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MINONG FLOWAGE

WASHBURN AND DOUGLAS COUNTIES

2024-28 AQUATIC PLANT MANAGEMENT PLAN
WDNR WBIC: 2692900

Prepared by: Dave Blumer, Lake Educator

MINONG FLOWAGE ASSOCIATION
MINONG, WI 54859

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PREPARED FOR THE MINONG FLOWAGE ASSOCIATION

INTRODUCTION

The Minong Flowage (Flowage), located in northwestern WI, is a popular destination for fishing, boating, water sports, and swimming. The very popular Totogatic County Park owned by Washburn Co., Swift Nature Camp, a private nature camp for youth, and several private campgrounds bring in visitors from near and far to enjoy what the Flowage has to offer. The Flowage is also an important resource for wild rice harvest and production, consistently ranking in the top ten annually for rice producing water bodies in Wisconsin. The dam that creates the Flowage is owned by Washburn Co. and leased by Renewable World Energies to create hydro-electric power in the area.

In 2002, Eurasian water milfoil (EWM), an aquatic invasive plant species, was found in the Flowage. A subsequent aquatic plant survey determined that EWM was likely present in the Flowage several years before being detected. Predictions made at that time suggested EWM would only grow to nuisance levels in about 100 acres of the Flowage in any given year. Unfortunately, this was not the case, as by 2008 the amount of moderate to dense growth EWM in the Flowage exceeded 300 acres.

Since 2008, the Minong Flowage Association (MFA) in cooperation with the Wisconsin Department of Natural Resources (WDNR), Washburn and Douglas Counties, Tribal entities including the Great Lakes Indian Fish and Wildlife Commission (GLIFWC) and St. Croix Chippewa Indians of Wisconsin, Renewable World Energies, and other stakeholders, has been managing the Flowage with the goal of controlling EWM and maintaining the health and overall quality of the Flowage.

To that end, there are many different management areas on the Minong Flowage that will be referenced throughout this document (Figure 1). The East Basin and northern third of Serenity Bay are where most wild rice is located. Serenity Bay, North Basin, North Shore, and several areas north of the DNR Bay contain large submerged and emergent stump fields. The Totogatic River flows into the Flowage through the East Basin, with additional flow coming from Cranberry Lake and Cranberry Flowage through the Channel to Cranberry. The Central Basin is a wide open flat approximately 9-12 ft. deep with several islands popular with lake users. The North and West Shores have several shallow flats but are generally deeper water with steeper shores. DNR Bay is home to the Swift Nature Camp and the WDNR owned public boat landing. The County Park area is home to the other public boating landing, campground, and popular swimming areas. Delcore Pond is the small water body adjacent to the County Park and connected to the Flowage through a short, narrow, shallow channel. The East Bay is moderately deep and has several shoreline areas with a mucky bottom. The Deep South Basin is an area of steep shores and deeper water, up to 20+ feet, except for a large shallow flat midway through the area. The hydro-electric dam is located on the extreme south end of the Flowage. Both above and below the Minong Flowage, the Totogatic River has been given a Wisconsin Wild River designation.[1]

[1] https://dnr.wisconsin.gov/topic/lands/totogatic/info

Despite being considered part of the Minong Flowage by the WDNR and GLIFWC, Cranberry Flowage north of Hwy T is not considered part of the management area under the responsibility and guidance of the MFA and its consultants. The Cranberry Lake Association works with its own consultants to manage this area and Cranberry Lake, north of the Cranberry Flowage.

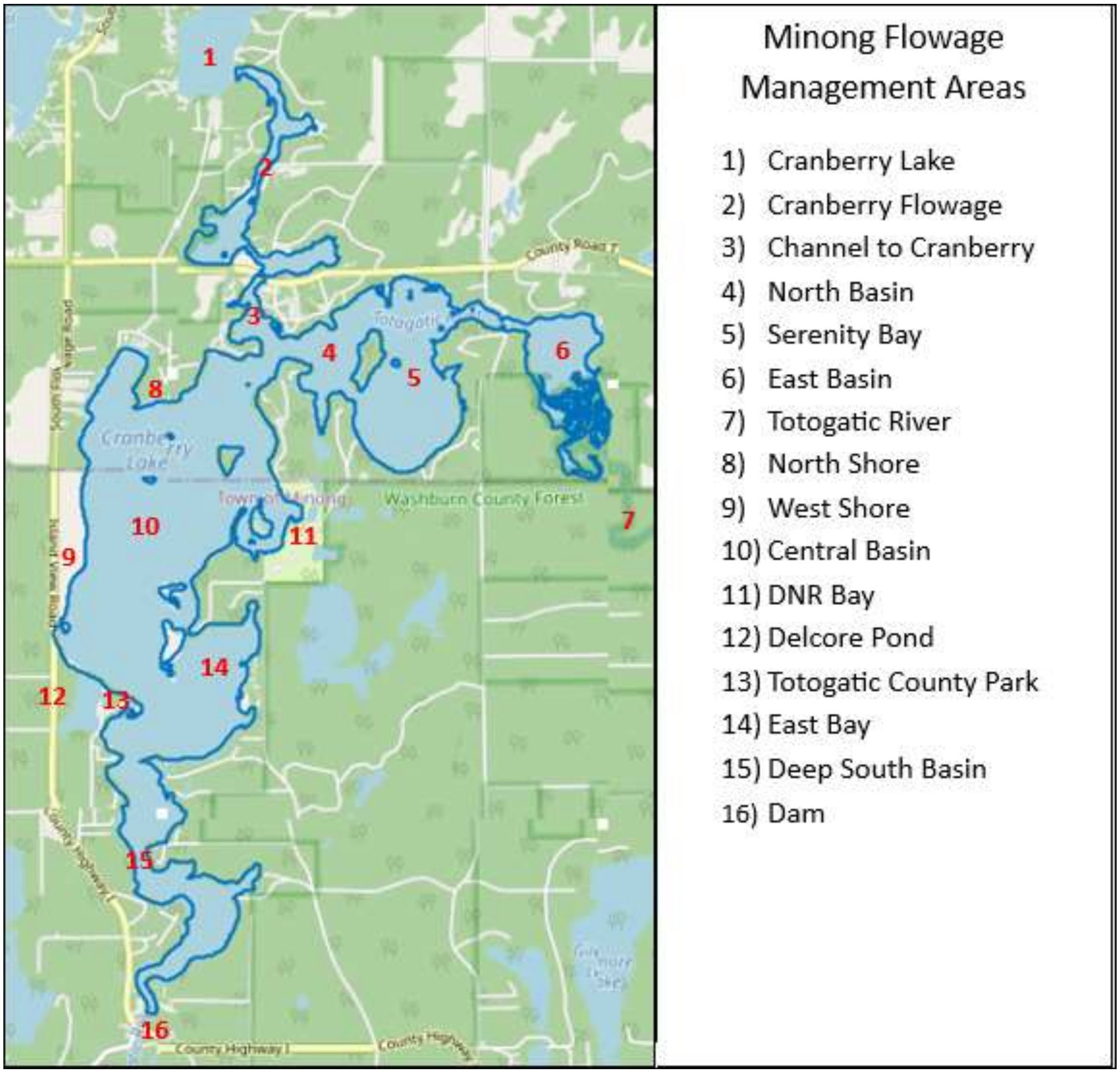


Figure 1: Management areas within and adjacent to the Minong Flowage

An Aquatic Plant Management (APM) Plan was completed in 2009 that laid out a strategy to restore the aquatic plant community to what it may have been more like prior to the introduction of EWM. Aggressive management actions that included the use of aquatic herbicides, physical removal, biological control, and an unexpected drawdown of 5-1/2 feet that lasted 11 months through the spring, summer, fall and winter of 2013 into 2014 reduced the level of EWM from over 300 acres in the fall of 2008 to just under 15 acres in the fall of 2014. The drawdown was the result of a dam update/repair project required by the State to bring it up to current code. Despite the highly reduced amount of EWM after the extended drawdown, EWM reclaimed much of its former area within a couple of seasons.

Per WDNR guidelines, the existing 2009-2014 APM Plan was updated beginning in early 2015 and completed in early 2016. Under the guidance of the new APM Plan, small-scale herbicide applications were completed in the spring of both 2015 and 2016. The 2015 application served as a tool to evaluate herbicide movement in the Flowage, particularly in the Serenity Bay and North Basin areas of the Flowage. The 2016 application was the first under the guidelines of the new 2016-2020 APM Plan. It was also the last herbicide application to be completed until the spring of 2023.

Between 2015 and 2023 other forms of management were evaluated including removal of EWM by diver, and by Diver-Assisted Suction Harvest or DASH. A dye study was completed in 2015 to determine the potential movement of herbicide within and out of Serenity Bay and the North Basin. Planning began for a winter drawdown solely for the purpose of EWM control in 2018, but permitting issues and other questions related to a winter drawdown delayed it until the winter 2021/22. During that time, the 2016-2020 APM Plan was extended to cover management until the end of 2023.

This document is a summary of all management actions that occurred from 2014 to 2023, expands on management alternatives that could be implemented in the Flowage to control EWM and other aquatic invasive species (AIS), evaluates changes in the native aquatic plant community and water quality, and makes management recommendations for the next five years.

MINONG FLOWAGE ASSOCIATION

The Minong Flowage Association (MFA) is a non-profit organization whose lake property owners have a common goal to help maintain the quality of the Minong Flowage, surrounding shorelines, and the lake life they both provide. The MFA serves as a voice for lake property owners providing an avenue for input of ideas and concerns.

From its by-laws, the purpose of the MFA is to work with city, county and state governments and their agencies to ensure the lake's ecosystem and quality of life are managed in such a way that it benefits members, residents, lake property owners and all who use the lake. The ecosystem refers to but is not limited to quality and depth of water, shoreline, flora, fauna, fish, surrounding lands, and the Totogatic River.

The management and direction of the MFA is determined by its membership. A Board of Directors manages and directs MFA business between meetings, subject to ratification at the annual meeting usually held in June. At any given time, the Board consists of no less than seven and no more than nine members, with an odd number preferred for voting purposes.

The MFA Board holds quarterly meetings to:

- Review and act on property owner input.
- Give guidance on how to adhere to WDNR, county and state regulations.
- Provide administrative efforts for grant applications which fund programs to keep the water clean and the community safe.
- Create communications to property owners via email, website, and Facebook.

For more information on the Minong Flowage Association, click on the following link: http://www.minongflowage.org .

MINONG FLOWAGE DAM

The roughly 1560-acre Minong Flowage was created in 1937 when a dam with an 18-ft head was installed on the Totogatic River. The dam is currently leased by Renewable World Energies, Inc for production of hydro-electric power. In 2010 an assessment of the dam changed the state hazard rating for the dam from “significant” to “high” (Ayres Associates, 2012). The assessment concluded that the existing dam could not handle the required 1000-year flood event without over-topping. The maximum discharge from the old dam during a high-water event was only 3,065 cubic feet per second (cfs), far short of the required 12,340 cfs for a 1000-year flood event. Washburn County was given 10 years to upgrade the dam. In 2011 several alternatives for upgrading the dam were presented, and a design was chosen. In 2013, the old dam was replaced by a new dam (Figure 2) with a structural height of 27-ft and a goal of keeping the water level in the Flowage at the normal pool elevation previously established.

Figure 2: New dam on the Minong Flowage, May 2014

IMPAIRED WATERS AND AQUATIC INVASIVE SPECIES

The Minong Flowage was evaluated for impaired water status under WI 303d impaired waters program in every two-year cycle from 2012 to 2022. Phosphorus and algae data indicate a healthy lake system, putting the Flowage on the 2022 Healthy Waters List. At one point, the Flowage was listed as an impaired water due to mercury contamination in fish tissue, but that designation was removed in 2009.

In the Minong Flowage, EWM (2002), Chinese mystery snails (2013), curly-leaf pondweed (CLP) (1994), common carp (?), purple loosestrife (2014), and rusty crayfish (?) have been identified and vouchered.

ACCESS, DEVELOPMENT, AND RECREATION

The Flowage can be accessed through several public and private boat landings. The WDNR owns a landing on the east side of the Flowage, and there is a county landing on the west side at the Totogatic

County Park. There are two other public access points, one just off Smiths Bridge Road on the east side, and one on the south end of Cranberry Lake in Douglas County. Boats can travel between Cranberry Lake and the Minong Flowage via the Cranberry Flowage which flows under the Hwy T Bridge near Wascott. Pogo's Inn also maintains a private access point adjacent to the Hwy T Bridge. There are numerous other unregulated, private access points at people's homes or cottages.

The shoreland around the Flowage is well-developed with approximately 300 property owners. It is home to the Totogatic County Park. Totogatic Park offers a 107-site modern campground with showers, flush toilets, beach, boating, firewood, ice, pavilion, playground, basketball, and volleyball courts. The park offers a unique opportunity for water-based recreation with most of the campsites directly on the lake shore. Sandy lake bottoms and easy access to the water allow for swimming and boat mooring at many of the sites. The lake is also home to Swift Nature Camp, a summer camp for boys and girls ages 6-15 to learn about nature and the environment. There are two resorts on the lake, one seasonal with a bar area and one that is open year-round with a restaurant/bar. Both offer private RV sites with the seasonal resort expanding to 40 sites in 2024. There is one restaurant/bar with approximately 10 RV sites that operates seasonally. Cranberry Lake has 3 resorts that support 200 RV sites and 75 boat slips. These resorts have access to the Minong Flowage via the Cranberry Flowage. Private home rentals are numerous and expanding including a new 14-bedroom house/lodge. Combined, these enterprises increase the public use of the Flowage. As an example, the number of boats and people contacted at the County Campground landing through watercraft inspection/Clean Boats, Clean Waters monitoring in 2023 was more than 2.8 times for boats and more than 1.6 times for people than were contacted in 2022, with only 6 more hours of inspection time.

The Minong Flowage is above average for walleye production and is a popular destination for local and visiting fishermen. The fishery consists mainly of walleye, but also has abundant northern pike, largemouth bass, bluegill, black crappie, and yellow perch. Smallmouth bass, rock bass, pumpkinseed, black bullhead, yellow bullhead, and carp are also present. Large open-water areas are popular for boating, water-skiing, and tubing, with several sand bar/island areas that are popular swimming destinations. Smaller back water areas and the miles of shoreline are popular canoe and kayak areas. The Flowage is an important resource for wild rice harvest and production, consistently ranking in the top ten annually for rice producing water bodies in Wisconsin. The East Basin is popular with local duck hunters. In the winter, snowmobiling and ice fishing are popular.

Many on the Minong Flowage feel there is more boat traffic coming from Cranberry Lake and the Cranberry Flowage, though there is no data to confirm this. Watercraft inspection is not being completed at the Cranberry Lake public boat landing. An increase in the number of campground sites at both Cranberry Lake campgrounds, an increase in the number of sites at the Totogatic County Park, and increased use of VRBOs (Vacation Rentals by Owner) and Airbnb's likely support the feeling that boat traffic and public use of the Flowage is increasing.

This increase in use comes with its own issues. The Minong Flowage, like other water bodies in Wisconsin, sees its share of large wake-generating boats used for surfing and wake boarding. The maximum depth of the Flowage in its largest basins is only 12ft, with an average depth of only 7-8ft. Wake boats can disturb sediment and dislodge aquatic plants in water as deep as 20ft. There are other lake issues caused by wake boats as well. Figure 3 shows many of the hazards associated with wake boats.

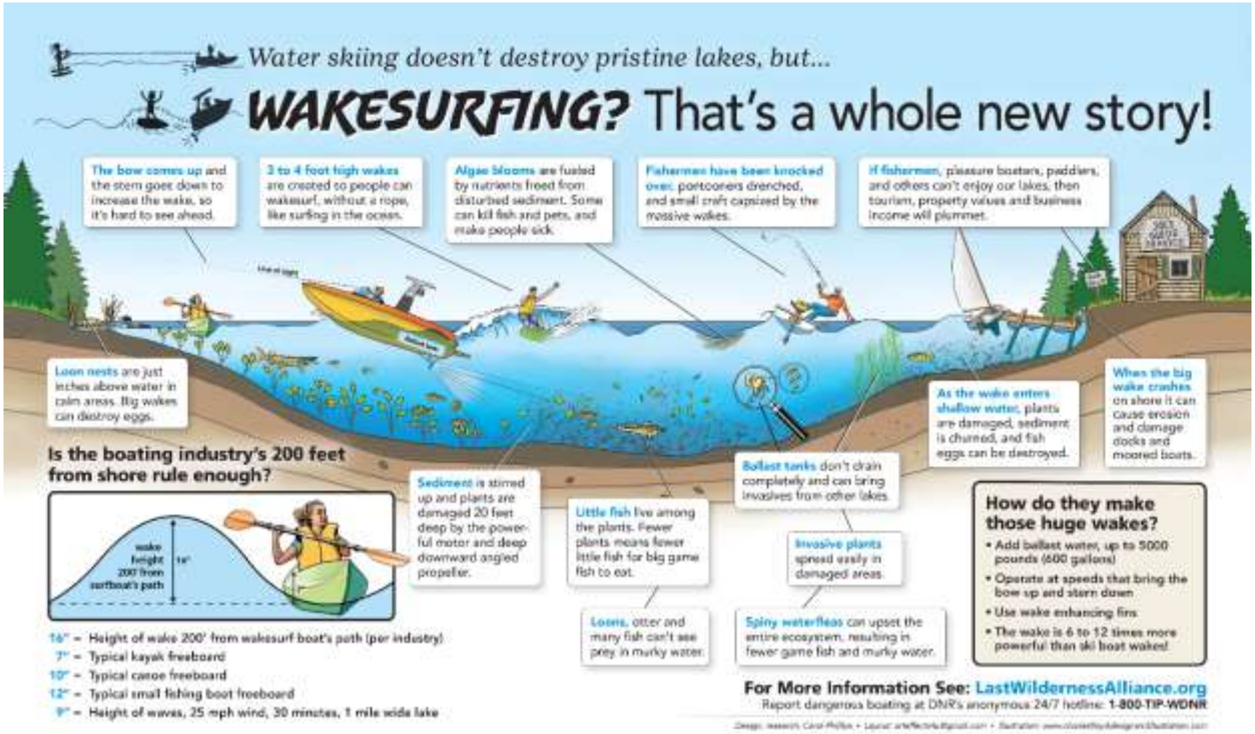


Figure 3: Impacts of wake boats on lakes (Last Wilderness Alliance)

But it is not just increased boating that negatively impacts the Flowage. Most of the shore, including that of the several islands within the Flowage, is sand. The islands are very popular with lake users. Figure 4 is a photo taken in 2022 of lake users loving one of the islands to death. While no damage was intended by those constructing this "slip and slide", running up the sandy bank to get to the top of the slide, done despite the informational signs put in place to help protect the island, wears away the structure that holds the island in place.

Figure 4: Slip and slide installed on Sand Island in the Minong Flowage, July 2022

NEED FOR MANAGEMENT

Aquatic plants are the most important part of a lake ecosystem. A lake's rooted plants are the basis of the aquatic ecosystem. They capture the sun's energy and turn it into usable food, "clean" the water of excess nutrients, stabilize shorelines and lake beds, and provide habitat for other organisms like the lake's fish populations. Because of this, preserving them is critical to maintaining a lake's overall health.

In Wisconsin, there are generally two main reasons why aquatic plant management is considered: 1) There are demonstrated ecological changes because of one or more specific aquatic plant (target plant).; and 2) Lake use is restricted or obstructed by one or more specific aquatic plants.

To determine if the first reason applies questions like "has the target plant spread, and/or gotten denser"; and "has that spread and increase in density negatively impacted other, more desirable aquatic plants (non-target plants)?" need to be answered. If the answer to these questions is generally "no", then aquatic plant management is likely not necessary. To determine if the second reason applies, where, when, and what species is causing restricted or obstructed lake use must be determined.

Non-native, aquatic invasive species like EWM and CLP can be problematic, but only when they take over habitat previously filled with other, likely more desirable native aquatic plants, creating a more monotypic plant community. Diversity is key. Generally, the more diverse the aquatic plant community is (i.e. a greater number of different aquatic plants in a lake) the healthier the lake is. The Minong Flowage has a diverse native aquatic plant community consisting of 77 different species (rake, visual, & boat survey) in 2023 and only 151 acres of EWM with an average rake density of 1.49. In 2008, when there were 325+ acres of EWM with an average rake density of 1.93, there were only 65 different species (rake, visual, and boat survey). The average rake density for all aquatic plant species in 2008 was 2.69, in 2023 it was 2.20. Though it is impossible to account for all the changes in the aquatic plant community simply due to the presence of EWM, it is reasonable to assume that if EWM was left unmanaged, it would negatively impact the aquatic plant community.

The presence of EWM does impact lake use and access. Large areas of dense growth EWM have impacted swimming and boating areas adjacent to the County Campground. In the DNR Bay, dense growth EWM has impacted lake use by the Swift Nature Camp and created a major source of EWM potentially being transported by careless boaters away from the DNR boat landing. Property owners in Serenity Bay and the North Basin have had restricted access to open water due to large, dense beds of EWM at times. In a more extreme example of lake use restriction, the presence of dense growth EWM in Serenity Bay hampered the search for two drowning victims in late 2023.

Both reasons why aquatic plant (EWM) management should occur in the Minong Flowage are confirmed beyond reasonable doubt.

EWM MANAGEMENT

First identified in 2002, by 2008, EWM had taken over more than 325 surface acres or nearly 21% of the 1,560-acre Minong Flowage. Management actions including physical removal, the use of herbicides, biological control, and drawdown implemented between 2009 and 2014 reduced the surface area of EWM to less than 20 acres surveyed in the fall of 2014. However, despite a 16-acre herbicide application in the spring of 2015 and diver/DASH removal, by the fall of 2015 EWM rebounded to cover more than 90 acres. After a 27-acre herbicide application in the spring of 2016, by the fall of 2016 EWM was up to more than 125 acres. The herbicide application of 27 acres in the spring of 2016 was the last large-scale management action implemented on the Flowage until the 2021/22 winter drawdown. Between 2016 and 2021 fall EWM fluctuated between a low of 85 acres in 2018 and more than 205 acres in 2021 before the drawdown was implemented. In the fall of 2022, after the drawdown, there was 116 acres of EWM. This increased to 151 acres in the fall of 2023 despite a 15 acres herbicide application in the spring of 2023.

Figure 5 shows all the EWM in the Minong Flowage south of the Hwy T bridge mapped in 2008 (left), and the total area of the Flowage covered by EWM when overlaying all fall bed mapping results from the last 8 years (2016-2023). Table 1 compares the bed number and acreage between the two maps. From the two maps, if left unmanaged, EWM will again reach levels comparable to 2008.

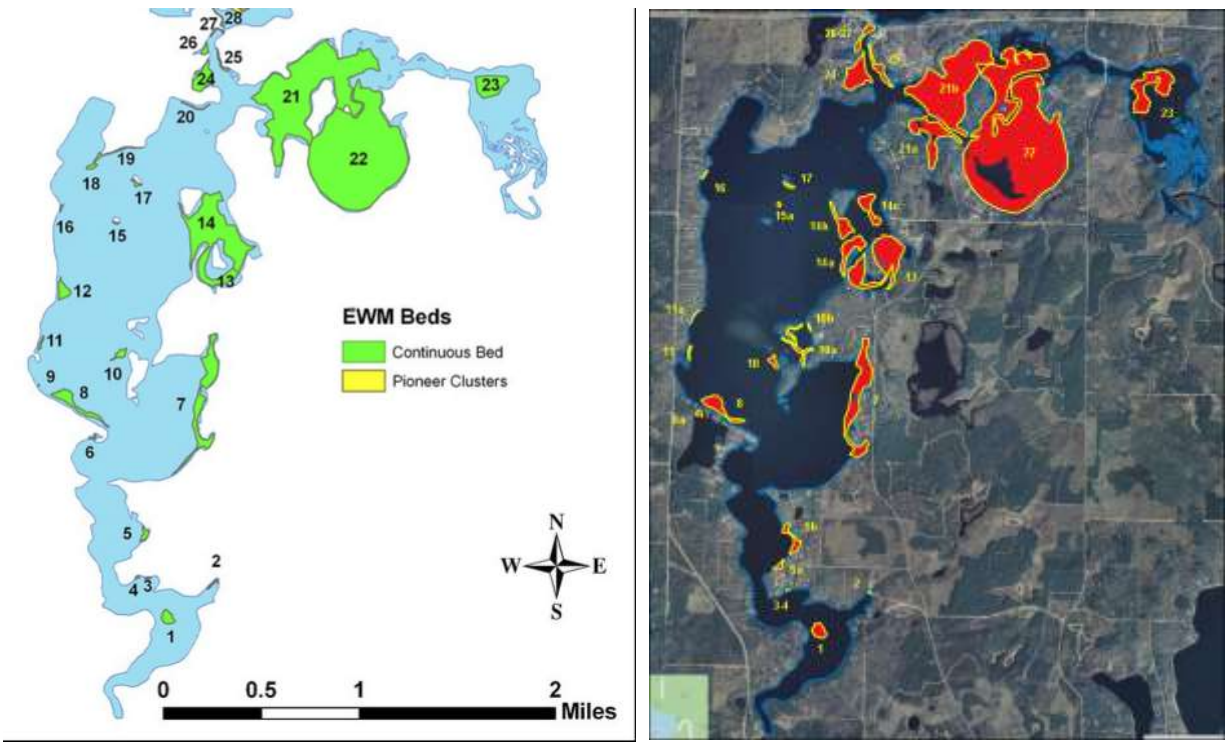


Figure 5: Left - 2008 EWM bed mapping (326 acres); 2016-23 overlap of EWM bed mapping (312 acres)

Table 1: Bed # and total acreage from 2008 and the combined mapping results from 2016-2023

EWM Bed #	2008 Acreage	Combined 2016-23 Acreage
1	2.14	2.3
2	0.28	0.09
3	0.13	0.07
4	0.13	
5a	1.07	0.65
5b		2.47
6	0.23	NB
7	16.03	16.84
8	5.3	4.62
8a	Delcore Pond	0.43
9	0.02	NB
10	1.21	0.99
10a		2.57
10b		0.11
11	0.38	0.4
12	2.56	NB
13	8.17	21.2
14a	38.24	5.02
14b		4.1
14c		4.2
15	0.12	NB
15a		0.19
16	0.1	0.16
17	0.44	0.36
18	1.1	NB
19	0.5	NB
20	0.42	NB
21a	96.95	12.13
21b		55.98
22	133.63	151.44
23	8.92	13.09
24	5.89	8.09
25	0.72	2.66
26	0.75	2.03
27	0.32	
	325.75	312.19

Controlling the spread of EWM in the Minong Flowage is going to take more than just regular winter drawdowns or large-scale application of aquatic herbicides. Where EWM thrives in the Flowage is just too diverse. The last winter drawdown proved effective at controlling EWM in water up to 5ft in depth. It did not however have any lasting impact on EWM in deeper areas of the Flowage. Herbicide applications are effective but must be done in a manner that does not negatively impact areas of the Flowage with wild rice which likely rules out any application in the northern half of the North Basin, the northern half of Serenity Bay, and the basin east of Smith's Bridge. Diver and DASH removal can be used in a few areas, but dark water and underwater obstructions limit where, and experience has shown that the amount of EWM that can be removed by these methods is minimal and comes at a high cost. Although mechanical harvesting could be used in some areas, harvesting of EWM is not usually done unless other management alternatives are ineffective or prohibited.

An integrated approach, using many management alternatives is recommended. Small-scale physical removal (hand and rake) by individual property owners, larger scale physical removal (hand and rake) by trained teams, diver removal/DASH, application of herbicides, and winter drawdown should all be combined to prevent EWM from increasing in distribution and density while at the same time maintaining or improving the native aquatic plant community.

The management discussion section of this APM Plan that begins on page 137 provides greater detail about these management actions and suggests a scenario-based approach to implementing them. The management section of this APM Plan is also pulled out in its entirety and made a separate document in Appendix A.

OVERALL MANAGEMENT GOAL

The main management goal of this plan focuses on protecting and enhancing the native aquatic plant diversity, distribution, and density that exists in the Flowage. Establishing a healthy and diverse native aquatic plant community is the most important factor in ensuring the Minong Flowage does not experience deteriorating conditions over the next five years. The most important objective for this goal is to prevent EWM and/or other AIS from becoming the primary aquatic plants in the system. Between 2002 and 2008 when no management was occurring, EWM expanded in distribution and density to impact more than 330 surface water acres (>21%). Management between 2009 and 2014 that included three years of large-scale herbicide application and an extended (March-February) drawdown brought the total area to <20 acres. Between 2015 and 2021 and despite two years of smaller-scale herbicide application (2015 & 2016), distribution and density increased to over 200 acres. A winter drawdown was implemented over the 2021-22 season with less than expected results. During this time, the native aquatic plant community fluctuated, but by the summer of 2023, it was as good or better than it had been since 2008 with approximately half the EWM.

This management plan presents a strategy that strives to keep EWM and other AIS in check while continuing to give native aquatic plants more time to recover and reestablish after management is implemented.

With the increased amount of public use, management actions must also maintain a lake environment that supports the rights of the public to use the resource and those of the property owners on the Flowage who are invested long-term. Large beds of EWM interfere with lake use and lower property values. Winter drawdowns may be an effective tool to control EWM, but they also limit winter recreation like ice fishing and snowmobiling.

IMPLEMENTATION GOALS

There are seven goals associated with this Aquatic Plant Management Plan. Each goal has several objectives and a list of actions to complete to help meet the objective and accomplish the goal (Appendix B). Each of these goals is important for keeping the Minong Flowage healthy and maintaining its expected uses over at least the next five years. The objectives included in this plan are measurable and presumed to be reachable and reasonable. The actions in this plan are intended to be implemented by the MFA with input and assistance from its lake constituency and from the WDNR, private consultants, and other resource professionals.

- Goal 1 – Maintain open and involved stakeholder participation in EWM management planning, implementation, and evaluation.

- Goal 2 – Protect and enhance the native aquatic plant community.
- Goal 3 – Minimize the negative impact of EWM on the native aquatic plant community, lake use and access, and the investment of property owners.
- Goal 4 – Reduce the threat that a new aquatic invasive species will be introduced and go undetected in the Minong Flowage and that existing AIS will be carried to other lakes.
- Goal 5 – Improve the level of knowledge property owners and lake users have related to aquatic invasive species and how they can impact the lake.
- Goal 6 – Improve the level of knowledge property owners and lake users have related to how their actions impact the aquatic plant community, lake community, water quality.
- Goal 7 – Complete APM Plan implementation and maintenance for a period of five years following adaptive management practices.

PUBLIC INFORMATION, INPUT, AND INVOLVEMENT

The process of managing EWM in the Flowage will continue to require sharing of information, solicitation of input, and involvement from many different stakeholders. Primary among them are the property owners and users of the Flowage, WDNR, Tribal interests, Renewable World Energies, Douglas and Washburn Counties, local businesses, and the Towns of Minong and Wascott. MFA Board Members work very hard to keep the public and other stakeholders informed and involved in management planning and implementation and will continue to do so. All meetings of the MFA are open to the public with the Annual Meeting being held in early June. The MFA publishes at least one newsletter each year that comes out in the spring. The Spring Newsletter is sent to all known Minong Flowage and Cranberry Flowage stakeholders regardless of their association membership status who have a valid email address. It announces the date of the annual meeting and conveys information about plans and activities regarding the care and management of the lake. Correspondences, meeting notes, agendas, and draft documents are posted on the MFA webpage at www.minongflowage.org.

MFA WEBPAGE/FACEBOOK PAGE

In 2023, approximately 198 individual emails were included in mass emails from the MFA to keep its constituency informed. On average, 80% of those emails were opened by the recipient. When the spring newsletter was sent out, it went to almost double the normal email distribution. In recent years, the MFA has been relying more on its private Facebook page to solicit information from its membership as it is more current and interactive. There are currently 260 members on the Facebook page versus 141 active MFA members.

MINONG TOWN LAKES COMMITTEE

The MFA maintains membership on the Minong Town Lakes Committee (MTLC) in Washburn County. This committee is an approved, standing committee sponsored by the Town of Minong Board of Directors, and consists of two representatives from each lake that is considered within the governing boundaries of the Town of Minong. This includes the Minong Flowage, Nancy Lake, Horseshoe Lake, Kimball Lake, Bass Lake, Big Sand Lake, and Gilmore Lake. It was established in 2008 to help guide the Town of Minong on matters related to protecting and managing the town's most valuable resources – its lakes. The committee meets quarterly and is positioned to have a broader perspective of the lakes for better communications and coordinating efforts for grant applications for AIS Boat Launch personnel and other matters. The Committee does not have set dues, but rather looks for donations from each lake association to help supplement its efforts.

WATERCRAFT INSPECTION-CLEAN BOATS CLEAN WATERS

Through the Minong Town Lakes Committee, watercraft inspection is completed at the County Park boat landing. Figure 6 reflects results from all the years CBCW has been completed. Most striking is the huge increase in both the number of boats inspected and people contacted in 2023 as compared to previous years with about the same number of inspection hours put in. Whether this increase is an anomaly, or the new norm is unknown. However, a review of CBCW data from other lakes and landings in the Town of Minong including Gilmore, Bear, Big McKenzie, Nancy, Lower Kimball, and Pokegama lakes do not show a similar change.[2] Watercraft inspection is also completed by the MFA at the WDNR

[2] https://apps.dnr.wi.gov/lakes/invasives/WatercraftSummary.aspx?location=66&show=landings

landing on the east side of the lake, but not at the same level. The spike seen at the County Park boat landing in 2023 is not repeated at the WDNR landing.

Figure 6: Watercraft inspection results from the County Park boat landing in Washburn County

COUNTY PARK BOAT LAUNCH FEE BOX

There is a “Fee Box” located at the County Park boat launch. It was installed circa 2008 by Washburn County in support of the MFA’s management efforts to control invasive species, primarily EWM. The County Park provides all fees collected at the boat landing as an annual financial donation to the MFA in support of costs incurred to manage invasive species in the Flowage. Since the establishment of the boat launch fee, tens of thousands of dollars have been donated to the MFA from the County Park fees. The park officials do not police the payment of the fee, it is a voluntary payment by all users of the boat landing, whether they be property owners, campers, or day users of the Flowage.

INFORMATIONAL BUOYS

The MFA places several buoys on the Flowage to inform boaters of hazards they may encounter. Four large "Milfoil Area" buoys are anchored and very visible at the last big bend at the south end of the Flowage towards the dam. This area supports a large bed of EWM and is very shallow. The buoys help move boaters out and around the area. Five "No Wake" and two "Slow 5 mph" speed limit buoys are placed in the Channel to Cranberry leading to the Co. Rd. T bridge.

STAKEHOLDERS' DISCUSSION

At least once a year, the MFA tries to set up an in-person meeting to discuss management planning, implementation, and evaluation efforts being made. Stakeholders are contacted with special emphasis made to involve the WDNR, GLIFWC, and Tribal Resources as these three generally have the most say in whatever management efforts are being considered. The first meeting is coordinated in the early spring before any management actions are finalized. In the event any stakeholder cannot attend in person, the meeting is opened to outside entities through video conferencing. During the meeting, the MFA shares what it would like to do and why. It shares results from prior year management and evaluation efforts including results from aquatic plant surveys completed. The MFA asks for and values input from all the stakeholders as it pertains to EWM management and the Minong Flowage in general. If necessary, additional meetings are coordinated at other times during the year.

These meetings are a place for open and honest dialogue about the Minong Flowage, an opportunity for stakeholders to share their concerns and opinions, and a place to explore alternatives to management proposals, all with the purpose of advancing efforts to improve, protect, and restore the Minong Flowage and the valuable resources it provides.

WATERSHED CHARACTERISTICS

The watershed of the Minong Flowage has a direct drainage basin of approximately 8.3 square miles (left side of Figure 7), and a total drainage area (for the Totogatic River) of approximately 302 square miles (Figure 7). The larger Totogatic River Watershed is more than 80% forest or woody wetland. Only 3.2% of the entire watershed is considered developed or open space (Figure 8).

