Low ecological and cultural functionality characterized at the Twin Lakes

Manoomin is unable to rebound due to ongoing sulfate loading from mine discharges

Historically, Sandy Lake and Little Sandy Lake, also known as the Twin Lakes, were important ricing sites for Ojibwe Bands in northeastern Minnesota. Manoomin (wild rice) on these lakes provided cultural and ecological services to the Anishinaabe people. Since U.S. Steel constructed a tailings basin for their Minntac iron ore operation in the mid-1960s, Manoomin has declined drastically in these lakes, with only remnant plants and no stands existing today. While some restoration actions – including beaver dam management and small-scale Manoomin reseeding – have been attempted, they have not addressed the fundamental problem of sulfate discharge from the mine. A seepage collection system, constructed to collect mine waste water discharging from the tailings basin, has not fully stopped the flow of sulfate into the lakes. This case study highlights the difficulties in restoring degraded Manoomin habitat, the relationship between water pollution and Manoomin, and the importance of protecting existing Manoomin and its associated habitat.

Threats to Manoomin at the Twin Lakes

U.S. Steel's Minntac iron ore operation facility includes two mining areas, several processing plants, a heating and utility plant, a water reservoir, and a tailings basin (MWH, 2004). Construction of the tailings basin began in 1966 (MWH, 2004). Part of the seepage from the tailings basin discharges to the east into the Sand River, flows into the Twin Lakes, and into the Sand River watershed. Discharge from the tailings basin has changed the chemical composition and hydrologic condition of the Twin Lakes by increasing sulfate levels and, to a lesser extent, increasing the volume of water in the lakes.

Water seeping out of the Minntac tailings basin and moving toward the Twin Lakes in Minnesota. Credit: GLIFWC, 2016.

About the Twin Lakes

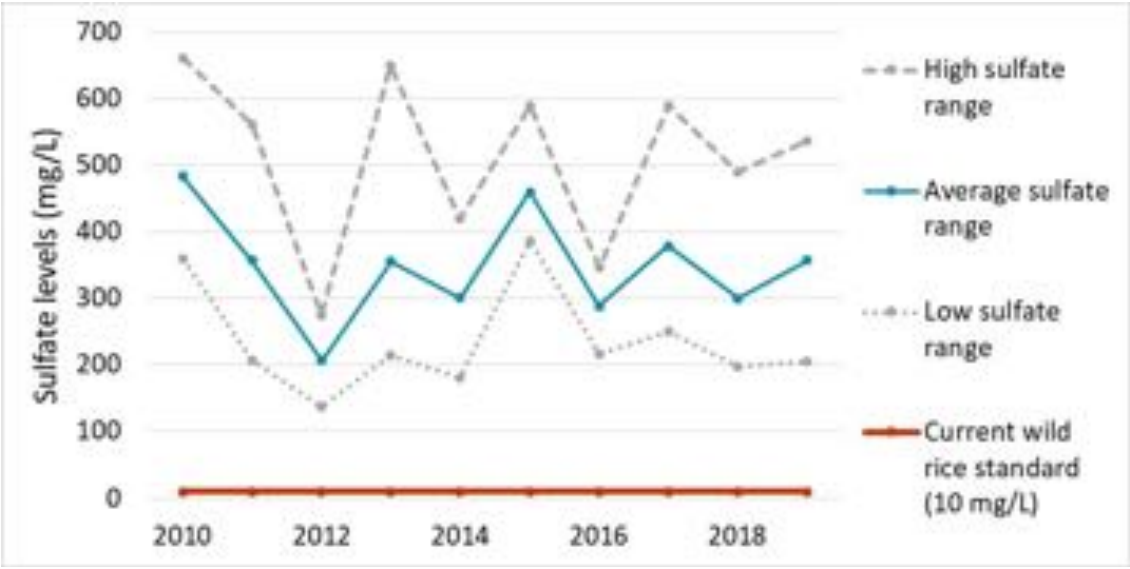
The Twin Lakes are located in St. Louis County in northeastern Minnesota. Sandy Lake is approximately 120 acres and Little Sandy Lake is approximately 90 acres. The Twin Lakes are located immediately downstream of the tailings basin for U.S. Steel's Minntac iron ore operation. Prior to mining operations, the Twin Lakes produced good stands of Manoomin and were important ricing sites for Ojibwe Bands and vital habitat for a range of wildlife species.

