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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 management, protection, and policy in the Lake Superior region and throughout the Great Lakes. For additional information about this effort and results from the other case studies, please see the full report at [insert URL].

Acknowledgments

The Project Team would like to acknowledge Roger Labine (LVD) and Peter David (GLIFWC) for their valuable input and feedback in the development of this case study, and for participating in the cultural and ecological characterization of Lac Vieux Desert's Rice Bay.

Restoration of Keweenaw Bay Indian Community's Sand Point Sloughs increases cultural and ecological functionality

Significant progress made but additional restoration could counter-balance losses

Recent restoration efforts on eight acres at Keweenaw Bay Indian Community's (KBIC's) Sand Point Sloughs have improved the cultural and ecological functionality of the sloughs' Gichimanidoo gitigan (The Great Spirit's Garden); however, given the significant historical losses, much more restoration is needed. Based on methods applied in this study, it would take an additional 175 acres of similar Manoomin (Wild Rice) restoration to counter-balance the lost cultural and ecological functionality that have occurred over time. This is equivalent in scale to 22 times the current restoration efforts at the sloughs. In addition, future restoration actions will need to be adaptive to respond to changing climate conditions.

Threats to Manoomin at Sand Point Sloughs

Connected to Lake Superior, Sand Point Sloughs is part of a dynamic coastal system. In the early 20th century, a copper ore processing plant, Mass Mill, operated on the west side of Keweenaw Bay on the south shore of Lake Superior. During the copper ore processing, approximately six billion pounds of mine tailings, locally known as stamp sands, were disposed into Keweenaw Bay. Lake currents continue to carry these tailings southward and redeposit them onto Sand Point, located just four miles south of the Mass Mill. Sand Point, approximately 45 acres in size, has an extensive beach area with approximately 2.5 miles of lake front and is connected to the sloughs. These tailings contain high concentrations of heavy metals that have the potential to cause environmental harm to natural resources.

More recently, Sand Point Sloughs has been affected by regional hydrologic conditions – including higher water levels – that are occurring at a regional scale and are beyond local control. As a plant species sensitive to changes in water level, higher water levels have negatively affected the establishment and abundance of Manoomin in Sand Point Sloughs. The sloughs' connection to Lake Superior also opens the pathway to aquatic invasive species, such as carp and reed canary grass. Carp, for example, are bottom feeders that uproot Manoomin (Premo et al., 2014). Manoomin abundance may be impeded by competing native vegetation, such as ginoozhegoons (pickerelweed); and by excessive browsing by wildlife on new stands, such as waterfowl.

About Sand Point Sloughs

Sand Point Sloughs are relatively shallow backwater sloughs connected to Lake Superior that are culturally important to the KBIC. Native people used this area for hundreds of years, as indicated by the existence of ancient burial grounds and stories that have been passed on through oral tradition (KBIC, 2003). Manoomin is believed to have been present in Sand Point Sloughs prior to the 1900s (Ravindran et al., 2014). Today, the site contains the KBIC Pow Wow grounds, a traditional healing clinic, extensive wetlands, and Manoomin beds. A marina, campground, lighthouse, and recreational beaches signify the community's appreciation of this area.

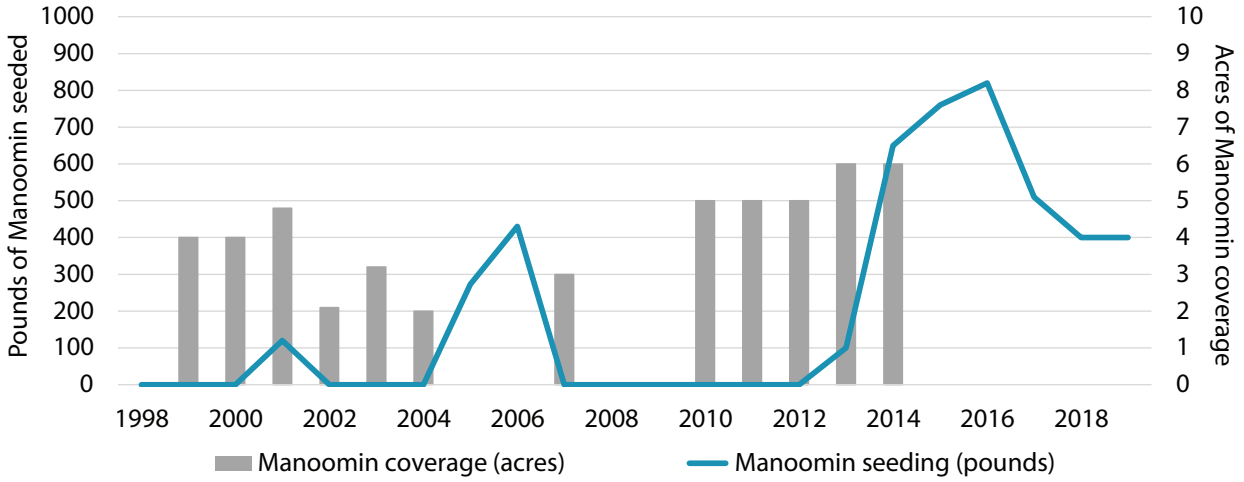
This area also holds ecological value as habitat. It provides for a number of species including medicinal plants, insects, fish, and other non-human relatives.

Actions taken to improve the abundance of Manoomin at Sand Point Sloughs

Sand Point Sloughs are a KBIC Tribal Trust property, wholly owned by KBIC and located entirely within KBIC L'Anse Reservation boundaries. KBIC took over management of the sloughs in the early 1990s, and shortly after began efforts to reintroduce Manoomin. Between 1991 and 1997, KBIC seeded nearly 1,800 pounds of Manoomin across 8 acres of Sand Point Sloughs. By 1999, Manoomin density was sufficient for KBIC to engage in the tradition of ricing. Between 1999 and 2002, community members harvested an estimated 60 to 150 pounds per year (Ravindran et al., 2014). Since 2013, KBIC has seeded annually at Sand Point Sloughs. KBIC continues to tend to this site in an effort to keep Manoomin teachings and traditions vital. However, since 2002, community members have not been able to harvest Manoomin at Sand Point Sloughs due to decreased abundance of Manoomin related to regional hydrologic conditions.

In addition to seeding efforts, KBIC and partners have undertaken remediation along the Sand Point shoreline, which was listed as a brownfield site. Remediation efforts included capping stamp sands to stabilize the tailings; planting native plants, trees, and shrubs to increase habitat for birds and other wildlife; and installing mounds and boulders to provide relief in the topography, reduce erosion, and protect valuable coastal wetlands, including Manoomin beds (Ravindran et al., 2014).

Floating wild rice. Credit: KBIC NRD



Manoomin seeding and acres of Manoomin coverage at the Sand Point Sloughs, 1999 to 2019 (Manoomin coverage data not recorded after 2014).

Approach to characterizing Manoomin at Sand Point Sloughs

Twelve metrics characterize the cultural and ecological functions of Sand Point Sloughs' Manoomin and its associated habitat. These metrics describe how Manoomin at the Sloughs contributes to maintaining connections with the Anishinaabe culture, how it supports ecological functionality and is resilient to changing conditions, and how it allows for continued learning and sharing of Anishinaabe values.

Cultural Metrics

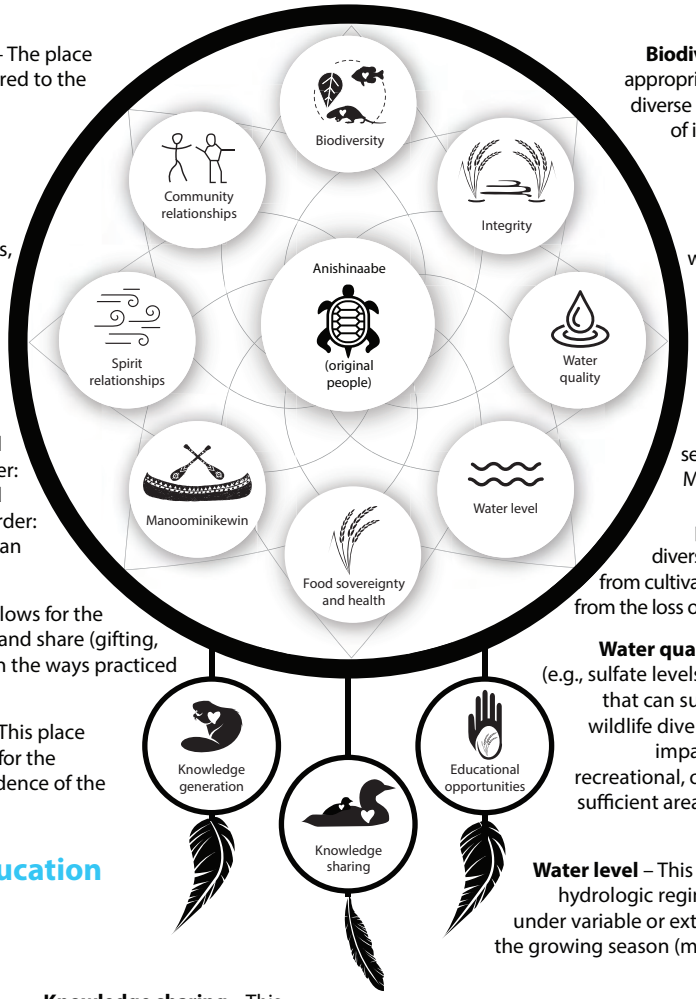
Anishinaabe (original people) – The place provides Manoomin, which is sacred to the Anishinaabe and central to the foundations of their culture, sovereignty, and treaty rights.