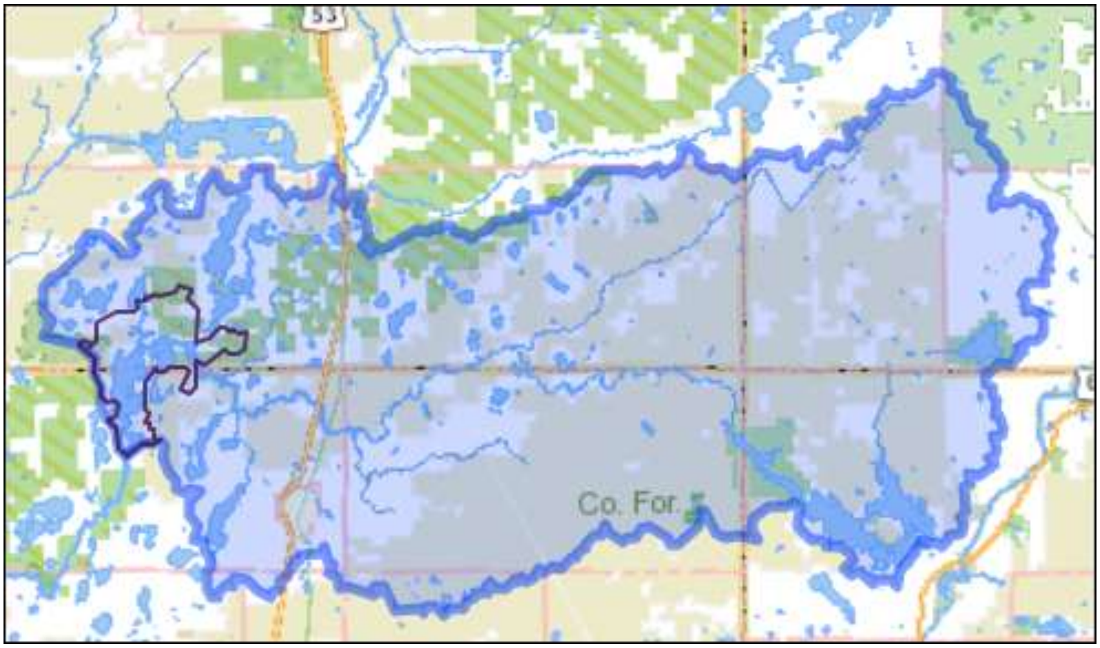


Figure 7: Direct drainage area of the Minong Flowage and total drainage area of the Totogatic River Watershed *(WEx, 2023)*

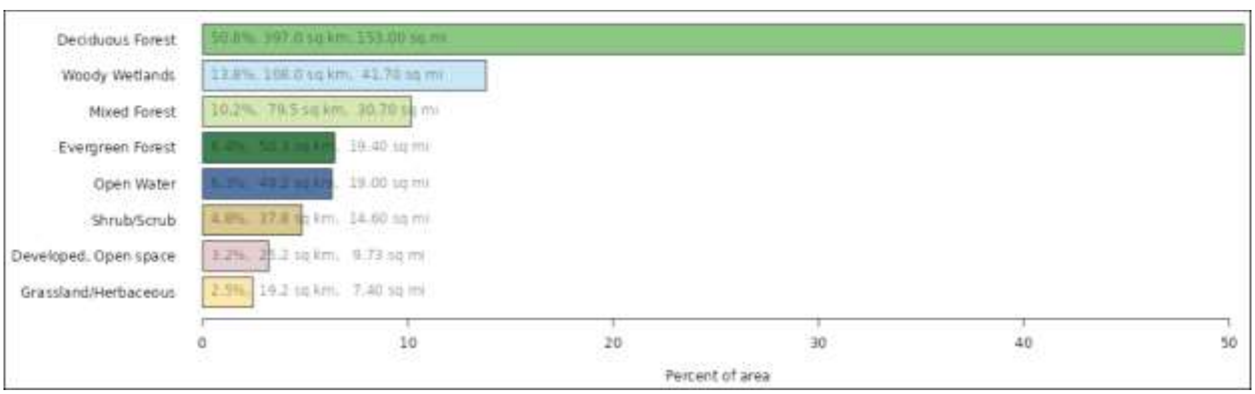


Figure 8: Land use in the Totogatic River Watershed (WEx, 2023)

MINONG FLOWAGE NEARSHORE AREA – SHORELAND HABITAT ASSESSMENT

In 2017 the nearshore area of the Flowage was evaluated following guidelines for a WDNR Shoreland Habitat Assessment. The purpose of the survey was to provide management recommendations to individual property owners on the Flowage based on an evaluation of their property. The protocol involves photographing each parcel from the lake which is then matched to land use information about the riparian zone. For this survey, the riparian zone is defined as the strip of land, along the shore, from the high-water mark and then inland to 35ft. The information collected includes ground cover (lawn, impervious surfaces, and native plants), the number of human structures in the riparian zone, and various other runoff concerns.

During the evaluation, each individual parcel was given a “priority” ranking. The priority rankings were developed by LEAPS to determine the needs of each lake relating to projects that could realistically be completed on each parcel. For the Minong Flowage, those parameters that would have the biggest impact on rainwater runoff and habitat quality - percentage of canopy cover, percentage of undisturbed vegetation, and a summed percentage of manicured lawn, impervious surfaces, and easily eroded surfaces were considered. Additional consideration was given to the number of buildings present in the riparian zone and the presence or absence of lawns that sloped directly to the lake. The worse a parcel scored during this evaluation, the higher priority ranking it received. High priority simply means that an individual property could benefit from runoff or habitat improvement projects more than a property with a lower priority. Those properties with low or no priority are already in a condition that reduces runoff and provides healthy habitat for fish and wildlife.

Of the 175 individual parcels evaluated in the Douglas County part of the Flowage, 26 had ranked “high” in priority for implementing projects to reduce runoff and improve habitat. Of the remaining properties, 26 were ranked “moderate”, 30 ranked “low”, and 93 ranked “no priority” (Figure 9).

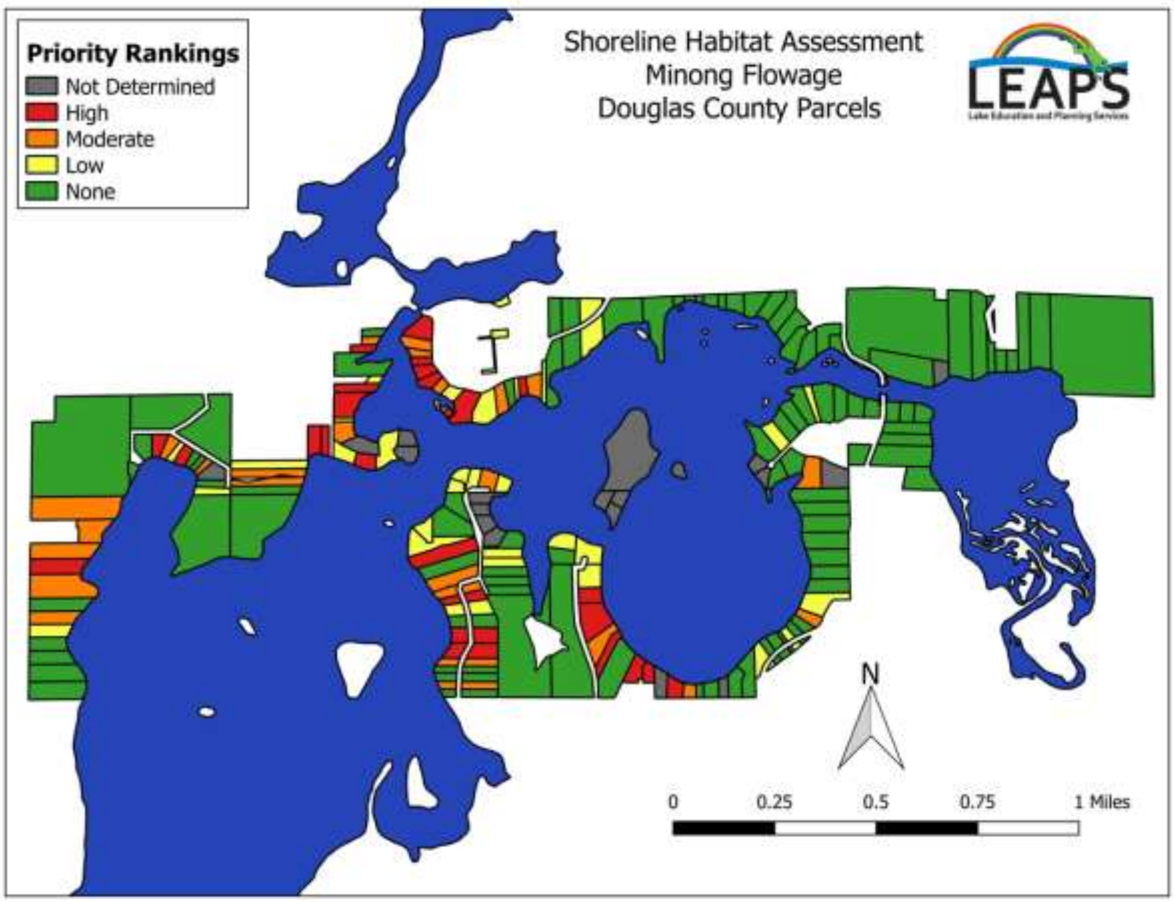


Figure 9: Priority rankings for Douglas County parcels on the Minong Flowage

Of the 188 individual parcels evaluated in the Washburn County part of the Flowage, 24 had ranked “high” in priority for implementing projects to reduce runoff and improve habitat. Of the remaining properties, 20 were ranked “moderate”, 46 ranked “low”, and 87 ranked “no priority” (Figure 10).

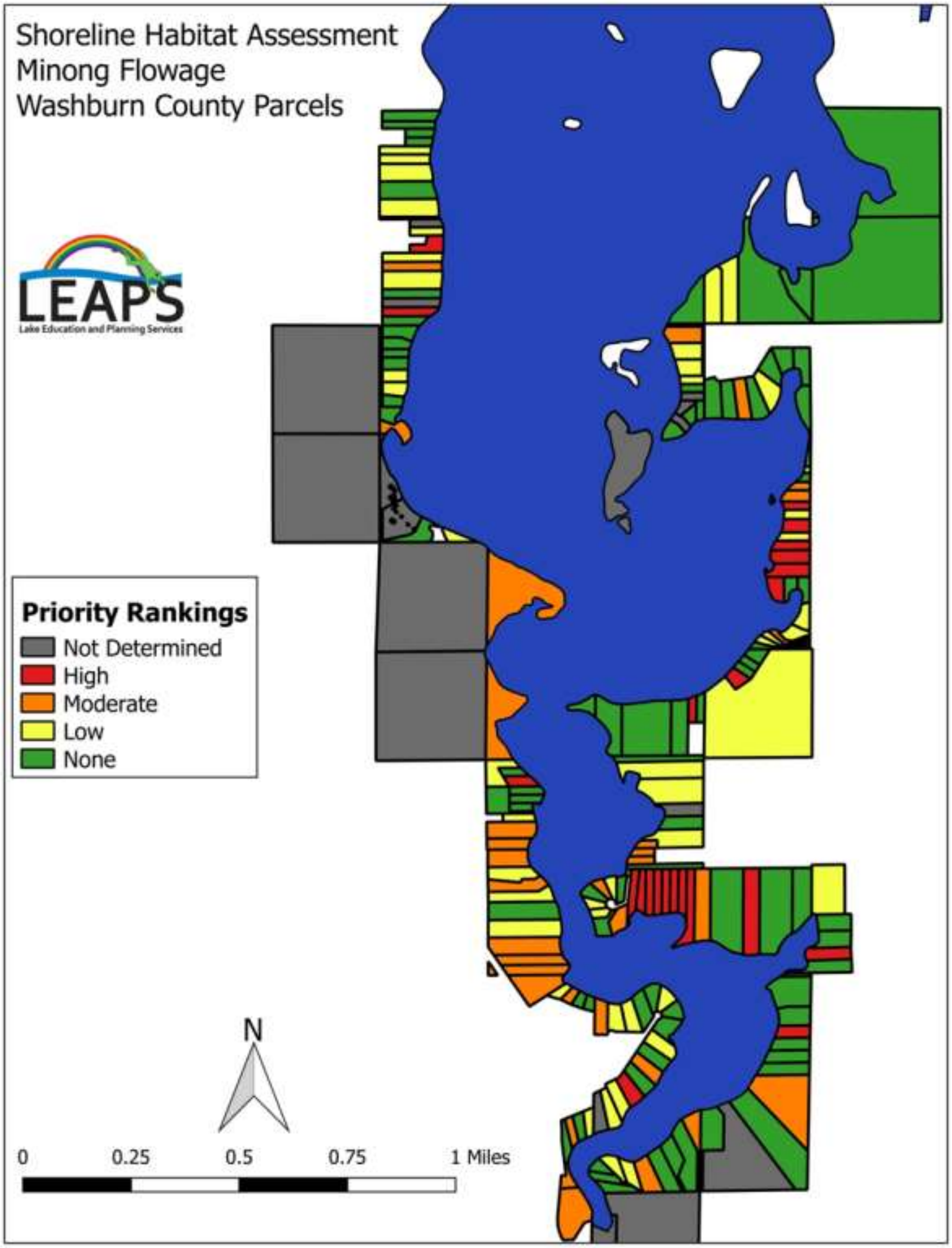


Figure 10: Priority rankings for Washburn County parcels on the Minong Flowage

During the shoreland habitat assessment, the amount of coarse woody debris in the Flowage was also documented. Woody debris provides habitat for fish, birds, and numerous other types of wildlife and helps protect the shore from bank erosion. Coarse woody debris is defined as wood in no deeper than 2 feet of water that is at least 4 inches in diameter, at the widest point, and at least 5 feet long. Lake-wide results for the Flowage are shown in Figure 11.

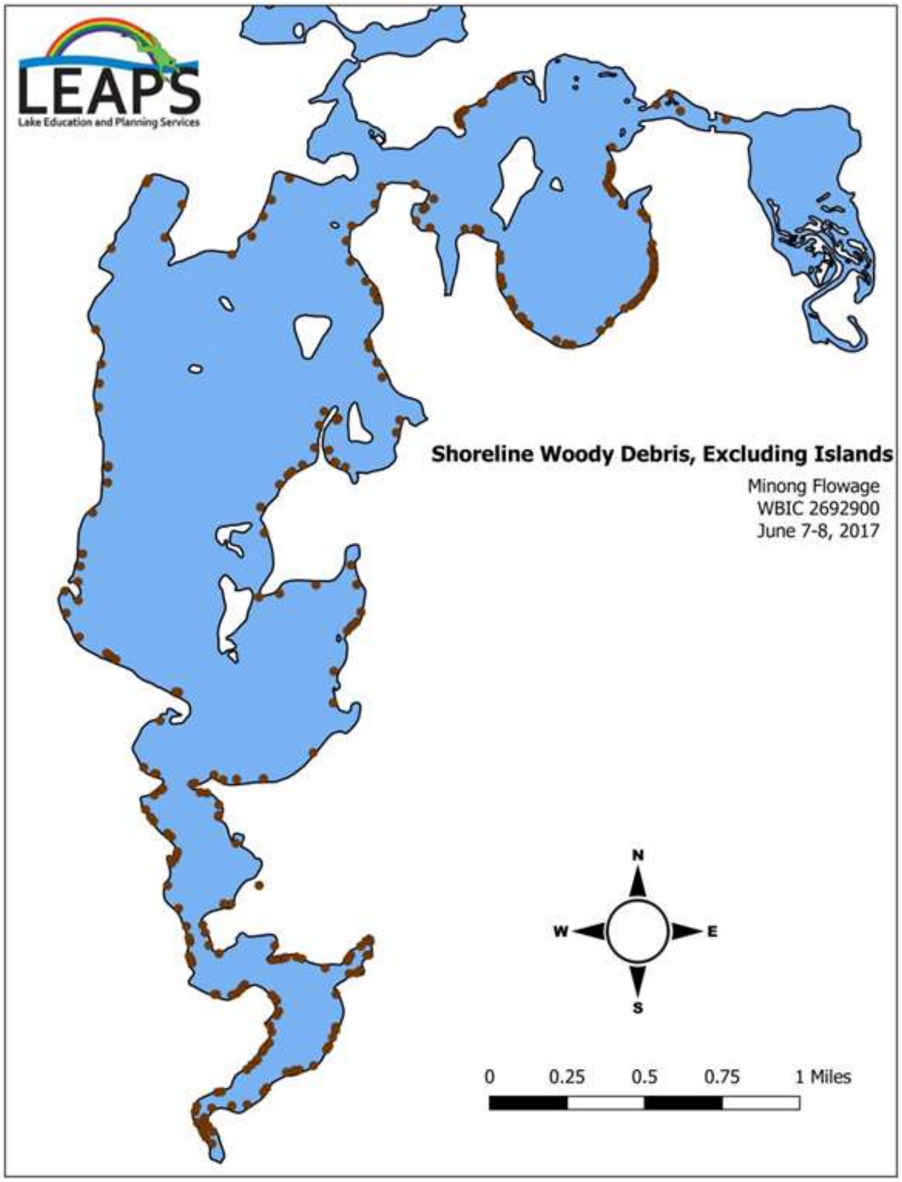


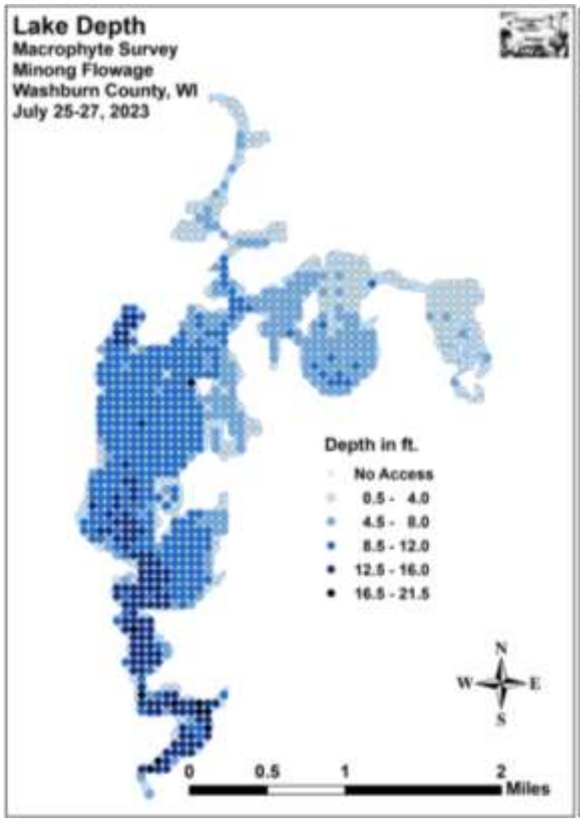
Figure 11: Coarse woody debris surrounding the Minong Flowage

LAKE CHARACTERISTICS

The Minong Flowage (WBIC 2692900) is a 1,564-acre eutrophic reservoir on the Totogatic River located in north-central Washburn County and south-central Douglas County, Wisconsin in the Towns of Minong and Wascott (T42N R13W S13 SW NE) (Figure 12). It reaches a maximum depth of 21.5ft near the dam on the far south end and has an average depth of approximately 9ft (Figure 13). The bottom is predominantly sand and sandy muck in the central and deep south basins, and organic muck in the northern bays (Figure 13). Late summer Secchi disk readings of water clarity over the last 10yrs have averaged 3.4ft (WEx, 2023). This poor to very poor water clarity produced a maximum depth of plant growth the ranged from 7.5ft to 9.5ft documented in six whole-lake, point-intercept (PI), summer, aquatic plant surveys (2008, 2012, 2014, 2018, 2021, and 2023). The data indicates a littoral zone that averaged 832 acres (53.2% of the total 1564-acre surface area) from 2008 to 2023, with a maximum area of 920 acres in 2008 and a minimum area of 666 acres in 2012. The 2023 littoral zone covered about 906 acres (Figure 14)

The Flowage has approximately 24 miles of shoreline and is 1.08 miles wide at its widest point. There are 16 islands in the Flowage with a total area of 45.6 acres. The largest island is 16.2 acres in size. The Flowage is fed by the Totogatic River from the east and Cranberry Lake in Douglas County to the north via the Cranberry Flowage. The total volume of the Flowage is approximately 12,840 acre-feet. The Minong Flowage is wild rice water. Over the period from 1992-2013, the Minong Flowage had the 7th highest amount of reported wild rice harvested in the state.

Figure 12: Minong Flowage, Washburn-Douglas Counties, WI



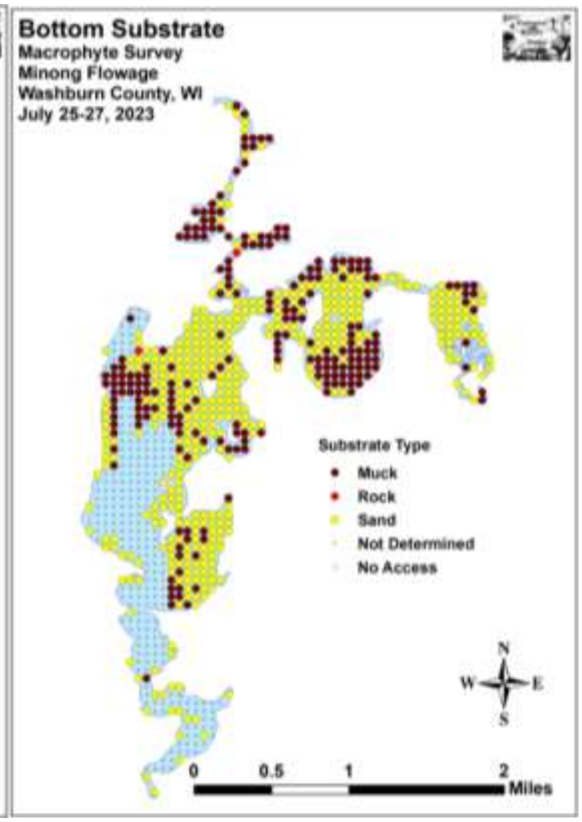


Figure 13: 2023 Lake depth and substrate *(Berg, 2023)*

Figure 14: 2023 littoral zone *(Berg, 2023)*

WATER QUALITY

Water clarity and water chemistry are important indicators of water quality. Secchi disk readings of water clarity and chemistry parameters including total phosphorus, chlorophyll a, and temperature and dissolved oxygen profiles have been collected by Wisconsin Citizen Lake Monitoring Network (CLMN) volunteers at multiple sites since 1994. The most sampled site is the Deep Hole Near the Dam (Site # 663099). The next most sampled site is the Central Basin – NW of the Youth Camp (Site # 163300). Long-term trend data can be generated for both sites. Two other sites, North Basin (10029924) and Serenity Bay (10031141) have also been sampled, but not enough data exists to establish any trends in changing water quality.

WATER CLARITY

Water clarity is a measurement of how deep sunlight can penetrate the waters of a lake. It is measured using an 8” disk divided into four sections, two black and two white, that is lowered into the lake water from the surface by a rope marked in measurable increments (Figure 15). The water clarity reading is the point at which the Secchi disk can no longer be seen from the surface of the lake. The color of the water (like dark water stained by tannins from nearby bogs and wetlands), particles suspended in the water column (like sediment or algae), and weather conditions (sunny, cloudy, windy) can impact how far a Secchi disk can be seen down in the water. Some lakes have Secchi disk readings of just a few inches, while other lakes have conditions that allow the Secchi disk to be seen for dozens of feet before it disappears.

Figure 15: Black and white Secchi disk

Figure 16 shows all the Secchi disk readings taken at the Deep Hole Near Dam since volunteer involvement in CLMN began. Figure 17 reflects the same data over the course of the year from April to October. Figure 18 shows that there is a slight trend toward worsening Secchi disk readings of water clarity over time, however the trends are not significant.

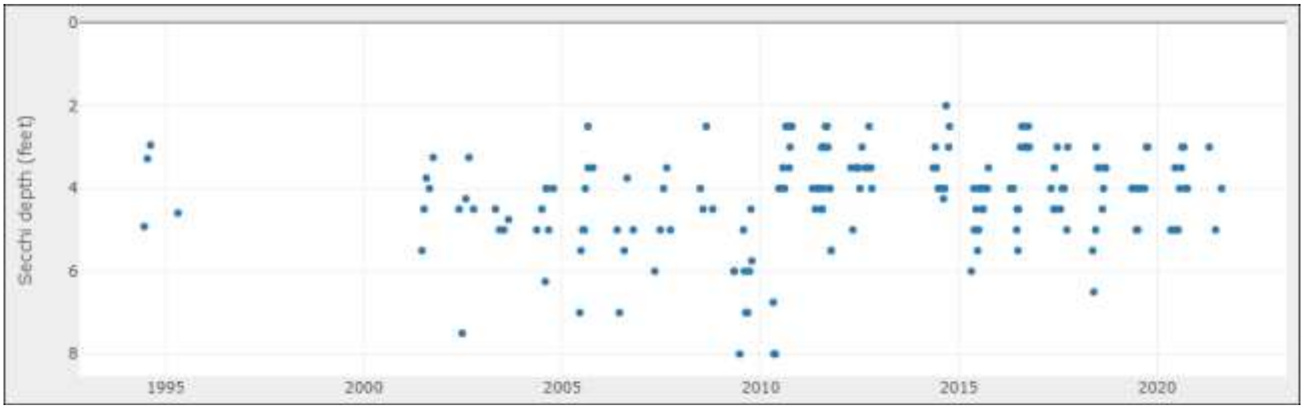


Figure 16: Minong Flowage – Deep Hole – 663099. Time series of all CLMN Secchi disk results *(WEx, 2023)*

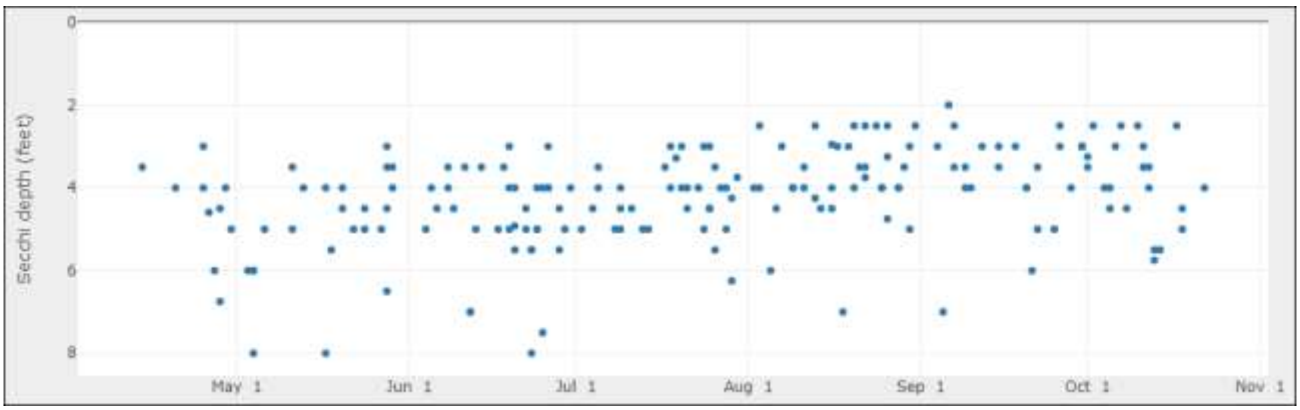


Figure 17: Minong Flowage – Deep Hole – 663099. All CLMN Secchi disk results plotted by day of year (WEx, 2023)

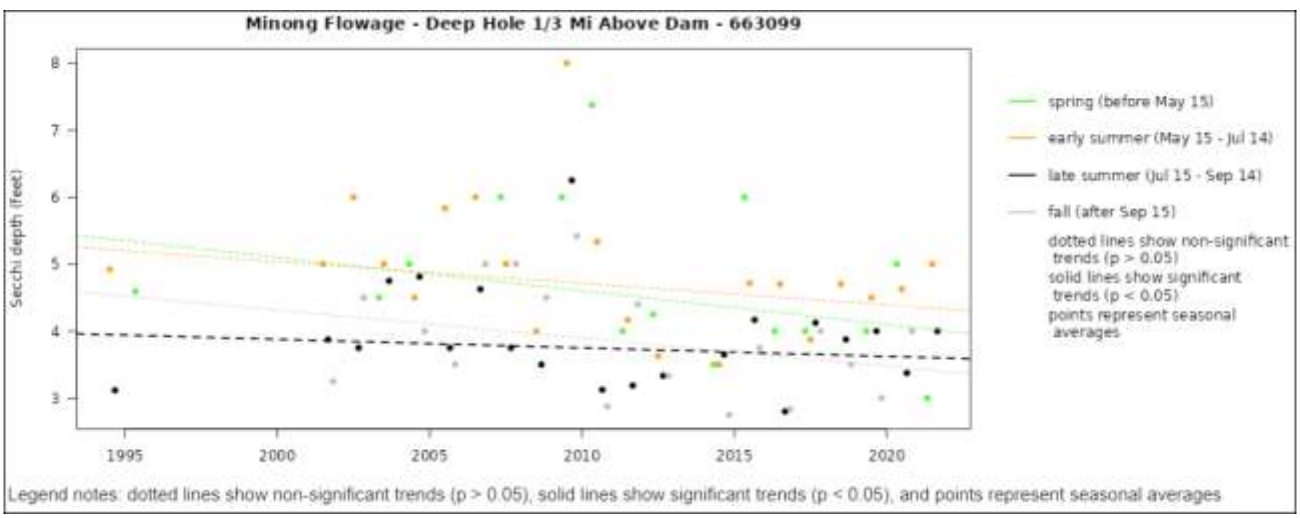


Figure 18: Trends in Secchi disk results – Minong Flowage – Deep Hole – 663099 (WEx, 2023)

Figure 19 shows all the Secchi disk readings taken in the Central Basin since volunteer involvement in CLMN began. Figure 20 reflects the same data over the course of the year from April to October. Figure 21 shows that there is a slight trend toward worsening Secchi disk readings of water clarity over time, and in the case of the Central Basin the changes are statistically significant at least for early summer and fall data. Anecdotally, the volunteers monitoring the Central Basin and several property owners have commented that the water quality in the Central Basin seemed to be getting worse.

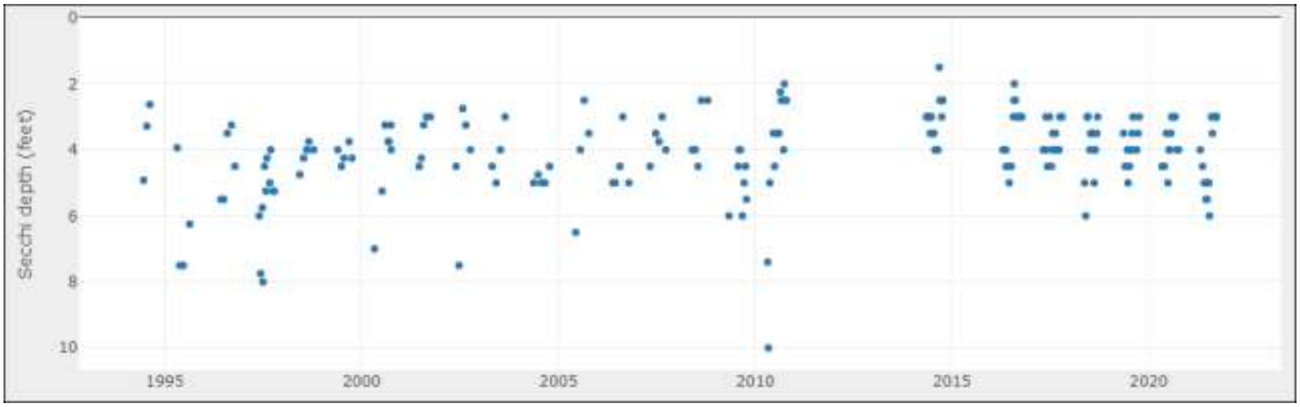


Figure 19: Minong Flowage – Central Basin – 163300. Time series of all CLMN Secchi disk results (WEx, 2023)

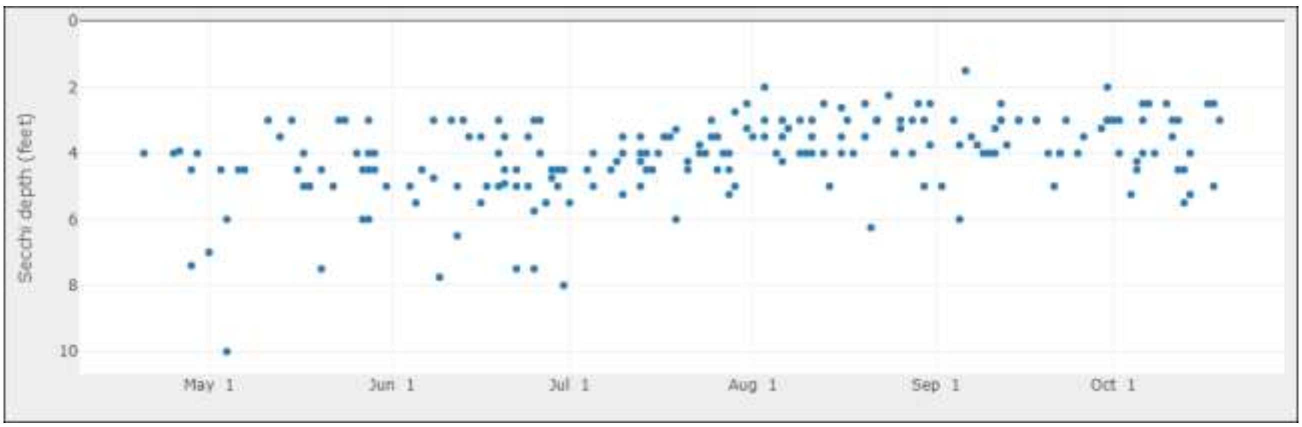


Figure 20: Minong Flowage – Central Basin – 163300. All CLMN Secchi disk results plotted by day of year (WEx, 2023)

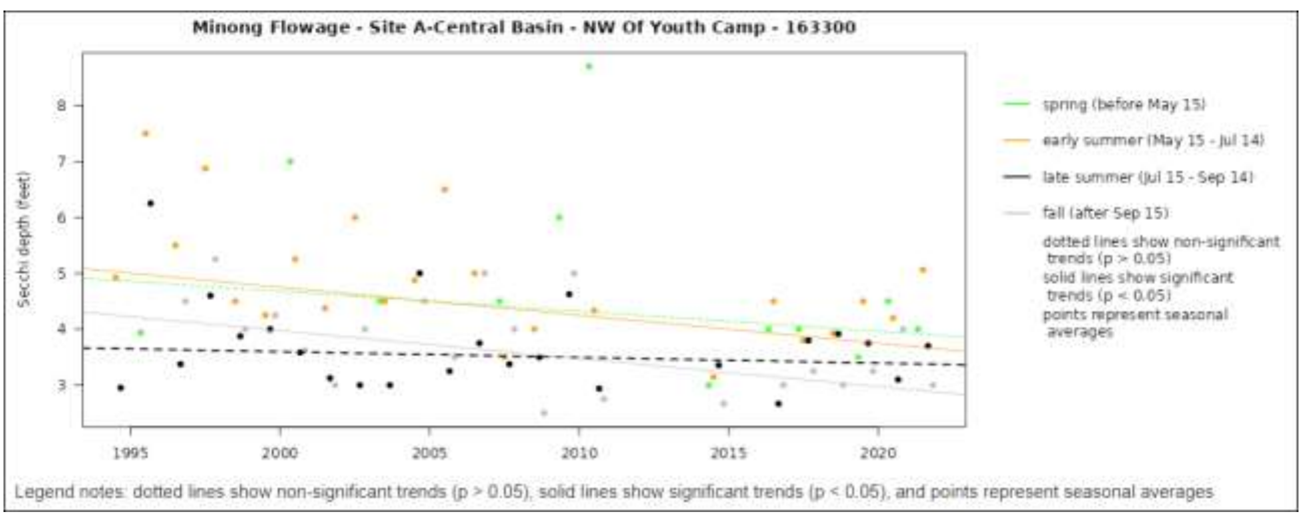


Figure 21: Trends in Secchi disk results – Minong Flowage – Central Basin – 163300 (WEx, 2023)

TOTAL PHOSPHORUS AND CHLOROPHYLL-A

Phosphorus is an important nutrient for plant growth and is commonly the nutrient limiting plant production in Wisconsin lakes. There are many sources of excess phosphorus to lake water: farm runoff, roadway runoff, failing septic systems, and decay of grass clippings, leaves, and other lawn debris that end up in the lake to name a few. Impoundments like the Minong Flowage that have more than 0.03mg/l of total phosphorus (TP) may experience noticeable algae blooms.

Chlorophyll-a (Chla) is the green pigment found in plants and algae. The Chla concentration is used as a measure of the algal population in a lake. Values greater than 10µg/L are considered indicative of eutrophic conditions and concentrations of 20µg/L or higher are associated with algal blooms.

Collection of water samples from the Deep Hole Near Dam for TP concentration started in 1994/95 with a gap until 2001. From 2001 to 2023 more consistent TP and Chla sampling was completed. Since that time, TP concentrations in the spring and early summer have seen a slight, but non-significant increase (Figure 22). Late summer TP has remained consistent, but exhibits a very slight, insignificant decrease (Figure 22). Late summer TP concentration is usually above 0.03mg/l leading to occasional, noticeable algae blooms. Chla data collected since the early 2000's shows decreasing concentrations in the early summer, late summer, and fall, but only the fall change over time is considered statistically significant (Figure 23). Almost all late summer and fall averages exceed 10µg/L with many fall averages, particularly before 2010, exceeding 20µg/l (Figure 23).

