New Jersey's Evolving Coastal Environment

The environment around us is constantly evolving. Varying environmental conditions lead to changes in the surrounding ecosystems. Factors such as warming ocean temperatures, sea level rise, ocean acidification and many others contribute to changes in the spatial distribution and stock status of many marine species' populations.

A catch is sorted during the Delaware River Seine Survey.

A juvenile horse-eye jack caught on the Delaware River.

Recently, these changes have brought non-native species into New Jersey's coastal waters and NJDEP Fish & Wildlife's Marine Resources Administration (MRA), comprised of the Bureau of Habitat and Shellfisheries and the Bureau of Marine Fisheries (BMF), conducts many scientific surveys studying various species populations within New Jersey. These surveys are conducted in the State's rivers, bays and in the Atlantic Ocean, and are good indicators of the environmental evolution occurring around us and its impact on marine species coastwide. The data collected provides information about species interactions and environmental impacts and are an important part of ecosystem management. Survey longevity is beneficial to species population studies, development of fishery management plans and projections of sustainable harvest levels.

Read on to learn about the many surveys conducted by the MRA and BMF and look ahead to page 12 for profiles of some non-native fish that are becoming increasingly prevalent in New Jersey's waters.

Delaware River Striped Bass Recruitment Survey

In 1980, the Bureau of Marine Fisheries developed a seine survey in the Delaware River targeting young of year striped bass. As the Bureau of Marine Fisheries' longest running survey, it not only provides a juvenile abundance estimate for striped bass, but also for many other ecologically and economically important species in New Jersey.

After each seine haul, species are sorted, counted and a subsample of lengths are collected. Data provides information about species interactions and environmental impacts. The total number of fish collected over the years varies without trend. Environmental impacts such as floods or droughts cause the salt line to move up and down the river. During periods of drought, saltwater fish move farther into freshwater regions, while during flood events freshwater species move into the lower portions of the river.

The Delaware River is also a success story with respect to water quality improvements. In the 1940's, the river was considered "grossly polluted." The Federal Clean Water Act was enacted in 1972 and water quality levels in the river began to improve. By the late 1980's, major improvements were being seen throughout the river. Several water quality parameters are collected during seine surveys at each station: water temperature, dissolved oxygen (DO), salinity and pH. Over the years, the average water temperature has fluctuated but is trending upwards. Average DO and pH have remained relatively constant over the years with slight annual fluctuations. Salinity is the most variable parameter collected because it is most easily influenced by outside forces, however, it trends downward during the survey months (June through October).

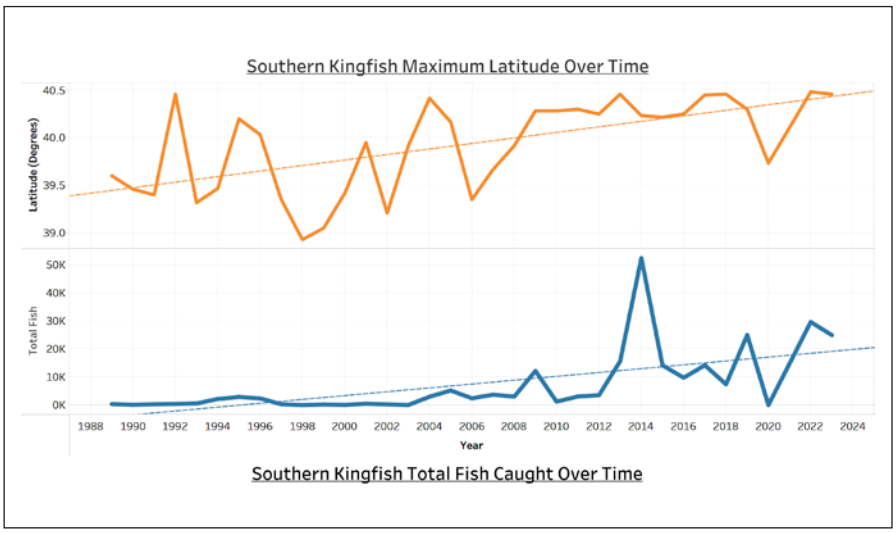
Dramatic environmental events such as 100-year floods, hurricanes and nor'easters are occurring more frequently and more intensely and each one affects the ecosystems around us. This ever-changing environment is one reason why the number of fish and the number of species caught during this survey varies from year to year. Over 100 unique species have been collected since 1980, with an average year identifying over 40 different species. Due to higher water temperatures, species that typically prefer warmer water have begun to show up in the survey's catches, including gray snapper, threadfin shad, horse-eye jack, and Southern kingfish. With consistent monitoring, BMF is hopeful that future population trends and harvest potential within the Delaware River can be predicted.

