlantic herring in this region. The protected species potentially affected by this action are sea turtles, large whales, small cetaceans and pinnipeds, Atlantic sturgeon, Atlantic salmon, and some species of seabirds.

The most common gear types used in the herring fishery are purse seines, midwater trawls, and bottom trawls. To evaluate the impacts on protected species and seabirds, it is important to note that the majority of landings is by the midwater trawl fishery, but the majority of activity in terms of trips and permits is to purse seine vessels. Section 3.6.1.5 characterizes the fishing days, number of trips, and pounds landed by area and gear type. Although herring fishing is a year-round activity, takes of protected species and seabirds are more likely to occur in specific seasons, not throughout the year. In addition to the potential impacts from incidental takes, this section also assess the potential impacts on protected species and seabirds in terms of forage impacts. Some protected species and seabirds in this region prey on Atlantic herring.

NMFS, relatively recently, concluded that the Atlantic Herring FMP will not adversely affect or jeopardize the continued existence of any ESA listed species (NMFS 2014a). With respect to Amendment 8, there will not be major changes in the amount or areas that herring vessels fish from most of the alternatives under consideration. The alternatives under consideration that may impact herring fishing patterns directly are identified, and potential impacts are described. Discussions regarding potential interactions with protected species and seabirds as well as impacts on prey availability are largely qualitative and based on whether alternatives under consideration are expected to shift effort to areas that may have increased interactions, or change gear types that may have differential impacts on protected resources. Many protected species migrate through and forage within areas that overlap where the herring fishery operates. The alternatives under consideration are evaluated below in terms of whether they are expected to greatly change the availability of herring as prey, or shift herring effort from areas or seasons that have different levels of potential interactions with protected species.

4.5.1 Atlantic herring ABC control rule

These alternatives specify the formulaic approach, or control rule, used for determining annual target fishing levels in the herring fishery, including the timeframe over which the determinations would apply, and the mechanism (amendment or framework) for control rule updates. The focus in this section is on the potential effects of the control rule alternatives on protected resources in terms of potential gear interactions and impacts on forage.

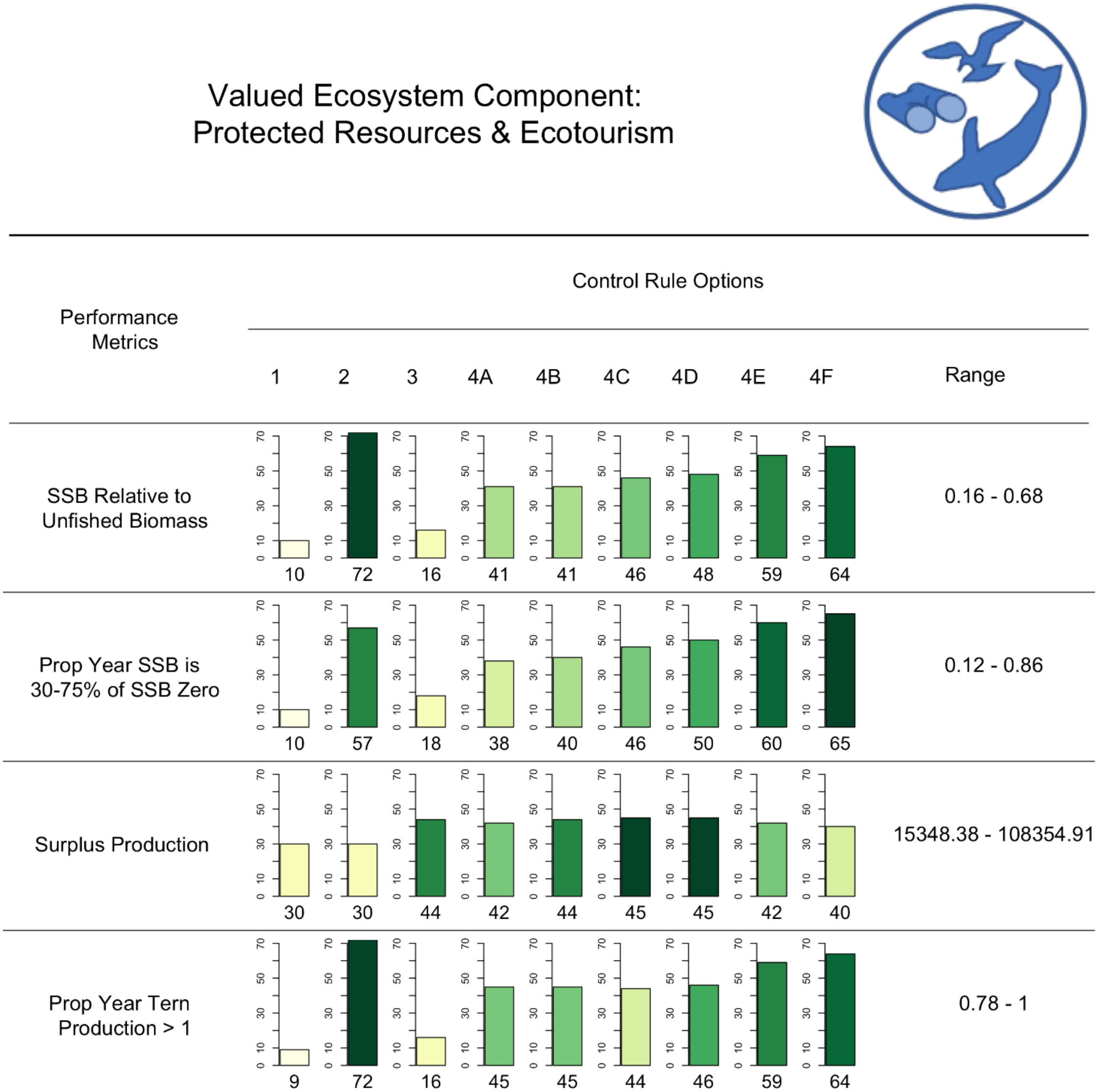
In general, alternatives related to the ABC control rule are not expected to have substantial impacts to protected species and seabirds, positive or negative, because the overall range of alternatives under consideration has relatively small differences in projected biomass estimates under the different alternatives. Figure 68 and Figure 69 summarize the range of projected short-term yields and herring biomass estimates under several different herring conditions. While the level of potential gear interactions or impacts on overall forage available may vary under different alternatives, the overall magnitude of differences are small.

This MSE process did investigate whether a metric for marine mammals could be developed. Diet information for a wide range of marine mammals suggest that the species with the highest proportions of herring in their diets are: minke whales, humpback whales, harbor seals, and harbor porpoises (Smith *et al.* 2015). However, no data are available to parametrize a stock-recruit relationship for any species, and there were none in the literature for stocks in this region. Analysts did update an existing food web model for the Gulf of Maine to evaluate potential effects of changes in herring production and/or biomass on marine mammals (Link et al, 2008; Appendix III). Overall, food web modelling showed that a simulated increase in herring production may produce modest but uncertain benefits to marine mammal predators, primarily because increased herring was associated with decreases in other forage groups that marine mammals also prey on. There are tradeoffs to consider with increased herring and decreased productivity of other forage groups in terms of expected benefits to predators. Many protected species predators in this region are opportunistic and rely on many prey, so increases of one prey could have negative impacts on other prey species in that forage group.

While a specific metric could not be developed for marine mammals, the MSE process did include a specific metric for tern production, to evaluate the potential impacts of ABC control rules on tern production. In addition, several more general herring biomass parameters can be used as metrics to evaluate prey availability in general. These metrics have been combined into one overall table with the summary results for the predator species VEC (Figure 98). The metrics identified that best represent potential impacts on protected species are: SSB relative to unfished biomass, proportion of years SSB is 30-75% of unfished biomass, surplus production, and tern production. When evaluating the summary results it is helpful to also review the individual results for each metric that include the results across operating models, or different potential states of nature. In some cases, an alternative may rank low overall for example, but based on the individual results, it may actually perform only slightly worse than other alternative. The overall range of results per metric are included in the right-hand column of Figure 98 to characterize the range of results across all control rule alternatives. For example, the range of results for the tern production metric is relatively small, all alternatives perform relatively well for that metric. Therefore, there are minimal differences in terms potential impacts of different ABC control rules on tern production in the long term.

Figure 98 – Summary of the metrics that are indicators of potential impacts on the valued ecosystem metric – <u>protected resources and associated ecotourism businesses that depend on those resources</u>

Protected resource Metrics: SSB relative to unfished biomass, surplus production, and tern productivity.



4.5.1.1 Alternatives for ABC control rule

There are four ABC control rule alternatives (in addition to No Action) with several sub-options; each one varies in terms of the parameters that drive the overall shape of each CR, or the mathematical relationship between biomass estimates and catch advice:

- **No Action/Interim Control Rule.** This is the policy used in recent specification setting processes during fishing years 2013-2018. Under this control rule, the ABC is projected to produce a probability of exceeding F_{MSY} in the third year that is less than or equal to 50%. The same ABC is used for three years.
- **Alternative 1** would implement a rule that is similar to the interim control rule as approximated by its average performance in recent years. This alternative was developed to identify a control rule that would function like the interim control rule, but would be applicable in all cases, regardless of whether abundance is increasing or decreasing.
- **Alternative 2** sets the ABC based on available biomass (SSB), and would identify the ABC associated with a maximum fishing mortality of 50% F_{MSY}. The maximum allowable ABC occurs when the SSB is two times SSB_{MSY}. The fishery is not prosecuted (ABC=0) when SSB/SSB_{MSY} falls below 1.1 times SSB_{MSY}.
- **Alternative 3** is also biomass-based. If SSB is at or about 70% of SSB_{MSY}, fishing mortality is set at 90% of F_{MSY}. Below this SSB value, F decreases. If SSB reaches 30% of SSB_{MSY} (or less), the fishery is not prosecuted (ABC=0). This alternative is closer to No Action in terms of F rates, but includes a fishery cutoff, which is conceptually similar to Alternative 2, although not triggered until a lower biomass value is reached.
- **Alternative 4** is also biomass-based, but accounts for other objectives as well. Specifically, Alternative 4 would set the ABC to achieve specific metrics (or objectives) identified in the Management Strategy Evaluation process. Six distinct ABC control rule sub-options are part of this alternative. The primary metrics used to identify this range of six performance based alternatives are: 1) set %MSY to be 100%, with an acceptable level as low as 85%; 2) set variation in annual yield at <10%, with an acceptable level as high as 25%; 3) set the probability of overfished at 0%, with an acceptable level as high as 25%; and 4) set the probability of a fishery closure (ABC=0) between 0-10%.

The range of ABC control rule alternatives are expected to have generally ***low negative*** impacts to protected species and seabirds in this region, ***but compared to No Action, there may be neutral to low positive impacts***. From an incidental take perspective, while MMPA protected species interactions with the herring fishery are common, ESA listed species interactions with the Atlantic herring fishery are rare to non-existent, and no new risks are expected. Overall, all of the ABC control rule alternatives have similar or lower projected yields for the fishery, so fishing levels are expected to be similar or lower depending on the alternative selected. ABCs are expected to be similar or lower, and when the stock-wide ACL is distributed across the four management areas there is very little change in the management area sub-ACLs. Even if the ABC is reduced to some extent, the impacts on ESA and MMPA protected species are not expected to change much form current levels under No Action. As interactions can still occur under all of the alternatives, even with reduced effort, the impacts of an alternative (on its own) is low negative. However, if one alternative comparted to another is expected to have reduced effort, and thus, a reduced potential for interactions, than that alternative relative to other will have positive impacts to protected species. The potential for incidental takes of marine mammals and seabirds could be higher under Alternatives 1 and 3 compared to Alternative 4, and especially compared to Alternative 2, because the yields are lower. However, all alternatives are at similar or lower levels of yield compared to current activity, so impacts on incidental takes are expected to be neutral to low negative, with some alternatives potentially having more positive impacts compared to No Action than others if total effort reduced (Alternativ2 2 and some options of Alternative 4).

From a forage perspective, the range of ABC control rule alternatives produce very similar estimates of projected herring biomass in the short term (Figure 79). In the long term, there are larger differences between the alternatives, but they are in the range of No Action, or higher biomass estimates. There was insufficient data available to build a specific metric to evaluate the control rules in terms of marine mammal abundance. Several metrics from the MSE analysis can be used as proxies for potential impacts on protected resources, and one was specific to seabirds. For example, the metrics that evaluate biomass relative to unfished biomass, surplus production, and tern productivity can all be used to evaluate the potential impacts on protected resources. Alternatives 2 and 4 rank highest for these metrics, but in some cases the differences between alternatives is not substantial. For example, all alternatives are expected to maintain tern productivity at a high level, some slightly higher than other, but overall they all perform well for that metric. Alternative 2 is expected to maintain herring biomass at a higher fraction of unfished biomass (about 35-75% of B_0), compared to other alternatives (closer to 20-40% of B_0).

These metrics provide a way to evaluate the potential impacts relative to herring availability as prey for protected species and seabirds in the ecosystem, and overall the results suggest ***neutral to low positive*** impact compared to No Action, biomass may be higher for some alternatives, but the direct impacts on protected resources are somewhat uncertain; there may be modest benefits, but many predators are opportunistic and there may be negative impacts on other prey species that need to be factored in.

4.5.1.2 Alternatives for setting three-year ABCs

There are two alternatives associated with the method used for setting ABCs in a multiyear specification process.

- **Alternative 1/No Action** would set the same ABC for all three years of a specification cycle.
- **Alternative 2** would also set the ABC for three years, but with annual application of a control rule based on the most recent herring assessment and short-term projections.

Regardless of the alternative selected, three years of ABC values will be set with each specification action, as is currently done. Alternative 2 would allow the ABC and ACLs to vary annually, according to biomass projections and the control rule alternative selected in this action. Neither of these alternatives have direct or indirect impacts on protected species and seabirds because the alternatives do not affect the spatial distribution or intensity of fishing activities. The ABC values themselves may vary slightly under Alternative 1 and 2 in this section, but the differences are expected to be minimal and relatively stable over the three-year time frame. Therefore, the length of time an ABC is in place has essentially no direct or indirect impact on protected species and seabirds, ***neutral impacts*** expected overall for both alternatives.

4.5.1.3 FMP provisions that may be changed through a framework adjustment

The Council recommends that future modifications to the ABC CR could be made by amendment or framework. This section does not have any alternatives; this recommendation is administrative, and would have ***no direct impacts on protected species and seabirds, positive or negative***.

4.5.2 Potential Localized Depletion and User Conflicts

The primary sources of information used by the PDT for these analyses are: 1) incidental take maps created by the Protected Species Division at GARFO (Section 4.5.2.1); 2) available information on seabird foraging and incidental take (Section 4.5.2.2); and 3) consideration of how effort should shift due to this action. Overall, the main driver of assessing the potential impacts on protected species impacts is ***where will effort (and associated gear type) shift to*** and ***how will fishing behavior change in the area relative to current conditions***. Section 4.1.2.5. p. 277 summarizes input the PDT requested from herring industry advisors related to potential effort shifts from these measures. This input was taken into consideration when evaluating the over potential impacts on protected species. In general, the main driver of these impact findings is how the alternatives could affect incidental take and interactions with protected species. Forage information is also summarized, but because these foodwebs are complex and these predators have other prey options, the impacts can be somewhat indirect. Therefore, information on forage is summarized, but the overall impact finding is generally more influenced by the potential impacts on protected resources in terms of the potential for incidental take.

4.5.2.1 Marine mammal incidental take maps

The marine mammal incidental take maps will help in assessing protected impacts; however, there's always the caveat, depending on observer coverage rates and area observed, an area on a map that is absent of documented takes may not mean interactions do not occur in that area. Instead, it may just mean, observers were never onboard vessels fishing in that area and therefore, we have no take information available for that site. In situations like this, the best that can be done is to take a look at observed interactions (with gear of interest) in surrounding areas, as well as information on species distribution in space and time to see if co-occurrence is likely when vessels are expected to be in the area.

Looking at the marine mammal incidental take maps (2007-present), there have been numerous observed MWT takes in the GB area. When the data are examined more closely, the majority of observed interactions on MWT vessels in Area 3 occurred in the summer, when Area 1A is closed to those vessels. Consideration of each LD alternative and how each may change existing effort in GB is needed. For example, any LD alternative that may result in more MWT vessels on GB, relative to current conditions, may result in more interactions in this area (again magnitude of interaction risk is, in part, associated with tow times). Alternatively, if an LD alternative resulted in a shift in MWT effort out of the GB area, there could be some benefits experienced by protected species as effort is moving out of a relatively high interaction area, and potentially being redistributed to an area with a lower risk of an interaction (which we would need to define and provide information to support that the area is a "low risk" area).

An alternative consideration is purse seines. Taking a look at the marine mammal observed interaction maps, purse seine interactions in the Northern GOM are high. Similar to the considerations made for MWT vessels, under each LD alternative, how will purse seine presence and effort potentially change if MWT vessels are prohibited (seasonally or year round). Any increase in the number of purse seines or the duration of tows in this area, has the potential to increase interactions in this area.

Figure 99 – Observed marine mammal interactions with the herring fishery (i.e. defined as vessels targeting herring with the gears specified) pre-Amendment 1 (top) and post Amendment 1 (bottom) with relevant herring management areas

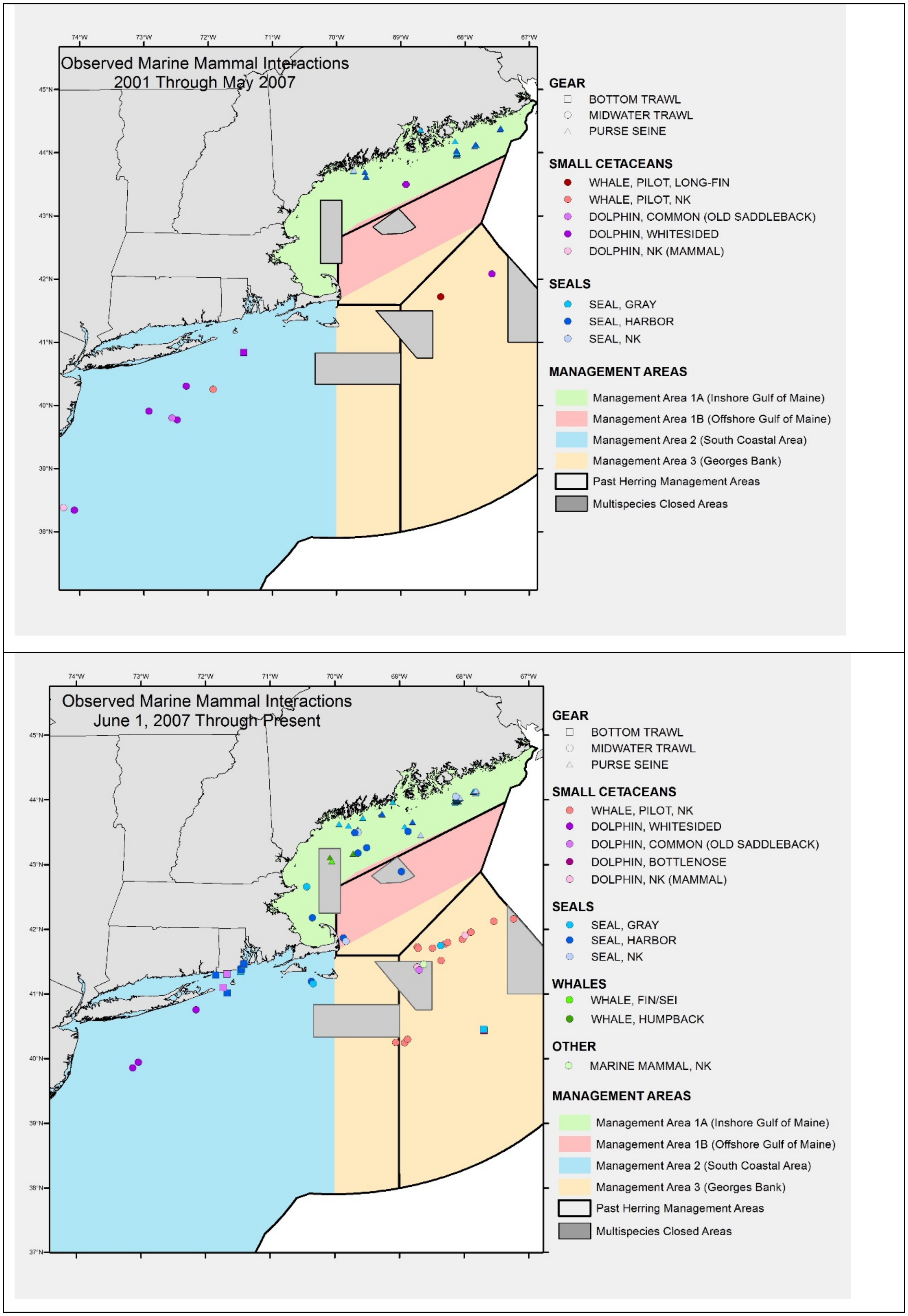
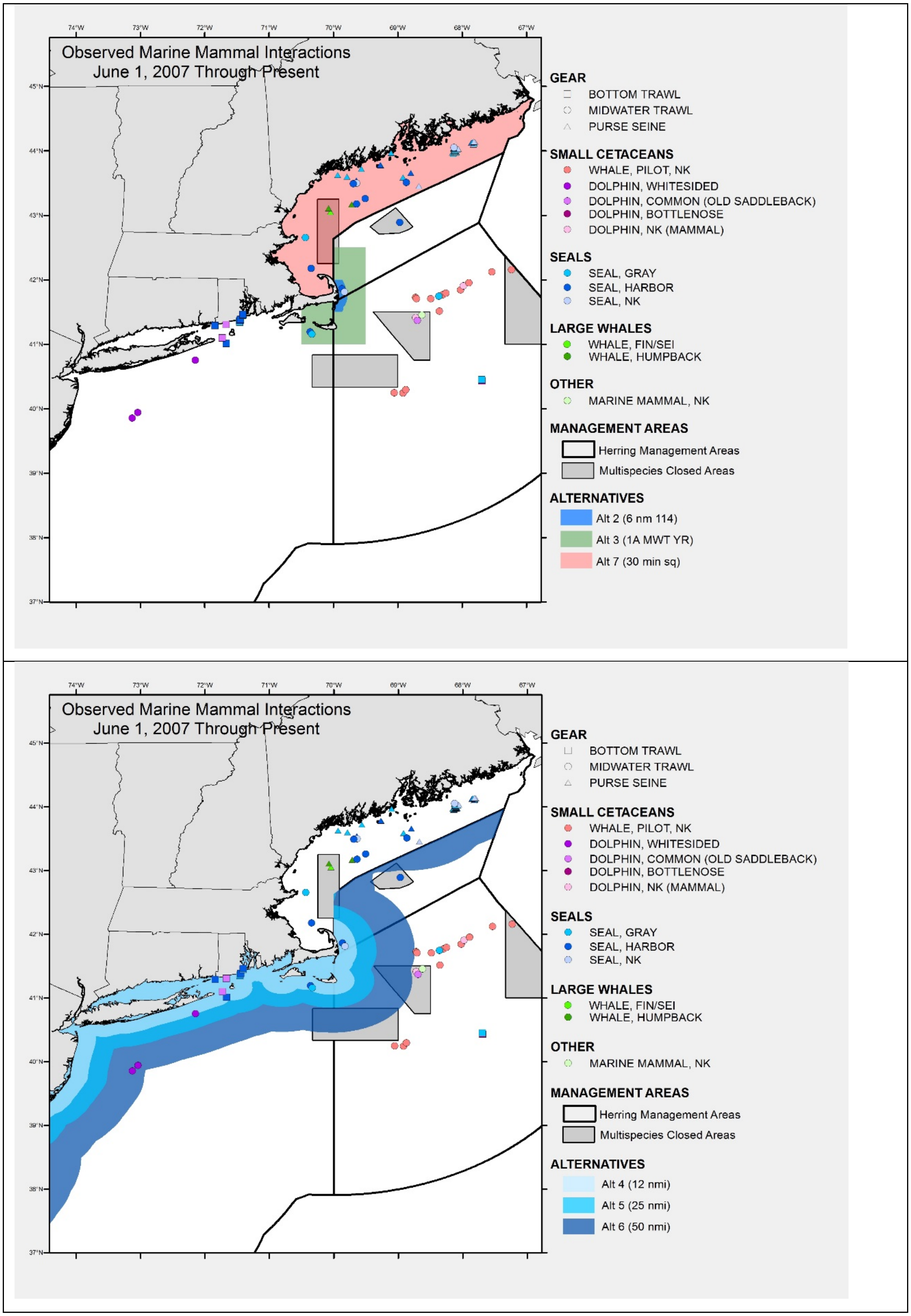


Figure 100 – Observed marine mammal interactions with the herring fishery (i.e. defined as vessels targeting herring with the gears specified) overlayed with Alternatives 2, 3 and 7 (top) and Alternatives 4, 5, and 6 (bottom) with relevant herring management areas



4.5.2.2 Additional information on potential impacts on seabirds

Seabird fledging success is determined not only by the abundance of forage species, but also by the availability of forage species near breeding colonies during the breeding season (Clay et al. 2014). Therefore, localized depletion of forage fish can have adverse effects on nesting seabirds. Some seabirds migrate great distances and require suitable habitat, including suitable food sources, at key locations along their migratory routes. During development of this action, stakeholders provided specific information about the species of birds that are potentially more dependent on herring. Staff from USFWS helped to identify the subset of species that are known to consume herring from the overall list of priority species for this region (Table 18). Furthermore, the MSE analysis prepared for the ABC control rule section of Amendment 8 included a specific metric for common tern, a species that generally has a higher proportion of herring in its' diet and has more extensive data on counts of breeding pairs and estimates of fledging success.

Correspondence to the Council included references about seabird diet and foraging behavior that are considered in these draft impacts (Goyert 2015 and Goyert 2014). Herring is among the top prey items fed to common tern chicks in Massachusetts, comprising over 20% of their diet (see Bird Island, Table 92). Between 1998-2009, the USFWS documented that common terns nesting on Petit Manan Island (Steuben ME) fed their chicks an average of 61% herring (range: 40-91%) and productivity was 1.06 chicks / pair (USFWS unpub data). During the last seven years, the amount of herring that common terns fed their chicks declined to an average of 21% herring (range: 11-34%) and common tern productivity declined by 25% (average of 0.79 chicks / pair). Atlantic puffin colonies in Maine have experienced similar declines in amount of herring fed to chicks and annual productivity. Since 2010, the amount of herring fed to puffin chicks has declined by approximately 60% while average productivity has declined by 24% (USFWS and National Audubon Society unpub data). This information indicates that the seabirds were not able to switch to other forage fish to compensate for a decrease in herring availability at this colony. On Machias Seal Island (Maine / NB border), terns, Atlantic puffins, and razorbills fed their chicks a diet that averaged 60-90% herring from 1995-2000. By 2000, the amount of herring in the seabirds' diets declined to less than 40%. In recent years, the amount of herring has continued to decline and now represents 10-20% or less of the seabird diet (Lauren Scopel, University of New Brunswick, pers comm.). Recent analysis of herring stocks and seabird diet determined that juvenile herring in the eastern Gulf of Maine are now less abundant and may have lower productivity than herring in the western Gulf of Maine. This analysis also concluded that common terns, puffins, and razorbills select herring preferentially, supporting the need for cautious herring management (Scopel *et al.* 2017).

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Outer Cape Cod is known as a foraging hot spot for Common and Roseate terms, especially near Monomoy Island; the largest breeding colony for Common terns in New England (11,000 pairs in 2017). The USFWS estimates that up to 45,000 pairs of terns may stage (rest and refuel) on Cape Cod each fall for up to 8 weeks before the birds migrate to South America. Based on tagging data, the foraging range during breeding and post-breeding has been documented as far as 50km or 27nm between sites. However, a more typical foraging distance may be 30 km (16 nm; Figure 101). This figure shows sandlance, another food source for common tern, but the foraging distance (open black circles) is the relevant part of the figure – about 30km from the shore. Common tern colonies are found along the coast throughout New England, and as far south as Long Island, NY and coastal New Jersey.

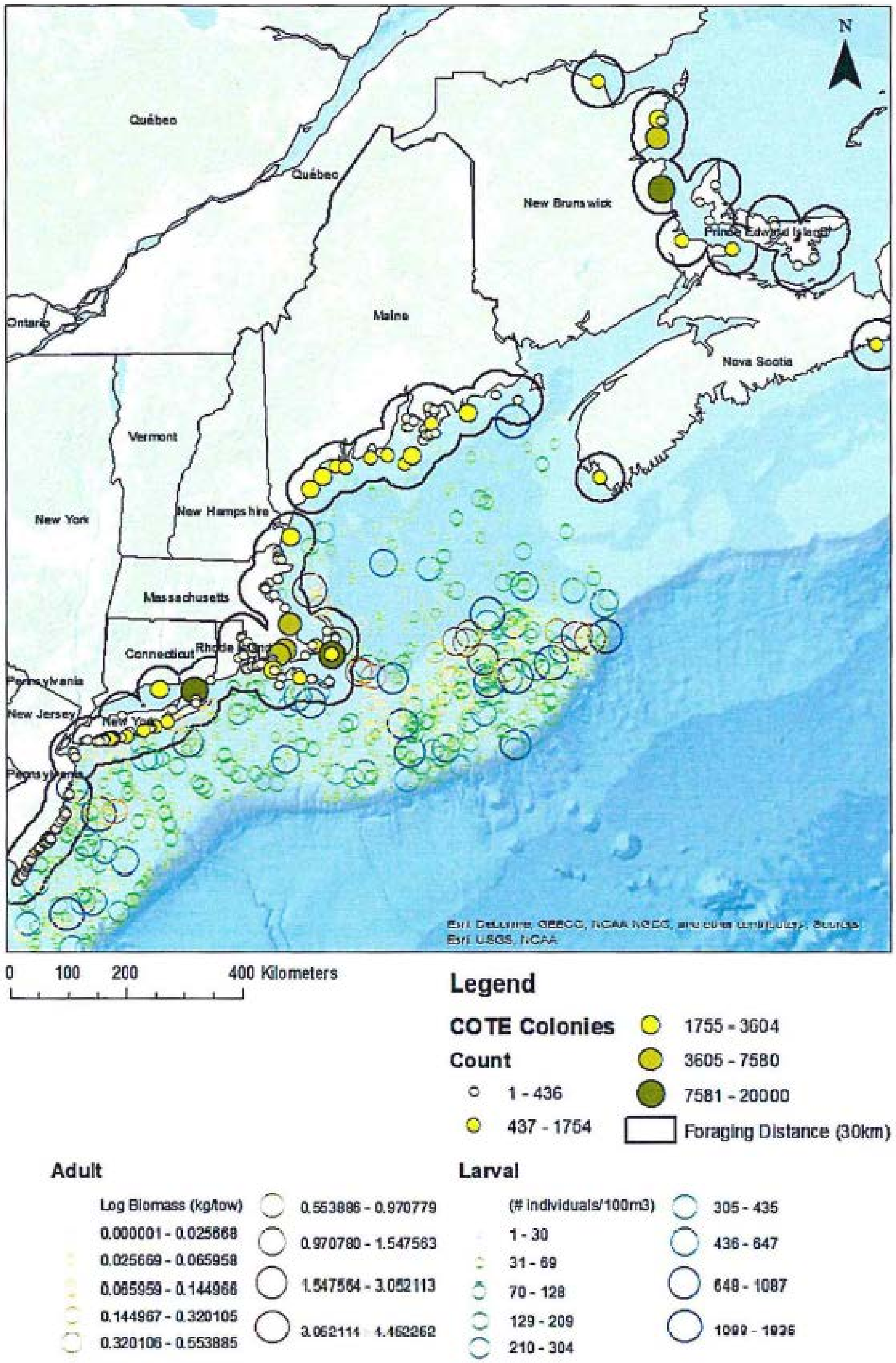
Table 98 – Average percentage prey composition (and range) of nest-provisioning at tern colonies from New York to Maine

Location	Species	Date	Sand Lance	Herring	Hake
Machias Seal IS, NB/ME border	Atlantic Puffin*	1995-2016	14.7 (0-89)	43 (2-94)	26.7 (1.1-80)
Petit Manan, ME	Common Tern	1998-2017	8.5 (0-25.5)	45.7 (11-91)	15.4 (0-30)
Petit Manan, ME	Arctic Tern	1998-2017	4.9 (0-22)	38 (2-84)	21.9 (0-60)
Seal Is, ME	Atlantic Puffin	2005-2017	12.2 (1-55)	20 (1.5-80)	38 (2.3-85)
Matinicus Rk, ME	Atlantic Puffin	2006-2017	12.4 (0.3-30)	10.2 (0-59)	46.9 (5.2-82)
Matinicus Rk, ME	Razorbill	2006-2017	14.3 (1.3-69)	30.6 (11.8-63)	30.2 (12-52)
Eastern Egg Rock, ME	Roseate Tern	1999–2013	6.8 (0-25)	23.7 (6–64)	61.3 (34–81)
Jenny I., ME	Roseate Tern	2007–12	19.6 (11–70)	23.9 (2–20)	52.6 (11–59)
Outer Green I., ME	Roseate Tern	2005–07	32.5 (16–37)	14.8 (9–37)	51.7 (44–54)
Stratton I., ME	Roseate Tern	1999–2013	80.6 (29–84)	8.4 (1–20)	10.0 (1–43)
Monomoy, MA	Common Tern	1998-2000, 2002-2004 & 2007-2017	73.5 (49-95)	7.9 (0–22)	2.9 (0-4)
Bird I., MA	Common Tern	2009–11	29.7 (17-41)	21 (16-27)	
Great Gull Is, NY	Common Tern	2016	78	4	14

Source: Unpublished data, University of New Brunswick USFWS, National Audubon Society, MA Fish and Wildlife, and Museum of Natural History. MSI data represents % biomass, all other values represent % of diet

Figure 101 – Common tern colony size and foraging distance

Note: Adult and larval biomass in open circles is sandlance biomass, not Atlantic herring; data from NOAA Ecosystems Monitoring Survey 2005-2015



Incidental catch in commercial fisheries

The Northeast large marine ecosystem (LME) supports approximately 58 species of seabirds [Croxall et al 2012], of which 45% have had documented interactions with federally permitted commercial fisheries (Hatch 2017). Over a 19-year period, the author estimated that 48,821 seabirds interacted with commercial fishing gear. Hatch concluded that seabird –fishery interactions generally occurred close to shore (mean 40km) and in relatively shallow depths (mean 76 m). In addition, shearwaters and fulmars represented 52% of the interactions with commercial fishing gear, while loons represented 21% of interactions. Gillnets accounted for 83% of seabird-fishery interactions, while purse seine and midwater trawls each represented approximately 3% of the interactions (Hatch 2017). Currently, no mitigation strategies are in place to reduce seabird bycatch in any fishery operating in the US Northeast or Mid-Atlantic. Given the dearth of published research on seabird-fisheries interactions in the northeast and mid-Atlantic, high uncertainty in cumulative impacts, and the current priority status of several seabird species (Table 18), a better understanding of how seabird - fishery interactions affect population viability and resilience is needed (Hatch 2017). Observed records of seabird interactions with the herring fishery are in Figure 96.

4.5.2.3 Impacts of measures to address potential localized depletion and user conflicts

4.5.2.3.1 No Action – Prohibition of MWT gear in Area 1A June – September

Under No Action, management measures implemented by Amendment 1 would remain. As a result, significant changes in effort (e.g., gear quantity, soak/tow time, area fished) are not expected under this Option.

Understanding expected fishing behavior/effort in a fishery informs potential interaction risks with protected species (ESA listed and MMPA protected species) and seabirds. Specifically, interaction risks with protected species are strongly associated with amount, time, and location of gear in the water with vulnerability of an interaction increasing with increases in any or all of these factors. Taking into consideration the latter, as well as fishing behavior/effort, impacts of No Action to protected species are below.

MMPA (Non-ESA listed) Protected Species Impacts

Species of marine mammals interact with the Atlantic herring fishery (see Section 3.4). Impacts of No Action on marine mammals (i.e., minke whales, species of small cetaceans, and pinnipeds) are somewhat uncertain without quantitative analysis. However, we have considered, to the best of our ability, available information on marine mammal interactions with commercial fisheries, including the herring fishery over the last five or more years (Hayes *et al.* 2017) (See Marine Mammal Stock Assessment Reports: http://www.nmfs.noaa.gov/pr/sars/region.htm; and NEFSC NEFOP reports: http://www.nefsc.noaa.gov/fsb/take_reports/nefop.html).

Aside from several large whale species, harbor porpoise, pilot whales, and several stocks of bottlenose dolphin, there has been no indication that takes of any other marine mammal species in commercial fisheries has exceeded potential biological removal (PBR) thresholds, and therefore, gone above and beyond levels which would result in the inability of each species population to sustain itself (Hayes *et al.* 2017) (http://www.nmfs.noaa.gov/pr/sars/region.htm). Although, several species of large whales, harbor porpoise, pilot whales, and several stocks of bottlenose dolphin have experienced take levels that have resulted in exceeding the PBR threshold of each species, take reduction plans or strategies have been implemented to reduce bycatch in the fisheries affecting these species. These plans/strategies are still in place and are continuing to assist in decreasing bycatch levels for these species. The information in Hayes *et al.* (2017) and past marine mammal stock assessment reports collectively describe commercial fishery interactions with marine mammals, not addressing the effects of any FMP specifically. However, the information demonstrates that fishery operations over the last five or more years have not resulted in a collective level of take that threatens the continued existence of marine mammal populations (aside from those species noted above).

Based on this, and that voluntary measures exist that reduce serious injury and mortality to marine mammal species incidentally caught in trawl fisheries (i.e., Atlantic Trawl Gear Take Reduction Team; Section 3.4), it is expected that No Action, maintaining status quo conditions, will not result in take levels that will affect the continued existence of marine mammals. Thus, No Action is expected to have ***low negative*** impacts on marine mammals.

ESA Listed Species Impacts

As in Section 3.4, ESA listed species interactions with the Atlantic herring fishery are non-existent. However, the fishery does use some gear types known to interact with species; therefore, risk does exist. As No Action will maintain current operating conditions, changes in fishing effort or behavior above and beyond that which has been characteristic of the fishery over the last several years is not expected. As interactions with ESA listed species over this time frame have remained non-existent, the No Action alternative is not expected to introduce any new risks (e.g., changes in gear or effort) to ESA listed species that have not already been considered by NMFS and deemed "not likely to adversely affect" these species (NMFS 2012a; b; 2013b; 2014a; b). In fact, in NMFS most recent assessment of the Atlantic Herring FMP it was concluded that the Atlantic Herring FMP may affect, but is not adversely affect or jeopardize the continued existence of any ESA listed species (NMFS 2014a; b). As a result, the effects of No Action on ESA listed species are expected to be ***neutral*****.**

4.5.2.3.2 Alternative 2 (Closure within 6nm in Area 114 to all vessels fishing for herring)

Alternative 2 will result in a closure within 6nm in Area 114 to all vessels fishing for herring. This closure encompasses a relatively small area and does not represent a primary herring fishing area. Vessels may respond to Alternative 2 by shifting effort to just outside the closure; however, overall, relative to current operating conditions, significant changes in fishing behavior and effort are not expected in the fishery under Alternative 2.

As Alternative 2 is not expected to result in any significant changes in fishing behavior/effort, the potential for protected species interactions with herring fishing gear and therefore, serious injury or mortality, are not expected to go above and beyond that which has been considered in the fishery to date (http://www.nmfs.noaa.gov/pr/sars/region.htm; (http://www.nefsc.noaa.gov/fsb/take_reports/nefop.html) (Hayes *et al.* 2017; NMFS 2014a; b). Specifically, as ESA listed species have never been taken in the herring fishing to date, nor has the fishery resulted in levels of take of MMPA protected species that jeopardize the continued existence of marine mammal populations (i.e., resulted in exceedance of PBR), we do not expect Option 2 to introduce any new risks or additional takes to protected species that have not already been considered and/or authorized by NMFS to date (Hayes *et al.* 2017; NMFS 2014a; b) (http://www.nmfs.noaa.gov/pr/sars/region.htm;http://www.nefsc.noaa.gov/fsb/take_reports/nefop

.html). For these, and the reasons in Section 1.1.1, we expect impacts of Alternative 2 on protected species (ESA listed and MMPA protected species) to be similar to those described in Alternative 1 (i.e., MMPA protected species: low negative; ESA listed species: neutral). Alternative 2 would have ***neutral impacts relative to No Action*** on protected resources for the reasons in Section 1.1.1 (Alternative 1).

4.5.2.3.2.1 Seasonal sub-options (A: June – August or B: June – October)

There are two seasonal sub-options for Alternative 2, sub-option A: June-August or sub-option B: June October; during these periods of time, herring fishing would be prohibited within 6nm in Area 114. Regardless of the seasonal sub-option chosen, neither sub-option will result in significant changes in fishing behavior or effort relative to current operating conditions. As in Alternative 2, at most, there may be a shift in effort to areas just outside the closure during the specified timeframe. However, as this area does not represent a prime area for herring fishing and comprises a relatively small area, whether a seasonal window is in place or not, overall effort and fishing behavior is not expected to differ significantly from current operating conditions. As a result, interaction risks to protected species are not expected to be any greater than those under in Alternative 1 (No Action). Based on this, impacts to protected species from either Alternative 2 seasonal sub-option are expected to be ***neutral*** (ESA listed species) to low negative (MMPA protected species) similar to those under in Alternative 1.

4.5.2.3.3 Alternative 3 (Prohibit MWT gear in Area 1A year-round)

Alternative 3 would result in a year round prohibition of MWT gear from management area 1A. The changes in herring fishing effort/behavior from this restriction are likely varied, with the following possible scenarios:

1. MWT vessels shift effort, year round, to Management Area 1B, 2, and/or 3 (Georges Bank specifically);
2. MWT vessels convert to purse seine gear and shift effort into Management Area 1A; and/or;
3. Existing purse seine effort increases in Area 1A.

Thus, there is likely to be a range of potential impacts to protected species. For instance, under scenario 1, the MWT fleet may shift effort to other herring Management Areas. During the current MWT seasonal restriction (June-September) in Management Area 1A, MWT effort has primarily shifted to Management Area 3. It is likely that MWT vessels would respond in a similar manner under Alternative 3, at least during June-September, the seasonal window they are accustomed to fish in Area 3. However, as the option for MWT vessels to shift to Management Area 1A during October through December is no longer available to the MWT fleet, effort will need to remain in Area 3 or be redirected to Management Area 1B or 2.

If effort remains in Area 3 year round, there is the potential for interactions with protected species, specifically MMPA protected species, to increase. Reviewing Figure 99 and Figure 100, as well as NEFOP observer data, there is a high incidence of observed marine mammal (non-ESA listed; dolphin species, pilot whales, and seal species) interactions with MWT gear in Area 3, specifically the northern edge of Georges Bank. The incidences of observed interactions within Area 3 on GB coincide with the months in which the seasonal restrictions in herring Management Area 1A are currently in affect (June-Sept) for MWT vessels. As marine mammal species (non-ESA listed) observed to interact with MWT gear on Georges Bank during June through September will still be present at various times from October through May, if MWT vessels remain in this area year round, marine mammal species will be exposed to MWT gear and therefore, interaction risks, they were previously exposed to during this timeframe, but at lower levels. Based on this, under this scenario, impacts to MMPA protected species are likely to be negative. However, interactions (primarily seals) that could have occurred within the GOM from MWT gear would be lower, which could have some benefit to those species; but purse seine gear would still be used to harvest the Area 1A TAC, which also has interactions with seals.

Alternatively, outside of the June-September timeframe, the MWT fleet may decide to redirect effort from Area 3 to Area 1B and/or 2 for the remainder of the year, similar to what is currently done in the fishery. Under this scenario, interactions with protected species, specifically MMPA protected species, would not be expected to be any greater than current operating conditions. Based on Figure 99 and Figure 100 (marine mammal interaction maps), as well as NEFOP observer data, since 2007, there have only been a small number (i.e., eight) of observed marine mammal (non-ESA listed; dolphin species, pilot whales, and seal species) interactions with MWT gear in herring Management Areas 1B and 2; these interactions were observed during November through May.

Based on this information, while marine mammals (e.g.., dolphin species, pilot whales, and seal species) may occur in the waters of herring Management Area 1B and 2 throughout the year, there may be a low co-occurrence of effort and marine mammals from October through May. Thus, it is not expected that any effort that is redirected from Area 3 to Area 1B or 2 during October-May would result in any significant increase in interactions with MMPA protected species relative to what has currently been observed in these regions during these timeframes to date. Under this scenario, impacts to MMPA protected species are expected to be similar to current conditions, low negative. For ESA listed species, scenario 1 is expected to have neutral impacts to ESA listed species, as there has never been an ESA listed species taken in the herring fishery, including the MWT fleet, and interaction risks with this gear type in general are rare to non-existent.

Under scenario 2, the MWT fleet could convert to purse seine gear to access Area 1A year round (i.e., June through December). Should this occur, interactions with protected species, specifically MMPA protected species, could increase in Area 1A. Reviewing Figure 99 and Figure 100 (marine mammal interaction maps), as well as NEFOP observer data, numerous purse seine interactions with marine mammals (non-ESA listed species; primarily species of seals) occur in Management Area 1A. If MWT vessels convert to purse seine gear, these vessels, combined with the existing purse seine fleet operating in Management Area 1A will equate to an in increase in the amount of purse seine gear operating in this management area.

As interaction risks with protected species are strongly associated with amount, time, and location of gear in the water, vulnerability of an interaction increases with increases in any or all of these factors. Based on this, with a currently high co-occurrence of marine mammals and purse seine gear in management 1A (as evidenced by the numerous interactions observed in this area), combined with an increase in the amount of purse seine gear operating in Management Area 1A, the potential for an interaction with a marine mammal species (non-ESA listed) is likely to increase and therefore, impacts to MMPA protected species are expected to be negative. For ESA listed species, scenario 2 is expected to result in neutral impacts to ESA listed species as there has never been an ESA listed species taken in the Herring fishery, including the purse seine fleet, and interaction risks with this gear type in general are rare to non-existent.

Under scenario 3, if MWT vessels do not convert to purse seine gear, the existing purse seine fleet could increase effort/activity in Area 1A if MWT vessels are prohibited from this herring management area year round. As provided above, numerous purse seine interactions with marine mammals (primarily species of seals) occur in Management Area 1A. Should the purse seine fleet increase effort (e.g., tow times) in this management area, interactions with MMPA protected species are likely to increase. Based on this, impacts to MMPA protected species under scenario 3 are likely to be negative, while impacts to ESA listed species will be neutral; see scenario 2 for additional information to support this determination.

Depending on the response of the MWT fleet to Alternative 3, impacts to MMPA protected species may range from negative to low negative, while for ESA listed species they will be neutral. Relative to No Action (Alternative 1), Alternative 3 may result in ***neutral to negative impacts*** to MMPA species due to the potential for interactions with MMPA protected species to increase relative to current operating conditions; impacts to ESA listed species relative to No Action will be ***neutral***.

4.5.2.3.4 Alternative 4 (Prohibit MWT gear inside 12 nm south of Area 1A)

Alternative 4 would prohibit MWT gear inside 12nm south of Area 1A. Because this alternative includes portions of several herring management areas (Areas 1B, 2, and 3), how MWT vessels respond to this Alternative may vary based on the ability of the vessels to still catch the TAC allocated to the respective herring management area. In herring Management Area 1B, MWT vessels typically catch their Area 1B TAC within the 30 minute square 114 off the back side of the Cape. Under Alternative 4, MWT vessels could no longer access this area, making it difficult to harvest their Area 1B TAC. For Area 3, the majority of catch for this management area occurs outside of the 12nm boundary, so MWT fishing behavior and effort is unlikely to be affected in this management area. In Area 2, most MWT fishing effort occurs closer to shore, and therefore, similar to Area 1B, Alternative 4 would prevent MWT vessels from accessing these waters, making it somewhat difficult to harvest the area TAC.

Based on the above, fishing behavior/effort is most likely to be affected in herring Management Area 1B and 2, with some potential changes in Area 3. As MWT vessels will be prohibited from accessing the nearshore waters needed to attain the TAC for each respective management area, fishing behavior/effort in these areas may change in several possible ways:

1. MWT vessels fish just outside the 12nm boundary in Area 1B and 2;
2. MWT vessels shift effort to offshore waters within Area 3;
3. Existing bottom trawl effort increases in nearshore waters of Area 1B, 2, and 3; and/or
4. MWT vessels convert to bottom trawl gear (aside from MWT gear, the most common gear used in nearshore waters south of Area 1A to catch herring).

Depending on the response of the vessels, impact to protected species will vary. Considering scenario 1, if vessels just shift to areas just outside the 12nm boundary in Area 1B and 2, effort may remain similar to current conditions in these areas or, it may decrease due to the vessels inability to access nearshore waters needed to attain the respective management area TAC. Under these circumstances, protected species risk of interacting with MWT vessels are not expected to be any greater than those under current operating conditions; that is impacts to MMPA protected species under scenario 1 are likely to be low negative and neutral for ESA listed species.

If we consider scenario 2, MWT vessels that once fished within the nearshore waters (within 12nm) of Areas 1B and 2 would shift effort to offshore waters within Area 3, where there is more ability to harvest the area TAC due to the accessibility to the herring resource. Depending on the number of vessels operating in Area 3 at a specific time, effort in this management area has the potential to increase or remain similar to current operating conditions. As provided in Alternative 3, numerous marine mammal (non-ESA listed species) interactions with MWT gear have been observed in Area 3. As interaction risks with protected species are strongly associated with amount, time, and location of gear in the water, vulnerability of an interaction increases with increases in any or all of these factors. Based on this, should effort increase in offshore areas within herring Management Area 3, there is the potential for interactions with MMPA protected species to increase (as provided in Alternative 3). Based on this, impacts to MMPA protected species may be low negative (no change in effort from current conditions) to negative (increase in effort), while impacts to ESA listed species are likely to be neutral.

Another possible scenario is that with no MWT vessels permitted within 12nm south of Area 1A, existing bottom trawl effort increases in the nearshore waters. Currently, bottom trawl effort represents a small component of the overall herring fishery. Based on NEFOP observer data, since 2007, there has been 21 observed MMPA protected species (i.e., harbor and gray seals, whitesided and common dolphins) interactions with bottom trawl gear associated with the herring fishery; no interactions with ESA listed species have been observed to date. These incidences occurred primarily in nearshore waters of Southern New England. Taking the latter into consideration, and that both ESA listed and MMPA protected species are vulnerable to interactions with bottom trawl gear (irrespective of fishery), and are known to occur in nearshore waters of Management Areas 1B, 2, and 3, should bottom trawl effort increase to levels above those currently experienced in the fishery, interaction risks to both MMPA protected and ESA listed species are expected to increase. As a result, under this scenario, there is the potential for interactions with MMPA protected species to increase, and for interactions to occur with ESA listed species for the first time in the herring fishery. Based on this information, impacts of scenario 3 on MMPA protected species and ESA listed species are negative.

A fourth possible scenario is that existing MWT trawl vessels will convert to bottom trawl gear to attain the Management Area TAC allocated to Area 1B, 2, and 3. Combined with existing bottom trawls already operating in these herring management areas, should this scenario occur, bottom trawl effort in the nearshore waters is likely to increase. For the reasons provided above in scenario 3, impacts of scenario 4 on MMPA protected species and ESA listed species are expected to be negative.

Taking into consideration the above scenarios, Alternative 4 has the potential to result impacts ranging from ***low negative to negative*** for MMPA protected species, and ***neutral to negative*** impacts to ESA listed species. Relative to No action (Alternative 1), Alternative 4 has the potential to result in impacts that range from high negative (if effort shifts to areas with higher interactions or to gear types with higher interactions) to low positive impacts (if effort decreases and less herring is caught) to MMPA protected species, and ranging from neutral to high negative impacts to ESA listed species.

Area sub-options (A: Areas 1B, 2 and 3 or B: Areas 1B and 3 only)

There are two area sub-options under Alternative 4, sub-option A: Areas 1B, 2, and 3 or sub-option B: Areas 1B and 3. Regardless of the sub-option chosen, effort and/or changes in fishing behavior are not expected to differ significantly from than that described above. As a result, both sub-options are expected to result in impacts to protected species that are similar to those provided above (i.e., low negative to negative impacts to MMPA protected species and neutral to negative impacts to ESA listed species). For rationale to support this determination, see section above under Alternative 4 relative to No Action (Alternative 1), either Alternative 4 area sub-option has the potential to result in impacts that range from ***high negative to low positive*** impacts to MMPA protected species, and ranging from ***neutral to high negative*** impacts to ESA listed species.

Seasonal sub-options (A: year-round or B: June-September)

There are two seasonal sub-options under Alternative 4, sub-option A: year round or sub-option B: June through September. Under either sub-option, effort and/or changes in fishing behavior are not expected to differ significantly from than that described above in. As a result, both sub-options are expected to result in impacts to protected species that are similar to those provided in the section above for Alternative 4 (i.e., low negative to negative impacts to MMPA protected species and neutral to negative impacts to ESA listed species). For rationale to support this determination, see above. Relative to No Action (Alternative 1), either Alternative 4 seasonal sub-option has the potential to result in impacts that range from ***high negative to low positive*** impacts to MMPA protected species, and ranging from ***neutral to high negative*** impacts to ESA listed species.

4.5.2.3.5 Alternative 5 (Prohibit MWT gear inside 25 nm south of Area 1A)

Alternative 5 will prohibit MWT gear inside 25nm south of Area 1A. Because this alternative includes portions of several herring management areas (Areas 1B, 2, and 3), how MWT vessels respond to this Alternative may vary based on the ability of the vessels to still catch the TAC allocated to the respective herring management area. In herring Management Area 1B, MWT vessels typically catch their Area 1B TAC within the 30 minute square 114 off the back side of the Cape. If this alternative is chosen, MWT vessels could no longer access most of this area, making it very difficult to harvest their Area 1B TAC. For Area 3, the majority of catch for this management area occurs outside of the 25nm boundary, so MWT fishing behavior and effort is unlikely to be affected in this management area. In Area 2, most MWT fishing effort occurs closer to shore, and therefore, similar to Area 1B, this Alternative would prevent MWT vessels from accessing these waters, making it difficult to harvest the area TAC.

Based on the above, potential changes in fishing behavior/effort are expected to be similar to those provided in Alternative 4; however, with most of the 30 minute square 114 off the back side of the Cape within 1B encompassed within the 25nm closure, it will be extremely difficult for vessels to their Area 1B TAC. Similarly, with more even more of the nearshore area prohibited to MWT vessels in Area 2 under Alternative 5, harvesting the Area 2 TAC will also be extremely difficult for these vessels. Based on this, of the potential changes in fishing behavior/effort described in Alternative 4, shifts in effort to just outside the 25 nm boundary (scenario 1 in Alternative 4) is unlikely to occur in Area 1B and 2. If anything, a decrease in effort is more likely to occur in Management Areas 1B and 2 as a result of Alternative 5. Area 3 will be the only management area where vessels may still be capable of harvesting their area

TAC outside of the 25nm boundary. All other potential changes in effort/fishing behavior provided in Alternative 4 are still possible (scenarios 2 through 4) as a result of Alternative 5.

For the reasons provided above, Alternative 5 is expected to result in impacts to protected species that are similar to those provided in the section above for Alternative 4 (i.e., ***low negative to negative impacts to MMPA protected species and neutral to negative impacts to ESA listed species***). For rationale to support this determination, see Section 4.5.2.3.4. Relative to No Action (Alternative 1), Alternative 5 has the potential to result in impacts that range from high negative to low positive impacts (relative to No Action if effort does decrease resulting in decrease in interactions) to MMPA protected species, and ranging from neutral to high negative impacts to ESA listed species.

Area sub-options (A: Areas 1B, 2 and 3 or B: Areas 1B and 3 only)

There are two area sub-options under Alternative 5, sub-option A: Areas 1B, 2, and 3 or sub-option B: Areas 1B and 3. Under either sub-option, effort and/or changes in fishing behavior are not expected to differ significantly from than that described above for Alternative 4. As a result, both sub-options are expected to result in impacts to protected species that are similar to those provided in Section 4.5.2.3.4 (i.e., ***low negative to negative impacts to MMPA protected species and neutral to negative impacts to ESA listed species;*** rationale in Section 4.5.2.3.4). Relative to No Action (Alternative 1), either Alternative 5 area sub-option has the potential to result in impacts that range from high negative to low positive impacts to MMPA protected species, and ranging from neutral to high negative impacts to ESA listed species.

