Atlantic States Marine Fisheries Commission

1050 N. Highland Street • Suite 200A-N • Arlington, VA 22201
703.842.0740 • 703.842.0741 (fax) • www.asmfc.org

MEMORANDUM

TO: Atlantic Menhaden Management Board

FROM: Megan Ware, FMP Coordinator

DATE: April 27, 2017

SUBJECT: Update on Development of Draft Amendment 3

At the February 2017 meeting, the Atlantic Menhaden Management Board (Board) tasked the Plan Development Team (PDT) with drafting Amendment 3. Included in meeting materials is the latest draft of Amendment 3. The PDT notes that this is a working draft and changes will continue to be made following the May Board meeting.

Several conference calls have taken place over the last three months. The PDT met via conference call on February 22nd, March 31st, and April 26th to work on Draft Amendment 3. Additionally, the Allocation Workgroup met via conference call on April 17th to review the allocation methods and provide recommendations to the Board on ways to hone-in on the number of management alternatives. Finally, the BERP Workgroup met via conference call on April 24th to discuss the development of Lenfest reference points for menhaden. The purpose of this memo is provide an update to the Board on progress made to date and identify areas of focus over the next three months.

Reference Points

The BERP Workgroup had a conference call with members of the Lenfest Forage Fish Task Force to clarify the methods used to calculate the Pikitch et al. (2012) reference points. The BERP Workgroup is currently calculating the various ERP options based on existing guidelines for forage fish species (e.g. Pikitch et al (2012), 75% rule-of-thumb, etc). It is expected that those will be ready ahead of the August Board meeting and will be included in a subsequent draft of Amendment 3.

Allocation Methods

Preliminary allocation tables are provided for most of the allocation methods currently included in Draft Amendment 3. It is important to note that these values are subject to change given many states 2016 landings are preliminary and New York has submitted a proposal to re-calibrate their menhaden landings (see below). Seasonal allocation percentages have not been calculated given the data submitted by states included landings by year, not month. If the Board is interested in pursuing the seasonal allocation method, staff may have to use ACCSP data to calculate these percentages.

The allocation section (*Section 4.3.2*) is divided into three tiers, based on the possible combinations of allocation methods. To complete an allocation method, an option must be chosen in each tier. If the Board selects an allocation method which does not include state specific quotas, a coastwide reporting mechanism is needed to monitor quotas in-season. Specifically, as Draft Amendment 3 currently reads, states would need to submit landings to

SAFIS to allow for near real-time monitoring of either a coastwide, regional, seasonal, fleet, or sector based quota.

At the February 2017 meeting, the Board agreed to keep all allocation methods presented in the PID in draft Amendment 3. As the PDT has begun to delve into this management document, it has become clear that there a multitude of allocation methods, and there is concern that this could impede effective public comment and resulting Board action in November. The Allocation Workgroup met to discuss ways to hone-in on the allocation methods. They are recommending several changes to Draft Amendment 3, such as removing the three-fleet allocation method and replacing the current regional approaches with a management alternative that creates a regional quota for the New England states and jurisdictional quotas for the mid-Atlantic and South Atlantic states (see subsequent memo from the Allocation Workgroup). The Board will need to review these recommendations and provide direction to the PDT.

Allocation Timeframes

Currently, data from 1985-2016 are used to calculate allocation percentages in Draft Amendment 3. The Allocation Workgroup is recommending that data prior to 2007 not be used to calculate allocation percentages given only one reduction facility was operating from 2007-2016 and reporting has significantly improved over the last decade. The Board will need to discuss this recommendation and provide direction to the PDT. If older landings data are used in Draft Amendment 3, the Board will need to decide if historic reduction landings from states which no longer have a reduction fishery should be used to calculate allocation percentages. It is also important to note that Florida did not collect gear specific landings data prior to 1993. If the Board would like to include data between 1985 and 1992, the PDT will have to estimate Florida's gear specific landings using data between 1993 and 1994 (a net ban was implemented in 1995).

NY Proposal on Re-Calibrated Landings

ASMFC received a proposal from New York on April 11th to re-calibrate the state's menhaden landings prior to 2013. The intent of this proposal is to address inconsistent or nonexistent reporting in the state. The proposal uses the difference in landings between 2009-2012 (when there was limited reporting) and 2013-2016 (when reporting was required) to scale historic landings. The proposal from New York is included in supplemental materials.

The PDT discussed this proposal on their April 26th conference call and compiled a list of questions for New York regarding the re-calibration. The questions focus on the inclusion of purse seine landings in the calibration, given these gears have historically been required to report, and other changes in the fishery, such as changes in the number of participants or gears used, which could have contributed to the reported increase in landings from 2013-2016. Pending the answers to these questions, the PDT will provide a recommendation to the Board regarding this proposal.

Areas of Continued Focus

Under the current timeline, the Board is scheduled to review and approve Draft Amendment 3 for public comment in August 2017. In the coming months, the PDT will continue to develop and refine the document. Areas of focus will include finalizing allocation percentages, further developing *Section 4.3.5 Incidental Catch and Small Scale Fisheries*, reviewing reporting requirements for effective quota monitoring, compiling the reference points based on existing guidelines for forage fish species, and including socio-economic data from the recent study on the commercial fishery. The AP is also expected to meet to provide guidance on Draft Amendment 3 to the Board and PDT.

Questions for the Board to Consider
The following is a list of questions for the Board to consider ahead of the May meeting.

1. How can the number of allocation methods be honed-in?
    a. Should the current regional allocation methods be replaced with an option that creates a regional quota for the New England states and jurisdictional quotas for the Mid-Atlantic and South Atlantic states (per the recommendation of the Allocation WG)?
    b. Should the two-fleet allocation method be maintained while the three-fleet allocation method is removed from Draft Amendment 3 (per the recommendation of the Allocation WG)?
    c. Should a management alternative for soft caps be maintained (per the recommendation of the Allocation WG)?
    d. Is the Board still interested in pursuing a seasonal allocation method given ACCSP landings, not state submitted landings, may be used in the calculations?
2. Should the allocation timeframes be altered to only include data from 2007-2016 (per the recommendation of the Allocation WG)?
    a. If data between 1985 and 2005 is going to be used in calculating allocation percentages, should reduction landings from states which no longer have a reduction fishery be included in the calculations?

Atlantic States Marine Fisheries Commission

1050 N. Highland Street • Suite 200A-N • Arlington, VA 22201
703.842.0740 • 703.842.0741 (fax) • www.asmfc.org

MEMORANDUM

TO: Atlantic Menhaden Management Board

FROM: Allocation Work Group

DATE: April 27, 2017

SUBJECT: Recommendations on Management Alternatives to Include in Draft Amendment 3

The Allocation Work Group (WG) met via conference call on April 17th to discuss the allocation methods currently included in Draft Amendment 3. The purpose of this call was to provide recommendations to the Board on ways to hone-in on the number of allocation options, given the current multitude of variations may complicate the document and thus impede effective public comment and resulting Board action in November. The discussion focused on four topics: 1) the fleet capacity allocation method; 2) the use of soft quotas; 3) the regional allocation method; and 4) the use of historic reduction landings from states which no longer have a reduction fishery. Below is a summary of the questions posed to the WG and the recommendations made for Board consideration.

Allocation Work Group Participants:
-Robert Ballou (RI)
-Jim Gilmore (NY)
-Russ Allen (NJ)
-Lynn Fegley (MD)
-Rob O'Reilly (VA)
-Robert Boyles (SC)
-Megan Ware (ASMFC)

1. Fleet Capacity Allocation Method
Questions: Are there benefits (or concerns) for either the two-fleet or three-fleet allocation method? Should one of these options be removed from Draft Amendment 3?

Recommendation: The WG recommended that the two-fleet option be maintained in Draft Amendment 3 but the three-fleet option be removed from the document. Overall, the WG concluded that the three-fleet option is overly complicated and the two-fleet option still achieves the goals of this allocation method: 1) to ensure that small gears and stationary gears have equitable access to menhaden commercial quota, along with the larger mobile gears; and 2) to simplify management and reduce the administrative burden on states with lower menhaden landings (e.g. in states where the management cost exceeds the value of the fishery).

2. Soft Quotas
Questions: Should soft quotas be included as a management alternative? If yes, for which gears should this option apply?

Recommendation: The WG recommended that soft quotas be maintained as a management alternative in Draft Amendment 3. They commented that in the two-fleet option, the small-capacity fleet has only accounted for 4-6% of commercial harvest in recent years and, under a soft cap, landings by these gear types would still be monitored. The WG recommended that the soft cap option be further developed by the PDT so that there are clear, up-front controls on the small-capacity fleet, such as a trip limit or limited entry mechanism. They also recommended that, if a soft cap is implemented, there be an annual evaluation of landings by gear type. This will allow the Board to assess trends in the fishery and consider a management response should harvest by a specific gear type significantly increase.

3. Regional Allocation Method
Questions: Is there a regional allocation method which best reflects the menhaden fishery? Is there a regional allocation option which should be removed from Draft Amendment 3?

Recommendation: Members of the WG expressed concern about the current regional allocation options, specifically that they may exclude some states from participating in the fishery due to the timing and movement of menhaden. Others noted that grouping large mobile gears and small stationary gears within a single region may disadvantage specific participants in the fishery. Importantly, the WG did note that, given the episodic nature of menhaden in the New England states, a regional approach may be favorable in this area. As a result, the WG recommended that the current regional allocation options be removed from Draft Amendment 3 and replaced with an option that considers a regional quota for the New England states (Maine through Connecticut or New York) and jurisdictional quotas for the Mid-Atlantic and South Atlantic states (New York or New Jersey through Florida).

4. Historic Menhaden Landings
Question: Should historic reduction harvest from states which no longer have a reduction fishery be included in the landings used to calculate allocation percentages?

Recommendation: Members of the WG expressed discomfort using landings data from over a decade ago to inform current allocation percentages. Some noted that historic landings are less reliable as many states did not require reporting from menhaden harvesters and dealers. Others noted that historic trends may not be indicative of the current fishery, especially in regard to states which once had a reduction fishery but no longer do. Many pointed to issues surrounding the allocation of summer flounder quota as a sign that historic landings, pre-dating 2007, should not be used to determine future allocations. As a result, the WG recommended that the timeframes currently included in Draft Amendment 3 be replaced with the following options:

A) 2009-2011 (status quo)
B) 2013-2016 (four years under Amendment 2)
C) 2007-2012 (six years before Amendment 2)
C) 2012-2016 (five most recent years of data)
C) 2007-2016 (most recent decade of data)

For all of these time periods, there is only one reduction plant in operation, which negates the need to address the use of historic reduction landings from states that no longer have a reduction fishery. These timeframes also address concerns about inconsistent or nonexistent reporting in the 1980's and 1990's.

To provide context to the Board's discussion, state-by-state allocation tables are presented below for the time periods proposed.

Table 1: State-by-state allocation percentages for the time periods recommended by the Allocation WG.

	2009-2011 TAC %	2013-2016 TAC %	2007-2012 TAC %	2012-2016 TAC %	2007-2016 TAC %
ME	0.02%	0.29%	0.16%	0.22%	0.21%
NH	0.00%	0.00%	0.00%	0.00%	0.00%
MA	0.84%	0.67%	1.19%	0.59%	1.00%
RI	0.02%	0.19%	0.02%	0.15%	0.08%
CT	0.02%	0.01%	0.02%	0.01%	0.02%
NY	0.07%	0.31%	0.08%	0.25%	0.16%
NJ	11.29%	11.16%	11.44%	12.63%	11.34%
DE	0.01%	0.03%	0.02%	0.03%	0.02%
MD	1.51%	1.71%	1.95%	1.97%	1.86%
PRFC	0.62%	0.75%	0.88%	0.85%	0.83%
VA	85.08%	84.59%	83.90%	83.05%	84.15%
NC	0.50%	0.20%	0.33%	0.18%	0.28%
SC	0.00%	0.00%	0.00%	0.00%	0.00%
GA	0.00%	0.00%	0.00%	0.00%	0.00%
FL	0.02%	0.07%	0.02%	0.06%	0.04%

Atlantic States Marine Fisheries Commission

Draft Amendment 3 to the Interstate Fishery Management Plan for Atlantic Menhaden

ASMFC Vision Statement:
Sustainably Managing Atlantic Coastal Fisheries

April 2017

Amendment 3 to the Interstate Fishery Management Plan for
Atlantic Menhaden

Prepared by

Atlantic States Marine Fisheries Commission
Atlantic Menhaden Plan Development Team

Plan Development Team Members:
Jeff Brust, New Jersey Department of Fish and Game
Joe Cimino, Virginia Marine Resources Commission
Jesse Hornstein, New York Department of Environmental Conservation
Nicole Lengyel, Rhode Island Department of Environmental Management
Nichola Meserve, Massachusetts Department of Marine Fisheries
Derek Orner, National Marine Fisheries Service
Harry Rickabaugh, Maryland Department of Natural Resources
Winnie Ryan, Maritime Research
Andrew Scheld, Virginia Institute for Marine Science
Krista Shipley, Florida Fish and Wildlife Conservation Commission
Megan Ware (Chair), Atlantic States Marine Fisheries Commission

DRAFT

This is a report of the Atlantic States Marine Fisheries Commission pursuant to U.S. Department of Commerce, National Oceanic and Atmospheric Administration Award Nos. XXXXXXXXX.

The Atlantic States Marine Fisheries Commission seeks your input on Draft 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 XXXXX.** 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 before finalizing Amendment 3.

You may submit public comment by attending a public hearing held in your state or jurisdiction or mailing, faxing, or emailing written comments to the address below. Comments can also be referred to your state's members on the Atlantic Menhaden Management Board or Atlantic Menhaden Advisory Panel; however, only comments received at a public hearing or written comments submitted to the Commission will become part of the public comment record.

Mail: Megan Ware
Atlantic States Marine Fisheries Commission
1050 N. Highland Street, Suite 200 A-N
Arlington VA. 22201

Email: comments@asmfc.org
(Subject: Amend 3)
Phone: (703) 842-0740
Fax: (703) 842-0741

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

DRAFT

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		**X**					
Board review of public comment; Board direction on what to include in Draft Amendment 3			**X**				
Preparation of Draft Amendment 3 ***Current Step***				**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**

Table of Contents

DRAFT

DRAFT

1.0 INTRODUCTION

The Atlantic States Marine Fisheries Commission (ASMFC), under the authority of the Atlantic Coastal Fisheries Cooperative Management Act, is responsible for managing Atlantic menhaden (*Brevoortia tyrannus)* from Maine through Florida. ASMFC has coordinated the interstate management of Atlantic menhaden in state waters (0-3 miles) since 1981. Amendment 3 to the Interstate Fishery Management Plan for Atlantic menhaden replaces Amendment 2. Management authority in the exclusive economic zone (3-200 miles from shore) lies with NOAA Fisheries.

1.1 BACKGROUND INFORMATION

At their May 2015 meeting, the Atlantic Menhaden Management Board (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 Board approved the Amendment 3 Public Information Document for public comment in October 2016. Public comment was received and hearings were held between December 2016 and January 2017. At their February 2017 meeting, the Board tasked the Plan Development Team (PDT) with developing Draft Amendment 3.

1.1.1 Statement of Problem

1.1.1.1 Ecological Reference Points

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. 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 which updated the reference points for Atlantic menhaden in order to provide a better measure of sustainability. Specifically, the overfishing target and threshold were changed to $F_{57\%MSP}$ (0.38) and $F_{26\%MSP}$ (1.26), respectively. Furthermore, 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).

An important outcome of the 2015 Stock Assessment and Peer Review Report was the high priority given to the development of ERPs for Atlantic menhaden management. 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, which includes other fish, birds, mammals, and humans who utilize and depend on marine resources.

1.1.1.2 Allocation

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 allocation formula assigns each state a percentage of the TAC based on each jurisdiction's average landings between 2009 and 2011. Since it was implemented in 2013, the quota system has maintained the annual harvest of menhaden below the annual coastwide TAC set by the Board.

Amendment 2 requires allocation to be revisited every three years. In reviewing menhaden allocations, the Board expressed interest in investigating different allocation methods and timeframes given concerns that the approach may not strike a balance between gear types and regions. Specifically, some states have expressed concern that under the current allocation method, increases in the TAC result in limited benefits to small-scale fisheries. In addition, concerns have been expressed that the current allocation method does not provide a balance between the present needs of the fishery and future growth opportunities. Given improvements in the condition of the Atlantic menhaden stock, the three-year period of historical catch on which allocation is based may limit 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.

1.1.2 Benefits of Implementation

Amendment 3 is designed to integrate the ecological role of menhaden into the management of the species and establish an allocation method which provides fair and equitable access to all participants in the fishery.

Amendment 3 contains a management program designed to account for the multiple roles that menhaden play, both in supporting fisheries for human use and the marine ecosystem. Issues addressed in Amendment 3 include:

1. Reference Points: How menhaden should be allocated between the marine ecosystem, and those that harvest menhaden for human use.
2. Allocation Method: How menhaden should be allocated between those jurisdictions and fisheries which directly or indirectly harvest menhaden.
3. Allocation Timeframe: The timeframe upon which the allocation method is based.

4. Quota Transfers: How menhaden quota is moved between those which receive an allocation.
5. Quota Rollovers: Whether unused quota can be rolled over into the subsequent fishing year.
6. Incidental Catch: How landings from non-directed fisheries are accounted for in the management of the species.
7. Episodic Events Program: A program designed to minimize discards in the fishery when menhaden are in greater abundance than they normally occur.
8. Chesapeake Bay Reduction Fishery Cap: A cap which limits harvest by the reduction fishery in the Chesapeake Bay, an important nursery ground for menhaden.

1.1.2.1 Ecological Benefits
Atlantic menhaden occupy an important link in the coastal marine food chain as they transfer planktonic material into animal biomass. Due to their interconnectivity with other species, menhaden provide top-down controls on phytoplankton and zooplankton populations while supporting a variety of predator species, including important commercial and recreational species such as striped bass and weakfish, iconic bird species such as osprey and bald eagles, and charismatic marine mammals such as the humpback whale. Reduced menhaden populations may impact the abundance and diversity of predator populations, particularly if other prey options are limited or not available. The geographic extent of menhaden from Maine to Florida highlights the widespread ecological role of this species as they affect marine ecosystems along the Atlantic coast. Overall, maintaining a healthy Atlantic menhaden population will contribute to a balanced marine ecosystem (see *Section 1.2.1.5 Ecological Roles* for additional information).

1.1.2.2 Social/Economic Benefits
Managing menhaden ecologically and providing equitable access to menhaden across all Atlantic coast states will provide a more stable economic and social base for both bait and reduction fisheries, and consumptive and non-consumptive stakeholders. It is expected that this will allow for greater resilience in communities dependent upon fisheries along the eastern coast of the United States.

1.2 DESCRIPTION OF THE RESOURCE

1.2.1 Species Life History

1.2.1.1 Stock Structure and Migration
Atlantic menhaden are euryhaline species that inhabit nearshore and inland tidal waters from Florida to Nova Scotia, Canada. Size-frequency information and tagging studies indicate that the Atlantic menhaden resource is a single unit stock (Dryfoos et al. 1973; Nicholson 1972 and 1978). Recent genetic studies also support the treatment of Atlantic menhaden as a single stock (Anderson 2007; Lynch et al. 2010).

Spawning occurs principally at sea, with some activity in bays and sounds in the northern portion of its range (Judy and Lewis 1983). Eggs hatch at sea and the larvae are transported by ocean currents (Checkley et al. 1988; Nelson et al. 1977; Quinlan et al. 1999) to estuaries where they metamorphose and grow rapidly as juveniles (Edwards 2009). Adults stratify by size during the summer, with older, larger individuals migrating north to southern New England by May and the Gulf of Maine by June. During November and December, most of the adult population that migrated north of Chesapeake Bay moves south of the Virginia and North Carolina capes. Adults that remain in the south Atlantic region during spring and summer migrate south later in the year, reaching northern Florida by fall. Schools of adult menhaden reassemble in late March or early April and migrate northward. By June the population is redistributed from Florida to Maine (Ahrenholz, 1991).

1.2.1.2 Age and Growth

Atlantic menhaden older than age-6 were present in the spawning population during the 1950s and early 1960s, but fish older than age-6 have been uncommon since. In recent years, the majority of the landings are comprised of fish ages 1-4 (SEDAR, 2015).

Growth of Atlantic menhaden varies from year-to-year and occurs primarily during the warmer months (AMTC 2006). Growth of juveniles is density dependent (Ahrenholz et al. 1987); in other words, growth rates are accelerated during the first year when juvenile abundance is low and are reduced when juvenile abundance is high. Lengths of young-of-year menhaden range widely in size, and this variation is a function of density, timing of larval ingress, temperature, and food availability (Ahrenholz 1991; Houde 2011). Adult menhaden can reach a total length of up to 500 mm and a weigh over 1.5 kg (Cooper, 1965; Smith and O'Bier, 1996; SEDAR, 2015). Due to their greater migratory range (see *Section 1.2.1.1*), larger fish of a given age are captured farther north than smaller fish of the same age (Nicholson 1978; Reish et al. 1985). This fact complicates any attempt to estimate overall growth for the entire stock from size-at-age data compiled from any individual area along the coast.

1.2.1.3 Spawning and Reproduction

Some Atlantic menhaden become sexually mature during their first year, with more than 50% mature at age-2 (SEDAR, 2015). First-spawning age-3 fish have accounted for most of the stock's egg production since 1965 (Vaughan and Smith 1988). Atlantic menhaden mature at smaller sizes at the southern end of their range (180 mm FL in the south Atlantic versus 210 mm FL in the Chesapeake Bay and 230 mm farther north) because of latitudinal differences in size-at-age and the fact that larger fish of a given age are distributed farther north than smaller fish of the same cohort (Lewis et al. 1987).

Spawning of Atlantic menhaden is thought to occur throughout the year (Higham and Nicholson, 1964); however, it varies by season and region based on migration patterns. Spawning in the north occurs in the summer months (Kendall and Reintjes,1975; Judy and Lewis, 1983; Lozano and Houde, 2012), mid-Atlantic spawning occurs in early fall as fish start to migrate south, and peak spawning occurring in the South Atlantic Bight in December (Higham and Nicholson, 1964; Judy and Lewis, 1983; Lozano and Houde, 2012). Spawning is followed by the coastward dispersion of eggs and larvae, and ingress into estuaries where juvenile development occurs (Warlen, 1994; Rice et al., 1999; SABRE, 1999; Warlen et al., 2002; Lozano and Houde, 2013; Houde et al., 2016).

Timing and location of spawning seem to be limited by temperature, usually occurring in waters warmer than 14-16°C (Stegmann et al. 1999, Light and Able 2003), or within the 15-20°C isotherms (MDSG 2009). Hall et al. (1991) report that temperatures below 5 or above 33°C are lethal to larvae, and based on a review of field and laboratory studies, Warlen et al. 2002 concluded that optimum temperature for hatching, larval survival, and growth is ≥16°C. Reported salinities range from ~25 to 33 (MDSG 2009), although salinity tolerance limits for eggs and larvae are wide ranging. Available literature has not been summarized to indicate typical or persistent locations of continental shelf spawning areas but egg concentrations have been observed near shorelines, bay mouths or inlets as well as 70 to 140 km offshore (Marak et al 1962, Kendall and Reintjes 1975, Judy and Lewis 1983).

Recently, there has been progress in relating measures of primary productivity to recruitment and growth of YOY menhaden. Research has shown there has been a positive correlation between recruitment and euphotic-zone *chl-a* and integrated annual primary production in the Chesapeake Bay (Houde and Harding 2009), suggesting that menhaden populations are controlled in part by bottom-up processes (i.e., quantity of food available). Despite these findings, additional work has found no significant correlation between YOY menhaden abundance and *chl-a* for the entire four-decade period that included periods of both low and high menhaden recruitment events in Chesapeake Bay. The strong correlation between YOY menhaden abundance and *chl-a* in recent years (1989-2004) as noted above did not persist throughout the longer time series (1966-2006). On average, years with low freshwater flow and low turbidity supported higher abundances and recruitment of YOY menhaden (Love et al 2006; Lynch et al 2010; Houde et al., 2016). Other simple correlations between YOY menhaden abundance and environmental or hydrographic variables were not significant or were only marginally significant (e.g., negative correlations with total dissolved phosphorus and with abundances of zooplankton taxa favored by low salinities). These conflicting bodies of work further highlight the complexity that exists between nutrient cycling, climatic drivers, and understanding the life history traits of Atlantic menhaden.

1.2.1.4 Mortality

The Atlantic menhaden population is subject to a high natural mortality rate. Natural mortality is also higher during the first two years of life than during subsequent years. Literature estimates of natural mortality have ranged from M = 0.37 (Schaaf and Huntsman, 1972) to M= 0.52 (Dryfoos et al., 1985). Previous assessments, beginning with Ahrenholz et al. (1987), used M=0.45, whereas the 2015 benchmark stock assessment used a time varying but age constant natural mortality to better account for known sources of natural mortality such as predation, pollution, habitat degradation, toxic algal blooms, and hypoxia (SEDAR, 2015).

Predation remains a large source of natural mortality for menhaden due to their high abundance in estuaries and coastal waters during the warmer months of the year (Ahrenholz, 1991). Many large piscivorous sea mammals, birds, and fish are potential predators on Atlantic menhaden. Menhaden are preyed upon by species such as bluefish, striped bass, king mackerel, Spanish mackerel, pollock, cod, weakfish, silver hake, tunas, swordfish, bonito, tarpon, and a variety of sharks. See additional details in *Ecological Roles* section below.

Coastal pollution, habitat degradation, and disease also threaten marine fish species like Atlantic menhaden which spend their first year of life in estuarine waters and the rest of their life in both ocean and estuarine waters. Fish kills, due principally to low dissolved oxygen conditions, disease, and parasites are additional and poorly understood sources of natural mortality (Burkholder et al. 1992; Blazer et al. 1999; Noga 2000; Law 2001; Glasgow et al. 2001; Vogelbein et al. 2001; Kiryu et al. 2002; Reimschussel et al. 2003; Burkholder et al. 2005). A variety of diseases are thought to affect menhaden survival (Stephens et al. 1980; Noga and Dykstra 1986; Noga et al. 1988; Levine et al. 1990a; Levine et al. 1990b; Dykstra and Kane 2000; Goshorn et al. 2004; Stine et al. 2005; Blazer et al. 2007). Menhaden are also known to induce fatal hypoxic events and reports of such school-induced hypoxia and resulting fish kills go back to the 1800's (Oviatt et al. 1972; Smith 1999).

1.2.1.5 Ecological Roles

Menhaden occupy an important link in the coastal marine food chain, transferring planktonic material into animal biomass. As a result, menhaden influence the conversion and exchange of energy and organic matter within the coastal ecosystem throughout their range (Peters and Schaaf 1981; Lewis and Peters 1984; Peters and Lewis 1984). Studies have indicated that menhaden are a part of the diet of many species including striped bass (*Morone saxatilis*), bluefish (*Pomatomus saltatrix*), weakfish (*Cynoscion regalis*), and piscivorous birds (Viverette et al. 2007). As a result, changes in the abundance and distribution of menhaden can have impacts on a variety of species given their role in the food web.

Atlantic menhaden occupy two distinct types of feeding niches during their lifetime. Phytoplankton is the major food of juvenile and young adult menhaden. The role of zooplankton in the diet becomes more important in older menhaden as gill raker spacings on their filtering apparatus increase in size (Friedland et al. 1984, 2006). The relative importance of each food type varies with ontogeny, region, and in relation to local availability.

The role of Atlantic menhaden in systems function and community dynamics has received much attention in recent years. Spatially-explicit bioenergetics models have also been used to estimate carrying capacity of menhaden in the Bay as well as the reduction of habitat volume from eutrophication and hypoxia (Brandt and Mason 2003; Luo et al. 2001). Additionally, simulation models indicate that Atlantic menhaden in Narragansett Bay and Chesapeake Bay potentially have substantial effects on zooplankton and phytoplankton populations, and on nutrient dynamics (Durbin and Durbin 1975, 1998; Gottlieb 1998). However, a study by Lynch et al. (2010) for Chesapeake Bay suggests that the menhaden population probably plays little role in removing nitrogen from Chesapeake Bay waters, and may actually provide additional nitrogen to Bay phytoplankton. Results suggest that YOY menhaden focus their grazing on patches of elevated phytoplankton abundance and/or supplement their diet with other sources (e.g. zooplankton and detritus) to maintain a positive nitrogen balance. Population-level estimates of net nitrogen removal imply that menhaden play a minimal role regarding water quality in Chesapeake Bay.

1.2.2 2015 Stock Assessment Summary

Based on tagging (Dryfoos et al. 1973; Nicholson 1978) and genetic studies (Anderson 2007; Lynch 2010), the Atlantic menhaden fishery is believed to be a single stock or population of fish, and is assessed as a single coastwide stock. Data used in the stock assessment includes commercial and recreational landings at age from Maine to Florida, two fishery independent adult indices based on nine state surveys, one each for the northern and southern regions, and a juvenile abundance index (JAI) developed from state seine, trawl, and other gear surveys along the coast.

Growth is estimated using a time invariant weight-length relationship based on fishery-dependent data that is bias corrected using the methods in Schueller et al. (2014). Weight at age is estimated from overall weight-length parameters and annual lengths at age. Maturity at age is developed using maturity records from reduction fishery catches and NEAMAP survey data. A logistic regression is fit to length and maturity data in addition to using time-varying lengths at age to calculate time-varying maturity at age. Natural mortality is calculated by an age-varying, time invariant approach using the methods of Lorenzen (1996) that are scaled to tagging estimates of natural mortality. This estimate of natural mortality accounts for multiple sources of mortality including predation, pollution, habitat degradation, toxic algal blooms, and hypoxia. The assessment model is structured into “fleets-as-areas” in order to account for differences between bait and reduction fisheries in the north and south. In addition, dome shaped selectivity is used for all fishery fleets.

The Beaufort Assessment Model (BAM) is used to produce final assessment results. This is a statistical forward-projection model that has been used in previous Atlantic menhaden assessments (SEDAR 2015).

1.2.2.1 Abundance and Structure

Annual Atlantic menhaden population size (age 0 and older at the start of the fishing season) has ranged from approximately 10 to 85 billion fish since 1955 (Figure 1). Population size averaged 44.9 billion menhaden during 1955-1959 when landings were high (averaging >600,000 mt). During the 1960’s, the menhaden stock contracted geographically, and the population averaged 16.4 billion fish. Total menhaden landings dropped to a low of 172,200 mt in 1969. In the 1970s and 1980s the menhaden population began to expand and the population size averaged 34.7 billion fish. During this time period, average landings rose to over 300,000 mt. During the 1990s, the Atlantic menhaden stock contracted again, and catches declined from 431,500 mt in 1990 to 205,800 mt in 1999. From 2000-2013, the population size has averaged 20.4 billion fish and total catches have averaged about 200,000 mt per year.

The oldest menhaden age classes comprise the smallest proportion of the population (Figure 1), but this proportion has increased in recent years (SEDAR 2015). For this reason, biomass is likely increasing at a faster rate than abundance because of the increased number of older fish at age and the associated increase in weight at age (SEDAR 2015).

1.2.2.2 Fishing Mortality

Highly variable fishing mortalities are noted throughout the entire time series and are dependent upon fishing effort. The highest fishing mortalities for the commercial reduction fishery in the north are estimated to have occurred in the 1950s (Figure 2), whereas the highest fishing mortality rates for the commercial reduction fishery in the south are estimated to have occurred during the 1980s and 1990s (Figure 2). The highest fishing mortalities for the commercial bait fishery in the north are estimated to have occurred in the 1950s and 1990s (Figure 3), while the highest fishing mortality rates for the commercial bait fishery in the south are estimated to have occurred during the late 1990s and early 2000s (Figure 3).

In the 2015 benchmark assessment, the TC initially recommended that the Board adopt a fishing mortality threshold based on the maximum F value at age-2 during the 1960-2012 time period and a target fishing mortality based on the median F value during this time period. However, in order to provide a more robust measure of fishing pressure under changing selectivity, it was recommended by the Peer Review panel that the geometric mean fishing mortality on ages-2 to -4 be used instead of the suggested age-2 reference points. This recommendation was accepted for use by the TC because these ages represent the fully selected fishing mortality rates depending upon the year and fishery (i.e., bait and reduction). As a result, the fishing mortality reference points are F-target ($F_{57\%\ MSP}$) = 0.38 and F-threshold ($F_{26\%\ MSP}$) = 1.26.

Based on these reference points, fishing mortality has remained below the threshold level (1.26) since the 1960s, hovered around the target (0.38) through the 1990s, dropped below the target in 2003, and was estimated to be 0.22 in 2013 (the terminal year of the assessment).

1.2.2.3 Recruitment

Age-0 recruits of Atlantic menhaden (Figure 4) were high during the late 1950s, especially the 1958 year-class. Recruitment was generally poor during the 1960s and high during the late 1970s and early 1980s. Since then, recruitment has been low with notable year classes in 2005 and 2010. The estimated number of age-0 fish in 2013 (the terminal year of the assessment) was 6.38 billion fish, which is the second lowest recruitment event, in numbers of fish, from 1955-2013 (Figure 4).

1.2.2.4 Spawning Stock Biomass (Fecundity)

Often reproductive capacity of a stock is modeled using female weight-at-age, primarily because of a lack of fecundity data. To the extent that egg production is not linearly related to female weight, indices of egg production (fecundity) are better measures of the reproductive output of a stock at a given size and age structure. Additionally, fecundity better emphasizes the important contribution of older and larger individuals to egg production. Thus, in the most recent benchmark stock assessment (SEDAR 2015), modeling increases in egg production with size was preferable to female biomass as a measure of the reproductive capability of the stock.

Population fecundity (*FEC*, number of maturing ova) was highest in the early 1960s, early 1970s, and the present decade, and has generally been higher with older age classes making up a larger proportion of the population (Figure 5). Large values of population fecundity were present in 2012 and 2013, which were the last two years of the model, but were similar in magnitude to historical values of population fecundity. Throughout the time series, age-2 and age-3 fish have produced most of the total estimated number of eggs spawned annually; however, in more recent years, ages-4+ have contributed a higher proportion to the overall number of eggs.

1.2.2.5 Maximum Spawning Potential

Amendment 2 (2013) implemented maximum spawning potential (MSP) based reference points that relate current stock conditions as a percent of unfished conditions. An unfished stock is equal to 100% MSP. Considering the modeling and data input changes that occurred in the 2015 Benchmark Stock Assessment, the TC and Peer Review Panel recommended new MSP based reference points that are applicable to the results of the assessment (ASMFC 2015).

The fecundity (FEC) reference points match the F reference points meaning they are equal to the fecundity estimated when F reaches equilibrium at its target and threshold MSP levels, respectively. The associated reference points for population fecundity are FEC-target ($FEC_{57\%MSP}$) = 189,270 (billions of eggs), and FEC-threshold ($FEC_{26\%MSP}$) = 86,821 (billions of eggs). In other words, the FEC target would maintain 57% of the spawning potential of an unfished stock, and the threshold would preserve 26% of the spawning potential of an unfished stock. In 2013, fecundity was estimated to be 170,536 billion eggs, which is 10% below the target level.

1.2.3 Current Stock Status

The current stock status determination is based on the 2015 Atlantic Menhaden Benchmark Stock Assessment report (SEDAR 2015). The fishing mortality reference points are *F*-target (*F57% MSP*) = 0.38 and *F*-threshold (*F26% MSP*) = 1.26. The associated reference points for population fecundity are *FEC*-target (*FEC57%MSP*) = 189,270 (billions of eggs), and *FEC*-threshold (*FEC26%MSP*) = 86,821 (billions of eggs). Based on the 2015 stock assessment, overfishing is not occurring because fishing mortality for the terminal year (2013) is estimated to be *F* = 0.22 (*F70%MSP*), below both the target and the threshold (Figure 6). Additionally, the stock is not overfished because fecundity for 2013 is estimated to be *FEC* = 170,536 billion eggs, above the threshold and just below the target (Figure 7). See http://www.asmfc.org/species/atlantic-menhaden for the most recent stock assessment reports and most current stock status determination.

1.3 DESCRIPTION OF THE FISHERY

1.3.1 Commercial Fishery

Atlantic menhaden have supported one of the United States' largest fisheries since colonial times. Menhaden have repeatedly been listed as one the nation's most important commercial fisheries in terms of quantity. Preliminary Atlantic menhaden landings in 2016 totaled 180,801 mt (398.6 million lb) (Table 16). Landings records indicate that roughly 25 million mt (55.1 billion lb) of Atlantic menhaden have been caught by fishing fleets operating from Maine to Florida since 1940.

Native Americans were the first to use menhaden, primarily for fertilizer. Colonists soon recognized the value of whole menhaden for fertilizer and local seine fisheries gradually developed from New York to Maine. The menhaden oil industry began in Rhode Island in 1811 (Frye 1999). Numerous small factories were located along the Northeast coasts; however, their supply was limited to fish that could be captured by the traditional shore-based seines. In 1845, the purse seine was introduced, and an adequate supply of raw material was no longer a problem. By 1870, the industry had expanded southward, with several plants in the Chesapeake Bay and North Carolina areas (Whitehurst 1973). The industry gradually developed during the late 1800s and early 1900s and was described in considerable detail prior to World War I by Greer (1915). The primary use of menhaden changed from fertilizer to animal feed after World War I through a process known as fish reduction. Menhaden meal was mixed into poultry, swine, and cattle feeds as the amount used for fertilizer was decreasing (Harrison 1931). The current commercial fishery is divided into the reduction fishery, in which menhaden are produced into fish meal and fish oil, and the bait fishery, in which menhaden are harvested as a bait source for other commercial and recreational fisheries. A variety of gears are used to harvest menhaden commercially (Table 17).

1.3.1.1 Reduction Fishery

<u>Vessels, Reduction Plants, and Harvest Capacity</u>

The early menhaden purse seine reduction fishery utilized sailing vessels until coal-fired steamers were introduced after the Civil War. In the 1930s, diesel-powered vessels began to replace the steamers, although a few sailing vessels were still in use. The use of spotter aircraft to locate schools of menhaden began in 1946, a practice still in use today by the reduction fishery. The refrigeration of vessel holds in the 1960s and 1970s was crucial for the industry to maintain its viability. Despite restricted access to a number of traditional fishing grounds, a reduced fleet size, and fewer processing plants to land fish, refrigerated holds enabled the fleet to maximize the harvest during peak resource availability. Refrigeration also allowed the fleet to stay out longer and access a wider geographic area, greatly improving the ability to catch fish when and where they are available. All seven vessels in the menhaden fleet in 2013 utilized refrigerated fish holds, compared to only 60% of the fleet in 1980.

Currently, commercial reduction menhaden purse seine fishing operations use spotter aircraft to locate schools of menhaden and direct vessels to the fish. When a school is located, two purse boats, with a net stretched between them, are deployed. The purse boats encircle the school and close the net to form a purse, or bag. The net is then retrieved to concentrate the catch, and the mother ship comes along the side and pumps the catch into refrigerated holds. Individual sets can vary from 10 to more than 100 mt, and large vessels can carry 400-600 mt of refrigerated fish.

Historically, the total number of vessels fishing for menhaden was generally related to the availability of the resource. Greer (1915) reported 147 vessels in 1912. During 1955-1959, about 115-130 vessels fished during the summer season, while 30-60 participated in the North Carolina fall fishery. As the resource declined during the 1960s, fleet size decreased by more than 50%. Through the 1970s, approximately 40 vessels fished during the summer season, while nearly 20 were active in the fall fishery. During 1980-1990, 16-33 vessels fished the summer season, and the level of effort in the fall fishery ranged from 3 to 25 vessels. In 2013, only 7 vessels participated in the reduction fishery.

One of the major changes in the reduction fishery has been the decrease in the number of operating reduction plants. During peak landing years (1953-1962), there was anywhere from 19 to 25 reduction plants in operation located along the coast from Maine to Florida. Many plants closed in the late 1960's as the resource began to decline and, in 1975, there were 12 reduction plants in operation. In 1985, this decreased to 6 plants and by 1994, there were only three plants located in Virginia and North Carolina. A major change in the reduction industry took place following the 1997 fishing season, when the two reduction plants operating in Reedville, VA, consolidated into a single company and a single factory; this significantly reduced effort and overall production capacity. Another major event within the industry occurred in the spring of 2005 when the fish factory at Beaufort, NC, closed and the owners sold the property to coastal developers. Today, there is a single reduction plant along the U.S. Atlantic coast located in Reedville, Virginia.

Reduction landings averaged 310,900 mt from 1940-2016, but only averaged 161,700 mt from 2000 – 2016 (Figure 8, Table 18). Reduction landings since 1940 peaked in 1956 at 712,100 mt, with the lowest value since 1940 (131,000 mt) occurring in 2013. It is important to note that 2013 was the first year a TAC was implemented in the menhaden fishery. This TAC represented a 20% reduction from average landings in 2009-2011. Other causes of declines in reduction harvest include lower menhaden abundance, reduced fleet size, and reduced reduction plant capacity.

The directed menhaden purse seine fishery for reduction is seasonal. The presence of menhaden schools is dependent on the temperature of coastal waters. Two fairly distinct fishing seasons occur, the "summer fishery" and the "fall fishery". The summer fishery begins in April with the appearance of schools of menhaden off the North Carolina coast. The fish migrate northward, appearing off southern New England in May-June. The fall fishery begins when migratory fish appear off Virginia and North Carolina. In early fall, this southward migration is initiated by cooling ocean temperatures. By late November-early December, most of the fish are found between Cape Hatteras and Cape Fear, North Carolina.

Reduction Fishery Products

Menhaden reduction plants, through a process of heating, separating, and drying, produce fish meal, fish oil, and fish solubles from fresh menhaden. Meal is a valuable ingredient in poultry and livestock feeds because of its high protein content (at least 60%). Meal can also be found in pet foods for fish and dogs. Menhaden oil is (or has been) used in cooking oils, margarine, soap, linoleum, waterproof fabrics, and certain types of paint. Menhaden oil is often marketed as a source of omega-3 fatty acids and can be incorporated into food and beverage products as well as dietary supplements. Solubles are the aqueous liquid component remaining after oil removal. In general, most meal producers add the soluble component to the meal to create a product termed "full meal." Solubles can be used in the aquaculture industry as an attractant and as a fertilizer.

Internal Waters Processing

Section 306 of the Magnuson-Stevens Fishery Conservation and Management Act (PL 94-265) allows foreign fish processing vessels to operate within the internal waters of a state with the permission of the Governor of that state. Up to three IWP ventures operated within Maine's coastal waters during 1988-1993. Under state jurisdiction, a foreign vessel was permitted to process menhaden caught by US vessels into fish meal and oil during the 1988-1993 fishing seasons. In 1987, two New England-based menhaden vessels began to fish in the Gulf of Maine, landing the catch at a Canadian processing plant. Another Canadian factory in Nova Scotia processed menhaden in 1992 and 1993. No menhaden have been processed in the North Atlantic since the summer of 1993.

1.3.1.2 Bait Fishery

Menhaden from bait fisheries is primarily harvested with purse seines, pound nets, gill nets, and trawls, with a smaller amount of harvest coming from cast nets, fyke nets, and haul seines. Menhaden are taken for bait in almost all Atlantic coast states and are frequently used for bait in crab pots, lobster pots, and hook and line fisheries (both sport and commercial).

Since 1985, the proportion of menhaden landed as bait has generally increased (Table 18, Figure 8). Reported bait landings averaged 10% of the total Atlantic menhaden landings from 1985-2000 and 20% of total landings from 2001 to 2016. This increase in the percent of coastal bait landings can be attributed to better data collection in the fishery and a decline in coastal reduction landings. The closure of reduction plants in New England and the mid-Atlantic may have influenced growth in the bait fishery, making more product available for the lobster and crab pot fisheries, as well as bait for sport fishermen. Additionally, the passage of a net ban in Florida in November 1994 reduced the availability of bait in that state, which may have opened up new markets for menhaden bait caught in Virginia and the Mid-Atlantic States. The appearance of growth in the Atlantic coast bait fishery must be tempered by the knowledge that reporting systems for bait landings, particularly for Atlantic menhaden, have historically been incomplete.

Menhaden bait landings have not always been well-documented leading to an under-estimate of historic harvest. Historically, there have been some well-documented, large-scale, directed bait fisheries for menhaden using gears such as purse seines, pound nets, and gill nets; however, there have also been many small-scale directed bait fisheries, such as those using cast nets and beach seines, which have supplied large quantities of bait and had few, if any, reporting requirements. Estimates of menhaden bait landings have improved over the years as most states implemented reporting requirements for the smaller scale fisheries by the late 2000's. States were required to implement timely reporting as a part of Amendment 2 (2012) in order to monitor quota allocations.

Given the geographic expanse of the menhaden bait fishery, there are regional differences in how and when menhaden are harvested. In the southeast, menhaden landings are dominated by Florida and North Carolina. In Florida, menhaden landings are primarily landed with cast nets as the state implemented a net ban in 1994. Prior to this time, Florida had significant bait landings from gill nets and purse seines. Fishermen in North Carolina use cast nets, gill nets, and pound nets to harvest menhaden. The principal use for menhaden as bait in North Carolina is in the blue crab pot fishery. In addition, some keep menhaden alive in holding tanks for "slow trolling" for king mackerel, or bottom fishing for cobia. There are no directed menhaden fisheries in South Carolina and Georgia.