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.



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 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.

Cultural and ecological characterization at Sand Point Sloughs

Sand Point Sloughs' 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

This characterization begins after the copper ore processing plant ceased operations around the 1920s.

1920 to 1990: Before KBIC ownership

Based on the combined ranking of cultural and ecological metrics, Sand Point Sloughs was characterized as "not very good" during this period. This ranking reflects the absence of Manoomin from the sloughs and the deposition of mine tailings onto Sand Point. Although Manoomin was absent, the sloughs were still a place of cultural and ecological importance: waterfowl and other wildlife foraged at the sloughs; and community members fished, hunted, and gathered there and held Pow Wows on the grounds. Given the intrinsic cultural and ecological values of the sloughs, some cultural metrics – including spirit relationships, knowledge sharing, and food sovereignty – were characterized with a higher ranking.

1991 to 1998: With active management of Manoomin

Once KBIC took over management of Sand Point Sloughs in the early 1990s and began seeding activities, Manoomin grew modestly. Although community members could not yet harvest Manoomin, the presence of Manoomin significantly improved the ranking of most cultural and ecological metrics. During this period, Sand Point Sloughs ranked as "pretty good" based on the combined ranking of cultural and ecological metrics.

1999 to 2005: With active management and harvesting of Manoomin

Once Manoomin was adequately established at Sand Point Sloughs, KBIC was able to open Sand Point Sloughs to their community members for harvesting. Harvesting allowed the recovery and sharing of Anishinaabe practices, values, beliefs, and language at the sloughs in ways that had not been practiced for years. During this period, Sand Point Sloughs ranked as "doing great" based on the combined ranking of improved cultural and ecological metrics.

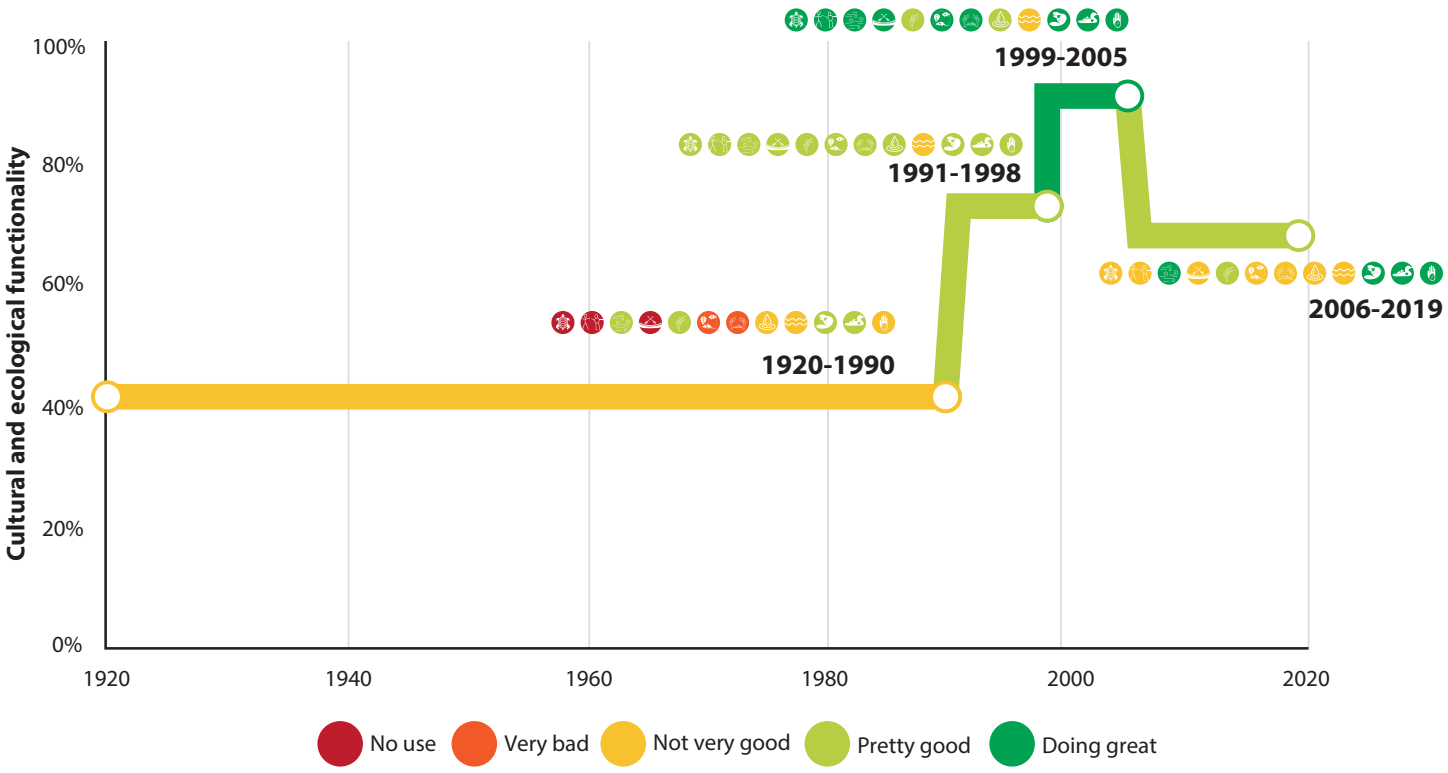
2006 to 2019: With higher water levels

Sand Point Sloughs is connected to Lake Superior, and affected by changes in the lake's water level and invasive and competitive species. Invasive species and competing vegetation that have been documented at Sand Point Sloughs may be impacting Manoomin abundance. Water levels have also fluctuated in Sand Point Sloughs, with lower water levels recorded in 2006 and 2007, and higher water levels in recent years (Ravindran et al., 2014). During this period, Sand Point Sloughs' functionality decreased to "pretty good" based on the combined ranking of cultural and ecological metrics. The decrease in ecological and cultural functionality provided by Manoomin in recent years suggests the need for adaptive management of Manoomin. Actions taken that may have been successful in restoring Manoomin in the past may need to be adjusted to respond to additional threats, such as climate change, to be successful in the future.

For each of the four time periods, the water level metric was ranked as "not very good." Due to their location, the Sand Point Sloughs are influenced by regional factors such as Lake Superior water levels, which are beyond local control.

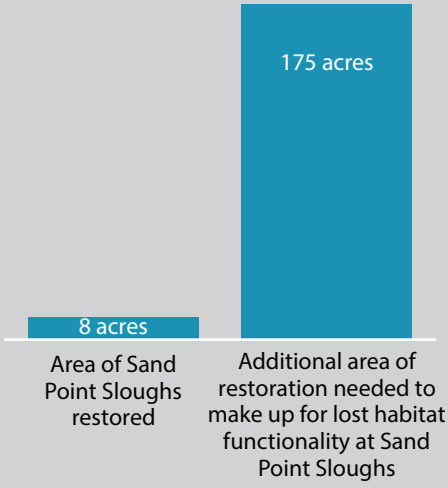
Cultural and ecological characterization at Sand Point Sloughs

The cultural and ecological functionality provided by the Manoomin and its associated habitat at Sand Point Sloughs varied over time, both in aggregate and for individual metrics.



Additional restoration needed

Based on the characterization of the degree of cultural and ecological function over the four time periods, a Habitat Equivalency Analysis demonstrates the additional equivalent units of restoration needed to counter-balance the severity and timespan of degradation . Given the success of restoration at the 8-acre Sand Point Sloughs, 175 acres of similar Manoomin restoration is needed to counter-balance the lost habitat functionality that has occurred over time. In other words, 22 equivalent restoration efforts at Sand Point Sloughs (from 1991 to 2019) are needed to counter-balance lost cultural and ecological habitat functionality (from 1920 to 1990).



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GREAT LAKES Wild Rice INITIATIVE

Introduction of Manoomin at Net River Impoundment and Vermillac Lake provides cultural and ecological functionality

With favorable conditions, restoration can enhance Gichimanidoo gitigan

Tending to Gitimanidoo gitigan (The Great Spirit's Garden) through Manoomin (wild rice) seeding efforts at Net River Impoundment and Vermillac Lake has benefited natural resources at these locations. Seeding the Net River Impoundment also has the potential to create a Manoomin seed bank for other lakes in the area, including Vermillac Lake. Although documentation of Manoomin presence in these waterbodies is not available from historical records, efforts to introduce Manoomin at these systems have shown preliminary success. Therefore, additional seeding could help counter-balance the lost ecological functionality and inspire cultural practices to occur at these locations. Based on methods applied in this study, it would take an additional 1,129 acres of similar Manoomin seeding to counter-balance the lost ecological functionality that have occurred over time, which is equivalent in scale to nearly 12 times the current restoration efforts at the Net River Impoundment and Vermillac Lake.

