

Ocean coastal acidification: Development of a spectrophotometric method for monitoring seawater pH at the Bowdoin Coastal Studies Center
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Ocean acidification (OA) is the decline of seawater pH caused by increasing atmospheric carbon dioxide levels. Coastal environments are acidifying faster than the open ocean due to changes in freshwater flow, biological productivity from nutrient runoff, and coastal upwelling of CO₂ rich waters. Laboratories and ocean science groups in the Gulf of Maine use several different types of pH probes to measure and monitor ocean coastal acidification (OCA). With varying precision and accuracy among these instruments, the development of a spectrophotometric pH method using meta-Cresol Purple could allow for improved monitoring and quantification of OCA in the Gulf of Maine. This method differs from other methods of measuring pH, because this is a lab-based method that requires collecting samples in bottles and bringing them back to the lab for analysis. Most pH probes use a different technology that make them more portable and accessible, but result in a lower precision and accuracy than the spectrophotometric method [Dickson et al., 2007]. With the development of Bowdoin's OA monitoring platform at the Coastal Studies Center, we are setting up the spectrophotometer to validate the sensors measurements and potentially calibrate an automated pH sensor.

Since CO₂ affects pH, many samples have been analyzed to learn how to minimize air-sample gas exchange for this method. I developed a protocol for collecting, transferring, filtering, and handling the sample that minimized gas exchange. Conducting experiments on this spectrophotometric method throughout the summer has shown that the values produced by the spectrophotometer are accurate and precise (to within +/- 0.0055 pH units). Other small experiments have been conducted on the spectrophotometer to fine tune the precision of the instrument. The first experiment tested if seawater samples need to be filtered to remove particulate matter, such as phytoplankton and zooplankton, or terrigenous particles before being analyzed. There was no significant difference between filtered and unfiltered samples, suggesting that the samples do not need to be filtered. This is beneficial, because not filtering samples can reduce the sample's exposure to CO₂ that can occur during filtration.

The second experiment was to test if the spectrophotometer could be used to calibrate a handheld pH probe that can be more easily deployed in the field. Our results show that it's possible to calibrate the pH instrument with the spectrophotometer. Further experiments will be conducted to learn if the spectrophotometer could be used to calibrate larger pH probes used for depth profiling. If this calibration is possible, then instruments from other monitoring groups in Maine through the Maine Ocean Coastal Acidification Partnership could use the spectrophotometer to calibrate their pH probes. Other questions for further research include how often the calibration needs to occur, and is it possible to correct for impurities in meta-Cresol Purple dye that can alter pH values produced.

The broader significance of this research is that as climate change continues, ocean acidification will increase globally, impacting many aspects of complex coastal ecosystems. In order to determine how heavily impacted certain coastal regions will be varies based on the pre-existing seawater pH values. In order to know the pre-existing conditions and natural variability, data must be continuously recorded and monitored for changes in natural fluxes. In coastal Maine several groups are beginning to develop pH monitoring programs. The development of a spectrophotometric pH intercalibration method is one way to ensure that the data are accurate, precise, and comparable to one another.

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References: Dickson A.G., C.L. Sabine, and J.R. Christian. 2007. Guide to Best Practices for Ocean CO₂ Measurements. PICES Special Publication. 3:191.