**PROJECT TITLE: Temporal analysis of sulfate loading**

**I. PROJECT STATEMENT**

**The study characterizes the introduction, movement, and fate of sulfate between point of discharge and point of impact in a way that allows addressing the issues of impact on wild rice and mercury bioaccumulation in fish.**

To manage sulfate impacts requires first the ability identify sources and quantify the mass discharge in time intervals. Second, it requires understanding how the sulfate travels, rate of dilution and the sulfate mass lost versus retained. Finally, it requires quantifying concentrations over time at the point of impact and resultant impact of levels of methyl mercury in fish.

A preponderance of scientific study exists characterizing the relationship between sulfate pollution, methyl mercury creation, and methyl mercury bioaccumulation in fish.

* In soil and water where oxygen is low – slow stretches of streams, muddy lake bottoms, marshes and peat bogs – bacteria consume sulfate in a process that converts inorganic mercury into methyl mercury.
* Aquatic life low on the food chain ingests the methyl mercury. Smaller fish consume the aquatic life low on the food chain. Larger fish consume smaller fish. The methyl mercury bioaccumulates.
* The public health risk derives from the consumption of fish in which methyl mercury has accumulated. Methyl mercury is a potent neurotoxin. The young and unborn are particularly at risk. For them, methyl mercury causes diminished coordination, attention span and intelligence.

The study evaluates sulfate and its impact in promoting methyl mercury production in three watersheds in northeastern Minnesota. These watersheds were chosen for the following reasons:

* Two of the watersheds include a mix of dischargers, industrial and municipal, located at various distances from the points of impact. The third watershed is pristine, to provide a benchmark.
* The watersheds include flow through both streams and lakes and over distances of more than 100 miles as the water flows.
* The watersheds lie in areas with minimal topsoil cover. Because the topsoil is less able to absorb sulfate, the watersheds are particularly vulnerable to sulfate pollution impact.
* Yellow perch are present in all three watersheds, providing an excellent benchmark species for determining methyl mercury concentration.

The watersheds include:

* Vermilion River in St. Louis County - Entities discharging sulfate to the Vermillion River watershed include US Steel Minntac Taconite Tailings Basin in Mountain Iron, MN, via the Sand River; ArcelorMittal Minorca Upland Taconite Tailings Basin in Wuori Township, MN, via the Wouri Creek and Pike River; Bois Forte Waste Water Treatment Plant in the Vermilion Sector of the Bois Forte Indian Reservation in Tower MN, via Lake Vermillion; and the Tower MN Waste Water Treatment Plant in Tower MN, via the East Two River. Flow is through the Wouri Creek and the Sand River into the Pike River into Lake Vermilion and from Lake Vermilion through the Vermilion River into Crane Lake.
* Embarrass River in St. Louis County - Entities discharging sulfate to the Embarrass River include Cliffs Erie NorthShore Mine in Babbitt, MN, via Spring Mine Creek; PolyMet LLC Tailings Basin (former LTV Steel Mining Company Taconite Tailings Basin) near Embarrass, MN, via unnamed creeks, Trimble Creek and Heikilla Lake; and the Biwabik MN Waste Water Treatment Plant in Biwabik, MN. Flow is from tributary streams into the Embarrass River and through the Embarrass River into Embarrass Lake.
* Voyageurs National Park watershed in St. Louis County – No municipal or industrial entities discharge sulfate into Loon Lake, Kabetogema Lake and Mukooda Lake. These lakes constitute the benchmark pristine lakes.

**II. PROJECT ACITIVITIES AND OUTCOMES**

**Activity 1: Periodic measurement of sulfate mass per unit time flow and daily monitoring of water conductivity at critically chosen points on the watersheds. Measurement of sulfate mass per unit time at critically chosen points, when conductivity indicates a rapid change in sulfate mass flow.**

The sampling points are chosen to allow identification of the load from different dischargers and to allow identification of loss and dilution along the watershed. A rapid change in conductivity at a sampling point signals a potential rapid change in sulfate concentration at that point. Such changes are expected to be infrequent, but sampling at such times provides a more complete characterization of the temporal patterns of the sulfate load.

Periodic sulfate mass measurements are monthly, May to October.

**ENTRF BUDGET: $96,800**

| **Outcome** | **Completion Date** |
| --- | --- |
| 1. Quantification of sulfate loads per discharger, fate of loading including cumulative effects of dilution and sequestration, and the resulting sulfate concentrations at the point of impact per time interval for the three watersheds.  | January 31, 2022 |
| 2. Comparisons of loading per time interval and over time between different types of dischargers and amongst similar types of dischargers. | January 31, 2022 |

**Activity 2: Periodic measurement of sulfate concentrations in the impact lakes. End of the season measurement of mercury concentrations in young-of-the-year perch in the impact lakes.**

The study uses young-of-the-year perch as a target species to characterize mercury accumulation. They consume the lower level organism that consume the methyl mercury. Their life span lies within the sulfate concentration monitoring period. They are abundant and easy to capture by seining.

The young-of-the-year perch seining and the mercury analysis is once per year, mid-September to early October.

**ENTRF BUDGET: $42,000**

| **Outcome** | **Completion Date** |
| --- | --- |
| 1. Analysis and correlation of sulfate concentration versus methyl mercury in the sample fish for the impact lakes. | January 31, 2022 |