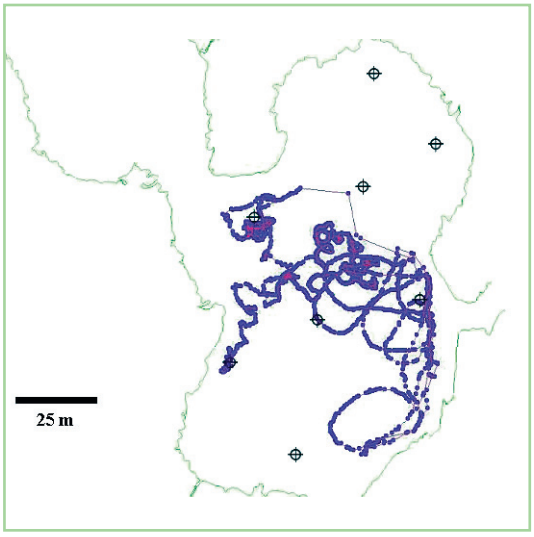
What do fish do 24/7?

Have you ever wondered how much a fish swims in a day or where in a lake at a given moment fish are distributed? Using novel technology, researchers at the Queen's University Biological Station are now able to address those questions and more in Warner Lake, located in eastern Ontario. The project, referred to as the Queen's Ecological Observatory, is a consortium of researchers from Queen's University, the University of British Columbia, and the University of Illinois. The main infrastructure includes an acoustic telemetry array consisting of 14 hydrophones and two receivers donated to Queen's University by Lotek Wireless Inc. Multiple users (from different institutions) are able to tag fish in the lake to address their independent questions simultaneously, while also monitoring how animals in different studies interact. Aside from simple maintenance and monitoring, the system requires little direct involvement from biologists, enabling data collection 24 hours a day, 365 days per year. Imagine trying to find a graduate student with that stamina!



24-hour winter movement track of a single largemouth bass during February 2004 (generated by the Queen's GIS Lab). The lake was ice covered during this period.

In a pilot study this past year, researchers monitored the 3-dimensional position of 22 tagged largemouth bass at 15-second intervals as well as the water temperature where the fish were situated. The transmitters use the same technology as cellular telephones, enabling multiple transmitter signals to be logged simultaneously, even if the arrival times overlap. What is most fascinating is the resolution—the position solutions are at submeter accuracy. Gone are the days of determining fish locations with respect to gross habitat features such as "that bay."

Ultrasonic telemetry transmitter equipped with temperature and pressure (depth) sensors.

Simple mathematical calculations reveal that in a given day, researchers are logging up to 126,720 position solutions for the 22 tagged fish. With this vast amount of data, analysis and visualization can become challenging. To address these challenges, researchers at the Queen's Geographic Information Systems (GIS) lab in collaboration with Lotek Wireless Inc. are developing tools that will enable biologists to explore the data and interface fish observations with detailed habitat features. One promising approach to visualizing the data involves using animations to illustrate fish movements over time. Imagine the types of information that could be revealed using this level of detail.

The pilot study currently in progress is focusing on the winter biology of largemouth bass. Already researchers have learned that largemouth bass aren't nearly the sedentary creatures during winter that one might conclude from reading existing literature. In fact, bass move extensively under ice both horizontally and vertically. By measuring the distance between successive fixes, it is also possible to estimate swimming speeds and thus energetics.

According to University of Illinois/Illinois Natural History Survey graduate student Kyle Hanson, some of the most interesting data were collected during transition times—i.e., during the fall when waters cooled and ice formed on the lake and during the spring when ice cover dissipated. "During the fall as water temperature dropped, fish began to aggregate near the bottom in the deepest part of the lake. However, as winter progressed, fish were really quite active (see visualization). In the spring, the shallower basin of the lake became ice-free about one week earlier than the deeper basin where fish had over wintered. At that time, all but a few fish moved out of the deep basin into the shallow basin until ice cover had melted from the entire lake."

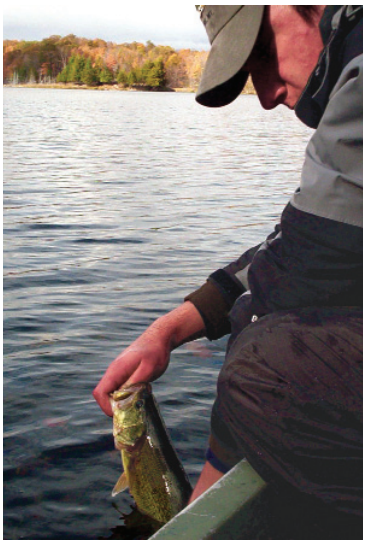
Hanson also noted interesting social behavior; at times fish seemed to aggregate and move as a group. One animation shows all but a few of the tagged fish in an area of about 30 m^2, then all fish moving as a cohesive group some 200 m to an adjacent shoreline before dispersing. This type of information is not possible to determine when manually tracking several individuals independently.

Initial work has focused on establishing long time-series of data to evaluate system performance and develop a baseline on large-mouth spatial ecology and behavior. As the project develops, more efforts will be placed on experimentation and manipulation to address more complex hypotheses. Over the next few years researchers intend to use this array to address questions associated with the energetics of parental care, the behavioral consequences of different catch-and-release angling practices, and how fish respond to different types of recreational watercraft.

The hope is also to expand beyond monitoring all things fish to include other aquatic organisms including water snakes, turtles, and waterfowl. One of the longer term goals of the ecological observatory program is to add a second telemetry array to monitor animal movements in the air and on land around the lake enabling researchers to adopt a community approach to telemetry studies. At that point questions dealing with predator-prey interactions and the movement of animals across the air-water interface would be possible.

For more information on the Queen's Ecological Observatory, see the project website at www.gis.queensu.ca. Examples of animations, as well as more detail on the consortium, technology, and biology are available at that site.

—Steven Cooke, University of British Columbia



Graduate student Kyle Hanson releases a telemetered largemouth bass into Warner Lake.

Erratum

In the article "Fishing Down Coastal Food Webs in the Gulf of California" by Sala et al. (*Fisheries* 29[3]:19-25), the captions for Table 1 and Figures 1 and 2 should read "...in Baja California Sur" rather than "...in the southern Gulf of California." There is a distinction between the state, for which there are large-scale catch data, and the southern Gulf, from which the authors collected their own data.