Atlantic herring

*Clupea harengus*

Atlantic
Midwater trawl, Purse Seine

November 17, 2014
Lindsey Feldman, Consulting researcher

Disclaimer

Seafood Watch® strives to have all Seafood Reports reviewed for accuracy and completeness by external scientists with expertise in ecology, fisheries science and aquaculture. Scientific review, however, does not constitute an endorsement of the Seafood Watch® program or its recommendations on the part of the reviewing scientists. Seafood Watch® is solely responsible for the conclusions reached in this report.
About Seafood Watch®

Monterey Bay Aquarium’s Seafood Watch® program evaluates the ecological sustainability of wild-caught and farmed seafood commonly found in the United States marketplace. Seafood Watch® defines sustainable seafood as originating from sources, whether wild-caught or farmed, which can maintain or increase production in the long-term without jeopardizing the structure or function of affected ecosystems. Seafood Watch® makes its science-based recommendations available to the public in the form of regional pocket guides that can be downloaded from www.seafoodwatch.org. The program’s goals are to raise awareness of important ocean conservation issues and empower seafood consumers and businesses to make choices for healthy oceans.

Each sustainability recommendation on the regional pocket guides is supported by a Seafood Report. Each report synthesizes and analyzes the most current ecological, fisheries and ecosystem science on a species, then evaluates this information against the program’s conservation ethic to arrive at a recommendation of “Best Choices,” “Good Alternatives” or “Avoid.” The detailed evaluation methodology is available upon request. In producing the Seafood Reports, Seafood Watch® seeks out research published in academic, peer-reviewed journals whenever possible. Other sources of information include government technical publications, fishery management plans and supporting documents, and other scientific reviews of ecological sustainability. Seafood Watch® Research Analysts also communicate regularly with ecologists, fisheries and aquaculture scientists, and members of industry and conservation organizations when evaluating fisheries and aquaculture practices. Capture fisheries and aquaculture practices are highly dynamic; as the scientific information on each species changes, Seafood Watch®’s sustainability recommendations and the underlying Seafood Reports will be updated to reflect these changes.

Parties interested in capture fisheries, aquaculture practices and the sustainability of ocean ecosystems are welcome to use Seafood Reports in any way they find useful. For more information about Seafood Watch® and Seafood Reports, please contact the Seafood Watch® program at Monterey Bay Aquarium by calling 1-877-229-9990.
**Guiding Principles**

Seafood Watch defines sustainable seafood as originating from sources, whether fished\(^1\) or farmed, that can maintain or increase production in the long-term without jeopardizing the structure or function of affected ecosystems.

Based on this principle, Seafood Watch had developed four sustainability **criteria** for evaluating wild-catch fisheries for consumers and businesses. These criteria are:

- How does fishing affect the species under assessment?
- How does the fishing affect other, target and non-target species?
- How effective is the fishery’s management?
- How does the fishing affect habitats and the stability of the ecosystem?

Each criterion includes:

- Factors to evaluate and score
- Guidelines for integrating these factors to produce a numerical score and **rating**

Once a rating has been assigned to each criterion, we develop an overall recommendation. Criteria ratings and the overall recommendation are color-coded to correspond to the categories on the Seafood Watch pocket guide and online guide:

- **Best Choice/Green**: Are well managed and caught in ways that cause little harm to habitats or other wildlife.
- **Good Alternative/Yellow**: Buy, but be aware there are concerns with how they’re caught.
- **Avoid/Red**: Take a pass on these for now. These items are overfished or caught in ways that harm other marine life or the environment.

---

\(^1\) “Fish” is used throughout this document to refer to finfish, shellfish and other invertebrates.
Summary
This report recommends the Atlantic herring midwater trawl fishery as a “Good Alternative” and the purse seine fishery as a “Best Choice” fishery.

Atlantic herring are found offshore and in every major estuarine ecosystem from the Gulf of Maine to the Chesapeake Bay. They are opportunistic feeders and prey on a variety of pelagic organisms. When herring are juveniles, prey includes small copepods; when herring are adults, prey includes chaetognaths, euphasiids, pteropods, and larger copepods. Atlantic herring is also a major prey species for fish species such as cod, haddock, cunner, red hake, spiny dogfish, and bluefish; elasmobranchs such as thorny skate and dusky shark; marine mammals such as white-sided dolphins, harbor porpoises, minke whales, fin whales, and humpback whales; and a variety of seabirds.

The Atlantic herring fishery has been operational since the early 1900s, and there are records of catch starting in 1960. Atlantic herring is managed jointly in Federal waters by the National Marine Fisheries Service (NMFS) and New England Fishery Management Council (NEFMC), and in state waters by the Atlantic States Marine Fisheries Commission (ASMFC). The fishery is managed by four distinct management areas: Area 1A in the Gulf of Maine, Area 1B that extends from Cape Cod to the exclusive economic zone (EEZ) border, Area 3 south of Cape Cod to George’s Bank, and Area 2 inshore south of Nantucket. The fishery operates in Areas 1A, 1B, and 3 in the summer and in Areas 2 and 3 in the winter.

Stock assessments are conducted regularly every 1–3 years along with setting of annual landings quotas and new management measures. The herring stock is currently not overfished or experiencing overfishing. A new assessment in 2012 resolved many of the uncertainties in previous assessments and updated estimates of natural mortality by considering the important role of Atlantic herring as a forage fish in the Northeast ecosystem. The midwater trawl fishery catches river herring (alewife and blueback herring, and American shad), which are considered species of concern due to their status as depleted and overfished, respectively. The poor condition of the river herring stocks is a main contributor to the “Good Alternative” ranking of the midwater trawl fishery. The NEFMC and NMFS are currently developing a river herring catch cap in the Atlantic herring fishery that should minimize bycatch of river herring if the cap is set at an appropriate level. Other bycatch species include Atlantic mackerel, haddock, harbor and gray seals, common and white-sided dolphins, and long- and short-finned pilot whales. The marine mammals are ranked by NMFS as Category II fisheries in the midwater trawl fishery, and harbor and gray seals are ranked as Category III fisheries in the herring purse seine fishery. The Atlantic herring fishery is not expected to have a significant impact on any of the marine mammal populations, so this contributes to a low bycatch score for both fisheries. In addition, NMFS has implemented a haddock catch cap in the herring fishery, which minimizes the amount of haddock caught incidentally in the fishery.

Fisheries management has been highly effective in the Atlantic herring fishery; the stock is in good condition, regulations are set based on the best scientific information available, and management is
beginning to take ecosystem-based approaches. Midwater trawl gear usually has little impact on bottom habitat because it does not regularly touch the bottom. However, herring are known to school near the bottom, and occasionally the net chains drag along the bottom, causing minimal impact to the substrate. This impact on habitat is a main contributor to the “Good Alternative” ranking for the midwater trawl fishery.

Table of Conservation Concerns and Overall Recommendations

<table>
<thead>
<tr>
<th>Stock / Fishery</th>
<th>Impacts on the Stock</th>
<th>Impacts on other Spp.</th>
<th>Management</th>
<th>Habitat and Ecosystem</th>
<th>Overall Recommendation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Atlantic herring</td>
<td>Green (5.00)</td>
<td>Red (2.16)</td>
<td>Green (3.46)</td>
<td>Green (3.61)</td>
<td>Good Alternative (3.408)</td>
</tr>
<tr>
<td>East coast Atlantic - Trawl, Midwater</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Atlantic herring</td>
<td>Green (5.00)</td>
<td>Green (5.00)</td>
<td>Green (4.00)</td>
<td>Green (3.61)</td>
<td>Best Choice (4.358)</td>
</tr>
<tr>
<td>East coast Atlantic - Purse Seine, Unassociated</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Scoring Guide

Scores range from zero to five where zero indicates very poor performance and five indicates the fishing operations have no significant impact.

Final Score = geometric mean of the four Scores (Criterion 1, Criterion 2, Criterion 3, Criterion 4).

- **Best Choice/Green** = Final Score >3.2, and no Red Criteria, and no Critical scores
- **Good Alternative/Yellow** = Final score >2.2, and neither Harvest Strategy (Factor 3.1) nor Bycatch Management Strategy (Factor 3.2) are Very High Concern, and no more than one Red Criterion, and no Critical scores, and does not meet the criteria for Best Choice (above)
- **Avoid/Red** = Final Score <=2.2, or either Harvest Strategy (Factor 3.1) or Bycatch Management Strategy (Factor 3.2) is Very High Concern, or two or more Red Criteria, or one or more Critical scores.

---

2 Because effective management is an essential component of sustainable fisheries, Seafood Watch issues an Avoid recommendation for any fishery scored as a Very High Concern for either factor under Management (Criterion 3).
Table of Contents

About Seafood Watch® ........................................................................................................................................ 2

Guiding Principles ............................................................................................................................................. 3

Summary ......................................................................................................................................................... 4

Introduction .................................................................................................................................................. 7

Assessment ................................................................................................................................................... 10

  Criterion 1: Stock for which you want a recommendation ...................................................................... 10

  Criterion 2: Impacts on Other Species .................................................................................................... 15

  Criterion 3: Management effectiveness ..................................................................................................... 26

  Criterion 4: Impacts on the habitat and ecosystem ................................................................................ 35

Acknowledgements ....................................................................................................................................... 39

References ..................................................................................................................................................... 40
Introduction
Scope of the analysis and ensuing recommendation

Atlantic herring range from Labrador to Cape Hatteras in the Northwest Atlantic and are most abundant north of Cape Cod, Massachusetts. Atlantic herring are targeted primarily using single and paired midwater trawl gear, followed by purse seine and bottom trawl fishing gear (NEFMC 2013a). Atlantic herring is also caught as bait for other fisheries (such as bluefish tuna) in small gillnets (NEFMC 2013a). This report analyzes the midwater trawl and purse seine fisheries, because less than 1% of catch is with bottom trawl and gillnet gear.