Threats to Manoomin at Net River Impoundment and Vermillac Lake

Both the Net River Impoundment and Vermillac Lake possibly had Manoomin beds in the past. Many believe that historical trails around the Net River Impoundment indicate traditional use of these places for cultural practices (Evelyn Ravindran, KBIC personal communication, August 20, 2019). Land use changes have altered the local landscape, which may have contributed to the presence or absence of Manoomin at these places.

"Keweenaw Bay Indian Community's (KBIC's) long-term goal is to develop harvestable, self-sustaining wild rice populations on the Reservation and within the Ceded Territory for future generations."

KBIC NRD, 2019

Credit: KBIC NRD.

About Net River impoundment and Vermillac Lake

The Net River is nearly 15 miles long and flows from Baraga County to Iron County, Michigan. Impounded in 1990 as a wetland mitigation site to provide waterfowl benefits, the Net River Impoundment is now 35 acres in size. Vermillac (or Worm) Lake is a 423-acre lake in Baraga County. Both the Net River Impoundment and Vermillac Lake are located outside the L'Anse Indian Reservation, but within Ceded Territory.

Actions taken to improve Manoomin at Net River Impoundment and Vermillac Lake

KBIC is receiving more and more teachings from Manoomin and is working to understand which locations on the L'Anse Indian Reservation and within Ceded Territory have conditions that are conducive to grow and sustain Manoomin (BIA, 2019). KBIC is interested in having local sources of Manoomin as seed banks for future restoration activities; as well as places where community members can harvest, prepare, and gift Manoomin. KBIC is currently assessing suitable Manoomin habitat across their territory, and focusing restoration in lakes with the most favorable conditions for Manoomin.

In the early 2010s, KBIC worked with the Michigan Department of Natural Resources to identify additional areas for Manoomin restoration. The Net River Impoundment and Vermillac Lake were selected as lakes with potential for Manoomin beds, and KBIC seeded test plots at both lakes. Given their success, KBIC then seeded the Net River Impoundment and Vermillac Lake with nearly 2,000 pounds of Manoomin seed. Cultural teachings and practices related to Manoomin are beginning to occur at the Net River Impoundment. KBIC continues to seed 97 acres across both lakes with nearly 2,000 pounds of Manoomin each year.

The ultimate goal of seeding efforts is for the Net River Impoundment to produce a Manoomin seed source for Vermillac Lake and other KBIC restoration sites. In keeping with the principles of the honorable harvest, KBIC aims to achieve conditions that will allow the rice to reseed itself to feed wildlife and nourish the people.

Survey point. Credit: KBIC NRD

Rice stand. Credit: KBIC NRD

Approach to characterizing Manoomin at Net River Impoundment and Vermillac Lake

Twelve metrics characterize the cultural and ecological functions of the Net River Impoundment's and Vermillac Lake's Manoomin and associated habitats. These metrics describe how Manoomin at these areas 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.

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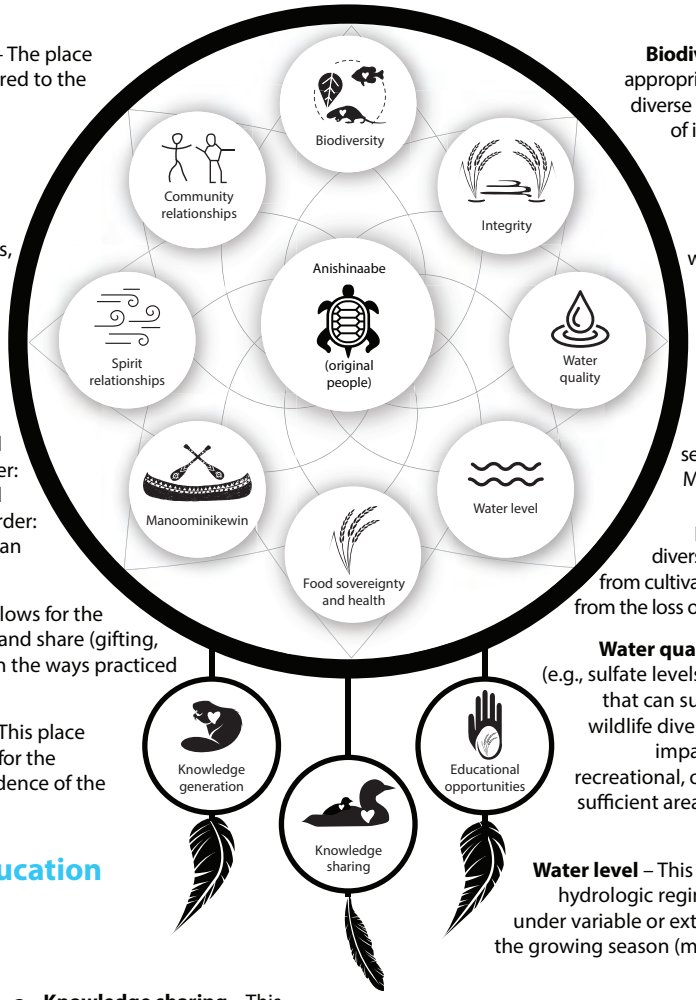

Ecological Metrics

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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 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.

Cultural and ecological characterization at Net River Impoundment and Vermillac Lake

Manoomin and its associated habitat at the Net River Impoundment and Vermillac Lake were characterized over two time periods. Each metric was ranked using the following five-point descriptive scale:

No use | Very bad | Not very good | Pretty good | Doing great

This characterization begins after the Net River was impounded as a wetland mitigation bank in 1990.

1990 to 2013: Before Manoomin seeding

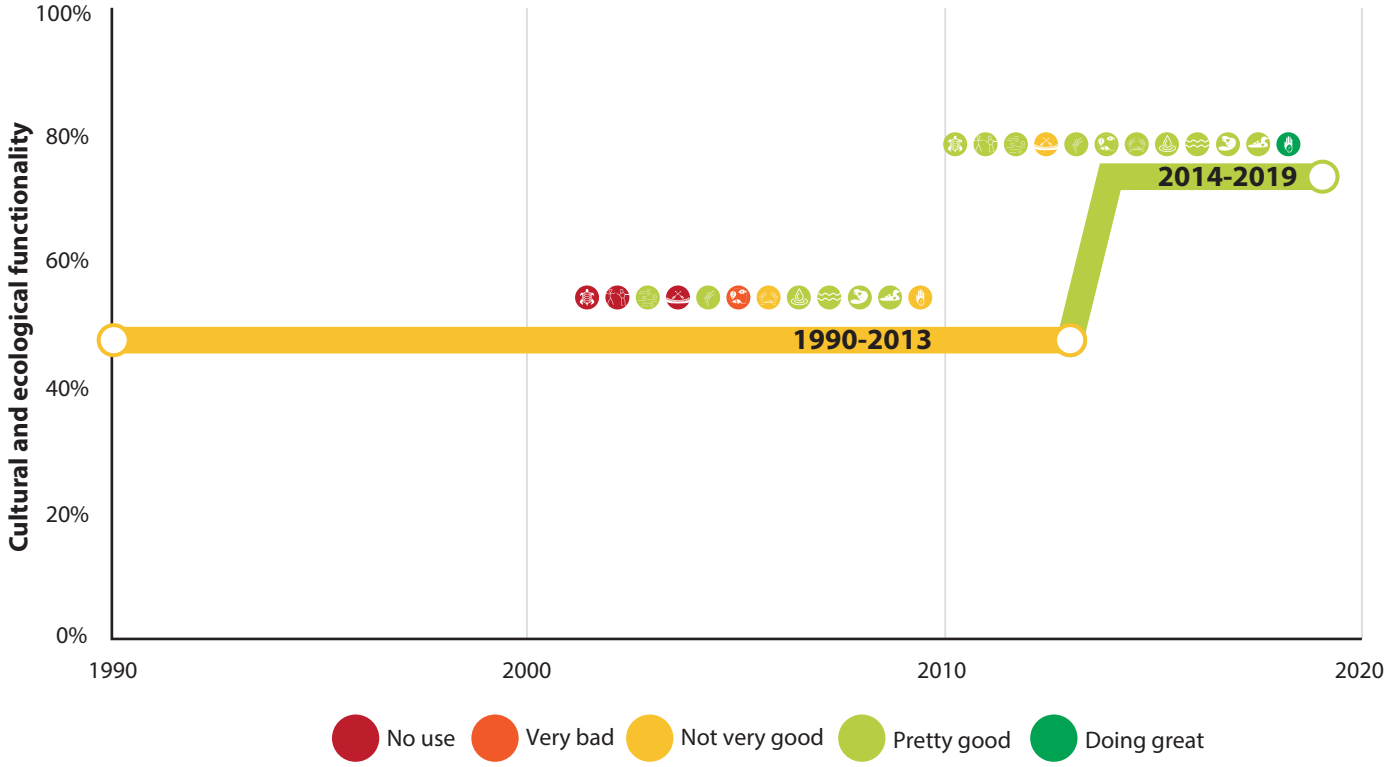
Based on the combined ranking of cultural and ecological metrics, conditions at the Net River Impoundment and Vermillac Lake were characterized as "not very good" during this period. This ranking reflects the absence of Manoomin from the Net River Impoundment and Vermillac Lake before 2013. Although Manoomin was absent, these areas were culturally and ecological important. Community members used these sites for gathering, fishing, and hunting activities; during these activities, families passed down knowledge to their children or grandchildren about traditional practices and resources. Given the intrinsic cultural and ecological value of these places, some metrics – including spirit relationships, food sovereignty, knowledge generation and sharing, and water level and quality – ranked higher in cultural and ecological characterization.

