Benthification of Great Lakes Ecosystems: A Synergism between Nutrient Reduction and *Driessena*?

NYSG researchers have examined the primary forces that are driving the flow of energy and materials in Great Lakes ecosystems downward from the water column into the lake bottom sediments. Their original "benthification" model is now providing a management tool to municipalities and researchers.

Trending downward-- "benthification" of food webs

The Great Lakes ecosystems have undergone considerable ecological change during the past three decades. One major ecosystem shift has been the change of the flow of energy and materials from the pelagic zone (water column) to the benthic zone (bottom sediments) of the lakes. This process, dubbed "benthification," is the result of the interaction among several factors that causes increased water clarity. Such factors include successful efforts by municipalities to reduce phosphorus loading and the filtering activities of introduced invasive species such as zebra and quagga mussels (dreissenids). Dreissenids clarify the water column by filter feeding but at the same time increase the amount of nutrients in the sediment. Greater water clarity and nutrients in the sediments provides better growing conditions for submerged vegetation, allowing them to increase their biomass and density.

Researchers analyze the trend and develop a useful tool

The research team of Dr. Edward Mills from Cornell University and Christine Mayer of Syracuse University looked into the process of benthification. The team analyzed long-term data sets from temperate lakes to quantify and describe the benthification process. Their analyses revealed that two primary forces driving this process were filter-feeding by *Dreissena* and phosphorus

Sodus Bay, Lake Ontario. NYSG research on the interaction between zebra mussels and reduced phosphorus loading provided a modeling tool that helped municipalities manage nuisance levels of submerged plants that threatened to overtake this popular waterway. Photo by Diane Kuehn

abatement. The team also examined the historical and current extent of submerged aquatic vegetation (SAV) in two embayments in the Lake Ontario ecosystem. They showed that with the arrival of *Dreissena* and reduction of phosphorus, water clarity increased and SAV areas expanded.. Using the results from this project, the team developed a model to predict changes in SAV habitats.

The result is that this project has fleshed out the concept and documented the process of benthification in the Great Lakes. The concept and idea of benthification is now generally accepted and used in the research and management community largely due to the efforts of this work. The project documented the impact of this process on submerged aquatic vegetation and developed initial modeling that incorporates habitat data from published research and SAV surveys. This provides a tool for managers and researchers to use to help predict future changes in local embayment environments. For example results from this

research have helped municipalities manage nuisance levels of SAV in Sodus Bay.

Students

One scholar was supported on this project. Ben Zhu, a Fall 2005 thesis completion award winner, completed his PhD at Syracuse University in June 2006. Dr. Zhu is now a research scientist at the Finger Lakes Institute at Hobart and William Smith Colleges, Geneva, NY.

Publications

Fitzgerald, D.G., B. Zhu, S.B. Hoskins, D.E. Haddad, K.N. Green, L.G. Rudstam, and E.L. Mills. 2006. Quantifying submerged aquatic vegetation using aerial photograph interpretation: Application in studies assessing fish habitat in freshwater ecosystems. Fisheries 31(2): 61-73.

Zhu, B. 2006. Direct and Indirect Ecological Effects of Dreissenid Mussels (the Zebra

Mussel *Dreissena polymorpha* and the Quagga Mussel *D. bugensis*) on Submerged Macrophytes in North American Lakes. PhD Dissertation, Syracuse University, Syracuse, NY. 135pp.

Zhu, B., D.G. Fitzgerald, C.M. Mayer, L.G. Rudstam, and E.L. Mills. 2006. Alteration of ecosystem function by zebra mussels in Oneida Lake: Impacts on submerged macrophytes. Ecosystems 9(6): 1017-1028.

Zhu, B., D.G. Fitzgerald, S.B. Hoskins, L.G. Rudstam, C.M. Mayer, and E.L. Mills. 2007. Quantification of Historical Changes of Submerged Aquatic Vegetation Cover in Two Bays of Lake Ontario with Three Complementary Methods. Journal of Great Lakes Research 33(1): 122-135.