Overview of the species and management bodies

Atlantic herring are found offshore and in every major estuarine ecosystem from the Gulf of Maine to the Chesapeake Bay (NEFMC 2013a). They inhabit depths from 0 to 400 meters (m) on the continental shelf, but are usually found from 11–200 m (NEFMC 2014b). Herring prefer cold waters of 5–9 °C (Celsius) during spawning season, but throughout their adulthood are found in waters from 0–20 °C inshore and 2.5–10.5 °C on the continental shelf (NEFMC 2014b). Herring spawn once annually and can spawn along the coast of Maine, in Nova Scotia, or even as far offshore as George’s Bank. They mature at ages 2–4 and can live 15–18 years. The Atlantic herring fishery is known to target fish starting at age 3 up to age 12 (NMFS 2005). They are synchronous spawners and produce 55,000–210,000 eggs once a year by depositing them on the sea floor (NMFS 2005). Herring eggs are preyed upon by many fish species including cod, haddock, red hake, sand lance, and winter flounder, and egg mortality is high (NMFS 2005).

Herring are plankton feeders and prey on a variety of pelagic zooplankton: when herring are juveniles, prey include small copepods, and when herring are adults, prey include chaetognaths, euphasiids, pteropods, and larger copepods (NMFS 2005). Herring feed most often in spring and summer months, and often at dawn and dusk in the upper levels of the water column. They are also a major prey species for fish species such as cod, haddock, cunner, red hake, spiny dogfish, and bluefish; elasmobranchs such as thorny skate and dusky shark; marine mammals such as white-sided dolphins, harbor porpoises, minke whales, fin whales, and humpback whales, and a variety of seabirds (NEFMC 2005).

The Atlantic herring fishery has been operating since the early 1900s, and there are records of catch starting in 1960. Herring was first regulated through the International Commission for Northwest Atlantic Fisheries until 1976, when the U.S. passed the Magnuson-Stevens Fishery Conservation and Management Act. A herring fishery management plan was implemented in 1978, but withdrawn because catch quotas were not being enforced in state waters and foreign nationals were prohibited from landing any herring. Herring was managed in state waters through spawning closures until 2001, when a Federal Fishery Management Plan (FMP) was reinstated (NEFMC 2013a). The fishery is managed by four distinct management areas: Area 1A in the Gulf of Maine, Area 1B that extends from Cape Cod to the exclusive economic zone (EEZ) border, Area 3 south of Cape Cod to George’s Bank, and Area 2
inshore south of Nantucket (NEFMC 2013a). The fishery operates in Areas 1A, 1B, and 3 in the summer and in Areas 2 and 3 in the winter (NEFMC 2013a).

Atlantic herring is managed jointly in federal waters by the National Marine Fisheries Service (NMFS) and New England Fishery Management Council (NEFMC), and in state waters by the Atlantic States Marine Fisheries Commission (ASMFC). Atlantic herring is managed jointly in state and federal waters under complementary management plans that set quotas for all four management areas. The state and federal agencies jointly implement quotas, catch caps, and other management measures, but the NEFMC prohibits midwater trawling from June 1 to September 30 in federal waters, and the ASMFC operates using spawning closures and a “days out” program that limits the number of days per week that vessels can land herring in state waters (ASMFC 2014).

Production Statistics

Atlantic herring landings were over 100,000 mt from 1962–1976, and decreased with the implementation of the Magnuson-Stevens Act and the elimination of foreign fishing from U.S. waters. U.S. landings averaged around 80,000 mt from 1977 to 1981; they dropped to 45,000 mt in 1982. Landings increased to over 100,000 mt again in 1995 and have remained high since. Landings from 2007–2009 averaged 88,000 mt. Landings have decreased since then due to a reduction in quota over potential concerns about the stock.

![Figure 1: Total catch (metric tons) of Atlantic herring from vessel trip report data 1960–2010 (NEFMC 2013a).](image-url)
Importance to the U.S./North American market

Herring is sold in the U.S. fresh, frozen, and salted primarily as bait, but for a small food market as well (NEFMC 2013a). One of the major herring dealer/processors (Norpel) reported selling 30% of herring landings domestically and 70% internationally (NEFMC 2013a). Herring is exported to a variety of markets either frozen or salted. Exports averaged about 60 million kilograms (kg) annually from 2008–2013, and primary markets were Canada, China, Japan, Brazil, and Mexico (NMFS 2014). Herring imports are primarily from Canada; total imports in 2013 were 19 million kg, of which 12 million kg were from Canada alone (NMFS 2014).

Common and market names

Herring, sea herring, kipper, sild, common herring, Labrador herring, sardine, and sperling.

Primary product forms

Atlantic herring can be purchased fresh, frozen, pickled, smoked, preserved in oil, and salted. In the U.S., the sardine processing fishery has closed, but sea herring is commonly used as bait for important fisheries such as lobster, tuna, and crab.
Assessment

This section assesses the sustainability of the fishery(s) relative to the Seafood Watch Criteria for Fisheries, available at http://www.seafoodwatch.org.

Criterion 1: Stock for which you want a recommendation

This criterion evaluates the impact of fishing mortality on the species, given its current abundance. The inherent vulnerability to fishing rating influences how abundance is scored, when abundance is unknown. The final Criterion 1 score is determined by taking the geometric mean of the abundance and fishing mortality scores. The Criterion 1 rating is determined as follows:

- Score >3.2=Green or Low Concern
- Score >2.2 and <=3.2=Yellow or Moderate Concern
- Score <=2.2=Red or High Concern

Rating is Critical if Factor 1.3 (Fishing Mortality) is Critical.

Criterion 1 Summary

<table>
<thead>
<tr>
<th>ATLANTIC HERRING</th>
</tr>
</thead>
<tbody>
<tr>
<td>Region / Method</td>
</tr>
<tr>
<td>East coast Atlantic Purse Seine, Unassociated</td>
</tr>
<tr>
<td>East coast Atlantic Trawl, Midwater</td>
</tr>
</tbody>
</table>

Criterion 1 Assessment

ATLANTIC HERRING

Factor 1.1 - Inherent Vulnerability

Scoring Guidelines

- Low—The FishBase vulnerability score for species is 0-35, OR species exhibits life history characteristics that make it resilient to fishing, (e.g., early maturing (community)
- Medium—The FishBase vulnerability score for species is 36-55, OR species exhibits life history characteristics that make it neither particularly vulnerable nor resilient to fishing, (e.g., moderate age at sexual maturity (5-15 years), moderate maximum age (10-25 years), moderate maximum size, and middle of food chain).
High—The FishBase vulnerability score for species is 56-100, OR species exhibits life history characteristics that make is particularly vulnerable to fishing, (e.g., long-lived (>25 years), late maturing (>15 years), low reproduction rate, large body size, and top-predator).

Note: The FishBase vulnerability scores is an index of the inherent vulnerability of marine fishes to fishing based on life history parameters: maximum length, age at first maturity, longevity, growth rate, natural mortality rate, fecundity, spatial behaviors (e.g., schooling, aggregating for breeding, or consistently returning to the same sites for feeding or reproduction) and geographic range.

<table>
<thead>
<tr>
<th>East coast Atlantic, Purse Seine, Unassociated</th>
</tr>
</thead>
<tbody>
<tr>
<td>East coast Atlantic, Trawl, Midwater</td>
</tr>
</tbody>
</table>

Medium

Atlantic herring has medium inherent vulnerability, based on a FishBase score of 39 out of 100 (Cheung and Pauly 2005). Atlantic herring are found offshore and in every major estuarine ecosystem from the Gulf of Maine to the Chesapeake Bay (NEFMC 2013a). They inhabit depths from 0 to 400 meters (m) on the continental shelf, but are usually found from 11–200 m (NEFMC 2014b). Herring prefer cold waters from 5–9 °C (Celsius) during spawning season, but throughout their adulthood are found in waters from 0–20 °C inshore and 2.5–10.5 °C on the continental shelf (NEFMC 2014b). Herring spawn once annually and can spawn along the coast of Maine, in Nova Scotia, or even as far offshore as George’s Bank. They mature at ages 2–4 and can live 15–18 years. The Atlantic herring fishery is known to target fish starting at age 3 up to age 12 (NMFS 2005). They are synchronous spawners and produce 55,000–210,000 eggs once a year by depositing them on the sea floor (NMFS 2005). Herring eggs are preyed upon by many fish species including cod, haddock, red hake, sand lance, and winter flounder, and egg mortality is high (NMFS 2005).

