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Using data from the LISST-100 to recreate phytoplankton size distribution and processes in Harpswell Sound, Maine

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Phytoplankton are the simple single-celled photosynthesizers that live in the ocean and form the base of the food chain. Cell size is a basic proxy for physiological rates as well as ecosystem structure. Thus, cell size can be used in a model framework to track changing environmental conditions that could potentially lead to harmful algal blooms (HABs, aka "red tides")— events that can be detrimental to human health, marine life, and fisheries. HABs occur when a single algae (phytoplankton) species either grows unconstrained to a concentration such that it becomes toxic or causes low oxygen concentration in the water. In typical estuaries, less dense freshwater flows towards the ocean, and denser salty seawater flows into the estuary in the subsurface. However, Harpswell Sound is a reverse estuary that receives its freshwater input at its mouth from the upstream Kennebec River. This yields upstream surface low salinity flow and downstream deep high salinity flow. This rare dynamic allows phytoplankton located in the surface of seawater to be retained in the sound in conditions conducive to high growth and HABs, and can be used as a warning for conditions throughout the Gulf of Maine.

To study the temporal and spatial dynamics of phytoplankton in the sound, we used the LISST-100, which uses light scattering properties to collect continuous in-situ water column observations of particle concentrations and size distributions. Although the LISST-100 was built to measure sediment size with a spherical shape, studies have been conducted that show it can accurately describe a diverse range of phytoplankton shapes and sizes, provided the population has sufficient size differences and is fairly concentrated, conditions found in Harpswell Sound. Weekly profiles of the water column were collected at the Bowdoin Buoy from 5/21/14-6/18/14, as well as a 20-day continuous time series collected at Bowdoin's Coastal Studies Center dock from 5/30/14-6/18/14 along with supplementary oceanographic data.

We determined that semi-diurnal tidal fluctuations are sufficient to move water masses past the buoy and dock with each tide, thereby connecting them. Phytoplankton were found to be in the 3-50 micron size range, with a peak diameter of approximately 7 microns. Additionally, three independent phytoplankton blooms were observed over the course of the 20-day time series as different water masses flowed through the sound. They were sourced in the oceanic water masses found under the freshened surface layer. Over the five-week period the populations gradually surfaced with their water mass as the overlying freshwater dissipated in the absence of rainfall. The LISST-100 served as a useful tool for determining phytoplankton distribution and dynamics within Harpswell Sound, and with further research there is great potential to continue to increase proficiency with the instrument in order to better understand phytoplankton dynamics and harmful algal blooms.

Mentor: Professor Collin Roesler
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