LISTENING FOR HISTORY

Exploring Thunder Bay National Marine Sanctuary with Sound

By John C. Bright

How do you find a shipwreck in a 23,000-square-mile (59,570 km^2) lake? For researchers, it can be like finding a needle in a haystack. Last year, researchers in Thunder Bay National Marine Sanctuary used acoustics to explore deep-water areas off Presque Isle.

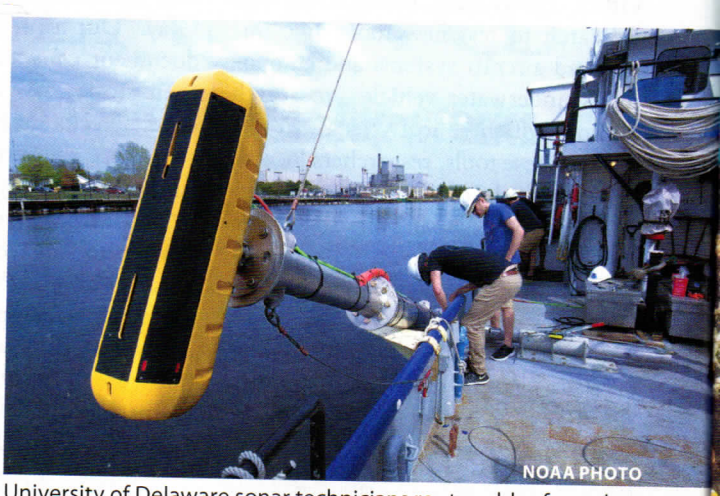
Unlike on land, where features can be documented with aerial imagery or satellites equipped with cameras, visual survey isn't practical underwater. In some cases, the water is too murky or turbid, to take photographs. At deeper depths there simply isn't any ambient light. A camera, therefore, would only see darkness unless an array of lights was lowered down with it to illuminate the area.

Sound, however, is astonishingly efficient underwater. The density of water, both freshwater and saltwater, allows sound waves to travel great distances. When these waves encounter an object, they bounce off and in some cases reflect back in the direction of their original travel. In fact, by knowing the speed of sound through water, researchers can calculate how far away an object is. If the object being mapped is the lake floor, in this case the bottom of Lake Huron, the distance to the bottom, or water depth, can be determined by the time delay between a sound wave emitted at the surface, its travel to the lake floor and return back to the source at the surface.

The behavior of sound in water is so reliable that hydrographers can make detailed maps of the seafloor — accurate to within inches. Archaeologists can also use this technology to locate undiscovered shipwrecks. Where the lake bottom is flat and even, a historical shipwreck will appear as a large "anomaly" in the sonar data — a feature that sits upright off the bottom in stark contrast to the surrounding natural features. Once located, researchers can return with additional tools, such as underwater robots or divers, to further document a potential discovery.

Using Sound To Reveal Lost Shipwrecks

When researchers are first characterizing the lakebed or seafloor, we use a sonar system that can see a wide strip of the bottom at once. By running a pre-planned grid of overlapping passes — a technique referred to as "mowing the lawn" for the pattern it creates — researchers end up with a complete map of a given area. However, this wide-scanning sonar results in a less detailed image, or lower-resolution one, than a more focused sonar would reveal.

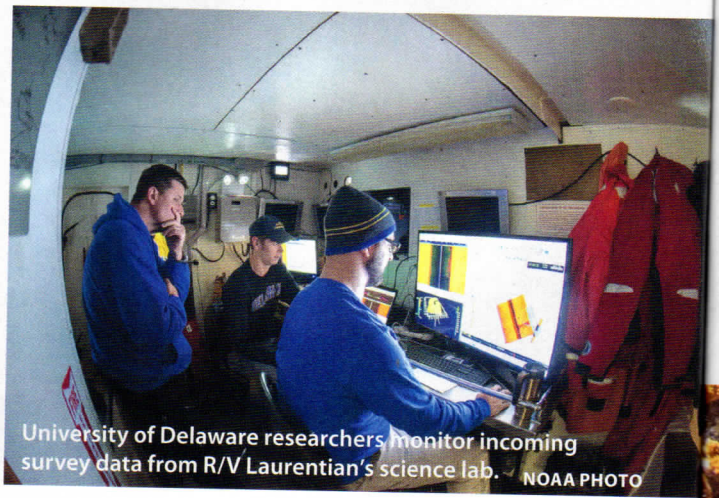


NOAA PHOTO

University of Delaware sonar technicians route cables from the echosounder (yellow device in foreground) along a pole mount used to lower and secure the echosounder along the side of the vessel. The team installed and tested the entire sonar system while dockside to ensure proper operation before getting underway within the survey area.

NOAA PHOTO

A University of Delaware sonar technician prepares to lower a device that will measure the speed of sound throughout the entire water column. These sound velocity profiles were collected once every four hours during the entire survey.



University of Delaware researchers monitor incoming survey data from R/V Laurentian's science lab. NOAA PHOTO

Once the wide-area survey is completed, archaeologists examine the data and tag anomalies against the surrounding lake floor. These may turn out to be lost shipwrecks. Later, researchers will return to those targets with more detailed documentation methods.

