Protecting Forage Fish on the Northeast U.S. Continental Shelf

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Mid-Atlantic Council Initiates Action to Protect Unmanaged Forage Species

The Mid-Atlantic Fishery Management Council voted at its meeting in action that would protect unmanaged species of forage fish in the region. This action would place restrictions on the development or expansion of these fish.

Forage fish are small, low trophic level fish that play a central role in marine ecosystems. These species facilitate the transfer of energy to higher trophic levels, consuming very small prey, such as zooplankton, and then being eaten by larger predator fish and other marine animals. Forage fish also serve a biologic role in sustaining the productivity and structure of marine ecosystems.

Given the importance of forage fisheries to the productivity of many recreationally valuable species, the Council has become increasingly concerned with management options to protect unmanaged forage species. "The North Atlantic herring is a particularly sensitive species that has previously experienced rapid expansions, and subsequent collapses, due to overfishing. In this scenario, the collapse of the herring population would result in a suite of economic, social, and ecological consequences," said the Council’s Chairman, Rick Fair.

Herring rules could change as regulators consider future of critical fish species

Published March 20, 2015 / Associated Press

PORTLAND, MAINE – The health of the Atlantic herring — a little forage fish that lives in massive schools that can number in the billions — is critical to the future of the New England fishing industry, and new steps need to be taken to ensure the strength of the fishery, regulators said.

So federal regulators are working on a plan to change the rules they use to set catch limits that make sure Atlantic herring aren’t overfished. Herring are important because they are sold as food and used as bait, and they play a vital role in the food web of the Atlantic Ocean, where they serve as food for marine species ranging from cod to whales, regulators said.
Comprehensive Ecosystem-Based Amendment 1: Protecting Unfished and Unmanaged Forage Fish Species of the U.S. Portion of the California Current Ecosystem

Draft Environmental Assessment for Amendment 15 to the Coastal Pelagic Species Fishery Management Plan Amendment 25 to the Pacific Coast Groundfish Fishery Management Plan Amendment 3 to the Highly Migratory Species Fishery Management Plan and Amendment 19 to the Pacific Coast Salmon Fishery Management Plan

September 2014
The ocean food web

Along the U.S. West Coast, most major fish, mammal and seabird species rely on forage fish for food—a group of about 30 species of small schooling fish. Scientists increasingly recognize that maintaining this small group of fish is key to ocean health.

**FISHERIES**
- Chinook salmon
- Albacore tuna
- Sturgeon
- Yelloweye rockfish

**MARINE MAMMALS**
- California sea lion
- Pacific white-sided dolphin
- Humpback whale

**SEABIRDS**
- Brown pelican
- Pomarine jaeger
- Horned puffin
- Caspian tern
- Common murre

**FORAGE FISH**
- Pacific herring
- Pacific jack mackerel
- Pacific sardine
- Eulachon (smelt)
- Northern anchovy

**ZOOPLANKTON**
- Copepod
- Seastar larva
- Fish larva
- Radiolarian
- Ostracod
- Planktonic foraminifer

**PHYTOPLANKTON**
- Phytoplankton

Source: OCEANA: “FORAGE FISH: Feeding the California Current Large Marine Ecosystem,” Marine Forage Species Management off the U.S. West Coast, October 2011

MARK NOWLIN / THE SEATTLE TIMES
Forage Fish Definition

- Small throughout lifespan
- Major prey throughout lifespan
  - For fish, marine mammals, birds
  - >5% of diet, 5 or more years
  - High mortality due to consumption
- Central in food webs, highly productive
  - Trophic level between 2 and 4
  - Many trophic links, energy conduit
  - Production >1/100th; biomass >1/1000th of system primary production
- Often
  - Schooling, pelagic
  - High recruitment variability
### Some Key Forage Fishes on the Northeast U.S. Continental Shelf

