ASMFC Stock Assessment Overview: Atlantic Menhaden

Introduction

This document presents a summary of the 2010 benchmark stock assessment for Atlantic menhaden. The assessment was peer-reviewed by an independent panel of scientific experts through the 20th SouthEast, Data, Assessment, and Review (SEDAR) workshop. This assessment is the latest and best information available on the status of the coastwide Atlantic menhaden stock for use in fisheries management.

Management Overview

The first Fishery Management Plan (FMP) for Atlantic menhaden was developed in 1981, providing managers with a suite of options for managing the fishery. Soon after, a combination of state restrictions, local land use rules, and changing economic conditions resulted in the closure of all but three Atlantic coast menhaden reduction plants north of Virginia by the early 1990s. Currently, one plant operates seasonally in Reedville, Virginia.

In 1988, the Atlantic States Marine Fisheries Commission (Commission) initiated a revision to the FMP. The Plan Revision included a suite of objectives to improve data collection and promote awareness of the fishery and its research needs, including six management triggers used to annually evaluate the menhaden stock and fishery. In 2001, Amendment 1 was passed, providing specific biological, social, economic, ecological, and management objectives for the fishery.

Addendum I (2004) established the current set of biological reference points. Addendum II (2005) initiated a five-year research program for Chesapeake Bay aimed at examining the possibility of localized depletion. Addendum III (2006) instituted a harvest cap of 109,020 metric tons for reduction landings from Chesapeake Bay (2006-2010) and a provision allowing under-harvest in one year to be credited only to the following year's harvest, not to exceed 122,740 metric tons. Addendum IV (2009) extends the Chesapeake Bay harvest cap three additional years (2011-2013) at the same cap levels.

What Data Were Used?

The Atlantic menhaden assessment used both fishery-dependent and independent data as well as information about Atlantic menhaden biology and life history. Fishery-dependent data come from the commercial reduction and bait fisheries, while fishery-independent data are collected through scientific research and surveys.

Life History

Atlantic menhaden undergo extensive north-south migratory movements and are believed to consist of a single population. Adults move inshore and northward in spring and group by age and size along the Atlantic coast. Older, larger menhaden are typically found in colder, northerly habitats during summer whereas immature menhaden are found in large numbers in estuarine and inshore areas from Chesapeake Bay southward. The population extends as far north as the Gulf of Maine though it has been recorded that since the mid-1800s its occurrence has fluctuated tremendously from year to year from periods of great abundance to periods of scarcity or compete absence. Spawning occurs in oceanic waters along the continental shelf as well as in sounds and bays in the northern extent of their range. Eggs hatch at sea and larvae are carried by inshore currents to estuaries where they transform to the juvenile stage soon

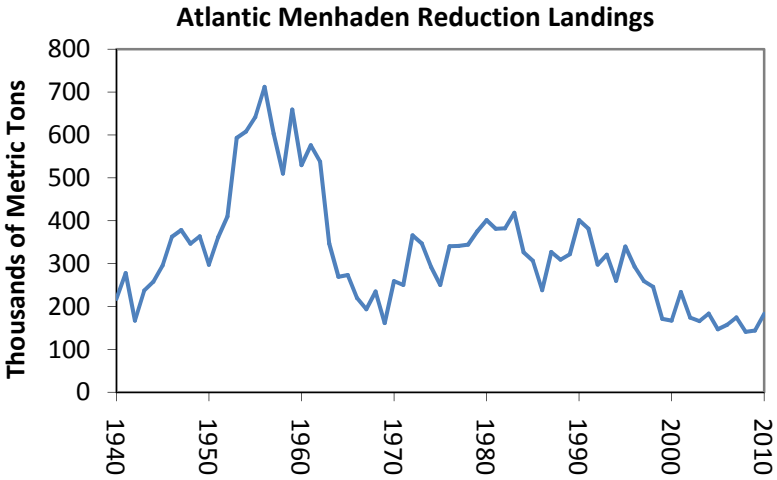
upon arrival. Adults overwinter off the coast of North Carolina. Menhaden mature by age 3 and can live up to 10 years. However, fish older than age 6 have been uncommon since the mid-1960s.