Factor 1.2 - Abundance

Scoring Guidelines

- **5 (Very Low Concern)** — Strong evidence exists that the population is above target abundance level (e.g., biomass at maximum sustainable yield, BMSY) or near virgin biomass.
- **4 (Low Concern)** — Population may be below target abundance level, but it is considered not overfished
- **3 (Moderate Concern)** — Abundance level is unknown and the species has a low or medium inherent vulnerability to fishing.
- **2 (High Concern)** — Population is overfished, depleted, or a species of concern, OR abundance is unknown and the species has a high inherent vulnerability to fishing.
- **1 (Very High Concern)** — Population is listed as threatened or endangered.
Because the current herring biomass \( B_{\text{MSY}} = 157,000 \text{ mt} \) is greater than the spawning stock biomass threshold \( (1/2 SSB_{\text{MSY}} = 78,500 \text{ mt}) \), the herring stock is not overfished (SARC 2012). The assessment ran a model with several harvest scenarios, and all of them found that the stock will not become overfished through 2015, when the herring stock will next be assessed. Therefore, the Atlantic herring stock status is scored as “very low” concern.

**Rationale:**
The Stock Assessment Review Committee (SARC) of the 54th Northeast Regional Stock Assessment Workshop (SAW 54) reviewed the 2012 benchmark stock assessment for Atlantic herring that used a new ASAP model to estimate biological reference points. The assessment was completely revised from previous ones and eliminated significant sources of uncertainty, including a concerning retrospective pattern. Differences from the previous stock assessment include the presence of a large 2008 year class that is recruiting into the current population, portioning catch by mobile and fixed gear types, and a more reliable estimate of natural mortality.

**Figure 2:** Atlantic herring spawning stock biomass (SARC 2012). Solid line is target reference point (SSB Target = 157,000 mt); dashed line is limit reference point (SSB Threshold = 78,500mt). 2011 SSB = 518,000 mt.

**Factor 1.3 - Fishing Mortality**

**Scoring Guidelines**

- **5 (Very Low Concern)**—Highly likely that fishing mortality is below a sustainable level (e.g., below fishing mortality at maximum sustainable yield, FMSY), OR fishery does not target
species and its contribution to the mortality of species is negligible (≤ 5% of a sustainable level of fishing mortality).

- **3.67 (Low Concern)**—Probable (>50%) chance that fishing mortality is at or below a sustainable level, but some uncertainty exists, OR fishery does not target species and does not adversely affect species, but its contribution to mortality is not negligible, OR fishing mortality is unknown, but the population is healthy and the species has a low susceptibility to the fishery (low chance of being caught).

- **2.33 (Moderate Concern)**—Fishing mortality is fluctuating around sustainable levels, OR fishing mortality is unknown and species has a moderate-high susceptibility to the fishery and, if species is depleted, reasonable management is in place.

- **1 (High Concern)**—Overfishing is occurring, but management is in place to curtail overfishing, OR fishing mortality is unknown, species is depleted, and no management is in place.

- **0 (Critical)**—Overfishing is known to be occurring and no reasonable management is in place to curtail overfishing.

### East coast Atlantic, Purse Seine, Unassociated

**Very Low Concern**

Since the current fishing mortality rate ($F_{2011} = 0.14$) is less than the fishing mortality threshold ($F_{MSY} = 0.27$), the herring stock is not experiencing overfishing (SARC 2012). Since the stock is not experiencing overfishing and fishing mortality is low, this is scored as “very low” concern.

**Rationale:**

Fishing mortality rates were higher in previous years and averaged 0.23 from 2000–2009, but the overfishing was still not occurring because fishing mortality was below the threshold level (NEFMC 2013). Fishing mortality rates in 2010 and 2011 were low because of the strong 2008 year class that recruited into the population (SARC 2012). The Atlantic herring fleet consistently catches the entire quota for certain management areas, but often does not harvest the overall quota. In addition, quotas are set with enough of a buffer to ensure the productivity of the stock; the 2013–2015 quotas were set with a buffer of approximately 75% $F_{MSY}$. The assessment ran through several harvest scenarios, and all of them found that overfishing of the herring stock will not occur through 2015, when the next stock assessment will occur (SARC 2012). However, the stock assessment has a number of uncertainties such as previous retrospective inconsistencies, which appear to have been improved upon in this assessment but still remain. In addition, the assessment model estimated a large 2008 year class recruiting into the current population, which leads biomass estimates to be robust and fishing mortality to be low.
Figure 3: Atlantic herring age-5 fishing mortality (solid line) and $F_{\text{MSY}}$ (dashed line) estimated from the ASAP model base run. The $F_{\text{MSY}}$ reference line is only provided during 1996–2011 because the reference point from this assessment is only for this time period.
Criterion 2: Impacts on Other Species

All main retained and bycatch species in the fishery are evaluated in the same way as the species under assessment were evaluated in Criterion 1. Seafood Watch® defines bycatch as all fisheries-related mortality or injury to species other than the retained catch. Examples include discards, endangered or threatened species catch, and ghost fishing. To determine the final Criterion 2 score, the score for the lowest scoring retained/bycatch species is multiplied by the discard rate score (ranges from 0-1), which evaluates the amount of non-retained catch (discards) and bait use relative to the retained catch. The Criterion 2 rating is determined as follows:

- Score >3.2=Green or Low Concern
- Score >2.2 and <=3.2=Yellow or Moderate Concern
- Score <=2.2=Red or High Concern

Rating is Critical if Factor 2.3 (Fishing Mortality) is Critical.

Criterion 2 Summary

<table>
<thead>
<tr>
<th>Atlantic herring: East coast Atlantic, Purse Seine, Unassociated</th>
</tr>
</thead>
<tbody>
<tr>
<td>Subscore:</td>
</tr>
<tr>
<td>Species</td>
</tr>
<tr>
<td>ATLANTIC HERRING</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Atlantic herring: East coast Atlantic, Trawl, Midwater</th>
</tr>
</thead>
<tbody>
<tr>
<td>Subscore:</td>
</tr>
<tr>
<td>Species</td>
</tr>
<tr>
<td>ALEWIFE</td>
</tr>
<tr>
<td>ATLANTIC MACKEREL</td>
</tr>
<tr>
<td>AMERICAN SHAD</td>
</tr>
<tr>
<td>PILOT WHALE (UNSPECIFIED)</td>
</tr>
<tr>
<td>ATLANTIC HERRING</td>
</tr>
</tbody>
</table>
The species analyzed in this report are mainly those caught or encountered incidentally in the Atlantic herring fishery. In the midwater trawl fishery, haddock, river herring/shad, and Atlantic mackerel are often retained, while marine mammals are discarded dead or released alive when possible. Atlantic mackerel makes up nearly 10% of total catch in the Atlantic herring midwater trawl fishery, while haddock and river herrings (alewife, blueback, and American shad) make up less than 1% of catch. George’s Bank haddock was chosen as a main species because catch of haddock in the herring fishery is controversial, there is a haddock catch cap in the herring fishery, and it is an important groundfish stock in the Northeast bottom trawl fishery.

Alewife, blueback, and American shad are collectively referred to as “river herring.” Even though observed river herring catch in the Atlantic herring fishery is less than 1% of total catch, they were still included as a main species in this report because the majority of river herring stocks are depleted and, due to relatively low observer coverage, the full extent of river herring bycatch in the Atlantic herring fishery is unknown. Framework 3 to the Atlantic herring Fishery Management Plan is in development and proposes to implement a river herring catch cap in the Atlantic herring fishery to limit incidental catch, but until the regulations have been in effect for some time, the outcome of such measures are unknown.

A number of marine mammals are known to be caught in the herring fisheries (Table 2). But estimates suggest that very few are actually caught and killed in these fisheries relative to other fisheries (NMFS 2014e). Long-finned pilot whales and short-finned pilot whales are included under Criterion 2 for the midwater trawl fishery because these species are the drivers for the Category II rating. No mammals are assessed in Criterion 2 for the purse seine fishery.

Table 1: Marine mammal species known to be caught in the mid-Atlantic midwater trawl (including pair trawl) and Gulf of Maine Atlantic herring fisheries (NMFS 2014e). Category refers to the Category given under the NMFS List of Fisheries. Bolded species are those driving the Category rating. PBR is Potential Biological Removal.

<table>
<thead>
<tr>
<th>Fishery</th>
<th>Category</th>
<th>Species</th>
<th>PBR</th>
<th>Total mortality</th>
<th>Fishery specific mortality</th>
</tr>
</thead>
<tbody>
<tr>
<td>Northeast mid-water trawl (including pair trawl)—includes non-herring fisheries</td>
<td>II</td>
<td><strong>Long-finned pilot whale, WNA</strong></td>
<td>199</td>
<td>44</td>
<td>2.4</td>
</tr>
<tr>
<td></td>
<td></td>
<td><strong>Short-finned pilot whale, WNA</strong></td>
<td>159</td>
<td>162 (short-finned and long-finned combined)</td>
<td>2.4 (short-finned and long-finned combined)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Gray Seal, WNA</td>
<td>Unknown</td>
<td>4959 (directed and incidental)</td>
<td>0.2</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Harbor Seal, WNA</td>
<td>1662</td>
<td>409</td>
<td>0.7</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Common Dolphin (short-beaked), WNA</td>
<td>1125</td>
<td>170</td>
<td>0.6</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Atlantic white-sided dolphin, WNA</td>
<td>304</td>
<td>116</td>
<td>6.0</td>
</tr>
<tr>
<td>Gulf of Maine Atlantic herring purse seine</td>
<td>III</td>
<td>Harbor Seal, WNA</td>
<td>1662</td>
<td>409</td>
<td>Very few</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Gray Seal, WNA</td>
<td>Unknown</td>
<td>4959 (directed and incidental)</td>
<td>Very few</td>
</tr>
</tbody>
</table>
**Criterion 2 Assessment**

**ALEWIFE**

**Factor 2.1 - Inherent Vulnerability**

*Scoring Guidelines (same as Factor 1.1 above)*

<table>
<thead>
<tr>
<th>East coast Atlantic, Trawl, Midwater</th>
<th>Medium</th>
</tr>
</thead>
</table>

Alewife has a low to medium inherent vulnerability, based on a FishBase score of 29 out of 100 (Cheung and Pauly 2005).

