



Michigan Tech

METALS IN AND AROUND TORCH LAKE: WHAT'S THE STORY?

METALS IN TORCH LAKE – ARE THEY A CONCERN?

Yes. The mining industry processed many tons of metal-rich ore and also left behind metal-rich materials that are potentially harmful to both humans and wildlife. Some of the lasting impacts include:

- Copper, the most abundant metal around Torch Lake, can be toxic to humans, but is more harmful to wildlife. For example, high copper concentrations in Torch Lake sediments (the lake bottom) prevent bottom-dwelling organisms from living in this lake. Torch Lake has been labeled as having the Beneficial Use Impairment (BUI) of degraded benthos (loss of bottom-dwelling organisms) as a result.
- High copper concentrations in the water and sediments of the Traprock River and its tributaries continue to affect the population of bottom-dwelling organisms in the river.
- Metal concentrations on the shore of the lake are highly variable. Very high metal (lead, arsenic, chromium, and others such as copper and zinc) concentrations in the soils at many of the ore-processing facilities on the shore are a potential threat to humans as evidenced by exceedances of the Michigan Part 201 Criteria (see map on following page). Children playing in these industrial soils and ingesting the metals could potentially be harmed.
- Mercury concentrations in fish in Torch Lake are so high that humans should restrict consumption of fish from the lake. See following page for details.

Terms and Acronyms

AOC = AREA OF CONCERN: A location that has experienced a high level of environmental degradation and has been designated under the U.S.-Canada Great Lakes Water Quality Agreement. There are currently 39 AOCs identified in the Great Lakes region including the Torch Lake area.

BUI = BENEFICIAL USE

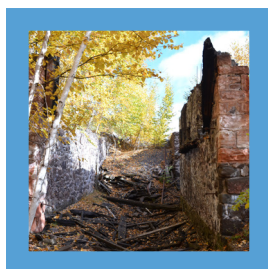
IMPAIRMENT: A change in the chemical, physical, or biological integrity of an area or body of water that affects how the natural resource can be used by humans. Examples include fish tumors or other deformities, beach closings, degradation of benthos, restrictions on fish and wildlife consumption, etc. There are 14 use impairments that were used to designate AOCs.

SEDIMENT CAPPING: Covering contaminated sediments with non-contaminated material.

TAILINGS: Crushed ore from which metals have been removed by gravity separation or chemical leaching.

STAMP SANDS: Mine tailings produced by stamp mills.

SMELTING: Heating metal-rich rock to facilitate separating the molten metal from the residual rock. When the residual rock has cooled, it is called slag.



WHAT IS MEANT BY “METALS”?

Metals are naturally occurring elements that share some common properties. For example, they are strong, malleable, and conduct heat and electricity. Metalloids, such as arsenic, have some, but not all, of the properties of metals. Many metals are essential nutrients, some are toxic at high concentrations, and others are toxic even at low concentrations. Trace metals occur naturally in very low concentrations. Rocks containing higher concentrations of metals are called ore deposits, but because most ore deposits are well below the surface of the ground, the metals are not a contamination concern. Mining processes bring ores to the surface, extract the trace metals, and concentrate them to the point that they exist in high and toxic concentrations.

