Oceanographic Surveys of Little Egg Inlet

Aims and Objectives

Much of New Jersey's coastline consists of shallow bays separated from the ocean by sandy barrier islands. Narrow inlets connect these shallow bays to the ocean. The flow of water through inlets establishes environmental conditions within the bays, such as how quickly excess nutrients and other pollutants flush out of the bay [1] and where larval life stages of fish and shellfish are transported [2]. In addition to water quality and fisheries, there is interest locally in patterns of sediment transport connected to post-Hurricane Sandy beach replenishment. Our nearest inlet, Little Egg Inlet (Fig. 1), filled in with so much sand in recent years that it is currently being dredged out for the first time [3]. I propose to use boat-board surveys to characterize the flow of water through Little Egg Inlet post-dredging. The primary objectives of this study are:

1. Collect spatial survey data on water flow through each branch of the inlet during two different tidal days
2. Quantify the exchange rate of water between the ocean and the coastal bays

I am requesting R&PD funding to support use of a boat for the surveys, partial summer salary for my time to conduct the work and preliminary data analysis, and a stipend for an undergraduate research assistant to continue data analysis.

Background Work Already Accomplished

I have prior experience in the methods required for this study from my graduate and postdoctoral work [4]. I have access to the necessary equipment and software for data collection at Stockton, which I have used to conduct demonstration surveys with students in my MARS 3309 Coastal Oceanography course (Fig. 2). Finally, I collected preliminary data at a single fixed station in August 2017, prior to dredging activity, and received Provost Faculty Opportunity Funds to repeat the fixed station data collection in Spring 2018. However, measurements at fixed stations lack complete spatial information about water velocity, which often has high variability from one side of an inlet to another (Fig. 2).

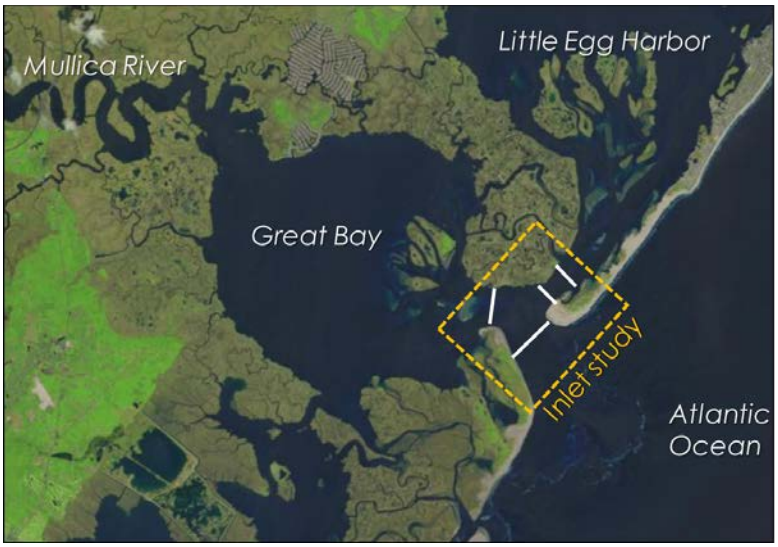

Figure 1. Map of Little Egg Inlet study area (yellow box). White lines are proposed survey transects of each branch of the inlet. During each survey, the transect lines will be repeated in a circuit for 14 hours to cover a full ebb and flood of the tide.

Methodology

My study site, Little Egg Inlet, lies between the coastal ocean and two of southern New Jersey's coastal bays, Great Bay and Little Egg Harbor (Fig. 1). Little Egg Inlet can be reached within 45 minutes by boat from the Stockton Marine Field Station. The accessibility of the site will simplify the logistics of collecting data and involving students.

I will use an Acoustic Doppler Current Profiler (ADCP) mounted to the side of a boat to collect water velocity data. ADCPs use low intensity sound pulses to measure the velocity (direction and speed) of water at multiple depths between the surface and bottom of the ocean (Fig. 2). I obtained an RDI RiverPro ADCP with startup funds in 2016, a model that is optimized for measuring velocities in relatively shallow water like Little Egg Inlet. The Stockton Marine Field Station has a custom-built aluminum pole to suspend the ADCP just below the surface of the water with its sound-producing transducers pointing downward. In this configuration, I can collect velocity data while the boat moves along a survey line.

