Division of Science and Research

Research Project Summary

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Comprehensive Estuarine Fish Inventory Program: Great-Bay Mullica River*

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Abstract

Estuaries are important spawning, nursery, and harvest areas for fish and invertebrates of recreational, commercial, and ecological importance along coastal New Jersey. Data about these systems is in increasing demand by many segments of the public. Resource managers, as well as recreational and commercial fishermen at all levels, are beginning to play a larger advisory role where fish habitats and fish survival are concerned. Fish constitute one of the largest portions of animal biomass and thus they are important to estuarine ecosystems. Data were collected between 2016 and 2018 to determine the spawning and nursery areas of fishes and crabs with emphasis on those of commercial, recreational, and ecological importance in the Mullica River – Great Bay estuary. The researchers evaluated how changes in water quality and habitat contribute to the distribution and abundance of fishes, as well as ecologically important invertebrates such as crabs and jellyfishes. The variation in habitat use of fishes and crabs were noted across life history stages with focus on larvae, juveniles, and adults using a variety of gear types.

Introduction

Estuaries are important areas for fish and invertebrates spawning, nursery, and harvest in the temperate waters of the northeastern U.S. Our knowledge of the life history and ecology of fishes in estuaries has been improving in recent years, in part, because the information on these topics is in increasing demand by ichthyologists, estuarine ecologists, pollution biologists and resource managers at local, state, federal, and international levels. The public is also becoming increasingly interested in fish life histories and the ecology of forage fishes as they are beginning to play a larger advisory role where fish habitats and fish survival are concerned. The fishes constitute one of the largest portions of the animal biomass and thus they are important to estuarine ecosystems. Some have estimated that up to 75% of economically important east coast fish populations are to some degree "estuarine dependent". A focus on estuarine fishes is also especially appropriate, largely because it is while they are in estuaries that they encounter several critical life history "bottlenecks" that can greatly affect survival rates and the resulting abundance of certain populations that humans wish to harvest or conserve. Further, an understanding of any long-term change is critical relative to their influence of fisheries and their management. This project was designed to inventory the Great Bay-Mullica River area and provide empirical data for the NJDEP Marine Fisheries program.

