



NORTHERN SHRIMP

Pandalus borealis

Life History and Habitat Needs

Geographic Range:

Northern shrimp, *Pandalus borealis*, are arctic-boreal, living in the cold waters of the Northern Hemisphere, where they have a patchy distribution throughout the North Atlantic, North Pacific, and Arctic Oceans.

In the northern Atlantic, the species occurs from Greenland to Massachusetts, with greatest concentrations in the Gulf of Maine, primarily in the southwestern region of the Gulf.

Movement/Migration:

Adult shrimp distributions appear to be governed by seasonal changes in water temperature. Egg-bearing females move inshore in late autumn and winter when nearshore waters have cooled. Females are found in abundance in nearshore waters only during the late winter and spring when coastal waters are coldest. After egg hatching (February through April), female shrimp return to offshore waters in the western Gulf. Larvae and young juveniles remain in nearshore waters for up to 20 months as they develop. Larval movement is more or less at the mercy of currents during their pelagic existence. After as little as a year, juveniles begin to migrate offshore to deeper waters where they complete their development. The factors triggering migration and specific inshore routes are poorly understood.

Spawning:

Spawning begins in late summer in offshore waters. By early fall, most adult females extrude their eggs onto the abdomen. Egg-bearing females move inshore in late autumn and winter, where the eggs hatch. While specific locations are not well documented, scientists suggest that spawning occurs in offshore summertime population centers in deep mud basins in the southwestern Gulf. *Pandalus borealis* is a protandrous hermaphrodite with larvae migrating to shallower water where they transform. Juveniles remain in coastal waters for a year or more before migrating to deeper offshore waters, where they mature at age 2 as males. By the end of their second winter, the males change into females and live more than a year as females.

Habitat Use:

Habitat preferences shift with different life stages. Pelagic larvae develop into juveniles that settle to the bottom in nearshore waters, usually within 10 miles of the coast. Immature shrimp remain inshore for up to 20 months as they grow and develop into mature males. Relatively little is known about the distribution and habitat requirements of this life stage. It has been suggested that female shrimp probably move inshore over muddy substrates and are eventually concentrated in, but not limited to, nearshore mud bottom channels. Preferred depth range is between 50 and 500m, but this varies considerably with latitude and season.

Ocean temperatures have an important influence on northern shrimp in the Gulf of Maine. Within its preferred temperature range, adult northern shrimp most commonly inhabit organic-rich mud bottoms or near-bottom waters; however, shrimp are not limited to this habitat and have been observed on rocky substrate. According to trawl survey data, northern shrimp primarily occupy areas with fine sediments (sand, silt, and clay) and are often associated with biotic or abiotic structures such as cerianthid anemone tubes and occasional boulders in these fine sediment habitats. During the summer months, adult shrimp are confined to cold waters (4-6°C) found only in the deeper basins (92-183 m) in the southwestern Gulf of Maine. During the winter and spring, when nearshore and offshore surface waters have cooled to the temperature range of shrimp, the amount of habitat available to adult shrimp increases. It is believed that northern shrimp leave the bottom at night and distribute themselves throughout the water column, presumably to feed. After spending the night dispersed in the water column, shrimp return to the bottom around dawn where they feed on a wide variety of soft bottom benthic invertebrates. Spring ocean

temperatures during the larval period are particularly important for recruitment, with cooler temperatures favoring higher recruitment.

Threats to Habitat

- Anthropogenic activities, including coastal development, pollutant run-off, and harbor dredging
- Changes in the oceanographic conditions due to the North Atlantic Oscillation or other natural factors that may cause warm water to intrude into some of the deep basins in the southwestern Gulf
- Mobile fishing gear in deep muddy bottom habitats, e.g., trawls used to harvest groundfish

ASMFC Habitat Areas of Particular Concern

Deep muddy basins in the southwestern region of the Gulf of Maine act as cold water refuges for adult shrimp during periods when most water in the Gulf reaches lethal temperatures. Nearshore water provides habitat for the larval and juvenile stages of northern shrimp.

Habitat Research Needs

- Study specific habitat requirements for all life stages
- Develop habitat maps for all life stages
- Identify migration routes of immature males offshore and egg-bearing females inshore
- Study the effects of large-scale climatic events (like the North Atlantic Oscillation) on the cold water refuges of shrimp in the Gulf of Maine
- Determine the short and long-term effects of mobile fishing gear on shrimp habitat
- Evaluate effects of habitat loss/degradation on northern shrimp

Additional Information

Northern shrimp are managed under Amendment 2 (2011) to the Interstate Fishery Management Plan for Northern Shrimp and Addendum I (2014), which can be found on the ASMFC website at www.asmfc.org or by contacting the ASMFC Habitat Program Coordinator at 703.842.0740.

In 2015, the Northern Shrimp Technical Committee evaluated a suite of indicators to determine the status of the stock for 2015. Using these indicators, the Technical Committee found abundance and biomass indices for 2012-2015 were the lowest on record for the 32-year time series. The stock has experienced failed recruitment for five consecutive years, including the three smallest year classes on record. As a result, the indices of fishable biomass from 2012-2015 are 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 2011 and 2012. While 2014 and 2015 temperatures were cooler, temperatures are predicted to continue to rise as a result of climate change. This suggests an increasingly inhospitable environment for northern shrimp. The Northern Shrimp Technical Committee considers the stock to have collapsed with little prospect of recovery in the immediate future. The increased abundance of northern shrimp predators (spiny dogfish, redfish and silver hake) may play a role in declining biomass. Northern shrimp stocks in other areas of the world (Greenland, Flemish Cap, Grand Banks) have also seen decreasing trends in abundance and recruitment, providing additional evidence that environmental conditions are impacting northern shrimp across their range.

Due to recruitment failure and a collapsed stock, moratoria were instituted for the 2014 to 2017 fishing seasons.

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