Ocean Stock Assessment Survey

New Jersey's Ocean Stock Assessment Survey began on August 20, 1988. Lead biologist, Don Byrne, set out to develop a comprehensive baseline of data for coastal recreational fish and their prey. In the first year, over 110 species were recorded, and as many as 144 species were documented in 2018. Overall, the survey has encountered nearly 300 distinct fish and invertebrate species and continues to observe species never seen in previous survey years.

One of the primary objectives of the survey is to track changes in relative abundance of recreational species. A notable trend is the high rates of fluctuation of many species, which is not uncommon. In other words, seeing low numbers of a species one year can often be followed by large numbers the next year. When interpreting data collected by a survey with so many variables, the big picture matters!

Another interesting trend that survey data can indicate is a change in a particular species' range. One example is the increasing occurrence of Southern kingfish and its expanding range northward. In the first years of the survey, encountering Southern kingfish was relatively uncommon, but that occurrence has become increasingly more frequent over the years and has shown its range expanding nearly 2 NM northward every year.



Data from the Ocean Stock Assessment Survey indicates that both occurrence and Northern expansion of Southern kingfish are trending upwards.

Surf Clam Stocks

At one time, the surf clam fishery was the largest molluscan fishery in New Jersey accounting for as much as 60% (by weight) of New Jersey's total reported molluscan commercial landings. While most of these landings have typically come from federal waters, New Jersey's inshore fishery had, at one time, contributed between 500,000 to 700,000 bushels to the total landings, and accounted for over 17% of the total landings for the entire Mid-Atlantic and New England regions combined.

The development and future success of this fishery was dependent on accurate and up to date survey information on the status of this resource, which was initiated by Rutgers University in the 1970s and continued by the Bureau of Marine Habitat and Shellfisheries from 1987 to 2019. During this time, stocks had reached an all-time high of 26.3 million bushels in 1997, with substantial recruitment events (i.e., juvenile surf clams entering the fishery). However, recruitment began to decline, and this was reflected in steep drops in the estimated standing stocks with a steady increase in the average size of the surf clams. While one might think that fishing pressure had something to do with it, the harvest in New Jersey's territorial waters had noticeably decreased and eventually ceased altogether around 2003. At that time, the offshore federal waters fishery began shifting to deeper waters farther offshore (Weinberg, 2005) and north toward New England waters. This decline was also documented across the Mid-Atlantic region.

The last New Jersey surf clam survey performed in 2019, estimated the entire stock to be 26.7 thousand bushels, only 0.1 % of the historic high. Studies conducted by Rutgers University (Kim and Powell, 2004) found that clams analyzed along what was known as the "mortality line" had low condition indices (an indicator of health) and tissue disorders indicative of malnutrition. A supporting theory points towards a warm water intrusion over the Mid-Atlantic Shelf. Water temperatures above the surf clam tolerance range could cause respiratory rates to increase and a decline in filtration rate, which would compromise their ability to acquire food and reduce energy used for maintenance and reproduction. In addition, temperature variations could also have shifted food supplies or caused a direct reduction on food source availability. These environmental factors most likely induced thermal stress and low condition indices that caused mortality within shallower waters and in the southern limits of the surf clam range (Weinburg, 2005).

A recent study conducted by Powell, et al., (2020) documented the range expansion of surf clams in response to the post-2000 warming of the North Atlantic northward to east of Nantucket, MA. At the same time, there was an increase in the harvest of surf clams within the deeper ocean quahog beds in cooler waters (MAMFC, 2022). Surf clam distribution correlates directly to shifts in environmental changes that have been observed over the last several decades and serves as a reminder of the sensitivities that contribute to how species respond to rapid changes to their environment.

Surf clams are processed by Shellfisheries staff during sampling.