**Factor 2.2 - Abundance**

*Scoring Guidelines (same as Factor 1.2 above)*

<table>
<thead>
<tr>
<th>East coast Atlantic, Trawl, Midwater</th>
<th>High Concern</th>
</tr>
</thead>
</table>

In 2012, 52 alewife and blueback herring river stocks were assessed, and 22 were found to be depleted, 1 was increasing, and the other 28 were considered unknown due to a lack of sufficient data (1 was not classified) (ASMFC 2012). Biological reference points could not be established due to a lack of data. The Natural Resources Defense Council (NRDC) petitioned the National Marine Fisheries Service (NMFS) to list both alewife and blueback herring as threatened under the Endangered Species Act (ESA). On August 13, 2013, NMFS declared that listing alewife or blueback herring under the ESA was not warranted because there are many conservation efforts currently underway to improve their habitat conditions as well as to reduce incidental catch in marine fisheries, such as the Atlantic herring and mackerel fisheries (78 Federal Register 155). There is a high level of concern about the stock, since the majority of stocks are in decline; but they were not listed as endangered and there are significant conservation efforts underway, so this is scored as “high” rather than very high concern.

**Factor 2.3 - Fishing Mortality**

*Scoring Guidelines (same as Factor 1.3 above)*

<table>
<thead>
<tr>
<th>East coast Atlantic, Trawl, Midwater</th>
<th>Moderate Concern</th>
</tr>
</thead>
</table>

Alewife and blueback herring are collectively called “river herring.” According to a qualitative assessment of the relative impacts of different activities on alewife that was conducted as part of the Endangered Species Act process, dams and other barriers are the greatest threat to recovery (Table 1; 78 Federal Register 155 2013). The assessment team noted that “Rangewide, for alewife and blueback herring, no other threats rose to the level of dams, but several other stressors ranked near the moderate threat level. The Team ranked incidental catch, water quality, and predation as threats likely to have some effect on the species now and into the foreseeable future that are widespread throughout the species’ range.” Addressing incidental catch specifically, the team noted that “Moratoria are in place on directed catch of these species throughout most of the United States; however, they are taken as incidental catch in several fisheries. The extent to which incidental catch is affecting river herring has not been quantified and is not fully understood.” (78 Federal Register 155 2013). In addition, a recent paper found that “At the levels seen in 2011 and 2012, bycatch in the midwater trawl fishery could not account for the overall decline in river herring.” (Bethoney et al. 2014). Thus, incidental fishing mortality may not be the greatest threat to recovery, but it has not properly been quantified, so it is considered “unknown.”

Where fishing mortality is unknown but the population is depleted, effective management must be in place to rate a “moderate” concern (rather than a “high” concern). Framework 3 to the Atlantic herring fishery management plan proposes to put river herring catch caps into place along with the river herring management areas, which were implemented in Amendment 5. Although the final levels have not been determined for the catch caps, the premise is that river herring bycatch in the Atlantic herring fishery will decline, or at least will not increase above a certain level (79 Federal Register 114 2014). Therefore, even though concerns about incidental mortality of river herring are significant, management is in place to reduce bycatch, so this is scored as “moderate” concern.

**Rationale:**
River herring landings peaked in the 1950s (landings were recorded as high as 34,000 mt in 1958) predominantly in Maryland, North Carolina, Virginia, and Massachusetts (ASMFC 2012). Landings began to decline in the 1970s; today, Massachusetts, Rhode Island, Connecticut, Virginia, and North Carolina have all enacted fishing moratoriums for river herring in state waters due to low recorded population numbers. Current estimates of incidental catch in midwater trawl fisheries are quite variable and range from 13.9 to 176.5 mt in New England and 1.2 to 382.6 mt in the Mid-Atlantic (ASMFC 2012).

| Table 2: Qualitative ranking of threats for alewife rangewide. Status Review Team members ranked threats by distributing 5 likelihood points among 5 ranks: 1-low, 2-medium/low, 3-medium, 4-medium/high, 5-high. The mean represents the overall Team average rank, mode represents the rank which received the likelihood points, and range represents range of ranks that were assigned likelihood points for each threat. N= number of Team members who ranked the threat between 1 and 5; likelihood points for threats that Team members ranked as either unknown or not applicable are not included (Table 1; 78 Federal Register 155 2013). |
Factor 2.4 - Discard Rate

East coast Atlantic, Trawl, Midwater

< 20%

Discards in the northeast Mid-Atlantic trawl fisheries and purse seine fisheries are less than 0.01% of landings (Benaka et al 2013). Although this figure does not likely apply only to the herring fisheries, it seems reasonable to assume a discard rate of less than 20% for the herring fisheries alone.

AMERICAN SHAD

Factor 2.1 - Inherent Vulnerability

Scoring Guidelines (same as Factor 1.1 above)

American shad has a medium to high vulnerability, based on a FishBase score of 51 out of 100 (Cheung and Pauly 2005).
Factor 2.2 - Abundance

*Scoring Guidelines (same as Factor 1.2 above)*

<table>
<thead>
<tr>
<th>East coast Atlantic, Trawl, Midwater</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>High Concern</strong></td>
</tr>
</tbody>
</table>

The coast-wide stock assessment conducted by the ASMFC in 2007 found that American shad stocks were in poor condition and on the decline. Shad stocks appeared to be on the decline in Maine, New Hampshire, Rhode Island, and Georgia, and for the Hudson, Susquehanna, James, and Edisto Rivers. Stocks that showed some signs of rebound included the Potomac and York Rivers stocks; however, there were not enough data to make any more conclusive statements about shad stock status (ASMFC 2007). The decline in shad stocks was likely due to overfishing, pollution, and habitat loss from dam construction (NEFMC 2013). An update in 2010 found some improvement but shad stocks were still in decline throughout their range (ASMFC 2010). Since shad stocks show some signs of improvement but are in decline, they are ranked as “high” concern.

Factor 2.3 - Fishing Mortality

*Scoring Guidelines (same as Factor 1.3 above)*

<table>
<thead>
<tr>
<th>East coast Atlantic, Trawl, Midwater</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Low Concern</strong></td>
</tr>
</tbody>
</table>

Due to uncertainty surrounding natural mortality estimates, the 2007 assessment was unable to calculate fishing mortality rates for shad stocks (ASMFC 2007). Recent shad harvests have been 500–900 mt, which is nearly two orders of magnitude lower than historical highs (NEFMC 2013). Incidental catch of shad in marine fisheries were only about 0.55% of coast-wide commercial shad harvest. But catch was only reported from ME, MA, and NJ (ASMFC 2010), and there are likely a substantial number of incidental landings that are unreported. The level of uncertainty over catches in the herring fishery and the species’ depleted state rate as “low” concern for fishing mortality rather than very low concern.

Factor 2.4 - Discard Rate

<table>
<thead>
<tr>
<th>East coast Atlantic, Trawl, Midwater</th>
</tr>
</thead>
<tbody>
<tr>
<td>&lt; 20%</td>
</tr>
</tbody>
</table>

Discards in the northeast Mid-Atlantic trawl fisheries and purse seine fisheries are less than 0.01% of landings (Benaka et al 2013). Although this figure does not likely apply only to the herring fisheries, it
seems reasonable to assume a discard rate of less than 20% for the herring fisheries alone.

**ATLANTIC MACKEREL**

**Factor 2.1 - Inherent Vulnerability**

*Scoring Guidelines (same as Factor 1.1 above)*

<table>
<thead>
<tr>
<th>East coast Atlantic, Trawl, Midwater</th>
<th>Medium</th>
</tr>
</thead>
</table>

Atlantic mackerel has a medium vulnerability, based on a FishBase score of 44 out of 100 (Cheung and Pauly 2005).

**Factor 2.2 - Abundance**

*Scoring Guidelines (same as Factor 1.2 above)*

<table>
<thead>
<tr>
<th>East coast Atlantic, Trawl, Midwater</th>
<th>Moderate Concern</th>
</tr>
</thead>
</table>

The stock status of Atlantic mackerel is unknown with respect to being overfished (MAFMC 2012). The most recent assessment in 2010 was not able to set biological reference points due to a series of unknowns and uncertainties with the assessment (MAFMC 2013) (MAFMC 2012). Since the stock status is unknown, but biomass estimates show that the population does not appear to be in decline, the stock is ranked as “moderate” concern.