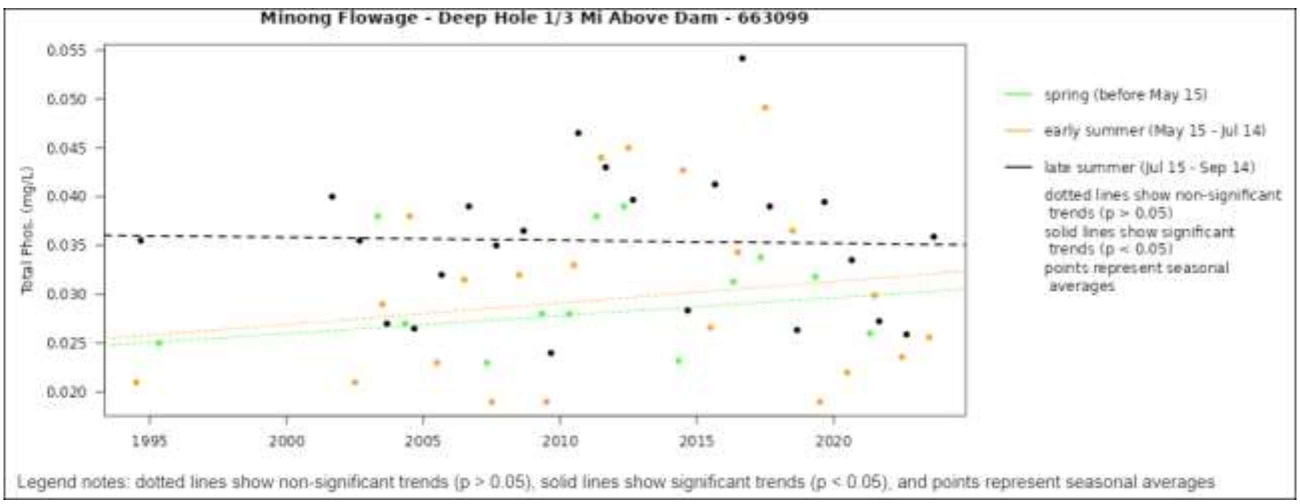


Figure 22: Trends in total phosphorus results – Minong Flowage – Deep Hole – 663099 (WEx, 2023)

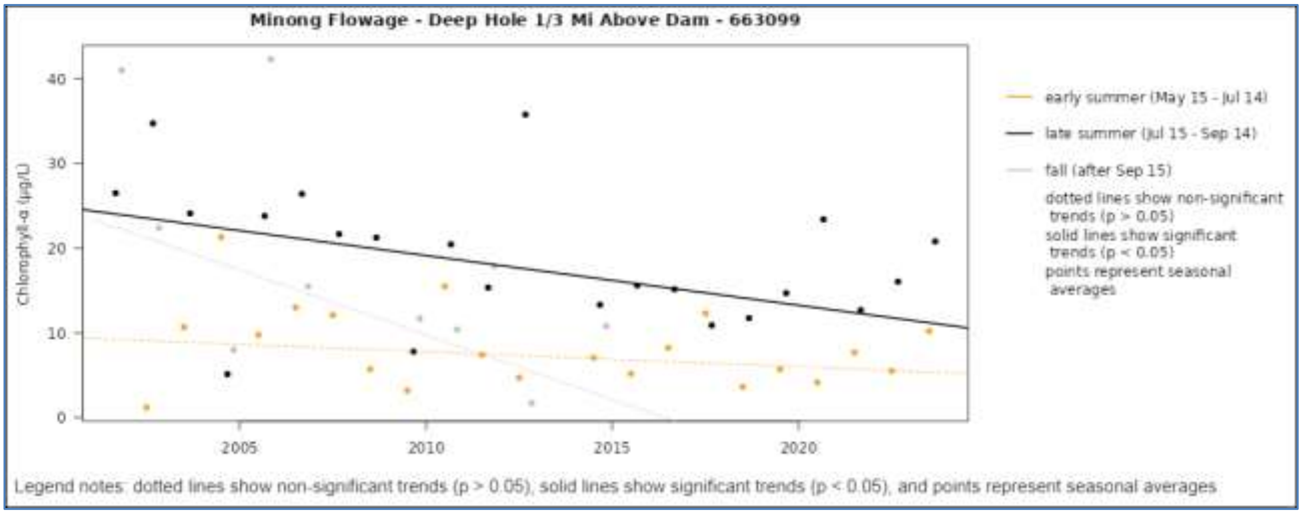


Figure 23: Trends in chlorophyll-a results – Minong Flowage – Deep Hole – 663099 (WEx, 2023)

Regular collection of water samples from the Central Basin for TP and Chla concentration began in 1994 with gaps from 2002-2008 and again from 2015 to 2020. Early summer TP shows a slight, but non-significant increase over time, but both late summer and fall TP shows non-significant decreases over time (Figure 24). More than 81% of all TP samples collected reach or exceed 0.03mg/L leading to occasional, noticeable algae blooms. Chla data collected shows early summer concentrations remaining consistent, with increasing, but non-significant concentrations during the late summer (Figure 25). More than 41% of all late summer and fall averages exceed 10µg/L, but only a few (17%) exceed 20µg/l (Figure 25).

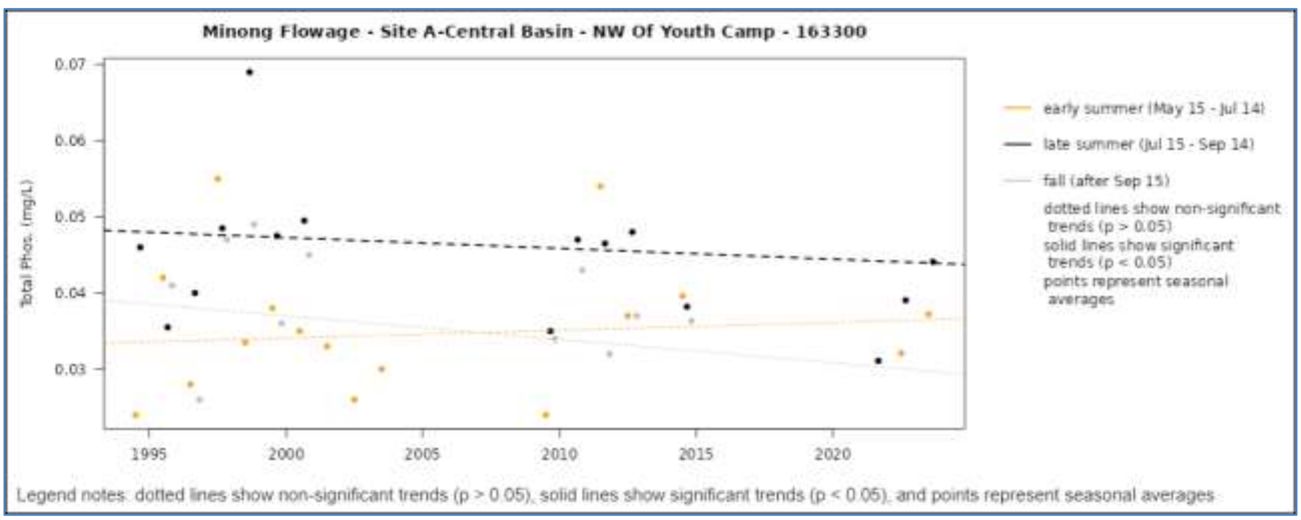


Figure 24: Trends in total phosphorus results – Minong Flowage – Central Basin – 163300 (WEx, 2023)

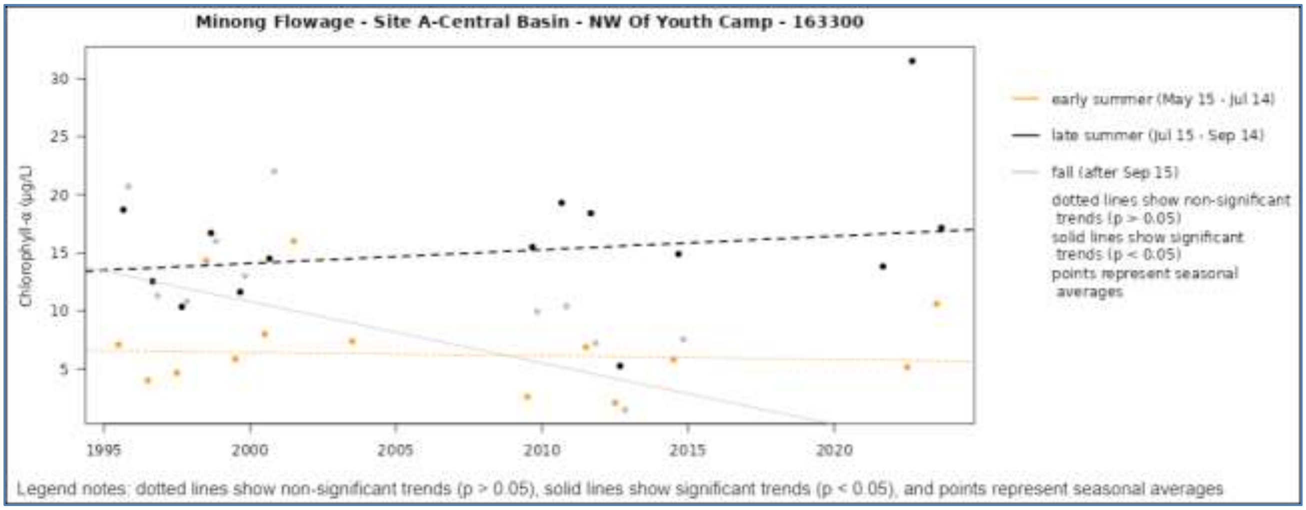


Figure 25: Trends in chlorophyll-a results – Minong Flowage – Central Basin – 163300 (WEx, 2023)

Over the last 10 years, the Minong Flowage at both the Deep Hole and in the Central Basin are just about average when compared to other reservoirs in WI with similar data (Figures 26 & 27). Secchi disk readings of water clarity are below average when compared to other reservoirs (Figures 26 & 27).

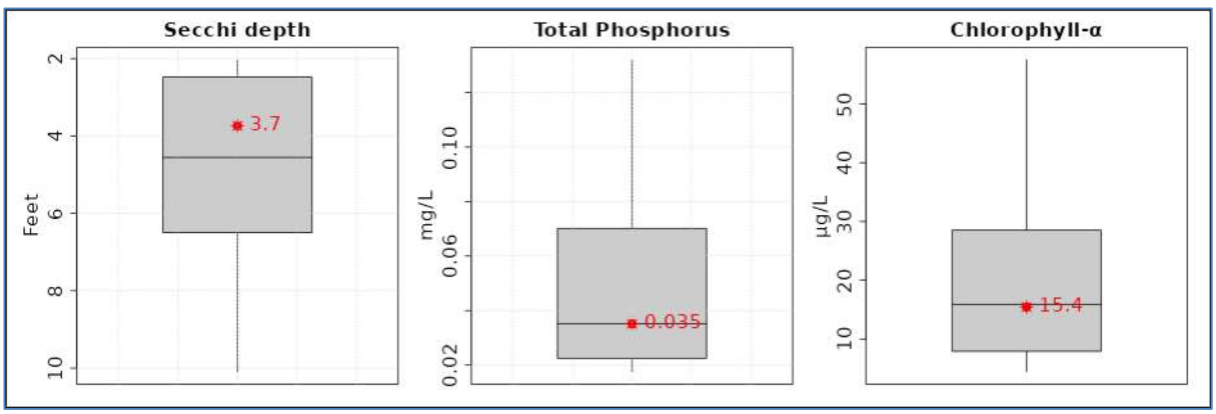


Figure 26: Late summer averages over the last 10 years compared to other reservoirs – Deep Hole – 663099 (WEx, 2023)

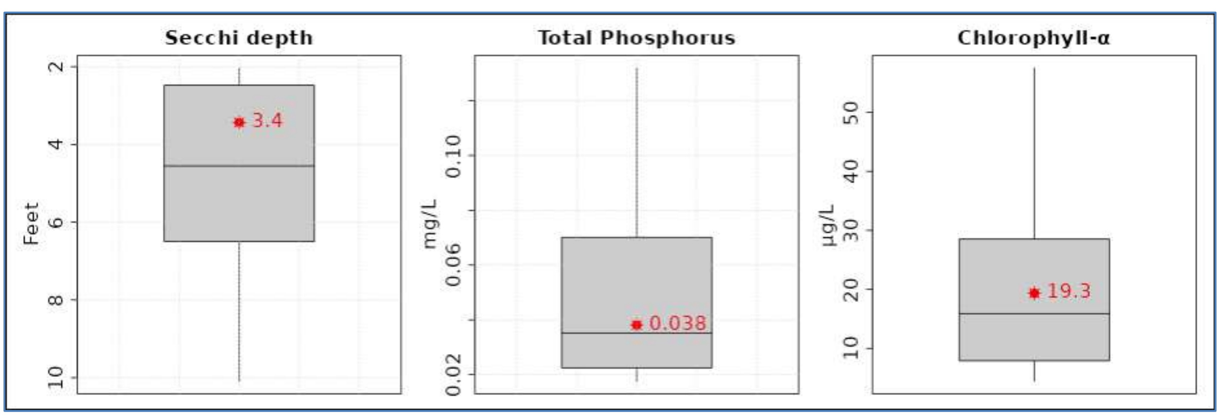


Figure 27: Late summer averages over the last 10 years compared to other reservoirs – Central Basin – 163300 (WEx, 2023)

TROPHIC STATE INDEX – LAKE PRODUCTIVITY

Water clarity (based on Secchi disk readings), TP, and Chla are parameters that can be used to determine the productivity or trophic status of a lake. The Carlson trophic state index (TSI) is a frequently used biomass-related index. The trophic state of a lake is defined as the total weight of living biological material (or biomass) in a lake at a specific location and time. Eutrophication is the movement of a lake's trophic state in the direction of more plant biomass. Eutrophic lakes tend to have abundant aquatic plant growth, high nutrient concentrations, and low water clarity due to algae blooms (Figure 28). Oligotrophic lakes, on the other end of the spectrum, are nutrient poor and have little plant and algae growth (Figure 28). Mesotrophic lakes have intermediate nutrient levels and only occasional algae blooms (Figure 28).

Using the average of data collected in the last 10 years for both the Deep Hole Near Dam and Central Basin sites from Figures 26 & 27, the Minong Flowage is clearly in the eutrophic category in lake productivity.

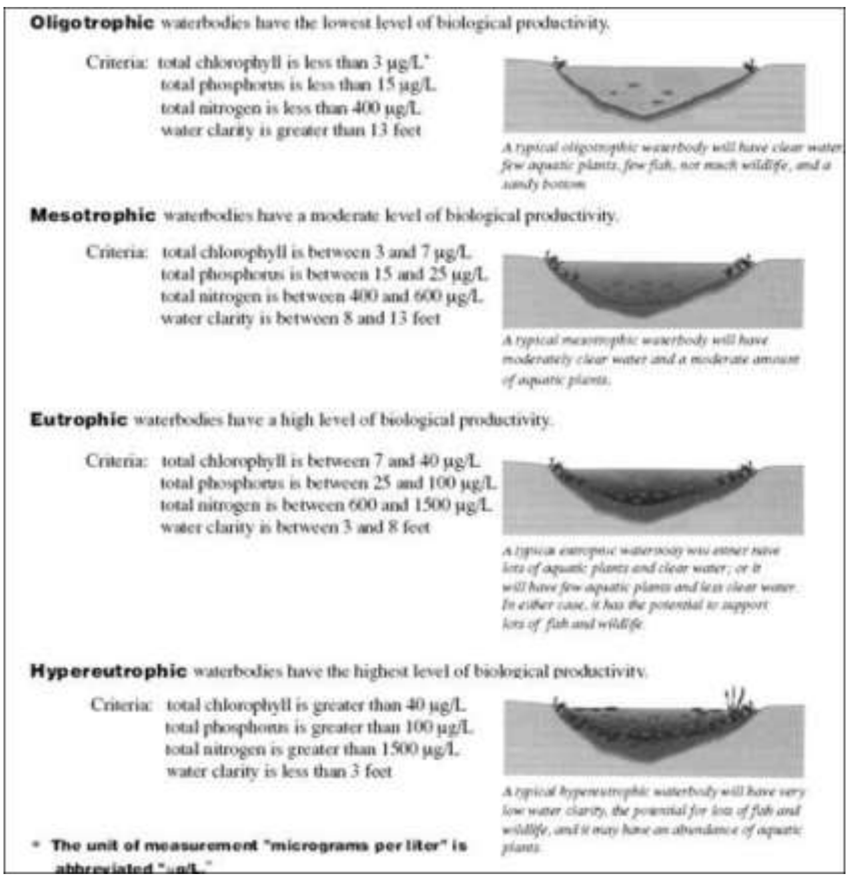


Figure 28: Trophic states in lakes

The TSI scale runs from "0" to "100". Generally, TSI values from 0-40 are considered oligotrophic, 40-50 are mesotrophic, 50-70 are eutrophic, and anything above 70 is considered hypereutrophic (Table 2).

Table 2: TSI Scale *(Cedar Corporation, 2006)*

Table 3-4: Trophic State Index (TSI)

TSI Value	Water Quality Attributes	Fisheries, Recreation or Example Lakes
<30	**Oligotrophic:** Clear water, oxygen through the year in the hypolimnion. Water supply may be suitable unfiltered.	Salmonid fisheries dominate.
30-40	Hypolimnia of shallower lakes may become anoxic during the summer.	Salmonid fisheries in deep lakes only. Example: Lake Superior (WDNR)
40-50	**Mesotrophic:** Water moderately clear but increasing probability of anoxia in hypolimnion during summer. Possible iron, manganese, taste and odor problems may worsen in water supply. Water turbidity requires filtration.	Walleye may predominate and hypolimnetic anoxia results in loss of salimonoids.
50-60	**Eutrophic:** Lower boundary of classic eutrophy. Decreased transparency, anoxic hypolimnion during the summer, macrophyte problems evident, warm water fisheries dominant.	Bass may dominate.
60-70	Dominance of blue-green algae, algal scums probable, extensive macrophyte problems. Possible episodes of severe taste and odor from water supply. Anoxic hypolimnion, water-water fisheries.	Nuisance macrophytes, algal scums and low transparency may discourage swimming and boating.
70-80	**Hypereutrophic:** Light limited productivity, dense algal blooms and macrophyte beds.	Lake Menomin & Tainter Lake, Dunn County, WI (WDNR).
>80	Algal scums, few macrophytes, summer fishery kills.	Dominant rough fish.

The measurements of all three parameters (Secchi - feet, TP & Chla) can be converted to values that fit in the TSI range of 0 to 100. By doing so, all three can be compared together to further classify a lake's trophic status. In Figures 29 & 30, the dark blue area is considered oligotrophic; light blue is mesotrophic; and green is eutrophic. Almost all the TSI values for Secchi, TP, and Chla for both sampling sites in the Minong Flowage fall in the light green area, with none of them exceeding 70, again clearly showing that the Flowage is a eutrophic system.

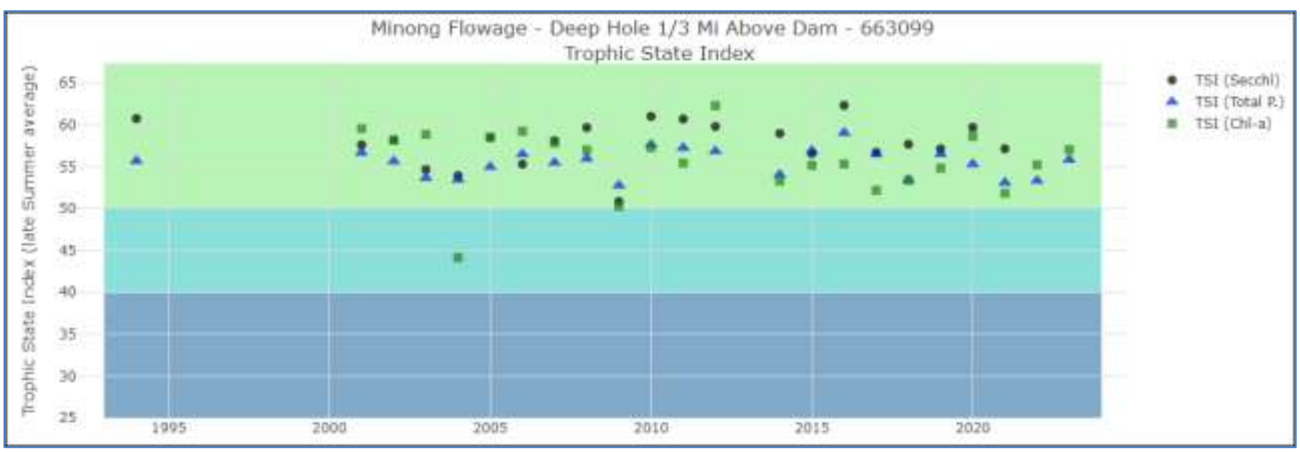


Figure 29: Trophic status – Minong Flowage – Deep Hole – 663099 (WEx, 2023)

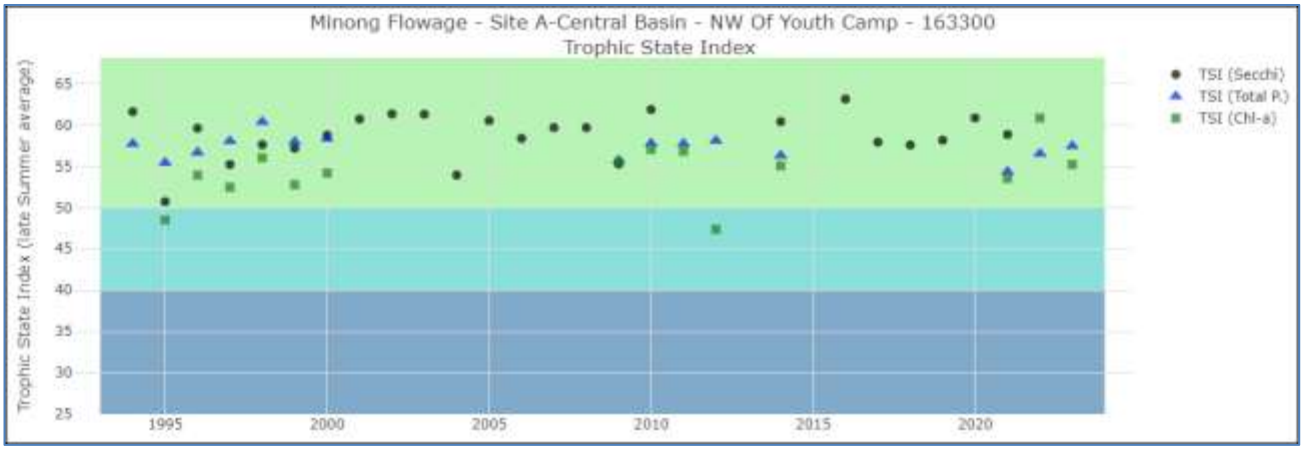


Figure 30: Trophic status – Minong Flowage – Central Basin – 663099 (WEx, 2023)

TEMPERATURE AND DISSOLVED OXYGEN

Temperature (Temp) and dissolved oxygen (DO) are important factors that influence aquatic organisms and nutrient availability in lakes. As temperature increases during the summer in deeper lakes, the colder water sinks to the bottom and the lake develops three distinct layers as shown in Figure 31. This process, called stratification, prevents mixing between the layers due to density differences which limits the transport of nutrients and dissolved oxygen between the upper and lower layers. In most lakes in Wisconsin that undergo stratification, the whole lake mixes in the spring and fall when the water temperature is between 53 and 66°F, a process called overturn. Overturn begins when the surface water temperatures become colder and therefore denser causing that water to sink or fall through the water column. Below about 39°F, colder water becomes less dense and begins to rise through the water column. Water at the freezing point is the least dense which is why ice floats and warmer water is near the bottom (called inverse stratification) throughout the winter.

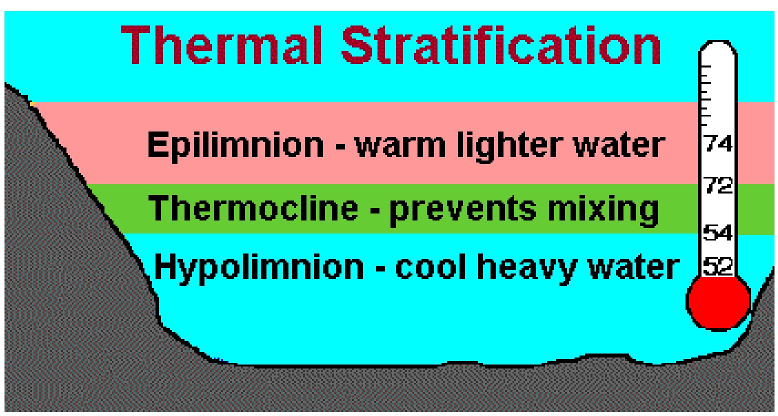


Figure 31: Summer thermal stratification

During the summer months, the upper warm layer, called the epilimnion, remains well oxygenated due to wind and wave action and photosynthesis. The middle layer, called the metalimnion or thermocline, is where changes in Temp and DO are the greatest. This middle layer acts as a barrier that prevents warmer, oxygen rich water in the epilimnion from mixing with colder, deeper water in the hypolimnion. It is common for DO levels to be depleted in the hypolimnion, as the decomposition of organic materials at the bottom of the lake consumes oxygen, and there is no source of new oxygen to replenish it.

Without oxygen, phosphorus formerly held in the substrate can be released into the hypolimnion. If the phosphorus released from sediments reaches the upper part of the lake through spring or fall overturn or when natural or human induced wave action mixes the lake, it can provide a significant internal source of phosphorus to fuel algae blooms.

The Minong Flowage is dimictic, meaning that the lake experiences spring and fall overturn with thermal stratification occurring in the summer. However, the stratification is generally stable only in the southern portion of the lake near the dam. The rest of the lake is shallow enough that natural and man-made wave action disrupts stratification. Additionally, inflow from the Totagatic River that then flows through the system brings in oxygen year-round. However, anoxic conditions (low or no DO) do occur at the Deep Hole Near Dam below 15ft from June through early September. Data suggests that warm water fish species require 2-5 mg/l of oxygen, and that cold water species require 5-9 mg/l to be healthy. During periods of oxygen depletion most fish species will vacate deeper water moving to other areas of the Flowage.

FISHERIES

The following fisheries information was taken from the 2016 Minong Flowage Comprehensive Fishery Survey Report prepared by the WDNR (Roberts, 2017). A comprehensive fish survey of the Minong Flowage was conducted by the WDNR during the 2016 sampling season. The primary objective of the study focused on assessing the status of gamefish and panfish populations in the Minong Flowage. The secondary objective was to evaluate any potential fisheries impacts from the 2013 drawdown (March 2013 – Feb. 2014).

The Minong Flowage's fishery consists of these gamefish: walleye, northern pike, smallmouth bass, and largemouth bass. Panfish present are bluegill, black crappie, yellow perch, rock bass, and pumpkinseed. Common forage species are golden redhorse, shorthead redhorse, and white sucker. Common carp, an invasive species, is also present.

Survey results and WDNR conclusions from 2016 for specific fish species follow.

WALLEYE

Walleye angling regulations have recently changed in the Flowage. Until 2014, there was a 15" minimum length limit on walleye, with angler bag limits each year being determined by Tribal harvest. In 2014, the length limit was changed to no minimum length limit, but only one fish can be over 14". At the same time, a fixed three bag limit was put into place.

The 2016 survey showed that the Minong Flowage continues to maintain an excellent population of walleye compared to other lakes in Northwest Wisconsin. The current (2016) population is higher than it was in 1989. The biggest concern with walleye in the Flowage is slow growth. Adult walleye grew below average for almost all ages collected. Strong natural reproduction continues to bolster the walleye population and survival to age-1 is excellent. The past three year-classes (post-drawdown) have ranged between 88 fish/mile to 136 fish/mile and represent first, third, and fourth highest year classes since 2000. It is unclear whether the drawdown, the regulation change, or both factors helped boost natural reproduction levels in the last three years.

NORTHERN PIKE

The northern pike density has changed since 2005. The most noticeable differences are a higher percentage of fish over 30 inches and a larger average size. The increase in size may be explained by the lower relative density in the flowage. Catch rates fell by 66% when compared to 2005. However, numerous other factors including habitat changes in vegetation, shoreline alteration/development, possible increased fishing pressure, and impacts from the drawdown could have impacted the pike population the past 11 years.

Aging of smaller northern captured was completed to determine changes in the last three year-classes. A strong year-class of age-2 northern pike suggested a good hatch in 2014. However, age-3 fish (drawdown year) were less abundant, while other year-classes were still relatively strong (until 24" cut-off). If the drawdown was the cause of lower recruitment in 2013 it seems northern pike have rebounded.

LARGEMOUTH BASS

Bass angling regulations were changed in 2012 from a 14" minimum length limit to no minimum length limit. In 2016, there was a noticeable lack of largemouth bass less than 12". Aging data suggested low numbers of fish under four years old. This trend also occurred in 2010 suggesting it may be tied to poor recruitment and not to the drawdown. Habitat in the Flowage does not favor good largemouth bass recruitment due to high turbidity, current, and changes in aquatic vegetation. The drawdown likely had some impact on largemouth bass recruitment since they prefer warm vegetated/woody habitat without current. These areas were likely limited or dry during the 2013 season. It is difficult to speculate whether these numbers are tied to the new regulation, the 2013 drawdown, or conditional poor recruitment. In addition, WDNR staff collected less than 100 fish during their night electrofishing in 2010 and 2016 creating very low sample sizes, which make drawing conclusions more difficult.

SMALLMOUTH BASS

The 2016 survey clearly showed that smallmouth bass benefitted from the drawdown. The 2013 year-class was the largest portion of the smallmouth aging sample. Smallmouth bass prefer a riverine environment and likely had a good recruitment year in 2013 for this reason. This year-class is already catchable and should provide good smallmouth bass angling opportunities.

BLUEGILL

The 2016 survey showed that the Minong Flowage's bluegill size structure improved over the six-year period since that last survey. This change was demonstrated by the 1.4" increase in average size. This size improvement may have been caused by a lower density of small bluegill in the Flowage. Only 9% of the sample was composed of bluegill less than 6" (48% in 2010). Bluegill aging suggested the 2013 year-class was less abundant than other year-classes. For this reason, it appears the drawdown negatively impacted the bluegill population abundance in 2013 with a concomitant increase in individual growth.

DRAWDOWN CONCERNS

After the 2016 survey, the WDNR concluded the following. If future drawdowns are utilized as a management tool to control EWM, consequences for the centrarchids (panfish) and northern pike should be considered. Severe reductions of the bluegill population could create a situation where common carp are more successful in the Flowage. Bluegills have been found to prey heavily on carp eggs/larvae and therefore are important for keeping the carp population in check. At this point, common carp are at low densities in the Minong Flowage but have the potential to increase dramatically under favorable conditions. Northern pike may have been impacted by the 2013 drawdown based on aging data but recovered in the subsequent year. It is unclear if largemouth bass saw large impacts resulting from the drawdown. Timing and frequency of a vegetation management drawdown will be a very important consideration. The drawdown likely impacted centrarchids the most by separating those species from littoral/spawning habitat and increasing mortality for juveniles that year. Overall, the Minong Flowage underwent some changes but still holds a sustainable quality fishery.

A winter drawdown (November to April) was implemented over the 2021-22 winter season. Planning for this drawdown considered recommendations made by WDNR fisheries staff to avoid possible negative impacts to the fishery in the Flowage. Fisheries survey data, post-2021/22 winter drawdown, indicates that walleye numbers remain high, with 2022 fall electro-shocking documenting 216 walleye per mile of shoreline, the highest number since data has been collected (Table 3).

Table 3: 2022 WDNR fall walleye population survey - 216 fish per mile - highest since 2002.

	Minong Flowage: GLIFWC & DNR						Minong Fl. [illegible]			Minong Fl. [illegible]		
	Count	Mile	fish/mile				Count	Mile	fish/mile	Count	Mile	fish/mile
1997												
1998												
1999												
2000	164	1.9	86.3							164.0	1.9	86.3
2001	586	5.3	110.6				586	5.3	110.6			
2002	957	5.3	180.6				957	5.3	180.6			
2003												
2004	678	6.0	113.0							678.0	6.0	113.0
2005	898	5.3	169.4				898	5.3	169.4			
2006												
2007												
2008												
2009	234	5.3	44.2	Milfoil treated acres		72.0	234	5.3	44.2			
2010	365	11.3	32.3	Milfoil treated acres		129.0	365	11.3	32.3	365	11.3	32.3
2011	743	11.3	65.8	Milfoil treated acres		87.0	743	11.3	65.8	743	11.3	65.8
2012	364	5.3	68.7				364	5.3	68.7	364	5.3	68.7
2013	278	4.9	56.7	5.5 foot Drawdown year - dam rebuilt						278	4.9	56.7
2014	642	5.3	121.1							642	5.3	121.1
2015												
2016												
2017												
2018	397	5.0	79.4							397	5.0	79.4
2019												
2020												
2021	314	5.0	62.8	5.0 foot winter drawdown for EWM control						314	5.0	62.8
2022			216.0	Previous high count was 180.6 in 2002								216.0
2023												
2024												
2025												
2026												
2027												
2028												
Average	509	5.9	100.5			96.0	592	7.0	95.9	438	6.2	90.2

2023 FISHERIES SURVEY AND CREEL RESULTS

A follow-up comprehensive fish survey and a Ceded Territory Creel Survey was completed by the WDNR in 2023. The following information was provided by Craig Roberts, WDNR Fisheries Manager for Washburn County.

In 2023, WDNR completed a comprehensive survey in Minong Flowage looking at the fish community with similar methods used in 2016. Adult walleye continue to have an excellent population at 4.1 fish/acre. Natural reproduction remains excellent in 2023 with a catch rate of 91.4 fish/mile age-0 walleye and 43.6 fish/mile for one year old walleye. Northern pike were caught at a higher rate than 2016 at 10.9 fish/net night. The average size on northern pike was the same as 2016 at 19.7 inches. Smallmouth bass abundance increased when compared to 2016 with a catch rate of 16.0 fish/mile. The average size also increased compared to 2016 at 12.3 inches. Largemouth bass catch rate and size stayed similar to 2016. Bluegill were captured at a higher rate than 2016 at 78.7 fish/mile. The average size of bluegill stayed the same at 7.2 inches. Other panfish were captured at low densities. Only two common carp were observed during the survey.

More complete results and analysis will be included in the 2023 WDNR fisheries report for the Minong Flowage. The 2023 WDNR creel survey was not complete at the time this APM was drafted. There is no indication that the winter drawdown completed in 2021-22 had any impacts on the health of the fishery.

WILDLIFE

Because of its size and diverse habitat, the Minong Flowage is teaming with wildlife. Waterfowl use it all season long and migrating ducks pass through it in the spring and fall. Wild rice is abundant in the Flowage, particularly in the East Basin where the Totagatic River enters the Flowage, providing food and cover for many waterfowl and other wildlife, as well as being an important cultural resource. Wild rice in Wisconsin is highly prized and protected. Any management activity that could impact wild rice in the Flowage will be and should be closely scrutinized. Loons are present on the Flowage but have not been observed to nest and have young for at least 10yrs (S. Johnson, personal communication). Shoreline conditions and heavy boat traffic throughout the nesting period may be inhibiting nesting activity. Nesting loons have been occasionally observed on Cranberry Lake, but increasing boat activity appears to be limiting nesting success. Muskrats and beavers are common.

MUSSELS

At least eight different freshwater mussel species are found in the Minong Flowage although none are threatened or endangered species (Matt Berg, Endangered Resource Services LLC, personal communication, December 2014). Prior to the 2013-14 extended drawdown there was no survey of the mussels in the Minong Flowage. During the extended drawdown, many empty and crushed mussel shells were present on the exposed lakebed prompting some concern. An impromptu survey was completed by the Grantsburg, WI High School Research Biology Class in 2013 determined that none of the species identified by their shells were threatened or endangered.

NHI

The Wisconsin Natural Heritage Inventory (NHI), established in Wisconsin by the Nature Conservancy, is part of an international network of NHI programs and is coordinated by an international non-profit organization. NHI programs focus on locating and documenting occurrences of rare species and natural communities, including state and federal endangered and threatened species. All NHI programs use a standard methodology for collecting, characterizing, and managing data, making it possible to combine data at various scales to address local, state, regional, and national issues.

In the area of the Minong Flowage this inventory lists several animal species including bald eagles, osprey, Blandings and wood turtles, least darters (a minnow), and banded killifish. Redhorse, a rough fish, are also present in the Flowage but not any of the three species that are listed as endangered or threatened in Wisconsin. Several plant species are listed including northern bur-reed, Torry's bulrush, and northeastern bladderwort. Aquatic plant surveys in 2003 and 2008 identified two additional plant species of special concern in Wisconsin, Vasey's pondweed, and small white-water lily. Several ecosystem communities are also mentioned including emergent marsh, northern dry forest, northern dry-mesic forest, and northern sedge-meadow. Special concern should be given to accommodate these species of special concern in and around the Minong Flowage.

To date, no critical habitat or sensitive areas surveys have been completed on the Flowage.

WHOLE-LAKE, POINT-INTERCEPT AQUATIC PLANT SURVEYS

Six whole-lake, point-intercept (PI) aquatic plant surveys have been completed on the Minong Flowage since EWM was first discovered in 2002: 2008, 2012, 2014, 2018, 2021, and 2023. Except 2018, both early season cold water and summer PI surveys were completed. Cold water surveys focused on CLP and EWM, summer surveys documented all aquatic plants in the system. The 2012 PI survey was completed the year prior to the extended drawdown from April 2013 to February 2014. The 2014 PI survey helped to determine the impact of the extended drawdown. The 2018 PI was done as a precursor to what at the time was expected to be a 2018-19 winter drawdown. The winter drawdown was put on hold due to permitting issues and a limited amount of EWM. The winter drawdown was again proposed for the winter of 2021-22 so the 2021 PI survey was considered a pre-treatment survey, with the 2023 PI survey considered a post-treatment survey. The following PI survey results will be summarized in this section of the plan. Much of the data referenced is from PI survey reports completed by Endangered Resource Services.

- CLP comparisons
- EWM comparisons
- Native aquatic plant comparisons
- Wild rice comparisons

CURLY-LEAF PONDWEED (CLP)

In 2008, CLP was present in the Minong Flowage at 22 sites including visuals. With its distribution and density in 2008, it was not considered a major management issue that needed to be addressed. After 3yrs of herbicide application to control EWM (2009-2011) CLP increased to 45 points in 2012 survey, with the biggest uptick in the East Basin. The extended drawdown reduced CLP to only 2 points in the 2014 survey. By 2021, CLP had increased to 12 points. The winter drawdown knocked it back again to only 4 sites in 2023 (Figures 32 & 33). Figure 34 shows the changes over time in total points with CLP and at different rake fullness levels. While CLP continues to be part of the early season aquatic plant growth, it is still not considered an issue that needs to be addressed with management actions.

Bed mapping of CLP supports this with the 2021 survey only documenting 4.31 acres, and 2023 documenting only a handful of plants (Figure 35). When future whole-lake PI surveys are completed, cold water surveys for CLP should be continued. MFA volunteer AIS monitors should actively look for CLP each year and if more than usual is found, official bed mapping should be considered.