Methods

In order to include all fish and most crab life history stages, sampling included multiple gear types across multiple seasons from 2016 to 2018 and along the salinity gradient from the vicinity of Little Egg Inlet, through Great Bay, to near the upper limits of saltwater intrusion of the Mullica River (Figure 1).
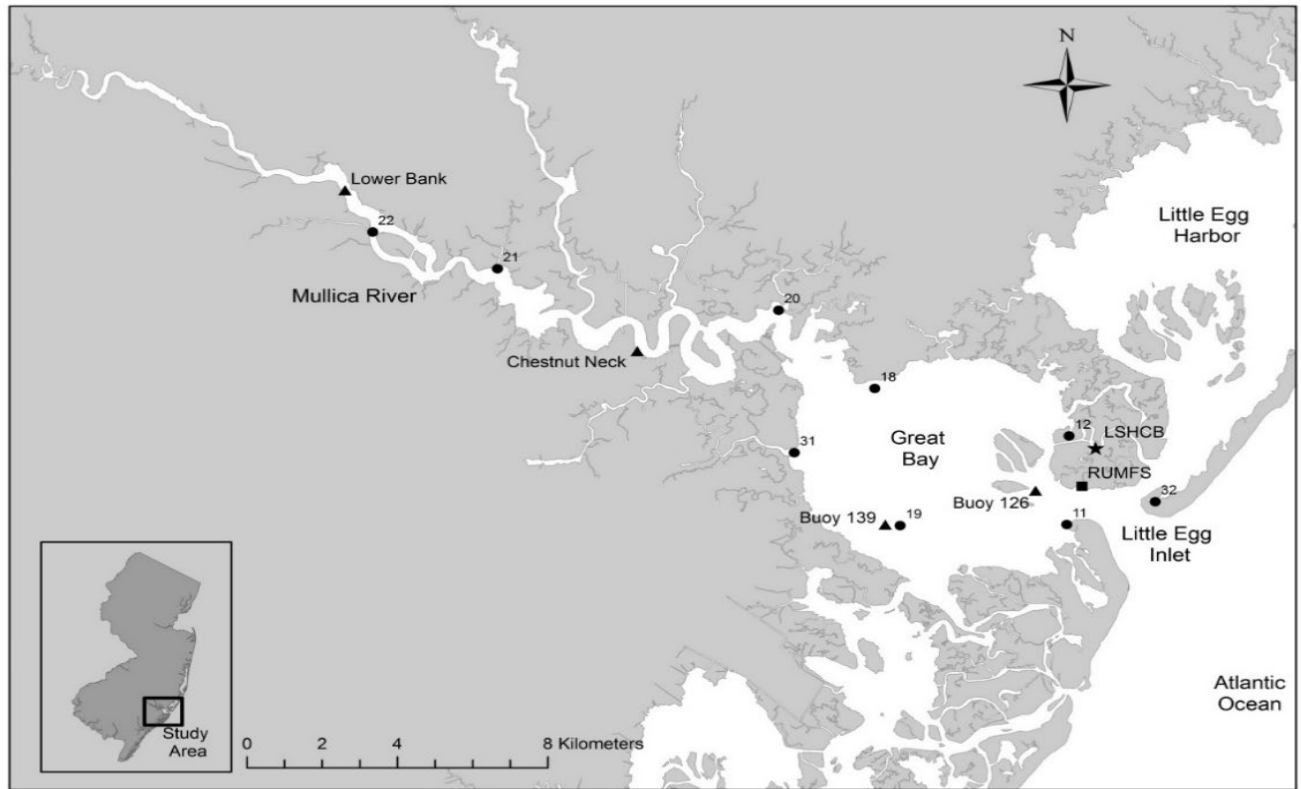
Figure 1. This map identifies all sampling locations for larval (ichthyoplankton net) and juvenile (otter trawl) fishes in the Great Bay-Mullica River estuary during 2016-2018. The star at Little Sheepshead Creek (LSHCB) indicates the ichthyoplankton sampling site. Closed circles indicate otter trawl locations including the Rutgers University Marine Field Station (RUMFS) and numbered sites. Triangles indicate location of System Wide Monitoring Protocol (SWMP) data loggers at numbered buoys or named sites.

Environmental Data: Continuous measurements of salinity, temperature, water height, pH, and dissolved oxygen were collected from four dataloggers across the estuarine salinity gradient at 15-minute intervals. Individual salinity measurements were made throughout the study area.

Larval Fish Composition, Abundance, and Size Data: Larval abundance is indicative of larval supply, which are annually available, abundant, and represented by all developmental stages (preflexion, flexion, postflexion) in southern New Jersey. Larvae were collected with a 1-meter diameter (1-mm mesh) circular plankton net at the bridge over Little Sheepshead Creek. This net was deployed to a depth of approximately 1.5 meters during the nighttime flood tide for three 30-minute sets. Fish abundance was standardized as sample density. Only taxa identifiable to species were included in larval abundance and density calculations. Physical variables including temperature, salinity, and dissolved oxygen were recorded at the same time.

Juvenile and Adult Fishes and Crab Data: Annually, juvenile fishes and crabs were sampled with an otter trawl at a variety of stations/habitats during March, May, July, September, and November. Fish were collected with three 2-minute tows at each station during the daytime. All fishes were identified and counted. Twenty of each species were randomly measured to the nearest mm total length (TL) or fork length (FL). Larger juvenile and adult fishes were sampled with gill nets along the salinity gradient. Anchored multi-mesh gill nets in several areas were set at intervals at night during the spring, summer and fall in upper creek, creek mouth, and nearshore bay habitats for approximately 60 minutes. All fishes were identified, counted, and measured. Several of the dominant species collected were represented by multiple age classes; thus, fish were divided into two age classes: young-of-the-year (age 0) and juveniles and adults (age 1+) based on available size estimates. For each gill net, depth, surface temperature, salinity, and dissolved oxygen were recorded at each sampling effort.