Seasonal sub-options (A: year-round or B: June-September)

There are two seasonal sub-options under Alternative 5, sub-option A: year round or sub-option B: June through September. Under either sub-option, effort and/or changes in fishing behavior are not expected to differ significantly from than that described above. As a result, both sub-options are expected to result in impacts to protected species that are similar to those provided for Alternative 4, see Section 4.5.2.3.4 (i.e., ***low negative to negative impacts to MMPA protected species and neutral to negative impacts to ESA listed species***). For rationale to support this determination, see Section 4.5.2.3.4. Relative to No Action (Alternative 1), the seasonal sub-options have the potential to result in impacts that range from high negative to low positive impacts to MMPA protected species, and ranging from neutral to high negative impacts to ESA listed species.

4.5.2.3.6 Alternative 6 (Prohibit MWT gear inside 50 nm south of Area 1A)

Alternative 6 will prohibit MWT gear inside 50nm south of Area 1A. Because this alternative includes portions of several herring management areas (Areas 1B, 2, and 3), how MWT vessels respond to this Alternative may vary based on the ability of the vessels to still catch the TAC allocated to the respective herring management area. In herring Management Area 1B, MWT vessels typically catch their Area 1B TAC within the 30 minute square 114 off the back side of the Cape. If this alternative is chosen, MWT vessels could no longer access this area, making it very difficult to harvest their Area 1B TAC. For Area 3, the majority of catch occurs outside of the 50 nm boundary, so MWT fishing behavior and effort is unlikely to be affected in Area 3. In Area 2, most MWT fishing effort occurs closer to shore, and therefore, similar to Area 1B, Alternative 6 would prevent MWT vessels from accessing these waters, making it difficult to harvest the area TAC.

Based on the above, potential changes in fishing behavior/effort are expected to be similar to those provided in Alternative 5, with the exception that even more MWT effort is likely to be constrained in Area 1B and 2 under Alternative 6. Taking this into consideration, impacts to protected species are expected to be similar to those provided in Alternative 5 (section 4.5.2.3.5; i.e., low negative to negative impacts to MMPA protected species and neutral to negative impacts to ESA listed species). Section 4.5.2.3.5 has rationale to support this determination. Relative to No Action (Alternative 1), Alternative 5 has the potential to result in impacts that range from ***high negative to low positive impacts*** (relative to No Action if effort does decrease resulting in decrease in interactions) to MMPA protected species, and ranging from ***neutral to high negative*** impacts to ESA listed species. Compared to Alternatives 4 and 5, this alternative may impact more fishing effort because it overlaps with a higher fraction of herring fishing activity.

Area sub-options (A: Areas 1B, 2 and 3 or B: Areas 1B and 3 only)

There are two area sub-options under Alternative 6, sub-option A: Areas 1B, 2, and 3 or sub-option B: Areas 1B and 3. Under either sub-option, effort and/or changes in fishing behavior are not expected to differ significantly from than that described above in Section 4.5.2.3.5. As a result, both sub-options are expected to result in impacts to protected species that are similar to those provided in Section 4.5.2.3.5 (i.e., ***low negative to negative impacts to MMPA protected species and neutral to negative impacts to ESA listed species***). Section 4.5.2.3.5 has rationale to support this determination. Relative to No Action (Alternative 1), both area sub-options have the potential to result in impacts that range from high negative to low positive impacts to MMPA protected species, and ranging from neutral to high negative impacts to ESA listed species.

Seasonal sub-options (A: year-round or B: June-September)

There are two seasonal sub-options under Alternative 6, sub-option A: year round or sub-option B: June through September. Under either sub-option effort and/or changes in fishing behavior are not expected to differ significantly from than that described above in. As a result, both sub-options are expected to result in impacts to protected species that are similar to those provided in Section 4.5.2.3.5 (i.e., ***low negative to negative impacts to MMPA protected species and neutral to negative impacts to ESA listed species***). Section 4.5.2.3.5 has rationale to support this determination. Relative to No Action (Alternative 1), both seasonal sub-options have the potential to result in impacts that range from high negative to low positive impacts to MMPA protected species, and ranging from neutral to high negative impacts to ESA listed species.

4.5.2.3.7 Alternative 7 (Prohibit MWT gear in thirty minute squares off Cape Cod)

Alternative 7 will prohibit MWT gear in thirty minutes squares off Cape Cod; this will affect fishing behavior and effort in portions of herring Management Areas 1B, 2, and 3. Taking the latter into consideration, effort and/or changes in fishing behavior are not expected to differ significantly from than that described in Section 4.5.2.3.5. Based on this, expected impacts to protected species would be similar to those provided in Alternative 5 (Section 4.5.2.3.5; i.e., ***low negative to negative impacts to MMPA protected species and neutral to negative impacts to ESA listed species***). Section 4.5.2.3.5 has rationale to support this determination. Relative to No Action (Alternative 1), Alternative 5 has the potential to result in impacts that range from high negative to low positive (relative to No Action if effort does decrease resulting in decrease in interactions) impacts to MMPA protected species, and ranging from neutral to high negative impacts to ESA listed species.

Area sub-options (A: five 30-minute squares in Areas 1B, 2 and 3 or three 30-minute squares in Areas 1B and 3 only)

There are two area sub-options under Alternative 7, sub-option A: Areas 1B, 2, and 3 or sub-option B: Areas 1B and 3. Under either sub-option, effort and/or changes in fishing behavior are not expected to differ significantly from than that described in Section 4.5.2.3.5. As a result, both sub-options are expected to result in impacts to protected species that are similar to those provided in Section 4.5.2.3.5 (i.e., ***low negative to negative impacts to MMPA protected species and neutral to negative impacts to ESA listed species***). Section 4.5.2.3.5 has rationale to support this determination. Relative to No Action (Alternative 1), both area sub-options have the potential to result in impacts that range from high negative to low positive impacts to MMPA protected species, and ranging from neutral to high negative impacts to ESA listed species.

Seasonal sub-options (A: year-round or B: June-September)

There are two seasonal sub-options under Alternative 7, sub-option A: year round or sub-option B: June through September. Under either sub-option, effort and/or changes in fishing behavior are not expected to differ significantly from than that described above. As a result, both sub-options are expected to result in impacts to protected species that are similar to those provided in Section 4.5.2.3.5 (i.e., ***low negative to negative impacts to MMPA protected species and neutral to negative impacts to ESA listed species***). Section 4.5.2.3.5 has rationale to support this determination. Relative to No Action (Alternative 1), both seasonal sub-options have the potential to result in impacts that range from high negative to low positive impacts to MMPA protected species, and ranging from neutral to high negative impacts to ESA listed species.

4.5.2.3.8 Alternative 8 (Revert boundary between Area 1B and 3 back to original boundary)

Alternative 8 will revert the management boundary between 1B and 3 back to its original boundary configuration. The reversion of this boundary is not expected to significantly change fishing behavior or effort relative to current conditions. As a result, the potential for protected species interactions with herring fishing gear and therefore, serious injury or mortality, are not expected to go above and beyond that which has been considered in the fishery to date (http://www.nefsc.noaa.gov/fsb/take_reports/nefop.html; http://www.nmfs.noaa.gov/pr/sars/region.htm) (Hayes *et al.* 2017; NMFS 2014a; b).

Specifically, as ESA listed species have never been taken in the herring fishing to date, nor has the fishery resulted in levels of take of MMPA protected species that jeopardize the continued existence of marine mammal populations (i.e., resulted in exceedance of PBR), we do not expect Alternative 2 to introduce any new risks to protected species that have not already been considered and/or authorized by NMFS to date (Hayes *et al.* 2017; NMFS 2014a; b) (http://www.nmfs.noaa.gov/pr/sars/region.htm; http://www.nefsc.noaa.gov/fsb/take_reports/nefop.html). For these, and the reasons provided in Section 4.5.2.3.1, we expect impacts of Alternative 8 on protected species (ESA listed and MMPA protected species) to be similar to those described in Alternative 1 (i.e., MMPA protected species: low negative; ESA listed species: neutral).

Relative to No Action (Alternative 1), Alternative 8 would have ***neutral*** impacts on protected resources for the reasons provided in Section 4.5.2.3.1 (Alternative 1). Based on the findings above, this alternative may have more neutral impacts than some of the alternatives under consideration that have the potential to shift more effort (i.e. Alternatives 4-7).

4.5.2.3.9 Alternative 9 (Remove seasonal closure of Area 1B from January – April)

In Area 1B, there is a seasonal closure to the herring fishery from January through April. Once the closure ends, effort in Area 1B often becomes very concentrated, resulting in the area TAC being caught within a matter of weeks in the late spring. Alternative 9 will remove this seasonal closure (January through April) in Area 1B. Removing this closure has the potential to redistribute effort in the fishery, and thus, minimize the likelihood of vessels concentrating in the area at any one time. As this alternative is not expected to give vessels incentive to increase effort, only spread out effort, significant changes in effort, relative to current operating conditions is not expected.

Currently, Area 1A incurs a seasonal closure to all herring fishing from January through May. At the same time, the seasonal closure in 1B is also in place. As a result, if vessels choose to fish, they can only operate in Area 2 or 3 during this seasonal timeframe. By lifting the seasonal restriction in 1B, vessels now have the opportunity to redirect some effort from Area 2 or 3 into Area 1B. Based on Figure 99 and Figure 100 (marine mammal interaction maps), as well as NEFOP observer data, since 2007, there have only been a small number (i.e., two) of observed marine mammal (non-ESA listed; seal species) interactions with herring gear (i,e., MWT) in herring Management Areas 1B. Based on this information and information provided in Section 3.4, while marine mammals (e.g., dolphin species, pilot whales, and seal species) may occur in the waters of herring Management Area 1B throughout the year, there may be a low co-occurrence of effort and marine mammals. As a result, it is not expected that any effort that is redirected from Area 2 or 3 to Area 1B would result in any significant increase in interactions with MMPA protected species relative to what has currently been observed in these regions. Based on this, under this scenario, impacts to MMPA protected species are expected to remain similar to current operating conditions, that is ***low negative***. For ESA listed species, Alternative 9 is expected to result in ***neutral*** impacts to ESA listed as there has never been an ESA listed species taken in the Herring fishery. Compared to other alternatives in this section, this alternative is expected to have more neutral impacts similar to Alternatives 1, 2 and 8, and lower potential for any low negative impacts described for Alternatives 4-7 and 8 due to uncertain effort shits.

4.6 IMPACTS ON PHYSICAL ENVIRONMENT AND ESSENTIAL FISH HABITAT

Since 1996, the MSA has included a requirement to evaluate the potential adverse effects of fisheries, including the Atlantic herring fishery, on Essential Fish Habitat (EFH) of Atlantic herring and other species. A general description of the physical environment and EFH is provided in the Affected Environment (Section 3.5). The EFH regulations specify that measures to minimize impacts should be enacted when adverse effects that are ‘more than minimal’ and ‘not temporary in nature’ are anticipated.

The magnitude of adverse effects resulting from a fishery’s operations is generally related to (1) the location of fishing effort, because habitat vulnerability is spatially heterogeneous, and (2) the amount of fishing effort, specifically the amount of seabed area swept or bottom time. To the extent that adoption of a management alternative would shift fishing to more vulnerable habitats, and/or increase seabed area swept, adoption would be expected to cause an increase in habitat impacts as compared to no action. If adoption of an alternative is expected to reduce seabed area swept or cause fishing effort to shift away from more vulnerable into less vulnerable habitats, a decrease in habitat impacts would be expected. The magnitude of an increase or decrease in adverse effects relates to the proportion of total fishing effort affected by an alternative.

Bearing in mind that both the direction and magnitude of changes are difficult to predict, because changes in fishing behavior in response to management actions can be difficult to predict, potential shifts in adverse effects are discussed for each of the alternatives under consideration. However, changes in the magnitude of fishing effort resulting from individual measures should be viewed in the context of the overall impacts that the herring fishery is estimated to have on seabed habitats. Specifically, previous analyses have concluded that adverse effect to EFH that result from operation of the herring fishery do not exceed the more than minimal or temporary thresholds.

An assessment of the potential effects of the directed Atlantic herring commercial fishery on EFH for Atlantic herring and other federally-managed species in the Northeast region of the U.S. was conducted as part of an EIS that evaluated impacts of the Atlantic herring fishery on EFH (NMFS 2005). This analysis was included in Appendix VI, Volume II of the FEIS for Amendment 1 to the Atlantic Herring FMP. It found that midwater trawls and purse seines do occasionally contact the seafloor and may adversely impact benthic habitats utilized by federally-managed species, including EFH for Atlantic herring eggs. However, after reviewing all the available information, the conclusion was reached that if the quality of EFH is reduced due to this contact, the impacts are minimal and/or temporary and, pursuant to MSA, do not need to be minimized, i.e., that there was no need to take specific action at that time to minimize the adverse effects of the herring fishery on benthic EFH. This conclusion also applied to pelagic EFH for Atlantic herring larvae, juveniles, and adults, and to pelagic EFH for any other federally-managed species in the region.

Atlantic herring vessels primarily use purse seines, single midwater trawls or midwater pair trawls, and bottom trawls to direct on herring, with the midwater pair trawl fleet harvesting the majority of landings since 2008 (Table 38, Table 39). The only gear type that has adverse impacts to EFH in this fishery is the bottom trawl component, and those vessels have only represented about 5% of total herring landings since 2008 and are primarily concentrated in SNE. There are also smaller scale operations that land herring with bottom trawls under a Category C permit, mostly in the GOM. If spatial management measures to address localized depletion restrict midwater trawls to the extent that vessels switch from midwater trawls to small mesh bottom trawls, this amendment could affect habitat impacts associated with the fishery. These issues are discussed further in the section on localized depletion alternatives.

4.6.1 Atlantic herring ABC control rule

These alternatives specify the formulaic approach, or control rule, used for determining annual target fishing levels in the herring fishery, including the timeframe over which the determinations would apply, and the mechanism (amendment or framework) for control rule updates. The focus in this section is on the potential effects of the control rule alternatives on living and non-living habitat structures. In general, alternatives related to the ABC control rule are expected to have ***no direct impacts to Essential Fish Habitat***, mainly because the fishery overall does not have adverse impacts to EFH. Herring is an important forage species, and its value as forage underpins the entire discussion of control rules and why they are important to management of the fishery. Forage is a component of EFH, which includes “waters and substrate necessary for spawning, feeding, breeding, and growth to maturity”. The analysis of the differential impacts of these control rule approaches on non-target predator species is covered under a different VEC, and will not be repeated here.

4.6.1.1 Alternatives for setting ABC control rule

There are four ABC control rule alternatives (in addition to No Action) with several sub-options; each one varies in terms of the parameters that drive the overall shape of each CR, or the mathematical relationship between biomass estimates and catch advice. These approaches are:

- **No Action/Interim Control Rule.** This is the policy used in recent specification setting processes during fishing years 2013-2018. Under this control rule, the ABC is projected to produce a probability of exceeding F_{MSY} in the third year that is less than or equal to 50%. The same ABC is used for three years.
- **Alternative 1** would implement a rule that is similar to the interim control rule as approximated by its average performance in recent years. This alternative was developed to identify a control rule that would function like the interim control rule, but would be applicable in all cases, regardless of whether abundance is increasing or decreasing.
- **Alternative 2** sets the ABC based on available biomass (SSB), and would identify the ABC associated with a maximum fishing mortality of 50% F_{MSY}. The maximum allowable ABC occurs when the SSB is two times SSB_{MSY}. The fishery is not prosecuted (ABC=0) when SSB/SSB_{MSY} falls below 1.1 times SSB_{MSY}.
- **Alternative 3** is also biomass-based. If SSB is at or about 70% of SSB_{MSY}, fishing mortality is set at 90% of F_{MSY}. Below this SSB value, F decreases. If SSB reaches 30% of SSB_{MSY} (or less), the fishery is not prosecuted (ABC=0). This alternative is closer to No Action in terms of F rates, but includes a fishery cutoff, which is conceptually similar to Alternative 2, although not triggered until a lower biomass value is reached.
- **Alternative 4** is also biomass-based, but accounts for other objectives as well. Specifically, Alternative 4 would set the ABC to achieve specific metrics (or objectives) identified in the Management Strategy Evaluation process. Six distinct ABC control rule sub-options are part of this alternative. The primary metrics used to identify this range of six performance based alternatives are: 1) set %MSY to be 100%, with an acceptable level as low as 85%; 2) set variation in annual yield at <10%, with an acceptable level as high as 25%; 3) set the probability of overfished at 0%, with an acceptable level as high as 25%; and 4) set the probability of a fishery closure (ABC=0) between 0-10%.

None of the ABC control rule alternatives are expected to have adverse impacts to EFH given that the fishery in general is prosecuted with gears that have only minimal and temporary habitat impacts; ***neutral*** impacts overall. Such minimal impacts that do exist will likely vary under the different alternatives, because the ABC values drive actual allocations in the fishery in terms of area-based ACLs. Higher ACLs are expected to lead to more fishing effort, and thus larger impacts to EFH, while lower ACLs are expected to lead to less fishing effort, and thus smaller impacts to EFH. Full utilization of the ACLs of course depends on the ability of the fishery to find herring in the management areas to which the sub-ACLs are allocated, subject to constraints such as seasonal and gear-based closures, and bycatch limits for haddock and river herring.

To the extent that the herring fishery causes any impacts on EFH, the largest impacts are likely to be associated with No Action, Alternatives 1 and 3, the lowest impacts associated with Alternative 2, and intermediate impacts associated with Alternatives 4a-4f. If biomass is at B_{MSY}, Alternatives 1 and 3 have equally high F=0.9, and the Alternative 4 fishing mortality ranges between F=0.6-0.7, and Alternative 2 has F=0. Compared to all other alternatives, Alternative 2 results in lower F rates and thus lower fishing effort at any biomass, with the maximum F=0.5 only allowed when B is at least double B_{MSY}.

4.6.1.2 Alternatives for setting three-year ABCs

There are two alternatives associated with the method used for setting ABCs in a multiyear specification process.

- **Alternative 1/No Action** would set the same ABC for all three years of a specification cycle.
- **Alternative 2** would also set the ABC for three years, but with annual application of a control rule based on the most recent herring assessment and short-term projections.

Regardless of the alternative selected, three years of ABC values will be set with each specification action, as is currently done. Alternative 2 would allow the ABC and ACLs to vary annually, according to biomass projections and the control rule alternative selected in this action. Neither of these alternatives have direct or indirect impacts on EFH because the fishery in general is prosecuted with gears that have only minimal and temporary habitat impacts, whether a constant ABC is set for three years in a row, or the ABC is allowed to vary in accordance with changing biomass projections. Therefore, neither of the multiyear ABC method alternatives is expected to have habitat impacts that are more than minimal or more than temporary; ***neutral*** impacts expected overall for both alternatives.

Such minimal impacts that do exist will likely vary under the two alternatives, but variation is likely to be very minimal between Alternatives 1 and 2. This is because the cohorts of fish used to generate the projections for years 2 and 3 of the specifications are well established by the time they are modeled in the assessment (see Section 3.1 for further explanation of this issue). In other words, even under Alternative 2, ABC is likely to be stable between years.

4.6.1.3 FMP provisions that may be changed through a framework adjustment

The Council recommends that future modifications to the ABC CR could be made by amendment or framework. This section does not have any alternatives; this recommendation is administrative, and would have ***no direct impacts on EFH, positive or negative***.

4.6.2 Potential localized depletion and user conflicts

The management measures in this part of the amendment direct herring fishing into specific seasons and areas. The measures apply by gear type and are primarily focused on midwater trawls. The fishery is already managed using time/area approaches to a certain extent, but the alternatives under consideration here would further adjust these measures to mitigate the potential for localized depletion of herring, and any associated user conflicts. In terms of impacts to habitat, there are a few key questions.

First, in terms of the potential impacts of fishing on the seabed, do the localized depletion alternatives lead to a change in the amount or location of fishing? Specifically, do the measures create incentives for herring fishermen to shift away from use of midwater trawls towards small mesh bottom trawls? The likelihood vessel operators making such a switch will relate to the degree to which midwater trawl effort is restricted under a given alternative. Alternatives that are more restrictive, i.e., larger areas extending for a longer duration, provide a greater incentive for vessels to switch gears. Omnibus Habitat Amendment 2 (2017) assumes that midwater trawls have minimal and temporary impacts on seafloor habitats, and that bottom trawls can have adverse effects, particularly in certain habitat types. However, the extent to which small mesh bottom trawls contact the seabed when they are targeting herring, which is a midwater species, was not explored specifically. If small mesh bottom trawl gear is fished "midwater", impacts to EFH may be similar to those associated with midwater trawls, i.e., minimal and temporary.

Second, considering herring as a prey item that is a component of EFH, do management measures intended to avoid localized prey removals thus increase the quality fish habitat? NMFS' Guidelines for identifying essential fish habitat (EFH) and adverse impacts on EFH reflect the importance of keystone species like Atlantic herring to the overall health of the ecosystem as well as the importance of prey abundance for other species (50 CFR 600, 1/17/02, p. 2378). Specifically, the guidelines state that "*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.*"

Omnibus Habitat Amendment 2 includes an analysis of which Council-managed species consume herring, and at what sizes. The following species and lifestages could benefit from localized reduction in herring removals:

- American plaice – larger adults, 41-70 cm
- Atlantic cod – medium and large adults, 50 cm+
- Halibut
- Haddock – large adults
- Pollock – adults
- White hake – larger adults, 50+ cm
- Silver hake – larger juveniles and adults
- Monkfish – adults 50+ cm
- Thorny, barndoor, little, and winter skates – adults

In a broader context, it is important to remember that bottom trawls are already restricted in various habitat management areas, and this system of habitat areas was recently revised under Omnibus Habitat Amendment 2. Thus, any shifts in effort in the herring fishery will be subject to spatial management measures that serve to minimize the impacts of bottom trawl gear on EFH on a regional and basis across all fisheries.

4.6.2.1 Alternative 1 (No Action: prohibit MWT gear in Area 1A from June – September)

Under Alternative 1/No Action, vessels fishing for herring with midwater trawl gear are excluded from fishing in Herring Management Area 1A June 1 through September 30. This gear prohibition has likely shifted midwater trawling effort from the Gulf of Maine to Georges Bank during this time period.

The gear effects evaluation from Herring Amendment 1 (Volume II, Appendix VI) indicates that bottom contact by midwater trawls occurs only occasionally, and that the use of bottom trawls and dredges, which contact the bottom continuously, far exceeds the use of herring midwater trawls in terms of the number of trips and hours fished. Bottom trawls and dredges are already fished on much of Georges Bank, and these gears will be able to fish in additional locations following implementation of Omnibus Habitat Amendment 2. Given existing patterns of fishing on Georges Bank, combined with low rates of seafloor contact and therefore impacts associated with midwater gears, any additional disturbance of bottom habitats caused by midwater trawl gears would be negligible. Therefore, No Action has likely had and will continue to have ***neutral*** impacts on EFH.

4.6.2.2 Alternative 2: Closure within 6 nautical miles from shore in Area 114 to all vessels fishing for Atlantic herring (all gear types)

Under Alternative 2, waters within 6 nm from shore in thirty-minute square 114 off Cape Cod would be closed to all vessels fishing for herring, regardless of gear type or herring permit type. This closure would sunset two years after implementation, unless extended by the Council. Sub-option A would close the area between June 1 and August 31, and sub-option B would close the area for an additional two months, through October 31. This alternative is expected to shift herring fishing with any gear type away from this area. Since midwater trawl gear is already prohibited in Area 1A during the Sub-option A timeframe, under this sub-option, midwater trawl gear use is likely to shift further east onto Georges Bank. As discussed under Alternative 1, midwater trawls have minimal contact with the seafloor and Georges Bank is already fished by bottom tending gears, so these shifts will have negligible impacts on EFH.

Midwater trawls are prohibited from Area 1A during the first half of the Sub-option B timeframe, but allowed in 1A after October 1. Thus, effort from the Alternative 2 area would shift to Georges Bank during September, but likely to both Georges Bank and Area 1A during October. Since all gear types fishing for herring are restricted under Alternative 2, there is no incentive to shift to bottom trawl gears. Given that midwater trawls have minimal impacts on EFH, effort shifts under Alternative 2 are expected to have ***neutral impacts*** on EFH.

4.6.2.3 Alternative 3: Year-round prohibition of midwater trawl gear in Herring Management Area 1A

If adopted, this alternative would extend the midwater trawl gear prohibition in Area 1A to be a year-round restriction (**Figure 5**). Midwater trawls would be allowed to convert to other gear types (purse seine, small mesh bottom trawl) to target herring.

Area 1A is an important fishing ground for the midwater trawl fleet during certain seasons, and a year-round restriction under Alternative 3 would likely provide incentives for vessels to switch gears. Shifting to use of a bottom trawl would likely be easier than shifting to use of purse seine gear, given that midwater trawl vessels and their crews are already configured for mobile gear use. However, bottom trawl use in Area 1A is restricted under habitat and groundfish regulations, with year-round closures in the Western Gulf of Maine habitat and groundfish closure areas (which overlap one another), and seasonal closures associated with the cod protection closures and cod spawning protection areas. In addition, small mesh bottom trawls can only be used in certain exemption areas. Given the extensive restrictions on the use of small mesh bottom trawls in the Gulf of Maine, Alternative 3 would likely have ***neutral*** impacts if vessels convert to purse seine gear, to ***low negative*** impacts to EFH if some effort converts onto bottom trawl vessels in restricted areas and seasons. If this measure prevents MWT vessels from fishing in Area 1A all together and vessels do not convert gear type to access the area, it is likely that existing purse seine vessels would harvest the full sub-ACL, with ***neutral*** impacts on EFH.

4.6.2.4 Alternative 4: Prohibit midwater trawl gear inside of 12 nautical miles south of Area 1A

If this alternative is adopted, waters within 12 nm from shore and south of Herring Management Area 1A would be closed to midwater trawl gear. Various area and season options were considered. Area options include sub-option A, Herring Management Areas 1B, 2, and 3, while sub-option B includes 1B and 3 only. Seasonal options include sub-option A, year-round, and sub-option B, June 1-September 30.

The area due east of Cape Cod and the area immediately off Rhode Island are consistently fished by midwater trawl gears, and this effort would be shifted out of these areas under Alternative 4. Effort east of Cape Cod would be displaced under either area sub-option, while effort in both areas would be displaced only if sub-option A is selected. Year-round restrictions would have a greater effect of effort shifts than seasonal prohibitions. Because the seasonal prohibition is the same as the 1A closure, under area sub-option A, nearly all midwater trawl effort would shift onto Georges Bank, beyond 12 nm from shore. Under area sub-option B, midwater trawls could be used on Georges Bank or in Area 2.

Shifts in midwater trawl effort alone are likely to have neutral impacts to EFH, because the gear does not have adverse impacts to habitat. Alternative 4, particularly if it is only adopted for Area 1B and Area 3, may not provide a strong enough incentive for vessels to switch to bottom trawl gear. Accounting for possible switches to bottom trawl gear, considering that small mesh bottom trawl can only be using in specific areas, and acknowledging that bottom trawls could be fished off bottom, the impacts of this alternative on EFH are likely ***neutral to low negative***.

4.6.2.5 Alternative 5: Prohibit midwater trawl gear inside of 25 nautical miles in areas south of Herring Management Areas 1A

If this alternative is adopted, waters within 25nm from shore and south of Herring Management Area 1A would be closed to midwater trawl gear. Various area and season options were considered. Area options include sub-option A, Herring Management Areas 1B, 2, and 3, while sub-option B includes 1B and 3 only. Seasonal options include sub-option A, year-round, and sub-option B, June 1-September 30.

Effort shifts are expected to be similar to those for Alternative 4, but with midwater trawls shifted further offshore. Shifts in midwater trawl effort alone are likely to have neutral impacts to EFH, because the gear does not have adverse impacts to habitat. Alternative 5, particularly if it is only adopted for Area 1B and Area 3, may not provide a strong enough incentive for vessels to switch to bottom trawl gear. Accounting for possible switches to bottom trawl gear, considering that small mesh bottom trawl can only be using in specific areas, and acknowledging that bottom trawls could be fished off bottom, the impacts of this alternative on EFH are likely ***neutral to low negative***.

4.6.2.6 Alternative 6: Prohibit midwater trawl gear inside of 50 nautical miles in waters south of Herring Management Areas 1A

If this alternative is adopted, waters within 50 nm from shore and south of Herring Management Area 1A would be closed to midwater trawl gear. Various area and season options were considered. Area options include sub-option A, Herring Management Areas 1B, 2, and 3, while sub-option B includes 1B and 3 only. Seasonal options include sub-option A, year-round, and sub-option B, June 1-September 30.

Effort shifts are expected to be similar to those for Alternative 4 and 5, but with midwater trawls shifted even further offshore. Shifts in midwater trawl effort alone are likely to have neutral impacts to EFH, because the gear does not have adverse impacts to habitat. However, given the relatively large spatial extent of the midwater trawl prohibition under Alternative 6, this alternative provides the strongest incentive for herring vessels to shift to the use of alternate gear types, most likely bottom trawls. Accounting for possible switches to bottom trawl gear, considering that small mesh bottom trawl can only be using in specific areas, and acknowledging that bottom trawls could be fished off bottom, the impacts of this alternative on EFH are likely ***low negative***.

4.6.2.7 Alternative 7: Prohibit midwater trawl gear within thirty minute squares 99, 100, 114, 115 and 123

If this alternative is adopted, vessels with midwater trawl gear would be prohibited from fishing within several thirty minute squares (Areas 99, 100, 114, 115, and 123). Various area and seasonal options were considered. Area options include sub-option A, Herring Management Areas 1B, 2, and 3 (all 30-minute squares), while sub-option B includes 1B and 3 only (30-minute squares 99, 114, and 123). Seasonal options include sub-option A, year-round, and sub-option B, June 1-September 30.

Alternative 7 would have fewer effects on fishing effort than Alternative 6 (50 nm), potentially similar to Alternatives 4 and 5 with the sub-options that focus just on Areas 1B and 3. Area 114 in particular is the portion of this alternative that is fished by midwater trawls. Fishing effort off RI and in the Great South Channel would not be affected by Alternative 7.

Shifts in midwater trawl effort alone are likely to have neutral impacts to EFH, because the gear does not have adverse impacts to habitat. Alternative 7, particularly if it is only adopted for Area 1B and Area 3, may not provide a strong enough incentive for vessels to switch to bottom trawl gear. Accounting for possible switches to bottom trawl gear, considering that small mesh bottom trawl can only be using in specific areas, and acknowledging that bottom trawls could be fished off bottom, the impacts of this alternative on EFH are likely ***neutral to low negative***.

4.6.2.8 Alternative 8: Revert the boundary between Herring Management Areas 1B and 3 back to original boundary

This alternative would revert the Herring Management Area boundaries between Area 1B and 3 back to what they were under the original Herring FMP, but maintain the current boundary between Areas 2 and 3. This measure could affect area-specific sub-ACL allocations and cause some minor shifts in fishing effort in the herring fishery, but any adverse habitat effects associated with the fishery will continue to be minimal and/or temporary; therefore ***neutral*** impacts expected overall. Sub-ACL allocations and their associated impacts will continue to be assessed through the fishery specification process.

4.6.2.9 Alternative 9: Remove seasonal closure of Area 1B

This alternative would remove the existing January 1 – April 30 closure in Area 1B. Given prior fishery use of the area, effort would potentially extend over a longer time period and begin earlier in the year, compared to a relatively short season extending only several weeks in May. Given the minimal effects of the fishery on EFH in general, impacts to habitat from Alternative 9 are expected to be ***neutral***.

4.7 IMPACTS ON HUMAN COMMUNITIES

4.7.1 Introduction

The analysis of impacts on human communities characterizes the magnitude and extent of the economic and social impacts likely to result from the alternatives considered, individually and in relation to each other.

A fundamental difficulty exists in forecasting economic and social change relative to fishery management alternatives when communities or other societal groups are constantly evolving in response to numerous external factors, such as market conditions, technology, alternate uses of waterfront, and tourism. Management regulations influence the direction and magnitude of economic and social change, but attribution is difficult with the tools and data available. While this analysis focuses on the human community impacts of the alternatives, external factors may also influence change, both positive and negative, in the affected communities. In many cases, these factors contribute to a community’s vulnerability and ability to adapt to new or different fishing regulations.

When examining potential economic and social impacts of management measures, it is important to consider impacts on the following: the fishing fleet (vessels grouped by fishery, primary gear type, and/or size); vessel owners and employees (captains and crew); herring dealers and processors; final users of herring; community cooperatives; fishing industry associations; cultural components of the community; and fishing families. While some management measures may have a short-term negative impact on some communities, this should be weighed against potential long-term benefits to all communities which can be derived from a sustainable herring fishery.

For the herring fishery, downstream industries include the lobster fishery, zoos, and consumers of herring for food. Upstream industries include gear repair, vessel services and haul-out operations and fueling stations. Competing industries include fishing operations that supply a similar product (such as the squid, mackerel, and non-reduction menhaden fisheries). The competing industries also include operations that use herring biomass in the water indirectly: whale- and bird-watching, recreational fishing, and commercial fishing operations.

Economic impacts: In general, the economic effects of regulations can be categorized into regulations that change costs (including transactions costs such as search, information, bargaining, and enforcement costs) or change revenues (by changing market prices or by changing the quantities supplied). These economic effects are usually felt by the directly regulated entities (e.g., herring fishery). They may also be felt by downstream industries that use outputs of these entities (e.g., lobster fishery), upstream industries that supply the regulated entities (e.g., shoreside support), and competing industries that use the same inputs or outputs as the regulated entities (e.g., other bait fisheries).

Social impacts: The social impact factors outlined below can be used to describe the Atlantic herring fishery, its sociocultural and community context and its participants. These factors or variables are considered relative to the management alternatives and used as a basis for comparison between alternatives. Use of these kinds of factors in social impact assessment is based on NMFS guidance (NMFS 2007) and other texts (e.g., Burdge 1998). Longitudinal data describing these social factors region-wide and in comparable terms is limited. While this analysis does not quantify the impacts of the management alternatives relative to the social impact factors, qualitative discussion of the potential changes to the factors characterizes the likely direction and magnitude of the impacts. The factors fit into five categories:

1. *Size and Demographic Characteristics* of the fishery-related workforce residing in the area; these determine demographic, income, and employment effects in relation to the workforce as a whole, by community and region.

2. The *Attitudes, Beliefs, and Values* of fishermen, fishery-related workers, other stakeholders and their communities; these are central to understanding the behavior of fishermen on the fishing grounds and in their communities.

3. The effects of the proposed action on *Social Structure and Organization*; that is, changes in the fishery's ability to provide necessary social support and services to families and communities.

4. The *Non-Economic Social Aspects* of the proposed action; these include lifestyle, health, and safety issues, and the non-consumptive and recreational uses of living marine resources and their habitats.

5. The *Historical Dependence on and Participation in* the fishery by fishermen and communities, reflected in the structure of fishing practices, income distribution, and rights (NMFS 2007).

4.7.2 Atlantic herring ABC control rule

Use of a control rule to determine the appropriate ABC for a particular stock has both long and short-term impacts on human communities to consider. Amendment 8 would establish a control rule process. Specific ABCs will be set through future specifications. Thus, impacts of the control rule alternatives on human communities are expected to be ***indirect***.

4.7.2.1 Alternatives for ABC control rule

The purpose of this action is to select an ABC control rule to achieve many objectives, including sustainability of the herring fishery and improved outcomes for other stakeholders. Some of these benefits may accrue to the herring fishery, others may accrue to components of the "ecosystem" (such as tuna, shorebirds, or other predators), and others may accrue to the users of other ecosystem components (such as the ecotourism, recreational fishing, or commercial fishing industries).

Overview of long-term impacts

Economic models (a focus of the Management Strategy Evaluation) aided the long-term impact analysis. Table 99 to Table 106 and Figure 102 to Figure 107 (p. 374-381) show the long-term (MSE) results for the metrics such as net revenue and IAV of net revenue, which help characterize the potential impacts on the herring, mackerel and lobster fisheries of the alternatives under consideration.

To interpret the tables, read across a row to discern the variability of outcomes of a control rule across the different operating models. Look across the Base Price and New Price tables to discern how the operating models perform under two different models of the herring market. The Base Price model was the initial economic model used in the MSE (subject of the March 2017 peer review). The New Price model was developed subsequent to the peer review.

Impacts on the Atlantic herring fishery. The long-term economic impacts of the ABC control rule alternatives on the herring fishery (and related businesses in the mackerel and lobster fisheries) can be evaluated using the summary table of MSE results for the herring fishery VEC (Figure 106). The metrics that have been identified to best represent the potential economic impacts are: probability overfished, probability overfishing occurring, yield relative to MSY, yield, proportion of years ABC=0, net revenue, streakiness, and interannual variation in yield (IAV).

Model results (included in the MSE, Sections 4.1.1.3 to 4.1.1.5 and 4.7.2.1; Appendix III) of gross revenue, net revenue, interannual variation (IAV) of net revenue, and stationarity help describe the long-term impacts of the ABC control rule alternatives on the herring fishery. Net revenue is the gross revenue minus the "non-crew remuneration" variable operating costs. IAV of net revenue is the year-to-year volatility of net revenue. Stationarity of net revenue measures the likelihood that a long-term equilibrium or steady state of net revenue is achieved. All alternatives resulted in an equilibrium state for net revenue, so its stationarity is not discussed further. High net revenues benefit the herring fishery, but high IAV is assumed bad, as it would produce unstable and unpredictable market outcomes.

Impacts on Atlantic mackerel fishery. Performance metrics specific to the Atlantic mackerel fishery were not included in the MSE. However, given that many Atlantic herring vessels also participate in the mackerel fishery, the impacts on these fisheries are closely linked.

Impacts on American lobster fishery. As a buyer of herring bait, the lobster fishery is assumed to benefit when Atlantic herring yield (ABC) is high, volatility (IAV of yield) is low, and prices are low. Yield (Figure 57, p. 239) is similar across the control rules (varying more by operating model). IAV of Yield (Figure 59, p. 243) for Alternative 1 and Alternatives 4A-4F is similarly low, and higher for Alternatives 2 and 3 (Figure 59, p. 243). Alternatives 2 and 3 also result in fishery closures (setting ABC=0 for up to 12% of years, depending on the model; Figure 60, p. 245). While stakeholders reported preferences for low IAV, it is difficult to translate these preferences into a cost of IAV to stakeholder groups, including the lobster fishery.

Impacts on predator fisheries and ecotourism. As industries reliant on herring as a prey item in the ecosystem, the predator fisheries (e.g., groundfish, tuna) and ecotourism (whale and bird watching) are expected to fare better with sufficient herring to sustain their predators. Direct and indirect metrics for the predators of Atlantic herring are reported in Sections 4.1.1.3.13 to 4.1.1.3.15. The performance of tuna weight and dogfish biomass (direct metrics) changes little across the alternatives. Tern production (direct metric) is highest for Alternative 2 and slightly lower for the other control rules. The indirect metrics show that herring biomass is highest for Alternative 2 and lowest for Alternative 1. Surplus production is similar across the alternatives (Figure 53, p. 232).

The overall long-term economic impacts of the ABC control rule alternatives on predator fisheries that rely on herring as forage can be evaluated using the summary table of MSE results for predator fisheries VEC (Figure 107). The metrics that best represent potential economic impacts are: tuna status and dogfish biomass, as proxies for the fisheries that prosecute these predators of herring.

Impacts on communities. Human communities are impacted by an ABC control rule, because the control rule is used to set harvest levels for the fishery. Lowering the Atlantic herring ABC could result in short-term revenue reductions, which may, in turn, have negative impacts on the *Size and Demographic Conditions* of the Atlantic herring fishery within fishing communities, with ripple effects on the communities involved in the Atlantic mackerel and American lobster fisheries. Likewise, increasing allowable harvests is expected to have positive short-term impacts on fishing communities. In the long term, fishing under a control rule that ensures continued, sustainable harvest of the resource not only benefits the directed herring fishery and its communities, but indirect fisheries that rely on herring as prey in the ecosystem.

The specific communities that may be impacted by this action are identified in Section 3.6.3. This includes 17 communities of interest in the Atlantic herring fishery (e.g., Gloucester, Portland, New Bedford, Rockland) within a list of about 140 key communities from Maine to New Jersey that are important to the Atlantic herring, Atlantic mackerel, American lobster, bluefin tuna, groundfish, and recreational fisheries, and to ecotourism. Many of these fisheries and ecotourism coexist within a given port (Table 78, p. 206). The communities more involved in the Atlantic herring fishery are likely to experience more direct impacts of this action, though indirect impacts may be experienced across all of the key communities. As an ABC control rule affects stock-wide harvest levels, impacts are expected to occur across the communities that participate in the Atlantic herring and other potentially affected fisheries, proportional to their degree of participation in the fisheries.

Overview of short-term impacts

It is also important to consider the short-term effects of control rules, i.e., the expected impacts over the next several years, which are evaluated in two analyses (Section 4.1.1.6). In the short term, impacts would depend on the specific ABC that results from using the control rule under the existing status of the resource. Generally, a reduction in ABC is likely to reduce revenue in the short term, which may in turn have negative impacts on the *Size and Demographic Conditions* of the fishery-related workforce. Likewise, increasing an ABC is expected to have positive impacts on the fishery. For fish stocks that are not undergoing overfishing (the current status of Atlantic herring), ABC requirements still might require reductions in catch targets compared to current catch quotas to prevent overfishing or achieve other objectives. In general, management via a control rule should contribute to the conservation of stocks through more rapid rebuilding of overfished stocks and preventing overfishing, even in stocks not presently overfished. The direct impacts of specific ABCs will be analyzed in future actions and would depend on the information available at that time.

Atlantic herring fishery. Short-term impacts were modeled separately from the MSE (Section 4.1.1.6). Gross and net revenue under each of the control rules were estimated using the New Price economic model under four biomass scenarios. The High (recent) biomass scenario is most likely to be in effect in the near future. The results from the other biomass scenarios provide some insight into the sensitivity of the outcomes relative to changes in biomass.

- *High biomass scenario (the recent condition)* - the short-term outcomes for the herring fishery, in terms of net revenue, are highest for Alternative 1 and Alternative 3 and lowest for Alternative 2.
- *Medium biomass scenario* - the short-term outcomes for the herring fishery are similar for all alternatives except Alternative 2, with net revenues $20M lower.
- *Medium B biomass scenario* - there is a good deal of variability in outcomes, although revenues in all scenarios are well below historical averages.
- *Poor biomass scenario* – short-term outcomes are similarly low, as there would be nearly no herring fishing under all alternatives.

Table 99 - Net revenue ($M) and interannual variation (IAV) of net revenue for all alternatives, using the High Mortality Operating Models and the Base Price model

Alternative		HiM Bias Old		HiM Bias Recent		HiM no Bias Old		HiM no Bias Recent	
		Net Revenue	IAV	Net Revenue	IAV	Net Revenue	IAV	Net Revenue	IAV
1	Straw A	$12.98M	0.30	$14.27M	0.29	$16.68M	0.23	$17.79M	0.23
2	Straw B	$17.92M	0.48	$18.91M	0.50	$10.96M	0.57	$12.18M	0.57
3	Predet	$15.32M	0.37	$16.35M	0.37	$17.22M	0.28	$18.39M	0.28
4A	Criteria A	$15.47M	0.25	$16.44M	0.25	$16.23M	0.22	$17.35M	0.21
4B	Criteria B	$15.58M	0.25	$16.48M	0.25	$16.23M	0.22	$17.35M	0.21
4C	Criteria C	$15.60M	0.26	$16.56M	0.26	$16.30M	0.22	$17.35M	0.22
4D	Criteria D	$15.93M	0.27	$16.82M	0.26	$16.47M	0.23	$17.45M	0.22
4E	Criteria E	$16.38M	0.25	$17.29M	0.25	$15.80M	0.23	$17.00M	0.22
4F	Criteria F	$16.81M	0.26	$17.76M	0.27	$16.20M	0.24	$17.27M	0.24

Table 100 - Net revenue ($M) and interannual variation (IAV) of net revenue, using the Low Mortality Operating Models and the Base Price model

Alternative		LoM Bias Old		LoM Bias Recent		LoM no Bias Old		LoM no Bias Recent	
		Net Revenue	IAV	Net Revenue	IAV	Net Revenue	IAV	Net Revenue	IAV
1	Straw A	$17.29M	0.42	$15.85M	0.44	$18.41M	0.32	$17.13M	0.35
2	Straw B	$10.11M	0.79	$7.80M	0.88	$14.20M	0.65	$11.94M	0.71
3	Predet	$15.45M	0.59	$12.99M	0.64	$17.08M	0.41	$14.95M	0.48
4A	Criteria A	$17.46M	0.36	$16.36M	0.38	$19.00M	0.26	$17.87M	0.29

4B	Criteria B	$17.45M	0.37	$16.14M	0.39	$18.99M	0.26	$17.83M	0.29
4C	Criteria C	$17.30M	0.39	$16.01M	0.43	$19.03M	0.26	$17.77M	0.31
4D	Criteria D	$17.12M	0.39	$15.28M	0.42	$18.98M	0.28	$17.58M	0.31
4E	Criteria E	$17.60M	0.37	$15.78M	0.42	$19.55M	0.25	$18.29M	0.28
4F	Criteria F	$17.03M	0.39	$14.97M	0.45	$19.22M	0.28	$17.52M	0.32

Table 101 - Difference in net revenue ($M) and IAV for Alternatives 2 – 4F relative to Alternative 1, using the High Mortality Operating Models and the Base Price model

Alternative		HiM Bias Old		HiM Bias Recent		HiM no Bias Old		HiM no Bias Recent	
		Net Revenue	IAV	Net Revenue	IAV	Net Revenue	IAV	Net Revenue	IAV
1	Straw A								
2	Straw B	$4.94M	0.18	$4.65M	0.20	-$5.73M	0.34	-$5.61M	0.34
3	Predet	$2.34M	0.06	$2.09M	0.07	$0.54M	0.05	$0.60M	0.05
4A	Criteria A	$2.49M	-0.05	$2.17M	-0.05	-$0.46M	-0.02	-$0.44M	-0.02
4B	Criteria B	$2.60M	-0.05	$2.21M	-0.04	-$0.46M	-0.01	-$0.44M	-0.02
4C	Criteria C	$2.63M	-0.04	$2.29M	-0.04	-$0.39M	-0.01	-$0.44M	-0.01
4D	Criteria D	$2.95M	-0.04	$2.55M	-0.03	-$0.21M	-0.01	-$0.34M	-0.01
4E	Criteria E	$3.40M	-0.06	$3.02M	-0.04	-$0.88M	-0.01	-$0.79M	-0.01
4F	Criteria F	$3.83M	-0.04	$3.49M	-0.03	-$0.48M	0.01	-$0.52M	0.01

Table 102 – Difference in net revenue ($M) and IAV for Alternatives 2 – 4F relative to Alternative 1, using the Low Mortality Operating Models and the Base Price model

Alternative		LoM Bias Old		LoM Bias Recent		LoM no Bias Old		LoM no Bias Recent	
		Net Revenue	IAV	Net Revenue	IAV	Net Revenue	IAV	Net Revenue	IAV
1	Straw A								
2	Straw B	-$7.18M	0.37	-$8.05M	0.44	-$4.21M	0.33	-$5.19M	0.36
3	Predet	-$1.84M	0.16	-$2.86M	0.21	-$1.33M	0.10	-$2.18M	0.13
4A	Criteria A	$0.16M	-0.06	$0.51M	-0.06	$0.60M	-0.06	$0.74M	-0.06
4B	Criteria B	$0.16M	-0.05	$0.29M	-0.05	$0.59M	-0.06	$0.70M	-0.06
4C	Criteria C	$0.01M	-0.03	$0.17M	0.00	$0.62M	-0.05	$0.64M	-0.04
4D	Criteria D	-$0.18M	-0.04	-$0.57M	-0.01	$0.57M	-0.04	$0.45M	-0.04
4E	Criteria E	$0.30M	-0.05	-$0.07M	-0.02	$1.15M	-0.07	$1.16M	-0.07
4F	Criteria F	-$0.27M	-0.03	-$0.88M	0.01	$0.81M	-0.04	$0.39M	-0.04

Figure 102 - Median net revenue ($M) for Alternatives 1 to 4A, using all herring operating models and the <u>Base Price</u> economic model

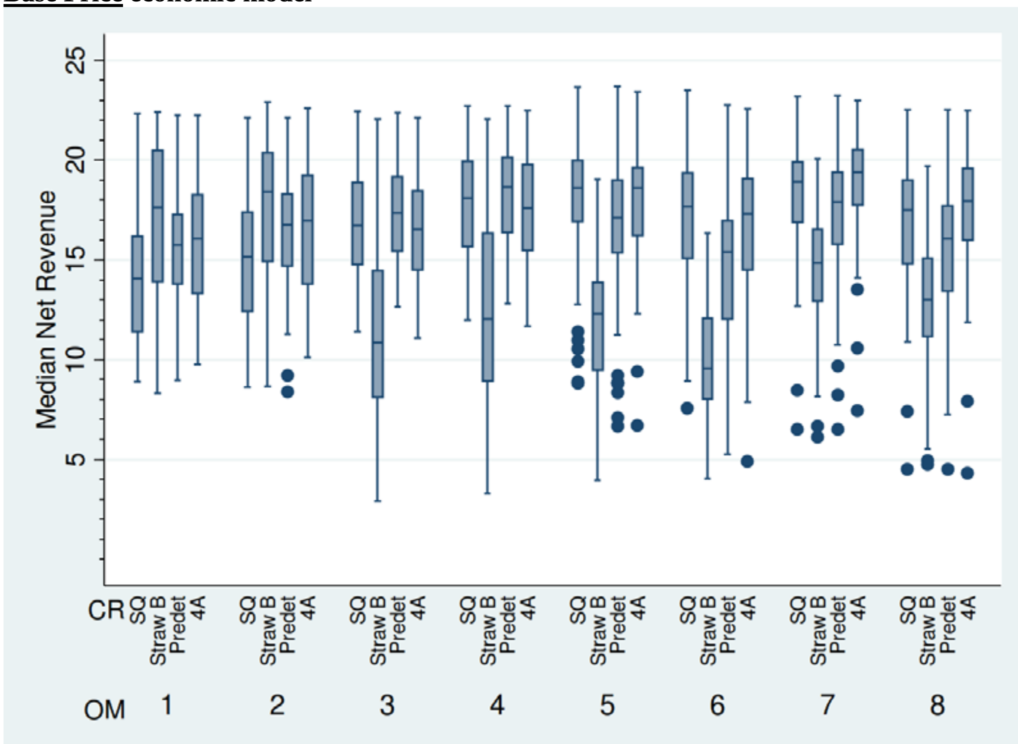


Figure 103 - Median net revenue ($M) for Alternatives 4A-4F, using all herring operating models and the <u>Base Price</u> economic model

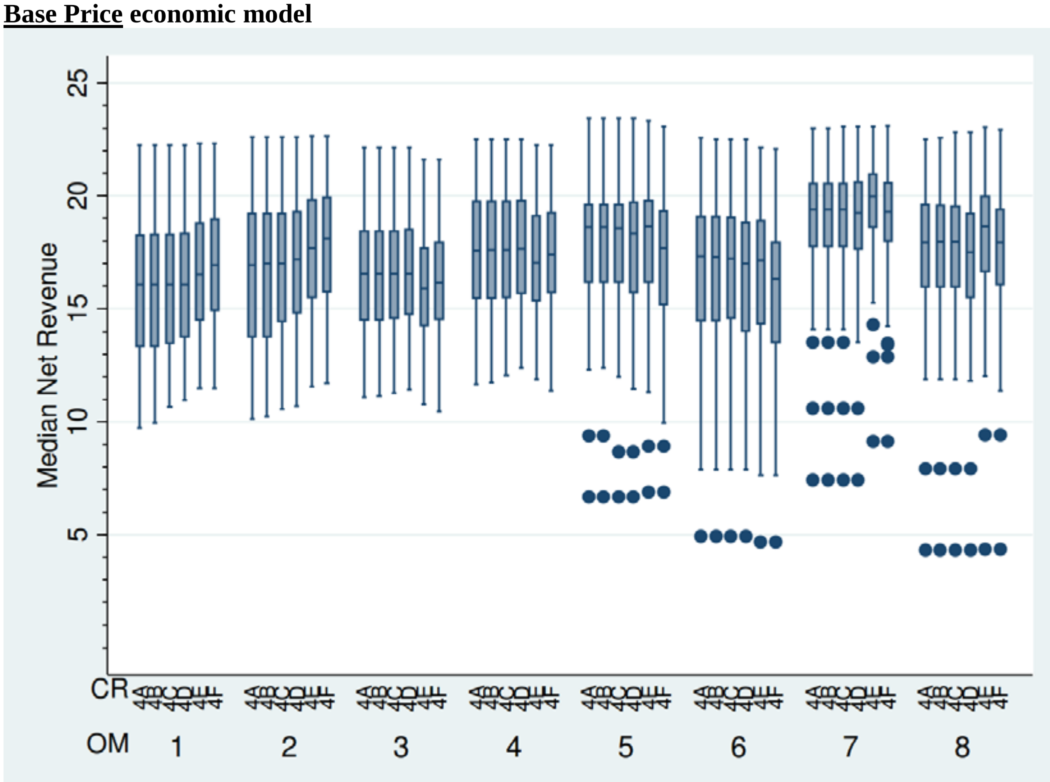


Figure 104 – IAV for Alternatives 1 to 4A, using all herring operating models and the Base Price economic model

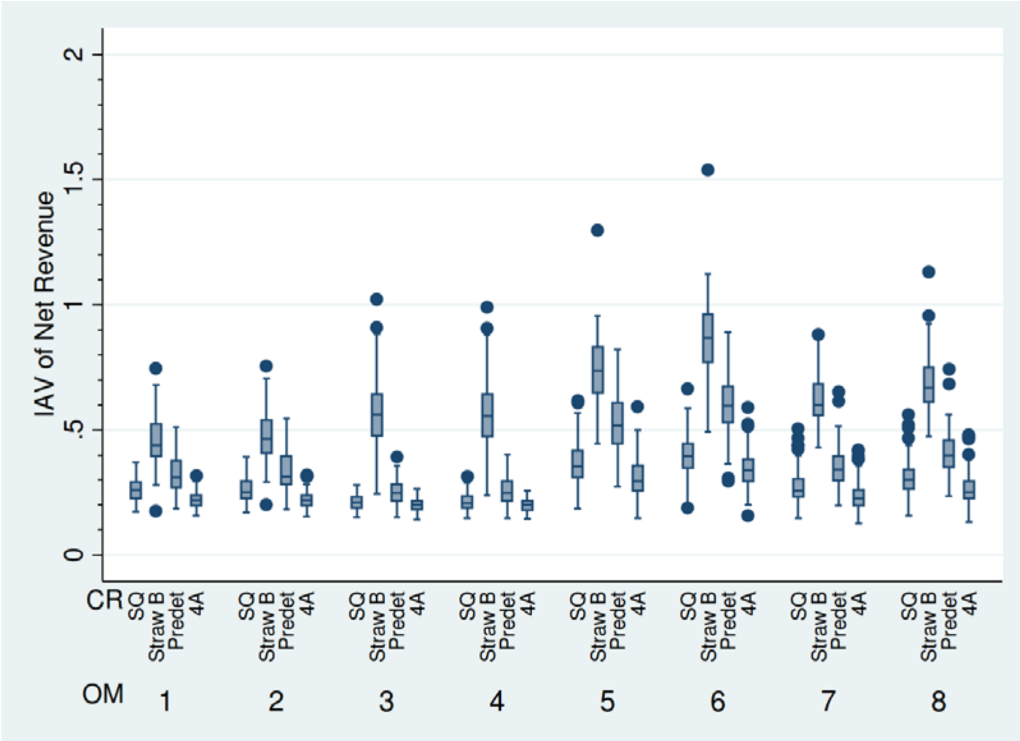


Figure 105 - IAV for the Alternatives 4A-4F, using all herring operating models and the Base Price economic model

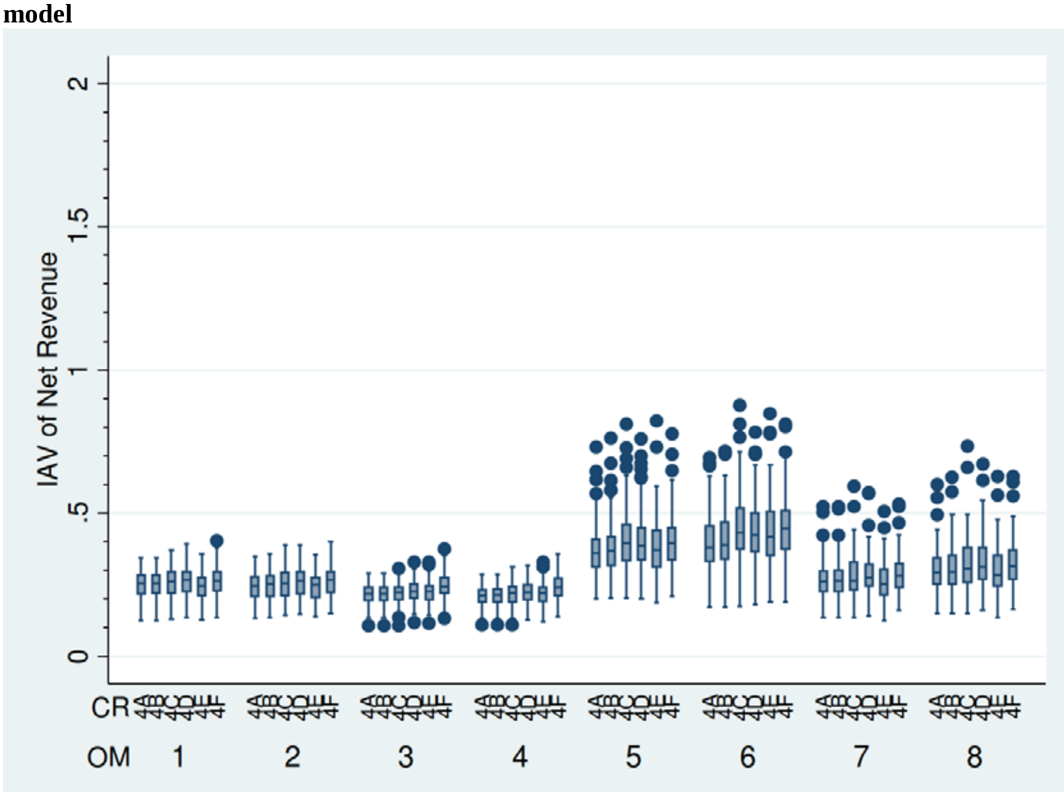


Table 103 - Net revenue ($M) and interannual variation (IAV) of net revenue, using the High Mortality Operating Models and the New Price model

Alternative		HiM Bias Old		HiM Bias Recent		HiM no Bias Old		HiM no Bias Recent	
		Net Revenue	IAV	Net Revenue	IAV	Net Revenue	IAV	Net Revenue	IAV
1	Straw A	$17.11M	0.29	$17.93M	0.29	$19.88M	0.23	$20.31M	0.23
2	Straw B	$20.54M	0.51	$20.77M	0.53	$15.01M	0.58	$15.81M	0.59
3	Predet	$18.70M	0.37	$19.50M	0.37	$20.44M	0.28	$20.96M	0.29
4A	Criteria A	$18.90M	0.24	$19.38M	0.24	$19.81M	0.20	$20.22M	0.20
4B	Criteria B	$18.91M	0.25	$19.38M	0.24	$19.81M	0.21	$20.23M	0.20
4C	Criteria C	$18.90M	0.25	$19.45M	0.25	$19.81M	0.21	$20.32M	0.21
4D	Criteria D	$19.04M	0.26	$19.61M	0.25	$19.93M	0.22	$20.40M	0.21
4E	Criteria E	$19.66M	0.24	$20.13M	0.24	$19.26M	0.21	$20.18M	0.21
4F	Criteria F	$19.95M	0.26	$20.47M	0.26	$19.64M	0.23	$20.53M	0.24

Table 104 - Net revenue ($M) and interannual variation (IAV) of net revenue, using the Low Mortality Operating Models and the New Price model

Alternative		LoM Bias Old		LoM Bias Recent		LoM no Bias Old		LoM no Bias Recent	
		Net Revenue	IAV	Net Revenue	IAV	Net Revenue	IAV	Net Revenue	IAV
1	Straw A	$22.36M	0.36	$22.41M	0.32	$22.26M	0.31	$21.46M	0.32
2	Straw B	$16.55M	0.92	$13.42M	0.99	$17.38M	0.72	$19.09M	0.72
3	Predet	$21.91M	0.49	$18.93M	0.55	$20.65M	0.45	$19.86M	0.47
4A	Criteria A	$21.75M	0.34	$21.28M	0.32	$22.42M	0.23	$21.83M	0.26
4B	Criteria B	$21.85M	0.35	$21.29M	0.34	$22.42M	0.23	$21.84M	0.26
4C	Criteria C	$21.90M	0.41	$21.02M	0.41	$22.42M	0.24	$21.56M	0.29
4D	Criteria D	$22.47M	0.36	$21.04M	0.35	$21.99M	0.27	$21.67M	0.30
4E	Criteria E	$22.19M	0.37	$21.22M	0.43	$22.28M	0.28	$21.82M	0.26
4F	Criteria F	$21.13M	0.38	$20.64M	0.39	$22.03M	0.28	$21.08M	0.32

Table 105 – Difference in net revenue ($M) and IAV for Alternatives 2 – 4F relative to Alternative 1, using the High Mortality Operating Models and the New Price model

Alternative		HiM Bias Old		HiM Bias Recent		HiM no Bias Old		HiM no Bias Recent	
		Net Revenue	IAV	Net Revenue	IAV	Net Revenue	IAV	Net Revenue	IAV
1	Straw A								
2	Straw B	$3.43M	0.22	$2.84M	0.24	-$4.87M	0.35	-$4.50M	0.37
3	Predet	$1.59M	0.08	$1.57M	0.08	$0.55M	0.05	$0.65M	0.06
4A	Criteria A	$1.79M	-0.05	$1.45M	-0.05	-$0.07M	-0.02	-$0.08M	-0.02
4B	Criteria B	$1.80M	-0.04	$1.45M	-0.05	-$0.07M	-0.02	-$0.08M	-0.02
4C	Criteria C	$1.79M	-0.04	$1.52M	-0.04	-$0.07M	-0.01	$0.01M	-0.02
4D	Criteria D	$1.93M	-0.03	$1.68M	-0.04	$0.05M	-0.01	$0.09M	-0.01
4E	Criteria E	$2.55M	-0.05	$2.20M	-0.05	-$0.62M	-0.01	-$0.13M	-0.01
4F	Criteria F	$2.84M	-0.03	$2.55M	-0.03	-$0.24M	0.01	$0.23M	0.01

Table 106 – Difference in net revenue ($M) and IAV for Alternatives 2 – 4F relative Alternative 1, using the Low Mortality Operating Models and the New Price model

Alternative		LoM Bias Old		LoM Bias Recent		LoM no Bias Old		LoM no Bias Recent	
		Net Revenue	IAV	Net Revenue	IAV	Net Revenue	IAV	Net Revenue	IAV
1	Straw A								
2	Straw B	-$5.81M	0.57	-$8.99M	0.68	-$4.88M	0.41	-$2.37M	0.40
3	Predet	-$0.45M	0.14	-$3.49M	0.23	-$1.61M	0.14	-$1.60M	0.15
4A	Criteria A	-$0.61M	-0.02	-$1.13M	0.01	$0.15M	-0.08	$0.38M	-0.06
4B	Criteria B	-$0.51M	0.00	-$1.12M	0.03	$0.15M	-0.08	$0.39M	-0.06
4C	Criteria C	-$0.46M	0.06	-$1.39M	0.10	$0.15M	-0.07	$0.11M	-0.04
4D	Criteria D	$0.11M	0.01	-$1.38M	0.03	-$0.27M	-0.05	$0.22M	-0.02
4E	Criteria E	-$0.17M	0.02	-$1.19M	0.12	$0.02M	-0.04	$0.37M	-0.06
4F	Criteria F	-$1.23M	0.03	-$1.78M	0.07	-$0.23M	-0.03	-$0.37M	-0.01

Figure 106 – Summary of the metrics that are indicators of potential impacts on the herring fishery and associated businesses (mackerel and lobster fisheries).