**Rationale:**

Spawning stock biomass declined from an average during 1962–1984 of 1.3 billion (age 1) fish to an average during 1985–2009 of 566 million (age 1) fish. However, retrospective patterns in the assessment show that recruitment estimates increased with each year of additional data, making the biomass estimates highly uncertain (TRAC 2010). The assessment committee was not confident setting reference points because of this and other uncertainties, and a review of mackerel stock status in 2013 confirmed the stock status as unknown (MAFMC 2013). The commercial fishing acceptable biological catch (ABC) has remained static at 80,000 mt (based on the average catch for 3 years, 2006–2008) since the 2010 assessment (TRAC 2010) (77 Federal Register 55, 2012), and will remain unchanged until 2015 when a new assessment will be conducted (MAFMC 2012).
Factor 2.3 - Fishing Mortality

*Scoring Guidelines (same as Factor 1.3 above)*

<table>
<thead>
<tr>
<th>East coast Atlantic, Trawl, Midwater</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Moderate Concern</strong></td>
</tr>
</tbody>
</table>

The stock status is also unknown with respect to overfishing (MAFMC 2012). Fishing mortality increased during 2000 to 2006 (from 0.17 to 1.11), but declined in 2008 ($F = 0.51$), which was the last year of data used for the 2010 assessment (TRAC 2010). Mackerel landings peaked in the early 2000s at 50,000 mt, but have declined so much in recent years (MAFMC 2013) that in 2011, only 1,000 mt of mackerel were landed (MAFMC 2013). The cause of the decline in landings is unknown. Since the fishing mortality status is unknown but commercial landings have been low in recent years, this is scored as “moderate” concern.

Factor 2.4 - Discard Rate

<table>
<thead>
<tr>
<th>East coast Atlantic, Trawl, Midwater</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>&lt; 20%</strong></td>
</tr>
</tbody>
</table>

Discards in the northeast Mid-Atlantic trawl fisheries and purse seine fisheries are less than 0.01% of landings (Benaka et al 2013). Although this figure does not likely apply only to the herring fisheries, it seems reasonable to assume a discard rate of less than 20% for the herring fisheries alone.

**HADDOCK: GEORGES BANK**

Factor 2.1 - Inherent Vulnerability

*Scoring Guidelines (same as Factor 1.1 above)*

<table>
<thead>
<tr>
<th>East coast Atlantic, Trawl, Midwater</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Medium</strong></td>
</tr>
</tbody>
</table>

Haddock has medium inherent vulnerability, based on a FishBase score of 47 out of 100 (Cheung and Pauly 2005). Haddock can live up to 17 years, but the U.S. commercial fishery catches fish that are between 3 and 7 years of age weighing between 1 to 3 kg. Haddock reaches sexual maturity between ages 1 and 4 and spawning occurs from January to June on George’s Bank. They are benthic feeders that prey on mollusks, polychaetes, amphipods, crabs, shrimps, and sea stars; haddock have also been known to prey on small fishes, but those do not make up the majority of the haddock diet (NEFSC 2006).
Factor 2.2 - Abundance

*Scoring Guidelines (same as Factor 1.2 above)*

<table>
<thead>
<tr>
<th>East coast Atlantic, Trawl, Midwater</th>
<th>Very Low Concern</th>
</tr>
</thead>
</table>

The SSB\textsubscript{2010} for Georges Bank haddock was estimated at 167,278 mt, which is above the SSB\textsubscript{MSY} of 124,900 mt (NEFSC 2012). This results in a score of “very low” concern.

**Rationale:**
Spawning stock biomass peaked in 2007 at over 250,000 mt and has since decreased, although it is still above biological reference points and is considered rebuilt. Short-term projections predict a further increase in biomass between 2011 and 2015, ranging from 147,700 mt to 240,200 mt (NEFSC 2012). One of the major factors in this projected increase is the strong 2010 year class recruiting to the fishery, estimated at 750 million age-1 fish (compared to an average of 19 million between 2000 and 2009). There is still uncertainty over the size of this cohort, but the projections described have taken this uncertainty into account.

Factor 2.3 - Fishing Mortality

*Scoring Guidelines (same as Factor 1.3 above)*

<table>
<thead>
<tr>
<th>East coast Atlantic, Trawl, Midwater</th>
<th>Very Low Concern</th>
</tr>
</thead>
</table>

Since the current fishing mortality rate for the George's Bank haddock stock (0.24) is below the F\textsubscript{40\%} proxy level of 0.39, overfishing is not occurring (NEFSC 2012). Catch of George's Bank haddock has steadily increased from 2000–2010 and is expected to continue to increase from 2012–2015 (NEFSC 2012); however, since the population is healthy, there are no concerns about overfishing occurring. Because the fishing mortality from 2011–2015 (0.20) is less than the F\textsubscript{40\%} proxy level of 0.39, it is likely that overfishing will not be occurring through the next benchmark stock assessment (NEFSC 2012). Since overfishing is not occurring, this is scored as “very low” concern.

Factor 2.4 - Discard Rate

<table>
<thead>
<tr>
<th>East coast Atlantic, Trawl, Midwater</th>
<th>&lt; 20%</th>
</tr>
</thead>
</table>
Discards in the northeast Mid-Atlantic trawl fisheries and purse seine fisheries are less than 0.01% of landings (Benaka et al. 2013). Although this figure does not likely apply only to the herring fisheries, it seems reasonable to assume a discard rate of less than 20% for the herring fisheries alone.

PILOT WHALE (UNSPECIFIED)

Factor 2.1 - Inherent Vulnerability

*Scoring Guidelines (same as Factor 1.1 above)*

| East coast Atlantic, Trawl, Midwater | High |

All marine mammals are considered to be highly vulnerable to overfishing according to the Seafood Watch criteria, due to biological characteristics such as high longevity, late age of maturation, and few offspring.

Factor 2.2 - Abundance

*Scoring Guidelines (same as Factor 1.2 above)*

| East coast Atlantic, Trawl, Midwater | High Concern |

Long-finned and short-finned pilot whales are difficult to differentiate at sea, so they are assessed together as one species. The population size of both long-finned and short-finned pilot whales is unknown (NMFS 2014g). “Unknown” stock status combined with “high” vulnerability (Factor 2.1) result in a score of “high” concern.

**Rationale:**

One survey from the summer of 2004 estimated the population at 12,619 individuals (NMFS 2014g). Another aerial survey in 2006 estimated 26,535 individuals, and the Canadian Trans-North Atlantic Sighting Survey in 2007 estimated 6,134 pilot whales (NMFS 2014g). Biopsy samples that were collected from 1998–2007 were used to distinguish long-finned from short-finned pilot whales. Using that data, the best available estimate is 12,619 long-finned pilot whales and 24,674 short-finned pilot whales. There is not enough data to determine whether the population is increasing or decreasing, and productivity rates are unknown. Since the stock status is unknown and the species is considered highly vulnerable to overfishing, there is high concern about the pilot whale stock.
Factor 2.3 - Fishing Mortality

**Scoring Guidelines (same as Factor 1.3 above)**

<table>
<thead>
<tr>
<th>East coast Atlantic, Trawl, Midwater</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Very Low Concern</strong></td>
</tr>
</tbody>
</table>

The potential biological removal (PBR) level for long-finned pilot whales (from the Western North Atlantic population) is 199 animals (NMFS 2014f), while that of short-finned pilot whales is 159 (NMFS 2014g). The total estimated annual mortality across both species for 2007–2010 is 206 (NMFS 2014f) (NMFS 2014g), of which at least 44 are long-finned pilot whales, so it is unlikely that PBR for either species is exceeded. The total catch across all northeast midwater trawl fisheries is 2.4 pilot whales. Thus, mortality from the herring trawl fishery is likely less than 1% of total mortality. So it is unlikely that the fishery is having any significant impact on these populations.

Factor 2.4 - Discard Rate

<table>
<thead>
<tr>
<th>East coast Atlantic, Trawl, Midwater</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>&lt; 20%</strong></td>
</tr>
</tbody>
</table>

Discards in the northeast Mid-Atlantic trawl fisheries and purse seine fisheries are less than 0.01% of landings (Benaka et al 2013). Although this figure does not likely apply only to the herring fisheries, it seems reasonable to assume a discard rate of less than 20% for the herring fisheries alone.
Criterion 3: Management effectiveness

Management is separated into management of retained species (harvest strategy) and management of non-retained species (bycatch strategy).

The final score for this criterion is the geometric mean of the two scores. The Criterion 3 rating is determined as follows:

- Score >3.2=Green or Low Concern
- Score >2.2 and <=3.2=Yellow or Moderate Concern
- Score <=2.2 or either the Harvest Strategy (Factor 3.1) or Bycatch Management Strategy (Factor 3.2) is Very High Concern = Red or High Concern

Rating is Critical if either or both of Harvest Strategy (Factor 3.1) and Bycatch Management Strategy (Factor 3.2) ratings are Critical.

Criterion 3 Summary

<table>
<thead>
<tr>
<th>Region / Method</th>
<th>Management of Retained Species</th>
<th>Management of Non-Retained Species</th>
<th>Overall Recommendation</th>
</tr>
</thead>
<tbody>
<tr>
<td>East coast Atlantic</td>
<td>4.000</td>
<td>All Species Retained</td>
<td>Green(4.000)</td>
</tr>
<tr>
<td>Purse Seine, Unassociated</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>East coast Atlantic</td>
<td>4.000</td>
<td>3.000</td>
<td>Green(3.464)</td>
</tr>
<tr>
<td>Trawl, Midwater</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Factor 3.1: Harvest Strategy

Scoring Guidelines

Seven subfactors are evaluated: Management Strategy, Recovery of Species of Concern, Scientific Research/Monitoring, Following of Scientific Advice, Enforcement of Regulations, Management Track Record, and Inclusion of Stakeholders. Each is rated as ‘ineffective,’ ‘moderately effective,’ or ‘highly effective.’