Menhaden bait landings in Virginia are dominated by purse seine vessels referred to as 'snapper rigs'. These vessels range from about 80 to 135 ft long and primarily sell bait to the sport and crab fisheries. In contrast, the Maryland and Potomac River bait fisheries are primarily executed by pound nets, a large fixed gear. The pound net fishery in the Chesapeake Bay region is prosecuted by numerous small, non-refrigerated vessels. Maximum hold capacity of these pound net vessels is 9 mt or less, but daily catches are usually well below vessel capacity and are limited by the number of fish encountered in the fixed gear. The majority of these fish supply the local blue crab pot fishery.

In the mid-Atlantic, there has been an expansion of the purse seine bait fishery in recent years, particularly in New Jersey. The New Jersey fishery utilizes about 20 carry vessels and about 15 catch vessels per year. Most operations have a catch vessel paired with a specific carry vessel, but some vessels are both catch and carry. Carry vessel length ranges from 59 to 90 feet, though most are in the 70-85 foot range, and catch vessel length ranges from 40 to 88 feet, but most are 40-50 feet. Net length is restricted to 150 fathoms (900 feet) by regulation. In New York and Delaware, menhaden bait landings are primarily caught in pound nets, gill nets, casts, and seines.

In the New England region, purse seine landings in Maine, Massachusetts and Rhode Island account for the majority of the recorded bait landings. The New England operators are fairly small, typically with one harvest vessel, ranging in size from the 30 to 90 feet in length. In Rhode Island, there is a historic floating fish trap fishery which harvests the majority of menhaden. In Connecticut, smaller directed gill net fisheries also harvest menhaden. The bulk of menhaden landings for bait in New England are used in the lobster fishery.

1.3.2 Recreational Fishery

Menhaden are important bait in many recreational fisheries and, as a result, some recreational fishermen employ cast nets to capture menhaden or snag them with hook and line. Recreational harvest is not well captured by the Marine Recreational Information Program (MRIP) because there is not a known direct harvest for menhaden, other than for bait. MRIP intercepts typically capture the landed fish from recreational trips as fishermen come to the dock or on the beach. Since menhaden caught by recreational fishermen are used as bait during their trip, they typically are not part of the catch that is seen by the surveyor completing the intercept.

From what is known, recreational catch has varied over time with a high of 672.3 mt in 1992 and a low of 12.2 metric tons in 2000. The average harvest between 1981 and 2015 was 206.8 mt. Landings have averaged 382.5 mt between 2011 and 2015. Preliminary recreational landings from 2016 are 845 mt, which would be a new high for the timeseries (Figure 9).

1.3.3 Subsistence Fishing

No subsistence fisheries for Atlantic menhaden have been identified at this time.

1.3.4 Non-Consumptive Factors

Menhaden provide an important forage based for many fish, bird, and marine mammal species. Please refer to *Section 1.1.2.1 Ecological Benefits*.

1.3.5 Interactions with Other Fisheries

Incidental bycatch of other finfish species in menhaden purse seines has been a topic of interest and concern for many years to the commercial and recreational fishing industry, as well as the scientific community (Smith 1896; Christmas et al. 1960; Oviatt 1977). Past studies have indicated that there is little or no bycatch in the menhaden purse seine fishery; however, there is currently no requirement for at-sea observers.

The Virginia Institute of Marine Science studied bycatch levels of finfish, turtles, and marine mammals in the Atlantic menhaden fishery. Results from that study indicated that bycatch in the 1992 Atlantic menhaden reduction fishery was minimal, comprising about 0.04% by number (Austin et al. 1994). The maximum percentage bycatch occurred in August (0.14%) while the lowest occurred in September (0.002%). Among important recreational species, bluefish accounted for the largest portion of bycatch (0.0075% of the total menhaden catch). No marine mammals, sea turtles, or other protected species were killed, captured, entangled or observed during sampling.

Additional data are available from the Gulf of Maine IWP fishery in 1991. Every catch unloaded onto the processing vessel was inspected by a state observer. A total of 93 fish were taken as bycatch along with roughly 60,000,000 individual menhaden (D. Stevenson, Maine DMR, pers. comm.; as cited in ASMFC 1992).

1.4 HABITAT CONSIDERATIONS

1.4.1 Physical Description of Habitat

1.4.1.1 Gulf of Maine

The Gulf of Maine is a semi-enclosed sea of 36,300 mi^2 (90,700 km^2) bordered on the northeast, north and west by the coasts of Nova Scotia, New Brunswick, and the New England states. To the south and east, the Gulf is open to the North Atlantic Ocean; however, Georges Bank forms a partial southern boundary below about 165 ft (50 m). The interior of the Gulf of Maine is characterized by five major deep basins (>600 ft, 200 m) which are separated by irregular topography that includes shallow ridges, banks, and ledges. Basins make up about 30% of the floor area (Thompson, 2010). Retreating glaciers (18,000–14,000 years ago) left behind a variety of patchily distributed sediment types including silt, sand, clay, gravel, and boulders (NMFS, 2015). Major tributary rivers are the St. John in New Brunswick; St. Croix, Penobscot, Kennebec, Androscoggin, and Saco in Maine; and Merrimack in Massachusetts.

The predominantly rocky coast north of Portland, Maine is characterized by steep terrain and bathymetry, with numerous islands, embayments, pocket beaches, and relatively small estuaries. Tidal marshes and mud flats occur along the margins of these estuaries. Farther south, the coastline is more uniform with few sizable bays, inlets, or islands, but with many small coves. Extensive tidal marshes, mud flats, and sandy beaches along this portion of the coast are gently sloped. Marshes exist along the open coast and within the coves and estuaries.

The surface circulation of the Gulf of Maine is generally counterclockwise, with an offshore flow at Cape Cod which joins the secondary, clockwise gyre on the northern edge of Georges Bank. The Northeast and Great South Channels, which bookend Georges Bank, serve as the primary inflow and outflow channels of marine waters, respectively. Some of the water entering the Northeast Channel flows into the Bay of Fundy; another portion turns west to feed the Maine Coastal Current, initiating the counterclockwise direction of flow. The counterclockwise gyre is more pronounced in the spring when river runoff adds to the southwesterly flowing coastal current. Surface currents reach velocities of 1.5 knots (80 cm sec) in eastern Maine and the Bay of Fundy region under the influence of extreme tides, up to 52 ft (16 m) and gradually diminish to 0.2 knots (10-20 cm/sec) in Massachusetts Bay where tidal amplitude is about 10 ft (3 m) (Thompson, 2010).

There is great seasonal variation in sea surface temperature in the Gulf, ranging from 4°C in March throughout the Gulf to 18°C in the western Gulf and 14°C in the eastern Gulf in August. The Gulf of Maine sea surface temperature has been warming steadily over the last 35 years. In the most recent decade, the warming trend (0.23 °C /year) was faster than 99 percent of the global ocean (Pershing et al., 2015). The warming is related to a northward shift in the Gulf Stream and to changes in the Atlantic Multidecadal Oscillation and Pacific Decadal Oscillation (Pershing et al., 2015). The salinity of the surface layer also varies seasonally, with minimum values in the west occurring during summer, from the accumulated spring river runoff, and during winter in the east under the influence of runoff from the St. Lawrence River (from the previous spring). With the seasonal temperature and salinity changes, the density stratification in the upper water column also exhibits a seasonal cycle. From well mixed, vertically uniform conditions in winter, stratification develops through the spring and reaches a maximum in the summer. Stratification is more pronounced in the southwestern portion of the Gulf where tidal mixing is diminished.

1.4.1.2 Middle Atlantic Region

The coastal zone of the mid-Atlantic states varies from a glaciated coastline in southern New England to the flat and swampy coastal plain of North Carolina. Along the coastal plain, the beaches of the barrier islands are wide, gently sloped, and sandy, with gradually deepening offshore waters. The area is characterized by a series of sounds, broad estuaries, large river basins (e.g., Connecticut, Hudson, Delaware, and Susquehanna), and barrier islands. Conspicuous estuarine features are Narragansett Bay (Rhode Island), Long Island Sound and Hudson River (New York), Delaware Bay (New Jersey and Delaware), Chesapeake Bay (Maryland and Virginia), and the nearly continuous band of estuaries behind barrier islands along southern Long Island, New Jersey, Delaware, Maryland, Virginia, and North Carolina. The complex estuary of Currituck, Albemarle, and Pamlico Sounds behind the Outer Banks of North Carolina (covering an area of 2,500 square miles) is an important feature of the region. Coastal marshes border those estuaries along much of the glaciated coast from Cape Cod to Long Island Sound. Nearly continuous marshes occur along the shores of the estuaries behind the barrier islands.

At Cape Hatteras, the Continental Shelf extends seaward approximately 20 mi (33 km), and gradually widens northward to about 68 mi (113 km) off New Jersey and Rhode Island where it is intersected by numerous underwater canyons. Surface circulation north of Cape Hatteras is generally southwesterly during all seasons, although this may be interrupted by coastal indrafting and some reversal of flow at the northern and southern extremities of the area. Speeds of the drift north of Cape Hatteras are on the order of six miles (9.7 km) per day. There may be a shoreward component to this drift during the warmer half of the year and an offshore component during the colder half. The western edge of the Gulf Stream meanders in and out off Cape Hatteras, sometimes coming within 12 mi (20 km) of the shore, but it becomes less discrete and veers to the northeast north of Cape Cod. Surface currents as high as 4 knots (200 cm/sec) have been measured in the Gulf Stream off Cape Hatteras.

Hydrographic conditions in the mid-Atlantic region vary seasonally due to river runoff and changing water temperatures. The water column becomes increasingly stratified in the summer and homogeneous in the winter due to fall-winter cooling of surface waters. In winter, the mean range of sea surface temperatures is 0-7°C off Cape Cod and 1-14°C off Cape Charles (at the southern end of the Delmarva Peninsula); in summer, the mean range is 15-21°C off Cape

Cod and 20-27°C off Cape Charles. The tidal range averages slightly over 3 ft (1 m) on Cape Cod, decreasing to the west. Within Long Island Sound and along the south shore of Long Island, tide ranges gradually increase, reaching 6 ft (2 m) at the head of the Sound and in the New York Bight. South of the Bight, tide ranges decrease gradually to slightly over 3 ft (1 m) at Cape Hatteras. Prevailing southwest winds during the summer along the Outer Banks often lead to nearshore upwelling of colder bottom water from offshore, so that surface water temperatures can vary widely during that period (15-27°C over a period of a few days).

The waters of the coastal middle Atlantic region have a complex and seasonally dependent circulation pattern. Seasonally varying winds and irregularities in the coastline result in the formation of a complex system of local eddies and gyres. Surface currents tend to be strongest during the peak river discharge period in late spring and during periods of highest winds in the winter. In late summer, when winds are light and estuarine discharge is minimal, currents tend to be sluggish, and the water column is generally stratified.

1.4.1.3 South Atlantic Region

The south Atlantic coastal zone extends in a large oceanic bight from Cape Hatteras south to Biscayne Bay and the Florida Keys. North of Florida it is bordered by a coastal plain that stretches inland for a hundred miles and a broad continental shelf that reaches into the ocean for nearly an equal distance. This broad shelf tapers down to a very narrow and precipitous shelf off the southeastern coast of Florida. The irregular coastline of North Carolina, South Carolina, Georgia, and eastern Florida is generally endowed with extensive bays and estuarine waters, bordered by nutrient-rich marshlands. Barrier beaches and dunes protect much of the shoreline. Along much of the southern coast from central South Carolina to northern Florida estuarine salt-marsh is prominent. Most of the east coast of Florida varies little in general form. Sand beaches with dunes are sporadically interrupted by mangrove swamps and low banks of earth and rock.

The movements of oceanic waters along the South Atlantic coast have not been well defined. The surface currents, countercurrents, and eddies are all affected by environmental factors, particularly winds. The Gulf Stream flows along the coast at 6-7 miles per hour (10-11 km/hr). It is nearest to the coast off southern Florida and gradually moves away from the coast as it flows northward. A current that flows southward, inshore of the Gulf Stream, exists for most of the year north of Cape Canaveral.

Sea surface temperatures during the winter increase southward from Cape Hatteras to Fort Lauderdale, Florida, with mean minimums ranging from 2-20°C and maximums ranging from 17-26°C. In the summer, the increases are more gradual, ranging north to south from minimums of 21-27°C to maximums of 28-30°C. Mean sea-surface salinity is generally in the range of 34 to 36 ppt year round. Mean tidal range is just over 3 ft (1 m) at Cape Hatteras and increases gradually to about 6-7 ft (2 m) along the Georgia coast. Tides decrease south of Cape Canaveral to 3 ft (1 m) at Fort Lauderdale.

1.4.2 Environmental Requirements of Atlantic Menhaden

1.4.2.1 Temperature, Salinity and Dissolved Oxygen

Atlantic menhaden occur throughout a wide range of physicochemical conditions. Several studies have raised questions about the species' environmental limits and optimum conditions. June and Chamberlin (1959) and Reintjes and Pacheco (1966) reported that larval menhaden did not enter estuarine waters at temperatures below 3°C. Many studies have noted an affinity of young menhaden for low salinity waters. Wilkens and Lewis (1971) speculated that larval menhaden require low salinity water to metamorphose properly, and Lewis (1966) found that although larvae metamorphosed in salinities of 15-40 ppt, one-third of the juveniles developed slightly crooked vertebral columns. However, larvae held in the laboratory at 25-40 ppt metamorphosed completely with no abnormalities (Reintjes and Pacheco 1966; Hettler 1981), and larvae trapped in a natural cove at Beaufort, North Carolina, transformed into juveniles at 24-36 ppt (Kroger et al. 1974).

Salinity also affects temperature tolerance, activity, metabolism and growth. Low salinities decreased survival at temperatures below 5°C, and survival was poor at 6°C in freshwater (Lewis 1966). The effect of salinity on upper temperature tolerance was not significant (Lewis and Hettler 1968). Larvae that Hettler (1976) reared at 5-10 ppt exhibited significantly higher activity levels, metabolic rates, and growth rates than those reared at 28-34 ppt. Lewis (1966) also noted slower growth at high salinities. Subtle physiological adaptations to low salinity may be an evolutionary response to larvae "seeking" the food-rich estuarine environment. Rogers et al. (1984) noted that pre-juveniles of many fishes, including those of *Brevoortia* species, entered estuarine habitats during seasonal peaks of freshwater influx when the area of low salinity and fresh tidal water was greatest.

Salinities of 10-30 ppt did not affect developing embryos, though temperature did (Ferraro 1980). Mortality of embryos was complete at temperatures less than 7°C and was significantly higher at 10°C than at 15, 20, and 25°C. Time to hatching was significantly shorter at each progressively higher temperature. Surface temperature in the spawning areas of the South Atlantic Region during the months of highest egg capture were generally 12-20°C (Walford and Wicklund 1968). The lowest temperatures at which Atlantic menhaden eggs and larvae were collected in the North Atlantic region were between 10 and 13°C (Ferraro 1980). The temperature range for the Middle Atlantic region was 0-25°C, but most eggs and larvae were collected at 16-19°C (Kendall and Reintjes 1975).

The limits of larval temperature tolerance are affected by acclimation time. Survival above 30°C (Lewis and Hettler 1968) and below 5°C (Lewis 1965) was progressively extended by acclimation temperatures closer to test values, suggesting that rapid changes to extreme temperatures are more likely to be lethal than prolonged exposure to slowly changing values. Winter shutdown of power plant operations may result in rapid temperature decreases near the effluent discharge area. Mortality of juvenile Atlantic menhaden to a temperature decrease of 10°C (from 15 to 5°C) was less at rates of decrease of 6.7°C /h or lower than at faster rates. Winter menhaden kills can be minimized by reducing the rate of decrease as the power plant discharge is shut down (Burton et al. 1979).

A potential management consideration is that, historically, estuarine zones received freshwater from contiguous wetlands and riverine systems. However, channelization, diking of river courses, ditching and draining of marginal wetlands, and urbanization have reduced the freshwater retention capacities of coastal wetlands. Furthermore, extensive filling of estuarine marshlands has diminished the area receiving runoff in many locations. In combination, these changes cause rapid discharge of high volumes of freshwater during brief periods and reduced amounts of freshwater at other times. High inflows, particularly those that occur in early spring after the arrival of pre-juvenile menhaden, can expose fish to extreme fluctuations of temperature, turbidity, and other environmental conditions. Although the effects of altered freshwater flow regimes on Atlantic menhaden are not known, effects on other estuarine dependent, offshore spawned fishes range from disappearance (Rogers et al. 1984) to death (Nordlie et al. 1982).

Dissolved oxygen, particularly at low levels, can impact the survival of menhaden. Lewis and Hettler (1968) observed increased survival of juveniles at 35.5^{o}C with increased dissolved oxygen (DO) saturation. Burton et al. (1980) reported a mean lethal DO concentration of 0.4 mg/l, but warned against interpretation of this value as “safe,” in view of the interactive nature of environmental factors. Westman and Nigrelli (1955) observed mass mortalities from gas embolism only in areas with highly variable salinity and organic pollution sufficiently severe to make shellfish unfit for human consumption. Lewis and Hettler (1968) observed decreased survival at high temperatures by fish affected by gill parasites. The interaction of environmental factors must be considered when one defines healthy ranges for an organism.

1.4.2.2 Primary Production

Abundance of YOY juvenile menhaden is strongly and positively correlated with *chl-a* and primary production in Chesapeake Bay (Houde and Harding 2009). Furthermore, the relationship between *chl-a* and abundance of YOY recruits is principally generated in spring months during the period larvae are transitioning to the filter-feeding juvenile stage when menhaden become dependent on phytoplankton for food. Although recent research indicates that age-1+ menhaden may derive most energy from zooplankton food (Lynch et al. 2010; Friedland et al. 2011), it is apparent that YOY menhaden can efficiently filter small phytoplankton (Friedland et al. 2006) and that it is their primary food. The timing, intensity, quality, and spatial variability of the spring phytoplankton bloom in Chesapeake Bay show high interannual variability and are strongly affected by climate (Adolf et al. 2006; Miller and Harding 2007). This variability in primary production is probably a key factor controlling production potential of young menhaden in estuarine habitats.

Analysis of two decades of ichthyoplankton survey data (1977–1987 and 1999–2008) revealed a shift in the timing of larval occurrence on the Northeast US shelf ecosystem. Relative larval abundance occurred later in the fall, compared to the previous 10-yr sampling period (Walsh et al. 2015). These results are consistent with the hypothesis that warming in the NEUS Shelf (Friedland and Hare 2007) is causing changes to spawning times.

1.4.2.3 Environmental Factors and Recruitment Success

Relationships between recruitment success of YOY menhaden and factors other than variables associated with primary productivity were less clear. Numerous fish and avian predators are major consumers of young menhaden, but there are no estimates of predation rates or of variability in natural mortality rates of YOY menhaden. Bioenergetics and predation models indicate potential for predators to control abundances of YOY menhaden in the Chesapeake Bay (Annis et al. 2011).

There is evidence that the temperature experienced by YOY menhaden affects seasonal and inter-annual variability in growth within the Chesapeake Bay (Humphrey et al. 2014, Houde and Harding 2009), and is an important parameter in bioenergetics models that predict growth potential (Annis et al. 2011). Recent observations suggested that flow-related variables were important, but acted indirectly and in complex ways to exercise control over recruitment levels. Regional analyses supported the observation that menhaden recruitment, in general, is elevated in years of low late-winter precipitation and freshwater flow, when relatively warm and dry weather conditions, often described as "Bermuda High" patterns, prevail (Wood et al. 2004; Kimmel et al. 2009; Wood and Austin 2009).

1.4.2.4 Sediments and Turbidity

Forest clearing has led to changes in sediment loading as without the buffer provided by trees, shrubs, plants, and wetlands, storm water flows unchecked (Brush 1986). This results in erosion that brings increased sediment into estuaries, such as the Chesapeake Bay. In addition, the dramatic increase in impermeable surfaces has also increased runoff as impervious surfaces amplify storm water discharges into streams (Goetz and Jantz 2006). One consequence of these changes is that sediment grain size has changed over time so that very fine sediment now predominates, which reduces light penetration. Secchi disk readings from the Chesapeake Bay have steadily declined since 1985 from just over 2 meters to about 1 meter in 2008 (Greer 2008). Because filter feeding juvenile menhaden can retain particles as small as 5-7 µm, and to a minor extent particles <5 µm, there is a possibility that menhaden feeding could be compromised (Friedland et al. 1984).

Increased turbidity acts to shade submerged aquatic vegetation (SAV), thus decreasing the extent and composition of SAV beds. Loss of SAV may indirectly affect menhaden by increasing turbidity as a result of increased sediment resuspension (Orth et al., 2006) which in turn can lower phytoplankton productivity. SAV has also been shown to exercise control over ecosystem function through nutrient recycling and linkage to fish productivity (Orth et al., 2006; Hughes et al., 2009), which may impact menhaden abundance, although specific impacts are not known at present.

1.4.2.5 Water Movement

Currents and circulation features play an important role in cueing reproduction, and in controlling dispersal of larval stages, assuring that some larvae are transported to the coastal estuaries and embayments that serve as juvenile nurseries. Most larval menhaden are found shoreward of the Gulf Stream Front (GSF); those sampled in the GSF or seaward of it presumably are rapidly advected northeast and lost to the population, although it is possible that warm-core rings and onshore streamers could return some larvae to the shelf (Hare and Govoni 2005). There is ample evidence, based on observations and models, that coastward transport of larvae is supported by favorable winds and currents on the shelf (e.g., Checkley et al. 1988; Werner et al., 1999). Models and observations of advective mechanisms at estuary mouths present a less-clear picture of how menhaden larvae move into estuaries, although it is apparent that winds, tides, and larval behavior control the ingress.

Interannual variability in recruitment is believed to be, at least partly, controlled by variability in oceanographic conditions that affect hydrography, circulation, and possibly biological productivity. Weather and climate patterns are probable drivers of such variability. Wood et al. (2004) demonstrated that prevalence of a late-winter climate pattern designated a “Bermuda-Azores High” that brings dry and warm late-winter weather to the Mid-Atlantic region is associated with high recruitment of Atlantic menhaden. This weather pattern may promote favorable shoreward transport or feeding conditions for early-stage menhaden larvae while on the continental shelf.

The remarkable temperature tolerance of larval menhaden is notable in distribution statistics. Larvae have been collected at temperatures from 0 to 25 °C. The low-temperature observations are for late-stage menhaden larvae (usually >20 mm length) in winter that have been advected to the mouths of mid-Atlantic estuaries (e.g., Kendall and Reintjes 1975).

The mechanics and details of larval ingress to estuaries are poorly known, despite numerous studies to describe and explain it. Larval ingress may occur in pulses, supported by wind generated high-inflow events (Forward et al. 1999b). Wind forcing may play an important role, in combination with entrainment in up-estuary residual flow (Hare et al 2005).

1.4.2.6 Substrate and System Features

The association of Atlantic menhaden with estuarine and nearshore systems during all phases of its life cycle is well documented. It is evident that young menhaden require these food rich waters to survive and grow, and the fishery is concentrated near major estuarine systems. Filling of estuarine wetlands, in addition to exacerbating extremes in environmental conditions, has physically limited the nursery habitat available to Atlantic menhaden and other estuarine-dependent species. The relative importance, however, of different habitat types (i.e. sounds, channels, marshes) and salinity regimes has received little detailed attention (Rogers and Van Den Avyle 1989).

1.4.3 Identification and Distribution of Essential Habitat

Estuarine and nearshore waters along the Atlantic coast from Florida to Nova Scotia serve as important habitat for juvenile and/or adult Atlantic menhaden. Within this wide geographic range, hydrographic and circulation features constrain population distribution (MDSG 2009). Adult menhaden distribution is bounded by the Gulf Stream Front on the seaward side and usually within waters warmer than 10°C (MDSG 2009).

Adult Atlantic menhaden spawn in oceanic waters along the continental shelf, as well as in sounds and bays in the northern extent of their range (Judy and Lewis 1983). Around June, fish are stratified by age and size along the coast, with larger, spawning-age fish north of Long Island (Judy and Lewis 1983). Winds and tides transport larvae shoreward from the shelf (Checkley et al. 1988, Werner et al. 1999) toward nursery grounds in the estuaries. Larvae are between one and three months old, usually closer to two months, at first ingress into estuaries (Warlen et al. 2002, MDSG 2009). In the Chesapeake Bay monthly larval ingress was variable, but peaked between November and April (Lozano and Houde 2013), and peak ingress into North Carolina estuaries occurred from February through April (Lewis and Mann 1971, Hettler and Chester 1990, Hettler et al. 1997).

After entering the estuary, larvae congregate in large concentrations near the upstream limits of the tidal zone, where they metamorphose into juveniles (June and Chamberlin 1959, Houde 2011). The relative densities of juvenile menhaden have been positively correlated with higher chlorophyll *a* levels in the lower salinity zones of estuaries, resulting in highly patterned distributions (Friedland et al. 1989 & 1996, Houde and Harding 2009).

Many factors in the estuarine environment affect the behavior and well-being of menhaden. The combined influence of weather, tides, and river flow can expose estuarine fish to rapid changes in temperature and salinity. It has been reported that salinity affects menhaden temperature tolerance, activity and metabolic levels, and growth (Lewis 1966; Hettler 1976). Factors such as waves, currents, turbidity, and dissolved oxygen levels can impact the suitability of the habitat, as well as the distribution of fish and their feeding behavior (Reintjes and Pacheco 1966). As juvenile menhaden grow and develop, they form dense schools throughout the lower salinity portions of the estuary; most eventually migrate to the ocean in late fall-winter. Historical information suggests most spawning age menhaden move south of Cape Hatteras during the winter (Judy and Lewis 1983). However, there have been recent observations of dense concentrations of menhaden overwintering in 5-7°C waters adjacent to southern Long Island and Block Island, as well as winter fishery landings of menhaden harvested from these locations (John Manderson, NOAA, pers. comm.).

Historically, Chesapeake Bay was considered to be the most productive nursery area (contributing 69% of Atlantic menhaden recruits [age 1] to the coast wide population), followed by the south Atlantic (17%), and the Mid-Atlantic sections from Maryland to New York (12%) (Ahrenholz et al. 1989, ASMFC 2004, Anstead et al. 2017). However new research credits the Chesapeake Bay with 30% of age 1 recruits and New England and the southeast estuaries contributing equal portions to the population (Anstead et al. 2016). Furthermore, recruits from all three areas, in the same proportions, have been shown to persist in the population beyond the first year to ages 2-4, therefore becoming part of the reproductive population (Anstead et al. 2017).

Pollution and habitat degradation threaten the Atlantic menhaden population, particularly during the estuarine residency of larvae and juveniles. Important estuaries such as the Chesapeake Bay and the Albemarle-Pamlico system are especially susceptible to pollution because they are generally shallow, have a high total volume relative to freshwater inflow, limited tidal exchange, and a long retention time. Most tributaries of these systems originate in the Coastal Plain and have relatively little freshwater flow to remove pollutants, particularly during drier-than-average summers. Shorelines of most estuarine areas are becoming increasingly developed, even with existing habitat protection programs. Thus, nursery habitats of greatest long-term importance to the menhaden stock and fishery are increasingly at risk.

1.4.4 Anthropogenic Impacts on Atlantic Menhaden and Their Habitat

The human population along the coast is steadily increasing, and the average number of people per square mile in coastal counties has nearly doubled since 1960 (U.S Census Bureau 2010). Increasing human presence precipitates industrial and municipal expansion, thus intensifying anthropogenic pressure on resources and accelerating competition for use of land and water. Consequently, estuarine and coastal habitats have been significantly reduced and continue to be stressed by dredging, filling, coastal construction, energy plant development, pollution, waste disposal, nutrient loading, and other human-related activities.

Degraded water quality in estuaries threatens critical nursery habitat for young menhaden. Concern has been expressed (Ahrenholz et al. 1987) that the outbreaks of ulcerative mycosis in the 1980s may have been symptomatic of deteriorating water quality in estuarine waters along the east coast. Human population growth and increasing development in the coastal zone are expected to further reduce water quality unless steps are taken to ameliorate their effect on the environment (Cross et al. 1985). Altering habitats and water quality can affect menhaden habitat use and productivity - responses that are magnified in estuaries where human use and biological productivity heavily interact.
Perhaps the most significant physical alteration of the Chesapeake Bay watershed in recent decades has been the increase in impervious surfaces. More than 400,000 hectares are currently categorized as impervious surface and that value continues to climb (Brush 2009). These surfaces increase the nutrient, sediment, and contaminant flow rate to the Chesapeake Bay (Clagett 2007), and exacerbate eutrophication and expansion of hypoxic and anoxic zones. Although not well studied at present, reduced water quality associated with increases in impervious surfaces could diminish habitat quality for menhaden or their predators.

Menhaden fish kills, both human-caused and naturally occurring, are a persistent problem in bays and estuaries throughout the range. Most states keep records of fish kills, documenting water quality, number of fish killed, and likely causes. Localized die-offs often occur due to critically low dissolved oxygen (DO) levels, which may result from a variety of factors including high temperature, low flow, overcrowding, or algal blooms. Infectious diseases, parasites, toxicants, or miscellaneous human activity (e.g. thermal shock or fishing discards) may also cause localized mortality. In Maryland, nearly 50 years of records document annual menhaden kills ranging from tens to tens-of-millions of fish (max est. 47M fish in 1974), caused by a variety of factors from concussive explosions to disease to toxicants from spills or discharge (C. Poukish, MD DNR, pers. comm.). The most common factor was low DO in the presence of algal blooms, which causes an annual spring die-off. In the Neuse and Tar-Pamlico River estuaries in North Carolina low oxygen events cause significant mortality of Atlantic menhaden and other fish species nearly every summer (R. Wilson Laney, USFWS, pers. comm.; also see http://deq.nc.gov/about/divisions/water-resources/water-resources-data/water-sciences-home-page/nc-fish-kill-activity/fish-kill-events, and NC Department of Environmental Quality 2015). In Florida, nutrient inputs, exacerbated by low flushing in the Indian River Lagoon, result in Harmful Algal Blooms (HABs) and, ultimately, menhaden kills (K. Smith, FL FWC, pers. comm.).

In recent years the menhaden population appears to be rebounding and expanding to reoccupy its historic geographic range. With more fish returning to areas heavily used and impacted by humans, the potential for fish kills increases. For example, in 2016, tens of thousands of menhaden were killed when a lock closure trapped them in the Shinnecock Canal in New York. As large numbers of menhaden start appearing in historic places, policies and practices should be adjusted to anticipate and avoid or minimize mortality events.

At one time, fish kills may have solely been a natural occurrence, but anthropogenic impacts to water quality and flow have certainly exacerbated the frequency and intensity of these mortality events. State efforts to track fish kills can provide information on patterns and trends. North Carolina, for example, instituted a fish kill investigation procedure in 1996 to collect and track fish kill information. Data is maintained in a central database and is reviewed as part of an effort to monitor water quality trends. As we better understand causes of fish kills, mediation and prevention policies and practices can be developed.

A growing body of literature is beginning to describe shifts in species distributions and spawning locations and seasons, possibly due to a changing climate on the Atlantic coast (e.g. Walsh et al. 2015, Kleisner et al. 2016). Menhaden ingress to estuaries is sensitive to changes in wind patterns and temperatures, which are known to be variable and may be influenced by climate change (Quinlan et al. 1999, Austin 2002). Moreover, nursery habitats within bays and estuaries are likely to be altered by the effects of climate change, in some cases potentially enhancing menhaden productivity and other cases resulting in lower production and recruitment. The effects of climate change are predicted to include: increased water temperatures, sea-level rise, and changes in precipitation patterns and climate variability (including increased storm and drought events), among other related phenomena (Sherman et al. 2009). These changes can influence salinity, temperature, and nutrients throughout nursery grounds.

In addition to long-term climate change, the Atlantic coast has also experienced shorter-term, decadal fluctuations in weather, shifting between cold-wet and warm-dry periods. Austin (2002) showed that the 1960s were warmer and wetter than the 1970s and 1990s in the Mid-Atlantic. Menhaden recruitment success tends to be relatively high in years when late winter-spring conditions are warm and dry (Wood 2000). Although menhaden recruitment has been correlated with the Atlantic Multidecadal Oscillation (Buchheister et al. 2016), the correlation between Chesapeake Bay and southern New England is reversed and the mechanisms of influence are unknown. The generally low recruitments of YOY menhaden in recent years appear to be constrained by frequent cool and wet winter-spring conditions that favor recruitment of anadromous spawners, but not offshore-spawning fishes such as menhaden (Kimmel et al. 2009). It is not certain whether climate change will have positive or negative impacts on the long-term abundance and productivity of menhaden.

1.4.5 Description of Programs to Protect, Restore, & Preserve Atlantic Menhaden Habitat

The federal Coastal Zone Management Act provides a framework under which individual coastal states have developed their own coastal habitat protection programs. In general, wholesale dredging and filling are not allowed. Individual development projects are subject to state and federal review and permit limitations. Every Atlantic coast state has a coastal habitat protection program in place (Table 11.27 in ASMFC 1992). These protection programs have greatly reduced the loss of vital coastal habitat to dredging and filling since the mid-1970s. Virtually all proposals affecting coastal habitat are now reviewed by a variety of local, state, and federal agencies, and wholesale destruction of coastal wetlands is rare. Many important estuarine habitats are now protected as part of various wildlife refuges, national and state parks, and public and private nature preserves. In addition, a federal permit program is conducted by the U.S. Army Corps of Engineers, generally in cooperation with the state programs. Every state also conducts water quality protection programs under the federal Clean Water Act. National Pollution Discharge Elimination System permits are required for point-source discharges.

Unfortunately, these programs provide much less control over non-point pollution, especially from agricultural and silvicultural activities, and excess nutrient inputs from diverse sources continue to contribute to hypoxic and anoxic conditions in estuarine menhaden habitat. A coast wide compilation and spatial analysis of menhaden mortality event data could be conducted to reveal patterns and trends. Additional work to more precisely define menhaden habitat parameters for all life stages and to develop accompanying map products is needed to inform diverse multi-agency and project applicant consultations and permitting processes so that further impacts to menhaden habitats are avoided or minimized.

1.5 IMPACTS OF THE FISHERY MANAGEMENT PROGRAM

1.5.1 Biological and Ecological Impacts

1.5.1.1 Reference Points

The adoption of ecosystem reference points (ERPs) will expand the focus of menhaden management from assessing the status of menhaden alone, to assessing the status of menhaden in relation to other prey and predator species. ERPs will seek to ensure maintenance of a forage base needed to support larger finfish (e.g. striped bass, bluefish, weakfish), coastal birds (e.g. osprey), and marine mammals (e.g. humpback whales). An ecosystem approach to setting reference points for menhaden may also increase the spawning biomass of the menhaden stock, promoting a higher stock abundance along the coast.

Continued use of the existing single-species reference points from the 2015 Stock Assessment will continue to provide a greater measure of sustainability than the reference points established in Amendment 2; however, these reference points consider the status of menhaden independent of other species. As a result, it is unclear if they are protecting a large enough forage base to support predator populations. Under the current reference points, the menhaden stock is not overfished and overfishing is not occurring.

1.5.1.2 Total Allowable Catch

Limiting menhaden catch through a Total Allowable Catch (TAC) is a way to maintain menhaden within in the limits of reference points. After the TAC is harvested in a given year, the directed fishing season closes. This allows for greater protection of the spawning biomass, as opposed to allowing fishing to continue without a TAC. If properly set and enforced, quotas will prevent overfishing and ensure a sustainable resource for the future. Maintenance of a sustainable resource will also increase the forage base of commercially and recreationally important predator species.

The intent of quota allocation under this Amendment is to identify a fair and equitable method through which to distribute quota to various fisheries, gear types and regions. An allocation method which addresses the needs of each user group and is flexible to respond to future changes in the fishery will provide stability for the fishery and resource. It may also reduce the need for other management tools, such as the incidental catch provision, which, under Amendment 2, allows for the harvest of menhaden outside of the TAC. Reducing harvest under the incidental catch provision will ensure a greater amount of harvest is counted towards the TAC and help support a sustainable resource.

1.5.1.3 Chesapeake Bay Reduction Fishery Cap

Maintenance of a Chesapeake Bay cap on the reduction fishery will ensure continued protection of this important nursery ground for menhaden. The cap prohibits harvest of menhaden by the reduction fishery when 100% of the cap has been reached. This protection helps support menhaden recruitment in the Bay and a forage base for predators in the Chesapeake Bay, such as striped bass.

The Chesapeake Bay Reduction Fishery Cap was originally implemented in 2005 to prevent localized depletion of menhaden. Given the concentrated harvest of menhaden within the Chesapeake Bay, there was concern regarding the potential for localized depletion. In 2005, the Board established the Atlantic Menhaden Research Program (AMRP) to evaluate the possibility of localized depletion. Results from the peer review report in 2009 were unable to conclude localized depletion is occurring in the Chesapeake Bay and 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”.

While the AMRP peer review report was not able to provide conclusive evidence that localized depletion is occurring, maintenance of the Chesapeake Bay reduction fishery cap does provide a greater level of protection in the region than the TAC alone.

1.5.1.4 Data Collection and Reporting Requirements
This Amendment requires states to implement timely quota monitoring programs so that the harvest of menhaden can stay within the TAC and the potential for overages is limited. Furthermore, purse seine or bait seine vessels are required to submit Captain’s Daily Fishing Reports on a daily basis, and states must collect biological samples relative to their level of harvest. This level of reporting is necessary for the implementation of a quota management system, as lengthy delays could lead to quota overages or premature closures of the fishery. Furthermore, continued biological sampling will increase knowledge on the stock’s age structure, improving the precision of menhaden abundance estimates in stock assessments.

1.5.2 Social and Economic Impacts

(Add text from Winnie and Andrew)

2.0 GOALS AND OBJECTIVES

2.1 HISTORY OF MANAGEMENT

The first coastwide fishery management plan (FMP) for Atlantic menhaden was passed in 1981 (ASMFC 1981). The 1981 FMP did not recommend or require specific management actions, but provided a suite of options should they be needed. After the FMP was approved, a combination of additional state restrictions, establishment of local land use rules, and changing economic conditions resulted in the closure of most reduction plants north of Virginia (ASMFC 1992). In 1988, the ASMFC concluded that the 1981 FMP had become obsolete and initiated a revision to the plan.

The 1992 Plan Revision included a suite of objectives to improve data collection and promote awareness of the fishery and its research needs (ASMFC 1992). Under this revision, the menhaden program was directed by the Board, which at the time was composed of up to five state directors, up to five industry representatives, one representative from the National Marine Fisheries Service, and on representative from the National Fish Meal and Oil Association.

Representation on the Board was revised in 2001 to include three representatives from each state in the management unit, including the state fisheries director, a legislator, and a governor's appointee. The reformatted Board has passed two amendments and six addenda to the 1992 FMP revision.

Amendment 1, passed in 2001, provided specific biological, social/economic, ecological, and management objectives for Atlantic menhaden. No recreational or commercial management measures were implemented as a result of Amendment 1.

Addendum I (2004) addressed biological reference points for menhaden, specified the frequency of stock assessments to be every three years, and updated the habitat section of the FMP.

Addendum II (2005) instituted a harvest cap on the reduction fishery in the Chesapeake Bay. This cap, based on average landings from 2000-2004 (see technical Addendum I), was established for the 2006 through 2010 fishing seasons. Addendum II also outlined a series of research priorities to examine the possibility of localized depletion of Atlantic menhaden in the Chesapeake Bay. They included: determining menhaden abundance in Chesapeake Bay; determining estimates of removal of menhaden by predators; exchanging of menhaden between bay and coastal systems; and conducting larval studies.

Addendum III (2006) revised the Chesapeake Bay Reduction Fishery Cap to 109,020 metric tons, which is an average of landings from 2001-2005. Implementation of the cap remained for the 2006 through 2010 fishing seasons. Addendum III also allowed a harvest underage in one year to be added to the next year's quota. As a result, the maximum cap in a given year was extended 122,740 metric tons.

Addendum IV (2009) extended the Chesapeake Bay harvest cap three additional years (2011-2013) at the same levels as established in Addendum III.

Addendum V (2011) establishes a new F threshold and target rate based on maximum spawning potential (MSP) with the goal of increasing abundance, spawning stock biomass, and menhaden availability as a forage species.

Amendment 2, approved in December 2012, established a 170,800 metric ton (mt) total allowable catch (TAC) for the commercial fishery beginning in 2013. This TAC represented a 20% reduction from average landings between 2009 and 2011. The 2009-2011 time period was also used to allocate the TAC among the jurisdictions. The Amendment also established requirements for timely reporting and required states to be accountable for their respective quotas by paying back any overages the following year. The amendment included provisions that allowed for the transfer of quota between jurisdictions and a bycatch allowance of 6,000 pounds per trip for non-directed fisheries that operated after a jurisdiction's quota has been landed. Further, it reduced the Chesapeake Bay reduction fishery harvest cap by 20% to 87,216 metric tons.

At its May 2015 meeting, the Board established a 187,880 mt TAC for the 2015 and 2016 fishing years. This represents a 10% increase from the 2013 and 2014 TAC. In October 2016, the Board approved a TAC of 200,000 mt for the 2017 fishing year, representing a 6.45% increase from the 2015 and 2016 fishing years.

In August 2016, the Board approved Addendum I which added flexibility to the current bycatch provision by allowing two licensed individuals to harvest up to 12,000 pounds of menhaden bycatch when working together from the same vessel using stationary multi-species gear. The intent of this Addendum was to accommodate cooperative fishing practices which traditionally take place in the Chesapeake Bay.

In May 2013, the Board approved Technical Addendum I which established an episodic events set aside program. This program set aside 1% of the coastwide TAC for the New England States (ME, NH, MA, RI, CT) to harvest Atlantic menhaden when they occur in higher abundance than normal. In order to participate in the program, a state must have reached its individual quota prior to September 1 before harvesting from the set aside. At its October 2013 meeting, the Board extended the episodic event set aside program through 2015, adding a re-allocation provision that re-allocated unused set aside as of October 31 to the coastwide states based on the same allocation percentages included in Amendment 2. At its May 2016 meeting, the Board again extended the episodic events program until final action on Amendment 3 and added New York as an eligible state to harvest under the program.

At its February 2014 meeting, the Board passed a motion to manage cast net fisheries for Atlantic menhaden under the bycatch allowance for 2014 and 2015, with the states bearing responsibility for reporting. At its November 2015 meeting, the Board approved a motion to continue the management of cast net fisheries under the bycatch allowance for 2016. In February 2017, the Board extended management of the cast net fishery under the bycatch provision until implementation of Amendment 3.

2.2 PURPOSE AND NEED FOR ACTION

The 2015 Atlantic Menhaden Benchmark Stock Assessment and Peer Review Report categorized the development of ERPs as a high priority for management of the species. Currently, the stock is assessed with single-species biological reference points, which were defined in the 2015 Stock Assessment. 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. In addition, Amendment 2 requires quota allocations to be revisited every three years. The Atlantic menhaden quota is currently allocated to Atlantic coast jurisdictions based on 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. In order to pursue the implementation of ERPs as well as changes to the allocation method and timeframe, the Board needs to consider changes in the management tools used to regulate the fishery.

2.3 GOAL

Amendment 3 to the Interstate Fishery Management Plan for Atlantic Menhaden replaces Amendment 2 to the 1981 FMP for Atlantic Menhaden.

The goal of Amendment 3 is to manage the Atlantic menhaden fishery in a manner which equitably allocates the resource between all user groups, including those who extract and utilize menhaden for human use, predators which rely on menhaden as a source of prey, and those whose livelihood depends on the health of the marine ecosystem. This will require holistic management and allocation of the resource that is biologically, economically, and socially sound in order to protect the resource and those who benefit from it.

2.4 OBJECTIVES

The following objectives are intended to support the goal of Amendment 3.

- Maintain the Atlantic menhaden stock at levels which sustain viable fisheries and support predators which depend on the forage base.
- Ensure sufficient menhaden spawning stock biomass to prevent stock depletion and recruitment failure.
- Construct regulations based on the best available science and coordinate management efforts among the Atlantic coast jurisdictions.
- Develop a management program which ensures fair and equitable access to the fishery for all regions and gear types.
- Improve understanding of menhaden biology and multi-species interactions that may bear upon predator-prey dynamics.
- Maintain existing culture and social features of the fishery to the extent possible.

2.5 MANAGEMENT UNIT

The management unit for Amendment 3 is defined as the range of Atlantic menhaden within U.S. waters of the northwest Atlantic Ocean, from the estuaries eastward to the offshore boundary of the Exclusive Economic Zone (EEZ). This definition is consistent with recent stock assessments which treat the entire resource in U.S. waters of the northwest Atlantic as a single stock.