Herring Fishery Metrics: Probability of overfished, probability of overfishing, yield relative to MSY, Yield, Proportion of years no fishery (ABC=0), net revenue, and interannual variation in yield.

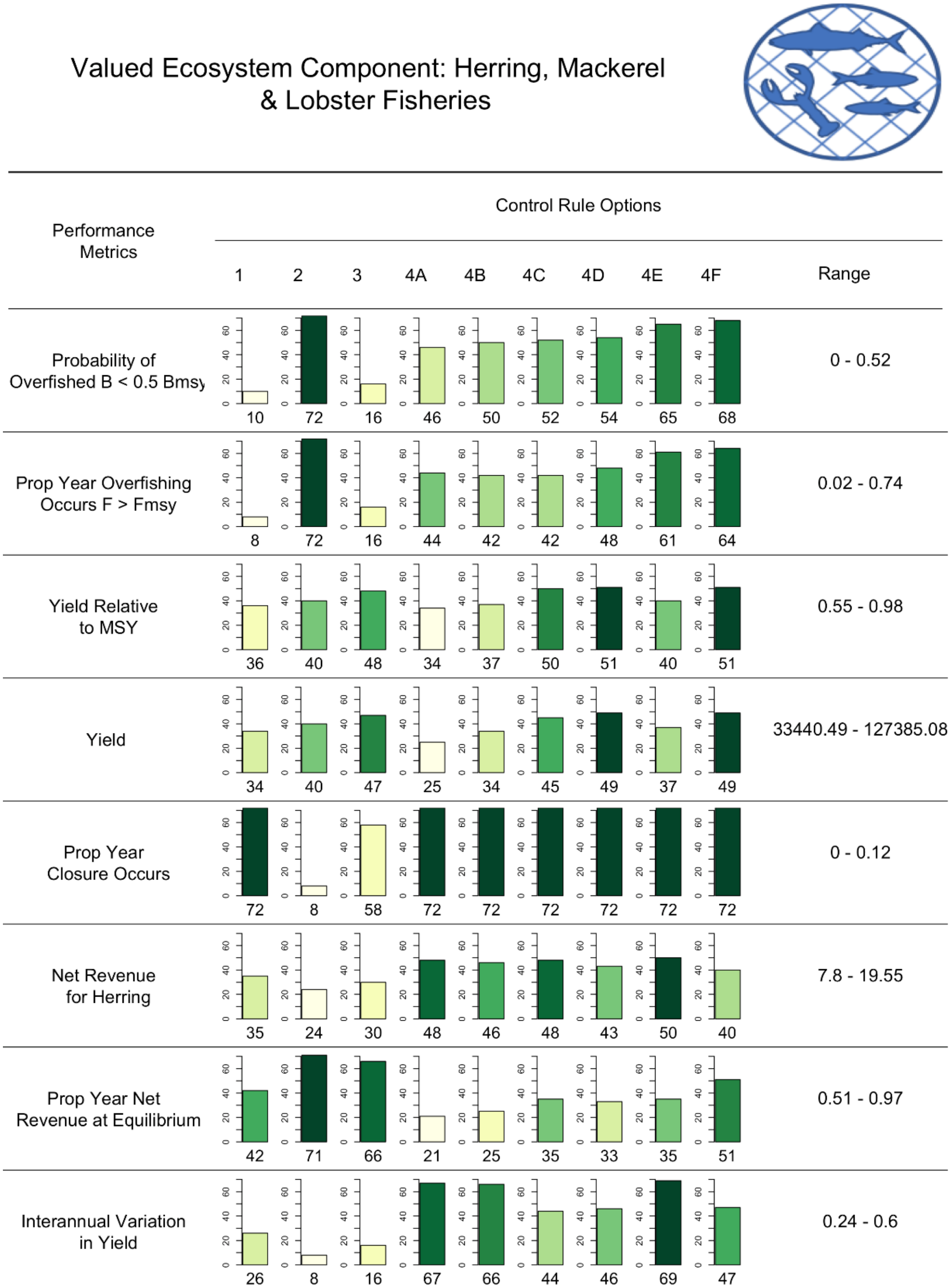
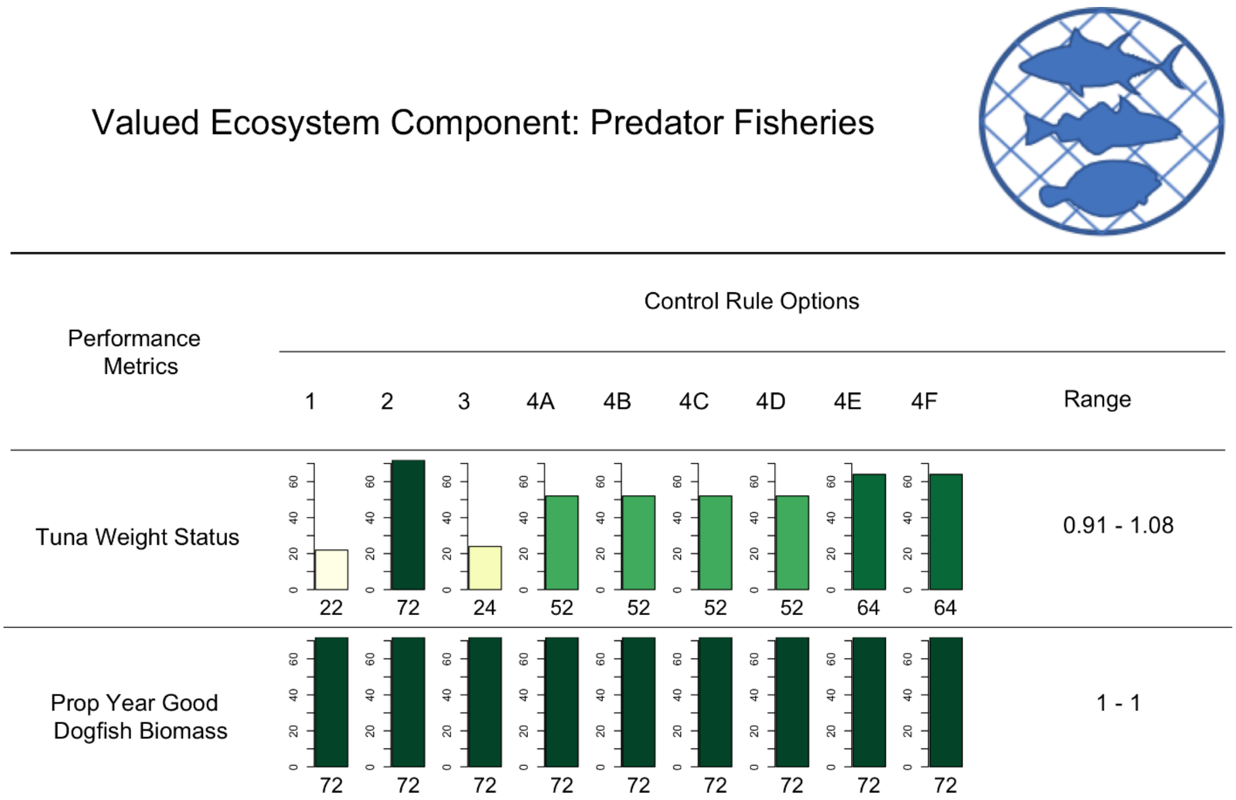


Figure 107 – Summary of the metrics that are indicators of potential impacts on predator fisheries

Predator Fishery Metrics: Tuna weight status and dogfish biomass.



4.7.2.1.1 No Action: Interim Control Rule – Policy used in recent specification setting processes (fishing years 2013-2018)

Under No Action, the ABC control rule used for the last two cycles, or six fishing years (2013-2018), would be used. The interim or sometimes called "status quo" or "default" control rule is biomass based, but the ABC is set at the same level for three years. ABC is set at the catch that is projected to produce a probability of exceeding F_{MSY} in the third year that is 50%.

The No Action alternative was not analyzed in the MSE, due to technical limitations (Section 2.1.1.1); thus, impacts described here are largely qualitative.

Impacts on Atlantic herring fishery

Long term. The impacts on the Atlantic herring fishery of No Action are expected to be ***indirect and uncertain in the long term, but likely not significant***. No Action may not be viable under scenarios of increasing biomass (Section 2.1.1.1), so a different control rule may be necessary in the future. Thus, using the status quo control rule indefinitely may result in uncertainty about the long-term management of the fishery, a low negative impact on the *Attitudes, Beliefs, and Values* of stakeholders.

Short term. The impacts on the Atlantic herring fishery of No Action are expected to be ***indirect and low positive in the short term***. The No Action control rule has been used to manage the fishery since 2013. Recent use of this approach has not resulted in significant adverse social or economic impacts (NEFMC 2014a; 2016). It has prevented overfishing, the stock is not overfished, and the biomass is well above B_{MSY}, though there is some degree of uncertainty in the assessment (Section 3.1.6). Stability in the approach to specifications give a sense of certainty about regulations and the future of the Atlantic herring fishery, which is a substantial benefit to business and household planning, a positive impact on the *Attitudes, Beliefs, and Values* of the fishery. Of course, No Action does not guarantee stability in yield and revenue, and without the ability to model No Action in the MSE, it is difficult to project potential variation in these metrics. Since 2013, the annual gross revenue of the fishery has ranged from $25-32M (Figure 37, p. 155).

Impacts on Atlantic mackerel fishery

The impacts on the Atlantic mackerel fishery of No Action are expected to be ***indirect and uncertain in the long term, but likely not significant***, and ***low positive in the short term***. Given that many Atlantic herring vessels also participate in the mackerel fishery, the impacts on these fisheries are closely linked. Stability in the approach to setting Atlantic herring specifications gives a sense of certainty about regulations and the future of the herring and mackerel fisheries, which is a substantial benefit to business and household planning and a positive impact on the *Attitudes, Beliefs, and Values* of the fishery.

Impacts on American lobster fishery

The impacts on the American lobster fishery of No Action are expected to be ***indirect and uncertain in the long term, but likely not significant***, and ***low positive in the short term***. As consumers of Atlantic herring bait, the lobster fishery benefits from having stability in the approach to setting Atlantic herring specifications, providing a sense of certainty about regulations and the future of the Atlantic herring fishery, which is a substantial benefit to business and household planning and a positive impact on the *Attitudes, Beliefs, and Values* of the fishery.

Impacts on predator fisheries and ecotourism

The impacts on predator fisheries and ecotourism of No Action are expected to be ***indirect and uncertain in the long term, but likely not significant***, and ***neutral to low positive in the short term***. No Action may not be viable under scenarios of increasing biomass (Section 2.1.1.1), so a different control rule may be necessary in the future. Thus, using the status quo control rule indefinitely may result in uncertainty about the long-term management of the fishery, a negative impact on the *Attitudes, Beliefs, and Values* of predator fisheries and ecotourism. Use of the No Action approach in recent years has prevented overfishing of Atlantic herring, the stock is not overfished, and the biomass is well above B_{MSY}, though there is some degree of uncertainty in the assessment (Section 3.1.6). Should the status of the herring stock remain unchanged, there may only be minor differences in overall ABC going forward, which may not have measurable differences in overall impacts on predators, many of which are opportunistic.

Impacts on communities

The impacts on communities of No Action are expected to be ***indirect and uncertain in the long term***, but likely not significant, and ***low positive in the short term***. No Action has prevented overfishing and an overfished herring resource, which have positive impacts among human communities, though there is assessment uncertainty. As an ABC control rule affects stock-wide harvest levels, impacts are expected to occur across the communities that participate in the Atlantic herring and other potentially affected fisheries (about 140 ports identified in Section 3.6.3), proportional to their degree of participation in the fisheries.

4.7.2.1.2 Alternative 1: Control rule that would resemble the interim control rule as approximated by its average performance in recent years (*Strawman A*)

Under Alternative 1, ABC would be set using the following parameters:

- A maximum fishing mortality rate equal to 90% of F_{MSY};
- Upper biomass parameter equal to 0.5 for the ratio of SSB/SSB_{MSY}; and
- No fishery cutoff.

These parameters perform as the No Action ABC control rule has performed on average over the last six years (2013-2018, resulting in an average annual fishing mortality rate equal to 90% of F_{MSY}), but are more compatible with MSE modeling and long-term projections than No Action.

Impacts on Atlantic herring fishery

Long term. The impacts on the Atlantic herring fishery of Alternative 1 are expected to be ***indirect and low negative to low positive in the long term.*** Alternative 1 would be viable under all biomass scenarios and would provide a degree of certainty about the long-term management of the fishery, a ***low positive impact relative to No Action*** on the *Attitudes, Beliefs, and Values* of the fishery. The MSE Base Price model indicates that, across all states of nature (i.e., herring operating models), impacts would generally be ***low positive relative to Alternatives 2 and 3*** and ***low negative relative to Alternative 4*** in terms of net revenue (Figure 61). However, Alternatives 2 and 3 may have more long-term stationarity of net revenue (Figure 62). Under the New Price economic model, the range of net revenue is $17-22M (depending on herring operating model); a higher range than under Alternative 2 ($13-21M), but lower relative to Alternatives 3-4 ($19-22M; Table 103 and Table 104). The range in interannual variability of net revenue ($0.23-0.36M) is lower than under Alternative 2 ($0.51-0.99M), but similar to Alternatives 3 and 4.

Short term. The impacts on the Atlantic herring fishery of Alternative 1 are expected to be ***indirect and neutral to low positive in the short term***. If the current, high biomass state continues, Alternative 1 would have ***neutral impacts relative to No Action and Alternative 3***, producing essentially the same ABC (Figure 70, Figure 71, Table 94; 111,000 mt). Similar revenue outcomes are also expected. The short-term annual gross and net fishery revenue under Alternative 1 are modeled to be $33M and $27.6M, respectively (Figure 70 and Figure 71), which is similar to the annual gross revenue of the fishery since 2013, $25-32M (Figure 37, p. 155). Impacts may be ***low positive relative to Alternatives 2 and 4***, which may have lower revenue outcomes***.***

Impacts on Atlantic mackerel fishery

The impacts on the Atlantic mackerel fishery of Alternative 1 are expected to be ***indirect and low positive (relative to No Action and Alternatives 2 and 3) to low negative (relative to Alternative 4) in the long term.*** Impacts are expected to be ***neutral (relative to No Action and Alternative 3) to low positive (relative to Alternatives 2 and 4) in the short term.*** The mackerel fishery occurs primarily in conjunction with Atlantic herring midwater trawl fishery, so impacts would largely mirror those of the Atlantic herring fishery.

Impacts on American lobster fishery

The impacts on the American lobster fishery of Alternative 1 are expected to be ***indirect and low positive (relative to No Action and Alternatives 2 and 3) to low negative (relative to Alternative 4) in the long term.*** The lobster fishery fares better with more stable bait supply; under Alternative 1, yield may be less variable than under Alternatives 2 and 3, but more so than under Alternative 4 (Figure 59, p. 243). Impacts are expected to be ***neutral (relative to No Action and Alternative 3) to low positive (relative to Alternatives 2 and 4) in the short term.*** The ABC under Alternative 1 would be essentially the same as under No Action and Alternative 3 (Table 94; 111,000 mt), but higher than under Alternatives 2 and 4.

Impacts on predator fisheries and ecotourism

The impacts on predator fisheries and ecotourism of Alternative 1 are expected to be ***indirect and low positive in the long term and short term***, but the positive impacts are not as high as some of the other alternatives under consideration. Predator fisheries and ecotourism fare better under positive Atlantic herring resource conditions, and low positive impacts on Atlantic herring are expected under Alternative 1 (Section 4.2.1.1.2). Alternative 1 is expected to keep tern productivity above the acceptable threshold for reproductive success (Section 4.1.1.3.13), a positive outcome for ecotourism. Across operating models, the tuna weight metric hovers around 1 (0.91-1.04; tuna weight is equal to threshold weights), a positive outcome for the tuna fishery, though the tuna weight metric is slightly higher for Alternatives 2-4.

Impacts on communities

The impacts on communities of Alternative 1 are expected to be ***indirect and low positive in the long term*** and ***neutral to low positive in the short term***. While the Atlantic herring, mackerel, and lobster fisheries may have neutral short-term impacts, impacts on other users may be low positive. To the degree that Alternative 1 prevents overfishing and an overfished herring resource, positive impacts among human communities are expected. As an ABC control rule affects stock-wide harvest levels, impacts are expected to occur across the communities that participate in the Atlantic herring and other potentially affected fisheries (about 140 ports identified in Section 3.6.3), proportional to their degree of participation in the fisheries.

4.7.2.1.3 Alternative 2: Maximum fishing mortality is 50% F_{MSY} and fishery cutoff when biomass less than 1.1 of SSB/SSB_{MSY} (*Strawman B*)

Under Alternative 2 (Strawman B), ABC is set as a function of biomass (biomass based), the upper biomass parameter equals 2.0 for the ratio of SSB/SSB_{MSY}, maximum fishing mortality is set at 50% of F_{MSY}, and this control rule includes a fishery cutoff when biomass is less than 1.1 for the ratio of SSB/SSB_{MSY}.

Impacts on Atlantic herring fishery

Long term. The impacts on the Atlantic herring fishery of Alternative 2 are expected to be ***indirect and low negative to low positive in the long term***. Alternative 2 would be viable under all biomass scenarios and would provide a degree of certainty about the long-term management of the fishery, a ***low positive impact relative to No Action*** on the *Attitudes, Beliefs, and Values* of the fishery. However, Alternative 2 includes a fishery cutoff at 1.1 SSB/SSB_{MSY}, and the potential for closing the fishery at this point is expected to have a negative impact on the *Attitudes, Beliefs, and Values* of the fishery. Should such a closure occur, there would be negative impacts on the *Size and Demographic Characteristics* of the fishery-related workforce and the *Historical Dependence on and Participation* in the fishery.

The MSE Base Price model indicates that, across all states of nature (i.e., herring operating models), impacts would generally be ***low negative relative to Alternatives 1, 3, and 4*** in terms of net revenue (Figure 61). However, Alternative 2 may have the most stationarity of net revenue (Figure 62). Under the New Price economic model, the range of net revenue is \$13-21M (depending on herring operating model), lower than Alternatives 1, 3, and 4 (\$17-22M; Table 103 and Table 104). The range in interannual variability of net revenue (\$0.51-0.99M) is higher than the other alternatives (\$0.20-0.55M).

Short term. The impacts on the Atlantic herring fishery of Alternative 2 are expected to be ***indirect and low negative in the short term.*** If the current, high biomass state continues, Alternative 2 would have ***low negative impacts relative to No Action and Alternatives 1, 3 and 4***, as it would produce the lowest ABC (73,000 mt vs. 86,000-110,000 mt), 38,000 mt lower than under No Action or Alternatives 1 or 3 (Table 94). The short-term annual gross and net fishery revenue under Alternative 2 are modeled to be \$25M and \$22M, respectively (Figure 70 and Figure 71), which is on the low end of the annual gross revenue of the fishery since 2013, \$25-32M (Figure 37, p. 155).

Impacts on Atlantic mackerel fishery

The impacts on the Atlantic mackerel fishery of Alternative 2 are expected to be ***indirect and low positive (relative to No Action) to low negative (relative to Alternatives 1, 3, and 4) in the long term***. Impacts are expected to be ***low negative relative to No Action and Alternatives 1, 3 and 4*** in the short term. The mackerel fishery occurs primarily in conjunction with Atlantic herring midwater trawl fishery, so impacts would largely mirror those of the Atlantic herring fishery.

Impacts on American lobster fishery

The impacts on the American lobster fishery of Alternative 2 are expected to be ***indirect and low positive (relative to No Action) to low negative (relative to Alternatives 1, 3, and 4) in the long term***. The lobster fishery fares better with more stable bait supply; under Alternative 2, yield may be more variable than under Alternatives 1, 3 and 4 (Figure 59, p. 243). Impacts are expected to be ***low negative relative to No Action and Alternatives 1, 3 and 4*** in the short term. The ABC under Alternative 2 would be lowest relative to No Action and Alternatives 1, 3, and 4 (Table 94; 73,000 mt).

Impacts on predator fisheries and ecotourism

The impacts on predator fisheries and ecotourism of Alternative 2 are expected to be ***indirect and positive in the long term*** and ***low positive in the short term***. Predator fisheries and ecotourism fare better under positive Atlantic herring resource conditions, and positive impacts on Atlantic herring are expected under Alternative 2 (Section 4.2.1.1.3). Alternative 2 is expected to produce the best outcomes for the tuna weight metric (Section 4.1.1.3.14). Alternative 2 has good outcomes for the indirect predator and ecotourism metrics: SSB relative to unfished biomass, is highest. The frequency of overfishing and probability of overfished herring stocks are the lowest of all the alternatives. Alternative 2 is expected to keep tern productivity above the acceptable threshold for reproductive success (Section 4.1.1.3.13), a positive outcome for ecotourism. It is difficult, however, to convert these metrics into monetized benefits for the predator fisheries and ecotourism stakeholders. In the short term, SSB is likely to be quite similar across alternatives in the short-run, regardless of biomass state (Figure 68). The one exception would be a biomass state similar to the Medium A (1995) panel, in which Alternative 2 results in higher biomass.

Impacts on communities

The impacts on communities of Alternative 2 are expected to be ***indirect and negative to positive in the long term***, and ***negative to low positive in the short term***. While the Atlantic herring, mackerel, and lobster fisheries may have negative short-term impacts, impacts on other users may be low positive. To the degree that Alternative 2 prevents overfishing and an overfished herring resource, positive impacts among human communities are expected. As an ABC control rule affects stock-wide harvest levels, impacts are expected to occur across the communities that participate in the Atlantic herring and other potentially affected fisheries (about 140 ports identified in Section 3.6.3), proportional to their degree of participation in the fisheries.

4.7.2.1.4 Alternative 3: Control rule parameters defined upfront

Under Alternative 3, the ABC control rule would be based on defining the parameters that dictate the shape of the control rule: 0.3 for the lower biomass parameter, 0.7 for the upper biomass parameter, and setting the maximum fishing mortality at 0.9, or 90% of F_{MSY}.

Impacts on Atlantic herring fishery

Long term. The impacts on the Atlantic herring fishery of Alternative 3 are expected to be ***indirect and low negative to low positive in the long term***. Alternative 3 would be viable under all biomass scenarios and would provide a degree of certainty about the long-term management of the fishery, a ***low positive impact relative to No Action*** on the *Attitudes, Beliefs, and Values* of the fishery. However, Alternative 3 includes a fishery cutoff at 0.3 SSB/SSB_{MSY}, and the potential for closing the fishery at this point is expected to have a negative impact on the *Attitudes, Beliefs, and Values* of the fishery. Should such a closure occur, there would be negative impacts on the *Size and Demographic Characteristics* of the fishery-related workforce and the *Historical Dependence on and Participation* in the fishery. The potential for closure would be less than under Alternative 2, but closure is more likely than under Alternative 1, which has no fishery cutoff.

The MSE Base Price model indicates that, across all states of nature (i.e., herring operating models), impacts would generally be ***low positive relative to Alternative 2*** and ***low negative relative to Alternatives 1 and 4*** in terms of net revenue (Figure 61). However, Alternative 2 may have higher long-term stationarity of net revenue (Figure 62). Under the New Price economic model, the range of net revenue is $19-22M (depending on herring operating model); higher than under Alternatives 1 and 2 ($13-22M), but similar to Alternative 4 ($19-22M; Table 103 and Table 104). The range in interannual variability of net revenue ($0.28-0.55M) is lower than under Alternative 2 ($0.51-0.99M), but similar to Alternatives 1 and 4.

Short term: The impacts on the Atlantic herring fishery of Alternative 3 are expected to be ***indirect and neutral to low positive in the short term***. If the current, high biomass state continues, Alternative 3 would have ***neutral impacts relative to No Action and Alternative 1***, producing essentially the same ABC (Figure 70, Figure 71, Table 94; 111,000 mt). Similar revenue outcomes are also expected. The short-term annual gross and net fishery revenue under Alternative 3 are modeled to be $33M and $27.6M, respectively (Figure 70 and Figure 71), which is similar to the annual gross revenue of the fishery since 2013, $25-32M (Figure 37, p. 155). Impacts may be ***low positive relative to Alternatives 2 and 4***, which may have lower revenue outcomes***.***

Impacts on Atlantic mackerel fishery

The impacts on the Atlantic mackerel fishery of Alternative 3 are expected to be ***indirect and low positive (relative to No Action and Alternative 2) to low negative (relative to Alternatives 1 and 4) in the long term.*** Impacts are expected to be ***neutral (relative to No Action and Alternative 1) to low positive (relative to Alternatives 2 and 4) in the short term***. The mackerel fishery occurs primarily in conjunction with Atlantic herring midwater trawl fishery, so impacts would largely mirror those of the Atlantic herring fishery.

Impacts on American lobster fishery

The impacts on the American lobster fishery of Alternative 3 are expected to be ***indirect and low positive (relative to No Action and Alternative 2) to low negative (relative to Alternatives 1 and 4) in the long term.*** The lobster fishery fares better with more stable bait supply; under Alternative 3, yield may be less variable than under Alternatives 2, but more so than under Alternative 4 (Figure 59, p. 243). ***Impacts are expected to be neutral (relative to No Action and Alternative 1) to low positive (relative to Alternatives 2 and 4) in the short term.*** The ABC under Alternative 3 would be essentially the same as under No Action and Alternative 1 (Table 94; 111,000 mt), but higher than under Alternatives 2 and 4.

Impacts on predator fisheries and ecotourism

The impacts on predator fisheries and ecotourism of Alternative 3 are expected to be ***indirect and low positive in the long term and short term***, but the positive impacts are not as high as some of the other alternatives under consideration. Predator fisheries and ecotourism fare better under positive Atlantic herring resource conditions, and low positive impacts on Atlantic herring are expected under Alternative 3 (Section 4.2.1.1.2). In the long term, Alternative 3 produces the same dogfish, tern, and tuna outcomes as Alternative 1. Alternative 3 has good outcomes for the indirect predator and ecotourism metrics: SSB, SSB relative to unfished biomass, is slightly higher than Alternative 1. The frequency of overfishing and probability of overfished herring stocks are also lower than status quo (but higher than Alternative 2). Alternative 1 is expected to keep tern productivity above the acceptable threshold for reproductive success (Section 4.1.1.3.13), a positive outcome for ecotourism. It is difficult to convert these metrics into monetized benefits for the predator fisheries and ecotourism stakeholders. In the short term, Alternative 3 would result in SSB that are similar to Alternative 1 in all biomass states except the Medium B state, in which it would be higher (Figure 68). In the short term, Alternative 3 is likely to have neutral to slight positive effects on predator fisheries.

Impacts on communities

The impacts on communities of Alternative 3 are expected to be ***indirect and low positive in the long term*** and ***neutral to low positive in the short term***. While the Atlantic herring, mackerel, and lobster fisheries may have neutral short-term impacts, impacts on other users may be low positive. To the degree that Alternative 3 prevents overfishing and an overfished herring resource, positive impacts among human communities are expected. As an ABC control rule affects stock-wide harvest levels, impacts are expected to occur across the communities that participate in the Atlantic herring and other potentially affected fisheries (about 140 ports identified in Section 3.6.3), proportional to their degree of participation in the fisheries.

4.7.2.1.5 Alternative 4: Control rule alternatives based on desired performance of specific metrics identified in the Management Strategy Evaluation process

Alternative 4 has six ABC control rule options (A-F) based on the desired performance for a handful of primary metrics identified by the Council: 1) constrain %MSY to be 100%, with an acceptable level as low as 85%; 2) variation in annual yield set at a preferred level <10%, acceptable level as high as 25%; 3) probability of overfished set at 0%, with an acceptable level as high as 25%; and 4) probability of herring closure (ABC=0) set between 0-10%.

Impacts on Atlantic herring fishery

Long term: The impacts on the Atlantic herring fishery of the Alternative 4 options are expected to be ***indirect and low positive in the long term***. Alternative 4 would be viable under all biomass scenarios and would provide a degree of certainty about the long-term management of the fishery, a ***low positive impact relative to No Action*** on the *Attitudes, Beliefs, and Values* of the fishery. Alternatives 4B, 4C, and 4E include a fishery cutoff at 0.1 or 0.3 SSB/SSB_{MSY}, and the potential for closing the fishery at these points is expected to have a negative impact on the *Attitudes, Beliefs, and Values* of the fishery. Should such a closure occur, there would be negative impacts on the *Size and Demographic Characteristics* of the fishery-related workforce and the *Historical Dependence on and Participation* in the fishery.

The MSE Base Price model indicates that, across all states of nature (i.e., herring operating models), impacts would generally be ***low positive relative to Alternatives 1, 2 and 3*** in terms of net revenue (Figure 61). However, Alternatives 1, 2 and 3 may have more long-term stationarity of net revenue (Figure 62). Under the New Price economic model, the range of net revenue is $19-22M (depending on herring operating model); a higher range than under Alternatives 1 and

2 ($13-21M) and similar to Alternative 3 (Table 103 and Table 104). The range in interannual variability of net revenue ($0.20-0.55M) is lower than under Alternative 2 ($0.51-0.99M), but similar to Alternatives 1 and 3. Of the Alternative 4 options, Option 4E would have the highest net revenue.

Short term: The impacts on the Atlantic herring fishery of the Alternative 4 options are expected to be ***indirect and low negative to low positive in the short term.*** If the current, high biomass state continues, Alternative 4 would have ***low negative impacts relative to No Action and Alternatives 1 and 3***, produce a lower ABC (86,000-100,000; Table 94), but ***low positive impacts relative to Alternative 2***. The short-term annual gross fishery revenue under the Alternative 4 options is modeled to range from $30.1M to $27.8M (Figure 70 and Figure 71). Likewise, net fishery revenue ranges from $25.9M to 24.2M, which is similar to the annual gross revenue of the fishery since 2013, $25-32M (Figure 37, p. 155).

Impacts on Atlantic mackerel fishery

The impacts on the Atlantic mackerel fishery of the Alternative 4 options are expected to be ***indirect and low positive (relative to No Action and Alternatives 1-3) in the long term.*** Impacts are expected to be ***low negative (relative to No Action and Alternatives 1 and 3) to low positive (relative to Alternative 2) in the short term***. The mackerel fishery occurs primarily in conjunction with Atlantic herring midwater trawl fishery, so impacts would largely mirror those of the Atlantic herring fishery.

Impacts on American lobster fishery

The impacts on the American lobster fishery of the Alternative 4 options are expected to be ***indirect and low positive (relative to No Action and Alternatives 1-3) in the long term.*** The lobster fishery fares better with more stable bait supply; under Alternative 4, yield may be less variable than under Alternatives 1-3 (Option 4E would be least variable; Figure 59, p. 243). Impacts are expected to be ***low negative (relative to No Action and Alternatives 1 and 3) to low positive (relative to Alternative 2) in the short term.*** The ABC under Alternative 4 would be lower than under No Action and Alternatives 1 and 3 (Table 94), but higher than under Alternative 2.

Impacts on predator fisheries and ecotourism

The impacts on predator fisheries and ecotourism of Alternatives 4A-4F are expected to be ***indirect and low positive in the long term and short term***. Predator fisheries and ecotourism fare better under positive Atlantic herring resource conditions, and low positive impacts on Atlantic herring are expected under these Alternatives (Section 4.2.1.1.2). In the long term, Alternatives 4A-F produce the same dogfish, tuna, and tern outcomes as Alternative 1. Alternatives 4A-4F are is expected to keep tern productivity above the acceptable threshold for reproductive success (Section 4.1.1.3.13), a positive outcome for ecotourism. Alternative 4 has good outcomes for the indirect predator and ecosystem metrics: SSB, SSB relative to unfished biomass, is slightly higher than Alternative 1. The frequency of overfishing and probability of overfished herring stocks are also lower than Alternative 1, but higher than Alternative 2. It is difficult to convert these metrics into monetized benefits for the predator fisheries and ecotourism stakeholders. In the short term, Alternatives 4A-4F would result in SSB that is slightly higher than Alternatives 1 and 3 under all biomass states (Figure 68), so would likely have low positive effects on predator fisheries and ecotourism.

Impacts on communities

The impacts on communities of Alternatives 4A-4F are expected to be ***indirect and low positive in the long term*** and ***low negative to low positive in the short term***. While the Atlantic herring, mackerel, and lobster fisheries may have low negative short-term impacts, impacts on other users may be low positive. To the degree that Alternatives 4A-4F prevent overfishing and an overfished herring resource, positive impacts among human communities are expected. As an ABC control rule affects stock-wide harvest levels, impacts would likely occur across the communities that participate in the Atlantic herring and other potentially affected fisheries (about 140 ports identified in Section 3.6.3), proportional to their degree of participation in the fisheries.

4.7.2.2 Alternatives for setting three-year ABCs

Long term. Figure 108 to Figure 115 show the long-term (MSE) results for the net revenue and interannual variability of net revenue metrics for each ABC control rule under the two alternatives for setting three-year ABCs, which help characterize the potential impacts on the herring, mackerel and lobster fisheries of the alternatives under consideration.

***Short term*.** The short-term effects of control rules, i.e., the expected impacts over the next several years, are evaluated using two shorter-term analyses (Section 4.1.1.6).

Figure 108 – MSE results for the two alternatives for setting three-year ABCs ("status quo" and "annual"), showing median net revenue ($M) across <u>high</u> mortality operating models for ABC control rule Alternatives 1-4A

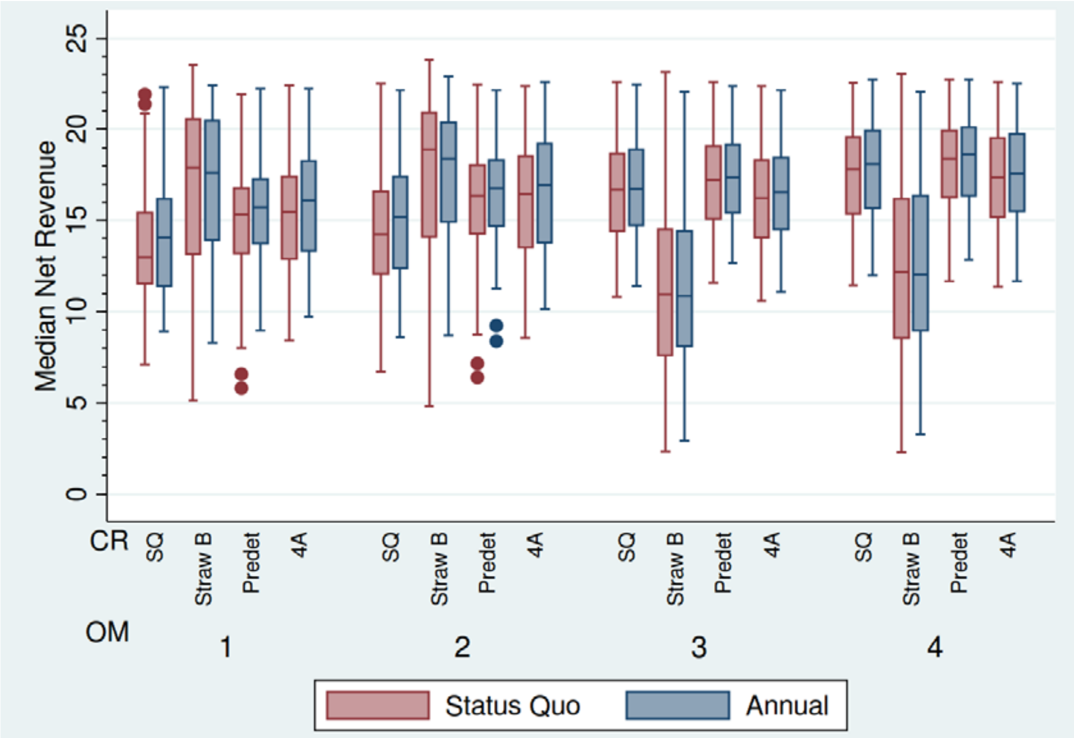


Figure 109 – MSE results for the two alternatives for setting three-year ABCs ("status quo" and "annual"), showing median net revenue ($M) across <u>low</u> mortality operating models for ABC control ruls Alternatives 1-4A

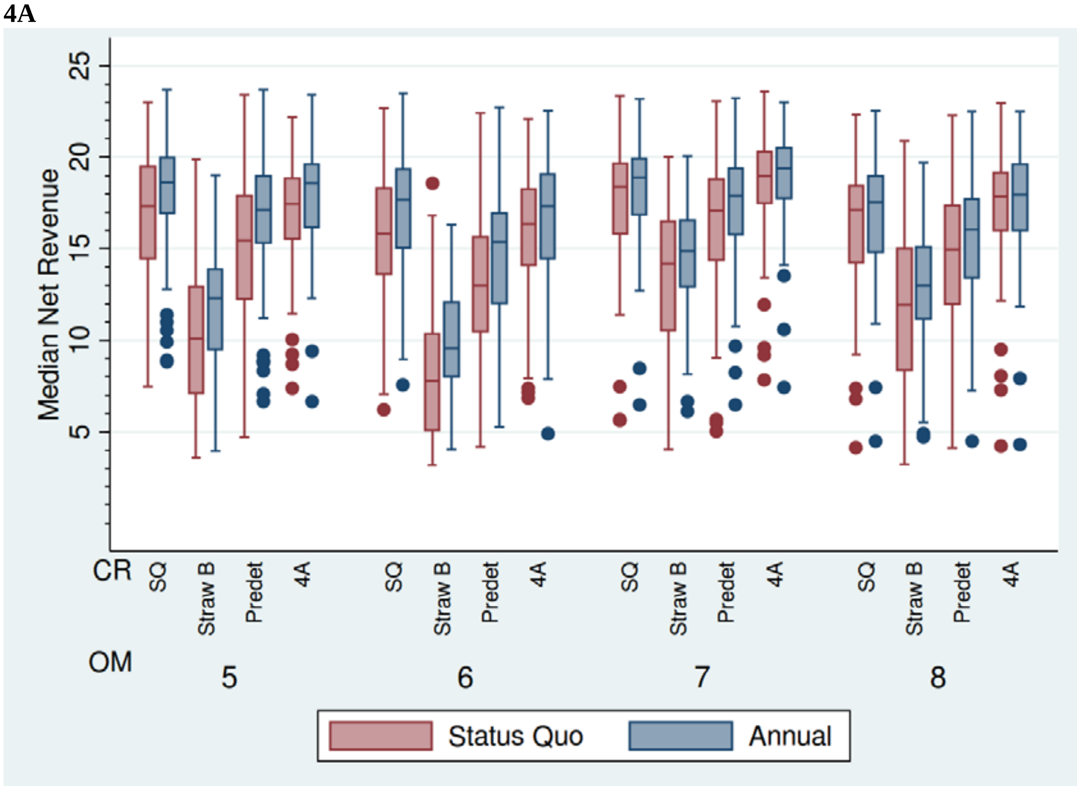


Figure 110 – MSE results for the two alternatives for setting three-year ABCs (“status quo” and “annual”), showing median net revenue ($M) across high mortality operating models for ABC control rule Alternatives 4A-4F

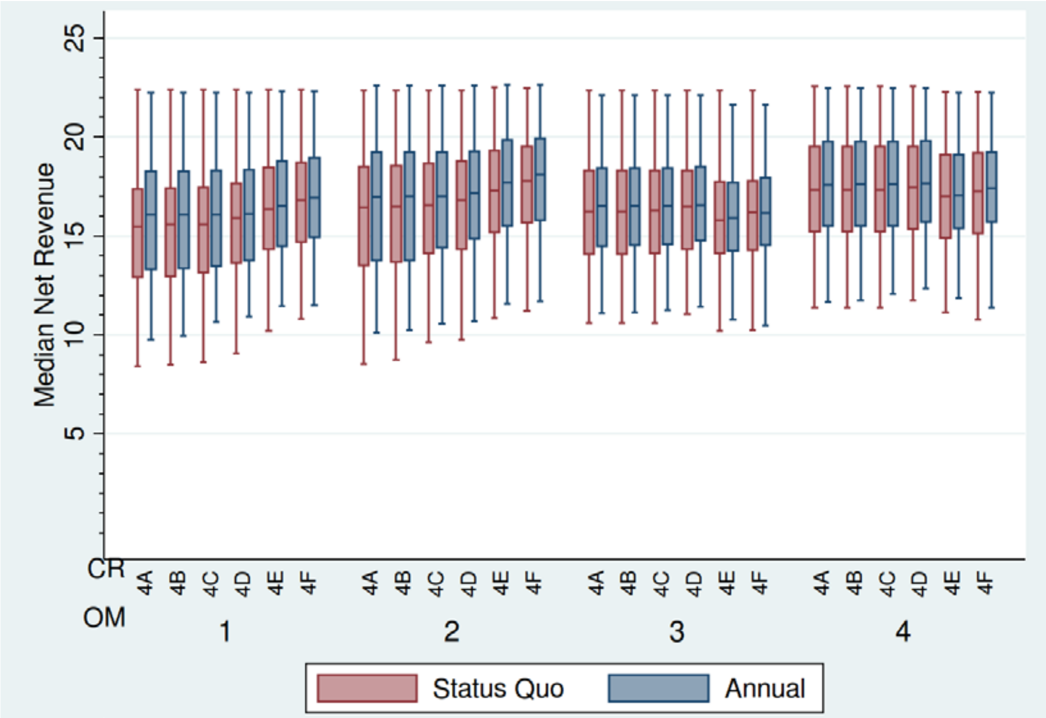


Figure 111 - MSE results for the two alternatives for setting three-year ABCs (“status quo” and “annual”), showing median net revenue ($M) across low mortality operating models for ABC control rule Alternatives 4A-4F

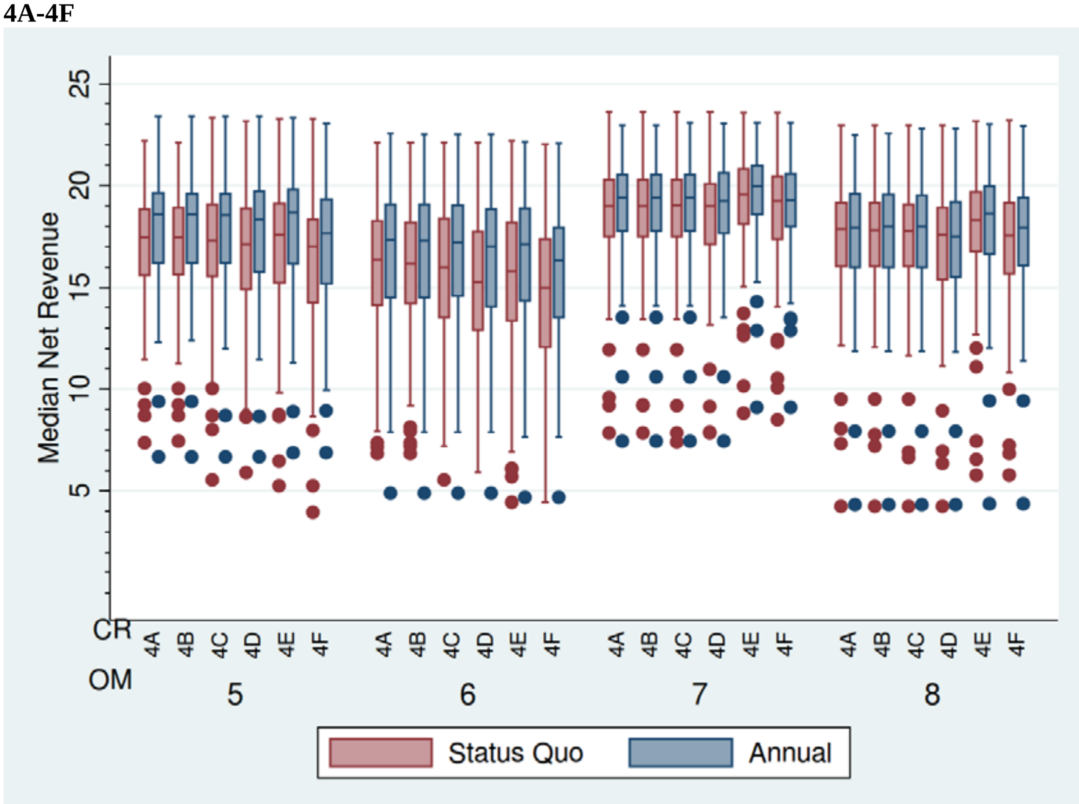


Figure 112 - MSE results for the two alternatives for setting three-year ABCs ("status quo" and "annual"), showing IAV across <u>high</u> mortality operating models for ABC control rule Alternatives 1-4A

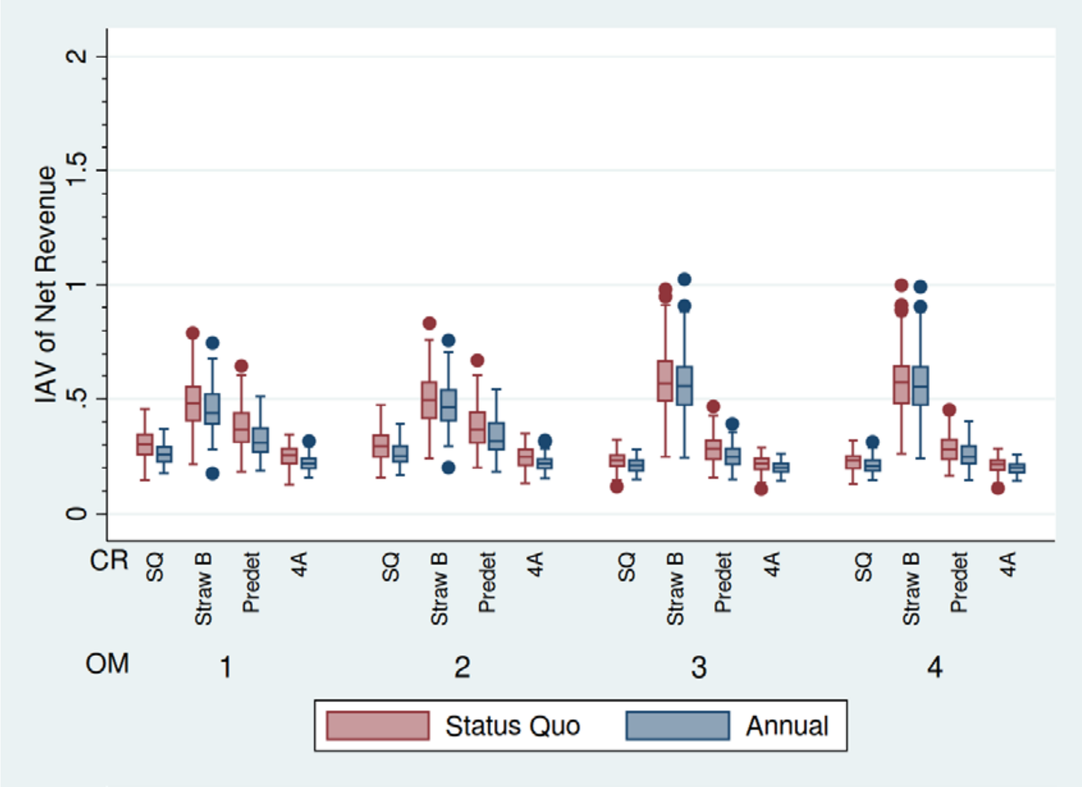


Figure 113 - MSE results for the two alternatives for setting three-year ABCs ("status quo" and "annual"), showing IAV across <u>low</u> mortality operating models for ABC control rule Alternatives 1-4A

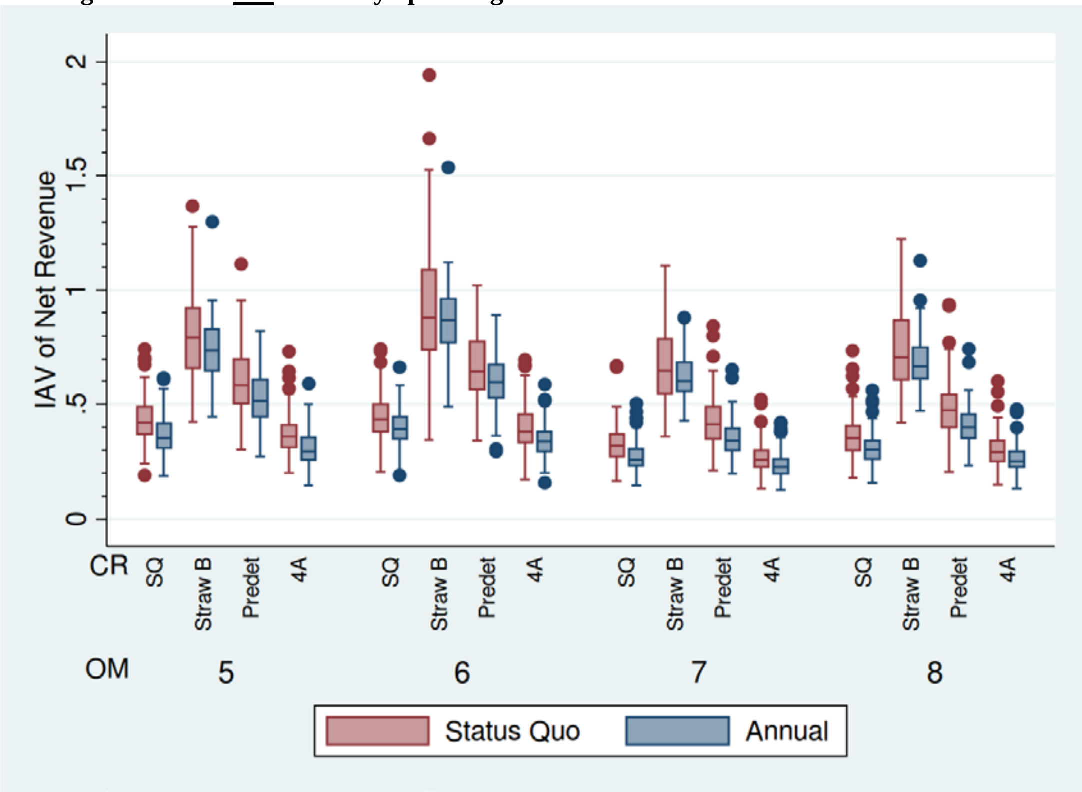


Figure 114 - MSE results for the two alternatives for setting three-year ABCs ("status quo" and "annual"), showing IAV across <u>high</u> mortality operating models for the ABC control ruls Alternatives 4A-4F

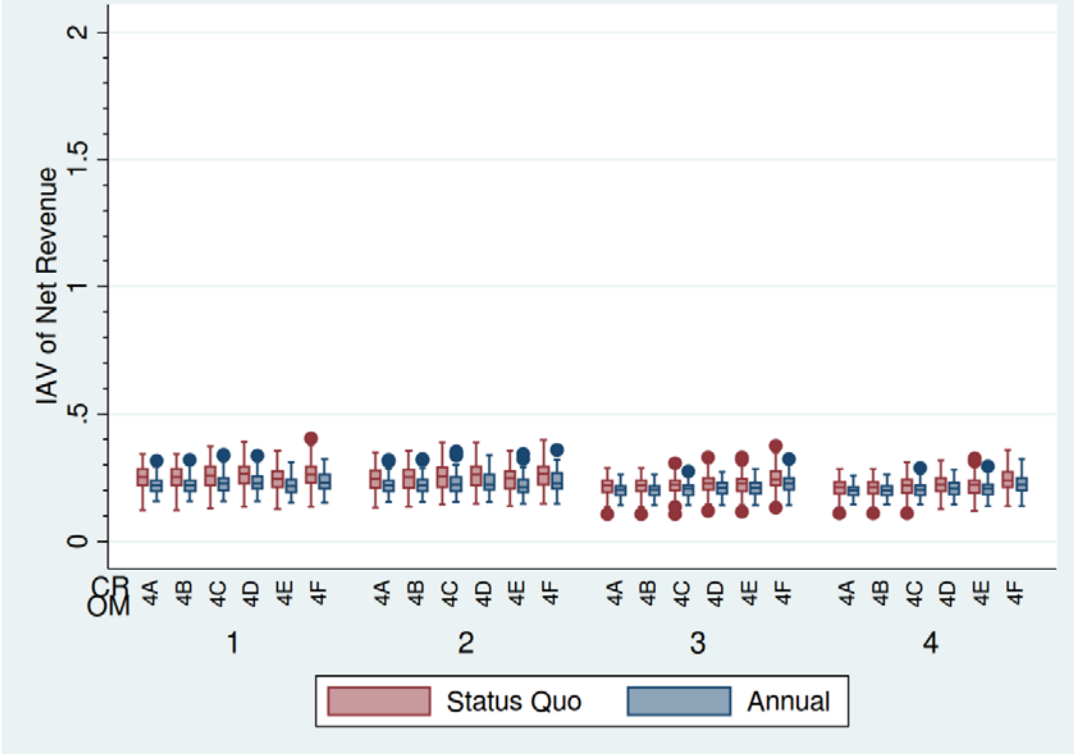
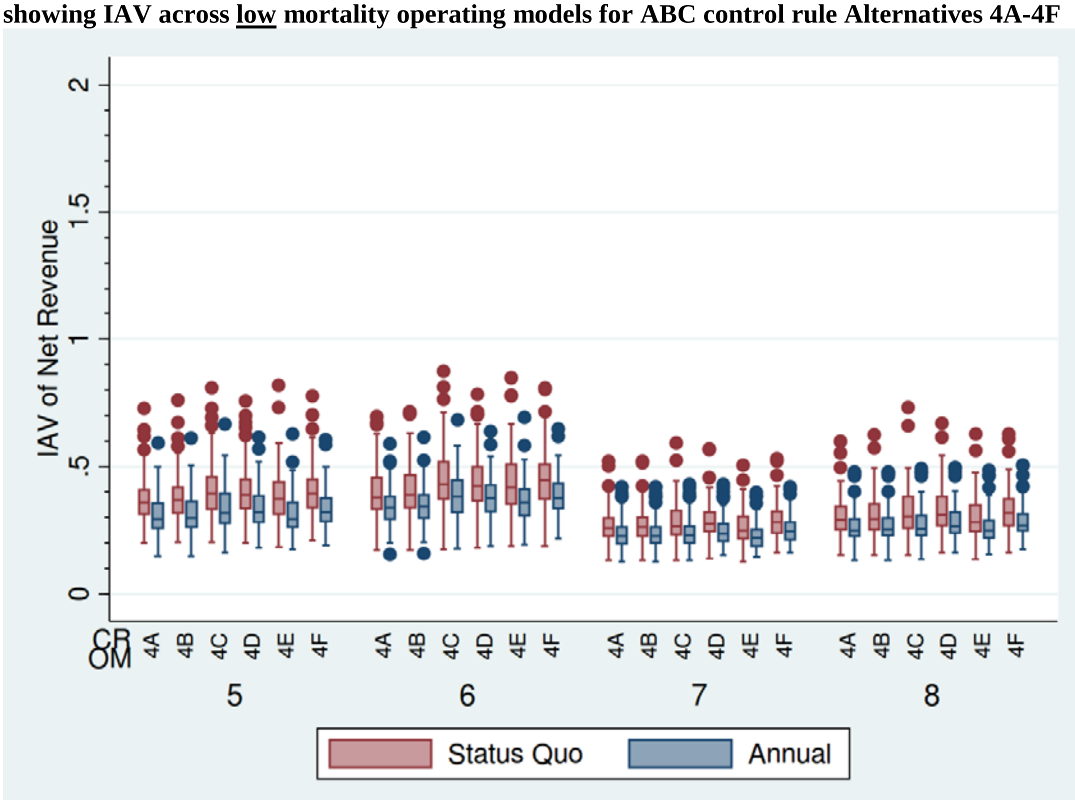


Figure 115 - MSE results for the two alternatives for setting three-year ABCs ("status quo" and "annual"), showing IAV across <u>low</u> mortality operating models for ABC control rule Alternatives 4A-4F



4.7.2.2.1 Alternative 1: Set ABC at the same level for three years (*No Action*)

Under No Action, the ABC control rule would be used to set ABC at the same level for three years (consistent value in mt for three years at a time).