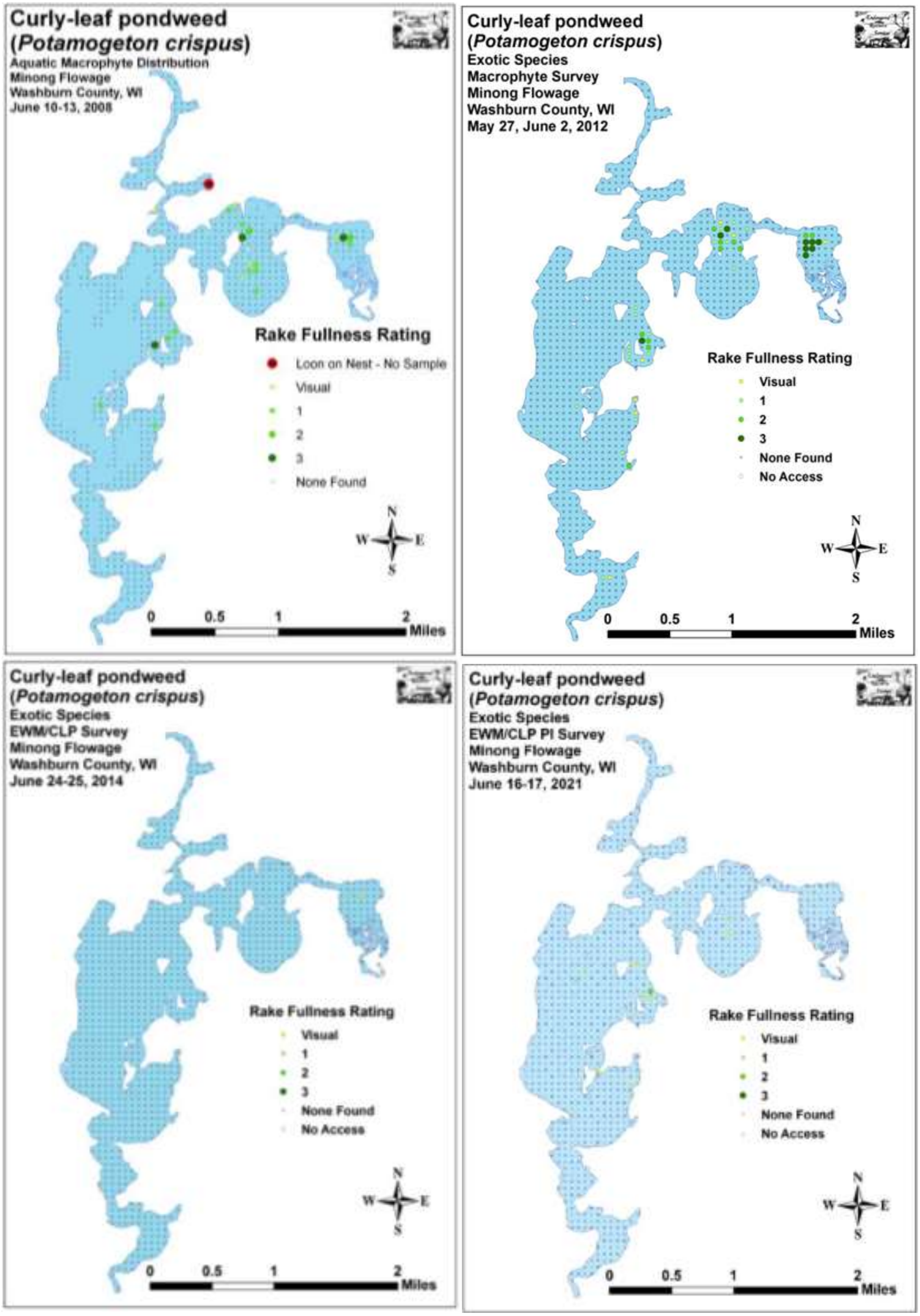


Figure 32: 2008, 2012, 2014, and 2021 spring CLP distribution and density (ERS)

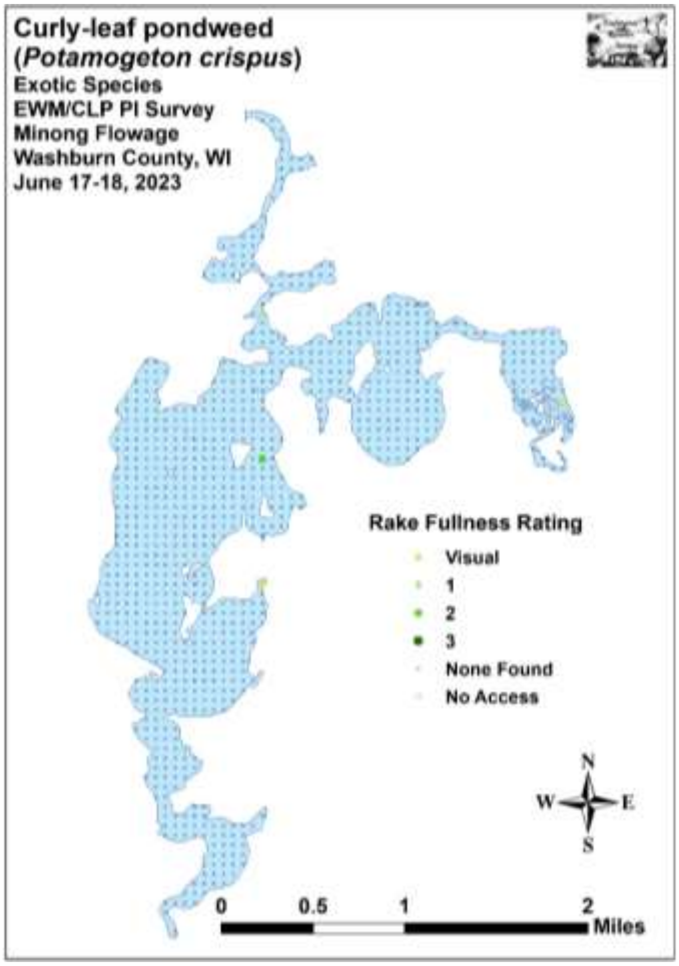


Figure 33: 2023 spring CLP distribution and density (ERS)

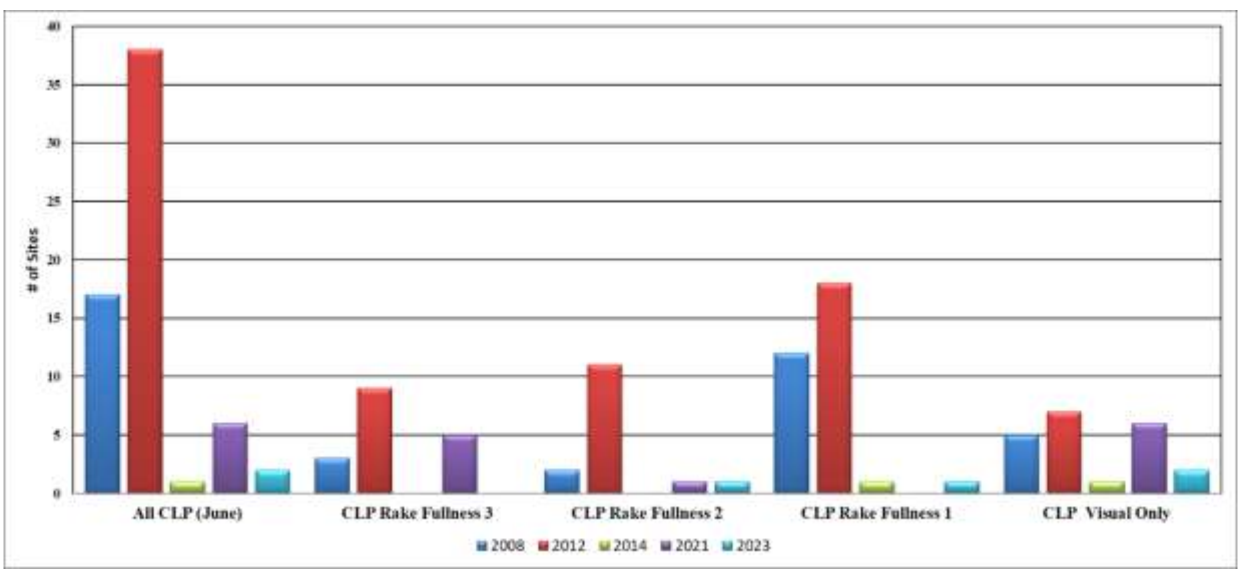


Figure 34: Changes in spring CLP rake fullness – 2008, 2012, 2014, 2021 & 2023 (ERS)

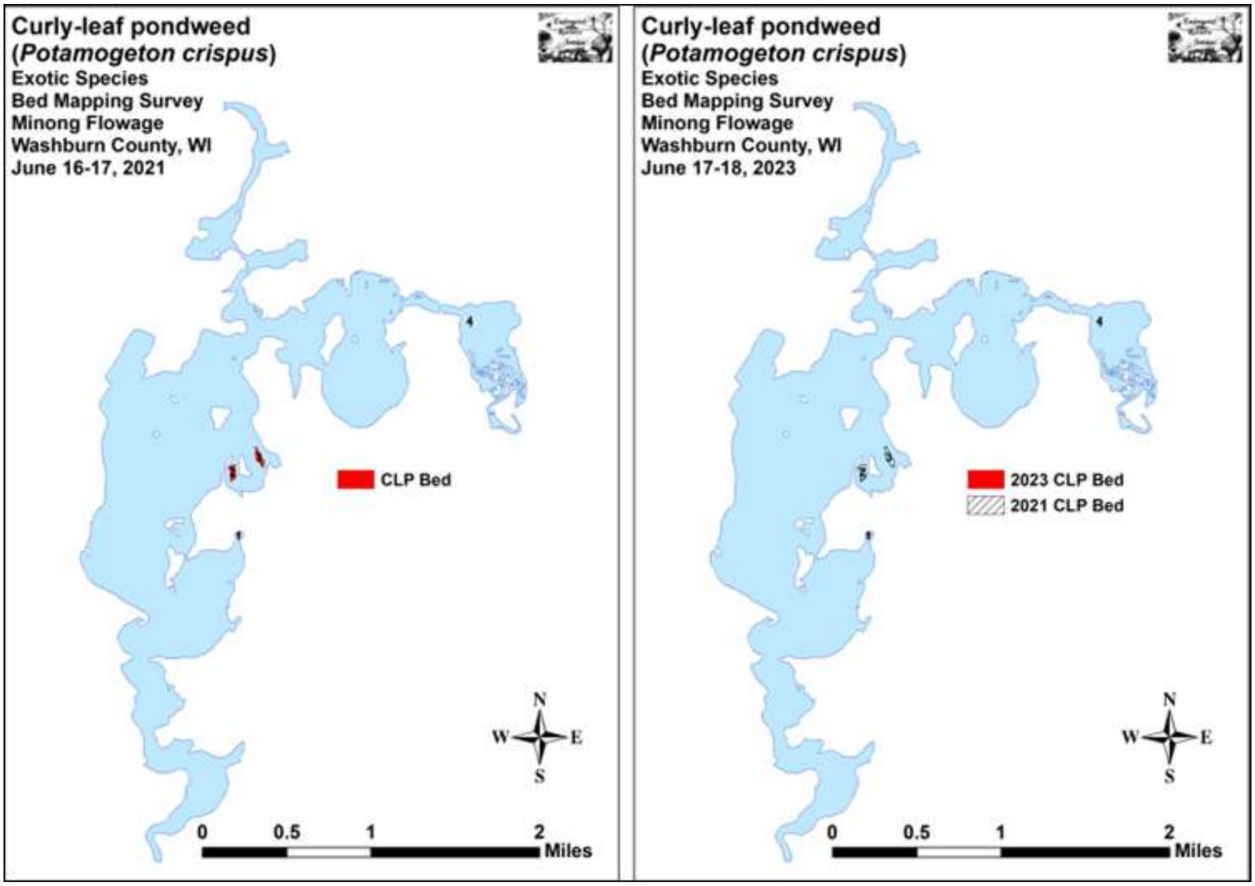


Figure 35: 2021 and 2023 CLP bed mapping results (ERS)

EURASIAN WATER MILFOIL (EWM)

The cold-water PI surveys completed since 2008 also included documentation of EWM, however this data is not included. Instead, EWM results from the summer PI surveys are presented. In 2008, EWM was present in the Minong Flowage at 188 sites including visuals and was the 2nd most common aquatic plant species in the Flowage. After 3yrs of herbicide application (2009-2011) EWM decreased to 81 points in the 2012 survey but was still the 2nd most common species. The extended drawdown reduced EWM to only 15 points in the 2014 survey, near the bottom in terms of most common species. By 2018, EWM increased to 60 points and was the 4th most common species (Figure 36). In 2021 EWM increased again to 117 points and became the 3rd most common species (Figure 37). After the winter drawdown, EWM was back down to 70 points and only the 9th most common species in the 2023 survey (Figure 37). Figure 38 shows the changes over time in total points with EWM and at different rake fullness levels.

These results suggest that past management actions have been successful at reducing the amount and density of EWM, but it does not take very long for EWM to reclaim lost acreage without management. When comparing the results before (2021) and after (2023) the winter drawdown specifically, visual analysis of the maps show that after the winter drawdown, EWM was much reduced in the southern basin, the shallow bays and flats on the north end of Serenity Bay, and in the Totogatic River Inlet; but little changed on the south end of Serenity Bay and in the deep flats west of the island that forms Serenity Bay's western border. This confirmed that the winter drawdown was most effective in water ≤5ft and much less effective in deeper water.

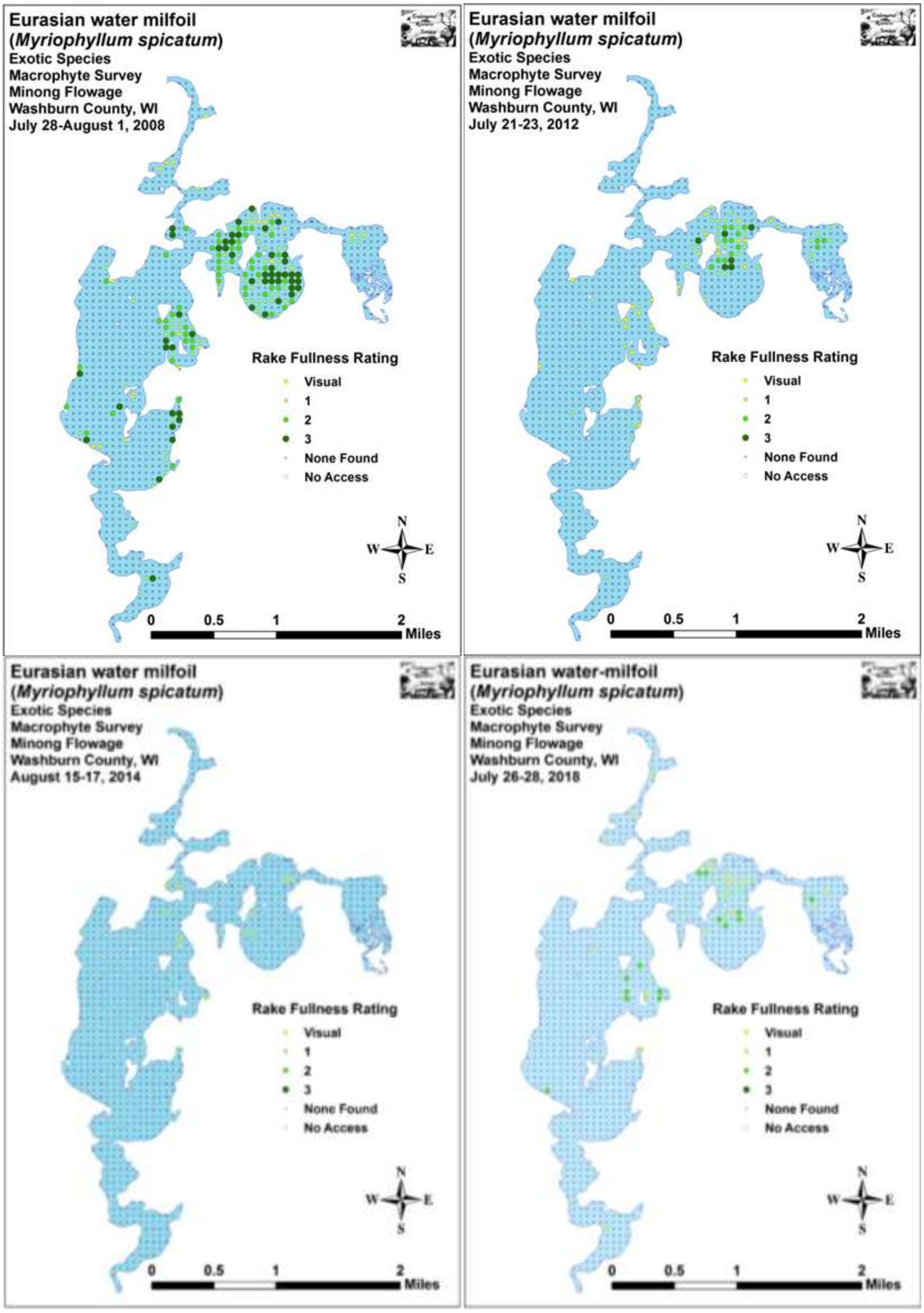


Figure 36: 2008, 2012, 2014, and 2018 EWM distribution and density (ERS)

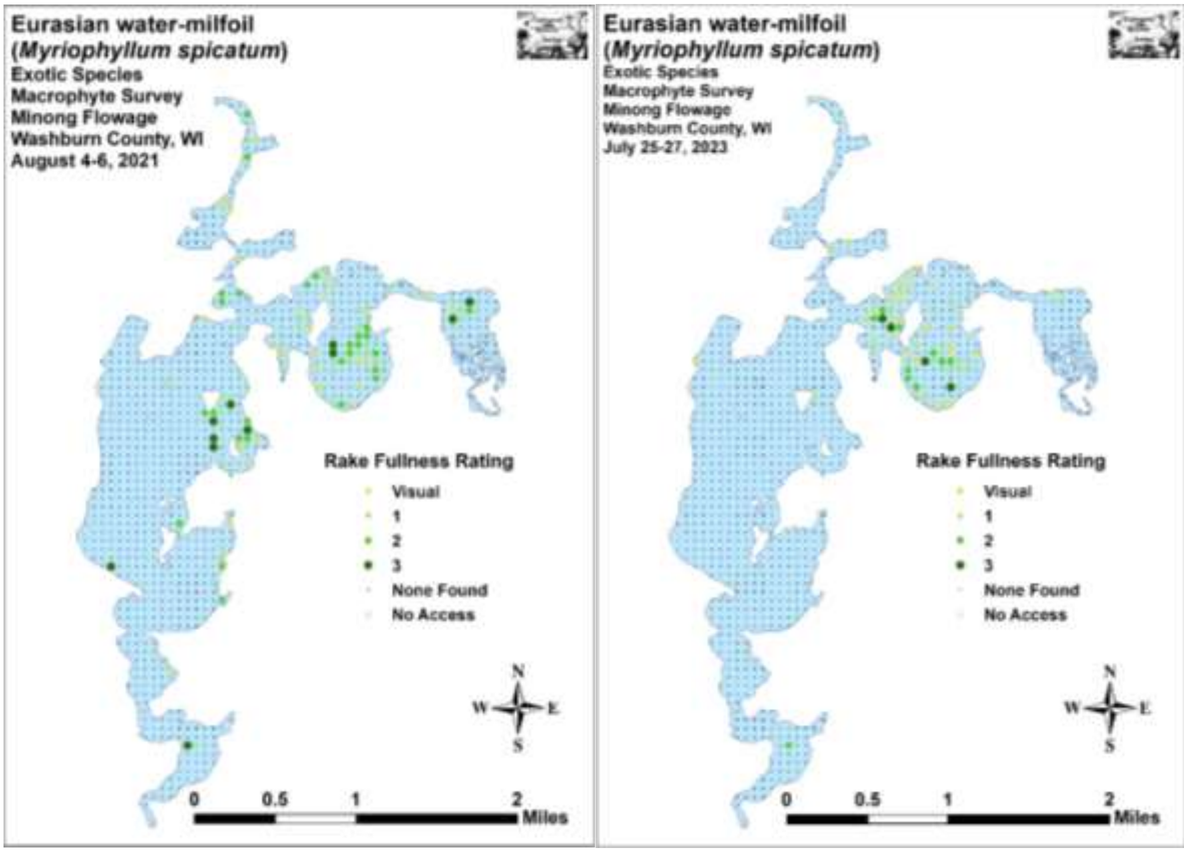


Figure 37: 2021 and 2023 EWM distribution and density (ERS)

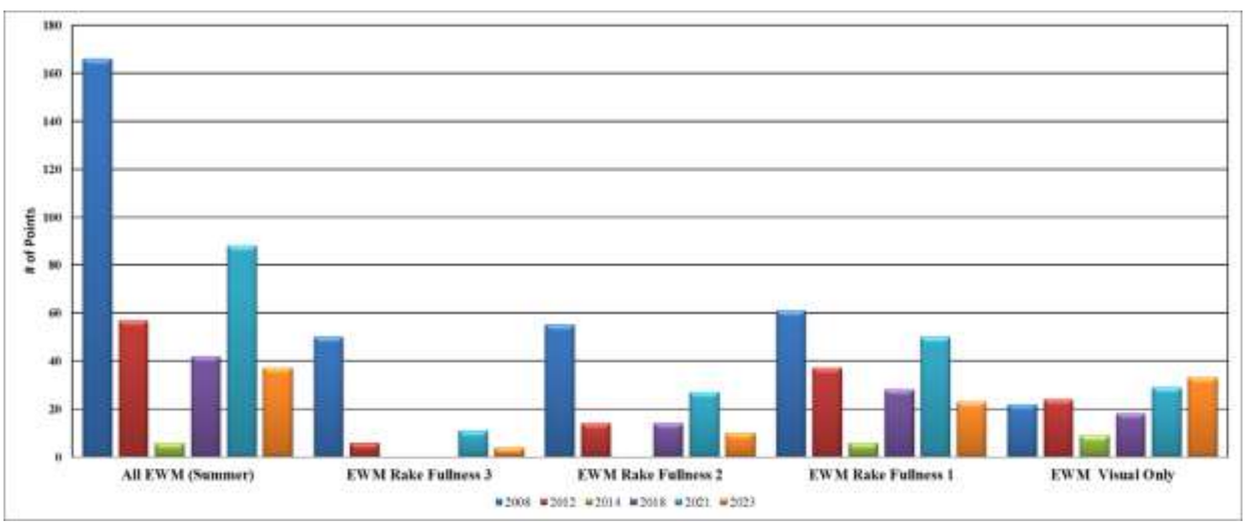


Figure 38: Changes in EWM rake fullness – 2008, 2012, 2014, 2018, 2021 & 2023 (ERS)

EWM BED MAPPING

EWM bed mapping has been completed in the fall of every year since 2014, the fall after the extended drawdown. Since that time, herbicides have been applied three times: 2015, 2016, and 2023. A winter drawdown of 5.0ft was completed over the 2021-22 winter season. Table 4 reflects the results of fall bed mapping completed from 2014 to 2023. In the fall of 2014, EWM was at its lowest level due to an extended drawdown. In the fall of 2015, one year after the extended drawdown, EWM had increased to >90acres despite three beds totaling 15.7 acres being chemically treated. In 2016, EWM increased again to >125 acres despite a large 26.9-acre treatment in the DNR Bay. During the fall survey, EWM in the DNR Bay treatment area was gone, but it increased in other untreated areas. Between 2016 and 2021, no management other than physical removal by property owners was completed, leading to >205 acres in the fall of 2021, just before the winter drawdown was implemented. In the fall of 2022, following the winter drawdown, EWM was down by about 56% to just over 116 acres. Nearly all the decline was in water ≤5.0ft. By the fall of 2023, EWM was back up to >150 acres despite a 14.5-acre chemical treatment. EWM in deeper water quickly reestablished in the shallow water impacted by the winter drawdown.

Table 4: Annual fall EWM bed mapping from 2014 to 2023 (ERS)

2023 Area in Acres	2022 Area in Acres	2021 Area in Acres	2020 Area in Acres	2019 Area in Acres	2018 Area in Acres	2017 Area in Acres	2016 Area in Acres	2015 Area in Acres	2014 Area in Acres
0.73	0.36	1.91	1.69	1.71	1.72	1.62	1.40	0.50	0.32
1.04	0.76	1.40	1.07	0.81	0.32	0.23	0.33	0	0
0	0	0	0	0.07	0.56	0.22	0.81	0.58	0
0	0.04	0.61	0.43	0.47	0.68	0.47	0.48	0.31	0
0.06	0.04	0	0	0	1.77	1.66	1.80	1.40	0
0	0	1.75	0.90	0.63	0.07	0	0	0	2.68
0.19	0	11.59	2.91	2.81	1.47	1.93	2.06	0	0
0	3.79	3.33	1.39	0.62	1.20	1.27	2.55	1.96	1.42
0.17	0.50	0	0	0	0	0	0	0	0
0.07	0	0.78	0.05	0.30	1.14	0.09	1.05	0	0
0.14	0	0.83	0.14	0.29	0.42	0.15	0.30	0	0
1.34	0.18	8.58	5.79	6.84	0.66	0.27	1.49	0	0
0	0	4.43	1.95	1.34	11.50	1.06	0	16.39	0
0	0	4.48	3.23	2.38	2.19	0	0	1.23	0
0.95	0.04	3.37	2.98	2.48	3.48	2.41	0.75	0	0
0.68	0.17	2.42	2.31	2.13	2.73	1.50	1.46	0	0
0	0	0	0	0	2.10	1.55	0.76	0.18	0
0.04	0	0.36	0	0	0	0	0	0	0
0.04	0.09	00	0	0	0	0	0	0	1.90
0	0	0	0	0	2.56	3.11	0.85	0	1.57
4.42	6.29	5.25	2.62	1.53	0.31	0.45	0	0	0
0	0	0.61	0.45	0	0.67	0.47	0.31	0	0.05
1.02	1.37	1.22	0.29	0	0	0	0	0	0
0.27	0	0	0	0	0.22	0.18	0.10	0	0.57
0.81	1.50	0.75	0	0	1.49	0.88	0.09	0	0.85
8.06	4.28	3.94	0.86	0.56	58.54	54.45	75.32	43.08	4.58
80.57	68.59	90.74	51.30	32.80	29.05	26.05	24.27	19.43	0
0	0	27.87	25.08	21.99	10.73	8.00	7.61	5.30	0
49.66	28.16	19.20	5.36	4.68	3.21	3.51	1.80	-----	0.10
0.02	0	5.23	0.20	0.12	0.31	0.14	0	0	0
0.60	0	5.16	1.12	0.70	2.79	1.23	0	0	0
150.90	**116.13**	**205.85**	**112.13**	**85.27**	**141.88**	**112.88**	**125.58**	**90.36**	**14.02**

NATIVE AQUATIC PLANTS

Aquatic plants form the foundation of healthy and flourishing lake ecosystems - both within lakes and rivers and on the shores around them. They not only protect water quality, but they also produce life-giving oxygen. Aquatic plants are a lake's own filtering system, helping to clarify the water by absorbing nutrients like phosphorus and nitrogen that could stimulate algal blooms. Plant beds stabilize soft lake and river bottoms and reduce shoreline erosion by reducing the effect of waves and current. Healthy native aquatic plant communities help prevent the establishment of invasive non-native plants like EWM, purple loosestrife, or phragmites. Aquatic plants provide important reproductive, food, and cover habitat for fish, invertebrates, and wildlife. It's aquatic plants that fashion a nursery for all sorts of creatures ranging from birds to beaver to bass to bugs.[3]

The main purpose of repeated whole-lake PI survey is to provide a means to compare changes in the native aquatic plant community in a body of water over time. Though some changes do occur naturally, most significant changes are due to disturbance created by man including development of the lake shore, lake use, increased amounts of nutrients and other pollutants that may cause eutrophication, and the introduction and management of AIS like EWM. The six PI surveys that have been completed in the Minong Flowage show that despite any collateral damage from past active management, it continues to have an exceptionally rich and diverse native plant community that is home to many high-value species.

Table 5 shows survey statistics from all six PI surveys. Despite some ups and downs, survey statistics from 2023 are close in many categories (number of species per site), and way better in some others (species richness). The average number of native species per site with vegetation was at its highest in 2023 at 3.54. Previous bests were in 2008 and 2012 at 3.48. The Simpson Diversity Index score in 2023 (0.96) was also higher than the score in 2008 (0.94). The number of species identified in the Flowage – on the rake, with visuals, and with visuals and the boat survey are the highest they have been since the PI surveys began at 70, 73, and 77 respectively. Figure 39 shows native species richness in 2008 and 2023. Figure 40 shows the rake fullness rating for all vegetation during the surveys. The average rake fullness is slightly less in 2023 (2.2) than it was in 2008 (2.69) but this is likely due to the density of EWM in 2008. In both 2021 and 2023 the average rake fullness rating was higher than in any other survey except 2008.

Table 5: Aquatic Plant Summer PI Survey Summary Statistics 2008, 2012, 2014, 2018, 2021 & 2023

Summary Statistics: Minong Flowage Summer PI Surveys	**2008**	**2012**	**2014**	**2018**	**2021**	**2023**
Total number of points sampled	875	876	876	878	878	878
Total number of sites with vegetation	377	242	227	220	325	328
Total number of sites shallower than the maximum depth of plants	517	374	462	433	510	509
Frequency of occurrence at sites shallower than maximum depth of plants	72.92	64.71	49.13	50.8	63.7	64.4
Simpson Diversity Index	0.94	0.95	0.96	0.95	0.96	0.96
Maximum depth of plants (ft)	9.5	7.5	9.0	8.5	9.5	9.5
Mean depth of plants (ft)	4.00	3.10	3.22	3.00	3.85	3.95
Median depth of plants (ft)	4.0	3.0	3.0	3.0	4.0	4.0
Average number of all species per site (shallower than max depth)	2.77	2.31	1.35	1.76	2.30	2.34
Average number of all species per site (veg. sites only)	3.8	3.57	2.75	3.46	3.61	3.64
Average number of native species per site (shallower than max depth)	2.44	2.15	1.33	1.66	2.10	2.26
Average number of native species per site (veg. sites only)	3.48	3.48	2.75	3.28	3.36	3.54
Species richness	59	57	52	60	68	70
Species richness (including visuals)	61	60	55	62	72	73
Species richness (including visuals and boat survey)	65	69	64	69	78	77
Mean rake fullness (veg. sites only)	2.69	2.18	2.1	2.08	2.33	2.20

[3] https://dnr.wisconsin.gov/topic/lakes/plants

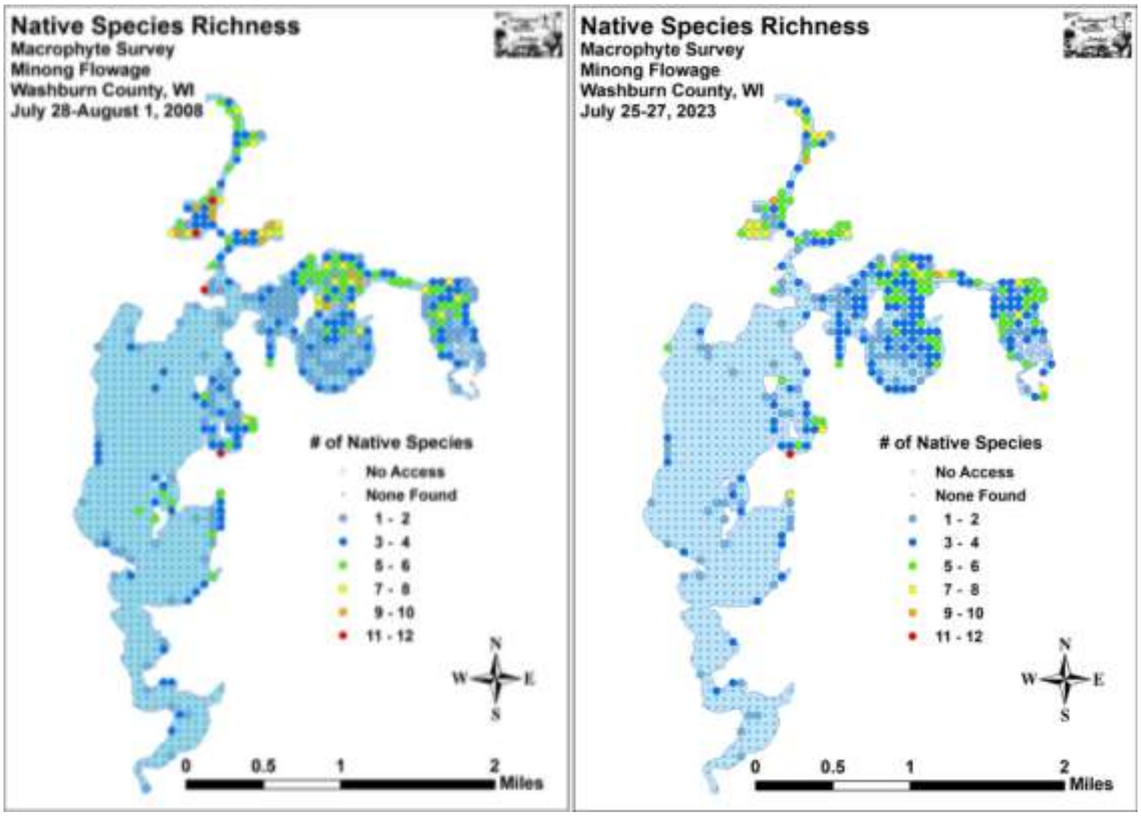


Figure 39: Native Species Richness (diversity/distribution) 2008 & 2023 (ERS)

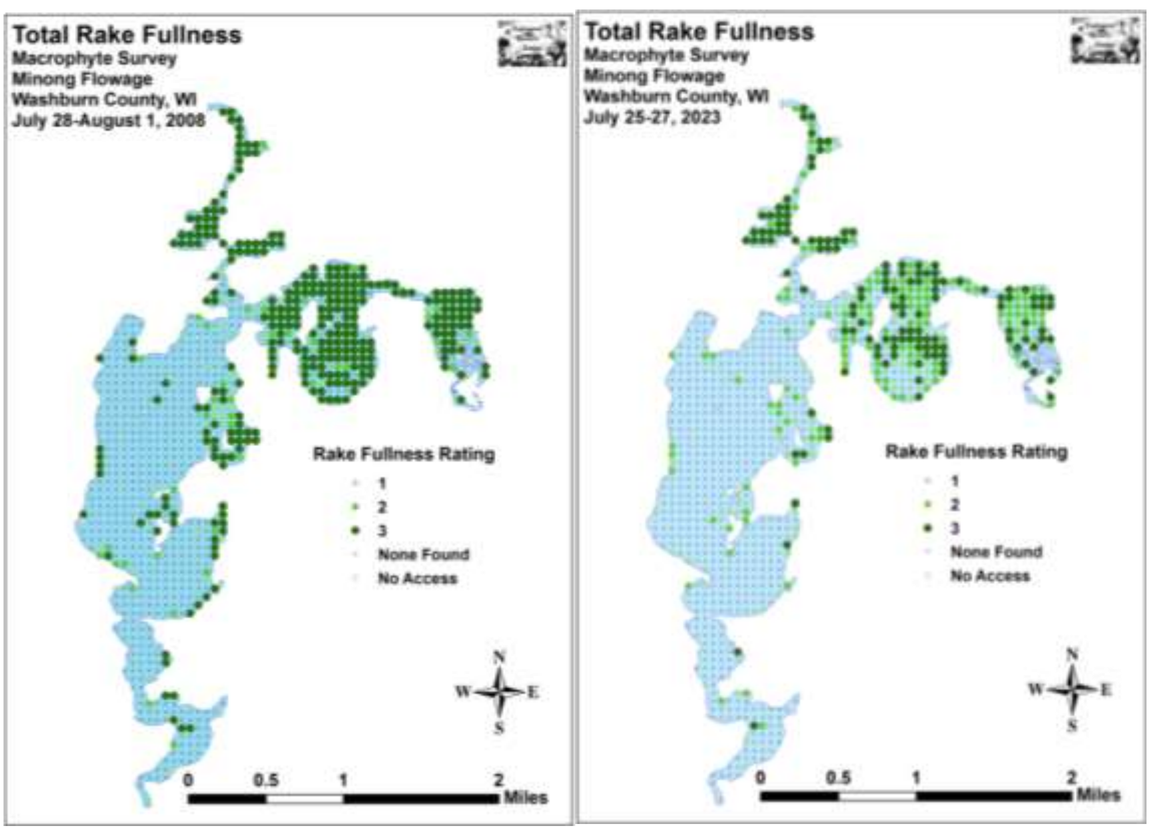


Figure 40: Total rake fullness (density) 2008 & 2023 (ERS)

In 2008, the following were the 10 most common aquatic plant species in the lake based on the number of points they were identified on the rake during the PI survey. The last two species on the list were tied for the 10th most common species in 2008.

1. Coontail
2. Eurasian watermilfoil
3. Common waterweed
4. Wild celery
5. Fern-leaf pondweed
6. Small pondweed
7. Northern wild rice
8. Flat-stem pondweed
9. White water lily
10. Large-leaf pondweed
10. Watershield

Table 6 looks at the total number of points the top ten species from 2008 were identified on the rake and their most common species rank for all six PI surveys. Table 7 breaks down the changes due in part to 3yrs of herbicide application (2012/2008); the extended drawdown (2014/2012); the winter drawdown (2021/2023); and the overall changes from 2008 to 2023 (2008/2023). In both Tables, water star grass and slender naiad are referenced because they were in the top ten species from the 2023 PI survey. From 2008 to 2023 these species increased by 264% and 180% respectively.

From this data, it appears that the extended drawdown had the most negative impacts on the top ten aquatic plants in the Minong Flowage (down 61%), followed by the 3yr herbicide application (down 38%). The winter drawdown, overall, appears to have had a positive impact (up 23%) with 7 of the top 10 species including wild rice, seeing increases after the drawdown rather than decreases. Both watershield and large-leaf pondweed rebounded after the winter drawdown to what they had been in 2008, after seeing large decreases in between. EWM is the biggest loser from 2008 to 2023 with a decrease of 78%. Fern-leaf pondweed, coontail, and wild celery were the next biggest losers with decreases of 65%, 53%, and 41% respectively from 2008 to 2023.

Outside of the top ten most common species, eight other species decreased by 50% or more between 2008 and 2023: Water smartweed (50%), Clasping-leaf pondweed (50%), Water marigold (72%), Small bur reed (75%), Flat-leaf bladderwort (75%), White water crowfoot (80%), Creeping bladderwort (85%), and Northern watermilfoil (88%). In total, 24 species from 2008 saw increases in the number of sites on the rake. Nine new species were found on the rake at 2 or more sites in 2023. Of all the aquatic plant species found on the rake at two or more sites in 2008, only Three-way sedge was not found on the rake in 2023.

