ASMFC Stock Assessment Overview: American Lobster

Introduction

The 2015 benchmark stock assessment for lobster is the most comprehensive evaluation of stock status to date. It differs from previous stock assessments in that it combines the Gulf of Maine and Georges Bank stocks into a single biological unit. The assessment was peer-reviewed by an independent panel of scientific experts through the Atlantic States Marine Fisheries Commission's external review process.

Management Overview

The management unit for American lobster (*Homarus americanus*) extends from Maine to North Carolina. The species was historically divided into three biological stock areas which include the Gulf of Maine (GOM), Georges Bank (GBK), and Southern New England (SNE).

American lobster is managed under Amendment 3 to the Interstate Fishery Management Plan and its subsequent Addenda I-XXIV. The Amendment seeks to limit effort and increase egg production in the fishery by instituting traps limits, setting minimum/maximum sizes, and prohibiting the possession of berried lobsters and v-notched females.

After the 2006 stock assessment revealed the depleted condition of the SNE stock, the American Lobster Management Board established a 15 year rebuilding timeline (Addendum XI). When the 2009 assessment showed continued declines in SNE, the Board implemented a 10% reduction in exploitation for SNE (Addendum XVII). In 2012, the Board passed Addendum XVIII which reduces traps allocated to the inshore SNE by 50% and to SNE offshore waters by 25% over 5 years.

What Data Were Used?

The American lobster assessment used both fishery-dependent and independent data as well as information about lobster biology and life history. Fishery-dependent data came primarily from the commercial fishery. Fishery-independent data were collected through scientific research and surveys.

Life History

American lobster is a bottom-dwelling crustacean that prefers rocky habitat, but can also be found on sand or mud bottoms. The species' range extends from Newfoundland south to the Mid-Atlantic region. In the U.S., American lobster is most abundant from the inshore waters of Maine to Cape Cod, Massachusetts.

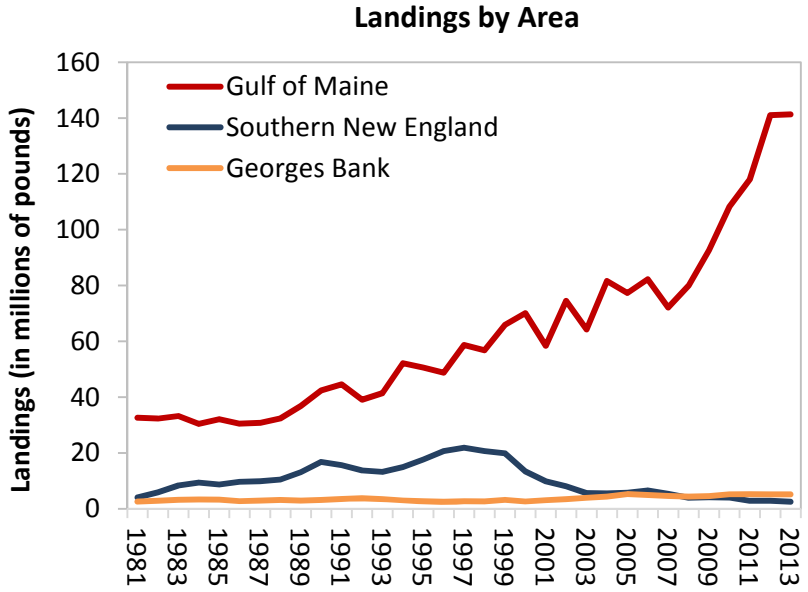
Lobsters grow by molting, which results in incremental growth patterns. This makes aging, which uses a species' hard parts to assess age, unfeasible as all the hard body parts are shed with each molt. Lobsters have long life spans and continue to grow throughout their lives, potentially reaching more than 40 pounds in weight. Females carry fertilized eggs externally for 9-11 months, which then hatch into pelagic larvae that are dispersed passively (water currents) and actively (larval swimming behaviors).