Results

Sampling Activity: The results of each year of sampling along the estuarine environmental gradient in the Mullica River-Great Bay included collection of approximately 10,000 larvae by plankton net, 1,500 juveniles and adults by otter trawl, fyke net, and small mesh gill nets. Over 500 juveniles and adult specimens were collected using large mesh gill nets (Table 1).

Table 1. Sampling effort during 2017 and 2018 for larval, juvenile and adult fishes along an estuarine environmental gradient in the Mullica River-Great Bay (MR-GB) using plankton nets (1.0 m, 1mm mesh), otter trawl (4.9m), and gill nets (four 45' nets [5 panels: one each of 2",3", 5" 6" mesh nets])

Year	Life Stage	Sampling Gear	Sample (min)	Frequency	Total Hauls	Total Fishes	MR-GB Sites Sampled
2017	Larvae	Plankton net	90	Bi-weekly	60	7,564	Little Sheepshead Creek
2017	Juveniles and Adults	Otter Trawl	2	1x/month, 3x/site: Mar, May, Jul, Sep, Nov	135	1,813	Grassy Channel, The Cut, Graveling Point, Buoy 139, Ballanger Creek Mouth, Turtle Creek Mouth, Landing Creek Mouth, Motts Creek Mouth, Holgate Cove
2017	Juveniles and Adults	Gill nets	60-176	1x/mo, Mar, May, Jul, Sep, Nov	140	306	Ballanger Creek, Graveling Point, Landing Creek, Nacote Creek, The Cut, Turtle Creek, Wading River
2018	Larvae	Plankton net	90	Bi-weekly	19	10,103	Little Sheepshead Creek
2018	Juveniles and Adults	Otter Trawl	2	1x/month, 3x/site: Mar, May, Jul, Sep, Nov	135	1,580	Grassy Channel, The Cut, Graveling Point, Buoy 139, Ballanger Creek Mouth, Turtle Creek Mouth, Landing Creek Mouth, Motts Creek Mouth, Holgate Cove
2018	Juveniles and Adults	Gill nets	60-144	1x/mo, Mar, May, Jul, Sep, Nov	140	516	Ballanger Creek, Graveling Point, Landing Creek, Nacote Creek, The Cut, Turtle Creek, Wading River

Length Composition of Fishes and Crabs in the Mullica River-Great Bay Estuary: Specimen length data were collected as larvae (plankton net) or juveniles and adults (otter trawl, fyke and gill net). See Figure 2 for example. Gizzard Shad were captured with only one gear type, while other species were collected in two gears across more than one life history stage, (i.e., Blue Crab, Black Sea Bass, Spot, Horseshoe Crab, Summer Flounder, Bluefish).
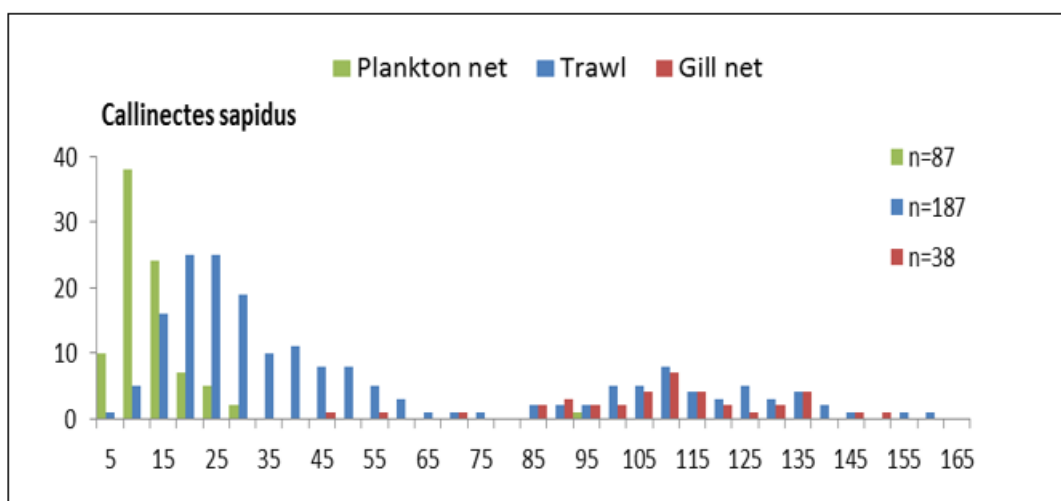