A unique aspect of the Atlantic menhaden assessment is that it incorporated both age-specific and time-varying estimates of natural mortality (M). Annual M estimates were derived from the Commission's multispecies virtual population analysis (MSVPA) that explicitly modeled predator-prey interactions among menhaden, striped bass, weakfish, bluefish, and several other prey species from Maine to North Carolina. Natural mortality rates prior to the start of the MSVPA in 1982 were assumed to be the average M-at-age during 1982-2008. Average menhaden natural mortality declined from a high in the 1980s to relatively lower levels in the 1990s, followed by a modest increase since 2000.

Commercial Data

The Reduction Fishery

Atlantic menhaden are harvested primarily for reduction to fish meal, fish oil, and fish solubles. The reduction fishery grew with the advent of purse seine gear in the mid-1800s. Purse seine landings reached a high point in the 1950s with peak landings of 712,100 metric tons in 1956. At the time, over 20 menhaden reduction factories ranged from northern Florida to southern Maine. In the 1960s, the Atlantic menhaden stock contracted geographically, and many of the fish factories north of Chesapeake Bay closed because of a scarcity of fish. Reduction landings dropped to a low of in 161,000 metric tons in 1969.



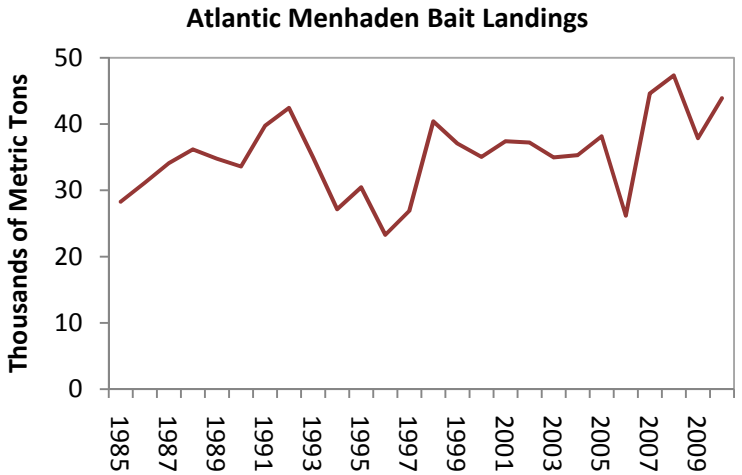
In the 1970s and 1980s, the menhaden population began to expand (primarily because of a series of above average year classes entering the fishery), and reduction landings rose to around 300,000-400,000 metric tons. Adult menhaden were again abundant in the northern half of their range and as a result reduction factories in New England and Canada began processing menhaden again by the mid-1970s. However, by 1989 all shore-side reduction plants in New England had closed mainly because of odor abatement regulations.

During the 1990s, the Atlantic menhaden stock contracted again (as in the 1960s) mostly due to a series of poor to average year classes. Over the next decade, several reduction plants consolidated or closed, resulting in significant reduction in fleet size and fishing capacity. Since 2005 there has been one operational reduction factory processing Atlantic menhaden on the Atlantic coast. In recent years (2008-2010), landings have averaged 156,100 metric tons. Numerous portside samples are taken to obtain information about the weight, length, and age distribution of the fished population.

The Bait Fishery

As reduction landings have declined in recent years, menhaden landings for bait have become relatively more important to the coastwide total landings of menhaden. Commercial landings of menhaden for bait occur in almost every Atlantic coast state. Recreational fishermen also catch Atlantic menhaden as bait for various game fish. A majority of the menhaden-for-bait landings are used commercially as bait for crab pots, lobster pots, and hook-and-line fisheries.