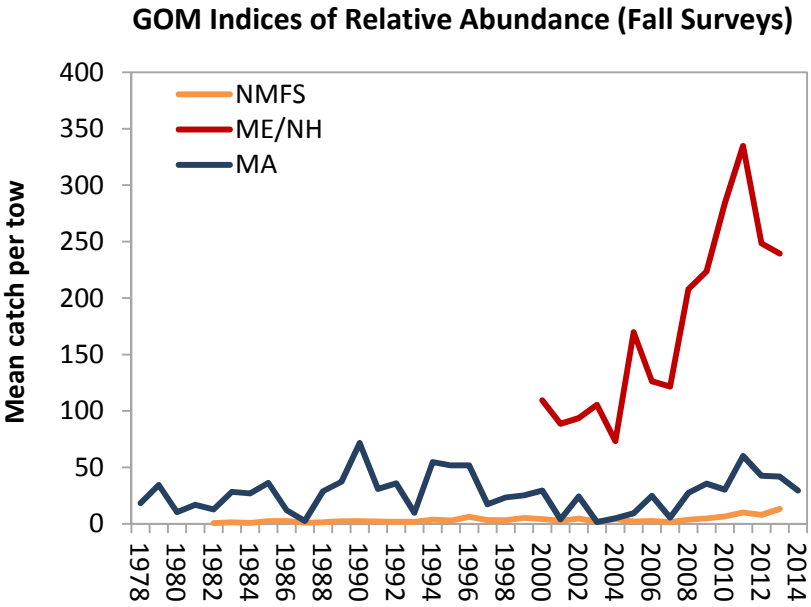
All aspects of lobster life history are strongly influenced by water temperature. Due to increasing water temperatures in the Northwest Atlantic, lobsters in the GOM stock appear to be experiencing longer time periods within an optimal temperature range of 12° – 18° C. This is likely contributing to increased recruitment in this stock. In contrast, water temperatures in SNE have increased to an extent that is producing stressful conditions for lobsters, with many portions of the inshore environment experiencing prolonged time periods when temperatures exceed 20° C. These stressful temperatures cause a number of health issues in lobsters and are likely contributing to the lack of recruitment in the SNE stock.

Commercial and Recreational Data

Fishery-dependent data sources used in the stock assessment include landings reports, and commercial at-sea sampling and port sampling programs conducted by state agencies and the National Marine Fisheries Service (NMFS).

The GOM stock accounts for more than 90% of U.S. American lobster landings and is primarily an inshore fishery. SNE has historically been the second largest fishery, although dramatic declines in recent years have lowered the contribution of this stock to only 2% of the U.S. total in 2013. While the SNE fishery was predominantly an inshore fishery, since 2008 a higher percentage of landings have come from the offshore component. This is due to declines in the inshore landings. The GBK fishery is predominantly an offshore fishery, and has represented an average of 5% of U.S. total landings since 1981.





Commercial trap sampling and port sampling programs provide data that characterize the commercial catch, in terms of size composition and sex ratio. The commercial trap sampling program also provides information on discards of egg-bearing females and v-notched females, which are released alive to protect the spawning stock.

Fishery-independent Surveys

There were multiple bottom trawl surveys (otter trawls) available for use in this assessment. These surveys are conducted by Maine/New Hampshire (ME/NH), Massachusetts, Rhode Island, Connecticut and New Jersey within the respective state's jurisdictional waters. Additionally, a nearshore survey conducted by the

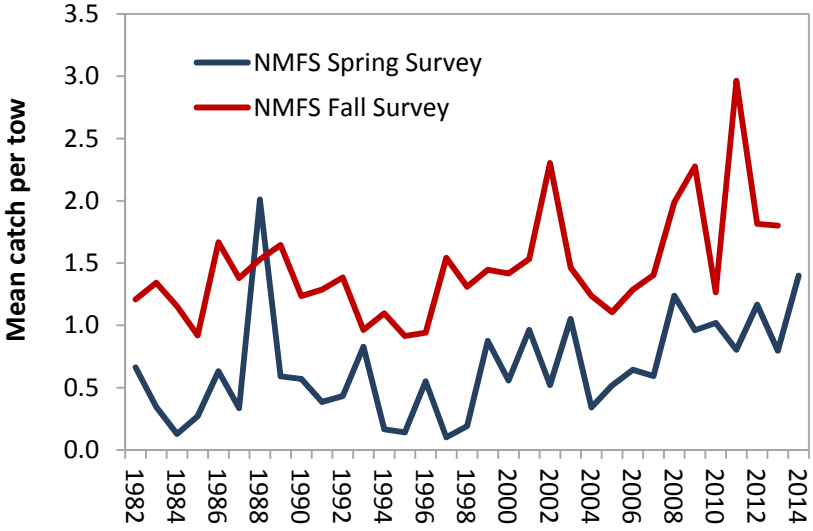
Northeast Area Monitoring and Assessment Program (NEAMAP) that encompasses the Mid-Atlantic to Block Island Sound was available as well as the NMFS Northeast Fisheries Science Center (NMFS NEFSC) offshore survey covering U.S. offshore waters from Maine to New Jersey. These surveys all employ a stratified random sampling design and occur at least twice a year, in the spring and fall. These surveys provided indices of relative lobster abundance for incorporation into population modeling.