2014 to 2019: After Manoomin seeding

Once KBIC began seeding the Net River Impoundment and Vermillac Lake, Manoomin grew at these places. Currently, Manoomin supports wildlife and other ecosystem functions. These places have the potential for Manoomin harvesting in the future, although they cannot yet support it. The presence of Manoomin significantly improved the ranking of most of the cultural and ecological metrics. During this period, conditions at the Net River Impoundment and Vermillac Lake ranked as "pretty good" based on cultural and ecological metrics. Although Manoomin provides many cultural and ecological functionality, additional management of water levels at the Net River Impoundment could continue to improve the abundance of Manoomin and the long-term sustainability of healthy Manoomin beds.

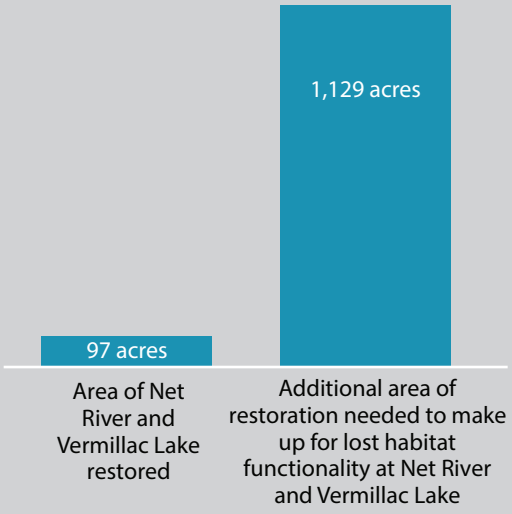
Cultural and ecological characterization at Net River Impoundment and Vermillac Lake

Cultural and ecological functionality provided by Manoomin and its associated habitat at the Net River Impoundment and Vermillac Lake have increased over time, both in aggregate and for the individual metrics.



Additional restoration needed

Based on the characterization of the degree of cultural and ecological function over the two time periods, a Habitat Equivalency Analysis can demonstrate the additional equivalent units of restoration needed to counter-balance the severity and timespan of degradation. With seeding, resource managers successfully established Manoomin across the Net River Impoundment and Vermillac Lake. However, given that the period of degradation is much larger (over 20 years) than the period of restoration (around 5 years), an additional 1,129 acres of similar Manoomin restoration is needed to counter-balance the lost habitat functionality that has occurred over time. In other words, nearly 12 equivalent restoration efforts at the Net River Impoundment and Vermillac Lake (from 2014 to 2019) are needed to counter-balance the lost cultural and ecological habitat functionality (from 1990 to 2013).



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GREAT LAKES Wild Rice INITIATIVE

Introduction of Manoomin at Hiles Millpond provides cultural and ecological functionality

With favorable conditions, restoration can enhance Manoomin habitat

Establishing Manoomin (wild rice) at Hiles Millpond significantly enhances its cultural and ecological functionality. It also helps to make up for the loss of Manoomin on other waters throughout the region. Although recent restoration efforts have shown preliminary success, Manoomin has been absent from Hiles Millpond for a long time. Therefore, additional restoration could help counter-balance lost cultural and ecological functionality. Based on the methods applied in this study, 864 additional acres of similar Manoomin restoration would counter-balance the lost cultural and ecological functionality that have occurred over time. This is equivalent in scale to nearly three times the current restoration efforts at Hiles Millpond. The successful introduction of Manoomin at Hiles Millpond suggests that naturally suitable soils, combined with seeding and modifications in water-level management, can yield high-quality Manoomin and habitat.

Threats to Manoomin at Hiles Millpond

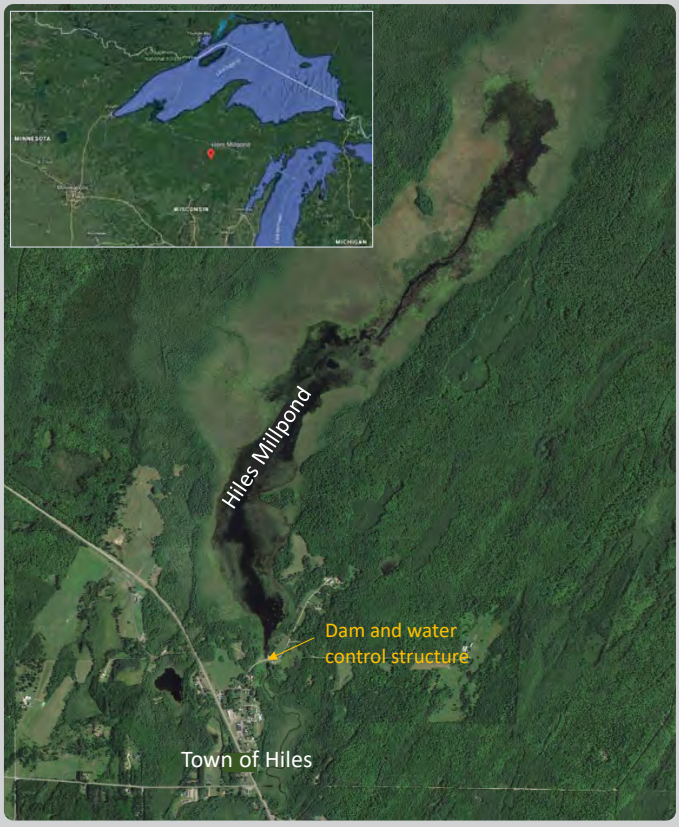
Water became ponded at Hiles Millpond in the late 1880s when the Hiles Lumber Company built a dam for logging purposes. Although there is no record of the presence of Manoomin at Hiles Millpond, it may have been there prior to dam construction since Manoomin is in nearby waters. If Manoomin was present at Hiles Millpond historically, it could have been negatively affected by changes in water levels associated with construction of the dam.

The area and waters around the Town of Hiles were traditionally used by the Lac du Flambeau Band of Lake Superior Chippewa Indians (LDF Band), the Sokaogon Chippewa Community, and other Ojibwe Bands and their ancestors. However, use of the area by Bands for hunting, gathering, fishing, and trapping was limited during much of the last century up until the 1980s. Use of this area increased after this time when relations with the local community in the Town of Hiles improved.

About Hiles Millpond

Hiles Millpond is an approximately 300-acre lake located in Forest County, Wisconsin, an 1842 Ceded Territory.

The millpond provides excellent wildlife habitat, especially for waterfowl, furbearers, eagles, and other wetland-dependent species. The lake also supports a northern pike and panfish fishery.



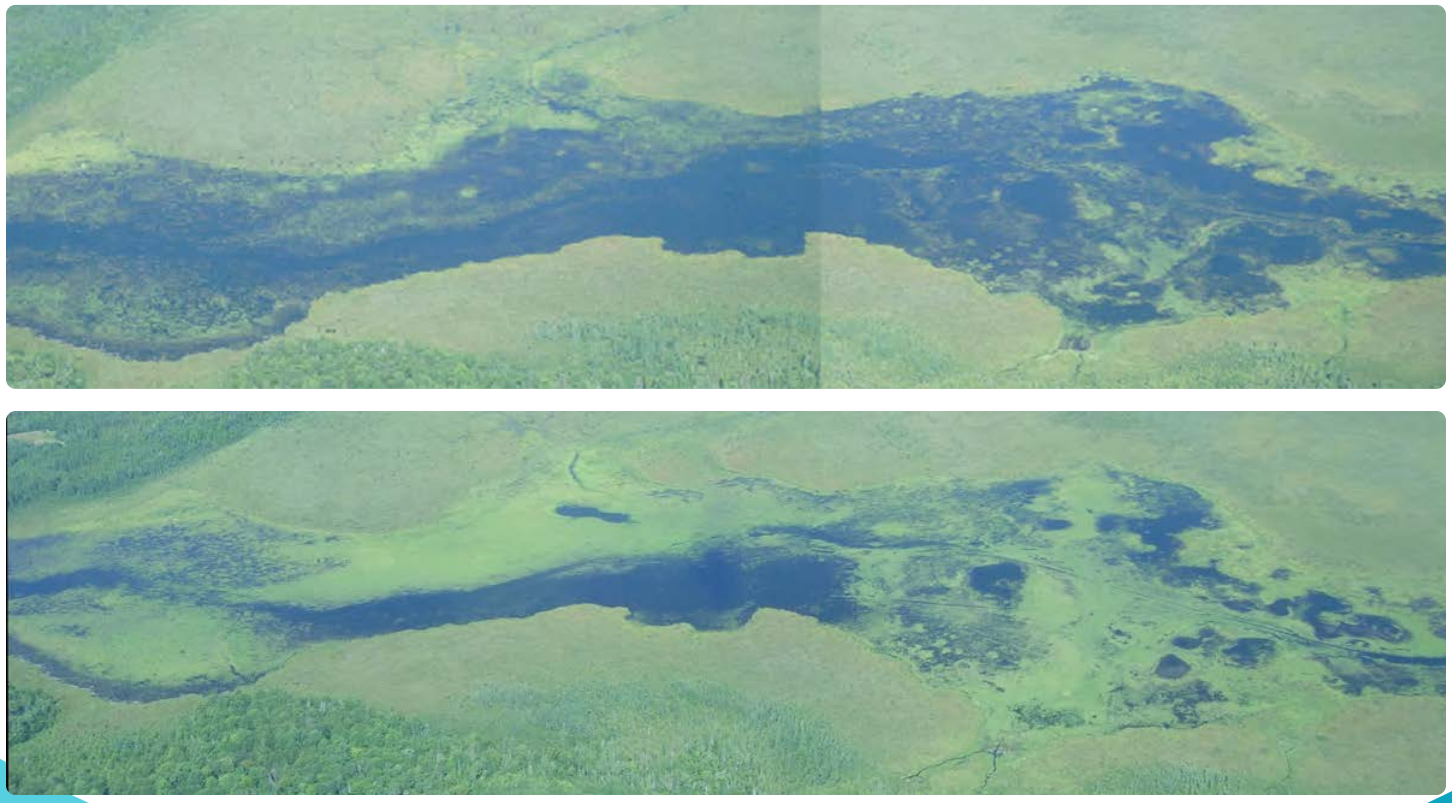
Actions taken to improve the abundance of Manoomin at the Hiles Millpond