2.5.1 Management Area

The management area for Amendment 3 shall be the entire Atlantic coast distribution of the resource from Maine through Florida.

2.6 REFERENCE POINTS

2.6.1 History of Reference Points

2.6.1.1 Amendment 1 Reference Points

The reference points in Amendment 1, adopted in 2001, were developed from the historic spawning stock per recruit (SSB/R) relationship. As such, F_{MED} was selected as $F_{threshold}$ (representing replacement level of stock, also known as F_{REP}) and was calculated by inverting the median value of R/SSB and comparing to the SSB/R curve following the method of Sissenwine and Shepherd (1987). The spawning stock biomass corresponding to $F_{threshold}$, was calculated as a product of median recruitment and SSB/R at F_{MED}, from equilibrium YPR analysis, which became the SSB_{target}. The threshold for SSB ($SSB_{threshold}$) was calculated to account for natural mortality [(1-*M*)*SSB-target, where *M*=0.45]. In Amendment 1, the F_{target} was based on F_{MAX} (maximum fishing mortality before the process of recruitment overfishing begins).

2.6.1.2 Addendum 1 Reference Points

Based on the 2003 benchmark stock assessment for Atlantic menhaden, the reference points were modified per the recommendation of the Technical Committee (TC) (ASMFC 2004). The TC recommended using population fecundity (number of maturing or ripe eggs) as a more direct measure of reproductive output of the population compared to spawning stock biomass (the weight of mature females). For Atlantic menhaden, older menhaden release more eggs than younger menhaden per unit of female biomass. By using the number of eggs released, more reproductive importance is given to older fish in the population. The TC also recommended modifications to the fishing mortality (*F*) target and threshold. Specifically, the TC recommended continued use of F_{MED} to represent F_{REP} as the $F_{threshold}$, but estimated it using fecundity per recruit rather the SSB per recruit. Because the analysis calculated an F_{MAX} (target) that was greater than *F*MED (and may be infinite), they recommended instead that F_{target} be based on the 75th percentile. This approach was consistent with the approach used for the $F_{threshold}$. For biomass (or egg) benchmarks, the TC recommended maintaining the approach used in Amendment 1.

2.6.1.3 Addendum V Reference Points

In November 2011, Addendum V was approved, which established an interim fishing mortality threshold of $F_{15\%MSP}$ and target of $F_{30\%MSP}$.

2.6.1.4 Amendment 2 Reference Points

The Board adopted an interim biomass threshold of $SSB_{30\%MSP}$ and target of $SSB_{30\%MSP}$ to match the interim fishing mortality reference points adopted through Addendum V.

2.6.1.5 2015 Benchmark Stock Assessment Reference Points

As a part of the 2015 Stock Assessment, the TC recommended that the Board adopt SPR reference points based on the maximum of the geometric mean F value experienced by ages 2 to 4 during the 1960-2012 time period as the threshold, and the median geometric mean F value experienced by ages 2 to 4 during the 1960-2012 time period as the target, along with the associated FEC values. The 1960-2012 time period represents a time with little to no restrictions on total harvest in which the population appears to have been sustainable given that the population did not experience collapse. Because the fisheries have dome-shaped selectivity, which varies by fleet over time, the age at full fishing mortality changes over time. Ages 2 to 4 represent the ages of fully selected fishing mortality rates depending upon the year and fishery (i.e., bait and reduction). Using these metrics, the maximum F experienced was $F_{26\%}$ = 1.26, and the median was $F_{57\%}$ = 0.38. The associated FEC reference points would be $FEC_{26\%}$ = 86,821 and $FEC_{57\%}$ = 189,270 (billions of eggs). The Board accepted these updated reference points following approval of the 2015 Stock Assessment for management use.

2.6.2 ASMFC Multi-Species Management Efforts

At the May 2010 Board meeting, the Multi-Species Technical Committee (MSTC) was tasked with collaborating with the Atlantic Menhaden TC to develop alternative reference points for menhaden that account for predation. These groups led to a reformation of the subcommittee that updated and refined the Multispecies Virtual Population Analysis (MSVPA). The MSPVA-X model generates a natural mortality matrix which can be input to the single-species menhaden assessment. While this approach was attempted for several Atlantic menhaden stock assessments, the Board tasked this group with developing ecological reference points (ERPs) for menhaden using multispecies models. This joint subcommittee was eventually renamed the Biological Ecological Reference Points Workgroup (BERP Workgroup) because model consideration for the Board task expanded beyond the MSVPA. The overarching goal of the BERP Workgroup is to develop menhaden-specific ecosystem reference points that account for the abundance of menhaden and the species role as a forage fish.

In the *Ecological Reference Points for Atlantic Menhaden* report, the BERP Workgroup presented suite of preliminary ERP models and ecosystem monitoring approaches for feedback as part of the 2015 Benchmark Stock Assessment (Appendix E, SEDAR 40 Stock Assessment Report). In this report, the BERP Workgroup recommended the use of facilitated workshops to develop specific ecosystem and fisheries objectives to drive further development of ERPs for Atlantic menhaden. This Ecosystem Management Objectives Workshop (EMOW) contained a broad range of representation including Commissioners, stakeholder representatives, and technical representatives to provide various perspectives on Atlantic menhaden management. The EMOW identified potential ecosystem goals and objectives that were reviewed and approved by the Board. The BERP Workgroup then assessed the ability of each preliminary ERP model to address EMOW-identified management objectives and performance measures, and selected models accordingly.

Currently, the BERP Workgroup is evaluating this suite of multispecies models to ensure they are able to generate ERPs which meet as many management objectives as possible. Some of the models under consideration are a Bayesian surplus production model with a time-varying population growth rate. This model estimates the trend in total Atlantic menhaden stock biomass and fishery exploitation rate by allowing the population growth rate to fluctuate annually in response to changing environmental conditions. The approach produces dynamic, maximum sustainable yield-based ecological reference points that implicitly account for the forage services menhaden provide. Another production model being evaluated by the BERP Workgroup is a Steele-Henderson model. This type of Steele-Henderson modeling permits non-fisheries effects (predation and environmental) to be quantified and incorporated into the single species stock assessments, allowing fixed and non-equilibrium (time-varying) ecological overfishing thresholds to be established. This approach is not intended to replace more complex multispecies ecosystem assessment models, but rather to expand the scope of the single species assessments to include the separate and joint effects of fishing, predation and environmental effects at the fish community level. Finally, a multispecies statistical catch-at-age modeling framework is being considered. This model uses standard statistical catch-at-age techniques and single species models are linked using trophic calculations to provide a predator-prey feedback between the population models. The statistical framework is believed to be an improvement from the existing MSVPA because using statistical techniques may help to estimate many of the model parameters while incorporating the inherent uncertainty in the data. An external model being considered is an Ecopath with Ecosystem model, however the application of this model is for strategic planning (to explore tradeoffs), not quota setting advice. The model is flexible and able to explore additional menhaden relevant scenarios, ERPs, and questions. This model could be used to evaluate the other models being developed.

The development of menhaden-specific ERPs is expected to continue over the next couple of years. In 2017, the BERP Workgroup will finish their review of the merits of each modeling approach currently being considered and decide which models are appropriate frameworks for menhaden ERPs. In 2018, the BERP Work Group will hold data workshops to collect, select, and standardize the data that will be input into the models. This will include data that pertains not only to menhaden abundance but also the abundance of species such as bluefish, striped bass, and other prey species. In early 2019, assessment workshops will be held to review preliminary model results and in the fall of 2019, the multi-species models will be peer-reviewed, along with the current single-species model, which has traditionally been used for menhaden management. This will allow for direct comparison between the two modeling approaches. Table 19 outlines the current schedule for the BERP Workgroup.

2.6.3 External Guidelines for Forage Fish

In addition to the menhaden-specific ecosystem reference points which are being developed by the BERP Workgroup, there also exists precautionary guidelines on developing ERPs for forage fish. These guidelines are based on a series of models which look at a variety of forage fish species across diverse ecosystems. An advantage of these guidelines is that they are readily available for use and provide a precautionary approach to the management of forage fish. However, given they are based on a variety of species and regions, the guidelines are not specific to the Atlantic menhaden stock and, as a result, make generalizations regarding stock recruit relationships and the prevalence of menhaden in predator diets.

One guideline for the management of forage fish species is the 75% rule-of-thumb, which recommends that forage fish populations be maintained at three-fourths of their unfished biomass levels in order to lower impacts on marine ecosystems (Smith et al., 2011). The peer-reviewed analysis investigated five regions around the world to determine the ecosystem impacts of fishing low trophic level species. The analysis found that, while results varied among forage fish species, in general, the proportion of ecological groups impacted increased with depletion of the forage fish. Relative abundance of the forage fish species in comparison to other prey species and food web connectivity were found to be important factors in determining the level of impact on other ecological groups. The study concluded that a target of 75% unfished biomass for forage fish species would reduce impacts on other species while maintaining fisheries yields at roughly 80% of their current levels. Menhaden was not a species included in this study.

The Lenfest Ocean Program, a grant-making program managed by The Pew Charitable Trusts, has also developed guidelines for the development of forage fish ERPs. In their 2012 report by Pikitch et al., Lenfest describes how they used a suite of 10 previously published Ecopath with Ecosim models to assess the impacts of forage fish harvest on a variety of ecosystems. The Chesapeake Bay was a region modeled in this analysis. Various management strategies which specify fishing mortality were run in the Ecopath with Ecosim models to determine impacts on predator populations. From these results, a general equation was developed to predict predator responses to forage fish harvest. The analysis recommends a hockey stick 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. This report has not been peer-reviewed.

2.6.4 Definition of Overfishing and Overfished/Depleted

The Board will evaluate the current status of the Atlantic menhaden stock with respect to its reference points. Changes to the reference points can be made through Board action following a peer-reviewed stock assessment or through Adaptive Management (*Section 4.6*). The Board can adopt any advice of the stock assessment report or peer review report.

Threshold reference points are the basis for determining stock status (i.e., whether overfishing is occurring or if a stock is overfished). When the fishing mortality rate (F) exceeds the F-threshold, then overfishing is occurring. This means that the rate of removal of fish by the fishery exceeds the ability of the stock to replenish itself. When the biomass or reproductive output (measured as population fecundity) falls below the threshold, then the stock is overfished, meaning there is insufficient mature female biomass or egg production (population fecundity) to replenish the stock.

Reference points will direct the Board on when additional management measures are needed in the menhaden stock. If the current F exceeds the threshold level, the Board will take steps to reduce F to the target level. If current F exceeds the target, but is below the threshold, the Board should consider steps to reduce F to the target level. If current F is below the target F, then no action would be necessary to reduce F. Similarly, if the current biomass/fecundity is below the threshold level, the Board will take steps to increase biomass/fecundity to the target level; if current biomass/fecundity is below the target, but above the threshold, the Board should consider steps to increase biomass/fecundity to the target level. If current biomass/fecundity is above the target biomass/fecundity, then no action would be necessary to increase biomass/fecundity.

Option A: Single Species Reference

Single-species reference points are used to manage the Atlantic menhaden fishery. The fishing mortality target and threshold for Atlantic menhaden is $F_{57\%MSP}$ (0.38) and $F_{26\%MSP}$ (1.26) and the corresponding fecundity target and threshold for Atlantic menhaden is $FEC_{57\%MSP}$ (189,270 billion eggs) and $FEC_{26\%MSP}$ (86,821 billion eggs). As of the terminal year of the 2015 Benchmark Stock Assessment, the stock is not overfished and overfishing is not occurring. Under this option, the development of ERPs would not be pursued.

Option B: Menhaden-Specific ERPs with Interim Use of Single Species Reference Points

Under this option, single-species reference points would be used to manage the Atlantic menhaden fishery until menhaden-specific ERPs are developed by the BERP Workgroup. The fishing mortality target and threshold for Atlantic menhaden would be $F_{57\%MSP}$ (0.38) and $F_{26\%MSP}$ (1.26) and the corresponding fecundity target and threshold for Atlantic menhaden would be $FEC_{57\%MSP}$ (189,270 billion eggs) and $FEC_{26\%MSP}$ (86,821 billion eggs). As of the terminal year of the 2015 Benchmark Stock Assessment, the stock is not overfished and overfishing is not occurring.

Option C: Menhaden-Specific ERPs with Interim Use of 75% Rule of Thumb

Option D: Menhaden-Specific ERPs with Interim Use of Pikitch et al. Reference Points

Option E: Menhaden-Specific ERPs with Interim Use of 75% Target, 40% Threshold

(Add text regarding reference point management alternatives)

2.6.4 Stock Rebuilding Program

If it is determined that the Atlantic menhaden resource is experiencing overfishing or has become overfished, the Board will initiate and develop a rebuilding schedule.

3.0 MONITORING PROGRAM SPECIFICATION

In order to achieve the goals and objectives of Amendment 3, the collection and maintenance of quality data is necessary.

3.1 COMMERCIAL CATCH AND LANDINGS PROGRAM

The reporting requirements for the Atlantic menhaden fishery are based on Captains Daily Fishing Reports (CDFRs) and a Board approved method for timely quota monitoring (*Section 3.1.2*). The ASMFC, NMFS, US Fish & Wildlife Service, the New England, Mid-Atlantic, and South Atlantic Fishery Management Councils, and all the Atlantic coastal states have developed a coastwide fisheries statistics program called the Atlantic Coastal Cooperative Statistics Program. A minimum set of reporting requirements for fishermen and dealers has been developed as the standard for data collection on the Atlantic coast.

3.1.1 Reduction Fishery Catch Reporting Process

Daily vessel unloads (in thousands of standard fish) are emailed to the NMFS each day. Harvest by the Reedville menhaden fleet is reported through Captains Daily Fishing Reports (CDFRs), which are deck logbooks that are maintained by the Virginia reduction purse-seine vessels. CDFRs are an important tool to monitor reduction harvest in the Chesapeake Bay so that harvest does not exceed the Chesapeake Bay Reduction Fishery Cap (*Section 4.3.7*).

Total removals by area are calculated at the end of the fishing season. At-sea catches from the CDFRs are summed by vessel, and compared to total vessel unloads from company catch records. Individual at-sea sets are then multiplied by an adjustment factor (company records/ at-sea estimates). Adjusted catches by set are converted to metric tons, and accumulated by fishing area. Catch totals are reported by ocean fishing areas, while catches inside and outside Chesapeake Bay are delineated by the Chesapeake Bay Bridge Tunnel.

A NMFS port agent samples purse-seine catches at dockside in Reedville, VA throughout the fishing season (May through December) providing data for age composition determination.

3.1.2 Bait Fishery Catch Reporting Process

Quota monitoring, whether for a state, region, coast, season, fleet, or sector is dependent upon the strength of state specific monitoring programs. As a part of Amendment 2, each states was required to implement a timely quota monitoring system in order to maintain menhaden harvest within the TAC and minimize the potential for overages. Table 20 outlines the current reporting requirements of each jurisdiction.

In order to monitor the menhaden quota allocations prescribed in Amendment 3, states must, at a minimum, maintain the current quota monitoring system in place. States must require menhaden purse seine and bait seine vessels (or snapper rigs) to submit CDFR’s or similar daily trip level reports. Mandatory reporting requirements will be reviewed as a part of the annual fishery review (*Section 5.3 Compliance Reports*). States which habitually exceed their quota should assess the effectiveness of their current reporting program and make changes as necessary (e.g. Increase the frequency of reporting). It is recommended that states collect the following ACCSP data elements: (1) trip start date (2) vessel identifier (3) individual fisherman identifier (4) dealer identification (5) trip number (6) species (7) quantity (8) units of measurement (9) disposition (10) county or port landed (11) gear (12) quantity of gear (13) number of sets (14) fishing time (15) days/hours at sea (16) number of crew (17) area fished. See Tables 21 and 22 for details on these data elements.

If an allocation method is implemented which does not have a jurisdictional component, states must work to report landings via the Standard Atlantic Fisheries Information System (SAFIS). Specifically, menhaden landings must be reported through SAFIS so that regional, fleet, sector, or coastwide quotas may be monitored in near real-time. SAFIS is an electronic platform which allows fishermen and dealers to submit commercial landings reports into a single database. This system, which meets ACCSP data standards, allows managers to monitor landings and appropriately respond when a quota is met. It also fulfils state and federal reporting requirements, and allows fishermen and dealers to access previous data submissions. Should SAFIS be implemented, trip-level reports may be submitted on a weekly basis, but no later than 5 days after landing. States may choose to implement either a one ticket or two ticket system; however, all reports must include: date, species landed, quantity landed, units of measure, disposition (bait or reduction), state landed, and gear type. If a state is unable to implement SAFIS reporting by the start of the 2018 fishing year, that state must submit weekly landings reports to ASMFC so that a regional, fleet, sector, or coastwide quota may be monitored in 2018. All states must implement SAFIS reporting by 2019. Per *Section 4.5.3.1*, New Hampshire, South Carolina, and Georgia are exempt from timely quota monitoring and are not required to report through SAFIS.

Any changes to a state's current quota monitoring program must be reviewed by the PDT and approved by the Board.

3.1.2.1 Incidental Catch Reporting
Landings of menhaden under *Section 4.3.5: Incidental Catch and Small Scale Fisheries* must be reported through the timely reporting system specified in Section 3.1.2.

3.1.2.2 Episodic Events Reporting
States participating in the Episodic Events Program (*Section 4.3.6*) must implement daily trip level harvester reporting. Each state must track landings and submit weekly reports to ASMFC staff.

3.2 RECREATIONAL FISHERY CATCH REPORTING PROCESS

The Marine Recreational Information Program (MRIP) contains estimated Atlantic menhaden catches from 1981-2016. Recreational harvest of menhaden was previously collected through the Marine Recreational Fisheries Statistics Survey (MRFSS), which was a recreational data collection program used from 1981-2003. The MRFSS program was replaced by MRIP in 2004

DRAFT

and was designed to provide more accurate and timely reported as well as greater spatial coverage. The MRFSS and MRIP programs were simultaneously conducted in 2004-2006 and this information was used to calibration MFRSS recreational harvest estimates to MRIP recreational harvest estimates. Recreational catches of menhaden were downloaded from http://www.st.nmfs.noaa.gov/st1/recreational/queries/index.html using the query option.

An online description of MRIP survey methods can be found here: http://www.st.nmfs.noaa.gov/recreational-fisheries/index#meth

3.3 FOR-HIRE FISHERY CATCH REPORTING PROCESS

ACCSP standards allow for the use of MRIP for-hire sampling or a census system such as ACCSP's eTrips. For-hire sampling provides data by period, but eTrips can provide data within a 24-hour period.

3.4 SOCIAL AND ECONOMIC COLLECTION PROGRAMS

(Add text from Winnie and Andrew)

3.5 BIOLOGICAL DATA COLLECTION PROGRAMS

3.5.1 Fishery-Dependent Data Collection

3.5.1.1 Reduction Fishery

The Beaufort Laboratory of the Southeast Fisheries Science Center (NMFS) conducts biological sampling of the Atlantic menhaden reduction fishery (Smith 1991). The program began preliminary sampling in the Mid-Atlantic and Chesapeake Bay areas during 1952-1954 and has continued uninterrupted since 1955, sampling the entire range of the Atlantic menhaden purse-seine reduction fishery. Detailed descriptions of the sampling procedures and estimates gathered through the program are cited in Smith (1991).

The biological data, or port samples, for length- and weight-at-age are available from 1955 through 2016, and represent one of the longest and most complete time series of fishery data sets in the nation. The NMFS employs a full-time port agent at Reedville, VA to sample catches throughout the fishing season for age and size composition of the reduction catch (Table 23).

3.5.1.2 Bait Fishery

<u>10 Fish Sampling</u>

Each state in the New England (ME, NH, MA, RI, CT) and Mid-Atlantic (NY, NJ, DE) regions are required to collect one 10-fish sample (age and length) per 300 metric tons landed for bait purposes. The TC recommends collecting the samples by gear type. One 10-fish sample consists of 10 fish collected from a distinct landing event (e.g., purse seine trip, pound net set). Each collection of 10 fish is from an independent sampling event; therefore, multiple 10-fish samples should not be collected from the same landing event.

Each state in the Chesapeake Bay (MD, PRFC, VA) and South Atlantic (NC) regions are required to collect one 10-fish sample (age and length) per 200 metric tons landed for bait purposes. The TC recommends collecting the samples by gear type. One 10-fish sample consists of 10 fish collected from a distinct landing event (e.g., purse seine trip, pound net set). Each collection of 10 fish is an independent sampling event; therefore, multiple 10-fish samples should not be collected from the same landing event.

Table 24 shows the number of 10-fish samples collected by the jurisdictions in 2016 as well as the number of age and length samples collected.

Pound Net Monitoring

Catch information from pound net fisheries is critical to determine changes in the relative abundance of adult menhaden along the east coast. At a minimum, each state with a pound net fishery must collect catch and effort data elements for Atlantic menhaden including total pounds (lbs) landed per day and number of pound nets fished per day. A pound net fishery includes floating fish traps and fishing weirs. These are harvester trip level ACCSP data requirements. In order to characterize selectivity of this gear in each state, a goal of collecting five 10-fish samples annually is recommended. One 10-fish sample consists of 10 fish collected from a distinct landing event (e.g., pound net set). Each collection of 10 fish is an independent sampling event; therefore, multiple 10-fish samples should not be collected from the same landing event.

3.5.2 Fishery-Independent Data Collection

Assessment of the Atlantic menhaden stock requires information from a variety of fishery-independent surveys along the coast. As a part of the 2015 Stock Assessment, sixteen fishery-independent surveys were used to create a Juvenile Abundance Index, seven surveys were used to create a Northern Adult Index, and two surveys were used to create a Southern Adult Index. For many of the surveys used, the primary objective is to measure the abundance of species other than menhaden; however the bycatch of menhaden in these surveys can provide important information regarding stock conditions. Table 25 shows the surveys used to assess the status of Atlantic menhaden in the 2015 Stock Assessment.

3.5.3 Observer Programs

As a condition of state and/or federal permitting, vessels are required to carry at-sea observers when requested. A minimum set of standard data elements are to be collected through the ACCSP at-sea observer program (refer to the ACCSP Program Design document for details). Specific fisheries priorities will be determined by the Discard/Release Prioritization Committee of the ACCSP.

3.6 ASSESSMENT OF STOCK CONDITION

An Atlantic menhaden stock assessment will be performed every three years by the Stock Assessment Subcommittee (SASC). The TC and Advisory Panel (AP) will meet to review the stock assessment and all other relevant data sources. The stock assessment report shall follow the general outline as approved by the ISFMP Policy Board for all Commission-managed species. In addition to the general content of the report as specified in the outline, the stock assessment report will also address the specific topics detailed in the following sections.

3.6.1 Assessment of Population Age/Size Structure

Estimates of Atlantic menhaden age and size structure will be monitored based on results of the stock assessment. Improvements to data sources and modeling assumptions during the 2015 benchmark stock assessment, such as increased sampling of the bait fishery, addition of several surveys, and incorporation of dome shaped selectivity, greatly improved the understanding of size and age distribution of the menhaden stock.

3.6.2 Assessment of Annual Recruitment

Recruitment of Atlantic menhaden will be estimated through two primary methods. The first is the estimate of recruitment to age-1 from the stock assessment model. The second is the examination of various fishery-independent data sources, including the juvenile abundance indices that are integrated in to the statistical modeling process.

3.6.3 Assessment of Fecundity

Population fecundity, a measure of total egg production output of the population, is estimated from the stock assessment model every three years. Indices of egg production are considered better measures of reproductive output of a stock given that egg production is not linearly related to female weight. Additionally, fecundity better emphasizes the important contribution of older and larger individuals to the population’s egg production.

3.6.4 Assessment of Fishing Mortality

Fishing mortality (F) rates will be estimated by the stock assessment model every three years. Fishing mortality will be estimated for each age-class for examination, but the metric used for comparison to the reference point values will be full F, or the comprehensive fishing mortality rate for all ages of the entire coastwide stock. Currently, fishing mortality rates are estimated for the reduction fishery, the bait fishery, and the recreational fishery.

3.7 STOCKING PROGRAM

Given the current technology, stocking of menhaden is not cost-effective and should not be considered as a management tool.

4.0 MANAGEMENT PROGRAM

4.1 RECREATIONAL FISHERY MANAGEMENT MEASURES

No recreational fishery management measures are proposed in this amendment. Recreational landings of Atlantic menhaden are currently believed to be insignificant in terms of total harvest. Therefore, regulation of the recreational fishery is unnecessary at this time. The Board has the option of considering management changes to the recreational fishery through a future addendum, as detailed in Adaptive Management (*Section 4.6*).

4.2 FOR-HIRE FISHERIES MANAGEMENT MEASURES

No management measures for the for-hire fisheries are proposed in this amendment. The Board has the option of considering management changes to the recreational fishery through a future addendum, as detailed in Adaptive Management (*Section 4.6*).

4.3 COMMERCIAL FISHERY MANAGEMENT MEASURES

4.3.1 Total Allowable Catch

The Board will set an annual or multi-year TAC based on the following procedure.

The Atlantic Menhaden TC will annually review the best available data including, but not limited to, commercial and recreational catch/landing statistics, current estimates of fishing mortality, stock status, survey indices, assessment modeling results, and target mortality levels. The TC will calculate TAC options based on the Board selected method of setting a TAC (see *Section 4.3.1.1*). The Board will set an annual TAC through Board action with the option of setting a multi-year TAC, reviewed annually.

4.3.1.1 TAC Setting Method

The Board will set the TAC based on the best available science (e.g., projection analysis); however, if the projections are not recommended for use by the TC, the Board will set a quota based on the ad-hoc approach used by the Regional Fishery Management Councils (ORCS 2011).

<u>Ad-hoc Approach to Setting a TAC</u>

As an alternative to using projections to set TACs, ad hoc approaches are used by several regional Fishery Management Councils for species with poor assessment data or uncertain stock assessment results. Typically, in these situations, most Councils use their landings/catch data as the only reliable means of setting harvest limits. A document entitled “Calculating Acceptable Biological Catch for Stocks that have reliable Catch Data Only (Only Reliable Catch Stocks – ORCS)” was recently published, and serves as guidance to set interim removal levels under these conditions (ORCS 2011).

To summarize the ORCS report; generally an average of the last 3-5 years of landings are used as this reflects recent history. A precautionary multiplier is then applied to decrement the average landings and set a harvest limit. The appropriate multiplier is cautiously decided based on factors such as life history, ecological function, stock status, and an understanding of exploitation. Typically this multiplier can range from 0.85 to 0.25 (Table 26).

In the New England approach for Atlantic herring and red crab, the multiplier was chosen at 1.0 suggesting catch be maintained at current levels. The rationale was that the stock was not overfished and overfishing was not likely to be occurring. Other evidence, such as size at age, also indicated that the overall stock status was good. Further, landings were well monitored and discards of the target stock were low.

In the case of the Pacific Fishery Management Council the multiplier for coastal pelagics was set at 0.25. This number reflected the importance of herring as forage for stellar Sea Lions and other endangered mammals, the high level of exploitation, and the fact that Pacific Herring spawn in discreet and vulnerable aggregations (when they are targeted by the fishery).

It should be noted that the multiplier is never set at a value greater than 1.0; indicating that catch should not be allowed to increase in these uncertain situations. Table 27 provides some additional decision making framework information that goes into the choice of a multiplier.

4.3.1.2 Indecision Clause

If the Board is unable to approve a TAC for the subsequent fishing year by December 31st of the previous year, the TAC for the subsequent fishing year will be set at one half of the TAC from the previous year.

4.3.2 Quota Allocation

The Board must determine how to allocate the TAC among the different participants in the menhaden fishery. Once an allocation has been harvested, the fishery for that state, coast, season, region, sector, or fleet closes. Menhaden harvest for specific gear types or states may be permitted after an allocation has been reached, depending on the management options selected in *Section 4.3.5: Incidental Catch* and *Section 4.3.6: Episodic Events Set Aside Program*.

To account for the various combinations of allocation methods and timeframes, the management alternatives have been divided into three tiers. A management alternative must be selected in each tier to compile a single allocation method. The first tier asks whether allocation should be divided by sector, fleet, season, be based on the TAC level, or none of the above. The second tier asks if allocation should be further divided among jurisdictions or regions. The third tier asks which allocation timeframe should be used as the basis for the allocation methods. Allocation percentages for the various options can be found in Tables 1-12.

Should quota not be allocated by jurisdiction, states will be required to submit trip-level reports to SAFIS for near real-time monitoring of the quota. See *Section 3.1.2 Bait Fishery Catch Reporting Process* for additional information.

Tier 1: Allocation Based on Disposition, Fleet, Season, TAC Level, or None of the Above
The allocation strategy selected in this tier will decide if the fishery will be divided by sector (bait and reduction), fleet, season, if allocation should be based on TAC level, or if none of these options should be used. The TAC may be further subdivided in Tier 2.

Option A: Status Quo
The TAC is not divided by disposition, fleet, or season and the allocation strategy does not depend on the level of TAC. Any division of the quota by jurisdiction or region is considered in Tier 2.

Option B: Disposition Quota
Menhaden commercial TAC is divided between the bait and reduction fishery. The only current reduction fishery is located in Virginia. The bait allocation can be further divided by jurisdiction or region in Tier 2; however, the reduction fishery quota allocation will be assigned to Virginia or any region in which Virginia is placed. Should the bait quota not be further divided into jurisdictional quotas, SAFIS will be used to monitor landings in season. Once 80% of the bait allocation is reached (as indicated through SAFIS), a trip limit of 25,000 pounds will be implemented in the bait sector. A fisherman cannot land menhaden more than once in a single calendar day. The bait fishery will close when 95% of the allocation has been reached (as indicated through SAFIS) in order to minimize overages by the sector. Trip limits, a required fishery closure when 95% of the allocation has been reached, and reporting through SAFIS do not apply if disposition quotas are further allocated by state.

Sub-option 1: Seventy percent of the overall Menhaden commercial TAC is allocated to the reduction fishery, and 30% of the overall TAC is allocated to the bait fishery. For reference, 30% of 200,000 metric tons is 60,000 mt or roughly 132 million pounds.

Sub-option 2: The percentage of menhaden commercial TAC allocated to the reduction fishery and the bait fishery is dependent on historical landings from one of the timeframes selected in Tier 4 (Table 1).

Option C: Fleet-Capacity Quota
Menhaden commercial TAC is divided by fleet capacity without regard to the disposition of the catch. Allocations to each fleet can be further divided by jurisdiction or region in Tier 2. In addition, each fleet's fishery will be closed when 95% of the quota is reported to be caught (as indicated through SAFIS). This fishery closure, as well as reporting through SAFIS, do not apply if fleet-capacity quotas are further allocated by state or if a fleet is operating under a soft cap. If a fleet-capacity allocation method is chosen, a small-scale fishery set aside (Option E) in *Section 4.3.6 Incidental Catch and Small Scale Fisheries* does not apply.

If a soft cap is chosen below, states will continue to monitor landings by gear types in the small-capacity fleet. Landings by gears subject to a soft cap will be reported to the Board as a part of the annual FMP Review (*Section 5.3: Compliance Report*). Should a gear type subject to a soft quota show a continued and significant increase in its proportion of landings relative to total landings in the fishery, the Board has the authority, through adaptive management, to reduce an existing trip limit or re-assign that gear type to another fleet.

<u>Sub-option 1: Two Fleets Based on Gear Type</u>

Quota is divided between two fleets (Table 2) which are defined as:

- Small-Capacity Fleet: cast net, traps (excluding floating fish traps), pots, haul seines, fyke nets, hook and line, trawls (excluding pair trawls), bag nets, hoop nets, hand lines, trammel nets, bait nets, pound nets, anchored/staked gill nets, drift gill nets, fishing weirs, and floating fish traps. Between 2007 and 2016, this fleet caught, on average, 5.16% of total landings in the commercial fishery.
- Large-Capacity Fleet: purse seines and pair-trawls. Between 2007 and 2016, this fleet caught, on average, 94.84% of total landings in the commercial fishery.

<u>Sub-option A:</u> All fleet quotas are hard caps, in which all fisheries within a fleet are closed when the quota is met.

<u>Sub-option B:</u> The Small-Capacity fleet operates on a soft cap, in which the fisheries within the Small-Capacity-fleet do not close. All gears in the small-capacity fleet operate under a 25,000 pound trip limit per day throughout the fishing year. The Large-Capacity fleet quota is a hard cap, in which all fisheries within the Large-Capacity fleet are closed when 95% of the quota is reported to be caught. There is no trip limit for the large-capacity fleet. If this option is chosen, the management alternatives in *Section 4.3.6 Incidental Catch and Small Scale Fisheries* do not apply.

<u>Sub-option 2:</u> Three Fleets Based on Gear Type

The commercial TAC is divided between three fleets (Table 3) which are defined as:

- Small-Capacity Fleet: cast net, traps (excluding floating fish traps), pots, haul seines, fyke nets, hook and line, bag nets, hoop nets, hand lines, trammel nets, and bait nets.
- Medium-Capacity Fleet: pound nets, anchored/staked gill nets, drift gill nets, fishing weirs, floating fish traps, trawls (excluding pair trawls), stop seines, and purse seines which have a capacity of no more than 120,000 lbs of menhaden.
- Large-Capacity Fleet: pair trawls and purse seines which have a capacity of more than 120,000 lbs of menhaden.

<u>Sub-option A:</u> All fleet quotas are hard caps, in which all fisheries within a fleet are closed when the quota is met.

<u>Sub-option B:</u> The Small-Capacity fleet operates on a soft cap, in which the fisheries within the Small-Capacity-fleet do not close. Gears in the small-capacity fleet operate under a 10,000 pound trip limit per day throughout the fishing year. The Large-Capacity and Medium Capacity fleet quotas are hard caps, in which all fisheries within each fleet

are closed when 95% of the quota is reported to be caught. There is no trip limit for the medium or large capacity fleets.

Option D: Seasonal Quota
The menhaden commercial TAC is divided between four seasons (Table 4). The seasons are defined as: (1) Winter, Jan-March, (2) Spring, April-June, (3) Summer, July-September, and (4) Fall, October-December. Allocations to each season can be further divided by jurisdiction or region in Tier 2. The commercial fishery for each season will close when 95% of that season's allocation has been met.

Option E: Allocation Based on TAC Level
The coastwide menhaden commercial TAC will be allocated using two different methods depending on the level at which the annual TAC is set. At or below the baseline annual TAC level of 212,500 mt, quotas will be allocated to jurisdictions based on average landings from 2009-2011 (i.e: the current allocation method, Table 7). If the annual TAC is set above the base level TAC, the difference between the annual TAC and 212,500 mt will be allocated using a strategy that is more favorable to the bait fishery. A sub-option below must be selected to determine the allocation method used when the TAC is greater than 212,500 mt. If an allocation strategy based on the TAC level is chosen, the management alternatives in Tier 2 do not apply and the Board can skip to management alternatives in Tier 3.

Sub-option 1: If the annual TAC is greater than 212,500 mt, the difference between the annual TAC and 212,500 mt will be distributed such that the reduction fishery gets 50% of the allocation (included in Virginia's quota) and the other 50% is distributed to jurisdictions based on bait landings during a timeframe chosen in Tier 3 (Table 5).

Sub-option 2: If the annual TAC is greater than 212,500 mt, the difference between the annual TAC and 212,500 mt will be distributed such that the reduction fishery gets 30% of the allocation (included in Virginia's quota) and the other 70% is distributed to jurisdictions based on bait landings during a timeframe chosen in Tier 3 (Table 6).

Tier 2: Allocation Based on Jurisdictions or Regions
The following section, in conjunction with the management alternative chosen in Tier 1, will determine how the commercial Atlantic menhaden TAC is distributed. The allocation strategy selected in Tier 1 will determine if the commercial TAC is already divided by sector, fleet, season, is based on the TAC level, or none of the above.

Option A: Coastwide Allocation. Under this option the quota will not be subdivided any further. All fisheries will operate within the allocation structure selected in Tier 1. If Option A was selected in Tier 1, there will be one coastwide TAC for the entire commercial fishery.

Option B: Jurisdictional Allocation. The coastwide commercial Atlantic menhaden TAC will be divided among the Atlantic coast jurisdictions that participate in the Atlantic menhaden commercial fishery (Table 7).

Option C: Jurisdiction Allocation with Minimum Base Allocation.
Menhaden commercial TAC is allocated to the Atlantic coast jurisdictions which participate in the menhaden fishery; however, each jurisdiction receives a minimum percentage of the coastwide TAC prior to the allocation being divided.

Sub-option 1: Each jurisdiction receives 1% of the coastwide TAC prior to the allocation being divided (Table 8). For reference 1% of a 200,000 mt TAC equals 4.4 million pounds and 15% of a 200,000 mt TAC (the sum of each jurisdictions 1%) equals 66.1 million pounds.

Sub-option 2: Each jurisdiction receives 0.5% of the coastwide TAC prior to the allocation being divided (Table 9). For reference 0.5% of a 200,000 mt TAC equals 2,204,623 pounds and 7.5% of a 200,000 mt TAC (the sum of each jurisdictions 0.5%) equals 33.1 million pounds.

Option D: Regional Allocation.
The coastwide commercial Atlantic menhaden TAC will be divided by region. The fishery in each region will be monitored through SAFIS and will be closed when 95% of the allocation is reached.

Sub-option 1: A two region split will be used to divide the coastwide commercial TAC, with the regions defined as (1) Chesapeake Bay, which includes Maryland, Potomac River Fisheries Commission, and Virginia, and (2) The Coast, which includes all other jurisdictions. Menhaden landed in a state are attributed to its respective region (Table 10).

Sub-option 2: A three region split will be used to divide the coastwide commercial TAC. The regions are defined as (1) New England, Maine through Connecticut, (2) Mid-Atlantic, New York through Delaware, and (3) South Atlantic, Maryland through Florida. Menhaden landed in a state are attributed to its respective region (Table 11).

Sub-option 3: A four region split will be used to divide the coastwide commercial TAC. The regions are defined as (1) New England, Maine through Connecticut, (2) Mid-Atlantic, New York through Delaware, (3) Chesapeake Bay, Maryland through Virginia and (4) South Atlantic, North Carolina through Florida. Menhaden landed in a state are attributed to its respective region (Table 12).

Tier 3: Allocation Timeframe
Option A: 2009-2011 (status quo)
The quota allocation is based on the three-year average landings from 2009 to 2011. All landings within this time period were subject to mandatory reporting. This time frame was selected when developing Amendment II in 2012, since it represented the most accurate bait landings available at the time.

DRAFT

<u>Option B: 2012-2016</u>
The quota allocation time frame is based on the five-year average landings from 2012 to 2016. This time frame 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.

<u>Option C: 1985-2016</u>
The quota allocation time frame is based on average landings from 1985 to 2016. This time frame includes the longest range of years available with adequate landings data, and as such should capture more variability in landings. Bait landings going back to 1985 include more uncertainty, primarily due to voluntary reporting of bait landings in some states. Reduction fisheries in North Carolina, Florida, and Maine also existed during this time period, but have not been in operation since 2005, 1987, and 1993, respectively. Total landings between 2013 and 2016 include transfers, bycatch, and landings under the episodic events program.

<u>Sub-Option A:</u> Reduction landings from states which no longer have a reduction fishery do not count towards the state's average landings.

<u>Sub-Option B:</u> Reduction landings from states which no longer have a reduction fishery do count towards the state's average landings.

<u>Option D: 1985-1995</u>
The quota allocation time frame is based on the eleven-year average landings from 1985 to 1995. Bait landings from 1985 to 1995 include more uncertainty, primarily due to voluntary reporting of bait landings in some states. Reduction fisheries in North Carolina, Florida, and Maine also existed during this time period, but have not been in operation since 2005, 1987, and 1993, respectively.

<u>Sub-Option A:</u> Reduction landings from states which no longer have a reduction fishery do not count towards the state's average landings.

<u>Sub-Option B:</u> Reduction landings from states which no longer have a reduction fishery do count towards the state's average landings.

<u>Option E: Weighted Allocation</u>
The quota allocation time frame is based on a weighted average, using the 1985-1995 and 2012-2016 time frames. Each time frame is given 50% weight. This option takes into account a more historical time period and the most recent time period. All potential data concerns for the 1985 -1995 time period mentioned in Option D would still apply.

<u>Sub-Option A:</u> Reduction landings from states which no longer have a reduction fishery do not count towards the state's average landings.

<u>Sub-Option B:</u> Reduction landings from states which no longer have a reduction fishery do count towards the state's average landings.

DRAFT

Table 1: Percent of menhaden commercial TAC allocated to the reduction and bait fisheries based on historic landings. Landings under the bycatch program and episodic events set aside are included in the allocation percentages. The table on the left (a) is based on total reduction landings from all states which had, or have, a reduction fishery. The table on the right (b) only includes reduction landings from Virginia, the sole Atlantic coast state which still has an active reduction plant.

a)

	% Bait	% Reduction
2009-2011	21.2%	78.8%
2012-2016	24.7%	75.3%
1985-2016	13.5%	86.5%
1985-1995	8.3%	91.7%
Weighted	16.5%	83.5%

b)

	% Bait	% Reduction
2009-2011	21.2%	78.8%
2012-2016	24.7%	75.3%
1985-2016	15.0%	85.0%
1985-1995	9.9%	90.1%
Weighted	17.3%	82.7%

Table 2: Percent of menhaden commercial TAC allocated to the small and large capacity fleets based on historic landings. Landings under the bycatch program and episodic events set aside are included in the allocation percentages. The table includes historic reduction landings from those states which no longer have a reduction plant. Given FL did not code landings by gear type prior to 1993, percent landings by gear type in 1993 and 1994 were used to estimate gear landings from 1988-1992. Florida reduction landings were available for 1985-1987.

	2009-2011	2012-2016	1985-2016	1985-1995	Weighted
Large Capacity (Purse Seine, Pair Trawl)	96.2%	94.3%	89.1%	87.2%	90.8%
Small Capacity (All Other Gears)	3.8%	5.7%	10.9%	12.8%	9.2%

Table 3: Three-fleet allocation strategy.

Allocations not yet calculated

Table 4: Season allocation strategy.

Allocations not yet calculated

Table 5: Percent of menhaden commercial TAC greater than 212,500 mt that is allocated to each jurisdiction based on historic bait landings (including landings under the bycatch program and episodic events set aside). Under this scenario, the Virginia reduction fishery gets 50% of the difference between the annual TAC and 212,500 mt (included in Virginia's percentage below) and the states bait fisheries are allocated the other 50%. These allocation percentages only apply if the annual TAC is greater than 212,500 mt.

	2009-2011 TAC %	2012-2016 TAC %	1985-2016 TAC %	1985-1995 TAC %	Weighted TAC %
ME	0.04%	0.45%	0.22%	0.11%	0.32%
NH	0.00%	0.00%	0.01%	0.04%	0.01%
MA	1.99%	1.19%	1.99%	3.54%	2.10%
RI	0.05%	0.30%	2.16%	7.39%	3.03%
CT	0.04%	0.02%	0.10%	0.12%	0.06%
NY	0.17%	0.51%	0.41%	0.57%	0.53%
NJ	26.66%	25.52%	19.19%	12.04%	20.34%
DE	0.03%	0.06%	0.06%	0.10%	0.08%
MD	3.57%	3.98%	3.59%	3.22%	3.69%
PRFC	1.47%	1.73%	3.66%	7.06%	3.78%
VA	64.76%	65.75%	66.62%	61.53%	64.13%
NC	1.17%	0.36%	1.56%	3.04%	1.39%
SC	0.00%	0.00%	0.00%	0.00%	0.00%
GA	0.00%	0.00%	0.00%	0.00%	0.00%
FL	0.05%	0.12%	0.42%	1.24%	0.56%

DRAFT

Table 6: Percent of menhaden commercial TAC greater than 212,500 mt that is allocated to each jurisdiction based on historic bait landings (including landings under the bycatch program and episodic events set aside). Under this scenario, the Virginia reduction fishery gets 30% of the difference between the annual TAC and 212,500 mt (included in Virginia's percentage below) and the state's bait fisheries are allocated the other 70%. These allocation percentages only apply if the annual TAC is greater than 212,500 mt.

	2009-2011 % TAC	2012-2016 % TAC	1985-2016 % TAC	1985-1995 % TAC	Weighted % TAC
ME	0.06%	0.63%	0.30%	0.16%	0.45%
NH	0.00%	0.00%	0.01%	0.05%	0.02%
MA	2.79%	1.67%	2.79%	4.96%	2.94%
RI	0.06%	0.42%	3.02%	10.34%	4.24%
CT	0.06%	0.03%	0.14%	0.17%	0.09%
NY	0.24%	0.71%	0.58%	0.80%	0.74%
NJ	37.32%	35.73%	26.87%	16.86%	28.47%
DE	0.05%	0.09%	0.09%	0.14%	0.11%
MD	5.00%	5.57%	5.03%	4.51%	5.16%
PRFC	2.06%	2.42%	5.12%	9.88%	5.29%
VA	50.66%	52.06%	53.26%	46.14%	49.78%
NC	1.64%	0.50%	2.18%	4.25%	1.94%
SC	0.00%	0.00%	0.00%	0.00%	0.00%
GA	0.00%	0.00%	0.00%	0.00%	0.00%
FL	0.07%	0.17%	0.59%	1.74%	0.78%

DRAFT

Table 7: Percent of menhaden commercial TAC allocated to each jurisdiction based on historic landings (including bycatch and episodic event landings). Table (a) is based on total reduction landings from all states which had, or have, a reduction fishery. Table (b) only includes reduction landings from Virginia, the sole Atlantic coast state which still has an active reduction plant.

