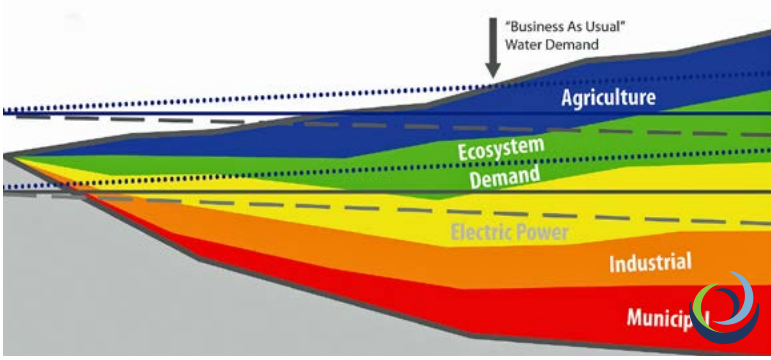
SERVICE AREA

Decision Support for Resource Managers



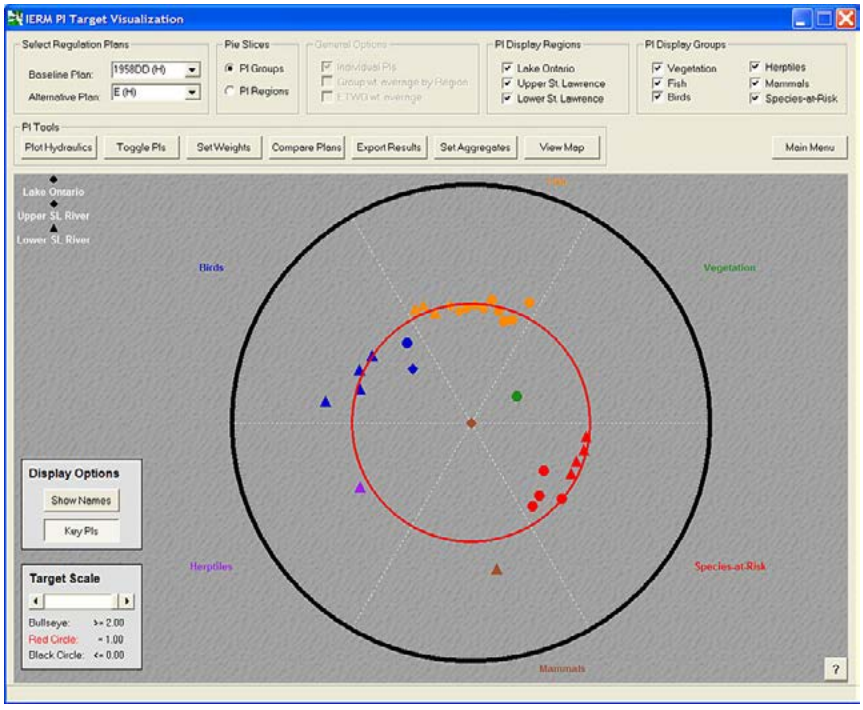
Effective management of natural resources calls for informed decisions that balance environmental, financial, and social performance measures. The basis for these management decisions often requires consideration of complex and disparate types of information. Furthermore, the decision-making process needs to be as transparent as possible to a wide range of stakeholders. These requirements lead to a need for useful decision support tools.

LimnoTech's experience with water resource management decision-making has given rise to an unrivaled understanding of how to develop and apply decision support tools. We have found that the following features are essential for an effective decision support tool:

- Ease of use for non-experts, understandable by upper managers, stakeholders and public;
- Integration of best available data with sound science;
- Focus on problem at hand (developing, evaluating, and comparing scenarios to prioritize actions); and
- Clear spatial context, and intelligent and intelligible presentation of inputs and outputs.

The examples below highlight some of the decision support tools we have developed.

CalLite GUI Development. LimnoTech is leading a GUI development team that worked with modelers from the U.S. Bureau of Reclamation and the California Department of Water Resources to implement a flexible GUI providing ready access to key model inputs, scenario management, and dashboards for visualization and comparison of model results. The CalLite GUI was implemented as a Java wrapper around the CalLite model, which simulates the hydrology of California's Central Valley as well as Sacramento Delta salinity responses to river flow and export changes. The GUI improves the utility of the CalLite model to stakeholders by simplifying the process to set up different management and climate assumptions and to evaluate their impact on water availability. CalLite's utility is also extended by the GUI's capability to be easily reconfigurable by CalLite model developers without having to update and recompile the GUI code.