In 1992, safety inspections found several problems with the dam structure at Hiles Millpond. To meet contemporary safety standards, the Town of Hiles needed to replace the dam structure. Since the town lacked adequate funds, federal, state, tribal, and nongovernmental organizations entered into a cooperative effort. A Memorandum of Understanding included a provision for the town to cooperate with the Forest Service to manage the millpond for productive wildlife and fish habitats, including possible manipulation of water levels, following completion of the project. The dam and water control structure were rebuilt in fall 1993.

Shortly after, biologists realized that the ecological benefits of Hiles Millpond could be significantly enhanced by establishing Manoomin on the millpond. Establishing Manoomin could also help to make up for the loss of Manoomin on other waters in the region, many of which were difficult or impossible to recover due to excessive development, conflicting uses, or other threats to Manoomin (Peter David, GLIFWC, personal communication, November 27, 2019).

In 1998, GLIFWC and the Forest Service cooperatively seeded the Hiles Millpond flowage with a relatively modest amount of Manoomin (329 pounds). Small patches of Manoomin then expanded modestly over the next several years. In 2011, Manoomin expanded significantly under natural drought conditions, which led biologists to believe that Manoomin might increase if the typical summer water level was lowered slightly.

Although the Town of Hiles was initially concerned that lower water levels might negatively affect the northern pike fishery, it ultimately agreed to manage the water level for Manoomin. Once lowered, Manoomin showed an immediate response. Manoomin abundance increased significantly from 2013, before water levels were lowered, to 2014, following a lowering of water levels. In recent years, over 125 acres of Manoomin can be found across much of the lake and surrounding wetlands (Peter David, GLIFWC, personal communication, November 27, 2019).



Manoomin abundance on a portion of the Hiles Millpond, 2013 above, and 2014 below, following a lowering of water levels. Credit: Peter David, GLIFWC

Approach to characterizing Manoomin at Hiles Millpond

Twelve metrics characterize the cultural and ecological functions of Hiles Millpond Manoomin and its associated habitat. These metrics describe how Manoomin at Hiles Millpond 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.

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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.

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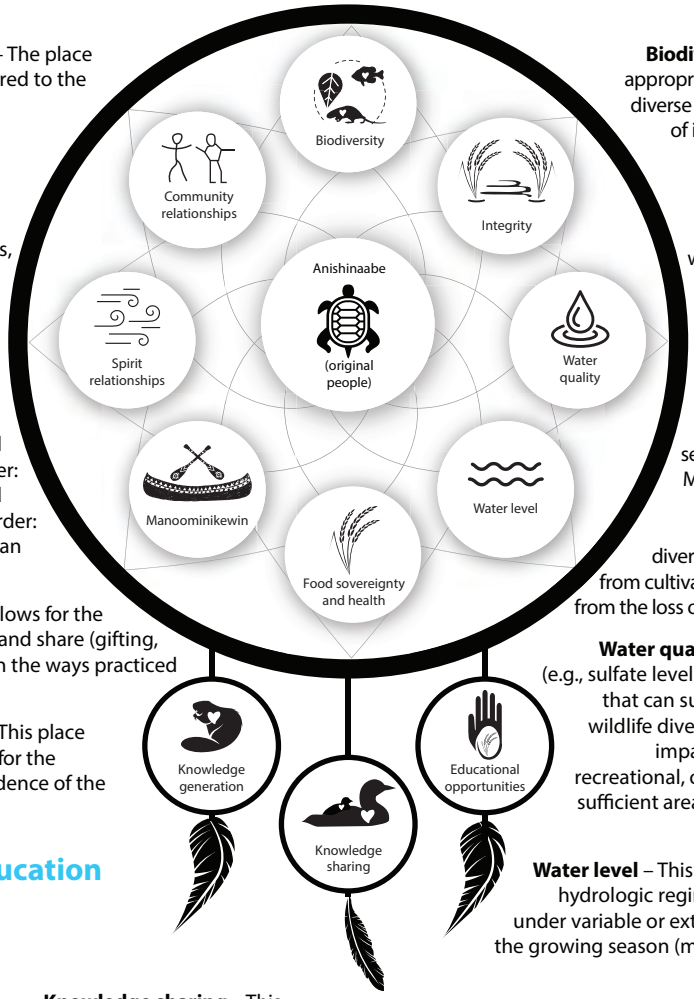


Ecological Metrics

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).

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

Cultural and ecological characterization at Hiles Millpond

Manoomin and its associated habitat at Hiles Millpond were characterized over three time periods. Each metric was ranked using the following five-point descriptive scale:

No use · Very bad · Not very good · Pretty good · Doing great

The characterization starts in 1980 because prior to that time community members were less likely to travel to Hiles Millpond to harvest Manoomin, and undertake other traditional hunting and gathering practices.

1980 to 1997: Before Manoomin seeding

Based on the combined ranking of cultural and ecological metrics, Hiles Millpond was characterized as "very bad" during this period. Because of the absence of Manoomin in the millpond, most of the metrics – particularly cultural metrics – ranked low on the score range.

1998 to 2013: After Manoomin seeding

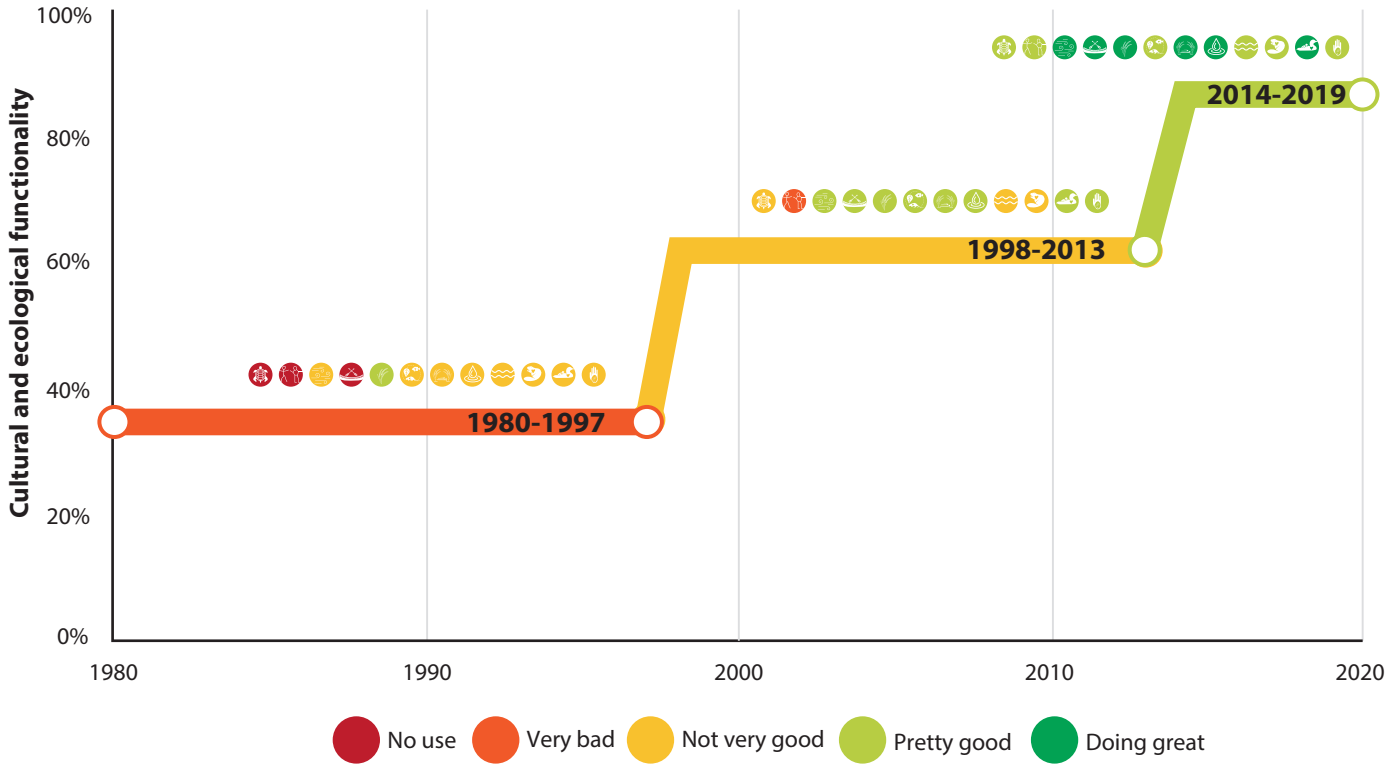
Once seeding activities began in 1998, Manoomin began to grow at the Millpond. The presence of Manoomin improved the rankings for most of the cultural and ecological metrics. In particular, the presence of Manoomin at Hiles Millpond allowed for some harvesting, preparation, and sharing of Manoomin by the community. It also improved the Anishinabee's connections and balance with spirit beings and relatives, and it supported diverse biological communities. During this period, Hiles Millpond ranked as "not very good" based on the combined ranking of the cultural and ecological metrics.