(a)

	2009-2011 TAC %	2012-2016 TAC %	1985-2016 TAC %	1985-1995 TAC %	Weighted
ME	0.02%	0.22%	0.89%	1.88%	1.28%
NH	0.00%	0.00%	0.00%	0.01%	0.00%
MA	0.84%	0.59%	0.55%	0.62%	0.61%
RI	0.02%	0.15%	0.60%	1.29%	0.88%
CT	0.02%	0.01%	0.03%	0.02%	0.02%
NY	0.07%	0.25%	0.11%	0.10%	0.15%
NJ	11.29%	12.63%	5.31%	2.10%	5.91%
DE	0.01%	0.03%	0.02%	0.02%	0.02%
MD	1.51%	1.97%	0.99%	0.56%	1.07%
PRFC	0.62%	0.85%	1.01%	1.23%	1.10%
VA	85.08%	83.05%	82.74%	81.82%	82.26%
NC	0.50%	0.18%	7.54%	9.94%	6.41%
SC	0.00%	0.00%	0.00%	0.00%	0.00%
GA	0.00%	0.00%	0.00%	0.00%	0.00%
FL	0.02%	0.06%	0.20%	0.41%	0.28%

(b)

	2009-2011 TAC %	2012-2016 TAC %	1985-2016 TAC %	1985-1995 TAC %	Weighted
ME	0.02%	0.22%	0.06%	0.02%	0.10%
NH	0.00%	0.00%	0.01%	0.01%	0.01%
MA	0.84%	0.59%	0.60%	0.70%	0.66%
RI	0.02%	0.15%	0.65%	1.46%	0.95%
CT	0.02%	0.01%	0.03%	0.02%	0.02%
NY	0.07%	0.25%	0.12%	0.11%	0.17%
NJ	11.29%	12.63%	5.77%	2.38%	6.37%
DE	0.01%	0.03%	0.02%	0.02%	0.02%
MD	1.51%	1.97%	1.08%	0.64%	1.15%
PRFC	0.62%	0.85%	1.10%	1.39%	1.18%
VA	85.08%	83.05%	89.95%	92.40%	88.76%
NC	0.50%	0.18%	0.47%	0.60%	0.44%
SC	0.00%	0.00%	0.00%	0.00%	0.00%
GA	0.00%	0.00%	0.00%	0.00%	0.00%
FL	0.02%	0.06%	0.13%	0.25%	0.17%

DRAFT

Table 8: Percent of menhaden commercial TAC allocated to each jurisdiction based on historic landings, with each jurisdiction receiving, at a minimum, a 1% quota allocation. Table (a) is based on total reduction landings from all states which had, or have, a reduction fishery. Table (b) only includes reduction landings from Virginia, the sole Atlantic coast state which still has an active reduction plant.

(a)

	2009-2011 TAC %	2012-2016 TAC %	1985-2016 TAC %	1985-1995 TAC %	Weighted
ME	1.02%	1.19%	1.75%	2.60%	2.09%
NH	1.00%	1.00%	1.00%	1.01%	1.00%
MA	1.72%	1.50%	1.47%	1.53%	1.52%
RI	1.02%	1.13%	1.51%	2.10%	1.75%
CT	1.01%	1.01%	1.02%	1.02%	1.02%
NY	1.06%	1.21%	1.10%	1.08%	1.13%
NJ	10.60%	11.74%	5.51%	2.79%	6.02%
DE	1.01%	1.03%	1.02%	1.01%	1.02%
MD	2.28%	2.67%	1.84%	1.48%	1.91%
PRFC	1.53%	1.73%	1.86%	2.05%	1.93%
VA	73.31%	71.59%	71.33%	70.55%	70.92%
NC	1.42%	1.15%	7.41%	9.45%	6.45%
SC	1.00%	1.00%	1.00%	1.00%	1.00%
GA	1.00%	1.00%	1.00%	1.00%	1.00%
FL	1.02%	1.05%	1.17%	1.35%	1.24%

(b)

	2009-2011 TAC %	2012-2016 TAC %	1985-2016 TAC %	1985-1995 TAC %	Weighted
ME	1.02%	1.19%	1.06%	1.02%	1.09%
NH	1.00%	1.00%	1.01%	1.01%	1.01%
MA	1.72%	1.50%	1.51%	1.59%	1.56%
RI	1.02%	1.13%	1.55%	2.24%	1.81%
CT	1.01%	1.01%	1.03%	1.02%	1.02%
NY	1.06%	1.21%	1.11%	1.10%	1.14%
NJ	10.60%	11.74%	5.91%	3.02%	6.42%
DE	1.01%	1.03%	1.02%	1.02%	1.02%
MD	2.28%	2.67%	1.92%	1.54%	1.98%
PRFC	1.53%	1.73%	1.94%	2.18%	2.01%
VA	73.31%	71.59%	77.46%	79.54%	76.44%
NC	1.42%	1.15%	1.40%	1.51%	1.37%
SC	1.00%	1.00%	1.00%	1.00%	1.00%
GA	1.00%	1.00%	1.00%	1.00%	1.00%
FL	1.02%	1.05%	1.11%	1.21%	1.15%

Table 9: Percent of menhaden commercial TAC allocated to each jurisdiction based on historic landings, with each jurisdiction receiving, at a minimum, a 0.5% quota allocation. Table (a) is based on total reduction landings from all states which had, or have, a reduction fishery. Table (b) only includes reduction landings from Virginia, the sole Atlantic coast state which still has an active reduction plant.

(a)

	2009-2011 TAC %	2012-2016 TAC %	1985-2016 TAC %	1985-1995 TAC %	Weighted
ME	0.52%	0.70%	1.32%	2.24%	1.68%
NH	0.50%	0.50%	0.50%	0.51%	0.50%
MA	1.28%	1.05%	1.01%	1.07%	1.06%
RI	0.52%	0.64%	1.05%	1.69%	1.31%
CT	0.52%	0.51%	0.53%	0.52%	0.52%
NY	0.57%	0.73%	0.61%	0.59%	0.64%
NJ	10.94%	12.18%	5.41%	2.45%	5.96%
DE	0.51%	0.53%	0.52%	0.52%	0.52%
MD	1.90%	2.32%	1.42%	1.02%	1.49%
PRFC	1.08%	1.29%	1.44%	1.64%	1.51%
VA	79.19%	77.32%	77.04%	76.18%	76.59%
NC	0.96%	0.66%	7.47%	9.69%	6.43%
SC	0.50%	0.50%	0.50%	0.50%	0.50%
GA	0.50%	0.50%	0.50%	0.50%	0.50%
FL	0.52%	0.56%	0.69%	0.88%	0.76%

(b)

	2009-2011 TAC %	2012-2016 TAC %	1985-2016 TAC %	1985-1995 TAC %	Weighted
ME	0.52%	0.70%	0.56%	0.52%	0.59%
NH	0.50%	0.50%	0.51%	0.51%	0.51%
MA	1.28%	1.05%	1.06%	1.15%	1.11%
RI	0.52%	0.64%	1.10%	1.85%	1.38%
CT	0.52%	0.51%	0.53%	0.52%	0.52%
NY	0.57%	0.73%	0.61%	0.60%	0.65%
NJ	10.94%	12.18%	5.84%	2.70%	6.39%
DE	0.51%	0.53%	0.52%	0.52%	0.52%
MD	1.90%	2.32%	1.50%	1.09%	1.57%
PRFC	1.08%	1.29%	1.52%	1.79%	1.59%
VA	79.19%	77.32%	83.71%	85.97%	82.60%
NC	0.96%	0.66%	0.93%	1.05%	0.90%
SC	0.50%	0.50%	0.50%	0.50%	0.50%
GA	0.50%	0.50%	0.50%	0.50%	0.50%
FL	0.52%	0.56%	0.62%	0.73%	0.66%

Table 10: Percent of menhaden commercial TAC allocated to two regions based on historic landings. Table (a) is based on total reduction landings from all states which had, or have, a reduction fishery. Table (b) only includes reduction landings from Virginia, the sole Atlantic coast state which still has an active reduction plant.

(a)

	2009-2011 TAC %	2012-2016 TAC %	1985-2016 TAC %	1985-1995 TAC %	Weighted
MD, PRFC, VA	87.21%	85.87%	84.75%	83.61%	84.43%
All Other States	12.79%	14.13%	15.25%	16.39%	15.57%

(b)

	2009-2011 TAC %	2012-2016 TAC %	1985-2016 TAC %	1985-1995 TAC %	Weighted
MD, PRFC, VA	87.21%	85.87%	92.13%	94.43%	91.10%
All Other States	12.79%	14.13%	7.87%	5.57%	8.90%

Table 11: Percent of menhaden commercial TAC allocated to three regions based on historic landings. Table (a) is based on total reduction landings from all states which had, or have, a reduction fishery. Table (b) only includes reduction landings from Virginia, the sole Atlantic coast state which still has an active reduction plant.

(a)

	2009-2011 TAC %	2012-2016 TAC %	1985-2016 TAC %	1985-1995 TAC %	Weighted
ME, NH, MA, RI, CT	0.90%	0.97%	2.07%	3.82%	2.79%
NY, NJ, DE	11.38%	12.91%	5.44%	2.22%	6.08%
MD, PRFC, VA, NC, SC, GA, FL	87.73%	86.11%	92.49%	93.96%	91.13%

(b)

	2009-2011 TAC %	2012-2016 TAC %	1985-2016 TAC %	1985-1995 TAC %	Weighted
ME, NH, MA, RI, CT	0.90%	0.97%	1.35%	2.22%	1.73%
NY, NJ, DE	11.38%	12.91%	5.92%	2.51%	6.56%
MD, PRFC, VA, NC, SC, GA, FL	87.73%	86.11%	92.73%	95.27%	91.70%

DRAFT

Table 12: Percent of menhaden commercial TAC allocated to four regions based on historic landings. Table (a) is based on total reduction landings from all states which had, or have, a reduction fishery. Table (b) only includes reduction landings from Virginia, the sole Atlantic coast state which still has an active reduction plant.

(a)

	2009-2011 TAC %	2012-2016 TAC %	1985-2016 TAC %	1985-1995 TAC %	Weighted
ME, NH, MA, RI, CT	0.90%	0.97%	2.07%	3.82%	2.79%
NY, NJ, DE	11.38%	12.91%	5.44%	2.22%	6.08%
MD, PRFC, VA	87.21%	85.87%	84.75%	83.61%	84.43%
NC, SC, GA, FL	0.52%	0.24%	7.74%	10.35%	6.70%

(b)

	2009-2011 TAC %	2012-2016 TAC %	1985-2016 TAC %	1985-1995 TAC %	Weighted
ME, NH, MA, RI, CT	0.90%	0.97%	1.35%	2.22%	1.73%
NY, NJ, DE	11.38%	12.91%	5.92%	2.51%	6.56%
MD, PRFC, VA	87.21%	85.87%	92.13%	94.43%	91.10%
NC, SC, GA, FL	0.52%	0.24%	0.60%	0.85%	0.61%

4.3.2.1 Overage Payback

Any overage of a quota allocation is subtracted for that specific quota allocation in the subsequent year on a pound for pound basis. The exception to this rule is if overage reconciliation is implemented under *Section 4.3.3: Quota Transfers* whereby, if the overall TAC is not exceeded in a specific year, any state or region-specific quota overage is automatically forgiven in its entirety. Overage determination is based on final allocations, including transfers if applicable.

4.3.2.2 Allocation Revisit Provision

Quota allocations will be revisited every three years following implementation of Amendment 3, or may be revisited at any time through the adaptive management process (*Section 4.6*).

4.3.3 Quota Transfers

The option to transfer quota only applies if the Board selects regional or state-based quotas, including state-specific quotas with a fixed minimum and an allocation strategy based on the TAC level. If a regional or state-based allocation option is not selected, no quota transfers are permitted.

All transfers require a donor region or state (giving the quota) and a receiving region or state (receiving the quota). Transfers cannot be greater than the amount of quota allocated to the donor region or state for that fishing year. In order to initiate a transfer, a member of each state agency involved must submit a signed letter to the Commission identifying the involved parties, the pounds of quota to be transferred, and justification for the transfer (i.e.: an expected quota overage, safe harbor landings, etc). Letters regarding regional quotas must indicate that all states in the region agree to the transfer and may be signed by multiple state agencies. The Executive Director or designated ASMFC staff will review all transfer requests. The transfer becomes final upon receipt of signed letters from the Commission to the donor and receiving parties. In the event that the donor or receiving member of a transaction subsequently wishes to change the amount of the transfer, both parties have to agree to the change and submit letters to the Commission which are signed by a member of the state agency. Parties participating in a quota transfer may add a provision which states that if the donor state or region incurs an overage in the current fishing year due to the transfer, the overage will be accommodated and paid back by the receiving state in the subsequent year.

If a region or state receives multiple requests to transfer quota at the same time, it is recommended that the state or region considers the requests in the order in which they were received. Transfer requests intended to resolve issues other than quota overages (i.e. safe harbor) may need to be addressed ahead of the order in which they were received.

Transfers do not permanently affect the region or state-specific shares of the coastwide quota, i.e., the region or state-specific shares remain fixed. Regions or states have the responsibility to close the Atlantic menhaden commercial fishery in their jurisdiction once the quota (or a percentage thereof) is reached. Once quota has been transferred, the region or state receiving quota becomes responsible for any overages of their new quota (the receiving region or state's original quota plus any quota transferred). Overages will be deducted from the corresponding region or state's quota the following fishing season.

Option A: Quota Transfers Permitted
Two or more regions or states, under mutual agreement, may transfer or combine their Atlantic menhaden quota.

Option B: Quota Transfers Permitted with Accountability Measures for Overages
Two or more regions or states, under mutual agreement, may transfer or combine their Atlantic menhaden quota. If a state or region exceeds its quota allocation (comprised of the allocation distributed at the beginning of year plus the distribution of unused episodic set aside) by more than 5% in two consecutive years, it may not receive a quota transfer in the third year.

Option C: Quota Reconciliation
In a year where the coastwide TAC is not exceeded, any state or region-specific quota overage is automatically forgiven in its entirety. As a result, quota overages are not deducted in the subsequent fishing year. The intent of this option is to streamline the quota transfer process as quota transfers are not needed to address quota overages. Quota transfers can still be made between two or more regions or states, under mutual agreement, to address concerns

unrelated to quota overages; quota transfers cannot be made to address remaining quota overages after quota reconciliation.

If the coastwide TAC is exceeded and a state(s) or region(s) exceeds its quota allocation, regions or states with an underage automatically have their unused quota transferred to a “common pool” that is re-distributed to states with overages. The common pool quota is redistributed based on the number of jurisdictions with an overage (Table 13). Any overage that remains after the redistribution of the common pool quota is deducted from a region or state’s quota the subsequent year. Quota rollovers are not permitted under quota reconciliation (*Section 4.3.4*).

Table 13: Process for re-distribution of “common pool” quota when the coastwide TAC is exceeded (Option C). The redistribution process can be repeated until all 100,000 lbs of unused quota are distributed. For this example, the amount of available common pool quota is 100,000 lbs. Two rounds of common pool allocation are needed to distribute the full 100,000 lbs.

	Available Common Pool Quota Round 1: 100,000		
	Overage (lbs)	**Quota Allocated from Common Pool (lbs)**	**Remaining Overage**
Region/State 1	100,000	33,333	66,667
Region/State2	50,000	33,333	16,667
Region/State 3	10,000	33,333 (accept 10,000)	0

	Available Common Pool Quota Round 2: 23,333		
	Overage (lbs)	**Quota Allocated from Common Pool (lbs)**	**Remaining Overage**
Region/State 1	66,667	11,667	55,000
Region/State 2	16,667	11,667	5,000

<u>Option D: Quota Reconciliation with Accountability Measures for Overages</u>

In a year where the coastwide TAC is not exceeded, a portion of the state or region’s quota overage is forgiven. The portion of the overage forgiven is dependent on the state or region’s history of overages (Table 14). For example, if a state or region had an overage in the two previous consecutive years, 50% of the current quota overage is forgiven. States or regions must pay back the remaining portion of the overage in the subsequent year. The intent of this option is to dissuade states or regions from habitually exceeding their quota. Quota transfers can still be made between two or more regions or states, under mutual agreement, to address concerns unrelated to quota overages; quota transfers cannot be made to address remaining quota overages after quota reconciliation.

Table 14: The percentage of overage forgiven based on the number of consecutive years a state or region has had an overage. For example, a state or region which had an overage in the previous year gets 70% of its quota overage in the current year forgiven. If a state or region exceeds its quota in three consecutive years or more, it must pay back in full its overage.

Number of Consecutive Years of Overage	% of Overage Forgiven
0	85%
1	70%
2	50%
3 or more	0%

If the coastwide TAC is exceeded and a state(s) or region(s) exceeds its quota allocation, regions or states with an underage automatically have their unused quota transferred to a "common pool" that is re-distributed to states with overages. The common pool quota is redistributed based on the number of jurisdictions with an overage (Table 15). The amount of redistributed common pool quota a state or region can receive is dependent on a state or region's history of overages and cannot exceed the percentages outlined in Table 14. For example, a state or region which had overages in the two previous years cannot received an amount of redistributed common pool quota greater than the 50% of their overage. This process can be repeated until all common pool quota is distributed. Any overage that remains after the redistribution of the common pool quota is deducted from a region or state's quota the subsequent year. Quota rollovers are not permitted under quota reconciliation (*Section 4.3.4*).

Table 15: Process for re-distribution of "common pool" quota when the coastwide TAC is exceeded and there are accountability measures for overages (Option D). The redistribution process can be repeated until either all 100,000 lbs of unused quota are distributed or each state reaches the maximum amount of quota it can accept due to a history of overages. In this example, there is 100,000 lbs of unused quota available for redistribution and it takes three rounds for each state to accept the maximum amount of quota it can receive.

	Available Common Pool Quota Round 1: 100,000					
	Overage (lbs)	# of Previous Years With an Overage	Max Quota that Can Be Accepted (lbs)	Quota Allocated from Common Pool (lbs)	Quota Accepted from Common Pool (lbs)	Remaining Overage
Region/ State 1	100,000	2	50,000	33,333	33,333	66,667
Region/ State2	50,000	0	42,500	33,333	33,333	16,667
Region/ State 3	10,000	1	7,000	33,333	7,000	3,000

	Available Common Pool Quota Round 2: 26,334					
	Overage (lbs)	# of Previous Years With an Overage	Max Quota that Can Be Accepted (lbs)	Quota Allocated from Common Pool (lbs)	Quota Accepted from Common Pool (lbs)	Remaining Overage
Region/ State 1	66,667	2	16,667	13,167	13,167	53,500
Region/ State2	16,667	0	9,167	13,167	9,167	7,500

	Available Common Pool Quota Round 3: 4,000					
	Overage (lbs)	# of Previous Years With an Overage	Max Quota that Can Be Accepted (lbs)	Quota Allocated from Common Pool (lbs)	Quota Accepted from Common Pool (lbs)	Remaining Overage
Region/ State 1	53,500	2	3,500	4,000	3,500	50,000

4.3.4 Quota Rollovers

The option for quota rollovers only applies if the stock status is not overfished and overfishing is not occurring. Any quota that is rolled over must be used in the subsequent fishing year. If the rolled over quota is not used, it cannot be carried into a second fishing year. Quota rollovers are applicable to all allocation methods described in *Section 4.3.2*. If a state or region based allocation is adopted, unused quota from a specific state or region is rolled over to that state or region. If a coastwide allocation is adopted and there is no further allocation by state or region, unused quota is rolled over into the subsequent year's TAC. If a fleet-capacity allocation is adopted and there is no further allocation by state or region, unused quota from a specific fleet is rolled over to that fleet. If a disposition allocation is adopted and there is no further allocation by state or region, unused quota from a specific sector (bait vs. reduction) is rolled over to that sector. If a seasonal allocation is adopted and there is no further allocation by state or region, unused quota from the four seasons will be added together and that value will be rolled over into the TAC for the subsequent year. Quota rollovers are not permitted if quota reconciliation is implemented (*Section 4.3.3 Options C and D).* Therefore, if a reconciliation option is selected, Option A in this section is selected by default. Unused quota allocated to set aside programs, such a small-scale fishery set aside or the episodic events set aside, cannot be rolled over into the subsequent year.

<u>Option A: Unused Quota May Not Be Rolled Over</u>
Unused quota may not be rolled over from one fishing year to the next.

<u>Option B: 100% Quota Rollover</u>
Any unused portion of a quota allocation may be rolled over into the subsequent fishing year only. Unused quota that was received as part of a transfer may not be rolled over.

<u>Option C: 10% Total Quota Rollover</u>
Up to 10% of a quota allocation may be carried over into the subsequent fishing year only. For example, if a quota allocation is 1 million pounds, up to 100,000 pounds of unused quota may be rolled over into the subsequent fishing year. Unused quota that was received as part of a transfer may not be rolled over.

<u>Option D: 5% Total Quota Rollover</u>
Up to 5% of a quota allocation may be carried over into the subsequent fishing year only. For example, if a quota allocation is 1 million pounds, up to 50,000 pounds of unused quota may be rolled over into the subsequent fishing year. Unused quota that was received as part of a transfer may not be rolled over.

Option E: 50% Unused Quota Rollover

Up to 50% of the unused portion or a quota allocation may be rolled over into the subsequent fishing year only. For example, if a quota allocation is 1 million pounds and 600,000 pounds were harvested, up to 200,000 pounds of unused quota could be rolled over into the subsequent year. Unused quota that was received as part of a transfer may not be rolled over.

4.3.5 Incidental Catch and Small Scale Fisheries

4.3.6 Incidental Catch and Small Scale Fisheries

The Board may establish provisions for small-scales gears and non-directed gear types. Tables 28 and 29 show landings under the current bycatch provision from 2013-2016. For the purposes of this Amendment, small-scale gears include cast nets, traps (excluding floating fish traps), pots, haul seines, fyke nets, hook and line, bag nets, hoop nets, hand lines, trammel nets, and bait nets. Non-directed gear types include pound nets, anchored/stake gillnets, drift gill net, trawls, fishing weirs, fyke nets, and floating fish traps. Stationary multi-species gears are defined as pound nets, anchored/stake gill nets, fishing weirs, floating fish traps, and fyke nets.

Landings under the incidental catch provision will be reported to the Board as a part of the annual FMP Review (*Section 5.3: Compliance Report*). Should a specific gear type show a continued and significant increase in landings under the incidental catch provision, or it becomes clear that a non-directed gear type is directing on menhaden under the incidental catch provision, the Board has the authority, through adaptive management, to alter the trip limit or remove that gear from the incidental catch provision.

If a fleet-based allocation method is chosen in *Section 4.3.2 Quota Allocation*, Option E: Small-Scale Fishery Set Aside does not apply. If a two-fleet allocation method with a soft quota for the small-capacity fleet is chosen in *Section 4.3.2 Quota Allocation*, the management alternatives in this section do not apply. If a three-fleet allocation method with a soft quota for the small-capacity fleet is chosen in *Section 4.3.2 Quota Allocation*, the management alternatives in this section would only apply to non-directed gear types.

Option A: Catch Limit for Non-Directed Gear Types

After a quota allocation is met for a given jurisdiction, region, season, sector, or fleet, the fishery moves to an incidental catch fishery in which **non-directed gear types** may land up to 6,000 pounds of menhaden per trip/day. Two permitted individuals, working from the same vessel fishing stationary multi-species gear, are authorized to work together and land up to 12,000 pounds from a single vessel – limited to one vessel trip per day. A trip is based on a calendar day such that no vessel may land menhaden more than once in a single calendar day. The use of multiple carrier vessels per trip to offload any bycatch exceeding 6,000 pounds of Atlantic menhaden is prohibited. Incidental catch landings are reported by states to the Commission as a part of annual Compliance Reports. Under this option, landings in the incidental catch fishery do not count towards the TAC.

Option B: Catch Limit for Small Scale Fisheries and Non-Directed Gear Types
After a quota allocation is met for a given jurisdiction, region, season, sector, or fleet, the fishery moves to an incidental catch fishery in which **small-scale gears** and **non-directed gear types** may land up to 6,000 pounds of menhaden per trip/day. Two authorized individuals, working from the same vessel fishing stationary multi-species gear, are permitted to work together and land up to 12,000 pounds from a single vessel – limited to one vessel trip per day. A trip is based on a calendar day such that no vessel may land menhaden more than once in a single calendar day. The use of multiple carrier vessels per trip to offload any bycatch exceeding 6,000 pounds of Atlantic menhaden is prohibited. Incidental catch landings are reported by states to the Commission as a part of annual Compliance Reports. Under this option, landings in the incidental catch fishery do not count towards the TAC.

Option C: Catch Cap and Trigger
After a quota allocation is met for a given jurisdiction, region, season, sector, or fleet, the fishery moves to an incidental catch fishery in which **small-scale gears** and **non-directed gear types** may land up to 6,000 pounds of menhaden per trip/day. Two authorized individuals, working from the same vessel fishing stationary multi-species gear, are permitted to work together and land up to 12,000 pounds from a single vessel – limited to one vessel trip per day. A trip is based on a calendar day such that no vessel may land menhaden more than once in a single calendar day. The use of multiple carrier vessels per trip to offload any bycatch exceeding 6,000 pounds of Atlantic menhaden is prohibited.

A catch cap for the incidental catch fishery is set at 2% of the TAC. For 2017, this represents approximately 8.8 million pounds, which is 148% higher than the maximum bycatch landing of 6.6 million pounds in a single year between 2013 and 2016. Incidental catch landings are reported by states to the Commission as a part of annual Compliance Reports. If reported incidental catch exceeds the Cap by more than 10% in a single year or exceeds the Cap two years in a row, regardless of the percent overage, management action is triggered by the Board to reduce incidental landings in the fishery. Under this option, landings in the incidental catch fishery do not count towards the TAC.

Option D: Incidental Catch Fishery Set Aside
2% of the overall TAC is set aside for an incidental catch fishery, which occurs after a quota allocation is met for a given jurisdiction, region, season, sector, or fleet. Under an incidental catch fishery, there is a 6,000 pound/trip/day menhaden allowance for **small-scale gears and non-directed gear types.** All landings by these gear types which occur after a quota allocation has been met, are counted towards the set aside. Two authorized individuals, working from the same vessel fishing stationary multi-species gear, are permitted to work together and land up to 12,000 pounds from a single vessel – limited to one vessel trip per day. A trip is based on a calendar day such that no vessel may land menhaden more than once in a single calendar day. The use of multiple carrier vessels per trip to offload any bycatch exceeding 6,000 pounds of Atlantic menhaden is prohibited.

Landings made by small-scale fisheries and non-directed fisheries following the closure of the directed fishery are reported by states to the Commission as a part of annual Compliance Reports. If the set aside is exceeded in a given year, the overage is deducted from the subsequent year's set aside. The percentage of TAC set aside for the incidental catch fishery can by altered under Adaptive Management (*Section 4.5*). Under this option, landings in the incidental catch fishery do count towards the TAC.

Option E: Small-Scale Fishery Set Aside

1% of the overall TAC is set aside for **small-scale gears**. Trips by these gears types are limited to 3,000 pounds of Atlantic menhaden per trip/day. A trip is defined by a calendar day such that a fisherman cannot land menhaden more than once in a single calendar day. Landings by small-scale fisheries are reported by states to the Commission as a part of annual Compliance Reports. If the coastwide set aside is exceeded in a given year, the overage is deducted from the subsequent year's set aside. The percentage of TAC set aside for small-scale fisheries can by altered under Adaptive Management (*Section 4.5*).

If a jurisdictional allocation method is chosen in *Section 4.3.2* and a state which only has landings by small-scale gears is allocated quota, that state may choose to add its jurisdictional quota to the small-scale fishery set aside. For example, if Florida, a state which exclusively has a cast net fishery, is allocated 0.5% of quota, the state may aggregate its state quota with the small-scale fishery set aside, making the set aside allocation 1.5%.

Landings by all other gear types' count towards the quota allocated to either states, regions, seasons, sectors, or fleets. Once the respective quota allocation is met, the menhaden fishery is closed and no landings of menhaden are permitted by those gear types. Under this option, landings in the small scale fishery do count towards the TAC. This option does not apply if a two-fleet allocation method is chosen with a soft cap for the small-capacity fleet.

Option F: All Catch Included in TAC

All catch of menhaden, including incidental catch, counts towards the directed fishery TAC. Once the quota allocation for a specific state, region, season, sector, or fleet is reached, the menhaden fishery is closed and no landings of menhaden are permitted by that state, region, sector, fleet, or in that season which has met is quota allocation.

4.3.6 Episodic Events Set Aside Program

The Board may set aside a portion of the TAC for episodic events. Episodic events are defined by any instance in which a qualified state has reached its annual quota allocation available to them prior to September 1 and the state can prove the presence of unusually large amounts of menhaden in its state waters. The goal of the set aside is to add flexibility to the management of the species so that states can harvest menhaden during episodic events, reduce discards, and prevent fish kills. Eligibility to participate in the episodic events set aside program is reserved for the states of Maine, New Hampshire, Massachusetts, Rhode Island, Connecticut, and New York. Landings per year under the set aside can be found in Table 29.

4.3.6.1 TAC Set Aside
A percentage of the TAC is set aside for use in the episodic events program.

Option A: 1% of TAC Set Aside (Status quo)
1% of the overall TAC is set aside for episodic events.

Option B: 3% of TAC Set Aside
3% of the overall TAC is set aside for episodic events.

Option C: 0% of TAC Set Aside
No portion of the overall TAC is set aside for episodic events. Under this option, there is no episodic events program.

4.3.6.2 Mandatory Provisions
In order for an eligible state to participate in the episodic events set aside program, states must implement the following provisions.

A. Participating states must implement daily trip level harvester reporting. Each state must track landings and submit weekly reports to ASMFC staff. Should several states be approved to participate in the episodic event set aside program, ASMFC staff may require more frequent reporting to ensure the set aside is not exceeded.
B. Episodic events harvest and landings must be restricted to state waters of the jurisdiction approved to participate in the set aside.
C. Participating states must implement a maximum daily trip limit no greater than 120,000 pounds/vessel. A daily trip is defined by a calendar day such that no vessel harvesting under the episodic events program may land menhaden twice in a single calendar day.

4.3.6.3 Declaring Participation
A state must apply to participate in the episodic events program prior to September 1st. In order to apply, a state must send a letter to ASMFC declaring interest in harvesting under the set aside. The letter must demonstrate the following:

A. The state has implemented the mandatory provisions stated in Section 4.3.6.2.
B. The applying state has fully harvested its annual quota allocation prior to September 1.
   I. If a jurisdictional quota is implemented, a state must reach its quota prior to September 1.
   II. If a coastwide quota is implemented, the coastwide quota must be reached prior to September 1.
   III. If a seasonal quota is implemented:
      - The current seasonal quota must be reached;
      - The state's eligibility to harvest under the set aside would only apply until the start of the next season or October 31, whichever occurs first;
      - There is no limit on the number of times a state may apply to participate in the episodic events program provided they can demonstrate that they meet the

provisions of the program at the time of application and the requirements above have been satisfied.

IV. If a regional quota is implemented, the regional quota in which the state participates must be reached prior to September 1. A state within a region may apply to participate without the other states/jurisdictions within its region applying.

V. If disposition quotas are implemented, the quota allocated to the bait sector must be reached prior to September 1.

VI. If fleet capacity quotas are implemented, only gear types which have reached their quota prior to September 1 are eligible to harvest under the set aside program. A state must declare in their letter to ASMFC, prior to approval to participate, which gear types will be allowed to harvest under the set aside program.

C. The state has unusually large amounts of menhaden in its state waters. This can be demonstrated through:
   I. Surveys (aerial, seine) which indicate high biomass;
   II. Landings reports which indicate an unusually high rate of menhaden harvest at the time of declaration into the set aside;
   III. Or information highlighting the potential for fish kills, associated human health concerns, and the ability of harvest under the set aside to reduce or eliminate the fish kill.

D. The state has not declared de minimis status. If a qualifying state was previously granted de minimis status, it will lose that status and will need to collect biological data and catch and effort data for an adult index as required by Section 3.5: Biological Data Collection Programs.

Once the application letter is received by ASMFC staff, the PRT will review the state's compliance with the requirements of the episodic events set aside program. Once verified, ASMFC will send a letter notifying the state that it can harvest menhaden under the set aside. Only harvest that occurs on or after the date of the aforementioned notification letter, and prior to the states eligibility ending, will be considered episodic event set aside harvest. ASMFC staff will also notify the Board when any state is approved to harvest under the set aside.

4.3.6.4 Procedure for Unused Set Aside

If an episodic event is not triggered by September 1 in any state, the unused set aside quota will be rolled into the overall TAC on September 1 and redistributed based on the allocation method and timeframe selected in *Section 4.3.2*. If an episodic event is triggered, any unused set aside as of October 31st of each year will be redistributed based on the allocation method and timeframe selected in *Section 4.3.2*.

4.3.6.5 Procedure for Set Aside Overages

If the episodic event set aside is exceeded, any overages will be deducted from the next year's episodic event set aside amount.

4.3.7 Chesapeake Bay Reduction Fishery Cap

The Chesapeake Bay Reduction Fishery Cap limits allowable harvest from the Chesapeake Bay by the reduction fishery. The intent of the Cap is to prevent all of the reduction fishery harvest from occurring in the Chesapeake Bay, a critical nursery area for Atlantic menhaden. Harvest for reduction purposes shall be prohibited within the Chesapeake Bay when 100% of the cap is harvested from Chesapeake Bay, which is defined as areas shoreward of the Chesapeake Bay Bridge Tunnel. Harvest above the Cap in any given year will be deducted from the next year's allowable harvest. In recent years reduction harvest in the Chesapeake Bay has consistently underperformed the 87,216 mt cap, with less than 45,000 mt harvest in 2014 and 2016 and less than 50,000 mt harvested in 2015.

<u>Option A: Cap Set At 87,216 mt</u>
The Chesapeake Bay Reduction Fishery Cap is maintained as 87,216 metric tons.

> <u>Sub-Option A: Limited Rollover of Unused Cap Permitted</u>
> A maximum of 10,976 metric tons of un-landed fish under the Cap can be rolled over into the subsequent year. This rollover amount equals 12.58% of the Cap. Unused landings under the Cap cannot be rolled over for multiple years and under no circumstances can the allowable harvest under the Cap in a given year exceed 98,192 metric tons.
>
> <u>Sub-Option B: No Rollover of Unused Cap Permitted</u>
> Any amount of un-landed fished under the Cap cannot be rolled over into the subsequent year. As a result, under no circumstances can the allowable harvest under the Cap in a given year exceed 87,216 metric tons.

<u>Option B: Cap Set At Average Ches. Bay Reduction Landings from 2012-2016 (~51,000 mt)</u>
The Chesapeake Bay Reduction Fishery Cap is reduced to 51,000 metric tons. This value represents an approximation of the five-year average of reduction harvest from the Chesapeake Bay between 2012 and 2016. An approximate value is used given reduction landings in the Chesapeake Bay are confidential.

> <u>Sub-Option A: Limited Rollover of Unused Cap Permitted</u>
> A maximum of 6,418 metric tons of un-landed fish under the Cap can be rolled over into the subsequent year. This rollover amount equals 12.58% of the Cap. Unused landings under the Cap cannot be rolled over for multiple years and under no circumstances can the allowable harvest under the Cap in a given year exceed 57,418 metric tons.
>
> <u>Sub-Option B: No Rollover of Unused Cap Permitted</u>
> Any amount of un-landed fished under the Cap cannot be rolled over into the subsequent year. As a result, under no circumstances can the allowable harvest under the Cap in a given year exceed 51,000 metric tons.

<u>Option C: Remove Cap</u>
The Chesapeake Bay Reduction Fishery Cap. Under this option, there is no limit on harvest by the reduction fishery in the Chesapeake Bay.

4.4 HABITAT CONSERVATION AND RESTORATION RECOMMENDATIONS

In order to ensure the productivity of populations, each state should identify and protect critical nursery areas for Atlantic menhaden within its boundaries. Such efforts should inventory historical habitats, identify habitats presently used by menhaden, and impose or encourage measures to retain or increase the quantity and quality of Atlantic menhaden habitat.

4.4.1 Preservation of Existing Habitat

States should provide inventories and locations of critical Atlantic menhaden habitat to other state and federal regulatory agencies. Regulatory agencies should be advised on the types of threats to Atlantic menhaden populations and recommended measures that should be employed to avoid, minimize or eliminate any threat to current habitat extent or quality.

4.4.2 Habitat Restoration and Improvement

While Atlantic menhaden appear to be utilizing the bulk of their historic nursery areas, water quality in these areas should be maintained or improved, if impaired, to prevent hypoxic fish kills and minimize the threat of increased mortality due to disease and parasitism. Protection of wetlands will protect and improve menhaden habitat.

4.4.3 Avoidance of Incompatible Activities

Federal and state fishery management agencies should take steps to limit the introduction of compounds which are known, or suspected, to accumulate in any animal species' tissue and which pose a threat to human health or any animals' health.

Each state should establish windows of compatibility for activities known or suspected to adversely affect Atlantic menhaden life stages and their habitats, such as navigational dredging, inlet modifications, and dredged material disposal, and notify the appropriate construction or regulatory agencies in writing.

Projects involving water withdrawal from nursery habitats (e.g. power plants, irrigation, water supply projects) should be scrutinized to ensure that adverse impacts resulting from larval/juvenile impingement, entrainment, and/or modification of flow, temperature and salinity regimes due to water removal, will not adversely impact estuarine dependent species, including Atlantic menhaden, especially early life stages.

Each state which contains Atlantic menhaden nursery areas within its jurisdiction should develop water use and flow regime guidelines which are protective of these nursery areas and which will ensure to the extent possible, the long-term health and sustainability of the stock.

4.4.4 Fishery Practices

The use of any fishing gear or practice which is documented by management agencies to have an unacceptable impact on Atlantic menhaden (e.g. habitat damage, bycatch mortality) should be prohibited within the effected essential habitats.

DRAFT

4.5 ALTERNATIVE STATE MANAGEMENT REGIMES

States are required to obtain prior approval from the Board of any changes to their management program for which a compliance requirement is in effect. Changes to non-compliance measures must be reported to the Board but may be implemented without prior Board approval. A state can request permission to implement an alternative management measure to any mandatory compliance measure only if that state can show, to the Board's satisfaction, that its alternative proposal will have the same conservation value as the measure contained in this amendment or any addenda prepared under Adaptive Management (*Section 4.6*). States submitting alternative proposals must demonstrate that the proposed action will not contribute to overfishing of the resource. All changes to a state's plan must be submitted in writing to the Board and to the Commission as part of the Annual Compliance Reports.

4.5.1 General Procedures

A state may submit a proposal for a change to its regulatory program or any mandatory compliance measure under this amendment to the Commission, including a proposal for *de minimis* status. Such changes shall be submitted to the Chair of the Plan Review Team (PRT), who shall distribute the proposal to the Board, the PRT, the TC, and the AP.

The PRT is responsible for gathering the comments of the TC and the AP. The PRT is also responsible for presenting these comments as soon as possible to the Board for decision.

The Board will decide whether to approve the state proposal for an alternative management program if it determines that it is consistent with the target fishing mortality rate applicable as well as the goals and objectives of this amendment.

In order to maintain consistency within a fishing season, new rules should be implemented prior to the start of the fishing season. Given the time needed for the TC, AP, and Board to review the proposed regulations, as well as the time required by an individual state to promulgate new regulations, it may not be possible to implement new regulations for the current fishing season. In this case, new regulations should be effective at the start of the following season after a determination to do so has been made.

4.5.2 Management Program Equivalency

The TC, under the direction of the PRT, will review any alternative state proposals under this section and provide its evaluation of the adequacy of such proposals to the Board. The PRT can also ask for reviews by the Law Enforcement Committee or the AP.

4.5.3 *De Minimis* Fishery Guidelines

The ASMFC Interstate Fisheries Management Program Charter defines *de minimis* as "a situation in which, under the existing condition of the stock and scope of the fishery, the conservation and enforcement actions taken by an individual states would be expected to contribute insignificantly to a coastwide conservation program required by a Fishery Management plan or amendment," (ASMFC 2016).

A state can apply annually for *de minimis* status if a state does not have a reduction fishery, following the procedure in *Section 4.5.3.2.* To be eligible for *de minimis* consideration in the bait fishery, a state must prove that its commercial bait landings in the most recent two years for which data are available did not exceed 1% of the coastwide bait landings.

4.5.3.1 Plan Requirements if De Minimis Status is Granted

If *de minimis* status is granted, the *de minimis* state is required to implement, at a minimum, the coastwide management requirements contained in *Section 4.0*. Additionally all *de minimis* states except New Hampshire, South Carolina, and Georgia must adhere to timely quota monitoring as approved by the Board (*Section 3.1.2*).

States granted *de minimis* status are exempt from collecting biological data and the adult CPUE index data (*Section 3.5.1.2*).

If the coastwide fishery is closed for any reason through Emergency Procedures (*Section 4.7*), *de minimis* states must close their fisheries as well.

Any additional components of the FMP, which the Board determines necessary for a *de minimis* state to implement, can be defined at the time *de minimis* status is granted.

4.5.3.2 Procedure to Apply for De Minimis Status

States must specifically request *de minimis* status each year. Requests for *de minimis* status will be reviewed by the PRT as part of the annual FMP review process (*Section 5.3: Compliance Report*). Requests for *de minimis* must be submitted to the ASMFC Atlantic Menhaden FMP Coordinator as a part of the state's yearly compliance report. The request must contain the following information: all available commercial landings data for the current and 2 previous full years of data, commercial regulations for the current year, and the proposed management measures the state plans to implement for the year *de minimis* status is requested. The FMP Coordinator will then forward the information to the PRT and, if necessary, the TC and SASC.

In determining whether or not a state meets the *de minimis* criteria, the PRT will consider the information provided with the request, the most recent available coastwide landings data, any information provided by the TC and SASC, and projections of future landings. The PRT will make a recommendation to the Board to either accept or deny the *de minimis* request. The Board will then review the PRT recommendation and either grant or deny the *de minimis* classification.

The Board must make a specific motion to grant a state *de minimis* status. By deeming a given state *de minimis*, the Board is recognizing that: the state has a minimal Atlantic menhaden fishery; there is little risk to the health of the menhaden stock if the state does not implement the full suite of management measures; and the overall burden of implementing the complete management and monitoring requirements of the FMP outweigh the conservation benefits of implementing those measures in the particular state.

If commercial landings in a *de minimis* state exceed the *de minimis* threshold, the state will lose its *de minimis* classification, will be ineligible for *de minimis* in the following year, and will be required to implement all provisions of the FMP. If the Board denies a state's *de minimis* request, the state will be required to implement all the provisions of the FMP. When a state rescinds or loses its *de minimis* status, the Board will set a compliance date by which the state must implement the required regulations.

4.6 ADAPTIVE MANAGEMENT

The Board may vary the requirements specified in this Amendment as a part of adaptive management in order to conserve the Atlantic menhaden resource. The elements that can be modified by adaptive management are listed in *Section 4.6.2*. The process under which adaptive management can occur is provided below.

4.6.1 General Procedures

The PRT will monitor the status of the fishery and the resource and report on that status to the Board annually or when directed to do so by the Board. The PRT will consult with TC, the SASC, and the AP in making such review and report.

The Board will review the report of the PRT, and may consult further with the TC, SASC, or AP. The Board may, based on the PRT report or on its own discretion, direct the PDT to prepare an addendum to make any changes it deems necessary. The addendum shall contain a schedule for the states to implement the new provisions.

The PDT will prepare a draft addendum as directed by the Board, and shall distribute it to all states for review and comment. A public hearing will be held in any state that requests one. The PDT will also request comment from federal agencies and the public at large. After a 30-day review period, staff, in consultation with the PDT, will summarize the comments received and prepare a final version of the addendum for the Board.

The Board shall review the final version of the addendum prepared by the PDT, and shall also consider the public comments received and the recommendations of the TC, SASC, and AP. The Board shall then decide whether to adopt, or revise and then adopt, the addendum.

Upon adoption of an addendum by the Board, states shall prepare plans to carry out the addendum, and submit them to the Board for approval according to the schedule contained in the addendum.

