Temporal Variability of Carbonate Chemistry and Ocean Acidification in Coastal Maine

Eli Franklin, Class of 2025

Given the Gulf of Maine's (GoM) increasing annual production of shellfish, expected to surpass $20M in annual revenue in 2028, localized research on ocean conditions known to impact shellfish growth is of interest to coastal Maine communities. This summer, I studied the carbonate chemistry of the Basin Preserve alongside Henry Zucco and Caroline Vauclain with Michèle LaVigne as our faculty advisor. The Basin Preserve is along the New Meadows River, a tidal embayment with significant aquaculture production, in Phippsburg, Maine, USA. Here, community members initiated the Basin Oyster Project, an oyster reef restoration effort with oyster farmers and scientists. Oyster reef establishment has the potential to provide erosion control and storm surge protection, but could rely, in part, on favorable carbonate chemistry parameters such as Total Alkalinity (TA), Dissolved Inorganic Carbon (DIC), and Omega aragonite (Ωa).

The GoM is warming, and while this can mask some impacts of decreasing pH on Ωa, coastal runoff and the Labrador current can make coastal sites more vulnerable to future Ωa decline. Previous studies have focused on offshore carbonate chemistry in the GoM. Yet, Maine's coastal bays and inlets create unique oceanographic conditions, which could cause the local carbonate chemistry to be more temporally variable in nearshore sites such as the Basin Preserve. We collected in-situ measurements and water samples every other Wednesday in the Basin (May-August 2024), twice along the New Meadows River (July-August 2024), and weekly at the dock at the Schiller Coastal Studies Center (July-August 2024). One sample trip was completed covering a tidal cycle in the Basin, with measurements occurring every hour from the first high tide of the day to the last high tide of the day. On each sample trip, we measured surface salinity, pH, temperature, turbidity, and dissolved oxygen with a YSI EXO2 Sonde. We then filtered seawater samples to measure TA, DIC, and nutrient concentrations in the LaVigne lab at Roux.

Initial results show surface TA values increasing from 2050 to 2100 µmol/kg from early June-late July. Our measurements show changes in the carbonate chemistry system being closely tied to salinity, and Ωa variation throughout the tidal cycle exhibited a positive correlation with dissolved oxygen. These findings are significant as we work to understand what processes drive the carbonate chemistry system in the Basin.

Data collection and analyses from this summer will be explored further in my Earth and Oceanographic Science Honors project. I will explore carbonate chemistry predictor models trained from data collected throughout the summer. Estimates of the historical DIC, TA, and Ωa values from temperature, salinity, and oxygen records in the Basin could then serve as a proxy for the carbonate chemistry of other bays, basins, and coastal conditions in Maine and determine the relevance of offshore data for coastal stakeholders. Further, this project provides a baseline for future studies in the Basin and will provide a tool for continued collaboration among scientists and oyster farmers to estimate complex carbonate chemistry parameters. This summer has provided me with the opportunity to develop my lab skills, enhance my research collaboration efforts, and decide to move forward with an Honors project. Thank you to the Rusack Coastal Studies Fellowship for funding this opportunity.

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