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Sea Surface Temperatures Reach Record Highs on Northeast Continental Shelf

Changing cod distribution observed as ecosystem warms bottom to top

During the first six months of 2012, sea surface temperatures in the Northeast Shelf Large Marine Ecosystem were the highest ever recorded, according to the latest Ecosystem Advisory issued by NOAA's Northeast Fisheries Science Center (NEFSC). Above-average temperatures were found in all parts of the ecosystem, from the ocean bottom to the sea surface and across the region, and the above average temperatures extended beyond the shelf break front to the Gulf Stream.

The annual 2012 spring plankton bloom was intense, started earlier and lasted longer than average. This has implications for marine life from the smallest creatures to the largest marine mammals like whales. Atlantic cod continued to shift northeastward from its historic distribution center.

The Northeast US Continental Shelf Large Marine Ecosystem (LME) extends from the Gulf of Maine to Cape Hatteras, North Carolina. The NEFSC has monitored this ecosystem with comprehensive sampling programs from 1977 onward; prior to 1977, this ecosystem was also monitored by the NEFSC through a series of separate but coordinated programs dating back decades.

"A pronounced warming event occurred on the Northeast Shelf this spring, and this will have a profound impact throughout the ecosystem," said Kevin Friedland, a scientist in the NEFSC's Ecosystem Assessment Program. "Changes in ocean temperatures and the timing of the spring plankton bloom could affect the biological clocks of many marine species, which spawn at specific times of the year based on environmental cues like water temperature."

Friedland said the average sea surface temperature (SST) exceeded 10.5 degrees C (51°F) during the first half of 2012, exceeding the previous record high in 1951. Average SST has typically been lower than 9 degrees C (48°F) over the past three decades. Sea surface temperature in the region is based on both contemporary satellite remote-sensing data and long-term ship-board measurements, with historical SST conditions based on ship-board measurements dating back to 1854.

In some nearshore locations like Delaware and Chesapeake Bays in the Middle Atlantic Bight region, temperatures were more than 6 degrees C (11°F) above historical average at the surface and more than 5 degrees C (9°F) above average at the bottom. In deeper offshore

waters to the north, bottom waters were 1 degree C (2°F) warmer in the eastern Gulf of Maine and greater than 2 degrees C (3.6°F) warmer in the western Gulf of Maine.

Ocean bottom temperature data cited in the advisory posted today came from a variety of sources, including eMOLT, a cooperative research program between the Northeast Fisheries Science Center and lobstermen who deploy temperature probes attached to lobster traps. While some of the temperature probes from the eMOLT program are still in the water and have not yet been returned, those that have been returned indicate that bottom water temperatures in 2012 were the warmest since the eMOLT program began in 2001.

Atlantic cod distribution in the Gulf of Maine continues a northeasterly shift, with the spring 2012 data consistent with a response to ecosystem warming. Warming ocean temperatures and the resulting impact on the distribution of 36 fish stocks was reported by the Center in a 2009 study published in *Marine Ecology Progress Series*. That study analyzed annual NEFSC spring survey data from 1968 to 2007 and other information and found that about half of the 36 fish stocks studied in the Northwest Atlantic Ocean, many of them commercially valuable species, have been shifting northward over the past four decades, with some disappearing from US waters as they move farther offshore.

Friedland notes that although cod didn't shift as much as other species like hake in the 2009 study, the effects of warming water on ocean currents and other ocean circulation patterns could change that. "Cod distribution continues to be dynamic, with northerly shifts detected in the spring 2012 data, consistent with a response to ecosystem warming," Friedland said. "The big question is whether or not these changes will continue, or are they a short-term anomaly?"

Mike Fogarty, who heads the Ecosystem Assessment Program, says the abundance of cod and other finfish is controlled by a complex set of factors, and that increasing temperatures in the ecosystem make it essential to monitor the distribution of many species, some of them migratory and others not.

"A complex combination of factors influence ocean conditions, and it isn't always easy to understand the big picture when you are looking at one specific part of it at one specific point in time, " Fogarty said, a comparison similar to not seeing the forest when looking at a single tree in it. "We now have information from a variety of sources collected over a long period of time on the ecosystem, and are continually adding more data to clarify specific details. The data clearly show a relationship between all of these factors."

The 2012 spring plankton bloom, one of the longest duration and most intense in recent history, started at the earliest date recorded since the ocean color remote sensing data series began in 1998. In some locations, the spring bloom began in February, and was fully developed by March in all areas except Georges Bank, which had an average although variable spring bloom. The 2012 spring bloom in the Gulf of Maine began in early March, the earliest recorded bloom in that area.

"What this early start means for the Northeast Shelf ecosystem and its marine life is unknown," Fogarty said. "What is known is that things are changing, and we need to continue monitoring and adapting to these changes."

Intensive surveys of environmental conditions on the Northeast Shelf from Cape Hatteras, North Carolina to Nova Scotia were conducted from 1977 to 1987 as part of the Marine Resources Monitoring, Assessment & Prediction (MARMAP) program. The efforts continued at reduced levels through the 1990s and are ongoing today as part of the Center's Ecosystems Monitoring (EcoMon) program.

Plankton samples are collected six times a year in each of the four subareas of the Northeast Shelf: the Middle Atlantic Bight, Southern New England, Georges Bank, and the Gulf of Maine. EcoMon scientists also collect water samples and other oceanographic data about conditions during each season in each of the four areas to provide a long-term view of changing conditions on the Shelf.

Ecosystem advisories have been issued twice a year by the NEFSC's Ecosystems Assessment Program since 2006 as a way to routinely summarize overall conditions in the region. The reports show the effects of changing coastal and ocean temperatures on fisheries from Cape Hatteras to the Canadian border. The advisories provide a snapshot of the ecosystem for the fishery management councils and also a broad range of stakeholders from fishermen to researchers.

The Spring 2012 Ecosystem Advisory with supporting information is available online at (http://www.nefsc.noaa.gov/ecosys/advisory/current/advisory.html).

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Related links:

North Atlantic Fish Populations Shifting as Ocean Temperatures Warm (2009 news release): http://www.nefsc.noaa.gov/press_release/2009/SciSpot/SS0916/

Ecosystem Assessment Program: http://www.nefsc.noaa.gov/ecosys/

Spring 2012 Ecosystem Advisory: http://www.nefsc.noaa.gov/ecosys/advisory/current/advisory.html

Ecosystem Advisory Archives: http://www.nefsc.noaa.gov/ecosys/advisory/archives.html