4.6.2 Measures Subject to Change

The following measures are subject to change under adaptive management upon approval by the Board:

(1) Management areas and unit
(2) Reference points, including an overfishing and overfished definition
(3) Rebuilding targets and schedules
(4) TAC specification and quota allocation
(5) Episodic events set aside program
(6) Small scale fishery set aside
(7) Incidental catch fishery set aside
(8) Incidental catch provision
(9) *De minimis* specifications
(10) Chesapeake Bay reduction fishery cap
(11) Effort controls
(12) Fishing year and/or seasons
(13) Trip limits
(14) Limited entry
(15) Area closures
(16) Gears assigned to fleets
(17) Gear restrictions including mesh sizes
(18) Recreational fishery management measures
(19) For-hire fishery management measures
(20) Research set aside programs
(21) Research or monitoring requirements
(22) Frequency of stock assessments
(23) Reporting requirements
(24) Measures to reduce or monitor bycatch
(25) Observer requirements
(26) Recommendations to the Secretaries for complementary actions in federal jurisdictions
(27) Any other management measures currently included in Amendment 3

4.7 EMERGENCY PROCEDURES

Emergency procedures may be used by the Board to require any emergency action that is not covered by, is an exception to, or a change to any provision in Amendment 3. Procedures for implementation are addressed in the ASMFC Interstate Fisheries Management Program Charter, Section Six (c)(10) (ASMFC 2016).

4.8 MANAGEMENT INSTITUTIONS

The management institutions for Atlantic menhaden shall be subject to the provisions of the ISFMP Charter (ASMFC 2016). The following is not intended to replace any or all of the provisions of the ISFMP Charter. All committee roles and responsibilities are included in detail in the ISFMP Charter and are only summarized here.

4.8.1 Atlantic States Marine Fisheries Commission and ISFMP Policy Board

The ASMFC (Commission) and the ISFMP Policy Board are generally responsible for the oversight and management of the Commission's fisheries management activities. The Commission must approve all fishery management plans and amendments, including Amendment 3. The ISFMP Policy Board reviews any non-compliance recommendations of the various Boards and Sections and, if it concurs, forwards them to the Commission for action.

4.8.2 Atlantic Menhaden Management Board

The Board was established under the provisions of the Commission's ISFMP Charter (Section Four; ASMFC 2016) and is generally responsible for carrying out all activities under this Amendment.

The Board establishes and oversees the activities of the PDT, PRT, TC, SASC, BERP Workgroup, and the AP. In addition, the Board makes changes to the management program under adaptive management, reviews state programs implementing the amendment, and approves alternative state programs through conservation equivalency. The Board reviews the status of state compliance with the management program annually, and if it determines that a state is out of compliance, reports that determination to the ISFMP Policy Board under the terms of the ISFMP Charter.

4.8.3. Atlantic Menhaden Plan Development Team

The Plan Development Team (PDT) is composed of personnel from state and federal agencies who have scientific knowledge of Atlantic menhaden and management abilities. The PDT is responsible for preparing and developing management documents, including addenda and amendments, using the best scientific information available and the most current stock assessment information. The ASMFC FMP Coordinator chairs the PDT. The PDT will either disband or assume inactive status upon completion of Amendment 3.

4.8.4 Atlantic Menhaden Plan Review Team

The Plan Review Team (PRT) is composed of personnel from state and federal agencies who have scientific and management ability and knowledge of Atlantic menhaden. The PRT is responsible for providing annual advice concerning the implementation, review, monitoring, and enforcement of Amendment 3 once it has been adopted by the Commission. After final action on Amendment 3, the Board may elect to retain members of the PDT as members of the PRT, or appoint new members.

4.8.5 Atlantic Menhaden Technical Committee

The Atlantic Menhaden Technical Committee (TC) consists of representatives from state or federal agencies, Regional Fishery Management Councils, the Commission, a university, or other specialized personnel with scientific and technical expertise and knowledge of the Atlantic menhaden fishery. The Board appoints the members of the TC and may authorize additional seats as it sees fit. The role of the TC is to assess the species' population, provide scientific advice concerning the implications of proposed or potential management alternatives, and respond to other scientific questions from the Board, PDT, or PRT. The SASC reports to the TC.

4.8.6 Atlantic Menhaden Stock Assessment Subcommittee

The Atlantic Menhaden Stock Assessment Subcommittee (SASC) is appointed and approved by the Board, with consultation from the Atlantic Menhaden TC, and consists of scientists with expertise in the assessment of the Atlantic menhaden population. Its role is to assess the Atlantic menhaden population and provide scientific advice concerning the implications of proposed or potential management alternatives, and to respond to other scientific questions from the Board, TC, PDT or PRT. The SASC reports to the TC.

4.8.7 Biological Ecological Reference Point Work Group

The Biological Ecological Reference Point Work Group (BERP Workgroup) is comprised of representatives from each technical committee for weakfish, striped bass, bluefish, and menhaden, in addition to state and federal biologists with expertise on multispecies modeling approaches. The intent of the BERP Work Group is to assist the Commission with its multispecies modeling efforts and facilitate the use of multispecies model results in management decisions. More specifically, the BERP Work Group is tasked with identifying potential ecological reference points that account for Atlantic menhaden's role as a forage fish.

4.8.8 Atlantic Menhaden Advisory Panel

The Atlantic Menhaden Advisory Panel (AP) is established according to the Commission's Advisory Committee Charter. Members of the AP are citizens who represent a cross-section of commercial and recreational fishing interests and others who are concerned about Atlantic menhaden conservation and management. The AP provides the Board with advice directly concerning the Commission's Atlantic menhaden management program.

4.8.9 Federal Agencies

4.8.9.1 Management in the Exclusive Economic Zone

Management of Atlantic menhaden in the EEZ is within the jurisdiction of the three Regional Fishery Management Councils under the Magnuson-Stevens Act (16 U.S.C. 1801 et seq.). In the absence of a Council Fishery Management Plan, management is the responsibility of the

National Marine Fisheries Service as mandated by the Atlantic Coastal Fishery Conservation and Management Act (16 U.S.C. 5105 et seq.).

4.8.9.2 Federal Agency Participation in the Management Process

The Commission has accorded the United States Fish and Wildlife Service (USFWS) and the National Marine Fisheries Service voting status on the ISFMP Policy Board and the Atlantic Menhaden Management Board in accordance with the Commission's ISFMP Charter. The National Marine Fisheries Service can also participate on the Atlantic Menhaden PDT, PRT, TC and SASC.

4.8.9.3 Consultation with Fishery Management Councils

At the time of adoption of Amendment 3, none of the Regional Fishery Management Councils had implemented a management plan for Atlantic menhaden, nor had they indicated an intent to develop a plan.

4.9 RECOMMENDATION TO THE SECRETARY OF COMMERCE FOR COMPLEMENTARY MEASURES IN FEDERAL WATERS

The quota management approach adopted can be implemented and monitored within the jurisdictions of the Atlantic states. Therefore, a specific recommendation to the Secretary for complimentary action in federal jurisdictions is unnecessary at this time. The Board may consider further recommendations to the Secretary if changes to Amendment 3 occur through the adaptive management process (*Section 4.6*).

4.10 COOPERATION WITH OTHER MANAGEMENT INSTITUTIONS

The Board will cooperate, when necessary, with other management institutions during the implementation of this amendment, including the National Marine Fisheries Service and the New England, Mid-Atlantic, and South Atlantic Fishery Management Council.

5.0 COMPLIANCE

Full implementation of the provisions included in this amendment is necessary for the management program to be equitable, efficient and effective. States are expected to implement these measures faithfully under state laws. Although ASMFC does not have authority to directly compel states to implement these measures, it will continually monitor the effectiveness of state implementation and determine whether states are in compliance with the provisions of this fishery management plan. The Board sets forth specific elements that the Commission will consider in determining state compliance with this fishery management plan, and the procedures that will govern the evaluation of compliance. Additional details of the procedures are found in the ASMFC Interstate Fishery Management Program Charter (ASMFC 2016).

5.1 MANDATORY COMPLIANCE ELEMENTS FOR STATES

A state will be determined to be out of compliance with the provision of this fishery management plan according to the terms of Section Seven of the ISFMP Charter if:

- It fails to meet any schedule required by Section 5.2, or any addendum prepared under adaptive management (*Section 4.6*); or
- It has failed to implement a change to its program when determined necessary by the Board; or
- It makes a change to its regulations required under *Section 4* or any addendum prepared under adaptive management (*Section 4.6*), without prior approval of the Board.

5.1.1 Regulatory Requirements

To be considered in compliance with this fishery management plan, all state programs must include a regime of restrictions on Atlantic menhaden fisheries consistent with the requirements of *Section 3.1: Commercial Catch and Landings Programs; Section 3.5.1: Fishery-Dependent Data;* and *Section 4.3: Commercial Fishery Management Measures*. A state may propose an alternative management program under *Section 4.5: Alternative State Management Regimes*, which, if approved by the Board, may be implemented as an alternative regulatory requirement for compliance.

States may begin to implement Amendment 3 after final approval by the Commission. Each state must submit its required Atlantic menhaden regulatory program to the Commission through the ASMFC staff for approval by the Board. During the period between submission and Board approval of the state's program, a state may not adopt a less protective management program than contained in this Amendment or contained in current state law. The following lists the specific compliance criteria that a state/jurisdiction must implement in order to be in compliance with Amendment 3:

- Commercial fishery management measures as specified in *Section 4.3* including the Total Allowable Catch (*Section 4.3.1*), Overage Payback (*Section 4.3.2.1*) Quota Allocation (*Section 4.3.2*), Quota Transfers (*Section 4.3.3*), Quota Rollovers (*Section 4.3.4*), Incidental Catch Provision (*Section 4.3.5*), Episodic Events Set Aside (*Section 4.3.6*), and the Chesapeake Bay Reduction Fishery Harvest Cap (*Section 4.3.7*).
- Monitoring requirements as specified in Section 3.1
- All state programs must include law enforcement capabilities adequate for successfully implemented the compliance measures contained in this Amendment.
- There are no mandatory research requirements at this time; however, mandatory research requirements may be added in the future under Adaptive Management, *Section 4.6*.
- There are no mandatory habitat requirements in Amendment 3. See *Section 4.4* for habitat recommendations.

5.2 COMPLIANCE SCHEDULE

States must implement this Amendment according to the following schedule:

Month Day, 201X:	Submission of state programs to implement Amendment 3 for approval by the Board. Programs must be implemented upon approval by the Board.
Month Day, 201X:	States with approved management programs must implement Amendment 3. States may begin implementing management programs prior to this deadline if approved by the Board.

5.3 COMPLIANCE REPORTS

Each state must submit to the Commission an annual report concerning its Atlantic menhaden fisheries and management program for the previous year, no later than April 1st. A standard compliance report format has been prepared and adopted by the ISFMP Policy Board. States should follow this format in completing the annual compliance report.

The report shall cover:
- the previous calendar year's fishery and management program including mandatory reporting programs (including frequency of reporting and data elements collected), fishery dependent data collection, fishery independent data collection, regulations in effect, total harvest (including directed landings, bycatch landings, landings under a soft cap, and landings under the episodic events program), de minimis requests, and future regulatory changes.
- the planned management program for the current calendar year summarizing regulations that will be in effect and monitoring programs that will be performed, highlighting any changes from the previous year.

5.4 PROCEDURES FOR DETERMINING COMPLIANCE

Detailed procedures regarding compliance determinations are contained in the ISFMP Charter, Section Seven (ASMFC 2016). In brief, all states are responsible for the full and effective implementation and enforcement of fishery management plans in areas subject to their jurisdiction. Written compliance reports as specified in the Amendment must be submitted annually by each state with a declared interest. Compliance with Amendment 3 will be reviewed at least annually; however, the Board, ISFMP Policy Board or the Commission may request the PRT to conduct a review of state's implementation and compliance with Amendment 3 at any time.

The Board will review the written findings of the PRT within 60 days of receipt of a State's compliance report. Should the Board recommend to the Policy Board that a state be determined out of compliance, a rationale for the recommended noncompliance finding will be addressed in a report. The report will include the required measures of Amendment 3 that the state has not implemented or enforced, a statement of how failure to implement or enforce required measures jeopardizes Atlantic menhaden conservation, and the actions a state must take in order to comply with Amendment 3 requirements.

The ISFMP Policy Board will review any recommendation of noncompliance from the Board within 30 days. If it concurs with the recommendation, it shall recommend to the Commission that a state be found out of compliance.

The Commission shall consider any noncompliance recommendation from the ISFMP Policy Board within 30 days. Any state that is the subject of a recommendation for a noncompliance finding is given an opportunity to present written and/or oral testimony concerning whether it should be found out of compliance. If the Commission agrees with the recommendation of the ISFMP Policy Board, it may determine that a state is not in compliance with Amendment 3, and specify the actions the state must take to come into compliance.

Any state that has been determined to be out of compliance may request that the Commission rescind its noncompliance findings, provided the state has revised its Atlantic menhaden conservation measures.

5.5. ANALYSIS OF THE ENFORCEABILITY OF PROPOSED MEASURES

The Law Enforcement Committee with, during the implementation of this amendment, analyze the enforceability of management measures as they are proposed.

6.0 RESEARCH NEEDS

The following list of research needs have been identified in order to enhance the state of knowledge of the Atlantic menhaden resource. Research recommendations are broken down into several categories: data; assessment methodology, habitat, and socio-economic. Each category is further broken down into recommendations that can be completed in the short term (within 5 years) and recommendations that will require long term commitment (6+ years).

6.1 STOCK ASSESSMENT AND POPULATION DYNAMICS RESEARCH NEEDS

6.1.1 Annual Data Collection

<u>Short Term:</u>

1. Continue current level of sampling from bait fisheries, particularly in the mid-Atlantic and New England. Analyze sampling adequacy of the reduction fishery and work with industry and states to effectively sample areas outside of that fishery.
2. Conduct ageing validation study to confirm scale to otolith comparisons. Use archived scales to do radio isotope analysis.
3. Conduct a comprehensive fecundity study.
4. Place observers on boats to collect at-sea samples from purse-seine sets.
5. Investigate relationship between fish size and school size in order to address selectivity.

6. Investigate relationship between fish size and distance from shore.
7. Evaluate alternative fleet configurations for the removal and catch-at-age data.
8. Investigate interannual variability in the maturity of menhaden via collection of annual samples along the Atlantic coast.

Long Term:

1. Develop a menhaden specific coastwide fishery independent index of adult abundance at age.
2. Conduct studies on spatial and temporal dynamics of spawning.
3. Conduct studies on the productivity of estuarine environments related to recruitment.
4. Investigation of environmental covariates related to recruitment.
5. Validate multispecies/ecosystem model parameters through the development and implementation of stomach sampling program that will cover major menhaden predators along the Atlantic coast. Validation of prey preferences, size selectivity and spatial overlap is critically important to the appropriate use of such model results.

6.1.2 Assessment Methodology

Short Term:

1. Conduct Management Strategy Evaluation (MSE) on the various reference point options (single species, multi-species) for menhaden.
2. Continue to develop an integrated length and age based model.
3. Continue to improve methods for incorporation of natural mortality.
4. Consider estimating (time-varying) growth within the assessment model.
5. Account for co-variation among parameters and inputs in future uncertainty analyses of the assessment model.
6. Examine the variance assumption and weighting factors of all the likelihood components in the model.

Long Term:

1. Develop a seasonal spatially-explicit model, once sufficient age-specific data on movement rates of menhaden are available.
2. Continue exploring the development of multispecies models that can take predator-prey interactions into account. This should inform and be linked to the development of assessment models that allow natural mortality to vary over time.
3. Evaluate the sensitivity of reference points to recent productivity trends.
4. Reconsider models that allow natural mortality to vary over time.
5. Collect age-specific data on movement rates of menhaden to develop regional abundance trends.
6. Investigate the effects of global climate change on distribution, movement, and behavior of menhaden.

6.2 HABITAT RESEARCH NEEDS

1. Study specific habitat requirements for all life history stages.
2. Develop habitat maps for all life history stages.
3. Identify migration routes of adults.
4. Study the effects of large-scale climatic events and the impacts on Atlantic menhaden.
5. Evaluate effects of habitat loss/degradation on Atlantic menhaden.

6.3 SOCIO-ECONOMIC RESEARCH NEEDS

1. Due to the fact that there is only a single reduction company, data on the reduction fleet and all matters related to costs are nearly impossible to obtain. Some other mechanism for estimating or obtaining data for appropriate economic analysis should be undertaken.

2. Studies should be conducted to fully recognize the linkages between the menhaden fishery and the numerous other fisheries which it supports and sustains. Menhaden oil, chum, and several other types of bait are used in a number of fisheries ranging from crayfish to crab to sharks. This includes both commercial and recreational fisheries. Despite knowing that these links exist, no clear analysis has taken place.

3. Studies on the recreational component of the menhaden fishery should be undertaken to better understand what gear is being used, where it is being prosecuted, disposition of the catch, and who the users may be in terms of socioeconomic issues and other factors.

4. Social aspects of the non-consumptive sector have not been analyzed due to budge and time limitations. This would include components of the bird watching and whale watching industries, including where they live and what their particular interests are in menhaden.

7.0 PROTECTED SPECIES

In the fall of 1995, Commission member states, the National Marine Fisheries Service (NMFS) and the U.S. Fish and Wildlife Service (USFWS) began discussing ways to improve implementation of the Marine Mammal Protection Act (MMPA) and the Endangered Species Act (ESA) in state waters. Historically, these policies had been only minimally implemented and enforced in state waters (0-3 miles). In November 1995, the Commission, through its Interstate Fisheries Management Program (ISFMP) Policy Board, approved an amendment to its ISFMP Charter (Section Six (b)(2)) so that protected species/fishery interactions are addressed in the Commission's fisheries management planning process. As a result, the Commission's fishery management plans describe impacts of state fisheries on certain marine mammals and endangered species, collectively termed "protected species". The following section outlines: (1) the federal legislation which guides protection of marine mammals and sea turtles, (2) the protected species with potential fishery interactions; (3) the specific type(s) of fishery interaction; (4) population status of the affected protected species; and (5) potential impacts to

Atlantic coastal state and interstate fisheries.

7.1 MARINE MAMMAL PROTECTION ACT (MMPA) REQUIREMENTS

Since its passage in 1972, one of the underlying goals of the MMPA has been to reduce incidental serious injury and mortality of marine mammals in the course of commercial fishing operations to insignificant levels approaching a zero mortality and zero serious injury rate. Under the 1994 Amendments, the Act requires the National Marine Fisheries Service (NMFS) to develop and implement a take reduction plan to assist in the recovery of, or prevent the depletion of, each strategic stock that interacts with a Category I or II fishery. Specifically, a strategic stock is defined as a stock: (1) for which the level of direct human-caused mortality exceeds the potential biological removal (PBR)[1] level; (2) which is declining and is likely to be listed under the Endangered Species Act (ESA) in the foreseeable future; or (3) which is listed as a threatened or endangered species under the ESA or as a depleted species under the MMPA. Category I and II fisheries are those that have frequent or occasional incidental mortality and serious injury of marine mammals, whereas Category III fisheries have a remote likelihood of incidental mortality and serious injury of marine mammals. Each year NMFS publishes a List of Fisheries (LOF), which classifies commercial fisheries into one of these three categories.

Under 1994 mandates, the MMPA also requires fishermen in Category I and II to register under the Marine Mammal Authorization Program (MMAP). The purpose of this is to provide an exception for commercial fishermen from the general taking prohibitions of the MMPA. All fishermen, regardless of the category of fishery in which they participate, must report all incidental injuries and mortalities caused by commercial fishing operations within 48 hours.

Section 101(a)(5)(E) of the MMPA allows for the authorization of incidental taking of ESA-listed marine mammals in the course of commercial fishing operations if it is determined that: (1) incidental mortality and serious injury will have a negligible impact on the affected species or stock; (2) a recovery plan has been developed or is being developed for such species or stock under the ESA; and (3) where required under MMPA Section 118, a monitoring program has been established, vessels engaged in such fisheries are registered, and a take reduction plan has been developed or is being developed for such species or stock. MMPA Section 101(a)(5)(E) permits are not required for Category III fisheries, but any serious injury or mortality of a marine mammal must be reported.

[1] PBR is the number of human-caused deaths per year each stock can withstand and still reach an optimum population level. This is calculated by multiplying the minimum population estimate by the stock's net productivity rate and a recovery factor ranging from 0.1 for endangered species to 1.0 for healthy stocks.

7.2 ENDANGERED SPECIES ACT (ESA) REQUIREMENTS

The taking of endangered sea turtles and marine mammals is prohibited and considered unlawful under Section 9(a)(1) of the ESA. In addition, NMFS or the USFWS may determine Section 4(d) protective regulations to be necessary and advisable to provide for the conservation of threatened species. There are several mechanisms established in the ESA to allow for exceptions to the prohibited take of protected species listed under the ESA. Section 10(a)(1)(A) of the ESA authorizes NMFS to allow the taking of listed species through the issuance of research permits for scientific purposes or to enhance the propagation or survival of the species. Section 10(a)(1)(B) authorizes NMFS to permit, under prescribed terms and conditions, any taking otherwise prohibited by Section 9(a)(1)(B) of the ESA if the taking is incidental to, and not the purpose of, carrying out an otherwise lawful activity. In recent years, some Atlantic state fisheries have obtained section 10(a)(1)(B) permits for state fisheries. Recent examples are at http://www.nmfs.noaa.gov/pr/permits/esa_review.htm#esa10a1b.

Finally, Section 7(a)(2) requires federal agencies to consult with NMFS to ensure that any action that is authorized, funded, or carried out by such agency is not likely to jeopardize the continued existence of any listed species or result in the destruction or adverse modification of critical habitat of such species. If, following completion of consultation, an action is found to jeopardize the continued existence of any listed species or cause adverse modification to critical habitat of such species, reasonable and prudent alternatives will be identified so that jeopardy or adverse modification to the species does not occur. Section (7)(o) provides the actual exemption from the take prohibitions established in Section 9(a)(1), which includes Incidental Take Statements that are provided at the end of consultation via the ESA Section 7 Biological Opinions.

7.3 PROTECTED SPECIES WITH POTENTIAL FISHERY INTERACTIONS

A number of protected species inhabit the management unit, which includes inshore and nearshore waters, for Atlantic Menhaden. Ten are classified as endangered or threatened under the ESA; the remainder are protected under provisions of the MMPA. The species found in coastal Northwest Atlantic waters are listed below.

Endangered	
Right whale	(*Eubalaena glacialis*)
Blue Whale	*(Balaenoptera musculus)*
Fin whale	(*Balaenoptera physalus*)
Leatherback turtle	(*Dermochelys coriacea*)
Kemp's ridley	(*Lepidochelys kempii*)
Hawksbill turtle	*(Eretmochelys imbricata)*
Shortnose sturgeon	(*Acipenser brevirostrum*)
Atlantic sturgeon	*(Acipenser oxyrinchus oxyrinchus)*

Threatened

Loggerhead turtle	(*Caretta caretta*)
North Atlantic Green turtle dps	*(Chelonia mydas)*

MMPA

Includes all marine mammals above in addition to:

Minke whale	(*Balaenoptera acutorostrata*)
Humpback whale	*(Megaptera novaeangliae)*
Bottlenose dolphin	(*Tursiops truncatus*)
Atlantic-white sided dolphin	*(Lagenorhynchus acutus)*
Harbor seal	(*Phoca vitulina*)
Grey seal	(*Halichoerus grypus*)
Harp seal	(*Phoca groenlandica*)
Harbor porpoise	*(Phocoena phocoena)*

In the Northwest Atlantic waters, protected species utilize marine habitats for feeding, reproduction, as nursery areas and as migratory corridors. For several stocks of marine mammals, including humpback whales, menhaden are an important prey species. Some species occupy the area year round while others use the region only seasonally or move intermittently nearshore, inshore and offshore. Interactions may occur whenever fishing gear and marine mammals overlap spatially and temporally.

For sea turtles, the Atlantic seaboard provides important developmental habitat for post-pelagic juveniles, as well as foraging and nesting habitat for adults. The distribution and abundance of sea turtles along the Atlantic coast is related to geographic location and seasonal variations in water temperatures. Water temperatures dictate how early northward migrations begin each year and is a useful factor for assessing when turtles will be found in certain areas. Interactions may occur whenever fishing gear and sea turtles overlap spatially and temporally.

7.3.1 Marine Mammals

Five marine mammal species are primarily known to co-occur with or become entangled in gear used by the Atlantic menhaden fishery. They include the Atlantic right whale, humpback whale, fin whale, coastal bottlenose dolphin, and harbor porpoise.

North Atlantic Right Whale

The North Atlantic right whale (*Eubalaena glacialis*) is among the most endangered large whale species in the world. Despite decades of conservation measures, the population remains at low numbers. In 2012, 440 individually recognized whales were known to be alive (Corkeron et al., 2016). Modeling work using data collected through the mid-1990s indicated that if the conditions that existed at that time were to continue, western North Atlantic right whales would be extinct within 200 years (Caswell et al. 1999).

North Atlantic right whales have a wide distribution through the Atlantic Ocean but are generally found west of the Gulf Stream, from the southeast U.S. to Canada (e.g., Bay of Fundy and Scotian Shelf) (Kenney 2002; Waring et al. 2009). North Atlantic right whales also frequent Stellwagen Bank and Jeffreys Ledge, as well as Canadian waters including the Bay of Fundy and Browns Banks, in the spring through fall. The distribution of right whales in the summer and fall is linked to the distribution of their principal zooplankton prey (Winn et al. 1986). Right whales feed by swimming continuously with their mouths open, filtering large amounts of water through their baleen and capturing zooplankton on the baleen's inner surface. Calving occurs in the winter months in coastal waters off of Georgia and Florida (Kraus et al. 1988). Mid-Atlantic waters are used as a migratory pathway from the spring and summer feeding/nursery areas to the winter calving grounds off the coast of Georgia and Florida.

The North Atlantic Right Whale is listed as endangered throughout its range. Ship strikes and fishing gear entanglements are the principal factors believed to be retarding recovery of western North Atlantic right whales population (NMFS, 2012). Data collected from 1970 through 1999 indicate that anthropogenic interactions in the form of ship strikes and gear entanglements were responsible 19 out of 45 reported right whale deaths (Knowlton and Kraus, 2001).

<u>Humpback Whale</u>

Humpback whales, known for their displays of breeching and bubble net feeding, can be found in all major oceans. In the western North Atlantic, humpback whales calve and mate in the West Indies during the winter and migrate to northern feeding areas during the summer months. Calves are recruited to the feeding grounds of their mothers in a practice referred to as maternal philopatry (Clapham and Mayo 1987; Katona and Beard 1990). In the Gulf of Maine, sightings are most frequent from mid-March through November, from the Great South Channel north along the outside of Cape Cod to Stellwagen Bank and Jeffrey's Ledge (CETAP 1982). They feed on a number of species of small schooling fish, particularly sand lance, mackerel, and Atlantic herring. Humpback whales have also been observed feeding on krill (Wynne and Schwartz 1999).

In the western Atlantic Ocean, humpback whales have become increasingly more abundant. The overall North Atlantic population, derived from genetic tagging data collected by the Years of the North Atlantic Humpback (YONAH) project was estimated to be 4,894 males and 2,804 females. As a result, the West Indies population of humpback whales, which migrates up to New England, was not considered at risk of extinction or likely to become so within the foreseeable future (81 FR 62259, September 8, 2016). While not listed as endangered or threatened, the major known sources of anthropogenic mortality and injury of humpback whales are commercial fishing gear entanglements and ship strikes.

<u>Fin Whale</u>

Fin whales inhabit a wide range of latitudes between 20 to 75 degrees north and 20 to 75 degrees south (Perry et al. 1999). Like right and humpback whales, fin whales are believed to use high latitude waters primarily for feeding, and low latitude waters for calving. However, evidence regarding where the majority of fin whales winter, calve, and mate is still scarce. Clark (1995) reported a general pattern of fin whale movements in the fall from the Labrador/Newfoundland region, south past Bermuda and into the West Indies, but also noted strandings along the U.S. Mid-Atlantic coast from October through January. This could suggest the possibility of an offshore calving area (Clark 1995; Hain et al. 1992). The predominant prey of fin whales varies greatly in different areas depending on what is locally available (IWC 1992). In the western North Atlantic, fin whales feed on a variety of small schooling fish (e.g., herring, capelin, and sand lance) as well as squid and planktonic crustaceans (Wynne and Schwartz 1999).

The fin whale is listed as endangered throughout its range. Like right whales and humpback whales, anthropogenic mortality of fin whales includes entanglement in commercial fishing gear and ship strikes (NMFS, 2011). Of 12 fin whale mortalities recorded between 2009 and 2013, nine were associated with vessel interactions (Waring et al., 2016). Experts believe that fin whales are struck by large vessels more frequently than any other cetacean (Laist et al. 2001).

Bottlenose Dolphin

Common bottlenose dolphins are found throughout the western Atlantic coast, with primary habitat along the U.S. ranging from New York through Florida. The distribution of the species changes seasonally, with a greater abundance of bottlenose dolphins found in the Mid-Atlantic waters in the summer (NMFS, 2008). In the winter, most bottlenose dolphins are found south of the Virginia-North Carolina border (NMFS, 2008). The species is often aggregated in groups, ranging up to 15 individuals along the coast, but can be found in larger herds offshore. Bottlenose dolphins eat a variety of prey including invertebrates and fish.

On the Atlantic coast, five stocks of common bottlenose dolphins are considered depleted under the MMPA, meaning that the population stock is below its optimum sustainable level (Waring et al., 2016). The primary source of human-induced mortality is interactions with fishing gear, particularly coastal gillnets. Between 1995 and 2000, 12 bottlenose dolphin mortalities were reported in gillnets targeting dogfish shark species, striped bass, Spanish mackerel, kingfish, and weakfish (NMFS, 2008). Four more mortalities were observed in 2003-2006 (NMFS, 2008). In response, a Bottlenose Dolphin Take Reduction Plan was implemented in May 2006 to reduce the incidental mortality and serious injury of bottlenose dolphins in commercial fishing gear (71 FR 24776, April 26, 2006).

Harbor Porpoise

The harbor porpoise ranges from Labrador to North Carolina. The southern-most stock of harbor porpoise is referred to as the Gulf of Maine/Bay of Fundy stock and spends its winters in the Mid-Atlantic region. Harbor porpoises are generally found in coastal and inshore waters, but will also travel to deeper, offshore waters. There are insufficient data to determine population trends for this species because harbor porpoises are widely dispersed in small groups, they spend little time at the surface, and their distribution varies unpredictably from year to year depending on environmental conditions (NMFS, 2002). Shipboard line transect sighting surveys have been conducted to estimate population size of the harbor porpoise stock. The best estimate of abundance for the Gulf of Maine/Bay of Fundy harbor porpoise stock is 79,883 from a 2011 survey (NMFS, 2016).

The Gulf of Maine harbor porpoise was proposed to be listed as threatened under the ESA on January 7, 1993, but NMFS determined this listing was not warranted (NMFS, 1999). NMFS removed this stock from the ESA candidate species list in 2001. The primary threat to the harbor porpoise is incidental catch in fishing gear, such as gillnets and trawls. The Harbor Porpoise Take Reduction Plan was implemented to reduce incidental mortality and serious injury in gillnet fisheries in the Gulf of Maine and mid-Atlantic.

7.3.1.1 Gear Interactions with Marine Mammals

Marine mammal interactions have been documented in the primary fisheries that target menhaden, including the purse seine, pound net, and gillnet fisheries, and in those fisheries for which menhaden is bycatch, including trawl, haul seine, pound net and gillnet fisheries. The bycatch reports included below do not represent a complete list but rather available records. It should be noted that without an observer program for many of these fisheries, actual numbers of interactions are difficult to obtain.

<u>Purse Seine</u>

The U.S. mid-Atlantic menhaden purse seine fishery is currently listed as a Category II fishery while the Gulf of Maine menhaden purse seine fishery is listed as a Category III fishery. In the 2017 LOF (82 FR 3655, January 12, 2017), the Gulf of Maine menhaden purse seine fishery is listed as having a remote likelihood or no incidental mortality or injury of marine mammals, and the U.S. mid-Atlantic menhaden purse seine fishery is documented as having incidental mortality or injury of bottlenose dolphin.

Historically, Atlantic menhaden purse seine fishermen have reported an annual incidental take of one to five coastal bottlenose dolphins (NMFS, 1991). This information comes from reports required under a small take exemption issued under the then Section 101(a)(4) of the MMPA. The Atlantic purse seine fishery reported the lethal incidental take of one minke whale in 1990 (NMFS, 1993); however, the target species of the purse seine (i.e. tuna or menhaden) is unknown. In addition, an incidental take of a humpback whale in the mid-Atlantic menhaden purse seine fishery was reported in 2001 (66 FR 6545, January 22. 2001); however, in 2005 humpback whales were removed from the list species killed or injured in the fishery because an interaction had not been reported in subsequent years. In 2006, the mid-Atlantic menhaden purse seine fishery was elevated from a Category III fishery to a Category II fishery (71 FR 48802, August 22, 2006). This change was made after interactions with bottlenose dolphins in other purse seine fisheries, such as those in the Gulf of Mexico. This required the fishery to comply with registration requirements, applicable take reduction plan requirements, and observer coverage. Limited observer coverage has occurred in the fishery since 2008.

<u>Pound Nets</u>

The Virginia pound net fishery is listed as a Category II fishery in the 2017 LOF due to documented interactions with bottlenose dolphins (82 FR 3655, January 12, 2017). Between 2004 and 2008, there were 17 bottlenose dolphins killed in pound net gear and 3 bottlenose dolphins were released alive (76 FR 37716, June 28, 2011). There is no formal observer coverage for the Virginia pound net fishery but there has been sporadic monitoring by the Northeast Fishery Observer Program. All other Atlantic coast pound net fisheries are listed as a Category III fishery.

Gillnets

The mid-Atlantic gillnet fishery is listed as a Category I fishery in the 2017 LOF (82 FR 3655, January 12, 2017). The fishery was originally listed as a Category II fishery but in 2003, it was elevated to a Category I fishery after stranding and observer data documented the incidental mortality and serious injury of bottlenose dolphins (68 FR 41725, July 15, 2003). Other species with documented interactions include the harbor porpoise, common dolphin, harbor seal, harp seal, long-finned pilot whale, short-finned pilot whale, and white-sided dolphin; however, since gillnet fisheries target many species, not all incidents may have occurred while harvesting menhaden. Between 1995 and 2013, observer coverage has ranged from 1% to 5%.

The Chesapeake Bay inshore gillnet, the North Carolina inshore gillnet, the northeast anchored float gillnet, the northeast drift gillnet, and the southeast Atlantic gillnet fisheries are all listed as Category II fisheries in the 2017 LOF (82 FR 3655, January 12, 2017). The primary species reported interacting with these gears is the bottlenose dolphin; however, the harbor seal, humpback whale, and white-sided dolphin have been documented in the northeast anchored float gillnet. Both the Chesapeake Bay inshore gillnet and the North Carolina inshore gillnet fisheries were elevated from a Category III fishery to a Category II fishery in the 2006 and 2001 LOFs, respectively (66 FR 42780, August 15, 2001; 71 FR 48802, August 22, 2006).

The Delaware River inshore gillnet, the Long Island Sound inshore gillnet, the southeast Atlantic inshore gillnet, and the Rhode Island/Southern Massachusetts/New York Bight inshore gillnet fisheries are listed as Category III fisheries in the 2017 LOF (82 FR 3655, January 12, 2017). There have been no documented interactions with marine mammals in the past five years with the exception of the southeast Atlantic inshore gillnet fishery which has documented an interaction with a bottlenose dolphin.

Haul/Beach Seine

The Mid-Atlantic haul/beach seine fishery is listed as a Category II fishery in the 2017 LOF due to interactions with coastal bottlenose dolphin (82 FR 3655, January 12, 2017). NMFS has recorded one observed take of a bottlenose dolphin in this fishery in 1998 (Waring and Quintal 2000). Harbor porpoise was deleted from the list of species killed or injured in the Mid-Atlantic haul/beach seine fishery due to no other interactions between 1999 and 2003. The fishery was observed from 1998-2001 but there has been limited observer coverage since 2001.

Fyke Net, Floating Fish Trap, Fish Weir

Floating fish traps, northeast and Mid-Atlantic fyke nets, and fish weirs are listed as a Category III fishery in the 2017 LOF (82 FR 3655, January 12, 2017). There are no documented interactions between marine mammals and the northeast/mid-Atlantic fyke net fishery nor the floating fish trap fisheries. In the Mid-Atlantic mixed species weir fishery there have been documented interactions with bottlenose dolphins.

Trawls
The mid-Atlantic mid-water trawl fishery is listed as a Category II fishery in the 2017 LOF (82 FR 3655, January 12, 2017). In 2001, the mid-Atlantic mid-water trawl fishery was elevated to Category I based on mortality and injury of common dolphins and pilot whales. In 2007, the fishery was down-graded to a Category II fishery due to reductions in the interactions with common dolphins and pilot whales (72 FR 14466, March 28, 2007). The mid-Atlantic mid-water trawl fishery continues to be listed as a Category II fishery due to interactions with white-sided dolphins. Interactions with other species include the gray seal and the harbor seal. Observer coverage in the fishery has ranged from 0% to 13.33% between 1997 and 2008.

The northeast mid-water trawl fishery is also listed as a Category II fishery in the 2017 LOF (82 FR 3655, January 12, 2017). The fishery has had documented interactions with the common dolphin, gray seal, harbor seal, long-finned pilot whale, short-finned pilot whales, and minke whale. Importantly, not all mid-water trawls target menhaden as this is the primary gear used in the northeast groundfish fisheries. Observer coverage in the fishery has ranged from 0% to 19.9% between 1997 and 2008.

Cast Net
Currently, cast net is listed as a Category III fishery in the 2017 LOF (82 FR 3655, January 12, 2017). There are no documented marine mammal species incidentally injured or killed in the cast net fishery.

Traps/Pots
The Atlantic mixed species trap/pot fishery is listed as a Category II fishery in the 2017 LOF (82 FR 3655, January 12, 2017). The gear is primarily involved in entanglement events with species such as the fin whale and the humpback whale. Historically, the minke whale and the harbor porpoise were also listed as species injured or killed by the Atlantic mixed species trap/pot fishery but these species were removed in 2005 because interactions had not been documented in recent years. There is no observer program for this fishery.

7.3.2 Sea Turtles

All sea turtles that occur in U.S. waters are listed as either endangered or threatened under the Endangered Species Act of 1973 (ESA). Five species occur along the U.S. Atlantic coast, namely, loggerhead (*Caretta caretta*), Kemp's Ridley (*Lepidochelys kempi*), green (*Chelonia mydas*), leatherback (*Dermochelys coriacea*), and hawksbill (*Eretmochelys imbricata*).

Loggerhead Turtle
The loggerhead turtle is the most abundant species of sea turtle in U.S. waters, commonly occurring throughout the inner continental shelf from Florida through Cape Cod,

Massachusetts. This species is found in a wide range of habitats throughout the temperate and tropical regions of the globe, including the open ocean, continental shelves, bays, lagoons, and estuaries (NMFS, 2013). NOAA Fisheries and USFWS have identified five nesting sub-populations along the northwest Atlantic Ocean. They include 1) southern Florida through Georgia; 2) Florida through Key West; 3) the Dry Tortugas; 4) the northern Gulf of Mexico; 5) and the greater Caribbean (76 FR 58867, September 22, 2011). Nesting sites along the coast of the U.S. primarily occur from Virginia through Alabama (76 FR 58867, September 22, 2011). The activity of the loggerhead is limited by temperature, with loggerhead turtles not appearing in the Gulf of Maine before June and generally leaving by mid-September. Loggerhead sea turtles are primarily benthic feeders, opportunistically foraging on crustaceans and mollusks. Under certain conditions they also feed on finfish, particularly if they are easy to catch (*e.g.,* caught in gillnets or inside pound nets where the fish are accessible to turtles).

The northwest Atlantic population of loggerhead turtles is listed as threatened under ESA. Threats to the population include destruction of nesting habitat as the result of development and erosion, sand dredging, fishing practices, and marine pollution (76 FR 58867, September 22, 2011).

<u>Kemp's Ridley</u>

Kemp's ridley sea turtles are found throughout the Gulf of Mexico and North Atlantic coast; however their only major nesting site is in Rancho Nuevo, Tamaulipas, Mexico (Carr 1963). Juvenile Kemp's ridleys use northeastern and mid-Atlantic waters of the U.S. Atlantic coastline as primary developmental habitat, with shallow coastal embayments serving as important foraging grounds during the summer months. Juvenile ridleys migrate south as water temperatures cool in fall, and are predominantly found in shallow coastal embayments along the Gulf Coast during the fall and winter months. Kemp's ridleys can be found from New England to Florida, and are the second most abundant sea turtle in Virginia and Maryland waters (Keinath *et al.* 1987; Musick and Limpus 1997). In the Chesapeake Bay, ridleys frequently forage in shallow embayments, particularly in areas supporting submerged aquatic vegetation (Lutcavage and Musick 1985; Bellmund *et al.* 1987; Keinath *et al.* 1987; Musick and Limpus 1997). These turtles primarily feed on crabs, but also consume mollusks, shrimp, and fish (Bjorndal 1997).

Kemp's ridley are listed as endangered primarily as the result of the destruction of habitat, particularly nesting habitat in Mexico, bycatch in fisheries, the harvesting of eggs and nesting turtles, and vessel collisions.

<u>Green Turtle</u>

Green turtles are distributed throughout the world's oceans, primarily between the northern and southern 20^{o} isotherms (Hirth 1971). Most green turtle nesting in the continental United States occurs on the Atlantic Coast of Florida, with documented nests also along the Gulf coast of Florida and the Florida Panhandle. While nesting activity is important in determining population distributions, the availability and location of foraging grounds also plays an important role in their spatial distribution. Juvenile green sea turtles occupy pelagic habitats after leaving the nesting beach and are primarily omnivorous (Bjorndal 1985). At approximately 20 to 25 cm carapace length, juveniles leave pelagic habitats and enter benthic foraging areas, shifting to an herbivorous diet (Bjorndal 1997). Post-pelagic green turtles feed primarily on sea grasses and benthic algae (Bjorndal 1985). Known feeding habitats along U.S. coasts of the western Atlantic include shallow lagoons and embayments in Florida, such as the Indian River Lagoon (Ehrhart et al. 1986). Along the Atlantic coast, green turtles can be found from Florida up to Massachusetts.

Green turtles are listed as threatened along the North Atlantic. Threats to the North Atlantic population of green turtles includes the degradation of nesting beaches due to coastal development, the degradation of forage habitat due to pollution, the illegal harvest of green turtles and their eggs, entanglement in fishing gear, such as gillnets, trawls, longlines, and traps, vessel strikes, and the persistence of an often lethal disease known as fibropapillomatosis (81 FR 20057, May 6, 2016).

<u>Leatherback Turtle</u>

The leatherback is the largest living turtle and its range is farther than any other sea turtle species, exhibiting broad thermal tolerances (NMFS 2013). Leatherback turtles are often found in association with jellyfish, with the species primarily feeding on Cnidarians (medusae, siphonophores) and tunicates (salps, pyrosomas). While these turtles are predominantly found in the open ocean, they do occur in coastal water bodies such as Cape Cod Bay and Narragansett Bay, particularly the fall. The most significant nesting in the U.S. occurs in southeast Florida (NMFS, 2013).

The leatherback turtle is listed as endangered throughout its range. Primary causes of this population decline include the degradation of nesting beaches as the result of coastal development and beach sand mining, the poaching of eggs on nesting beaches, increased human pollution in pelagic waters, the presence of disease and parasites, and the entanglement of leatherbacks in active and abandoned fishing gear (NMFS, 2013).

<u>Hawksbill Turtle</u>

The hawksbill turtle is found throughout the world's oceans, primarily between 30^{o}N and 30^{o}S latitude. In the continental U.S., hawksbill turtles commonly occur in southern Florida and the Gulf of Mexico, with a preferred habitat being coral reefs and other hard bottom habitats (NMFS 2007). Nesting sites in the Atlantic are typically found in Mexico, Puerto Rico, and the U.S. Virgin Islands (NMFS 2007). During their juvenile life stage, hawksbill turtles occupy the pelagic environment, floating with algal mats in the Atlantic (NMFS 2007). The diet of hawksbill turtles primarily consists of sponges, invertebrates, and algae (NMFS 2007).

The hawksbill turtle is listed as endangered throughout its range. Primary threats to the population include loss of coral reef habitat, the illegal harvest of eggs and nesting females, increased recreational and commercial use of beaches, and the incidental capture of hawksbill turtles in fishing gear (NMFS 2007).

7.3.2.1 Potential Impacts of Menhaden Fishery on Sea Turtles

The Atlantic seaboard provides important developmental habitat for post-pelagic juveniles, as well as foraging and nesting habitat for adult sea turtles. The distribution and abundance of sea turtles along the Atlantic coast is related to geographic location and seasonal variations in water temperatures. Water temperatures dictate how early northward migration begins each year and is a useful factor for assessing when turtles will be found in certain areas. Moderate to high abundances of sea turtles have been observed both offshore and nearshore when water temperatures are greater than or equal to 21^{o} C. As a result, sea turtles do not usually appear on the summer foraging grounds in the Gulf of Maine until June, but are found in Virginia as early as April. As water temperatures decline below 11^{o} C, abundance declines and turtles typically move from cold inshore waters in the late fall to warmer waters in the Gulf Stream, generally south of Cape Hatteras, North Carolina.