Integrated Ecological Response Decision Support for Lake Ontario

The International Joint Commission (IJC) had conducted studies on Lake Ontario and the St. Lawrence River to evaluate the impacts of alternative water level regulation plans on various components of these systems, because existing water-level regulations may be contributing to unsustainable ecological impacts. LimnoTech was contracted to develop a decision support system to allow an integrated evaluation of the impacts of water level regulation on several indicators of ecological performance, including wetland habitat quality and quantity, fish species utilizing ecological services provided by nearshore and wetland habitats, terrestrial fauna (birds, mammals, amphibians and reptiles) that inhabit shoreline habitats in the system, and at-risk or endangered species.

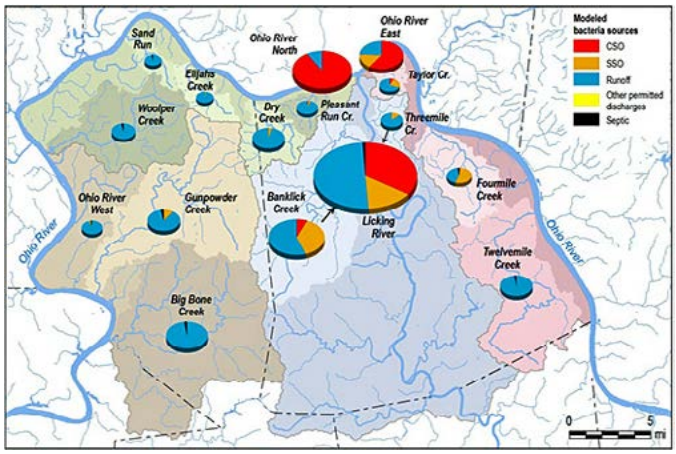
This decision support system condenses results from more than 600 ecological indicators into the 32 most important indicators for decision-making. It allows direct comparison between management scenarios for indicators within six categories and covering various geographic regions within the system, displayed using a target diagram. Any indicator that is significantly improved compared to the baseline plan is plotted near the center of the target, while indicators that

are degraded are plotted outside the red circle representing baseline conditions. The alternative displayed below shows improved conditions for Species-at-Risk and Vegetation, but degraded conditions for Herptiles and Mammals. Users of the decision tool have the ability to control which indicators are displayed, as well as the weighting factors used to describe each indicator.

Water Prism Decision Support System

The Water Prism Decision Support System supports decision-making for power plant siting and retrofit options by considering current and future electric power sector water demands and exploring opportunities with various generation technologies, advanced cooling technologies, nontraditional water sources, and in-plant water reuse. This tool recognizes watershed and regional hydrology characteristics, water demands of competing water resource stakeholders, and community water-sharing strategies. Water Prism helps to evaluate potential benefits of water risk reduction for the electric power and other sectors and to visualize output in high-level "prism" graphics.

Water Prism uses a water balance approach to compute water demand within a watershed under current and projected "business as usual" conditions. A background watershed model and information for groundwater resources inform the Water Prism regarding available water resources supply. Water Prism also accounts for ecological flow limits within the system (e.g., minimum flows or reservoir levels). Data input requirements for the application of Water Prism include climate, land use, current water withdrawal and discharge records, and projected water demands. The Water Prism GUI provides user control for inputs, scenario management and comparison, and display of results.



Watershed Improvement Prioritization Tool

Sanitation District No. 1 of Northern Kentucky (SD1) is currently taking a watershed-based approach to water quality management, and is prioritizing control measures on those projects and sub-watersheds where the greatest water quality benefit will occur. LimnoTech developed a decision support tool to evaluate the relative risk from pollutant contributions associated with inventoried sources (e.g., septic systems, runoff, combined sewer overflows [CSOs], sanitary sewer overflows [SSOs], and other permitted point sources), and provides a uniform and objective methodology for estimating pollutant contributions and for ranking SD1 sub-watersheds according to potential impact on instream water quality. The tool helps identify sub-watersheds and sources to target for controls to most efficiently improve water quality.

The tool calculates scores for potential instream water quality impacts at catchment outlets from fecal coliform, total nitrogen, total phosphorus, and total suspended solids. Monitored discharge flows and concentrations are used to characterize contributions from point sources, and for comparison to results. Other parameters, such as nonpoint source impacts, are based on results from detailed watershed/water quality models that are in turn calibrated to monitored instream flows and concentrations.