Impacts on Atlantic herring fishery

The impacts on the Atlantic herring fishery of Alternative 1 are expected to be ***indirect and low negative in the long term and low positive in the short term relative to Alternative 2***. In the long term, the median net revenue is generally lower, and IAV of net revenue is generally higher, for Alternative 1, across all of the ABC control rule alternatives and operating models (Figure 108 to Figure 115), both negative outcomes for the herring fishery. However, maintaining a constant ABC over a three-year period provides consistency for fishing industry operations, stability for the industry and a steady supply to the market (in addition to the stability provided by a three-year specifications process). In the short term, if the current, high biomass state continues, Alternative 1 would produce an ABC for three years that is generally higher than under Alternative 2 in which ABC would not necessarily be the same value (Table 94), a positive outcome relative to Alternative 2.

Impacts on Atlantic mackerel fishery

The impacts on the Atlantic mackerel fishery of Alternative 1 are expected to be ***indirect and low negative in the long term and low positive in the short term relative to Alternative 2.*** The mackerel fishery occurs primarily in conjunction with Atlantic herring midwater trawl fishery, so impacts would largely mirror those of the Atlantic herring fishery.

Impacts on American lobster fishery

The impacts on the American lobster fishery of Alternative 1 are expected to be ***indirect and low negative in the long term and low positive in the short term relative to Alternative 2.*** In the long term, the IAV of net revenue is generally higher for Alternative 1 than 2, across all of the ABC control rule alternatives and operating models (Figure 108 to Figure 115), a negative outcome for the lobster fishery. However, maintaining a constant ABC over a three-year period helps provide a steady supply to the market (in addition to the stability provided by a three-year specifications process). In the short term, if the current, high biomass state continues, Alternative 1 would produce an ABC for three years that is generally higher than under Alternative 2 in which ABC would not necessarily be the same value (Table 94), a positive outcome relative to Alternative 2.

Impacts on predator fisheries and ecotourism

The impacts on predator fisheries and ecotourism of Alternative 1 are expected to be ***indirect and slightly low negative in the long term and short term relative to Alternative 2***. Predator fisheries and ecotourism fare better under positive Atlantic herring resource conditions, but slightly low negative impacts on Atlantic herring are expected under Alternative 1 (Section 4.2.1.2.1).

Impacts on communities

The impacts on communities of Alternative 1 are expected to be ***indirect and low negative in the long term*** and ***low negative to low positive in the short term***. While the Atlantic herring, mackerel, and lobster fisheries may have low positive short-term impacts, impacts on other users may be low negative. To the degree that Alternative 1 prevents overfishing and an overfished herring resource, positive impacts among human communities are expected. As an ABC control rule affects stock-wide harvest levels, impacts are expected to occur across the communities that participate in the Atlantic herring and other potentially affected fisheries (about 140 ports identified in Section 3.6.3), proportional to their degree of participation in the fisheries.

4.7.2.2.2 Alternative 2: Set ABC for three years with annual application of control rule

Under Alternative 2, the ABC control rule would be used to set ABC every three years, but ABC would not necessarily be the same value. Each year the ABC value could change. ABC would be set each year based on the most recent herring assessment and short-term projections.

Impacts on Atlantic herring fishery

The impacts on the Atlantic herring fishery of Alternative 2 are expected to be ***indirect and low positive in the long term and low negative in the short term relative to Alternative 1***. In the long term, the median net revenue is generally higher, and IAV of net revenue is generally lower, for Alternative 2, across all of the ABC control rule alternatives and operating models (Figure 108 to Figure 115), both positive outcomes for the herring fishery. However, a varying ABC may result in instability within the industry, making business planning and markets less predictable, which may be offset to some degree by the stability provided by knowing the ACLs. Impacts on the *Size and Demographic Characteristics* of the fishery-related workforce are less certain than under scenarios of consistent trend. In the short term if the current, high biomass state continues, Alternative 2 would produce a generally lower and variable ABC for three years than under Alternative 1 in which ABC be the same value (Table 94), a negative outcome relative to Alternative 1.

Impacts on Atlantic mackerel fishery

The impacts on the Atlantic mackerel fishery of Alternative 2 are expected to be ***indirect and low positive in the long term and low negative in the short term relative to Alternative 1***. The mackerel fishery occurs primarily in conjunction with Atlantic herring midwater trawl fishery, so impacts would largely mirror those of the Atlantic herring fishery.

Impacts on American lobster fishery

The impacts on the American lobster fishery of Alternative 2 are expected to be ***indirect and low positive in the long term*** and ***low negative in the short term relative to Alternative 1.*** In the long term, the IAV of net revenue is generally lower for Alternative 2, across all of the ABC control rule alternatives and operating models (Figure 108 to Figure 115), a positive outcome for the lobster fishery. However, a varying ABC may result in instability within the industry, making business planning and markets less predictable, which may be offset to some degree by the stability provided by knowing the ACLs. In the short term if the current, high biomass state continues, Alternative 2 would produce a generally lower and variable ABC for three years than under Alternative 1 in which ABC be the same value (Table 94), a negative outcome relative to Alternative 1.

Impacts on predator fisheries and ecotourism

The impacts on predator fisheries and ecotourism of Alternative 2 are expected to be ***indirect and slightly low positive in the long term and short term relative to Alternative 1***. Predator fisheries and ecotourism fare better under positive Atlantic herring resource conditions, and slightly low positive impacts on Atlantic herring are expected under Alternative 2 (Section 4.2.1.2.1).

Impacts on communities

The impacts on communities of Alternative 2 are expected to be ***indirect and low positive in the long term*** and ***low negative to low positive in the short term***. While the Atlantic herring, mackerel, and lobster fisheries may have low negative short-term impacts, impacts on other users may be low positive. To the degree that Alternative 2 prevents overfishing and an overfished herring resource, positive impacts among human communities are expected. As an ABC control rule affects stock-wide harvest levels, impacts are expected to occur across the communities that participate in the Atlantic herring and other potentially affected fisheries (about 140 ports identified in Section 3.6.3), proportional to their degree of participation in the fisheries.

4.7.2.3 FMP provisions that may be changed through a framework adjustment

The Council recommends that future modifications to the ABC control rule could be made by amendment or framework, but not through specifications. This recommendation is administrative, and would have ***no direct impacts on the human communities, positive or negative***. The processes to develop an amendment or framework would provide more opportunity for public input than a typical specifications process, so this recommendation would have a positive, indirect impact on the *Attitudes, Beliefs, and Values* of fishermen and other stakeholders.

4.7.3 Potential Localized Depletion and User Conflicts

4.7.3.1 Overview of impacts

The impact analysis of the alternatives to address potential localized depletion and user conflicts uses a few approaches to identify the potentially impacted fisheries, each with their own caveats and limitations. Together, they provide a general sense of recent fishing activity and indicate the importance of specific areas to particular fisheries and gear types. Recent effort and gross revenue generated from within an alternative area helps estimate the impact of closing the area(s) to fishing vessels and communities.

4.7.3.1.1 General impacts of area closures on human communities

This action considers a range of spatial and temporal closures for the entire Atlantic herring fishery or just for midwater trawl gear. The following is a description of the economic and social impacts that can generally occur from area closures.

Area closure alternatives can have numerous social impacts across various fisheries and communities. The most direct impacts would be on vessels currently fishing in these areas that would no longer have access to those areas. The addition of new closures would force the fishing operations to modify where and how they fish. This could have a negative impact on the *Historical Dependence on and Participation* in the affected fisheries. This would also have a negative social impact on the *Size and Demographic Characteristics* of the affected fisheries, because of a probable reduction in fishing opportunity, revenue, and employment. Negative social impacts would be expected in the *Non-economic Social Aspects* of the fishery, as there would be have less flexibility in choosing where to fish.

There are numerous caveats associated with landings/revenue estimates. Redistribution of effort into other locations may mitigate negative effects, but alternative fishing choices are difficult to predict. Relocation may be challenging if other locations are already crowded with gear or if it is difficult to catch the target species outside the closed area. If effort can be redistributed outside closed areas, net losses to displaced fishermen will be dependent on changes in efficiency and costs of fishing in alternate fishing grounds. The impacts analysis explores, qualitatively, possible alternate fishing location choices, based on current distributions of effort. While a relatively small fraction of revenue in a particular fishery may come from a particular area/season, the revenue may be concentrated amongst a small number of individuals and/or communities.

In response to area closures, some Atlantic herring vessels may have to change the times and areas within which they operate, moving to less desirable fishing grounds. Fishermen have developed agreements over time about sharing fishing grounds, so it may be difficult to adjust to new area closures. When deploying and fishing their nets, fishermen account for bathymetry, current, wind, and area restrictions. These factors may prevent them from fishing efficiently outside a particular area/season. The impact on these operations may be some combination of increased costs and/or decreased revenues. Increased costs may occur if operations have to travel further to reach alternative fishing grounds, or if they must fish in areas with lower catch-per-unit of effort (and thus, incur increased costly fishing effort to catch the same amount of fish). Decreased revenues may occur if fishing operations find that they are unable to catch the same amount of fish, because increased travel or fishing time makes it impossible to catch the same amount of fish in the time available. Decreased revenues may also occur if shifts in fishing activity also make it harder to deliver a quality product.

The ability to adapt to a new closure is highly variable. Less mobile fishermen may bear a larger impact as they are less able to easily switch harvest areas. Smaller vessels would be less adaptable to near shore closures, as their range is limited and they cannot easily prosecute the fishery in offshore areas. Any change in fishing behavior by less mobile fishing businesses that attempt to employ more mobile fishing strategies would likely have additional social costs, such as disruptions to family and community life, as well as increase the likelihood of safety risks. Increased risk can result when fishermen spend longer periods at-sea to access offshore areas that would not be affected by the closures. Fishermen severely impacted by the new closed areas may leave fishing entirely or at least seek temporary opportunities in another fishery or gear type that is less affected by the management alternatives. Both possibilities would cause a change in the *Size and Demographic Characteristics* of the different fisheries.

If an area is closed to some but not all fishing gears (e.g., closed to MWTs only), fishermen who may remain active within a given area may experience indirect positive benefits via reduced gear conflicts – though fishermen active outside the area may have negative impacts due to crowding. Negative impacts on *Attitudes, Beliefs, and Values* may be based on perceptions of differing levels of impact to particular gear types or fisheries. This may cause resentment among fishermen who would be affected by the restrictions. This could negatively affect the *Social Structure and Organization* of a community.

There are many instances in which fishermen have differing views than those held by ocean and fisheries scientists. A fisherman's view is based largely on personal experience and their own proximal environment, which can be at odds with the larger environment described by fisheries scientists. This continued lack of faith in the science used to inform management decisions could undermine the perceived legitimacy of future management actions and have a negative social impact on the formation of *Attitudes, Beliefs, and Values* about management. The impact of new closures on the *Attitudes, Beliefs, and Values* of fishermen is uncertain and is largely related to the level of acceptance and belief in the efficacy of the new closures to adequately address concerns about localized depletion.

There is the potential for positive social impacts derived from new closures. These are generally associated with the potential future and long-term benefits that the closures would have on the improvement of fish stocks. These benefits are difficult to analyze, because of the uncertainty associated with the magnitude of the benefit, how these benefits would distribute among fishing communities, and the timing of these impacts. For example, vessels that are unable to adapt to new restrictions in the short term may not be able to benefit from the potential stock increases in the long term. Additionally, the short-term impacts on markets, processing capability, and other infrastructure during the period of adjustment to the new closures may be such that these shoreside resources are lost and unable to recover in the future when potential stock increases occur.

Those communities that are more dependent on the Atlantic herring fishery and are located in proximity to the potential closures would have larger social impacts than those that participate in a range of fisheries. The full impacts of this action would ripple through the economy (e.g., fuel, bait, ice suppliers). After the first point of sale, a host of other related industries, including seafood retailers, restaurants, transportation firms, all of their suppliers, and ultimately the consumers that frequent these establishments are also impacted by area management decisions. Because the primary focus in this document is on ex-vessel revenues, the information provided is a partial analysis; optimally, broader societal impacts would be determined.

4.7.3.1.2 Herring fishery costs

To estimate the economic impact of moving fishing effort by the midwater trawl (paired and single) fleet from inshore to offshore waters, observer data were binned into one of four ranges of distance from shore (Table 107 and Table 108). The four ranges align with localized depletion Alternatives 4-6. The total number of trips, average catch (kept, discarded combined), days absent (trip start to trip end), steam time (time from dock until net first set) are included. The average cost of damages incurred during the trip, food, fuel (used and cost), oil, supplies, and water are also calculated for each range. Data are from observed trips, 2014-2017, using final loaded NEFOP data. A number of trips (32) were taken in more than one of the ranges; for these trips, the trip was assigned to the range that was furthest from shore. Average catches are the same for all the distance categories, but costs and steam time generally increase for trips farther offshore.

Table 107 - Atlantic herring fishery trip data, by distance from shore, 2014-2017

Distance (nm)	Trips	Average Catch (lbs.)	Days absent	Steam time (hours)	Fuel used (gal.)	Fuel price
<12	56	340,511	2.6	13	1,599	$2.43
12-25	47	325,329	3.4	18.3	2,562	$2.71
25-50	12	234,949	4.3	28.4	3,342	$2.78
>50	130	338,830	4.2	20.8	3,298	$2.51
Source = NEFOP data.						

Table 108 – Average Atlantic herring fishery trip costs, by distance from shore, 2014-2017

Distance (nm)	Fuel	Damage	Food	Oil	Supply	Water	Total
<12	$3,886	$231	$338	$159	$9	$3	$4,626
12-25	$6,943	$1,615	$511	$308	$109	$2	$9,488
25-50	$9,291	$25	$393	$335	$13	$0	$10,057
>50	$8,278	$78	$556	$206	$125	$6	$9,250
Source = NEFOP data.							

4.7.3.1.3 Additional information on bluefin tuna fishery

Recent commercial bluefin tuna catch data indicate that the fishery occurs in January-March, is closed April and May, peaks in September and October, with catch slowing in November and December (Table 109). Within Herring Management Area 1A (inshore Gulf of Maine), the bluefin tuna fishery primarily overlaps with the herring purse seine fishery, largely due to the seasonal exclusion of midwater (MWT) trawl gear from Area 1A. From June 1 through September 30, 72.8% of the annual Area 1A quota is available to purse seine and fixed gear fisheries only. The herring fishery in Area 1A opens to all gear types (including MWT) on October 1 (subject to spawning closures, which may cause a delay up to a few weeks). The period from October 1 through December 31 has the remaining 27.2% of the quota. Overlap between MWT and bluefin tuna vessels generally is heaviest during October (after the herring spawning closures), when tuna catch rates are still high, and MWT vessels have access to 1A quota. The Area 1A herring quota is generally harvested by late October or early November, and fishing for herring in this area thereafter is only for research purposes. In spite of overlap with MWT fisheries in Area 1A, October is similar to September in monthly bluefin catch average, and October of 2016 recorded the highest bluefin catch of any month in this five-year period. Overlap between bluefin tuna fisheries and MWT gear may occur in other herring management areas throughout the traditional bluefin fishing season.

High-resolution spatial data for bluefin tuna catches are limited. There are some spatial data for the recreational fishery, collected by the Large Pelagic Survey. Bluefin dealer data and trip reports record the location of commercial catch, but the bluefin tuna reporting areas are broader in scope and differ from GARFO Statistical areas (Figure 44). There is some level of overlap with vessels holding both bluefin tuna and GARFO permits, thereby triggering the VTR requirement, but that overlap and consistency in reporting bluefin in the VTRs have not been assessed.

Table 109 - Monthly commercial general and harpoon category landings (mt), 2012-2016.

	2012	2013	2014	2015	2016	Monthly Average
Jan-March*	37.1	32.4	36.3	31.4	51.5	**37.76**
June	39.6	38.9	38.2	24.9	54.8	**39.28**
July	71.2	53.4	48	120.5	118.4	**82.3**
August	61.2	37.7	55.2	82.9	73.1	**62.02**
September	106.8	41.6	101.3	177.2	185.7	**122.52**
October	106	25.8	113.3	111	243.7	**119.96**
November	23.9	8.4	40.1	99.7	51.8	**44.78**
December	27.6	56.9	38.7	11	0	**26.84**

*No bluefin fishery in April and May.
Source: NMFS HMS Division

4.7.3.1.4 Sociocultural impacts

The sociocultural impacts of Alternatives 2-9 are expected to be ***uncertain, but potentially low negative to low positive relative to Alternative 1***. The sociocultural impacts are expected to be ***negative*** for the fishermen and fishing communities constrained, primarily the midwater trawl fishery. Establishing the Area 1A MWT closure likely changed the *Social Structure and Organization* of communities as well as *Historical Dependence on and Participation* in the fishery by individuals and communities. Since Area 1A was closed seasonally to just MWT vessels, fishermen who remained active within a given area likely experienced indirect positive benefits via reduced gear conflicts – though fishermen active outside the area may have negative impacts due to crowding. Additional changes are expected from Alternative 2-9. There may continue to be reduced user or gear conflicts in some areas and increased crowding in other areas. Negative impacts on *Attitudes, Beliefs, and Values* may be based on perceptions of differing levels of impact to particular gear types or fisheries. This could cause resentment among the subset of fishermen constrained, negatively affecting the *Social Structure and*

Organization of communities. Effort shifts to other gear types and to other areas may not fully resolved the user conflicts, and perhaps displace conflicts to other areas/seasons. Relative to Alternatives 3-7, Alternative 2 would be a lower cost means to reduce user conflicts.

4.7.3.2 Alternative 1 (No Action: prohibit MWT gear in Area 1A from June – September)

Under No Action, vessels fishing for herring with midwater trawl gear would be excluded from fishing in Area 1A June 1 through September 30.

Impacts on Atlantic herring fishery

<u>*Fishery-wide impacts.*</u> The impacts on the Atlantic herring fishery of No Action are expected to be ***neutral***. The seasonal midwater trawl closure implemented in 2007 would remain, resulting in no additional economic or social impacts on fishery-related businesses and communities. The *Size and Demographic Characteristics* of the fishery-related workforce would likely be unchanged. Since 2004, the Area 1A sub-ACL of Atlantic herring has been over 96% harvested each year, with two exceptions: 2012 (88%) and 2016 (91%). Thus, the gear closure, by itself, has likely not limited the ability of the fishery to adapt and harvest the resource.

There have been many changes to the management of Atlantic herring since 2007, causing substantial changes within the fishery as available times and areas have become more truncated, including:

- MWT gear exclusion from Area 1A in June-September, starting in 2007;
- The Area 1A sub-ACL was reduced from ~60,000 mt in 2005 to ~27,000 by 2010;
- Area 1A has been closed to all herring fishing from January-May, first under ASMFC days-out regulations, and then the federal FMP has allocated 0% for January-May has existed since implementation of the 2013-2015 specifications; and
- ASMFC Atlantic herring spawning closures, implemented in 2016 have closed much of Area 1A to all herring fishing from late August into November (Table 4, p. 78).
- ASMFC landings restrictions in Area 1A (i.e., days out of the fishery, weekly limits, carrier restrictions, trimester measures) have limited effort (ASMFC 2017c).
- The requirement to have 100% observer coverage to fish for Atlantic herring in groundfish closed areas, and obtaining an observer has become more difficult.

Thus, it is difficult to identify causal changes from just the seasonal MWT closure alone. Although the herring resource has improved since the implementation of Amendment 1, to the long-term benefit of the fishery, those benefits are directly linked to the seasonal MWT closure, in isolation of all other measures that have been adopted (Section 4.2.2.1, p. 291).

Since 2000, there has been a marked change in removals by area (Figure 35, p. 143). Since 2007, catch in the offshore areas (Areas 2 & 3) increased while catch inshore decreased. This is likely due to several factors, including the reduction in Area 1A quota from ~60,000 mt in 2005 to ~27,000 by 2010. Catches over all have decreased and then increased, due in part, to changes in Optimum Yield and overall quotas fishery-wide. While fishery-wide catch has declined since 2000, price has increased from $0.05 to >$0.15 per pound, a three-fold increase (Figure 116). This increase is thought to be largely due to the reductions in overall catch, the shift to more offshore harvest and consolidation of the fleet given management actions to control access.

The purse seine fishery has become dominant in Area 1A since 2007, both in terms of the proportion of annual Atlantic herring catch (Figure 117), the number of trips (Figure 118), and catch per trip (Figure 83, p. 294; Figure 82 and Figure 83, p. 293). Within June-September, the number of active permits in Area 1A was 20-25 annually prior to 2007 but declined to under ten by 2014 (Figure 119). Summertime revenue per permit has increased in Area 1A above pre-2007 levels, from $100K-$300K in 2000-2007 to $800K in 2014. Three midwater trawl vessels retrofitted to also fish with a purse seine, so that they could continue in the summer fishery in Area 1A. Without the MWT landings, and with the recent limits on landing days, landings tend to stack up within a few days rather than be spread across a week, which may be creating challenges in moving the herring to market (Section 4.1.2.5).

<u>Midwater trawl impacts</u>. The impacts on the midwater trawl fishery of No Action are expected to be ***low negative***. To some degree, negative impacts would be mitigated by the ability of MWT vessels to act as carrier vessels, switch between gear types, and to fish in all other management areas and at other times of year (herring is mostly in Area 1A in the summer), particularly offshore, which is inaccessible to the purse seine fleet due to gear logistics. However, there may be several constrains to doing so (e.g., carrier limits, operational constraints, herring are migratory, increased costs of fishing offshore; Table 108, p. 400; Section 4.1.2.5).

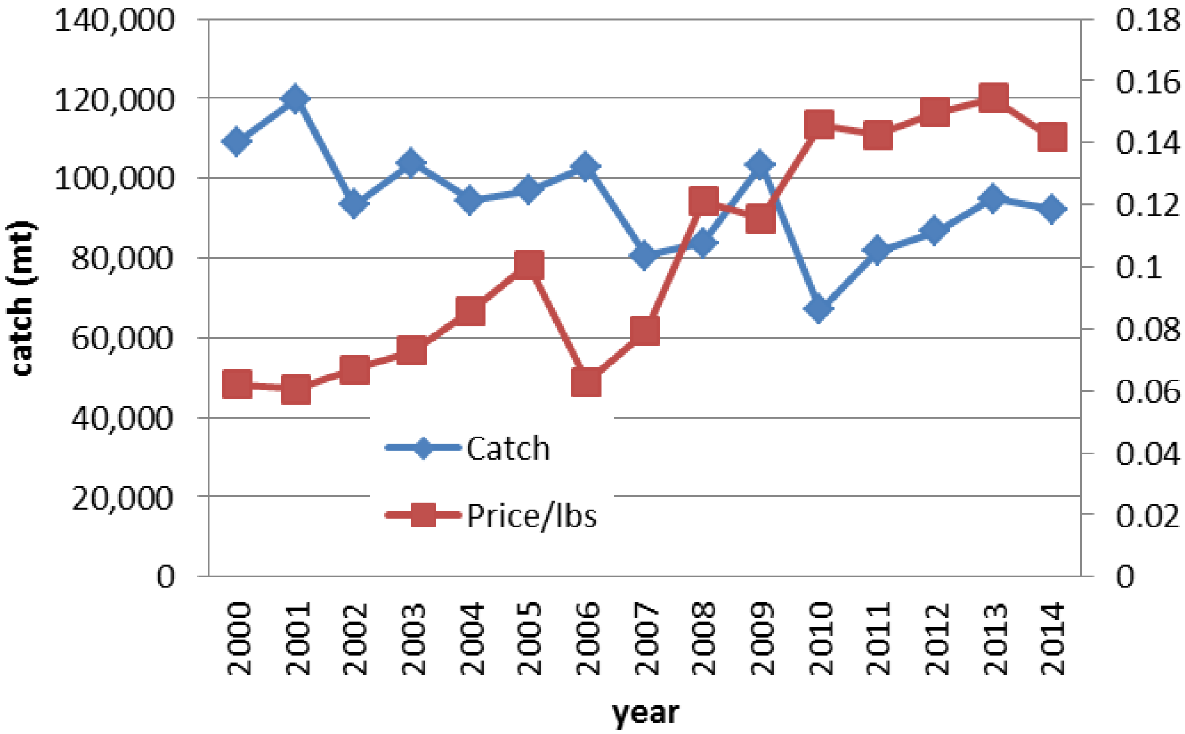
Some vessels fishing with MWT prior to Amendment 1 have remained active in Area 1A in June-September by adjusting their operations. Some have acted as carrier vessels for the purse seine fishery. Use of a carrier vessel, which also occurred prior to the MWT closure, allows a purse seine vessel to increase fishing capacity per trip. Region-wide, the number of vessels with carrier Letters of Authorization increased from six in 2006 to 13-18 in 2007-2010 (Table 41, p. 153). However, a few fishermen have noted that the revenue that a MWT vessel derives from acting as a carrier vessel is lower than if it is actively fishing (revenue is shared 50/50 or 40/60 with the harvester), and recent ASMFC carrier restrictions (Section 3.6.1.5) have made acting as a carrier uneconomical (Section 4.1.2.5).

Fishermen have noted that some MWT vessels have been reconfigured to allow switching between purse seine and MWT, so that the vessel may continue in the directed fishery. However, the estimated cost is $1-3M, and it can take several years of fishing to recoup these costs. The learning curve may require a year or two of lost income and fuel expenses to learn how to fish with a PS. For these and other reasons, fishermen claim that it is very difficult for the conversion between MWT and PS gear to be successful (Section 4.1.2.5).

The current seasonal spawning closures (implemented in 2016) extend the January-September Area 1A MWT closure through October and potentially into November (as occurred in 2017), unless aggregations of herring can be found outside the spawning closures in October-November. Thus, MWT fishing can only occur in Area 1A for a few months late in the year.

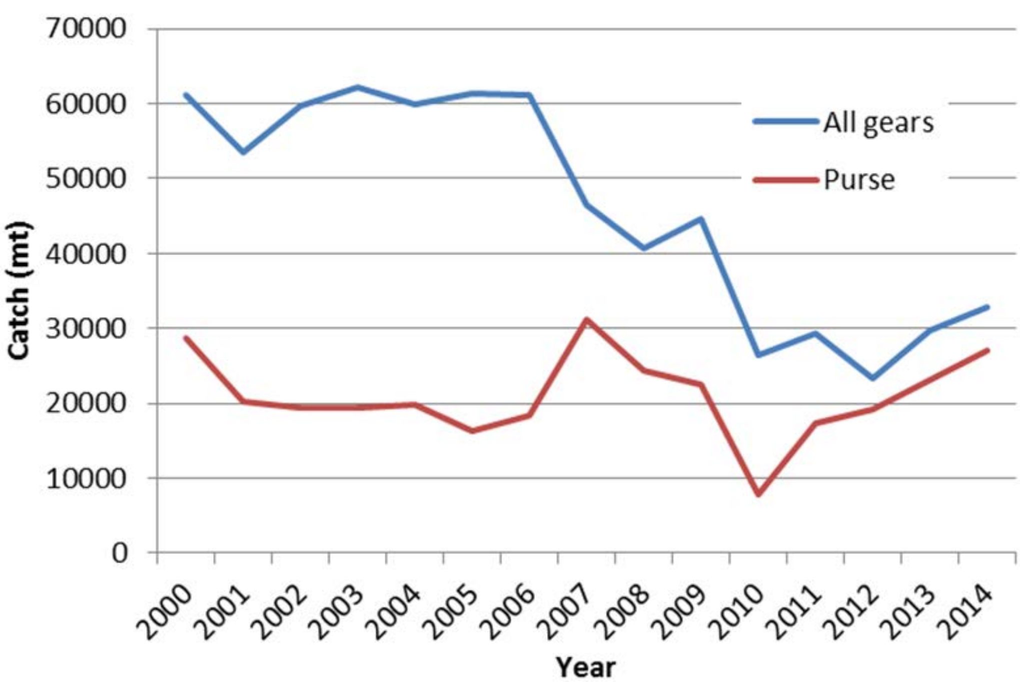
<u>Purse seine impacts</u>. The impacts on the purse seine fishery of No Action are expected to be ***positive***, as they would continue to benefit from the seasonal 1A MWT closure. With the current seasonal spawning closures (implemented in 2016), Area 1A is essentially closed to the purse seine fishery from late August through October and potentially into November (as occurred in 2017), unless aggregations of herring can be found outside the spawning closures in those months. Spawning closures would continue under Alternative 1.

Figure 116 – Atlantic herring catch and price per lbs., all gears all areas



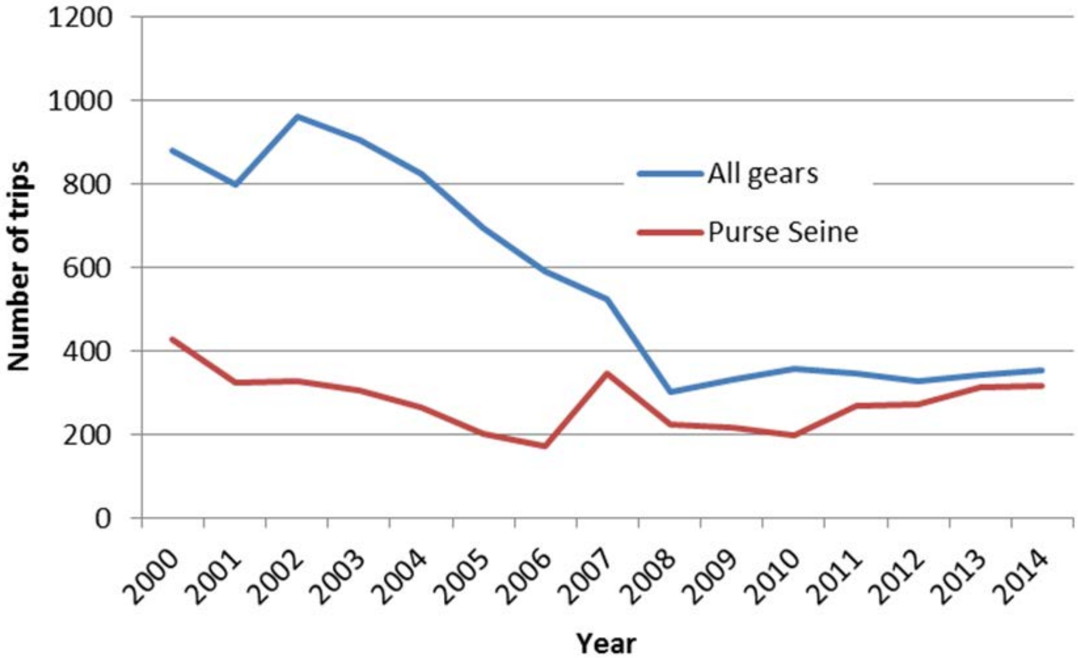
Note: Only catches >6,600 lbs. are included. *Source:* VTR data, accessed 2016.

Figure 117 - Annual Atlantic herring catch in Area 1A for purse seines and all gears



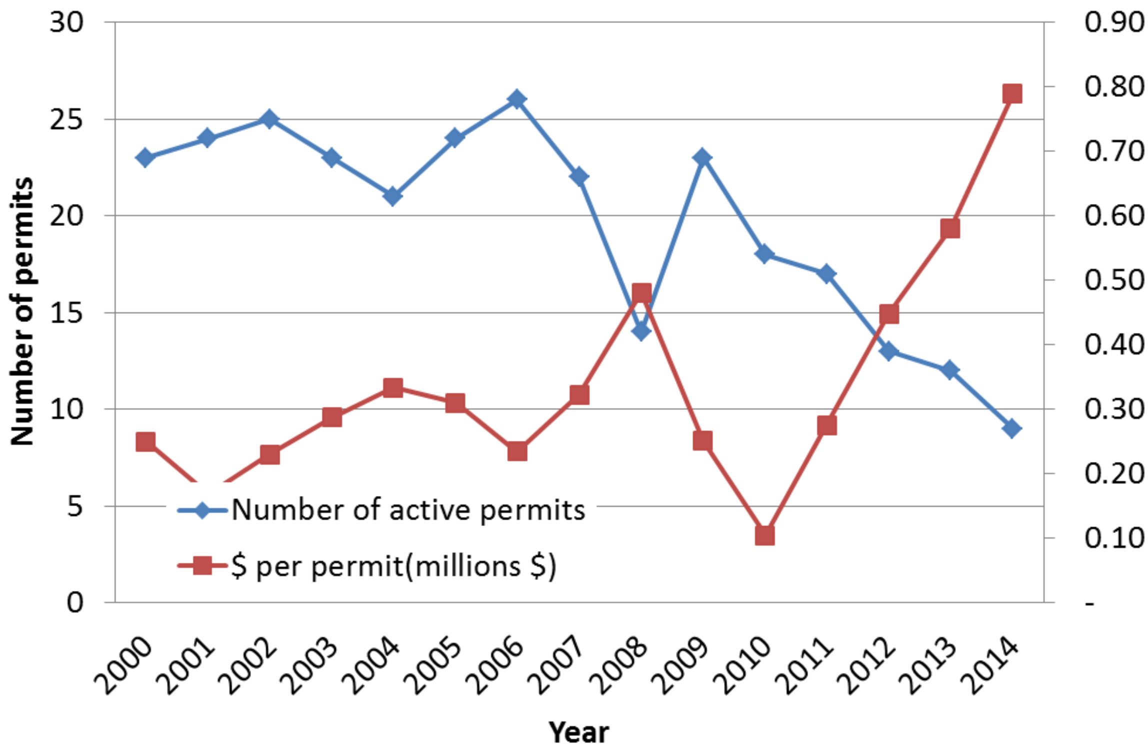
Note: Only catches >6,600 lbs. are included. *Source:* VTR data, accessed 2016.

Figure 118 - Annual number of trips in Area 1A for purse seines and all gears



Note: Only catches >6,600 lbs. are included. Source: VTR data, accessed 2016.

Figure 119 - Number of active permits and average total revenue (average catch times average price/lbs summed) in Area 1A, June through September by year



Note: Only catches >6,600 lbs. are included. *Source:* VTR data, accessed 2016.

Impacts on Atlantic mackerel fishery

The impacts on the Atlantic mackerel fishery of No Action are expected to be ***low negative***. The mackerel fishery occurs primarily with midwater trawl gear and in conjunction with Atlantic herring fishing. Thus, the mackerel MWT fishery is also prohibited in Area 1A June-September. To some degree, negative impacts would be mitigated by the ability of MWT vessels to act as carrier vessels and to fish in all other management areas at other times of year, particularly offshore, which is inaccessible to the purse seine fleet due to vessel size. However, there are several constrains to doing so (e.g., carrier limits, operational constraints, herring are migratory, increased costs of fishing offshore; Table 108, p. 400).

Impacts on American lobster fishery

The impacts on the American lobster fishery of No Action are expected to be ***neutral.*** Since 2004, the Area 1A sub-ACL of Atlantic herring has been over 96% harvested each year, with two exceptions: 2012 (88%) and 2016 (91%). Thus, the gear closure, by itself, has not likely limited the ability of the herring fishery overall to adapt and harvest the resource to supply the bait market.

Impacts on predator fisheries and ecotourism

The impacts on predator fisheries and ecotourism of No Action are expected to be ***positive***. Predator fisheries and ecotourism fare better under positive Atlantic herring resource conditions. Although neutral impacts on Atlantic herring are expected under No Action (Section 4.2.2.1), Atlantic herring is neither overfished nor subject to overfishing (Section 3.1.6). Based on the overlap analysis, with its assumptions and limitations (Section 4.1.2.3; Appendix VII), substantial overlap with the commercial groundfish fishery occurred near Cape Ann (MA) during the summer months prior to Amendment 1. Since 2007, however, the overlap analysis suggests that interaction has been minimal (2%). The greatest overlap with the bluefin tuna fishery has been in October, but prior to Amendment 1, there was some overlap in July-September in Area 1A. For commercial whale watch operators, the greatest overlap with the herring MWT fishery, prior to Amendment 1, occurred in several areas within Area 1A from May-November. Assuming that a low degree of overlap with the Atlantic herring midwater trawl fishery is a positive outcome for predator fisheries and ecotourism, there have been positive impacts of No Action.

Impacts on communities

The impacts on fishing communities of No Action are expected to be ***negative to positive***. While the Atlantic herring, mackerel, and lobster fisheries may have negative to neutral impacts, impacts on other users may be positive. To the degree that Alternative 1 has reduced user conflicts in Area 1A in the summer, positive impacts among human communities have resulted. General community impacts of area closures are described in Section 4.7.3.1.1 (p. 398).

<u>*Herring communities*</u>. Although the VTR analysis has some degree of error, it is estimated that from 2000-2006, the Atlantic herring landings revenue from midwater trawl gear in Area 1A was about $4.5M annually, attributed to 44 permits (Table 110). From greatest to least, most of the revenue was from herring landed in Portland, Rockland, Gloucester, Newington, Prospect Harbor, Bath, and 17 other (confidential) ports in the Northeast U.S.

The named ports above are the top (non-confidential) herring ports that were likely impacted by the Area 1A closure, and are all physically located adjacent to Area 1A. Of the five named ports, Portland, Rockland and Gloucester are herring *Communities of Interest*, according to the criteria in Section 3.6.4.2 (p. 197). They have medium-high or high engagement in or reliance on the Atlantic herring fishery (Table 72).

The herring fishing communities that could be impacted by Alternative 1 are primarily located in Maine, New Hampshire, and Massachusetts. The herring MWT revenue attributed to these states from Area 1A during 2000-2006 ($4.5M/year) is about 35% of all herring revenue for these states during that time period ($13M/year). Certain individual permit holders could have much more of their revenue attributed to fishing from this area/time.

Table 110 – Atlantic herring revenue to states, regions, and top ports attributed to MWT fishing in Area 1A, June-September, 2000-06

State/Port	Average revenue, 2000-2006	Total permits, 2000-2006[a]
Maine	$3.4M	33
Portland	$2.1M	17
Rockland	$0.7M	5
Prospect Harbor	$0.1M	6
Bath	$0.0M	3
New Hampshire	$0.3M	6
Newington	$0.2M	4
Massachusetts	$0.8M	14
Gloucester	$0.7M	11
Other state(s)*	$0.0M	2
Total $ & permits	**$4.5M**	**44**
Total ports	**23**	

Notes: Ports listed are the top ten ports by landing revenue that are non-confidential.
[a] Totals may not equal the sum of the parts, because permits can land in multiple ports/states.
* Confidential
Source: VTR analysis

Communities of other users. Alternative 1 may impact other users of Atlantic herring and their associated communities, many of which coexist (with each other and with the herring fishery) within communities. Within Maine, New Hampshire, and Massachusetts, 10 communities adjacent to Area 1A are particularly important to the mackerel fishery (Table 78; p. 206), though mackerel communities impacted by this alternative would likely mirror the herring communities. For the lobster fishery, 46 such communities have been identified, though herring as bait is distributed to the lobster fishery region-wide. Additionally, 52 communities adjacent to Area 1A are particularly important to the fisheries and ecotourism that rely on herring as a prey item in the ecosystem, though these users are from a broader region.

4.7.3.3 Alternative 2 (Closure inside 6 nm in Area 114 to all vessels fishing for herring)

Under Alternative 2, waters inside 6 nm in the thirty minute square 114 would be closed to all vessels fishing for Atlantic herring, regardless of gear type or herring permit type, according to the seasonal option selected (Figure 4). Alternative 2 would be additive to No Action, would not apply to RSA fishing, and includes a two-year sunset provision from the date of implementation, so impacts are expected to be ***short-term***.

Impacts on Atlantic herring fishery

The impacts on the Atlantic herring fishery of Alternative 2 are expected to be ***short-term and low negative relative to Alternative 1.*** There would be more times and areas closed to the fishery, though it is difficult to determine if herring fishing would be precluded altogether or shift to other areas. To some degree, negative impacts would be mitigated by the ability of herring vessels to fish in other management areas/seasons, particularly offshore, which is more accessible to the MWT fleet than other gear types. However, there are several constrains to doing so (e.g., carrier limits, operational constraints, herring are migratory, increased costs of fishing offshore; Table 108, p. 400; Section 4.1.2.5). Since at least 2007, the price of herring has been highest in July and August (Section 3.6.1.7), so summertime closures may result in lower annual revenue for the fishery.

Since 2007, the herring and mackerel revenue from the Alternative 2 area/seasons has been about \$45K-105K annually. As explained below, the fishery is predominantly located elsewhere during the months under consideration. Still, any fishery closure may hamper adaptability to changing conditions and result in foregone revenue. Given the *low importance* of this area/seasons to the herring fishery in the past, Alternative 2 by itself, would likely *not impede* the ability to harvest optimum yield.

Considering just the recent (2007-2015) revenue from the areas/seasons under consideration, the impacts of Alternative 2 would be ***low positive relative to Alternatives 3-6, 7 (depending on the Alternative 7 option), and 8.*** Impacts would be ***low negative relative to Alternative 9,*** as a new seasonal closure would likely be more negative than removing the January-April Area 1B closure.

<u>*Seasonal sub-option A (June-August).*</u> The impacts of seasonal sub-option A on the Atlantic herring fishery are expected to be ***low positive relative to sub-option B,*** as there would be less times and areas closed to it. From 2000-2007, Atlantic herring landings attributed to fishing in statistical area 114 inside 6 nm in June-August are just 0.1% of the annual total of that area (Table 111). Since 2007, these months have become slightly more important, comprising 7% of the total. Atlantic herring and mackerel revenue attributed to fishing in this portion of statistical area 114 inside 6 nm in June-August has been ≤0.5% of total fishery revenue (from all areas) during those months since 2000 (Table 112).

<u>*Seasonal sub-option B (June-October)*</u>. The impacts of seasonal sub-option B on the Atlantic herring fishery are expected to be ***low negative relative to sub-option A,*** as there would be more times and areas closed to it. From 2000-2007, Atlantic herring landings attributed to fishing in statistical area 114 inside 6 nm in June-October are 10% of the annual total for that area (Table 111). Since 2007, these months have become slightly more important, comprising 17% of the total. Atlantic herring and mackerel revenue attributed to fishing in this area/season has been ≤0.6% of total fishery revenue (from all areas) during those months since 2000 (Table 112). Although low relative to fishery-wide totals, there has been substantially more herring fishing activity in September and October in this area (and all areas) than in June-August (sub-option A).

Table 111 – Annualized Atlantic herring landings (mt) within 6 nm in statistical area 114, in two seasons, all gears (Alternative 2)

Sub-Option	Season	Herring landings (mt)	
		2000 - 2007	2007 – 2015
A	June – August	0.3 (0.1%)	124.2 (6.9%)
B	June – October	216.2 (9.8%)	310.5 (17%)
n/a	Year-round	2,212 (100%)	1,794 (100%)
Note: "2000-2007" includes data through May 2007, pre-Amendment 1 implementation. "2007-2015" includes data from June 2007 onward. *Source:* VTR analysis.			

Table 112 – Annualized Atlantic herring and mackerel revenue within 6 nm of statistical area 114 and in all areas, in two seasons, all gears (Alternative 2)

Sub-Option	Season	Atlantic herring and mackerel average nominal revenue			
		2000 - 2007		2007 – 2015	
		Area 114, inside 6 nm	Total all areas	Area 114, inside 6 nm	Total all areas
A	June – August	$54 (0.0%)	$8,317, 093	$44,845 (0.5%)	$9,903,620
B	June – October	$64,986 (0.5%)	$14,374,704	$104,781 (0.6%)	$17,062,596
Note: "2000-2007" includes data through May 2007, pre-Amendment 1 implementation. "2007-2015" includes data from June 2007 onward. *Source:* VTR analysis.					

Impacts on Atlantic mackerel fishery

The impacts on the Atlantic mackerel fishery of Alternative 2 are expected to be ***short-term and low negative relative to Alternative 1***. There would be more times and areas closed to the fishery, though it is difficult to determine if mackerel fishing would be precluded altogether or shift to other areas. As explained below, the fishery is predominantly located elsewhere during those months. Still, any fishery closure may hamper adaptability to changing conditions and may result in foregone revenue. Given the low importance of this area and season to the mackerel fishery in the past, Alternative 2 by itself, would likely not impede the ability to harvest optimum yield.

Considering just the recent (2007-2015) revenue from the areas/seasons under consideration, the impacts of Alternative 2 would be ***low positive relative to Alternatives 3-6, 7 (depending on the Alternative 7 option), and 8.*** Impacts would be ***low negative relative to Alternative 9,*** as a new seasonal closure would likely be more negative than removing the January-April Area 1B closure.

<u>*Seasonal sub-option A (June-August).*</u> The impacts would be ***low positive relative to sub-option B***, as there would be less times and areas closed to it. From 2000-2015, Atlantic mackerel landings attributed to fishing in statistical area 114 inside 6 nm in June-August have been <1% of the total for all areas during those months (Table 113). Atlantic herring and mackerel revenue attributed to fishing in this area/season has been ≤0.5% of total fishery revenue (from all areas) during those months since 2000 (Table 112).

<u>*Seasonal sub-option B (June-October).*</u> The impacts would be ***low negative relative to sub-option A***, as there would be more times and areas closed to it. From 2000-2015, Atlantic

mackerel landings attributed to fishing in statistical area 114 inside 6 nm in June-October have been <0.9% of the total for all areas during those months (Table 113). Atlantic herring and mackerel revenue attributed to fishing in this area/season has been ≤0.6% of total fishery revenue (from all areas) during those months since 2000 (Table 112).

Table 113 – Annualized Atlantic mackerel landings (mt) within 6 nm of statistical area 114 and in all areas, in two seasons, all gears (Alternative 2)

Season	January 2000 - May 2007		June 2007 – December 2015	
	Area 114, inside 6 nm	Total all areas	Area 114, inside 6 nm	Total all areas
June 1 – August 31 (Sub-option A)	<1 (<0.5%)	183	<5 (<1%)	394
June 1 – October 31 (Sub-option B)	<1 (<0.3%)	391	<10 (<0.9%)	1,098

Impacts on American lobster fishery

The impacts on the American lobster fishery of Alternative 2 are expected to be ***short-term and low negative relative to Alternative 1***. Given the low importance of this area and season to the herring fishery in the past, Alternative 2, by itself, would likely not impede the ability to harvest optimum yield for that fishery, and thus, would have minimal impact on the bait market. As herring prices are generally insensitive to quantity changes, if this measure reduces herring landings, then the price of herring for bait could increase, potentially increasing costs for the lobster fishery. Considering the relative impact on the herring fishery, impacts on the lobster fishery of Alternative 2 would be ***low positive relative to Alternatives 3-6, 7 (depending on the Alternative 7 option), and 8.*** Impacts would be ***low negative relative to Alternative 9,*** as a new seasonal closure would likely be more negative than removing the January-April Area 1B closure, a season when prices are relatively low. The impacts of ***sub-option A would be low positive relative to sub-option B***, as there would be less times and areas closed to the herring fishery under sub-option A.

Impacts on predator fisheries and ecotourism

The impacts on predator fisheries and ecotourism of Alternative 2 are expected to be ***short-term, uncertain, but potentially low positive relative to Alternative 1***. Assuming that removing overlap between the Atlantic herring and predator fisheries and ecotourism is a positive outcome for the predator fisheries and ecotourism, this alternative would have a positive effect, based on the overlap analysis, with its assumptions and limitations (Section 4.1.2.3; Appendix VII). If MWT fishing shifts to other times/areas remaining open, there may be negative impacts to the degree new overlaps result. The area off the "back side of the Cape" is an area of high importance for the recreational fishery in the summer, so overlaps with this fishery would be reduced under Alternative 2 (data limitations precluded quantitative analysis). However, some recreational fisheries (e.g., striped bass) occur only in state waters.

The impacts on predator fisheries and ecotourism of Alternative 2 ***could potentially be low negative relative to Alternatives 3-6, and 7 (depending on the Alternative 7 option),*** as it may remove less overlap with the herring fishery. Impacts could be ***low positive relative to Alternative 8.*** Impacts would be ***neutral relative to Alternative 9;*** both adding a summer time closure and removing the January-April Area 1B closure for the herring fishery would likely reduce user conflicts.

Seasonal sub-option A (June-August). The impacts of ***sub-option A would be low negative relative to sub-option B***, as there would be less times and areas closed to the herring fishery. Since 2007, there has been minimal overlap (2%) between the Atlantic herring midwater trawl fishery and the commercial groundfish, commercial bluefin tuna and commercial whale watch operators during the months of June-August in the area under consideration (Figure 75).

Seasonal sub-option B (June-October). The impacts of ***sub-option B would be low positive relative to sub-option A,*** as there would be more times and areas closed to the herring fishery. Since 2007, there has been minimal overlap (3%) between the Atlantic herring midwater trawl fishery and the commercial groundfish, commercial bluefin tuna and commercial whale watch operators during the months of June-September in the area under consideration (Figure 75).

Impacts on communities

The impacts on fishing communities of Alternative 2 are expected to be ***short-term and low negative to low positive relative to Alternative 1***. While the Atlantic herring, mackerel, and lobster fisheries may have low negative to neutral impacts, impacts on other users may be low positive. To the degree that user conflicts are reduced, positive impacts among human communities are expected. General community impacts of area closures are described in Section 4.7.3.1.1 (p. 398). The VTR analysis results reported here have some degree of error (Section 4.1.2.2).

