Coast "Sweeping" the Lake

The Coast Guard lowers the *Phantom* ROV into a shipping lane on Lake Ontario. Two ROVs from NOAA's National Undersea Research Center (NURC) were used to collect lakebed sediments for research teams from the Marine Sciences Research Center of SUNY Stony Brook.

For decades, sweeping unwanted debris overboard in international waters has been common practice on commercial ships. Do impacts to the Great Lakes warrant a revision of cargo sweeping regulations?

Historically, the Great Lakes have linked the region's vast resources to the world. Starting with the fur trade in the seventeenth century, ships bearing a rich variety of natural resources made their way from the North American wilderness through the Great Lakes and beyond. By mid-nineteenth century, urbanization and industrialization in the lake watershed was on the rise and commercial ships practiced cargo sweeping—a quick way to clean decks and cargo holds of coal, cement clinker, boiler slag and iron ore.

Today, regulations set up by an international marine pollution treaty and enforced by the Coast Guard generally prohibit the discharge of debris within twelve miles of land. As the Great Lakes are a confined international waterway, ships may not be able to distance themselves properly when discharging. In order to determine if and how cargo sweeping regulations should be changed, a group of researchers aimed to assess the ecological impact of these ship-derived deposits.

A team of investigators and several Sea Grant Scholars from the Marine Sciences Research Center (MSRC) at SUNY Stony Brook made this a truly interdisciplinary project. They tracked the physical changes in the profile of the lake bottom, the chemical changes occuring both in the water column and in the sediments, and the biological impacts of cargo debris on benthic community structure.

During three cruises in 1995 and 1996, the team visited nine sites along well-used shipping lanes in western Lake Ontario. Side-scan sonar deployed from Coast Guard cutters "swept" the lake bottom to identify deposits

Dual-frequency sonar provided by Patricia Manley of Middlebury College (l.) made possible these mosaic images of the lake bottom. The dark areas show the anamolies associated with ship-derived debris.

All photos courtesy of Vincent Breslin

Watch

believed to be the result of cargo sweeping. Because of the high reflectivity of ship-derived debris against a background of fine-grained lakebed sediments, the deposits appeared as acoustic backscatter anomalies or ABAs in the images. Then remotely operated vehicles (ROVs) were used to photograph and sample the lakebed near the ABAs.

Sonar proved to be an effective technique in identifying areas of cargo sweeping debris. With known sedimentation rates, and the approximate age of the ABAs, it suggested to Sea Grant Scholar Vicki Ferrini that debris deposited any time within the past 100 years is probably detectable by this sonar in the muddy deep lake sediments. Thus while dual frequency side scan was useful for detecting ship-derived waste, it could not distinguish between deposits at the surface of the lake bottom from those buried deeper in the sediments. “This conclusion is important because it suggests that only a fraction of the hundreds to thousands of ABAs identified in muddy lake sediments are at or near the sediment surface,” says investigator Roger Flood. “Indeed, many of the ABAs may have been created by cargo sweeping events that long predate modern shipping practices.”

Once an area that contained debris was identified, it underwent serious scrutiny by each research team. The geology team used box corers and grab samplers to collect sediment. They calculated grain size of the surface sediments and determined the depth of the deposit using X-radiography and magnetic susceptibility. The chemistry team measured metal content in the sediments and biological tissues to determine impacts associated with ship debris. The biology team collected samples of organisms to compare the type and composition of invertebrates inside and outside of the ship-derived waste deposits.

Although no changes in the international agreement about the practice of cargo sweeping have been made to date, a firm foundation assessing its physical, chemical and biological impacts on western Lake Ontario has been laid. Current interest in ship-derived debris is evidenced by a September 1999 workshop entitled “The Environmental Implications of Cargo Sweeping in the Great Lakes” held at the Great Lakes Environmental Research Laboratory (GLERL) in Ann Arbor, Michigan. According to GLERL Director Stephen Brandt, this project and other related research will provide much needed information for the US Coast Guard to revisit the issue of cargo sweeping regulations.

Continued on page 14

The research team (from l. to r.): Vicki Ferrini, Nicole Maher, Bruce Brownawell, Maura Clyne, Bob Cerrato, Si-Hoon Song and Vincent Breslin. Sea Grant Scholar Ferrini used sonar to locate ship-derived debris with advisor Roger Flood (pictured below). Scholar Maher studied benthic community structure with advisor Cerrato while Scholars Clyne and Song conducted trace metals analysis with advisor Breslin.