GOM survey indices indicate increasing relative abundance since the early 2000s, as particularly evident by the ME/NH survey. In GBK, survey indices show slight increases throughout the time series and fall catch is consistently higher than spring catch. Survey indices in SNE generally indicate peak abundance in the mid- to late 1990s, followed by declines to very low levels in recent years.

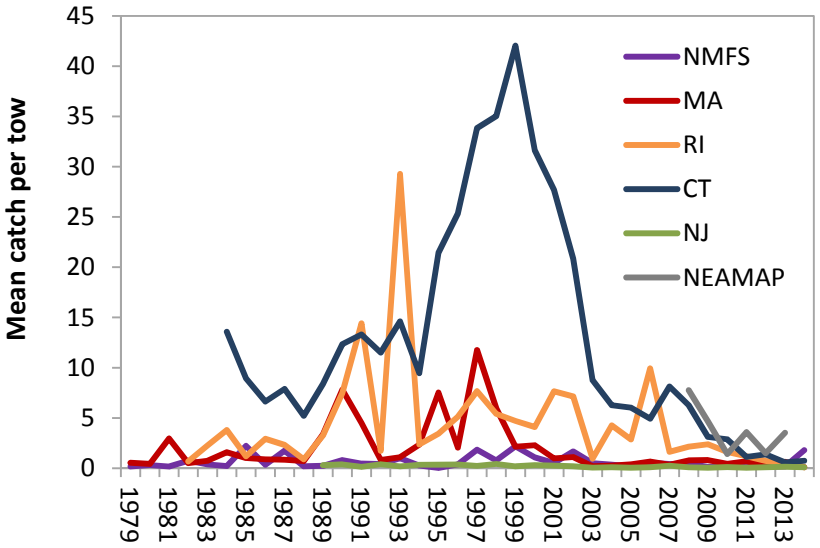
This assessment is the first time the coastwide Ventless Trap Survey (VTS) data were used in the model. VTS uses a series of traps, some of which have escape vents and some of which do not, to determine catch rates of legal and sub-legal sized lobsters. Data from 2006 – 2012 were used in the assessment model. The GOM VTS index indicates increasing abundance over the relatively short time series, while the SNE index shows slight declines in abundance during the same time period.

Young-of-the-year (YOY) larval surveys and settlement surveys are also used to provide information regarding incoming recruitment to the GOM and SNE stocks. There were two larval surveys available from Long Island Sound, one which is an entrainment survey and the other which is a plankton net survey. Several settlement surveys were also available from Maine (GOM), Massachusetts (GOM and SNE), and Rhode Island (SNE). These surveys