<table>
<thead>
<tr>
<th>Common name</th>
<th>Species</th>
<th>Fished Y/N</th>
<th>Mean Annual Landings (mt) (2008-2012)</th>
<th>Current status</th>
<th>Management Authority</th>
<th>Bycatch Important Y/N</th>
</tr>
</thead>
<tbody>
<tr>
<td>Atlantic herring</td>
<td><em>Clupea harengus</em></td>
<td>Y</td>
<td>82,422</td>
<td>3.3; 0.52</td>
<td>NEFMC/ASMFC</td>
<td>Y</td>
</tr>
<tr>
<td>Atlantic menhaden</td>
<td><em>Brevoortia tyrannus</em></td>
<td>Y</td>
<td>210,776</td>
<td>0.22-1.4* ; 3.36</td>
<td>ASMFC</td>
<td>N</td>
</tr>
<tr>
<td>Atlantic mackerel</td>
<td><em>Scomber scombrus</em></td>
<td>Y</td>
<td>12,003</td>
<td>Unknown, unknown</td>
<td>MAFMC</td>
<td>Y</td>
</tr>
<tr>
<td>Butterfish</td>
<td><em>Peprilus triacanthus</em></td>
<td>Y</td>
<td>244</td>
<td>1.7; 0.025</td>
<td>MAFMC</td>
<td>Y</td>
</tr>
<tr>
<td>Alewife</td>
<td><em>Alosa pseudoharengus</em></td>
<td>Y</td>
<td>605</td>
<td>“Depleted” ; unknown</td>
<td>ASMFC</td>
<td>Y</td>
</tr>
<tr>
<td>Blueback herring</td>
<td><em>Alosa aestivalis</em></td>
<td>Y</td>
<td>6</td>
<td>“Depleted” ; unknown</td>
<td>ASMFC</td>
<td>Y</td>
</tr>
<tr>
<td>Longfin squid</td>
<td><em>Doryteuthis pealii</em></td>
<td>Y</td>
<td>9,892</td>
<td>1.284; unknown</td>
<td>MAFMC</td>
<td>Y</td>
</tr>
<tr>
<td>Illex squid</td>
<td><em>Illex illecebrosus</em></td>
<td>Y</td>
<td>11,227</td>
<td>Unknown, unknown</td>
<td>MAFMC</td>
<td>Y</td>
</tr>
<tr>
<td>Bay anchovy</td>
<td><em>Anchoa mitchilli</em></td>
<td>N</td>
<td>Unassessed</td>
<td></td>
<td></td>
<td>N</td>
</tr>
<tr>
<td>Striped anchovy</td>
<td><em>Anchoa hepsetus</em></td>
<td>N</td>
<td>Unassessed</td>
<td></td>
<td></td>
<td>N</td>
</tr>
<tr>
<td>Silver anchovy</td>
<td><em>Engraulis eurystole</em></td>
<td>N</td>
<td>Unassessed</td>
<td></td>
<td></td>
<td>N</td>
</tr>
<tr>
<td>Round herring</td>
<td><em>Etrumeus teres</em></td>
<td>N</td>
<td>Unassessed</td>
<td></td>
<td></td>
<td>N ?</td>
</tr>
<tr>
<td>Thread herring</td>
<td><em>Opisthonema oglinum</em></td>
<td>Y</td>
<td>0</td>
<td>Unassessed</td>
<td></td>
<td>Y, small</td>
</tr>
<tr>
<td>Spanish sardine</td>
<td><em>Sardinella aurita</em></td>
<td>Y</td>
<td>0</td>
<td>Unassessed</td>
<td></td>
<td>Y, small</td>
</tr>
<tr>
<td>Sand lance</td>
<td><em>Ammodytes americanus and A. dubius</em></td>
<td>N</td>
<td>0</td>
<td>Unassessed</td>
<td></td>
<td>N</td>
</tr>
<tr>
<td>Atlantic silverside</td>
<td><em>Menidia menidia</em></td>
<td>Y</td>
<td>6</td>
<td>Unassessed</td>
<td></td>
<td>N</td>
</tr>
</tbody>
</table>
Managed forage abundance trends

- **Atlantic Menhaden Fecundity**
  - Graph showing fecundity trends over years with fecundity, fecundity target, and fecundity threshold.