Table 6: Most common aquatic plant species from all six PI surveys from 2008 to 2023

Species	Year	Total Sites	Most Common Species Rank
Coontail	2008	187	1
	2012	93	1
	2014	28	6
	2018	94	1
	2021	114	1
	2023	87	3
EWM	2008	166	2
	2012	57	2(T)
	2014	6	19(T)
	2018	42	4
	2021	88	3
	2023	37	9
Common waterweed	2008	130	3
	2012	57	2(T)
	2014	33	5
	2018	57	2
	2021	76	4
	2023	100	2
Wild celery	2008	90	4
	2012	46	5(T)
	2014	3	22(T)
	2018	32	8
	2021	44	9
	2023	53	8

Species	Year	Total Sites	Most Common Species Rank
Fern-leaf pondweed	2008	83	5
	2012	54	3(T)
	2014	11	15(T)
	2018	28	10(T)
	2021	42	10
	2023	29	13
Small pondweed	2008	82	6
	2012	29	8
	2014	11	15(T)
	2018	28	10(T)
	2021	104	2
	2023	109	1
Northern wild rice	2008	72	7
	2012	47	4
	2014	58	2
	2018	33	7
	2021	69	5
	2023	86	4
Flat-stem pondweed	2008	61	8
	2012	46	5(T)
	2014	3	22(T)
	2018	29	8
	2021	46	7
	2023	59	6

Species	Year	Total Sites	Most Common Species Rank
White water lily	2008	57	9
	2012	54	3(T)
	2014	68	1
	2018	44	3
	2021	45	8
	2023	36	10
Large-leaf Pondweed	2008	35	10(T)
	2012	22	10
	2014	2	23(T)
	2018	7	21(T)
	2021	11	24(T)
	2023	36	24(T)
Watershield	2008	35	10(T)
	2012	38	6
	2014	2	23(T)
	2018	7	21(T)
	2021	25	14
	2023	36	28(T)
Water Star Grass	2008	22	15
	2023	80	5
Slender Naiad	2008	20	16(T)
	2023	56	7

(T) - Tied with one or more other species in rank

Table 7: Changes in the top ten aquatic plant species from 2008 over the six PI surveys

Calculation	Coontail	EWM	Common waterweed	Wild celery	Fern-leaf pondweed	Small pondweed	Northern wild rice
In Top 5 of PI	5 out 6 (#1 in 4)	4 of 6	6 of 6	2 of 6	2 of 6	2 of 6	4 of 6
3yr Herbicide	down 50%	down 66%	down 56%	down 49%	down 35%	down 65%	down 35%
Extended drawdown	down 70%	down 89%	down 42%	down 93%	down 80%	down 62%	up 23%
Winter drawdown	down 24%	down 58%	up 32%	up 20%	down 31%	up 5%	up 25%
2008 to 2023	down 53%	down 78%	down 23%	down 41%	down 65%	up 33% (#1 in 2023)	up 19%

Calculation	Flat-stem pondweed	White waterlily	Watershield	Large-leaf pondweed	Water star grass	Slender naiad	Top 10 Species Average
In Top 5 of PI	1 of 6	3 of 6	0 of 6	0 of 6	*	*	*
3yr Herbicide	down 25%	down 5%	up 9%	down 37%	*	*	**down 38%**
Extended drawdown	down 93%	up 25%	down 95%	down 91%	*	*	**down 61%**
Winter drawdown	up 28%	down 20%	up 44%	up 227%	*	*	**up 23%**
2008 to 2023	down 3%	down 37%	up 3%	up 3%	up 264%	up 180%	**down 22%**
*** not calculated**							

FLORISTIC QUALITY INDEX (FQI)

The FQI measures the impact of human development on a lake's aquatic plants. The species in the index are assigned a Coefficient of Conservatism (C) which ranges from 1-10. The higher the value assigned, the more likely the plant is to be negatively impacted by human activities relating to water quality or habitat modifications. Plants with low values are tolerant of human habitat modifications, and they often exploit these changes to the point where they may crowd out other species. The FQI is calculated by averaging the conservatism value for each native index species found in the lake during the PI survey,[4] and multiplying it by the square root of the total number of plant species (N) in the lake.

[4] Species that were only recorded as visuals or during the boat survey, and species found in the rake that are not included in the index are excluded from FQI analysis (ERS).

Statistically speaking, the higher the index value, the healthier the lake's aquatic plant community is assumed to be.

Table 8 shows the FQI values for all six whole-lake PI surveys. All FQI values in 2023 except for the mean C are the highest they have ever been including the 1st PI survey in 2008. All values declined after the 3yr herbicide application and were at their lowest after the extended drawdown. From that point on the values again improved to where they are now after the winter drawdown.

Table 8: Floristic Quality Index values from all PI surveys

Year of PI Survey	# of Species (N)	Mean C	FQI	C=8,9, or 10	% of N	Notes
2008	52	6.6	47.3	20	38.5	1st PI survey
2012	51	6.5	46.5	19	37.3	Post 3yr herbicide
2014	45	6.4	42.9	16	35.6	Post ext. drawdown
2018	55	6.4	47.7	20	36.4	Limited herbicide
2021	59	6.5	49.6	22	37.3	No management
2023	62	6.4	50.7	24	38.1	Post winter drawdown

WILD RICE

The following excerpt and photo (Figure 41) are taken from the 2010 WI Ceded Territory Manoomin Inventory prepared by GLIFWC (David, 2010).

"Although the majority of the Minong Flowage is in Washburn County, the existing rice beds are on the far northeast portion of the flowage, which is in Douglas County. This is a significant bed with a long history. This site is heavily harvested, but not date-regulated because it is a flowage rather than a natural lake. The harvest location is often reported as "Smiths Bridge" by respondents to the harvest survey. The Smiths Bridge access point is visible in the photo above; most of the rice occurs east of the bridge (at the bottom of the photo) but in recent years the bed has increased in size west of the bridge. Eurasian water milfoil was recently located in close proximity to the Minong Flowage rice beds, and at present likely represents the greatest threat to the beds; this will be an important site to monitor and perhaps to study in an effort to determine treatments which might control the milfoil while having the least impact on the rice. Watch status is medium-high because of the need to monitor both the possible expansion of the bed, and the possible negative impacts of invasive aquatics."


Figure 41: 2007 wild rice beds in the Minong Flowage (east and west of Smith Bridge)

Wild rice in the Flowage has shown population fluctuations that appear to be independent of water level management. In the 2008 whole-lake PI survey, it was found in the rake at 72 points. Of these, 41 had a rake fullness value of 3, 16 were a 2, and the other 15 were a 1 for a mean rake fullness of 2.36. It was also recorded as a visual at 7 points (Figure 42).

After three years of herbicide application to control EWM, the 2012 PI survey found rice at 47 points (Figure 42). Eight points rated a rake fullness of 3, 15 rated a 2, and 24 were a 1 (mean rake fullness of 1.66) with an additional 15 visual points. When compared to 2008, this represented a non-significant decline in distribution, but a highly significant decline in density. Most of these losses occurred west of Smith's Bridge and in the north half of the Totogatic inlet. Rice declines in water from 1-3ft deep were strongly correlated with areas where EWM had colonized. Declines in water <1ft, especially in bays north of the channel near the shoreline, may have been due to fluctuating water levels caused by the late May/early June floods that were observed to uproot many young rice plants.

After the extended drawdown to repair the dam, the 2014 PI survey found 58 points with rice in the rake. Of these, 22 rated a rake fullness of 3, 20 a rake of 2, and the remaining 16 a rake of 1 for a mean of 2.10. It was also recorded as a visual at 16 points. While other emergents seemed to be knocked back by the extended drawdown, the rice survived and showed evidence of local expansion as it jumped to the second-ranked native species in 2014 (Figure 43). When compared to 2012, this was a non-significant increase in distribution, but a moderately significant increase in density.

Large-scale flooding in 2016 had a significant negative impact on wild rice, appearing to have swept most of the rice out of the delta region in the Totogatic inlet, and, by the 2018 PI survey, the local population was still little recovered (Figure 43). Rice was documented in the rake at 33 points – a significant decline in distribution compared to 2014. Of these, none rated a 3, just three were a 2, and the remaining 30 were a 1 (mean rake fullness of 1.09) with most samples being represented by a single stem. Rice was also a visual at 18 points. These data also represented a highly significant decline in mean density.

The 2021 PI survey found rice had undergone a moderately significant increase in distribution and a highly significant increase in density (mean rake fullness of 1.57) from 2018. Rice was found in the rake at 69 points. Four of these points rated a rake of 3, 31 were a 2, and 34 were a 1 with 18 additional visuals. It was noted by the surveyor, that rice was reestablishing throughout the river inlet and west of Smith's Bridge including in the northern regions of Serenity Bay (Figure 43).

Following the 2021-22 drawdown, the 2023 PI survey found the rice population was higher than during any previous survey (Figure 43), and there were harvestable rice beds both west of Smith's Bridge on the north end of Serenity Bay (Figure 43), and east of Smith's Bridge in the delta (Figure 43). Rice was found at 86 sites, a non-significant increase over 2021. Seven points had a rake fullness of 3, 34 rated a 2, and 45 were a 1 with 13 additional visual sightings. This combined mean rake fullness of 1.56 was a non-significant decline (p=0.47) in density.

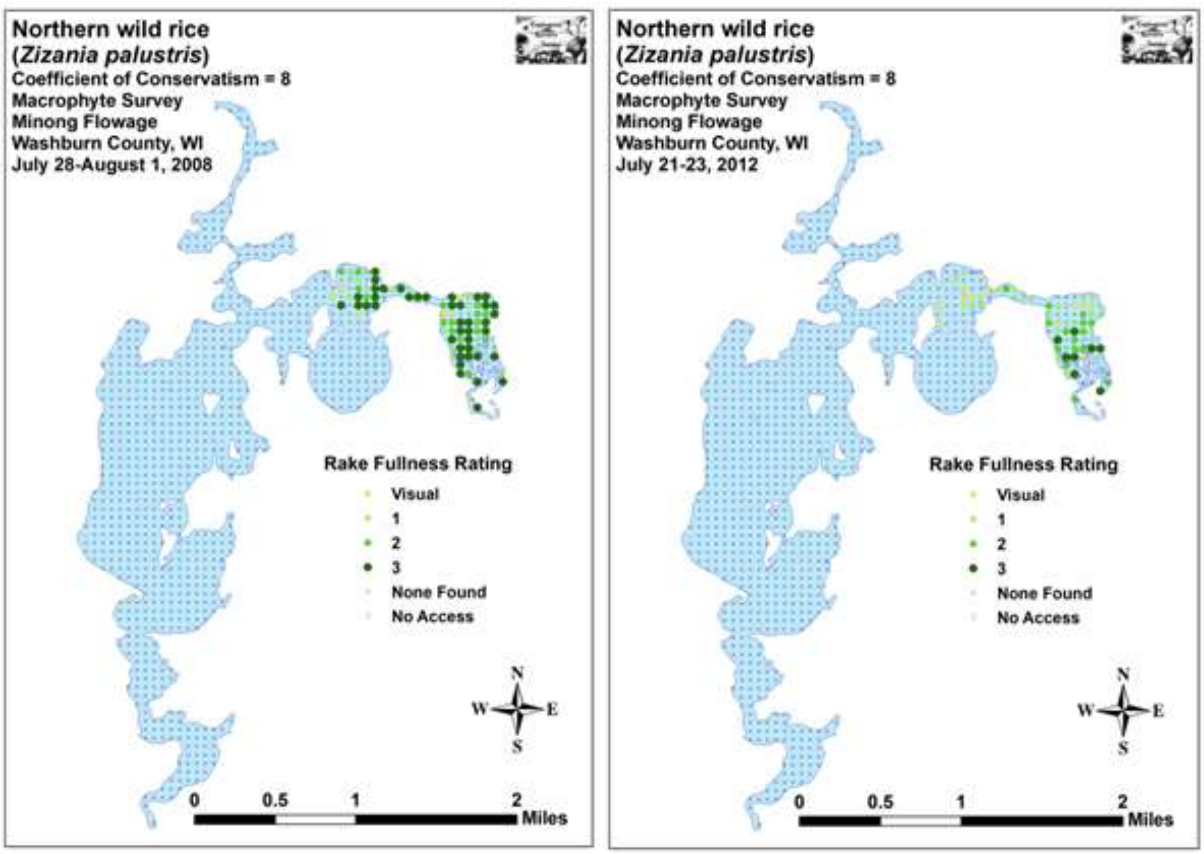


Figure 42: 2008 and 2012 wild rice distribution and density (ERS)

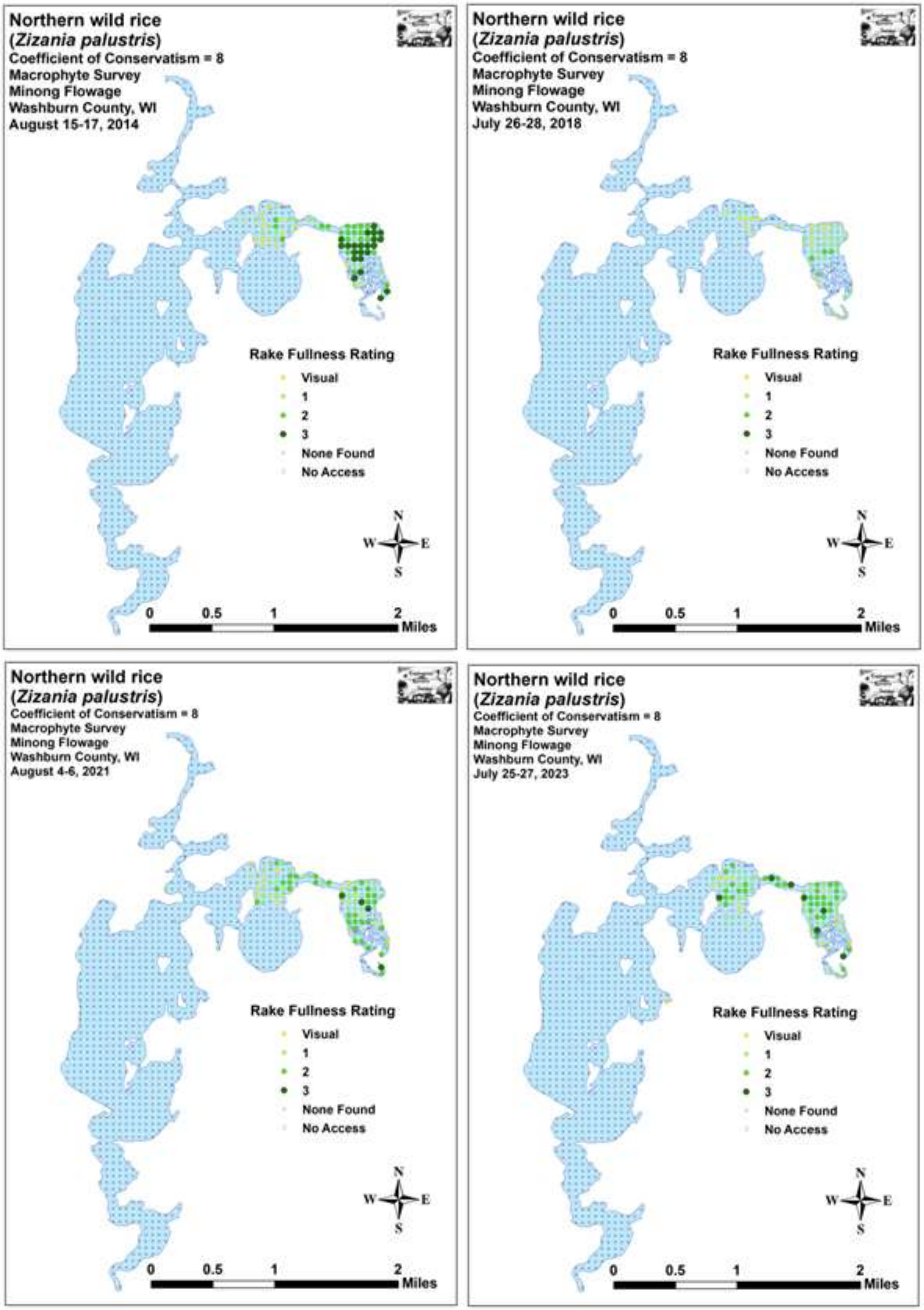


Figure 43: 2014, 2018, 2021, and 2023 wild rice distribution and density (ERS)

Table 9 shows the estimated acreage of wild rice in the Flowage based on the 878-point PI survey grid where each point represents about 1.78 surface water acres. Wild rice was down slightly in 2012 after three years of herbicide application. It was up almost to the original area after the 2013-14 extended drawdown. In 2018, after massive flooding in 2016, wild rice was down again to its lowest level of all surveys. By 2021, it had recovered from the 2016 floods and increased in distribution. After the 2021-22 winter drawdown, it again increased to its widest distribution since the PI surveys began. It is obvious that drawdowns increase the distribution of wild rice.

Table 9: Estimated wild rice in the Minong Flowage during each summer PI survey.

Year of PI Survey	# of Points w/wild rice (including visuals)	Estimated acreage of wild rice based on 1.78 acres/PI point
2008	79	140.6
2012	62	110.4
2014	74	131.7
2018	51	90.8
2021	87	154.9
2023	99	176.2

GLIFWC generally completes aerial photo documentation of the wild rice beds in the Minong Flowage on an annual basis. On-the-water mapping of wild rice has only been done a couple of times since 2008. While GLIFWC's annual aerial photo documentation should be continued, bed mapping is not recommended in this APM Plan.

CONCLUSIONS

From 2008 to 2023, changes in aquatic vegetation, good and bad, were likely brought about by a combination of factors including use of herbicides and drawdowns for EWM management; changes in water clarity/quality which impacted the extent of the littoral zone; and seasonal growing conditions. The extended drawdown from April 2013 to February 2014 clearly had the most negative impact on aquatic plants in the Flowage. It also negatively impacted trees growing on the shore, increased the amount of coarse woody debris on the shoreline when stumps and other forms were pulled from the bottom during the refill in February 2014, and caused several consumer wells to go dry. An extended drawdown should not be done again. Large-scale herbicide applications several years in a row like what was done from 2009-2011 should also not be done again.

Conversely, the winter drawdown appears to have improved the native aquatic plant community while also reducing the amount of EWM. It also appears that single year, smaller applications of aquatic herbicides to control EWM can be completed with limited negative impact to the native aquatic plant community. And by doing so, may delay the need to repeat a winter drawdown "too soon" allowing the entire aquatic plant community to recover more fully.

The PI survey data also shows that if left unmanaged, EWM will re-colonize areas where it has been found before. Efforts to restore the native plant community, or just giving native plants more time to recover between major management actions without competition from non-native, aquatic plant species would be beneficial and is a goal of this plan.

FISH AND AQUATIC PLANTS

Based on an assessment of the literature (Dibble, 1997) there are predictable responses by fish in relation to aquatic plants. Vegetated areas support fish densities much higher than un-vegetated areas. Comparisons of vegetated and un-vegetated areas within the same water body generally show that fish assemblages in un-vegetated areas have lower densities and fewer species. Structurally oriented fish exploit aquatic plant beds, with juvenile sunfishes being numerically dominant in vegetation in most North American water bodies, but if plants occupy an entire water body, growth becomes stunted because food resources are depleted. Open water species and benthic omnivores often decline in abundance as plants increase in areal coverage.

When aquatic plants cover an entire water body, foraging by piscivores (examples: bass, walleye, northern) is hampered by stems and leaves, stunted sunfishes increase in abundance due to lower predation and higher prey abundance, and spawning by nest builders is confined to limited areas that may increase competition and decrease spawning success. Conversely, water bodies that lack vegetation generally have lower densities of littoral fishes, although standing crop may not differ substantially, and fishes become more aggregated (Dibble, 1997).

Most comparative studies of plant and fish abundance conclude that intermediate vegetation levels, defined as 10-40% coverage of study sites, including areas ranging from individual coves to entire water bodies, promote high species richness and are optimal for growth and survival (Dibble, 1997).
Table 10 compares the total surface area of the Flowage considered to be part of the littoral or plant growing zone and how much of that area had aquatic plant growth during each of the six whole-lake, point-intercept, aquatic plant surveys completed. It also shows the total rake fullness (RF) in those vegetated areas. If vegetative coverage of 10-40% is optimal for the growth and survival of the fishery, then only in 2008, when 43% of the Flowage's surface area was covered with moderate to dense aquatic plant growth (2.69 out of 3.0 RF), would the vegetation in the Minong Flowage be considered detrimental to the overall health of the fishery. It was also in 2008, that the distribution (335 acres) and density (1.93) of EWM was at its greatest (Table 10).

EWM poses some challenges to fishery managers. In some waters, it can improve fish production, especially in waters too turbid to support native plant growth. By increasing the surface area for invertebrate colonization, EWM expands the food base for benthivores and protects emerging year-classes from piscivores. Through seasonal growth and senescence, it creates a dynamic littoral zone where openings in plant beds appear and disappear, cruising lanes for piscivores come and go, and edge effect for crappies expands and shrinks (Engel, 1995). However, some of its effects can be detrimental to fisheries. When dense, EWM obstructs swimming space of open water fishes, shelters too many juvenile fishes, and disrupts foraging movements of piscivores. In replacing native plants that harbor a diverse array of invertebrates, EWM may create food shortages for fish. By blocking sunlight penetration and water movements, it depletes dissolved oxygen inshore that can cause fish kills when shoots decay in autumn (Engel, 1995).

In 2008, EWM covered 21.5% of the total surface area of the Flowage and nearly 50% of the littoral zone (Table 10). Moderate to dense growth EWM totaled 187 acres, 12.0% of the total surface area of the Flowage and nearly 28% of the littoral zone (Table 10). It is these conditions that lead to management actions being implemented.

Table 10: Littoral zone, Littoral zone w/vegetation, total EWM, EWM in the lake and the littoral zone, and rake fullness (RF) on a 1-3 scale from all summer, whole-lake, point-intercept surveys.

Year of Whole Lake PI	Littoral Zone (acres)	% of Lake (1560 acres)	Littoral w/Veg (acres)	% of Lake (1560 acres)	Whole Lake RF (all veg)	EWM acreage (all)	% of Lake (1560 acres)	% of Littoral w/Veg	EWM RF (all)	EWM acreage (2-3 RF)	EWM Management Action
2008	920	59.0	671	43.0	2.69	335	21.5	49.9	1.93	187	none
2012	666	42.7	431	27.6	2.19	144	9.2	33.4	1.46	36	Herbicide (3yrs)
2014	821	52.6	406	26.0	2.10	27	1.7	6.7	1.00	0	Ext. Drawdown (DD)
2018	771	49.4	392	25.1	2.08	107	6.9	27.3	1.33	25	none
2021	908	58.2	579	37.1	2.33	208	13.3	35.9	1.56	68	none
2023	906	58.1	584	37.4	2.20	125	8.0	21.4	1.49	25	Winter DD&Herbicide (1yr)

The distribution and abundance of aquatic plant growth (native and nonnative) in the Minong Flowage is important to maintaining a healthy fishery and has been a concern in the aftermath of each of the large-scale EWM management actions that have been implemented. After the first large-scale management action (herbicide application from 2009-2011) the littoral zone and whole-lake plant density decreased as did the distribution and density of EWM (Year 2012, Table 10). Whether or not more time would have helped the aquatic plant community recover more fully is unknown as the second large-scale management action (the 2013-14 extended drawdown) was completed.

The extended drawdown was not a planned management action but did provide valuable information for future management planning. After the extended drawdown, the littoral zone increased but the distribution and density of aquatic vegetation did not (Table 10). EWM was reduced to <2.0% if the surface area of the Flowage. Between 2014 and 2018 two years (2015 & 2016) of relatively small-scale herbicide application was completed and planning for a winter drawdown began with the expectation that a winter drawdown would be completed over the 2018-19 winter season. This did not happen because in 2018, the littoral zone had gotten smaller, and the distribution and density of native aquatic plant vegetation had decreased to a level lower than in 2014 (Table 10). Conversely, the distribution and density of EWM had increased, but not to levels deemed necessary to implement the winter drawdown.

From 2017 and 2021 no management of EWM was completed except physical removal by property owners. In 2021, the littoral zone had expanded to nearly its original 2008 acreage. The percent of the littoral zone with vegetation jumped to >37% from only 25% in 2018. The density of aquatic vegetation also increased to 2.33 RF. Unfortunately, like native aquatic vegetation, EWM also increased over that time from 107 acres in 2018 to 208 acres in 2021. The total RF for EWM in 2021 was 1.56 with nearly 70 acres of moderate to dense growth (Table 10). During this time, planning for a winter drawdown continued and due to the levels of EWM identified in 2021, it was completed, beginning in November 2021, and ending in April 2022.

The last whole-lake, point-intercept survey on the Flowage was completed in 2023, more than a year after the winter drawdown. Results from the survey show that the extent of the littoral zone and the percent of the littoral zone with vegetation did not change from the 2021 results. The whole-lake density of aquatic vegetation decreased slightly. All measurements of EWM also decreased. Total acreage was down to 125 acres, as was the amount of dense growth EWM. The data shows that the winter drawdown had less impact on native vegetation than did the extended drawdown, while at the same time helped reduce the amount of EWM by nearly 40%. However, the winter drawdown alone did not do this. A small-scale herbicide application was also completed in the spring of 2023.

The increased amount of vegetation in the Flowage after the 2021-22 winter drawdown was a positive development. While open-water fish species may see little change because of increased aquatic plant growth, panfish likely will. As mentioned, a limited amount of habitat for panfish could mean fewer panfish. Fewer panfish could lead to other fishery issues like an increase in the carp population (Bajer, 2012).

CARP

The common carp, an invasive benthic fish from Eurasia, has been strongly implicated in the disappearance of vegetative cover and reduced waterfowl abundance in North American shallow lakes. A recent study documented ecological changes in a recently restored shallow lake at a time that it was experiencing a large increase in its carp population (Bajer et al. 2009). It was documented that when the biomass of carp in these lakes remained at approximately 30 kg/ha there was no discernible effect on vegetative cover or waterfowl in the lake. However, an increase to 100 kg/ha was associated with an approximate 50% decrease in both vegetative cover and waterfowl. When the biomass of carp exceeded 250 kg/ha, the vegetative cover was reduced to only 17% of the original cover and waterfowl use declined to approximately 10% of its original value. This suggests that the common carp is extremely damaging to the ecological integrity of shallow lakes when its density exceeds 100 kg/ha (Bajer et al. 2009).

Another study completed by Johnson and Havranek (2010), looked at the relationship between an increase in carp biomass and a decrease in wild rice in the Clam Lakes in Burnett County, WI. The decline of wild rice in other lakes has been associated with water level fluctuations (Moyle, 1944), unfavorable weather (Moyle 1944), low nitrogen availability in sediments (Walker et al. 2010), and destruction of rice plants by carp and muskrats (Moyle 1944). Other studies have reported that wild rice beds typically experience natural declines in about one out of every four years (Moyle 1944) (Walker, 2010). However, even after substantial natural declines, rice beds typically reestablish quickly from seeds remaining in lake sediments (Moyle 1944). In the Clam Lakes, wild rice all but disappeared over a very short time and data collected on the lakes suggested there was no seed bank to recover (Johnson J. , 2010). This decline coincided with a dramatic increase in carp population and biomass. Previous studies, documented by Johnson and Havranek (2010), have reported that carp can severely reduce aquatic vegetation by uprooting plants, eating plant shoots, feeding on seeds in lake sediments, or by increasing turbidity. Another study reviewed by Johnson and Havranek (2010) reported that many wild rice stands in southern Minnesota disappeared after carp invaded area lakes in the early 1900s. In both cases an increase in carp biomass was triggered by a change in conditions on the body of water that led to a favorable recruitment year for carp.

AQUATIC INVASIVE SPECIES (AIS)

There are currently eight non-native species officially documented in the Minong Flowage – EWM, curly-leaf pondweed (CLP), purple loosestrife, reed canary grass, hybrid cattail, Rusty crayfish, Chinese mystery snails, and common carp. Of these, only EWM is causing significant issues in the Flowage. Information on these and other AIS is included in Appendix C.

AIS PREVENTION STRATEGY

Although the Minong Flowage already has eight non-native, invasive species, there are more that could be introduced. Zebra mussels are present in lakes only a few miles away. Spiny waterflea are in several lakes closer to Lake Superior. Other plant species like yellow iris, giant reed grass and Japanese knotweed can also be found in northwestern WI. The MFA will continue to do watercraft inspection and AIS signage at the public boat landings and strive to add signage to private landings. They will also continue monitoring the Flowage for other species. Both programs will follow UW-Extension Lakes and

WDNR protocol through the Clean Boats, Clean Waters program and the Citizen Lake Monitoring Network AIS Monitoring program.

Additionally, having educated and informed lake residents is the best way to keep non-native AIS at bay in the Minong Flowage. To foster this, the MFA will host and/or sponsor lake community events including AIS identification and management workshops; and distribute education and information materials to lake property owners and lake users through the newsletter, webpage, general mailings, and during public meetings.

2008-2014 MANAGEMENT PLANNING AND IMPLEMENTATION

A survey of the Minong Flowage was completed by the WDNR in 2003, the year after EWM was first identified in the Flowage. At that time, EWM occupied approximately 100 acres. Five years later, in 2008 survey work identified 335 acres of EWM. It was estimated that if left unmanaged that it could invade more than 500 acres of the 1500+ acre body of water. A summary of all management completed on the Minong Flowage between 2008 and 2014 is included in Table 11. More information about what was done between 2008 and 2014 can be found in the last APM Plan that covered the years 2016-2023.

Table 11: Management History on the Minong Flowage

Management History - Minong Flowage 2008-2014							
Task	2008	2009	2010	2011	2012	2013	2014
APM Plan	X						S
AIS Control Grant		X					
AIS Education Grant					X		X
Spring EWM Treatment		68 acres	119 acres	87 acres	P (22 acres)		
Fall EWM Treatment			6.3 acres			P (16.3 acres)	
Land Owner Treatments		X	X	P	P		
Pre Treatment Plant Survey		X	X	X	X	X*	
Post Treatment Plant Survey		X	X	X		X*	
Summer EWM Survey							X
Whole-lake PI Plant Survey	X				X		X
CLP Survey	X				X		X
Residual Testing		X	X	X	P		
Weevil Monitoring		X	X	X	X		
Weevil Rearing				X	X		
Fall EWM Bed Mapping	X	X	X	X	X	X	X
Wild Rice Mapping	X	X	X	X	X		X
Dam Repair/Drawdown						X	
Lake Tour		X	X	X	X		P

X - Completed
P - Proposed
X* - not really a pre or post
S - Started

In the fall of 2014, after a nearly year-long drawdown (Apr. 2013 to Feb. 2014), EWM bed mapping identified 8 areas totaling just over 14 acres (Figure 44). This after an earlier summer survey only found 15 individual EWM plants scattered throughout the system.

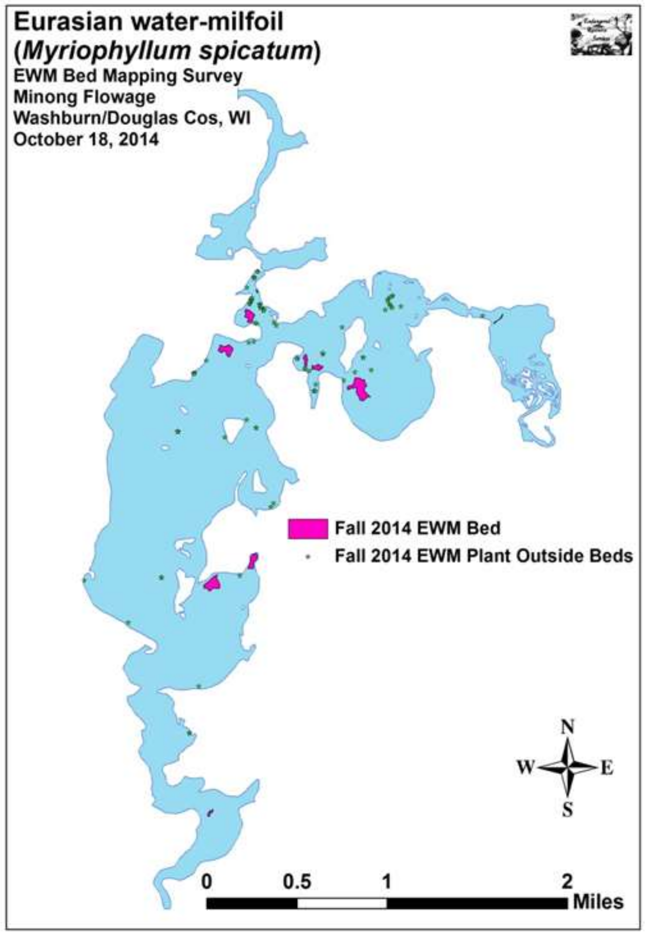


Figure 44: 2014 EWM fall bed mapping results (ERS)

In October 2014, the WDNR, in cooperation with the MFA and other stakeholders completed a Rhodamine Dye Study in Serenity Bay and the North Basin to determine water movement through that area of the Minong Flowage. The results of the Dye Study (see next section) and the fall EWM bed mapping results provided a starting point for the next nine years of EWM management in the Minong Flowage. Table 12 and the following sections summarize what was done in each year from 2014 to 2023. Grant funding was used in 2014-2015 (AEPP43114), 2016-2017 (ACEI18616), 2018-2019 (ACEI 21318), and 2021-2023 (ACEI 26521) to support these activities.

Table 12: Management Planning and Implementation from 2014 to 2023

Management History - Minong Flowage 2014-2023										
Task	**2014**	**2015**	**2016**	**2017**	**2018**	**2019**	**2020**	**2021**	**2022**	**2023**
APM Plan		x	x					ext.		x
AIS Control Grant			ACEI18616		ACEI21318			ACEI26521		
AIS Education Grant	AEPP 43114									
Spring EWM Treatment		x	x							x
Residual Testing			x							
Pre/Post Treatment Plant Survey		x	x					x		x
Summer/Fall EWM Bed Mapping	x	x	x	x	x	x	x	x	x	x
CLP Survey	x		x					x		
Whole-lake PI Plant Survey	x				x			x		x
Wild Rice Mapping	x									
EWM Weevil Monitoring			x							
Winter Drawdown					p	p		x	x	
Bathymetric Survey			x							
Dye Study	x									
x - Completed										
p - Proposed										

2014

OCTOBER 2014 DYE STUDY

A rhodamine WT dye (dye) study was completed for the Minong Flowage in fall of 2014 to quantify potential exposure times for undefined future aquatic herbicide treatments in potential target areas and in non-target wild rice beds (Skogerboe, 2014). The planned dye study was expected to provide background concentration and exposure time data, to design possible aquatic herbicide treatments and quantify the potential exposure of herbicides to wild rice beds. This was the first time in the state of Wisconsin that a flow study using dye was completed before a potential herbicide treatment.

John Skogerboe, with the WDNR at the time, set up the dye study and collected the study results. Implementation of the study began on October 10, 2014, with red rhodamine dye being applied to designated areas within Serenity Bay and the North Basin (Figure 45).

Figure 45: Rhodamine dye applied to waters of the Minong Flowage (left) and the designated study areas (right). The area outlined in green was considered wild rice water for the purposes of the study.

The amount of dye moving through the system was measured at a series of points associated with a 100x100meter grid, and at different times post-application (Figure 46).

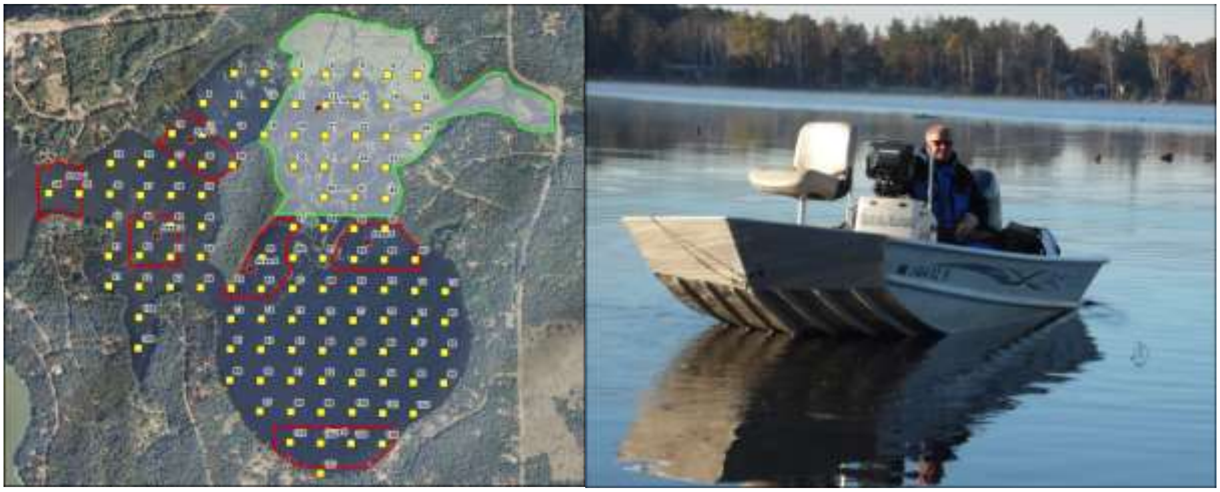


Figure 46: Dye monitoring points and John Skogerboe on the Minong Flowage, October 10, 2014

The results of the 2014 Dye Study showed that herbicides applied to the proposed treatment areas in the study did not drift into the wild rice beds. Even with a west wind, the dye moved downstream towards the dam in 1-12 hours, there was no drift towards the rice beds (Figure 47).

Figure 47: Fall 2014 dye concentration and movement 2, 7, & 27 hours post-dye application

2015

APPLICATION OF AQUATIC HERBICIDES

Based on the 2014 fall EWM bed mapping, it was decided to chemically treat five areas in 2015. A preliminary chemical treatment plan was drawn up using both liquid 2,4D and diquat herbicides treating nine beds totaling 23.8 acres. A 160-pt pre-treatment survey completed on May 15, 2015, only documented EWM at 19 of the 160 points. As a result, the original treatment proposal was reduced to 5 areas totaling 15.7 acres (Figure 48).