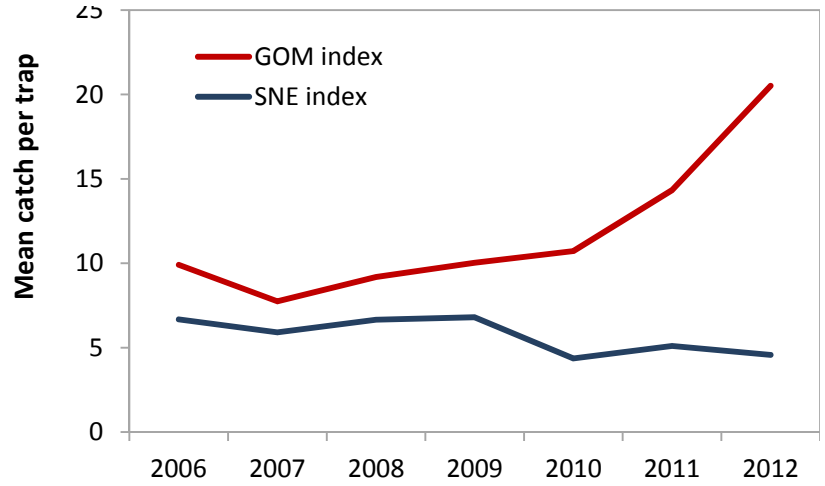
GBK Indices of Relative Abundance



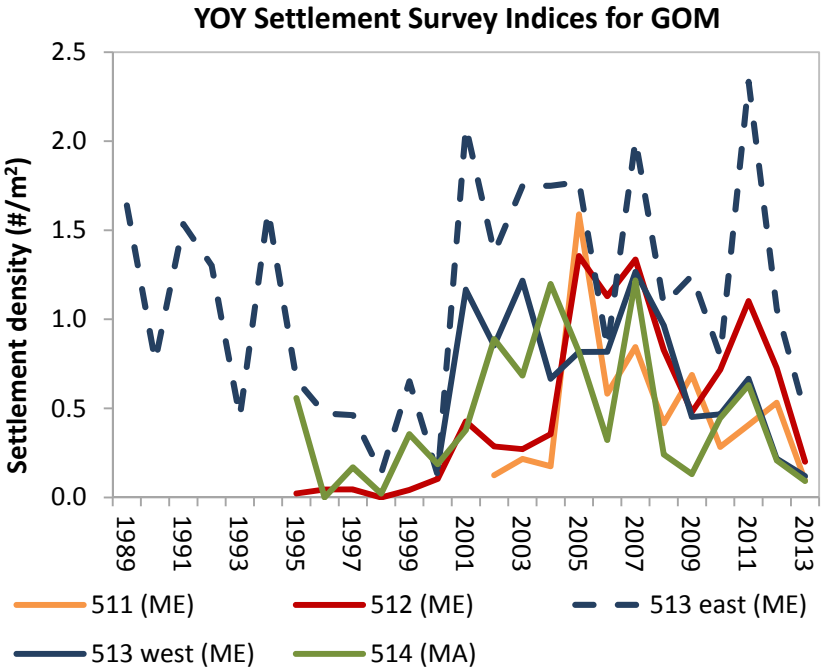
SNE Indices of Relative Abundance (Spring Surveys)



Ventless Trap Survey Indices of Abundance for GOM and SNE

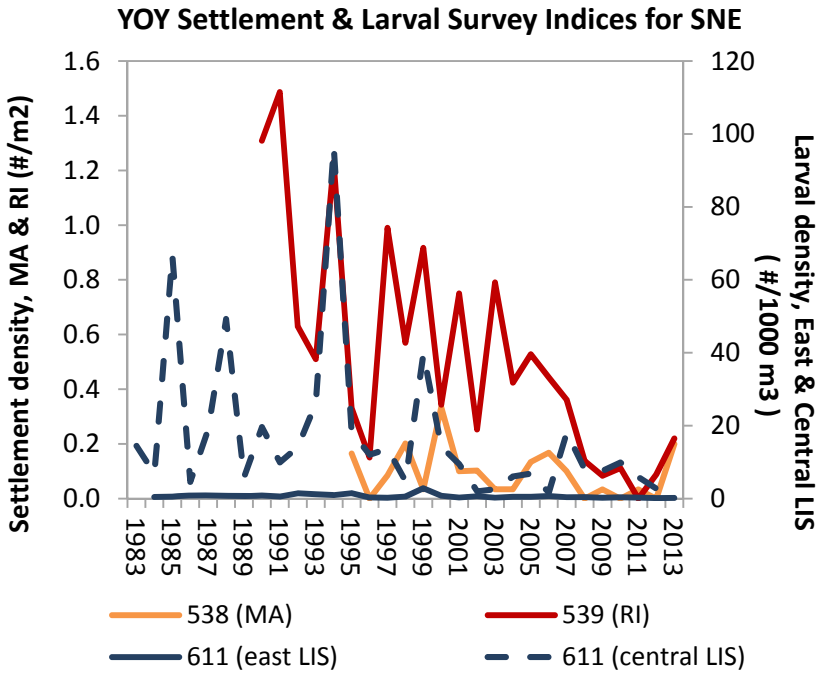


are SCUBA-based air-lift suction sampling that provide density estimates of newly settled YOY lobsters. Several of the GOM settlement surveys have been trending downwards since the mid-2000s, particularly in Area 513 (east and west) and Area 514. This downward trend warrants some attention, as it may indicate that future recruitment to the GOM fishery will decline. In SNE, settlement and larval indices have declined and remain at very low levels. Based on the very low values in SNE YOY indices, further declines in the SNE resource and landings are likely.