The effect of water temperature on the distribution of sea turtles is important in assessing possible interactions with the menhaden fishery. Menhaden are also affected by water temperatures and similarly migrate north in the spring and south in the fall. Thus, the menhaden purse seine fishery exhibits seasonal changes, with the fishery ramping up off North Carolina in April and extending into New England in June. Observer data indicates minimal interaction between these purse seines and sea turtles. From September 1978 through early 1980, approximately 40 sea days were observed for fish sampling aboard menhaden purse seiners fishing from Maine south to North Carolina. No sea turtles were recorded as bycatch (S. Epperly, NMFS SEFSC, pers. comm.). Other gears used to catch menhaden include trawls, fixed nets, gillnets, haul/beach seines, pound nets, and cast nets. Several states have indicated that sea turtles have been incidentally captured in menhaden fixed nets and trawls, but not seine nets (ASMFC, Atlantic Coastal Fisheries Characterization Database, unpubl. data). An observer program for protected species has not been established for the menhaden fishery. However, under the ESA Annual Determination to Implement Sea Turtle Observer Requirement (80 FR 14319, April 18, 2015), two fisheries that target menhaden are included. These include the Chesapeake Bay Inshore Gillnet Fishery and Mid-Atlantic menhaden purse seine fishery,

7.3.3 Atlantic Sturgeon

The Atlantic sturgeon is an ancient anadromous fish that can live up to 60 years. Historically, sturgeon were found from Canada through Florida; however, the species currently extends through Georgia (ASMFC 1998). As adults, Atlantic sturgeon live in the ocean and migrate from the south Atlantic in the winter to New England waters in the summer (ASMFC 1998). Precise spawning locations of sturgeon are not known but it is thought that they prefer hard substrates such as rock or hard clay (Gilbert, 1989). As juveniles, sturgeon reside in brackish water near river mouths before moving into the coastal ocean waters. The diet of this species is primarily composed of mussels, shrimp, and small fish (ASMFC 1998).

Since 1998, there has been a moratorium on the harvest of Atlantic Sturgeon in both state and federal waters; however, the population has continued to decline and, in 2012, Atlantic sturgeon became listed under the ESA. The listing identifies five distinct population segments, which include the Gulf of Maine, the New York Bight, the Chesapeake Bay, Carolina, and the South Atlantic (77 FR 5914 and 77 FR 5880, February 6, 2012). All population segments are listed as endangered except for the Gulf of Maine population, which is listed as threatened. Primary threats to the species include historic overfishing, the bycatch of sturgeon in other fisheries, habitat destruction from dredging, dams, and development, and vessel strikes (77 FR 5914; 77 FR 5880).

Impacts on the Atlantic sturgeon population as a result of the menhaden fishery would likely occur through bycatch in gear types such as gillnets, pound nets, and purse seines. There has been no reported or observed bycatch of Atlantic sturgeon in the menhaden gillnet fisheries (77 FR 5880). Furthermore, some states have implemented measures to reduce the bycatch of sturgeon by restricting the use of gillnet gear in coastal waters and instituting seasonal closures for anchored or staked gillnets when sturgeon may be present (77 FR 5880). As a result, impacts to the sturgeon population from the menhaden fishery are thought to be limited.

7.3.4 Seabirds

Like marine mammals, seabirds are vulnerable to entanglement in commercial fishing gear. Under the Migratory Bird Treaty Act, it is unlawful “by any means or in any manner, to pursue, hunt, take, capture, [or] kill” any migratory birds except as permitted by regulation (16 U.S.C. 703). Given that an interaction has not been quantified in the Atlantic menhaden fishery, impacts to seabirds are not considered to be significant. Endangered and threatened bird species, such as the piping plover, are unlikely to be impacted by the gear types employed in the menhaden fishery. Other human activities such as coastal development, habitat degradation and destruction, and the presence of organochlorine contaminants are considered to be the major threats to some seabird populations.

7.4 PROPOSED FEDERAL REGULATIONS/ACTIONS PERTAINING TO THE RELEVANT PROTECTED SPECIES

In May 2016, the National Marine Fisheries Service proposed areas of Atlantic Sturgeon critical habitat along the Atlantic coast. The proposed critical habitat primarily consisted of rivers including the Penobscot River in Maine, the Hudson River in New York, the Potomac River in Maryland, and the Neuse River in North Carolina (81 FR 36077; 81 FR 35701). Comments on the proposal were accepted through the fall of 2016; however, a final rule has not yet been released.

7.5 POTENTIAL IMPACTS TO ATLANTIC COASTAL STATE AND INTERSTATE FISHERIES

There are several take reduction teams, whose management actions have potential impacts to coastal menhaden fisheries. The Northeast sink and Mid-Atlantic coastal gillnet fisheries are the two fisheries regulated by the Harbor Porpoise Take Reduction Plan (50 CFR 229.33 and 229.34). Amongst other measures, the plan uses time area closures in combination with pingers in Northeast waters, and time area closures along with gear modifications for both small and large mesh gillnets in mid-Atlantic waters. Although the plan predominately impacts the dogfish and monkfish fisheries due to higher porpoise bycatch rates, other gillnet fisheries are also affected.

The Atlantic Large Whale Take Reduction Plan (50 CFR 229.32) addresses the incidental bycatch of large baleen whales, primarily the northern right whale and the humpback whale, in several fisheries including the Northeast sink gillnet and Mid-Atlantic coastal gillnet. Amongst other measures, the plan closes right whale critical habitat areas to specific types of fishing gear during certain seasons and modifies fishing gear and practices. The Atlantic Large Whale Take Reduction Team continues to identify ways to reduce possible interactions between large whales and commercial gear. In 2014 and 2015, the Atlantic Large Whale Take Reduction Plan was modified to reduce the number of vertical lines associated with trap/pot fisheries and require expanded gear markings for gillnets and traps in Jeffrey's Ledge and Jordan Basin, respectively (79 FR 35686, June 27, 2014; 80 FR 30367, May 28, 2015).

The Bottlenose Dolphin Take Reduction Team first convened in 2001 to discuss incidental catch of coastal bottlenose dolphins in Category I and II fisheries. In 2006, a Bottlenose Dolphin Take Reduction Plan was established, which created gear regulations for the mid-Atlantic coastal gillnet fishery, the Virginia pound net fishery, the mid-Atlantic beach seine fishery, and the North Carolina inshore gillnet fishery, among others. Specifically, the plan established mesh sizes for the gill net fisheries and prohibited night fishing for some regions and gear types (71 FR 24776, April 26, 2006).

DRAFT

8.0 REFERENCES

Adolf, J. E., C. L. Yeager, W. D. Miller, M. E. Mallonee, and L. W. Harding. 2006. Environmental forcing of phytoplankton floral composition, biomass, and primary productivity in Chesapeake Bay, USA. Estuarine, Coastal and Shelf Science 67(1-2):108- 122.

Ahrenholz, D.W. 1991. Population biology and life history of the North American menhadens, Brevoortia spp. Mar. Fish. Rev. 53: 3-19.

Ahrenholz, D.W., J.F. Guthrie, and R.M. Clayton. 1987. Observations of ulcerative mycosis infections on Atlantic menhaden (*Brevoortia tyrannus*). U.S. NMFS Tech. Mem. NMFS-SEFC 196. 28 p.

Ahrenholz, D.W., W.R. Nelson, and S.P. Epperly. 1987. Population and fishery characteristics of Atlantic menhaden, Brevoortia tyrannus. Fish. Bull. 85: 569-600.

AMAC. 2000. Atlantic Menhaden Management Review, 2000. Report to ASMFC Atlantic Menhaden Board. 18 p.

Anderson, J.D. 2007. Systematics of the North American menhadens: molecular evolutionary reconstructions in the genus Brevoortia (Clupeiformes: Clupeidae). Fishery Bulletin 205:368-378.

Annis, E. A., E. D. Houde, L. W. Harding, Jr., M.E. Mallonee, and M. J. Wilberg. 2011. Calibration of a bioenergetics model linking primary production to Atlantic Menhaden,Brevoortia tyrannus, growth in Chesapeake Bay. Mar. Ecol. Prog. Ser. Vol. 437: 253-267.

Anstead, K.A., J.J. Schaffler, and C.M. Jones. 2016. Coast-wide nursery contribution of new recruits to the population of Atlantic menhaden. Trans. Am. Fish. Soc. 145: 627-636.

Anstead, K.A., J.J. Schaffler, and C.M. Jones. 2017. Contribution of nursery areas to the adult population of Atlantic menhaden. Trans. Am. Fish. Soc. 146: 36-46.

Atlantic Large Whale Take Reduction Plan Regulations. 1999. 64 Fed. Reg. 7529 (February 16, 1999).

Atlantic Large Whale Take Reduction Plan Regulations. 2015. 80 Fed. Reg. 30367 (May 28, 2015).

Atlantic States Marine Fisheries Commission (ASMFC). 1992. Fishery Management Plan for Atlantic Menhaden: 1992 revision. FMR No. 22. ASMFC, Washington, D.C. 159 p.

Atlantic States Marine Fisheries Commission. 1981. Fishery Management Plan for Atlantic Menhaden. ASMFC, Washington, D.C. 146 p.

Atlantic States Marine Fisheries Commission. 1992. Fishery Management Plan for Atlantic Menhaden: 1992 revision. FMR No. 22. ASMFC, Washington, D.C. 159 p.

Atlantic States Marine Fisheries Commission. 1998. Amendment 1 to the Interstate Fishery Management Plan for Atlantic Sturgeon.

Atlantic States Marine Fisheries Commission. 2001. Amendment 1 to The Interstate Fishery Management Plan for Atlantic Menhaden. ASMFC, Washington, D.C. 146 p.

Atlantic States Marine Fisheries Commission. 2004. Addendum I to Amendment I to the Atlantic Menhaden Fishery Management Plan. ASMFC, Washington DC 52 p.

Atlantic States Marine Fisheries Commission. 2004. Atlantic Menhaden Stock Assessment Report for Peer Review. Atlantic States Marine Fisheries Commission, Stock Assessment Report No. 04-01 (supplement). ASMFC, Washington, D.C. 145 p. 2007.06.001 WOS:000250912300003.

Atlantic States Marine Fisheries Commission. 2005. Addendum II to Amendment 1 to the Atlantic Menhaden Fishery Management Plan. ASMFC, Washington, D.C. 30 p.

Atlantic States Marine Fisheries Commission. 2006. Addendum III to Amendment 1 to the Atlantic Menhaden Fishery Management Plan. ASMFC, Washington, D.C. 6 p.

Atlantic States Marine Fisheries Commission. 2009. Addendum IV to Amendment 1 to the Atlantic Menhaden Fishery Management Plan. ASMFC, Washington, D.C. 5 p.

Atlantic States Marine Fisheries Commission. 2011. Addendum V to Amendment 1 to the Atlantic Menhaden Fishery Management Plan. ASMFC, Arlington, VA 17 p.

Atlantic States Marine Fisheries Commission. 2012. Amendment 2 to The Interstate Fishery Management Plan for Atlantic Menhaden. ASMFC, Arlington, VA 114 p.

Atlantic States Marine Fisheries Commission. 2013. Technical Addendum I: Episodic Events Set Aside Program to Amendment 2 to the Atlantic Menhaden Fishery Management Plan. ASMFC, Arlington, VA 4 p.

Atlantic States Marine Fisheries Commission. 2015. Atlantic Menhaden Southeast Data, Assessment, and Review (SEDAR) 40 Stock Assessment Report. 146 p.

Atlantic States Marine Fisheries Commission. 2016. Addendum I to Amendment 2 to the Atlantic Menhaden Fishery Management Plan. ASMFC, Arlington, VA 12 p.

Atlantic States Marine Fisheries Commission. 2016. Interstate Fisheries Management Program Charter. ASMFC, Arlington VA. 29 p.

Austin, H. 2002. Decadal oscillations and regime shifts, a characterization of the Chesapeake Bay Marine Climate. *In*: Fisheries in a Changing Climate. Amer. Fish. Soc. Symp. 32: 155-170.

Austin, H. M., J. Kirkley, and J. Jucy. 1994. By-catch and the fishery for Atlantic menhaden (Brevoortia tyrannus) in the mid-Atlantic bight: AN assessment of the nature and extent of by-catch. VIMS, Va. Mar. Resour. Advisory No. 53, Va. Sea Grant College Prog. Publ. No. VSG-94-06, 39 p.

Bellmund, S.A., J.A. Musick, R.C. Klinger, R.A. Byles, J.A. Keinath, and D.E. Barnard. 1987. Ecology of sea turtles in Virginia. Virginia Institute of Marine Science, College of William and Mary, Gloucester Point, Virginia.

Berrien, P., and J. Sibunka. 1999. Distribution patterns of fish eggs in the U.S. northeast continental shelf ecosystem, 1977–1987. U.S. Dep. Commer., NOAA Tech. Rep. NMFS 145, 310 p.

Best, P.B., A. Branadâo, and D.S. Butterworth. (2001). Demographic parameters of southern right whales off South Africa. J. Cetacean Res. Manage. (Special issue) 2: 161- 169.

Bjorndal KA. 1985. Nutritional ecology of sea turtles. Copeia 3:736– 751. doi:10.2307/1444767

Bjorndal, K. A. 1997. Foraging ecology and nutrition of sea turtles. Pages 199-231 in P. L. Lutz and J. A. Musick, editors. The biology of sea turtles. CRC Press, Boca Raton, Florida, USA.

Blazer, V. S., C. A. Ottinger and C. L. Densmore. 2007. Chapter 13. Factors affecting fish health. pp.54-59. In: Phillips, S. W. (ed.). Synthesis of U.S. Geological Survey science for the Chesapeake Bay ecosystem and implications for environmental management. U.S. Geological Survey Circular 1316.

Bottlenose Dolphin Take Reduction Plan Regulations. 2006. 71 Fed. Reg. 24776 (April 26, 2006).

Brandt, S. B., and D. M. Mason. 2003. Effect of nutrient loading on Atlantic menhaden (Brevoortia tyrannus) growth rate potential in the Patuxent River. Estuaries 26(2A):298- 309.

Brush, G. S. 1986. Geology and paleoecology of Chesapeake Bay: A long-term monitoring tool for management. J. Wash. Acad. Sciences 76: 146-160.

Brush, G.S. 2009. Historical land use, nitrogen, and coastal eutrophication: A paleoecological perspective. Estuar. Coast. 32: 18-28.

Buchheister, A., T.J. Miller, E.D. Houde, D.H. Secor, and R.J. Latour. 2016. Spatial and temporal dynamics of Atlantic menhaden (*Brevoortia tyrannus*) recruitment along the Northwest Atlantic Ocean. ICES J. Mar. Sci. 73: 1147-1159.

Burkholder, J. M., A. S. Gordon, P. D. Moeller, J. M. Law, K. J. Coyne, A. J. Lewitus, J. S. Ramsdell, H. G. Marshall, N. J. Deamer, S. C. Cary, J. W. Kempton, S. L. Morton, and P. A. Rublee. 2005. Demonstration of toxicity to fish and to mammalian cells by Pfiesteria species: Comparison of assay methods.

Burkholder, J. M., E. J. Noga, C. W. Hobbs, H. B. Glasgow, and S. A. Smith. 1992. New “phantom” dinoflagellate is the causative agent of major estuarine fish kills. Nature 358:407-410 (see correction in Nature 360:768).

Burnett, L. E. (1997). The challenge of living in hypoxic and hypercapnic aquatic environments. American Zoology 37: 633-640.

Burton, D. T., L. B. Richardson, and C. J. Moore. 1980. Effect of oxygen reduction rate and constant low dissolved oxygen concentration on two estuarine fish. Trans. Am. Fish. SOC. 109:552-557.

Burton, D. T., P. R. Abell, and T. P. Capizzi. 1979. Cold Shock effect of rate of thermal decrease on Atlantic menhaden, *Brevoortia tyrannus.* Mar. Pollut. Bull. 10:347-349.

Carr, A. 1963. Panspecific reproductive convergence in Lepidochelys kempii. Ergebnisse der Biologie 26:298-303.

Caswell, H., M. Fujiwara and S. Brault. (1999). Declining survival probability threatens the north Atlantic right whale. Proc. Nat. Acad. Sci. 96:3308-3313.

CETAP. 1982. A characterization of marine mammals and turtles in the mid- and north Atlantic areas of the U.S. outer continental shelf. Cetacean and Turtle Assessment Program, University of Rhode

Island. Final Report #AA551- CT8-48 to the Bureau of Land Management, Washington, DC, 538 pp.

Checkley, D.M., Jr., S. Raman, G.L. Maillet and K.M. Mason. 1988. Winter storm effects on the spawning and larval drift of a pelagic fish. Nature 335(6188): 346-348.

Christmas, J.Y., G. Gunter, and E.C. Whatley. 1960. Fishes taken in the menhaden fishery of Alabama, Mississippi and eastern Louisiana. U.S. FWS., Spec. Sci. Rep. Fish. No. 339, 10 p.

Clagett, P.R. 2007. Human population growth and land-use change. *In*: Phillips, S.W. (ed). Synthesis of U.S. Geological Survey Science for the Chesapeake Bay Ecosystem and Implications for Environmental Management: U.S. Geological Survey Circular 1316. 63 p.

Clapham, P.J. & Mayo, C.A. 1987. Reproduction and recruitment of individually identified humpback whales, Megaptera novaeangliae, observed in Massachusetts Bay, 1979-1985. Can.. J. of Zool. 65: 2853-2863.

Clark, C. W. 1995. Application of US Navy underwater hydrophone arrays for scientific research on whales. *Reports of the International Whaling Commission* 45: 210-212.

Cooper, R. A. 1965. An unusually large menhaden, *Brevoortia tyrannus* (Latrobe), from Rhode Island. Transactions of the American Fisheries Society, 94:412.

Corkeron, P., E. Josephson, K. Maze-Foley, and P.E. Rosel, editors. 2016. Draft U.S. Atlantic and Gulf of Mexico Marine Mammal Stocks Assessments, 2016. NOAA Technical Memorandum NOAA-NE-xxx. 343 p.

Critical Habitat for the Endangered Carolina and South Atlantic Distinct Population Segments of Atlantic Sturgeon. 2016. 81 Fed. Reg. 36077 (June 3, 2016).

Cross, F.A., D.S. Peters, and W.E. Schaaf. 1985. Implications of waste disposal in coastal waters on fish populations, pp. 383-399 *In*: Cardwell, R.D., R. Purdy, and R.C. Bahner (eds). Aquatic Toxicology and Hazard Assessment: Seventh Symposium. ASTM STP854. Amer. Soc. for Testing and Materials, Philadelphia.

Designation of Critical Habitat for the Gulf of Maine, New York Bight, and Chesapeake Bay Distinct Population Segments of Atlantic Sturgeon. 2016. 81 Fed. Reg. 35701 (June 3, 2016).

Determination of Nine Distinct Population Segments of Loggerhead Sea Turtles as Endangered or Threatened; Final Rule. 76 Fed. Reg. 58868 (September 22, 2011).

Dryfoos, Robert L., Randall P. Cheek, and Richard L. Kroger. 1973. Preliminary analyses of Atlantic menhaden, Brevoortia tyrannus, migrations, population structure, survival and exploitation rates, and availability as indicated from tag returns. Fishery Bulletin 71(3):719-734.

Durbin, A.G. and E.G. Durbin. 1998. Effects of menhaden predation on plankton populations in Narragansett Bay, Rhode Island. Estuaries 21(3): 449-465.

Durbin, A.G., and E.G. Durbin. 1975. Grazing rates of the Atlantic menhaden, Brevoortia tyrannus, as a function of particle size and concentration. Mar. Biol. (Berl.) 33: 265-277.

Dykstra, M., and A. S. Kane. 2000. Pfiesteria piscicida and ulcerative mycosis of Atlantic Menhaden — Current status of understanding. J. of Aquatic Animal Health 12: 18-25.

Edward, J.L. 2009. An RNA:DNA-based index of growth in juvenile Atlantic menhaden (Brevoortia tyrannus): laboratory calibration and field assessment. University of Maryland, Marine-Estuarine Environmental Sciencies, Masters Sci. thesis.

Ehrhart, L.M., R.B. Sindler, and B.E. Witherington. 1986. Preliminary investigation of papillomatosis in green turtles: phase I--frequency and effects on turtles in the wild and in captivity. Final report to U.S. Department Commerce; NOAA, NMFS, Miami Laboratory. Contract No. 40-GENF-6-0060l.

Endangered Species Act of 1973, Pub L. No. 93-205, 16 U.S.C. § 1531, 87 Stat. 884 (1973).

Ferraro, S. P. 1980. Embryonic development of Atlantic menhaden, Brevoortia tyrannus, and a fish embryo age estimation method. U.S. Natl. Mar. Fish. Serv. Fish. Bull. 77:943-949.

Final Listing Determinations for Two Distinct Population Segments of Atlantic Sturgeon *(Acipenser oxyrinchus)* in the Southeast. 77 Fed. Reg. 5914 (February 6, 2012).

Final rule to List Eleven Distinct Population Segments of the Green Sea Turtle (Chelonia mydas) as Endangered or Threatened and Revision of Current Listings Under the Endangered Species Act; Final Rule. 81 Fed. Reg. 20057 (April 6, 2016).

Forward, Jr., R.B., M.C. De Vries, R.A. Tankersley, D. Rittschof, W.F. Hettler, J.S. Burke, J.M. Welch and D.E. Hoss. 1999. Behaviour and sensory physiology of Atlantic menhaden larvae, Brevoortia tyrannus, during horizontal transport. In: Crowder, L.B. and F.E. Werner (eds.) Fisheries Oceanography of the Estuarine-Dependent Fishes of the South Atlantic Bight. Fish. Oceanogr. 8(suppl. 2): 37-56.

Friedland KD, Hare JA. 2007. Long-term trends and regime shifts in sea surface temperature on the continental shelf of the northeast United States. Cont Shelf Res. 27(18):2313–28. doi: 10.1016/J.Csr.

Friedland, K. D., D. W. Ahrenholz, J. W. Smith, M. Manning, and J. Ryan. 2006. Sieving functional morphology of the gill raker feeding apparatus of Atlantic menhaden. J. Exp. Zool. 305A:974-985.

Friedland, K. D., Patrick D. Lynch, and Christopher J. Gobler. 2011. Time Series Mesoscale Response of Atlantic Menhaden Brevoortia tyrannus to Variation in Plankton Abundances. Journal of Coastal Research: Volume 27, Issue 6: pp. 1148 – 1158.

Friedland, K.D., D.W. Ahrenholz, and J.F. Guthrie. 1989. Influence of plankton on distribution patterns of the filter-feeder *Brevoortia tyrannus* (Pisces, Clupeidae). Mar. Ecol. Prog. Ser. 54: 1-11.

Friedland, K.D., D.W. Ahrenholz, and J.F. Guthrie. 1996. Formation and seasonal evolution of Atlantic menhaden juvenile nurseries in coastal estuaries. Estuaries 19(1): 105-114.

Friedland, K.D., L.W. Haas, and J.V. Merriner. 1984. Filtering rates of the juvenile Atlantic menhaden Brevoortia tyrannus (Pisces: Clupeidae), with consideration of the effects of detritus and swimming speed. Mar. Biol. (Berl.) 84: 109-117.

Geer, R.L. 2008. Shadow on the Chesapeake. Chesapeake Quarterly 7(3): 4-13.

Gilbert, R.J., and AR. Heidt. 1979. Movements of the short nose sturgeon, Acipenser brevirostrum, in the Altamaha River. Assoc. Southeastern Biol. Bull. 26:35.

Goetz, S. J., and P. Jantz. 2006. Sattelite maps show Chesapeake Bay urban development. EOS 87(15): 149, 152.

Goshorn, D., J. Deeds, P. Tango, C. Poukish, A. Place, M. McGinty, W. Butler, C. Luckett, and R. Magnien. 2004. Occurrence of Karlodinium micrum and its association with fish kills in Maryland Estuaries. In Proceedings of the Tenth International Conference on Harmful Algae, St. Petersburg, FL.

Gottlieb, S.J. 1998. Ecological role of Atlantic menhaden (Brevoortia tyrannus) in Chesapeake Bay and implications for management of the fishery. MS Thesis, U. of MD, MEES Program. 112 p.

Greer, R.L. 1915. The menhaden fishing industry of the Atlantic coast. Rep. U.S. Comm. Fish., 1914, Append. 3, 27 p.

Hain, J. H. W., M. J. Ratnaswamy, R. D. Kenney, and H. E. Winn. 1992. The fin whale, Balaenoptera physalus, in waters of the northeastern United States continental shelf. Rep. Int. Whal. Commn. 42: 653-669.

Hall Jr., L.W., S.A. Fisher, and J.A. Sullivan. 1991. A synthesis of water quality and contaminants data for the Atlantic menhaden, *Brevoortia tyrannus*: implications for Chesapeake Bay. J. Environ. Sci. Health Part A Environ. Sci. Eng. 26: 1513-1544.

Harbor Porpoise Take Reduction Plan Regulations. 1998. 63 Fed. Reg. 66464 (December 2, 1998).

Harbor Porpoise Take Reduction Plan Regulations. 2013. 78 Fed. Reg. 61821 (October 4, 2013).

Hare, J. A. and J. J. Govoni. 2005. Comparison of average larval fish vertical distributions among species exhibiting different transport pathways on the southeast United States continental shelf. Fish. Bull., U.S. 103:728-736.

Hare, J. A., S. Thorrold, H. Walsh, C. Reiss, A. Valle-Levinson and C. Jones. 2005. Biophysical mechanisms of larval fish ingress into Chesapeake Bay. Marine Ecology Progress Series 303:295-310.

Harrison, R.W. 1931. The menhaden industry. U.S. Bur. Fish., Invest. Rep. 1, 113 p.

Hettler Jr., W.F., and A.J. Chester. 1990. Temporal distribution of ichthyoplankton near Beaufort Inlet, North Carolina. Mar. Ecol. Prog. Ser. 68: 157-168.

Hettler, W. F., and D. R. Colby. 1979. A1 teration of heat resistance of Atlantic menhaden, Brevoortia tyrannus, by photoperiod. J. Comp. Biochem. Physiol. 63A: 141-143.

Hettler, W. F., Jr., D. S. Peters, D. R. Colby, and L. H. Laban. 1997. Daily variability in abundance of larval fishes inside Beaufort Inlet. Fish. Bull. 95:477–493.

Hettler, W.F. 1976. Influence of temperature and salinity on routine metabolic rate and growth of young Atlantic menhaden. J. Fish. Biol. 8: 55-65.

Hettler, W.F. 1981 Spawning and rearing Atlantic menhaden. Prog. Fish-Cult. 43:80-84.

Higham, J.R., and W.R. Nicholson. 1964. Sexual maturation and spawning of Atlantic menhaden. Fish. Bull. 63: 255-271.

Hilgartner, W. B. and G.S. Brush. 2006. Prehistoric habitat stability and post-settlement habitat change in a Chesapeake Bay freshwater tidal wetland, USA. Holocene 16:479-494.

Hirth, H.F. 1971. Synopsis of biological data on the green turtle Chelonia & (Linnaeus) 1758. FA0 Fish. Synop. 85:l-8, 19.

Houde unpublished. 2011. Unpublished data. Larval ingress research supported by NOAA Chesapeake Bay Office, Maryland DNR, and Atlantic States Marine Fisheries Commission. University of Maryland Center for Environmental Science, Chesapeake Biological Laboratory, Solomons, MD.

Houde, E. D. and L. W. Harding, Jr. 2009. Menhaden abundance and productivity in Chesapeake Bay: linking the environment and primary production to variability in fish recruitment. Final Report to NOAA Chesapeake Bay Office, Annapolis, MD. Grant No. NA04NMF4570359. Ref. No.

Houde, E. D., Annis, E. R., Harding, L. W., Mallonee, M. E., and M. J. Wilberg. 2016. Factors affecting the abundance of age-0 Atlantic menhaden (*Brevoortia tyrannus)* in Chesapeake Bay. ICES Journal of Marine Science, 73(9):2238-2251.

Hughes, A. R., S. L. Williams, C. M. Duarte, K. L. Heck, Jr., and M. Waycott. 2009. Associations of concern: declining seagrasses and threatened dependent species. Front. Ecol. Environ. 7(5): 242-246.

Humphrey, J., Wilberg, M.J., Houde E.D. & M. C. Fabrizio. 2014. Effects of Temperature on Age-0 Atlantic Menhaden Growth in Chesapeake Bay. Transactions of the American Fisheries Society. Vol. 143. Pages 1255-1265.

Identification of 14 Distinct Population Segments of the Humpback Whale *(Megaptera novaeangliea)* and Revision of Species-Wide Listing; Final Rule. 81 Fed. Reg. 62259 (September 8, 2016).

International Whaling Commission. 1992. Report of the comprehensive assessment special meeting on North Atlantic fin whales. Rep. int. Whal. Commn 42:595B644.

Judy, M.H., and R.M. Lewis. 1983. Distribution of eggs and larvae of Atlantic menhaden, Brevoortia tyrannus, along the Atlantic coast of the United States. U.S. NMFS. Spec. Sci. Rep. Fish. 774. 23 p.

June, F.C., and J.L. Chamberlin. 1959. The role of the estuary in the life history and biology of Atlantic menhaden. Proc. Gulf Carib. Fish. Inst. 11: 41-45.

Katona, S. K., and J. A. Beard. 1990. Population size, migrations, and feeding aggregations of the humpback whale (Megaptera novaeangliae) in the western North Atlantic Ocean. Rep. int. Whal. Commn. Special Issue 12: 295- 306.

Keinath, J.A., J.A. Musick, and R.A. Byles. 1987. Aspects of the biology of Virginia sea turtles: 1979-1986. Virginia Journal of Science 38(2):81.

Kendall, A.W. and J.W. Reintjes. 1975. Geographic and hydrographic distribution of Atlantic menhaden eggs and larvae along the middle Atlantic coast from R/V Dolphin cruises, 1965-1966. NMFS Fish. Bull. 73: 317-355.

Kenney, R. D. 2002. North Atlantic, North Pacific and southern right whales. Pages 806- 813 In W. F. Perrin, B. Wursig, J. G. M. Thewissen (eds.), Encyclopedia of marine mammals. Academic Press, San Diego, CA.

Kimmel, D. G., W. D. Miller, L. W. Harding Jr., E. D. Houde, and M. R. Roman. 2009. Estuarine ecosystem response captured using a synoptic climatology. Estuaries and Coasts. 32:3: 403-409.

Kiryu, Y., J. D. Shields, W. K. Vogelbein, D. E. Zwerner, and H. Kator. 2002. Induction of skin ulcers in Atlantic menhaden by injection and aqueous exposure to the zoospores of Aphanomyces invadans. J. of Aquatic Animal Health 14(1): 11-24.

Kleisner, K.M., M.J. Fogarty, S. McGee, A. Barnett, P. Fratantoni, J. Greene, J.A. Hare, S.M. Lucey, C. McGuire, J. Odell, and V.S. Saba. 2016. The effects of sub-regional climate velocity on the distribution and spatial extent of marine species assemblages. PLoS ONE 11(2): e0149220. doi:10.1371/journal.pone.0149220

Knowlton, A.R. and S.D. Kraus. 2001. Mortality and serious injury of North Atlantic right whales (Eubalaena glacialis) in the North Atlantic Ocean. J. Cetacean Res. Manage. (Special Issue) 2: 193-208.

Kraus, S. D., M. J., Crone and A. R. Knowlton. 1988. The North Atlantic right whale. Pages 684-698 *in* W. J. Chandler, ed. Audubon Wildlife Report, 1988/1989. Academic Press, New York, NY.

Kroger, R. L., J. F. Guthrie, and M. H. Judy. 1974. Growth and first annulus formation of tagged and untagged Atlantic menhaden. Trans. Am. Fish. SOC. 103:292-296.

Laist, D. W., Knowlton, A. R., Mead, J. G., Collet, A. S. and Podesta, M. 2001. Collisions between ships and whales. *Marine Mammal Science* 17(1): 35-75.

Laney, Wilson, Personal Communication. USFWS. March 2017.

Levine, J. F. 1990b. Species distribution of ulcerative lesions on finfish in the Tar-Pamlico River Estuary, North Carolina. Dis, of Aquatic Org. 8:1-5.

Levine, J. F., J. H. Hawkins, M. J. Dykstra, E. J. Noga, D. W. Moye, and R. S. Cone 1990a. Epidemiology of Ulcerative Mycosis in Atlantic Menhaden in the Tar-Palmico River Estuary, North Carolina. J. of Aquatic Animal Health 2:162-171.

Lewis R. M. and W. F. Hettler, Jr.1968. Effect of temperature and salinity on the survival of young Atlantic menhaden, Brevoortia tyrannus. Trans. Am. Fish. Soc. 97: 344-349.

Lewis, R. M. 1965. The effect of minimum temperature on the survival of larval Atlantic menhaden, Brevoortia tyrannus. Trans. Am. Fish. Soc. 94: 409-412.

Lewis, R.M. 1966. Effects of salinity and temperature on survival and development of larval Atlantic menhaden, *Brevoortia tyrannus*. Trans. Am. Fish. Soc. 95: 423-426.

Lewis, R.M., and W.C. Mann. 1971. Occurrence and abundance of larval Atlantic menhaden, *Brevoortia tyrannus*, at two North Carolina Inlets with notes on associated species. Trans. Am. Fish. Soc. 100: 296-301.

Lewis, R.M., D.W. Ahrenholz, and S.P. Epperly. 1987. Fecundity of Atlantic menhaden, Brevoortia tyrannus. Estuaries 10(4): 347-350.

Lewis, V.P., and D.S. Peters. 1984. Menhaden - a single step from vascular plant to fishery harvest. J. Exp. Mar. Biol. Ecol. 84: 95-100.

Light, P.R., and K.W. Able. 2003. Juvenile Atlantic menhaden (*Brevoortia tyrannus*) in Delaware Bay, USA are the result of local and long-distance recruitment. Estuar. Coast. Shelf. S. 57:1007-1014.

List of Fisheries for 2001. 66 Fed. Reg. 42780 (August 15, 2001).

DRAFT

List of Fisheries for 2003. 68 Fed. Reg. 41725 (July 15, 2003).
List of Fisheries for 2006. 71 Fed. Reg. 48802 (August 22, 2006).
List of Fisheries for 2007. 72 Fed. Reg. 14466 (March 28, 2007).
List of Fisheries for 2012. 76 Fed. Reg. 73911 (November 29, 2011).
List of Fisheries for 2017. 82 Fed. Reg. 3655 (January 12, 2017).
Lorenzen, K. 1996. The relationship between body weight and natural mortality in juvenile and adult fish: A comparison of natural ecosystems and aquaculture. Journal of Fish Biology 49:627-647.
Love, J. W., A. K. Johnson and E. B. May. 2006. Spatial and temporal differences of Atlantic menhaden (Brevoortia tyrannus) recruitment across major drainages (1966-2004) of the Chesapeake Bay watershed. Estuaries and Coasts 29:794-801.
Lozano, C. and E. D. Houde. 2013. Factors contributing to variability in larval ingress of Atlantic menhaden, *Brevoortia tyrannus.* Estuarine, Coastal and Shelf Science, 118:1-10.
Lozano, C., Houde, E. D., Wingate, R. L., and D. H. Sector. 2012. Age, growth and hatch dates of ingressing larvae and surviving juveniles of Atlantic menhaden *Brevoortia tyrannus.* Journal of Fish Biology, 81:1665-1685.
Luo, J., K. J. Hartman, S. B. Brandt, C. F. Cerco, and T. H. Rippetoe. 2001. A spatially-explicit approach for estimating carrying capacity: an application for the Atlantic menhaden (Brevoortia tyrannus) in Chesapeake Bay. Estuaries 24(4):545-556.
Lutcavage, M. and J.A. Musick. 1985. Aspects of sea turtle biology in Virginia. Copeia 2:449- 456.
Lynch, A. J., J. R. McDowell, J. E. Graves. 2010. A molecular genetic investigation of the population structure of Atlantic menhaden (Brevoortia tyrannus). Fishery Bulletin 108:87-97.
Lynch, P.D., M.J. Brush, E.D. Condon, and R.J. Latour. 2010. Net removal of nitrogen through ingestion of phytoplankton by Atlantic menhaden (Brevoortia tyrannus) in Chesapeake Bay. Marine Ecological Progress Series 401: 195-209.
Magnuson-Stevens Fishery Conservation and Management Act, Pub. L. No. 94-265, 16 U.S.C. § 1801 et seq., 90 Stat. 331 (1976).
Manderson, John, Personal Communication. NOAA Northeast Fishery Science Center. April 2017.
Marine Mammal Protection Act of 1972 As Amended, Pub. L. No. 92-522, 16 U.S.C. § 11361-1362, 1371-1389, 1401-1407, 1411-1418, 1421-1421h, 1423-1423h, 86 Stat. 1027 (1972).
MDSG, 2009. EBFM Menhaden Species Team. Ecosystem-Based Fisheries Management For Chesapeake Bay: Menhaden Background and Issue Briefs. Maryland Sea Grant, College Park, MD. UM-SG-TS-2009-08.
Miller, W. D., and L. W. Harding, Jr. 2007. Climate forcing of the spring bloom in Chesapeake Bay. Marine Ecology Progress Series 331:11-22.
Musick, J. A., and C. J. Limpus. 1997. Habitat utilization and migration in juvenile sea turtles. Pages 137-164 in P. L. Lutz and J. A. Musick, editors. The biology of sea turtles. CRC Press, Boca Raton, Florida, USA.
National Marine Fisheries Service. 1991. Proposed regime to govern the interactions between marine mammals and commercial fishing operations after October 1, 1993. Draft Environmental Impact Statement, June 1991.
National Marine Fisheries Service. 1993. Report on Implementation of the Marine Mammal Protection Act Interim Exemption Program, 1988-1993. Office of Protected Resources, NMFS, NOAA. 63 pp.
National Marine Fisheries Service. 1995. Status Reviews of Sea Turtles Listed Under the Endangered Species Act of 1973. Silver Spring, MD.
National Marine Fisheries Service. 1997. Fin Whale *(Balaenoptera physalus):* Western North Atlantic Stock.
National Marine Fisheries Service. 1999. Endangered Species Act Section 7 Consultation. Biological Opinion. Consultation Regarding the Federal Atlantic Herring Fishery.

National Marine Fisheries Service. 2002. U.S. Atlantic and Gulf of Mexico Marine Mammal Stock Assessments – 2002.

National Marine Fisheries Service. 2007. Hawksbill Sea Turtle *(Eretmochelys imbricata)* 5-Year Review: Summary and Evaluation. Office of Protected Resources. Silver Spring, MD.

National Marine Fisheries Service. 2008. Bottlenose Dolphin *(Tursiops truncates):* Western North Atlantic Coastal Morphotype Stocks.

National Marine Fisheries Service. 2011. Fin Whale *(Balaenoptera physalus)* 5-Year Review: Summary and Evaluation. Office of Protected Resources. Silver Spring, MD.

National Marine Fisheries Service. 2012. North Atlantic Right Whale 5 Year Review: Summary and Evaluation. Northeast Regional Office. Gloucester, MA.

National Marine Fisheries Service. 2013. Biological Report on the Designation of Marine Critical Habitat for the Loggerhead Sea Turtle, *Caretta caretta.*

National Marine Fisheries Service. 2013. Leatherback Sea Turtle *(Dermochelys coriacea)* 5-Year Review: Summary and Evaluation. Office of Protected Species, Silver Spring, MD.

National Marine Fisheries Service. 2015. Standardized Bycatch Reporting Methodology: An Omnibus Amendment to the Fishery Management Plans of the Mid-Atlantic and New England Regional Fishery Management Councils.

Nelson, W.R., M.C. Ingham, and W.E. Schaaf. 1977. Larval transport and year-class strength of Atlantic menhaden, Brevoortia tyrannus. Fish. Bull. 75: 23-41.

Nicholson, W.R. 1972. Population structure and movements of Atlantic menhaden, Brevoortia tyrannus, as inferred from back-calculated length frequencies. Ches. Sci. 13: 161-174.

Nicholson, W.R. 1978. Movements and population structure of Atlantic menhaden indicated by tag returns. Estuaries 1(3): 141-150.

Noga, E. J. and M. J. Dykstra. 1986. Oomycete fungi associated with Ulcerative Mycosis in Menhaden, Brevoortia-tyrannus (Latrobe). Journal of Fish Diseases 9(1):47-53.

Noga, E. J., J. F. Levine, M. J. Dykstra, and J. H. Hawkins. 1988. Pathology of ulcerative mycosis in Atlantic menhaden Brevoortia tyrannus. Dis. of Aquatic Org. 4: 189-197.

Nordlie, F. G. 1976. Influence of environmental temperature on plasma ionic and osmotic concentrations in *Mugil cephalus*. L. Comp. Biochem. Physiol. 55A:379-381.

Nordlie, F. G., W. A. Szelistowski, and W. C. Nordlie. 1982 Ontogenesis of osmostic regulation in the striped mullet, *Mugil cephalus*. L. J. Fish Biol. 20:79-86.

North Carolina Department of Environmental Quality. 2015. North Carolina Division of Water Resources Annual Report of Fish Kill Events 2015. North Carolina Department of Environmental Quality Division of Water Resources, Raleigh, NC.

ORCS-Berkson, J., L. Barbieri, S. Cadrin, S. L. Cass-Calay, P. Crone, M. Dorn, C. Friess, D. Kobayashi, T. J. Miller, W. S. Patrick, S. Pautzke, S. Ralston, M. Trianni. 2011. Calculating Acceptable Biological Catch for Stocks That Have Reliable Catch Data Only (Only Reliable Catch Stocks – ORCS). NOAA Technical Memorandum NMFS-SEFSC- 616, 56 P.

Orth, R, J., T. J. B. Carruthers, W. G. Dennison, C. M. Duarte, J. W. Fourqurean, K. L. Heck, Jr., A. R.Hughes, G. A. Kendrick, W. J. Kenworthy, S. Olyarnik, F. T. Short, M. Waycott, and S. L.Williams. 2006. A global crisis for seagrass ecosystems. BioScience 56(12): 987-996.

Oviatt, A. 1977. Menhaden, sport fish and fishermen, p. 53-66 In: Clepper, H. [Ed.] Marine recreational fisheries 2. Sport Fish. Inst., 220 p.

Oviatt, C.A., A.L. Gall, and S.W. Nixon. 1972. Environmental effects of Atlantic menhaden on surrounding waters. Chesapeake Sci. 13: 321-323.

Paerl, H. W., J. L. Pickney, J. M. Fear, and B. L. Peierls. 1998. Ecosystem responses to internal and watershed organic matter loading: consequences for hypoxia in the eutrophying Neuse River Estuary, North Carolina, USA. Marine Ecol. Progress Ser. 166: 17-25.

Perry S. L., DeMaster D. P. and Silber G. K. 1999. The fin whale. *Marine Fish Review* 61(1): 44-51.

Pershing, A. J., Alexander, M. A., Hernandez, C. M., Kerr, L. A., Bris, A. L. Mills, K. E., Nye, J. A., Record, N. R., Scannell, H. A., Scott, J. D., Sherwood, G. D., and A. C. Thomas. 2015. Slow adaptation in the face of rapid warming leads to collapse of the Gulf of Maine cod fishery. *Science,* Vol. 350, Issue 6262: 809-812.

Peters, D.S., and V.P. Lewis. 1984. Estuarine productivity: Relating trophic ecology to fisheries, p. 255-264 In: B.J. Copeland, K. Hart, N. Davis and S. Friday, (eds.) Research Managing the Nation's Estuaries. UNC Sea Grant College, Pub. UNC-SG-84-08, 420 p.

Peters, D.S., and W.E. Schaaf. 1981. Food requirements and sources for juvenile Atlantic menhaden. Trans. Am. Fish. Soc. 110: 317-324.

Poukish, Charles, Personal Communication. Environmental Assessment Division, Maryland Department of the Environment. March 2017.

Quinlan, J.A., B.O. Blanton, T.J. Miller, and F.E. Werner. 1999. From spawning grounds to the estuary: using linked individual-based and hydrodynamic models to interpret patterns and processes in the oceanic phase of Atlantic menhaden *Brevoortia tyrannus* life history. Fish. Ocean. 8 (Supplement 2): 224-246.

Reimschussel, R., C. M. Gieseker, C. Driscoll, A. Baya, A. S. Kane, V. S. Blazer, J. J. Evans, M. L. Kent, J. D. W. Moran and S. L. Poynton. 2003. Myxosporean plasmodial infection associated with ulcerative lesions in young-of-the-year Atlantic menhaden in a tributary of the Chesapeake Bay, and possible links to Kudoa clupeidae. Diseases Aquatic Organisms 53:143-166.

Reintjes, J.W., and A. Pacheco. 1966. The relation of menhaden to estuaries. Am. Fish. Soc. Spec. Publ. 3: 50-58.

Reish, R.L., R.B. Deriso, D. Ruppert, and R.J. Carroll. 1985. An investigation of the population dynamics of Atlantic menhaden (Brevoortia tyrannus). Can. J. Fish. Aquat. Sci. 42 (Suppl. 1): 147-157.