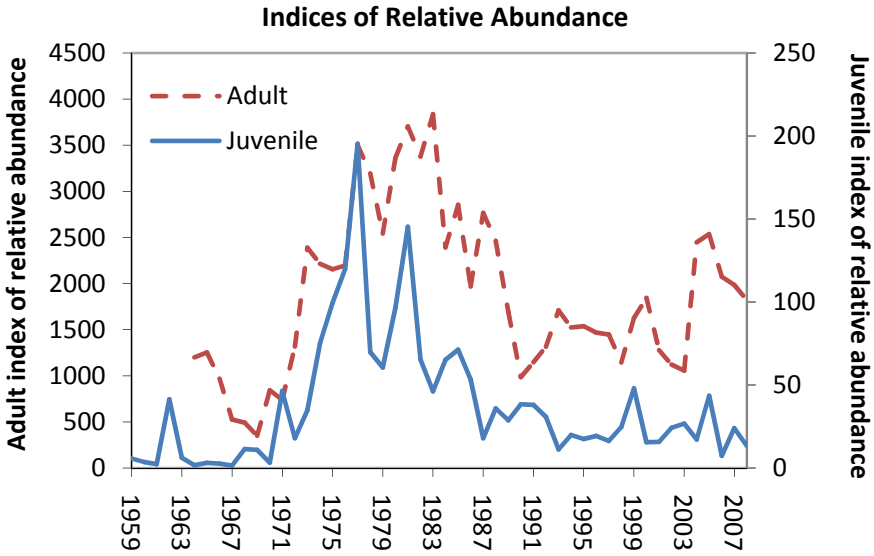
Total landings of menhaden for bait along the US East Coast have been relatively stable in recent years, averaging about 43,000 metric tons during 2008-2010, with peak landings of about 47,300 metric tons in 2008. Between 2001 and 2010, the percent of total menhaden landings attributed to the bait fishery rose from 13 to a high of 25% in 2008. Currently it is approximately 19% of the total menhaden harvest.



Since the mid-1980s, portside samples have been taken to obtain information about the weight, length, and age distribution of the fished population.

Fishery-Independent Surveys

Data collected from seine surveys conducted in Rhode Island, Connecticut, New York, New Jersey, Virginia, Maryland, and North Carolina were used to develop an index of relative abundance for juvenile menhaden. Although menhaden are a bycatch species in these surveys, the seine catch-per-haul data represent the best available information for the construction of a menhaden juvenile abundance index. Data from all seven surveys were statistically combined into one coastwide index. The index increased from historic lows in the 1960s to a sharp peak in 1977 and declined steadily thereafter.

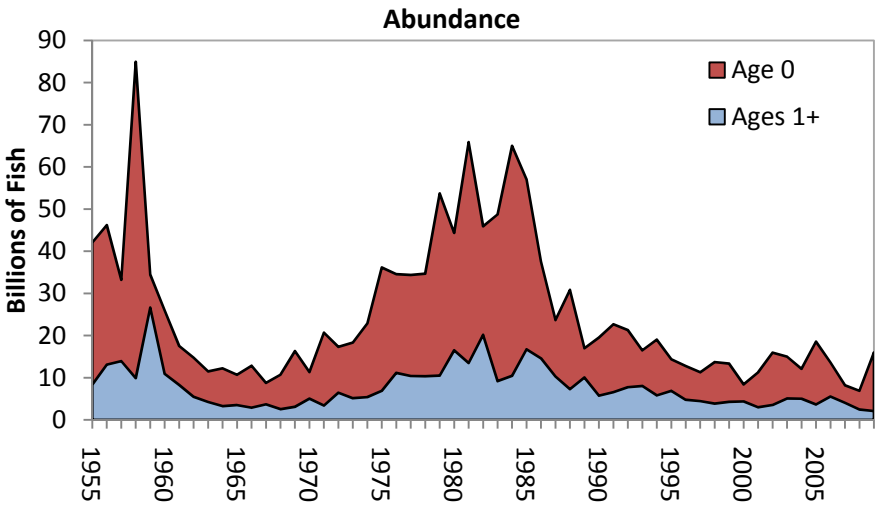


Fishery-Dependent Surveys

Pound net landings collected by the Potomac River Fisheries Commission (PRFC) were used to develop a fishery-dependent index of relative abundance for adult menhaden. Pound nets are stationary fishing gear used to harvest fish in the Potomac River of Chesapeake Bay, including menhaden ages 1-3 years. Other than the reduction landings, these data represent the only other available information that can be used to infer changes in relative abundance of adult menhaden along the US East Coast. The index increased from historic lows in the 1960s to a sharp peak in the early 1980s, declined to lower levels in the 1990s, then exhibited a modest increase in recent years. The PRFC adult index largely tracks the fishery-independent juvenile index with a lag of two years (i.e., it takes juveniles about two years to grow large enough to be caught regularly in PRFC pound nets).