What Models Were Used?

The University of Maine (UMaine) Stock Assessment Model for American Lobster (Chen et al 2005) was the only model used in this stock assessment. It is a statistical catch-at-length model that tracks the population of lo bsters by sex in 5 mm size bins over time. Survey indices, landings data, size composition of catch, and information on gear selectivity and conservation discards are inputs to the model. Some critical parameters such as growth, natural mortality, and molt seasonality are assumed to be known and are inputs to the model. The model generates predictions of annual total catch and size composition for surveys and for commercial catch, and uses statistical maximum likelihood methods to compare the predictions to the observed data. The end results are estimates of abundance, spawning stock biomass, population size composition, recruitment, and annual exploitation rates. While there is some uncertainty in the scale of the results, both the Stock Assessment Committee and the Peer Review Panel agree the estimates of trends are robust and very reliable.



In addition to the UMaine model, a number of model-free stock indicators were used to examine trends in abundance, mortality, and fishery performance. These indicators were based on empirical data, and were free from the assumptions inherent to the modeling process.

Gulf of Maine/Georges Bank (GOM/GBK)

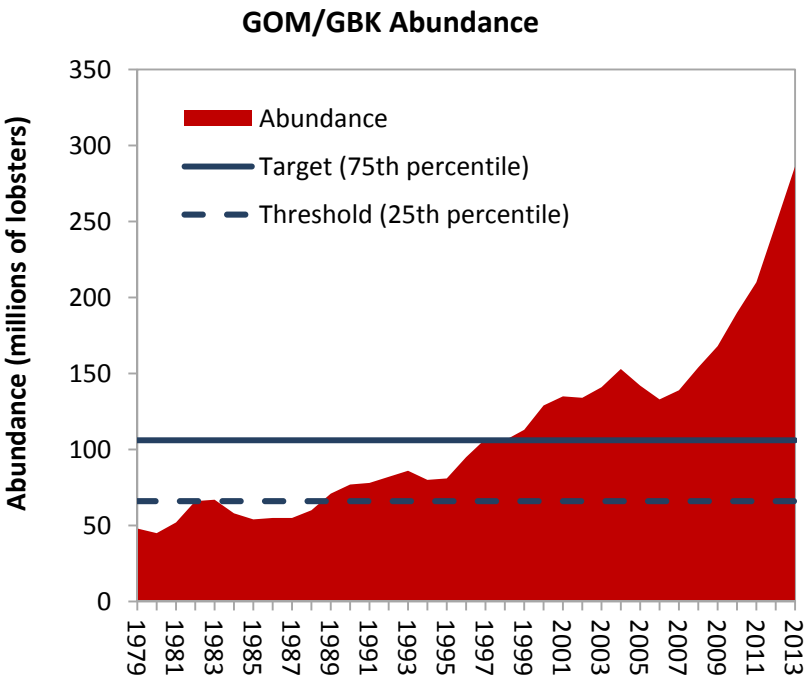
Data from the NMFS NEFSC survey showed an exchange of large lobsters (>100 mm CL) from GOM in the spring to GBK in the fall. Additionally, size compositions estimated for incoming recruits suggested that

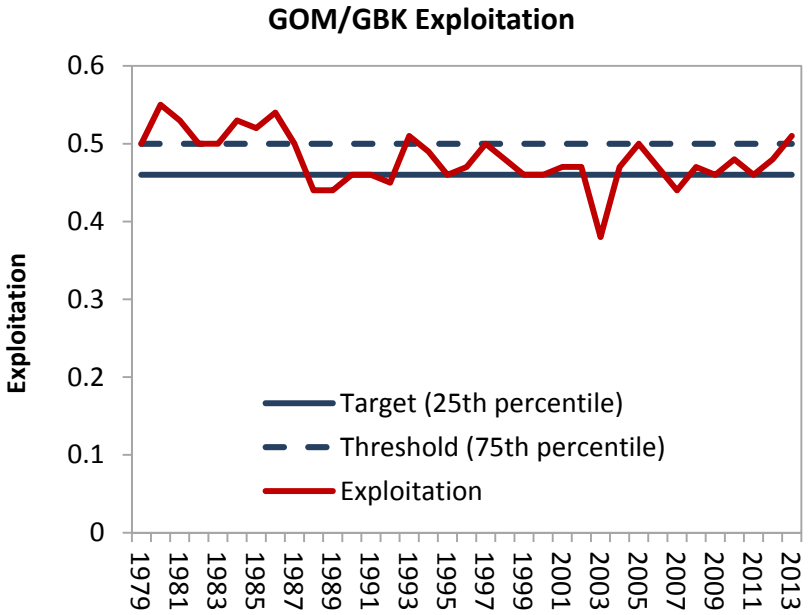
lobsters were likely moving into the GBK stock, not growing in from smaller size classes. As a result, the GOM and the GBK stocks were combined into a single biological unit (GOM/GBK) and model run.