- 5 (Very Low Concern)—Rated as ‘highly effective’ for all seven subfactors considered.
- 4 (Low Concern)—Management Strategy and Recovery of Species of Concern rated ‘highly effective’ and all other subfactors rated at least ‘moderately effective.’
- 3 (Moderate Concern)—All subfactors rated at least ‘moderately effective.’
- 2 (High Concern)—At minimum, meets standards for ‘moderately effective’ for Management Strategy and Recovery of Species of Concern, but at least one other subfactor rated ‘ineffective.’
• 1 (Very High Concern)—Management exists, but Management Strategy and/or Recovery of Species of Concern rated ‘ineffective.’
• 0 (Critical)—No management exists when there is a clear need for management (i.e., fishery catches threatened, endangered, or high concern species), OR there is a high level of illegal, unregulated, and unreported fishing occurring.

Factor 3.1 Summary

<table>
<thead>
<tr>
<th>Region / Method</th>
<th>Strategy</th>
<th>Recovery</th>
<th>Research</th>
<th>Advice</th>
<th>Enforce</th>
<th>Track</th>
<th>Inclusion</th>
</tr>
</thead>
<tbody>
<tr>
<td>East coast Atlantic</td>
<td>Highly</td>
<td>Highly</td>
<td>Highly</td>
<td>Highly</td>
<td>Highly</td>
<td>Moderately</td>
<td>Highly</td>
</tr>
<tr>
<td>Purse Seine, Unassociated</td>
<td>Effective</td>
<td>Effective</td>
<td>Effective</td>
<td>Effective</td>
<td>Effective</td>
<td>Effective</td>
<td></td>
</tr>
</tbody>
</table>

Subfactor 3.1.1 – Management Strategy and Implementation

Considerations: What type of management measures are in place? Are there appropriate management goals, and is there evidence that management goals are being met? To achieve a highly effective rating, there must be appropriate management goals, and evidence that the measures in place have been successful at maintaining/rebuilding species.

East coast Atlantic, Purse Seine, Unassociated

East coast Atlantic, Trawl, Midwater

Highly Effective

The Atlantic herring fishery is a limited-access fishery in which the number of vessels that can participate is capped at a certain level based on historical participation. The fishery is managed by the NMFS in conjunction with the NEFMC in Federal waters and by the ASMFC in state waters. The most recent benchmark stock assessment was conducted in 2012, and stock status updates occur every 1–3 years prior to setting new quotas and developing new management measures necessary for the preservation of the stock. Biological reference points are based on a model fit to a Beverton-Holt stock recruitment curve. The biological reference points that were used for setting the quota levels (F_{MSY} = 0.27 and 1/2 SSB_{MSY} = 157,000) are appropriate for the fishery and were updated in 2012 using a more robust and reliable assessment model, which developed a new estimate of natural mortality that reflects the role of herring as an important forage fish in the Northeast ecosystem. The overfishing limit was set at 169,000 mt for 2013, 136,000 mt for 2014, and 114,000 mt for 2015. The allowable biological catch (ABC) was set at 114,000 mt, and after deducting estimated Canadian catch, the domestic annual harvest was set at 107,800 mt. The buffer between the overfishing limit and the allowable biological catch was determined to be sufficient to account for herring as a forage fish and reflective of overall
scientific uncertainty (78 Federal Register 193 2013).

Two different approaches for setting the annual sub-ACLs (allowable catch limits) were developed to account for herring as an important forage species. The first method would set the annual quota based on 75% of $F_{MSY}$. The second method was based on a constant catch scenario that would set the annual quota at the same level for all 3 years (2013–2015). Using this method, there would be no more than a 50% probability that $F_{MSY}$ would be exceeded in 2015. Ultimately, the annual quota was set using the second method so that fishing vessels could plan their businesses around constant quotas for 3 years in a row, but the assessment scientists were confident that either method would ensure adequately high biomass levels, and that the stock would still not be overfished in 2015 when the next assessment will occur (78 Federal Register 193 2013). Besides setting the sub-ACLs conservatively, additional accountability measures were put in place that prevent the fishery from exceeding its annual quota, such as closing fishing in each management area once 92% of the management area sub-ACL is harvested, closing the entire herring fishery when the stock-wide annual catch limit (ACL) is harvested, and deducting overages from the following years’ management area sub-ACL if they do occur (78 Federal Register 193 2013).

The domestic annual harvest is divided into four sub-ACLs, and when harvest of a particular sub-ACL reaches 92%, that management area is closed to directed fishing (78 Federal Register 193 2013). The ASMFC implements additional management measures in state waters to protect the herring stock, including seasonal closed areas for spawning and a “days out” program that controls fishing effort by limiting the number of days per week that herring can be landed in a particular state (ASFMC 2014). Atlantic herring fishery management is rated as “highly effective” due to the acceptance of appropriate biological reference points, buffers for uncertainty, and measures to limit fishing effort and protect the spawning stock.

**Subfactor 3.1.2 – Recovery of Species of Concern**

*Considerations: When needed, are recovery strategies/management measures in place to rebuild overfished/threatened/endangered species or to limit fishery’s impact on these species and what is their likelihood of success? To achieve a rating of Highly Effective, rebuilding strategies that have a high likelihood of success in an appropriate timeframe must be in place when needed, as well as measures to minimize mortality for any overfished/threatened/endangered species.*

<table>
<thead>
<tr>
<th>East coast Atlantic, Purse Seine, Unassociated</th>
<th>Highly Effective</th>
</tr>
</thead>
<tbody>
<tr>
<td>East coast Atlantic, Trawl, Midwater</td>
<td></td>
</tr>
</tbody>
</table>

Although herring were overfished for a few years around 1980, the population quickly recovered and
has been above the target since then (Figure 2). No other species are landed in the fishery.

**Subfactor 3.1.3 – Scientific Research and Monitoring**

*Considerations: How much and what types of data are collected to evaluate the health of the population and the fishery’s impact on the species? To achieve a Highly Effective rating, population assessments must be conducted regularly and they must be robust enough to reliably determine the population status.*

| East coast Atlantic, Purse Seine, Unassociated |
| East coast Atlantic, Trawl, Midwater |
| **Highly Effective** |

A variety of fishery-dependent and -independent data is used in Atlantic herring stock assessments to determine the status of the stock. The 2012 assessment used the following fishery-dependent data: catch at age data from 1964–2011 from NMFS Vessel Trip Reports (VTR), which are sent from the vessel captain to NMFS on a weekly basis; North American Fisheries Organization (NAFO) reports; Maine Department of Marine Resources (DMR) data collections; and other state landings reports. Data on the Canadian weir fishery from 1965–2011 was provided by the Department of Fisheries and Oceans, Canada and was also used in the assessment (NEFSC 2012a). Fishery-independent data came from the annual NMFS bottom trawl survey that has run from 1968 (spring survey) and 1963 (fall survey) through 2011; a Massachusetts Division of Marine Fisheries (DMF) bottom trawl survey from 1977–2011; a Maine/New Hampshire bottom trawl survey (2000/2001–2011); and a herring acoustic survey from 1999–present that has been used to estimate abundance and biomass (NEFSC 2012a). Atlantic herring fisheries research is ranked as “highly effective” due to the plethora and robustness of data used in the assessment process.

**Subfactor 3.1.4 – Management Record of Following Scientific Advice**

*Considerations: How often (always, sometimes, rarely) do managers of the fishery follow scientific recommendations/advice (e.g. do they set catch limits at recommended levels)? A Highly Effective rating is given if managers nearly always follow scientific advice.*

| East coast Atlantic, Purse Seine, Unassociated |
| East coast Atlantic, Trawl, Midwater |
| **Highly Effective** |
Regulations have always been developed and implemented based on the best scientific information available. The NEFMC has always followed the advice of the Science and Statistical Committee (SSC) when setting annual landings quotas and developing new management measures. The ASMFC’s management plan mirrors the regulations set by the NEFMC and NMFS. In addition, state marine fisheries agencies collect biological samples from the herring fleet to determine (using the gonadosomatic index (GSI)) levels of spawning mature female herring. When spawning females are detected in the area, the state implements a 4-week spawning closure of that area as a precautionary measure. This results in a score of “highly effective.”

Subfactor 3.1.5 – Enforcement of Management Regulations

Considerations: Do fishermen comply with regulations, and how is this monitored? To achieve a Highly Effective rating, there must be regular enforcement of regulations and verification of compliance.