Ongoing sulfate loading renders restoration ineffective at the Twin Lakes

The Twin Lakes are severely degraded by sulfate-laden mine waste from U.S. Steel's tailings basin. Because sulfate concentrations are high, any attempts to restore Manoomin stands that do not address this fundamental issue have proven largely ineffective. For example, multiple attempts by natural resource managers to adjust water levels through beaver management (in the 1970s to 1990s and 2015 to 2018) have not improved Manoomin stands in a measurable way. Modest reseeding efforts (in 1991 and 1992) have also not been effective. Restoration efforts are not successful because sulfate levels at the Twin Lakes are at least 10 times higher than the Manoomin sulfate standard; the current sulfate standard is 10 mg/L (see graph below; Tribal Wild Rice Task Force, 2018).

In 2010, U.S. Steel was required to construct a seepage collection system to collect some of the mine wastewater discharging at the base of the tailings basin. While this reduced the total volume of water discharging from the mine site, it did not fully stop it. As a result, mine waste high in sulfate continued to contaminate the Twin Lakes after the collection system was installed. The 1854 Treaty Authority monitored lake conditions before the installation of the seepage collection system (2010) and after (2011 to 2019). Data collected included information on water quality (sulfate and other water quality indicators) and water-depth recordings; as well as data from inlet and outlet field surveys, vegetation surveys, and aerial surveys (Vogt, 2020). Results showed that sulfate levels remained elevated well above the standard over the nine years of monitoring after the installation of the seepage system, and remained substantially unchanged from conditions prior to the installation (see graph below).

During the monitoring study, very limited Manoomin stalks were also observed across the Twin Lakes. In 2015, U.S. Steel planted test plots to determine if Manoomin had the potential to grow in the Twin Lakes. In this small-scale test plot, U.S. Steel reseeded with 40 pounds of Manoomin. After seeding, Manoomin success has varied but has been limited across years (Vogt, 2020). Full-scale reseeding was not attempted.



Sulfate concentrations at the inlet to the Twin Lakes compared to current standard sulfate levels (10 mg/L) for Manoomin, 2010 to 2019.

Approach to characterizing Manoomin at the Twin Lakes

Twelve metrics characterize cultural and ecological functions of the Twin Lakes' Manoomin and its associated habitat. These metrics describe how Manoomin at the Twin Lakes contributes to maintaining connections with the Anishinaabe culture, how ecological functionality is supported and resilient to changing conditions, and how continued learning and sharing of Anishinaabe values are promoted.

Cultural Metrics

Anishinaabe (original people) – The place provides Manoomin, which is sacred to the Anishinaabe and central to the foundations of their culture, sovereignty, and treaty rights.

Community relationships – Manoomin at this place contributes to bonding, traditions, and strengthening family and community connections.

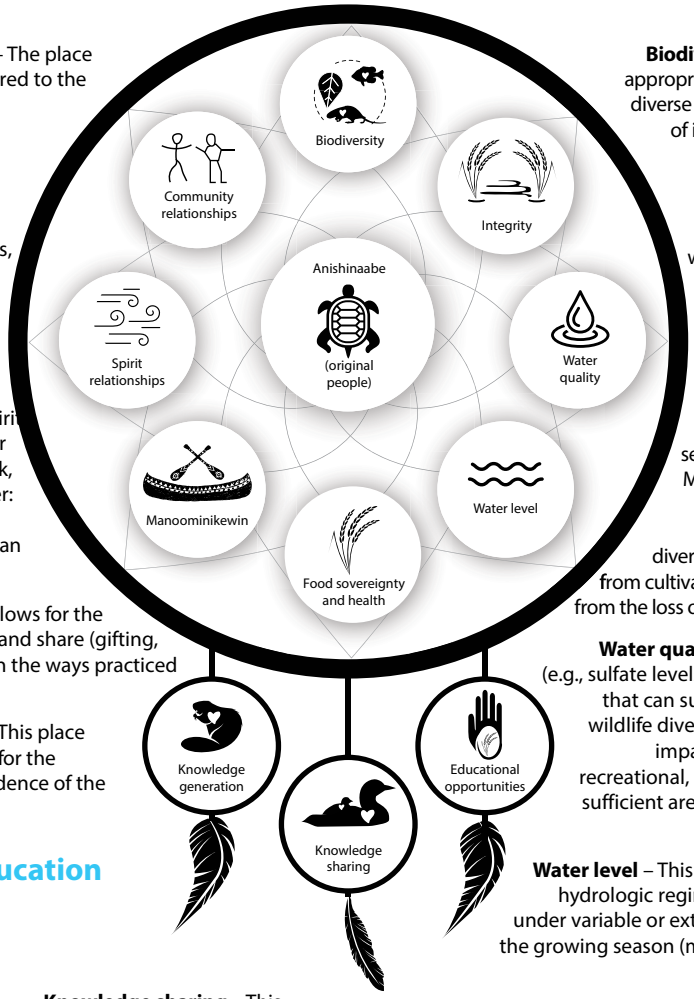
Spirit relationships – Manoomin at this place enables the Anishinaabe to maintain connections and balance with spirit beings (or relatives) from all other orders of creation (first order: rock, water, fire and wind; second order: other plant beings; third order: animal beings; fourth order: human beings).

