Ron Essig

Fish and Wildlife staff and volunteers sort fish during the ocean trawl survey.

NJ Fisheries Surveys:
Signals from our Research

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Typical catch from the Delaware River seine survey.

Introduction

New Jersey Division of Fish and Wildlife's Marine Fisheries Administration has surveyed fishes in the Atlantic Ocean annually since 1988 and in the Delaware River since 1980. Surveys conducted continuously over such a time period offer a rich view of the natural environment and are indispensable tools with which to assess fish populations. We analyzed these two fishery-independent surveys to see what story they might tell.

The Surveys

The Ocean Stock Assessment Survey departs five times a year on the 81-foot research vessel *Seawolf*. Nearly 200 randomly selected sites, from Sandy Hook to Cape May, are sampled over the course of the year. Each survey takes about a week to complete. Sampling is conducted using a 30-meter otter trawl net deployed in depths ranging from 18–90 feet, out to about 20 nautical miles from the shore. Catches are sorted by species, counted, weighed and most lengths are measured.

The Delaware River Seine Survey is divided into three regions. The survey consists of 32 fixed stations within an area extending from the Salem River to Trenton. Each station is sampled bi-monthly from mid-June to mid-November. The net used is 100 feet long and 6 feet deep with ¼-inch mesh. It is pulled onto the beach from both ends. The catch is funneled into the bag in the center of the net. All fish are identified, counted and sub-samples are measured.

Water quality variables including dissolved oxygen, temperature and salinity are collected from both surveys at each sampling location.

Materials and Methods

There are several approaches that could have been utilized. For example, the analysis could have concentrated on a single species in a single survey, all species encountered in all surveys or some combination thereof. In the end, our approach focused on a subset of species common to both surveys that are also familiar to most anglers and outdoor enthusiasts. Those species are:

Alewife	American Shad
Atlantic Croaker	Atlantic Menhaden
Bay Anchovy	Black Drum
Blueback Herring	Blue Crab
Bluefish	Spot
Striped Anchovy	Striped Bass
Weakfish	

With about three decades of data, the results could fill volumes. Here, we concentrate on specific areas of the two surveys and a specific time of year. Both surveys occur in August (as well as October), providing a useful starting place. (A future article will examine October surveys.)

For the ocean trawl survey analysis, our attention narrowed to the Atlantic Ocean waters between northern Long Beach Island and Shark River that are between 30 and 65 feet deep. For the Delaware River seine survey analysis, we assessed data from the southern-most region of eight stations from the Hope Creek Nuclear Generating Station to the Delaware Memorial Bridges. Using a class of

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The Delaware River seine survey net is hauled in by (l to r) staff Jennifer Pyle, Maryellen Gordon, Heather Corbett and Tiffany Hewitt.

exploratory statistical techniques suited nicely for our dataset of multiple species, we examined changes in community composition as well as changes in select environmental variables.

Results

Ocean trawl: Stratum 16 (August)

The first result is that not all species we set out to describe occur in the selected time window. Recall, however, that for this discussion we pared down the results from the complete time series to address the 13 selected species.

For the ocean trawl survey analysis, trends in the abundance of several species have moved in tandem over time. For example, bay anchovies, blue crabs and weakfish have generally become less abundant in our survey (in this area and month). Atlantic croaker, blueback herring, and striped anchovies have more complicated abundance trends peaking at different times.

Since Fish and Wildlife collects a number of environmental variables while conducting the surveys, it is appropriate to examine trends in those variables as well as the relationship with species abundance.

Revealed was a rather dramatic drop in water temperature during the first decade of the time series after which the rate of decline moderates. Salinity has undulated with an upward trend over the last five years. Finally, and surprisingly, dissolved oxygen follows a pattern very similar to water temperature. (Ordinarily, dissolved oxygen and water temperature trend in opposite directions since warmer water holds less oxygen than cold water). Interestingly, the trend in dissolved oxygen levels recorded since around the mid- to late-1990s hovers around hypoxic (dangerously low) conditions.

Examination of trends in species abundance and environmental data suggests that there is a relationship between the two—though not necessarily one that's causative. Weakfish, bay anchovies and striped anchovies all appear to be more abundant with warmer temperatures. Bay and striped anchovies also appear sensitive to dissolved oxygen, with a very low abundance of these species below hypoxic levels.

Finally, with respect to relationships among species, one of the more interesting observations is the positive association between weakfish and bay anchovies; when one is abundant, so is the other. Bay anchovies are a dominant part of weakfish diets (Figure 1). What might be occurring here is weakfish congregating on bay anchovies when they are abundant.

Delaware River Seine Survey: Region I (August)

As with the ocean trawl survey data above, trends in the abundance of several species have moved in tandem over time. For example, in this region and survey month, Atlantic croaker (prey) and striped bass (predator) have generally increased in abundance. Interestingly, several species have a complementary abundance (Figure 2). Blueback herring and blue crabs are forage species, and what this figure might be showing is the effects of predator switching based on which forage species is more abundant. Some of our constituents have suggested that when striped bass are abundant bluefish are not. Figure 3 offers support for this idea but note that these are young of the year data.