2014 to 2019: With water level management

After resource managers adjusted water levels for Manoomin in 2014, its coverage continued to expand. More Manoomin allowed for harvesting, preparation, and sharing of Manoomin in ways practiced by ancestors. It also allowed for knowledge generation and sharing of Anishinaabe practices, values, beliefs, and language. Although Manoomin provides many cultural and ecological functionality, additional management of water levels could continue to improve Manoomin and its associated habitat at Hiles Millpond. During this period, Hiles Millpond ranked as "pretty good" based on the combined ranking of cultural and ecological metrics.

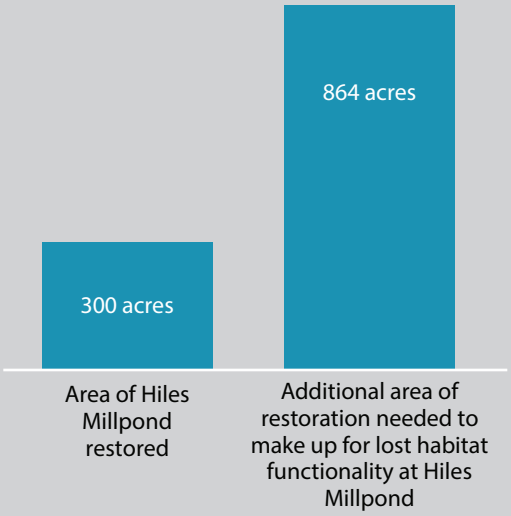
Cultural and ecological characterization at Hiles Millpond

Cultural and ecological functionality provided by Manoomin and its associated habitat at Hiles Millpond have increased over time, both in aggregate and for individual metrics.



Additional restoration needed

Based on the characterization of the degree of cultural and ecological function over the three time periods, a Habitat Equivalency Analysis demonstrates the additional equivalent units of restoration needed to counter-balance the severity and timespan of degradation. With modest seeding and slight modifications in water-level management, resource managers successfully established Manoomin across the Hiles Millpond. The analysis indicates that an additional 864 acres of similar Manoomin restoration is needed to counter-balance the lost habitat functionality that has occurred over time. In other words, nearly three equivalent restoration efforts at Hiles Millpond (from 1998 to 2019) are needed to counter-balance the lost cultural and ecological habitat functionality (from 1980 to 1997).



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. For additional information about this effort and results from the other case studies, please see the full report at [insert URL].

Acknowledgments

The Project Team would like to acknowledge Peter David (GLIFWC), Eric Chapman and Joe Graveen (LDF Band), and Peter McGeshick (Sokaogon Chippewa Community) for their valuable input and feedback in the development of this case study, and for participating in the cultural and ecological characterization of the Hiles Millpond. In addition, we would like to acknowledge that Peter David provided background information used in this case study.

GREAT LAKES Wild Rice INITIATIVE

Efforts to manage Big Rice Lake have not improved Manoomin functionality

Manoomin continues to be affected by hydrologic conditions and other threats

Historically, Big Rice Lake was one of the best-producing Manoomin (wild rice) lakes in northeastern Minnesota, and Manoomin on this lake provided cultural, ecological, and educational services to the Anishinaabe people. Over the last two decades, natural resource managers actively managed Big Rice Lake to improve conditions of Manoomin and its associated habitat. However, their actions – including water management, vegetation control, and beaver control – have been largely ineffective in recent years and Manoomin abundance continues to remain low. Manoomin and its habitat at Big Rice Lake have declined across all cultural and ecological metrics, and ginoozhegoons (pickerelweed) continues to outcompete Manoomin in parts of the lake. This case study highlights the difficulties in restoring degraded Manoomin and its associated habitat, and the importance of protecting it.

Credit: Todd Marsee, Michigan Sea Grant

Threats to Manoomin at Big Rice Lake

Hydrologic changes, impacts from competing vegetation, and perhaps climate change have threatened Manoomin at Big Rice Lake. Manoomin is very sensitive to changes in water levels. At Big Rice Lake, flooding and deep water prevent seed germination, whereas low or stable water conditions encourage the proliferation of other vegetation, such as ginoozhegoons, which can outcompete Manoomin for space and resources. Climate change could change precipitation patterns, which may increase both the likelihood of drought and the frequency of heavy rain events that can cause flooding in Big Rice Lake.

About Big Rice Lake

Big Rice Lake, located in St. Louis County in northeastern Minnesota, is approximately 1,870 acres. Archeological evidence indicates human use on sites surrounding the lake for hundreds – perhaps thousands – of years for ricing, sugar bush, and hunting activities.

The lake is an important feeding and resting area for migrating waterfowl. In years of good Manoomin production, mallards, goldeneyes, wood ducks, blue winged teal, and ring-necked ducks use the lake. In 1992, Big Rice Lake became a Designated Wildlife Lake because of its "outstanding value to wildlife." Currently, the lake supports a bald eagle nesting territory, as well as muskrats, minks, beaver, otter, great blue herons, and trumpeter swans.

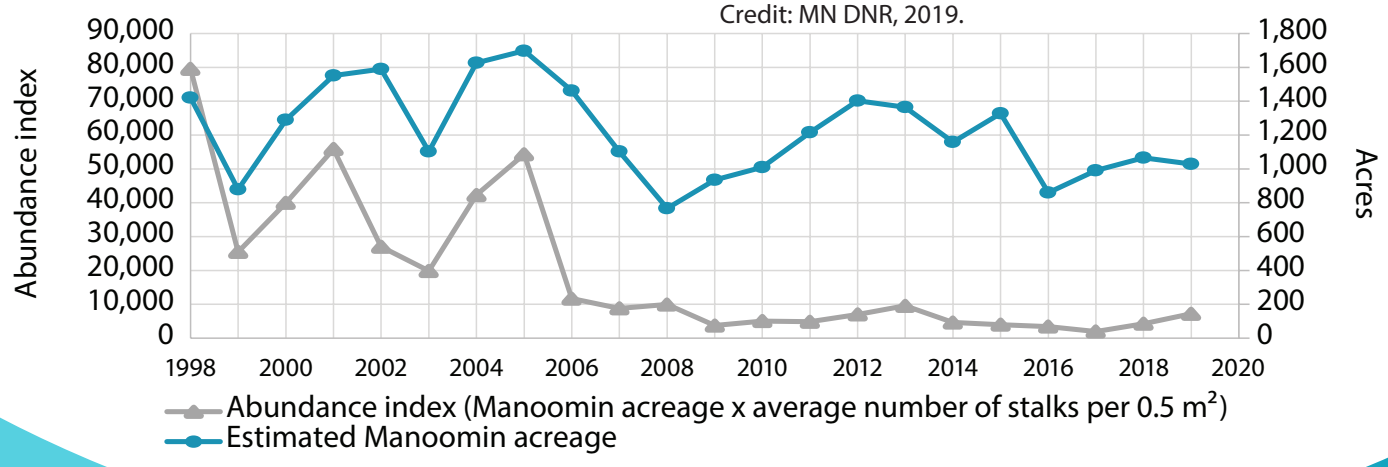
Actions taken to improve the abundance of Manoomin at Big Rice Lake

Natural resource managers have taken several actions to increase Manoomin at Big Rice Lake. In 1995, federal and state agencies built a rock weir at the outlet of the lake to increase the water flow out of the lake and reduce rapid water-level changes that can negatively impact Manoomin growth (MN DNR, 2013). Since its installation in 1995, the weir's height has been adjusted several times. Natural resource managers lowered the weir in 2005 and reestablished it in 2007 to create unfavorable conditions for ginoozhegoons and other vegetation that competes with Manoomin. Initially, the installation of the rock weir seemed to improve Manoomin coverage at Big Rice Lake; however, despite adjustments to the weir, the more stable water level favored ginoozhegoons over Manoomin. Manoomin dramatically declined in 2006, as shown in graph below.