Herring communities. Gloucester is the top (non-confidential) herring port likely impacted by Alternative 2, and is identified as a herring *Community of Interest,* according to the criteria in Section 3.6.4.2.1; p. 197). It has medium-high or high engagement in or reliance on the Atlantic herring fishery (Table 72). Gloucester is the port with the most landings under either sub-option A or B. The herring fishing communities that could be impacted by Alternative 2 are primarily located in Maine and Massachusetts.

- *Seasonal sub-option A (June-August)*. It is estimated that from 2000-2006, the Atlantic herring landings revenue from within 6 nm in Area 114, during June-August is attributed to five permits landing in five Northeast U.S. ports. The revenue is very low, just a $56 per year annual average. From 2007-2015, there were five permits with herring landings attributed to this area/season, with a total revenue of $43K/year (Table 114). Most of the revenue is attributed to Gloucester and four other (confidential) ports in the Northeast U.S. The herring revenue attributed to ME and MA from this area/season during 2007-2015 ($43K/year) is about 0.2% of all herring revenue for these states during that time period ($21M/year). Certain individual permit holders could have much more of their revenue attributed to fishing from this area/time.
- *Seasonal sub-option B (June-October).* It is estimated that from 2000-2006, the Atlantic herring landings revenue from within 6 nm in Area 114, during June-October, from 2000-2006, was $69K/year, attributed to 19 permits landing in Gloucester, Portland and nine other (confidential) ports in the Northeast U.S. (Table 115). From 2007-2015, there was an increase in average revenue, $99K, attributed to fewer permits (16) and ports (seven, including Gloucester), from herring landings attributed to this area/season. The herring revenue attributed to ME and MA from this area/season during 2007-2015 ($99K/year) is about 0.5% of all herring revenue for these states during that time period ($21M/year).

Certain individual permit holders could have much more of their revenue attributed to fishing from this area/time.

Communities of other users. Alternative 2 may impact other users of Atlantic herring and their associated communities, many of which coexist (with each other and with the herring fishery) within communities. Off the "back side of the Cape" (within Massachusetts), just one community, Provincetown, has been identified as being particularly important to the mackerel fishery (Table 78; p. 206), though mackerel communities impacted by this alternative would likely mirror the herring communities. For the lobster fishery, two adjacent communities have been identified, though herring as bait is distributed to the lobster fishery region-wide. Additionally, about 10 adjacent communities are particularly important to the fisheries and ecotourism that rely on herring as a prey item in the ecosystem, though these users are known to hail from other ports, particularly within Massachusetts.

Table 114 – Atlantic herring revenue to states, regions, and top ports attributed to fishing (all gears) within 6 nm in Area 114, during June 1-August 31, 2007-2015 (Alternative 2, sub-option A)

State/Port	Average revenue, 2007-2015	Total permits, 2007-2015[a]
Sub-Option A (June 1 – August 31)		
Maine	$13K	3
Massachusetts	$30K	4
Gloucester	$30K	4
Other state(s)[b]	$0K	2
Total $ & permits	**$43K**	**5**
Total ports	**5**	
Notes: Ports listed are the top ten ports by landing revenue that are non-confidential. [a] Totals may not equal the sum of the parts, because permits can land in multiple ports/states. [b] Confidential. *Source:* VTR analysis		

Table 115 – Atlantic herring revenue to states, regions, and top ports attributed to fishing (all gears) within 6 nm in Area 114, during June 1-October 31, 2000-2015 (Alternative 2, sub-option B)

State/Port	June-Oct, 2000-2006		June-Oct, 2007-2015	
	Average revenue	Total permits[a]	Average revenue	Total permits[a]
Maine	$11K	5	$37K	4
Portland	$9K	4	[b]	[b]
Massachusetts	$58K	15	$60K	11
Gloucester	$56K	10	$57	8
Other state(s)[b]	$0K	4	$1K	3
Total $ & permits	**$69K**	**19**	**$99K**	**16**
Total ports	**11**		**7**	
Notes: Ports listed are the top ten ports by landing revenue that are non-confidential. [a] Totals may not equal the sum of the parts, because permits can land in multiple ports/states. [b] Confidential. *Source:* VTR analysis				

4.7.3.1 Alternative 3 (Prohibit MWT gear in Area 1A year-round)

Under Alternative 3, the seasonal midwater trawl gear prohibition in Area 1A would be extended to be a year-round restriction. Currently, all herring fishing is prohibited in Area 1A January-May, and the areas remains closed to MWT gear June-September. Since 2016, spawning closures close much of Area 1A to the entire fishery through October and into November (Table 4, p. 78). Alternative 3 would be additive to No Action and not apply to RSA fishing.

Impacts on Atlantic herring fishery

<u>*Fishery-wide impacts.*</u> The impacts on the Atlantic herring fishery of Alternative 3 are expected to be ***neutral relative to No Action***. If midwater trawls are prohibited from Area 1A year-round (except for RSA fishing), the Area 1A sub-ACL is still expected to be harvested. There exists sufficient capacity among the purse seine vessels to do so, if that sufficient herring are in areas/depths accessible to PS gear. Given the regulatory restrictions on small mesh bottom trawls, it is unlikely that this gear would expand into the Gulf of Maine. There has been some PS activity in the fall in Area 1A (Appendix IX), and this could expand under Alternative 3. Thus, the same amount of herring would likely be harvested from the area, just with a different gear type.

<u>*Midwater trawl impacts.*</u> The impacts on midwater trawl vessels of Alternative 3 are expected to be ***low negative relative to No Action***, since fall fishing in Area 1A has been important to these vessels in the past. From 2000, Atlantic herring and mackerel revenue attributed to MWT fishing in Area 1A was $8.7M, or 30% of the annual total attributed to that gear type (Table 116). Since 2007, with the June-September MWT closure in Area 1A, the annual average dropped to $3.3M, or 18% of the annual total attributed to that gear type.

Alternative 3 may hamper adaptability to changing conditions and may result in foregone revenue. It is difficult to determine if MWT vessels would be precluded from fishing altogether or shift to other areas. To some degree, negative impacts to MWT vessels would be mitigated if they can act as carrier vessels and fish in other management areas, particularly offshore, which is more accessible to the MWT fleet than other gear types. However, there are several constrains to doing so (e.g., carrier limits, operational constraints, herring are migratory, increased costs of fishing offshore; Table 108, p. 400). Since Amendment 1 implementation, some MWT vessels were retrofitted to be able to switch back and forth between using MWTs and purse seine gear, so that they could continue fishing in Area 1A in the summer. This comes at substantial cost, and it is uncertain whether additional MWT vessels would retrofit to retain some access to Area 1A altogether (Section 4.1.2.5).

Considering just the recent (2007-2015) revenue from the areas/seasons under consideration, the impacts of Alternative 3 would be ***low negative relative to Alternative 2*** and ***low negative to low positive relative to Alternatives 4-8,*** depending on the options in those alternatives. Impacts would be ***negative relative to Alternative 9,*** as a new seasonal closure would likely be more negative than removing the January-April Area 1B closure.

<u>*Purse seine impacts.*</u> The impacts on the purse seine fishery of Alternative 3 are expected to be ***positive.*** These vessels would benefit from the year-round Area 1A MWT closure.

Table 116 – Annualized Atlantic herring and mackerel revenue year-round within Area 1A, MWT gear only (Alternative 3)

Jan 2000 – May 2007		June 2007 – December 2015	
Inside 1A	All areas	Inside 1A	All areas
$8,723,038	$28,860,674 (30.2%)	$3,338,647 (17.8%)	$18,734,867

Impacts on Atlantic mackerel fishery

The impacts on the Atlantic mackerel fishery of Alternative 3 are expected to be ***low negative relative to No Action,*** as there would be more times and areas closed to it. From 2000-2007, annual Atlantic mackerel landings attributed to fishing with midwater trawl in Area 1A were just 0.1% of the total for all areas by that gear type (Table 117). Since then, the contribution has increased to 6.1%, though total mackerel landings declined by 77%. However, from January 2000 to May 2007, Atlantic herring and mackerel revenue attributed to MWT fishing in Area 1A were $8.7M, or 30% of the annual total attributed to that gear type (Table 116). Since June 2007, with the June-September MWT closure in Area 1A, the annual average dropped to $3.3M, or 18% of the annual total attributed to that gear type. Alternative 3 may hamper adaptability to changing conditions and may result in foregone revenue. Considering just the recent (2007-2015) revenue from the areas/seasons under consideration, the impacts of Alternative 3 would be ***low negative relative to Alternative 2*** and ***low negative to low positive relative to Alternatives 4-8,*** depending on the options in those alternatives. Impacts would be ***negative relative to Alternative 9,*** as a new seasonal closure would likely be more negative than removing the January-April Area 1B closure.

Table 117 – Annualized Atlantic mackerel landings (mt) within Area 1A, midwater trawl only (Alternative 3)

January 2000 - May 2007		June 2007 – December 2015	
Inside Area A1	All areas	Inside Area A1	All areas
21	30,082 (0.1%)	424	6,993 (6.1%)

Impacts on American lobster fishery

The impacts on the American lobster fishery of Alternative 3 are expected to be ***neutral relative to No Action,*** as the same amount of herring would likely be harvested from the area, and available for the bait market. As herring prices are generally insensitive to quantity changes, if this measure reduces herring landings, then the price of herring for bait could increase, potentially increasing costs for the lobster fishery. Impacts could be ***low negative to low positive relative to Alternatives 2 and 4-8***, depending on if herring bait supply becomes more limited. Impacts could be ***low negative relative to Alternative 9***, as removing the January-April 1B closure may lower costs for the lobster fishery.

Impacts on predator fisheries and ecotourism

The impacts on predator fisheries and ecotourism of Alternative 3 are expected to be ***uncertain, but potentially low positive relative to No Action***. Assuming that removing overlap between the midwater trawl Atlantic herring and predator fisheries and ecotourism is a positive outcome for the predator fisheries and ecotourism, Alternative 3 would have a positive effect, based on the overlap analysis, with its assumptions and limitations (Section 4.1.2.3; Appendix VII). Since

2007, there has been moderate to high degrees of overlap between the Atlantic herring MWT fishery and the commercial groundfish (31%), commercial bluefin tuna (51%), and commercial whale watch operators (91%) in Area 1A year-round (Figure 75). If MWT fishing shifts to other times/areas remaining open, there may be negative impacts to the degree new overlaps result. If MWT fishing in Area 1A is replaced by purse seines, negative outcomes for predator fisheries may result from overlap with purse seines.

The impacts on predator fisheries and ecotourism of Alternative 3 ***could potentially be low positive relative to Alternatives 2 and 4-8,*** depending on the options in those alternatives, as it may remove more overlap with the herring MWT fishery. Impacts would be ***neutral relative to Alternative 9;*** both adding a fall closure and removing the January-April Area 1B closure for the herring fishery would likely reduce user conflicts. For the commercial tuna fishery and whale watch industry, the overlap analysis indicates that Alternative 3 may have the most overlap of all the alternatives.

Impacts on communities

The impacts on fishing communities of Alternative 3 are expected to be ***low negative to low positive relative to Alternative 1***. While the Atlantic herring, mackerel, and lobster fisheries may have negative to neutral impacts, impacts on other users may be low positive. To the degree that user conflicts are reduced, positive impacts among human communities are expected. General community impacts of area closures are described in Section 4.7.3.1.1 (p. 398).

Herring communities. Although the VTR analysis has some degree of error, it is estimated that the Atlantic herring midwater trawl landings revenue from Area 1A, during October-December, from 2000-2006, was $2.4M/year, attributed to 32 permits (Table 118). From greatest to least, most of the revenue was from herring landed in Gloucester, Portland, Rockland, New Bedford, Prospect Harbor and 11 other ports in the Northeast U.S. From 2007-2015, there was an increase in average revenue, to $2.8M, attributed to fewer permits (16) and ports (15), from herring landings attributed to this area/season. Gloucester has had the most landings under either time period. New Bedford, Fall River and ports in states south of Massachusetts became more active in Area 1A MWT fishing in the recent time period. The named ports above are the top (non-confidential) herring ports most likely impacted by extending the Area 1A closure year-round. Of these, Portland, Rockland, Gloucester, and New Bedford are herring *Communities of Interest*, according to the criteria in Section 3.6.4.2.1; p. 197). They have medium-high or high engagement in or reliance on the Atlantic herring fishery (Table 72).

The herring fishing communities that could be impacted by Alternative 3 are primarily located in Maine and Massachusetts. The herring MWT revenue attributed to these states from Area 1A during 2007-2015 ($2.8M/year) is about 13% of all herring revenue for these states during that time period ($21M/year). Certain individual permit holders could have much more of their revenue attributed to fishing from this area/time.

Communities of other users. Alternative 3 may impact other users of Atlantic herring and their associated communities, many of which coexist (with each other and with the herring fishery) within communities. Within Maine, New Hampshire, and Massachusetts, 10 communities adjacent to Area 1A are particularly important to the mackerel fishery (Table 78, p. 206), though mackerel communities impacted by this alternative would likely mirror the herring communities. For the lobster fishery, 46 such communities have been identified, though herring as bait is distributed to the lobster fishery region-wide. Additionally, 52 communities adjacent to Area 1A are particularly important to the fisheries and ecotourism that rely on herring as a prey item in the ecosystem, though these users are from a broader region.

Table 118 – Atlantic herring revenue to states, regions, and top ports attributed to MWT fishing in Area 1A, October-December, 2000-2015 (Alternative 3)

State/Port	October-December, 2000-2006		October-December, 2007-2015	
	Average revenue	Total permits[a]	Average revenue	Total permits[a]
Maine	$0.7M	20	$1.0M	12
Portland	$0.4M	16	$0.7M	10
Rockland	$0.1M	3	[b]	[b]
Prospect Harbor	$0.0M	4	[b]	[b]
New Hampshire	$0.2M	7	[b]	[b]
Newington	$0.1M	3	[b]	[b]
Portsmouth	$0.0M	6	[b]	[b]
Massachusetts	$1.5M	21	$1.7M	17
Gloucester	$1.4M	17	$1.2M	9
New Bedford	$0.1M	4	$0.4M	10
Fall River	[b]	[b]	$0.0M	3
Rhode Island	$0.0M	5	[b]	[b]
Other state(s)[b]	$0.0M	2	$0.1M	7
Total $ & permits	**$2.4M**	**32**	**$2.8M**	**20**
Total ports	**16**		**15**	

Notes: Ports listed are the top ten ports by landing revenue that are non-confidential.
[a] Totals may not equal the sum of the parts, because permits can land in multiple ports/states.
[b] Confidential.
Source: VTR analysis.

4.7.3.2 Alternative 4 (Prohibit MWT gear inside 12 nm south of Area 1A)

Under Alternative 4, waters inside 12 nm south of Area 1A would be closed to midwater trawl gear, according to the area and seasonal options selected (Figure 6). Alternative 4 would be additive to No Action and not apply to RSA fishing.

Impacts on Atlantic herring fishery

The impacts on the Atlantic herring fishery of Alternative 4 are expected to be ***negative to low negative relative to Alternative 1, primarily impacting midwater trawl vessels*** and depending on the Alternative 4 options selected. With additional fishing restrictions inside 12nm, it would become more difficult for the fishery to harvest the Area 1B sub-ACL. This sub-ACL is small, about 4,000 mt in recent years, and typically caught within 30-minute square 114 off the "back side of the Cape" in nearshore waters by MWT vessels. During 2008-2014, MWT gear caught 54% of the 1B sub-ACL, 9% by purse seines, and 37% by small mesh bottom trawls (Table 38 and Table 39, p. 151). Fishing may also be negatively impacted in Areas 3 and 2, making it more difficult to harvest the sub-ACLs. For Area 3, the majority of catch is from outside of 12 nm, but a portion is consistently caught within 12 nm, mostly off the "back side of the Cape." Fishing takes place closer to shore in Area 2 compared to Area 3, so this potential impact is greater in

Area 2. In recent years, the fishery has not harvested the full sub-ACLs for Areas 2 and 3; implementing this measure could make it more difficult to do so.

Any fishery closure may hamper adaptability to changing conditions and may result in foregone revenue. It is difficult to determine if fishing would be precluded altogether or shift to other areas. To some degree, the ability of herring MWT vessels to fish in other management areas/seasons would mitigate negative impacts, particularly offshore, which is more accessible to the MWT fleet than other gear types. However, there are several constrains to doing so (e.g., carrier limits, operational constraints, herring are migratory, increased costs of fishing offshore; Section 4.1.2.5). Costs for trips occurring outside of 12 nm are generally double those occurring inside 12 nm (Table 108, p. 400).

Impacts for ***purse seine and SMBT vessels may be more neutral***, unless there is increased crowding from effort shifts. Given the regulatory restrictions on SMBTs, it is unlikely that this gear would expand substantially into Areas 1B and 3. Use of purse seines is unlikely on the "back side of the Cape" and offshore, as purse seining is difficult in strong tides, rough ocean conditions, and when herring occur in deep water. MWT vessels may shift to fishing outside of 12 nm within Area 1B and still harvest the sub-ACL, but most fishing in Area 1B is currently inside of 12 nm.

Considering just the recent (2007-2015) revenue from the areas/seasons under consideration, and depending on the options selected, the impacts of Alternative 4 would be ***negative relative to Alternative 2, negative to neutral relative to Alternatives 3, 7 and 8, neutral to positive relative to Alternatives 5 and 6.*** Impacts would be ***negative relative to Alternative 9,*** as a new seasonal closure would likely be more negative than removing the January-April Area 1B closure.

Area sub-option A (Areas 1B, 2 &3) and seasonal sub-option A (year-round). The impacts on the Atlantic herring fishery of Alternative 4, area sub-option A, seasonal sub-option A are expected to be ***negative relative to all the other Alternative 4 sub-options, primarily impacting midwater trawl vessels***; it would result in the most times/areas closed. From 2000-2007, Atlantic herring landings attributed to MWT fishing inside 12 nm in Areas 1B, 2, and 3 were 15% of the annual herring MWT landings for these Areas (Table 119). Since 2007, the 12 nm zone became more important, comprising 20% of the total. Atlantic herring and mackerel revenue attributed to MWT fishing in this area/season has been about $3.3-3.7M/year, 13-18% of the fishery-wide MWT revenue since 2000 (Table 120). If midwater trawls can no longer fish inside 12 nm in Areas 1B, 2, and 3 year-round (except for RSA fishing), the Area 1B sub-ACL is not expected to be fully harvested, though Area 1B is a small fraction of the total sub-ACL. Given the *importance* of the area/season of this option to the MWT fishery in the past, this option *may impede* the ability to harvest optimum yield, unless the allowable catch is harvested with other gear types.

Area sub-option A (Areas 1B, 2 &3) and seasonal sub-option B (June-September). The impacts on the Atlantic herring fishery of Alternative 4, area sub-option A, seasonal sub-option B are expected to be ***low negative relative to sub-option B/B and low positive relative to sub-options A/A and B/A, primarily impacting midwater trawl vessels***. From 2000-2007, Atlantic herring landings attributed to MWT fishing inside 12 nm, June-September, in Areas 1B, 2, and 3 were 0.3% of the herring MWT landings for that season (or 0.2% of annual) for these Areas (Table 119). Since 2007, the 12 nm zone became slightly more important, comprising 4% of the seasonal total (or 0.2% of annual). Atlantic herring and mackerel revenue attributed to MWT fishing in this area/season has been about $29-300K/year, 0.4-6% of the fishery-wide MWT revenue since 2000 (Table 120). If midwater trawls can no longer fish inside 12 nm in Areas 1B, 2, and 3 in June-September, the Area 1B sub-ACL still expected to be fully harvested. MWT vessels may shift to fishing outside of 12 nm within Area 1B in June-September. Fishing within 12 nm in Areas 1B, 2 and 3 has been most important to the herring MWT fishery during December and January (Figure 120). Given the *low importance* of the area/season of this option to the MWT fishery in the past, this option *may not impede* the ability to harvest optimum yield, particularly if the allowable catch is harvested with other gear types or if MWT effort shifts seasonally. Since at least 2007, the price of herring has been highest in July and August (Section 0, p. 154), so summertime closures may result in lower annual revenue for the fishery.

<u>*Area sub-option B (Areas 1B &3) and seasonal sub-option A (year-round).*</u> The impacts on the Atlantic herring fishery of Alternative 4, area sub-option B, seasonal sub-option A are expected to be ***low negative relative to sub-options A/B and B/B and low positive relative to sub-option A/A, primarily impacting midwater trawl vessels.*** From 2000-2007, Atlantic herring landings attributed to MWT fishing inside 12 nm year-round in Areas 1B and 3 were 8% of the annual herring MWT landings for Areas 1B, 2 and 3 (Table 119). Since 2007, the percentage remained the same. Atlantic herring and mackerel revenue attributed to MWT fishing in this area/season has been about $1.2-1.4M/year, 5-6% of the fishery-wide MWT revenue since 2000 (Table 120). If midwater trawls can no longer fish inside 12 nm in Areas 1B and 3 year-round (except for RSA fishing), the Area 1B sub-ACL is not expected to be fully harvested, though Area 1B is a small fraction of the total sub-ACL. Given the *importance* of the area/season of this option to the MWT fishery in the past, this option *may impede* the ability to harvest optimum yield, unless the allowable catch is harvested with other gear types.

<u>*Area sub-option B (Areas 1B &3) and seasonal sub-option B (June-September).*</u> The impacts on the Atlantic herring fishery of Alternative 4, area sub-option B, seasonal sub-option B are expected to be ***positive relative to all the other Alternative 4 sub-options, primarily impacting midwater trawl vessels;*** it would result in the least times and areas closed. From 2000-2007, Atlantic herring landings attributed to MWT fishing inside 12 nm, June-September, in Areas 1B and 3 were 0.3% of the herring MWT landings for that season for Areas 1B, 2 and 3 (or 0.1% of annual; Table 119). Since 2007, the 12 nm zone became slightly more important, comprising 4% of the seasonal total (or 1% of annual). Atlantic herring and mackerel revenue attributed to MWT fishing in this area/season has been about $22K-200K/year, 0.3-3% of the fishery-wide MWT revenue since 2000 (Table 120). If midwater trawls can no longer fish inside 12 nm in Areas 1B and 3 in June-September, the Area 1B sub-ACL still expected to be fully harvested. MWT vessels may shift to fishing outside of 12 nm within Area 1B in June-September. Given the *low importance* of the area/season of this option to the MWT fishery in the past, this option *may not impede* the ability to harvest optimum yield, particularly if the allowable catch is harvested with other gear types or if MWT effort shifts seasonally. Since at least 2007, the price of herring has been highest in July and August (Section 3.6.1.7), so summertime closures may result in lower annual revenue for the fishery.

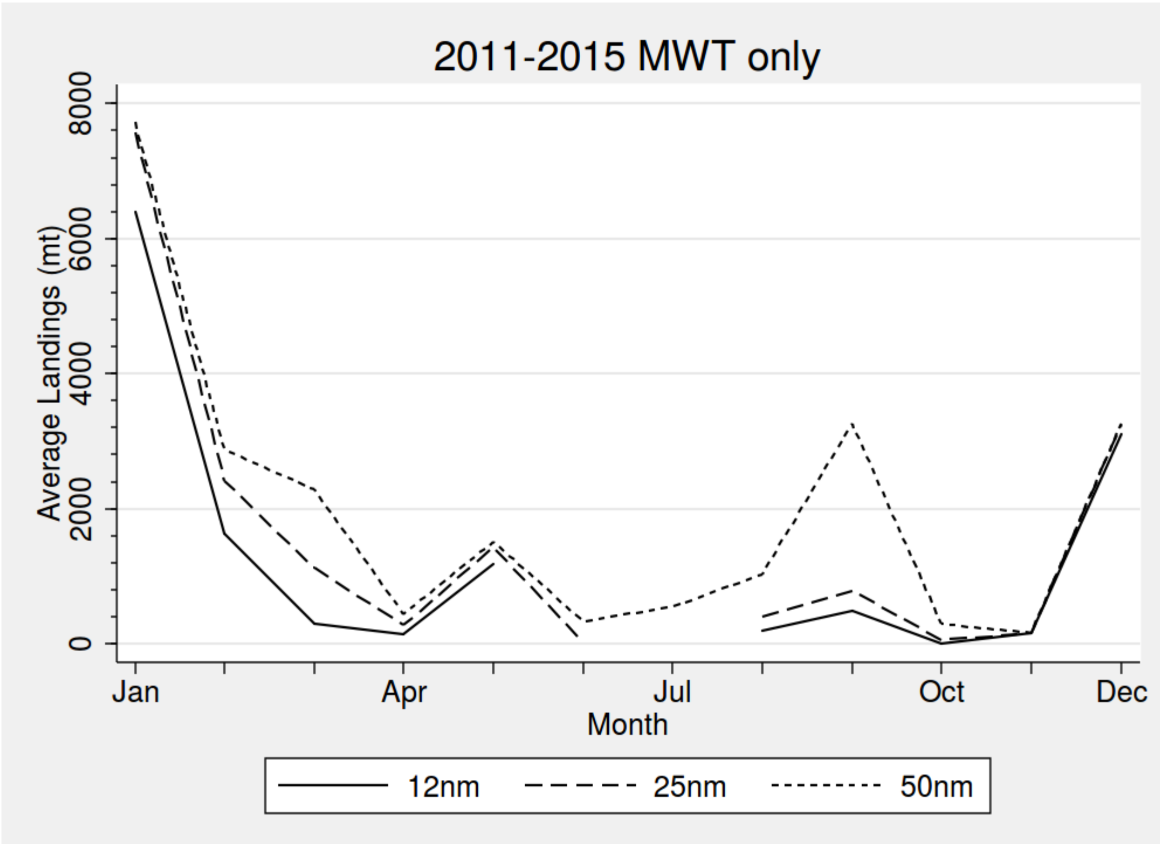
Table 119 – Annualized Atlantic herring MWT landings south of Area 1A (Alternatives 4, 5, 6)

Sub-options		Description	Time period	Herring MWT landings south of Area 1A (mt)			
Area	Season			Inside 12 nm	Inside 25 nm	Inside 50 nm	Total
A	A	Areas 1B, 2 & 3; year round	2000-2007	9,793 (15%)	14,072 (21%)	19,913 (30%)	66,979 (100%)
			2007-2015	11,457 (20%)	15,583 (28%)	23,338 (42%)	56,205 (100%)
A	B	Areas 1B, 2 & 3; June-Sept	2000-2007	102 (0.3%)	194 (0.6%)	1,748 (5.8%)	29,911 (100%)
			2007-2015	780 (3.7%)	1,175 (5.5%)	4,173 (20%)	21,286 (100%)
B	A	Areas 1B & 3; year round	2000-2007	5,125 (7.7%)	6,696 (10%)	9,179 (14%)	66,979 (100%)
			2007-2015	4,326 (7.7%)	5,960 (11%)	10,315 (18%)	56,205 (100%)
B	B	Areas 1B & 3; June-Sept	2000-2007	75 (0.3%)	166 (0.6%)	1,720 (5.8%)	29,911 (100%)
			2007-2015	760 (3.6%)	1,155 (5.4%)	4,154 (20%)	21,286 (100%)
Note: "2000-2007" includes data through May 2007, pre-Amendment 1 implementation. "2007-2015" includes data from June 2007 onward. "Total" for all rows includes all landings south of 1A. *Source:* VTR							

Table 120 – Annualized Atlantic herring and mackerel MWT revenue (Alternatives 4, 5, 6)

Sub-options		Description	Time period	Herring/mackerel MWT average nominal revenue			
Area	Season			Inside 12 nm	Inside 25 nm	Inside 50 nm	Total all areas
A	A	Areas 1B, 2 & 3; year round	2000-2007	$3.7M (13%)	$6.8M (24%)	$13M (45%)	$28.9M (100%)
			2007-2015	$3.3M (18%)	$4.9M (26%)	$8.0M (43%)	$18.7M (100%)
A	B	Areas 1B, 2 & 3; June-Sept	2000-2007	$29K (0.4%)	$52K (0.7%)	$0.5M (5.8%)	$7.9M (100%)
			2007-2015	$0.3M (4.4%)	$0.4M (5.9%)	$1.3M (19%)	$6.8M (5.7%)
B	A	Areas 1B & 3; year round	2000-2007	$1.4M (4.8%)	$1.8M (6.4%)	$2.6M (8.9%)	$28.9M (100%)
			2007-2015	$1.2M (6.4%)	$1.6M (8.6%)	$2.9M (16%)	$18.7M (100%)
B	B	Areas 1B & 3; June-Sept	2000-2007	$22K (0.3%)	$45K (0.6%)	$0.4M (5.1%)	$7.9M (100%)
			2007-2015	$0.2M (2.5%)	$0.4M (5.1%)	$1.3M (16%)	$7.9M (100%)
Note: "2000-2007" includes data through May 2007, pre-Amendment 1 implementation. "2007-2015" includes data from June 2007 onward. *Source:* VTR analysis.							

Figure 120 - Average monthly MWT landings from areas south of Area 1A, 12 nm, 25, and 50 nm from shore, 2011-2015



Impacts on Atlantic mackerel fishery

The impacts on the Atlantic mackerel fishery of Alternative 4 are expected to be ***negative to low negative relative to Alternative 1,*** depending on the Alternative 4 options selected. There would be more times and areas closed to the fishery, though it is difficult to determine if mackerel fishing would be precluded altogether or shift to other areas. Any fishery closure may hamper adaptability to changing conditions and may result in foregone revenue. Considering just the recent (2007-2015) revenue from the areas/seasons under consideration, and depending on the options selected, the impacts of Alternative 4 would be ***negative relative to Alternative 2, negative to neutral relative to Alternatives 3, 7 and 8, neutral to positive relative to Alternatives 5 and 6.*** Impacts would be ***negative relative to Alternative 9,*** as a new seasonal closure would likely be more negative than removing the January-April Area 1B closure.

<u>*Area sub-option A (Areas 1B, 2 &3) and seasonal sub-option A (year-round).*</u> The impacts on the Atlantic mackerel fishery of Alternative 4, area sub-option A, seasonal sub-option A are expected to be ***negative relative to all the other Alternative 4 sub-options***; it would result in the most times/areas closed. From 2000-2007, Atlantic mackerel landings attributed to fishing with midwater trawl year-round in areas inside 12 nm, south of Area 1A were 8.7% of the total for all areas by that gear type (Table 121). Since then, the contribution has increased to 12%, though total mackerel landings declined by 77%. Atlantic herring and mackerel revenue attributed to

MWT fishing in this area year-round has been about $3.3-3.7M/year, 13-18% of the fishery-wide MWT revenue since 2000 (Table 120).

Table 121 – Annualized Atlantic mackerel landings (mt) south of Area 1A, midwater trawl only (Alternative 4, 5, 6)

Sub-options		Description	Time period	Mackerel MWT landings south of Area 1A (mt)			
Area	Season			Inside 12 nm	Inside 25 nm	Inside 50 nm	Total
A	A	Areas 1B, 2 & 3; year round	2000-2007	2,618 (8.7%)	7,499 (25%)	21,341 (71%)	30,082 (100%)
			2007-2015	842 (12%)	2,116 (30%)	4,790 (69%)	6,993 (100%)
A	B	Areas 1B, 2 & 3; June-Sept	2000-2007	0	0	0	<10
			2007-2015	<1	<1	<1	<10
B	A	Areas 1B & 3; year round	2000-2007	59 (0.2%)	73 (0.2%)	146 (0.5%)	30,082 (100%)
			2007-2015	145 (2.1%)	203 (2.9%)	249 (3.6%)	6,993 (100%)
B	B	Areas 1B & 3; June-Sept	2000-2007	0	0	0	<10
			2007-2015	<1	<1	<1	<10

Area sub-option A (Areas 1B, 2 &3) and seasonal sub-option B (June-September). The impacts on the Atlantic mackerel fishery of Alternative 4, area sub-option A, seasonal sub-option B are expected to be ***low negative relative to sub-option B/B and low positive relative to sub-options A/A and B/A.*** From 2000-2015, Atlantic mackerel landings attributed to fishing with midwater trawl in June-September in areas inside 12 nm, south of Area 1A were virtually zero, and was very small for all areas (Table 121). Atlantic herring and mackerel revenue attributed to MWT fishing in this area/season has been about $29-300K/year, 0.4-5.7% of the fishery-wide MWT revenue since 2000 (Table 120).

Area sub-option B (Areas 1B &3) and seasonal sub-option A (year-round). The impacts on the Atlantic mackerel fishery of Alternative 4, area sub-option B, seasonal sub-option A are expected to be ***low negative relative to sub-options A/B and B/B and low positive relative to sub-option A/A.*** From 2000-2007, Atlantic mackerel landings attributed to fishing with midwater trawl inside 12 nm in Areas 1B and 3 were just 0.2% of the total for all areas by that gear type (Table 121). Atlantic herring and mackerel revenue attributed to MWT fishing in this area year-round has been about $1.2-1.4M/year, 5-6% of the fishery-wide MWT revenue since 2000 (Table 120).

Area sub-option B (Areas 1B &3) and seasonal sub-option B (June-September). The impacts on the Atlantic mackerel fishery of Alternative 4, area sub-option B, seasonal sub-option B are expected to be ***positive relative to all the other Alternative 4 sub-options, primarily impacting midwater trawl vessels;*** it would result in the least times and areas closed. From 2000-2015, Atlantic mackerel landings attributed to fishing with midwater trawl in June-September in areas inside 12 nm, in Areas 1B and 3 were virtually zero, and very small (<10 mt) for all areas (Table

121). Atlantic herring and mackerel revenue attributed to MWT fishing in this area/season has been about $22-200K/year, 0.3-2.5% of the fishery-wide MWT revenue since 2000 (Table 120).

Impacts on American lobster fishery

The impacts on the American lobster fishery of Alternative 4 are expected to be ***negative to low negative relative to Alternative 1,*** depending on the Alternative 4 options selected. There would be more times and areas closed to the herring midwater trawl fishery, potentially impairing the bait market. As herring prices are generally insensitive to quantity changes, if this measure reduces herring landings, then the price of herring for bait could increase, potentially increasing costs for the lobster fishery. Considering just the recent (2007-2015) herring revenue from the areas/seasons under consideration, and depending on the options selected, the impacts of Alternative 4 would be ***negative relative to Alternative 2, negative to neutral relative to Alternatives 3, 7 and 8, neutral to positive relative to Alternatives 5 and 6,*** depending on if bait supply becomes more limited***.*** Impacts would be ***negative relative to Alternative 9,*** as a new seasonal closure would likely be more negative than removing the January-April Area 1B closure, which may lower costs to the lobster fishery. ***Of the Alternative 4 sub-options, A/A would have the most negative impact and B/B would be least negative***.

Impacts on predator fisheries and ecotourism

The impacts on predator fisheries and ecotourism of Alternative 4 are expected to be ***uncertain, but potentially low positive relative to Alternative 1***. Assuming that removing overlap between the midwater trawl Atlantic herring and predator fisheries and ecotourism is a positive outcome for the predator fisheries and ecotourism, this alternative would have a positive effect, based on the overlap analysis, with its assumptions and limitations (Section 4.1.2.3; Appendix VII). If MWT fishing shifts to other times/areas remaining open, there may be negative impacts to the degree new overlaps result. If it is replaced by other gear types, negative outcomes for predator fisheries may result from overlap with these gears. Fishing within 12 nm in Areas 1B, 2 and 3 is most important to the herring MWT fishery during December and January (Figure 120, p. 421); however, user overlaps are likely to be highest in the late spring-fall.

The impacts on predator fisheries and ecotourism of Alternative 4 ***could potentially be low positive relative to Alternatives 2 and 8,*** as it may remove more overlap with the herring fishery and ***negative to neutral relative to Alternatives 3, and 5-7 (depending on the options),*** as it may remove less overlap with the herring fishery. Impacts would be ***neutral relative to Alternative 9;*** both adding a closure and removing the January-April Area 1B closure for the herring fishery would likely reduce user conflicts.

Area sub-option A (Areas 1B, 2 &3) and seasonal sub-option A (year-round). The impacts on predator fisheries and ecotourism of Alternative 4, area sub-option A, seasonal sub-option A are expected to be ***neutral relative to sub-option A/B and low positive relative to sub-options B/A and B/B***. Since 2007, there has been minimal to low degrees of overlap between the Atlantic herring MWT fishery and the commercial groundfish (15%), commercial bluefin tuna (5%), and commercial whale watch operators (11%) in this area year-round (Figure 75).

Area sub-option A (Areas 1B, 2 &3) and seasonal sub-option B (June-September). The impacts on predator fisheries and ecotourism of Alternative 4, area sub-option A, seasonal sub-option B are expected to be ***neutral relative to sub-options A/A and low positive relative to sub-option B/A and B/B.*** Since 2007, there has been low overlap between the Atlantic herring MWT fishery and the commercial groundfish (11%), commercial bluefin tuna (5%) and commercial whale watch operators (11%) during the months of June-September in the area under consideration (Figure 75). This degree of overlap is very similar to that of the year-round option (A/A). Many of the recreational users (recreational fishing and whale watching) are active during fair weather. Therefore, measures that reduce user conflicts in the summer and fall are likely to be nearly as effective as year-round measures.

<u>*Area sub-option B (Areas 1B &3) and seasonal sub-option A (year-round).*</u> The impacts on predator fisheries and ecotourism of Alternative 4, area sub-option B, seasonal sub-option A are expected to be ***neutral relative to sub-option B/B and low negative relative to sub-option A/A and A/B.*** Since 2007, there has been low degrees of overlap between the Atlantic herring MWT fishery and the commercial groundfish (7%), commercial bluefin tuna (4%), and commercial whale watch operators (11%) in this area year-round (Figure 75, p. 274).

<u>*Area sub-option B (Areas 1B &3) and seasonal sub-option B (June-September).*</u> The impacts on predator fisheries and ecotourism of Alternative 4, area sub-option B, seasonal sub-option B are expected to be ***neutral relative to sub-option B/A and low negative relative to sub-option A/A and A/B.*** Since 2007, there has been low overlap between the Atlantic herring MWT fishery and the commercial groundfish (7%), commercial bluefin tuna (4%) and commercial whale watch operators (11%) during the months of June-September in the area under consideration (Figure 75, p. 274). This degree of overlap is the same as that of the year-round option (B/A). Many of the recreational users (recreational fishing and whale watching) are active during fair weather. Therefore, measures that reduce user conflicts in the summer and fall are likely to be nearly as effective as year-round measures.

Impacts on communities

The impacts on fishing communities of Alternative 4 are expected to be ***negative to low positive relative to Alternative 1***. While the Atlantic herring, mackerel, and lobster fisheries may have negative to low negative impacts, impacts on other users may be low positive. To the degree that user conflicts are reduced, positive impacts among human communities are expected. General community impacts of area closures are described in Section 4.7.3.1.1 (p. 398). The VTR analysis results reported here have some degree of error (Section 4.1.2.2).

<u>*Herring communities*</u>. The herring fishing communities that could be impacted by Alternative 4 are primarily located in Maine, Massachusetts, and Rhode Island.

- <u>*Area sub-option A (Areas 1B, 2 &3) and seasonal sub-option A (year-round).*</u> It is estimated that the Atlantic herring MWT landings revenue from within 12 nm in Areas 1B, 2, and 3 year-round, from 2000-2006, was $2.7M/year, attributed to 33 permits (

- Table **122**). From greatest to least, most of the herring revenue was landed in Gloucester, New Bedford, Point Judith, North Kingstown, Providence, Portland, and 12 other ports in the Northeast U.S. From 2007-2015, there was an increase in average revenue, to $3.1M, attributed to about the same number of permits (34), but fewer ports (12), from herring MWT landings attributed to this area/season. Gloucester had the most revenue under the earlier time period, but New Bedford had the most revenue more recently. New Bedford, Fall River and ports in states south of Massachusetts became more active in MWT fishing in the recent time period. The named ports above are the top (non-confidential) herring ports most likely impacted by this option. Of these, Gloucester, New Bedford, Point Judith, N. Kingstown, and Portland are herring *Communities of Interest*, according to the criteria in Section 3.6.4.2.1 (p. 197). They have medium-high or high engagement in or reliance on the Atlantic herring fishery (Table 72), except for N. Kingstown which has medium and low rankings. The herring MWT revenue attributed to these states from this area/season during 2007-2015 ($3.1M/year) is about 13% of all herring revenue for these states during that time period ($23M/year). Certain individual permit holders could have much more of their revenue attributed to fishing from this area/time.
- *Area sub-option A (Areas 1B, 2 &3) and seasonal sub-option B (June-September).* It is estimated that the Atlantic herring MWT landings revenue from within 12 nm in Areas 1B, 2, and 3 June-September, from 2000-2006, was $31K/year, attributed to 11 permits (Table 123). From greatest to least, most of the revenue was from herring landed in Gloucester, Portland, and 7 other ports in the Northeast U.S. From 2007-2015, there was an increase in average revenue, to $312K, attributed to about the same number of permits (11), but fewer ports (5), from herring MWT landings attributed to this area/season. Gloucester had the most revenue under both time periods. Gloucester is the top (non-confidential) herring port likely impacted by this option, and is identified as a herring *Community of Interest*, according to the criteria in Section 3.6.4.2.1 (p. 197). It has medium-high or high engagement in or reliance on the Atlantic herring fishery (Table 72). The herring fishing communities that could be impacted by this option are primarily located in Maine and Massachusetts. The herring revenue attributed to these states from this area/season during 2007-2015 ($312K/year) is about 1% of all herring revenue for these states during that time period ($23M/year). Certain individual permit holders could have much more of their revenue attributed to fishing from this area/time.
- *Area sub-option B (Areas 1B &3) and seasonal sub-option A (year-round).* It is estimated that the Atlantic herring MWT landings revenue from within 12 nm in Areas 1B and 3 year-round, from 2000-2006, was $1.2M/year, attributed to 27 permits (Table 124). From greatest to least, most of the revenue was from herring landed in Gloucester, New Bedford, Portland, Point Judith, and 10 other ports in the Northeast U.S. From 2007-2015, average revenue remained constant, but was attributed to fewer permits (20) and ports (11), from herring MWT landings attributed to this area/season. Gloucester had the most revenue under both time periods. The named ports above are the top (non-confidential) herring ports most likely impacted by this option. They are all herring *Communities of Interest*, according to the criteria in Section 3.6.4.2.1 (p. 197). They have medium-high or high engagement in or reliance on the Atlantic herring fishery (Table 72). The herring fishing communities that could be impacted by Alternative 4, Area sub-option B, seasonal sub-option A are primarily located in Maine, Massachusetts, and Rhode Island. The herring MWT revenue attributed to these states from this area/season

during 2007-2015 ($1.2M/year) is about 5% of all herring revenue for these states during that time period ($23M/year). Certain individual permit holders could have much more of their revenue attributed to fishing from this area/time.

- *Area sub-option B (Areas 1B &3) and seasonal sub-option B (June-September).* It is estimated that the Atlantic herring MWT landings revenue from within 12 nm in Areas 1B and 3 June-September, from 2000-2006, was $24K/year, attributed to 11 permits (Table 125, p. 427). From greatest to least, most of the revenue was from herring landed in Gloucester, Portland, and 7 other ports in the Northeast U.S. From 2007-2015, there was an increase in average revenue, to $237K, attributed to about the same number of permits (10), but fewer ports (5), from herring MWT landings attributed to this area/season. Gloucester had the most revenue under both time periods. Gloucester and Portland are the top (non-confidential) herring ports most likely impacted by this option. They are herring *Communities of Interest*, according to the criteria in Section 3.6.4.2.1 (p. 197). They have medium-high or high engagement in or reliance on the Atlantic herring fishery (Table 72). The herring fishing communities that could be impacted by Alternative 4, Area sub-option B, seasonal sub-option B are primarily located in Maine and Massachusetts. The herring MWT revenue attributed to these states from this area/season during 2007-2015 ($1.2M/year) is about 5% of all herring revenue for these states during that time period ($23M/year). Certain individual permit holders could have much more of their revenue attributed to fishing from this area/time.

Communities of other users. Alternative 4 may impact other users of Atlantic herring and their associated communities, many of which coexist (with each other and with the herring fishery) within communities. From Massachusetts to New Jersey (states adjacent to Areas 1B, 2 and 3), 13 adjacent communities are particularly important to the mackerel fishery (Table 78; all adjacent to Area 2), though mackerel communities impacted by this alternative would likely mirror the herring communities. For the lobster fishery, 21 such communities have been identified (mostly adjacent to Areas 1B and 3), though herring as bait is distributed to the lobster fishery region-wide. Additionally, 71 adjacent communities are particularly important to the fisheries and ecotourism that rely on herring as a prey item in the ecosystem, though these users are from a broader region.

Table 122 – Atlantic herring revenue to states, regions, and top ports attributed to MWT fishing within 12 nm in Areas 1B, 2, and 3, year-round, 2000-2015

State/Port	2000-2006		2007-2015	
	Average revenue	Total permits[a]	Average revenue	Total permits[a]
Maine	$0.1M	9	$0.4M	7
Portland	$0.1M	7	$0.3M	6
New Hampshire	$0.0M	4	[b]	[b]
Massachusetts	$1.5M	24	$2.3M	23
Gloucester	$1.1M	19	$0.8M	9
New Bedford	$0.4M	11	$1.4M	21
Fall River	[b]	[b]	$0.5M	7
Rhode Island	$1.1M	19	$0.3M	9
Point Judith	$0.4M	10	$0.3M	6
North Kingstown	$0.3M	6	[b]	[b]
Providence	$0.3M	5	[b]	[b]
Other state(s)[b]	$0.0M	7	$0.1M	11
Total $ & permits	**$2.7M**	**33**	**$3.1M**	**34**
Total ports	**18**		**12**	

Notes: Ports listed are the top ten ports by landing revenue that are non-confidential.
[a] Totals may not equal the sum of the parts, because permits can land in multiple ports/states.
[b] Confidential *Source:* VTR analysis

Table 123 – Atlantic herring revenue to states, regions, and top ports attributed to MWT fishing within 12 nm in Areas 1B, 2, and 3, June-September, 2000-2015

State/Port	2000-2006		2007-2015	
	Average revenue	Total permits[a]	Average revenue	Total permits[a]
Maine	$12K	5	$103K	4
Portland	$9.7K	3	[b]	[b]
Massachusetts	$18K	6	$210K	7
Gloucester	$11K	4	$152K	5
Other state(s)[b]	$0.0K	2	[b]	[b]
Total $ & permits	**$31K**	**11**	**$312K**	**10**
Total ports	**9**		**5**	

Notes: Ports listed are the top ten ports by landing revenue that are non-confidential.
[a] Totals may not equal the sum of the parts, because permits can land in multiple ports/states.
[b] Confidential
Source: VTR analysis

Table 124 – Atlantic herring revenue to states, regions, and top ports attributed to MWT fishing within 12 nm in Areas 1B and 3, year-round, 2000-2015

State/Port	2000-2006		2007-2015	
	Average revenue	Total permits[a]	Average revenue	Total permits[a]
Maine	$0.1M	9	$0.3M	6
Portland	$0.1M	7	$0.3M	5
Massachusetts	$1.1M	21	$0.9M	17
Gloucester	$1.0M	19	$0.7M	9
New Bedford	$0.1M	6	$0.2M	12
Rhode Island	$0.0M	5	$0.0M	3
Point Judith	$0.0M	4	[b]	[b]
Other state(s)[b]	$0.0M	3	$0.0M	1
Total $ & permits	**$1.2M**	**27**	**$1.2M**	**20**
Total ports	**14**		**11**	

Notes: Ports listed are the top ten ports by landing revenue that are non-confidential.
[a] Totals may not equal the sum of the parts, because permits can land in multiple ports/states.
[b] Confidential
Source: VTR analysis

Table 125 – Atlantic herring revenue to states, regions, and top ports attributed to MWT fishing within 12 nm in Areas 1B and 3, June-September, 2000-2015

State/Port	2000-2006		2007-2015	
	Average revenue	Total permits[a]	Average revenue	Total permits[a]
Maine	$12K	5	$78K	5
Portland	$9K	3	$34K	3
Massachusetts	$12K	5	$159K	5
Gloucester	$11K	4	$148K	4
Other state(s)[b]	$0.2K	2	[b]	[b]
Total $ & permits	**$24K**	**11**	**$237K**	**10**
Total ports	**9**		**5**	

Notes: Ports listed are the top ten ports by landing revenue that are non-confidential.
[a] Totals may not equal the sum of the parts, because permits can land in multiple ports/states.
[b] Confidential
Source: VTR analysis

4.7.3.3 Alternative 5 (Prohibit MWT gear inside 25 nm south of Area 1A)

Under Alternative 5, waters within 25 nm south of Area 1A would be closed to midwater trawl gear, according to the area and seasonal options selected (Figure 6). Alternative 5 would be additive to No Action and not apply to RSA fishing.

Impacts on Atlantic herring fishery

The impacts on the Atlantic herring fishery of Alternative 5 are expected to be ***negative to low negative relative to Alternative 1, primarily impacting midwater trawl vessels*** and depending on the Alternative 5 options selected. With additional fishing restrictions inside 25 nm, it would become more difficult for the fishery to harvest the Area 1B sub-ACL. This sub-ACL is small, about 4,000 mt in recent years, and typically caught within 30-minute square 114 off the "back side of the Cape" in nearshore waters by MWT vessels. During 2008-2014, 54% of the 1B sub-ACL was caught by MWT, 9% by purse seines, and 37% by small mesh bottom trawls (Table 38 and Table 39, p. 151). Fishing may also be negatively impacted in Areas 3 and 2, making it more difficult to harvest the sub-ACLs. For Area 3, the majority of catch is from outside of 12 nm, but a portion is consistently caught within 12 nm, mostly off the "back side of the Cape." Fishing takes place closer to shore in Area 2 compared to Area 3, so this potential impact is greater in Area 2. In recent years, the fishery has not harvested the full sub-ACLs for Areas 2 and 3; implementing this measure could make it more difficult to do so.

Any fishery closure may hamper adaptability to changing conditions and may result in foregone revenue. It is difficult to determine if fishing would be precluded altogether or shift to other areas. To some degree, negative impacts would be mitigated by the ability of herring MWT vessels to fish in other management areas/seasons, particularly further offshore, which is more accessible to the MWT fleet than other gear types. However, there are several constrains to doing so (e.g., carrier limits, operational constraints, herring are migratory, increased costs of fishing offshore; Table 108, p. 400; Section 4.1.2.5).

Impacts for ***purse seine and SMBT vessels may be more neutral***, unless there is increased crowding from effort shifts. Given the regulatory restrictions on SMBTs, it is unlikely that this gear would expand substantially into Areas 1B and 3. Use of purse seines is unlikely on the "back side of the Cape" and offshore, as purse seining is difficult in strong tides, rough ocean conditions, and when herring occur in deep water. MWT vessels may shift to fishing outside of 25 nm within Area 1B and harvest some of the sub-ACL, but most fishing in Area 1B is currently inside of 25 nm.

Considering just the recent (2007-2015) revenue from the areas/seasons under consideration, and depending on the options selected, the impacts of Alternative 5 would be ***negative relative to Alternative 2, negative to neutral relative to Alternatives 3, 4, 7 and 8, neutral to positive relative to Alternative 6.*** Impacts would be ***negative relative to Alternative 9,*** as a new seasonal closure would likely be more negative than removing the January-April Area 1B closure.

<u>*Area sub-option A (Areas 1B, 2 &3) and seasonal sub-option A (year-round).*</u> The impacts on the Atlantic herring fishery of Alternative 5, area sub-option A, seasonal sub-option A are expected to be ***negative relative to all the other Alternative 5 sub-options, primarily impacting midwater trawl vessels***; it would result in the most times/areas closed. From 2000-2007, Atlantic herring landings attributed to MWT fishing inside 25 nm in Areas 1B, 2, and 3 were 21% of the annual herring MWT landings for these Areas (Table 119, p. 419). Since 2007, the 25 nm zone became more important, comprising 28% of the total. Atlantic herring and mackerel revenue attributed to MWT fishing in this area/season has been about $4.9-6.8M/year, 24-26% of the fishery-wide MWT revenue since 2000 (Table 120, p. 419). If midwater trawls can no longer fish inside 25 nm in Areas 1B, 2, and 3 year-round (except for RSA fishing), the Area 1B sub-ACL is not expected to be fully harvested, though Area 1B is a small fraction of the total sub-ACL. Given the *importance* of the area/season of this option to the MWT fishery in the past, this option *may impede* the ability to harvest optimum yield, unless the allowable catch is harvested with other gear types.

Area sub-option A (Areas 1B, 2 &3) and seasonal sub-option B (June-September). The impacts on the Atlantic herring fishery of Alternative 5, area sub-option A, seasonal sub-option B are expected to be ***low negative relative to sub-option B/B and low positive relative to sub-options A/A and B/A, primarily impacting midwater trawl vessels***. From 2000-2007, Atlantic herring landings attributed to MWT fishing inside 25 nm, June-September, in Areas 1B, 2, and 3 were 0.6% of the herring MWT landings for that season (or 0.3% of annual) for these Areas (Table 119, p. 419). Since 2007, the 25 nm zone became more important, comprising 5% of the seasonal total (or 2% of annual). Atlantic herring and mackerel revenue attributed to MWT fishing in this area/season has been about $52-400K/year, 0.7-6% of the fishery-wide MWT revenue since 2000 (Table 120, p. 419). If midwater trawls can no longer fish inside 25 nm in Areas 1B, 2, and 3 in June-September, the Area 1B sub-ACL still expected to be fully harvested. Given the *low importance* of the area/season of this option to the MWT fishery in the past, this option may *not impede* the ability to harvest optimum yield, particularly if the allowable catch is harvested with other gear types or if MWT effort shifts seasonally. Since at least 2007, the price of herring has been highest in July and August (Section 0, p. 154), so summertime closures may result in lower annual revenue for the fishery.

Area sub-option B (Areas 1B &3) and seasonal sub-option A (year-round). The impacts on the Atlantic herring fishery of Alternative 5, area sub-option B, seasonal sub-option A are expected to be ***low negative relative to sub-options A/B and B/B and low positive relative to sub-option A/A, primarily impacting midwater trawl vessels.*** From 2000-2007, Atlantic herring landings attributed to MWT fishing inside 25 nm year-round in Areas 1B and 3 were 10% of the annual herring MWT landings for Areas 1B, 2 and 3 (Table 119, p. 419). Since 2007, the percentage was 11%. Atlantic herring and mackerel revenue attributed to MWT fishing in this area/season has been about $1.6-1.8M/year, 6-9% of the fishery-wide MWT revenue since 2000 (Table 123, p. 419). If midwater trawls can no longer fish inside 25 nm in Areas 1B and 3 year-round (except for RSA fishing), the Area 1B sub-ACL is not expected to be fully harvested, though Area 1B is a small fraction of the total sub-ACL. Given the *importance* of this area/season of this option to the MWT fishery in the past, this option *may impede* the ability to harvest optimum yield, unless the allowable catch is harvested with other gear types.

Area sub-option B (Areas 1B &3) and seasonal sub-option B (June-September). The impacts on the Atlantic herring fishery of Alternative 5, area sub-option B, seasonal sub-option B are expected to be ***positive relative to all the other Alternative 5 sub-options, primarily impacting midwater trawl vessels;*** it would result in the least times and areas closed. From 2000-2007, Atlantic herring landings attributed to MWT fishing inside 25 nm, June-September, in Areas 1B and 3 were 0.6% of the herring MWT landings for that season for Areas 1B, 2 and 3 (or 0.2% of annual; Table 119, p. 419). Since 2007, the 25 nm zone became slightly more important, comprising 5% of the seasonal total (or 2% of annual). Atlantic herring and mackerel revenue attributed to MWT fishing in this area/season has been about $45-400K/year, 0.6-5% of the fishery-wide MWT revenue since 2000 (Table 120, p. 419). If midwater trawls can no longer fish inside 25 nm in Areas 1B and 3 in June-September, the Area 1B sub-ACL still expected to be fully harvested. Given the *low importance* of the area/season of this option to the MWT fishery in the past, this option may *not impede* the ability to harvest optimum yield, particularly if the allowable catch is harvested with other gear types, or if MWT effort shifts seasonally. Since at least 2007, the price of herring has been highest in July and August (Section 0, p. 154), so summertime closures may result in lower annual revenue for the fishery.