Abundance estimates for the GOM/GBK stock show an increasing trend starting in the late 1980s. After 2007, the rate of this increase accelerated, and currently GOM/GBK abundance is at record high levels. Spawning stock biomass and recruitment are also at or near record highs. Effective exploitation for the combined GOM/GBK stock has been relatively stable since the early 1990s.

Southern New England (SNE)

In contrast to GOM/GBK, model results for SNE show a completely different picture of stock health. Abundance estimates in SNE have declined dramatically since the late 1990s to record low levels. Model estimates of recruitment were near zero and exploitation estimates show a decline in effective exploitation since the early 2000s.





What is the Status of the Stock?

Reference Points

Abundance and exploitation reference points are used in the stock assessment. The GOM/GBK and SNE stocks are considered overfished if the abundance is less than the 25th percentile relative to the reference period. Overfishing is occurring if exploitation is greater than the 75th percentile.

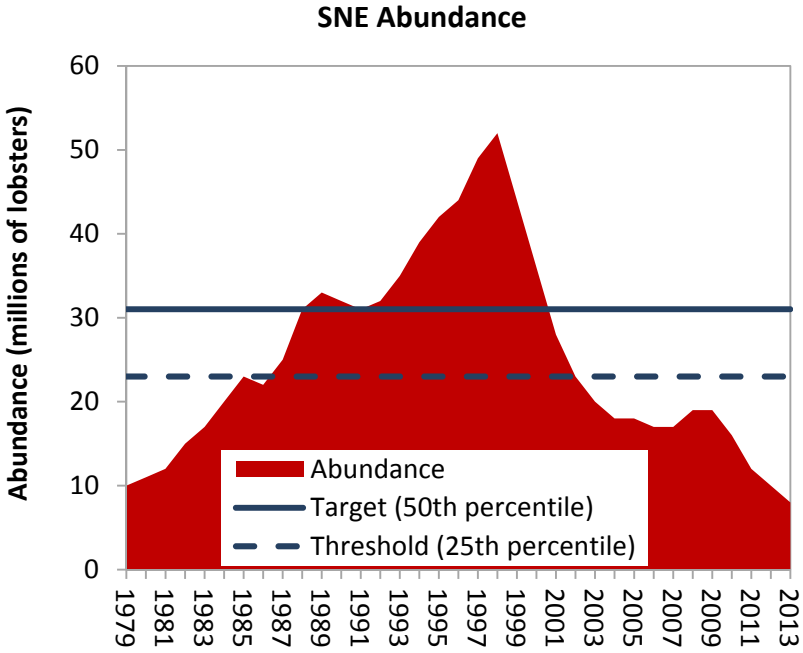
The GOM/GBK stock is not depleted and overfishing is not occurring. The reference abundance from 2011 to 2013 was 248 million lobsters which is well above the abundance threshold of 66 million lobsters. The reference effective exploitation (2011-2013) was 0.48, which is below the threshold of 0.50. Overall, the model results indicate a dramatic increase in overall stock abundance since 1995.