Since 2006, a cooperative effort of several federal, state, and tribal partners have taken additional management activities to further support Manoomin (Vogt, 2020). The Fond du Lac Band of Lake Superior Chippewa provided equipment and staff to cut ginoozhegoons. More recently, the Band used an airboat with chains to disturb the substrate of Big Rice Lake to encourage the germination of Manoomin seed in several test plots (Vogt, 2020). These efforts control about 100 acres of ginoozhegoons each year, but Manoomin regrowth in cut areas has been minimal (Vogt, 2020). Over the years, partners have also trapped beavers and removed beaver dams to control water levels.

Natural rock rapids at the outlet of Big Rice Lake in 1992. Credit: MN DNR, 2019.

Rock weir at the outlet of Big Rice Lake in 2016. Credit: MN DNR, 2019.



Manoomin Biomass and Stalk Density on Big Rice Lake.

Approach to characterizing Manoomin at Big Rice Lake

Twelve metrics characterize the cultural and ecological functions of Big Rice Lake's Manoomin and its associated habitat. These metrics describe how Manoomin at Big Rice Lake 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.

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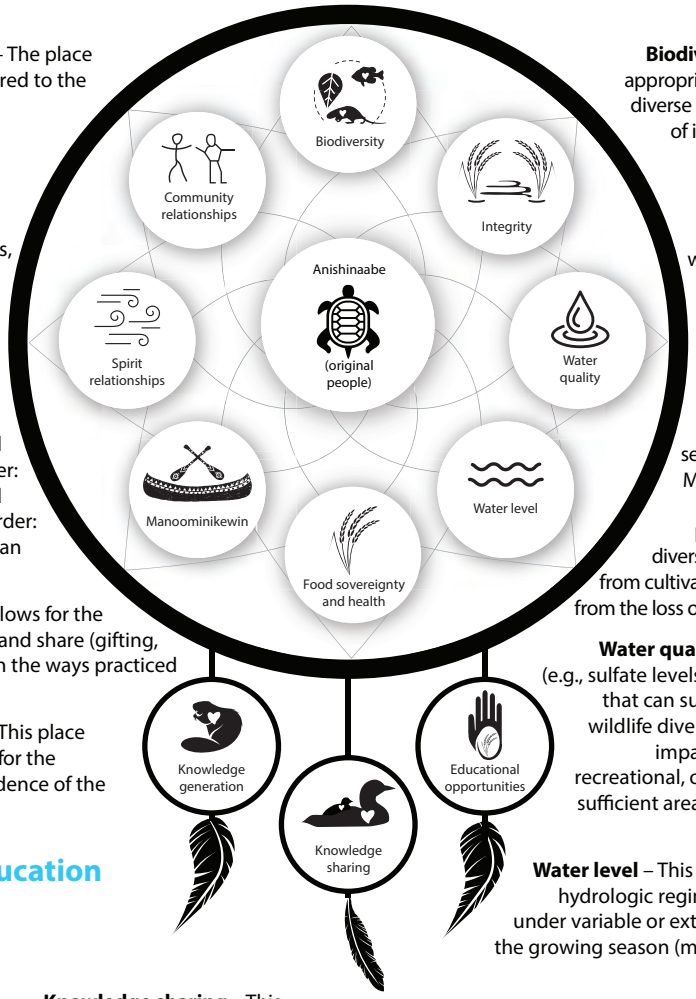


Ecological Metrics

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 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.

Cultural and ecological characterization at Big Rice Lake

Big Rice Lake's Manoomin and its associated habitat were characterized over three time periods. Each metric was ranked using the following five-point descriptive scale:

No use · Very bad · Not very good · Pretty good · Doing great

1900 to 1995: Before rock weir construction

Based on the combined ranking of the cultural and ecological metrics, Big Rice Lake was characterized as "pretty good." During this period, Big Rice Lake was dominated by Manoomin with variable production across years, which provided high-quality waterfowl and wildlife habitats, and the opportunity for harvesting. The lake was culturally and historically important to Ojibwe Bands who used the lake during this period and exercised their treaty rights.

1995 to 2005: After rock weir construction

Immediately after the installation of the rock weir in 1995, Manoomin coverage at Big Rice Lake seemed to improve in some years. However, over time the more stable water level favored ginoozhegoons over Manoomin, and Manoomin began to decline, although it remained at the "pretty good" ranking score based on the combined ranking of cultural and ecological metrics.

Credit: 1854 Treaty Authority.

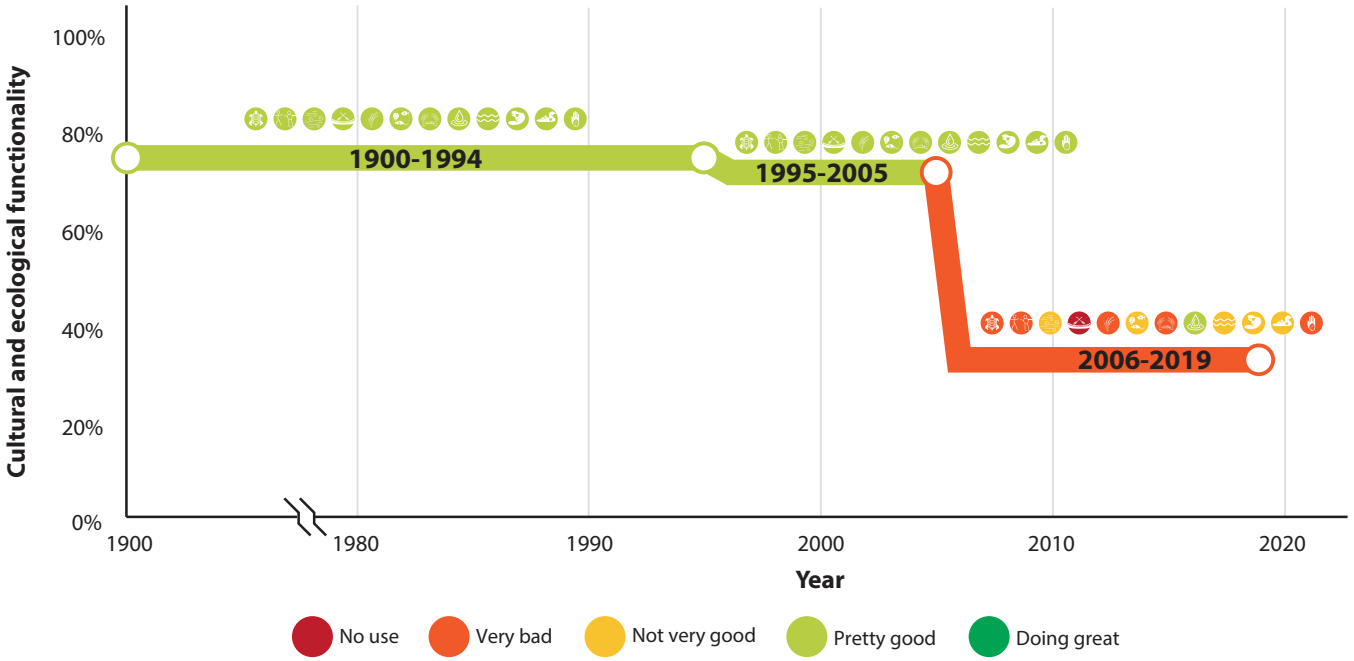
2006 to 2019: With active management of Manoomin

By 2006, Big Rice Lake ranked as "very bad" based on the combined ranking of cultural and ecological metrics. Hydrologic changes, competition from ginoozhegoons, and perhaps other unknown factors led to the dramatic decline of Manoomin. From 2006 to 2019, natural resource managers took active management steps to recover Manoomin at Big Rice Lake; however, it remained sparse in coverage, with only a few small, moderate-to-good density stands found on the lake. As a result, community members were unable to harvest, prepare, and share Manoomin in ways practiced by their ancestors. This also limited sharing, transmittal, and generation of Anishinaabe practices. The decline in Manoomin has also negatively affected migratory waterfowl that use the lake.

Credit: Lien, 2018.

Cultural and ecological characterization of Big Rice Lake

Cultural and ecological services provided by Manoomin and its associated habitat at Big Rice Lake decreased over time, both in total and for individual metrics.



Additional restoration needed

Since the 1990s, natural resource managers have tried to improve the conditions of Manoomin and its associated habitat at Big Rice Lake; however, recent actions have not been successful and conditions continue to be diminished.

If actions were taken to improve conditions in the future – such as the new restoration funding aimed at returning the natural functionality of the lake (Helmberger, 2019), we could use a Habitat Equivalency Analysis (HEA) to demonstrate the additional equivalent units of restoration that would be 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%, we would need over 400,000 acres of similar Manoomin restoration to counter-balance the lost habitat functionality that has occurred over time (from 1995 to 2019). This is equivalent in size to over 200 Big Rice Lakes. The table below 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.