Quagga mussels were found attached to coal pieces (dark-colored) and limestone (light) that had been swept off cargo ships.

Investigator Roger Flood sorts through sediment brought up by a box corer deployed from the US Coast Guard Cutter *Bramble.* The USCG contributed ship time to the project.

“Sweeping” the Lake

continued from page 9

Why Lake Ontario?

Western Lake Ontario has a high volume of shipping traffic with active Canadian ports of Hamilton, Toronto and Clarkson. Many ships also pass through Port Weller and the Welland Canal (just west of Niagara Falls) which connects Lake Ontario with Lake Erie and thus the rest of the Great Lakes. Cargo sweeping usually occurs once a ship is underway and well out of port resulting in debris accumulation on the lake bottom of the shipping lanes. In Lake Ontario, ores of iron, aluminum, lead, manganese and zinc are more likely to be swept overboard than coal. With an annual total of over a quarter of a million kilograms of debris in all of the Great Lakes, Lake Ontario accounts for over 40 percent although it is the smallest lake in water volume.

The harbor in Hamilton is a designated Area Of Concern because it fails to meet objectives of the Great Lakes water quality agreement. The International Joint Commission announced in late 1999, that although most of the problems in the western lake have been defined and remediation measures chosen, “questions remain concerning the selection of remedial measures for contaminated sediments.” Thus analysis of sediment data compiled during NYSG-funded research projects remains of great value.

> *“These tiny spheres serve as surrogate’s for the fossil-fuel burning history of the lake.*
> *—Vincent Breslin”*

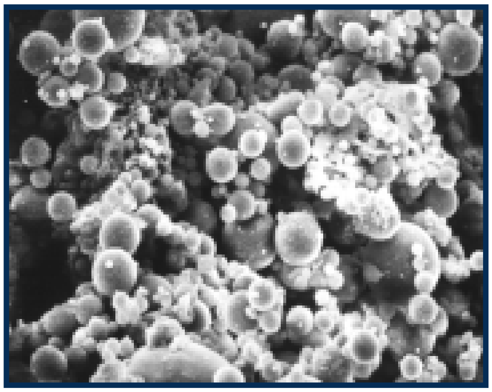
Cerrato, Song and Breslin examine a sediment core. Photo by Vincent Breslin

According to Maher, the biology team identified over 22,000 individual organisms from over a hundred samples. The benthic community was dominated by amphipods, ostracods (crustaceans), oligochaetes (worms), and bivalves (shelled mollusks). “Differences in community structure existed both within and between sites and a significant amount of faunal variation was explained by the ship-derived waste variables,” reports Maher, who sought to explain the changes in the living community. Three mechanisms were proposed to explain the change in community structure associated with ship-derived waste: physical disturbance, contaminant effects, and coarsening and de-enrichment. Although results provided support for and did not exclude any of these three mechanisms, the strongest evidence was present for the coarsening and de-enrichment of sediments via ship-derived waste additions. Maher plans to present these findings at the annual Benthic Ecology meeting in Wilmington, NC in March 2000.

Breslin and Song measured the accumulation of metals in the opossum shrimp *Mysis relicta.* By day these common lake dwellers remain in the bottom sediments. At night, they swim up into the lower reaches of the water column to feed on plankton. There, the shrimp may become food for alewife, smelt, sculpin and young lake trout. During this feeding migration, perhaps the shrimp were introducing metals ingested in the sediment into the water column. Breslin and Song estimated the concentrations of metals the shrimp transported to the water column and thus to fish. They found that aluminum, chromium, iron and vanadium were readily excreted and did not accumulate in shrimp tissue. But arsenic, cadmium, copper and zinc did accumulate and the nightly migration caused these contaminants to be introduced into the water column where the shrimp could be consumed by fish.

In a related study, species of the amphipod *Diporeia,* showed bioaccumulation that correlated well to the metal content in sediments most especially for copper and zinc. Perhaps with further investigation, these amphipods may have use as a bioindicator for these two metal contaminants. Breslin and Song presented these results at the International Association for Great Lakes Research conference in 1998.

— Barbara A. Branca



Materials enter the sediment from the atmosphere as well as from ships. Carbon fly ash, as seen with a scanning electron microscope, is generated during incomplete combustion of oil and coal. Sediment cores from the lakebed mirror the use of fossil fuels for over a hundred years and even show the decline in fly ash production with increased use and efficiency of particle collection devices over the last decade. Photo by Vincent Breslin