River Herring Monitoring Survey

As part of the MRA's on-going efforts to monitor populations of ecologically and economically important fish species, MRA staff conduct a multi-faceted population survey for blueback and alewife herring. Collectively known as "river herring," these two species were a staple subsistence and commercial fishery target since before colonialization and continue to be a vital link in the food chain for many freshwater and marine gamefish species. Over the last century, overharvesting and dams preventing access to their historical freshwater spawning grounds have led to a dramatic decrease in river herring populations along the east coast. In response to the Atlantic States Marine Fisheries Commission's (ASMFC) 2008 River Herring Stock Assessment, which determined river herring stocks to be depleted on a coastwide and regional basis, New Jersey closed the harvest of river herring in both fresh and marine waters in 2012 and initiated the River Herring Monitoring Survey.

A seine net is hauled onto the beach during the River Herring Survey.

The goals of the survey are to collect adult and young of year river herring to determine adult run strength and spawning success, and to gather data needed to support fishery management plans and coastwide stock assessments. Gillnet sampling for adult river herring undertaking their annual spawning run takes place on the Maurice and Great Egg Harbor Rivers from March through May. Young of year herring spawned in the spring are sampled in a seine net survey on the same rivers from July through the end of October. When considered together, these facets create a holistic picture of the current health of river herring populations in both target rivers.

Among the most important signals that fisheries managers pay attention to when analyzing data from long term monitoring surveys, is changes in catch over time. While still a relatively young survey, fisheries managers can still glean preliminary trends in changes in catches of river herring over time. Adult river herring catches in both rivers have remained relatively stable over the survey years with young of year river herring catches significantly varying year to year with no real trend. One trend that is apparent in the summer and fall portion of the seine survey is the increasing frequency of catches of species which have previously been thought of as "occasional southern visitors." Species that were an infrequent occurrence during the early years of the survey are now commonly encountered on a yearly basis. Young of year permit, Florida pompano, grey snapper, and large mullet (a.k.a. "corn cob" sized) are now seen quite often from July through the end of October. These catches mirror a regional trend from other state surveys along the mid-Atlantic bight up through the New England states as water temperatures along the east coast continue to rise and species ranges continue to shift northward. The MRA will continue to monitor these changes in species assemblages throughout our long-term surveys for potential new fisheries and interactions with native species.

Submerged Aquatic Vegetation Mapping

Lying just beneath the waves, New Jersey is home to a critical habitat – submerged aquatic vegetation. Submerged aquatic vegetation (SAV) refers to rooted, vascular plants that grow completely underwater, except for periods of brief exposure at low tides. SAV mapping efforts in New Jersey focus on the two dominant seagrass species, eelgrass (*Zostera marina*) and widgeon grass (*Ruppia maritima*).

Seagrasses provide food, energy, and habitat for many commercially and recreationally important species like shellfish, crustaceans, finfish, and waterfowl. Seagrasses are a sensitive indicator of water quality and can also improve water quality by storing and processing nutrients and trapping suspended sediments. Large, dense seagrass beds can even dampen waves and currents, which helps to protect our shorelines.

SAV are an important climate change mitigator, as they are capable of storing atmospheric carbon dioxide (CO_2) and buffering ocean acidification. In the process of carbon sequestration, seagrass beds will trap large amounts of carbon in their plant stems and store it over long periods of time in the sediments where they grow. Seagrasses' role in carbon sequestration has been termed 'blue carbon' and the full potential of carbon storage in seagrass species are still being explored.

Seagrasses, like other marine habitats, are threatened by climate change impacts, such as sea level rise, increasing temperatures, and coastal development resulting in the introduction of excess nutrients (eutrophication). They require sufficient light, making them sensitive to changes in water quality, clarity, and depth. Certain species also require specific temperature ranges, impacting their ability to grow and thrive as temperatures increase. Seagrasses also face several biotic (living) and abiotic (non-living) threats unrelated to climate change, and a significant loss of seagrass beds have been documented within the state. In addition to documented losses, seagrasses are known to move in and out of a particular area over time due to certain influences and species habitat preferences, and mapping can document changes in their distribution.

As climate change and other threats continue to result in the loss of seagrass beds, it is important to understand the current status and extent of beds throughout New Jersey. This can be accomplished by conducting new, routine mapping to compare with maps dating back to the late 1970's.

