

Winter Measurements in Saginaw Bay

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Overview

Winter measurements of water quality parameters in the Great Lakes are rare, but there is increasing evidence that conditions during this period can strongly influence the conditions and processes that occur during the succeeding summer. We propose to make time series measurements of water temperature, transparency, chlorophyll a, and dissolved oxygen at a limited number of stations in Saginaw Bay during the fall, winter, and spring of 2009-2010. These measurements will be supplemented with vertical profiles of these parameters when the weather permits. The results will be used as input to numerical models being developed as part of a complementary program on the effects of multiple stressors in Saginaw Bay. The research proposed here addresses objectives in two of NOAA's ecosystem research areas.

Objective

Increase number of regional coastal and marine ecosystems delineated with approved indicators of ecological health and socioeconomic benefits that are monitored and understood.

Proposed Work

Acoustic doppler current profilers and thermistor strings will be deployed at several locations in Saginaw Bay over the winter of 2009-2010 as part of the Multi-stressor program (Fig. 1). At two of these stations we propose to deploy an additional mooring with sensors to make time series measurements water conductivity, water transparency (a measure of the concentration of suspended sediment), dissolved oxygen, PAR, and chlorophyll a. The moorings will be deployed in October 2009 and retrieved in April 2010. Similar moorings were deployed successfully by Hawley and Eadie (2007) in Lake Erie during the winter of 2004-2005. Although the water depths were greater, Lake Erie also becomes almost completely ice-covered each winter. The results from that deployment show that although all of the optical sensors became fouled by ice during the period of ice cover, they worked well both prior to and after that period. Since optical sensors will be used to measure water transparency, dissolved oxygen, and chlorophyll a, these measurements are unlikely to be reliable between December and April. We will arrange with the Coast Guard to get permission to use one of their helicopters to go out on the ice to make vertical profiles at the two stations using a portable ctd vertical profiler at intervals during this period. Additional profiles will be made from a small boat throughout the bay before and after ice formation. After the moorings are retrieved in April or May, the data will be downloaded and provided to the modelers. If successful, the program may be continued during the winter of 2010-2011.



Figure 1: Location of adcps during 2009-2010

Scientific Rationale

Saginaw Bay is a shallow, semi-enclosed, highly-stressed bay on the southwestern shore of Lake Huron. Average water depth in the inner bay is less than 6 m, and less than 15 m in the outer bay. Excess nutrient loadings, the presence of anthropogenic pollutants, and excess sedimentation have led to proliferation of nuisance algae, degradation of benthos, loss of fishery habitats, and declining fish and wildlife populations. These problems have resulted in the designation of the bay as an Area of Concern by the International Joint Commission. Last year, a multiple-PI group lead by Dr. Craig Stow at GLERL successfully proposed a research program to NOAA's Center for Sponsored Coastal Research to examine the impact of multiple stressors

on the bay. The program (MultiStress 07 Adaptive Integrated Framework: a new methodology for managing impacts of multiple stressors in coastal ecosystems) includes the development of a set of numerical models that will be applied to the bay, and an observation program driven by the needs of the models to be developed. The models include a three-dimensional circulation model for the bay that will provide circulation patterns and residence times of materials in the bay, the temperature field, and the sediment resuspension potential of the bay's sediments. The outputs of this model will be used as input to the ecosystem models that will be developed.

Although comprehensive in many ways, the multi-stressor program's emphasis is on processes and conditions that occur during the stratified period (June-September). Measurements of most water quality parameters (there is limited current and temperature data) during the unstratified period (October-May) are rare in the Great Lakes, due in part to the difficulty of sampling during this period, and in part to the long-held assumption that the unstratified period is a period of relative dormancy. However recent research shows that conditions during the unstratified period can have a significant effect on the planktonic food web (Vanderploeg et al. 2007). This work was conducted during the spring in the open waters of Lake Michigan; there is almost no data from coastal embayments that covers the entire unstratified period (including the fall, when winds are the strongest and bottom resuspension is most intense, the winter, when many bays become ice-covered, and the spring, when the thermal bar forms and migrates into the open lake). However recent data from the western and central basins of Lake Erie (Twiss et al. 2008) found accumulations of elevated phytoplankton biomass when the lake was ice-covered. There is thus increasing evidence that conditions during the unstratified period can significantly affect biological processes during the ensuing summer.

Governmental/Societal Relevance

Both the MultiStress program and the research proposed here directly address objectives and milestones in two of NOAA's ecosystem research areas: 1) the programs address the milestone 'increasing the number of ecological characterizations that meet management needs' in the performance objective 'increasing the number of regional coastal and marine ecosystems delineated with approved indicators of health and socioeconomic benefits that are monitored and understood,' and 2) the programs address the milestone 'define the primary forcing factors and time and space scales that affect water quality and quantity for selected ocean, coastal, and Great Lakes regions' in the performance objective 'increase number of coastal communities incorporating ecosystem and sustainable development principles into planning and management.'

Relevance to Ecosystem Forecasting

The data collected will be used for calibration and verification of the ecosystem forecasts being developed for Saginaw Bay as part of the multi-stressor program.

References

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