Impacts on Atlantic mackerel fishery

The impacts on the Atlantic mackerel fishery of Alternative 5 are expected to be ***negative to low negative relative to Alternative 1,*** depending on the Alternative 5 options selected. There would be more times and areas closed to the fishery, though it is difficult to determine if mackerel fishing would be precluded altogether or shift to other areas. Any fishery closure may hamper adaptability to changing conditions and may result in foregone revenue. Considering just the recent (2007-2015) revenue from the areas/seasons under consideration, and depending on the options selected, the impacts of Alternative 5 would be ***negative relative to Alternative 2, negative to neutral relative to Alternatives 3, 4, 7 and 8, and neutral to positive relative to Alternative 6.*** Impacts would be ***negative relative to Alternative 9,*** as a new seasonal closure would likely be more negative than removing the January-April Area 1B closure.

Area sub-option A (Areas 1B, 2 &3) and seasonal sub-option A (year-round). The impacts on the Atlantic mackerel fishery of Alternative 5, area sub-option A, seasonal sub-option A are expected to be ***negative relative to all the other Alternative 5 sub-options;*** it would result in the most times/areas closed. From 2000-2007, Atlantic mackerel landings attributed to fishing with midwater trawl year-round in areas inside 25 nm, south of Area 1A were 25% of the total for all areas by that gear type (Figure 120). Since then, the contribution has increased to 30%, though total mackerel landings declined by 77%. Atlantic herring and mackerel revenue attributed to MWT fishing in this area/season has been about $4.9-6.8M/year, 24-26% of the fishery-wide MWT revenue since 2000 (Table 120, p. 419).

Area sub-option A (Areas 1B, 2 &3) and seasonal sub-option B (June-September). The impacts on the Atlantic mackerel fishery of Alternative 5, area sub-option A, seasonal sub-option B are expected to be ***low negative relative to sub-option B/B and low positive relative to sub-options A/A and B/A.*** From 2000-2015, Atlantic mackerel landings attributed to fishing with midwater trawl in June-September in areas inside 25 nm, south of Area 1A were virtually zero, and was very small for all areas (Figure 120, p. 420). Atlantic herring and mackerel revenue attributed to MWT fishing in this area/season has been about $52-400K/year, 0.7-6% of the fishery-wide MWT revenue since 2000 (Table 120, p. 419).

Area sub-option B (Areas 1B &3) and seasonal sub-option A (year-round). The impacts on the Atlantic mackerel fishery of Alternative 5, area sub-option B, seasonal sub-option A are expected to be ***low negative relative to sub-options A/B and B/B and low positive relative to sub-option A/A.*** From 2000-2007, Atlantic mackerel landings attributed to fishing with midwater trawl inside 25 nm in Areas 1B and 3 were just 0.2% of the total for all areas by that gear type (Figure 120, p. 420). Atlantic herring and mackerel revenue attributed to MWT fishing in this area/season has been about $1.6-1.8M/year, 6-9% of the fishery-wide MWT revenue since 2000 (Table 123, p. 419).

Area sub-option B (Areas 1B &3) and seasonal sub-option B (June-September). The impacts on the Atlantic mackerel fishery of Alternative 5, area sub-option B, seasonal sub-option B are expected to be ***positive relative to all the other Alternative 5 sub-options, primarily impacting midwater trawl vessels;*** it would result in the least times and areas closed. From 2000-2015, Atlantic mackerel landings attributed to fishing with midwater trawl in June-September in areas inside 25 nm, in Areas 1B and 3 were virtually zero, and very small (<10 mt) for all areas (Figure 120, p. 420). Atlantic herring and mackerel revenue attributed to MWT fishing in this area/season has been about $45-400K/year, 0.6-5% of the fishery-wide MWT revenue since 2000 (Table 120, p. 419).

Impacts on American lobster fishery

The impacts on the American lobster fishery of Alternative 5 are expected to be ***negative to neutral relative to Alternative 1,*** depending on the Alternative 5 options selected. There would be more times and areas closed to the herring midwater trawl fishery, potentially impairing the bait market. As herring prices are generally insensitive to quantity changes, if this measure reduces herring landings, then the price of herring for bait could increase, potentially increasing costs for the lobster fishery. Considering just the recent (2007-2015) herring revenue from the areas/seasons under consideration, and depending on the options selected, the impacts of Alternative 5 would be ***negative relative to Alternative 2, negative to neutral relative to Alternatives 3, 4, 7 and 8, neutral to positive relative to Alternative 6,*** depending on if bait supply becomes more limited. Impacts would be ***negative relative to Alternative 9,*** as a new seasonal closure would likely be more negative than removing the January-April Area 1B closure, which may lower costs to the lobster fishery. ***Of the Alternative 5 sub-options, A/A would have the most negative impact and B/B would be least negative***.

Impacts on predator fisheries and ecotourism

The impacts on predator fisheries and ecotourism of Alternative 5 are expected to be ***uncertain, but potentially low positive relative to Alternative 1***. Assuming that removing overlap between the midwater trawl Atlantic herring and predator fisheries and ecotourism is a positive outcome for the predator fisheries and ecotourism, this alternative would have a positive effect, based on the overlap analysis, with its assumptions and limitations (Section 4.1.2.3; Appendix VII). If MWT fishing shifts to other times/areas remaining open, there may be negative impacts to the degree new overlaps result. If it is replaced by other gear types, negative outcomes for predator fisheries may result from overlap with these gears. Fishing within 25 nm in Areas 1B, 2 and 3 is most important to the herring MWT fishery during December and January (Figure 120, p. 421). However, user overlaps are likely to be highest in the late spring-fall.

The impacts on predator fisheries and ecotourism of Alternative 5 ***could potentially be low positive relative to Alternatives 2, 4, 7 and 8,*** as it may remove more overlap with the herring fishery and ***negative to neutral relative to Alternatives 3, 6 and (depending on the options),*** as it may remove less overlap with the herring fishery. Impacts would be ***neutral relative to Alternative 9;*** both adding a closure and removing the January-April Area 1B closure for the herring fishery would likely reduce user conflicts.

<u>*Area sub-option A (Areas 1B, 2 &3) and seasonal sub-option A (year-round).*</u> The impacts on predator fisheries and ecotourism of Alternative 5, area sub-option A, seasonal sub-option A are expected to be ***neutral relative to sub-option A/B and low positive relative to sub-options B/A and B/B***. Since 2007, there has been low to moderate degrees of overlap between the Atlantic herring MWT fishery and the commercial groundfish (27%), commercial bluefin tuna (9%), and commercial whale watch operators (11%) in this area year-round (Figure 75, p. 274).

<u>*Area sub-option A (Areas 1B, 2 &3) and seasonal sub-option B (June-September).*</u> The impacts on predator fisheries and ecotourism of Alternative 5, area sub-option A, seasonal sub-option B are expected to be ***neutral relative to sub-options A/A and low positive relative to sub-option B/A and B/B.*** Since 2007, there has been low to moderate overlap between the Atlantic herring

MWT fishery and the commercial groundfish (20%), commercial bluefin tuna (8%) and commercial whale watch operators (11%) during the months of June-September in the area under consideration (Figure 75). This degree of overlap is very similar to that of the year-round option (A/A). Many of the recreational users (recreational fishing and whale watching) are active during fair weather. Therefore, measures that reduce user conflicts in the summer and fall are likely to be nearly as effective as year-round measures.

<u>*Area sub-option B (Areas 1B &3) and seasonal sub-option A (year-round).*</u> The impacts on predator fisheries and ecotourism of Alternative 5, area sub-option B, seasonal sub-option A are expected to be ***neutral relative to sub-option B/B and low negative relative to sub-option A/A and A/B.*** Since 2007, there has been low to moderate degrees of overlap between the Atlantic herring MWT fishery and the commercial groundfish (11%), commercial bluefin tuna (7%), and commercial whale watch operators (11%) in this area year-round (Figure 75, p. 274).

<u>*Area sub-option B (Areas 1B &3) and seasonal sub-option B (June-September).*</u> The impacts on predator fisheries and ecotourism of Alternative 5, area sub-option B, seasonal sub-option B are expected to be ***neutral relative to sub-option B/A and low negative relative to sub-option A/A and A/B.*** Since 2007, there has been low overlap between the Atlantic herring MWT fishery and the commercial groundfish (11%), commercial bluefin tuna (7%) and commercial whale watch operators (11%) during the months of June-September in the area under consideration (Figure 75, p. 274). This degree of overlap is the same as that of the year-round option (B/A). Many of the recreational users (recreational fishing and whale watching) are active during fair weather. Therefore, measures that reduce user conflicts in the summer and fall are likely to be nearly as effective as year-round measures.

Impacts on communities

The impacts on fishing communities of Alternative 5 are expected to be ***negative to low positive relative to Alternative 1***. While the Atlantic herring, mackerel, and lobster fisheries may have negative to low negative impacts, impacts on other users may be low positive. To the degree that user conflicts are reduced, positive impacts among human communities are expected. General community impacts of area closures are described in Section 4.7.3.1.1. The VTR analysis results reported here have some degree of error (Section 4.1.2.2).

<u>*Herring communities*</u>. The herring fishing communities that could be impacted by Alternative 5 are primarily located in Maine, Massachusetts, and Rhode Island.

- <u>*Area sub-option A (Areas 1B, 2 &3) and seasonal sub-option A (year-round)*</u>. It is estimated that the Atlantic herring MWT landings revenue from within 25 nm in Areas 1B, 2, and 3 year-round, from 2000-2006, was \$3.8M/year, attributed to 34 permits (Table 126). From greatest to least, most of the revenue was from herring landed in Gloucester, New Bedford, North Kingstown, Point Judith, Providence, Portland, and 13 other ports in the Northeast U.S. From 2007-2015, there was an increase in average revenue, to \$5.4M, attributed to the same number of permits (34), but fewer ports (14), from herring MWT landings attributed to this area/season. Gloucester had the most revenue under the earlier time period, but New Bedford had the most revenue more recently. New Bedford, Fall River and ports in states south of Massachusetts became more active in MWT fishing in the recent time period. The named ports above are the top (non-confidential) herring ports most likely impacted by this option. Of these, Gloucester, New Bedford, Point Judith, N. Kingstown, and Portland are herring *Communities of*

Interest, according to the criteria in Section 3.6.4.2.1 (p. 197). They have medium-high or high engagement in or reliance on the Atlantic herring fishery, except for N. Kingstown which has medium and low rankings (Table 72). The herring fishing communities that could be impacted by this option are primarily located in Maine, Massachusetts, and Rhode Island. The herring MWT revenue attributed to these states from this area/season during 2007-2015 ($5.4M) is about 23% of all herring revenue for these states during that time period ($23M). Certain individual permit holders could have much more of their revenue attributed to fishing from this area/time.

- *Area sub-option A (Areas 1B, 2 &3) and seasonal sub-option B (June-September).* It is estimated that the Atlantic herring MWT landings revenue from within 25 nm in Areas 1B, 2, and 3 June-September, from 2000-2006, was $55K/year, attributed to 18 permits (Table 127, p. 435). From greatest to least, most of the revenue was from herring landed in Gloucester, Portland, and 9 other ports in the Northeast U.S. From 2007-2015, there was an increase in average revenue, to $366K, attributed to fewer permits (15) and ports (7), from herring MWT landings attributed to this area/season. Gloucester had the most revenue under both time periods. Gloucester, Portland and New Bedford are the top (non-confidential) herring ports likely impacted by this option, and are herring *Communities of Interest*, according to the criteria in Section 3.6.4.2.1 (p. 197). They have medium-high or high engagement in or reliance on the Atlantic herring fishery (Table 72). The herring fishing communities that could be impacted by this option are primarily located in Maine and Massachusetts. The herring revenue attributed to these states from this area/season during 2007-2015 ($266K/year) is about 1% of all herring revenue for these states during that time period ($21M). Certain individual permit holders could have much more of their revenue attributed to fishing from this area/time.
- *Area sub-option B (Areas 1B &3) and seasonal sub-option A (year-round).* It is estimated that the Atlantic herring MWT landings revenue from within 25 nm in Areas 1B and 3 year-round, from 2000-2006, was $1.6M/year, attributed to 31 permits (Table 122). From greatest to least, most of the revenue was from herring landed in Gloucester, New Bedford, Portland, Point Judith, and 12 other ports in the Northeast U.S. From 2007-2015, average revenue increased slightly ($1.7M), but was attributed to fewer permits (21) and ports (13), from herring MWT landings attributed to this area/season. Gloucester had the most revenue under both time periods. The named ports above are the top (non-confidential) herring ports most likely impacted by this option. They are all identified as herring *Communities of Interest,* according to the criteria in Section 3.6.4.2.1 (p. 197). They have medium-high or high engagement in or reliance on the Atlantic herring fishery (Table 72). The herring fishing communities that could be impacted by this option are primarily located in Maine, Massachusetts, and Rhode Island. The herring MWT revenue attributed to these states from this area/season during 2007-2015 ($1.7M/year) is about 7% of all herring revenue for these states during that time period ($23M/year). Certain individual permit holders could have much more of their revenue attributed to fishing from this area/time.
- *Area sub-option B (Areas 1B &3) and seasonal sub-option B (June-September).* It is estimated that the Atlantic herring MWT landings revenue from within 25 nm in Areas 1B and 3 June-September, from 2000-2006, was $48K/year, attributed to 18 permits (Table 129). From greatest to least, most of the revenue was from herring landed in Gloucester, Portland, and 9 other ports in the Northeast U.S. From 2007-2015, there was

an increase in average revenue, to $360K, attributed to fewer permits (15) and fewer ports (7), from herring MWT landings attributed to this area/season. Gloucester had the most revenue under both time periods. Gloucester, Portland, and New Bedford are the top (non-confidential) herring ports most likely impacted by this option. They are herring *Communities of Interest*, according to the criteria in Section 3.6.4.2.1 (p. 197). They have medium-high or high engagement in or reliance on the Atlantic herring fishery (Table 72). The herring fishing communities that could be impacted by this option are primarily located in Maine and Massachusetts. The herring MWT revenue attributed to these states from this area/season during 2007-2015 ($360K/year) is about 2% of all herring revenue for these states during that time period ($21M). Certain individual permit holders could have much more of their revenue attributed to fishing from this area/time.

Communities of other users. Alternative 5 may impact other users of Atlantic herring and their associated communities, many of which coexist (with each other and with the herring fishery) within communities. From Massachusetts to New Jersey (states adjacent to Areas 1B, 2 and 3), 13 adjacent communities are particularly important to the mackerel fishery (Table 78, p. 206; all adjacent to Area 2), though mackerel communities impacted by this alternative would likely mirror the herring communities. For the lobster fishery, 21 such communities have been identified (mostly adjacent to Areas 1B and 3), though herring as bait is distributed to the lobster fishery region-wide. Additionally, 71 adjacent communities are particularly important to the fisheries and ecotourism that rely on herring as a prey item in the ecosystem, though these users are from a broader region.

Table 126 – Atlantic herring revenue to states, regions, and top ports attributed to MWT fishing within 25 nm in Areas 1B, 2, and 3, year-round, 2000-2015

State/Port	2000-2006		2007-2015	
	Average revenue	Total permits[a]	Average revenue	Total permits[a]
Maine	$0.2M	10	$0.7M	11
Portland	$0.1M	8	$0.5M	10
New Hampshire	$0.1M	6	[b]	[b]
Massachusetts	$1.9M	26	$4.1M	23
Gloucester	$1.3M	21	$1.5M	10
New Bedford	$0.6M	11	$2.5M	21
Fall River	$0.0M	5	$0.1M	8
Rhode Island	$1.6M	19	$0.4M	9
North Kingstown	$0.6M	6	[b]	[b]
Point Judith	$0.5M	10	$0.4M	6
Providence	$0.4M	5	[b]	[b]
Other state(s)[b]	$0.1M	7	$0.2M	12
Total $ & permits	**$3.8M**	**34**	**$5.4M**	**34**
Total ports	**19**		**14**	

Notes: Ports listed are the top ten ports by landing revenue that are non-confidential.
[a] Totals may not equal the sum of the parts, because permits can land in multiple ports/states.
[b] Confidential
Source: VTR analysis

Table 127 – Atlantic herring revenue to states, regions, and top ports attributed to MWT fishing within 25 nm in Areas 1B, 2, and 3, June-September, 2000-2015

State/Port	2000-2006		2007-2015	
	Average revenue	Total permits[a]	Average revenue	Total permits[a]
Maine	$18K	6	$107K	8
Portland	$13K	4	$47K	5
Massachusetts	$36K	11	$260K	11
Gloucester	$25K	8	$243K	6
New Bedford	[b]	[b]	$17K	7
Other state(s)[b]	$1K	6	[b]	[b]
Total $ & permits	**$55K**	**18**	**$366K**	**15**
Total ports	**11**		**7**	

Notes: Ports listed are the top ten ports by landing revenue that are non-confidential.
[a] Totals may not equal the sum of the parts, because permits can land in multiple ports/states.
[b] Confidential
Source: VTR analysis

Table 128 – Atlantic herring revenue to states, regions, and top ports attributed to MWT fishing within 25 nm in Areas 1B and 3, year-round, 2000-2015

State/Port	2000-2006		2007-2015	
	Average revenue	Total permits[a]	Average revenue	Total permits[a]
Maine	$0.2M	10	$0.5M	10
Portland	$0.1M	8	$0.3M	9
Rockland	$0.0M	3	[b]	[b]
New Hampshire	$0.0M	4	[b]	[b]
Massachusetts	$1.4M	24	$1.2M	18
Gloucester	$1.2M	21	$0.9M	10
New Bedford	$0.1M	6	$0.3M	12
Rhode Island	$0.1M	8	$0.0M	3
Point Judith	$0.0M	4	[b]	[b]
Other state(s)[b]	$0.0M	1	$0.0M	2
Total $ & permits	**$1.6M**	**31**	**$1.7M**	**21**
Total ports	**16**		**13**	

Notes: Ports listed are the top ten ports by landing revenue that are non-confidential.
[a] Totals may not equal the sum of the parts, because permits can land in multiple ports/states.
[b] Confidential
Source: VTR analysis

Table 129 – Atlantic herring revenue to states, regions, and top ports attributed to MWT fishing within 25 nm in Areas 1B and 3, June-September, 2000-2015

State/Port	2000-2006		2007-2015	
	Average revenue	Total permits[a]	Average revenue	Total permits[a]
Maine	$18K	6	$104K	8
Portland	$13K	4	$46K	5
Massachusetts	$29K	10	$256K	11
Gloucester	$25K	8	$239K	6
New Bedford	[b]	[b]	$16K	7
Other state(s)[b]	$1K	6	[b]	[b]
Total $ & permits	**$48K**	**18**	**$360K**	**15**
Total ports	**11**		**7**	

Notes: Ports listed are the top ten ports by landing revenue that are non-confidential.
[a] Totals may not equal the sum of the parts, because permits can land in multiple ports/states.
[b] Confidential
Source: VTR analysis

4.7.3.4 Alternative 6 (Prohibit MWT gear inside 50 nm south of Area 1A)

Under Alternative 6, waters within 50 nm south of Area 1A would be closed to midwater trawl gear, according to the area and seasonal options selected (Figure 6). Alternative 6 would be additive to No Action and not apply to RSA fishing.

Impacts on Atlantic herring fishery

The impacts on the Atlantic herring fishery of Alternative 6 are expected to be ***negative relative to Alternative 1, primarily impacting midwater trawl vessels***. With additional fishing restrictions inside 50 nm, it would become more difficult for the fishery to harvest the Area 1B sub-ACL. This sub-ACL is small, about 4,000 mt in recent years, and typically caught within 30-minute square 114 off the "back side of the Cape" in nearshore waters by MWT vessels. During 2008-2014, 54% of the 1B sub-ACL was caught by MWT, 9% by purse seines, and 37% by small mesh bottom trawls (Table 38 and Table 39, p. 151). Fishing may also be negatively impacted in Areas 3 and 2, making it more difficult to harvest the sub-ACLs. For Area 3, the majority of catch is from outside of 12 nm, but a portion is consistently caught within 12 nm, mostly off the "back side of the Cape." Fishing takes place closer to shore in Area 2 compared to Area 3, so this potential impact is greater in Area 2. In recent years, the fishery has not harvested the full sub-ACLs for Areas 2 and 3; implementing this measure could make it more difficult to do so.

Any fishery closure may hamper adaptability to changing conditions and may result in foregone revenue. It is difficult to determine if fishing would be precluded altogether or shift to other areas. To some degree, negative impacts would be mitigated by the ability of herring MWT vessels to fish in other management areas/seasons, particularly further offshore, which is more accessible to the MWT fleet than other gear types. However, there are several constrains to doing so (e.g., carrier limits, operational constraints, herring are migratory, increased costs of fishing offshore; Table 108, p. 400; Section 4.1.2.5).

Impacts for ***purse seine and SMBT vessels may be more neutral***, unless there is increased crowding from effort shifts. Given the regulatory restrictions on SMBTs, it is unlikely that this gear would expand substantially into Areas 1B and 3. Use of purse seines is unlikely on the "back side of the Cape" and offshore, as purse seining is difficult in strong tides, rough ocean conditions, and when herring occur in deep water. MWT vessels may shift to fishing outside of 50 nm within Area 1B and harvest some of the sub-ACL, but most fishing in Area 1B is currently inside of 50 nm.

Considering just the recent (2007-2015) revenue from the areas/seasons under consideration, and depending on the options selected, the impacts of Alternative 6 would be ***negative relative to Alternatives 2 and 8, and negative to neutral relative to Alternatives 3, 4, 5 and 7.*** Impacts would be ***negative relative to Alternative 9,*** as a new seasonal closure would likely be more negative than removing the January-April Area 1B closure.

Area sub-option A (Areas 1B, 2 &3) and seasonal sub-option A (year-round). The impacts on the Atlantic herring fishery of Alternative 6, area sub-option A, seasonal sub-option A are expected to be ***negative relative to all the other Alternative 6 sub-options, primarily impacting midwater trawl vessels***; it would result in the most times/areas closed. From 2000-2007, Atlantic herring landings attributed to MWT fishing inside 50 nm in Areas 1B, 2, and 3 were 30% of the annual herring MWT landings for these Areas (Table 119, p. 419). Since 2007, the 50 nm zone became more important, comprising 42% of the total. Atlantic herring and mackerel revenue attributed to MWT fishing in this area/season has been about $8-13M/year, 43-45% of the fishery-wide MWT revenue since 2000 (Table 120, p. 419). If midwater trawls can no longer fish inside 25 nm in Areas 1B, 2, and 3 year-round (except for RSA fishing), the Area 1B sub-ACL is not expected to be fully harvested, though Area 1B is a small fraction of the total sub-ACL. Given the *importance* of the area/season of this option to the MWT fishery in the past, this option *may impede* the ability to harvest optimum yield, unless the allowable catch is harvested with other gear types.

Area sub-option A (Areas 1B, 2 &3) and seasonal sub-option B (June-September). The impacts on the Atlantic herring fishery of Alternative 6, area sub-option A, seasonal sub-option B are expected to be ***low negative relative to sub-option B/B and low positive relative to sub-options A/A and B/A, primarily impacting midwater trawl vessels***. From 2000-2007, Atlantic herring landings attributed to MWT fishing inside 50 nm, June-September, in Areas 1B, 2, and 3 were 6% of the herring MWT landings for that season (or 3% of annual) for these Areas (Table 119, p. 419). Since 2007, the 50 nm zone became more important, comprising 20% of the seasonal total (or 7% of annual). Atlantic herring and mackerel revenue attributed to MWT fishing in this area/season has been about $0.5-1.3M/year, 6-19% of the fishery-wide MWT revenue since 2007 (Table 120, p. 419). If midwater trawls can no longer fish inside 25 nm in Areas 1B, 2, and 3 year-round (except for RSA fishing), the Area 1B sub-ACL is not expected to be fully harvested, though Area 1B is a small fraction of the total sub-ACL. Given the *importance* of the area/season of this option to the MWT fishery in the past, this option *may impede* the ability to harvest optimum yield, unless the allowable catch is fished with other gear types, or if MWT effort shifts seasonally. Since at least 2007, the price of herring has been highest in July and August (Section 3.6.1.7, p. 154), so summertime closures may result in lower annual revenue for the fishery.

Area sub-option B (Areas 1B &3) and seasonal sub-option A (year-round). The impacts on the Atlantic herring fishery of Alternative 6, area sub-option B, seasonal sub-option A are expected to be ***low negative relative to sub-options A/B and B/B and low positive relative to sub-option A/A, primarily impacting midwater trawl vessels.*** From 2000-2007, Atlantic herring landings attributed to MWT fishing inside 50 nm year-round in Areas 1B and 3 were 14% of the annual herring MWT landings for Areas 1B, 2 and 3 (Table 119, p. 419). Since 2007, the percentage increased to 18%. Atlantic herring and mackerel revenue attributed to MWT fishing in this area/season has been about $2.6-2.9M/year, 9-16% of the fishery-wide MWT revenue since 2000 (Table 120, p. 419). If midwater trawls can no longer fish inside 50 nm in Areas 1B and 3 year-round (except for RSA fishing), the Area 1B sub-ACL is not expected to be fully harvested, though Area 1B is a small fraction of the total sub-ACL. Given the *importance* of the area/season of this option to the MWT fishery in the past, this option *may impede* the ability to harvest optimum yield, unless the allowable catch is fished with other gear types.

Area sub-option B (Areas 1B &3) and seasonal sub-option B (June-September). The impacts on the Atlantic herring fishery of Alternative 6, area sub-option B, seasonal sub-option B are expected to be ***positive relative to all the other Alternative 6 sub-options, primarily impacting midwater trawl vessels;*** it would result in the least times and areas closed. From 2000-2007, Atlantic herring landings attributed to MWT fishing inside 50 nm, June-September, in Areas 1B and 3 were 6% of the herring MWT landings for that season for Areas 1B, 2 and 3 (or 3% of annual; Table 119, p. 419). Since 2007, the 50 nm zone became more important, comprising 20% of the seasonal total (or 7% of annual). Atlantic herring and mackerel revenue attributed to MWT fishing in this area/season has been about $0.4-1.3M/year, 5-16% of the fishery-wide MWT revenue since 2000 (Table 120, p. 419). If midwater trawls can no longer fish inside 50 nm in Areas 1B 3 in June-September, the Area 1B sub-ACL is not expected to be fully harvested, though Area 1B is a small fraction of the total sub-ACL. Given the *importance* of the area/season of this option to the MWT fishery in the past, this option *may impede* the ability to harvest optimum yield, unless the allowable catch is fished with other gear types, or if MWT effort shifts seasonally. Since at least 2007, the price of herring has been highest in July and August (Section 3.6.1.7, p. 154), so summertime closures may result in lower annual revenue for the fishery.

Impacts on Atlantic mackerel fishery

The impacts on the Atlantic mackerel fishery of Alternative 6 are expected to be ***negative to low negative relative to Alternative 1,*** depending on the Alternative 6 options selected. There would be more times and areas closed to the fishery, though it is difficult to determine if mackerel fishing would be precluded altogether or shift to other areas. Any fishery closure may hamper adaptability to changing conditions and may result in foregone revenue. Considering just the recent (2007-2015) revenue from the areas/seasons under consideration, and depending on the options selected, the impacts of Alternative 6 would be ***negative relative to Alternative 2 and 8, and negative to neutral relative to Alternatives 3-5, and 7.*** Impacts would be ***negative relative to Alternative 9,*** as a new seasonal closure would likely be more negative than removing the January-April Area 1B closure.

Area sub-option A (Areas 1B, 2 &3) and seasonal sub-option A (year-round). The impacts on the Atlantic mackerel fishery of Alternative 6, area sub-option A, seasonal sub-option A are expected to be ***negative relative to all the other Alternative 6 sub-options;*** it would result in the most times/areas closed. From 2000-2007, Atlantic mackerel landings attributed to fishing with midwater trawl year-round in areas inside 50 nm, south of Area 1A were 71% of the total for all areas by that gear type (Figure 120, p. 420). Since then, the contribution has decreased slightly to 69%, though total mackerel landings declined by 77%. Atlantic herring and mackerel revenue attributed to MWT fishing in this area/season has been about $8-13M/year, 43-45% of the fishery-wide MWT revenue since 2000 (Table 120, p. 419).

Area sub-option A (Areas 1B, 2 &3) and seasonal sub-option B (June-September). The impacts on the Atlantic mackerel fishery of Alternative 6, area sub-option A, seasonal sub-option B are expected to be ***low negative relative to sub-option B/B and low positive relative to sub-options A/A and B/A.*** From 2000-2015, Atlantic mackerel landings attributed to fishing with midwater trawl in June-September in areas inside 50 nm, south of Area 1A were virtually zero, and was very small for all areas (Figure 120, p. 420). Atlantic herring and mackerel revenue attributed to MWT fishing in this area/season has been about $0.5-1.3M/year, 6-19% of the fishery-wide MWT revenue since 2007 (Table 120, p. 419).

Area sub-option B (Areas 1B &3) and seasonal sub-option A (year-round). The impacts on the Atlantic mackerel fishery of Alternative 6, area sub-option B, seasonal sub-option A are expected to be ***low negative relative to sub-options A/B and B/B and low positive relative to sub-option A/A.*** From 2000-2007, Atlantic mackerel landings attributed to fishing with midwater trawl inside 50 nm in Areas 1B and 3 were just 0.5% of the total for all areas by that gear type (Figure 120, p. 420). Atlantic herring and mackerel revenue attributed to MWT fishing in this area/season has been about $2.6-2.9M/year, 9-16% of the fishery-wide MWT revenue since 2000 (Table 120, p. 419).

Area sub-option B (Areas 1B &3) and seasonal sub-option B (June-September). The impacts on the Atlantic mackerel fishery of Alternative 6, area sub-option B, seasonal sub-option B are expected to be ***positive relative to all the other Alternative 6 sub-options, primarily impacting midwater trawl vessels;*** it would result in the least times and areas closed. From 2000-2015, Atlantic mackerel landings attributed to fishing with midwater trawl in June-September in areas inside 50 nm, in Areas 1B and 3 were virtually zero, and very small (<10 mt) for all areas (Figure 120, p. 420). Atlantic herring and mackerel revenue attributed to MWT fishing in this area/season has been about $0.4-1.3M/year, 5-16% of the fishery-wide MWT revenue since 2000 (Table 120, p. 419).

Impacts on American lobster fishery

The impacts on the American lobster fishery of Alternative 6 are expected to be ***negative relative to Alternative 1***. Given the importance of this area and season to the herring midwater trawl fishery in the past, this alternative may impede the ability to harvest Atlantic herring optimum yield (unless another gear type expands into this area/season), potentially impairing the bait market. As herring prices are generally insensitive to quantity changes, if this measure reduces herring landings, then the price of herring for bait could increase, potentially increasing costs for the lobster fishery.

Considering just the recent (2007-2015) herring revenue from the areas/seasons under consideration, and depending on the options selected, the impacts of Alternative 6 would be ***negative relative to Alternative 2 and 8, negative to neutral relative to Alternatives 3-5, and 7,*** depending on if bait supply becomes more limited***.*** Impacts would be ***negative relative to Alternative 9,*** as a new seasonal closure would likely be more negative than removing the January-April Area 1B closure, which may lower costs to the lobster fishery. ***Of the Alternative 6 sub-options, A/A would have the most negative impact and B/B would be least negative***.

Impacts on predator fisheries and ecotourism

The impacts on predator fisheries and ecotourism of Alternative 6 are expected to be ***uncertain, but potentially low positive relative to Alternative 1***. Assuming that removing overlap between the midwater trawl Atlantic herring and predator fisheries and ecotourism is a positive outcome for the predator fisheries and ecotourism, this alternative would have a positive effect, based on the overlap analysis, with its assumptions and limitations (Section 4.1.2.3; Appendix VII). If MWT fishing shifts to other times/areas remaining open, there may be negative impacts to the degree new overlaps result. If it is replaced by other gear types, negative outcomes for predator fisheries may result from overlap with these gears. Fishing within 50 nm in Areas 1B, 2 and 3 is most important to the herring MWT fishery during December and January (Figure 120, p. 421). However, user overlaps are likely to be highest in the late spring-fall.

The impacts on predator fisheries and ecotourism of Alternative 6 ***could potentially be low positive relative to Alternatives 2, 4, 5, and 8*** as it may remove more overlap with the herring fishery and ***neutral to negative relative to Alternatives 3 (depending on the options),*** as it may remove less overlap with the herring fishery. Impacts would be ***neutral relative to Alternative 9;*** both adding a closure and removing the January-April Area 1B closure for the herring fishery would likely reduce user conflicts.

<u>*Area sub-option A (Areas 1B, 2 &3) and seasonal sub-option A (year-round).*</u> The impacts on predator fisheries and ecotourism of Alternative 6, area sub-option A, seasonal sub-option A are expected to be ***neutral relative to sub-option A/B and low positive relative to sub-options B/A and B/B***. Since 2007, there has been moderate degrees of overlap between the Atlantic herring MWT fishery and the commercial groundfish (39%), commercial bluefin tuna (17%), and commercial whale watch operators (11%) in this area/season (Figure 75).

<u>*Area sub-option A (Areas 1B, 2 &3) and seasonal sub-option B (June-September).*</u> The impacts on predator fisheries and ecotourism of Alternative 6, area sub-option A, seasonal sub-option B are expected to be ***neutral relative to sub-options A/A and low positive relative to sub-option B/A and B/B.*** Since 2007, there has been low to moderate overlap between the Atlantic herring MWT fishery and the commercial groundfish (31%), commercial bluefin tuna (17%) and commercial whale watch operators (11%) during the months of June-September in the area under consideration (Figure 75). This degree of overlap is the same as that of the year-round option (A/A). Many of the recreational users (recreational fishing and whale watching) are active during fair weather. Therefore, measures that reduce user conflicts in the summer and fall are likely to be nearly as effective as year-round measures.

<u>*Area sub-option B (Areas 1B &3) and seasonal sub-option A (year-round).*</u> The impacts on predator fisheries and ecotourism of Alternative 6, area sub-option B, seasonal sub-option A are expected to be ***neutral relative to sub-option B/B and low negative relative to sub-option A/A and A/B.*** Since 2007, there has been low degrees of overlap between the Atlantic herring MWT fishery and the commercial groundfish (17%), commercial bluefin tuna (13%), and commercial whale watch operators (11%) in this area/season (Figure 75, p. 274).

<u>*Area sub-option B (Areas 1B &3) and seasonal sub-option B (June-September).*</u> The impacts on predator fisheries and ecotourism of Alternative 6, area sub-option B, seasonal sub-option B are expected to be ***neutral relative to sub-option B/A and low negative relative to sub-option A/A and A/B.*** Since 2007, there has been low overlap between the Atlantic herring MWT fishery and the commercial groundfish (17%), commercial bluefin tuna (13%) and commercial whale watch operators (11%) during the months of June-September in the area under consideration (Figure 75, p. 274). This degree of overlap is the same as that of the year-round option (B/A). Many of the recreational users (recreational fishing and whale watching) are active during fair weather.

Therefore, measures that reduce user conflicts in the summer and fall are likely to be nearly as effective as year-round measures.

Impacts on communities

The impacts on fishing communities of Alternative 6 are expected to be ***negative to low positive relative to Alternative 1***. While the Atlantic herring, mackerel, and lobster fisheries may have negative impacts, impacts on other users may be low positive. To the degree that user conflicts are reduced, positive impacts among human communities are expected. General community impacts of area closures are described in Section 4.7.3.1.1 (p. 398). The VTR analysis results reported here have some degree of error (Section 4.1.2.2).

Herring communities. The herring fishing communities that could be impacted by Alternative 6 are primarily located in Maine, Massachusetts, and Rhode Island.

- *Area sub-option A (Areas 1B, 2 &3) and seasonal sub-option A (year-round)*. It is estimated that the Atlantic herring MWT landings revenue from within 50 nm in Areas 1B, 2, and 3 year-round, from 2000-2006, was $5.2M/year, attributed to 40 permits (Table 130). From greatest to least, most of the revenue was from herring landed in Gloucester, New Bedford, North Kingstown, Point Judith, Providence, Portland, Fall River and 19 other ports in the Northeast U.S. From 2007-2015, there was an increase in average revenue, to $6.5M, attributed to fewer permits (35) and ports (17), from herring MWT landings attributed to this area/season. Gloucester had the most revenue under the earlier time period, but New Bedford had the most revenue more recently. New Bedford, Fall River and ports in states south of Massachusetts became more active in MWT fishing in the recent time period. The named ports above are the top (non-confidential) herring ports that would most likely be impacted by this alternative/option. Of these, Gloucester, New Bedford, Point Judith, N. Kingstown, and Portland are herring *Communities of Interest*, according to the criteria in Section 3.6.4.2.1 (p. 197). They have medium-high or high engagement in or reliance on the Atlantic herring fishery (Table 72), except for N. Kingstown which has medium and low rankings. The herring fishing communities that could be impacted by Alternative 6, Area sub-option A, seasonal sub-option A are primarily located in Maine, Massachusetts, and Rhode Island. The herring MWT revenue attributed to these states from this area/season during 2007-2015 ($6.5M/year) is about 28% of all herring revenue for these states during that time period ($23M/year). Certain individual permit holders could have much more of their revenue attributed to fishing from this area/time.
- *Area sub-option A (Areas 1B, 2 &3) and seasonal sub-option B (June-September)*. It is estimated that the Atlantic herring MWT landings revenue from within 50 nm in Areas 1B, 2, and 3 June-September, from 2000-2006, was $0.5M/year, attributed to 30 permits (Table 131). From greatest to least, most of the revenue was from herring landed in Gloucester, Portland, Rockland, Bath, Newington, Prospect Harbor and 14 other ports in the Northeast U.S. From 2007-2015, there was an increase in average revenue, to $1.3M, attributed to fewer permits (18) and ports (12), from herring MWT landings attributed to this area/season. Gloucester had the most revenue under both time periods. New Bedford and Jonesport were also active during the later time period. The named ports above are the top (non-confidential) herring ports most likely impacted by this alternative/option. Of these, Gloucester, Portland, Rockland, New Bedford, and Jonesport are herring *Communities of Interest*, according to the criteria in Section 3.6.4.2.1 (p. 197). They have

medium-high or high engagement in or reliance on the Atlantic herring fishery (Table 72). The herring fishing communities that could be impacted by this alternative/option are primarily located in Maine and Massachusetts. The herring revenue attributed to these states from this area/season during 2007-2015 ($1.3M/year) is about 6% of all herring revenue for these states during that time period ($21M/year). Certain individual permit holders could have much more of their revenue attributed to fishing from this area/time.

- *Area sub-option B (Areas 1B &3) and seasonal sub-option A (year-round).* It is estimated that the Atlantic herring MWT landings revenue from within 50 nm in Areas 1B and 3 year-round, from 2000-2006, was $2.3M/year, attributed to 37 permits (Table 132). From greatest to least, most of the revenue was from herring landed in Gloucester, Portland, New Bedford, Point Judith, Rockland, Bath, Newington, Prospect Harbor and 15 other ports in the Northeast U.S. From 2007-2015, average revenue increased to $3.0M, but was attributed to fewer permits (23) and ports (17), from herring MWT landings attributed to this area/season. Gloucester had the most revenue under both time periods. Jonesport was also active during the later time period. The named ports above are the top (non-confidential) herring ports most likely impacted by this alternative/option. Of these, Gloucester, Portland, New Bedford, Point Judith, Rockland, and Jonesport are herring *Communities of Interest*, according to the criteria in Section 3.6.4.2.1 (p. 197). They have medium-high or high engagement in or reliance on the Atlantic herring fishery (Table 72). The herring fishing communities that could be impacted by Alternative 6, Area sub-option B, seasonal sub-option A are primarily located in Maine and Massachusetts. The herring MWT revenue attributed to these states from this area/season during 2007-2015 ($3.0M/year) is about 14% of all herring revenue for these states during that time period ($21M/year). Certain individual permit holders could have much more of their revenue attributed to fishing from this area/time.
- *Area sub-option B (Areas 1B &3) and seasonal sub-option B (June-September).* It is estimated that the Atlantic herring MWT landings revenue from within 50 nm in Areas 1B and 3 June-September, from 2000-2006, was $$0.5M/year, attributed to 30 permits (Table 133). From greatest to least, most of the revenue was from herring landed in Gloucester, Portland, Rockland, Bath, Newington, Prospect Harbor and 14 other ports in the Northeast U.S. From 2007-2015, there was an increase in average revenue, to $1.3M, attributed to fewer permits (18) and ports (12), from herring MWT landings attributed to this area/season. Gloucester had the most revenue under both time periods. Jonesport was also active during the later time period. The named ports above are the top (non-confidential) herring ports most likely impacted by this alternative/option. Of these, Gloucester, Portland, New Bedford, Point Judith, Rockland, and Jonesport are herring *Communities of Interest*, according to the criteria in Section 3.6.4.2.1 (p. 197). They have medium-high or high engagement in or reliance on the Atlantic herring fishery (Table 72). The herring fishing communities that could be impacted by Alternative 6, Area sub-option B, seasonal sub-option B are primarily located in Maine and Massachusetts. The herring MWT revenue attributed to these states from this area/season during 2007-2015 ($1.3M/year) is about 6% of all herring revenue for these states during that time period ($21M/year). Certain individual permit holders could have much more of their revenue attributed to fishing from this area/time.

Communities of other users. Alternative 6 may impact other users of Atlantic herring and their associated communities, many of which coexist (with each other and with the herring fishery) within communities. From Massachusetts to New Jersey (states adjacent to Areas 1B, 2 and 3), 13 adjacent communities are particularly important to the mackerel fishery (Table 78, p. 206; all adjacent to Area 2), though mackerel communities impacted by this alternative would likely mirror the herring communities. For the lobster fishery, 21 such communities have been identified (mostly adjacent to Areas 1B and 3), though herring as bait is distributed to the lobster fishery region-wide. Additionally, 71 adjacent communities are particularly important to the fisheries and ecotourism that rely on herring as a prey item in the ecosystem, though these users are from a broader region.

Table 130 – Atlantic herring revenue to states, regions, and top ports attributed to MWT fishing within 50 nm in Areas 1B, 2, and 3, year-round, 2000-2015

State/Port	2000-2006		2007-2015	
	Average revenue	**Total permits[a]**	**Average revenue**	**Total permits[a]**
Maine	$0.4M	22	$1.0M	15
Portland	$0.3M	17	$0.7M	13
New Hampshire	$0.1M	9	[b]	[b]
Massachusetts	$2.6M	27	$4.7M	23
Gloucester	$1.6M	21	$1.8M	10
New Bedford	$0.9M	13	$2.8M	21
Fall River	$0.0M	6	$0.1M	8
Rhode Island	$2.0M	19	$0.3M	10
North Kingstown	$0.7M	6	[b]	[b]
Point Judith	$0.7M	10	$0.3M	6
Providence	$0.5M	5	[b]	[b]
Other state(s)[b]	$0.1M	11	$0.4M	12
Total $ & permits	**$5.2M**	**40**	**$6.5M**	**35**
Total ports	**26**		**17**	

Notes: Ports listed are the top ten ports by landing revenue that are non-confidential.
[a] Totals may not equal the sum of the parts, because permits can land in multiple ports/states.
[b] Confidential
Source: VTR analysis

Table 131 – Atlantic herring revenue to states, regions, and top ports attributed to MWT fishing within 50 nm in Areas 1B, 2, and 3, June-September, 2000-2015

State/Port	2000-2006		2007-2015	
	Average revenue	Total permits[a]	Average revenue	Total permits[a]
Maine	$0.2M	18	$0.5M	11
Portland	$0.1M	12	$0.5M	7
Rockland	$0.0M	5	[b]	[b]
Bath	$0.0M	3	[b]	[b]
Prospect Harbor	$0.0M	4	[b]	[b]
Jonesport			$0.0M	5
New Hampshire	$0.0M	7	[b]	[b]
Newington	$0.0M	3		
Massachusetts	$0.2M	15	$0.7M	13
Gloucester	$0.2M	11	$0.5M	7
New Bedford	[b]	[b]	$0.2M	8
Other state(s)[b]	$0.0M	5	$0.0M	5
Total $ & permits	**$0.5M**	**30**	**$1.3M**	**18**
Total ports	**20**		**12**	

Notes: Ports listed are the top ten ports by landing revenue that are non-confidential.
[a] Totals may not equal the sum of the parts, because permits can land in multiple ports/states.
[b] Confidential. *Source:* VTR analysis

Table 132 – Atlantic herring revenue to states, regions, and top ports attributed to MWT fishing within 50 nm in Areas 1B and 3, year-round, 2000-2015

State/Port	2000-2006		2007-2015	
	Average revenue	Total permits[a]	Average revenue	Total permits[a]
Maine	$0.4M	22	$0.9M	14
Portland	$0.3M	17	$0.7M	12
Rockland	$0.0M	7	[b]	[b]
Bath	$0.0M	3	[b]	[b]
Prospect Harbor	$0.0M	4	[b]	[b]
Jonesport	[b]	[b]	$0.0M	5
New Hampshire	$0.1M	7	[b]	[b]
Newington	$0.0M	3	[b]	[b]
Massachusetts	$1.8M	24	$2.0M	18
Gloucester	$1.5M	21	$1.4M	10
New Bedford	$0.2M	7	$0.6M	12
Rhode Island	$0.1M	8	$0.0M	4
Point Judith	$0.1M	4	[b]	[b]
Other state(s)[b]	$0.0M	2	$0.0M	3
Total $ & permits	**$2.3M**	**37**	**$3.0M**	**23**
Total ports	**23**		**17**	

Notes: Ports listed are the top ten ports by landing revenue that are non-confidential.
[a] Totals may not equal the sum of the parts, because permits can land in multiple ports/states.
[b] Confidential. *Source:* VTR analysis

Table 133 – Atlantic herring revenue to states, regions, and top ports attributed to MWT fishing within 50 nm in Areas 1B and 3, June-September, 2000-2015

State/Port	2000-2006		2007-2015	
	Average revenue	Total permits[a]	Average revenue	Total permits[a]
Maine	$0.2M	18	$0.5M	11
Portland	$0.1M	12	$0.3M	6
Rockland	$0.0M	5	[b]	[b]
Bath	$0.0M	3	[b]	[b]
Prospect Harbor	$0.0M	4	[b]	[b]
Jonesport			$0.0M	5
New Hampshire	$0.0M	7	[b]	[b]
Newington	$0.0M	3	[b]	[b]
Massachusetts	$0.2M	15	$0.7M	13
Gloucester	$0.2M	11	$0.5M	7
New Bedford	[b]	[b]	$0.2M	8
Other state(s)[b]	$0.0M	5	$0.0M	5
Total $ & permits	**$0.5M**	**30**	**$1.3M**	**18**
Total ports	**20**		**12**	

Notes: Ports listed are the top ten ports by landing revenue that are non-confidential.
[a] Totals may not equal the sum of the parts, because permits can land in multiple ports/states.
[b] Confidential. *Source:* VTR analysis

4.7.3.5 Alternative 7 (Prohibit MWT gear in thirty minute squares off Cape Cod)

Under Alternative 7, vessels with midwater trawl gear would be prohibited to fish within several thirty minute squares (Areas 99, 100, 114, 115, and 123), according to the area and seasonal options selected (Figure 7). Alternative 7 would be additive to No Action and not apply to RSA fishing.

Impacts on Atlantic herring fishery

The impacts on the Atlantic herring fishery of Alternative 7 are expected to be ***low negative relative to Alternative 1, primarily impacting midwater trawl vessels***. With additional fishing restrictions inside these 30 minute squares, it would become more difficult for the fishery to harvest the Area 1B sub-ACL. This sub-ACL is small, about 4,000 mt in recent years, and typically caught within Square 114 off the "back side of the Cape" in nearshore waters by MWT vessels. During 2008-2014, 54% of the 1B sub-ACL was caught by MWT, 9% by purse seines, and 37% by small mesh bottom trawls (Table 38 and Table 39, p. 151). Fishing may also be negatively impacted in Areas 3 and 2, making it more difficult to harvest the sub-ACLs. For Area 3, the majority of catch is from outside of 12 nm, but a portion is consistently caught within 12 nm, mostly off the "back side of the Cape." Fishing takes place closer to shore in Area 2 compared to Area 3, so this potential impact is greater in Area 2. In recent years, the fishery has not harvested the full sub-ACLs for Areas 2 and 3; implementing this measure could make it more difficult to do so.

Any fishery closure may hamper adaptability to changing conditions and may result in foregone revenue. It is difficult to determine if fishing would be precluded altogether or shift to other areas. To some degree, negative impacts would be mitigated by the ability of herring MWT vessels to fish in other management areas/seasons, particularly offshore, which is more accessible to the MWT fleet than other gear types. However, there are several constrains to doing so (e.g., carrier limits, operational constraints, herring are migratory, increased costs of fishing offshore; Table 108, p. 400; Section 4.1.2.5).

Impacts for ***purse seine and SMBT vessels may be more neutral***, unless there is increased crowding from effort shifts. Given the regulatory restrictions on SMBTs, it is unlikely that this gear would expand substantially into Areas 1B and 3. Use of purse seines is unlikely on the "back side of the Cape" and offshore, as purse seining is difficult in strong tides, rough ocean conditions, and when herring occur in deep water. MWT vessels may shift to fishing outside of these squares within Area 1B, but virtually all fishing in Area 1B is currently inside Square 114.

Considering just the recent (2007-2015) revenue from the areas/seasons under consideration, and depending on the options selected, the impacts of Alternative 7 would be ***negative relative to Alternatives 2 and 8, and negative to neutral relative to Alternatives 3, 4, 5 and 6.*** Impacts would be ***negative relative to Alternative 9,*** as a new seasonal closure would likely be more negative than removing the January-April Area 1B closure.

Area sub-option A (Areas 1B, 2 &3) and seasonal sub-option A (year-round). The impacts on the Atlantic herring fishery of Alternative 7, area sub-option A, seasonal sub-option A are expected to be ***negative relative to all the other Alternative 7 sub-options, primarily impacting midwater trawl vessels***; it would result in the most times/areas closed. From 2000-2015, 99-100% of the Atlantic herring landings from fishing within 30-minute squares 99, 100, 114, 115, and 123 year-round were by MWT vessels (Table 134). Atlantic herring and mackerel revenue attributed to MWT fishing in this area/season has been about $1.6-1.9M/year, 7-9% of total MWT revenue since 2000 (Table 135). If midwater trawls can no longer fish within 30-minute squares 99, 100, 114, 115, and 123 year-round (except for RSA fishing), the Area 1B sub-ACL is not expected to be fully harvested, though Area 1B is a small fraction of the total sub-ACL. Given the *importance* of the area/season of this option to the MWT fishery in the past, this option *may impede* the ability to harvest optimum yield, particularly if the allowable catch is harvested with other gear types.

Area sub-option A (Areas 1B, 2 &3) and seasonal sub-option B (June-September). The impacts on the Atlantic herring fishery of Alternative 7, area sub-option A, seasonal sub-option B are expected to be ***low negative relative to sub-option B/B and low positive relative to sub-options A/A and B/A, primarily impacting midwater trawl vessels***. From 2000-2015, 95-100% of the Atlantic herring landings from fishing within 30-minute squares 99, 100, 114, 115, and 123 June-September were by MWT vessels (Table 134, p. 447). Atlantic herring and mackerel revenue attributed to MWT fishing in this area/season has been about $0.0-0.4M/year, 0.5-5% of total MWT revenue since 2000 (Table 135, p. 448). Given the *low importance* of this area and season to the MWT fishery in the past, this option may *not impede* the ability to harvest optimum yield, particularly if the allowable catch is fished with other gear types, or if MWT effort shifts seasonally. Since at least 2007, the price of herring has been highest in July and August (Section 3.6.1.7, p. 154), so summertime closures may result in lower annual revenue for the fishery.

Area sub-option B (Areas 1B &3) and seasonal sub-option A (year-round). The impacts on the Atlantic herring fishery of Alternative 7, area sub-option B, seasonal sub-option A are expected to be ***low negative relative to sub-options A/B and B/B and low positive relative to sub-option A/A, primarily impacting midwater trawl vessels.*** From 2000-2015, 99-100% of the Atlantic herring landings from fishing within 30-minute squares 99, 114, and 123 year-round were by MWT vessels (Table 134, p. 447). Atlantic herring and mackerel revenue attributed to MWT fishing in this area/season has been about $1.6-1.9M/year, 7-9% of total MWT revenue since 2000 (Table 135, p. 448). If midwater trawls can no longer fish within 30-minute squares 99, 114, and 123 year-round (except for RSA fishing), the Area 1B sub-ACL is not expected to be fully harvested, though Area 1B is a small fraction of the total sub-ACL. Given the *importance* of this area and season to the MWT fishery in the past, this option *may impede* the ability to harvest optimum yield, particularly if the allowable catch is fished with other gear types.

Area sub-option B (Areas 1B &3) and seasonal sub-option B (June-September). The impacts on the Atlantic herring fishery of Alternative 7, area sub-option B, seasonal sub-option B are expected to be ***positive relative to all the other Alternative 7 sub-options, primarily impacting midwater trawl vessels;*** it would result in the least times and areas closed. From 2000-2015, 99-100% of the Atlantic herring landings from fishing within 30-minute squares 99, 114 and 123 June-September were by MWT vessels (Table 134, p. 447). Atlantic herring and mackerel revenue attributed to MWT fishing in this area/season has been about $0-0.4M/year, 0.5-5% of total MWT revenue since 2000 (Table 135, p. 448). If midwater trawls can no longer fish within 30-minute squares 99, 114, and 123 June-September, the Area 1B sub-ACL is still expected to be fully harvested. Given the *low importance* of this area and season to the MWT fishery in the past, this option may *not impede* the ability to harvest optimum yield, particularly if the allowable catch is fished with other gear types. Since at least 2007, the price of herring has been highest in July and August (Section 3.6.1.7, p. 154), so summertime closures may result in lower annual revenue for the fishery.

Table 134 – Annualized Atlantic herring landings within 30-min squares: 99, 100, 114, 115 and 123 (Alternative 7)

Sub-options		Description	Time period	Herring landings within 30-min squares (mt)		
Area	Season			MWT only		All gear
A	A	Areas 1B, 2 & 3; year round	2000-2007	6,824	99%	6,917
			2007-2015	5,999	100%	6,020
A	B	Areas 1B, 2 & 3; June-Sept	2000-2007	132	95%	139
			2007-2015	1,100	100%	1,102
B	A	Areas 1B & 3; year round	2000-2007	6,401	99%	6,474
			2007-2015	5,600	100%	5,605
B	B	Areas 1B & 3; June-Sept	2000-2007	99	99%	100
			2007-2015	1,015	100%	1,016

*Note: "*2000-2007" includes data through May 2007, pre-Amendment 1 implementation. "2007-2015" includes data from June 2007 onward. "Total" for all rows includes all landings south of 1A.
Source: VTR analysis.

Table 135 – Annualized Atlantic herring and mackerel MWT revenue within 30-min squares: 99, 100, 114, 115 and 123 (Alternative 7)

Sub-options		Description	Time period	Herring/mackerel MWT revenue		
Area	Season			Inside		Total all areas
A	A	Areas 1B, 2 & 3; year round	2000-2007	$1.9M	6.6%	$28.9M
			2007-2015	$1.6M	8.7%	$18.7M
A	B	Areas 1B, 2 & 3; June-Sept	2000-2007	$0.0M	0.5%	$7.9M
			2007-2015	$0.4M	5.3%	$6.8M
B	A	Areas 1B & 3; year round	2000-2007	$1.9M	6.6%	$28.9M
			2007-2015	$1.6M	8.7%	$18.7M
B	B	Areas 1B & 3; June-Sept	2000-2007	$0.4M	5.3%	$6.8M
			2007-2015	$0.0M	0.5%	$7.9M

*Note: "*2000-2007" includes data through May 2007, pre-Amendment 1 implementation. "2007-2015" includes data from June 2007 onward.
Source: VTR analysis.

Impacts on Atlantic mackerel fishery

The impacts on the Atlantic mackerel fishery of Alternative 7 are expected to be ***low negative relative to Alternative 1***. There would be more times and areas closed to the fishery, though it is difficult to determine if mackerel fishing would be precluded altogether or shift to other areas. Any fishery closure may hamper adaptability to changing conditions and may result in foregone revenue. Considering just the recent (2007-2015) revenue from the areas/seasons under consideration, and depending on the options selected, the impacts of Alternative 7 would be ***negative relative to Alternative 2 and 8, and negative to neutral relative to Alternatives 3-6.*** Impacts would be ***negative relative to Alternative 9,*** as a new seasonal closure would likely be more negative than removing the January-April Area 1B closure.