In the summer of 2023, staff from the Bureau of Marine Habitat & Shellfisheries collaborated with Stockton University, Rutgers University's Center for Remote Sensing and Spatial Analysis, and the Barnegat Bay Partnership on a project to map SAV throughout the Barnegat Bay and Little Egg Harbor estuarine systems. The next survey, which is currently being planned, will focus on the State's northern coastal rivers.

Once mapping has been conducted statewide, consistent monitoring will be essential in understanding the status and trends of seagrass beds in the years to come. Monitoring will include continued mapping with field validation, as well as health parameter assessments. In efforts to reduce atmospheric carbon dioxide, seagrasses are recognized globally for their blue carbon potential. Continued mapping and monitoring will allow biologists to take important next steps in conserving New Jersey's seagrass species and mitigating climate change impacts.

An eelgrass meadow in Barnegat Bay.

Species Variety

Spotted Seatrout (*Cynoscion nebulosus*) & Weakfish (*Cynoscion regalis*)

Spotted seatrout are a mostly non-migratory species that can be found throughout the Atlantic coast but are most abundant south of the Chesapeake Bay. They spend most of their time in estuaries, and colder months in deeper nearshore waters. Due to their preference of warmer waters, it is not common to see spotted seatrout in New Jersey waters. However, with climate change continuing to alter our ocean temperatures, they have been known to show up throughout the Bureau of Marine Fisheries' sampling efforts. With climate change as a major influence, it is likely that we will see more spotted seatrout as the water continues to get warmer.

Spotted seatrout are often misreported (both recreationally and commercially) due to their similarities to weakfish. Far more prominent in New Jersey waters, weakfish are similar to spotted seatrout in body shape and coloring. The two species can be difficult to discern, but a few key differences can help to tell them apart. The easiest way to distinguish a weakfish from a spotted seatrout is to look at the spots. On the weakfish (below left), the spots never extend to the fins. On the spotted seatrout (below right), you can see how the spots along the body extend into the dorsal and caudal fins.

Weakfish are a more migratory species that span the Atlantic coast but are most prominent from New York southward to North Carolina. Similar to spotted seatrout, adult weakfish spawn in bays and estuaries during the warmer months and migrate south in the fall as water temperatures begin to decline. The two species also share similar habitat and food sources. Weakfish grow rapidly and mature at a young age, but their stock has faced a severe decline since the late 1990's.

With little to no catch, New Jersey is a *de minimis* state for spotted seatrout and is therefore not required to implement any monitoring requirements. Because of this, regulations are based on current weakfish management. With the increasing occurrence of spotted seatrout in New Jersey waters, New Jersey's Marine Fisheries Council has proposed separating the regulations and the BMF is in the process of creating those species-specific regulations.

Atlantic Cobia (*Rachycentron canadum*)

Atlantic cobia are large, fast growing, pelagic predators, common to the southeast Atlantic coastal states and, up until recently, only an occasional visitor to the ocean waters off of New Jersey. As ocean water temperatures in the Northwest Atlantic continue to rise at one of the highest rates on the globe, the Atlantic Migratory Group of cobia have begun to expand their native range northward into New Jersey waters. New Jersey fishermen are starting to encounter these strong fighting game fish with more and more regularity, providing new opportunities for both hook and line and spear-fishermen to add a new species to their catch list and bring home a fresh dinner.

An Atlantic cobia caught during the Ocean Stock Assessment Survey.

Cobia are becoming a frequent occurrence in recreational fishing surveys such as the Access Point Angler Intercept Survey (APAIS) and are more commonly being reported as landings by New Jersey's commercial fishermen. As the species' range continues to expand and fishing pressure increases within this expanded range, fisheries managers need to consider the impacts to ensure that the cobia population can continue to be harvested in a sustainable way that will not negatively impact the future health of cobia stocks.

In order to address these concerns, the ASMFC's Cobia Management Board has initiated a Benchmark Stock Assessment for Atlantic Cobia to better understand the biological and fisheries characteristics for this species. Based off the findings and recommendations from the Benchmark Stock Assessment, anticipated to be completed in early 2025, the Board can potentially initiate changes to the Atlantic Cobia Fishery Management Plan that will benefit both the fish and the fishermen as the species expands its range and becomes available to more fisheries in the mid-Atlantic up through New England.