What Models Were Used?

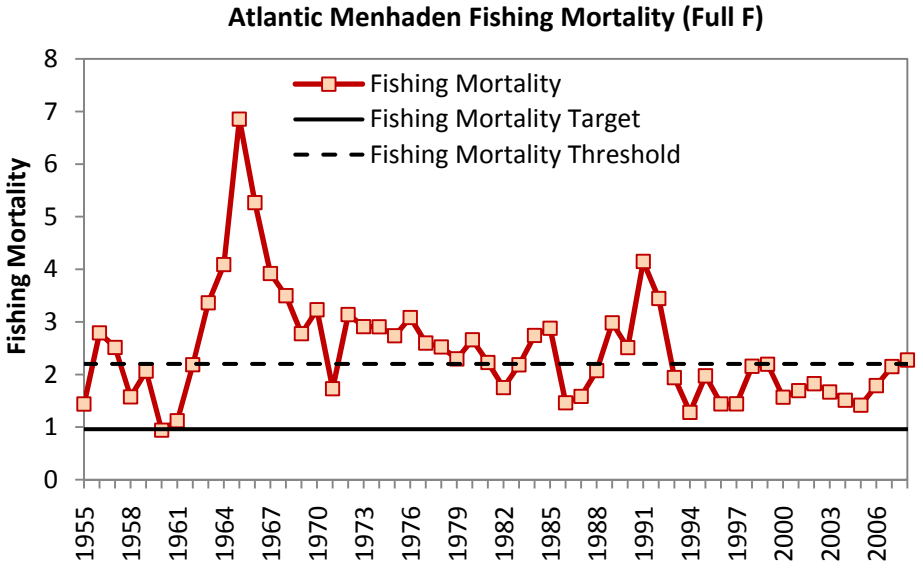
Five alternative modeling approaches were pursued, including the Beaufort Assessment Model, Stock Synthesis 3, the University of British Columbia Model, the MSVPA, and Stock Reduction Analysis. After comparing model performance, reliability, flexibility, and assumptions requirements among the five alternatives, the Beaufort Assessment Model was chosen as the base model for providing management advice.



The Beaufort Assessment Model is a statistical catch-at-age model that estimates population size at age and recruitment in 1955 and then projects the population forward in time to 2008. The model estimates trends in population dynamics, including abundance at age, recruitment, spawning stock biomass, egg production, and fishing mortality rates.

Model results indicate the population has undergone several periods of both high and low abundance over the time series. Abundance has declined steadily since the peak observed in the early 1980s and recruitment (age 0 fish) has been relatively low. Population fecundity (measured as number of maturing ova, or eggs) was high in the late 1950s and early 1960s, low in the late 1960s, and generally increasing since that time.

Fishing mortality rates were highly variable throughout the entire time series, with a decline in fishing mortality from the mid-1960s to the 1980s. Since the mid-1980s fishing mortality rates have varied between some of the highest and lowest values in the entire time series. The model suggests a high degree of variability, but in general the reduction fishery has experienced declining fishing mortality rates since the mid-1960s, while the bait fishery has experienced increasing fishing mortality rates since the 1980s.