Figure 2: Example of 2018 Blue Crab (Callinectes sapidus) individuals (y-axis) and length data (mm) (x-axis) for three gear types collected in the Mullica River-Great Bay Estuary.

Species collected with two or more gears included Alewife, White Catfish, Bay Anchovy, Silver Perch, Weakfish, Spider Crab, Atlantic Silverside, White Perch, Striped Bass, Oyster Toadfish, Winter Flounder, Northern Pipefish, and Spotted Hake. Individual juvenile and adult specimens (20-400 mm) and composited samples of larval (<20 mm) species included Silver Perch, Bay Anchovy, Atlantic Menhaden, Blue Crab, Black Sea Bass, Weakfish, Spot, Spider Crab, Horseshoe Crab, Atlantic Silverside, Oyster toadfish and Summer Flounder, Winter Flounder, Northern Pipefish. Adult fish (>400mm) included White Catfish, Menhaden, Weakfish, Gizzard Shad, Striped Bass, Summer Flounder and Bluefish.

Table 2: Summary Checklist of Vertebrate-Invertebrate Species collected 2016-2018 in the Mullica River-Great Bay Estuary.

Vertebrate-Invertebrate Category (2016-2018)	Number of Species	Abundancy Designation			
		Rare	Abundant	Common	Occasional
Cartilaginous Fishes	10	6	4	-	-
Ray-finned Fishes	140	51*	47*	31*	23*
Invertebrate Species	6	-	2	3	1
*More than one designation may be applied due to seasonality, variability, life stage or status					

A summary table of samples collected during this study is provided in Table 2. A detailed catalog of the specimen collected during this study is available in the full report. Of noted interest among the collection of cartilaginous fishes in the Mullica River-Great Bay estuary were various shark species associated with New Jersey estuarine waters including Dusky Shark (Carcharhinus obscura), Sandbar Shark (Carcharhinus plumbeus), Tiger Shark (Galeocerbo cuvier) and Smooth Hammerhead Shark (Sphyrna zygaena).

