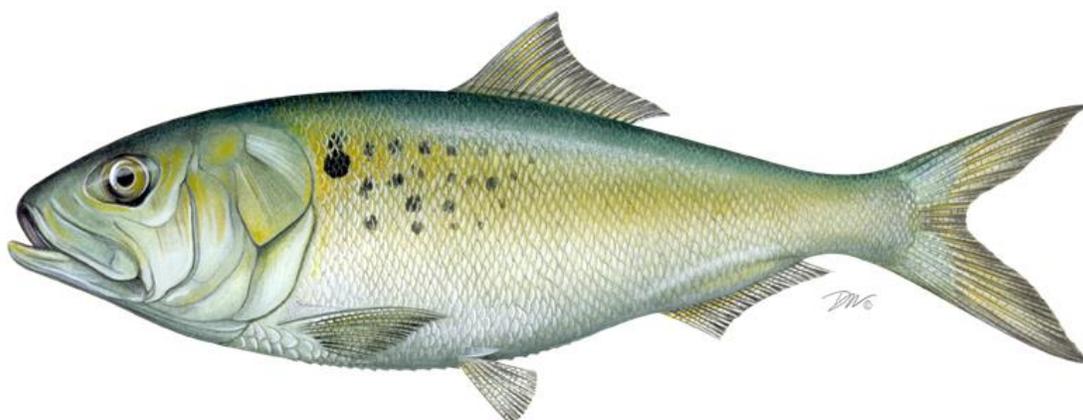


Atlantic States Marine Fisheries Commission

PUBLIC INFORMATION DOCUMENT

**For Amendment 3 to the
Interstate Fishery Management Plan For**

ATLANTIC MENHADEN



November 2016



Vision: Sustainably Managing Atlantic Coastal Fisheries

**The Atlantic States Marine Fisheries Commission seeks your input on the initiation of
Amendment 3 to the Atlantic Menhaden Fishery Management Plan**

The public is encouraged to submit comments regarding this document during the public comment period. Comments must be received by **5:00 PM (EST) on January 4, 2017**. Regardless of when they were sent, comments received after that time will not be included in the official record. The Atlantic Menhaden Management Board will consider public comment on this document when developing the first draft of Amendment 3.

You may submit public comment in one or more of the following ways:

1. Attend public hearings held in your state or jurisdiction, if applicable.
2. Refer comments to your state's members on the Atlantic Menhaden Board or Atlantic Menhaden Advisory Panel, if applicable.
3. Mail, fax, or email written comments to the following address:

Megan Ware
Fishery Management Plan Coordinator
Atlantic States Marine Fisheries Commission
1050 North Highland Street, Suite 200A-N
Arlington, Virginia 22201
Fax: (703) 842-0741
comments@asmfc.org (subject line: Menhaden PID)

If your organization is planning to release an action alert in response to the Amendment 3 PID, or if you have questions, please contact Megan Ware at (703) 842-0740.

**YOUR
COMMENTS
ARE INVITED**

The Atlantic States Marine Fisheries Commission (Commission) is developing an amendment to revise the Interstate Fishery Management Plan (FMP) for Atlantic Menhaden. The Commission, under the Atlantic Coastal Fisheries Cooperative Management Act, is charged with developing fishery management plans for Atlantic menhaden which are based on the best available science and promote the conservation of the stock throughout its range. The states of Maine through Florida participate in the management of this species via the Commission's Atlantic Menhaden Management Board (Board).

This is your opportunity to inform the Commission about changes observed in the fishery, actions you feel should or should not be taken in terms of management, regulation, enforcement, and research, and any other concerns you have about the resource or the fishery, as well as the reasons for your concerns.

**WHY IS THE
ASMFC
PROPOSING
THIS ACTION?**

At the May 2015 meeting, the Menhaden Board initiated the development of Amendment 3 to the Atlantic Menhaden FMP to pursue the development of ecological reference points (ERPs) and revisit allocation methods.

The 2015 Atlantic Menhaden Benchmark Stock Assessment and Peer Review Report categorized the development of ERPs as a high priority for Atlantic menhaden management. Currently, the stock is assessed with single-species biological reference points, which were defined in the 2015 stock assessment. Using these reference points, the assessment found the stock is not overfished and overfishing is not occurring. While the stock assessment accounts for natural mortality, that factor alone may not adequately account for the unique and significant ecological services that menhaden provide, or how changes in the population of predator species may impact the abundance of menhaden. ERPs are intended to consider the multiple roles that menhaden play, both in supporting fisheries for human use and the marine ecosystem. Thus, they are viewed as a tool that could improve the management of menhaden.

Additionally, Amendment 2 (implemented in 2013) requires quota allocations to be revisited every three years. The Atlantic menhaden quota is currently allocated to fifteen of the sixteen Atlantic coast states and jurisdictions based on each jurisdiction's three-year average landings between 2009 and 2011. In revisiting the allocations, the Board decided to investigate different allocation methods and timeframes given concerns that the current allocation method does not strike a balance between gear types and regions, as well as current and future harvest opportunities. Some states have also expressed concerns about unreported landings during the baseline years and the administrative burden of managing small allocations, the cost of which may outweigh the value of the fishery they are allocated.

The adoption of ERPs as well as changes to the current quota allocations would require changes in the management tools used to regulate the fishery. This document proposes a suite of management tools involving different types of reference points and allocation methods.

**WHAT IS THE
PROCESS FOR
DEVELOPING
AN
AMENDMENT?**

The publication of this document and announcement of the Commission’s intent to amend the existing FMP for Atlantic menhaden is the first step of the formal amendment process. Following the initial phase of information gathering and public comment, triggered by this Public Information Document (PID), the Commission will evaluate potential management alternatives and the impacts of those alternatives. The Board will also seek to narrow the number of proposed management options, especially in regard to quota allocation and incidental catch. The Commission will then develop Draft Amendment 3, incorporating the identified management options, for public review and comment. Following consideration of public comment, the Commission will specify the management measures to be included in Amendment 3, as well as a timeline for implementation. In addition to issues identified in this PID, the Draft Amendment may include other issues identified during the public comment period for this PID.

The timeline for completion of Amendment 3 is as follows:

	Oct 2016	Nov 2016 – Jan 2017	Feb 2017	Mar – July 2017	Aug 2017	Sept – Oct 2017	Nov 2017
Approval of Draft PID by Board	X						
Public review and comment on PID <i>Current step</i>		X					
Board review of public comment; Board direction on what to include in Draft Amendment 3			X				
Preparation of Draft Amendment 3				X			
Review and approval of Draft Amendment 3 by Board for public comment					X		
Public review and comment on Draft Amendment 3						X	
Board review of public comment on Draft Amendment 3							X
Review and approval of the final Amendment 3 by the Board, Policy Board and Commission							X

WHAT IS THE PURPOSE OF THIS DOCUMENT?

The purpose of this document is to inform the public of the Commission’s intent to gather information concerning Atlantic menhaden and to provide an opportunity for the public to identify major issues and alternatives relative to the management of this species. Input received at the start of the amendment development process can have a major influence in the final outcome of the amendment. This document is intended to solicit observations and suggestions from fishermen, the public, and other interested parties, as well as any supporting documentation and additional data sources.

To facilitate public input, this document provides a broad overview of the issues already identified for consideration in the amendment; background information on the Atlantic menhaden population, fisheries, and management; and a series of questions for the public to consider about the management of the species. In general, the primary question on which the Commission is seeking public comment is: **“How would you like management of the Atlantic menhaden fishery to look in the future?”**

WHAT ISSUES WILL BE ADDRESSED?

The primary issues considered in the PID are:

- Reference Points for Determining Stock Status
- Quota Allocation
- Allocation Timeframe
- Quota Transfers and Overage Payback
- Quota Rollovers
- Incidental Catch and Small Scale Fishery Allowance
- Episodic Events Set Aside Program
- Chesapeake Bay Reduction Fishery Cap
- Research Programs and Priorities

ISSUE 1: Reference Points

Background: Amendment 2 established single-species reference points to manage the menhaden stock. These reference points were based on maximum spawning potential (MSP) and included a measure of fishing mortality (F) and spawning stock biomass (SSB) to determine an overfishing and overfished status. Overfishing occurs when fishing is negatively affecting the stock through reduced abundance and recruitment. A stock is overfished if abundance or biomass is critically low. Per Amendment 2, overfishing was defined by a target and threshold of $F_{30\%MSP}$ and $F_{15\%MSP}$, respectively, while an overfished stock was defined by a target and threshold of $SSB_{30\%MSP}$ and $SSB_{15\%MSP}$, respectively.

In 2015, the Board approved a new Atlantic Menhaden Benchmark Stock Assessment, producing the reference points in use today. A key goal of these reference points is to provide a better measure of sustainability. As a result, the overfishing target and threshold were changed to $F_{57\%MSP}$ (0.38) and $F_{26\%MSP}$ (1.26), respectively, to provide a more conservative approach to menhaden management until multi-species reference points could be developed. Additionally, an overfished

target and threshold based on fecundity (FEC) were established at $FEC_{57\%MSP}$ (189,270 billion eggs) and $FEC_{26\%MSP}$ (86,821 billion eggs), respectively. As of 2013, the terminal year used for the 2015 assessment, the stock is not overfished ($FEC=170,536$ billion eggs) and overfishing is not occurring ($F=0.22$).

Given the crucial ecological role that menhaden play as forage fish, the Board has expressed interest in developing ecological reference points (ERPs) to manage the menhaden stock. Menhaden serve an important role in the marine ecosystem as they convert phytoplankton into protein and in turn provide a food source to a variety of species including larger fish (e.g., weakfish, striped bass, bluefish, cod), birds (e.g., bald eagles, osprey), and marine mammals (e.g., humpback whales, bottlenose dolphin). As a result, changes in the abundance of menhaden may have implications for the marine ecosystem. ERPs provide a method to assess the status of menhaden not only with regard to their own sustainability, but also with regard to their interactions with predators and the status of other prey species. This method accounts for changes in the abundance of several species when setting an overfished and overfishing threshold for menhaden. The benefit of this approach is that it allows fishery managers to consider the harvest of menhaden within a broad ecosystem context. Of course, people also extract and utilize marine resources, and are thus considered part of the marine ecosystem as well.

In May 2015, the Board tasked the Commission's Biological and Ecological Reference Point (BERP) Workgroup with developing ERPs for Atlantic menhaden. To begin this process, the Board identified fundamental objectives for the development of ERPs, including sustaining menhaden to provide for fisheries and predators. The BERP Workgroup subsequently identified four multi-species modeling approaches that could be used to successfully calculate ERPs for menhaden. These models can combine information on the abundance of menhaden and its predators to quantitatively assess ecosystem needs and set appropriate harvest targets and thresholds. Given the complexity of these models and the large amounts of data required, the BERP Workgroup does not expect to finish developing these menhaden-specific ERPs before Amendment 3 is finalized. The BERP Workgroup will be having several data, assessment, and modeling workshops over the next few years in order to complete the ERPs and have them peer reviewed by 2019.

In addition to the menhaden-specific reference points being developed by the BERP Workgroup, the Board is aware of other precautionary guidelines on developing ERPs for forage fish in general. For example, several organizations and scientific papers, such as Smith et al. (2011), support the use of a 75% rule-of-thumb, which recommends forage fish populations be maintained at three-fourths of their unfished biomass levels in order to lower impacts on marine ecosystems. This rule has been implemented by the Convention for the Conservation of Antarctic Marine Living Resources, which manages krill to maintain 75% of the unfished biomass in the water to account for the needs of predators.