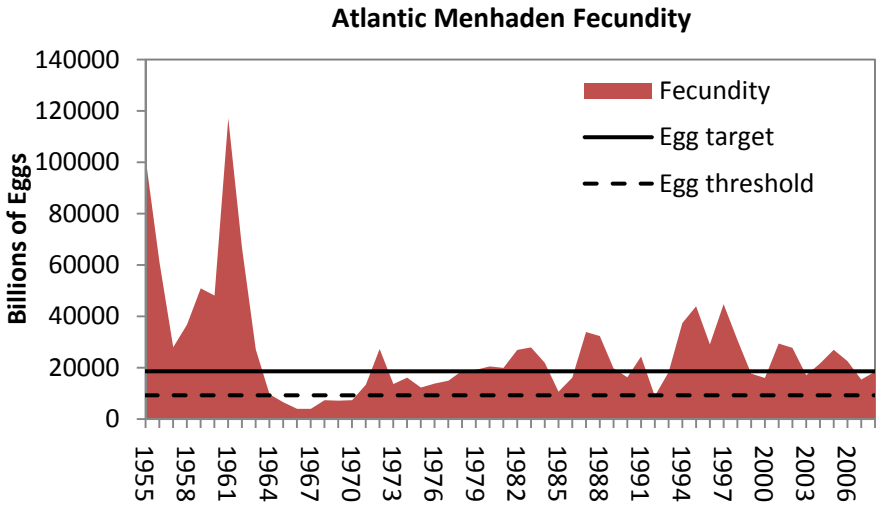


What is the Status of the Stock?

In 2008, the population was not overfished but overfishing was occurring, relative to the current biological reference points. The overfishing threshold for menhaden is F_{MEDIAN}, the instantaneous fishing mortality rate that should allow the population to replace itself. In earlier decades, fishing mortality rates were largely above the median (population replacement) line, however in the last decade, rates have fluctuated at or

below the median. Fishing mortality on all ages in 2008 (the latest year in the assessment) is estimated at 2.28, which was above the target and threshold in 2008, hence overfishing is occurring. Given the current overfishing definition, which sets the fishing mortality rate target at 0.96 and the threshold at 2.2, this is the first time overfishing has occurred since 1998.

The biological reference point that determines the fecundity target for Atlantic menhaden is defined as the mature egg production one would expect when the population is being fished at the threshold fishing mortality rate. Population fecundity was estimated to be well above the threshold and near the target. This means that the spawning stock in 2008 appears to be adequate to produce the target number of eggs, and thus the population is deemed not overfished. However, the number of young fish in the population has been consistently low in recent decades, indicating that high egg production may not be translating into high survival of young menhaden. Given this finding, the Peer Review Panel recommended examination of alternative reference points to provide more protection to the spawning stock biomass.



Data and Research Needs

The Atlantic menhaden stock assessment would be substantially improved by the development of a coastwide fishery-independent survey to replace or supplement the existing PRFC pound net index as a coastwide index of adult abundance at age. In addition, the collection of age structure data outside the range of the fishery would provide much needed information about animals not typically caught by the fishery. As modeling capabilities and data availability improve, a multispecies statistical catch-at-age model could be developed to better estimate menhaden natural mortality at age. Also, development of a spatially-explicit stock assessment model would be beneficial once sufficient age-specific data on movement rates of menhaden is available.

Whom Do I Contact For More Information?

Atlantic States Marine Fisheries Commission
1050 N. Highland Street
Arlington, VA 22201
703/842-0740
info@asmfc.org

Glossary

Age class: all of the individuals in a stock that were spawned or hatched in the same year. This is also known as the year class or cohort.

Catch-at-age: the number of fish of each age that are removed in a year by fishing activity.

Fishing mortality (F): the instantaneous (not annual) rate at which fish are killed by fishing

Natural mortality (M): the instantaneous (not annual) rate at which fish die because of natural causes (predation, disease, starvation, etc)

Statistical catch-at-age (SCAA) model: an age-structured stock assessment model that works forward in time to estimate population size and fishing mortality in each year. It assumes some the catch-at-age data have a known level of error.

References

ASMFC. 2010. Atlantic Menhaden Stock Assessment Report for Peer Review. Atlantic States Marine Fisheries Commission, Stock Assessment Report No. 10-2 (supplement), 309 p.

ASMFC. 2009. Guide to Fisheries Science and Stock Assessments. Washington, DC. http://www.asmfc.org/publications/GuideToFisheriesScienceAndStockAssessments.pdf