Presque Isle: The Intersection of a Maritime Highway

The waters off Presque Isle in central Lake Huron form a sort of crossroads for the area's shipping lanes. The lanes for vessels traveling up and down the lakes, whether to and

Got the Treasure-Hunting Bug?

Getting started as a treasure hunter is surprisingly easy. We asked search equipment expert Brian Fisher of JW Fishers Manufacturing to explain the basics of underwater search equipment.

How does metal detection work?

Most metal detectors consist of a few basic parts: the search coil or "head" that detects the metal, a box that contains the circuitry and controls and a shaft that connects the two. Some units have an optional stabilizer that steadies the unit as you move it back and forth in a sweeping motion.

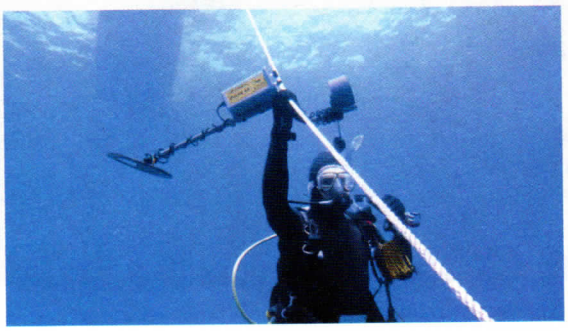
Metal detection uses three basic technologies: Very low frequency (VLF); Pulse Induction (PI); Beat-frequency Oscillation (BFO). PI detectors are suited for use on beaches and underwater because they can detect metal deeper into the ground. They operate by transmitting a continuous stream of high-energy electromagnetic pulses (one hundred per second), from the coil. After each pulse is transmitted, the detector then "listens" using a coil as the receiving antenna.

Do they work on land and underwater?

The unit must be specifically designed for underwater use. Obviously, it must be watertight and built to withstand increased water pressure at depth. JW Fishers' Pulse 8X is an example of a unit suitable for diving applications. It also is specially designed to function in a highly mineralized ocean environment — which drives land metal detectors crazy.

How do you know when it "finds" something?

When a transmitted pulse hits a metal object, a magnetic field is induced in the object. This causes eddy currents to flow in the metal, which in turn generates a second magnetic field. This field is picked up by the coil, amplified, and then displayed by the meter and heard in the underwater earphone. The greater the change on the meter scale (along with the higher pitch in the earphone) the closer the coil is to the metallic object.



How do most divers get started using underwater search equipment?

Divers get started using underwater search equipment because of their excitement or interest in finding "treasure." Finding anything underwater with a detector is very exciting. It doesn't have to be long-lost pirate treasure. Finding rings, coins, fishing lures or any other lost metal object is fun and can be very profitable. Many new people to the hobby of underwater detecting start by renting a detector from their local dive center.

How difficult is it to learn to use search equipment?

Most metal detectors are fairly simple to operate. Many dive centers put them into rental programs for this very reason. Anyone can walk in the door, pick up the detector and within a few minutes be successfully finding lost treasure. Sites where swimmers or boaters often congregate can yield lots of lost coins and jewelry. When searching for a particular lost object, laying out a proper search pattern is essential, using either a grid or "wheel" search. A classic way to conduct a "wheel" search involves using winding a rope around a tire rim. The diver swims in a circular pattern starting at the center and expanding the search area by unwinding rope from the wheel. This is best done in buddy teams, with one diver in charge of the search pattern while the other operates the detector. While searching for submerged objects, it's important to use good buoyancy control and monitor depth, time and gas supply limits. If searching in areas heavily used by boaters and fishers, be aware of possible entanglement hazards and watch for boat traffic.

from the Straits of Mackinaw or the Soo Locks, all converge within about 10 miles (16 km) of the Presque Isle lighthouse. Within this area, many ships have collided and sunk during periods of bad weather or limited visibility. Dozens of known shipwrecks are spread across the lake floor off Presque Isle and many more have yet to be found.

For this reason, researchers from Thunder Bay National Marine Sanctuary selected a large, 100 square mile (259 km^2) area off Presque Isle for a wide-area exploratory survey. Partnering with the University of Delaware and using a research vessel from the NOAA's Great Lakes Environmental Research Lab (GLERL), they conducted a two-week survey mission last May to search for undiscovered shipwrecks.

With a six-person survey crew, the mission involved 24-hour continuous operations for six days. Breaking into two-person watches, members of the team would spend four hours running the survey gear, followed by eight hours off, then another four hours on within a given 24-hour time period. That way, a team of researchers was constantly operating the sonar. The teams logged and organized data files, selected and managed survey scan lines and communicated with the research vessel's crew regarding navigation, survey speed and general movement throughout the survey area.

As sonar data was logged, researchers also took additional measurements of the speed of sound through water. Approximately every four hours, a device was sent to the bottom of the lake. As it traveled, it measured the speed of sound and produced a sound velocity profile. By accurately measuring how fast sound was moving through the water, the researchers could accurately determine the distance to the bottom.

As six days passed, over 400GB of sonar data was logged and 100 square miles (259 km^2) of area were covered. Now, researchers have to process all of the data and review it for anomalous objects that may turn out to be exciting new shipwreck discoveries.