The Lenfest Ocean Program, a grant-making program managed by The Pew Charitable Trusts, has also developed guidelines for the development of ERPs for forage fish. In their 2012 report by Pikitch et al., Lenfest describes how they applied a suite of 10 published models to develop a general equation to predict predator responses to specific levels of forage fish abundance. This equation proposes a control rule in which fishing mortality does not exceed half of the forage species natural mortality rate (for menhaden, $1/2 M = 0.29$) and that, when biomass falls below 40% of unfished biomass, fishing is prohibited.

Another ERP option could combine these guidelines, such that the 75% rule-of-thumb is combined with a fishing mortality target consistent with achieving 75% unfished biomass, and if biomass falls below 40% of unfished biomass, fishing is prohibited. The concept of a fishing mortality cutoff for forage species is used by the Pacific Fishery Management Council in conserving sardine (although the cutoff is set at 150,000 metric tons, or roughly 10% of the average unfished population size)¹.

In 2015, as a part of an initial effort to evaluate existing ERP guidelines, the Board asked the BERP Workgroup to review the ERPs proposed by Pikitch et al. (2012). In response, the BERP Workgroup noted several concerns, namely that the Lenfest equation was developed for forage species that are a main component (> 50%) of a predator's overall diet. Although menhaden are important forage for a number of species, and may be a main food source for some species during certain seasons, they do not account for more than 20% of the overall diet for any of the finfish predators currently considered in the multispecies models being used by the BERP Workgroup. The BERP Workgroup also raised concerns that the Pikitch et al. (2012) equation assumes a stock-recruit relationship can be defined for the forage species. Available data indicate recruitment of menhaden is driven primarily by environmental factors rather than stock size. For these reasons, the BERP Workgroup advised the Board that the Lenfest equation is not an appropriate method for developing ERPs for menhaden (See Appendix 2 for BERP Workgroup Memo dated April 20, 2015). Members of the Lenfest Forage Fish Task Force responded to the concerns raised by the BERP Workgroup, stating it is not necessary for predators to be highly dependent on menhaden (>50% of diet) for the report's management recommendations to apply and that the report's reference points can be applied without a specific stock-recruit relationship. The Lenfest Forage Fish Task Force also emphasized that the reference points in Pikitch et al. (2012) offer a precautionary approach to prevent stock collapse and maintain high levels of forage fish biomass in the water (See Appendix 3 for Lenfest Forage Fish Task Force memo date May 4, 2015).

¹ Oceana. April 12, 2016. The Role of Fishing in the Pacific Sardine Collapse. <http://usa.oceana.org/blog/role-fishing-pacific-sardine-collapse>

Moving forward, there are several options for the Board to consider.

- Continue use of the single-species reference points approved in the 2015 stock assessment.
- Adopt ERPs based on existing guidelines for forage fish in general.
- Adopt, upon completion, menhaden-specific ERPs developed by the BERP Workgroup. Since the BERP Workgroup's ERPs will not be completed before 2019, the Board would have to identify interim reference points to manage the stock. These could include the current single-species reference points or existing guidelines for forage fish species.

Importantly, the Board is interested in considering all viable approaches for developing ERPs and invites the public to submit information on other ERPs that have been peer-reviewed and could be proposed in draft Amendment 3. In order to be considered by the Board, submissions should include information on how the ERP was developed, what species it can be applied to, if it has been previously implemented, and how it has been peer-reviewed.

Statement of the Problem: Given the ecological importance of menhaden as a forage fish, the Board is interested in developing ERPs for the stock. Current options for ERPs include existing guidelines for forage fish species and those currently being developed by the BERP Workgroup. If the Board opts to pursue the ERPs developed by the BERP Workgroup, interim reference points could to be adopted, since this modeling work will not be completed until 2019.

Option A: Single Species Reference Points

The Atlantic menhaden stock continues to be managed with the single-species biological reference points developed in the 2015 benchmark stock assessment. These set an F target and threshold of $F_{57\%MSP}$ (0.38) and $F_{26\%MSP}$ (1.26), respectively, and a fecundity target and threshold of $FEC_{57\%MSP}$ (189,270 billion eggs) and $FEC_{26\%MSP}$ (86,821 billion eggs), respectively. Under this option, the Board would direct the BERP Workgroup to stop work on the development of menhaden-specific ERPs.

Option B: Existing Guidelines for Forage Fish Species

The Atlantic menhaden stock is managed with ERPs based on existing guidelines for forage fish species (e.g., the 75% rule-of-thumb, Pikitch et al. (2012) with $F_{64\%MSP}=0.29$, or some other peer-reviewed ERP). Under this option, the Board would direct the BERP Workgroup to stop work on the development of menhaden-specific ERPs.

Option C: Single-Species Reference Points Until ERPs are Developed by the BERP Workgroup

The Atlantic menhaden stock is managed with the current single-species reference points ($F_{57\%MSP}=0.38$, $F_{26\%MSP}=1.26$; $FEC_{57\%MSP}=189,270$ billion eggs, $F_{26\%MSP}=86,821$ billion eggs) until menhaden-specific ERPs are developed by the BERP Workgroup and adopted by the Board. It is expected that the BERP Workgroup will complete its analysis in 2019.

Option D: Existing Guidelines for Forage Fish Species Until ERPs are Developed by the BERP Workgroup

The Atlantic menhaden stock is managed with ERPs based on existing guidelines for forage fish species (e.g., the 75% rule-of-thumb, Pikitch et al. (2012) with $F_{64\%MSP}=0.29$, or a combination of these guidelines) until menhaden-specific ERPs are developed by the BERP Workgroup and adopted by the Board. It is expected that the BERP Workgroup will complete its analysis in 2019.

Public Comment Questions: Should the Board manage the Atlantic menhaden stock with single-species biological reference points or multi-species ERPs? Do you support the use of simpler, readily available ERPs until menhaden-specific ERPs are developed by the BERP Workgroup? Do you know of other approaches for establishing ERPs for menhaden that could be implemented through Amendment 3?

***ISSUE 2:
Quota
Allocation***

Background: Amendment 2 established a first-ever commercial total allowable catch (TAC) for Atlantic menhaden and divided this catch into commercial quotas for participating jurisdictions from Maine through Florida. The TAC and quota system were adopted in response to the 2011 benchmark stock assessment which found that the stock was experiencing overfishing. Since it was implemented in 2013, the quota system has maintained the harvest of menhaden below the coastwide limits set by the Board.

For 2013 and 2014, the Board set the TAC at 170,800 metric tons (mt), a 20% reduction from the average 2009-2011 coastwide landings. The 2015 benchmark stock assessment found the Atlantic menhaden stock is not overfished and overfishing is not occurring. In response, the Board raised the 2015 and 2016 TACs by 10% to 187,880 mt. The 2017 TAC was further raised to 200,000 mt after stock projections showed the increase would result in a 0% chance of overfishing. The state allocation formula established by Amendment 2 assigns each state a percentage of the TAC based on each state's average landings between 2009 and 2011. (See Table 1 in Appendix 1 for the state allocations and yearly quotas.)

Amendment 2 requires allocation to be revisited every three years. In revisiting allocations, via Amendment 3, the Board has decided to investigate different allocation methods and timelines given concerns that the approach does not strike a balance between gear types and regions, as well as the present needs of the fishery

versus future growth opportunities. For example, because 85% of the quota is allocated to Virginia, where the last remaining menhaden reduction fishery takes place, increases in the TAC provide limited benefit to the small-scale bait fisheries along the coast. Additionally, given improvements in the condition of the Atlantic menhaden stock, the process of determining allocation based on a narrow period of historical catch limits states who currently have minimal quota from participating in the growing fishery. Some states have also found evidence of un-reported landings during the reference period, meaning the quota system may have reduced their fisheries to a greater extent than originally intended.

Recognizing these concerns, the Board is interested in exploring alternative allocation strategies. Many fisheries use quotas and allocation formulas to limit harvest, offering examples of how catch can be allocated. Some fisheries are managed in a manner similar to the current system for menhaden. For example, the commercial summer flounder TAC is allocated to states via individual state percentages based on each state's average landings during a historical reference period. Others are managed differently. The Atlantic herring quota is currently allocated by season in the inshore management area. None of the quota is allocated between January and May due to spring spawning and interactions with other fisheries; 72.8% of the quota is available from June through September and 27.2% from October through December. In the South Atlantic, quota for golden tilefish is allocated by gear-type with the annual catch limit divided between the longline and hook-and-line fisheries. This was done to ensure continued participation by hook-and-line fishermen since the commercial quota was being rapidly harvested by the longline sector. Spiny dogfish uses both a regional and state allocation system with the northern region (ME–CT) receiving 58% of the quota and the states of NY through NC receiving individual state shares. This allocation system was used to allow southern states the ability to participate in the fishery before the total allowable catch is caught by the northern states.

In May 2015, the Menhaden Board established an Allocation Working Group to initiate the process of revisiting menhaden quota allocation. The Allocation Working Group considered landings history, the performance of state fisheries, and the challenges associated with the current management plan. As a result, the group created a broad range of allocation options which are presented below (Options A through G). Information on menhaden landings by jurisdiction, gear type, and disposition can be found in Tables 2 and 3 and Figure 1 of Appendix 1.

Statement of the Problem: Amendment 2 requires menhaden allocation to be revisited every three years. The Board is exploring different allocation strategies due to several concerns with the current state-by-state quotas, including inequitable access to quota among gear types and the inability for some states to participate in the growing fishery.

Option A. Jurisdictional Quotas (Status Quo)

Quotas are allocated to each state/jurisdiction in the management unit based on its landings during a selected reference period. (See Table 2 in Appendix 1 for commercial landings by jurisdiction.) The current reference period is 2009-2011. (Note that Issue 3 (pg 13) considers potential changes to this time period.)

Option B. State-Specific Quotas with Fixed Minimum

Quotas are allocated to each state/jurisdiction in the management unit based on its landings during a selected reference period; however, no state/jurisdiction receives less than a minimum fixed percent quota (e.g., 1% of the coastwide TAC). A minimum fixed-quota allocation provides growth opportunity for states that have small quotas. For example, in the American eel fishery, each state is allocated a minimum 2,000 pound quota in order to increase equity in the distribution of quota.

Option C. Coastwide Quota

There is one coastwide quota that applies to the entire Atlantic menhaden fishery.

Option D. Seasonal Quotas

The TAC is divided into designated seasons, such as a winter, spring, summer, and fall. Under this option, it may be possible to consider further allocation (e.g., regional, state by state) of the season-specific quotas to provide equitable access to the fishery. (See Figure 2 in Appendix 1 for a breakdown of commercial landings by month).

Option E. Regional Quotas

Quotas are allocated to designated regions. The intent of these geographic delineations would be to capture the spatial dynamics of the fishery. Specific regional options could include:

1. Two region split: (1) North, defined as waters north of Machipongo Inlet, VA, on the Delmarva Peninsula; and (2) South, defined as waters south of Machipongo Inlet, including the Chesapeake Bay. These regions match those used for stock assessment purposes in the 2015 Benchmark Stock Assessment.
2. Two region split: (1) Chesapeake Bay; and (2) Coast.
3. Three region split: (1) New England, defined as ME–CT; (2) Mid-Atlantic, defined as NY–DE; and (3) Chesapeake Bay South, defined as MD–FL.
4. Four region split: (1) New England, defined as ME–CT; (2) Mid-Atlantic, defined as NY–DE; (3) Chesapeake Bay, defined as MD–VA; and (4) South Atlantic, defined as NC–FL.

