Once a week, on calm clear days between May and September, retired veterinarian Harold Dziuk fires up the 15-horsepower engine on his fishing launch and sets off for a spot about a quarter mile from his home on Big Turtle Lake, a 2,000-acre body of water in Itasca County.

When he arrives, he cuts the engine and lets the boat stand offshore about 200 yards in some 50 to 60 feet of water. Gone fishing? Not quite. Although Dziuk sometimes brings tackle with him, the primary purpose of these expeditions is not recreational. He is one of about 1,200 volunteers who check lake water clarity as part of the Minnesota Pollution Control Agency’s (MPCA) Citizen Monitoring Program.

Each week he immerses a plate-shaped piece of white metal called a Secchi disk into the water on a rope and measures how far down he can drop it before it fades out of sight. At the end of the season he fills out a form and returns it to the MPCA. The information he and the others gather is used to make decisions about shoreline development and resource management.

“Those of us who live on the lakes see the need for this kind of monitoring,” Dziuk says. “Living here you become very concerned about the use of our water resources and shoreline.

“Volunteers monitor only about 1,000 lakes in Minnesota, and most large lakes are not included. Consequently, the water clarity of most lakes is estimated. Use of satellite-derived data will ensure a more accurate assessment of lake water clarity in Minnesota.”
Remote Sensing

In summers past, the MPCA and the Metropolitan Council have relied on volunteers to take Secchi disk readings on more than 1,000 Minnesota lakes—because, as Dziuk says, "the professional resource engineers and managers can't do it alone."

Now, however, a joint project of the College of Natural Resources' Remote Sensing and Geospatial Analysis Laboratory and the Water Resources Center offers the prospect of complementing the efforts of volunteers using remote sensing data collected by satellite.

In a nutshell, University researchers have developed a method to determine water clarity in all but the smallest of Minnesota’s 15,000 lakes by analyzing the multispectral reflectances (colors) of images of the lakes taken by Landsat satellites. "The Landsat satellite has a multispectral scanner with seven spectral bands," explains Marv Bauer, a forest resources professor and one of the project’s principal investigators. "Most of these bands have a resolution of 30 meters—about a quarter-acre. In our analysis of the images, we look at the visible bands, especially in the blue and red bands of the spectrum where chlorophyll absorbs solar radiation. The amount of chlorophyll is an indicator of the concentration of algae, which is related to water clarity."

Millions of Images

Thirty years ago, on July 23, 1972, NASA launched the first of what is now seven satellites whose purpose is to give us a good look at ourselves. Over the years these Landsat satellites have transmitted millions of images of the earth back down to us, where we use them to inform our activities in everything from agriculture to national security.

The newest of the satellites, Landsat 7, was launched in 1999. Cruising around the globe 14 times each day at a height of about 438 miles, Landsat 7 takes visible and infrared images of each spot it covers once every 16 days. Advantages of Landsat are that each image covers over 10,000 square miles and that several images can generally be acquired of the same area each year.
Images captured now can be compared to those taken over the past decade, making it possible to track clarity trends. With funding from the Metropolitan Council, the research team used the procedure to classify 13 years of Landsat data acquired between 1975 and 1998 for more than 500 lakes in the Twin Cities area. The team went on to create clarity readings for all of the state’s lakes larger than 20 acres. Lakes shown in yellow are the murkiest, corresponding to Secchi disk readings of 0.125 meters or less; those in deep blue correspond to readings of 8 meters or more.

The Landsat-derived readings correlate closely with Secchi readings taken by volunteers. If a lake looks murky from the sky, the evidence so far is that it will look murky from a boat as well.

The Landsat approach isn’t intended to replace the efforts of volunteers or to provide a tool for monitoring short-term changes in lakes. “But it can be used to see how conditions are changing over a larger scale of time,” says Pat Brezonik, director of the Water Resources Center who is, like Bauer, a principal investigator on the project.

Ready for Transfer
The researchers and Minnesota officials estimate that it will take about $150,000 to $200,000 to fund a state program exploiting the satellite breakthrough. “Basically, we’re at the point where we think this is ready to be transferred to state agencies,” says Bauer. “Both the MPCA and the Department of Natural Resources are interested in that possibility.”

Satellite remote sensing could be an “extraordinary tool” for monitoring lake quality, says Bruce Wilson, an MPCA research scientist. “We have used every trick of the trade, with a large body of volunteers and lab tests,” says Wilson, “but the truth is we can only monitor about 1,200 lakes a year. And now, out of the sky—literally—has come this opportunity to help provide the information we are asked for thousands of times a year by citizens, business owners, and local units of government.”

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—Bruce Wilson
Remote sensing makes that job easy for people to see not only water clarity, differences in clarity that require lots of samples to be taken now. “Large lakes, like Lake of the Woods, for example, have bay-to-bay differences in clarity that require lots of samples to monitor. This satellite imaging provides pictures of lake water changes over time that people can easily understand.

“The most difficult issue we face is presenting some way of comparing where we are today as opposed to where we’ve been,” he explains. “This satellite information is going to have a major impact on land-use decisions. If we can’t talk about the possible negatives for a lake, or show how it has gotten worse over time because of previous development—or gotten better over time because of investments in the environment—it’s very hard to influence decisions at the local level, which is critical because almost all the important land-use decisions are local decisions. “I see the potential here to obtain—relatively inexpensively—from a large region that are easy to process digitally and produce in maps and pictures that make it easy for people to see not only water clarity, but also how it has changed over time. Monitoring is important,” Wright says, “but communicating information to decision-makers is equally important. Remote sensing makes that job a whole lot easier.”

The following publications represent some of the research, teaching, and outreach efforts taking place within the College of Natural Resources. To obtain a copy, please contact the editor.