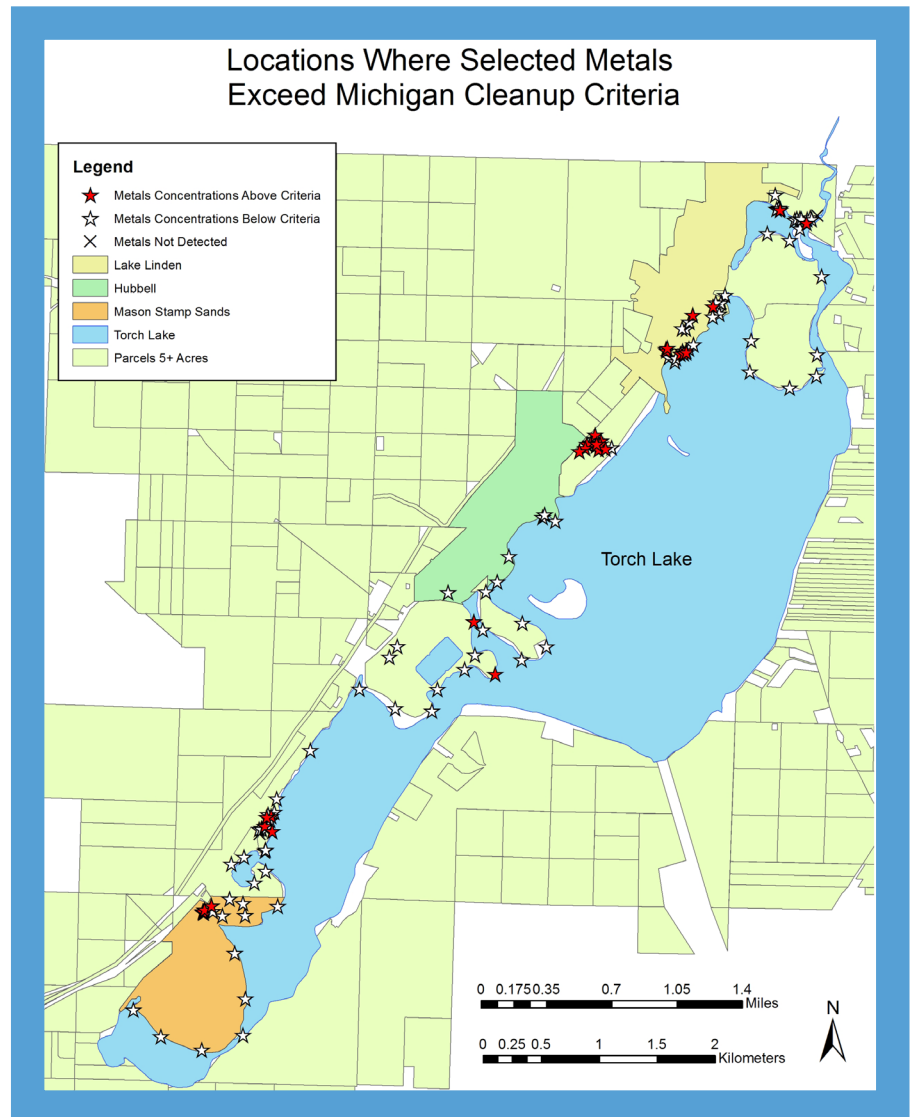
WHICH METALS ARE OF CONCERN AROUND TORCH LAKE?

At high concentrations, some of the metals found around Torch Lake, such as lead and mercury, cause damage to the nervous system. Others, such as arsenic and chromium, are carcinogens. Others can cause skin ulcerations. Copper, the major metal found in Torch Lake, is more harmful to wildlife than to humans. For example, copper is responsible for poisoning animals that live in the sediments as well as fish eggs deposited on the sediments in Torch Lake.

HOW AM I EXPOSED TO METALS AND WHAT ARE THEIR POTENTIAL HEALTH EFFECTS?

There are four major routes for exposure to toxic metals:

- **Eating contaminated fish** is the primary exposure route for mercury. Over time, this exposure can damage the nervous system, particularly of young children.
- **Direct physical contact** with metal-rich soils, sediments, or sludges can occur at sites where metals were disposed (illustrated in map above); reactions like skin irritation may occur as a result.



Michigan Department of Environment Quality and U.S. Environmental Protection Agency data compared to Michigan Part 201 Residential Soil Direct Contact Criteria. Map created August, 2013.

- **Breathing of air-borne, metal-rich dust** can lead to exposure at Torch Lake. This problem has largely been stopped by covering mine tailings (crushed ore from which metals were extracted) with soil.
- **Ingestion of metal-rich soils or sediments** is a risk to small children playing in soils with high metal content (see map above); health effects might include nervous system damage, cancer, and other illness.