Environmental Variables: Throughout the project period there was a distinct salinity gradient in the Mullica River-Great Bay estuary and the Wading River (Figure 3). While salinity decreases upstream, the most marked changes typically occur above Hog Island. From that point and upstream salinities are typically less than 5 parts per thousand (ppt), which is physiologically demanding for many marine fishes. The lowest salinities, typically less than 5 ppt and as low as 0 ppt, occur near the confluence with the Batsto River. A possible exception to this obvious transition is in the Bass River, which has relatively high salinity throughout its measured length. The salinities at the lower end of the estuary near Little Egg Inlet are typically above 18 ppt and often up to 28 ppt. Nearshore ocean salinities are typically greater than 30 ppt.
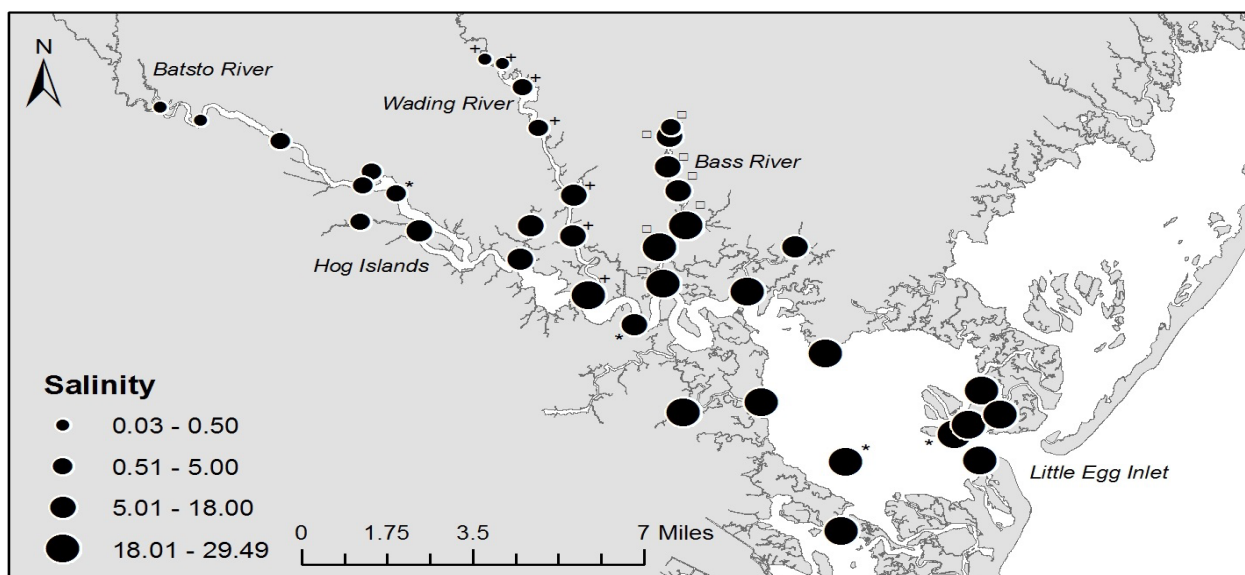

Figure 3: Salinity concentrations (ppt) for Mullica River-Great Bay estuary (2016-2018)

Seasonally, water temperatures fell to subzero in late January and mid-February in the saline portion of the estuary. Due to ice buildup, SWMP continuous data loggers were commonly unavailable at all sites for most of January and February, but the few temperature data collected in January were near or below ⁰0 C (Figure 4 for example). Temperatures peaked at all logger stations in mid-August at around 30° C except at Lower Bank where they

Figure 4: Example : Temporal variability of water quality variables at Lower Bank. (2018)

briefly reached 32^oC. Temperature variation was in phase on the seasonal scale, but on the daily scale was locally forced by tide.

Through the study, two riverine stations, Chestnut Neck and Lower Bank, experienced higher overall salinity ranges, as flow from both event scale (storm and tide) and seasonal differences (e.g. spring freshet) is constrained to a narrow channel at each site. The overall temperature/salinity profile of the Mullica River-Great Bay estuary provides habitat conditions between 0 and 32^oC and 0 and 29.49 ppt salinity.