Manoominikewin – This place allows for the Anishinaabe to harvest, prepare, and share (gifting, healing, and eating) Manoomin in the ways practiced by their ancestors for centuries.

Food sovereignty and health – This place provides the capacity to provide for the sustenance, health, and independence of the Anishinaabe.

Cultural and Ecological Education Metrics

Knowledge generation – This place allows for continued learning and generation of the Anishinaabe practices, values, beliefs, and language through experience.



Knowledge sharing – This place allows for the continued sharing and transmittal of the Anishinaabe practices, values, beliefs, and language among family members and community.

Educational opportunities – This place provides opportunities for language, land stewardship, and other educational programs, such as educational rice camps.

Ecological Metrics

Biodiversity – Healthy Manoomin and appropriate habitat at this place supports diverse biological communities (e.g., free of invasive species) that indicate the capacity of the place to support abundant associated plant and animal species (e.g., other native aquatic vegetation, fish, waterfowl, muskrat), providing for spiritual and subsistence needs.

Integrity – Physical habitat and hydrology, and water and sediment chemistry support stands of Manoomin that exhibit natural annual variability; viable seed bank ensures that sustainable Manoomin populations will persist even after occasional poor production years. Natural genetic diversity is maintained without impact from cultivated strains, or reduced gene flow from the loss of nearby Manoomin populations.

Water quality – This place has clean water (e.g., sulfate levels below 10 ppm) and sediments that can support robust stand density and wildlife diversity; is free of contamination or impacts from industrial, agricultural, recreational, or residential influence; and is of sufficient areal extent to sustain a Manoomin population.

Water level – This place has a natural or managed hydrologic regime that can maximize resilience under variable or extreme climatic conditions across the growing season (maintaining optimal depth range and flow).

Cultural and ecological characterization at the Twin Lakes

The Twin Lakes' Manoomin and its associated habitat were characterized over four time periods. Each metric was ranked using the following five-point descriptive scale: No use, Very bad, Not very good, Pretty good, Doing great

1950 to 1965: Before construction of the tailings basin

Based on the combined ranking of cultural and ecological metrics, conditions at the Twin Lakes were characterized as "doing great" during this period. Prior to the discharge of mine waste into the Twin Lakes, both lakes had moderately dense to dense stands of Manoomin. The Bois Forte Band of Chippewa, Grand Portage, and other community members historically harvested Manoomin in these lakes. In addition, Manoomin supported waterfowl (e.g., mallard, black ducks, green winged teal, wood ducks), fish such as northern pike, and other wildlife during this period (Minnesota Division of Game and Fish, 1966a, 1966b).

1966 to 1989: After construction of the tailings basin

After the discharge of mine waste started, Manoomin coverage in the Twin Lakes steadily declined. Compared to a 1966 vegetation survey of the Twin Lakes (Minnesota Division of Game and Fish, 1966a, 1966b), a 1987 survey found that Manoomin was essentially absent from both lakes, while water levels were considerably higher and water clarity increased dramatically (State of Minnesota, 1987). By 1989, the Twin Lakes ranked as "no use" based on the combined ranking of cultural and ecological metrics.