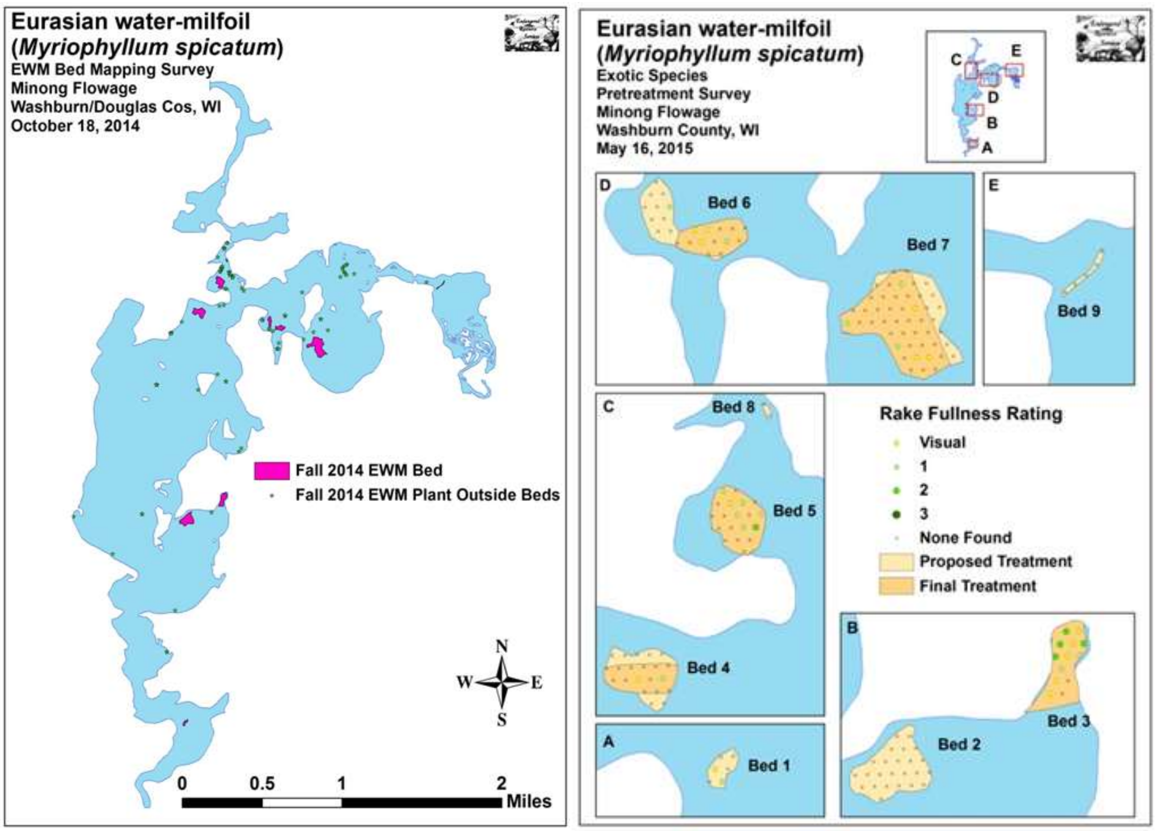


Figure 48: Fall 2014 EWM beds (left), and final 2015 chemical treatment areas (right)(ERS)

Beds 3 and 4 were well away from any wild rice and were expected to have adequate herbicide/target plant contact time so were chemically treated using liquid 2,4D (DMA 4) at a rate of 2.5ppm/acft (Table 13). Beds 5-7 were closer to areas of wild rice and from the 2014 dye study, herbicide/target plant contact time was expected to be shorter, so the areas were treated using diquat (Tribune), a contact herbicide at the maximum label rate of 2-gal/surface acres treated (Table 13). The treatment was completed by Northern Aquatic Services on May 19, 2015.

Table 13: 2015 modified chemical treatment of EWM in the Minong Flowage

2015 Minong Flowage Spring EWM Chemical Treatment Proposal (May 18, 2015 LEAPS)													
					Eurasian Watermilfoil — 2,4-D (DMA 4)			Eurasian Watermilfoil — Diquat (Reward)					
Treatment Location	Site Name	Acreage	Mean Depth (feet)	Volume (acre-feet)	Treatment a.i. ppm	Treatment application (gal)	Application rate (gal/ac-ft)	Max Label Treatment Rate (2 gal/acre)	Application rate (gal/ac-ft)	Max allowed diquat ion (2lbs/gallon)	Total diquat ion (mg) (Col.M x 453594)	Treatment a.i. ppm (Col.L/1233481.84)	Exceeds label or DNR rate
EastBayNE	Bed3-15Mod	2.78	3.0	8.34	2.5	14.8	1.78						NA
NorthShore	Bed4-15Mod	1.93	8.5	16.41	2.5	29.2	1.78						NA
ChantoCran	Bed5-15Mod	2.81	6.5	18.27				5.62	0.308	0.615	279133.538	0.226	no
NorthBasin	Bed6-15Mod	2.00	6.8	13.50				4.00	0.296	0.593	268795.259	0.218	no
SerenityBay	Bed7-15Mod	6.17	7.5	46.28				12.34	0.267	0.533	241915.733	0.196	no
Total		*15.69*		*102.79*		*44.0*		*21.96*					

A post-treatment survey of the same 160 points from the pre-treatment survey was completed on June 16, 2015. The post-treatment survey found EWM at only two points (down from the 19 in the pre-treatment survey) and as a visual, not on the rake, at an additional four points. These results demonstrated a statistically significant reduction in EWM post-treatment.

DIVER REMOVAL

In 2015, the MFA used some of its grant money to test out two other management alternatives for EWM removal. First, the MFA contracted with Aquatic Plant Management (APM), LLC to complete two days of diver removal for $2,500.00. On June 29th and 30th, 2015 APM conducted hand removal services of EWM on the Minong Flowage and the Cranberry Flowage (Figure 49). Four experienced divers spent a combined total of 37 hours on the water and were able to successfully remove approximately 130 gallons of EWM from the flowage. These divers concentrated their efforts in three areas: in the Cranberry Flowage just upstream of the Hwy T bridge; in the Minong Flowage in the DNR bay near Sawdust Island; and in the Minong Flowage on the Bed 1 sand bar on the south end closer to the dam.

According to a report completed by APM Inc., conditions on 6/29/2015 were very poor, with thunderstorms forcing them off the water shortly after launching. Conditions on 6/30/2015 were good, with little to no cloud cover and a mild wind. Water clarity was ok, with underwater visibility of 4-5 feet. The soft substrate of the channel area in the Cranberry Flowage allowed for complete removal of the EWM root systems, greatly decreasing the chance for regrowth. APM was able to remove all the emergent EWM that was in these areas, but any plants obscured by the native plant growth may have been missed. It was the assessment of APM Inc. that the woody debris in this area did not affect their ability to hand-harvest, nor pose a safety threat to divers in the area. The sandbar area had the most EWM of all the areas APM Inc. worked. They felt they were able to eradicate 90-95 percent of the plants in that area and anything that was missed was due to the poor visibility. They further commented that the sandbar area in Bed 1 had the greatest potential for regrowth, as the hard substrate prevented 100 percent removal of the root systems. The area on the NE side of the sawdust island had the densest clumps of EWM, but they were spread out sporadically, 30-40 feet apart. The abundant woody debris made complete removal of the plants difficult, but possible. However, the poor visibility combined with underwater snags posed a slight risk to diver safety.

Figure 49: APM Inc. on the Minong Flowage and the EWM they removed (approx. 12.0 cuft) (photos courtesy of Dan Maxwell)

DIVER-ASSISTED SUCTION HARVEST (DASH) REMOVAL

Also in 2015, the MFA contracted with Naturally DASH and Dredge, LLC, from Upper Michigan, a company offering DASH removal services to complete a two-day demonstration of DASH on the Cranberry Flowage (Figure 50). The expected cost of this demonstration was $5,000.00 for the two days. DASH removal started on a site along the west side of Cranberry Lake on June 29 and continued through June 30. On the first day of the DASH, the EWM density wasn't ideal for demonstrating DASH's efficiency. The divers were also getting way too many native plants mixed in with the EWM, so they moved to a site on the east side of the lake on the second day. The "east-side site" was good for the demonstration. However, it was inside of a large bed that was destined for an herbicide treatment which did occur the next day (July 1st). Therefore, monitoring the long-term characteristics (DASH harvest vs. herbicide treatment) of the site was not possible. In total, DASH removed about 33cuft of EWM over two days compared to the 12cuft removed by APM over the same time frame.

One important distinction though, is that the DASH team worked primarily in a bed of EWM that would have rated a 3 on a 0-3 rake-fullness rating scale. APM removed their EWM from areas that were mostly considered a 1 on 0-3 rake-fullness scale.

Figure 50: Naturally DASH & Dredge on Cranberry Lake and the EWM they removed (approx. 33cuft) (photos courtesy of Dan Maxwell)

In his summary of the diver and DASH EWM removal demonstrations on the Cranberry and Minong Flowages dated July 29, 2015, Dan Maxwell, who was the President of the MFA at the time, came to the following conclusions:

1) **Is hand-pulling (DASH or APM) cost efficient?**

Herbicide costs, safety (pro & con) and efficiencies are the standard by which other options are likely to be judged. Labor-intensive processes are expensive, and this was confirmed in my "APM cost per acre" calculations which show it to be about double or more the cost of herbicides. It is hard to look at a pile of harvested EWM that is the size of the grass clippings when I mow my lawn and justify that it is worth the $7,000 invested.

2) **Can divers operate safely in our waters?**

Yes, but certainly within limits. This was confirmed to me with their work in a stumpy area on the Cranberry Flowage on Tuesday morning. However, Matt Berg's insights, who viewed the process and is an experienced diver, had this to say. Low visibility/underwater obstacles is a concern when diving. Using SNUBA (underwater scuba diving tethered to the surface by air hoses) creates too many opportunities to get tangled up as the divers try to find plants. In addition, an obstacle filled environment like what is presented in the Minong Flowage makes it extremely easy to catch a hose on stumps/become entangled. Because of this, I can confidently say there is no price point that I would risk my life or my employee's lives to work in a stump field with low visibility.

3) **Can divers harvest effectively in poor visibility conditions?**

Yes, but certainly within limits. This was confirmed to me by APM's work on the Minong Flowage and DASH's work on Cranberry Lake where the depth exceeded 5'. The divers noted that they always work in obscured visibility due to the sediment that disperses when they disturb the vegetation.

4) **What do I think of the DASH process?**

Everybody enjoyed watching the DASH process, but I don't think it is a viable option for our waters and issues. The financial outlay is significant, but I see the ongoing operation to be the real challenge. Staffing and scheduling issues will take a concerted effort. The best scenario in my mind would be an owner/operator managing it as a small business, much like a landscaper or snowplowing contractor. The right person and a good business plan might qualify for financial assistance with the machine purchase.

5) **What do I think of the APM diver removal process?**

I like it. It's flexible, it's nimble and needs very little oversight. However, if next spring's EWM control situation is identical to 2015's actual treatment parameters (several beds combining to about 15 acres), I would still want to use the herbicide process because it has proven itself to be the most efficient, effective, safe, and economical (compared to all other options). I would, however, like to consider hiring them (or a similar organization) for a 3-day effort on optimum bed locations as an ongoing comparison study of efficiency and effectiveness.

BATHYMETRIC SURVEY

As a part of this project, the MFA incorporated new technology to collect bathymetric data throughout the system. Advanced sonar units were purchased through CIBioBase and attached to two volunteers' boats. The volunteers then spent time in 2014 and in 2015 boating around the Flowage with the sonar units recording their path. Data collected by the sonar was then downloaded by the volunteers and sent into CI Biobase where maps of water depth, aquatic vegetation and bottom hardness could be made. Average depth, the density of aquatic vegetation, and bottom hardness can also be determined using the data collected. Figure 51 shows all three parameters for the 2015 DNR Bay chemical treatment.

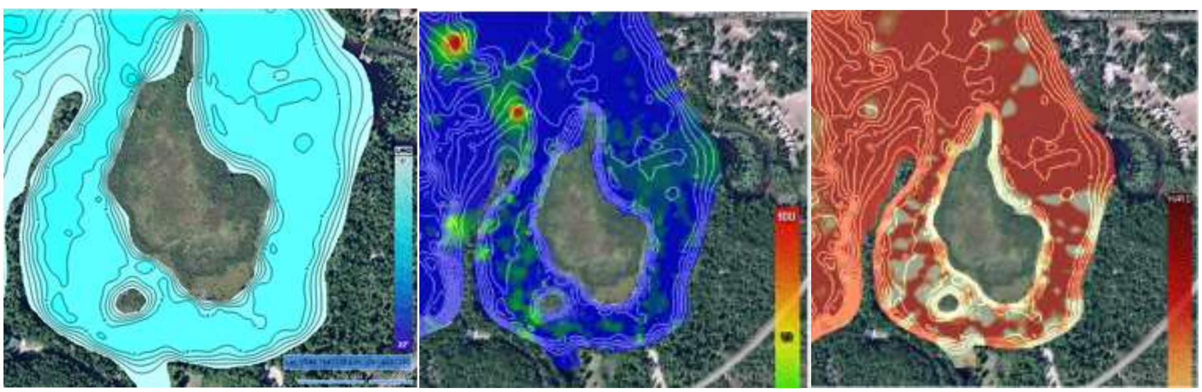


Figure 51: Depth (left), density of aquatic vegetation (middle), and bottom hardness (right) in the DNR Bay area (from CIBioBase)

FALL EWM BED MAPPING

Fall bed mapping, completed on September 27, 2015, mapped 11 beds on the flowage ranging in size from 0.18 acre to 43.08 acres. In total, these beds covered 90.36 acres (Figure 52). This was 76.34 acres more than 2014's 14.02 acres – a 545% increase. The bulk of this expansion occurred in Serenity Bay and the bay adjacent to the WDNR boat landing. Most areas that experienced chemical control remained free or nearly free of EWM. The notable exception to this was Bed 3B that ended up worse in fall 2015 than it had been in fall 2014. Hand pulling in Bed 1 nearest the dam, which was removed from the original 2015 chemical treatment proposal in favor of hand-pulling, also proved to have limited lasting benefit as it also expanded back to its fall 2014 density and had almost doubled in total size from the previous survey. The area in the DNR Bay near Sawdust Island also saw little benefit from the diver removal that was completed by APM in late June. EWM in the DNR Bay (Bed 6) expanded from no EWM in the fall of 2014 to more than 16 acres in the fall of 2015.

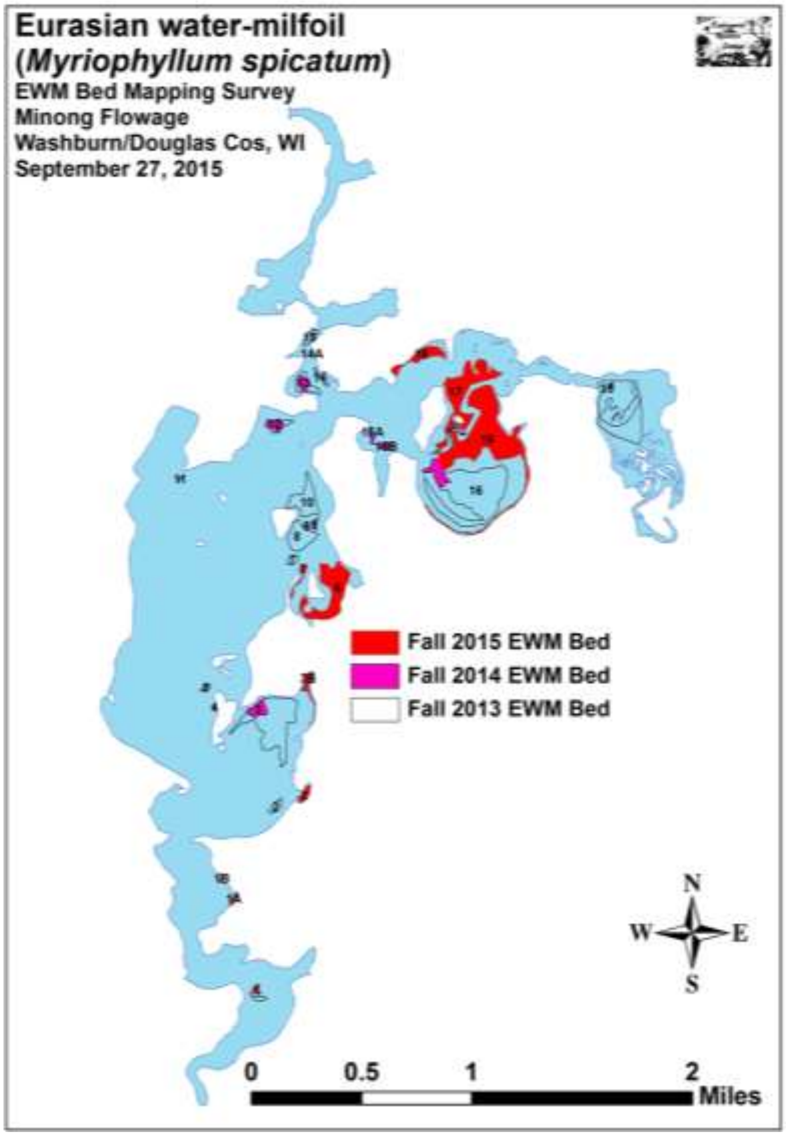


Figure 52: 2015 Fall EWM bed mapping results (ERS)

2016

Based on the fall 2015 EWM bed mapping survey and the guidelines in the 2016-2020 APM Plan, one area of EWM totaling 26.9 acres within the WDNR Boat Landing Bay was proposed for chemical treatment in the spring of 2016 using liquid 2, 4-D at a rate of 1.5 ppm (Figure 53). Due to the size of the treatment, formal pre- and post-treatment surveys were conducted as was a dye concentration/movement study.

Figure 53: 2016 spring EWM treatment area totaling 26.9 acres.

Application of DMA 4® herbicide was completed by Northern Aquatic Services (NAS) on May 16th. Surface water temperature was 51°F with winds from the W-NW at 2-7 mph. A description of the site and the amount of herbicide applied is in Table 14. At the time of application, white-stem pondweed, EWM, coontail, and curly-leaf pondweed were the only species identified.

Table 14 - 2016 EWM Herbicide Management Details

2016 Minong Flowage Preliminary Spring EWM Chemical Treatment Proposal (January 22, 2016 LEAPS)							
Treament Area Characteristics					Eurasian Watermilfoil — 2,4-D (DMA 4)		
Treatment Location	Site Name	Acreage	Mean Depth (feet)	Volume (acre-feet)	Treatment a.i. ppm	Treatment application (gal)	Application rate (gal/ac-ft)
WDNR Bay	Bed1-16	26.90	4.0	106.52	1.5	114.0	1.07
Total		*26.90*		*106.52*		*114.0*	
					EWM Treatment (26.9 acres); early spring application		

PRE AND POST-TREATMENT POINT-INTERCEPT AQUATIC PLANT SURVEY

Because the proposed EWM treatment was considered large-scale (>10 acres), pre- and post-treatment aquatic plant survey work was required using point-intercept survey methods. Within the 26.9-acre treatment area 131 points (4.9 pts/acre) were created to survey prior to and a month after the actual chemical application.

During the surveys, each point was located and sampled by rake. At each point, depth, bottom type, and plant species present was recorded. Visual sightings of EWM and CLP were noted if they occurred within 6ft of the point. All data collected was entered into the standard WDNR Aquatic Plant Management spreadsheet. Count data were then analyzed on the linked statistical summary sheet and the WDNR pre/post Chi-square analysis worksheet while differences in means were analyzed using t-tests.

Pre/post treatment differences were determined to be significant at $p < .05$, moderately significant at $p < .01$, and highly significant at $p < .005$.

The flowage's littoral zone (area where aquatic plants can grow) extended to 6.0ft during the pre-treatment survey and 6.5ft during the post-treatment survey. Mean and median depths for all plants were 4.3ft and 4.5ft respectively pre-treatment before rising slightly to 4.5ft and 5.0ft post-treatment (Table 15). EWM was established over mucky or firm sand.

Table 15: Pre/Post survey summary statistics Minong Flowage, Washburn County April 29, and June 15, 2016

Summary Statistics:	Pre	Post
Total number of points sampled	131	131
Total number of sites with vegetation	97	92
Total number of sites shallower than the maximum depth of plants	131	129
Frequency of occurrence at sites shallower than maximum depth of plants	74.05	71.32
Simpson Diversity Index	0.74	0.76
Mean Coefficient of Conservatism	5.7	5.5
Floristic Quality Index	15.1	18.1
Maximum depth of plants (ft)	6.0	6.5
Mean depth of plants (ft)	4.3	4.5
Median depth of plants (ft)	4.5	5.0
Average number of all species per site (shallower than max depth)	1.37	1.59
Average number of all species per site (veg. sites only)	1.86	2.23
Average number of native species per site (shallower than max depth)	0.80	1.48
Average number of native species per site (native veg. sites only)	1.33	2.10
Species richness	9	12
Mean rake fullness (veg. sites only)	1.55	1.55

Initial diversity within the area to be treated was moderate with a Simpson Index of 0.74; this was almost unchanged at 0.76 post-treatment. The Floristic Quality Index, a measure of only native species, also increased slightly from 15.1 pre to 18.1 post-treatment. Mean native species richness at sites with native vegetation was 1.33/site pre-treatment. This metric experienced a highly significant increase to 2.10/site post-treatment (Figure 54). Species richness also increased slightly from 9 to 12.

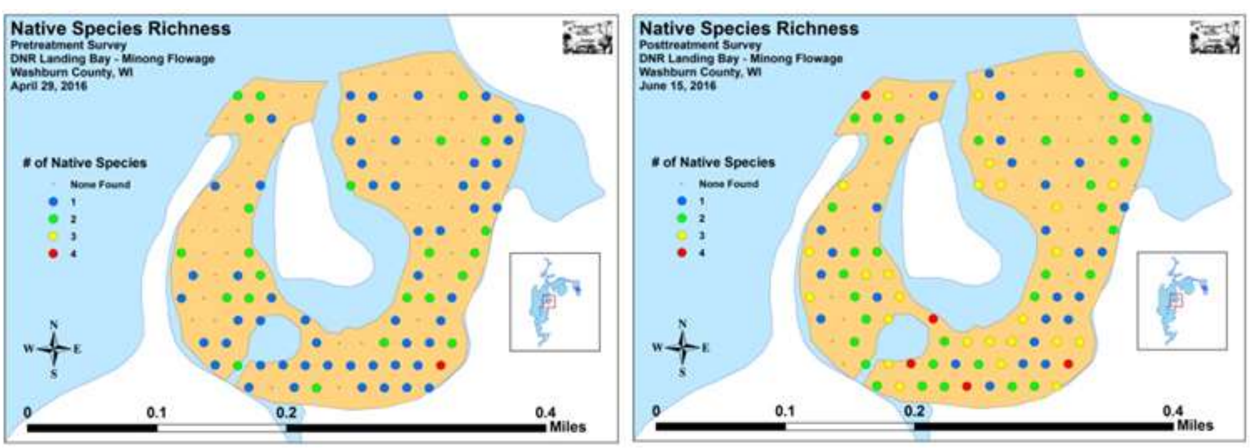


Figure 54 – Pre/Post native species richness (ERS)

EWM was found on the rake at 55 total sites during the pre-treatment survey. It was recorded as a visual at an additional eight points (Figure 55). During the post-treatment survey, no EWM was found anywhere in the bay either in the rake or inter-point. These findings demonstrated a highly significant reduction in total EWM (Figure 56).

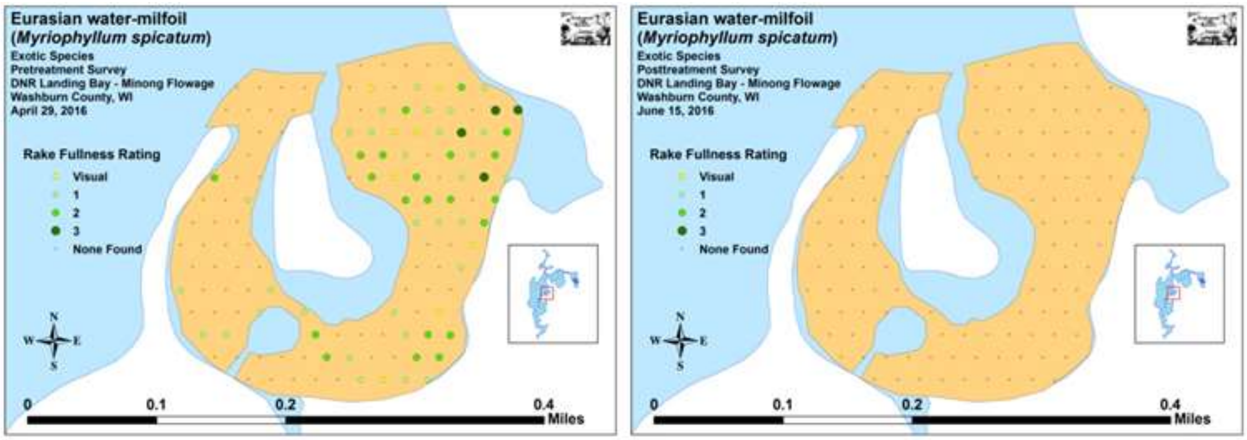
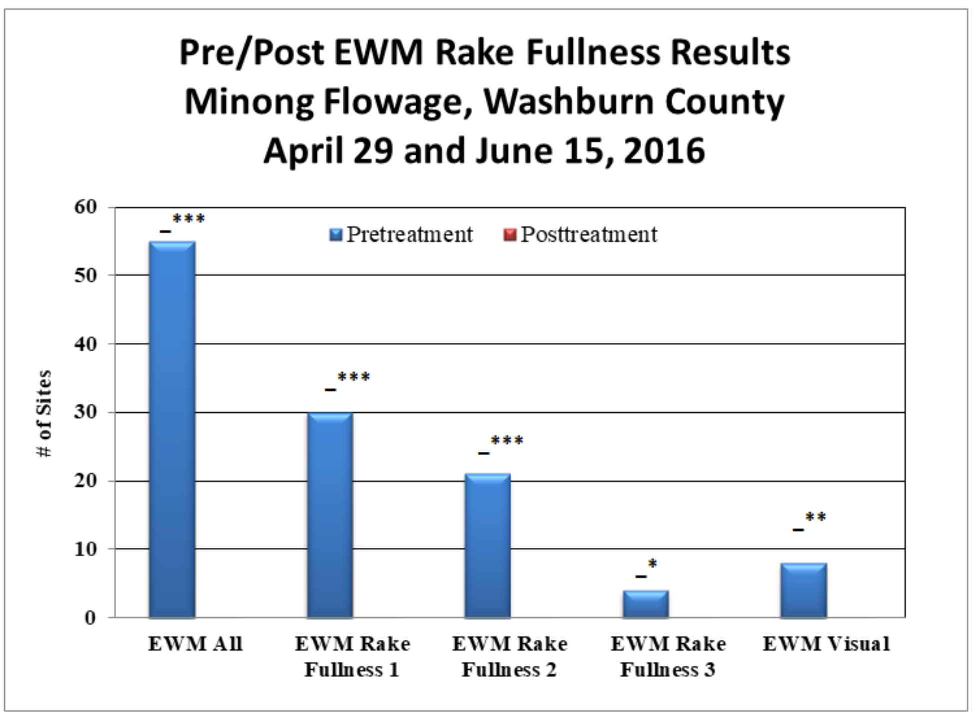


Figure 55 - Pre/Post EWM density and distribution (ERS)



Significant differences = * $p < .05$, ** $p < .01$, *** $p < .005$

Figure 56 - Pre/Post changes in EWM rake fullness. No red bars indicate that no EWM was found post-treatment. (ERS)

Common waterweed (*Elodea canadensis*), the most common native species in both the pre-treatment (66 sites – mean rake fullness 1.33) and post-treatment surveys (80 sites – mean rake fullness 1.48), experienced a nearly significant increase in both distribution and density following treatment. Coontail (*Ceratophyllum demersum*), the third most common native species pre-treatment (16 sites – mean rake fullness 1.25) experienced a highly significant increase in distribution to become the second most common native species post-treatment (42 sites – mean rake fullness 1.23). In addition to Coontail, Small pondweed (*Potamogeton pusillus*) and Ribbon-leaf pondweed (*Potamogeton epihydrus*) experienced moderately significant increases, and Flat-stem pondweed (*Potamogeton zosteriformis*) demonstrated a significant increase. Other than EWM (*Myriophyllum spicatum*), no species experienced significant declines (Figure 57).

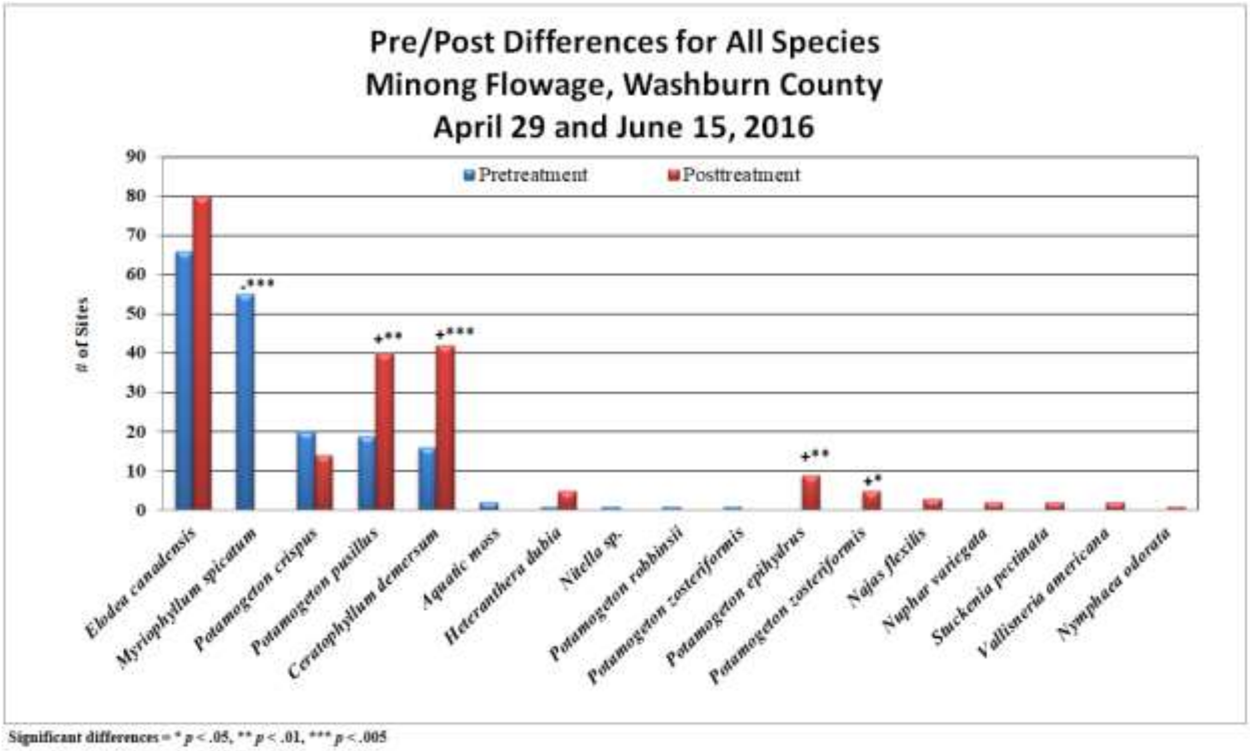


Figure 57 – 2016 Pre/Post Macrophyte Changes (ERS)

CHEMICAL CONCENTRATION/DISTRIBUTION STUDY

According to the APM Plan for the Minong Flowage, if chemical treatment is employed to control EWM, chemical residual testing is necessary. Chemical residual (or concentration) testing was completed for seven days after the 2016 herbicide application in the DNR Bay. Seven sites within the treatment area, adjacent to the treatment area, and downstream of the treatment area (Figure 58) were tested at different intervals spanning seven days (Table 16). Water samples were collected by Minong Flowage Association volunteers and sent to the Wisconsin State Lab of Hygiene for analysis.

Sample results indicate that the concentration in the treated area immediately following application (3 hours after treatment (HAT)) only reached about half of the expected concentration in the water but remained above 300 ppb for at least 36 hours after treatment (Figure 58). While the target objective for herbicide application was not reached, it appears that the long exposure time was effective at killing the target plant, given that no EWM was found in the treated area, even during the fall bed-mapping survey completed in October, 5 months after treatment.

Sample results also indicate that herbicide residual quickly dissipated once it left the treated area, and by four days after treatment, was basically gone from the entire system (Figure 59).

Figure 58 – 2016 Chemical residual (concentration) testing sites

Table 16 – 2016 Chemical residual (concentration) testing schedule

2016 Minong Flowage Chemical Concentration Monitoring Planning 4-27-2016 (LEAPS)

Location	SITE_NAME	SiteAbbr	Lat	Long	3 HAT	6 HAT	9-12 HAT	24 HAT	36 HAT	2 DAT	4 DAT	7 DAT
DNR Bay	DNRBayE-CC-16	DBE-16	45.49	-91.711	x	x	x	x	x	x	x	
DNR Bay	DNRBayW-CC-16	DBW-16	45.485	-91.717	x	x	x	x	x	x	x	
DNR Bay	NatCamp-CC-16	DBO-16	46.156	-91.927	x	x	x	x	x	x	x	x
Center Basin-Sand Island	CenSdls-CC-16	CSI-16	45.494	-91.722	x	x	x	x	x	x	x	x
Center Basin-CountyBeach	CoCamp-cc-16	OffCC-16	46.143	-91.935			x	x	x	x	x	x
Near Dam	NrDam-CC-16	NrD-16	46.123	-91.935			x	x	x	x	x	x
					4	4	6	6	6	6	6	4
												42

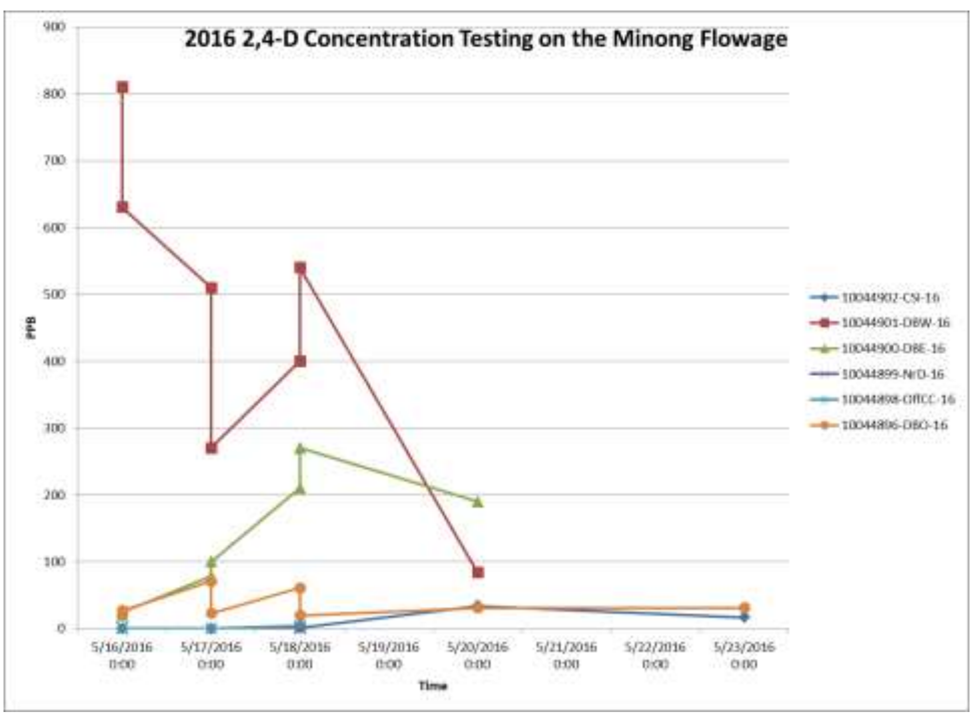


Figure 59 – 2016 chemical residual (concentration) testing results

EWM WEEVIL MONITORING

The MFA and their consultant worked with students and counselors at Swift Nature Camp to monitor EWM weevils. This was a follow-up to a weevil rearing project several years ago. The data they collected at best should be considered anecdotal. Only the number of adult weevils found and stem with weevil damage are likely credible (Table 17, Figure 60).

Table 17: 2016 weevil monitoring with campers from Swift Nature Camp

August 10, 2016 EWM Weevil Search - Swift Nature Camp						
Site	Stems	Stem Damage	Eggs	Larva	Pupa	Adults
A1	No Data Sheet					
A2	26	7	7	8	1	0
B1	24	9	14	5	1	7
B2	25	5	4	0	0	0
C1	20	0	55	10	0	4
C2	No Data Sheet					
D1	25	10	48	3	0	2
D2	25	2	81	17	1	9
E1	25	5	12	5	1	1
E2	No Data Sheet					
F1	14	2	97	15	2	1
F2	25	2	33	3	1	4
G1	27	2	8	0	0	1
G2	No Data Sheet					
H1	25	0	4	0	0	1
H2	41	1	0	3	0	0
Totals	302	45	363	69	7	30

Figure 60: 2016 EWM weevil monitoring with Swift Nature Camp

2016 FALL EWM BED-MAPPING

A fall EWM bed-mapping survey was completed on October 16th, 2016, by ERS. During the survey, 24 beds of EWM ranging in size from 0.09 acre to 75.3 acres were mapped (Figure 61). In total, they covered 125.6 acres. This was 35.2 acres more than the 90.4 acres mapped in 2015 – a 39% increase. It was also 111.56 acres more than 2014's (the year following the drawdown) 14.0 acres. The bulk of this expansion occurred in Serenity Bay and within the Northern wild rice beds east of Smith's Bridge, and along the eastern shoreline of the south basin. The eastern bay near the WDNR public boat landing, the only area to experience chemical control in 2016, remained free of EWM.

According to the plant surveyor, most of the flowage's EWM beds were still at a low density in 2016 and were unlikely to significantly impair navigation as the mean rake fullness of most beds was <1 or 1. The beds were, however, all canopied, actively fragmenting, and monotypic or nearly monotypic. With little competition from other species, it is reasonable to expect a rapid expansion in distribution and increases in the density in 2017.