As illustrated below (Figure 5), acidic waters (pH <5.3), due to the influence of tannins and other organic compounds released from the oak and pine trees of the Pine Barrens, typically occur in the freshwater portion of this study area. This is most evident in the tidal freshwaters in the Mullica River above Green Bank. At sites lower in the Mullica River, the pH becomes more basic as it is modified by higher salinity ocean waters. As anticipated, the Great Bay portion of the study area has the highest natural pH values.
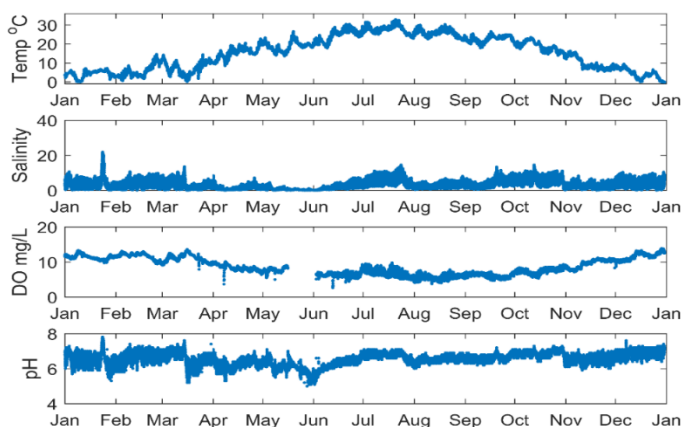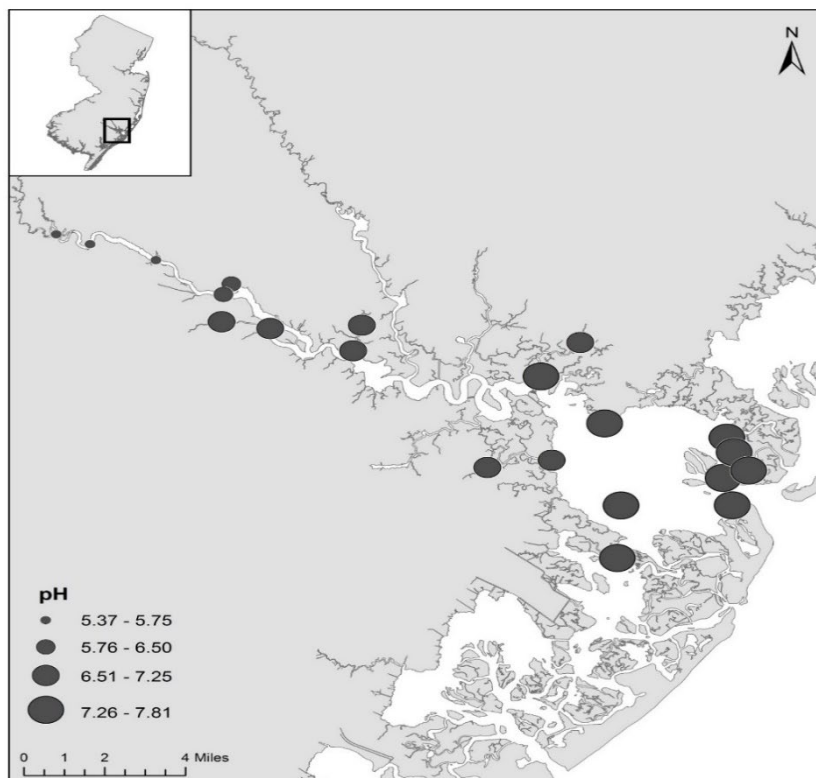

Figure 5. Acidic concentration (pH) of waters associated with the Mullica River-Great Bay estuary (2016-2018)

Conclusions

The data generated by this project provide a better understanding of estuarine fauna and ecosystem dynamics in the Great Bay study area. Sampling conducted as part of this research initiative clearly defined the ichthyoplankton (larval size species 1 mm or larger) identified to taxa or genus level, juvenile and adult species, and large juveniles and adult aquatic fauna in the Mullica River – Great Bay estuary. The juvenile and adult component of the fauna varies greatly seasonal and spatially in both occurrence and distribution based on otter trawl catches. The highest catches, for all species combined, were found near Little Egg Inlet and up the Mullica River. The spatial variation of many species captured with otter trawls was strongly influenced by salinity. Several species were only found in the higher salinities of Great Bay and the lower Mullica River. There was clear separation in species composition across the spring, summer, and fall samples, although there was some overlap of specific estuarine species. The results also illustrate that in order to develop a sound scientific management assessment tool for the NJDEP Division of Fish and Wildlife, the biases associated with each sampling gear, including the number and the size of animals captured, must be established and accounted for in order to best describe species and community structures.