With respect to environmental data, August water temperatures show a cooling trend for the first several years of the time series, but since about 1995, water temperatures have steadily risen. This rise in temperature was not accompanied by a change in salinity, but was—not surprisingly—accompanied by a decline in dissolved oxygen. While dissolved oxygen is low, it has generally remained above dangerously low conditions unlike with the ocean trawl survey data above.

Some of the species examined appear sensitive to dissolved oxygen. For example, Atlantic menhaden and bluefish appear to be more abundant with increasing dissolved oxygen, whereas the opposite is true for juvenile striped bass and American shad. It is uncertain if dissolved oxygen is driving the abundance patterns, but the existence of the pattern suggests that there may be environmental changes.

Discussion and Conclusions

Long term, continuous fishery surveys provide unique insights into the environment and are indispensable tools to sustainably manage fish populations. Two surveys that occur during the same period of time each year (August) were examined. Species community composition showed either similar trends in abundance (a decline for bay anchovy, blue crab and weakfish in the ocean trawl survey; an increase for striped bass and Atlantic croaker in the seine survey), or complementary but reverse trends (increasing for striped bass while decreasing for bluefish in the seine survey.)

Analyses of water quality measurements brought a somewhat surprising result of decreasing water temperature trends along with a concurrent decline in dissolved oxygen to near hypoxic levels for the ocean trawl survey. Weakfish and bay anchovy abundance may be affected adversely by the cooler temperature. Low dissolved oxygen can also have a negative effect on bay anchovies, yet no consistent trend was found correlating the anchovies' distribution with dissolved oxygen content. The periodic shifts seen in their distribution over the years may have been influenced by changes in habitat suitability (for example when salinities vary due to meteorological events) or by greater predation in areas containing higher dissolved oxygen.

The Delaware River seine survey saw an increase in water temperature over time accompanied by a decline in dissolved oxygen but not down to the levels seen in the ocean trawl survey. The abundance of bluefish may have been negatively affected by the decline in dissolved oxygen, a condition which may have the opposite effect on juvenile striped bass.

Further studies on the trends in environmental parameters, species abundance, community composition and predator-prey relationships should be conducted. Data collected from these long-running projects and analyses such as these are necessary components in our efforts to sustainably manage New Jersey's valuable fisheries resources.

Figure 1. Percent of average weakfish diet by age that consists of bay anchovies. Estimates are from the Atlantic States Marine Fisheries Commission's Multi-Species Technical Committee.

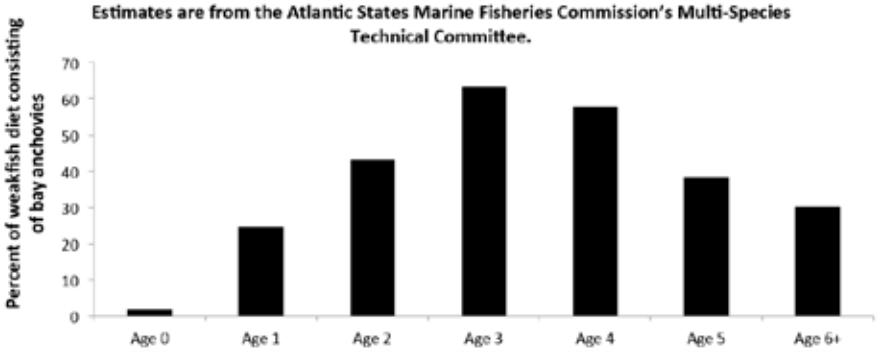

Figure 2. Abundance of two forage species collected in the Delaware River seine survey.

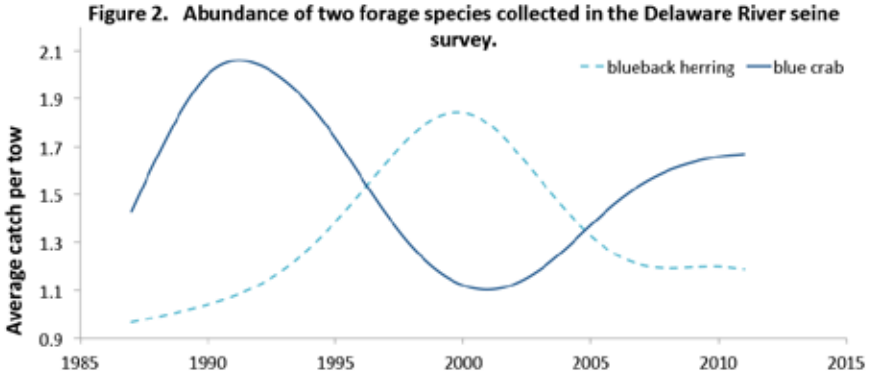

Figure 3. Trends in abundance for three recreationally and commercially important species collected in the Delaware River.