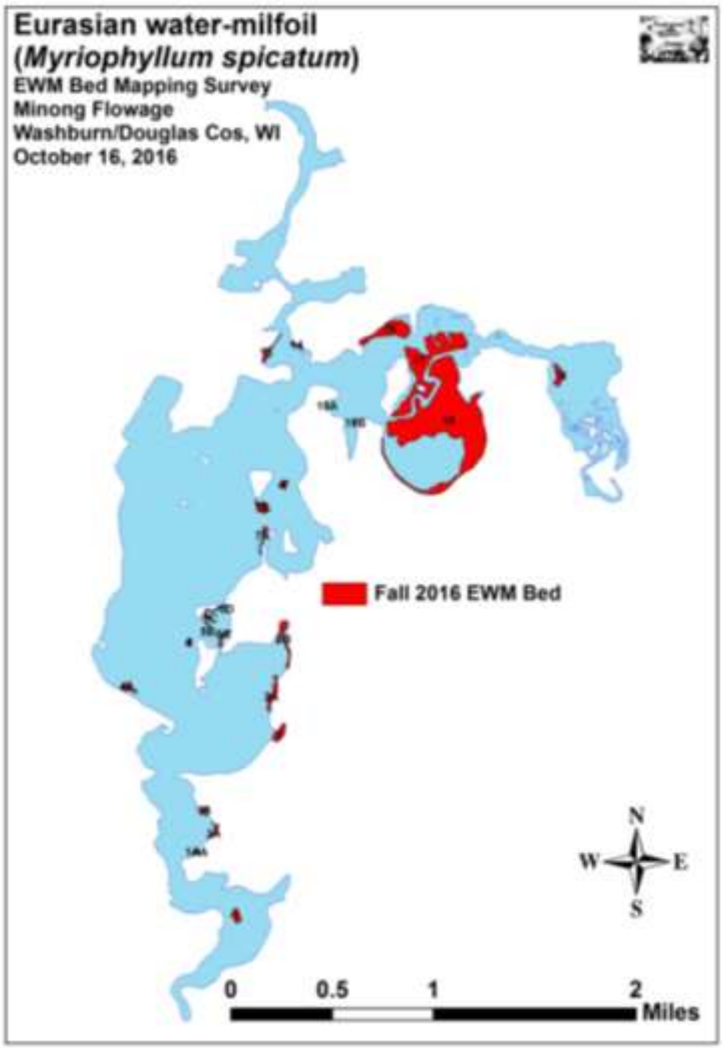


Figure 61 – October 2016 fall EWM survey results (ERS)

2016 WILD RICE MAPPING

On July 30, 2016, ERS completed a visual survey of the entire littoral zone of the flowage with the intent to map all beds of wild rice. A bed is defined as an area where wild rice makes up greater than 50% of all aquatic plants. However, as one of the goals of the 2016 survey was to document change since the last survey, and because rice density can be extremely variable from year to year, this definition was expanded in both 2014 and 2016 to include all areas that supported continuous rice plants. As such, the range and mean level of rice growth within each area using the WDNR's standard 1-3 rake fullness scale was completed; the potential for human harvest (none/low/moderate/high) was estimated; and representative photos of the rice at each location were taken.

The results of this survey were not good as a 1000-year storm event dropping a foot or more of rain occurred on July 11-12. The event caused the Colten Flowage Dam upstream on the Totogatic River to fail sending additional water through the system. Water levels on the Minong Flowage went up nearly 4-ft in a very short period as the storm water passed through the system.

In the survey it was found that this storm event significantly altered the braided channels in the delta area where the Totagatic River enters the flowage. It was also noted that most standing rice anywhere near the river channel was swept away, and the only surviving rice of significant density was in sheltered bays. Some late germinating individuals were still present in the channels, but they were just entering the floating-leaf stage at the time of the survey. With limited time left in the growing season, it seemed unlikely they would survive to set grain.

The 2016 wild rice survey found that the flood had eliminated the rice crop west of the bridge (Figure 62). In addition to the loss of rice, there were few surviving emergents of any kind along the channel. A natural pinch-point in the flowage, it appeared that strong currents had scoured the bottom throughout most of the former beds. In the East Basin, east of Smith Bridge, where wild rice is traditionally abundant, flood waters cut new channels in the delta and swept away most of the standing rice - only four beds totaling 32.33 acres were found (Figure 63).

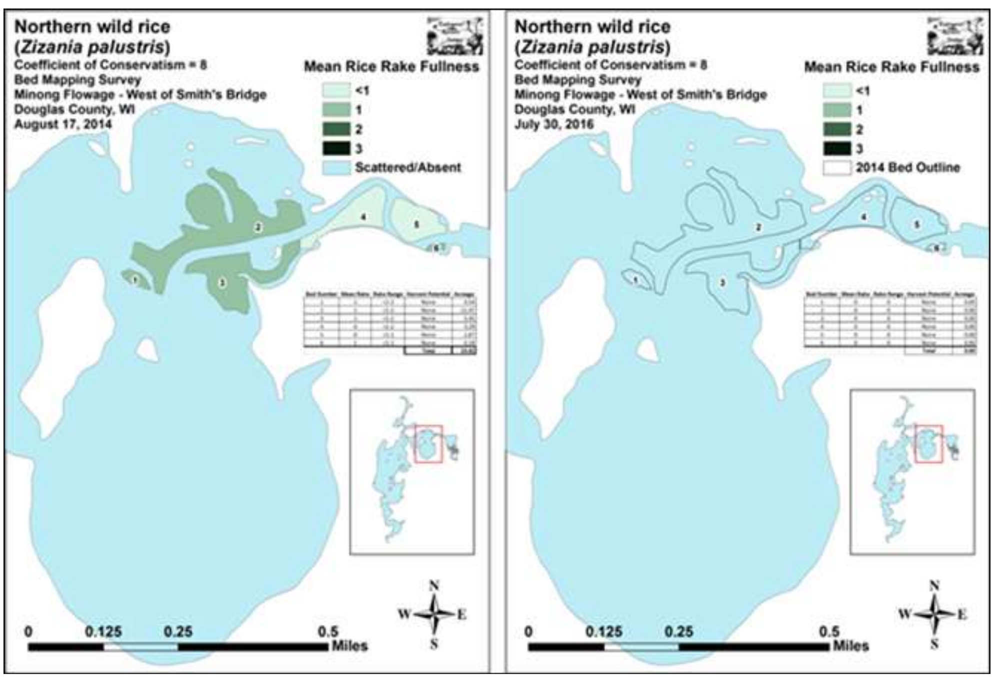


Figure 62: 2016 wild rice west of Smith Bridge (ERS)

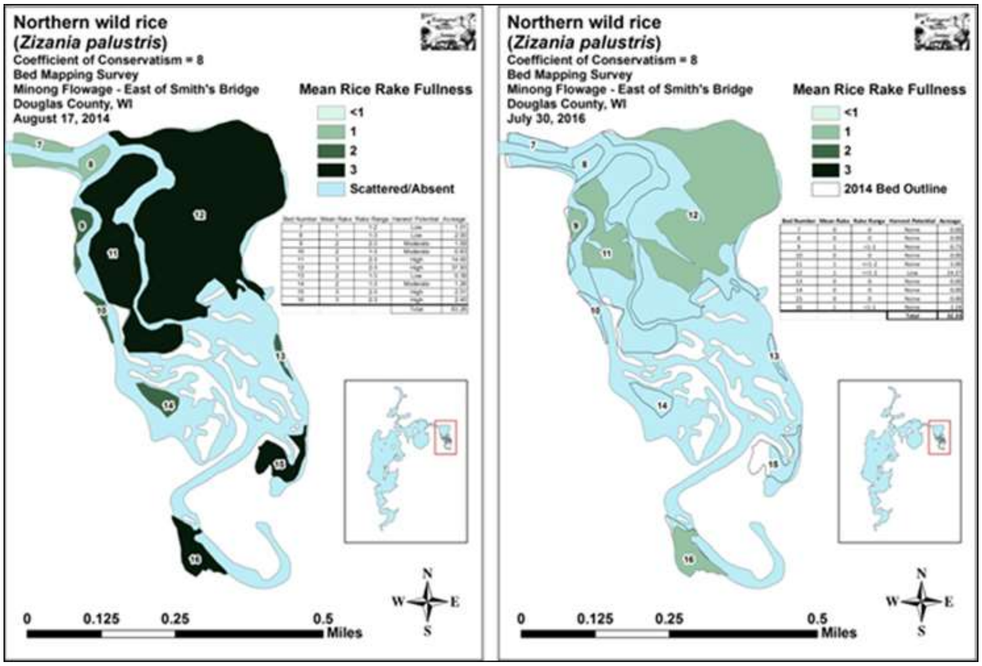


Figure 63: 2016 wild rice east of Smith Bridge (ERS)

2017

Based on the 2016 fall EWM bed mapping results, a preliminary chemical treatment proposal was made early in 2017 to manage approximately 29 acres of EWM in three areas of the Flowage. The largest area included 15.62 acres in Serenity Bay, nearly 10 acres along the east shore of the East Bay, and 3.28 acres along the County Park shoreline. Multiple smaller beds identified during the 2016 fall bed-mapping survey were combined to make larger treatment areas. Unfortunately, the particulars of the preliminary 2017 treatment proposal were just short of what is identified in the 2015 APM Plan as necessary to complete a chemical treatment, so the proposal was not sent to the WDNR for approval.

2017 CLP SURVEY

In 2017 only three CLP beds in the delta region east of Smith's Bridge totaling 6.9 acres were mapped (Figure 64). Throughout the entire rest of the flowage, only three other spots were found to have any CLP at all. In each case, there were never more than a handful of plants, and, consequently, they were not a navigation issue (Figure 64). Additionally, Minong Flowage Association volunteers identified CLP in a small bay off the Channel to Cranberry in both 2017 and 2018.

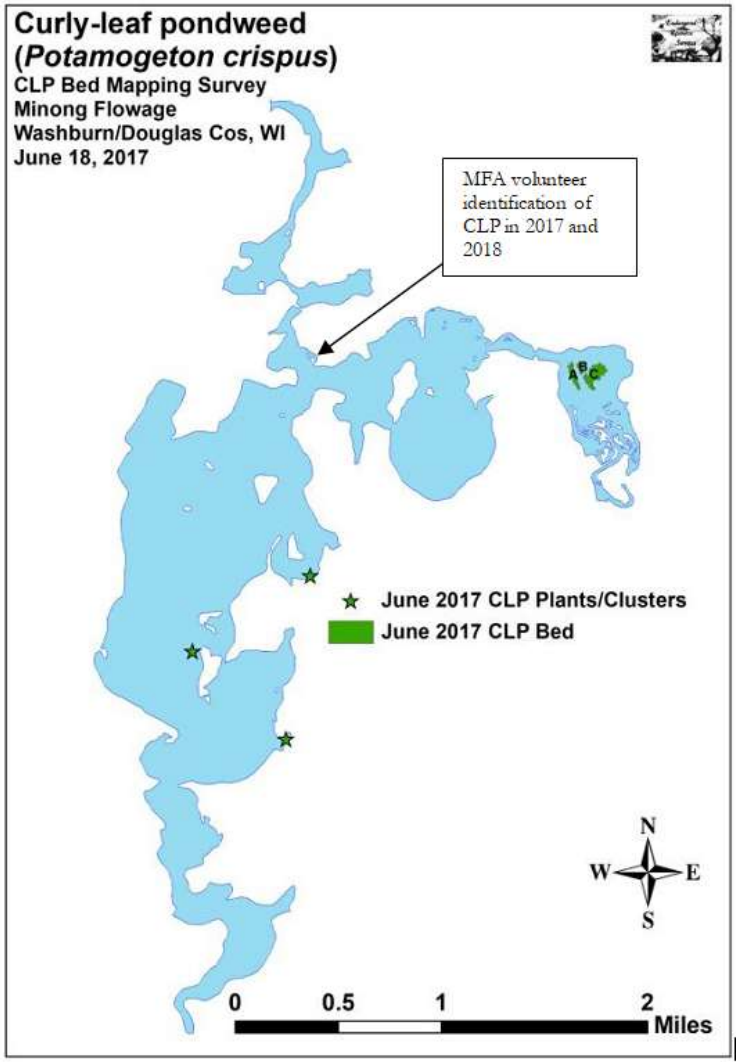


Figure 64: CLP bed map from June 18, 2017 (ERS)

2017 FALL EWM BED-MAPPING

During the fall 2017 EWM bed-mapping survey, 27 EWM beds covering 112.88 acres were mapped (Figure 65). The surveyor noted that floating EWM fragments were abundant along the entire eastern shoreline of the Flowage as well as in the delta area east of Smith's Bridge where EWM continued to expand into areas that formerly supported wild rice. Several of the beds identified in the fall of 2017 appeared in areas that hadn't supported EWM since before the drawdown. The fall 2017 beds covered 12.7 acres (-10.11%) less than the 125.6 acres mapped during the fall 2016 survey. Most of this year-over-year loss occurred in Serenity Bay (Bed 16) where areas over 6-ft that had supported plants in 2016 had almost none in 2017. Although this overall decline was positive, it was still more than the 90.4 acres mapped in 2015 or the 14.0 acres mapped in 2014.

In the fall of 2017, many of the Flowage's EWM beds in the north bays increased to the point that boats navigating through them would likely experience minor to moderate impairment. In the southern basin, most beds were still quite low in density and unlikely to significantly impair navigation. Areas on the western shoreline of the Flowage that supported sizable beds of EWM prior to the drawdown remained

EWM free in the fall of 2017; unfortunately, they also continued to have almost no native vegetation. Based on this, a winter drawdown over the 2018-19 winter season was first considered and proposed.

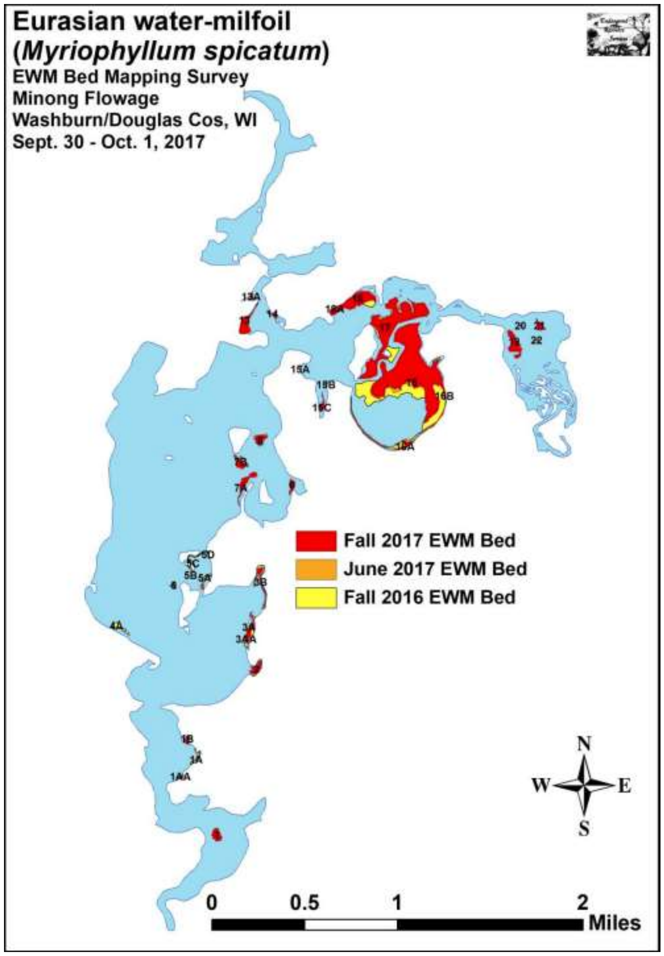


Figure 65: 2017 Fall EWM bed-mapping results (ERS)

2017 WILD RICE BED-MAPPING

In August 2014, 16 beds with continuous wild rice plants that covered 87.1 acres on either side of Smith's Bridge were mapped. As a result of a large flooding event in 2016, the 2016 survey found only four of these beds totaling 32.3 acres remained. The 2017 survey mapped six areas covering only 22.5 acres with one bed accounting for over 90% of the total area (Figures 66 & 67). The total acreage represented a further decline of 30% from 2016 and nearly 75% from the 2014 totals.

During the 2017 survey, a resident flock of about 40 geese had cropped every single rice plant that was identified. No plants were in flower during the survey. A trip back to the Flowage rice beds in the fall of 2017 confirmed that not a single plant produced a seed head. Unfortunately, the 2017 wild rice survey documented that there was virtually no recovery of wild rice west of Smith Bridge in the northern third of Serenity Bay and the river channel from there to Smith Bridge. Areas once supporting healthy stands of wild rice were now being nearly completely taken over by EWM.

The 2017 survey also documented little recovery of wild rice beds east of Smith Bridge. Surviving wild rice growth documented in 2017 appeared to be in poor health, suggesting that growing conditions were less than desirable in 2017.

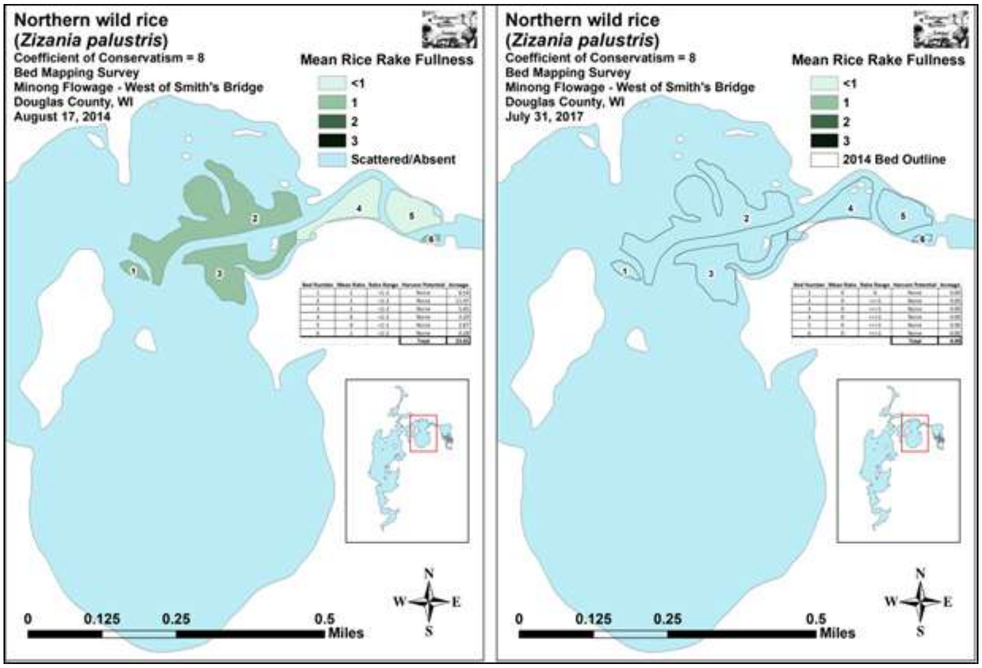


Figure 66: 2017 wild rice west of Smith Bridge (ERS)

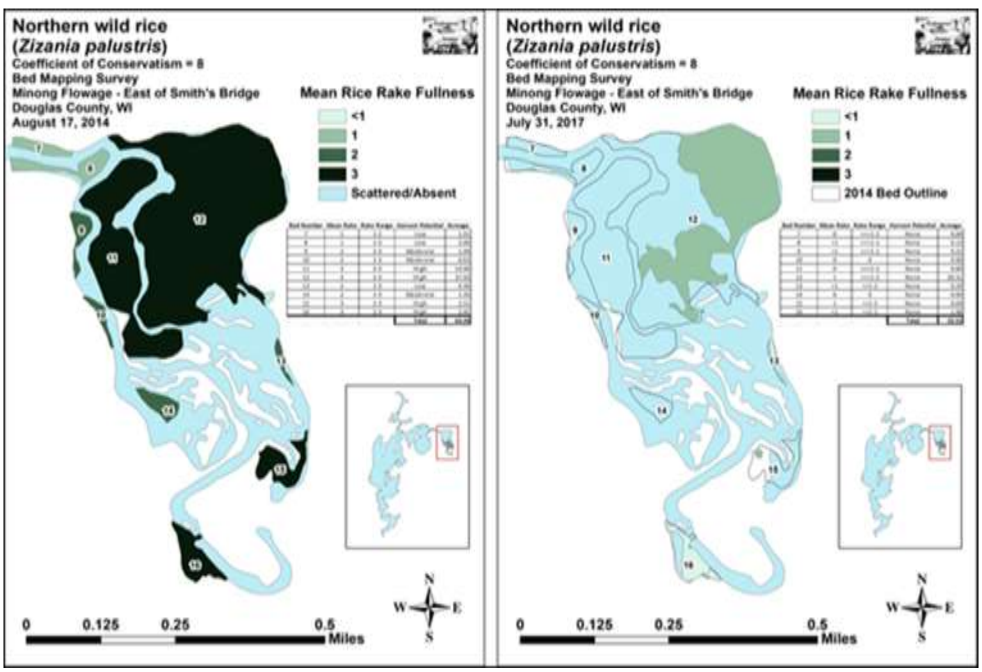


Figure 67: 2017 wild rice east of Smith Bridge (ERS)

2017 SHORELAND HABITAT ASSESSMENT

As a part of the three-year AIS project for the Minong Flowage, a Shoreland Habitat Assessment of the entire Minong Flowage was completed in 2017 following protocol developed by the WDNR (refer to the previous watershed section of the APM Plan).

WINTER DRAWDOWN PLANNING

In January 2017, the MFA made a request to the WDNR to allow initial winter drawdown planning to be a reimbursable expense in the AIS control grant ACEI 11816. On January 18, 2017, the WDNR approved this request, and a new task (initial drawdown planning) was added to an existing grant. The purpose of the request was to begin figuring out what needed to be done to get a request for a winter drawdown approved by the WDNR and other Stakeholders.

During the October 7, 2017, MFA/Stakeholders Meeting some initial findings related to a winter drawdown were laid out.

- A request for a drawdown would have to come from Washburn County.
- A drawdown would require formal consultation and approval from GLIFWC and Tribal Resources.
- A drawdown would require formal approval by Renewable World Energies, who operate the hydro-electric dam.
- A WDNR permit may be needed if the water level is drawn down below the minimum ordered level. What that level was, was not known at the time.
- No environmental assessment would be needed before the drawdown could be completed.

2018

WINTER DRAWDOWN PLANNING

More information about a possible winter drawdown was provided during a LEAPS presentation held during the 2018 MFA Annual Meeting on June 9th including the criteria in the existing APM Plan for considering a winter drawdown and a comparison of the management impacts on EWM and native aquatic vegetation from three years of large-scale chemical treatment from 2009-2011 and the year-long drawdown that was necessary due to the repair of the Minong Flowage Dam (Figure 68 & 69).

Figure 68: Slide from the 2018 Annual Meeting PowerPoint presentation

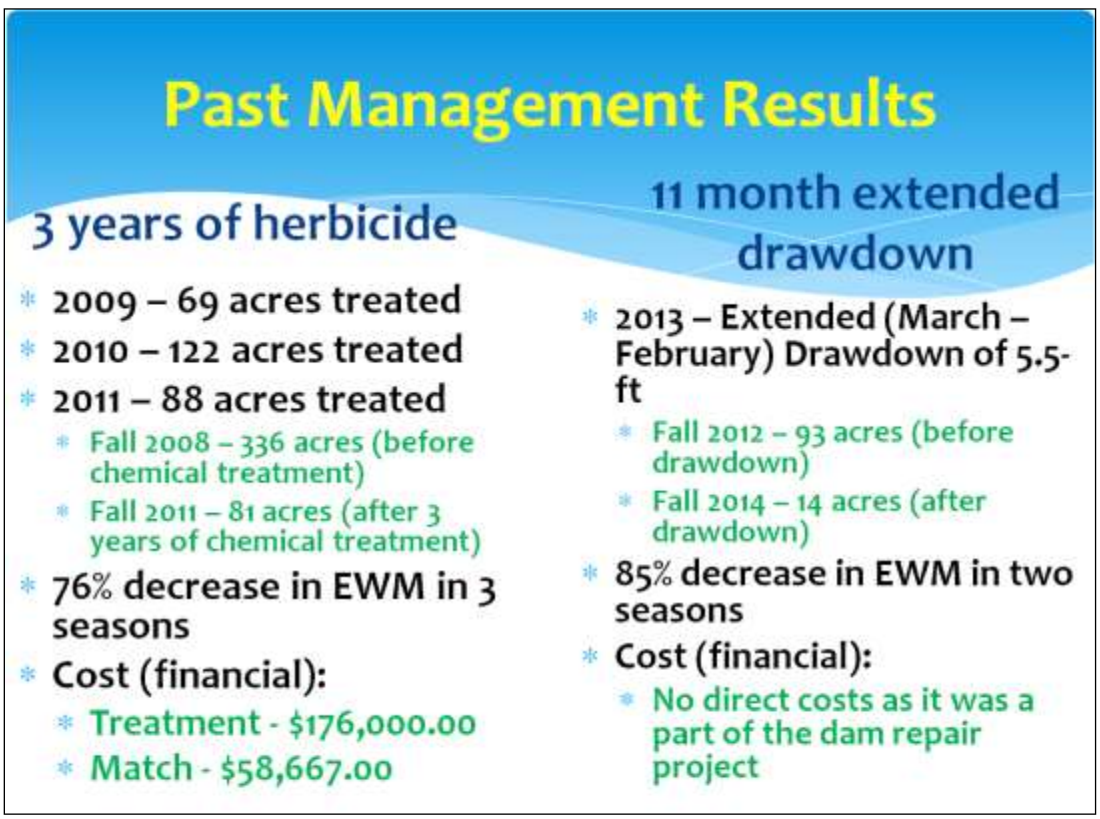


Figure 69: Slide from 2018 Annual Meeting PowerPoint presentation

PRE-DRAWDOWN, WHOLE-LAKE, POINT-INTERCEPT SURVEY

After receiving a 2-yr WDNR Surface Water AIS Control Grant to support planning and implementation of a winter drawdown, the MFA contracted with ERS (Matt Berg) to complete a summer, whole-lake, point-intercept (PI) aquatic plant survey and fall EWM bed mapping. The purpose of the PI survey was to document the extent of EWM and native aquatic plants in the lake prior to commencing what was expected to have been a winter drawdown over the 2018-19 winter season.

All active management on the flowage ceased in 2017, and, five summers after the refill, the 2018 survey found EWM had experienced a statistically significant expansion in both distribution and density when compared to the 2014 survey. During the 2018 survey, EWM was found on the sample rake at 42 points (19.09% of the vegetated littoral zone) and as a visual at an additional 18 points (Figure 70). EWM was the fourth most common species sampled and encompassed 5.5% of the total plant community's relative frequency.

Five growing seasons after the flowage refilled, the 2018 survey identified Coontail, Common waterweed, White water lily, and Water star-grass as the most widely distributed species. They were present at 42.7%, 25.9%, 20.0%, and 16.8% of points with vegetation and accounted for 30.5% of the total relative frequency. Short-stemmed bur-reed (4.6%), Northern wild rice (4.3%), and Wild celery (4.2%) also had relative frequencies over 4.0.

From 2014-2018, a total of 28 species underwent significant distribution changes (Figure 71). Many emergent and floating-leaf species that had benefitted from the drawdown predictably declined following the rise in water levels, while many submergent species benefited. Specifically, Nitella, Northern manna-grass, and Small bladderwort, Three-way sedge, Northern St. John's-wort, White water lily, Northern wild rice, Common arrowhead, Broad-leaved cattail, Needle spikerush, and Common bur-reed had statistically significant declines.

In addition to EWM, Coontail, Water-stargrass, filamentous algae, Flat-stem pondweed, Wild celery Common waterweed, Small pondweed, Fern pondweed, Ribbon-leaf pondweed, Creeping bladderwort, Water bulrush, Water marigold, Northern naiad, Vasey's pondweed, American bur-reed, and Hybrid cattail had statistically significant increases.

Regarding wild rice, the floods of 2016 appeared to have swept most of the rice out of the delta region in the Totagatic Inlet, and, by 2018, the local population was still little recovered. Wild rice was documented on the rake at 33 points – a significant decline in distribution compared to 2014 (Figure 72).

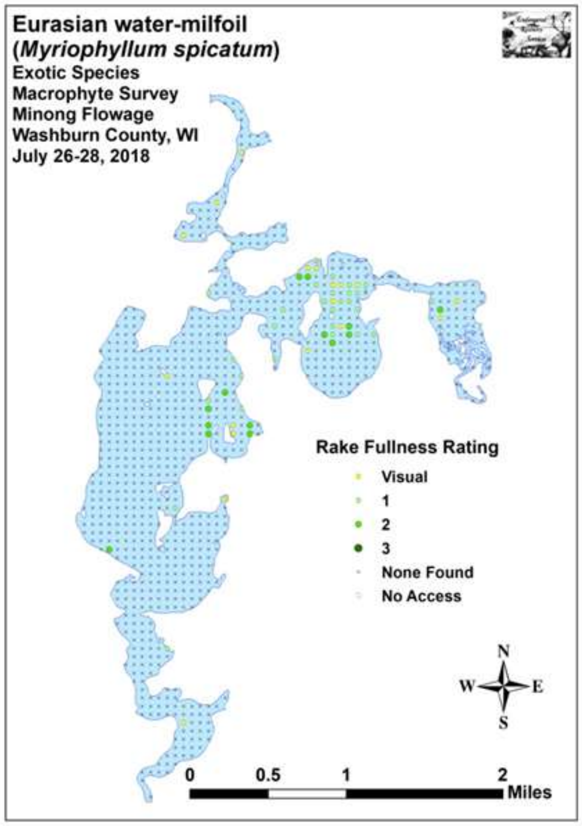


Figure 70: 2018 EWM from the summer, point-intercept survey (ERS)

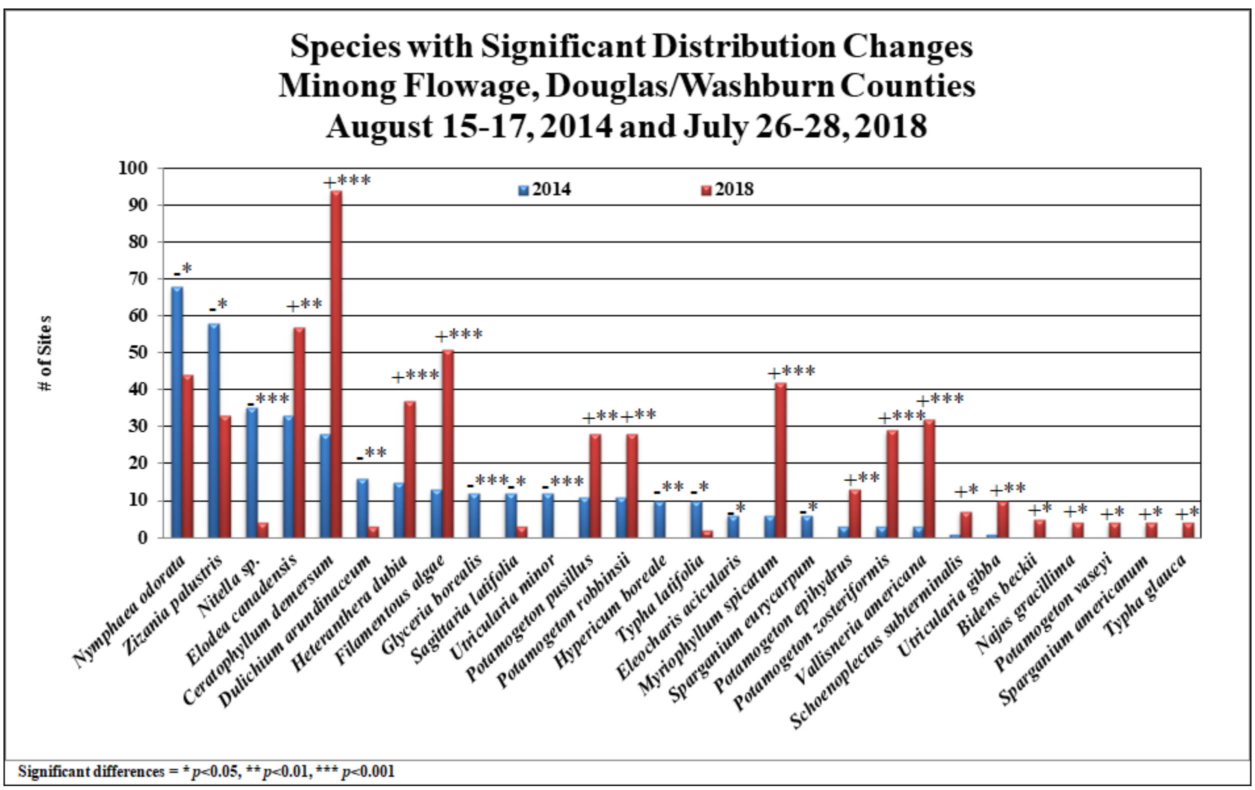


Figure 71: Aquatic plant species showing statistically significant changes from 2014-2018 (ERS)

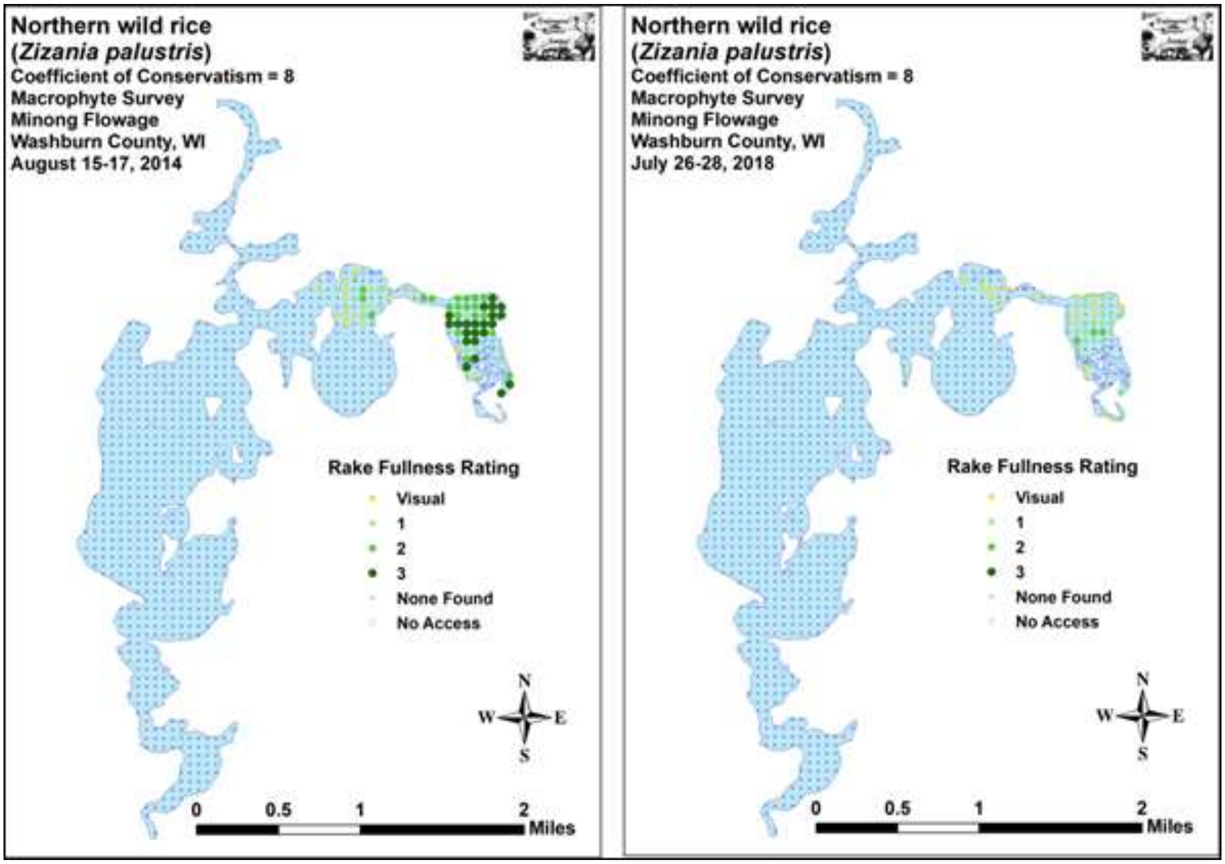


Figure 72: 2014 and 2018 Northern wild rice density and distribution (ERS)

2018 FALL EWM BED MAPPING

During the fall 2018 survey, 31 EWM beds that covered 141.88 acres or 9.07% of the flowage's surface area were mapped (Figure 73). This was an increase of 29.00 acres (+25.7%) over the 27 EWM beds that covered 112.9 acres (7.2% of the flowage's surface area) in the fall of 2017. It was also higher than the 125.6 acres mapped during the fall 2016 survey and represented a further expansion from the 90.4 acres mapped in 2015, and the 14.0 acres mapped in 2014. However, it was not enough to push for a 2018-19 winter drawdown. That, along with difficulties in figuring out what permits were needed to complete the drawdown, and more time needed to build support for the drawdown with the MFA constituency and other stakeholders led to the goal of completing the winter drawdown between 2018 and 2019 being dropped.

One issue related to not doing a winter drawdown between 2018 and 2019 was expressed by the aquatic plant surveyor. The surveyor's biggest concern with a continued policy of "no active management" in 2018 or 2019 is that the EWM beds in the Flowage seemed to be expanding into deeper water throughout the 2018 season. If a future 5ft drawdown is conducted to freeze out EWM, its value would potentially be limited if EWM plants continued to expand into water deeper than 5-6ft.

