

May 2014 PROGRESS REPORT:

“Understanding how fish respond to a changing ocean”

Ecosystem models for fisheries management and ocean planning

In 2013, The Nature Conservancy and NOAA’s Northeast Fisheries Science Center (NEFSC) began a two-year partnership to investigate ecosystem changes in the Northwest Atlantic Ocean. The results of the project are expected in the fall of 2015, and will be shared broadly with all interested parties, including with fishery managers and other ocean use planners.

Why this project?

The NEFSC and the Conservancy are engaging in this joint project to achieve the shared goal of understanding how distributions of fish species change over time in response to changes in ocean temperature. The Northeast shelf is a highly productive, temperate system that is strongly influenced by the tides, the Gulf Stream, and gyre circulation. Due to the high primary productivity in the region and the fact that the Northeast shelf is a boundary ecosystem between warm and cold temperate regions, there is a diverse array of fish and invertebrates that are supported, many of which are commercially important. The complex biotic, environmental, and anthropogenic forces at play here raise critical questions for sustaining our productive ocean, and the fisheries and businesses that rely on it. Some of these questions include:

- How do species interact and depend on each other?
- What are the effects of fishing in a dynamic and changing system?
- What is the role of climate change in shifting species and community distributions?

We are investing in answering these important scientific questions to provide resource managers with research and analysis, including consideration of climate factors, to understand and manage oceans and fish more effectively. We expect this work will add to the broader body of existing work evaluating the effects of climate change on ocean resources. We seek to help expand and enhance the ongoing and increasingly pressing conversations about the most effective means to manage ocean resources in response to climate change.

What work is already underway?

Our initial focus is on defining assemblages¹ of fish species with shared environmental preferences with a focus on temperature. Identifying and describing the spatial and temporal persistence of species assemblages is important for understanding species distributions and frequencies of occurrence. Knowledge of assemblages can also help identify the unique ecological qualities that can be used to understand different groups of fish species and possible implications of climate change. Therefore, much of our preliminary work has focused on defining current assemblages along the Northeast shelf.

What data are being used?

The National Oceanographic and Atmospheric Administration (NOAA) Northeast Fishery Science Center (NEFSC) has carried out a multispecies bottom trawl survey every autumn since 1963 and every spring since 1968. Approximately 350-400 stations are sampled in each survey using a stratified random design. The survey was originally implemented to meet several objectives: (1) to monitor trends in abundance, biomass, and recruitment (2) to monitor the geographic distribution of species (3) to monitor ecosystem changes (4) to monitor life history trends (e.g., trends in growth, longevity, mortality, and maturation) and food habits and (5) to collect physiographic, oceanographic and environmental data.

With respect to (5), water temperature and salinity, depth, location, and acoustic measurements are made at each tow station. This simultaneous collection of biological and physiographic/environmental data allows the determination of quantitative relationships between the species and the environment. For the purpose of this study, we selected 74 fish species in 43 families observed in the bottom trawl surveys from a wide range of functional groups for further analysis.

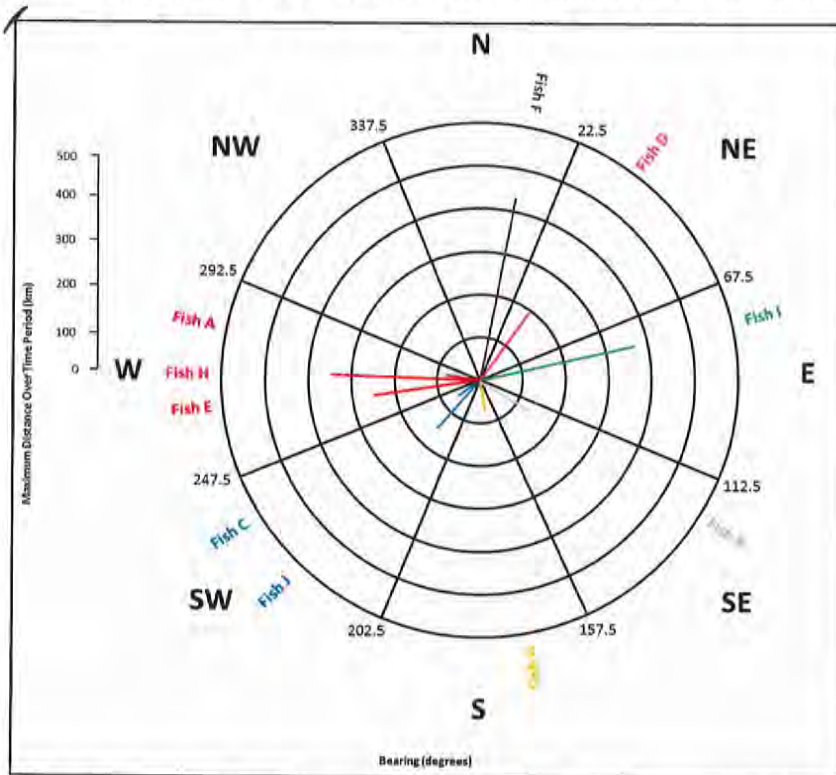
Many studies have examined shifts in the distribution of individual species, but more work is needed to measure and understand shifts in assemblages. Because oceanographic and habitat characteristics are so different between the Gulf of Maine/Scotian Shelf

¹ A *species assemblage* is a collection of species making up any co-occurring community of organisms in a given habitat or fishing grounds.

regions and the Mid-Atlantic Bight/Georges Bank regions, we are examining the assemblage structure in these areas separately. Bottom depth and surface and bottom temperature are proving to be very important in distinguishing unique assemblages in each region and period.

How are we defining species assemblages?

The key motivation in defining assemblages is to examine whether there are groups of species that move together given changes in temperature. In order to explore these changes, we explored whether there was a dominant shift in the distribution of the species between the first time period in the late 60s and 70s and the most recent time period. The average latitude and longitude weighted by the abundance was used to calculate the average latitude and longitude for each species. Then the bearing and direction between the centers of abundance was calculated for each species. The results of this analysis will show the average direction and distance that species and assemblages have moved over time. The graphic below shows how these results may be displayed.



An illustration of how some of the assemblage and species movement data may be presented. 'Compass' plots illustrating the average bearing and direction of movement of the centroid of the distributions of each of the species sampled by the bottom trawl survey in the fall.

Next steps

In the coming months, we will continue to develop models for assemblages and evaluate the effects of ecological/climate change in relation to other impacts such as fishing.

Using high resolution climate models, we will continue to develop models that incorporate ecological interactions in a changing environment. We will assess the *projected* impacts of climate change on distribution of vulnerable fish species, biomass hotspots, and areas of high fish biodiversity. And, we will assess implications for developing spatial protection strategies in response to climate change.

Prior to completion of the project, we will convene a peer review workshop to review this work. Once complete, we will share the results broadly, including with scientific and management bodies.

As the work progresses, we would greatly appreciate feedback and comment from the New England Fishery Management Council. We need input from resource managers to ensure the final results are useful to answering relevant management questions. We will then incorporate your ideas and needs into the project and provide periodic updates through its conclusion in the fall of 2015.

For more information and to offer comment, please contact the project leads:

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