Atlantic cobia could potentially serve as a test case for new management measures going forward as more game fish species from the south Atlantic expand their range northward into our waters. In the meantime, keep an eye out for these voracious predators as they swarm schools of bait alongside New Jersey's more commonly seen species such as bluefish and striped bass. They put up a great fight and make excellent table fare.

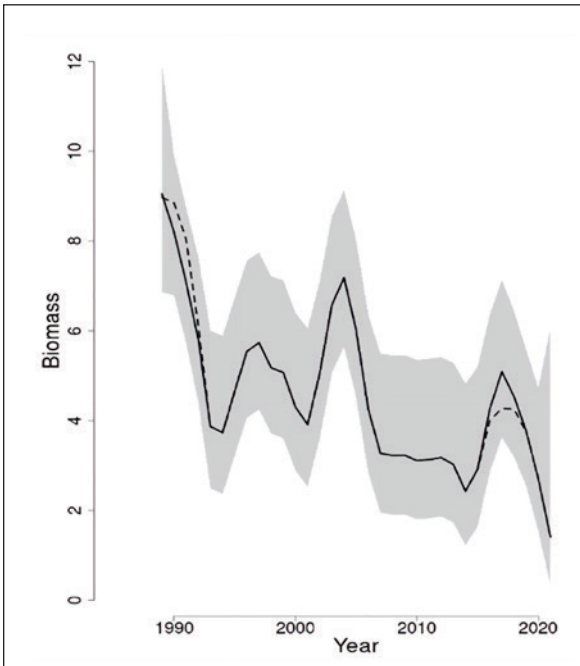
Atlantic Cod (*Gadus morhua*)

Atlantic cod are heavy bodied fish with a large head and distinct whisker-like structure (barbel) under their lower jaws that live near the ocean floor. They can live for more than 20 years, grow to over 50 inches, and weigh over 75 pounds! Cod is currently managed as two distinct stocks: Gulf of Maine and Georges Bank (GB); New Jersey is part of the GB stock. Recent research however suggests that there are actually four Atlantic Ocean stocks.

In 2023, New Jersey changed cod regulations, so they were identical in state (shore to 3 miles) and federal (greater than 3 miles from shore) waters in an effort to reduce fishing mortality and help rebuild the GB stock's abundance. In New Jersey, Atlantic cod landings generally tend to be low and variable, relative to other states, with most harvest occurring from federal waters in some years, and state waters in others. Historically, most harvest in New Jersey occurs between March and June.

According to the most recent stock assessment used for management, the GB stock is at abundance levels that are too low relative to where we want abundance, and fishing levels that are too high. Cod population declines have been attributed

Comparison of a weakfish (left) and spotted seatrout (right).



This figure depicts the trend in survey biomass (kilograms per tow) of Georges Bank Atlantic cod stock between 1989 and 2021. This plot depicts results from the most recently approved stock assessment used for management (solid line) compared with the previous assessment (dashed line). The index starts at a time series high in 1989. While the index oscillates over time, there is a general downward trend that ends in a time series low in 2021. The grey shaded region is the approximate 90% confidence interval.

to fishing pressure, low recruitment, environmental conditions (climate change), predator and prey composition, and broadscale atmospheric conditions (NOAA 2023). A stock assessment scheduled for June 2024 will update the model used for management advice and for providing stock status. Whether this assessment results in additional management changes for 2024 remains to be seen — please check our website for updates.

An Atlantic cod caught off the coast of New Jersey.

Conclusion

Environmental changes in New Jersey's coastal waters serve as an important means to estimate the future stock status of local marine species. As the world around us continues to change, it is important for scientists to continue to monitor these species on a state- and coast-wide level. New Jersey works closely with the Atlantic States Marine Fisheries Commission (ASMFC) and other east coast states to assess the stocks of many species and make management decisions when necessary. Recently, fishery management organizations from along the coast, including ASMFC and the Mid-Atlantic Fishery Management Council (MAFMC), have been exploring effective ways to manage issues related to climate change and shifts in fishery stock distribution. Changes in the environment have a significant impact on our ocean ecosystems and coastlines. Planning for the future is one of the best ways to prepare for these changes. For more information on this initiative, please visit: **https://www.mafmc.org/climate-change-scenario-planning**

By combining data collected from recreational and commercial stakeholders and scientists, New Jersey is prepared to manage any new species. Sound data collection pertaining to these species is important and the Marine Resources Administration is prepared to take on any challenges, if and when they come their way.