Rice, J.A., Quinlan, J.A., Nixon, S. W., Hettler, W. F., Warlen, S. M., and P. M. Steggmann. 1999. Spawning and transport dynamics of Atlantic menhaden: inferences from characteristics of immigrating larvae and predictions of a hydrodynamic model. Fisheries Oceanography 8:93-110.

Rogers, S. G., T. E. Targett, and S. B. VanSant. 1984. Fish-nursery use in Georgia salt-marsh estuaries: the influence of springtime freshwater conditions. Trans. AM. Fish. Soc. 113:595-606.

Rogers, S.G. and M.J. Van Den Avyle. 1989. Species Profiles: Life histories and environmental requirements of coastal fishes and invertebrates (Mid-Atlantic). Atlantic Menhaden. Biol. Rept. 82(11.108) TR EL-82-4. 23 p.

Schaaf, W. E. and G. R. Huntsman. 1972. Effects of fishing on the Atlantic menhaden stock: 1955-1969. Transactions of the American Fisheries Society, 101:290-297.

Schick, R. S., P. N. Halpin, A. J. Read, C. K. Slay, S. D. Kraus, B. R. Mate, M. F. Baumgartner, J. J. Roberts, B. D. Best, C. P. Good, S. R. Loarie, J.S. Clark. 2009. Striking the Right Balance in Right Whale Conservation. Canadian Journal of Fisheries and Aquatic Sciences 66(9):1399-1403.

Schueller, A.M., E.H. Williams, and R.T. Cheshire. 2014. A proposed, tested, and applied adjustment to account for bias in growth parameter estimates due to selectivity. Fisheries Research 158: 26-39.

Sherman, K., I. Belkin, K.D. Friedland, J. O'Reilly, and K. Hyde. 2009. Accelerated warming and emergent trends in fisheries biomass yields of the world's largest marine ecosystems. AMBIO: A Journal of the Human Environment 38(4): 215-224.

Smith, H.M. 1896. Notes on an investigation of the menhaden fishery in 1894 with special reference to the 93 food fishes taken. Bull. U.S. Fish Comm. 15: 285-302.

Smith, J. W. 1991. The Atlantic and gulf menhaden purse seine fisheries: origins, harvesting technologies, biostatistical monitoring, recent trends in fisheries statistics, and forecasting. Mar. Fish. Rev. 53(4):28–41.

Smith, J. W.1999. Distribution of Atlantic menhaden, Brevoortia tyrannus, purse-seine seta and catches from southern New England to North Carolina, 1985-1996, NOAA Tech. Rep. NMFS 144, 22p.

Smith, JW and WB O'Bier. 2011. The bait purse-seine fishery for Atlantic menhaden, Brevoortia tyrannus, in the Virginia portion of Chesapeake Bay. Mar Fish Rev 73(1): 1-12.

Smith, Kent, Personal Communication. Florida Fish Wildlife Conservation Commission. March 2017.

Stegmann, P.M., J.A. Quinlan, F.E. Werner, B.O. Blanton, and P. Berrien. 1999. Atlantic menhaden recruitment to a southern estuary: Defining potential spawning regions. Fish. Oceanogr. 8: 111-123.

Stephens, E. B., M. W. Newman, A. L. Zachary and F. M. Hetrick. (1980). A viral aetiology for the annual spring epizootics of Atlantic menhaden, Brevoortia tyrannus (Latrobe) in Chesapeake Bay. Journal of Fish Diseases 3:387-398.

Stine et al. 2005. Mycobacterial infection in laboratory-maintained Atlantic menhaden. J. Aquatic Animal Health 17:380-385.

Stout, V.F., C.R. Houle, and F.L. Beezhold. 1981. A survey of chlorinated hydrocarbon residues in menhaden fishery products. Mar. Fish. Rev. 43(3): 1-13.

Taking of Marine Mammals Incidental to Commercial Fishing Operations; Bottlenose Dolphin Take Reduction Plan Regulations; Sea Turtle Conservation; Restrictions to Fishing Activities; Final Rule. 71 Fed. Reg. 24776 (April 26, 2006).

Thompson, C. 2010. The Gulf of Maine in Context: State of the Gulf of Maine Report. Fisheries and Oceans Canada. Dartmouth, NS.

Threatened and Endangered Status for Distinct Population Segments of Atlantic Sturgeon in the Northeast Region. 77 Fed. Reg. 5880 (February 6, 2012).

U.S. Census Bureau. 2010. Coastline Population Trends in the United States: 1960 to 2008 Population Estimates and Projections. P25-1139. https://www.census.gov/prod/2010pubs/p25-1139.pdf

Vaughan, D.S., and J.W. Smith. 1988. A stock assessment of the Atlantic menhaden, Brevoortia tyrannus, fishery. NOAA Tech. Rep. NMFS 63, 18 p.

Viverette, C. B., Garman, G. ., McIninch, S. P., Markham, A. C., Watts, B. D., and S. A. Macko. 2007. Finfish-waterbird trophic interactions in tidal freshwater tributaries of the Chesapeake Bay. Waterbirds. 32:1: 50-62.

Walford, L.A., and R.I. Wicklund. 1968. Monthly sea temperature structure from the Florida Keys to Cape Cod. Serial Atlas of the Marine Environment. Folio 15. American Geographical Society, N .Y.

Walsh, H. J., Richardson, D. E., Marancik, K. E., and Hare, J. A. 2015. Long-term changes in the distributions of larval and adult fish the Northeast U.S. Shelf Ecosystem. PLoS ONE, 10: e0137382.

Waring GT, Josephson E, Fairfield-Walsh CP, Maze-Foley K, (eds.). 2009. U.S. Atlantic and Gulf of Mexico Marine Mammal Stock Assessments -- 2008. NOAA Tech Memo NMFS NE 210; 440 p.

Waring, G.T. J.M. Quintal and S.L. Swartz (eds.). 2000. U.S. Atlantic and GOM Marine Mammal Stock Assessments- 2000. NOAA Tech Memo. NMFS-NE-162, U.S. DOC. Washington, D.C. 303 p.

Waring, G.T., E. Josephson, K. Maze-Foley, and P.E. Rosel, editors. 2016. U.S. Atlantic and Gulf of Mexico Marine Mammal Stocks Assessments, 2015. NOAA Technical Memorandum NOAA-NE-238. 512 p.

Warlen, S. M. 1994. Spawning time and recruitment dynamic of larval Atlantic menhaden, *Brevoortia tyrannus,* in a North Carolina estuary. Fisheries Bulletin, 92:420-433.

Warlen, S.M., D.A. Wolfe, C.W. Lewis, and D.R. Colby. 1977. Accumulation and retention of dietary 14C-DDT by Atlantic menhaden. Trans. Am. Fish. Soc. 106: 95-104.

Warlen, S.M., K.W. Able, and E.H. Laban. 2002. Recruitment of larval Atlantic menhaden (*Brevoortia tyrannus*) to North Carolina and New Jersey estuaries: evidence for larval transport northward along the east coast of the United States. Fish. Bull. 100(3): 609-623.

Werner, F.E., B.O. Blanton, J.A. Quinlan and R.A. Luettich, Jr. 1999. Physical oceanography of the North Carolina continental shelf during the fall and winter seasons: implications for the transport of larval menhaden. In: Crowder, L.B. and F.E. Werner (eds.) Fisheries Oceanography of the Estuarine-dependent Fishes of the South Atlantic Bight. Fish. Oceanogr. 8(suppl. 2): 7-21.

Westman, J. R., and R. F. Nigrelli. 1955. Preliminary studies of menhaden and their mass mortalities in Long Island and New Jersey waters. N .Y. Fish Game J. 2: 142-153.

Whitehurst, J.W. 1973. The menhaden fishing industry in North Carolina. UNC-Sea Grant Publ. No. UNC-SG-72-12, 51 p.

Wiley, D. N., R. A. Asmutis, T. D. Pitchford, and D. P. Gannon. 1995. Stranding and mortality of humpback whales, Megaptera novaeangliae, in the mid-Atlantic and southeast United States, 1985-1992. Fish. Bull., U.S. 93: 196- 205.

Wilkens, E. P. H., and R. M. Lewos. 1971. Abundance and distribution of young Atlantic menhaden (*Brevoortia tyrannus)* in the White Oak River estuary, North Carolina. Fish. Bull., U.S. 69: 783-789.

Winn, H.E., C.A. Price and P.W. Sorensen. (1986). The distributional biology of the right whale (Eubalaena glacialis) in the western north Atlantic. Rep. Int. Whal. Comm. (Special issue) 10:129-138.

Wood, R. J., and H. M. Austin. 2009. Synchronous multidecadal fish recruitment patterns in Chesapeake Bay, USA. Can. J. Fish. Aquat. Sci.

Wood, R. J., E. D. Houde and S. Jung. 2004. Variability in the dynamics of forage fish abundances in Chesapeake Bay: retrospective analysis models and synthesis. Pages 97- 107. In; Orner, D. M. (ed.). Chesapeake Bay Fisheries Research Program, Symposium Report- -2003. NOAA Chesapeake Bay Office, Annapolis, MD.

Wood, R.J. 2000. Synoptic scale climatic foraging of multispecies fish recruitment patterns in Chesapeake Bay. Coll. of William and Mary, Ph.D. Dissertation, 163 p.

Wynne, K. and M. Schwartz. 1999. Marine Mammals and Turtles of the U. S. Atlantic and Gulf of Mexico. Rhode Island Sea Grant. Narragansett, Rhode Island. 114 pp.

DRAFT

9.0 TABLES

Table 16: Atlantic menhaden total commercial landings by jurisdiction (in pounds). This includes directed landings, landings under the bycatch allowance, and episodic events landings.

	ME	NH	MA	RI	CT	NY	NJ	DE	MD	PFRC	VA	NC	SC	GA	FL
1985	C		3,039,625	8,388,046	234,800	901,800	2,879,766	176,135	5,372,193	16,768,889	620,119,243	97,738,403	C	-	7,579,674
1986	C		3,411,000	10,389,187	254,400	399,650	2,453,593	20,081	5,449,350	10,971,973	445,664,204	66,377,931	9,952	-	7,997,973
1987	C		1,215,175	13,609,224	94,900	206,795	2,563,163	22,034	5,793,683	13,120,698	622,989,111	55,498,571	C	-	2,776,777
1988	C	C	8,047,320	15,583,437	175,200	504,100	1,984,045	127,713	6,430,164	13,231,368	565,962,962	73,715,713	500	-	1,026,228
1989	C	C	1,459,402	19,033,173	148,500	449,100	2,854,361	104,382	6,166,236	8,334,174	590,581,595	66,756,288	-	-	1,372,959
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	699,320,699	72,231,989	-	-	2,636,497
1991	C	204,000	12,798,310	5,090,375	96,300	650,150	16,597,402	278,774	3,540,179	5,376,264	638,130,543	110,528,754	-	-	2,062,983
1992	C	C	13,499,450	2,849,359	91,200	1,131,701	27,470,906	131,033	1,777,088	5,061,565	566,222,504	57,515,712	C	-	2,788,592
1993	19,520,455	C	1,211,569	5,146,280	195,827	1,048,993	28,296,741	164,406	2,326,613	7,884,001	622,024,284	64,711,384	-	-	2,584,766
1994	-		351,251	533,800	60,128	961,474	38,176,201	78,672	2,369,071	6,680,937	502,576,593	73,853,901	-	-	1,387,012
1995	-		2,910,613	5,873,315	255,264	1,087,978	36,572,507	101,388	4,264,754	7,002,818	691,212,717	2,792,221	-	-	687,944
1996	-		8,500	802	82,851	11,135	35,516,726	100,063	3,906,808	5,111,423	579,027,717	56,583,873	-	-	294,936
1997	-		238,500	5,750	72,329	553,953	38,118,579	55,733	3,457,237	5,757,370	494,098,429	56,295,597	C	-	408,492
1998	-	C	121,200	400	338,817	430,084	33,287,641	58,048	2,933,818	3,980,738	513,869,130	97,473,775	-	-	301,566
1999	-		292,800	2,330	30,298	242,886	27,753,567	78,551	4,460,534	4,860,883	374,934,651	57,434,540	-	-	288,144
2000	-		72,600	320,000	14,423	565,800	31,266,780	47,995	3,935,307	5,023,374	358,228,939	42,034,812	-	-	260,710
2001	-		144,600	-	38,865	576,426	26,375,573	53,257	3,970,243	3,329,035	484,517,820	57,261,488	-	-	179,951
2002	-		301,500	5,750	1,138,788	444,739	24,716,412	80,261	4,023,389	3,122,050	362,633,153	55,600,503	-	-	55,304
2003	-		218,255	62	46,515	384,875	17,080,463	43,193	3,163,252	2,438,790	372,479,419	68,444,122	-	-	35,810
2004	-	C	-	39,232	33,210	543,481	20,678,813	75,635	5,369,952	5,411,043	394,093,117	48,318,743	-	-	21,220
2005	-		2,177,724	14,453	30,636	871,081	17,574,826	120,658	10,635,776	4,759,905	370,689,041	50,987,985	-	-	39,404
2006	-		2,524,255	15,524	866,235	811,934	21,290,309	111,405	6,841,296	3,413,517	369,912,280	12,846,438	-	-	157,117
2007	C	C	5,543,805	8,948	90,254	483,557	37,202,485	81,850	11,210,764	5,036,906	416,447,111	1,134,167	-	-	71,373
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	344,813,285	645,231	-	-	60,098
2009	166,942	33	6,719,048	107,548	170,907	330,496	33,329,177	69,476	7,756,192	3,191,905	349,413,370	2,124,733	-	-	52,800
2010	38,000	C	4,973,857	78,149	42,489	394,556	50,497,253	51,933	6,903,300	2,790,728	430,527,995	1,299,130	-	-	76,593
2011	56,000		116,151	83,899	26,929	279,117	74,324,485	70,326	6,505,890	2,759,597	411,802,254	3,529,967	-	-	146,534
2012	C	C	1,648,395	106,606	37,454	258,271	85,457,890	140,375	13,746,098	5,892,228	386,545,236	538,783	-	-	126,141
2013	-		2,314,888	99,821	26,463	1,187,525	39,819,342	125,912	7,074,727	3,295,295	315,724,384	454,172	-	-	276,636
2014	-		2,226,294	500,903	36,552	825,549	41,449,670	161,512	7,005,271	3,175,893	324,209,381	917,375	-	-	220,694
2015	-		2,932,828	2,060,381	77,003	1,468,165	47,810,037	150,542	7,551,430	2,739,035	351,281,666	896,919	C	-	377,729
2016	4,548,566	-	3,069,433	317,328	66,957	1,439,173	45,826,473	75,238	5,198,654	2,504,823	334,145,464	860,761	-	-	272,425

Table 17: Average Atlantic menhaden landings by gear type over three time periods. All Atlantic coast states collected gear specific landings data by 1993.

	2009-2011 Avg. Landings (lbs)	2012-2016 Avg. Landings (lbs)	1993-2016 Avg. Landings (lbs)
Purse Seine	449,088,431	388,663,919	460,333,505
Pound Net, Fish Weir, Fish Trap	13,007,093	16,279,145	13,101,585
Gill Net	2,590,405	4,343,878	2,725,962
Trawl	2,590,405	2,222,175	958,165
Seines	51,388	389,425	204,929
Cast Net	244,094	627,658	301,767
Traps, Pots	4,671	10,045	8,132
Fyke Nets	55,444	10,876	19,279
Hand Lines, Rod-n-Reel	1,347	852	13,075
Other/Unknown	53,643	22,446	83,893

DRAFT

Table 18. Atlantic menhaden bait and reduction landings (in 1000 metric tons).

	Reduction Landings (1000 mt)	Bait Landings (1000 mt)
1985	306.7	26.6
1986	238.0	21.6
1987	327.0	25.5
1988	309.3	43.8
1989	322.0	31.5
1990	401.2	28.1
1991	381.4	29.7
1992	297.6	33.8
1993	320.6	23.4
1994	260.0	25.6
1995	339.9	28.4
1996	292.9	21.7
1997	259.1	24.2
1998	245.9	38.4
1999	171.2	34.8
2000	167.2	33.5
2001	233.7	35.3
2002	174.0	36.2
2003	166.1	33.2
2004	183.4	34.0
2005	146.9	38.4
2006	157.4	27.2
2007	174.5	42.1
2008	141.1	47.6
2009	143.8	39.2
2010	183.1	42.7
2011	174.0	52.6
2012	160.6	63.7
2013	131.0	37.0
2014	131.1	41.6
2015	143.5	45.8
2016	137.4	43.3

DRAFT

Table 19: Timeline for BERP Workgroup development of menhaden-specific ecosystem reference points.

2016	Summer	Review steele-henderson multi-species model
		Evaluate data needs of model
		Review preliminary methodology of statistical catch-at-age and production models
	Fall	Review results of Ecopath with Ecosim model
2017	Winter	Review multi-species statistical catch at age model
		Evaluate data needs of model
	Summer	Review multi-species production model
		Evaluate data needs of model
	Fall	Review finalized modeling plan and candidate models
		Decide which candidate models will be included for ERP development and peer review
		Discuss data requirements of the models and data sources
2018	Winter	**Data Workshop #1**
		Review data sources for the multi-species models
		Develop criteria for inclusion of data in models
	Summer	**Data Workshop #2**
		Approve data sources of multi-species models
		Discuss standardization of data across sources
2019	Winter	**Assessment Workshop #1**
		Review base run results from multi-species models
		Discuss sensitivity runs for models
	Spring	**Assessment Workshop #2**
		Review final model results of multi-species models
		Summarize findings and recommendations
	Summer	Write stock assessment report
	Fall	**Peer Review Workshop**
		Independent review of multi-species models and single species BAM model

DRAFT

Table 20: Current reporting requirements in the menhaden commercial fishery per state.

State	Dealer Reporting	Harvester Reporting	Notes
ME	monthly	**monthly/daily**	Harvesters landing greater than 6,000 lbs must report daily during episodic event
NH	**weekly**	monthly	Exempt from timely reporting. Implemented weekly, trip level reporting for state dealers.
MA	**weekly**	monthly/daily	Harvesters landing greater than 6,000 lbs must report daily
RI	**twice weekly**	quarterly/daily	Harvesters using purse seines must report daily
CT	**weekly/monthly**	monthly	No directed fisheries for Atlantic menhaden
NY	**Weekly**	monthly	Capability to require weekly harvester reporting if needed
NJ	**weekly**	monthly	All menhaden sold or bartered must be done through a licensed dealer
DE	—	**monthly/daily**	Harvesters landing menhaden report daily using IVR
MD	monthly	**monthly/daily**	PN harvest is reported daily, while other harvest is reported monthly.
PRFC	—	**weekly**	Trip level harvester reports submitted weekly. When 70% of quota is estimated to be reached, then pound netters must call in weekly report of daily catch.
VA	—	**monthly/weekly/daily**	Purse seines submit weekly reports until 97% of quota, then daily reports. Monthly for all other gears until 90% of quota, then reporting every 10 days.
NC	**monthly (combined reports)**		Single trip ticket with dealer and harvester information submitted monthly. Larger dealers (>50,000 lbs of landings annually) can report electronically, updated daily.
SC	**monthly (combined reports)**		Exempt from timely reporting. Single trip ticket with dealer and harvester information.
GA	**monthly (combined reports)**		Exempt from timely reporting. Single trip ticket with dealer and harvester information.
FL	**monthly/weekly (combined reports)**		Monthly until 50% fill of quota triggers implementation of weekly.

Table 21: ACCSP data elements, and descriptions, for commercial harvester reporting.

DATA ELEMENT	DESCRIPTION
Form Type/Version Number	Version identification number for the ACCSP reporting form
Reporting Form Series Number	Individual number for each reporting form (ie: trip ticket number)
Trip Start Date	Date trip started
Vessel Identifier	Unique vessel ID such as US Coast Guard documentation or state registration number
Individual Fisherman Identifier	Identified unique to a fisherman
Dealer Identification	Identifier for the dealer at point of transaction
Unloading Date	Date of the landing at dealer
Trip Number	Sequential number representing the number of a trip taken in a single day by either a vessel or individual
Species	Genus and species for each species landed, sold, released, or discarded
Quantity	Amount that is landed, sold, released, or discarded
Units of Measure	Landed units
Disposition	Fate of catch
Ex-vessel Value or Price	Dollar value or price for each species that is landed or sold
County or Port Landed	Location within a state where the product was landed
State Landed	State where the product was landed or unloaded
Gear	Types(s) of gear used to catch the landed species
Quantity of Gear	Amound of gear employed
Number of Sets	Total number of sets or tows of gear during a trip
Fishing Time	Total amount of time that the gear is in the water
Days/Hours at Sea	Time from the start of the trip to the return to the dock
Number of Crew	Number of crew, including the Captain
Area Fished	NOAA Fisheries statistical area where fishing occurred
Distance From Shore	Determination of catch distance from shore
Sale Disposition	To whom catch was sold

Table 22: ACCSP standard measurements of gear quantity, fishing time, and sets for commercial harvester reporting.

TYPE OF GEAR	QUANTITY	FISHING TIME	# SETS
Pound nets, traps and pots	# of traps, pots, or pound nets fished	Total soak time for each pot, trap, or pound net	# of strings hauled or # of pound nets fished
Trawls	# of trawls towed	Total tow time of each trawl	# of tows
Gill Nets	Float line length for string	Total soak time	# of strings/hauls
Nests/cast nets	# of pieces of apparatus	Search time	# of hauls/throws
Hook and line	# of lines	Total soak time	n/a
Purse seines	Length of floatline	Total search time	# of sets
Hand gear	# of lines	Total soak time	n/a

Table 23: Number of ten fish samples from the reduction fishery landings at Reedville, VA from 2007-2016.

	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016
# 10 fish samples	379	277	283	327	323	263	213	208	256	251

Table 24: Number of ten fish samples required and collected by each jurisdiction in the bait fishery in 2016. Number of samples required is based on total bait landings in that jurisdiction.

State	#10-fish samples required	#10-fish samples collected	Age samples collected	Length samples collected	Gear/Comments
ME	7	9	9	9	purse seine
MA	5	7	7	7	purse seine (2), cast net (5)
RI	0	5	60	60	floating fish trap
CT	0	1	5	5	gill nets
NY	2	9	90	90	seines
NJ	69	113	1130	1130	purse seine (100), and other gears (13)
DE	0	5	50	50	drift gill net
MD	12	19	247	732	pound net
PRFC	6	9	90	90	pound net
VA	71	82	820	820	pound net (16), gill net (64), haul seine (2)
NC	2	6	60	60	gillnet, seine
Total	116	**265**	**2,568**	**3,053**	

DRAFT

Table 25: Fishery independent surveys used in the juvenile abundance index, the northern adult index, and the southern adult index as a part of the 2015 Stock Assessment.

Index	Survey
Juvenile Abundance Index	Rhode Island Trawl Survey
	Connecticut Seine Survey
	Connecticut Thames River Survey
	Connecticut Long Island Sound Trawl Survey
	New York Peconic Bay Trawl Survey
	New York Western Long Island Sound Seine Survey
	New Jersey Ocean Trawl Survey
	New Jersey Juvenile Striped Bass Seine Survey
	Delaware Bay Juvenile 16ft Trawl Survey
	Delaware Inland Bay Juvenile Trawl Survey
	Maryland Juvenile Striped Bass Seine Survey
	Maryland Coastal Trawl Survey
	Virginia Striped Bass Seine Survey
	VIMS Juvenile Trawl Survey
	South Carolina Electrofishing Survey
	Georgia Trawl Survey
Northern Adult Index	Connecticut Long Island Sound Trawl Survey
	New Jersey Ocean Trawl Survey
	Delaware Bay Juvenile 16ft Trawl Survey
	Delaware Bay Juvenile 30ft Trawl Survey
	Chesapeake Bay Fishery-Independent Multispecies Survey
	ChesMMAP
	VIMS Juvenile Trawl Survey
Southern Adult Index	Georgia Trawl Survey
	SEAMAP Trawl Survey

Table 26. Summary of ad-hoc approaches used by Fishery Management Councils to set harvest limits in data poor situations.

Council	Species group	Multiplier	Comments
New England	Atlantic herring	1	Not OF, OF not occurring
New England	Red crab	1	Based on stock status
Caribbean		0.85	Used to set ABC and ACL
New England	Groundfish	0.75	
Pacific		0.75	Used to set ABC
Pacific	Groundfish	0.5	Used to set OY
Pacific	Coastal pelagics	0.25	Used to set ABC

Table 27. The method table showing possible actions for determining ABC based on different fishery impact categories and expert opinion. Taken from the workshop report of the 2nd National SSC meeting (from ORCS, 2011).

Historical Catch	Expert Judgment	Possible Action
Nil, not targeted	Inconceivable that catch could be affecting stock	Not in fishery; Ecosystem Component; SDC not required
Small	Catch is enough to warrant including stock in the fishery and tracking, but not enough to be of concern	Set ABC and ACL above historical catch; Set ACT at historical catch level. Allow increase in ACT if accompanied by cooperative research and close monitoring.
Moderate	Possible that any increase in catch could be overfishing	ABC/ACL = f(catch, vulnerability) So caps current fishery
Moderately high	Overfishing or overfished may already be occurring, but no assessment to quantify	Set provisional OFL = f(catch, vulnerability); Set ABC/ACL below OFL to begin stock rebuilding

ABC = Acceptable Biological Catch ACL = Annual Catch Limit
ACT = Annual Catch Target OFL = Overfishing Level

Table 28: Total number of bycatch trips by year from 2013-2016 separated into 1,000 pound landings bins

Bins (LBS)	2013 Trips	2014 Trips	2015 Trips	2016 Trips	Total Trips	% of Total Trips 2013-2016
1-1000	1,875	3,673	3,163	1,450	10,161	69%
1001-2000	252	517	582	148	1,499	10%
2001-3000	148	318	316	73	855	6%
3001-4000	110	190	139	48	487	3%
4001-5000	131	206	132	48	517	4%
5001-6000	158	265	196	108	727	5%
6000+	130	109	140	33	412	3%
Total	**2,804**	**5,278**	**4,668**	**1,908**	**14,658**	

Table 29: Average landings under the bycatch allowance from 2013–2016 by gear type (stationary and mobile) and jurisdiction. Highlighted cells represent the gear type with the highest landings within a jurisdiction. (C) = confidential landings, and (-) = no landings. Total confidential landings are 183,747 pounds (i.e., the sum of all C's in the table below). Note that sum of pounds and percent of total columns do not include confidential data.

State/Jurisdiction	ME	RI	CT	NY	NJ	DE	MD	PRFC	VA	FL	Sum lbs (NonConf)	% of Total
Stationary Gears While Fishing												
Pound net	-	47,907	-	96,176	C	-	1,943,711	688,428	112,609	-	2,888,830	61.36%
Anchored/stake gill net	-	C	913	0	79,850	23,227	19,722	1,704	966,832	C	1,092,248	23.20%
Pots	-	-	-	C	-	C	C	-	-	C	-	0.00%
Fyke nets	-	-	-	-	C	-	C	26	77	-	103	0.00%
Mobile Gears While Fishing											-	
Cast Net	-	C	-	152,669	C	-	C	-	-	150,585	303,253	6.44%
Drift Gill net	-	-	-	24,443	83,697	53,381	12,061	-	62,189	-	235,771	5.01%
Purse Seine	C	-	-	-	-	-	-	-	-	-	-	0.00%
Seines Haul/Beach	-	-	-	177,173	-	-	C	35	3,840	-	181,048	3.85%
Trawl	-	C	C	6,565	C	-	-	-	-	-	6,565	0.14%
Hook & Line	-	C	C	-	-	-	C	-	-	C	-	0.00%
Sum lbs (NonConf)	-	47,907	913	457,025	163,547	76,608	1,975,494	690,193	1,145,547	150,585	4,707,818	
% of Total	0.00%	1.02%		9.71%	3.47%	1.63%	41.96%	14.66%	24.33%	3.20%		

Table 30: Episodic event set aside for 2013-2016 and the percent used by participating states.

Year	Set Aside (lbs)	Landed (lbs)	% Used	Participating 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

DRAFT

10.0 FIGURES

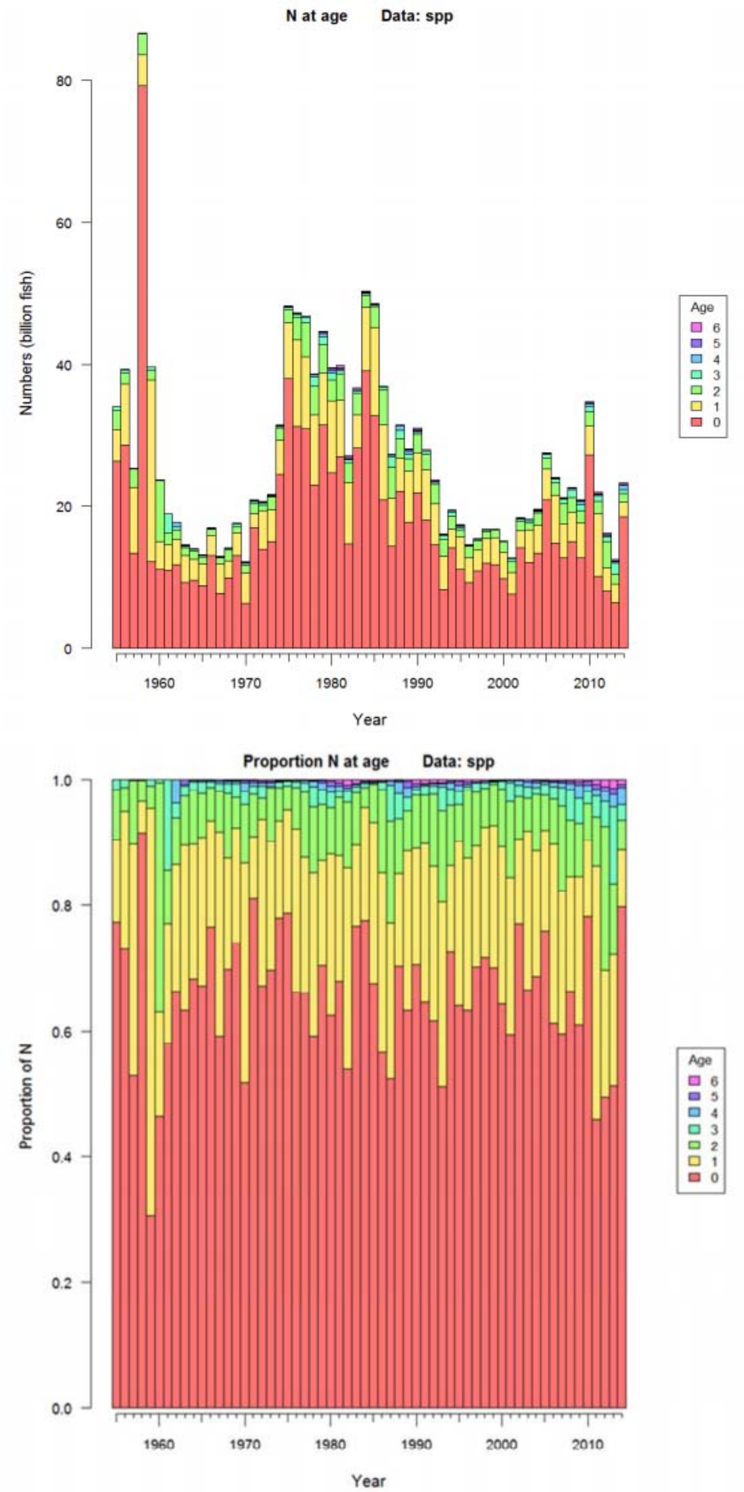

Figure 1. Numbers at age (upper panel) and proportion of numbers at age (lower panel) estimated from the base run of the BAM for ages 0-6+ during the time period 1955-2013. (Source: 2015 Stock Assessment)

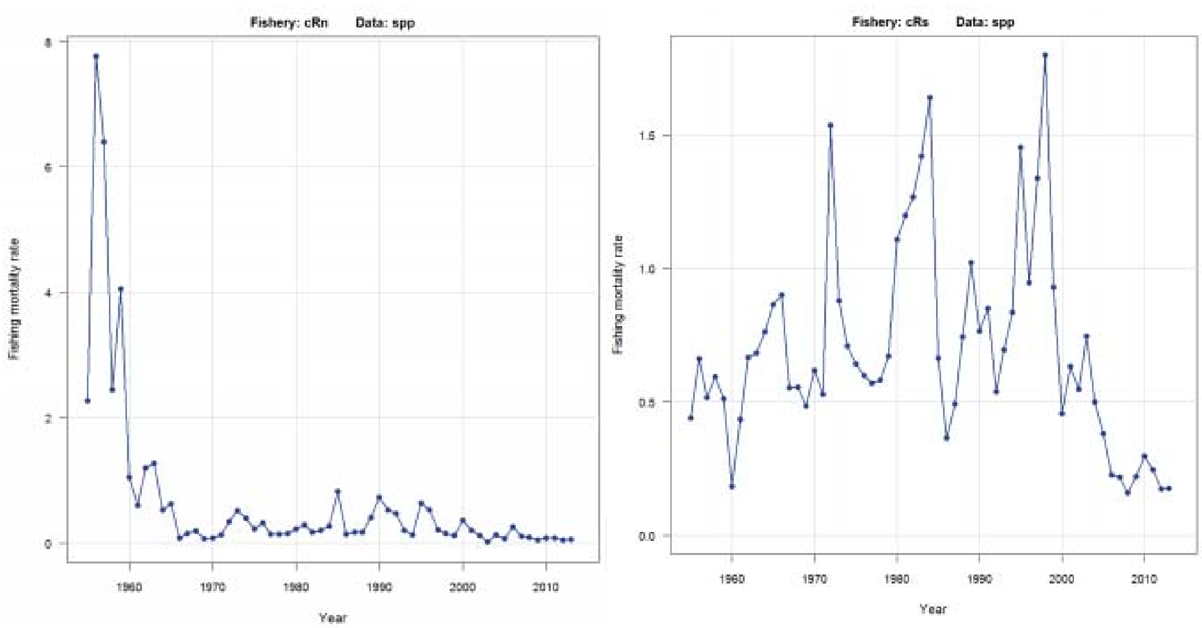

Figure 2. Fishing mortality rate for the northern commercial reduction fishery (left) and southern commercial reduction fishery (right) from 1955- 2013. The northern region is defined as waters north of Machipongo Inlet, VA and the southern region is comprised of waters south of Machipongo Inlet, VA. (Source: 2015 Stock Assessment)

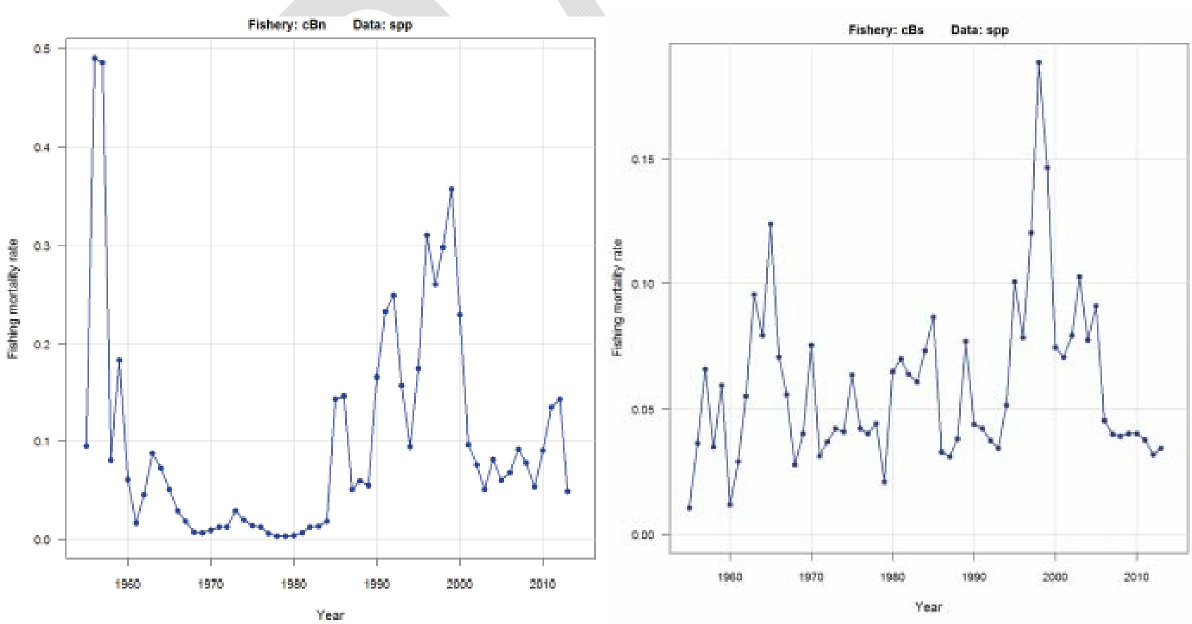

Figure 3. Fishing mortality rate for the northern commercial bait fishery (left) and the southern commercial bait fishery (right) from 1955-2013. The northern region is defined as waters north of Machipongo Inlet, VA and the southern region is comprised of waters south of Machipongo Inlet, VA. (Source: 2015 Stock Assessment)

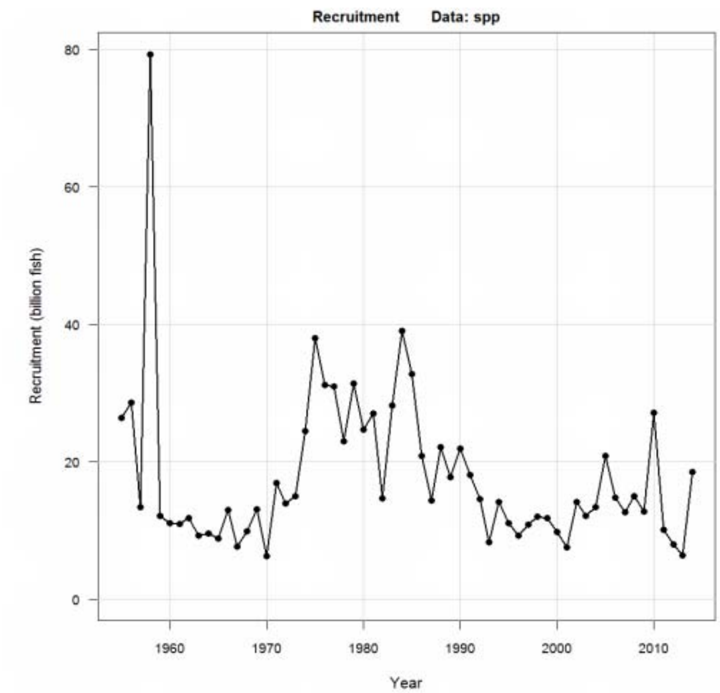

Figure 4. Number of recruits in billions of fish predicted from the base run of BAM for 1955-2013. (Source: 2015 Stock Assessment)

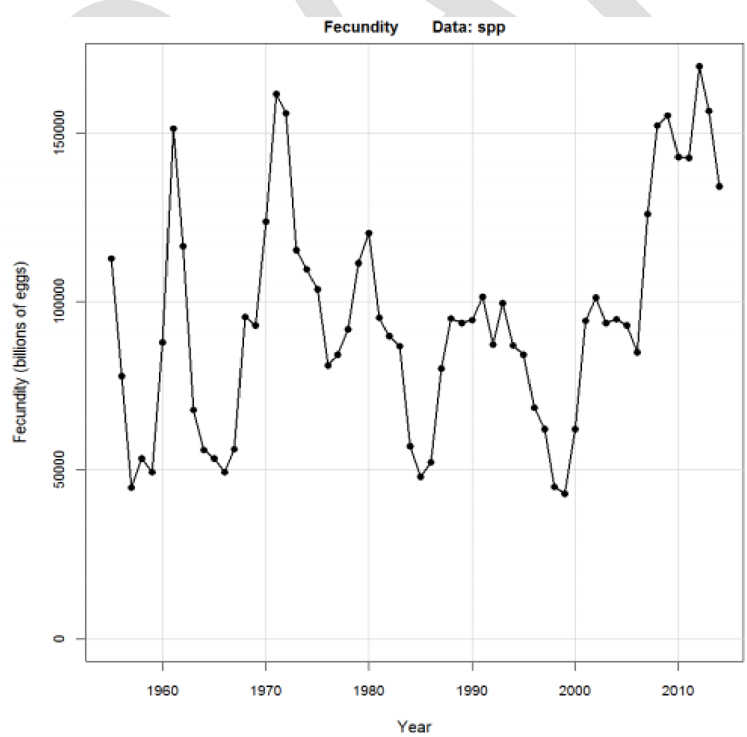

Figure 5. Fecundity in billions of eggs over time, 1955-2014, with the last year being a projection based on 2013 mortality. (Source: 2015 Stock Assessment)

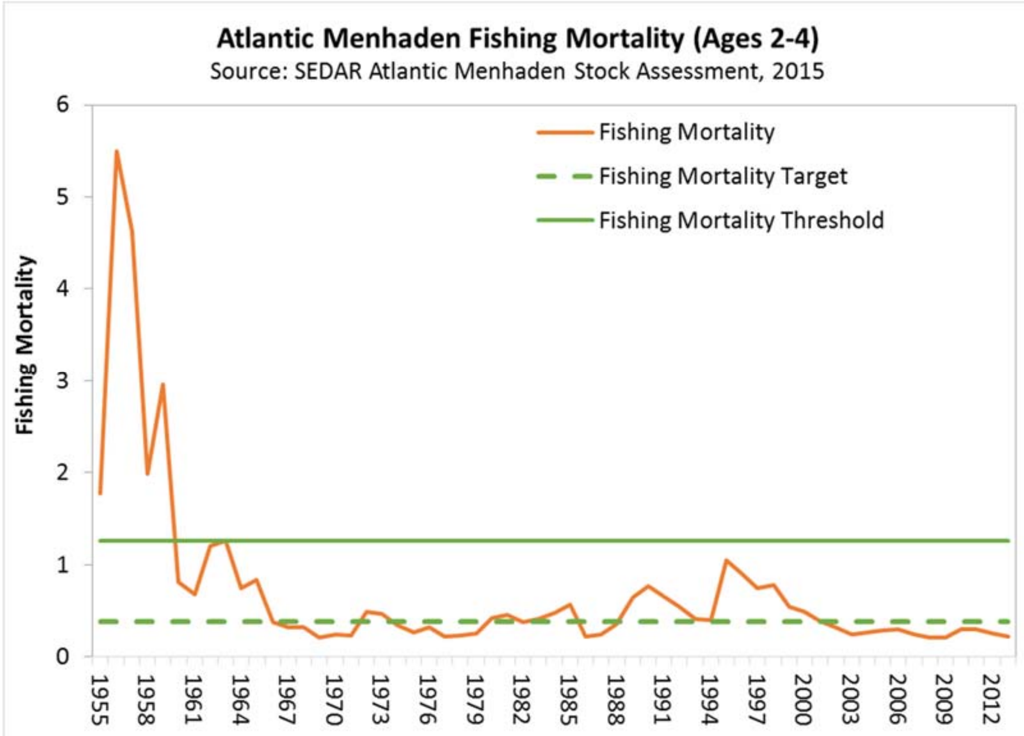

Figure 6: Atlantic menhaden fishing mortality (ages 2-4) from 1955-2013. Results of this figure show that overfishing is not occurring as fishing mortality is below the target.

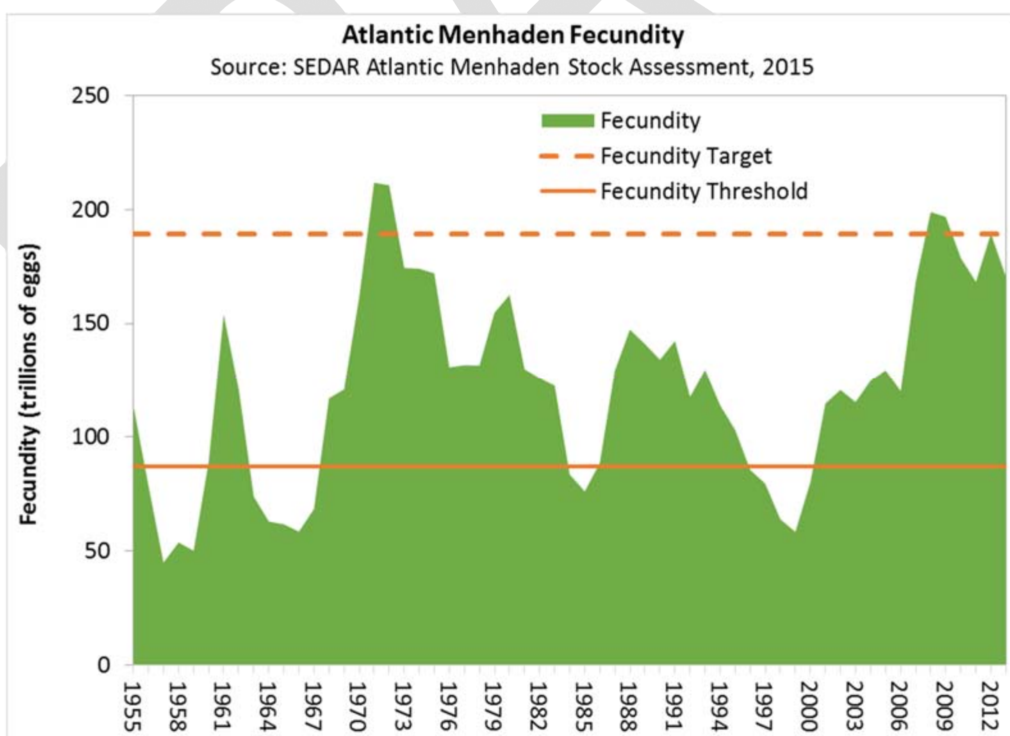

Figure 7: Atlantic menhaden fecundity (in trillions of eggs) from 1955 -2013. Results of this figure show the stock is not overfished as the fecundity is well above the threshold.