<table>
<thead>
<tr>
<th>Subfactor</th>
<th>Status</th>
</tr>
</thead>
<tbody>
<tr>
<td>East coast Atlantic, Purse Seine, Unassociated</td>
<td></td>
</tr>
<tr>
<td>East coast Atlantic, Trawl, Midwater</td>
<td>Highly Effective</td>
</tr>
</tbody>
</table>

The Atlantic herring fishery has mandatory vessel monitoring system (VMS) requirements, and fishing is monitored directly by the NMFS Law Enforcement office. Every herring vessel that has a limited-access permit is required to have a VMS onboard and to report their catch daily by 9 a.m. through their VMS units (NEFMC 2013a). This is especially important because the herring fishery is split into four management areas, of which some are seasonal and all are closed at different times of the year, depending on when the management area quota is harvested. The NMFS Law Enforcement Office also monitors fishing violations and prevents the illegal, unregulated, and unreported harvesting and trafficking of fish and wildlife (NMFS 2014a).

In addition, the ASMFC has a Law Enforcement Committee that works in conjunction with the Federal NOAA Fisheries Law Enforcement department and meets biannually to issue on the status of fisheries enforcement along the Atlantic coast (ASMFC 2014a). The Committee consists of law enforcement representatives from each state, and each meeting discusses any law enforcement issues for fisheries in general or specific species within their state waters. This results in a score of “highly effective.”

Subfactor 3.1.6 – Management Track Record

Considerations: Does management have a history of successfully maintaining populations at sustainable levels or a history of failing to maintain populations at sustainable levels? A Highly
Effective rating is given if measures enacted by management have been shown to result in the long-term maintenance of species overtime.

<table>
<thead>
<tr>
<th>East coast Atlantic, Purse Seine, Unassociated</th>
</tr>
</thead>
<tbody>
<tr>
<td>Moderately Effective</td>
</tr>
<tr>
<td>Measures enacted by management have resulted in the long-term maintenance of Atlantic herring abundance at appropriate levels for the stock. However, for forage species (see Factor 4.3), a rating of “highly effective” is only given when abundance of the stock is maintained at a level that is likely to be adequate to fulfill the species’ role in the wider ecosystem. It is too early to be confident that the reductions in quota provide for this role (see Factor 4.3). This results in a score of “moderately effective.”</td>
</tr>
</tbody>
</table>

Subfactor 3.1.7 – Stakeholder Inclusion

Considerations: Are stakeholders involved/included in the decision-making process? Stakeholders are individuals/groups/organizations that have an interest in the fishery or that may be affected by the management of the fishery (e.g., fishermen, conservation groups, etc.). A Highly Effective rating is given if the management process is transparent and includes stakeholder input.

<table>
<thead>
<tr>
<th>East coast Atlantic, Purse Seine, Unassociated</th>
</tr>
</thead>
<tbody>
<tr>
<td>Highly Effective</td>
</tr>
<tr>
<td>Atlantic herring is managed jointly by the NEFMC, NMFS, and the ASMFC. The management process is public and there are multiple opportunities for stakeholder input throughout the development and prior to the implementation of any new management measures. All management measures are developed jointly and ultimately approved by the NEFMC and the ASMFC. At all NEFMC and ASMFC meetings, public comments are encouraged, accepted, and considered when developing management measures. Public comments are also accepted in writing via mail or email at any time (NEFMC 2014) (ASMFC 2014a). The NEFMC and ASMFC both have advisory panels that comprise representatives from the commercial, charter boat, and recreational fishing industries as well as conservation interests, and these panels have the opportunity to provide comments throughout the entire management process. In addition, NMFS publishes all proposed management measures in the Federal Register to receive public comment. All comments from the public are considered and directly responded to before the management measures are finalized and implemented. This results in a score of “highly effective.”</td>
</tr>
</tbody>
</table>
**Bycatch Strategy**

<table>
<thead>
<tr>
<th>Region / Method</th>
<th>All Kept</th>
<th>Critical</th>
<th>Strategy</th>
<th>Research</th>
<th>Advice</th>
<th>Enforce</th>
</tr>
</thead>
<tbody>
<tr>
<td>East coast Atlantic</td>
<td>Yes</td>
<td>No</td>
<td>Moderately Effective</td>
<td>Highly Effective</td>
<td>Highly Effective</td>
<td>Highly Effective</td>
</tr>
<tr>
<td>Purse Seine, Unassociated</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>East coast Atlantic</td>
<td>No</td>
<td>No</td>
<td>Moderately Effective</td>
<td>Highly Effective</td>
<td>Highly Effective</td>
<td>Highly Effective</td>
</tr>
<tr>
<td>Trawl, Midwater</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Subfactor 3.2.1 – Management Strategy and Implementation**

*Considerations: What type of management strategy/measures are in place to reduce the impacts of the fishery on bycatch species and how successful are these management measures? To achieve a Highly Effective rating, the primary bycatch species must be known and there must be clear goals and measures in place to minimize the impacts on bycatch species (e.g., catch limits, use of proven mitigation measures, etc.).*

**East coast Atlantic, Purse Seine, Unassociated**

**Moderately Effective**

The main bycatch concerns in this fishery are groundfish, river herring, and marine mammals (see Criterion 2).

**Groundfish**

The Atlantic herring fishery has a catch cap in place to minimize incidental catch of haddock. The herring fishery is annually allocated 1% of the haddock allowable biological catch (ABC) for each haddock stock. When the haddock cap for a particular stock has been harvested, all herring vessels fishing with midwater trawl are prohibited from landing more than 2,000 lbs of herring in a defined haddock area, and haddock cannot be retained by the herring fishery for the remainder of the year (NMFS 2012a).

**River herring**

Fisheries managers are currently working on developing management measures for the Atlantic herring fishery that will minimize bycatch of river herring (NEFMC 2012a). A number of measures were considered during the development of Amendment 5 to the Atlantic herring fishery management plan (FMP), such as requiring 100% observer coverage in defined river herring areas, seasonal closed areas to protect river herring populations, implementing catch triggers that would have required a vessel to leave a particular area when a certain level of river herring was caught, and the development of a bycatch avoidance program to avoid areas where river herring are abundant (NEFMC 2012a). Ultimately, the only management measure that was implemented was the establishment of river herring
monitoring areas. There are no regulations associated with these monitoring areas at this time (NMFS 2014). In addition, the proposed rule for Framework 3 to the Atlantic Herring FMP proposes the implementation of a river herring catch cap in the herring fishery. The proposed river herring/shad cap is based on the median value of catch for the last 5 years (79 FR 114, 2014). If the catch cap is set at the appropriate level, it could be quite effective at getting Atlantic herring vessels to avoid river herring as much as possible and in minimizing bycatch of river herring in the Atlantic herring fishery as a whole (NEFMC 2014a). The effectiveness of this proposed rule is yet to be seen.

Marine Mammals
There are not currently any management measures to reduce marine mammal bycatch in the herring fishery. Although the herring fishery is not expected to have significant impacts on any marine mammals that the fishery encounters, there are a concerning number of incidental takes in the fishery. More research needs to occur on the impact of the fishery on marine mammals and potential gear modifications to reduce the number of takes.

Overall, management of the fishery’s impacts on these species/species groups is deemed “moderately effective” because it is too early to know if the river herring catch cap will be effective at reducing bycatch and there needs to be more research on how to avoid marine mammal interactions in the fishery.

Subfactor 3.2.2 – Scientific Research and Monitoring

Considerations: Is bycatch in the fishery recorded/documented and is there adequate monitoring of bycatch to measure fishery’s impact on bycatch species? To achieve a Highly Effective rating, assessments must be conducted to determine the impact of the fishery on species of concern, and an adequate bycatch data collection program must be in place to ensure bycatch management goals are being met.

East coast Atlantic, Purse Seine, Unassociated

East coast Atlantic, Trawl, Midwater

Highly Effective

Bycatch in the Atlantic herring fishery is recorded on daily vessel monitoring system (VMS) reports, weekly vessel trip reports (VTR), and through observer coverage in the fishery (NMFS 2012a). Observer coverage in the herring fishery was 26% in 2009 (NEFMC 2013a), which is a moderate amount of coverage but enough to get a sense of what is happening in the fishery. There are also regulations in development to implement an industry-funded observer program that will likely increase coverage rates (MAFMC 2014). Although the 26% observer coverage rate is higher than that of many other Northeast fisheries, the true nature of bycatch in the fishery would only be known with 100% observer coverage.
Since the Federal government does not have enough funding for 100% observer coverage, the herring industry has volunteered to pay for increased observer coverage. This factor is rated “highly effective.”

**Subfactor 3.2.3 – Management Record of Following Scientific Advice**

*Considerations: How often (always, sometimes, rarely) do managers of the fishery follow scientific recommendations/advice (e.g., do they set catch limits at recommended levels)? A Highly Effective rating is given if managers nearly always follow scientific advice.*

<table>
<thead>
<tr>
<th>Subarea</th>
<th>Rating</th>
</tr>
</thead>
<tbody>
<tr>
<td>East coast Atlantic, Purse Seine, Unassociated</td>
<td>Highly Effective</td>
</tr>
<tr>
<td>East coast Atlantic, Trawl, Midwater</td>
<td>Highly Effective</td>
</tr>
</tbody>
</table>

See Subfactor 3.1.4 in the Harvest Strategy above.

