



## Impacts of Historic Copper Mining on Keweenaw Stream Mouths

### History

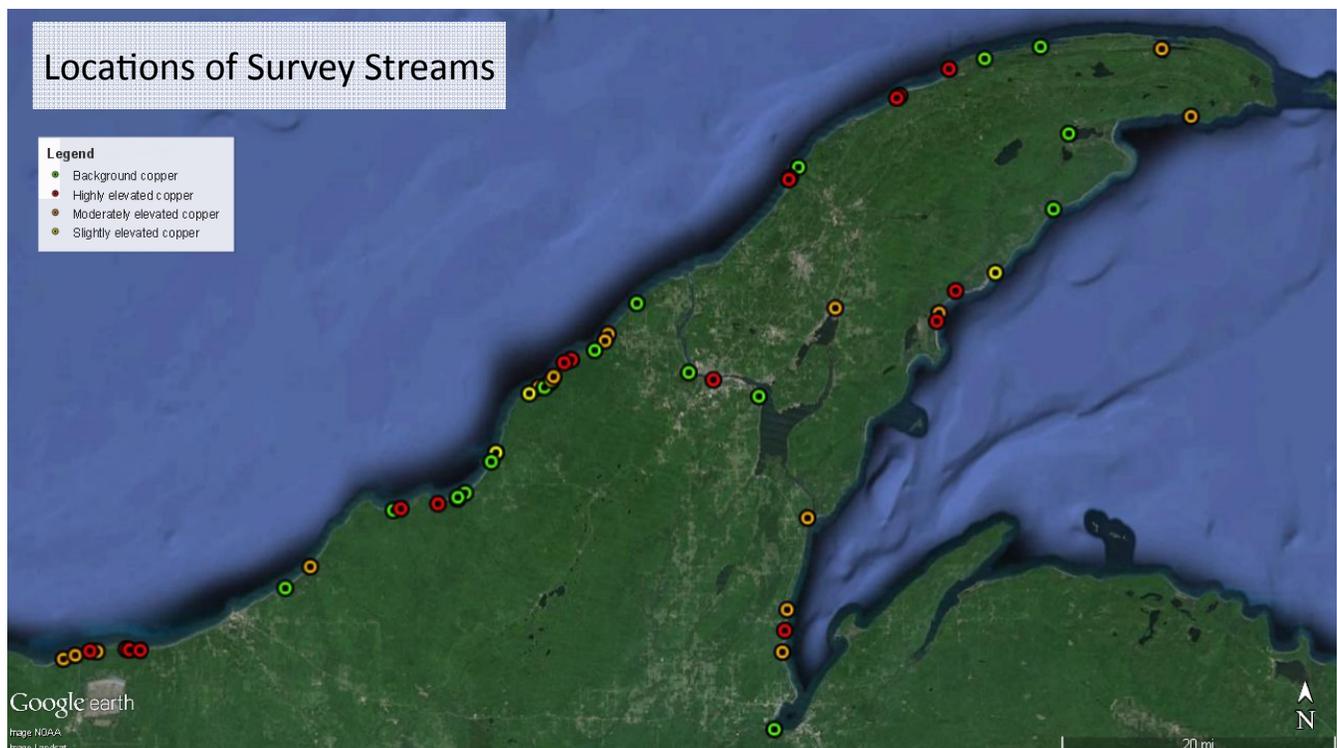
The Keweenaw Peninsula was one of the first great metal mining regions of North America. Production of copper from native lodes began in the late 1840s, peaked between 1890 and 1930, and ended in 1968. Over 140 mines were opened, and over 40 mills processed stamp rock. During this era, 4.8 million metric tons of copper were produced, and 344-368 million metric tons of stamp sands, or mine tailings, were discharged into the local environment. Harmful impacts from the mine residues on biota have been shown in individual streams and in coastal Lake Superior, but no comprehensive survey has documented the extent of impacts throughout the region.

### Potential Impacts

Of the numerous potential impacts of mining on streams, this project focused on:

1. Impaired connectivity with Lake Superior;
2. Altered stream bed substrate;
3. Elevated copper concentrations;
4. Toxicity to benthic macroinvertebrates.

Total copper concentrations were measured, and concentrations of toxic forms were calculated from water chemistry. Toxicity was assessed using multiple metrics; thresholds for each metric were identified with breakpoint analysis. Impacts not examined include alterations in stream flow, rerouting of stream beds, enhanced erosion of stream banks, enhanced erosion into streams, altered stream temperature, and effects on organisms other than benthic macroinvertebrates.





### Impaired connectivity with L. Superior

Stamp sands have formed sand or gravel bars across the mouths of some streams thereby limiting the ability of fish to swim in and out of the streams. While sand bars across river mouths are a common occurrence in Lake Superior, the mine tailings have blocked some streams that previously did not experience such blockage. Partial or complete blockage by stamp sands was observed in 9 stream mouths.



### Altered bottom substrate

The stamp sand deposits in streams range in size from coarse sands to coarse gravel. In 12 streams, these finer materials were found deposited on top of bedrock or within cobble fields. Because benthic organisms are strongly influenced by substrate size, deposits of stamp sands in reaches that previously had larger substrates likely caused a change in the community of benthic organisms.

### High copper concentrations

Of the 54 streams sampled, 21 had copper concentrations above the current legal limit in spring, and 9 were above the limit in summer. One third of streams had low copper concentrations typical of background or uncontaminated conditions. Streams with high total copper generally had the highest concentrations of toxic forms of copper. High copper concentrations near the river mouths did not always result from stamp sands in this reach of the streams; some streams with stamp sands had low copper concentrations and other streams without stamp sands near the mouths had high copper concentrations.



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### Toxicity to benthic organisms

In this study, we compared multiple measures (metrics) of the health of the invertebrate populations in the stream sediments. The different metrics had different sensitivities to copper. Some metrics indicated that harmful effects begin at copper concentrations below 1 part per billion (ppb). Seven of 16 metrics indicated that the threshold for harm to macroinvertebrates was very near the current water quality standard for copper in Michigan. All of the metrics examined in this study indicated that changes to invertebrate communities would occur at copper concentrations below the recently proposed surface water quality criterion. The new criterion would not protect streams from damage to macroinvertebrates caused by copper. Our assessment indicated that in 33% of survey streams macroinvertebrates had not been harmed by copper, in 7% only slight harm had occurred, and in 60% of Keweenaw streams moderate to severe damage to these communities has occurred.

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