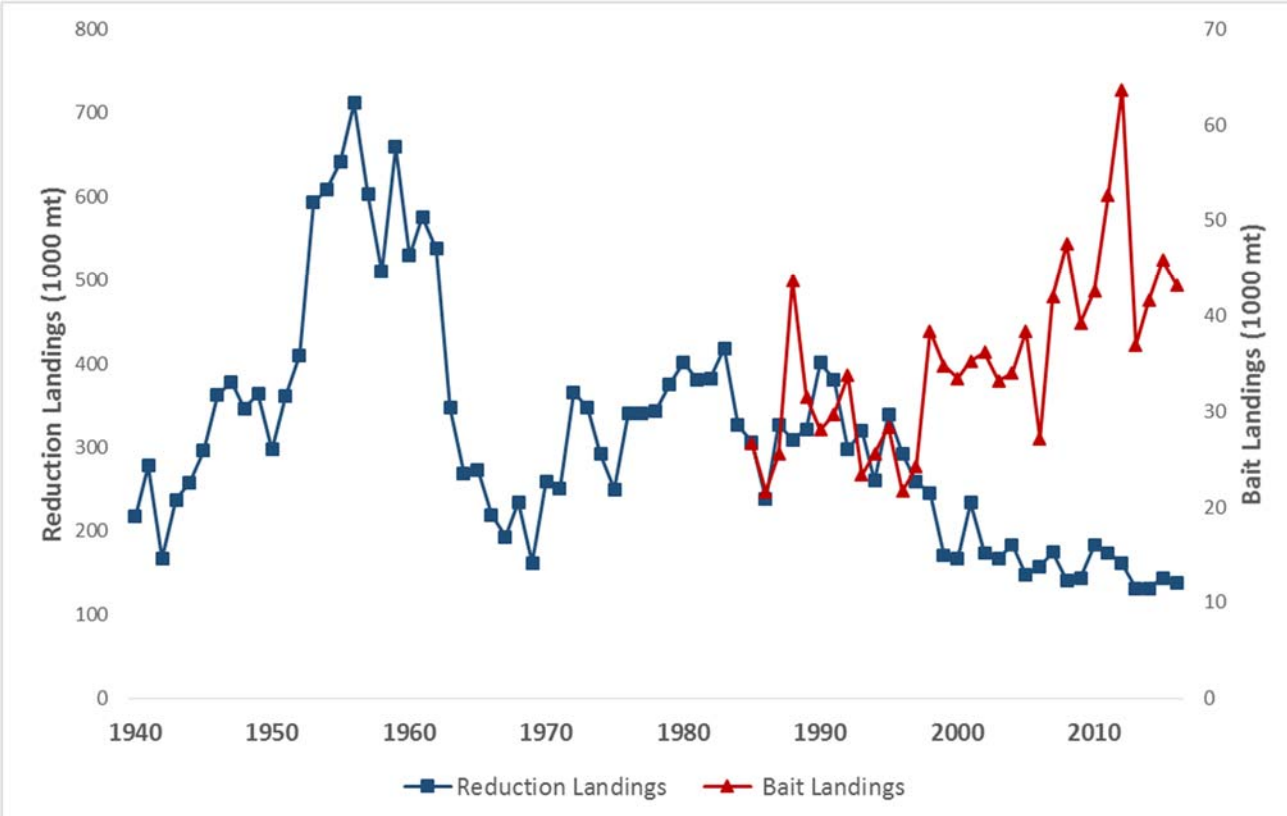

Figure 8: Landings from the reduction purse seine fishery (1940–2016) and bait fishery (1985–2016) for Atlantic menhaden. Note there are two different scales on the y-axes.

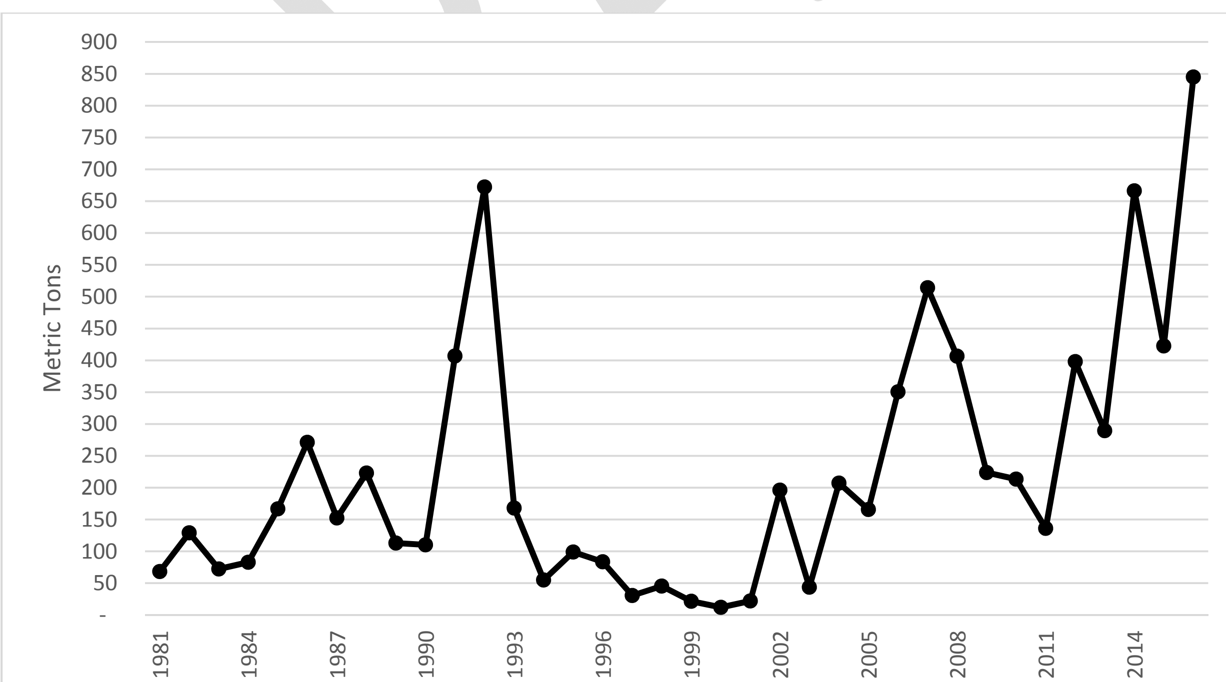

Figure 9: Recreational harvest of Atlantic menhaden from 1981-2016. Note: 2016 recreational landings are preliminary. (Source: MRIP).

DRAFT

NEW YORK STATE DEPARTMENT OF ENVIRONMENTAL CONSERVATION

Division of Marine Resources
205 North Belle Mead Road, Suite 1, East Setauket, NY 11733
P: (631) 444-0430 | F: (631) 444-0434 | FW.Marine@dec.ny.gov
www.dec.ny.gov

New York Menhaden Landings Recalibration

Historically, New York supported a large and active Atlantic menhaden processing fishery. The importance of this fishery diminished during the early to mid-1900s and the last processing plant ceased operations in 1969. From 1950-1969, menhaden harvest in New York averaged over 70 million pounds a year. From 1970 to present the menhaden fishery in New York has primarily been for local bait.

Many permit types in New York allow for the harvest of menhaden, although the only permit type requiring mandatory reporting of menhaden landings prior to 2009 was the menhaden purse seine license. New York implemented mandatory reporting on state trip reports for all permit holders between 2009 and 2011. However, compliance monitoring was not performed until 2013 due to staffing and funding constraints. In addition, discussions with permit holders post compliance monitoring indicated that many were unaware menhaden bait harvest needed to be reported. Thus, the validity of New York's menhaden landings history is of concern due to the significant under reporting of landings prior to 2013.

A previous effort to establish a more accurate landings history in New York occurred in 2013. Letters were sent to permit holders eligible to harvest menhaden between 2009 and 2012 requesting verifiable proof of landings during that time. Acceptable proof of landings included dated receipts, log book records, or trip reports that were not submitted to the state. Only five people were able to provide verifiable landings. While this process helped collect some of the missing information in our landings history, it still left New York with historical harvest data that does not represent the totality of our menhaden fishery during that time.

The current allocation system employed in Amendment 2 divides the TAC to each state/jurisdiction based on average landings between 2009 and 2011. This provides New York 0.055% of the TAC. The current allocation options proposed in the Public Information Document for Amendment 3 cover the time period during which New York's menhaden landings history is incomplete (1985-2012) and when our landings have been constrained by quotas and harvest limits (2013-2016) implemented in Amendment 2. The use of this information to set future quotas will continue to negatively impact New York menhaden fishers by setting quota limits well below true historical harvest levels in New York.

In order to provide a better estimate of our landings history, we compared landings and effort in the years prior to our compliance program (2009-2012) to post initiation of the program (2013-2016) (Table 1). The average annual menhaden reported landings were 315,610 lbs in 2009 - 2012, while average annual reported landings were 1,230,027 lbs in 2013 - 2016. The average yearly number of reported trips taken to harvest menhaden was 162 in 2009-2012, and 912 in 2013-2016. These values were used to determine the amount that reported landings and effort increased after compliance measures were in place.

Average Annual Landings			Average Annual Number of Trips	
2009-2012	315,610		2009-2012	162
2013-2016	1,230,027		2013-2016	912
Increase	2.90		Increase	4.62

Table 1. Average annual landings and effort pre (2009-2012) and post (2013-2016) initiation of New York's compliance program.

It was then assumed that during the years in which reporting was poor, prior to the beginning of our compliance program, landings were severely underreported. The landings multiplier (2.9) is assumed to be a low estimate of how much higher New York's landings were in the past, given that our landings in 2013-2016 occurred under Amendment 2 quotas/trip limits. In the same way, during 1985-2012 when there were no restrictions on menhaden harvest, it is probable that effort was at least 462% higher than reported based upon reporting levels from 2013-2016. For this reason, the effort multiplier (4.62) serves as a higher estimate of where New York's landings may have been during this time period. We present three time series of recalibrated landings in New York from 1985-2012; a low adjusted estimate (2.9 times our current landings), a higher adjusted estimate (4.62 times our current landings), and an average of the two (3.76 times our current landings), in order to account for the unreported landings during this time period (Table 2). In all three cases, these multipliers are still confounded by the limitations imposed by Amendment 2 and may represent underestimates.

	NY Landings		Adjusted Landings (Low-2.9)	Adjusted Landings (Higher-4.62)	Adjusted Landings (Average-3.76)
1985	901,800		2,612,786	4,167,178	3,389,982
1986	399,650		1,157,906	1,846,765	1,502,335
1987	206,795		599,147	955,590	777,369
1988	504,100		1,460,529	2,329,424	1,894,976
1989	449,100		1,301,178	2,075,271	1,688,224
1990	649,710		1,882,405	3,002,281	2,442,343
1991	650,150		1,883,680	3,004,314	2,443,997
1992	1,131,701		3,278,878	5,229,540	4,254,209
1993	1,048,993		3,039,248	4,847,350	3,943,299
1994	961,474		2,785,679	4,442,928	3,614,304
1995	1,087,978		3,152,199	5,027,498	4,089,848
1996	11,135		32,261	51,454	41,858
1997	553,953		1,604,968	2,559,792	2,082,380
1998	430,084		1,246,083	1,987,399	1,616,741
1999	242,886		703,714	1,122,365	913,040
2000	565,800		1,639,293	2,614,537	2,126,915
2001	576,426		1,670,079	2,663,639	2,166,859
2002	444,739		1,288,543	2,055,119	1,671,831
2003	384,875		1,115,099	1,778,490	1,446,794
2004	543,481		1,574,628	2,511,401	2,043,015
2005	871,081		2,523,783	4,025,226	3,274,505
2006	811,934		2,352,417	3,751,911	3,052,164
2007	483,557		1,401,010	2,234,495	1,817,753
2008	410,121		1,188,244	1,895,151	1,541,697
2009	330,496		957,546	1,527,207	1,242,377
2010	394,556		1,143,147	1,823,226	1,483,186
2011	279,117		808,686	1,289,787	1,049,236
2012	258,271		748,289	1,193,459	970,874
2013	1,187,525		1,187,525	1,187,525	1,187,525
2014	825,549		825,549	825,549	825,549
2015	1,467,861		1,467,861	1,467,861	1,467,861
2016	1,439,173		1,439,173	1,439,173	1,439,173
Average	640,752		1,564,735	2,404,153	1,984,444

Table 2. Current landings in New York and the values adjusted by the low, higher, and average multipliers.

In table 3, we show what our initial Amendment 2 quota would have been under each of the adjusted landings scenarios. In all cases, the quota New York would have received is more in line with our average total harvest of 1,230,027 pounds between 2013 and 2016. This is especially true for the higher and average scenarios, where our quota would have been 1,237,392 pounds, and 1,006,613 pounds respectively.

	Low Adjusted Landings	Higher Adjusted Landings	Average Adjusted Landings
2009-2011 Average Landings	969,793	1,546,740	1,258,267
20% Reduction (Amendment 2)	193,959	309,348	251,653
Quota	775,834	1,237,392	1,006,613

Table 3. New York's Initial Amendment 2 quota based on the low, higher, and average adjusted landings.

We believe that these scenarios provide a more realistic representation of the historical menhaden landings in New York, given the limitations of historical reporting.

Stony Brook University

School of Marine and Atmospheric Sciences

Dr. Ellen Pikitch
Discovery Hall, 167
Stony Brook University
Stony Brook, NY 11794
Email: ellen.pikitch@stonybrook.edu

To: Douglas Grout, Commission Chair
Robert Beal, Executive Director
Bob Ballou, Menhaden Management Board Chair
Megan Ware, Menhaden FMP Coordinator
Shanna Madsen, Fisheries Science Coordinator
Matt Cieri, Member, Atlantic Menhaden Technical Committee
Jason McNamee, Chair, Atlantic Menhaden Technical Committee
Atlantic States Marine Fisheries Commission

From: Ellen Pikitch on behalf of the Lenfest Forage Fish Task Force

Date: May 1, 2017

Subject: For the Public Record

Thanks again to those of you who participated in the call with me, Tim Essington and Edward Houde of the Lenfest Forage Fish Task Force, and the ASMFC BERP WG last week. We sincerely hope that dialogue was useful as you move forward management of menhaden within an ecosystem context. If you were on that call you might also have heard mention during the public comment period of the recent paper by Hilborn et al. in Fisheries Research. We also note that consideration of the Hilborn et al. paper is on the agenda of the ASMFS Spring Meeting scheduled for 9 May 2017, 3:30-5:45 pm (http://www.asmfc.org/home/2017-spring-meeting).

The 13 members of the Lenfest Forage Fish Task Force have written a response to the Hilborn et al. paper and associated materials that accompanies this letter and is attached. This statement discusses some of the striking misrepresentations of our work as well as some of the shortcomings of the Hilborn et al. paper itself. We are also preparing a more detailed technical response.

We hereby submit this letter and the accompanying statement[1] as a public comment for the Commission's upcoming meeting, in particular the agenda item considering the Hilborn et al. paper for technical review. The statement is attached, and publicly available at
[http://oceanconservationscience.org/media/2017/nr_2017.05.01.shtml]

We believe any review of the Hilborn et al. paper should consider the technical shortcomings we raise in the attached. Please feel free to reach out to me directly if you have any questions.

[1] Correcting the record on forage fish and their predators: A response from the Lenfest Forage Fish Task Force to recent publications, May 1, 2017

Correcting the record on forage fish and their predators

A response from the Lenfest Forage Fish Task Force to recent publications

May 1, 2017

Five years ago, we authored the report *Little Fish, Big Impact*, which included a suite of recommendations for the management of forage fish. The goal of our group, the Lenfest Forage Fish Task Force, was to bring attention to these important species and to provide recommendations for their sustainable management.

We are pleased to see that others continue to study forage fish and to reach conclusions similar to ours, including a recent publication by Ray Hilborn and others in *Fisheries Research* (Hilborn et al. 2017). That paper recommended, as we did, that fisheries management be tailored to individual species and ecosystems where possible. Our Task Force also went a step further, providing general advice for situations when information is insufficient for a tailored approach. We urged that this advice be used as an interim measure, in light of strong evidence that existing management approaches are not designed to take into account the variability in forage fish stocks, their unusual life-history characteristics, and the role they play in the ecosystem.

It is this general advice that the Hilborn et al. study took issue with. We are disappointed to see that it did so by mischaracterizing our work in several places and presenting technically questionable analyses. Moreover, there were a number of misleading and verifiably false statements in a video and press release associated with the study.

We feel compelled to correct the record promptly with the statement below, which addresses some of the worst falsehoods and examples of mischaracterization. We plan to address the many additional shortcomings of the paper in a separate publication.

Mischaracterizations in the press release and video

One of the obviously false statements in the press release is that our report "recommended slashing forage fish catch rates by 50 to 80 percent." In fact, we recommended reducing fishing *mortality*, not catch rates, an important distinction. And we recommended reductions of 25 to 50 percent relative to F_{MSY}, not 50 to 80 percent. This recommendation was part of a more detailed set of recommendations, which the materials did not acknowledge.

Another false statement in the video was that we concluded "that predators rise and fall with their prey populations as a generality." Our report contains many nuanced statements about the evidence for a strong link between forage and predator abundance, but none as simplistic as this quote.

The press release and video also seriously mischaracterize our work. For example, one of the study authors stated the following in the video:

> The Lenfest conclusion that forage fish fisheries can only be managed successfully to sustain predators as well as the forage fishery by very precautionary policies and reduced harvesting is not based on any fact. It's based on model predictions, on running alternative scenarios on models that we now understand have been fundamentally flawed.

The implication here is that if a conclusion is based on modeling, it has no sound basis. This is incorrect because this type of modeling uses empirical data and biological knowledge to construct a coherent picture of a species or system. It is generally accepted that all models have weaknesses, but when used with caution and good information, can provide a useful representation of a system. We are aware of the published critiques of the Ecopath with Ecosim (EwE) model, but we do not share the belief that it was not suitable for our purpose. We chose this modeling framework because it helped us to survey a large number of ecosystems and arrive at a reasonable approach for places where there is not yet enough data to tailor management of the system.

Moreover, our recommendations were not based exclusively on the output of a single type of model. We also relied on detailed case studies, analysis of the real-world impacts of various harvest strategies, and a comprehensive review of the literature on forage fish and their predators. One of the other modeling studies we considered (Smith et al. 2011), employed several different kinds of ecosystem models, including EwE, and came to similar conclusions about the need to greatly lower fishing mortality rates relative to F_{MSY}, a common fisheries benchmark, to sustain forage fish fisheries. Finally, we relied on empirical data suggesting global patterns that can be used as interim rules for management, such as the finding that successful seabird breeding requires forage fish abundance to be at least one-third of its long-term maximum (Cury et al. 2011). We based our recommendations on these multiple, independent lines of evidence, which the Hilborn et al. study does not acknowledge.

It should be noted that single-species models and simple predator-prey models also have limitations and uncertainties. They can yield unreliable predictions because they do not account for the full suite of complex ecosystem interactions. The Hilborn et al. study is therefore a contribution to an active area of research, not conclusive evidence that "reductions in fishing mortality rate would benefit predators less than argued by Pikitch et al. (2012)".

Our last example is the following statement by one of the authors in the video:

> What we found is there was essentially no relationship between how many forage fish there are in the ocean and how well predators do in terms of whether the populations increase or decrease.

This is a misleading overstatement of the Hilborn et al. study's findings because it asserts that the authors have proven a negative. This study only adds one piece of evidence to a large body of literature, much of which contradicts their paper. For example, empirical studies have already demonstrated a strong connection between forage fish and the abundance of predators in southern Africa, Norway, Peru, and Antarctica (the species in the last example is krill, which is not a fish but fits our definition of a forage species). Others trace the link between forage abundance and breeding success, both through field data (e.g. Boersma & Rebstock 2009) and global analysis of existing data (Cury et al. 2011).

When studies come into conflict, the scientific community does not blindly accept the most recent. Instead, it investigates the reasons for the discrepancy. We were surprised at the sweeping assertion in the statement above, given that there is a large body of evidence that supports the finding that dependent predators are strongly impacted by the abundance of their forage fish prey.

Shortcomings of the Hilborn et al. study

We now turn to five of the numerous shortcomings of the Hilborn et al. study itself. First, the study makes broad claims about the adequacy of our advice for **forage fish** management, yet six of the 11 species in its empirical analysis (Pacific hake, chub mackerel, Atlantic mackerel, and three squids) do not meet the definition of "forage fish" that we used in our 2012 report. While our definition is now in common use, we do not claim that it is the only correct one, only that one needs to pay attention to such things when making comparisons.

Second, the study used estimated population levels generated by stock assessment models to identify correlations between predators and prey. Yet, the models that generated these estimates were not designed for this purpose. In effect, the rigor and attention to detail demonstrated in their examination of ecosystem models was not applied to these models.

Third, the Hilborn et al. study only used examples from U.S. fisheries, which they note are among the best managed in the world. It therefore ignores major systems where forage fish have been demonstrated to play an important role, including large upwelling systems such as the Humboldt and Benguela systems, and Antarctic ecosystems.

Fourth, the study looked across food webs with very different levels of predator dependency on individual prey items and concluded that there was no strong dependency overall. This ignores the results of our report and other studies, such as Smith et al. (2011), showing that dependencies are strong in some food webs and weaker in others. To conclude that fishery management need not change because dependencies are not always strong is faulty reasoning.

Fifth, Hilborn et al. mischaracterized a paper by two of us (Essington & Plagányi, 2013). That paper addressed "recycled" models, which are designed for one purpose but used for another. Hilborn et al. incorrectly presented this paper as a blanket rejection of "recycling," when in fact it is a guide on how to do it thoughtfully. The Task Force did in fact proceed thoughtfully in its use of models, for example by considering the potential distorting effects of aggregating species groups.

A path forward

One point of agreement between us and the Hilborn et al. authors is that more information about individual systems can enable better management. In the five years since our Task Force, the Lenfest Ocean Program has sought to provide this information through numerous grants focused on forage fish, and by sponsoring a second Task Force that also included one of the Hilborn et al. co-authors (Essington et al. 2016). Past experience (e.g. Worm et al. 2009) has shown that scientists can make progress toward resolving disagreements through a process of open-minded collaboration.

Given the important role of forage fish from ecological, economic, and social perspectives, we welcome advances in improving management of these species, and our Lenfest team continues to support our default recommendations in situations where detailed information is lacking.

References

Boersma, P. D., and Rebstock, G. A. (2009). Foraging distance affects reproductive success in Magellanic penguins. *Marine Ecology Progress Series, 375*, 263–275.

Cury, P. M., Boyd, I. L., Bonhommeau, S., Anker-Nilssen, T., Crawford, R. J., Furness, R. W., Mills, J. A., Murphy, E. J., Österblom, H. Paleczny, M., Piatt, J. F., Roux, J. P., Shannon, L., & Sydeman, W. J. (2011). Global seabird response to forage fish depletion—one-third for the birds. *Science*, *334*(6063), 1703-1706.

Essington, T.E., Levin, P.S., Marshall, K.N., Koehn, L., Anderson, L.G., Bundy, A., Carothers, C., Coleman, F.C., Grabowski, J.H., Gerber, L.R., Houde, E.D., Jensen, O.P., Mollmann, C., Rose, K., Sanchirico, J.N. & Smith, A.D.M. (2016). *Building Effective Fishery Ecosystem Plans: A Report from the Lenfest Fishery Ecosystem Task Force*. Lenfest Ocean Program, Washington, D.C.

Essington, T. E., & Plagányi, É. E. (2013). Pitfalls and guidelines for "recycling" models for ecosystem-based fisheries management: evaluating model suitability for forage fish fisheries. *ICES Journal of Marine Science: Journal du Conseil*, fst047.

Hilborn, R., Amoroso, R. O., Bogazzi, E., Jensen, O. P., Parma, A. M., Szuwalski, C., & Walters, C. J. (2017). When does fishing forage species affect their predators? *Fisheries Research*.

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.

Smith, A. D., Brown, C. J., Bulman, C. M., Fulton, E. A., Johnson, P., Kaplan, I. C., Lozano-Montes, H., Mackinson, S., Marzloff, M., Shannon, L. J., Shin, Y. J., & Tam, J. (2011). Impacts of fishing low–trophic level species on marine ecosystems. *Science*, *333*(6046), 1147-1150.

Worm, B., Hilborn, R., Baum, J. K., Branch, T. A., Collie, J. S., Costello, C., Fogarty, M. J., Fulton, E. A., Hutchings, J. A., Jennings, S., Jensen, O. P., Lotze, H. K., Mace, P. M., McClanahan, T. R., Minto, C., Palumbi, S. R., Parma, A. M., Ricard, D., Rosenberg, A. A., Watson, R., & Zeller, D. (2009). Rebuilding global fisheries. S*cience*, *325*(5940), 578-585.

Task Force members

Ellen Pikitch
Chair of the Task Force
Professor and Executive Director
Institute for Ocean Conservation Science
Stony Brook University
ellen.pikitch@stonybrook.edu

David O. Conover
Vice President for Research and Innovation
University of Oregon
dconover@uoregon.edu

Dee Boersma
Director, Center for Ecosystem Sentinels
Wadsworth Endowed Chair in Conservation Science
University of Washington
boersma@u.washington.edu

Ian Boyd
Professor in Biology
University of St. Andrews
Chief Scientific Adviser at the UK Department of Environment, Food and Rural Affairs
ilb@st-andrews.ac.uk

Philippe Cury
Senior Scientist
Institut de Recherche pour le développement, France
Philippe.cury@ird.fr

Tim Essington
Professor
School of Fisheries and Aquatic Sciences
University of Washington
essing@uw.edu

Selina Heppell
Department Head, Professor of Fisheries
Department of Fisheries and Wildlife
Oregon State University
selina.heppell@oregonstate.edu

Edward Houde
Professor Emeritus
University of Maryland Center for Environmental Science
Chesapeake Biological Laboratory
ehoude@umces.edu

Marc Mangel
Director
Center for Stock Assessment Research
Distinguished Research Professor of Mathematical Biology
University of California, Santa Cruz
msmangel@ucsc.edu

Daniel Pauly
UBC Killiam Professor
Fisheries Centre
University of British Columbia
Canada
d.pauly@oceans.ubc.ca

Eva Plaganyi
Principal Research Scientist
CSIRO Oceans & Atmosphere
Australia
Eva.Plaganyi-Lloyd@csiro.au

Keith Sainsbury
Director
SainSolutions Pty Ltd
Professor, Marine System Management
Institute of Marine and Antarctic Science
University of Tasmania

Bob Steneck
Professor of Marine Sciences
University of Maine
School of Marine Sciences
steneck@maine.edu

OMEGA PROTEIN
Healthy Products for a Healthy World

Via Electronic Mail
Robert Ballou
Chair, Menhaden Management Board
Atlantic States Marine Fisheries Commission
1050 N. Highland Street, Suite 200 A-N
Arlington, VA 22201

RE: Amendment 3 Allocation Options

Dear Chairman Ballou:

At its upcoming meeting on May 9, 2017, the Atlantic Menhaden Management Board will review the status of Amendment 3 to the Interstate Fishery Management Plan ("ISFMP") for Atlantic Menhaden. Currently, the document contains an unwieldy number of reallocation options. Omega Protein encourages the Board to begin paring back alternatives, specifically by eliminating Option B, which allocates every state a minimum amount of quota. We also make recommendations for a few refinements to existing options.

While it is easy to see why, at least in the short run, the minimum allocation option is attractive to some. It grants low-quota states with active fisheries and high local abundance allocations several orders of magnitude higher than currently. In some cases, states would have their allocations increased by hundreds or even thousands of percent. Those without fisheries, such as Georgia, Pennsylvania, and South Carolina, or other *de minimis* states, like Florida and New Hampshire, would receive millions of pounds of quota that could be traded.

As a matter of principle, however, this option places the entire burden of conserving the menhaden resource on, at most, three states: Virginia, New Jersey, and, potentially, Maryland. This is contrary to ISFMP Charter's requirement that "[c]onservation programs and management measures shall be designed to achieve equivalent management results throughout the range of a stock or subgroups of that stock." ISFMP Charter, Section Six(a)(3). Wisely, the Board soundly rejected a similar proposal during its deliberations over Amendment 2, analogizing it to all states running up a bar tab and sticking one state with the entire bill.

Nor would such a precedent bode well for future difficult allocation decisions the Board will face. Establishing the principle that a simple majority can benefit at the expense of the minority would undermine the cooperative management system created by the Compact and Charter.

Only a handful of low-allocation states have both high current abundance and an active fishery interested in expanding. These include Rhode Island, New York, and Maryland. Maine remains a special case because traditionally it only periodically has menhaden in its near shore waters available for harvest. In Maine, abundance is truly episodic.

The most effective way to help these states is to start by restoring catch levels to the Amendment 2 baseline of 212,500 metric tons ("mt") from which the original 20 percent reduction was taken. This is consistent with current stock abundance and the fact that the stock has not experienced overfishing or been overfished for decades.

When the Atlantic States Marine Fisheries Commission reallocated spiny dogfish quota, it was done with concurrence of "donor" states like Virginia. In the same vein, Omega Protein is willing to take a lower allocation, but only once the stock has recovered to the point that the Board believes the Amendment 2 harvest reductions are no longer required. This is Option H in the document. The alternative allocation system would only be applied to additional quota above the 212,500 mt baseline. Option H represents a fair and equitable means of achieving reallocation while ensuring equal conservation results throughout the stock's range.

Finally, we would note that if, as appears likely, the Board chooses to change the years (currently 2009-2011) on which allocations are based, Virginia's share will be reduced. Thus, changing the base period alone will effectuate a measure of reallocation away from the state's historic share.

Given problems that have arisen with the quality of data going back to the 1980s and 1990s, coupled with the confounding effects of states that previously had reduction fisheries, the Plan Development Team recently discussed looking at the more recent period, post-2005 when the Beaufort Fisheries plant in North Carolina closed, as a potential new option. The period going back to 2006 has the advantage of better reporting (required by Amendment 1 in 2001). It also includes a series of years with high abundance throughout New England. For instance, in 2008, Maine landed over 4 million pounds of menhaden. It is thus worth considering replacing options that extend back before Amendment 1 with ones that begin at 2006.

In summary, Omega Protein urges the Board to reject the minimum allocation options; replace the allocation timeframe alternatives that include older years with two alternatives, 2006-2012 and 2006-2016, that better reflect the modern fishery; and consider adding our proposed alternatives (attached hereto with detailed justification) as Option H for analysis in the Amendment 3 public hearing draft.

Thank you very much for your time and attention to these comments. We will be on hand at the meeting to answer any questions you may have.

Sincerely,

Ben Landry
Director of Public Affairs,
Omega Protein Corporation

I. Quota Allocation (PID Issue 2) – The Board Should Chose Option H

Omega Protein understands fishermen's frustration with low allocations at a time when the stock is as abundant as it has been in decades. The Amendment 2 allocation system, however, was based on actual landings during a period when there was no constraint on catch or participation (save for decisions by some states to restrict use of efficient gear such as purse seines). Use of more recent years also avoids distortions in landings patterns that resulted from past reduction fisheries in states such as Maine, Massachusetts, Rhode Island, North Carolina, and Florida that have long since ceased.

Allocation based on current and recent historical participation is the most common and equitable approach utilized by the Commission and federal managers when a decision is made to restrict harvest. The main problem, as revealed both by the 2015 benchmark stock assessment and the volume of fish present coastwide, is that the decision to reduce landings came at a time when adult menhaden abundance was at its highest sustained level in the entire fifty-plus year time series. This is especially true in New England waters, including the Gulf of Maine where menhaden have moved inshore this year in numbers not seen since 2008.

While Omega Protein believes that the menhaden stock's condition warrants a return to at least the 2012 landings level of just under 225,000 mt, the Board has determined that landings should be maintained at levels below the Amendment 2 baseline. It thus appears the Board believes the Atlantic menhaden stock still requires conservation. In order to effectuate this conservation program, each state has taken the same proportionate catch reduction from the same baseline. This approach is consistent with standards governing management under an ISFMP.[4]

By contrast, TAC reallocation from states that had greater recent participation, such as Virginia and New Jersey, would foist the entire burden of conservation on only a few (or one) state. Historical bait and reduction fishermen in the "donor" states would see their harvest further reduced to allow new participants into the fishery in others. This outcome is neither fair nor equitable. Such an action would be an unprincipled act of majoritarianism.

For these reasons, Omega Protein can support reallocation only when every state is made whole from the cuts each endured under Amendment 2. This is the intent of Option H. Under this alternative, a greater share of menhaden TAC will go to states wishing increase participation when the stock is deemed to be healthy enough to sustain harvest levels above the Amendment 2 baseline.

As explained below, Omega Protein is willing to see its allowable harvest grow at a slower rate to allow increased participation by others, but only once this threshold is passed. It should not, however, be required to bear the entire burden of conservation. Omega Protein is entirely dependent on the menhaden resource. Nearly every other participant has access to other fisheries.

---

[4] *See, e.g.,* ISFMP Charter, Section Six(a)(3) ("Conservation programs and management measures shall be designed to achieve equivalent management results throughout the range of a stock or subgroups of that stock."); *see also id.* § (8)(ii) ("Fishery resources shall be fairly and equitably allocated or assigned among the states.").

Under the alternative allocation option presented below, Omega Protein would see its share of the fishery grow more slowly so that other states may take advantage of increased amounts of menhaden in their waters when they are present. Following that is a discussion of the states' performance under the current quota system. Finally, we provide suggest language to implement this alternative, including possible options for distributing the additional TAC among other jurisdictions.

A. Proposed Alternative for Reallocation When TACs Exceed 212,500 mt

Under this alternative, each state would be granted a base share of the annual TAC based on the formula established through Amendment 2. So long as the coast-wide TAC is at or below 212,500 mt, each state would be granted that proportion of the TAC commensurate with its share, as currently. When the TAC exceeds this baseline catch level, however, each state other than Virginia would continue to receive the same proportion of the quota plus, potentially, additional quota. Options for distributing this reallocated quota are presented below.

As to Virginia, it would receive 85.32% of the first 212,500 mt and just 50% of any coast-wide TAC above that amount.

This approach results in a slower expansion of the reduction sector when the menhaden stock is at high levels in order to allow for increased fishing opportunities for bait fishermen.[5] Another advantage of this approach is its consistency with the fact that menhaden expand their range when at higher abundances. Currently, as back in the 1980s when the striped bass population crash led to an abundant menhaden stock, there are more menhaden (at least as reflected in catches and anecdotal reports) in the northern and southern ranges than over most of the past two decades. Commensurately, however, the proposed alternative also ensures each jurisdiction contributes equally to menhaden conservation whenever, as currently, the Board determines that such conservation is necessary.

B. Distribution Options

The second level of allocation decisions is how to distribute the additional TAC available when the quota is greater than 212,500 among states interested in increasing harvest. We first discuss the current performance of the states relative to their allocation under Amendment 2, along with their historic participation in the fishery. We then present suggested options for reallocation.

1. *States' Use of Current Quota and Likely Future needs*

It does not appear that the southern states would benefit from reallocation. North Carolina has only harvested about half of its allocation since the adoption of Amendment 2. Neither South Carolina nor Georgia have a menhaden fishery. Florida's small gear fishery appears to operate entirely under the "bycatch" exemption. Florida's quota has not been constraining, with recent catch levels two to three times greater than its allocation. This state would only be meaningfully

[5] The Virginia General Assembly would determine the allocation as among the reduction and various bait fisheries within the state, as it does now. Omega Protein would advocate to have the Virginia bait sector quota increase at the same rate as in other states.

affected if the Board were to change the bycatch allowance in a manner that adversely impacts Florida's small gear fishery.

As to New England, availability of menhaden tends to be sporadic. It is the adult fish (generally age 4 and up) that seasonally inhabit these waters. It has long been established that menhaden migrate north during the spring and summer, segregating by age, with the oldest fish moving furthest northward. When, as currently, the population of older fish is high, menhaden abundance throughout New England increases. This historical pattern supports a higher allocation to New England states when menhaden abundance is high so long as the TAC itself grows in conjunction with population increases.

As to the individual states, Maine is in a unique situation. Situated at the extreme northern end of the stock's range, Maine only sporadically has menhaden in its coastal waters. When they do arrive, as they have this year, however, Maine's landings can be substantial. In most years, however, landings are low or nonexistent.[6] It is for this reason that the state's representatives advocated for the creation of the episodic event set-aside. However, Maine may be disadvantaged as the southern New England states, particularly Rhode Island, can take a significant portion of the set-aside before the fish reach Maine's waters. Maine may thus be best served by an episodic event set-aside specific to the Gulf of Maine, one available only for landings in Maine. The unused portion could roll-back to the other states if not utilized by a fixed date.

New Hampshire lacks a substantial fishery. Massachusetts landings mostly are from Narragansett Bay. It has not fully caught its allocation since Amendment 2, but landings have increased each year since 2013. There is likely room for expansion of the fishery in the state when menhaden are abundant in places like Buzzards Bay, Boston Harbor, and Ipswich Bay. Nonetheless, Massachusetts' needs can likely be met through its current allocation and the existing episodic event set-aside. The same is likely true of Connecticut which never had a substantial fishery.

Rhode Island and New York each desire a substantial increase in harvest opportunities over recent history. From 1985 to 2012, New York averaged landings of just under 558,000 pounds. Since the twenty percent cut imposed by Amendment 2 came into effect, New York's catch has averaged 1.2 million pounds, or double its historical landings over the prior twenty-seven years. Its catches since 2013 are four to nearly six-and-a-half times New York's menhaden allocation.

For its part, Rhode Island had a substantial fishery from 1985 to 1995, with average landings of 9.4 million pounds per year. With the end of local reduction processing, its landings dropped dramatically to 66,000 pounds per year up through 2012. This decline may be partially attributable to decreased local availability. Management actions, however, have also contributed to this

---

[6] An exception to this was during the 1980s and into the early 1990s when Maine had a consistently robust reduction fishery. This sustained period of high menhaden abundance coincided with a dramatic reduction in the striped bass population. This depletion was so severe that a federal moratorium on striped bass harvest was imposed in in 1984. As the striped bass population increased, the menhaden population decreased even as menhaden catches declined significantly. There is also a possibility that sustained high levels of catch of older menhaden in New England waters adversely impacted the population by disproportionately reducing fecundity at a given level of fishing mortality. From 1985 through 1993, catches from Connecticut to Maine averaged 30.4 million pounds per year. From 1994 to 2012, the average was only 3.1 million pounds.

reduction. The Narragansett Bay menhaden fishery has been the subject of great controversy, much as has the Chesapeake Bay fishery. As a result of advocacy by sports fishermen and environmentalists, the state imposed a cap on harvest in the Bay in 2007. As a result of this management program, it is highly unlikely that landings could ever achieve the levels of the early period. (It should be noted that most of menhaden landed in Massachusetts come from Narragansett Bay and count against the cap.) Since Amendment 2, however, Rhode Island has raised its landings substantially through its participation in the episodic event fishery. In 2015, Rhode Island landed 1.8 million pounds, but the nearly 3 million pounds landed in Massachusetts likely came mostly from the Narragansett Bay, as well.

Over the entire time series, Virginia and New Jersey were often the top two states in terms of bait landings. Average catches in New Jersey from 1985 to 2009 were 22.9 million pounds. Thereafter, however, fishermen in this state increased their bait harvest substantially. New Jersey landings totaled 50.5 million pounds in 2010, 74.3 million in, 2011 and 85.5 million in 2012. Its 2017 quota is 48.8 million pounds, which is more than twice the state's average catch prior to 2010, but is over forty percent lower than New Jersey's 2012 landings. New Jersey's purse seine sector, like that of Virginia, has stayed within its sub-allocation.

Maryland's landings under Amendment 2 have been about equal to the state's average harvest during the baseline period, or just over 7 million pounds per year. This is due to harvests made by pound net fishermen under the bycatch cap. These landings are substantially below Maryland's harvest of 13.7 million pounds in 2012. The same is true of the Potomac River Fishery Commission ("PRFC"), which averaged 2.9 million pounds during the Amendment 2 baseline years and 3 million pounds per year between 2013 and 2015. In 2012, the PRFC's landings were 5.9 million pounds.

Finally, Virginia has met its Amendment 2 target in each year save for a one percent overage in 2014. The fixed gear component of the bait fishery had a slight overage that year, but nothing on the order of the other Chesapeake Bay fisheries. Meanwhile, the reduction fishery and snapper rig sector have operated within their limits.

To sum up, six states – Rhode Island, New York, Delaware, Maryland, PRFC, and Florida – have averaged landings above their respective Amendment 2 allocations. New Jersey and Virginia have landed their allocations, while (of states with a fairly substantial quota), Massachusetts and North Carolina each have "underfished" their allocations by fifteen to seventy-five percent, depending on the year.

2. *Allocation/Reallocation Options*

With that discussion, we present several alternatives for distributing TAC reallocated from Virginia when the overall coast-wide quota exceeds the Amendment 2 baseline catch level of 212,500 mt. The simplest approach would be a proportionate redistribution. The plan development team could calculate each state's average share of the catch based on the reference period excluding Virginia's landings. Alternatively, each state (or each state with a fishery) could be given an equal share, or the quota could be given only to states that have fully utilized their Amendment 2 allocation.

Other approaches could utilize elements of other options presented in the Amendment 3 PID, such as use of a regional quota (Option E). For instance, Amendment 2 established a one percent episodic event set-aside. This has been routinely used by Rhode Island fishermen, and this year, too, by Maine. As the availability of fish in Maine's waters are truly "episodic" and Rhode Island fishermen wish for more reliable access to quota, it may make sense to reduce the set-aside to one-half percent and to grant that to Maine (along with the current "roll-back" provision if unused).

The other half percent could be rolled into the other New England states' quotas. Perhaps, though, a better approach would be to create a New England regional quota, similar to that used under the spiny dogfish FMP. Because the region has administered a similar system, this may be workable and may also provide flexibility for the region's fishermen to better target menhaden when and where they are available.

C. Draft Language for the Amendment 3 Public Hearing Draft

Option H. Allocation Strategy Based on TAC Level

1. Allocation when the TAC is less than or equal to 212,500 mt: 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 catch level 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 Amendment 2 allocation strategy).

2. Allocation of any TAC greater than 212,500 mt: When the TAC exceeds 212,500 mt, Virginia would receive 85.32% of 212,500 mt and 50% any TAC above this amount. Under this formula, there would be 778,453 pounds for each 1,000 metric tons above the baseline catch level available for reallocation. All other states will receive their share of the TAC as determined by the formula set forth in Amendment 2, plus a share of the TAC reallocated from Virginia according to the formula established below.

3. Alternatives for Redistributing Reallocated Quota:

a. Equal shares among states other than Virginia: Under this alternative, the extra TAC available for redistribution when the TAC exceeds 212,500 mt would be divided equally among all jurisdictions with a fishery, either in equal shares or proportional to each state's share of the TAC.

b. Regional TAC for New England, proportionate reallocation of TAC to States with need. Under this alternative, the New England states (optionally including New York) would share a common TAC, determined as the sum of shares of each New England state under Amendment 2, pus any additional TAC available if and when the coastal TAC is greater than 212,500 mt. Further, the episodic event set aside of 1 percent would be reduced to 0.5 percent and made available only to Maine. If not used by September 1, it would roll back into the coastal TAC. The other 0.5 percent would be added to the New England TAC. To the extent it is still available, Maine could participate in the common TAC once it has exhausted its set aside.

Reallocated quota when the TAC is greater than 212,500 would be divided among New England, New Jersey, Maryland, and the PRFC, the Virginia bait fishery if the use-based option is chosen. The rationale is that these states have had substantially larger fisheries in the past and have fully utilized their Amendment 2 allocations. Reallocated quota would be divided among these jurisdictions based on the proportion of landings during the baseline period.

c. Set aside 0.75 percent for the Small Capacity Fleet and manage under a soft TAC, allocate/reallocate the remaining TAC according to Alternative a or b above. These small capacity gears (cast net, trawl, trap/pot, haul seine, fyke net, and hook and line) averaged just over three million pounds per year over the Amendment 2 reference period. This option will allow these fleets to continue to operate at or around historic levels, while allowing states to focus enforcement on medium and large capacity gear fleets.