Dynamics of Estuarine Sand Dunes in Merrymeeting Bay

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Merrymeeting Bay is a large, tidal, freshwater bay located 30 km up the Kennebec River estuary from the outer Maine coast. Through this unique bay seven different watersheds drain into the Gulf of Maine including those of the Kennebec and Androscoggin, two of Maine’s largest rivers. The massive amount of water that flows through the bay transports sediments that supply Maine’s coastal beaches with sand, such as Popham Beach and Reid State Parks. A concern with rising global sea level is that much of this key sediment supply could become trapped in the bay and estuary before it reaches the coast. Understanding the dynamics of sand movement in Merrymeeting Bay is a prerequisite for assessing the future of sand beaches in mid-coast Maine.

The goal of my project was to map the bathymetry of Merrymeeting bay through daily and fortnightly tidal cycles and attempt to track the motion of the bay’s sand dunes throughout these cycles. I also wanted to explore the feasibility of using the Accoustic Dopplar Current Profiler (ADCP) to measure sediment motions over the bottom of the bay and thereby calculate sediment transport rates throughout the tidal cycles.

To measure the bathymetry I chose two quadrants in Merrymeeting Bay of approximately 250m² to map over the summer. In each quad I drove many closely spaced transects continuously measuring the depth beneath my boat with the ADCP. The ADCP measures water depth by bouncing four beams off the sea floor from a device mounted on the side of the boat. Back in the lab, after making corrections for the rising or falling tide, the rocking of the boat, and the angle of the four beams, I mapped the bathymetry using Geographic Information Systems (GIS). By mapping a given quadrant at two different periods in the summer or tidal cycle and comparing the two maps I was able to observe changes in the location and orientation of the sand dunes.

In order to measure bedload transport, we collected the moving sediment over ten minute periods using a Helley-Smith bedload sampler while running the ADCP. The Helley-Smith bedload sampler is essentially a streamlined “dust pan” that lies on the bottom of the bay and collects moving sand. The ADCP measured both current velocity throughout the water column, as well as the position of the boat in relation to the bottom by “bottom tracking”. The ADCP assumes the bottom is stationary. However, if sediment is moving across the bottom, as we are confident it is, we hypothesize that when at anchor the ADCP will not be measuring the motion of the boat in relation to the bottom but rather the motion of the sediment moving across the bottom. By comparing the amount of sediment collected to the current velocity recorded over the ten-minute period, as well as by looking at the sediment motion recorded by the ADCP’s bottom tracking, we were able to roughly calculate sediment transport rates in various currents.

Though much of the summer was spent perfecting methods of collecting data and working out corrections, ultimately I found an effective method of acquiring and mapping bathymetry data which did show ebb-oriented dune migration during the month of July near the Androscoggin River channel. Given the time constraints I did not compile enough detailed maps to precisely compare the dunes through various tidal stages. Future study could apply these methods to continue mapping and further understand the sand dune dynamics of Merrymeeting Bay. My method for measuring bedload transport using ADCP bottom tracking also shows great promise, especially at high current velocities.

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