

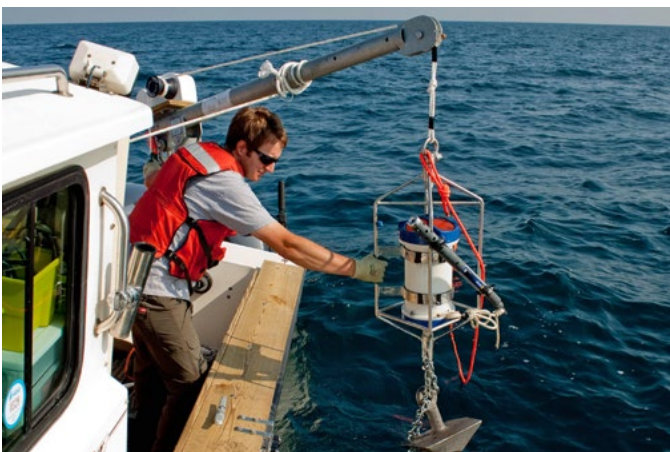
Lake Management Services and Qualifications



Lakes and reservoirs are valuable resources, providing recreational and aesthetic enjoyment, food, hydropower, and water supply. These resources also have considerable financial value to the surrounding communities. Because lakes and reservoirs can be affected by activities on the water and in their drainage areas, a holistic understanding of the waters, the living resources inhabiting them, and the lands draining to them is required to successfully manage them as resources.

Effective lake management considers myriad factors that could impact a lake, identifies and prioritizes the factors driving environmental conditions, and develops a plan to ensure that the often diverse uses of the resource are adequately protected. Implemented properly, lake and reservoir management allows for community self-determination regarding future uses, protective measures, and water quality goals.

This approach does not imply restricted uses, but rather knowledgeable use based on sound science. The health of a lake depends on the interaction between physical, biological, and chemical components, and the strong influence that people have on these characteristics. In this regard, lake managers must recognize that decisions regarding the use of lands adjacent to lake waters have a large effect on water quality, as can fishing and boating pressures.



Many factors must be considered to develop management plans that will adequately protect and preserve lakes.

Through more than 30 years of lake and watershed management projects, LimnoTech has developed the experience and techniques to understand and scientifically quantify these influences, so that this knowledge can be used to effectively manage the use of a lake to meet the desires of its resident community.



LimnoTech Services

LimnoTech serves communities with their lake management issues through the following services:

- Initiation and evaluation of community goals
- Identification, compilation, and evaluation of existing data
- Monitoring program design and implementation to fill information gaps
- Assessment of current water quality and sources of pollutants
- Point and nonpoint source pollution identification and characterization
- Assessment and evaluation of future threats to water quality, including:
 - Increased point source discharges
 - Changes in nonpoint source pollution
 - Watershed development impacts
- Evaluation of alternative management options:
 - Structural BMPs
 - Land use planning
 - In-lake management techniques
- Development and implementation of management plans

LimnoTech has extensive experience in lake and reservoir assessment, restoration, and management. This experience includes Clean Lakes Studies, integrated watershed and water quality investigations, evaluation of innovative restoration techniques, and other in-depth assessments on water bodies throughout the U.S.

Project water bodies have ranged from small ponds and urban lakes to some of the largest lakes and reservoirs in the nation. The following selected examples demonstrate the diversity of our experience.

Development of Integrated Ecological Response Models for the Lake Ontario / St. Lawrence River and the Upper Great Lakes Systems.

The International Joint Commission conducted studies on the Lake Ontario/St. Lawrence River and the Upper Great Lakes systems to evaluate the impacts of regulation plans and basin water supply scenarios, and to develop recommendations for new criteria and an updated plan for water level and flow regulation. LimnoTech has worked to conceptualize and develop an Integrated Ecological Response Model (IERM) to evaluate the impacts of water level regulation, basin supply, and climate change on indicators of ecological performance for these studies. The model integrated the research results from multiple ongoing research projects throughout the Lake Ontario/St. Lawrence River system. LimnoTech is configuring the IERM to evaluate the impacts of a range of water level conditions within Lakes Superior, Michigan, Huron, and Erie. The results of each integrated modeling effort are incorporated into the Shared Vision Model, a decision-support tool that facilitates comparisons of environmental and economic benefits and impacts for regulation plan alternatives.

Development and Application of Water Quality Model for a Nutrient TMDL.

LimnoTech developed a water quality model of the Upper Mississippi River and Lake Pepin system to inform development of nutrient and turbidity TMDLs. LimnoTech developed a linked modeling system containing a three-dimensional hydrodynamic model; a water quality model containing multiple species of algae and zooplankton; and a submerged aquatic vegetation model. The model was applied to simulate a range of load-reduction scenarios. Model results and data were incorporated into a Management Analysis Tool to assess modeling results and data for decision-making. The modeling results and Management Analysis Tool have been instrumental in developing site-specific criteria for turbidity and suspended solids concentrations, and

phosphorus, chlorophyll *a*, and secchi depth. The model and Management Analysis Tool continue to be used to finalize the TMDL and implementation plan.

Lake Houston Watershed Solids Transport and Lake Hydrodynamics, Lake Houston, TX.

The City of Houston's Northeast Water Purification System draws raw water from Lake Houston to meet residential water supply standards. Raw lake water can be compromised by watershed solids loading during rain events, resuspension of sediments under high flow conditions, algal growth, and lake shore erosion. LimnoTech provided data review, analysis and modeling services to characterize hydrodynamics in Lake Houston as well as in the east and west branches of the San Jacinto, and watershed sources of solids and organic carbon. Services led to the development of a conceptual model for factors influencing water quality in the lake. LimnoTech also developed a hydrodynamic model of the lake. Results of analyses were used to determine the quality of the lake as an ongoing source of raw water for the Houston area. Findings were used to plan operations procedures at the water

treatment plant, and to develop a plan for real-time water quality monitoring in the lake.

Development of a Process-oriented Aquatic Ecosystem Model to Investigate Multi-stressor Interactions in Saginaw Bay, Lake Huron.

LimnoTech worked with NOAA Great Lakes Environmental Research Laboratory to research and develop an Adaptive Integrated Framework (AIF) for understanding and managing large aquatic ecosystems subject to multiple stressors. To identify and understand the alterations in the Saginaw Bay

ecological structure and function in response to stressors such as zebra mussel invasion, nutrient loads, sediment loads, hydrology and water levels, and climate conditions, LimnoTech has developed a coupled aquatic ecosystem modeling framework by linking EFDC (a hydrodynamic and sediment transport model) with an advanced aquatic ecosystem model (A2EM). We developed this model by adding Dreissenid (zebra and quagga mussels) and Cladophora sub-models to our existing advanced eutrophication model. This model has quantified the relationship between nutrient loads, zebra mussel density, and physical (hydrodynamics, temperature, light) factors as stressors and algal blooms in this system. Model results have been used to advise water quality and fishery managers concerning management decisions, and to recommend research and monitoring activities of project partners to develop a better quantitative understanding of the system.



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