
Michigan

Eagle River Section 319

National Monitoring Program Project



Figure 21: Eagle River (Michigan) Project Location



Figure 22: Eagle River Stamp Snad Restoration Project Location

PROJECT OVERVIEW

The Eagle River Section 319 National Monitoring Program project is located in Keweenaw County in Michigan's western Upper Peninsula (Figure 1). The Eagle River is a small, largely undeveloped watershed that drains into Lake Superior at the small town of Eagle River. Land use consists mainly of conifer and hardwood forest and wetlands.

Native copper and silver have been mined in Michigan's Keweenaw Peninsula since the late 19th century. Copper was historically recovered from the parent rock by "stamping"- crushing the rock using steam-driven stamp heads followed by sluicing the crushed rock to separate out the native metals from the waste rock or stamp sands. During the mining period approximately 500 million tons of stamp sands were discharged directly into Lake Superior or into its tributaries from Keweenaw Peninsula milling operations. Between the 1840s and 1890s, several copper mines discharged stamp sands into both the East Branch and West Branch of the Eagle River, forming deposits up to 6 feet thick. A century and a half of water and wind erosion has transported stamp sands throughout the watershed, forming major deposits wherever the stream gradient is low enough for sediment deposition. For these reasons, an 8.5 mile reach of the Eagle River is currently on Michigan's 303(d) list for poor macroinvertebrate communities and elevated water column copper concentrations that exceed Michigan water quality standards.

This project proposes to reduce copper loadings to the Eagle River by restoring the stream channel flowing through two stamp sand deposits in the headwaters of the East Branch of the river, known as Central Mine sites #1 and #2, and stabilizing upland stamp sand deposits.

Project monitoring will employ a before-after control-impact design and include analysis of water chemistry (including total copper), sediment copper concentration, benthic macroinvertebrates, habitat characteristics, and geomorphic assessments. Pre-BMP monitoring occurred in 2006 and 2007, construction will occur in 2009, and post-BMP monitoring will continue through 2021.

PROJECT BACKGROUND

Project Area

The Eagle River watershed, in Keweenaw County on the Keweenaw Peninsula in Michigan's Upper Peninsula, is 21.2 square miles in size.

Project Hydrologic, Geologic, and Meteorologic Factors

The surficial geology of most of the watershed consists of glacial till (sand and gravel), more than 150 feet thick in some locations. Exposed basalt bedrock occurs mostly in the ridges and cliffs that parallel the Lake Superior shore. The basalt bedrock contains the copper ores that were the origin of the stamp sands.

Average annual precipitation is approximately 34 inches, which includes an average of 219 inches of snow. "Lake effect" precipitation is common, especially in late autumn and early winter. The major annual runoff event is often spring snowmelt.

Land Use

The Eagle River watershed is largely undeveloped; 88 percent of the area is forest, 8 percent is wetland, 2 percent is urban, and 2 percent is "other" (primarily roads and stamp sand deposits). Population data for the watershed are not available, but it is wholly within Keweenaw County, which had a population of only 2,301 in 2000.

Water Resource Type and Size

The Eagle River watershed drains into Lake Superior at the town of Eagle River. Watershed headwaters are predominantly wetlands, beaver ponds, and beaver meadows. Stream channels are predominantly small (less than 20 feet wide and 5 feet deep), and alternate between low-gradient, meandering channels that flow through wetlands, and higher-gradient, comparatively straight channels that flow over gravel and cobble riffles. The project reach consists of two low-gradient channels that are separated by a shorter, higher gradient reach in which stamp sand deposition is minimal.

Water Uses and Impairments

The Eagle River is a cold-water stream. The stream reach addressed in this project is small and shallow, and not a significant fishery resource. The Eagle River is not used as a drinking water source by any of the villages within its watershed (Central, Phoenix, or Eagle River).

An 8.5 mile reach of the Eagle River is currently on Michigan's 303(d) list for poor macroinvertebrate communities and elevated water column copper concentrations that exceed Michigan water quality standards.

Pollutant Sources

"Stamp sand" copper mining wastes, described above, are believed to be the primary source of copper to the Eagle River. Because adjacent streams with similar geologies but lacking stamp sand deposits do not exhibit high aqueous copper concentrations, groundwater transport of copper leached from underground copper deposits is not thought to be a significant source.

Pre-Project Water Quality and Ecological Objectives

Several previous studies of water quality and instream characteristics have been performed:

- Macroinvertebrate, instream habitat, and water chemistry surveys performed by the State of Michigan, in 1992, 1996, 2001, and 2006.
- Monitoring performed in 2006 by the Houghton/Keweenaw Conservation District during development of a Section 319-funded watershed management plan. This includes limited monitoring of:
 - Macroinvertebrates and fish using Michigan Department of Environmental Quality (MDEQ) sampling procedures
 - Riparian vegetation
 - Water chemistry, including aqueous copper concentrations
 - Channel geomorphology (cross-channel transects, pebble counts, sediment grain size analysis)
 - Stream flow

These studies documented that:

- Instream habitat and macroinvertebrate communities are impacted by the stamp sands.
- Aqueous concentrations of copper exceed State ambient water quality standards.
- More than a century after the stamp sands were deposited, riparian vegetation is still lacking. This impacts instream biological communities and increases stamp sand loadings to the stream.

Water Quality Objectives

The objective of this project is to reduce aqueous copper concentrations and improve instream habitat quality such that the East Branch of the Eagle River can be removed from Michigan's 303(d) list.