- **Atlantic Menhaden Biomass and Recruitment**
  - Graph showing biomass and recruitment trends over years with biomass and recruitment lines.

- **Atlantic Menhaden Fishing Mortality**
  - Graph showing fishing mortality trends over years with fishing mortality target and fishing mortality threshold.

- **Atlantic Menhaden Abundance**
  - Graph showing abundance trends over years with age 0 and ages 1+.
Managed forage abundance trends

American Shad & River Herring Commercial Landings
Source: Personal communication from NMFS Fisheries Statistics Division, Silver Spring, MD, 2013

River Herring
American Shad
Managed forage abundance trends

Managed forage abundance trends

Butterfish 2014 Assessment results
Managed forage abundance trends
Managed forage abundance trends
Forage Fishes Species in Predator Diets

Dogfish
- Mackerels
- Cod
- Herrings
- Sand lances
- Unid fish
- Herrings
- Sand lances
- Herrings
- Unid fish
- Mackerels

Cod
- Cod
- Mackerels
- Unid fish
- Herrings
- Herrings
- Unid fish
- Mackerels
- Herrings
- Unid fish
- Cod

Silver hake
- Mackerels
- Cods
- Unid fish
- Herrings
- Cods
- Unid fish
- Herrings
- Unid fish
- Mackerels
- Cods
Lenfest report and recommendations

Managing a crucial link in ocean food webs
What Are Forage Fish?

- Crucial species in food webs
- Small, often schooling pelagic species
- Sardines, anchovies, sand eels, krill, herring...
- Feed on plankton and transfer energy to upper trophic levels
Economic Value of Forage Fish

Direct value of commercial catch = $5.6 billion
Supportive commercial value = $11.3 billion
Total global commercial value = $16.9 billion

Value in 2006 dollars

First ever estimate of total value of forage fish to all fisheries
Lenfest report and recommendations

Key Recommendations

• Focus on predators
• Consider spatial & temporal management
• Cut forage fishing in half and leave twice as much fish in the ocean compared with conventional management in many ecosystems.
• Tailor management to available information
Forage as Ecosystem Component (EC) Species?

- Unfished forage species, or a complex of species, could be declared EC species in FMPs (prey for managed species or bycatch in the managed fishery)
- EC species not included as managed species in the FMPs, but abundances and habitats monitored
- Council adjust measures in FMPs in response to changes in abundance of the forage species complex or key species in that complex
- Being proposed by the Pacific Fishery Management Council (PFMC 2014)
Evaluating management tradeoffs

- Tradeoffs between forage species indirect in situ value
  - Prey value to high valued predator fisheries
    - Recreational
    - Commercial
  - Prey value to Endangered/Protected species
    - Whale watching industry
  - Cultural importance (historical river herring runs)

- and direct market value
  - Directed fisheries (food, agricultural and industrial products)
    - Changing consumer tastes: slow food
  - Inter-fishery linkages
    - Herring and lobster

- Extreme variability between species—case by case analysis
  - Understand key predators’ needs (species, amount, seasons, areas)
  - Understand forage role in economy (value, substitutability)
Incorporated into herring assessment:
predation evidence $\rightarrow$ increased recent M

Deroba et al. 2012 SAW /SARC 54
Forage Fish Harvest Control Rule
Conceptual illustration with Buffers to F and B

Managed Forage Species

Modified Council Risk Policy

Can the MAFMC Develop a Forage Policy?
Manage prey for predator productivity?

Predator
- Reliance on prey?
- Where/when?

Prey
- Seasonal migration
- Other factors affecting availability

Figures courtesy John Manderson
Consider Human Responses

• Does decreasing forage fish landings increase fishing pressure on other susceptible species?
  
  Effort pushed into less well managed/new fishery?

• Are there differential impacts due to seasonal migrations?

• How to handle potential increased market demand due to increased consumer interest in eating low on the food chain?

• All trade-offs must be carefully weighed