Option F. Disposition Quotas

Quotas are allocated to the bait and reduction fisheries separately. The intent of this option would be to capture the different dynamics that exist between the bait and reduction fisheries. Under this option, it may be possible to consider further

allocation (e.g., regional, state-by-state) of the disposition-specific quotas to provide equitable access to the fishery.

Option G. Fleet Capacity Quotas

Quotas are allocated to various fleets based on their harvest capacity, as determined by gear type. The intent of this option would be to capture the different scales of operation that exist in the fishery and their dynamics. It may be possible to consider further allocation (e.g., regional, state-by-state, disposition) of the capacity-specific quotas to provide equitable access to the fishery. Some of the specific fleet capacity options below include a “soft quota” concept, which sets a target quota but does not subject the fleet to a fishery closure. The intent of a soft quota would be to restrict the retention of menhaden but add flexibility for additional catch in years when fish are abundant.

Specific fleet options could include:

1. Two Fleet Capacity Allocation

Small Capacity Fleets:

Types of gears in the small-capacity fleet include, but are not limited to, cast net, trawl, trap/pot, haul seine, fyke net, hook and line, pound nets and gill nets. Total coastwide landings for these small-capacity gears are approximately 22 million pounds annually or 5% of coastwide landings from 2009–2012. The small-capacity fleet could be defined by a trip limit such that a vessel must land less than a certain poundage of menhaden to fish in the small-capacity fleet; otherwise they would move to the large-capacity fleet. Alternatively (or additionally), a trip limit could be established if the small-capacity fleet harvest grows to an unacceptable level. Given the small capacity of these gear types, this fleet could be managed with a soft quota, whereby harvest is allowed to fluctuate above the quota in years when fish are available (Figure 1). Flexibility in the quota would minimize menhaden discards from this fleet.

Large-Capacity Fleet:

Types of gears in the large-capacity fleet include, but are not limited to, purse seines and pair trawls. Total coastwide landings for these large-capacity gears are approximately 436.2 million pounds annually or approximately 95% of coastwide landings from 2009–2012, and include both bait and reduction fishery harvest. Given the large capacity of these gear types, this fleet would be managed with a hard quota.

2. Three Fleet Capacity Allocation

Small-Capacity Fleet:

Types of gears in the small-capacity fleet include, but are not limited to, cast net, trawl, trap/pot, haul seine, fyke net, and hook and line. Total coastwide landings for these small-capacity gears are approximately 3.14 million pounds annually or roughly 1% of coastwide landings from 2009–2012. Given the small capacity of these gear types, this fleet could be managed with a soft quota.

Medium-Capacity Fleet:

Types of gears in the medium-capacity fleet include, but are not limited to, pound nets and gill nets. Total coastwide landings for these gear types are approximately 18.92 million pounds annually or 4% of coastwide landings from 2009–2012. Given the medium capacity of these gear types, this fleet could be managed with a soft or hard quota.

Large-Capacity Fleet:

Types of gears in the large-capacity fleet include, but are not limited to, purse seines and pair trawls. Total coastwide landings for these gears are approximately 436.2 million pounds annually or 95% of coastwide landings from 2009–2012, and include both bait and reduction fishery harvest. Given the large capacity of these gear types, this fleet would be managed with a hard quota.

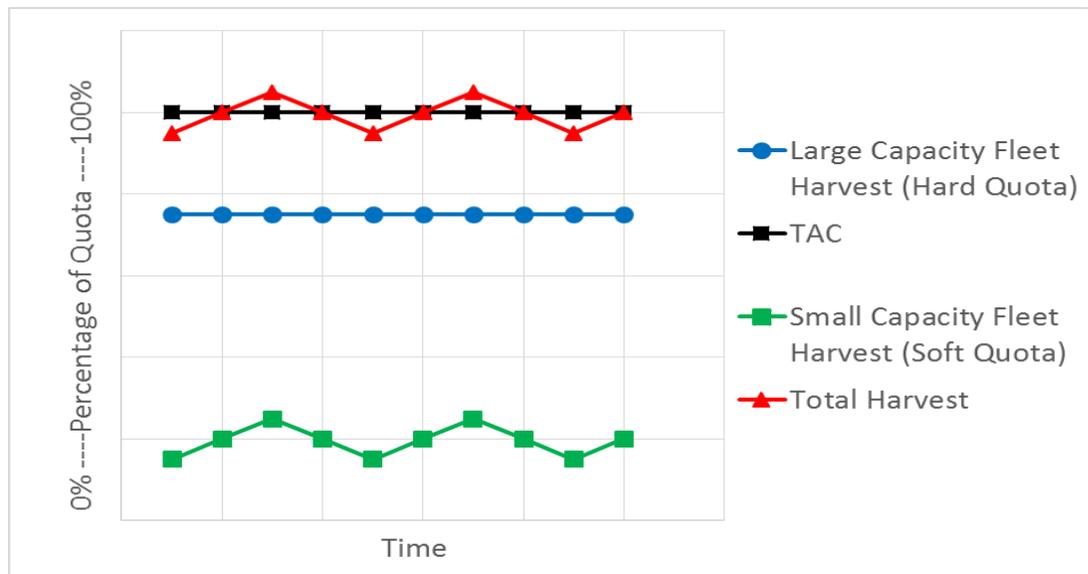


Figure 1. A graphical representation of the two fleet capacity allocation showing the fluctuating small capacity bait harvest and its impact on total harvest relative to the quota.

Option H. Allocation Strategy Based on TAC Level

The quota allocation strategy would vary depending on the amount of TAC available in each fishing year. The average landings for the years 2009–2011 (212,500 mt), from which a 20% reduction was taken in Amendment 2, would serve as the baseline. When the annual, coastwide TAC is at or below 212,500 mt, it would be allocated to jurisdictions based on average landings during 2009–2011 (i.e., the current allocation strategy). When the TAC exceeds 212,500 mt, the amount above 212,500 mt would be reallocated based upon an alternative allocation strategy, such as any of the other options presented in this section, or added to the episodic events set aside, or distributed to jurisdictions based on need or another agreement.

The intent of this option would be to ensure that each jurisdiction equally contributes to the conservation of the menhaden resource the Board determined

was necessary in adopting Amendment 2 and prevent the entire burden from being borne solely by high-quota jurisdictions. Once the TAC exceeds the baseline, however, additional harvest opportunities can be redistributed to other jurisdictions in order to address concerns expressed by proponents of reallocation.

Public Comment Questions: Should the Board maintain, or revise, the allocation formula currently used to manage the commercial Atlantic menhaden fishery? Which allocation option(s) provides for the fairest and most equitable distribution of coastwide total allowable catch? Which allocation option(s) strikes the best balance between current needs and future growth opportunities? Do you support the use of soft quotas for some user groups? What is a suitable small-capacity trip limit in Option G? How should a small-capacity gear be defined? Are there any other options, besides those offered in this document, that the Board should consider?

**ISSUE 3:
Allocation
Timeframe**

Background: As part of its required review of menhaden allocation, the Board is also considering changes to the reference period upon which the quotas are based. Amendment 2 divides the total allowable catch into jurisdictional quotas based on average landings between 2009 and 2011. A key question facing the Board is whether this timeframe represents a fair and equitable representation of coastwide menhaden catch – past, present, and future. It is important to note that the data quality of catch landings improves with time, with the most reliable bait landings available since 1985 and quota monitoring systems implemented in 2013.

Statement of the Problem: The reference period established by Amendment 2 does not consider history prior to 2009, nor recent changes in the fishery. In addition, some states have expressed concerns about underreported harvest during 2009–2011. In revisiting state-by-state quotas, the Board must decide if these three years are the most appropriate timeframe on which to base allocation.

Option A: 2009–2011 Average (Status Quo)

Quota allocation is based on the three-year average of landings between 2009 and 2011.

Option D: 2012-2016 Average

Quota allocation is based on the five-year average of total landings between 2012 and 2016. This timeframe includes the five most recent years of data and encompasses years prior to and after the implementation of a quota system. Total landings include transfers, bycatch, and landings under the episodic events program.

Option C: Longer Time-Series Average

Quota allocation is based on a longer time series average of landings. For example, quota allocation could be based on a four-year average of landings between 2009 and 2012, with 2012 being the last year before implementation of Amendment 2. Or

the allocation timeframe could be extended to include years prior to 2009, such as 2005 when the Beaufort, North Carolina reduction plant closed, or 1985 when more accurate bait landings data become available.

Option D: Weighted Allocation

Allocation is weighted over two time periods: a more distant period and a more recent period. For example, 50% of the allocation could be based on average landings between 2009 and 2012 while the other 50% of the allocation could be based on average landings between 2013 and 2015. Or, a portion of allocation could be based on landings in the 1980's while another portion of allocation could be based on landings in the 2000's. Weighting is intended to balance prior trends in the fishery with recent changes in catch.

Public Comment Questions: Should the Board consider changes to the reference period on which menhaden allocation is based? Should allocation consider prior trends as well as recent changes in the fishery? What years would you recommend as the basis for allocation?

***ISSUE 4:
Quota
Transfers
and Overage
Payback***

Background: Amendment 2 allows for two or more states to transfer (or combine) their Atlantic menhaden quota. Transfers often occur when a jurisdiction has exceeded its allocation for the year; rather than reduce its subsequent-year quota by the amount of the overage, as required by Amendment 2, a state can receive quota from another state that did not harvest its entire allocation. These transfers do not permanently affect a state's quota allocation. All states participating in a transfer (i.e., the donor states and the receiving states) must individually submit signed letters to the Commission, requesting approval for the transfer of a specified poundage of menhaden. Transfers are not final until written approval is granted by the ASMFC Executive Director.

As a practical matter, fisheries routinely, yet inadvertently, exceed or under perform their quota due to the challenges of quota monitoring, including delays in reporting and unanticipated changes in catch rates. Transfers are a useful technique to address these occurrences. However, some regions may be disadvantaged by the quota transfer system due to the timing of their fishery relative to other fisheries along the coast, meaning they may not know they've had an overage until late in the year when available quota has already been donated. Furthermore, there is no ASMFC guidance on how to apportion unused quota if there are multiple transfer requests at the same time.

Other FMPs allow for quota transfers and provide examples of potential management tools. The black sea bass FMP allows for quota reconciliation such that, in a year where the coastwide quota is not exceeded, any state-specific overage is forgiven in its entirety. This streamlines the transfer process and avoids the need for written approval from the individual states and the ASMFC Executive Director. This

could potentially be a viable option for the menhaden fishery given that states' harvest did not exceed the annual TAC from 2013-2015.

The black sea bass FMP also provides examples of what to do in years when the coastwide TAC is exceeded. Specifically, states that did not meet their allocation may transfer their unused quota to a common pool. This common pool quota is then redistributed to states that exceeded their quota based on the proportion of the state's overage. Any overage that remains after the redistribution of unused quota is deducted from a state's quota the subsequent year. It is important to note that quota reconciliation may not be compatible with quota rollovers (see Issue 5 on pg 15) as unused quota is used to offset overages.

Statement of the Problem: Amendment 2's procedure for quota transfers may not benefit states evenly, lacks specific guidance, and can be an administrative burden on donor and receiving states. Consequently, the Board is considering a quota reconciliation process to address quota overages, as a replacement for quota transfers for this purpose. Quota transfers could still occur for other reasons (e.g., a state grants a vessel safe harbor with catch destined for another state that is then unloaded there). In the case of the fleet capacity quota allocation options, reconciliation would not be necessary for any fleet assigned a soft quota.