**Subfactor 3.2.4 – Enforcement of Management Regulations**

*Considerations: Is there a monitoring/enforcement system in place to ensure fishermen follow management regulations and what is the level of fishermen’s compliance with regulations? To achieve a Highly Effective rating, there must be consistent enforcement of regulations and verification of compliance.*

<table>
<thead>
<tr>
<th>Subarea</th>
<th>Rating</th>
</tr>
</thead>
<tbody>
<tr>
<td>East coast Atlantic, Purse Seine, Unassociated</td>
<td>Highly Effective</td>
</tr>
<tr>
<td>East coast Atlantic, Trawl, Midwater</td>
<td>Highly Effective</td>
</tr>
</tbody>
</table>

See Subfactor 3.1.5 in the Harvest Strategy above.
Criterion 4: Impacts on the habitat and ecosystem

This Criterion assesses the impact of the fishery on seafloor habitats, and increases that base score if there are measures in place to mitigate any impacts. The fishery’s overall impact on the ecosystem and food web and the use of ecosystem-based fisheries management (EBFM) principles is also evaluated. Ecosystem Based Fisheries Management aims to consider the interconnections among species and all natural and human stressors on the environment.

The final score is the geometric mean of the impact of fishing gear on habitat score (plus the mitigation of gear impacts score) and the Ecosystem Based Fishery Management score. The Criterion 2 rating is determined as follows:

- Score >3.2=Green or Low Concern
- Score >2.2 and <=3.2=Yellow or Moderate Concern
- Score <=2.2=Red or High Concern

Rating cannot be Critical for Criterion 4.

Criterion 4 Summary

<table>
<thead>
<tr>
<th>Region / Method</th>
<th>Gear Type and Substrate</th>
<th>Mitigation of Gear Impacts</th>
<th>EBFM</th>
<th>Overall Recomm.</th>
</tr>
</thead>
<tbody>
<tr>
<td>East coast Atlantic</td>
<td>Purse Seine, Unassociated</td>
<td>3.00:Low Concern</td>
<td>0.25:Minimal Mitigation</td>
<td>4.00:Low Concern</td>
</tr>
<tr>
<td>East coast Atlantic</td>
<td>Trawl, Midwater</td>
<td>3.00:Low Concern</td>
<td>0.25:Minimal Mitigation</td>
<td>4.00:Low Concern</td>
</tr>
</tbody>
</table>

Justification of Ranking

Factor 4.1 – Impact of Fishing Gear on the Habitat/Substrate

Scoring Guidelines

- 5 (None)—Fishing gear does not contact the bottom
- 4 (Very Low)—Vertical line gear
- 3 (Low)—Gears that contacts the bottom, but is not dragged along the bottom (e.g. gillnet, bottom longline, trap) and is not fished on sensitive habitats. Bottom seine on resilient mud/sand habitats. Midwater trawl that is known to contact bottom occasionally
- 2 (Moderate)—Bottom dragging gears (dredge, trawl) fished on resilient mud/sand habitats. Gillnet, trap, or bottom longline fished on sensitive boulder or coral reef habitat. Bottom seine except on mud/sand
- 1 (High)—Hydraulic clam dredge. Dredge or trawl gear fished on moderately sensitive habitats (e.g., cobble or boulder)
• **0 (Very High)**—Dredge or trawl fished on biogenic habitat, (e.g., deep-sea corals, eelgrass and maerl)

  *Note: When multiple habitat types are commonly encountered, and/or the habitat classification is uncertain, the score will be based on the most sensitive, plausible habitat type.*

<table>
<thead>
<tr>
<th>East coast Atlantic, Purse Seine, Unassociated</th>
</tr>
</thead>
<tbody>
<tr>
<td>East coast Atlantic, Trawl, Midwater</td>
</tr>
</tbody>
</table>

**Low Concern**

Midwater trawls and purse seines are used to target pelagic schools of fish in the water column. In a study of 170 documents on fishing gear impacts on habitat, these gears were ranked has having the lowest possible impact on bottom habitat (Chuenpagdee et al. 2003). Midwater trawls are not known for having any lasting impacts on bottom habitat, as long as they don’t touch the bottom (Watling and Norse 1999). Herring midwater trawl gear occasionally contacts the bottom when the herring are quite close to the bottom and the net is towed low in the water column (NMFS 2005), but hard bottom habitats are avoided because the net is not designed to tow over rock substrate. In addition, the only part of a herring midwater trawl that touches the bottom is the chains attached to the footrope, the footrope itself, or weights attached to the net wings; the trawl doors have not been known to make contact with the bottom in any circumstances. Because of this, even when the herring net does touch the bottom, impacts to bottom substrate are minimal (NMFS 2005). An analysis by NMFS on the effects of herring fishing gear (midwater trawls and purse seines) found that any impact on the bottom is minimal and temporary (NMFS 2005). The impacts on habitats from midwater trawls and purse seines fishing for herring are thus rated a “low” concern.

**Factor 4.2 – Mitigation of Gear Impacts**

**Scoring Guidelines**

- **+1 (Strong Mitigation)**—Examples include large proportion of habitat protected from fishing (>50%) with gear, fishing intensity low/limited, gear specifically modified to reduce damage to seafloor and modifications shown to be effective at reducing damage, or an effective combination of ‘moderate’ mitigation measures.
- **+0.5 (Moderate Mitigation)**—20% of habitat protected from fishing with gear or other measures in place to limit fishing effort, fishing intensity, and spatial footprint of damage caused from fishing.
- **+0.25 (Low Mitigation)**—A few measures are in place (e.g., vulnerable habitats protected but other habitats not protected); there are some limits on fishing effort/intensity, but not actively being reduced.
• **0 (No Mitigation)**—No effective measures are in place to limit gear impacts on habitats.

<table>
<thead>
<tr>
<th>East coast Atlantic, Purse Seine, Unassociated</th>
</tr>
</thead>
</table>

<table>
<thead>
<tr>
<th>East coast Atlantic, Trawl, Midwater</th>
</tr>
</thead>
</table>

**Minimal Mitigation**

Fishing effort is actively controlled in the herring fishery through the implementation of a limited-access program as well as an annual quota divided between four management areas. The herring limited-access program was put into place in 2005, and no new permits are being issued for vessels that catch more than 2,000 lbs of herring per trip or per day (NMFS 2012a). Since the fishery has very little impact on the bottom, there are no ongoing efforts to make any gear modifications or employ other measures to further reduce the fishery impact on bottom habitat. The fishery receives a rating of “minimal mitigation” for controlling of fishing effort, but not actively reducing it.

**Factor 4.3 – Ecosystem-Based Fisheries Management**

**Scoring Guidelines**

- **5 (Very Low Concern)**—Substantial efforts have been made to protect species’ ecological roles and ensure fishing practices do not have negative ecological effects (e.g., large proportion of fishery area is protected with marine reserves, and abundance is maintained at sufficient levels to provide food to predators).
- **4 (Low Concern)**—Studies are underway to assess the ecological role of species and measures are in place to protect the ecological role of any species that plays an exceptionally large role in the ecosystem. Measures are in place to minimize potentially negative ecological effect if hatchery supplementation or fish aggregating devices (FADs) are used.
- **3 (Moderate Concern)**—Fishery does not catch species that play an exceptionally large role in the ecosystem, or if it does, studies are underway to determine how to protect the ecological role of these species, OR negative ecological effects from hatchery supplementation or FADs are possible and management is not place to mitigate these impacts.
- **2 (High Concern)**—Fishery catches species that play an exceptionally large role in the ecosystem and no efforts are being made to incorporate their ecological role into management.
- **1 (Very High Concern)**—Use of hatchery supplementation or fish aggregating devices (FADs) in the fishery is having serious negative ecological or genetic consequences, OR fishery has resulted in trophic cascades or other detrimental impacts to the food web.
Atlantic herring and river herring (alewife, blueback herring, and American shad) are considered species of exceptional importance to the Northeast ecosystem due to their role as forage fish. Forage fish are noted for their functional role in the ecosystem through the transfer of energy to higher trophic levels and marine food webs (Pikitch et al. 2012). The Lenfest Forage Fish Report (Pikitch et al. 2012) recommends a buffer of 50% from $F_{MSY}$ for fisheries with moderate data availability to preserve forage fish in their natural environment. The 2013-2015 herring specifications (quotas) were set using a level that approximates a 25% buffer from $F_{MSY}$ to account for the ecosystem role of herring (77 Federal Register 55, 2012). So, although the full 50% buffer was not used, the Atlantic herring fishery is a data-rich fishery and ecosystem characteristics were taken into consideration in the quota setting process. In addition, Framework 3 to the herring FMP is currently in development and it would set a river herring catch cap in the herring fishery. The catch cap would limit the amount of river herring bycatch and, if it is set at an appropriate level, could leave more river herring in the water to fulfill their role as forage fish in the ecosystem (NEFMC 2014a).

Because the ecosystem role of Atlantic herring has been assessed and is included in the TAC setting process at a level lower than that recommended by independent scientists, ecosystem-based fishery management is ranked as “low” concern.
Acknowledgements

Scientific review does not constitute an endorsement of the Seafood Watch® program, or its seafood recommendations, on the part of the reviewing scientists. Seafood Watch® is solely responsible for the conclusions reached in this report.

Seafood Watch® would like to thank three anonymous reviewers for graciously reviewing this report for scientific accuracy.
References


79 Federal Register 114. 2014. Fisheries of the Northeastern United States; Atlantic Herring Fishery; Framework Adjustment 3. Proposed rule, request for comments.


SFW Criteria 2014. Seafood Watch Criteria Document