Project Time Frame

1997-2021

PROJECT DESIGN

Nonpoint Source Control Strategy

Both Central Mine stamp sand sites, and the upstream reach including the headwaters of the East Branch of the Eagle River, are owned by the Keweenaw County Road Commission. Significant land use changes upstream or adjacent to the project location, including development or timber harvest, are not expected during the life of the project.

The pollution control strategy has four major components:

1. Relocate portions of the stamp sand deposits away from the stream channel, reducing transport of these materials into the channel, reducing the thickness of the deposits, and decreasing the distance from the riparian zone surface to the groundwater table.
 2. Use principles of natural channel design to create a stable, self-sustaining stream channel that will reduce stream bank erosion and provide better instream habitat.
 3. Take advantage of the natural revegetation propensity of thin, moist stamp sand deposits to create a stable vegetated riparian zone and stream banks.
 4. Actively revegetate upland areas where natural revegetation is improbable.
- Project Schedule
- Pre-BMP monitoring = 2007
 - BMP construction = 2009
 - Post-BMP monitoring = 2010, 2011, 2013, 2016, and 2021

Post-BMP monitoring in 2011, 2016, and 2021 will take advantage of MDEQ's 5-year rotating watershed monitoring schedule.

Water Quality Monitoring

A before-after control-impact (BACI) study design will be employed to assess the effectiveness of the stamp sand stabilization/channel restoration activities. Two different control streams will be used; see below.

Variables Measured

Biological

Benthic macroinvertebrates
Riparian vegetation

Chemical

Water chemistry, including total copper, hardness, pH, and total organic carbon
Sediment copper concentrations

Physical

Instream habitat characteristics
Geomorphic measurements, including cross-channel transects, longitudinal profiles, bank erosion hazard index, and pebble counts

Covariates and Misc.

Flow
Referenced photo points

Sampling Scheme

A variety of chemical, biological and physical variables will be monitored. Preliminary plans are outlined in Table 1.

Two different control streams will be used in this project:

- Buffalo Creek, for water chemistry, sediment chemistry, and riparian vegetation.
- The West Branch of the Eagle River, for benthic macroinvertebrates, instream habitat, riparian vegetation, and geomorphic measurements.

Buffalo Creek is a tributary to the East Branch of the Eagle River, entering it less than 0.5 miles downstream of the Central Mine #2 stamp sand deposit. The control site on the West Branch of the Eagle River is approximately 6 miles west of the Central Mine stamp sand deposits.

Table 1. Sampling Scheme Outline

Monitoring Activity	Sampling Sites	Sampling Frequency*
Benthic macroinvertebrates & instream habitat	A total of 5 reaches within the project area, plus a control stream	Annual
Riparian vegetation	Both banks at a total of 5 sites bracketing and within the project area, plus a control stream	Annual
Water chemistry	A total of 4 sites bracketing and within the project area, plus a control stream	Pre-BMP = 10 samples in a 12 month period; post-BMP = to be determined, based on statistical analysis of the pre-BMP data
Sediment chemistry	A total of 5 reaches within the project area, plus a control stream	Annual
Geomorphic measurements	Longitudinal profiles, cross-channel transects, bank erosion hazard index, & pebble counts in 5 reaches within the project area, plus a control stream	Annual
Monumented photo points	Numerous	Annual, minimum

* Annual refers to the pre-construction monitoring in 2007 and the post-construction monitoring scheduled through 2021.

The effectiveness of the remedial activities will be judged using the data collected by the monitoring activities described above. Evaluation criteria for each of the monitoring activities are outlined in Table 2.

Modifications Since Project Started

None

Progress to Date

As of June 2008, the majority of the pre-BMP sampling had been completed, including sediment and macroinvertebrate sampling, instream habitat and riparian vegetation observations, channel geomorphology measurements, and photo points. Water chemistry sampling should be completed by the end of July 2008.

Data Management and Analysis

Data Management and Storage

Data collected for the project will be maintained by MDEQ and appropriate water and sediment chemistry data will be loaded into EPA's STORET database.

Information, Education, and Publicity

Documentation of progress will be ongoing, and will be distributed to interested groups, both local and national.

Table 2. Evaluation Criteria for the Monitoring Activities.

Monitoring Activity	Evaluation Criteria
Benthic macroinvertebrates & instream habitat	MDEQ's P51 sampling protocol has scoring procedures for macroinvertebrates and instream habitat; recovery of macroinvertebrate community and instream habitat over time
Riparian vegetation	Plant community development (stamp sand deposits currently devoid of vegetation)
Water chemistry	Decrease in aqueous copper concentrations over time, & Michigan ambient water quality standards
Sediment chemistry	Decrease in sediment copper concentrations over time, & Michigan sediment quality guidelines
Geomorphic measurements	Interstation comparisons; changes over time; consistency of stable channel over time
Referenced photo points	Visible change over time

TOTAL PROJECT BUDGET

The total project budget is \$ 430,366. Pre- and post-construction monitoring activities will be funded with Clean Michigan Initiative funds, and staff will be funded by the MDEQ's Section 319 grant.

IMPACT OF OTHER FEDERAL AND STATE PROGRAMS

Staff from the Houghton/Keweenaw Conservation District and NRCS will play prominent roles in the construction phase of this project:

- Houghton/Keweenaw Conservation District staff will be primarily responsible for the financial aspects of the project and overall project administration.
- NRCS staff will have the lead responsibility for project design (including the natural channel design), and construction oversight.

There is also an on-going total maximum daily load study in several Keweenaw Peninsula streams, conducted by the MDEQ-Water Bureau, whose data may contribute to this study.

Other Pertinent Information

None.

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