

Species Profile: Northern Shrimp

Resource Struggles to Rebuild in the Face of Unfavorable Environmental Conditions

Introduction

Historically, northern shrimp, *Pandalus borealis*, have supported a small but important fishery in the Gulf of Maine (GOM), with average annual landings valued at six million dollars per year since 1980. In recent years, the fishery has been closed early when landings approached the total allowable catch (TAC). Currently, the northern shrimp stock is considered collapsed, and has led managers to close the fishery for the third straight season.

As one of the last open access fisheries in the region, the northern shrimp fishery has provided opportunities for fishermen to target an alternative species when other fishing is unavailable or not economically viable. Participation generally increases as the season length or price increases. Additionally, the number of participants in the fishery has increased because of limited entry programs in other Northeast fisheries. Unfortunately, shrimp biomass has remained at all-time lows in recent years, thus raising concern over the influx of effort into the fishery. This concern led to the suggestion that access to the shrimp fishery should be restricted. Limited entry has been used in a number of fisheries to control effort, as well as stabilize landings so that harvesters and processors are better able to make informed business decisions from year to year. To address these concerns, Amendment 3 was initiated in 2014 to consider management options for limiting effort in the fishery.

Life History

Northern shrimp are found in boreal waters of the North Atlantic, North Pacific and Arctic Oceans. On the U.S. Atlantic coast, the Gulf of Maine (GOM) is considered the southernmost extent of their range, and concentrations generally occur in the western part of the Gulf where temperatures are the coldest.

Northern shrimp are hermaphroditic, maturing first as males at roughly 2 ½ years of age and then transforming to females at about 3 ½ years. In the GOM, northern shrimp populations are part of a single stock. Spawning takes place in offshore waters during the late summer. Females extrude their eggs onto the abdomen and move into inshore waters in late fall and winter, where the eggs hatch. Larvae metamorphose to a juvenile state and remain in inshore waters for over a year before migrating to deeper waters where they mature as males and later transition to females. Females that survive their first egg hatch will repeat the process, living up to five years old and attaining a size of up to four inches in length. Northern shrimp are also an important link in the marine food web preying on both plankton and benthic invertebrates. In turn, northern shrimp are consumed by many commercially important fish species including cod, redfish, red and white hake, and pollock.

Northern shrimp abundance in the GOM appears to be closely correlated with ocean temperatures. Colder temperatures and higher spawning biomass tends to produce more recruits. Differences in size at age from year to year (and size at sex transition to some extent) have also been attributed to temperature effects, with more rapid growth rates at higher temperatures. Additionally, ocean temperatures appear to affect timing of the egg hatch, with the start of egg hatch occurring earlier in warmer years. This is of particular interest to managers because a better understanding of this relationship could allow them to set the start of the fishing season after majority of eggs have hatched, thus aiding rebuilding of the resource.

Commercial Fishery

For nearly four decades, the GOM northern shrimp have provided a small but valuable fishery to the New England states. In 2011, a year in which the TAC was exceeded, average price per pound was \$0.75, with total landings valued at an estimated \$10.6 million. The fishery has been characterized by drastic fluctuations in landings throughout its history and is seasonal in nature, peaking in late winter when egg-bearing females migrate inshore and ending in the spring under regulatory closure.

Species Snapshot



Northern Shrimp
Pandalus borealis

Stock Status: Collapsed and overfishing not occurring

Shrimp Facts:

- Northern shrimp first mature as males and metamorphose into females in their 3rd year.
- Most shrimp do not live more than 5 years.
- A spine located on the 3rd tail segment distinguishes northern shrimp from other pandalid species.
- The sex of a shrimp is easily determined by examining the first pleopod. A male has a characteristic spit with a serrated or two point top edge while a female has a single candle flame point.

Male: 2 points

Female: 1 point



The commercial fishery began in earnest in the late 1950s. By 1969, landings increased to a peak of 28.3 million pounds, of which 24.2 million pounds were landed by Maine vessels. New Hampshire vessels entered the fishery in 1966, but landings from New Hampshire were minor until the mid-80s. Landings by Massachusetts vessels were also insignificant in the 1960s, but the fishery developed rapidly in the early 1970s and by 1975 landings from Massachusetts vessels accounted for over 40% of the GOM total. Through the 1970s, total landings dropped precipitously to a low of 840,000 pounds in 1977. The fishery closed in 1978 due to stock collapse, and slowly reopened in 1979 at very low levels of harvest.