Public Comment Questions: Should the process for quota transfers be further defined or replaced by an automatic reconciliation process? Should state-specific quota overages be forgiven in years when the coastwide TAC is not exceeded? When the coastwide TAC is exceeded but at least one jurisdiction has an underage, should unused quota be pooled and redistributed through a specified transfer process to states with an overage? Should states be required to contribute unused quota to a common pool or should this be voluntary? Should there be accountability measures for a state that exceeds its quota by a certain percentage or repeatedly participates in quota reconciliation?

ISSUE 5:
Quota Rollovers

Background: Amendment 2 allows for unused quota to be rolled over for use in the subsequent fishing year only when the stock is not overfished and overfishing is not occurring. At the time of implementation (2013), the Atlantic menhaden stock was considered not overfished but overfishing was occurring. As a result, the amendment deferred defining the specifics of the rollover program until overfishing was no longer occurring.

In 2015, a new benchmark stock assessment was approved for management use which found the stock is not overfished and overfishing is not occurring. As a result, the stock, since 2015, has met the qualifications for quota rollovers; however, the amount of quota that can be carried into the next year has not been established. In August 2015, the Board agreed to consider the details of quota rollovers in Amendment 3. Other species, including spiny dogfish and Atlantic herring, allow for a percentage (5%

and 10%, respectively) of unused quota to be rolled over from one year to the next. For example, in the spiny dogfish fishery, if a state's annual quota is 1 million pounds, a maximum of 50,000 pounds (5%) of unused quota can be rolled over into the subsequent year.

It is important to note that the issues of quota reconciliation and quota rollover may not be compatible, such that it may not be possible to have quota overages automatically forgiven via reconciliation and unused quota roll over into the subsequent fishing year. Any unused soft quota would also not be eligible for quota rollover into the subsequent fishing year.

Statement of the Problem: The Atlantic menhaden stock is not overfished and overfishing is not occurring, thereby qualifying the stock for quota rollovers per Amendment 2. However, because the details of a quota rollover program were not specified in Amendment 2, no quota rollovers have taken place. The Board is looking to readdress and clarify the provisions via Amendment 3.

Public Comment Questions Should unused quota be rolled over into the subsequent year? Should the amount rolled over be limited to a percent of quota? Should all sectors of the fishery be allowed to roll over quota? Should quota rollover be mandatory or voluntary?

**ISSUE 6:
Incidental Catch
& Small Scale
Fishery
Allowance**

Background: Upon a state reaching its individual quota and closing its directed fishery, Amendment 2 provides a bycatch allowance of up to 6,000 pounds of Atlantic menhaden per vessel per trip for non-directed fisheries. The intent of this allowance is to accommodate and track incidental catch, i.e. catch that is not targeted but is harvested. As specified in Amendment 2, all landings that occur during a state-designated open season count towards a state's quota; however, menhaden caught after the closure of a state's directed fishery are considered bycatch and do not count towards the quota, nor the coastwide TAC.

Coastwide, the vast majority of menhaden harvested under the bycatch allowance is taken with stationary multi-species gears. Table 4 in Appendix 1 shows the average bycatch landings between 2013 and 2015 by gear and jurisdiction. On average, 5.7 million pounds of menhaden bycatch are landed each year, representing 1-2% of total landings in the fishery. Over 80% of the bycatch harvest comes from stationary gears, with the biggest contributors being the Maryland pound net fishery and the Virginia anchored gill net fishery. Cast nets contribute 6% of bycatch landings and represent the largest contributor from the mobile gear sector. This is followed by drift gill nets (5%) and beach seines (3.7%). Jurisdictions in the Chesapeake Bay contribute the most to bycatch landings of menhaden, with Maryland harvesting 40.7%, Virginia harvesting 24.9%, and the Potomac River Fisheries Commission harvesting 15.4% of annual coastwide bycatch landings. Between 2013 and 2015, 59.6% of bycatch trips using stationary gears landed less than 1,000 pounds of menhaden and 80.7% of trips landed

less than 3,000 pounds of menhaden (Table 5 in Appendix 1). In 2015, most menhaden landed under the bycatch allowance were landed in April (28%), September (23%), and October (21.3%). This corresponds with the closure of several states' directed fisheries in the spring and fall (Table 6 in Appendix 1).

Concerns have been raised regarding the current bycatch provision. The first is that landings under the bycatch allowance do not count toward a state's quota. As a result, bycatch landings may undermine the efficacy of the coastwide TAC since there is no yearly bycatch limit. Additionally, since neither "bycatch" nor "non-directed fisheries" is defined in Amendment 2, it is unclear who can harvest under the allowance. Many passive gears, such as pound nets, can be set to target menhaden but may also catch menhaden incidentally. Furthermore, the question arises to whether the bycatch allowance essentially supports small-scale directed fisheries rather than accommodating and tracking incidental catch. Cast nets, for example, direct on menhaden but are included in the bycatch provision.

Another concern is that the current bycatch provision dissuades cooperative fishing since the bycatch allowance is per vessel rather than permitted individual. This is particularly problematic in the Chesapeake Bay where it is traditional for multiple permitted individuals to work together from the same vessel to harvest menhaden. Addendum I (implemented in 2016) alleviated this problem by allowing two permitted individuals fishing from the same vessel using stationary multi-species gear to land up to 12,000 pounds of menhaden per trip per day (ASMFC 2016); however, there may be other ways to address this issue in Amendment 3.

Moving forward, there are several options to address concerns with the current bycatch provision. Bycatch could be defined as a percent composition to ensure it accounts for incidental landings. Bycatch could also be defined per permitted individual rather than per vessel to allow for cooperative fishing. Alternatively, bycatch could be included in the TAC or limited through a harvest cap to ensure it does not undermine the total quota. Additionally, the bycatch provision could be removed and replaced with a coastwide small-scale fishery set aside (Option F on pg 18). This would remove the administrative burden on states to closely monitor landings by small-scale fisheries, allow for flexibility in landings as abundances changes geographically and temporally, and bring the current bycatch fishery under the TAC.

In the management options presented below, the term 'bycatch' is replaced with the term 'incidental catch.' This change was made due to the various and conflicting definitions of bycatch among the states and to reflect the intent of the allowance to accommodate menhaden catch that is not targeted but is harvested.

Statement of the Problem: Under Amendment 2, there is a 6,000 pound incidental bycatch limit per vessel per trip/day for non-directed fisheries. Several issues have been identified with this allowance, namely that bycatch is not included in the TAC,

there is no definition of what constitutes bycatch, and the allowance does not support cooperative fishing.

Option A: Incidental Catch Limit per Vessel (Status Quo)

Following the closure of the directed fishery, there is an incidental catch limit per vessel per trip for non-directed fisheries. Two permitted individual fishing from the same vessel using stationary multi-species gear are allowed to land twice the allowance when working together.

Option B: Incidental Catch Allowance per Permitted Individual

An incidental catch limit would be established per person/trip, rather than per vessel/trip. As a result, multiple permitted individuals on the same vessel could each land the incidental catch limit.

Option C: Incidental Catch Included in Quota

All incidental catch of menhaden would count towards the directed fishery quota. Once the quota is reached, the menhaden fishery would be closed and no landings would be allowed.

Option D: Incidental Catch Cap and Trigger

Rather than a trip limit, incidental catch in the Atlantic menhaden fishery would be limited by a harvest cap (not part of the annual TAC). If the collective incidental landings exceed this cap by a certain percentage in a single year or by any percentage in two consecutive years, management action would be triggered by the Board to reduce incidental landings in the fishery. Separate harvest caps could be established for passive and active gears

Option E: Incidental Catch Defined by Percent Composition

Trips in the non-directed fisheries that land above a certain poundage of menhaden would be required to maintain their menhaden landings under a specific percent composition of catch. This option could be combined with either an incidental catch allowance per trip or a cap in order to limit menhaden landings in the non-directed fisheries.

Option F: Small-Scale Fishery Set Aside

A portion of the overall TAC would be set aside for gears participating in the small-scale fisheries. Trips by these gears would be limited to a certain poundage per day, and all trips conducted by these gears would count towards the small-scale fishery quota. Separate trip limits could be established for active and passive gears. If the quota is exceeded in a given year, payback could be required or the quota for the subsequent year could be adjusted up or down to meet the expected harvest by small-scale gears. While similar to Option G presented in *Issue 2: Quota Allocation*, the inclusion of this option would allow for the establishment of a small-scale fishery set aside regardless of what allocation option is chosen.

Public Comment Questions: Should there be a cap on incidental landings in the Atlantic menhaden fishery? Should incidental catch be defined as a percent composition? Should the incidental catch allowance be allocated to vessels or permit holders? Should the incidental catch provision be replaced with a small-scale fishery set aside, and if yes, what gears should be included in this sub-quota (see Table 3 in Appendix 1)? Should active and passive gears be treated differently under the incidental catch provision?

***ISSUE 7:
Episodic Events
Set Aside***

Background: Amendment 2 sets aside 1% of the overall TAC for episodic events, which are times and areas where Atlantic menhaden are available in more abundance than they normally occur. The purpose of the set aside is to enable increased harvest of menhaden during episodic events so as to minimize discards in the fishery. The details of the program, established as a pilot, were approved by the Board in May 2013 and are outlined in Technical Addendum I. In the fall of 2013, the Board extended the pilot program until further Board action. In 2016, the Board extended the program until finalization of Amendment 3.

Eligibility in the episodic events set aside program is reserved for the New England states (Maine through Connecticut). To participate in the program, these states must implement daily trip level harvest reporting, restrict the harvest and landing of menhaden under the episodic events program to state waters, and implement a maximum daily trip limit no greater than 120,000 pounds/vessel. In order for a state to declare participation in the program, a state must demonstrate it has reached its quota prior to September 1 and provide information indicating the presence of unusually large amounts of menhaden in its state waters. Any set aside quota that is not used by October 31 is returned to the coastwide quota and redistributed to the states. If the set aside quota is exceeded, overages are deducted from the next year's episodic events set aside amount.

In 2014 and 2015, Rhode Island was the only state to declare participation in the episodic set aside program, harvesting 8% of the set aside in 2014 and 45% of the set aside in 2015 (Table 1). In 2016, Rhode Island and Maine declared participation in the program, and New York sought Board approval to participate in the program. While New York is not considered a New England state under Technical Addendum I, New York highlighted the unusually large amounts of menhaden in the Peconic Bay estuary and the potential for fish kills. The Board approved New York's request to harvest under the episodic events set aside program, capping New York's harvest under the program to 1 million pounds.

Table 1: Episodic events set aside for 2013-2016 and the percent used by participating states.

Year	Set Aside (lbs)	Landed (lbs)	% Used	State	Unused Set Aside Reallocated (lbs)
2013	3,765,491				
2014	3,765,491	295,000	8%	RI	3,470,491
2015	4,142,040	1,883,292	45%	RI	2,258,748
2016	4,142,040	3,810,145	92%	ME, RI, NY	331,895

Given the increasing amounts of menhaden landed under the episodic events set aside program and New York’s request to harvest under the program, the Board is considering changes to the program. Specific questions include whether the percent of TAC allocated to the set aside should be increased, which states should be allowed to participate in the program, and whether the current definition of an episodic event is appropriate. Furthermore, some allocation options presented in this document would potentially negate the need for such a set aside.

Statement of the Problem: Since 2013, participation in and landings under the Episodic Events Set Aside Program have increased. As a result, the Board is considering changes to the scope of the program, including the amount of quota allocated to the set aside and which states are qualified to participate.

Public Comment Questions? Should a percentage of the TAC be set aside for episodic events? If yes, what percentage of the annual TAC should be set aside? Which jurisdictions should be allowed to participate in this program? Does the episodic event program need to be reconsidered as the distribution of menhaden changes? How should states demonstrate that an episodic event is occurring in state waters?