Area sub-option A (Areas 1B, 2 &3) and seasonal sub-option A (year-round). The impacts on the Atlantic mackerel fishery of Alternative 7, area sub-option A, seasonal sub-option A are expected to be ***negative relative to all the other Alternative 7 sub-options;*** it would result in the most times/areas closed. From 2000-2007, Atlantic mackerel landings attributed to MWT fishing within 30-minute squares 99, 100, 114, 115, and 123 year-round were 0.4% of the total for all areas by that gear type (Table 136). Since then, the contribution has increased to 3.2%, though total mackerel landings declined by 77%. Atlantic herring and mackerel revenue attributed to MWT fishing in this area/season has been about $1.6-1.9M/year, 7-9% of total MWT revenue since 2000 (Table 135).

Area sub-option A (Areas 1B, 2 &3) and seasonal sub-option B (June-September). The impacts on the Atlantic mackerel fishery of Alternative 7, area sub-option A, seasonal sub-option B are expected to be ***low negative relative to sub-option B/B and low positive relative to sub-options A/A and B/A.*** From 2000-2015, there were no Atlantic mackerel landings attributed to fishing with MWT within 30-minute squares 99, 100, 114, 115, and 123 June-September (Table 136). From January 2000 to May 2007, Atlantic herring and mackerel revenue attributed to midwater trawl fishing in this area/season were $3.7M, or 13% of the annual total attributed to that gear type (Table 120, p. 419). Atlantic herring and mackerel revenue attributed to MWT fishing in this area/season has been about $0.0-0.4M/year, 0.5-5% of total MWT revenue since 2000 (Table 135, p. 448).

<u>*Area sub-option B (Areas 1B &3) and seasonal sub-option A (year-round).*</u> The impacts on the Atlantic mackerel fishery of Alternative 7, area sub-option B, seasonal sub-option A are expected to be ***low negative relative to sub-options A/B and B/B and low positive relative to sub-option A/A.*** From 2000-2007, Atlantic mackerel landings attributed to fishing with MWT within 30-minute squares 99, 114, and 123 year-round were 0.2% of the total for all areas by that gear type (Table 136). Since then, the contribution has increased to 3.2%, though total mackerel landings declined by 77%. Atlantic herring and mackerel revenue attributed to MWT fishing in this area/season has been about $1.6-1.9M/year, 7-9% of total MWT revenue since 2000 (Table 135, p. 448).

<u>*Area sub-option B (Areas 1B &3) and seasonal sub-option B (June-September).*</u> The impacts on the Atlantic mackerel fishery of Alternative 7, area sub-option B, seasonal sub-option B are expected to be ***positive relative to all the other Alternative 6 sub-options, primarily impacting midwater trawl vessels;*** it would result in the least times and areas closed. From 2000-2015, there were no Atlantic mackerel landings attributed to fishing with MWT within 30-minute squares 99, 114, and 123 June-September (Table 136, p. 449). Atlantic herring and mackerel revenue attributed to MWT fishing in this area/season has been about $0-0.4M/year, 0.5-5% of total MWT revenue since 2000 (Table 135, p. 448).

Table 136 – Annualized Atlantic mackerel landings within 30-min squares: 99, 100, 114, 115 and 123 (Alternative 7)

Sub-options		Description	Mackerel MWT landings south of Area 1A (mt)			
Area	Season		Time period	Inside		Total
A	A	Areas 1B, 2 & 3; year round	2000-2007	113	0.4%	30,082
			2007-2015	224	3.2%	6,994
A	B	Areas 1B, 2 & 3; June-Sept	2000-2007	0	0%	<10
			2007-2015	0	0%	<10
B	A	Areas 1B & 3; year round	2000-2007	70	0.2%	30,082
			2007-2015	224	3.2%	6,994
B	B	Areas 1B & 3; June-Sept	2000-2007	0	0%	<10
			2007-2015	0	0%	<10

Impacts on American lobster fishery

The impacts on the American lobster fishery of Alternative 7 are expected to be ***low negative to neutral relative to Alternative 1***. Given the importance of some of these areas and seasons to the herring midwater trawl fishery in the past, this alternative may impede the ability to harvest Atlantic herring optimum yield, depending on the option, and may impact the bait market. As herring prices are generally insensitive to quantity changes, if this measure reduces herring landings, then the price of herring for bait could increase, potentially increasing costs for the lobster fishery.

Considering just the recent (2007-2015) herring revenue from the areas/seasons under consideration, and depending on the options selected, the impacts of Alternative 7 would be

negative relative Alternative 2 and 8, and ***negative to neutral relative to Alternatives 3-6,*** depending on if bait supply becomes more limited**.** Impacts would be ***negative relative to Alternative 9,*** as a new seasonal closure would likely be more negative than removing the January-April Area 1B closure, which may lower costs to the lobster fishery. ***Of the Alternative 7 sub-options, A/A would have the most negative impact and B/B would be least negative***.

Impacts on predator fisheries and ecotourism

The impacts on predator fisheries and ecotourism of Alternative 7 are expected to be ***uncertain, but potentially low positive relative to Alternative 1***. Assuming that removing overlap between the midwater trawl Atlantic herring and predator fisheries and ecotourism is a positive outcome for the predator fisheries and ecotourism, this alternative/option would have a positive effect, based on the overlap analysis, with its assumptions and limitations (Section 4.1.2.3; Appendix VII). If MWT fishing shifts to other times/areas remaining open, there may be negative impacts to the degree new overlaps result. If it is replaced by other gear types, negative outcomes for predator fisheries may result from overlap with these gears. The area off the "back side of the Cape" is an area of high importance for the recreational fishery in the summer, so overlaps with this fishery would be reduced under Alternative 7 (data limitations precluded quantitative analysis). However, some recreational fisheries (e.g., striped bass) occur only in state waters.

The impacts on predator fisheries and ecotourism of Alternative 7 ***could potentially be low positive relative to Alternatives 2 and 8,*** as it may remove more overlap with the herring fishery and ***low negative to low positive relative to Alternatives 3-6 (depending on the options),*** as it may remove more or less overlap with the herring fishery. Impacts would be ***neutral relative to Alternative 9;*** both adding a closure and removing the January-April Area 1B closure for the herring fishery would likely reduce user conflicts.

<u>*Area sub-option A (Areas 1B, 2 &3) and seasonal sub-option A (year-round).*</u> The impacts on predator fisheries and ecotourism of Alternative 7, area sub-option A, seasonal sub-option A are expected to be ***neutral relative to sub-option A/B and low positive relative to sub-options B/A and B/B***. Since 2007, there has low degrees of overlap between the Atlantic herring MWT fishery and the commercial groundfish (17%), commercial bluefin tuna (7%), and commercial whale watch operators (11%) in this area/season (Figure 75, p. 274).

<u>*Area sub-option A (Areas 1B, 2 &3) and seasonal sub-option B (June-September).*</u> The impacts on predator fisheries and ecotourism of Alternative 7, area sub-option A, seasonal sub-option B are expected to be ***neutral relative to sub-options A/A and low positive relative to sub-option B/A and B/B.*** Since 2007, there has low degrees of overlap between the Atlantic herring MWT fishery and the commercial groundfish (17%), commercial bluefin tuna (7%), and commercial whale watch operators (11%) in this area/season (Figure 75, p. 274). This degree of overlap is the same as that of the year-round option (B/A). Many of the recreational users (recreational fishing and whale watching) are active during fair weather. Therefore, measures that reduce user conflicts in the summer and fall are likely to be nearly as effective as year-round measures.

<u>*Area sub-option B (Areas 1B &3) and seasonal sub-option A (year-round).*</u> The impacts on predator fisheries and ecotourism of Alternative 7, area sub-option B, seasonal sub-option A are expected to be ***neutral relative to sub-option B/B and low negative relative to sub-option A/A and A/B.*** Since 2007, there has low degrees of overlap between the Atlantic herring MWT fishery and the commercial groundfish (10%), commercial bluefin tuna (6%), and commercial whale watch operators (11%) in this area/season (Figure 75, p. 274).

Area sub-option B (Areas 1B &3) and seasonal sub-option B (June-September). The impacts on predator fisheries and ecotourism of Alternative 7, area sub-option B, seasonal sub-option B are expected to be ***neutral relative to sub-option B/A and low negative relative to sub-option A/A and A/B.*** Since 2007, there has low degrees of overlap between the Atlantic herring MWT fishery and the commercial groundfish (10%), commercial bluefin tuna (7%), and commercial whale watch operators (11%) in this area/season (Figure 75, p. 274). This degree of overlap is almost the same as that of the year-round option (B/A). Many of the recreational users (recreational fishing and whale watching) are active during fair weather. Therefore, measures that reduce user conflicts in the summer and fall are likely to be nearly as effective as year-round measures.

Impacts on communities

The impacts on fishing communities of Alternative 7 are expected to be ***low negative to low positive relative to Alternative 1***. While the Atlantic herring, mackerel, and lobster fisheries may have low negative impacts, impacts on other users may be low positive. To the degree that user conflicts are reduced, positive impacts among human communities are expected. General community impacts of area closures are described in Section 4.7.3.1.1 (p. 398). The VTR analysis results reported here have some degree of error (Section 4.1.2.2).

Herring communities. The herring fishing communities that could be impacted by Alternative 7 are primarily located in Maine, Massachusetts, and Rhode Island.

- *Area sub-option A (Areas 1B, 2 &3) and seasonal sub-option A (year-round)*. It is estimated that the Atlantic herring MWT landings attributed to fishing within 30-minute squares 99, 100, 114, 115, and 123 year-round, from 2000-2006, was $1.7M/year, attributed to 30 permits (Table 137). From greatest to least, most of the revenue was from herring landed in Gloucester, New Bedford, Portland, Point Judith, North Kingstown, and 11 other ports in the Northeast U.S. From 2007-2015, there average revenue remained constant, but was attributed to fewer permits (20) and ports (13), from herring MWT landings attributed to this area/season. Gloucester had the most revenue under both time periods. The named ports above are the top (non-confidential) herring ports most likely impacted by this option. These are herring *Communities of Interest*, according to the criteria in Section 3.6.4.2.1 (p. 197). They have medium-high or high engagement in or reliance on the Atlantic herring fishery (Table 72). The herring fishing communities that could be impacted by this option are primarily located in Maine, Massachusetts, and Rhode Island. The herring MWT revenue attributed to these states from this area/season during 2007-2015 ($1.7M/year) is about 7% of all herring revenue for these states during that time period ($23M/year). Certain individual permit holders could have much more of their revenue attributed to fishing from this area/time.
- *Area sub-option A (Areas 1B, 2 &3) and seasonal sub-option B (June-September).* It is estimated that the Atlantic herring MWT landings attributed to fishing within 30-minute squares 99, 100, 114, 115, and 123 June-September, from 2000-2006, was $40K/year, attributed to 16 permits (Table 137). From greatest to least, most of the revenue was from Gloucester, Portland, and 8 other ports in the Northeast U.S. From 2007-2015, there was an increase in average revenue, to $343K, attributed to fewer permits (13) and ports (7), from herring MWT landings attributed to this area/season. Gloucester had the most revenue under both time periods. New Bedford was active during the later time period. The named ports above are the top (non-confidential) herring ports most likely impacted

by this option. These are herring *Communities of Interest*, according to the criteria in Section 3.6.4.2.1 (p. 197). They have medium-high or high engagement in or reliance on the Atlantic herring fishery (Table 72). The herring fishing communities that could be impacted by this option are primarily located in Maine and Massachusetts. The herring MWT revenue attributed to these states from this area/season during 2007-2015 ($343K/year) is about 2% of all herring revenue for these states during that time period ($21M/year). Certain individual permit holders could have much more of their revenue attributed to fishing from this area/time.

- *Area sub-option B (Areas 1B &3) and seasonal sub-option A (year-round).* It is estimated that the Atlantic herring MWT landings attributed to fishing within 30-minute squares 99, 114, and 123 year-round, from 2000-2006, was $1.6M/year, attributed to 29 permits (Table 137). From greatest to least, most of the revenue was from herring landed in Gloucester, New Bedford, Portland, Point Judith, Rockland, and 11 other ports in the Northeast U.S. From 2007-2015, there average revenue increased slightly ($1.7M), but was attributed to fewer permits (20) and ports (13), from herring MWT landings attributed to this area/season. Gloucester had the most revenue under both time periods. The named ports above are the top (non-confidential) herring ports most likely impacted by this option. These are herring *Communities of Interest*, according to the criteria in Section 3.6.4.2.1 (p. 197). They have medium-high or high engagement in or reliance on the Atlantic herring fishery (Table 72). The herring fishing communities that could be impacted by this option are primarily located in Maine, Massachusetts, and Rhode Island. The herring MWT revenue attributed to these states from this area/season during 2007-2015 ($1.6M/year) is about 7% of all herring revenue for these states during that time period ($23M/year). Certain individual permit holders could have much more of their revenue attributed to fishing from this area/time.
- *Area sub-option B (Areas 1B &3) and seasonal sub-option B (June-September).* It is estimated that the Atlantic herring MWT landings attributed to fishing within 30-minute squares 99, 114, and 123 June-September, from 2000-2006, was $40K/year, attributed to 16 permits (Table 137). From greatest to least, most of the revenue was from herring landed in Gloucester, Portland, and 8 other ports in the Northeast U.S. From 2007-2015, there average revenue increased to $342K, but was attributed to fewer permits (13) and ports (7), from herring MWT landings attributed to this area/season. Gloucester had the most revenue under both time periods. New Bedford was active during the later time period. The named ports above are the top (non-confidential) herring ports most likely impacted by this option. These are herring *Communities of Interest*, according to the criteria in Section 3.6.4.2.1 (p. 197). They have medium-high or high engagement in or reliance on the Atlantic herring fishery (Table 72). The herring fishing communities that could be impacted by this option are primarily located in Maine and Massachusetts. The herring MWT revenue attributed to these states from this area/season during 2007-2015 ($342K/year) is about 2% of all herring revenue for these states during that time period ($21M/year). Certain individual permit holders could have much more of their revenue attributed to fishing from this area/time.

Communities of other users. Alternative 7 may impact other users of Atlantic herring and their associated communities, many of which coexist (with each other and with the herring fishery) within communities. Within Massachusetts, no adjacent communities are particularly important to the mackerel fishery (Table 78), though mackerel communities impacted by this alternative would likely mirror the herring communities. For the lobster fishery, one adjacent community has been identified, though herring as bait is distributed to the lobster fishery region-wide. Additionally, about nine adjacent communities are particularly important to the fisheries and ecotourism that rely on herring as a prey item in the ecosystem, though these users are from a broader region.

Table 137 – Atlantic herring revenue to states, regions, and top ports attributed to MWT fishing within 30-min squares in Areas 1B, 2, and 3, year-round, 2000-2015

State/Port	2000-2006		2007-2015	
	Average revenue	Total permits[a]	Average revenue	Total permits[a]
Maine	$0.1M	10	$0.4M	9
Portland	$0.1M	8	$0.3M	7
Massachusetts	$1.4M	24	$1.2M	18
Gloucester	$1.3M	20	$0.9M	9
New Bedford	$0.2	8	$0.3M	12
Rhode Island	$0.0M	11	$0.0M	3
Point Judith	$0.0M	5	[b]	[b]
North Kingstown	$0.0M	6	[b]	[b]
Other state(s)[b]	$0.0M	2	$0.0M	1
Total $ & permits	**$1.7M**	**30**	**$1.7M**	**20**
Total ports	**16**		**13**	

Notes: Ports listed are the top ten ports by landing revenue that are non-confidential.
[a] Totals may not equal the sum of the parts, because permits can land in multiple ports/states.
[b] Confidential
Source: VTR analysis

Table 138 – Atlantic herring revenue to states, regions, and top ports attributed to MWT fishing within 30-min squares in Areas 1B, 2, and 3, June-September, 2000-2015

State/Port	2000-2006		2007-2015	
	Average revenue	Total permits[a]	Average revenue	Total permits[a]
Maine	$18K	6	$102K	6
Portland	$13K	4	$43K	3
Massachusetts	$19K	8	$242K	8
Gloucester	$17K	4	$228K	5
New Bedford	[b]	[b]	$14K	5
Other state(s)[b]	$3K	4	$0K	1
Total $ & permits	**$40K**	**16**	**$343K**	**13**
Total ports	**10**		**7**	

Notes: Ports listed are the top ten ports by landing revenue that are non-confidential.
[a] Totals may not equal the sum of the parts, because permits can land in multiple ports/states.
[b] Confidential
Source: VTR analysis

Table 139 – Atlantic herring revenue to states, regions, and top ports attributed to MWT fishing within 30-min squares in Areas 1B and 3, year-round, 2000-2015

State/Port	2000-2006		2007-2015	
	Average revenue	Total permits[a]	Average revenue	Total permits[a]
Maine	$0.1M	10	$0.4M	9
Portland	$0.1M	7	$0.3M	7
Rockland	$0.0M	3	[b]	[b]
Massachusetts	$1.4M	24	$1.2M	17
Gloucester	$1.2M	20	$0.9M	9
New Bedford	$0.1M	7	$0.3M	12
Rhode Island	$0.0M	8	$0.0M	3
Point Judith	$0.0M	4	[b]	[b]
Other state(s)[b]	$0.0M	3	$0.0M	1
Total $ & permits	**$1.6M**	**29**	**$1.7M**	**20**
Total ports	**16**		**13**	

Notes: Ports listed are the top ten ports by landing revenue that are non-confidential.
[a] Totals may not equal the sum of the parts, because permits can land in multiple ports/states.
[b] Confidential
Source: VTR analysis

Table 140 – Atlantic herring revenue to states, regions, and top ports attributed to MWT fishing within 30-min squares in Areas 1B and 3, June-September, 2000-2015

State/Port	2000-2006		2007-2015	
	Average revenue	Total permits[a]	Average revenue	Total permits[a]
Maine	$18K	6	$101K	6
Portland	$13K	4	$43K	3
Massachusetts	$19K	8	$241K	8
Gloucester	$17K	7	$227K	5
New Bedford	[b]	[b]	$14K	5
Other state(s)[b]	$3K	4	$0K	1
Total $ & permits	**$40K**	**16**	**$342K**	**13**
Total ports	**10**		**7**	

Notes: Ports listed are the top ten ports by landing revenue that are non-confidential.
[a] Totals may not equal the sum of the parts, because permits can land in multiple ports/states.
[b] Confidential
Source: VTR analysis

4.7.3.6 Alternative 8 (Revert boundary between Areas 1B and 3 back to original boundary)

Under Alternative 8, the boundary between Areas 1B and 3 would revert back to what it was under the original Herring FMP. The current boundary between Areas 2 and 3 would remain (Figure 8). Alternative 8 would be additive to Alternative 1 (No Action).

Impacts on Atlantic herring fishery

The impacts on the Atlantic herring fishery of Alternative 8 are expected to be ***low negative relative to Alternative 1***. Under Alternative 8, the size of Area 1B would increase by moving the southern boundary further south into what is currently Area 3. However, distribution of the ACL into management areas would not change in this action. The Area 1B sub-ACL has traditionally been a small fraction of the total ACL, amounting to around 4,000 mt from 2010-2015 (Table 28, p. 140) and around 4,600 mt for 2016-2018 (Table 24, p. 138). Since 2007, the landings attributed to what is currently Area 1B plus the portion of Area 3 that would become Area 1B, the boundary extension have been about 7,677 mt (Table 141). Assuming the Area 1B sub-ACL remains constant, and effort does not shift within Area 3, about 3,000 mt that could be harvested from Area 3 currently would be unharvested if the boundaries change. If so, in the short-term, reducing the size of Area 3 could make it more difficult to harvest the Area 3 sub-ACL. Assuming an average price of $300/mt (Section 3.6.1.7), this equates to about $0.9M in revenue. A portion of Area 3 landings is consistently caught nearshore that would be impacted, mostly off the "back side of the Cape", east of Chatham, MA. Moving Area 3 offshore would make it only accessible to larger vessels capable of fishing offshore, a negative impact for smaller vessels.

Under Amendment 1, the change in the management boundaries under Amendment 1 was intended, in part, to better reflect the distribution of the spawning components of the Atlantic herring stock. Therefore, if the boundaries change back, there may be increased risk of fishing one spawning component harder than another, which could have low negative impacts on the resource. This, in turn, could have long-term negative social impacts to the *Historical Dependence on and Participation in* the herring fishery if the long-term sustainability of the resource is jeopardized, a threat to continued access to fishery resources. There may be a negative impact on the *Attitudes, Beliefs, and Values* of stakeholders towards management should there be a perceived inability of regulators to properly manage fishery resources. Alternative 8 would primarily impact midwater trawl vessels, the vessels fishing off the "back side of the Cape" and on Georges Bank. However, impacts may occur fishery-wide should stock conditions deteriorate.

Considering just the recent (2007-2015) revenue from the areas/seasons under consideration, and depending on the options selected, the impacts of Alternative 8 would be ***negative to neutral relative to Alternative 2, negative to positive relative to Alternatives 4, 5 and 7, and positive relative to Alternative 3 and 6.*** Impacts would be ***uncertain but potentially neutral relative to Alternative 9,*** as shifting the boundary may or may not be more negative than removing the January-April Area 1B closure.

Impacts on Atlantic mackerel fishery

The impacts on the Atlantic mackerel fishery of Alternative 8 are expected to be ***low negative relative to Alternative 1***, due to the interconnectedness between the Atlantic herring and Atlantic mackerel midwater trawl fisheries. Reducing the size of herring Area 3 could make it more difficult to harvest the Area 3 herring sub-ACL, and thus mackerel as well. Moving Area 3 offshore would make it only accessible to larger vessels capable of fishing offshore, a more negative impact for smaller vessels. Considering just the recent (2007-2015) revenue from the areas/seasons under consideration, and depending on the options selected, the impacts of Alternative 8 would be ***negative to neutral relative to Alternative 2, negative to positive relative to Alternatives 4, 5 and 7, and positive relative to Alternative 3 and 6.*** Impacts would be ***low negative relative to Alternative 9,*** as shifting the boundary would likely be more negative than removing the January-April Area 1B closure for the mackerel fishery.

Table 141 – Annualized Atlantic herring landings (mt) from within the existing Area 1B boundary and the expanded boundary under Alternative 8, 2000-2015

Time period	Average Annualized Herring landings (mt)			
	Area 1B			Total
	Current 1B boundary	Portion of current Area 3 within Alt. 8 (1B extension)	1B + extension	
	A	B	A+B	
2000-2007	5,809 (6%)	3,637 (4%)	9,445 (10%)	96,841 (100%)
2007-2015	4,025 (5%)	3,652 (4%)	7,677 (9%)	82,472 (100%)

Note: "2000-2007" includes data through May 2007, pre-Amendment 1 implementation. "2007-2015" includes data from June 2007 onward.
Source: VTR analysis.

Impacts on American lobster fishery

The impacts on the American lobster fishery of Alternative 8 are expected to be ***low negative relative to Alternative 1***, due to the interconnectedness between the Atlantic herring and its bait market, primarily the Atlantic lobster fishery. This alternative would likely reduce herring landings, potentially impairing the bait market. As herring prices are generally insensitive to quantity changes, a reduction in herring landings could increase the price of herring for bait, potentially increasing costs for the lobster fishery. Considering just the recent (2007-2015) revenue from the areas/seasons under consideration, and depending on the options selected, the impacts of Alternative 8 would be ***negative to neutral relative to Alternative 2, negative to positive relative to Alternatives 4, 5 and 7, and positive relative to Alternative 3 and 6.*** Impacts would be ***low negative relative to Alternative 9,*** as shifting the boundary would likely be more negative than removing the January-April Area 1B closure for the lobster fishery.

Impacts on predator fisheries and ecotourism

The impacts on predator fisheries and ecotourism of Alternative 8 are expected to be ***uncertain, but potentially neutral relative to Alternative 1***. Alternative 8 may move some midwater trawl fishing activity offshore, reducing the potential for user conflicts inshore, a positive impact. However, should Atlantic herring stock conditions deteriorate, negative impacts to all users of Atlantic herring are expected. The impacts on predator fisheries and ecotourism of Alternative 8 ***could potentially be low negative relative to Alternatives 2-7*** as it may remove more less overlap with the herring fishery (though a quantitative overlap analysis of Alternative 8 was not done). Impacts would be ***neutral relative to Alternative 9;*** both reducing Area 3 herring fishing and removing the January-April Area 1B closure for the herring fishery would likely reduce user conflicts.

Impacts on communities

The impacts on fishing communities of Alternative 8 are expected to be ***negative relative to Alternative 1***. There could be negative impacts to the *Size and Demographic Characteristics* of the fishery-related workforce within communities should a deterioration occur in the Atlantic herring fishery or in other fisheries/users of Atlantic herring.

4.7.3.7 Alternative 9 (Remove seasonal closure of Area 1B from January – April)

Under Alternative 9, the seasonal closure (January 1 – April 30) in Area 1B that has existed since implementation of the 2013-2015 specifications would be removed. Alternative 9 would be additive to Alternative 1 (No Action).

Impacts on Atlantic herring fishery

The impacts on the Atlantic herring fishery of Alternative 9 are expected to be ***low negative relative to Alternative 1***. Generally, herring prices are lower in winter, with reduced demand from the lobster fishery (Section 3.6.1.7). Under Alternative 9, it is more likely that herring fishermen would fish early in the year in Area 1B, rather than wait for more favorable prices, due to a preference for some share of the resource prior to the sub-ACL being fully harvested. There would be some benefits to increased flexibility, but negative impacts on fishery revenue are expected (Section 4.1.2.5).

Between 2007 and 2011, 21% or less of the Area 1B sub-ACL had been caught by the end of April each year (Figure 121). However, in 2012, the sub-ACL was fully harvested before the end of January. It is likely that due to a 1B overage in 2010, the industry maximized 1B quota in 2012 before an overage deduction would have been implemented. Removing the delay of the opening of Area 1B may not allow sufficient time for overage or carryover determinations, so it may be more difficult to harvest within the sub-ACL.

Impacts would be ***positive relative to Alternatives 2-7,*** as a new closure would likely be more negative than removing the January-April Area 1B closure. Impacts would be ***uncertain but potentially neutral relative to Alternative 8,*** as shifting the boundary may or may not be more negative than removing the January-April Area 1B closure.

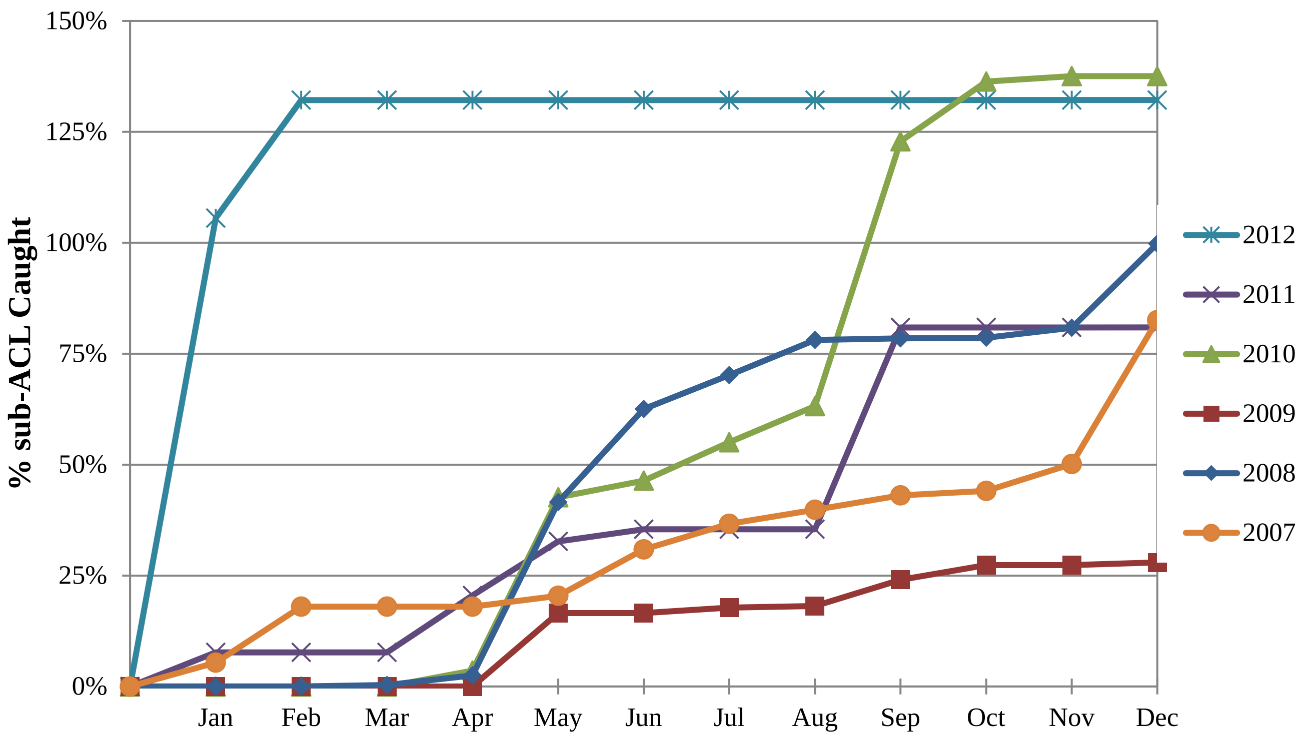
Impacts on Atlantic mackerel fishery

The impacts on the Atlantic mackerel fishery of Alternative 9 are expected to be ***low positive relative to Alternative 1***, as this would enable landings in the fishery earlier in the year, when the mackerel fishery tends to be more active (Section 4.1.2.5). Impacts would be ***positive relative to Alternatives 2-7,*** as a new closure would likely be more negative than removing the January-April Area 1B closure. Impacts would be ***uncertain but potentially neutral relative to Alternative 8,*** as shifting the boundary may or may not be more negative than removing the January-April Area 1B closure.

Impacts on American lobster fishery

The impacts on the American lobster fishery of Alternative 9 are expected to be ***low positive relative to Alternative 1***. Generally, herring prices are lower in winter, with reduced demand from the lobster fishery. Under Alternative 9, the lobster fishery would benefit from increased access to herring at lower cost. Impacts would be ***positive relative to Alternatives 2-7,*** as a new herring fishery closure would likely be more negative for the lobster than removing the January-April Area 1B herring fishery closure. Impacts would be ***uncertain but potentially low positive relative to Alternative 8,*** as shifting the boundary may reduce the amount of herring available for the bait market, a negative relative to having access to bait at lower costs.

Figure 121 - Area 1B sub-ACL use by month, 2007-2012



Source: NERO DIMS database, queried 12/7/2012.

Impacts on predator fisheries and ecotourism

The impacts on predator fisheries and ecotourism of Alternative 9 are expected to be ***uncertain, but potentially low positive relative to Alternative 1***. With this seasonal closure removed, Atlantic herring fishing in Area 1B is expected to shift earlier in the year when user overlaps are expected to be less. In fact, the 2013-2015 specifications predicted that the seasonal closure of Area 1B may result in user group conflicts, particularly between the midwater trawl herring vessels and recreational striped bass anglers, which use Area 1B in June. With the exception of 2011 and 2012, Area 1B had been open year-round to the herring fishery (only in 2012 was it closed in June) without significant conflict with other user groups. Some herring fishermen have attributed this closure to heightened conflicts with other user groups (Section 4.1.2.5). Removal of the seasonal split would likely decrease herring vessel activity in Area 1B in May.

Impacts would be ***neutral relative to Alternatives 2-8;*** adding herring fishery closures in the summer and fall, reducing herring fishing in Area 3, and removing the January-April Area 1B closure for the herring fishery would all likely reduce user conflicts.

Impacts on communities

The impacts on fishing communities of Alternative 9 are expected to be ***low negative to low positive relative to Alternative 1***. While the Atlantic herring fishery may have low negative impacts, impacts on other users may be low positive. To the degree that Alternative 9 reduces user conflicts in Area 1B in the summer, positive impacts among human communities are expected.

4.8 SUMMARY OF IMPACTS FOR ALL ALTERNATIVES ACROSS ALL VALUED ECOSYSTEM COMPONENTS

This section summarizes all of the analyses presented in Sections 4.1 through 4.7, in a format that impacts can be compared efficiently across each valued ecosystem component (VEC) in the biological environment (herring resource, non-target species, predator species, protected species, and EFH/physical environment), as well as the human environment (herring fishery, mackerel fishery, lobster fishery, ecotourism industries) (Table 142 - Table 144). More detailed discussion is included in each section above; these tables are intended to be very succinct to show how alternatives compare to each other.

Table 142 – Summary of potential impacts of ABC control rule alternatives across all VECs (ST – short term impacts and LT – long term impacts)

	Herring Biomass	Non-target species (Bycatch)	Predator Species	Protected Resources	Physical Environment and EFH	Herring Fishery (and related mackerel and lobster fisheries)	Predator Fisheries and Ecotourism
No Action	ST: Low positive LT: more uncertain	Negligible/Neutral	Neutral	Low negative	Neutral	ST: Low positive LT: Uncertain, likely not significant	ST: Neutral to low positive; LT: Uncertain, likely not significant
Alt. 1 (Strawman A)	ST: Low positive; LT: Low positive		Neutral	Low negative, neutral compared to No Action		ST: Neutral to low positive; LT: Low positive	ST: Low positive; LT: Low positive
Alt. 2 (Strawman B)	ST: Positive; LT: Positive		Low Positive	Low negative, Low positive compared to No Action		ST: Low Negative; LT: low positive to low negative	ST: Low positive; LT: positive
Alt. 3	ST: Low positive; LT: Low positive		Neutral	Low negative, neutral compared to No Action		ST: Neutral to low positive; LT: low positive to low negative	ST: Low positive; LT: Low positive
Alt. 4A	ST: Positive; LT: Positive		Low Positive	Low negative, but depending on the option, Neutral to Low Positive compared to No Action		ST: Low negative to low positive; LT: low positive	ST: Low positive; LT: low positive
Alt. 4B							
Alt. 4C							
Alt. 4D							
Alt. 4E							
Alt. 4F							

3-year specs	Herring Biomass	Non-target species (Bycatch)	Predator Species	Protected Resources	Physical Environment and EFH	Herring Fishery (and related mackerel and lobster fisheries)	Predator Fisheries
Alternative 1 (No Action – 3ys specs – same ABC)	Slightly low negative	Negligible/Neutral	Neutral	Neutral	Neutral	ST: low positive; LT: low negative	ST: low negative; LT: low negative
Alt. 2 (3yr specs with annual application)	Slightly low positive					ST: low negative; LT: low positive	ST: low positive; LT: low positive

Table 143 – Summary of potential impacts of measures to reduce potential localized depletion and user conflicts across biological environment

Alternative	Herring Resource	Non-target	Predator species	Protected resources	EFH/Physical Environment
Alternative 1 (No Action)	Neutral - Hard to assess impacts in isolation of other measures that have been implemented	Neutral Bycatch caps in place limit impacts on bycatch	Low positive in GOM and low negative on GB	Low negative on protected species and neutral on ESA species	Neutral
Alternative 2	Neutral – no impact overall Area is relatively small	Neutral Somewhat uncertain, but minimal	Neutral Relatively small area	Neutral	Neutral
Alternative 3	Neutral Area 1A TAC would still be harvest by other gear types	Neutral Effort shifts could reduce impacts on RH/S but increase impacts on haddock, but caps in place	Low negative to low positive Depends on how vessels react	Low negative to negative on protected species and Neutral to negative on ESA species if effort shifts to areas and gears with higher interactions	Neutral to low negative
Alternative 4 Alternative 5 Alternative 6	Neutral to low positive If sub-ACLs not harvested could be low positive impacts, but fishing activity may adjust, so could be neutral impacts	Neutral, somewhat uncertain due to unknown effort shifts. Effort more likely to move offshore under Alt 6 and longer season sub option	Somewhat uncertain Low negative to low positive More neutral if vessels convert gear and harvest the same level of herring	Low negative to negative on protected species and Neutral to negative on ESA species if effort shifts to areas and gears with higher interactions	Neutral to low negative for Alt. 4 and 5 Low negative for Alt 6 if vessels more inclined to convert to bottom trawl
Alternative 7	Neutral – little impact, Area 1B likely impacted, a corridor area	Neutral Effort shifts could reduce impacts on RH/S but increase impacts on haddock, but caps in place	Mostly neutral with low positive impacts inshore and low negative impacts offshore	Low negative to negative on protected species and Neutral to negative on ESA species if effort shifts to areas and gears with higher interactions	Neutral to low negative
Alternative 8	Neutral – if sub-ACLs stay the same, more uncertain if they change in future action, but still relatively low impacts.	Neutral Minimal amount of potential effort shift compared to others	Somewhat uncertain Low positive to low negative	Neutral	Neutral

Alternative 9	Neutral – little impact, when fish removed not expected to have direct impacts	Neutral Minimal impact – just season	Low positive, but somewhat uncertain	Low negative on protected species and neutral on ESA species	Neutral

Table 144 – Summary of potential impacts of measures to reduce potential localized depletion and user conflicts across human environment (re = relative to)

Alternative	Herring Fishery	Mackerel Fishery	Herring/Mackerel MWT revenue[1]	Lobster Fishery	Predator Fisheries/Ecotourism
Alternative 1	Fishery-wide = Neutral MWT = Low negative PUR = Positive	Low negative		Neutral	Positive
Alternative 2	Short-term and low negative re Alt 1; low pos re 3-8; low neg re 9. Option A low pos re B.	Short-term and low negative re Alt 1; low pos re 3-8; low neg re 9. Option A low pos re B.	0.5-0.6%	Short-term and low negative re Alt 1; low pos re 3-8; low neg re 9. Option A low pos re B.	Short-term, uncertain, potentially low pos re Alt 1; low neg re A3-7; low pos re A8; neutral re A9. Option A low neg re B
Alternative 3	Fishery-wide = neutral re No Action MWT = low negative re No Action, low neg re A2, low ne to low pos re A4-8; neg re A9 PUR = positive	Low neg re No Action; low neg re A2, low ne to low pos re A4-8; neg re A9	17.8%	Neutral re No Action; low neg to low pos re A2, 4-8; low neg re A9	Uncertain, potentially low pos re No Action, A2, A4-8; neutral re A9
Alternative 4	Neg to low neg re No Action, particularly for mwt PUR/smbt = neutral Neg re 2; neg to neut re 3,7,8; neut to pos re 5,6; neg re 9. Sub-Option A-A most negative, B-B least negative	Neg to low neg re No Action; neg re 2; neg to neut re 3,7,8; neut to pos re 5,6; neg re 9. Sub-Option A-A most negative, B-B least negative	0.3-18%	Neg to low neg re No Action; neg re 2; neg to neut re 3,7,8; neut to pos re 5,6; neg re 9. Sub-Option A-A most negative, B-B least negative	Uncertain, potentially low pos re No Action, A2 & 8; neg to neutral A3, 5-7; neutral re A9 Sub-Option A-A neutral re A-B, low pos re B-A and B-B

Alternative 5	Neg to low neg re No Action, particularly for mwt PUR/smbt = neutral Neg re 2; neg to neut re 3,4,7,8; neut to pos re 6; neg re 9. Sub-Option A-A most negative, B-B least negative	Neg to low neg re No Action Neg re 2; neg to neut re 3,4,7,8; neut to pos re 6; neg re 9. Sub-Option A-A most negative, B-B least negative	0.6-26%	Neg to low neg re No Action Neg re 2; neg to neut re 3,4,7,8; neut to pos re 6; neg re 9. Sub-Option A-A most negative, B-B least negative	Uncertain, potentially low pos re No Action, A2 4,7,8; neg to neutral A3, 6; neutral re A9 Sub-Option A-A neutral re A-B, low pos re B-A and B-B
Alternative 6	Neg re No Action, particularly for mwt PUR/smbt = neutral Neg re 2 and 8; neg to neut re 3,4,5,7; neg re 9. Sub-Option A-A most negative, B-B least negative	Neg to low neg re No Action Neg re 2 and 8; neg to neut re 3,4,5,7; neg re 9. Sub-Option A-A most negative, B-B least negative	5-45%	Neg re No Action Neg re 2 and 8; neg to neut re 3,4,5,7; neg re 9. Sub-Option A-A most negative, B-B least negative	Uncertain, potentially low pos re No Action, A2 4,5,8; neg to neutral A3; neutral re A9 Sub-Option A-A neutral re A-B, low pos re B-A and B-B
Alternative 7	Low neg re No Action, particularly for mwt PUR/smbt = neutral Neg re 2 and 8; neg to neut re 3,4,5,6; neg re 9. Sub-Option A-A most negative, B-B least negative	Low neg re No Action Neg re 2 and 8; neg to neut re 3,4,5,6; neg re 9. Sub-Option A-A most negative, B-B least negative	0.5-8.7%	Low neg to neutral re No Action Neg re 2 and 8; neg to neut re 3-6; neg re 9. Sub-Option A-A most negative, B-B least negative	Uncertain, potentially low pos re No Action, A2, 8; low neg to low pos re A3-6; neutral re A9 Sub-Option A-A neutral re A-B, low pos re B-A and B-B
Alternative 8	Low neg re No Action Neg to neutral re 2; neg to pos re 4,5,7; pos re 3,6; neut re 9.	Low neg re No Action Neg to neutral re 2; neg to pos re 4,5,7; pos re 3,6; neut re 9.	4%	Low neg re No Action Neg to neutral re 2; neg to pos re 4,5,7; pos re 3,6; neut re 9.	Uncertain, potentially neutral re No Action; low neg 2-7; neutral re A9
Alternative 9	Low neg re No Action Pos re 2-7; neutral re 8.	Low pos re No Action Pos re 2-7; neutral re 8.	n/a	Low pos re No Action Pos re 2-7; neutral re 8.	Uncertain, potentially low pos re No Action; neutral re 2-8

[1] *2007-2015 annualized MWT revenue for the areas/seasons that may be closed/inaccessible as a percent of all MWT revenue for the seasons.*

4.9 CUMULATIVE IMPACTS

A Cumulative Effects assessment (CEA) is a required part of an EIS or EA according to the Council on Environmental Quality (CEQ; 40 CFR part 1508.7) and NOAA's agency policy and procedures for NEPA (NOAA Administrative Order 216-6A). The purpose of the CEA is to integrate into the impact analyses the combined effects of many actions over time that would be missed if each action were evaluated separately. CEQ guidelines recognize that it is not practical to analyze the cumulative effects of an action from every conceivable perspective but, rather, the intent is to focus on truly meaningful effects. Thus, the potential direct and indirect effects of the Amendment 8 alternatives are examined together with past, present, and reasonably foreseeable future actions that affect the herring environment. Predictions of potential synergistic effects from multiple actions, past, present and/or future will generally be qualitative in nature, because of limitations in determining effects over the large geographic areas under consideration.

4.9.1 Valued Ecosystem Components

Consistent with CEA guidelines, cumulative effects can be identified by analyzing the impacts of the Proposed Action on valued ecosystem components (VECs). VECs represent the resources, areas, and human communities that may be affected by a Proposed Action or alternatives and by other actions that have occurred or will occur outside the Proposed Action. VECs are generally the "place" where the impacts of management actions are exhibited. An analysis of impacts is performed on each VEC to assess whether the direct/indirect effects of an alternative adds to or subtracts from the effects that are already affecting the VEC from past, present and future actions outside of the Proposed Action (i.e., cumulative effects). The VECs for Amendment 8 are:

1. Target Species (Atlantic Herring; Section 3.1)
2. Non-Target Species (Bycatch; Section 3.2)
3. Non-Protected Predator Species That Forage on Herring (Tuna, Groundfish, Striped Bass; Section 3.3)
4. Protected Species (Fish, Sea Turtles, Marine Mammals, Seabirds; Section 3.4)
5. Physical Environment and Essential Fish Habitat (Section 3.5)
6. Human Communities (Section 3.6)

Changes to the Herring FMP have potential to affect the Atlantic herring resource directly. Similarly, management actions that would alter the distribution and magnitude of herring fishing effort could affect non-target species (haddock and river herring/shad) and predator species directly or indirectly. The physical environment and EFH VEC focuses on habitat types vulnerable to activities related to fishing for herring. The protected species VEC focuses on those protected species with a history of encounters with the herring fishery or which rely on herring as prey. The human communities VEC could be affected directly or indirectly through a variety of complex economic and social relationships associated with either the managed species (Atlantic herring) or any of the other VECs.

The descriptive and analytic components of this document are organized consistently. The Affected Environment for Amendment 8 (Section 3.0) traces the history of each VEC since the implementation of Amendment 1 to the Herring FMP (in 2006) through the 2016-2018 Specifications, reflecting the impacts of past actions. The Affected Environment enhances understanding of the historical, current, and near-future conditions (baselines and trends) to characterize the anticipated environmental impacts of the management alternatives under consideration. The direct/indirect and impacts of these alternatives and measures are then assessed in Section 4.0 using a similar structure to that found in the Affected Environment. This EIS, therefore, follows each VEC through each management alternative.

The CEA identifies and characterizes the impact on the VECs by the alternatives under consideration when analyzed in the context of other past, present, and reasonably foreseeable future actions. To enhance clarity and maintain consistency, terms are as defined in Table 91.

4.9.2 Spatial and Temporal Boundaries

The geographic area that encompasses the physical, biological and human community impacts considered in the CEA are described in detail in Section 3.0 (Affected Environment). The geographic range for impacts to fish species is the range of each fish species in the western Atlantic Ocean. The physical environment, including habitat and EFH, is bounded by the range of the Atlantic herring fishery, from the GOM through the Mid-Atlantic Bight, and includes adjacent upland areas (from which non-fishing impacts may originate). For protected species, the geographic range is the Northwest Atlantic Ocean. The geographic range for human communities focuses on the Northeast U.S.

Overall, while the effects of the historical herring fishery are important and are considered in the analysis, the temporal scope of this CEA focuses principally on actions that have occurred since 1996, when the Magnuson-Stevens Act (SFA 1996) was amended and implemented new fisheries management and Essential Fish Habitat requirements. The temporal scope for marine mammals begins in the mid-1990s, when NMFS was required to generate stock assessments for marine mammals that inhabit waters of the U.S. EEZ, creating the baseline against which current stock assessments are evaluated. For turtles, the temporal scope begins in the 1970s, when populations were noticed to be in decline. The temporal scope for Atlantic herring is focused more on the time since the original Atlantic Herring FMP was implemented in 2001, because this FMP serves as the primary management action for the Atlantic herring fishery and has helped to shape the current condition of the resource.

The temporal scope of future actions, including Amendment 8, for all VECs, extends out five years. This period likely will reflect the dynamic nature of resource management. The lack of specific information on projects that may occur in the future makes it difficult to predict impacts beyond this timeframe with any certainty. This is also the rebuilding timeframe for Atlantic herring, as defined in its FMP, should it become overfished and subject to a rebuilding program.

4.9.3 Analysis of Total Cumulative Effects

A cumulative effects assessment ideally makes effect determinations based on the combination of the following: 1) combined effects from past, present and reasonably foreseeable future actions; 2) baseline condition of the VECs (the combined effects from past, present and reasonably foreseeable future actions plus the present condition of the VEC); and 3) impacts of the Amendment 8 alternatives. The combination of all these factors determines the cumulative effects assessment.

4.9.3.1 Past, Present, and Reasonably Foreseeable Future Actions

The following is a synopsis of the most applicable past, present, and reasonably foreseeable future actions that have the potential to interact with the current action (Table 145). Section 3.0 summarizes the current state of the Atlantic herring resource and fishery, and provides additional information about habitat, non-protected predator species, protected resources, and non-target species that may be affected by the alternatives under consideration. The impacts of non-fishing activities are also considered,

Most of the actions affecting the VECs come from fishery-related activities (e.g., Federal fishery management actions), which have straightforward effects on environmental conditions, and were, are, or will be taken, in large part, to improve those conditions. The reason for this is the statutory basis for Federal fisheries management - the reauthorized Magnuson-Stevens Act (SFA 1996). That legislation was enacted to promote long-term positive impacts on the environment in the context of fisheries activities. More specifically, the MSA stipulates that management comply with a set of National Standards that collectively serve to optimize the conditions of the human environment. Under this regulatory regime, the cumulative impacts of past, present, and future Federal fishery management actions on the VECs should be expected to result in positive long-term outcomes. Nevertheless, these actions are often associated with offsetting impacts. For example, constraining fishing effort frequently results in negative short-term socioeconomic impacts for fishery participants. However, these impacts are usually necessary to bring about the long-term sustainability of a given resource, and as such, should, in the long term, promote positive effects on human communities, especially those that are economically dependent upon the managed resource.

Non-fishing activities were also considered when determining the combined effects from past, present and reasonably foreseeable future actions. Activities that have meaningful effects on the VECs include the introduction of chemical pollutants, sewage, changes in water temperature, salinity, dissolved oxygen, and suspended sediment into the marine environment. A description of potential effects of climate change and changes in environmental conditions are generally discussed in more detail in Section 3.1.7. These activities pose a risk to the all VECs in the long term. Human induced non-fishing activities that affect the VECs are those that tend to be concentrated in near shore areas. Examples of these activities include, but are not limited to agriculture, port maintenance, beach nourishment, coastal development, marine transportation, marine mining, wind farm development, dredging and the disposal of dredged material. Wherever these activities co-occur, they are likely to work additively or synergistically to decrease habitat quality and, as such, may indirectly constrain the sustainability of the managed resources, non-target species, and protected resources. Decreased habitat suitability would tend to reduce the tolerance of these VECs to the impacts of fishing effort. Mitigation of this outcome through regulations that would reduce fishing effort could then negatively impact human communities.

Global climate change will affect all components of marine ecosystems, including human communities. Physical changes that are occurring and will continue to occur to these systems include sea-level rise, changes in sediment deposition, changes in ocean circulation, increased frequency, intensity and duration of extreme climate events, changing ocean chemistry, and warming ocean temperatures. Emerging evidence suggests that these physical changes may have direct and indirect ecological responses within marine ecosystems which may alter the fundamental production characteristics of marine systems [Stenseth et al. 2002]. Climate change could potentially exacerbate the stresses imposed by fishing and other non-fishing human activities and stressors (described in this section).

Results from the Northeast Fisheries Climate Vulnerability Assessment [Hare et al., 2016] indicate that climate change could have overall directional impacts on all VECs that range from negative to positive depending on the species, their climate vulnerability, potential for distribution change, and other factors. However, future mitigation and adaptation strategies to climate change may mitigate some of these impacts as more information becomes available to predict, evaluate, monitor, and categorize these changes.

For potential biological impacts of wind, the turbines and cables may influence water currents and electromagnetic fields, respectively, which can affect patterns of movement for various species (target, non-target, protected). Habitats directly at the turbine and cable sites would be affected, and there could be scouring concerns around turbines. Impacts on human communities in a general sense will be mixed – there will be economic benefits in the form of jobs associated with construction and maintenance, and replacement of some electricity generated using fossil fuels with renewable sources. But there may be negative effects on fishing activities in terms of effort displacement, or making fishing more difficult or expensive near the turbines or cables.

For oil and gas, this timeframe would include leasing and possible surveys. Seismic surveys impact the acoustic environment within which marine species live, and have uncertain effects on fish behaviors that could cumulatively lead to negative population level impacts. The science on this is fairly uncertain. If marine resources are affected by seismic, then so in turn the fishermen targeting these resources would be affected. However, there would be an economic component in the form of increased jobs where there may be some positive effects on human communities.

Table 145 - Summary of effects from past, present, and reasonably foreseeable future actions on the VECs

VEC	Past Actions	Present Actions	Reasonably Foreseeable Future Actions	Combined Effects of Past, Present, Future Actions
	A	B	C	A+B+C
Atlantic Herring	**Positive** Controlled effort and provided a sustainable fishery on a rebuilt resource	**Positive** Current regulations continue to manage for a sustainable stock	**Positive** Future actions will likely strive to maintain a sustainable stock	**Positive** Stock are being managed for sustainability
Non-Target Species	**Low Positive** Decreased effort and reduced bycatch; bycatch concerns remain for RH/S	**Low Positive** Current regulations continue to decrease effort and reduce bycatch; bycatch concerns remain for RH/S	**Positive** Future actions will likely improve monitoring and further address bycatch issues	**Low Positive** Decreased effort and reduced bycatch continue
Non-protected predator species	**Positive** Stock have been managed for sustainability	**Positive** Current regulations continue to manage for sustainable stocks	**Positive** Future actions will likely strive to maintain a sustainable stock	**Positive** Stock are being managed for sustainability
Protected Resources	**Positive** Reduced effort and thus interactions with protected resources	**Positive** Current regulations continue to control effort, thus reducing opportunities for interactions	**Mixed** Future actions will likely control effort and thus protected species interactions	**Positive** Continued effort controls along with past regulations will likely help stabilize protected species interactions
Physical Environment and Essential Fish Habitat	**Positive** Decreased effort and improved habitat protection	**Positive** Effort reductions and better control of non-fishing activities have been positive. Fishing activities and non-fishing activities continue to reduce habitat quality	**Positive** Future actions are likely to continue rebuilding a healthy environment and increase habitat quality	**Positive** Continued management of physical environment and EFH for an increased quality of habitat
Human Communities	**Mixed** Effort reductions and better control of non-fishing activities have been positive, but fishing industry and thus businesses have reduced	**Mixed** Continue to manage for a sustainable stock, thus controlling effort on the herring resource provides additional yield for fishery and non-fishery activities	**Mixed** Future regulations will likely control effort and but as stocks improve, effort will likely increase for fishery and non-fishing activities	**Mixed** Continued fisheries management will likely control effort for a sustainable fishery and thus fishery and non-fishery related activities will continue

4.9.3.1.1 Target Species (Atlantic Herring)

Past and Present Actions: Herring management measures were developed in two related, but separate FMPs in 1999 – one by the Council and one by the Atlantic States Marine Fisheries Commission (ASMFC). The status of the herring resource is updated in Section 3.1.6 and the herring fishery is summarized in Section 3.6.1. The herring resource is currently assessed on one unit, with inshore and offshore components, but it is considered one stock. The offshore component seems to have recovered from its collapse in the early 1970s and, overall, the inshore herring resource is not overfished, and overfishing is not occurring. There is more concern for the inshore stock since it receives more fishing pressure, but the most recent stock assessment (2015) indicates that the herring resource is in a "rebuilt" condition (above the biomass target) and that fishing mortality is well below the overfishing threshold.

The ASMFC manages the Atlantic herring fishery in State waters. The ASMFC adopted Amendment 2 in March of 2006, which revised management area boundaries, biological reference points, the specification process, research set-asides, internal waters processing operations, and measures to address fixed gear fisheries and required fixed gear fishermen to report herring catches through the IVR program. This action is expected to have low positive impacts on the herring resource by allowing for research funded through research set-asides and increased catch reporting.

The ASMFC also adopted an Addendum in 2010, which modified Amendment 1 and Amendment 2 to the Interstate Fisheries Management Plan for Atlantic Sea Herring by changing the specification setting process and associated definitions. The action is expected to have positive impacts on the herring resource by helping align the ASMFC's and the Council's processes for setting harvest specifications.

The ASMFC adopted Amendment 3 to the Interstate Fishery Management Plan for Atlantic Herring in February 2016. The ASMFC adjusted the default closing dates and boundaries of the three inshore spawning areas and allowed for a rollover provision for the fixed gear set-aside. This action is expected to have low positive impacts on the herring resource, because it helps to better protect spawning herring.

The Standard Bycatch Reporting Methodology Amendment was implemented in 2007 and revised in 2015. The amendment specified methods and processes to monitor bycatch in Greater Atlantic Region fisheries. This action is expected to have a low positive impact on the herring resource, because it improves information on herring discards and may help monitor the impacts of climate change.

Amendment 4 to the Atlantic Herring FMP, in 2011, established provisions for ACLs, set an interim ABC control rule, eliminated JVP, IWP, TALFF and reserve specifications, established provisions for sub-ACLs, and implemented accountability measures. This action is expected to have positive impacts on the herring resource by ensuring the fishery is sustainably managed using catch limits and accountability measures to prevent harvest overages.

