

## Session: Climate Research

# Overview of NEFSC Climate Science Program

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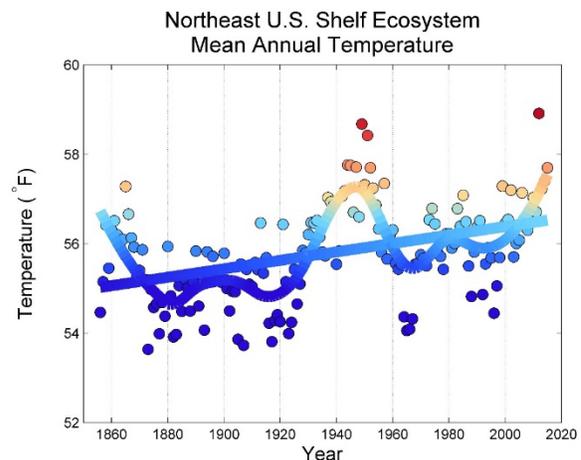
Climate change and variability are critical components of the dynamics of the Northeast U.S. Shelf ecosystem. Change in the climate has been observed for more than 50 years. Taylor *et al.* (1958) documented warming – now attributable largely to the Atlantic Multidecadal Oscillation (AMO). These authors also described numerous changes in fisheries that occurred with the warming: decreases in Southern New England yellowtail flounder, increases in Gulf of Maine American lobster and silver hake, and southern species occurring in northern areas. These changes were relatively short-lived with the downturn in the AMO and overall cooling.

Changes in the climate of the Northeast U.S. shelf are impacting species distributions and productivity. Numerous studies have found that species distributions are linked to interannual variability in temperature (Murawski 1993) and long-term trends in the AMO (Nye *et al.* 2009). Shifting species distributions are now well documented and affecting scientific surveys and fisheries management. Changes in species productivity have also been documented. The initial studies found that climate change can affect biological reference points over the long-term (century-scale; Fogarty *et al.* 2009, Hare *et al.* 2010). More recent studies have found changes in productivity at the medium-term (years-to-decade; Bell *et al.* 2014, Pershing *et al.* 2015).

The Northeast U.S. Shelf is changing rapidly. The pace of recent change is driven by a combination of the upturn in the AMO (decadal-scale variability) and long-term warming. The result is some of the fastest rates of warming in the world. Many other factors of the region's climate are also rapidly changing. New high-resolution climate models suggest that pace of long-term climate change may increase, as a result of both radiative forcing and changes in regional circulation. The rapid pace of change in climate is affecting distribution and productivity on most living marine resources in the region.

Recognizing the challenges, the Northeast Fisheries Science Center developed a Climate Science Program in 2009. The science structure of the GLOBEC program was used as a model linking modeling, observing, and field and laboratory research. The NEFSC Climate Science Program also put an emphasis on science to inform assessments and management advice, and thus emphasized both operational and research scientific enterprises. There was very little support for the Climate Science Program. However, passage of the Federal Ocean Acidification Research and Monitoring Act (FORAM) created opportunity for ocean acidification research. The ocean acidification component of the Climate Science Program was developed into the NEFSC Ocean Acidification Program, which is currently funded by the NOAA Ocean Acidification Program.

Progress was made on many of the elements of the Climate Science Program but without coordination or directed funding. One such activity was the Northeast Fisheries Climate Vulnerability Assessment. This project evaluated vulnerability to changes in productivity and potential to shift distribution for 82 fish and invertebrate species in the system, and involved scientists from across NOAA. This assessment is being used in numerous other applications including a link to social vulnerability and in Endangered Species Act listing decisions.



In response to increased attention to climate change and ecosystem-based fishery management from the Mid-Atlantic and New England Fishery Management Councils, the NEFSC formed the Climate, Ecosystem, Habitat and Assessment Steering Group in early 2014. The Steering Group provides structure and direction for NEFSC efforts pertaining to climate, ecosystem, and habitat research, and the integration and inclusion of this research into the assessments of living marine resources. More broadly, the group provides guidance on the development and application of ecosystem-based fishery management in the Northeast Region.

To date, the Steering Group has focused on fisheries assessments. Guidelines for the inclusion of climate, ecosystem, and habitat considerations in stock assessments have been developed and specific meetings have been held focused on Atlantic mackerel, Atlantic cod, and black sea bass. The Steering Group also formed a working group to examine regime shifts in the Northeast U.S. Shelf ecosystem. Over the past several months, the Steering Group has been reviewing ecosystem-based fishery management in the region and is planning discussions surrounding the Endangered Species Act and climate change.

The development of the NOAA Fisheries Climate Science Strategy brought climate change to the forefront of NOAA Fisheries planning. The strategy was released in 2015 and one of the first actions was to develop regional action plans. The Northeast Regional Action Plan, developed jointly by the NEFSC and GARFO, will be covered in a separate talk.

In summary, the NEFSC is in a good position organizationally and scientifically, to address climate change. Discussions and science are ongoing with partners. Joint research is underway with Climate Program Office and NOAA Fisheries funding. The two fishery management councils and the Atlantic States Marine Fisheries Commission are discussing the effect of climate change on managed species. Climate change considerations are being incorporated into Endangered Species Act listing decisions and Section 7 consultations. The challenges are primarily related to funding and governance. There is still very little funding coming to the NEFSC specifically for climate related science, but most living marine resources are being affected by climate change. As distribution and productivity changes occur in living marine resources, management is going to need to change, which will create pressure on management and governance structures.