**ISSUE 8:
Chesapeake Bay
Reduction
Fishery Cap**

Background: The Chesapeake Bay reduction fishery is currently limited by a harvest cap of 87,216 metric tons (mt). The goal of this restriction is to prevent all of the reduction fishery harvest from occurring in the Chesapeake Bay, a critical nursery area for Atlantic menhaden. Harvest by the reduction fishery is prohibited within the Chesapeake Bay when 100% of the cap has been reached. A maximum of 10,976 mt of un-landed fish can be rolled over into the subsequent year’s harvest cap. The Chesapeake Bay reduction fishery has consistently underperformed the 87,216 mt harvest cap, landing less than 50,000 mt in 2015, less than 45,000 mt in 2014, and less than 40,000 mt in 2013. Note that landings by the Chesapeake Bay reduction fishery are confidential and only approximate landings are provided.

The Chesapeake Bay Reduction Fishery Cap, which was originally implemented in 2006, was intended to prevent the localized depletion of menhaden. There was a hypothesis that the potential for localized depletion exists in the Chesapeake Bay given the concentrated harvest of the species in the area, particularly from the reduction fishery. Possible outcomes of localized depletion include compromised predator-prey relationships and chronic low recruitment of larval menhaden. The Board committed

to assessing the potential for localized depletion at its February 2005 meeting and established the Atlantic Menhaden Research Program (AMRP) to evaluate the possibility of such depletion occurring. In 2009, work completed under the AMRP was peer reviewed by the NOAA Center for Independent Experts (CIE). The peer review was unable to conclude localized depletion is occurring in the Chesapeake Bay given there were two assessment models which generated different advice. It also noted that given the high mobility of menhaden, the potential for localized depletion could only occur on a “relatively small scale for a relatively short time.” Since harvest by the reduction fishery has consistently been below the cap and there has not been conclusive evidence that localized depletion is occurring in the Chesapeake Bay, the Board would like feedback on whether this is an important management tool in the Atlantic menhaden fishery.

Statement of the Problem:

The Chesapeake Bay Reduction Fishery Cap was intended to protect menhaden nursery areas and prevent against localized depletion; however the reduction fishery has consistently under-performed its harvest cap and a peer review report was unable to conclude that localized depletion is occurring in the Chesapeake Bay. The Board would like feedback on whether this is an essential management tool.

Public Comment Questions: Should the Chesapeake Bay Reduction Fishery Cap be maintained? Is it an important tool for the management of Atlantic menhaden?

**ISSUE 9:
Research
Programs and
Priorities**

Background: As a part of the 2015 stock assessment, the Board’s Technical Committee outlined a series of research recommendations and priorities for the Atlantic menhaden stock. The intent of these recommendations is to help inform and support research conducted by states, institutions, and industry. Current recommendations include evaluating the productivity of different estuaries along the Atlantic coast, collecting age-specific data on movement rates of menhaden to develop regional abundance trends, updating information on maturity and fecundity, and investigating the effects of global climate change on the distribution and behavior of menhaden. While these recommendations outline a variety of research needs for the stock, there may be other pertinent research questions which could inform future management decisions. Furthermore, while none of the TAC is currently set aside for research purposes, there could be an option to establish a Research Set Aside (RSA), through which a portion of menhaden quota could be reserved for scientific studies. Other fisheries, such as Atlantic Herring, currently have a RSA to conduct research on the bycatch of river herring and better characterize catch.

Statement of the Problem: Research recommendations for the menhaden stock are currently provided as a part of the benchmark stock assessment process; however, there may be other recommendations that should be added to this list to inform future management of the resource and fishery. Furthermore, the Board could consider a RSA to help facilitate research on the stock.

Public Comment Questions: What are important research questions that need to be answered regarding the menhaden fishery and resource? How should research recommendations be prioritized? Should there be a RSA established for menhaden? If yes, what portion of TAC should be set aside for research purposes?

**BACKGROUND
INFORMATION
ON THE MGMT
& STOCK STATUS
OF ATLANTIC
MENHADEN**

Summary of Fishery Management

The Commission has coordinated interstate management of Atlantic menhaden (*Brevoortia tyrannus*) in state waters (0-3 miles) since 1981. Management authority in the exclusive economic zone (3-200 miles from shore) lies with NOAA Fisheries. As outlined in the Commission's Charter, fishery management plans shall be designed to prevent overfishing throughout the species' range, be based on the best available science, minimize waste of fishery resources, protect fish habitat, provide for public participation, and allow for fair and equitable allocation among the states.

In 1988, the Commission initiated a revision to the FMP. The Plan revision included a suite of objectives to improve data collection and promote awareness of the fishery and its research needs, including six management triggers used to annually evaluate the menhaden stock and fishery. In 2001, Amendment 1 was passed, providing specific biological, social, economic, ecological, and management objectives for the fishery. Subsequent addenda (I-V) to Amendment 1 sought to improve the biological reference points for menhaden and cap the reduction fishery. Addendum I revised the biological reference points and changed the frequency of stock assessments. Addenda II and III instituted a harvest cap on the Chesapeake Bay Atlantic menhaden reduction fishery for the 2006 through 2010 fishing seasons. Addendum IV extended this harvest cap through 2013. Addendum V, which was approved in November 2011, established a new F threshold and target rate (based on MSP) with the goal of increasing abundance, spawning stock biomass, and menhaden availability as a forage species.

The Atlantic menhaden fishery is currently managed through Amendment 2 to the Atlantic Menhaden FMP, which was passed in 2012 and implemented in 2013. It sets a coastwide TAC for the stock and allocates this harvest into state quotas. Amendment 2 also establishes a bycatch provision which allows for the harvest of up to 6,000 pounds of Atlantic menhaden per trip for non-directed fisheries and sets aside 1% of the overall TAC for episodic events. In order to effectively implement the management measures established in Amendment 2, states are required to implement timely reporting systems to monitor catch.

Technical Addendum I outlines the provisions of the episodic events set aside program. It restricts participation in the program to the New England states and requires these states to implement daily harvester reporting, restrict harvest to states waters, and set a 120,000 pound daily trip limit in order to harvest under the set aside. Technical Addendum I also outlines a process for declaring participation in the

program. Addendum I to Amendment 2 revisits the bycatch provision and allows two licensed individuals to harvest up to 12,000 pounds of menhaden bycatch when working from the same vessel fishing stationary, multi-species gear—limited to one vessel trip per day. Stationary multi-species gears are defined as pound nets, anchored/staked gill nets, and fyke nets.

Summary of Stock Status

The latest peer reviewed stock assessment is the 2015 benchmark assessment. The assessment used the Beaufort Assessment Model, a statistical catch-at-age model which estimates population size at age and recruitment in 1955 and then projects the population forward in time to the terminal year of the assessment (2013). The model estimates trends in population dynamics, including abundance at age, recruitment, spawning stock biomass, egg production, and fishing mortality rates. The current stock assessment model configuration does not directly output the unfished biomass of the Atlantic menhaden stock.

Model results indicate the population has undergone several periods of both high and low abundance over the time series. Biomass has fluctuated over time from an estimated high of over 2,284,000 metric tons in 1958 to a low of 667,000 metric tons in the mid-1990s. Population fecundity (measured as number of maturing ova, or eggs) has also varied throughout the time series with a large number of eggs seen in the early 1960s, the 1970s, the early 1990s, and the 2000's. Fishing mortality has steadily decreased throughout the model time series. This is primarily due to a decrease in harvest in the reduction fishery which peaked in the late 1950's at over 700,000 metric tons and decreased to roughly 130,000 metric tons in 2013. In contrast, bait landings have slowly increased from roughly 30,000 metric tons in the late 1980s to over 60,000 metric tons in 2012.

Population fecundity in 2013 was estimated to be 170,536 billion eggs, well above the fecundity threshold of 86,821 billion eggs (Figure 2). As a result, the population is deemed not overfished. Overfishing is also not occurring as the fishing mortality in 2013 (0.22) is below the fishing mortality threshold of 1.26 (Figure 3).

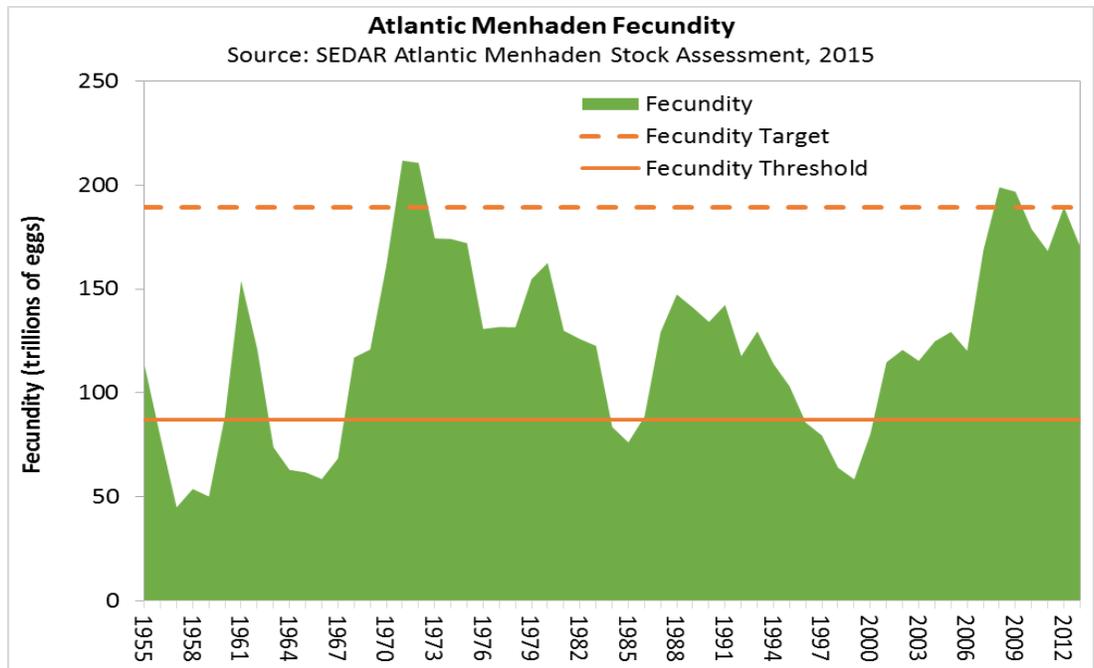


Figure 2: Atlantic menhaden fecundity target and threshold from the 2015 stock assessment. Population fecundity in 2013 was estimated to be 170,536 billion eggs, well above the fecundity threshold of 86,821 eggs.