Framework 2 to the Atlantic Herring FMP was implemented by NMFS concurrently with the 2013-2015 Atlantic herring fishery specifications on September 30, 2013. Framework 2 authorizes the Council to split sub-ACLs in all herring management areas seasonally and established a general policy for authorizing annual carryover of unutilized sub-ACL (up to 10%) under specific conditions. In addition to implementing harvest specifications, the 2013-2015 specifications established a new AM to limit catch when 95% of the herring ACL is projected to be reached and lowered the trigger (from 95% to 92% of the sub-ACL) to limit catch in each of the herring management areas. These actions are expected to have positive impacts on the herring resource by helping prevent overfishing and supporting sustainable management.

Amendment 5 to the Atlantic Herring FMP was implemented in 2014. Amendment 5 implemented measures for catch reporting, vessel requirements for catch sampling by observers, and slippage restrictions to ensure catch is available for sampling by an observer. This action is expected to have low positive impacts on the herring resource by improving catch reporting and catch sampling.

Framework 4 to the Atlantic Herring FMP became effective in 2016 and built on measures implemented in Amendment 5 to the Atlantic Herring FMP. The action clarified slippage requirements, required slippage to be reported via VMS, and established slippage consequences. This action is expected to have low positive impacts on the herring resource by refining slippage measures to help ensure catch is available to be sampled by an observer.

The 2016-2018 Herring Specifications were effective in 2016. The action set herring harvest limits, as well as river herring/shad catch caps, for the herring fishery. Because the herring ABC was slightly reduced from previous years, based on the 2015 herring stock assessment update, this action is expected to have a positive impact on the herring resource by supporting sustainability.

An Omnibus EFH Amendment was implemented in early 2018 (Amendment 3 to the Atlantic Herring FMP). This amendment may increase the protection of benthic habitats and modify the boundaries and access provisions of the Groundfish Closed Areas. This action may have low positive impacts on the herring resource if it increases protection for habitat important to herring and may help negate any negative impacts of climate change.

Reasonably Foreseeable Future Actions: NMFS is currently leading the development of an omnibus amendment to establish provisions for industry-funded monitoring across all New England and Mid-Atlantic Council-managed FMPs (Amendment 7 to the Herring FMP). This amendment considers provisions for observer coverage in the Atlantic herring and mackerel fisheries, which were disapproved in Amendment 5 (herring) and Amendment 14 (mackerel). The omnibus amendment only recently published final measures in April 2018, so is still considered a reasonable foreseeable future action for Amendment 8 because the impacts are not certain at this point. The long-term impacts of this action on the Atlantic herring resource are likely to be positive.

4.9.3.1.2 Non-Target Species

Past and Present Actions: Updated information about non-target species affected by the herring fishery is provided in Section 3.2. River herring and shad (RH/S) and haddock are non-target species of particular concern in the herring fishery. There are several other species that are caught, but haddock and RH/S are the only stocks with bycatch caps. Atlantic mackerel is another important species encountered in the herring fishery, which is sometimes caught more incidentally, and in some cases targeted and landed with herring, and separated later.

The Northeast Multispecies FMP has a multitude of management measures. Past and present actions to the regulated groundfish stocks have created mixed effects, as the combined effects of past actions have decreased effort, improved habitat protection, and implemented rebuilding plans when necessary, but some stocks remain overfished. Overall, the impacts of the FMP on haddock have been mixed but are currently low positive because the stock is not overfished and overfishing is not occurring.

In 2006, Framework 43 to the Northeast Multispecies FMP established a cap on the amount of herring caught in the herring fishery and prohibited some discarding of haddock. In 2011, Framework 46 adjusted the cap provisions so that they only apply to midwater trawl vessels and created caps for both the Georges Bank and Gulf of Maine haddock stocks. In 2017, Framework 56 increased the cap from 1% of the stock area ABC to 1.5% of the stock area ABC. Overall, the impacts of these actions on haddock have been positive because they improve the accountability for haddock caught in the herring fishery.

The ASMFC adopted Amendment 1 to the FMP for Shad and River Herring in 1998 and included measures to improve data collection and stock assessment capabilities. Amendments 2 and 3 to the Shad and River Herring FMP required approved sustainability plans for any state fishery. Overall, the impacts of the FMP on shad and river herring have been mixed but would be positive if they help these species no longer be depleted.

The Standard Bycatch Reporting Methodology Amendment was implemented in 2007 and revised in 2015. The amendment specified methods and processes to monitor bycatch in Greater Atlantic Region fisheries. This action is expected to have a low positive impact on non-target species because it improves information on non-target species discards and may help monitor the impacts of climate change.

Amendment 5 to the Atlantic Herring FMP was implemented in 2014. Amendment 5 implemented measures for catch reporting, vessel requirements for catch sampling by observers, and slippage restrictions to ensure catch is available for sampling by an observer. The amendment also expanded the 100% observer coverage requirement aboard midwater trawl vessels fishing in Closed Area I to apply to midwater trawl vessels fishing in any of the Groundfish Closed areas. Lastly, the amendment established provisions for river herring/shad catch caps in the herring fishery. This action is expected to have low positive impacts on non-target species by improving catch reporting and catch monitoring.

Amendment 14 to the Mackerel Squid Butterfish FMP was also implemented in 2014. Like Amendment 5, Amendment 14 implemented measures for catch reporting, vessel requirements for catch sampling by observers, and slippage restrictions to ensure catch is available for sampling by an observer. The amendment also established provisions for river herring/shad catch caps in the mackerel fishery. This action is expected to have low positive impacts on non-target species by improving catch reporting and catch monitoring.

Framework 3 to the Atlantic Herring FMP established catch caps for river herring/shad in the herring fishery. This action is expected to have a positive impact on river herring and shad, because it improves the accountability for river herring and shad caught in the herring fishery. However, the magnitude of that impact is uncertain because caps are not linked to river herring and shad stock status or fishing mortality at this time.

Framework 4 to the Atlantic Herring FMP became effective in 2016 and built on measures implemented in Amendment 5 to the Atlantic Herring FMP. The action clarified slippage requirements, required slippage to be reported via VMS, and established slippage consequences. This action is expected to have low positive impacts on non-target species by refining slippage measures to help ensure catch is available to be sampled by an observer.

The 2016-2016 Herring Specifications were effective in 2016. While this action increased the amount of the river herring/shad catch caps, the resulting caps are still lower than historical river herring and shad catch. This action is expected to have a positive impact on river herring and shad by providing a sufficient incentive for the herring fishery to avoid river herring and shad. However, the magnitude of that impact is uncertain because caps are not linked to river herring and shad stock status or fishing mortality at this time.

In early August 2013, when NMFS published its decision not to list river herring under the ESA, NMFS indicated that it would partner with ASMFC to form a technical expert working group (TEWG). The TEWG is focused on developing a dynamic conservation plan to help restore river herring throughout their range from Canada to Florida, identifying and implementing important conservation efforts, and conducting research to fill in some of the critical data gaps for these species. NMFS plans to continue to coordinate with all of management partners including the Mid-Atlantic and the New England Fishery Management Councils to maximize resources and identify ways to complement ongoing efforts to promote river herring restoration. This action is expected to have low positive impacts on river herring resulting from increased information about threats to river herring and increased cooperation among management partners to address threats to river herring.

The Mid-Atlantic Unmanaged Forage Omnibus Amendment, implemented in September 2017, restricted the expansion of commercial fisheries for certain forage species. This action included an annual catch limit for Atlantic chub mackerel and possession limits for chub mackerel and other forage species caught within Mid-Atlantic federal waters. This action is expected to have positive impacts on non-target species by help prevent the overharvest of forage species.

The Omnibus EFH Amendment, implemented in earl 2018, may increase the protection of benthic habitats and modify the boundaries and access provisions of the Groundfish Closed Areas. This action may have low positive impacts on non-target species, if it increases protection for habitat important to non-target species and may help negate any negative impacts of climate change.

Reasonably Foreseeable Future Actions: Amendment 23 to the Northeast Multispecies FMP was initiated by the Council in 2017 to implement measures to improve reliability and accountability of catch reporting and to ensure a precise and accurate representation of catch (landings and discards). The amendment will consider alternatives such as electronic monitoring, dockside sampling, and methods to determine total monitoring coverage rate. This action may have a low positive impact on haddock if additional monitoring improves the information for stock assessments and management decisions.

4.9.3.1.3 Non-Protected Predator Species That Forage on Herring

Section 3.3 includes a description of the life history and stock population status for the major predators of Atlantic herring which are not protected under the Endangered Species Act and/or the Marine Mammal Protection Act, including tuna, some species managed under the Groundfish FMP, and striped bass. The past management practices of the Council, ICCAT, ASMFC, and NMFS have resulted in positive impacts on the health of the predators of herring. Numerous actions have been taken to manage the commercial and recreational fisheries for the predator species. In addition, the specifications process is intended to provide the opportunity to regularly assess the status of the fisheries and make necessary adjustments to ensure that there is a reasonable expectation of meeting the objectives of the FMP and the targets associated with any rebuilding programs under the FMP. The statutory basis for Federal fisheries management is the MSA. To the degree with which this regulatory regime is complied, the cumulative impacts of past, present, and reasonably foreseeable future federal fishery management actions on the VECs should generally be associated with positive long-term outcomes. Constraining fishing effort through regulatory actions can often have negative short-term socioeconomic impacts. These impacts are usually necessary to bring about long-term sustainability of a given resource, and as such, should, in the long-term, promote positive effects on human communities, especially those that are economically dependent upon the related fisheries.

4.9.3.1.4 Protected Species: Fish, Turtles, Marine Mammals, Seabirds

Past and Present Actions: A general description of protected species that may be affected by this action is in Section 3.4 and in more detail in Amendment 5 to the Atlantic Herring FMP. Large whales may be adversely affected by habitat degradation, habitat exclusion, acoustic trauma, harassment, or reduction in prey resources due to trophic effects resulting from a variety of activities including the operation of commercial fisheries. Ship strikes and fishing gear entanglement continue to be the most likely sources of human-related injury or mortality for right, humpback, fin and minke whales. Sei, blue, and sperm whales are also vulnerable, but fewer ship strikes or entanglements have been recorded. Mobile bottom trawls, as well as midwater trawl gear, appear to be less of a concern for the large whale species. Other marine mammals, however, such as harbor porpoise, dolphins and to a greater degree seals, are vulnerable to entanglement in net gear, including midwater trawl gear and purse seines.

In addition to these actions, NMFS has implemented specific regulatory actions to reduce injuries and mortalities from gear interactions. The ALWTRP, implemented in 1999 with subsequent rule modifications, restrictions, and extensions, includes time and area closures for trap/pot fisheries (e.g., lobster and black sea bass) and gillnet fisheries (e.g., anchored gillnet and shark gillnet fisheries); gear requirements, including a general prohibition on having line floating at the surface in these fisheries; a prohibition on storing inactive gear at sea; and restrictions on setting shark gillnets off the coasts of Georgia and Florida and drift gillnets in the Mid-Atlantic. This plan also contains non-regulatory aspects, including gear research, public outreach, scientific research, a network to inform mariners when right whales are in an area, and increasing efforts to disentangle whales caught in fishing gear. The intent of the ALWTRP is to positively affect large whales (North-Atlantic right, humpback, and fin) by reducing their injury and death in waters off the U.S. East Coast due to incidental entanglement in fishing gear.

Turtles have documented entanglements in shrimp trawls, pound nets, bottom trawls and sink gillnets. Shrimp trawls are required to use turtle excluder devices (TEDs). The sea turtle life history also leaves them susceptible to many other human impacts, including impacts on land, in the benthic environment, and in the pelagic environment. Anthropogenic factors that impact the success of nesting and hatching include: beach erosion, beach armoring and nourishment; artificial lighting; beach cleaning; increased human presence; recreational beach equipment; beach driving; coastal construction and fishing piers; exotic dune and beach vegetation; and poaching. An increased human presence at some nesting beaches or close to nesting beaches has led to secondary threats such as the introduction of exotic fire ants, and an increased presence of native species (e.g., raccoons, armadillos, and opossums) which raid and feed on turtle eggs. Entanglement(s) in debris or ingestion of marine debris are also seen as possible threats.

The final submission for Amendment 5 to the Atlantic Herring FMP was presented to NMFS on Dec 21, 2012 and approved by Council in June 2012. Measures that were approved in Amendment 5 became effective on March 17, 2014. The focus of Amendment 5 is to establish a comprehensive catch monitoring program for the limited access herring fishery, address river herring bycatch, establish criteria for midwater trawl vessel access to groundfish closed areas, and adjust other aspects of the fishery management program to keep the Herring FMP in compliance with the MSA.

The Omnibus EFH Amendment, implemented in early 2018, and the combined direct impacts of the measures on protected resources are expected to be minimal, generally ranging from low negative to low positive overall. In general, the effort shifts associated with spatial management areas are expected to have some indirect effects on fishery interactions with protected resources, but these interactions are also managed directly via gear-based measures and seasonal restrictions.

Reasonably Foreseeable Future Actions: The Harbor Porpoise Take Reduction Plan for the GOM and Mid-Atlantic coasts was originally implemented in 1998, and NMFS published a proposed rule in July 2009 indicating additional management restrictions for gillnetters. Future measures of this plan may be implemented if take reduction goals are not met, which could further reduce fishing effort, a positive effect on the population of this species.

The Sea Turtle Strategy is a gear-based approach to addressing sea turtle bycatch. Under the Strategy, NMFS has identified trawl gear as a priority for reducing sea turtle bycatch and is considering proposing changes to the TED requirements in the trawl fisheries. TED requirements are designed to have a positive effect on protected resources, specifically turtles by allowing for most turtles caught in trawl nets to escape. NMFS is working to develop and implement bycatch reduction measures in all trawl fisheries in the Atlantic and Gulf of Mexico when and where sea turtle takes have occurred or where gear, time, location, fishing method, and other similarities exist between a particular trawl fishery and sea turtle takes have occurred by trawls (72 FR 7382, February 15, 2007). On February 15, 2007, NMFS issued an advance notice of proposed rulemaking to announce that it is considering amendments to the regulatory requirements for TEDs (72 FR 7382). On May 8, 2009, NMFS issued a NOI to prepare an EIS (74 FR 88 May 8, 2009), and held public scoping meetings throughout the East coast.

4.9.3.1.5 Physical Environment and Essential Fish Habitat

Past and Present Actions: The Atlantic herring EFH designation, which was developed as part of an EFH Omnibus Amendment prepared by Council for its entire managed species, is in Section 3.5.2.1. The EFH Omnibus Amendment was approved for Atlantic herring by the Secretary of Commerce on October 27, 1999. The final rule implementing the Atlantic Herring FMP to allow for the development of a sustainable Atlantic herring fishery was published on December 11, 2000 (65 FR 77450).

Because the gears used in the Atlantic herring fishery have only occasional bottom contact with the primary substrates used by herring for egg deposition, and because the noises produced by herring fishing operations only temporarily disperse schools of juvenile and adult herring, EFH impacts assessments for the fishery have concluded that it does not have an adverse effect on herring EFH. In addition, these assessments have concluded that the herring fishery does not have an adverse impact on EFH designated for non-herring species.

Various measures have been implemented in the Northeast Region to protect the EFH of Council-managed species. In particular, all bottom-tending mobile gear is prohibited from the level 3 Habitat Closed Areas (HCAs) established in 2004 under Amendment 13 to the Northeast Multispecies FMP and Amendment 10 to the Atlantic Sea Scallop FMP. In large part, these HCAs overlap with areas established in 1994 and 1998 to protect overfished stocks of cod, haddock and other groundfish species. As mobile bottom-tending gear is largely prohibited from the groundfish closures, they have incidental EFH protection benefits. Other measures to protect EFH include spatially-specific roller gear restrictions in the Multispecies and Monkfish fisheries.

The Omnibus EFH Amendment, implemented in early 2018, reviews and updates EFH designations, identifies Habitat Areas of Particular Concerns (HAPCs), reviews prey information for all managed species, reviews non-fishery impacts to EFH, and reviews the current science on fishing impacts to habitat. It will also include coordinated and integrated measures intended to minimize the adverse impact of Council-managed fishing on EFH. It may also modify the boundaries and access provisions (including those for midwater trawl gear) related to the year-round groundfish closed areas. The net effect of new EFH and HAPC designations and more targeted habitat management measures should be positive for the physical environment and EFH.

Reasonably Foreseeable Future Actions: Offshore wind project construction south of MA/RI may begin as early as 2019 (three projects including Vineyard Wind, Bay State Wind, and South Fork Wind Farm). Additional areas offshore MA, RI, NY, and NJ (plus areas further south) have been leased and will have site assessment activities in the next few years. These projects could have low negative impacts on EFH, as well as herring, non-target, and fishing communities if there are any negative impacts on those resources. Furthermore, there could be negative impacts on protected species of birds and marine mammals if they interact with the wind farms.

The Strategy for Sea Turtle Conservation and Recovery in Relation to Atlantic Ocean and Gulf of Mexico ("Strategy") is a gear-based approach to addressing sea turtle bycatch. NMFS is currently considering proposing changes to the regulatory requirements for trawl fisheries to protect sea turtles. As described in a Notice of Intent (NOI) to prepare an Environmental Impact Statement (EIS) for Sea Turtle Conservation and Recovery in Relation to the Atlantic Ocean and Gulf of Mexico Trawl Fisheries (74 FR 88 May 8, 2009), NMFS is considering expanding the use of TEDs in trawl fisheries and modifying the geographic scope of the TED requirements. Since TED requirements may decrease the catch retention of some target species, vessels may tow longer to offset this loss of catch, likely resulting in negative impacts to habitat and EFH.

4.9.3.1.6 Human Communities

Past and Present Actions: A general description of the human communities that may be affected by this action is in Section 3.6 and in more detail in Amendment 5 to the Herring FMP. Past and present actions affecting the Atlantic herring resource have also affected fishery-related businesses and communities.

In 2010, the ASMFC adopted an addendum that modified Amendment 1 and Amendment 2 to the Interstate FMP for Atlantic Sea Herring by changing the specification setting process and associated definitions. Based on the difficulty of having two sets of acronyms, one for the NEFMC plan and one for the ASMFC plan, for one cooperatively managed species the addendum was developed to establish an identical set of definitions and acronyms as those that the NEFMC is required to use under MSA. The addendum also established a new specification setting process that is more in line with the ASMFC Sea Herring Section's usual process for setting specifications while taking into account the new process that was enacted through Amendment 4 to the Atlantic Herring FMP.

Amendment 4 to the Atlantic Herring FMP (2010), primarily responded to the requirements of the MSA and NEPA. The amendment established ACLs by first defining terms to bring the FMP into compliance with the new requirements of the MSA, setting an interim ABC control rule, eliminating JVP, IWP, TALFF and reserve specifications, establishing sub-ACLs, and modifying the specifications process to utilize these elements. Three Accountability Measures (AMs) were also established in Amendment 4: an in-season AM that closes the directed herring fishery in a management area when there is a projection that 95% of the sub-ACL is reached, an AM for overage deductions, which subtracts the amount of an ACL or sub-ACL overage from subsequent ACLs/sub-ACLs, and another AM which established provisions for closing the directed herring fishery if the haddock catch cap (Framework 43 and 46 to the Multispecies FMP, see below) is reached.

In 2006, Framework 43 to the Northeast Multispecies FMP was enacted, which modified the restrictions for herring vessels so that herring fishing could continue on Georges Bank, but prohibited certain herring vessels from discarding haddock and limited possession of other groundfish to small amounts. It also adopted a cap on the amount of haddock that could be caught by certain herring vessels. In 2011, Framework 46 changed these catch cap provisions so that they would apply only to midwater trawl vessels with a herring permit, because these vessels caught nearly all the haddock caught by the herring fishery. Catches of haddock by midwater trawl vessels fishing in Herring Management Areas 1A, 1B, and 3 that are documented by at-sea observers are now extrapolated to an estimate of the total catch of haddock. Individual estimates are then developed for each haddock stock (GOM and GB haddock). The cap is then applied based on the multispecies fishing year (May 1 through April 30), and is 1 percent of the Acceptable Biological Catch (ABC) of each stock. If the haddock catch estimate extrapolated from observer reports exceeds a stock-specific cap, midwater trawl vessels are limited to catching 2,000 pounds of Atlantic herring in a relevant area. If there is an overage of the cap, the cap for the following year is reduced by the amount of the overage. To monitor the cap, midwater trawl vessels fishing in Herring Management Areas 1A, 1B, and 3 are also required to report total kept catch by haddock stock area and gear used.

Framework 2 to the Atlantic Herring FMP was implemented by NMFS concurrently with the 2013-2015 Atlantic herring fishery specifications on September 30, 2013. Framework 2 authorizes the sub-ACLs in all herring management areas to be split seasonally (by month) during the specifications process. It also authorizes annual carryover of unused sub-ACL (up to 10%) under specific conditions. Seasonal (monthly) splits of sub-ACLs in Areas 1A and 1B are effective for the 2014 and 2015 fishing years, and carryover provisions apply as well.

Additional AMs for the Atlantic herring fishery were implemented through the 2013-2015 specifications; the AMs will remain effective beyond the 2015 fishing year. Under the new AMs (effective September 30, 2013), the trigger for closing the directed herring fishery in a management area is reduced to 92% of the sub-ACL (not including RSAs). When 92% of a management area sub-ACL is projected to be reached, the directed herring fishery in that area will close, and all herring permit holders will be limited to 2,000 pounds of herring per trip in that area for the remainder of the fishing year. In addition, the new AMs establish a trigger for closing the directed herring fishery in all management areas. The trigger for closing the directed herring fishery in all management areas is 95% of the stockwide Atlantic herring ACL. When

95% of the stockwide ACL for herring is projected to be reached, the directed herring fishery in all management areas will close, and all herring permit holders would be limited to 2,000 pounds of herring per trip for the remainder of the fishing year. These AMs were adopted to further prevent the stockwide Atlantic herring ACL and management area sub-ACLs from being exceeded during the fishing year, as well as improve the likelihood that the total ACL (OY) can be caught on a continuing basis while preventing overfishing.

Amendment 5 to the Atlantic Herring FMP was approved by Council in June 2012. After review and revision, the final submission for Amendment 5 was presented to NMFS on March 25, 2013, and measures approved in Amendment 5 just recently became effective (March 17, 2014). The focus of Amendment 5 is to establish a comprehensive catch monitoring program for the Atlantic herring fishery, address river herring bycatch, establish criteria for midwater trawl vessel access to groundfish closed areas, and adjust other aspects of the fishery management program to keep the Herring FMP in compliance with the MSA. The amendment also establishes a long-term strategy for river herring bycatch avoidance/minimization through industry-based avoidance and, presumably, a catch cap for river herring.

Amendment 14 to the Mackerel Squid Butterfish (MSB) FMP was developed by the MAFMC concurrent with Amendment 5. Many of the actions contained with both Amendments have been developed to compliment and/or replicate each other, to avoid conflicting overlaps of restrictions on vessels that participate in both fisheries. In some cases, however, the actions contained in both Amendments present some conflict with each other. Actions proposed in Amendment 14 include: vessel reporting measures, dealer reporting measures, at-sea observation optimization measures, other sampling and monitoring measures such as port-side monitoring, at-sea observer coverage requirements, mortality caps on river herring, restrictions in areas of high river herring catch, mesh requirements, and the potential addition of river herring as a stock in the fishery. The ways in which these actions overlap can be seen in Table 196 of the Amendment 5 FEIS. The MAFMC also implemented a RH/S catch cap for the directed mackerel fishery through its specifications process. The 2014 RH/S catch cap for the Atlantic mackerel fishery is 236 mt. During the MSB specifications process (June 2014), the MAFMC recommended a catch cap of 89-155 mt for the directed mackerel fishery for the 2015 fishing year (the amount will be scaled based on mackerel catch in the directed mackerel fishery during the fishing year). These measures are expected to have positive impacts on the RH/S resources.

Quickly following the completion of Amendment 5 in 2013, the Council developed Framework 3 to the Atlantic Herring FMP, which also expanded on the management measures in Amendment 5 and established catch caps for RH/S as well as related provisions to manage and minimize interactions with these species in the directed Atlantic herring fishery. The RH/S catch caps implemented through Framework 3 became effective in late 2014. The long-term impact of the catch cap process/provisions on fishery-related businesses and communities is expected to be low positive. Framework 3 enhances industry-based bycatch reduction initiatives and builds on the approach taken in Amendment 5 to the Herring FMP. It reduces the likelihood that more restrictive limits will be imposed in the future if the industry can continue to reduce and avoid RH/S interactions. The RH/S catch caps proposed for the 2014 and 2015 fishing years were expected to have a low negative impact on fishery-related businesses and communities, but the catch caps are not likely to preclude directed Atlantic herring fishing in all areas and provide midwater trawl vessels an opportunity to fish in Area 3 (Georges Bank) without a RH/S catch cap, thereby potentially mitigating some of the negative impacts.

Framework 4 to the Atlantic Herring FMP (effective February 26, 2015) builds on measures implemented in Amendment 5, further enhance catch monitoring and address discarding on Atlantic herring vessels. It implemented a requirement that vessels report slippage (i.e., catch discarded prior to sampling by an observer) via the vessel monitoring system; slippage consequences measures (i.e., requirement to move 15 nm (27.78 km) or return to port following a slippage event); and clarifications to existing slippage measures and definitions. To the extent that these measures enhance the Atlantic herring catch monitoring program and reduce bycatch to the extent practicable, the long-term impacts of this action on fishery-related businesses and communities are expected to be low positive.

NMFS has also led the development of an omnibus amendment to address the Standardized Bycatch Reporting Methodology (Amendment 6 to the Atlantic Herring FMP). This amendment establishes a process and provisions for allocating observer coverage across all Federally-managed fisheries. The proposed measures include bycatch reporting and monitoring mechanisms; analytical techniques and allocation of at-sea fisheries observers; a standardized bycatch reporting methodology performance standard; a review and reporting process; framework adjustment and annual specifications provisions; a prioritization process; and provisions for industry-funded observers and observer set-aside programs. The SBRM amendment measures became effective in mid-2015.

Reasonably Foreseeable Future Actions: The NEFMC and MAFMC are working with NMFS to develop an omnibus amendment to implement provisions for industry-funded monitoring across all fisheries. This amendment considers provisions for observer coverage in the Atlantic herring and mackerel fisheries. The target implementation date for the omnibus amendment is in 2016.

Implementation of the Omnibus EFH Amendment may result in additional habitat protections, which may or may not affect fishery-related businesses and communities depending on changes in vessel effort. This amendment may also modify the boundaries and access provisions (including those for midwater trawl gear) related to the year-round groundfish closed areas. Similarly, if revisions are made to the Harbor Porpoise Take Reduction Plan, vessels could face additional restrictions, possibly resulting in positive impacts to bycatch through effort reductions.

NMFS is currently considering proposing changes to the regulatory requirements for trawl fisheries to protect sea turtles. As described in a NOI to prepare an EIS (74 FR 88 May 8, 2009), NMFS is considering expanding the use of TEDs to other trawl fisheries and modifying the geographic scope of the TED requirements. TED requirements may have a negative effect on fishery-related businesses and communities, as they may increase the cost of fishing, however the extent of the measures is unknown at this time.

4.9.3.2 Baseline Conditions

The CEA baseline conditions for resources and human communities is the combined effects of the past, present, and reasonably foreseeable future actions plus the present condition of the VECs (i.e., status/trends from Section 3.0; Table 146). In general, straightforward quantitative metrics of the baseline conditions are only available for the managed resources, non-target species, and protected resources. The conditions of the habitat and human communities VECs are complex and varied, and the reader should refer to the characterizations given in Sections 3.5 and 3.6, respectively.

Table 146 - Baseline conditions of the VECs

VEC		Status/Trends	Effects of Past, Present Reasonably Foreseeable Future Actions (Table 145)	Combined CEA Baseline Conditions
		A	B	A+B
Target species		Not overfished, not subject to overfishing	**Positive** Stocks are being managed for sustainability	**Positive** Stocks are being managed for sustainability
Non-target species	**Haddock**	Not overfished, not subject to overfishing	**Low Positive** Decreased effort and reduced bycatch continue	**Low positive** Decreased effort and controlled bycatch through caps; some stocks in poor status (RH/S) and some stocks healthy (haddock)
	River Herring/Shad	Depleted; overfished/overfishing status not determined due to many other sources of mortality		
Non-protected predator species	**Bluefin Tuna**	Not subject to overfishing, may be overfished	**Positive** Stock are being managed for sustainability	**Mixed** Stocks are being managed for sustainability, but some in poor status
	Large Mesh Multispecies (Groundfish)	Of seven key stocks, three are overfished and one is subject to overfishing		
	Atlantic Striped Bass	Not overfished, not subject to overfishing		
Protected resources	**Sea Turtles**	Endangered or threatened	**Positive** Continued effort controls along with past regulations will likely help stabilize protected species interactions	**Mixed** Stocks are being managed for sustainability, but some in poor status. Reduced gear encounters through effort reductions and additional management actions taken under the ESA and MMPA.
	Large Whales	Endangered or protected		
	Small Cetaceans and Pinnipeds	Protected		
	Atlantic Sturgeon	Endangered or threatened		
	Atlantic Salmon	Endangered		
	Seabirds	Low-high conservation concern		
Physical Environment and EFH		Fishing impacts are complex/variable and typically adverse; Non-fishing activities have had negative but site-specific habitat effects	**MIxed** Continued management of EFH for an increased quality of habitat, but non-fishing impacts expected to increase	**Mixed** Reduced habitat disturbance by fishing gear; impacts from non-fishing activities, could increase and have a negative impact.

Human Communities	Complex/variable. Herring revenues have been variable.	**Mixed** Continued fisheries management will likely control effort for a sustainable fishery and thus fishery and non-fishery related activities will continue	**Mixed** Lower revenues for stocks yet to rebuild; sustainable resources should support viable communities and economies.

4.9.3.3 Impacts from Amendment 8 Alternatives

The Amendment 8 alternatives would modify the Atlantic herring FMP by: 1) proposing a long-term ABC control rule for the Atlantic herring fishery that may explicitly account for herring's role in the ecosystem and to address the biological and ecological requirements of the Atlantic herring resource; and 2) proposing measures to address potential localized depletion of Atlantic herring to minimize possible detrimental biological impacts on predators of herring and associated socioeconomic impacts on other user groups. The measures are designed to maintain the sustainability of the herring resource. The impacts of the alternatives under consideration are in Section 4.2 through 4.7 and summarized in Table 147. More detailed tables by alternative are included in Section 4.8.

Table 147 - Summary of Amendment 8 impacts expected on the VECs

Alternatives	VECs					
	Herring Resource	**Non-Target Species**	**Non-Protected Predator Species**	**Protected Resources**	**Physical Habitat/EFH**	**Human Communities**
ABC Control Rule	Low positive to positive	Negligible/ Neutral	Neutral to low positive	Low negative to low positive	Neutral	Low negative to low positive
Setting 3-year specifications	Low negative to low positive	Negligible/ Neutral	Neutral	Neutral	Neutral	Low negative to low positive
Localized Depletion / User Conflicts	Neutral to low positive	Neutral	Low negative to low positive	Low negative to neutral	Low negative to neutral	Negative to positive

4.9.4 Cumulative Effects Summary

The regulatory atmosphere within which Federal fishery management operated requires management actions be taken in a manner that will optimize the conditions of resources, habitat, and human communities. Consistent with NEPA, the M-S Act requires that management actions be taken only after consideration of impacts to the biological, physical, economic, and social dimensions of the human environment. Given this regulatory environment, and because fishery management actions must strive to create and maintain sustainable resources, the overall cumulative effects of the on all VECs should yield non-significant neutral to low positive impacts. This is not to say that some aspects of the VECs are not experiencing negative impacts, rather that, overall and compared to the level of unsustainable effort that existed prior to and just after the fishery came under management control, the overall long-term trend is positive.

To determine the magnitude and extent of cumulative impacts of the alternatives, the incremental impacts of the direct and indirect impacts should be considered, on a VEC-by-VEC basis, in addition to the effects of all actions (those effects identified and discussed relative to the past, present, and reasonably foreseeable future actions of both fishing and non-fishing actions). Table 147 summarizes likely effects of the groups of management alternatives contained in Amendment 8. The CEA baseline (Table 146), represents the sum of the past, present, and reasonably foreseeable future (identified hereafter as “other”) actions and conditions of each VEC. When an alternative has a positive effect on a VEC, for example, reduced fishing mortality on a managed species, it has a positive cumulative effect on the stock size of the species when combined with the other actions that were also designed to increase stock size. In contrast, when an alternative has a negative effect on a VEC, such as increased mortality, the cumulative effect on the VEC would be negative and tend to reduce the positive effects of the “other” actions. The resultant positive and negative cumulative effects are described below for each VEC.

Target Species Resource

Section 4.2 describes the impacts of the Amendment 8 alternatives on the Atlantic herring resource. Analysis considered the potential impacts of the alternatives, in combination with relevant past, present, and reasonably foreseeable future actions as well as applicable non-fishing impacts. The incremental impacts from the alternatives are not likely to result in significantly negative cumulative effects on the Atlantic herring resource. The significance criteria that applies to the Atlantic herring resource requires the consideration of whether the alternatives are reasonably expected to jeopardize the sustainability of any species and result in cumulative adverse impacts with a substantial effect on the species.

When the direct and indirect effects of the alternatives are considered in combination with all other actions (*i.e*., past, present, and reasonably foreseeable future actions), ***the cumulative effects should yield non-significant positive impacts on the herring resource.*** The impacts of the Amendment 8 alternatives are likely to be *low positive to positive* (Table 147). The impacts of the ABC control rule alternatives are likely to be low positive to positive. The impacts of the control rule time period alternatives are likely to be low negative to low positive. The impacts of the localized depletion alternatives are likely to be neutral to low positive. The combined impacts of past federal fishery management actions have been positive, as the stock has been managed for sustainability, resulting in a rebuilt herring resource and increased herring biomass (Table 146).

Non-Target Species (Bycatch)

Section 4.3 describes the impacts of the Amendment 8 alternatives on non-target species. Analysis considered the potential impacts of the alternatives, in combination with relevant past, present, and reasonably foreseeable future actions as well as applicable non-fishing impacts. The incremental impacts from the alternatives are not likely to result in significantly negative cumulative effects on the non-target species. The significance criteria that applies to non-target species requires the consideration of whether the alternatives are reasonably expected to jeopardize the sustainability of any species and result in cumulative adverse impacts with a substantial effect on the species.

When the direct and indirect effects of the alternatives are considered in combination with all other actions (*i.e*., past, present, and reasonably foreseeable future actions), ***the cumulative effects should yield non-significant neutral impacts on non-target species.*** The impacts of the Amendment 8 alternatives are likely to be *neutral* (Table 147). The impacts of the ABC control rule alternatives are likely to be negligible/neutral. The impacts of the control rule time period alternatives are likely to be negligible/neutral. The impacts of the localized depletion alternatives are likely to be neutral. The combined impacts of past federal fishery management actions have been mixed, as decreased effort and reduced bycatch continue, though some non-target stocks are in poor status (Table 146). In addition, current regulations continue to manage for sustainable stocks, thus controlling effort on direct and discard/bycatch species. The actions proposed by Amendment 8 are expected to continue this trend. Finally, future actions are anticipated to continue rebuilding and thus limit the take of discards/bycatch in the herring fishery, particularly through ACL management with AMs. The other measures proposed in this action are expected to have primarily neutral impacts on non-target species. Continued management of directed stocks will also control catch of non-target species. In addition, the effects of non-fishing activities on bycatch are potentially negative.

Non-Protected Predator Species

Section 4.4 describes the impacts of the Amendment 8 alternatives on non-protected predator species (i.e. tuna and groundfish). Analysis considered the potential impacts of the alternatives, in combination with relevant past, present, and reasonably foreseeable future actions as well as applicable non-fishing impacts. The incremental impacts from the alternatives are not likely to result in significantly negative cumulative effects on the non-protected predator species. The significance criteria that applies to non-protected predator species requires the consideration of whether the alternatives are reasonably expected to jeopardize the sustainability of any species and result in cumulative adverse impacts with a substantial effect on the species.

When the direct and indirect effects of the alternatives are considered in combination with all other actions (*i.e*., past, present, and reasonably foreseeable future actions), ***the cumulative effects should yield non-significant low positive impacts on non-protected predator species.*** The impacts of the Amendment 8 alternatives are likely to be *low negative to low positive* (Table 147). The impacts of the ABC control rule alternatives are likely to be low negative to low positive. The impacts of the control rule time period alternatives are likely to be neutral. The impacts of the localized depletion alternatives are likely to be low negative to low positive. The combined impacts of past federal fishery management actions have been mixed, as the stocks has been managed for sustainability, though some non-target stocks are in poor status (Table 146).

Protected Species

Section 4.5 describes the impacts of the Amendment 8 alternatives on protected species. Analysis considered the potential impacts of the alternatives, in combination with relevant past, present, and reasonably foreseeable future actions as well as applicable non-fishing impacts. The incremental impacts from the alternatives are not likely to result in significantly negative cumulative effects on the protected species. The significance criteria that applies to protected species requires the consideration of whether the alternatives are reasonably expected to jeopardize the sustainability of any species and result in cumulative adverse impacts with a substantial effect on the species.

When the direct and indirect effects of the alternatives are considered in combination with all other actions (*i.e*., past, present, and reasonably foreseeable future actions), ***the cumulative effects should yield non-significant neutral impacts on protected species.*** The impacts of the Amendment 8 alternatives are likely to be *low negative to low positive* (Table 147). The impacts of the ABC control rule alternatives are likely to be low negative to low positive. The impacts of the control rule time period alternatives are likely to be neutral. The impacts of the localized depletion alternatives are likely to be low negative to neutral. The combined impacts of past federal fishery management actions have been mixed, as the stocks has been managed for sustainability, though some protected species are in poor status (Table 146).

Physical Environment and EFH

Section 4.6 describes the impacts of the Amendment 8 alternatives on the physical environment and EFH. Analysis considered the potential impacts of the alternatives, in combination with relevant past, present, and reasonably foreseeable future actions as well as applicable non-fishing impacts. The incremental impacts from the alternatives are not likely to result in significantly negative cumulative effects on the physical environment and EFH.

When the direct and indirect effects of the alternatives are considered in combination with all other actions (*i.e*., past, present, and reasonably foreseeable future actions), ***the cumulative effects should yield non-significant neutral impacts on the physical environment and EFH.*** The impacts of the Amendment 8 alternatives are likely to be *low negative to low positive* (Table 147). The impacts of the ABC control rule alternatives are likely to be neutral. The impacts of the control rule time period alternatives are likely to be neutral. The impacts of the localized depletion alternatives are likely to be low negative to neutral. The combined impacts of past federal fishery management actions have been mixed (Table 146). Because fishing with the gears used in the directed herring fishery, does not impact EFH in a manner that is more than minimal or more than temporary in nature, the impacts to EFH of these alternatives are negligible, regardless of how much fishing takes place in any area. However, it is likely that fishing and non-fishing activities will continue to degrade habitat quality.

Human Communities

Section 4.7 describes the impacts of the Amendment 8 alternatives on human communities. Analysis considered the potential impacts of the alternatives, in combination with relevant past, present, and reasonably foreseeable future actions as well as applicable non-fishing impacts. The incremental impacts from the alternatives are not likely to result in significantly negative cumulative effects on human communities.

When the direct and indirect effects of the alternatives are considered in combination with all other actions (*i.e*., past, present, and reasonably foreseeable future actions), ***the cumulative effects should yield non-significant low positive impacts on human communities.*** The impacts of the Amendment 8 alternatives are likely to be *negative to positive* (Table 147). The impacts of the ABC control rule alternatives are likely to be low negative to low positive. The impacts of the control rule time period alternatives are likely to be low negative to low positive. The impacts of the localized depletion alternatives are likely to be low negative to positive. The combined impacts of past federal fishery management actions have been mixed (Table 146). Fishing opportunities in the short term have been curtailed to enable long-term sustainable harvests, which should lead to a long-term positive impact on fishing communities and economies.

5.0 DATA AND RESEARCH NEEDS

The MSA (Section 303(a)) requires that FMPs identify data and research needs.
To be completed for FEIS

6.0 APPLICABLE LAWS/EXECUTIVE ORDERS

6.1 MAGNUSON-STEVENS FISHERY CONSERVATION AND MANAGEMENT ACT

To be completed for FEIS

6.2 NATIONAL ENVIRONMENTAL POLICY ACT

The National Environmental Policy Act (NEPA) provides a mechanism for identifying and evaluating the full spectrum of environmental issues associated with federal actions, and for considering a reasonable range of alternatives to avoid or minimize adverse environmental impacts. This document is designed to meet the requirements of both the MSFCMA and NEPA. The Council on Environmental Quality (CEQ) has issued regulations specifying the requirements for NEPA documents (40 CFR 1500 – 1508) and NOAA's policy and procedures for NEPA are found in NOAA Administrative Order 216-6. The required elements of an Environmental Impact Statement Assessment (EIS) are specified in 40 CFR 1508.9(b) and NAO 216-6 Section 5.04b.1. They are included in this document as follows:

- The need for this action - Section 1.4
- The alternatives that were considered – Section 2.0
- The environmental impacts of the Proposed Action - Section 4.0 [proposed action TBD]
- The agencies and persons consulted on this action - Section 6.2.4
- An executive summary – page 5
- A table of contents – page 7
- Background and purpose - Section 1.0
- A summary of the document – page 5
- A brief description of the affected environment – Section 3.0
- Cumulative impacts of the alternatives - Section 4.9
- A list of preparers – Section 6.2.3
- An index - Section 9.0

6.2.1 Public Scoping

The Council announced its intent to prepare Amendment 8 and an Environmental Impact Statement (EIS) on February 26, 2015. The scoping period extended from that date until April 30, 2015. A second scoping period was held August 21 -September 30, 2015. Section 1.6 summarizes the scoping process, comments, and responses to those comments.

6.2.1 Areas of Controversy

To be completed for FEIS

6.2.1 Document Distribution

This document is available on the Council's web page, www.nefmc.org and has been provided to all Council members. Announcements of document availability will be made in the *Federal Register* and to the interested parties' mailing list. Copies were distributed to:

U.S. EPA, Region 1
1 Congress St., 11th Floor
Boston, MA 02203-0001

U.S. EPA, Region 2
290 Broadway, 25th Floor
New York, NY 10007

U.S. EPA, Region 3
1650 Arch Street
Philadelphia, PA 19106

U.S. EPA, Region 4
61 Forsyth Street
Atlanta, GA 30303

District Commander
First U.S. Coast Guard District
408 Atlantic Avenue
Boston, MA 02210-2209

Director, Office of Marine Conservation
Department of State
2201 "C" Street, NW
Washington, DC 20520

Executive Director
Marine Mammal Commission
4340 East-West Highway
Bethesda, MD 20814

Director, Office of Environmental Policy and Compliance
U.S. Department of Interior
Main Interior Building (MS 2462)
1849 "C" Street, NW
Washington, DC 20520

6.2.2 Point of Contact

Questions concerning this document may be addressed to:

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6.2.3 List of Preparers

The following personnel participated in the preparation of this DEIS.

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National Marine Fisheries Service. Timothy Cardiasmenos, Glenn Chamberlin, Dr. Jonathan Deroba, Marianne Ferguson, Dr. Sarah Gaichas, Dr. Min-Yang Lee, Daniel Luers, Brant McAfee, Carrie Nordeen, Danielle Palmer, Sara Weeks

State agencies. Matthew Cieri (Maine DMR), Micah Dean (MADMF), Renee Zobel (NHFG)

Academic. Dr. Madeleine Hall-Arber (MIT Sea Grant, retired)

Mid-Atlantic Fishery Management Council. Jason Didden

U.S. Fish and Wildlife Service. Linda Welch, Caleb Spiegel

6.2.4 Agencies Consulted

The following agencies were consulted in the preparation of this document:

- Atlantic States Marine Fisheries Commission and Atlantic Herring Section
- Mid-Atlantic Fishery Management Council
- New England Fishery Management Council, which includes representatives from the following additional organizations:
    - Connecticut Department of Environmental Protection
    - Maine Department of Marine Resources
    - Massachusetts Division of Marine Fisheries
    - New Hampshire Fish and Game
    - Rhode Island Department of Environmental Management
- National Marine Fisheries Service, NOAA, Department of Commerce
- United States Coast Guard, Department of Homeland Security
- United States Fish and Wildlife Service, Department of Interior

6.2.5 Opportunity for Public Comment

Amendment 8 was developed from 2015-2018. Two public scoping periods occurred in 2015. Two public workshops on the Management Strategy Evaluation occurred in 2016. Opportunities for public comment occurred at Advisory Panel, Committee, and Council meetings. There are limited opportunities to comment at PDT meetings and conference calls. A public comment period occurred in 2018. Over 60 public meetings related to this action (Table 148). Meeting discussion documents and summaries are available at www.nefmc.org.

To be completed for FEIS, this table is only through the DEIS phase.

Table 148 - Public meetings related to Amendment 8

Date	Meeting Type	Location
	2015	
1/5/2015	HE_EBFM PDT	Holiday Inn, Taunton, MA
1/15/2015	HE-AP	Sheraton Harborside, Portsmouth, NH
1/16/2015	HE-CTE	Sheraton Harborside, Portsmouth, NH

1/27-29/2015	Council Meeting	Sheraton Harborside, Portsmouth, NH
3/6/2015	HE-PH – A8	Samoset Resort,Rockland, ME
3/26/2015	HE-PH – A8	DoubleTree, Danvers, MA
4/6/2015	HE-PH – A8	Webinar - Grout Travel
4/20/2015	HE-PH – A8	Hilton Hotel, Mystic, CT
5/13/2015	HE-PDT	GARFO Office, Gloucester, MA
6/15-17/2015	Council Meeting	Hotel Viking, Newport, RI
7/22/2015	HE-CTE	Four Points Wakefield
9/1/2015	HE-PDT	GARFO Office, Gloucester, MA
9/14/2015	HE-AP	Hilton Garden Inn, Boston
9/15/2015	HE-CTE	Hilton Garden Inn, Boston, MA
9/29 – 10/1/2015	Council Meeting	Radisson Hotel, Plymouth, MA
12/10/2015	HE-PDT	GARFO Office, Gloucester, MA
2016		
1/12/2016	HE_PDT	Doubletree, Danvers, MA
1/13/2016	HE_CTE	Doubletree, Danvers, MA
1/21/2016	PDT Call	Webinar
2/10/2016	PDT Call	Webinar
3/15/2016	HE_AP	Doubletree Danvers, MA
3/16/2016	HE_CTE	Doubletree Danvers, MA
3/22/2016	HE_PDT	Four Points, Wakefield, MA
3/29/2016	HE_AP	Holiday Inn, Portsmouth, NH
3/30/2016	HE_CTE	Holiday Inn, Portsmouth, NH
4/14/2016	PDT Call	Webinar
5/23/2016	HE_PDT	GARFO, Gloucester, MA
6/1/2016	HE_AP	Four Points, Wakefield, MA
6/2/2016	HE_CTE	Four Points, Wakefield, MA
7/28/2016	PDT	GARFO, Gloucester, MA
8/16/2016	HE_AP	Holiday Inn, Mansfield, MA
8/17/2016	HE_CTE	Holiday Inn, Mansfield, MA
9/7/2016	PDT Call	Webinar
9/15/2016	PDT Call	Webinar
9/20-22/2016	Council Meeting	DoubleTree, Danvers, MA
10/4/2016	HE_PDT	GARFO, Gloucester, MA
10/20/2016	HE_CTE	DoubleTree, Portland, ME
11/15-17/2016	Council Meeting	Hotel Viking, Newport, RI
11/29/2016	PDT	Mariners House, Boston, MA
12/20/2016	PDT Call	Webinar
2017		
1/10/2017	HE_AP	Four Points, Wakefield, MA

1/11/2017	HE_CTE	Four Points, Wakefield, MA
01/24-26/17	Council Meeting	Sheraton Harbroside, Portsmouth, NH
2/7/2017	HE_CTE	Hotel 1620, Plymouth, MA
2/15/2017	PDT Call	Webinar
3/21/2017	PDT Call	Webinar
4/4/2017	HE_AP	Wentworth By the Sea, New Castle
4/5/2017	HE_CTE	Wentworth By the Sea, New Castle
4/11/2017	PDT Call	Webinar
04/18-20/17	Council Meeting	Hilton mystic, Mystic, CT
6/6/2017	PDT Call	Webinar
07/12-13/17	HE_PDT	GARFO, Gloucester, MA
8/14/2017	PDT Call	Webinar
9/13/2017	HE_AP	Four Points, Wakefield, MA
9/14/2017	HE_CTE	Four Points, Wakefield, MA
09/26-28/17	Council meeting	Beauport, Gloucester, MA
10/24/2017	HE_PDT	Hotel 1620, Plymouth, MA
11/20/2017	HE_AP	Holiday Inn, Taunton, MA
11/21/2017	HE_CTE	Holiday Inn, Taunton, MA
12/5-7/17	Council Meeting	Hotel Viking, Newport, RI

6.3 ENDANGERED SPECIES ACT

To be completed for FEIS

6.4 MARINE MAMMAL PROTECTION ACT

To be completed for FEIS

6.5 COASTAL ZONE MANAGEMENT ACT

To be completed for FEIS

6.6 ADMINISTRATIVE PROCEDURES ACT

To be completed for FEIS

6.7 DATA QUALITY ACT

To be completed for FEIS

6.8 EXECUTIVE ORDER 13132 (FEDERALISM)

To be completed for FEIS

6.9 EXECUTIVE ORDER 13158 (MARINE PROTECTED AREAS)

To be completed for FEIS

6.10 PAPERWORK REDUCTION ACT

To be completed for FEIS

6.11 REGULATORY IMPACT REVIEW

To be completed for FEIS

7.0 REFERENCES

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8.0 GLOSSARY

ABC Control Rule (ABC CR): The specified approach to setting the ABC for a stock or stock complex as a function of scientific uncertainty in the estimate of OFL and any other scientific uncertainty. The ABC control rule will consider uncertainty in factors such as stock assessment issues, retrospective patterns, predator-prey issues, and projection results. The ABC control rule will be specified and may be modified based on guidance from the SSC during the specifications process. Modifications to the ABC control rule can be implemented through specifications or framework adjustments to the Herring FMP (in addition to future amendments), as appropriate.

Acceptable Biological Catch (ABC): The maximum catch that is recommended for harvest, consistent with meeting the biological objectives of the management plan. The MSA interpretation of ABC includes consideration of biological uncertainty (stock structure, stock mixing, other biological/ecological issues), and recommendations for ABC should come from the NEFMC SSC. ABC can equal but never exceed the OFL.

OFL – Scientific Uncertainty = ABC (Determined by SSC)

Annual Catch Limit (ACL): A stock-wide ACL accounts for both scientific uncertainty (through the specification of ABC) and management uncertainty (through the specification of the stock-wide ACL and buffer between ABC and the ACL). The ACL is the annual catch level specified such that the risk of exceeding the ABC is consistent with the management program. The ACL can equal but never exceed the ABC. ACL should be set lower than the ABC as necessary due to uncertainty over the effectiveness of management measures. The stock-wide Atlantic herring ACL equates to the U.S. optimum yield (OY) for the Atlantic herring fishery and serves as the level of catch that determines whether accountability measures (AMs) become effective. The AM for the stock-wide ACL, total fishery closure at 95%, reduces the risk of overfishing.

ABC – Management Uncertainty = Stock wide ACL = OY

Assessment model: Method for determining stock status, the results of which are used by the control rule.

"Back side of the Cape": A colloquial term for the nearshore area of ocean immediately to the east of Cape Cod Massachusetts.

Bycatch: (v.) The capture of nontarget species in directed fisheries which occurs because fishing gear and methods are not selective enough to catch only target species. (n.) Fish which are harvested in a fishery but are not sold or kept for personal use, including economic discards and regulatory discards but not fish released alive under a recreational catch and release fishery management program.

Capacity: The level of output a fishing fleet is able to produce given specified conditions and constraints. Maximum fishing capacity results when all fishing capital is applied over the maximum amount of available (or permitted) fishing time, assuming that all variable inputs are utilized efficiently.

Catch: The sum total of fish killed in a fishery in a given period. Catch is given in either weight or number of fish and may include landings, unreported landings, discards, and incidental deaths.

Continental shelf waters: The waters overlying the continental shelf, which extends seaward from the shoreline and deepens gradually to the point where the sea floor begins a slightly steeper descent to the deep ocean floor; the depth of the shelf edge varies, but is about 200 m in many regions.

Days absent: An estimate by port agents of trip length. These data were collected as part of the NMFS weighout system prior to May 1, 1994.

Discards: Animals returned to sea after being caught; see *bycatch (n.).*

Essential Fish Habitat (EFH): Those waters and substrate necessary to fish for spawning, breeding, feeding, or growth to maturity. The EFH designation for most managed species in this region is based on a legal text definition and geographical area that are described in the Habitat Omnibus Amendment (NEFMC 1998).

Exclusive Economic Zone (EEZ): A zone in which the inner boundary is a line coterminous with the seaward boundary of each of the coastal States and the outer boundary is line 200 miles away and parallel to the inner boundary

Exempt fisheries: Any fishery determined by the Regional Director to have <5% regulated species as a bycatch (by weight) of total catch according to 50 CFR 648.80(a)(7).

Fishing effort: The amount of time and fishing power used to harvest fish. Fishing power is a function of gear size, boat size and horsepower.

Framework adjustments: Adjustments within a range of measures previously specified in a fishery management plan (FMP). A change usually can be made more quickly and easily by a framework adjustment than through an amendment. For plans developed by the NEFMC, the procedure requires at least two Council meetings including at least one public hearing and an evaluation of environmental impacts not already analyzed as part of the FMP.

Harvest control rule: Relationship describing how the results of the assessment are translated into advice for management (i.e., turns the assessment result into an allowable biological catch).

Landings: The portion of the catch that is harvested for personal use or sold.

Limited-access permits: Permits issued to vessels that met certain qualification criteria by a specified date

Localized depletion: When harvesting takes more fish than can be replaced either locally or through fish migrating into the catch area within a given time period.

Management Objective: Desirable outcomes from management. Objectives can include ecological, economic, societal goals. High level goals/objectives (e.g., what would like) can be unpacked into operational objectives (e.g., how much?).

Management strategy: Combination of monitoring, assessment, and management control rule used as the basis for management advice. In the MSE, the output from the management strategy is applied to the operating model to update the system dynamics.

Management Strategy Evaluation (MSE): Analytical framework for testing and comparing the performance of management options.

Metric ton: A unit of weight equal to a thousand kilograms (1kgs = 2.2 lbs.). A metric ton is equivalent to 2,205 lbs. A thousand metric tons is equivalent to 2.2 million lbs.

Northeast Shelf Ecosystem: The Northeast U.S. Shelf Ecosystem has been described as including the area from the Gulf of Maine south to Cape Hatteras, extending from the coast seaward to the edge of the continental shelf, including the slope sea offshore to the Gulf Stream.

Operating model: model which represents the real world resource and fishery dynamics, used as the basis for testing management options. Multiple operating models can be considered, each representing a possible state of nature.

Overfishing Limit (OFL): The catch that results from applying the maximum fishing mortality threshold to a current or projected estimate of stock size. When the stock is neither overfished nor subject to overfishing, usually F_{MSY} or its proxy.

$$\mathbf{OFL \geq ABC \geq ACL}.$$

Performance metric: Specific quantitative measure that represents a management objective and can be used to evaluate progress towards that objective.

Statistical area: A delineated area of ocean used to track where fish were caught. NMFS overlays a grid of statistical areas onto nautical charts to accurately identify specific areas of the ocean. Statistical areas are about one degree square, although in many cases they do not correspond exactly to specific latitudes and longitudes.

Stock: A grouping of fish usually based on genetic relationship, geographic distribution and movement patterns. A species, subspecies, geographical grouping, or other category of fish capable of management as a unit.

Stock area: A group of connected statistical areas that defines the geographic distribution of a particular population of an individual species. For example, the Gulf of Maine cod stock area comprises statistical areas 464, 465, 467, 510, 511, 512, 513, 514, and 515. All catch of cod in any of these stock areas is attributed to the GOM cod stock.

Total Allowable Catch (TAC): The amount (in metric tons) of a stock that is permitted to be caught during a fishing year. This value is calculated by applying a target fishing mortality rate to exploitable biomass.

Trade-off: Degree to which performance against a set of management objectives are related. A strong tradeoff between two objectives implies that gaining on one means forgoing the other.

Valued Ecosystem Component (VEC): A resource or environmental feature that is important (not only economically) to a local human population, or has a national or international profile, or if altered from its existing status, will be important for the evaluation of environmental impacts of industrial developments, and the focusing of administrative efforts.

9.0 INDEX

To be completed for FEIS