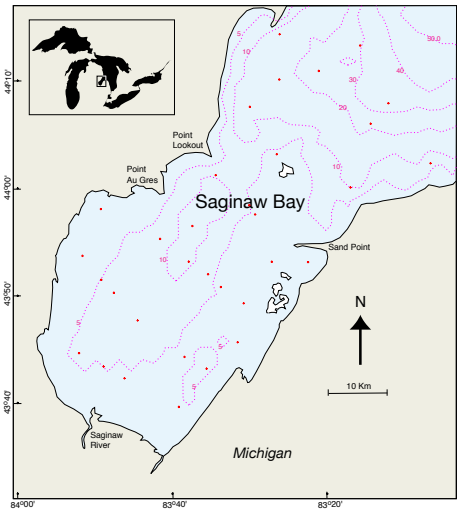
Managing the Impact of Multiple Stressors in Saginaw Bay

In 2007, the NOAA Great Lakes Environmental Research Laboratory, in conjunction with several partner agencies and institutions, has just begun a 5 year project to study the effects of multiple stressors on Saginaw Bay in Lake Huron. Like many coastal areas around the world, Saginaw Bay has been subjected to numerous stressors originating from human activities. These stressors have included toxic contaminants, nutrients, sediments, overfishing, exotic species, and more recently, declining water levels. The combined effect of these stressors has compromised the health of Saginaw Bay and resulted in the loss of many ecosystem features and services that people value. The goal of this project is to help identify management actions that will improve water quality and fish production in the Bay and restore the ecosystem services that are important to the population of that area.

To accomplish this goal we have been conducting research in the field and the laboratory to study how these stressors interact to influence Saginaw Bay's fisheries and water quality. The information from these studies will be used to guide the development of several mathematical models that will help identify useful management options. Mathematical models will help researchers to organize what is known about the effects of stressors in Saginaw Bay and to identify the important processes about which very little is known. Additionally, the models will allow scientists to conduct simulated experiments, such as reducing phosphorus input to the Bay, to evaluate the logical outcome of alternative management actions.

Another objective is the development of an "Adaptive Integrative Framework" so that our models and field studies will be used interactively to inform one another. As an important component of this Adaptive Integrative Framework, our research will be conducted in coordination with local stakeholder groups under the guidance of representatives from the Michigan Departments of Natural Resources (DNR) and Environmental Quality (DEQ). This interactive environment will help the public understand the goals and difficulties involved in effectively studying and managing Saginaw Bay. In turn, our research will be informed and guided by local knowledge and an enhanced appreciation of the ecosystem services that the public considers most important.



Low water levels in Saginaw Bay, Lake Huron, create problems for recreational users and marina operators and may contribute to muck problems.

Muck accumulation along the Bay City, MI shoreline.

Top objectives determined from a workshop held in April 2008

Fisheries

- Management of dominant percid (walleye and yellow perch) populations and their associated fisheries.
- Manage for diverse ecosystem, fish community and fisheries.
- Restoration of native species and control of non-natives.
- Manage for long-term sustainability.

Water Quality

- Predicting and managing muck deposition on beaches.
- Prediction and managing *E. coli*/pathogens outbreaks.
- Determine what type of management efforts or policy changes would be effective in reducing the impacts of contaminants in Saginaw Bay (i.e. dredging of hot spots).
- Managing sediment loading.
- Managing and understanding the impacts of agriculture in Saginaw Bay (i.e. nutrient loads, sedimentation, *E. coli*).

Important Stressors & Their Effects

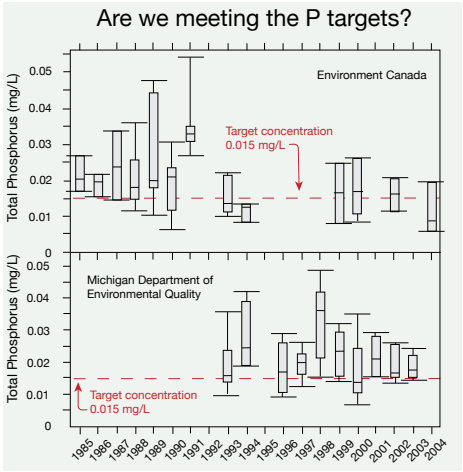
Water Levels

Water levels in Lakes Michigan and Huron began a rapid decline in the late 1990s. A statistical analysis of water level data that corrects for the effect of precipitation suggests that an underlying decline began much earlier, perhaps in the mid-1970s. The reason for this decline is unclear, but may be related to increased evaporation in the watershed, a possible consequence of global climate change. Declining water levels have made Saginaw Bay shallower which may be increasing the influence of the invasive zebra and quagga mussels on water quality.

Quagga mussel (top) and zebra mussel (bottom) are invasive species in the Great Lakes that contribute to problems such as shoreline muck accumulation.

Phosphorus

Phosphorus is a nutrient that causes algae to grow. While it is essential to have some phosphorus in the water, too much can stimulate the growth of nuisance and toxic algae. Even though the Great Lakes Water Quality Agreement established a target phosphorus load for Saginaw Bay in 1978, inputs of this important nutrient continue to cause problems. Limited monitoring in the Bay makes it unclear if the target phosphorus loads are currently being met.



Total phosphorus data by year. Boxes show upper & lower data quartiles; the central solid line represents the median. Whiskers represent 1.5 times the interquartile range up to the max and min data values.

Toxic blue-green algae Microcystis.

Invasive Species

Many invasive species have entered the Great Lakes in recent years. Zebra and quagga mussels have been especially important because they filter large quantities of water, removing some algae and sediments from the water column. As a result the water has generally become clearer since these mussels invaded. However, the bad news is that because the water is clearer, more sunlight reaches the bottom of the shallow Bay causing nuisance algae to grow. These algae accumulate in the shallow areas along the shoreline and decay, resulting in a very unpleasant "muck". Lower water levels make the problem worse by exposing more shoreline. In addition, zebra and quagga mussels refuse to filter some of the toxic or harmful species of algae (some cyanobacterial, aka blue-green algae) – returning them to the water where they continue to grow.

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