ARE FISH FROM TORCH LAKE SAFE TO EAT?

The Michigan Department of Health and Human Services publishes fish consumption guidelines in its annual

Eat Safe Fish Guide. Guidelines for Torch Lake from the 2016 edition differ depending on the size and type of fish caught. These suggest people should limit consumption of walleye to 6 to 12 servings per year, smallmouth bass and largemouth bass to 1 to 2 servings per month, northern pike to 2 servings per month, and suckers to 4 to 12 servings per month — all depending on the size of the fish. A serving for a typical adult is about 8 ounces of fish. A serving for a child ranges from 2 to 4 ounces.

The *Eat Safe Fish Guide* also gives instructions for choosing safe fish and how to clean and cook fish to minimize exposure to harmful chemicals.

See: www.michigan.gov/eatsafefish

WHY ARE METALS HERE?

In Torch Lake, most metals present are from mining-related activities. For all toxic metals, including mercury, the amount remaining from local activities exceeds the amount deposited from the air. Several milling and separation procedures extracted metals from ores and concentrated them in fine-grained solids.

Stamp mills crushed the ore into fine particles. Heavier particles containing copper were separated from the crushed ore. The residual particles, called stamp sands, often were dumped into Torch Lake. Metal concentrations in stamp sands are still much higher than in normal soil. The stamp sands themselves pose relatively little risk to humans, but they cause ecological harm because of the high toxicity of copper to numerous organisms.

Smelting produced a variety of wastes including slags and sludges. The most volatile metals, such as mercury and lead, were released from the smelter stacks and then deposited from the plume downwind from the smelters. The slag in the top right photo is a smelting by-product that contains high concentrations of various metals. The sludges (bottom right photo) produced from electrolysis (use of electricity to purify copper) and chemical leaching (use of liquid chemicals to dissolve or extract copper from the ore) also contained high metal concentrations. Sludges and slags were produced and discarded at multiple places along the western shoreline of Torch Lake.

WHAT CAN BE DONE ABOUT TOXIC METALS HERE?

Mercury in fish: The source(s) of mercury to fish in Torch Lake (for example, from stamp sands, sludges, slags, or atmospheric deposition) must be identified. If the mercury comes from sources within the lake sediments, capping of the sediments would be one option to remove this source.

Copper in lake sediments: To date there has been disagreement as to whether the high copper concentrations in the newly deposited sediments are a result of upward migration from the known contamination of deeper sediments, or a result of ongoing and undefined inputs to the lake.

Correct choice of a remediation alternative hinges on resolution of this issue.

Elevated metal concentrations on shore:

Once located, the contaminated soils can be removed or the metals remediated.

Dispersal of metal-rich soil by the wind:

Capping the stamp sand piles with soil has already largely solved this problem.

ABOUT THIS PROJECT

Intensive copper mining took place on the Keweenaw Peninsula from 1845 through 1968. Mining shaped the people and the environment of the Copper Country, as it is known, and continues to influence the region today.

On the social side, mining influenced individual lives. Where and how people lived, their social status, their health, and their longevity were all influenced by mining activity. Mining also affected community population and dynamics, dictating the locations of towns, social structures, and transportation systems.

On the environmental side, mining influenced the shape of the land surface and waterways, the quality of the air as well as surface and ground water. It also exposed humans and ecosystems to a variety of pollutants.

Torch Lake, one hub of mining-related activities, has become the center of efforts by regulatory agencies to mitigate harmful impacts from mining activities. This project was conducted by researchers at Michigan Technological University and funded by Michigan Sea Grant. Researchers assembled and evaluated available information, identified critical information gaps, and, by working with local stakeholders and government agencies, helped determine possible pathways for improving conditions in and around Torch Lake.



Slag on the Torch Lake shoreline at Hubbell.



Sludge on the Torch Lake shoreline at Lake Linden.

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