Hypothetical percentage of improvement in habitat functionality	Acres needed to counter-balance historical losses given hypothetical improvement *(Acres rounded to the nearest hundred)*	Number of Big Rice Lakes needed to counter-balance historical losses given hypothetical improvement
2.5%	411,900	220
5.0%	205,900	110
10.0%	103,000	55
20.0%	51,500	28

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About this effort

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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. In addition, the Project Team would like to thank Thomas Howes (Fond du Lac Band of Lake Superior Chippewa), Tara Geshick (Bois Forte Band of Lake Superior Chippewa), Daniel Ryan (U.S. Forest Service), and Melissa Thompson and Tom Rusch (Minnesota Department of Natural Resources) for participating in the cultural and ecological characterization of Big Rice Lake.

GREAT LAKES Wild Rice INITIATIVE

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

The Twin Lakes are located immediately downstream of the tailings basin for U.S. Steel's Minntac iron ore operation. The 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

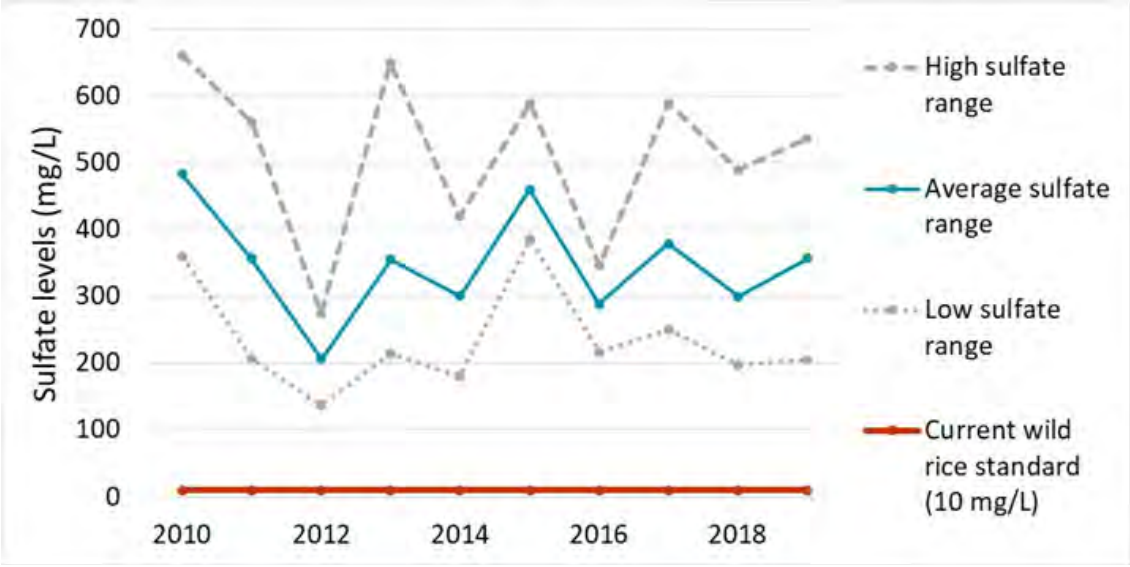
The Twin Lakes are located in St. Louis County in northeastern Minnesota. Sandy Lake is approximately 120 acres and Little Sandy Lake is approximately 90 acres. Prior to mining operations, the Twin Lakes produced good stands of Manoomin and were important ricing sites for Ojibwe Bands and vital habitat 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.

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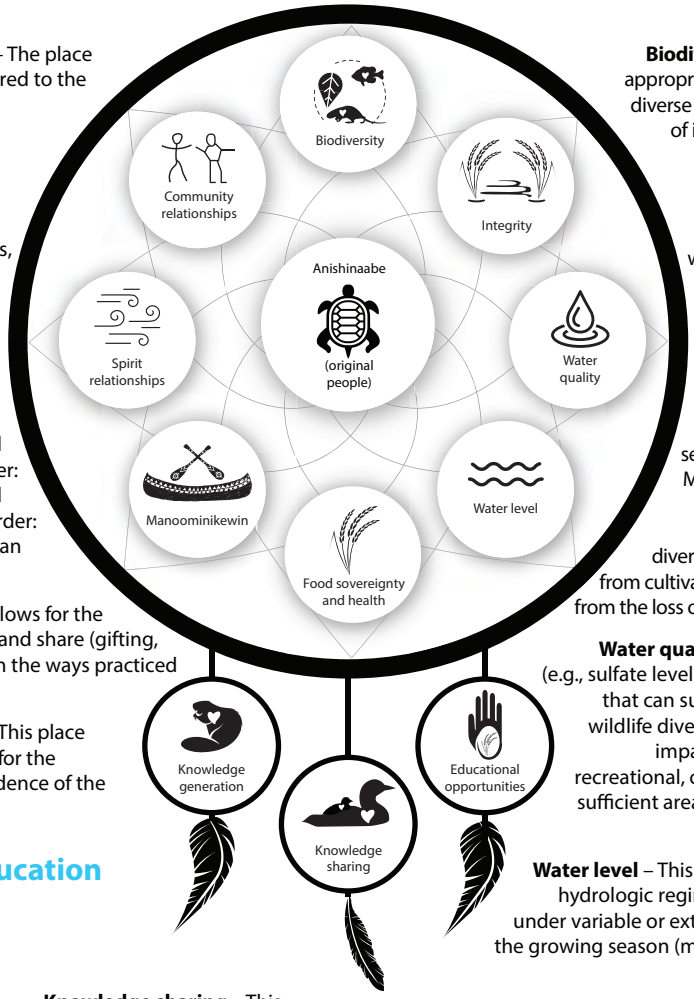


Ecological Metrics

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).

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

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 "pretty good" 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 (Michigan 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 (Michigan 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

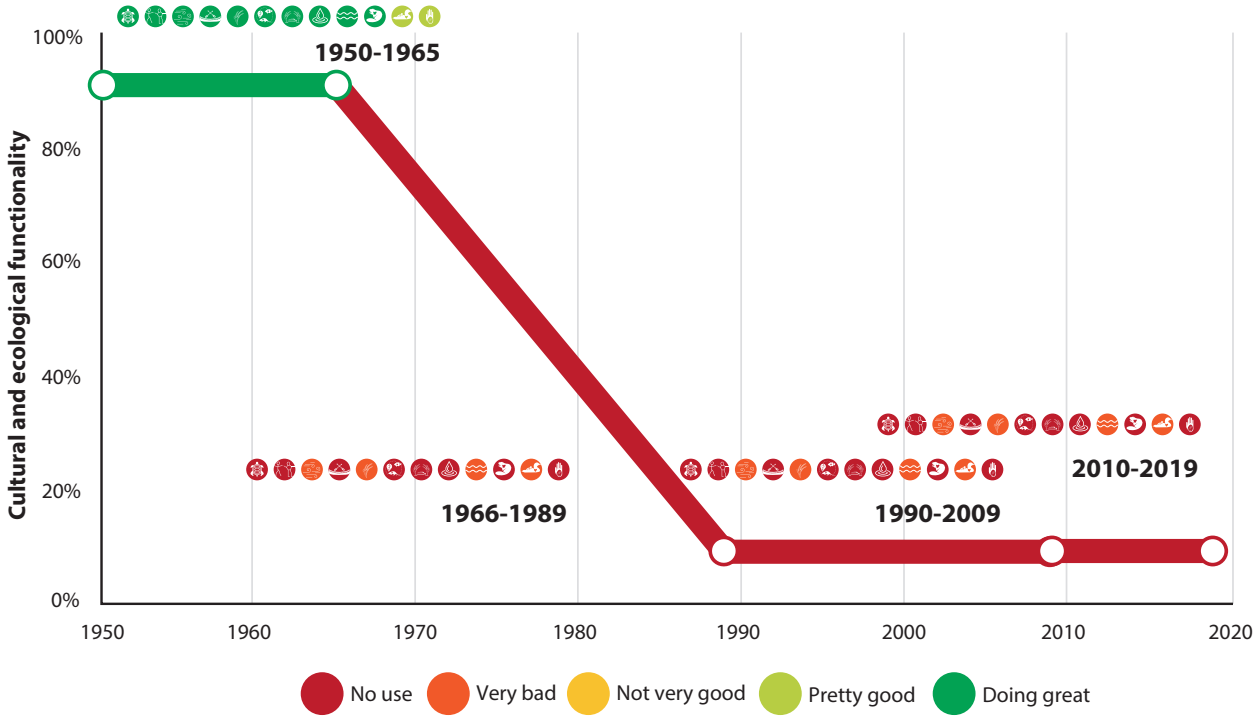
During this period, some actions were undertaken to recover Manoomin, including beaver management and small-scale reseeding efforts. However, these actions did not address the fundamental issue of high levels of sulfate and were largely ineffective at restoring the abundance of Manoomin and its associated 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 below 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 Big Rice Lake (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 this lake.

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.

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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. For additional information about this effort and results from the other case studies, please see the full report at [insert URL].

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