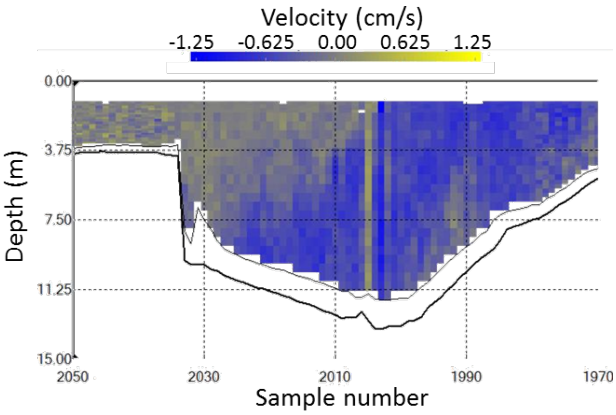

Figure 2. ADCP velocity data collected by MARS 3309 class in a transect crossing the Mullica River. Blue indicates water flowing down-river, yellow is water flowing up-river. Flow on the left side of the channel was weaker than the right side.

Boat surveys will measure (1) the variability of the velocity patterns from side-to-side across the inlet, (2) the total volume of water flowing in or out of each section of the inlet, and (3) how the flow patterns change as the tide height changes. A large volume of water passes through the inlet with each flood and ebb of the tide, making tides a major driver of changes in velocity. However, tidal flows typically slosh water back and forth with little net movement of water. To measure the steady background transport of water (and any chemical constituents, sediment or larval stages of fish and shellfish that it carries), we must measure velocities repeatedly over a full flood and ebb cycle of the tide. I plan to conduct two 14-hour long surveys of the inlet to characterize and remove the effects of tides on flow through the inlet. One survey will take place during larger than average tides, such as the new moon tides on August 11-13, 2018 that are predicted to have a 2 meter height difference between high and low tide [5]. The second survey will be conducted during smaller than average tides, such as the quarter moon tides on August 19-21, 2018 with a predicted height difference of 1 meter [5].

Processing of the survey data has two phases. First, I will use a software program supplied by the manufacturer for initial quality-control of the data and to export it to a format that can be read by Matlab software for further analysis. Second, the data will be subdivided into individual survey lines and translated to a fixed grid of distance across the inlet. Once data processing is complete, I will supervise a research student in analysis of summary statistics and comparison of the velocity data with other environmental data (e.g., tides, wind, and sea level).

Project timeline:

July 15-31, 2018	Set up ADCP on boat and test software configuration
August 11-13, 2018	First 14-hour survey (depending on weather and staff availability)
August 19-21, 2018	Second 14-hour survey
August 22-31, 2018	Process survey data
Fall 2018	Student research assistant analyzes data
Spring 2019	Finalize analysis and present results

Importance

This study will contribute to the field of research on physics of exchange of water through inlets to shallow water estuaries. This topic was highlighted as one in need of additional attention at the Coastal and Estuarine Research Federation conference that I attended in November 2017. Little Egg Inlet is an excellent example of an inlet with minimal modification by erosion control measures, allowing comparisons with other areas with greater anthropogenic interference. Issues of sedimentation and water quality are not only locally important, but also relevant to similar coastlines globally. Furthermore, this study will help me achieve scholarship objectives in my faculty plan of establishing a locally-accessible research program and involving students in use of ocean technology and data analysis.

Further Research

This study will augment two ongoing collaborative efforts. First, I am a co-PI on a proposal in preparation with the Stockton Coastal Research Center involving sediment transport along the coast near this study site. Second, I am working with scientists at the U.S. Geological Survey on a pilot study of the seabed just outside of Little Egg Inlet in June 2018 that we plan to expand to a larger scale investigation of the morphological changes of the inlet over time by applying for additional external funding. Having spatially-detailed surveys of the flow of water through the inlet will assist with interpretation of results from these other studies and demonstration of the methodology for grant proposals. In the longer term, the study results will add to my catalog of physical circulation of the Mullica River-Great Bay Estuary that I plan to develop into a publication.

Outcomes

Results of this study will be presented to the Stockton community and at a national conference. I will encourage the student research assistant to present a poster at the NAMS Undergraduate Research Symposium in April 2019 and give a talk at our Marine Science program research seminar series. I plan to present at the Gordon Research Conference for Coastal Ocean Dynamics in June 2019, a high-profile meeting in my subdiscipline. I will further use outcomes of this study to develop proposals for external funding with colleagues at the USGS and Coastal Research Center. Such proposals will likely be submitted to the National Science Foundation, National Oceanic and Atmospheric Association, U.S. Army Corps of Engineers, and/or state sources such as the New Jersey Sea Grant Consortium or New Jersey Department of Environmental Protection.