Landings fluctuated considerably throughout the next two decades, from a low of 734,000 pounds in 1980 to a high of 21 million pounds in 1996, then steadily declining again through 2002. In keeping with historic trends, the majority of the catch in those years had been taken by Maine vessels (76%), with Massachusetts vessels accounting for most of the remainder (17%). From 2003 to 2006 landings were steady, averaging 4.6 million pounds. In 2007 and 2008, landings jumped to 10.8 and 10.9 million pounds, respectively, despite declining stock abundance since 2006. The 2010 to 2012 fishing seasons were closed early due to industry exceeding the TAC, and in 2013 landings were a mere 761,689 pounds. A complete moratorium was implemented in 2014, and again in 2015. This past December, the moratorium was extended through 2016.

The northern shrimp fleet is comprised of lobster vessels in the 30-45 foot range that re-rig for shrimping, as well as other trawlers well into the 55-80 foot range. The shrimp trap fishery has grown in recent years, accounting for over 45% of Maine's active vessels from 2006 to 2010. However, the otter trawl remains the primary gear deployed, and is typically chain or roller rigged depending on the type of bottom fished. There has been a recent trend towards the use of heavier and larger roller, or "rockhopper" gear. In

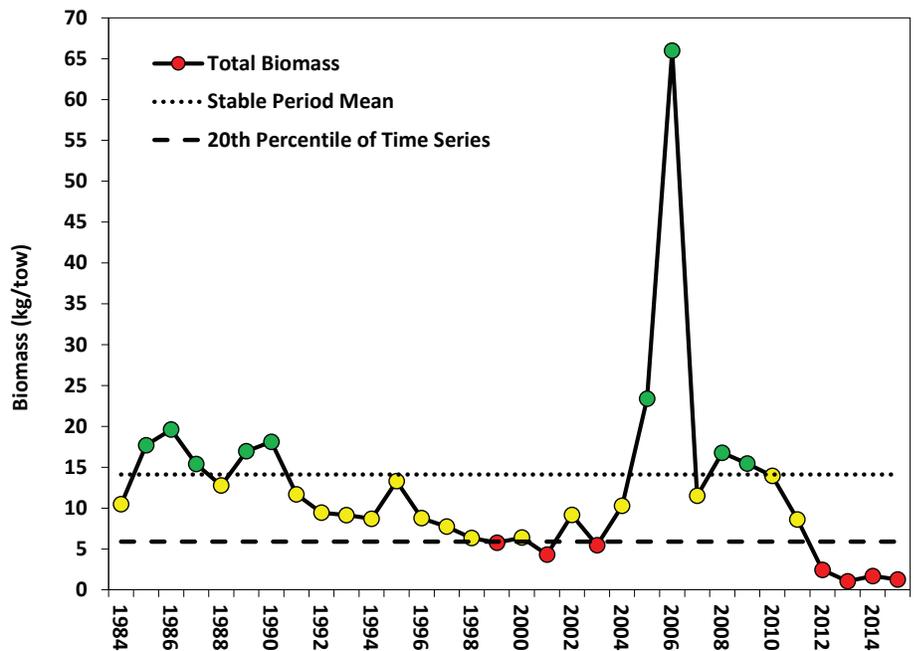
addition to the introduction of electronic equipment (e.g., GPS, radars, and near real time data acquisition of sea surface temperatures and ocean bathymetry, among others), these innovations have substantially increased fishermen's ability to find and catch shrimp.

Status of the Stock

Historically, results of the catch-survey analysis (CSA) from the annual stock assessment for northern shrimp have guided management decisions for the fishery. In 2014, a benchmark assessment explored new analytic methods, including a new model and modifications to the existing CSA model. Due to extreme fluctuations in recent years, the models had difficulty fitting the data and thus were not approved for management use by the peer review panel. Therefore, all subsequent stock status reports do not present modeling results and instead use an index-based approach to evaluate stock status.

According to the 2015 stock status report, GOM northern shrimp populations continue to meet the criteria defining a collapsed stock. Abundance and biomass indices since 2012 are the lowest on record. The stock has also experienced failed recruitment for five consecutive years. As a result, the indices of fishable biomass from 2012 to 2015 are also the lowest on record. Recruitment of northern shrimp is related to both spawning biomass and ocean temperatures, with higher spawning biomass and colder temperatures producing stronger recruitment. Ocean temperatures in western GOM shrimp habitat have increased over the past decade and reached unprecedented highs in the past several years. While 2014 and 2015 temperatures were cooler, temperatures are predicted to continue rising as a result of climate change. This suggests an increasingly inhospitable environment for northern shrimp and the need for

Total Biomass of Northern Shrimp from the Gulf of Maine Summer Shrimp Survey
Stock Status Report for Gulf of Maine Northern Shrimp, 2015



The graph represents the annual biomass index relative to the reference period (dotted line) and to the 20th percentile of the time series (dashed line). The reference period (1985-1994) is the time period during which the fishery experienced stable landings and value. Green dots are values that are equal to or above the stable period mean (SPM); red dots are values that are equal to or below the 20th percentile of the time series; yellow dots are values between the SPM and the 20th percentile.