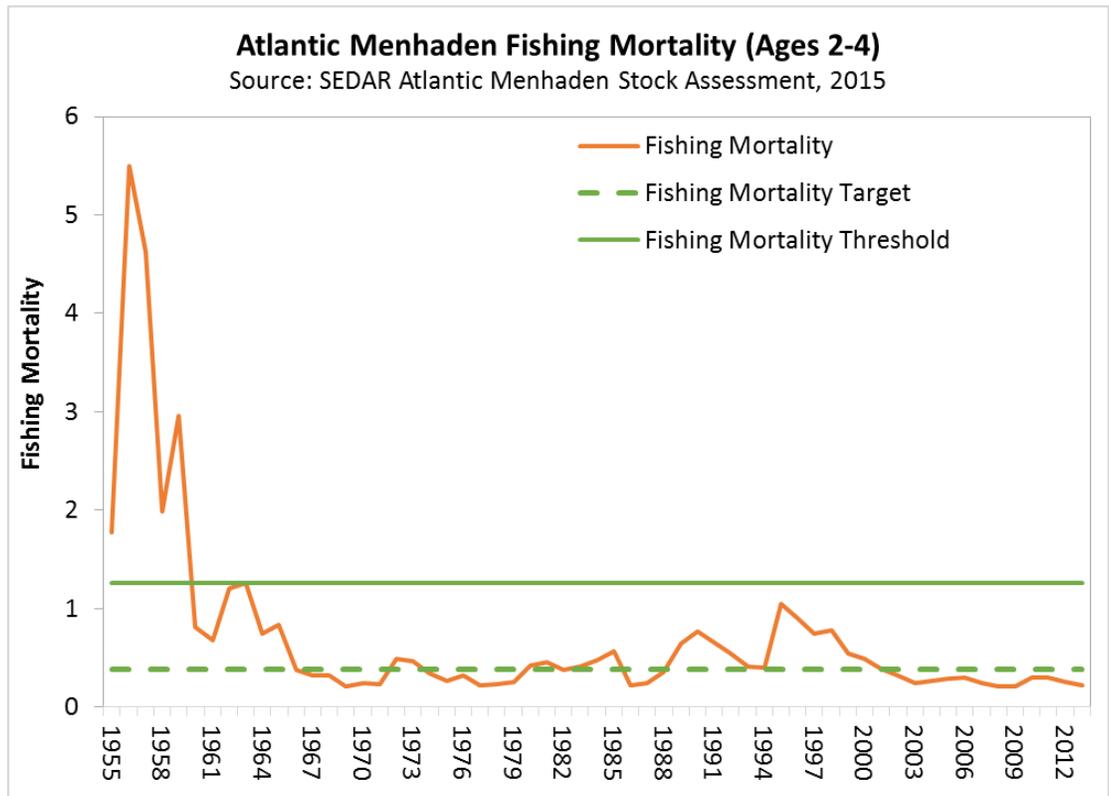


Figure 3: Atlantic menhaden fishing mortality target and threshold from the 2015 stock assessment. Overfishing is also not occurring as the fishing mortality in 2013 (0.22) is below the fishing mortality threshold of 1.26.

Social and Economic Impacts

Changes in the allocation of total allowable catch are expected to have socioeconomic impacts on affected states/jurisdictions, regions, and fishery interests. Overall, improvements in the menhaden stock which lead to increased TAC should benefit fishery participants; however, reductions in allocation to a particular area or interest could lead to reduced employment and associated reductions in the economic benefits derived from menhaden. In general, the reduction sector is expected to take fish in response to the allowable catch in relation to prices of competing oils (for example flax or other vegetable oils), and demand for oil and fishmeal products. The bait sector is expected to take fish in response to allowable catch in relation to the following factors: available fish, competing products (for example herring as bait for lobster), demand for menhaden as a primary desired bait, and prices for competing products in addition to the cost of fishing, fuel and vessel maintenance.

Currently, there is little socioeconomic data available with which to assess the specific effects of changes in allocation and other management actions. The Commission's Committee on Economics and Social Sciences (CESS) issued a request for proposals to fund research in order to characterize the coastwide commercial fisheries, including the bait and reduction sectors and the fishery communities they support. The study will gather both primary and secondary information from stakeholders to understand spatial trends in landings, the distribution of revenue, operational costs, and participation in the fishery. A project was selected early in 2016 and the research is presently being conducted. It is anticipated this data and other project deliverables will be available to the Commission and CESS early in 2017. Information from this survey will be incorporated into Draft Amendment 3.

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Appendix 1

Table 1. Atlantic menhaden allocation and quotas for 2013-2016. Current state-by-state allocation is based off of average landings between 2009 and 2011. Quota totals do not include the 1% of the TAC which is reserved for the Episodic Events Set Aside Program. Florida exceeded their quota in 2015 and this overage is deducted from their 2016 quota.

State	Allocation	2013-2014 Quota (lbs)	2015-2016 Quota (lbs)
ME	0.00039	146,787	161,466
NH	0.0000003	112	123
MA	0.00839	3,126,024	3,438,630
RI	0.00018	66,779	73,457
CT	0.00017	65,034	71,537
NY	0.00055	206,695	227,365
NJ	0.11192	41,721,164	45,893,335
DE	0.00013	49,230	54,153
MD	0.01373	5,116,874	5,628,568
PFRC	0.00621	2,314,174	2,545,595
VA	0.85322	318,066,790	349,873,884
NC	0.00493	1,836,948	2,020,645
SC	0.00000	-	-
GA	0.00000	-	-
FL	0.00018	66,995	73,695 (72,030 in 2016)
TOTAL	-	372,783,605	410,062,453

Table 2: Atlantic menhaden total landings (1985-2015) by jurisdiction. Landings include directed harvest, bycatch, and landings from the Episodic Events Set Aside Program. Total coastwide landings and jurisdictional percentages of total landings do not include confidential data.

	ME	NH	MA	RI	CT	NY	NJ	DE	MD	PFRC	VA	NC	SC	GA	FL	TOTAL
1985	33,192,713		3,039,625	8,388,046	234,800	901,800	2,879,766	176,135	5,372,193	16,768,889	620,118,526	97,738,403	C		7,579,674	796,390,570
1986	C		3,411,000	10,389,187	254,400	399,650	2,453,593	20,081	5,449,350	10,971,973	445,663,686	66,377,931	9,952		7,997,973	553,398,776
1987	18,668,660		1,215,175	13,609,224	94,900	206,795	2,563,163	22,034	5,793,683	13,120,698	622,988,388	55,498,571	C		2,776,777	736,558,068
1988	19,687,805	C	8,047,320	15,583,437	175,200	504,100	1,984,045	127,713	6,430,164	13,231,368	525,926,170	73,715,713	500		1,026,228	666,439,763
1989	380,619	C	1,459,402	19,033,173	148,500	449,100	2,854,361	104,382	6,166,236	8,334,174	588,063,122	66,756,288			1,372,959	695,122,316
1990	5,744,597	264,500	1,709,605	17,102,650	96,706	649,710	9,041,459	167,116	1,662,275	4,523,776	696,229,253	72,231,989			2,636,497	812,060,133
1991	16,107,463	204,000	12,798,310	5,090,375	96,300	650,150	16,597,402	278,774	3,540,179	5,376,264	636,489,011	110,528,754			2,062,983	809,819,965
1992	14,857,195	C	13,499,450	2,849,359	91,200	1,131,701	27,470,906	130,833	1,777,088	5,061,565	566,221,850	57,515,712	C		2,788,592	693,395,451
1993	19,520,455	C	1,211,569	5,146,280	195,827	1,048,993	28,296,741	164,046	2,326,613	7,884,001	296,453,210	64,711,384			2,584,766	429,547,595
1994			351,251	533,800	60,128	961,474	38,176,201	78,672	2,369,071	6,680,937	270,775,349	73,853,901			1,387,012	395,227,796
1995			2,910,613	5,873,315	255,264	1,087,978	36,572,507	101,388	4,264,754	7,002,818	360,140,489	58,374,081			687,944	477,271,151
1996			8,500	802	82,851	11,135	35,516,726	100,063	3,906,808	5,111,423	294,195,660	53,850,943			294,936	393,079,847
1997			238,500	5,750	72,329	553,953	38,118,579	55,733	3,457,237	5,757,370	267,021,139	97,727,057	C		408,492	413,416,309
1998	C	C	121,200	400	338,817	430,084	33,287,641	58,048	2,933,818	3,980,738	513,879,901	57,976,455			301,566	613,309,912
1999	C		292,800	2,330	30,298	242,886	27,753,567	78,551	4,460,534	4,860,883	374,942,360	42,799,080			288,144	455,753,158
2000	C		72,600	320,000	14,423	565,800	31,266,780	47,980	3,935,307	5,023,374	358,236,761	56,280,112			260,710	456,025,297
2001	C		144,600	-	38,865	576,426	26,375,573	53,257	3,970,243	3,329,035	484,528,580	56,012,396			179,951	575,209,116
2002	70,062		301,500	5,750	1,138,788	444,739	24,716,412	80,261	4,023,389	3,122,050	362,640,618	69,190,596			55,304	465,789,469
2003			218,255	62	46,515	384,875	17,080,463	42,593	3,163,252	2,438,790	372,486,794	48,936,502			35,810	444,833,911
2004		C	-	39,232	33,210	543,481	20,678,813	75,635	5,369,952	5,411,043	394,100,339	50,577,983			21,220	476,851,047
2005	30,302		2,177,724	14,453	30,636	871,081	17,574,826	120,658	10,635,776	4,759,905	368,988,147	13,386,245			39,404	418,629,157
2006	37,297		2,524,255	15,524	866,235	811,934	21,290,309	111,405	6,841,296	3,413,517	365,305,722	962,648			157,117	402,337,258
2007	C	C	5,543,805	8,948	90,254	483,557	37,202,485	81,850	11,370,064	5,036,906	405,836,300	1,134,167			71,373	467,054,635
2008	4,310,055	C	14,131,256	269,288	104,881	410,121	38,210,688	72,970	8,153,008	4,820,645	339,001,968	645,231			60,098	410,190,616
2009	166,942	33	6,719,048	107,548	170,907	330,496	33,329,177	69,476	7,756,192	3,191,905	335,238,841	2,124,733			52,800	389,258,097
2010	C	C	4,973,857	78,149	42,489	394,556	50,497,253	51,933	6,903,300	2,790,728	404,384,758	1,299,130			76,593	471,531,136
2011	C		116,151	83,899	26,929	279,117	74,324,485	70,326	6,506,430	2,759,597	389,652,459	3,529,967			146,534	477,551,894
2012	39,383	C	1,648,395	106,606	37,454	258,271	85,457,890	130,725	13,737,314	5,892,228	386,552,474	538,783			126,141	494,526,039
2013	C		2,314,888	99,821	26,463	1,187,525	39,819,342	125,909	7,074,727	3,295,295	316,537,921	454,172			224,872	371,168,714
2014	C		2,226,294	500,903	36,552	825,549	41,449,670	161,509	7,005,271	3,175,893	322,492,690	917,375			220,587	379,145,293
2015	C		2,932,128	1,802,089	77,003	1,468,165	47,811,837	150,542	7,551,430	2,739,035	350,524,668	839,637	C		377,729	416,275,905
% of total landings 1985-2015	0.8%	0.0%	0.6%	0.7%	0.0%	0.1%	5.7%	0.0%	1.1%	1.1%	81.2%	8.4%	0.0%	0.0%	0.2%	100.0%

Table 3: Atlantic menhaden coastwide landings averages by gear type for 2009-2012 and 2013-2014. Bycatch allowance landings are included in the 2013-2014 average. Data are preliminary and subject to change.

Landings in Pounds	2009-2012 Average	Percent by Gear	2013-2014 Average	Percent by Gear
Purse Seine	436,211,312	95.188%	353,766,645	94.207%
Pound Net	16,129,566	3.520%	13,990,507	3.726%
Trawl	2,639,414	0.576%	1,444,210	0.385%
Gill Net	2,784,530	0.608%	5,052,734	1.346%
Cast Net	213,494	0.047%	750,823	0.200%
Trap/Pots	104,775	0.023%	156,790	0.042%
Fyke Net	51,994	0.011%	3,865	0.001%
Haul Seine	64,215	0.014%	118,651	0.032%
Other	65,608	0.014%	237,735	0.063%
Total	458,264,908	100%	375,521,959	100%

Table 4: Average landings under the bycatch allowance from 2013-2015 by gear type and jurisdiction. The highlighted cells indicate the high bycatch landings in the Maryland pound net fishery and the Virginia anchored gill net fishery. (C)= confidential landings and (-)=no landings. Total confidential landings were 209,277 pounds (i.e., the sum of all C's in the table below). Note that the sum of pounds and percent of total columns do not include confidential data.