1990 to 2009: With limited restoration actions

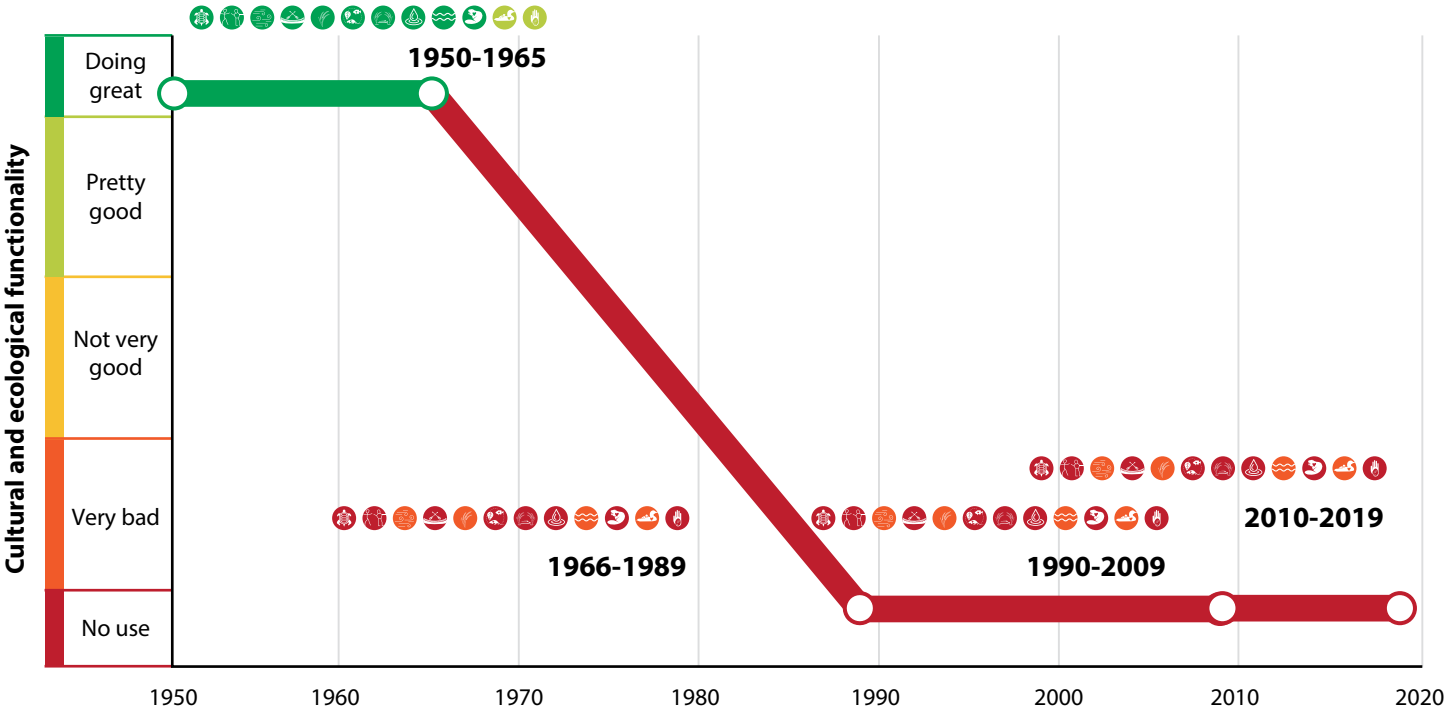
During this period, some actions were undertaken to recover Manoomin, including beaver management and small-scale reseeding efforts. However, these actions did not address the fundamental issue of high levels of sulfate and were largely ineffective at restoring the abundance of Manoomin and its associated habitat at the Twin Lakes. Given the absence of Manoomin on the lakes, community members were unable to harvest, prepare, and share Manoomin in ways practiced by their ancestors. The lost use of the Twin Lakes also limits sharing, transmittal, and generation of Anishinaabe practices at these lakes. During this period, the ranking of the Twin Lakes remained near "no use" based on the combined ranking of cultural and ecological metrics.

2010 to 2019: After construction of the seepage collection system

After U.S. Steel constructed the seepage system, Manoomin remained essentially absent from the Twin Lakes. With the lakes unable to support Manoomin, community members remained unable to harvest, prepare, and share Manoomin in ways practiced by their ancestors. During this period, the ranking of the Twin Lakes remained near "no use" based on the combined ranking of cultural and ecological metrics.

Cultural and ecological characterization of the Twin Lakes

Cultural and ecological functionality provided by Manoomin and its associated habitat at the Twin Lakes declined over time, both in aggregate and for the individual metrics.