Timeline of Management Actions: FMP ('86); Amendment 1 ('04); Amendment 2 ('11); Addendum I ('12)

strong conservation efforts to help restore the stock.

Fortunately, the recruitment index increased slightly in the 2014 survey (2013 year class). Since landings are typically dominated by four and five year old shrimp, the 2013 year class could provide favorable conditions for a fishing season in the near future. Furthermore, the 2013 year class is comprised of uncharacteristically small females that are expected to spawn for the next three seasons, making them the primary contributors for rebuilding the stock in the long-term. Accordingly, a primary goal of the 2016 moratorium is to protect the 2013 year class and the future sustainability of the resource.

Atlantic Coastal Management

The GOM northern shrimp fishery has been managed by the Commission's Northern Shrimp Section (Section) since 1973, making it the longest running interstate management program on the U.S. Atlantic coast. The Section is comprised of the States of Maine, New Hampshire, and the Commonwealth of Massachusetts.

The first Fishery Management Plan (FMP) was implemented in 1986. The FMP established strict guidelines for a defined fishing season to be set annually by the Section and allowed for the use of gear limitations. Amendment 1, implemented in 2004, established biological reference points for the first time and expanded the tools available to manage the fishery. Amendment 1 resulted in a rebuilt stock and increased fishing opportunities. However, in the 2010 and 2011 fishing seasons, landings rates were far greater than expected, resulting in early seasonal closures and an overharvest of the recommended TAC.

Implemented in 2011, Amendment 2 responded to these issues and completely replaced the FMP. The Amendment provides management options to slow catch rates throughout the season, including trip limits, trap limits, and days out of the fishery. Additionally, Amendment 2 modifies the fishing mortality reference points to include a threshold level, includes a more timely



Northern shrimp being sampled on the Gulf of Maine Summer Shrimp Survey. Photo (c) Elaine Brewer, MA DMF

and comprehensive reporting system, and allows for the initiation of a limited entry program to be pursued through the adaptive management process. Addendum 1 to Amendment 2, approved in 2012, further clarifies the annual specifications process, allocates the TAC with 87% for the trawl fishery and 13% for the trap fishery based on historical landings, and introduces a research set aside (RSA) provision which allows the section to “set aside” a percentage of the TAC to help support research on the northern shrimp stock and fishery.

A Cooperative Winter Sampling Program (program) was initiated during the 2014 moratorium. The intent of the program is to collect, in years of a moratorium, biological samples similar to those that might have been collected from commercial shrimp catches. These samples are used to estimate the winter size and sex-stage composition of the shrimp, and have informed annual stock assessments and subsequent management decisions for over thirty years. A handful of trawlers and trappers are selected at random and contracted to fish in the program. For the first time, the 2016 program, which is currently underway, permits the sale of shrimp as additional compensation. The Section approved the program with a 22 metric ton (~50,000 pounds) RSA quota, a 1,800 pound trip limit for trawlers, and a weekly trap limit of 40 traps and 600 pound limit per week for trappers. The GOM northern shrimp population

has experienced significant changes in recent years. Additionally, changes in other Northeast fisheries have resulted in increased effort in the northern shrimp fishery. This increased fishing pressure, paired with failed recruitment, the lowest abundance indices on record, and unfavorable environmental conditions, has resulted in uncertainties in the future of the resource. In 2014, to address these uncertainties, the Section initiated development of Amendment 3, which considers management measures to control effort and stabilize the fishery. Additionally, Amendment 3 seeks to improve the annual specifications process since current estimates of fishing mortality are not usable for establishing the TAC.

The Public Information Document for Draft Amendment 3 sought public comment throughout the winter and early spring of 2015. The Section reviewed public comment and the Advisory Panel's recommendations in June 2015, and further directed the Plan Development Team to develop limited entry and state-by-state allocation options for Draft Amendment 3. However, given the collapsed status of the stock and the fact that the fishery is currently under a moratorium, the Section decided to postpone further action on Amendment 3 so that additional management options can be explored. For more information, please contact Max Appelman, Fishery Management Plan Coordinator, at mappelman@asmfc.org.