State/Jurisdiction	RI*	NY	NJ**	DE	MD	PRFC	VA	FL	Sum lbs (NonConf)	% of Total
Stationary Gears While Fishing										
Pound net	57,231	128,854	C	-	2,306,552	884,843	122,913	-	3,500,393	60.9%
Anchored/stake gill net	C	-	100,202	28,998	5,131	-	1,242,512	C	1,376,843	24.0%
Pots	-	C	-	C	10,001	-	-	C	10,001	0.2%
Fyke nets	-	-	C	-	C	-	C	-	<1000	0.0%
Mobile Gears While Fishing										
Cast Net	C	183,137	C	-	C	-	-	163,776	346,913	6.0%
Drift Gill net	-	18,175	129,620	66,117	16,082	-	57,794	-	287,788	5.0%
Seines Haul/Beach	-	206,587	-	-	C	-	5,119	-	211,706	3.7%
Trawl	C	9,733	C	-	-	-	-	-	9,733	0.2%
Hook & Line	C	-	-	-	C	-	-	C	<300	0.0%
Sum lbs (NonConf)	57,231	546,485	229,822	95,116	2,337,766	884,843	1,428,339	163,776	5,744,572	
% of Total	1.0%	9.5%	4.0%	1.7%	40.7%	15.4%	24.9%	2.9%		

NJ** an ad hoc method was used to split gill net data between stationary and mobile gears

RI* trips do not include those landed under the episodic events set aside because those landings are counted as part of the directed fishery.

Table 5: Total number of bycatch allowance trips landing menhaden by stationary gears from 2013-2015 by jurisdiction and percent of total trips by 1,000 pound landings bins. (C)= confidential landings.

Bins (LBS)	VA	MD	PRFC	NJ	NY	DE	RI*	FL	Total Trips	Total Bin%
1-1000	71%	35%	31%	85%	88%	91%	53%	100%	5,350	59.6%
1001-2000	13%	12%	21%	10%	9%	4%	14%	0%	1,176	13.1%
2001-3000	7%	8%	15%	3%	C	4%	18%	0%	716	8.0%
3001-4000	3%	7%	10%	1%	3%	1%	4%	0%	426	4.7%
4001-5000	3%	7%	13%	C	C	1%	3%	0%	441	4.9%
5001-6000	2%	14%	10%	C	C	0%	6%	0%	519	5.8%
6000+	0%	16%	0%	C	C	0%	3%	0%	351	3.9%
Total Trips	4672	2057	1138	477	345	165	102	23	8,979	
Total Trips %	52.0%	22.9%	12.7%	5.3%	3.8%	1.8%	1.1%	0.3%		

RI* trips do not include those landed under the episodic event set aside because those landings are counted as part of the directed fishery.

Table 6: Menhaden bycatch landings by month in 2015. Jurisdictions which landed under the bycatch allowance include Rhode Island, Connecticut, New York, New Jersey, Delaware, Maryland, Potomac River Fisheries Commission, Virginia, and Florida. Bycatch landings correspond to the closure of states' directed fisheries in the spring and fall. Landings under the Episodic Events Program are not included in this table. (C)=confidential landings. Note: the total sum of pounds does not include confidential landings.

	Pounds	%
January	-	
February	-	
March	C	
April	1,746,125	28.4%
May	214,409	3.5%
June	239,290	3.9%
July	160,574	2.6%
August	199,904	3.2%
September	1,416,328	23.0%
October	1,308,829	21.3%
November	640,627	10.4%
December	232,055	3.8%
Total	6,158,140	100.0%

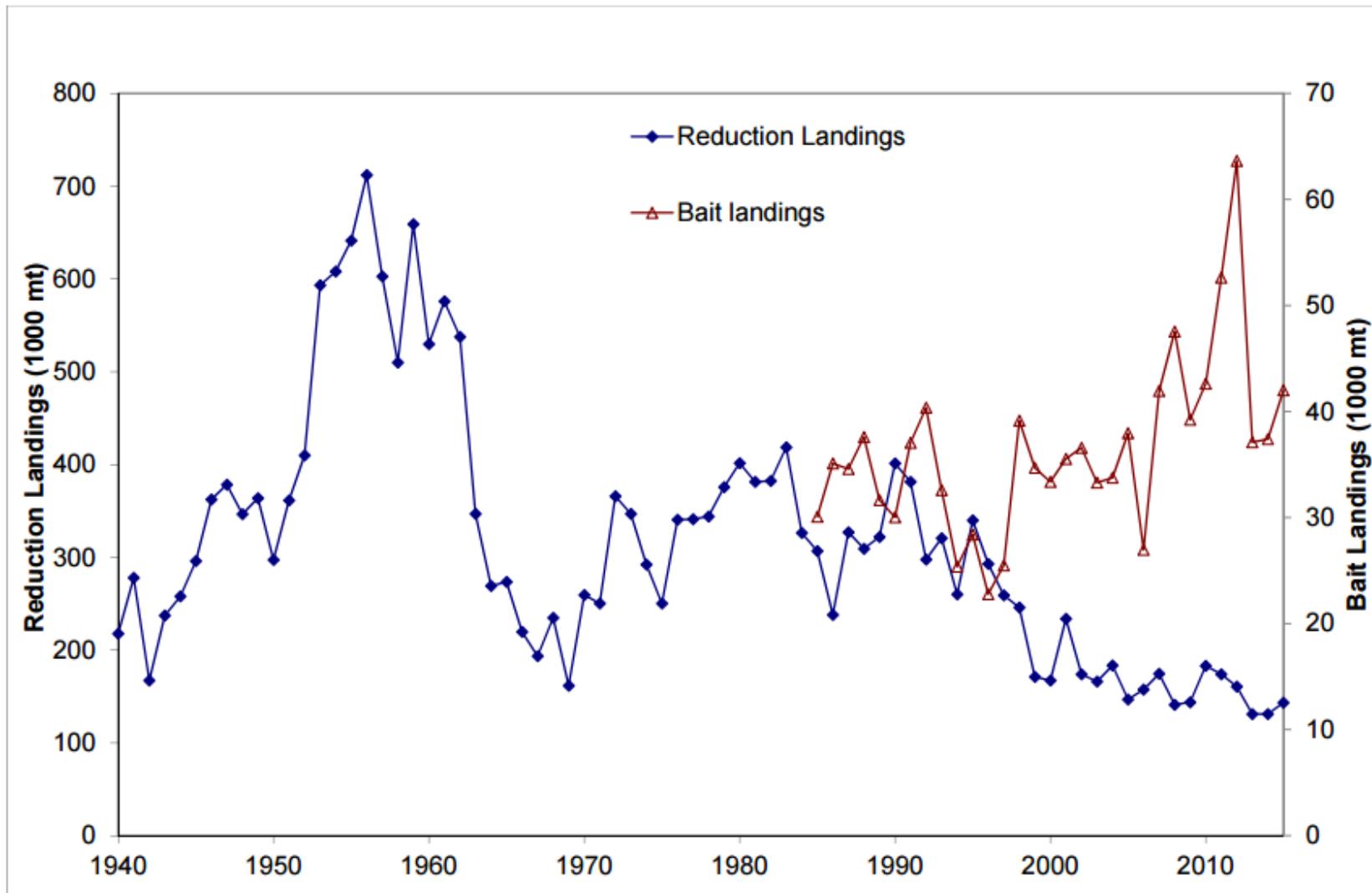


Figure 1: Landings from the reduction purse seine fishery (1940-2015) and the bait fishery (1985-2015) for Atlantic menhaden. Note the two vertical axes are on different scales.

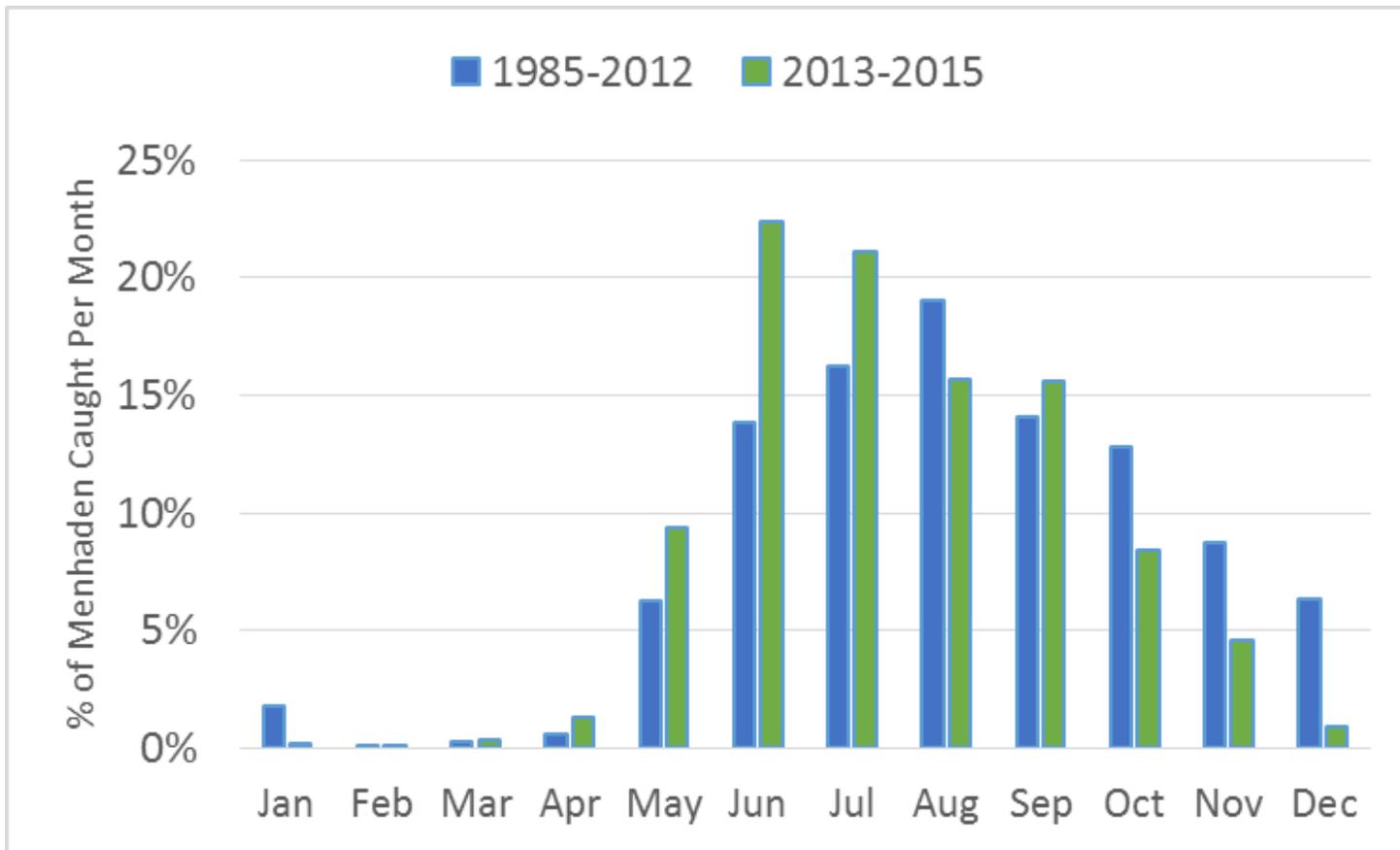


Figure 2: Percent of landings from the menhaden commercial fishery by month. Blue bars show landings from 1985 to 2012 and the green bars show landings from 2013-2015 (following the implementation of Amendment 2).