Additional actions needed

Since the installation of a tailings basin for the U.S. Steel's Minntac facility in the mid-1960s, the abundance of Manoomin at the Twin Lakes has steadily declined. Actions taken at the Twin Lakes to improve Manoomin and its associated habitat have been limited and have not addressed the fundamental problem of sulfate loading from the mine. If actions were taken to improve conditions in the future, we could use a Habitat Equivalency Analysis (HEA) to demonstrate the additional equivalent units of restoration needed to counter-balance the severity and timespan of degradation. For example, if actions were implemented over the next 20 years (2020 to 2040) to improve habitat functionality by 2.5%, over 100,000 acres of similar Manoomin restoration would be needed to counter-balance the lost habitat functionality that has occurred over time (from 1966 to 2019). This is equivalent in size to over 550 Twin Lakes. The table to the right provides the HEA results, assuming several hypothetical scenarios of improvements in habitat functionality; it is important to note that we do not know what actions are needed to create these percent improvements, but they would likely require addressing the fundamental problem of sulfate loading from the mine. The main purpose of these scenarios is to highlight that if only minimal restoration is achieved at Twin Lakes (which may be anticipated, given the long history of attempting restoration, with minimal response), then significant equivalent amounts of this restoration would be needed to balance the prolonged period of degradation at these lakes.

Hypothetical percentage of improvement in habitat functionality from 2020 to 2040	Acres needed to counter-balance historical losses given hypothetical improvement *(Acres rounded to the nearest hundred)*	Number of Twin Lakes needed to counter-balance historical losses given hypothetical improvement
2.5%	116,700	556
5.0%	58,400	278
10.0%	29,200	139
20.0%	14,600	69

This case study demonstrates the difficulty in restoring Manoomin and its associated habitat when the root cause of the degradation – in this case, sulfate discharge – is not addressed. Given the difficulty of restoring degraded habitat, it is important to protect and preserve existing Manoomin habitat to ensure a future with Manoomin.

References

Minnesota Division of Game and Fish. 1966a. Section of Research and Planning. Federal Aid Project PR FW-1-R-11 Game Lake Survey. Dates of Field Work: Lake Survey Sept. 3, 1966, Lake Mapping Sept. 3, 1966a. Lake Name: Little Sandy.

Minnesota Division of Game and Fish. 1966b. Section of Research and Planning. Federal Aid Project PR FW-1-R-11 Game Lake Survey. Dates of Field Work: Lake Survey Sept. 3, 1966, Lake Mapping Sept. 3, 1966. Lake Name: Sandy.

MWH. 2004. Minntac Water Inventory Reduction Environmental Impact Statement. Prepared for Minnesota Pollution Control Agency. Prepared by MWH. September. Available: https://www.pca.state.mn.us/sites/default/files/minntac-deis.pdf. Accessed October 15, 2019.

State of Minnesota. 1987. Game Lakes Survey Sandy Lake & Little Sandy. Office Memorandum from Amy Loiselle, Area Hydrologist, to Jeff Lightfoot, Wildlife Area Supervisor. July 21.

Tribal Wild Rice Task Force. 2018. Tribal Wild Rice Task Force Report. December 15. Available: http://mnchippewatribe.org/pdf/TWRTF.Report.2018.pdf. Accessed October 15, 2019.

Vogt, D.J. 2020. Sandy Lake and Little Sandy Lake Monitoring (2010–2019). 1854 Treaty Authority. Technical Report 20-01. January.

About this effort

This case study is part of the Lake Superior Manoomin Cultural and Ecosystem Characterization Study. The project was initiated by a team of Lake Superior Basin Anishinaabe communities, and federal and state agencies, with technical support from Abt Associates. This project aims to describe the importance of Manoomin to help foster community stewardship and education; and to inform Manoomin stewardship, protection, and policy in the Lake Superior region and throughout the Great Lakes. Funding for this project was received via Great Lakes Restoration Initiative. For more information on the Initiative and Action Plan go to https://www.glri.us/.

Acknowledgments

The Project Team would like to acknowledge Darren Vogt (1854 Treaty Authority) and Nancy Schuldt (Fond du Lac Band of Lake Superior Chippewa) for their valuable input and feedback in the development of this case study. The Project Team would also like to thank Wayne Dupuis (Fond du Lac Band of Lake Superior Chippewa), Tara Geshick (Bois Forte), John Coleman and Esteban Chiriboga (Great Lakes Indian Fish & Wildlife Commission), and Amy Myrbo for participating in the cultural and ecological characterization of the Twin Lakes.