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Climate Warming Continues to Affect Northeast Shelf Waters and the Ocean Food Chain

Warmer surface temperatures, increased wind speeds, and larger temperature differences among water masses are affecting the base of the food chain in ocean waters off the Northeastern U.S., modifying the timing and magnitude of plankton blooms in the region. These findings appear in the latest Current Conditions report from NOAA's Northeast Fisheries Science Center (NEFSC), which tracks ocean conditions on the Northeast Shelf. The report covers July through December 2015.

"Temperature drives ocean ecosystems in the same way it drives weather patterns," said Kevin Friedland, an oceanographer with the Center's Ecosystem Assessment Program. "The report shows how water temperature change caused by climate warming is affecting ocean organisms in our part of the Atlantic -- spawning and the transport of eggs, young animals, and their prey. Warming is changing the ecosystem, and will continue to do so in the decades ahead."

Sea surface temperature (SST) was well above average on the Northeast Shelf in 2015, averaging more than 13 degrees C (55°F), despite severe winter conditions in the region. After a record year in 2012, when the average sea surface temperature was more than 14 degrees C (57°F), sea surface temperatures in 2015 were the fourth highest, with the second half of the year the second highest, in the sea sampling time series dating back to 1854.

"Ocean surface waters were colder than average in the spring of 2015, but warmer than average during the summer and fall of 2015, especially at the northern end of the Northeast Shelf ecosystem in the Gulf of Maine, on Georges Bank and on the Scotia Shelf," said Friedland. "Temperatures were higher at both the surface and the bottom, suggesting that the heat at the surface was distributed vertically over shallow areas such as Georges Bank and Nantucket Shoals and near shore along southern New England."

Cool water habitats in the region, those areas between 5 and 15 degrees C (41-59°F), have been decreasing in area since 1980 and reached their least extent in the time series in 2015. Warm water habitats, those between 16 and 27 degrees C (60-80°F), have increased in area. Cold water habitats, those areas between 1 and 4 degrees C (34-39°F), have remained fairly stable over time.

Given the interest in shifting ocean conditions, wind speed and frontal strength are reported for the first time in this issue of the Current Conditions advisory, and will be an ongoing feature in future editions.

Wind speed can affect the movement of marine organisms at early life stages, between spawning and rearing habitats. It can also affect water column turbulence, a factor governing encounter rates between plankton predators and prey.

According to the report, the winter wind speed in 2015 was the highest since the wind speed time series began in 1988. Winter wind speeds have increased by one meter per second, from 8.2 to 9.2 meters per second, while summer wind speeds have increased from 5.2 meters per second to a recent average of 6.0 meters per second.

Temperature fronts, which form at the interface between differing water masses, often mark the boundary of an ocean current within the ecosystem. Fronts are of biological significance because they tend to concentrate organisms at both lower and upper trophic levels. In most of the region, the frontal magnitude, the change in sea surface temperature per unit distance across a frontal feature, has increased since 1982 and reached its highest level in 2015.

The report also noted the impact changes in the spring and fall thermal transition dates have on plankton bloom timing. The fall 2015 transition date, marking the occurrence of the average temperature between summer and winter, was among the latest dates recorded during the past three decades. That date has shifted by nearly one month in the northern part of the ecosystem, but not as much on the southern end of the ecosystem. On the Scotian Shelf, for example, the fall transition date was around November 20 during the 1980s and was around December 20 by 2014. It was not detected before the end of 2015.

Plankton blooms were detected in all areas of the Northeast Shelf in 2015. “Phytoplankton production during the year is essential to the health of the ecosystem,” Friedland said. “The bloom is a critical source of nutrition for the early life history stages of many species. Many marine organisms time their reproductive cycles to best utilize seasonal phytoplankton blooms, like the spring and fall blooms, and in turn temperature plays a role in the development of these blooms.”

The spring bloom was the largest recorded, with chlorophyll levels more than twice as high as average levels. The fall bloom was well-developed and covered a large area including Georges Bank and much of the Gulf of Maine, but had average chlorophyll levels and was of shorter duration than usual and started later than is typical in the Gulf of Maine. There was also a large fall bloom in the Mid-Atlantic Bight, which is not typical for the area. That bloom developed in July, the earliest start date in 20 years.

Species distribution trends for the period 1968 to 2015 are also included in the Current Conditions report. Of the 48 species listed, 24 species have moved northeasterly into deeper water, 18 species are moving northeasterly into shallower water, and six species have moved along the shelf to the southwest, mostly into shallower water.

Current Conditions, formerly called Ecosystem Advisories, have been published twice each year 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 a broad range of stakeholders including fishery managers, fishermen, researchers and the interested public.

To view the spring 2016 summary of conditions during the second half of 2015 for the Northeast U.S. Shelf and related background data, go to Current Conditions (http://www.nefsc.noaa.gov/ecosys/current-conditions/).

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Related links:

Current Conditions: http://www.nefsc.noaa.gov/ecosys/current-conditions/

Northeast U.S. Continental Shelf Ecosystem: http://www.nefsc.noaa.gov/ecosys/

NEFSC's Oceanography Branch: http://www.nefsc.noaa.gov/epd/oceanography/