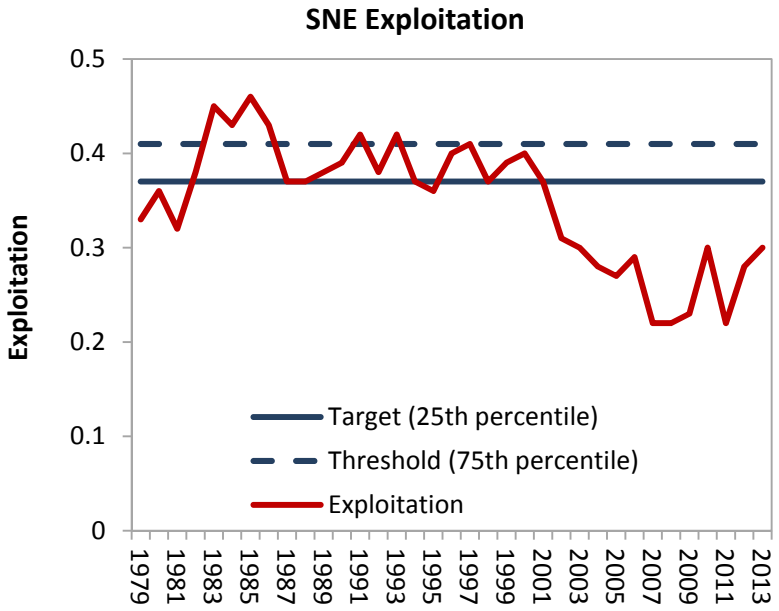
In contrast, the SNE stock is depleted. The reference abundance (2011-2013) was 10 million lobsters which is well below the threshold abundance of 24 million lobsters. Overfishing is not occurring in the SNE stock with the reference exploitation (2011-2013) at 0.27 which is below the threshold of 0.41.

Indicators

Model-free stock indicators were also used to assess the lobster stocks. These include exploitation rates as an indicator of mortality, total spawning potential and year class strength as indicators of relative abundance, and total landings and catch per unit effort as fishery performance indicators.

Indicators for the GOM/GBK stock showed heavy fishing, especially in the fall, but also high stock abundance. Three of the five YOY indicators for the GOM were below the 25th percentile which may hint at the potential for declines in recruitment in future years. Fishery performance indicators were generally positive with landings above the 75th percentile throughout the 2000s.





Indicators for the SNE stock showed that exploitation was at or above the 25th percentile for the majority of the period from 2008-2013. Contrastingly, the average spawning stock abundance from 2008-2013 was below the 25th percentile in six of the eight surveys. Recruitment abundance was worse, with all eight surveys at or below the 25th percentile. All four YOY abundance indices were below the median and warrant close monitoring as these signals indicate poor abundance of newly recruited lobster. These recruitment indices indicate that the stock is not rebuilding and is in recruitment failure. The inshore portion of the SNE stock is in particularly poor condition as survey encounter rates were below the 25th percentile. Fishery performance indicators were generally poor, with commercial landings and catch per unit effort below the time series 25th percentile.

Data and Research Needs

The Technical Committee compiled a list of prioritized research needs to improve understanding of lobster life history and population dynamics as well as aid in the development of future stock assessments. High priority needs included a comprehensive tagging study to examine stock connectivity between the GOM and GBK and calibration work to determine how catch in the ventless trap surveys relates to catch in bottom trawl surveys. The Technical Committee also supports efforts to update size at maturity and growth patterns, especially given the recent changes in water temperature.

What are the Next Steps for Management?

The Board reviewed the results of the stock assessment and the peer review report in August 2015 and approved the benchmark assessment for management use. The Board is now considering the implications of combining the GOM and GBK biological stocks as well as the continued low abundance and recruitment in SNE.

Whom Do I Contact For More Information?

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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 Per Unit Effort (CPUE): The ratio of catch to a standard unit of effort. It can be used as a measure or relative abundance or to track changes in abundance.
Carapace Length (CL): The length of the lobster measured from the rear of the eye socket to the rear of the carapace.
Exploitation (u): The percent of a fish population removed by fishing over the course of a year.
Fishery-Dependent Data: Information collected from fishermen and dealers on catch, landings, and effort.
Fishery-Independent Data: Information collected by scientists via a long-term research survey or other scientific survey.
Overfished: A stock exploited to a level of abundance considered too low to ensure safe reproduction.
Overfishing: Harvesting from a stock at a rate greater than the stock's reproductive capacity to replace fish removed through harvest.
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.
Spawning stock: The female portion of a fish stock that is mature.
Ventless Trap Survey: A survey in which a series of six traps are deployed, three of which have escape vents that allow sublegal lobsters to exit and three traps that do not have vents. The vented traps are designed to monitor trap catch rates of mostly legal-sized lobster while the ventless traps are signed to collect information on the catch rates of sublegal lobsters.
Young-of-the-year (YOY): An individual fish in its first year of life; for most species, YOY are juveniles.

References

ASMFC. 2015. American Lobster Stock Assessment Report for Peer Review. Atlantic States Marine Fisheries Commission, Stock Assessment Report.

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