Evolving Coastal Environment Contributors

Michael Celestino (Research Scientist), Nina Colagiovanni (Assistant Biologist), Greg Hinks (Principal Biologist), Samantha MacQuesten (Assistant Biologist), Brian Neilan (Principal Biologist), Jeff Normant (Supervising Biologist) and Jen Pyle (Senior Biologist)

Species Introductions: Evidence of an Evolving Coastline

Permit (*Trachinotus falcatus*)

Features: Gray, dark or iridescent blue back, shading to silver sides, possible golden tints on belly. Dorsal fin begins over anal fin. Dorsal, anal and caudal fins long and sloped back. Forehead sharply rises to a "hump" then slopes back. Compressed body that is deeper than Florida pompano. Caudal fin has a narrow fork. Small permit have teeth on their tongue (absent in pompano). Up to 2.6 feet in length.

Habitat: Massachusetts to Brazil, Gulf of Mexico, Bahamas, Antilles and Bermuda. In coastal waters. Adults are pelagic or near bottom in channels and over seagrass flats, reefs or mud bottoms.

Behavior: Spawn primarily in early summer and again in fall. Have a specialized plate at the back of their mouth that helps them crush hard-shelled animals such as clams and crabs. Feed on small fish and invertebrates.

Florida Pompano (*Trachinotus carolnius*)

Features: Dark greenish gray on back, shading to silver sides and yellowish coloration on belly. Dorsal fin begins in front of anal fin. Dorsal, anal and caudal fins are short and upright. Forehead slopes gently backward. Deep, compressed body with a small mouth. Caudal fin with a wider fork than permit. Up to 2 feet in length.

Habitat: Massachusetts to Florida, Gulf of Mexico to Brazil. Along sandy beaches and in brackish bays and inlets. Adults are pelagic.

Behavior: Spawn offshore March to September. Feed on mollusks and crustaceans, especially sand fleas.

Crevalle Jack (*Caranx hippos*)

Features: Back bluish green to greenish-gold, belly silver or yellowish. Prominent black spot on gill cover. Black spot at the base of each pectoral fin. Second dorsal fin and anal fin almost identical in size. No scales on throat. Body deep, front of head steep. Up to 5 feet in length.

Habitat: Nova Scotia to Florida, Gulf of Mexico, Bahamas, Greater Antilles to Uruguay. In brackish to marine waters.

Behavior: Peak spawning occurs offshore March through September. Tolerate a wide range of salinities. Feed mainly on small fish.

Gray (Mangrove) Snapper (*Lutjanus griseus*)

Features: Dark brown or gray in color, with red-orange spots in bars along the sides. Two large canine teeth near front of upper jaw. Anchor-shaped vomerine tooth patch. Dorsal fins with dark or reddish borders. Young have dark stripe from snout, through eye, to upper edge of gill cover. Juveniles have blue line below eyes. Up to 2 feet in length.

Habitat: Massachusetts to Florida, Gulf of Mexico, Bahamas, Caribbean Sea to Brazil. Around mangroves, rocky areas, coral reefs, estuaries, tidal creeks and river mouths.

Behavior: Spawn June through August. Feed on crustaceans and small fish.

Southern Kingfish (*Menticirrhus americanus*)

Features: Back is grayish brown, fading to silvery sides and belly. 7 to 8 indistinct diagonal dark blotches on sides. Scales on underside are nearly the same size as body scales. Barbel on lower jaw. Similar to Northern kingfish, which has a distinct "V" mark above pectoral fins. Up to 2 feet in length.

Habitat: Massachusetts to Southern Florida, Gulf of Mexico, Western Caribbean Sea to Brazil. Over sandy mud to hard sand bottoms in shallow coastal waters.

Behavior: Thought to prefer high wave action areas such as sand bars where the crashing waves dislodge and suspend small crabs and other small crustaceans. Feed on fish and invertebrates.