Appendix 2



Atlantic States Marine Fisheries Commission

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MEMORANDUM

April 20, 2015

To: Atlantic Menhaden Management Board
From: Biological Ecological Reference Points Workgroup
RE: Ecological Reference Points using Pikitch et al. (2012)

At its February meeting, the Atlantic Menhaden Management Board (Board) tasked the BERP WG with developing ecological reference points for Atlantic menhaden using Pikitch et al. (2012) as described in the ERP Report. As the Workgroup noted in the ERP Report, models or ERPs presented in the ERP report required further review by the BERP WG. To complete this task, the Workgroup reviewed the methodology by Pikitch et al. (2012) to determine which “information tier” Atlantic menhaden fit into. Subsequently, the WG evaluated the applicability of the recommended management action associated with that information tier. After detailed discussions, the WG concluded:

1. The WG recognizes that the recommendations in Pikitch et al. (2012) are based on the idea that the variable stock dynamics of forage species, like Atlantic menhaden, may require additional management precautions than other non-forage species.
2. The WG acknowledges that while the ERPs referenced in Pikitch et al. (2012) may be a bet-hedging strategy, it assumes that there must be some stock-recruitment relationship that has not yet been identified for Atlantic menhaden.
3. The WG decided that menhaden fall under the “intermediate information tier” as defined by Pikitch et al. (2012), with strong caveats (please see the attached table).
4. The intermediate information tier recommends management actions in the form of applying a hockey stick harvest control rule with $BLIM \geq 0.4B_0$ and $F=0.5M$. In this scenario, fishing would be prohibited when biomass levels fall below 40 percent of unfished biomass. When biomass is greater than 40 percent of unfished biomass, the fishing mortality would not exceed half the species’ natural mortality rate. The recommended fishing mortality rate from Pikitch et al. (2012) and a comparison to the 2015 Benchmark Stock Assessment single species reference points are displayed below including the terminal year F2013.

Reference Points/Terminal Year F	Benchmark
F26%MSP (threshold)	1.26
F57% MSP (target)	0.38
F64% MSP (Pikitch et al. 2012)	0.29
F70% MSP (F in terminal year 2013)	0.22

5. The WG notes that many of the case studies examined in Pikitch et al. (2012) involved predators that were “highly dependent” (i.e., $\geq 50\%$ of diet) on a single forage species, with strong trophic effects caused by changes in forage abundance. However, in the case of the coast-wide stock of Atlantic menhaden, the primary predator species are more opportunistic, consuming a diverse prey base.
6. While the WG was able to identify that striped bass may meet the Pikitch et al. (2012) predator dependency definition (with menhaden as forage) at certain times of the year and in certain areas (e.g., Chesapeake Bay in winter), the WG determined that none of our predator species of interest could fit the criteria of “highly dependent” predator (with menhaden as forage) on a coast-wide scale. Therefore, the WG does not believe the reference point recommendations in Pikitch et al. (2012) are applicable to this system.
7. Ultimately, the BERP WG does not feel that the management actions recommended in Pikitch et al. (2012) are appropriate for Atlantic menhaden specific management. Furthermore, the WG cannot evaluate if the Pikitch et al. (2012) buffers will actually provide enough forage to sustain predators of interest at desired population levels. Overall, although the ERPs in Pikitch et al. (2012) are less than ideal, predator removals are a large source of mortality for this stock. As such, through the framework of the ERP Report, the WG is working to have better ERP advice that is specific to Atlantic menhaden management.

The WG recommends that the Board form a subcommittee to collaborate with the BERP WG and industry to define more concrete ecosystem management goals and objectives. This would help the WG identify which models might be the most appropriate to achieve proposed objectives. Moving forward, the WG would like to combine the recommendations of a Board subcommittee with those of the Atlantic menhaden peer reviewers to define an objective approach to developing ERPs.

References

Pikitch, E., Boersma, P.D., Boyd, I.L., Conover, D.O., Cury, P., Essington, T., Heppell, S.S., Houde, E.D., Mangel, M., Pauly, D., Plagányi, É., Sainsbury, K., and Steneck, R.S. (2012). Little Fish, Big Impact: Managing a Crucial Link in Ocean Food Webs. Lenfest Ocean Program. Washington, DC. 108 pp.

Appendix 3:



TO:

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RE:

Biological Ecological Reference Points Working Group memo dated April 20, 2015

It was brought to our attention that the Biological Ecological Reference Points (BERP) Working Group (WG) had been tasked “with developing ecological reference points for Atlantic menhaden using Pikitch et al. (2012) as described in the ERP Report.” However, as the WG detailed in its memorandum to you on April 20, 2015, “the WG does not believe the reference point recommendations in Pikitch et al. (2012) are applicable to this system.” Furthermore, “the BERP WG does not feel that the management actions recommended in Pikitch et al. (2012) are appropriate for Atlantic menhaden specific management.

As two co-authors of Pikitch et al. (2012), we are responding to several possible misinterpretations and flawed arguments in the WG memo. We do so by responding to the main reasons the WG gives for concluding that the Pikitch et al. (2012) recommendations are not applicable or appropriate:

1. “The WG acknowledges that while the ERPs referenced in Pikitch et al. (2012) may be a bet-hedging strategy, it assumes that there must be some stock-recruitment relationship that has not yet been identified for Atlantic menhaden.”

- **Brief response:** It is not necessary to identify a stock-recruitment relationship for Atlantic menhaden to apply the Pikitch et al. (2012) recommendations.

Detailed Response: The recommendations in Pikitch et al. (2012) are not a bet-hedging strategy, but rather a precautionary approach that will reduce the odds of forage fish population collapse, keep higher forage fish biomass in the water, and, importantly, prevent or ameliorate impacts on dependent fish, marine mammal, and seabird populations that depend on forage fish. A recent paper in the *Proceedings of the National Academy of Sciences* by Essington et al. (2015) provides additional evidence of the importance of using a high minimum biomass threshold to prevent collapse and maintain high levels of forage fish in the water. The paper also finds minimal impact on fishery yields from this practice over the long term.

Regarding the stock-recruitment relationship, the WG has misinterpreted Pikitch et al. (2012). Its recommendations are derived, in part, from an assessment of the effects of forage fish on dependent predators in 10 Ecopath with Ecosim (EwE) models from around the world. EwE does contain a mathematical function that sets the renewal rate (equivalent to recruitment) for some of its trophic groups, but it does not assume a specific strength or pattern. The report's recommendations regarding reference points may therefore be applied without concern about a particular stock-recruitment relationship.

In a memo dated April 22, 2015, the Atlantic Menhaden Technical Committee offers projections based on the assumption that recruitment is independent of density and centered on median recruitment. According to the SEDAR 40 stock assessment for Atlantic menhaden, the BAM model indicates only three years with recruitment above this median in the last 23 years, so this approach is less conservative than that taken by Pikitch et al. (2012).

2. “None of our predators of interest could fit the criteria of ‘highly dependent’ predator (with menhaden as forage) on a coast-wide scale.”

- **Brief response:** It is not necessary for predators to be highly dependent to apply the report's management recommendations.

Detailed response: The report defines a “highly dependent” predator as one that relies on a forage fish species for at least 50 percent of its diet. As the WG memo correctly states in the table on page three, the existence of such predators is a reason to increase the biomass limit reference point and reduce the fishing mortality limit reference point relative to the recommended hockey stick harvest control rule (HCR). When such predators are absent, as is the case when Atlantic menhaden are considered on a coast-wide basis, the report provides a clear recommendation: use a biomass limit reference point of $0.4B_0$ and a fishing mortality limit reference point of $0.5M$.

It is important to note that the WG's predators of interest do not include the birds and mammals known to consume menhaden and to depend on menhaden in their diets. This is an additional argument in support of considering the biomass and fishing mortality limit reference points proposed by Pikitch et al. (2012). The WG is probably correct that none or few of the fish predators in the coastal western Atlantic are highly dependent on menhaden, as defined by Pikitch et al. (2012), at least in recent history. In the past, this might have been different, either throughout the system or in particular regions, such as the Chesapeake Bay.

3. “The WG cannot evaluate if the Pikitch et al. (2012) buffers will actually provide enough forage to sustain predators of interest at desired population levels.”

- **Brief response:** The buffers presented in Pikitch et al. (2012) were designed to do exactly that in a precautionary sense. The WG's statement that, because the adequacy of these buffers cannot be determined, the WG proposes to adopt an even higher fishing mortality level is illogical.

Detailed response: A key recommendation of Pikitch et al. (2012) was to use the “PREP equation” (PREP stands for “predator response to the exploitation of prey”), to predict predator declines using only the fraction of the predator's diet that is composed of the target forage fish. Since these diet data are available for predators of interest, it is appropriate to use the PREP equation to determine the biomass of forage fish necessary to achieve any desired level of predator

abundance (with a given probability of success), up to its estimated biomass of the predator in the absence of forage fish fishing. As an alternative to the PREP equation, the report recommends using data from models specific to the ecosystem. Since the WG indicates its ERP models are under development, we contend that it is appropriate to use the PREP equation at this time.¹ As noted above, the WG has proposed reference points that are less conservative than those in Pikitch et al. (2012). We do not see the logic of adopting a *higher* level of fishing mortality as a reference point on the ground that the Pikitch et al. reference points might not provide enough forage to sustain predators of interest.

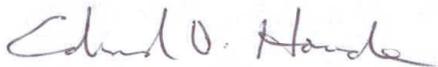
4. The report’s “recommended HCR and ERPs make little sense when there is no dependent predator or stock-recruit relationship.”

- **Brief response:** The report’s recommendations are adaptable for a variety of situations, including this one.

Detailed response: To clarify, although it is correct that there is no identified *highly* dependent predator in the system, striped bass and bluefish are dependent on menhaden for more than 10 percent of their diets. As noted above, use of Pikitch et al. (2012) recommendations does not require the existence of a stock-recruit relationship. Under the circumstances, and as an alternative approach, it makes sense to apply the Pikitch et al. (2012) HCR and ERP recommendations. The recommendations were developed to work in many circumstances, including when there are no identified highly dependent predators and when the stock-recruit relationship is uncertain. The WG was tasked to apply the Pikitch et al. (2012) approach in its charge and it should follow that directive.



Ellen Pikitch, Chair, Lenfest Forage Fish Task Force



Edward D. Houde, Member, Lenfest Forage Fish Task Force

REFERENCES

Pikitch, E., Boersma, P.D., Boyd, I.L., Conover, D.O., Cury, P., Essington, T., Heppell, S.S., Houde, E.D., Mangel, M., Pauly, D., Plagányi, É., Sainsbury, K., and Steneck, R.S. 2012. Little Fish, Big Impact: Managing a Crucial Link in Ocean Food Webs. Lenfest Ocean Program. Washington, DC. 108 pp.

Essington, T., P.E. Moriarty, H.E. Froehlich, E.E. Hodgson, L.E. Koehn, K.L. Oken, M.C. Siple, and C.C. Stawitz. 2015. Fishing amplifies forage fish population collapses. Proceedings of the National Academy of Sciences. doi: 10.1073/pnas.1422020112.

¹ One of us (Houde, with co-investigators) has research under way to provide ecosystem-specific ERPs, scheduled to be delivered later this year