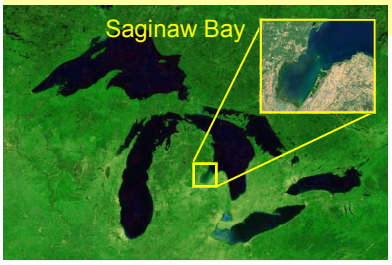
Coastal Ecosystems Projects

Improving Water Quality Targets in Saginaw Bay

The USGS Great Lakes Science Center is dedicated to providing scientific information for restoring, enhancing, managing and protecting living resources and their habitats in the Great Lakes region. The USGS Great Lakes Science Center is headquartered in Ann Arbor, Michigan, and has biological stations and research vessels located across the Great Lakes Basin.



Saginaw Bay is one of the most productive and valuable Great Lakes ecosystems. The goal of this project is to help guide improved water quality management of the bay.

This project is investigating how environmental factors, such as nutrient input, lead to particular outcomes in Great Lakes bays, such as muck accumulation on shorelines (top photo) and abundance of walleye and other fishery species (bottom photo).

Background

Humans have long been attracted to bays in the Great Lakes because they offer protected harbors and are biologically productive places with abundant fish and wildlife. Bays are productive, in part, because they collect the sediment and nutrients that run off of land, which get converted into food for aquatic animals. However, the tight linkage to land-based runoff also makes bays more prone to the effects of pollution including excess sediment, nutrients, or industrial discharges. Saginaw Bay, a Lake Huron bay located on the eastern coast of Michigan, is one of Michigan's most diverse and productive aquatic ecosystems. The Bay receives runoff from some of Michigan's most intensely used agriculture lands and industrial activities have historically also been focused within the watershed. Contaminated sediments, fish consumption advisories, habitat degradation, and symptoms of eutrophication led to Saginaw Bay being designated as a Great Lakes Area of Concern (AOC) by the U.S. EPA in 1987, and billions of dollars have since been invested in pollution reduction and restoration of the Saginaw Bay ecosystem.

Researchers at the USGS Great Lakes Science Center in partnership with the Michigan Department of Environmental Quality Office of the Great Lakes are embarking on a project to clarify the relationship between environmental stressors (such as nutrients) and their ecological responses (such as fisheries productivity, algae blooms, and muck accumulation on beaches). Clarifying these relationships could help managers assess the current condition of Saginaw Bay, examine tradeoffs between different management endpoints, guide environmental policies to meet AOC restoration goals, and ultimately improve the environment and quality of life in the Saginaw Bay area.

Project Objective

The main objective of this project is to synthesize existing knowledge in a form that can guide determination of nutrient targets that are protective of beach quality, productive fisheries, and good water quality.

Approach

To meet the main objective, the research team is focusing on key management goals for Saginaw Bay. Potential goals include reduction of muck and pathogens such as *E. coli* on shorelines, and promotion of fisheries for walleye, yellow perch, and other species.

After management goals have been determined, the research team will compile ecological information from

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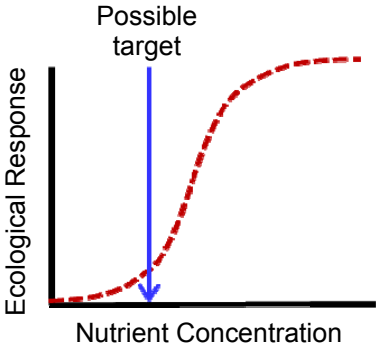
Response Curve



Project scientists will build response curves (figure above) to understand relationships between environmental stressors and ecological responses. In this hypothetical example, increased nutrient concentrations (a stressor) are related to a rapid increase in an ecological response (dashed red line). Management targets can be set to maintain nutrient concentrations at levels that promote desirable outcomes. For example, a low nutrient concentration target (blue arrow) may be desirable to minimize muck accumulation.

Understanding these responses can lead to better decision making to promote healthy beaches (top photo) and recreation (bottom photo) in Saginaw Bay and other Great Lakes bays.

Saginaw Bay and other bays in the Great Lakes to identify relationships between ecological stressors and responses, called response curves. Potential ecological stressors to be explored are excess nutrients, invasive species, and shoreline development, and potential responses include fish biomass, algae concentrations in the water during the growing season, and abundances of plankton as a food source for target fisheries. The response curves will provide evidence for the levels of a stressor – such as nutrient concentration – that causes a particular degree of a response – such as the amount of muck. In the simplest case, increase in a stressor may cause a uniformly increasing or decreasing response. Alternatively, the relationship could be more complex, involving rapid changes in response with relatively little change in stressor levels. Response curves are important because researchers can use the curves to determine levels at which particular stressors become problematic, which can help with setting of management targets to reduce problematic outcomes. Through this project, the research team will be building many response curves for Great Lakes bays. Response curves can then be used to look at trade-offs in the ecosystem. For example, increasing nutrients may cause more muck on shorelines, but also lead to increases in fish availability. So by reducing nutrients both positive and negative outcomes could be realized. In this case, managers and policy makers could use the detailed information in the response curves to determine the optimal nutrient level that promotes high fish abundances while reducing muck accumulation.

The final part of this project will be to communicate knowledge gained from studying response curves to managers. The research team is developing a communications plan which will enable them to target the information generated to be of maximum use to managers for setting nutrient targets in Saginaw Bay and other bays, and communicating these to the public.

Expected Outcomes

Excessive nutrient inputs, beach fouling, and habitat degradation are pervasive threats to Great Lakes ecosystems in general, and Saginaw Bay in particular. This project will provide the information needed to understand how these ecological stressors affect key management goals in Saginaw Bay, such as reduction of the negative effects of nutrient enrichment, and promotion of productive fisheries. Additionally, information generated by this project could assist managers in meeting AOC restoration targets. More generally, because data from many systems will be used to create response curves, information generated can be applied to other nutrient-rich systems, such as the western basin of Lake Erie, Green Bay, or Grand Traverse Bay. Some of these areas are also designated as AOCs, so knowledge gained by this project will have a wide-reaching, positive impact through remediation of other degraded systems, ultimately enhancing the quality of life across the Great Lakes.

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