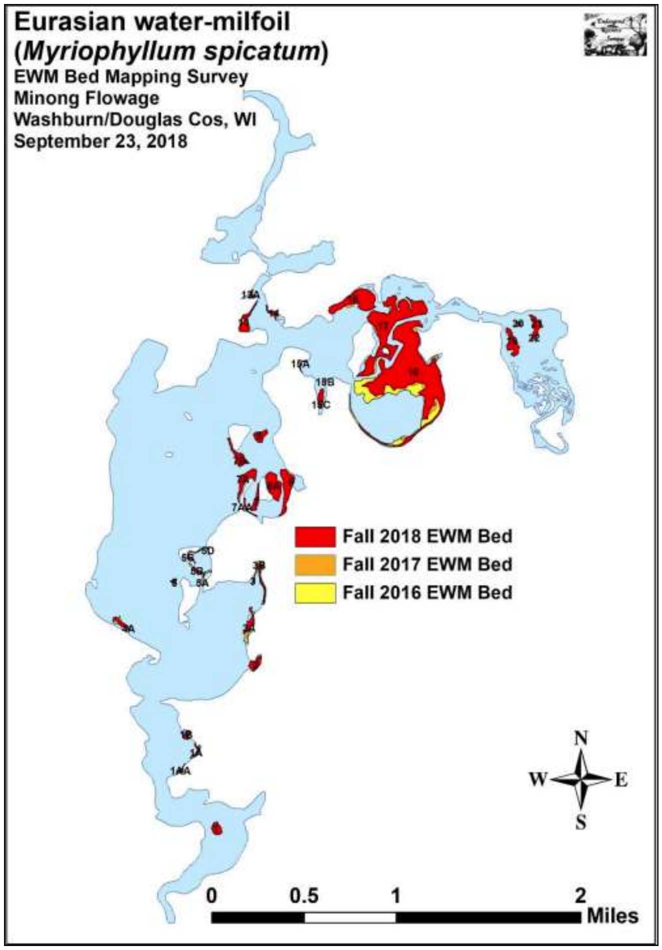


Figure 73: 2018 fall EWM bed mapping results (ERS)

2019

No EWM management was completed in 2019. However, winter drawdown planning continued ultimately ending up with WDNR approval of a "Pool Elevation" drawdown permit. A 3-yr AIS control grant was applied for in the fall of 2019, however, it was not awarded due in part to not having a clear understanding as to whom would be paying Renewable World Energies, the operators of the hydro-electric dam, for lost power generation revenue during the drawdown.

2019 FALL EWM BED MAPPING

During the August 2019 survey, 25 EWM beds that covered 85.3 acres or 5.5% of the flowage's surface area were located (Figure 74). This was a decrease of 56.6 acres (-39.9%) from the 2018 fall survey when 31 beds totaling 141.9 acres were mapped; it was also the lowest total since 2014. As no active management occurred on the flowage in 2019, the reason for this decline is likely tied to annual growing conditions although no obvious changes were noted. Most EWM plants seemed dormant or nearly so, and there weren't many floating fragments in the Flowage. Especially in the northeast bays and river inlet, plants appeared black, spindly, and generally unhealthy. Rake sampling often produced root crowns with a single live stem and many decomposing stems that were lying on the bottom.

In general, a significant pullback along the deep-water edges of beds and thinning within the remaining bed areas was documented.

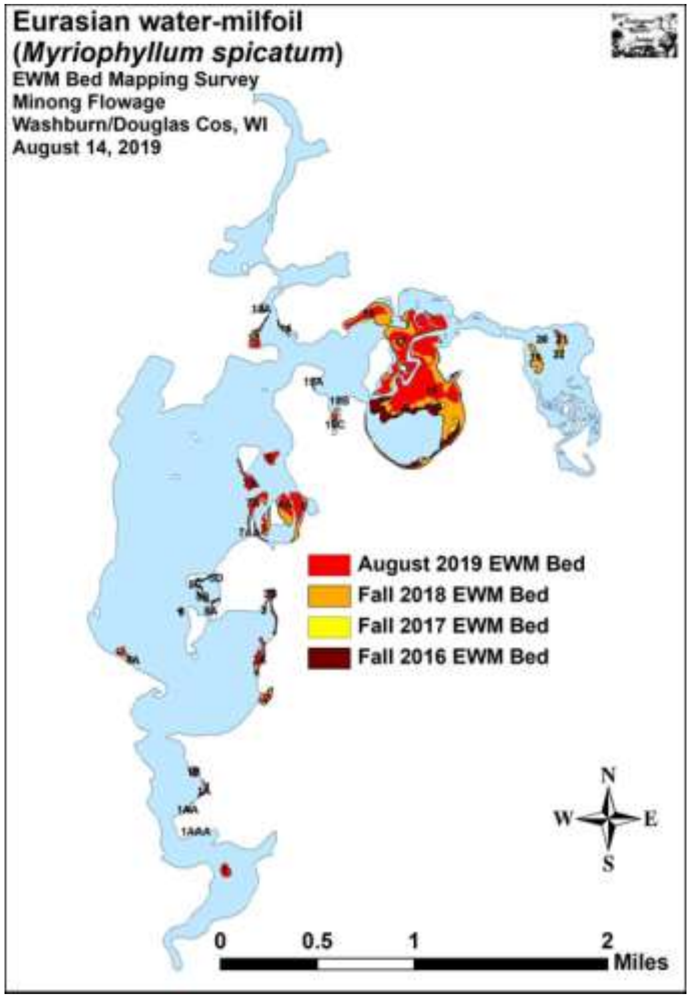


Figure 74: 2019 fall EWM bed mapping results (ERS)

2020

As in 2019, no EWM management was completed in 2020. Related to the winter drawdown, the WDNR acknowledged that reimbursement made to RWE for lost power generation during the drawdown was an eligible grant expense, opening the door for a new 3-yr AIS Control Grant applied for in the fall of 2020 covering the years 2021-23. Also, the permit awarded in 2019 for doing a winter drawdown was extended through the end of 2024.

2020 FALL EWM BED MAPPING

During the August 2020 survey, 28 EWM beds that covered 112.1 acres or 7.2% of the flowage's surface area were located (Figure 75). This was an increase of 26.9 acres (+31.5%) from the 2019 survey when 25 beds totaling 85.3 acres were mapped. It was, however, still -20.97% below the 2018 fall survey when 31 beds totaling 141.88 acres were mapped.

Most of the increase in coverage seen in 2020 came from low density EWM filling in gaps and expanding along the edges of previously identified beds in the northeast bays. Despite these increases, many plants in these bays again seemed dormant or nearly so. Conversely, in the bays south of the CTH T bridge and in the south basin, a general uptick in plant health with most beds showing active canopied growth was documented. This was accompanied by a noticeable increase in floating fragments which were common to abundant; especially near the county campground and in the beds in and around the WDNR boat landing bays. Regardless of the location, EWM plants continued to be absent at most depths over 4ft.

These conditions now met all the criteria for reconsidering a winter drawdown, now planned for the winter between 2021 and 2022. All the necessary permits were in place, a grant to support the drawdown that included reimbursement to RWE was submitted and expected to be awarded, and general support for the winter drawdown was more apparent with both the MFA constituency and other stake holders.

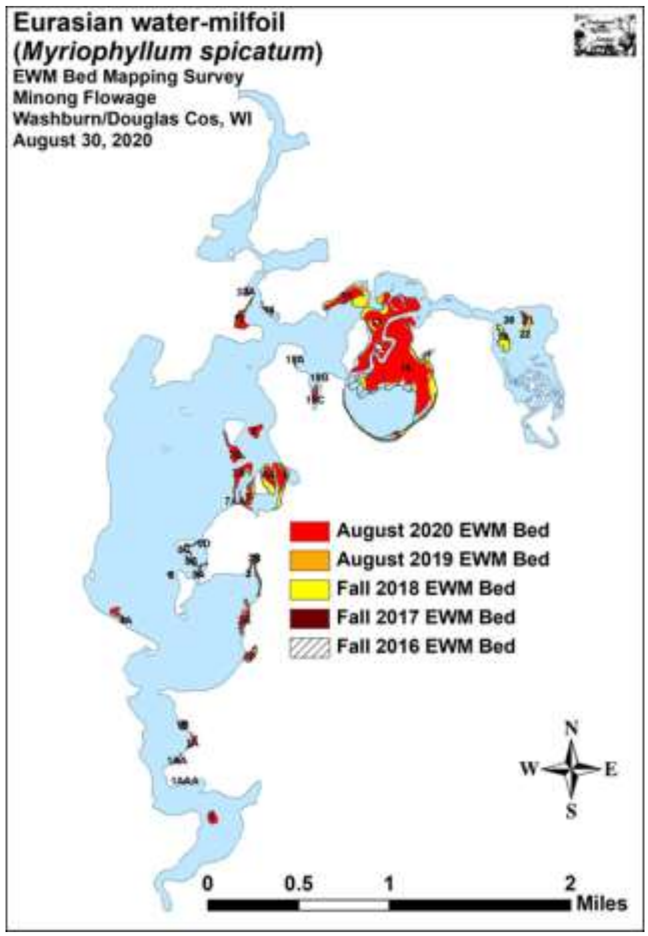


Figure 75: 2020 EWM bed mapping results (ERS)

2021

In the beginning of 2021, a new 3-yr AIS control grant was awarded to the MFA to once again plan and implement a winter drawdown. In this case, the drawdown was planned and ultimately implemented over the 2021-22 winter season. Another whole-lake, point-intercept, aquatic plant survey was completed in the summer of 2021, as was CLP bed mapping, and fall EWM bed mapping.

2021 COLD-WATER, EARLY-SEASON, POINT-INTERCEPT SURVEY

Endangered Resource Services began work on the Minong Flowage June 16-17 when both an early season, whole-lake, point-intercept (PI), aquatic plant survey was completed. This survey samples all 878 points on the lake documenting depth, substrate, and aquatic plant present. The early season PI survey is completed specifically to document the presence of curly-leaf pondweed (CLP) and EWM. This is the fourth time a survey like this has been completed on the Minong Flowage. CLP was identified on the rake at 6 points representing about 11 acres (Figure 76). EWM was identified on the rake at 55 points representing about 100 acres (Figure 76).

Figure 77 shows the 2021 results as they compare to results from previous surveys in 2008, 2012, and 2014. Although a whole-lake PI survey was completed in 2018, the cold-water, early season PI was not included. The year 2012 was the year prior to the first drawdown and the year after a 3-yr large-scale herbicide application project. The year 2014 was the year after the first drawdown project, when there was very little aquatic vegetation of any kind in the Flowage. For both species, the distribution increased from what it was immediately following the first drawdown and the 2021 season.

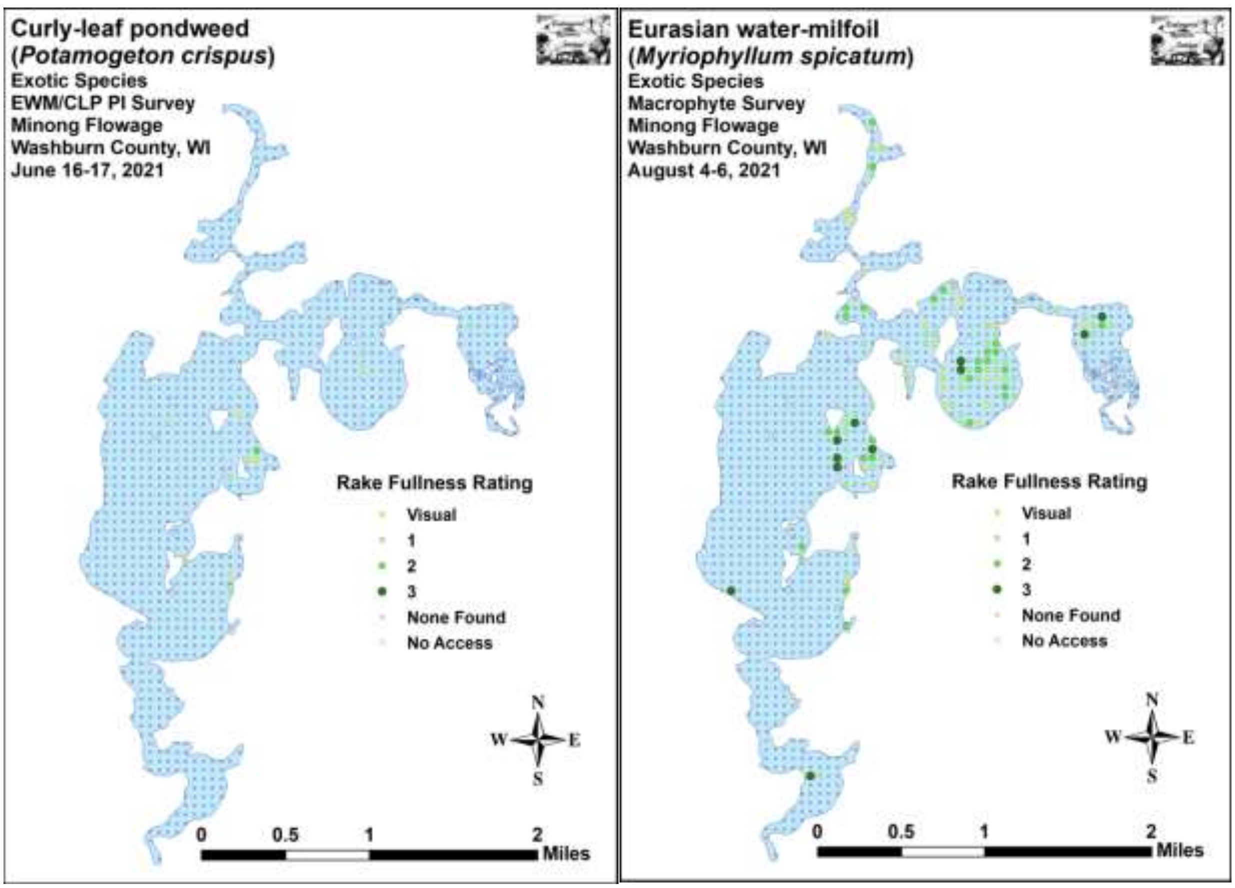


Figure 76: 2021 early season CLP and EWM point-intercept survey results (ERS)

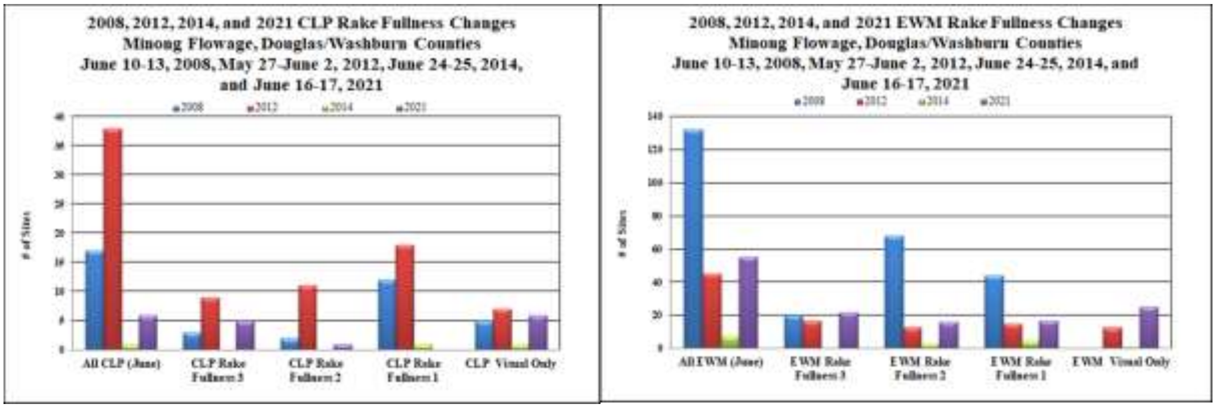


Figure 77: 2021 CLP and EWM PI survey results compared to previous surveys (ERS)

2021 CLP AND EWM BED MAPPING

Immediately following the 2021 early season PI survey, a formal CLP bedmapping survey was completed. In 2012, 15 beds totaling 27.04 acres were identified (Figure 78). In 2021, only 4.3 acres, primarily in two beds in the DNR Bay area of the Flowage were identified (Figure 78).

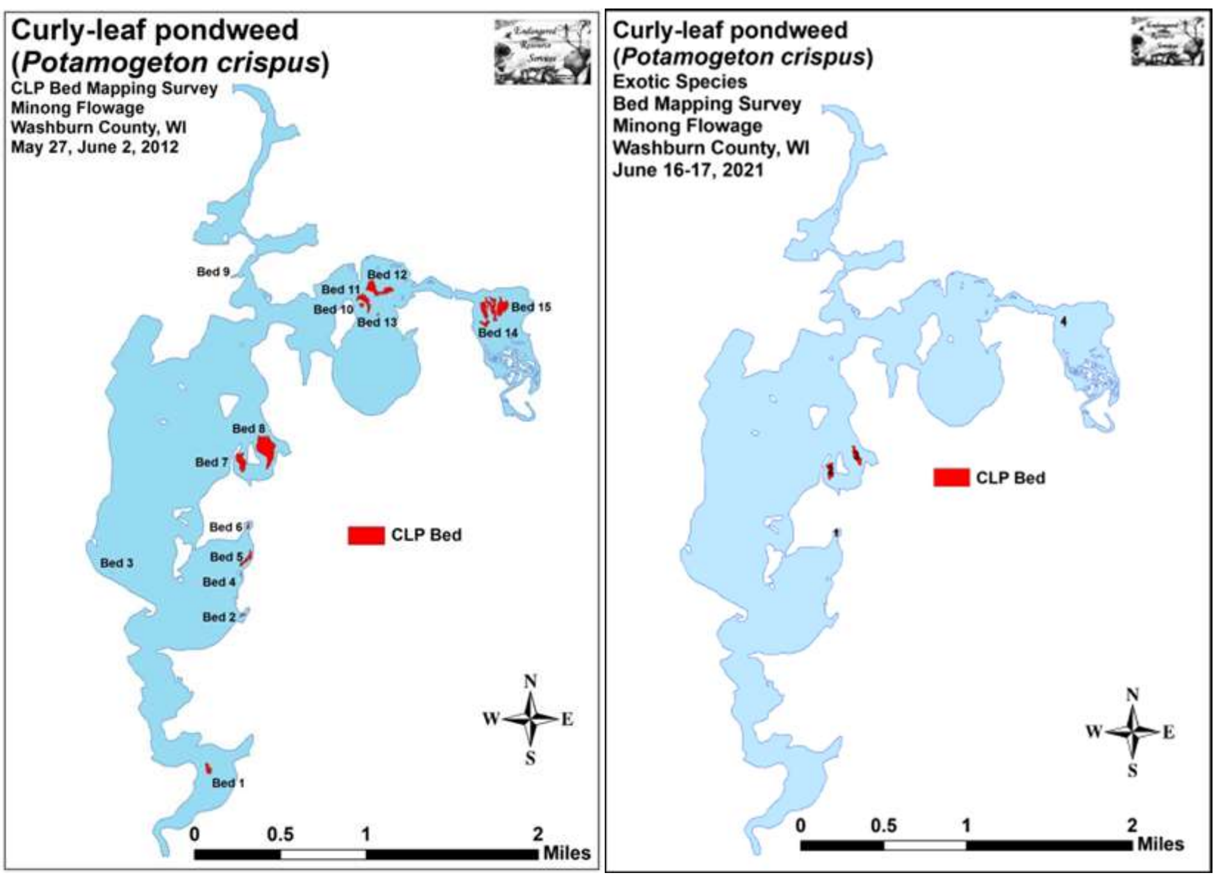


Figure 78: CLP bed mapping in 2012 and 2021 (ERS)

During a fall bed mapping survey on September 19, 2021, more than 200 acres of EWM was mapped in the Flowage (Figure 79). This was up from 112 acres in 2020 and supported the decision to implement the winter drawdown between 2021 and 2022.

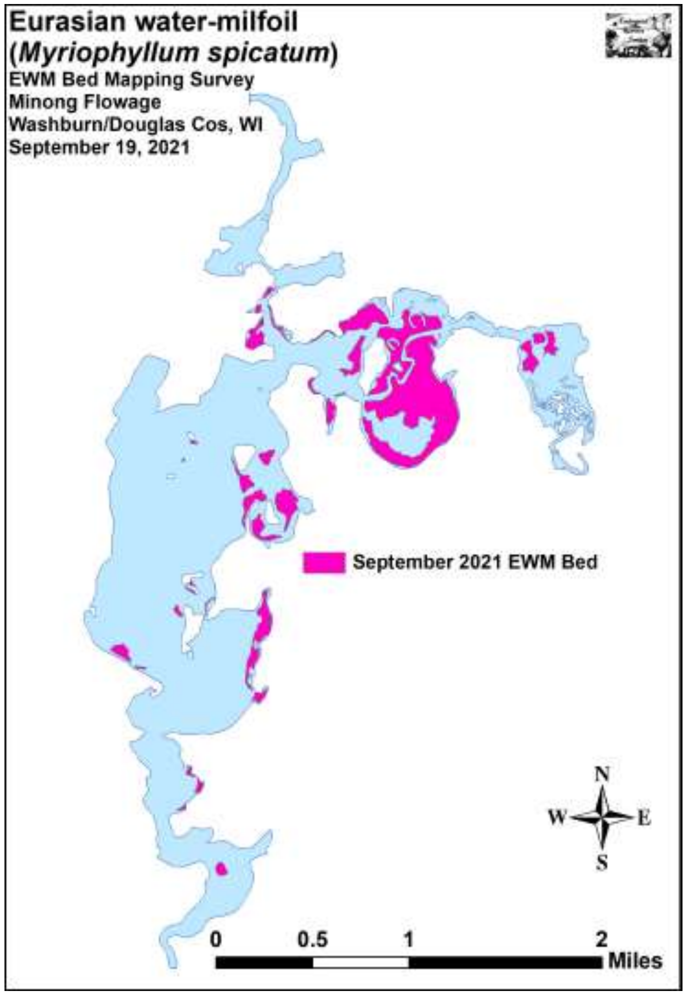


Figure 79: 2021 EWM bed mapping (ERS)

2021 SUMMER PI SURVEY

The whole-lake PI survey that was done in the early season was repeated in the summer. The top five most abundant plant species were Coontail, Small pondweed, EWM, Common waterweed, and Wild rice. EWM was identified at 88 points during the summer survey, nearly 160 surface water acres of the Flowage.

This is the fifth time a whole-lake, summer, PI survey has been completed on the Minong Flowage. During the 2008 survey, the top five most abundant plant species were Coontail, EWM, Common waterweed, Wild celery, and Fern-leaf pondweed. Wild rice was seventh. The main difference between 2008 and 2021 is the amount of EWM present. In 2008, EWM was present at 166 points, nearly 300 surface water acres of the Flowage (Figure 80).

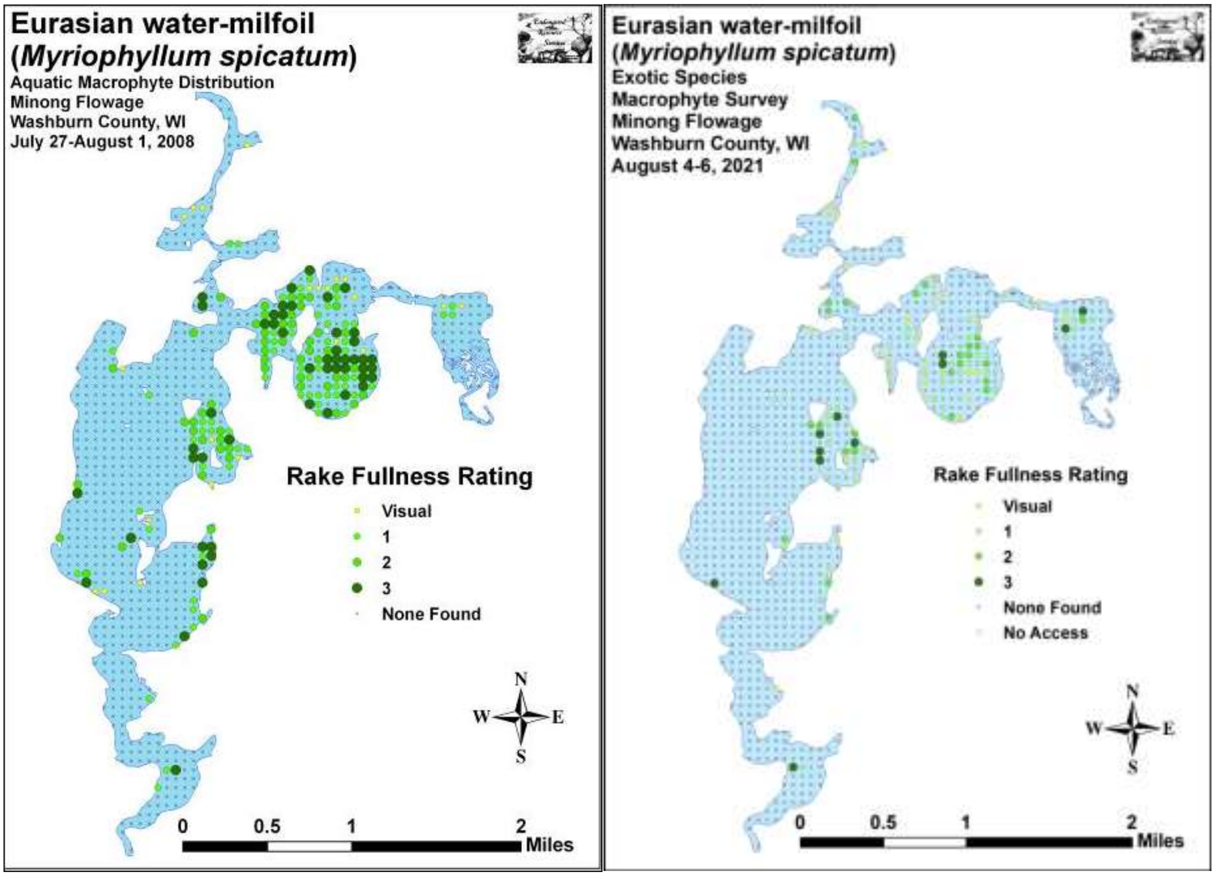


Figure 80: 2008 and 2021 EWM during a summer PI survey (ERS)

WINTER DRAWDOWN IMPLEMENTATION

In August 2021, a winter drawdown plan first drawn up in 2018 was updated in support of the planned 2021-22 winter drawdown. In early September, it was decided that the winter drawdown would commence. It started on September 20, 2021, and reached the 5-ft reduction in lake level goal in early November. Throughout the drawdown, MFA members kept tabs on it. Updates from Washburn County were sent regularly to the MFA Board, Stakeholders, and LEAPS. Renewable World Energies also began sending invoices through Washburn County for "lost power generation".

Winter weather conditions influence the ability of a drawdown to impact the target plant species. To be most effective, light snow and very cold temperatures are needed. These are the conditions that were presented during the drawdown.

2022

No management of EWM was completed in 2022. Instead, 2022 served as an evaluation year as it pertains to the results of the winter drawdown.

COMPLETED WINTER DRAWDOWN

Included in the 2021-22 Winter Drawdown Plan was a condition that the water level in the Minong Flowage would not be returned to normal in the spring until all the ice had been declared "out of the lake". The official "ice out" date was April 24, 2022. Once the refill of the Flowage started, it only took 12 days, with the official end date of the drawdown being May 6, 2022. There were only a couple minor issues with the refill. In mid-March a large rain event caused the water level in the Flowage to rise to 2.5 ft above the official drawdown level. This happened at a time when there was still a lot of ice in the Flowage. The problem was exacerbated by a mechanical issue with the mudgate of the dam, delaying how fast RWE could open gates and pass more water through. There were a couple of comments shared with the MFA about debris in the water and washing up on shore. There was even a report of a minor fishkill, but this could not be substantiated.

The final tally of the expense for lost power generation was $28,588.70, only 71% of what was included in the grant to cover that cost ($40,000.00). The total expense would have been 10% higher were it not for RWE reducing by that much as a donation in support of the winter drawdown and the WDNR grant that helped support it.

2022 EWM BED MAPPING

After the drawdown, reports of EWM fragments moving around in the Flowage started coming in, in early June. This led to the first summer meandering survey to evaluate the effectiveness of the winter drawdown. On June 27, 2022, LEAPS completed a meandering survey that began at the WDNR landing on the east side of the Flowage and moved clockwise around the lake. It did not get into the North Basin, Serenity Bay, or the East Basin past Smith Bridge. During the survey, 10 beds of dense growth EWM totaling more than 20 acres in the main basin of the Flowage, mostly in water deeper than 5-ft, were located (Figure 81). This was a major disappointment, as it was expected that the winter drawdown would have killed almost all the EWM in the system. It seemed to do this in water that was <5ft, but in anything deeper, the EWM seemed not to be impacted.

A more formal EWM bed mapping survey was completed by ERS on September 24, 2022. This survey identified 19 beds of EWM totaling 116.9 acres (Figure 81). The survey found the same thing that the June survey did – that EWM was under control in water <5-ft deep but growing aggressively in water deeper than that. Nearly all the areas mapped in June had expanded, and the North Basin and Serenity Bay, which were not mapped in June, had a lot of EWM. EWM was also found in the East Basin past Smith's Bridge, but it was not considered a "bed" at the time of the survey. The fall survey showed a reduction in the EWM acreage of 89.6 acres (44%) from 2021 fall totals, but all of it was in water <5ft deep (Figure 82).

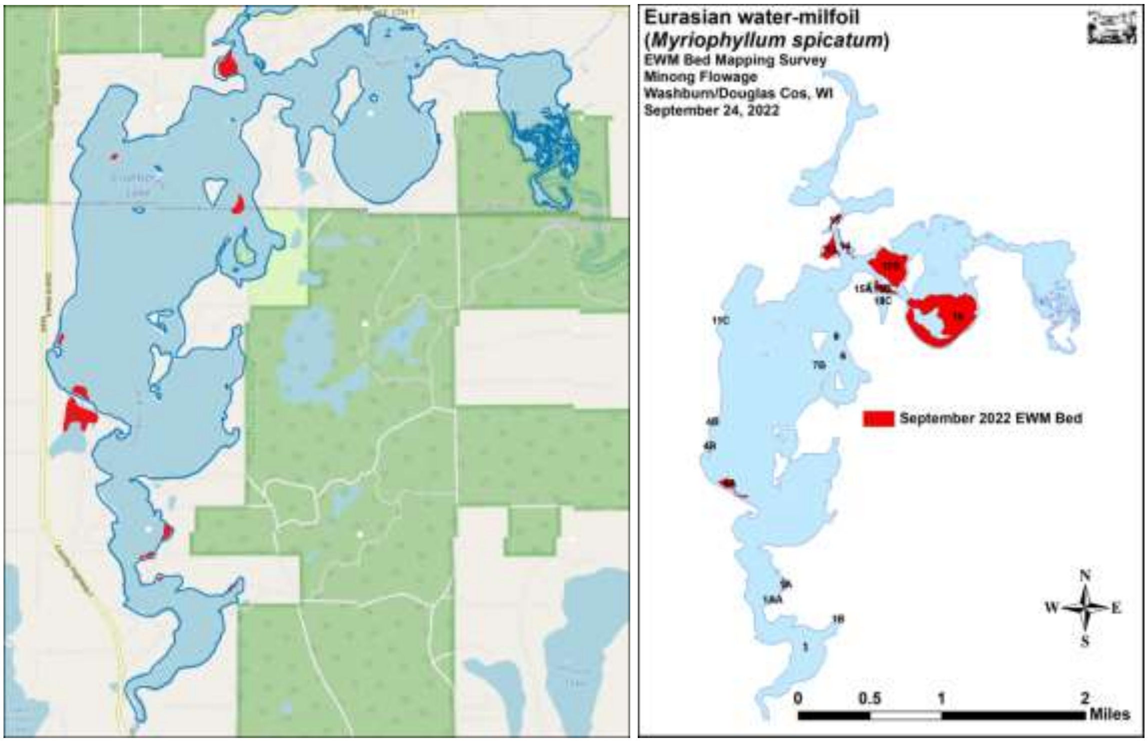


Figure 81: June EWM bed mapping survey results (LEAPS) and September survey results (ERS)

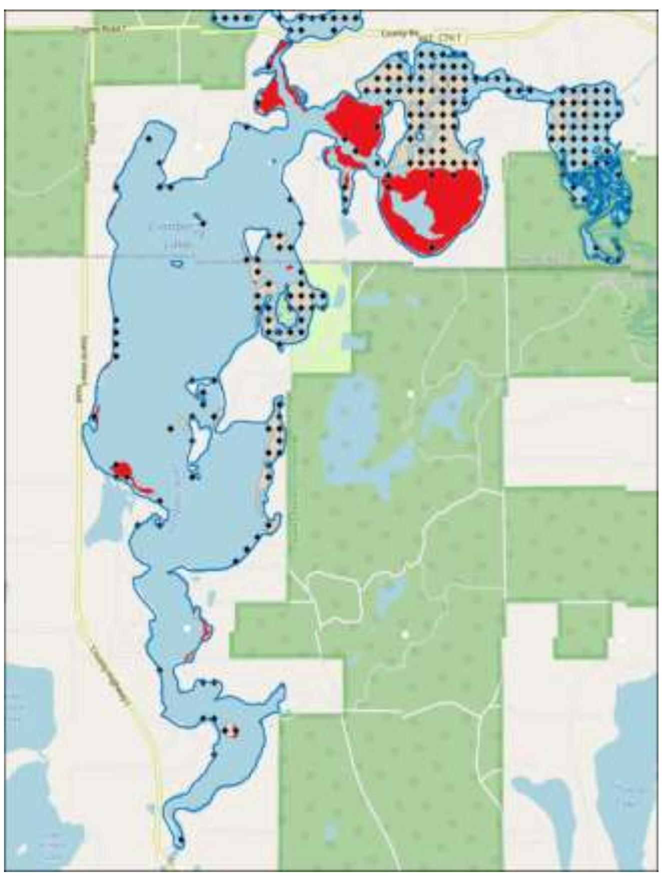


Figure 82: 2021 bed mapping (tan), 2022 bed mapping (red), and water <5-ft deep (black points)

2023

The results of the 2021-22 winter drawdown were less than what was expected. While it was effective at reducing the amount of EWM in areas of the Flowage where the water depth was <5ft, it had little impact on EWM in deeper water. As a result, the MFA pursued a permit for the application of aquatic herbicides to three locations: the bay off the Channel from Cranberry, the flat out in front of the Washburn County Park, and Delcore Pond within the boundaries of the County Park (Figure 83, Table 18).

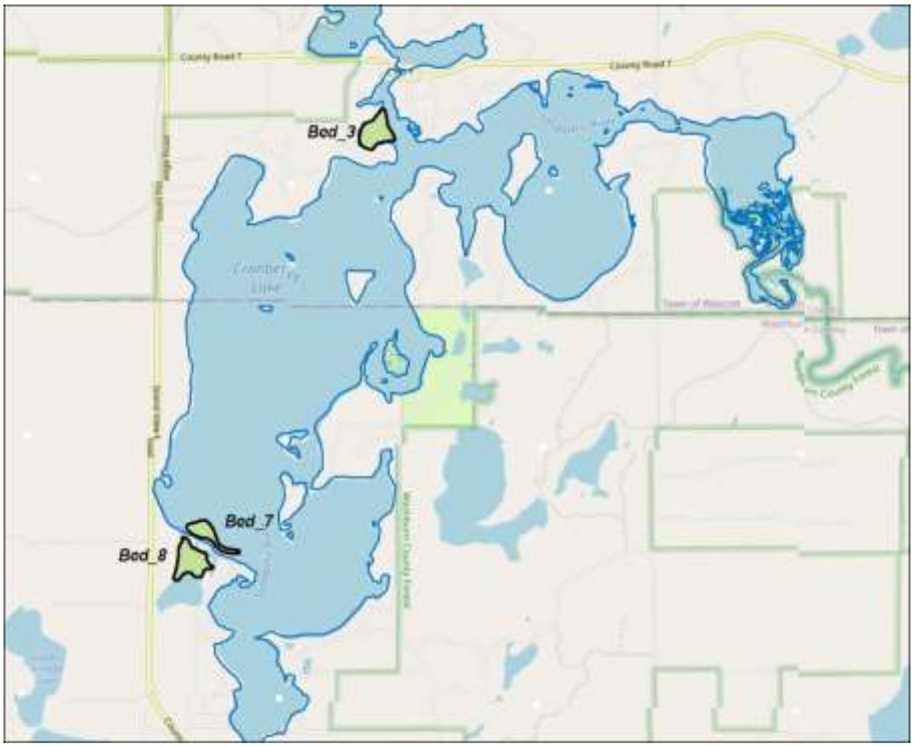


Figure 83: 2023 Preliminary EWM spring chemical treatment

Table 18: 2023 Preliminary EWM spring chemical treatment

2023 Minong Flowage Spring EWM Chemical Treatment Proposal - Liquid 2,4D (April 16, 2023)							
Treament Area Characteristics					2,4D		
Treatment Location	Site Name	Acreage	Mean Depth (feet)	Volume (acre-feet)	Treatment a.i. ppm	Application rate (gal/ac-ft)	Treatment application (gal)
ChanfromCran-Bay	Bed_3	8.9	6.0	53.40	3.0	2.13	113.74
CountyPark-Flat	Bed_7	5.6	6.0	33.60	4.0	2.84	95.42
CountyPark-Pond	Bed_8	9.5	6.0	57.00	3.0	2.13	121.41
Total		24.00		144.00			330.58
					EWM Treatment (24.0acres); early spring application		

2023 Spring EWM Chemical Treatment

After meeting with the WDNR and Tribal Resources/GLIFWC in May 2023, the treatment permit was approved by the WDNR. However, a pre-treatment survey completed by LEAPS on May 23 of all three proposed management areas showed little to no EWM in Delcore Pond, so that treatment area was removed from the final treatment. The final chemical treatment included two beds (3 & 7) totaling

14.5acres and was completed on May 31, 2023, using a liquid 2,4D herbicide (2,4D Amine 4) at a 3-4 ppm application rate.

2023 WHOLE-LAKE, PI SURVEY

2023 was the third year of the 3yr AIS Control grant used to help plan, implement, and evaluate the 2021-22 winter drawdown. A whole-lake, PI survey was completed in 2021 prior to the drawdown, and one was completed in 2023, a year after the winter drawdown. Both the 2021 and 2023 PI surveys included a cold-water early season PI and a summer PI. As a part of the 2023 summer PI survey, Delcore Pond within the boundaries of the Washburn County Park was sampled. This was the first time Delcore Pond was officially sampled as a part of a PI survey. Fall EWM bed mapping was completed on both bodies of water in 2023. Figure 84 shows the 2023 PI survey results for both the Minong Flowage and Delcore Pond.

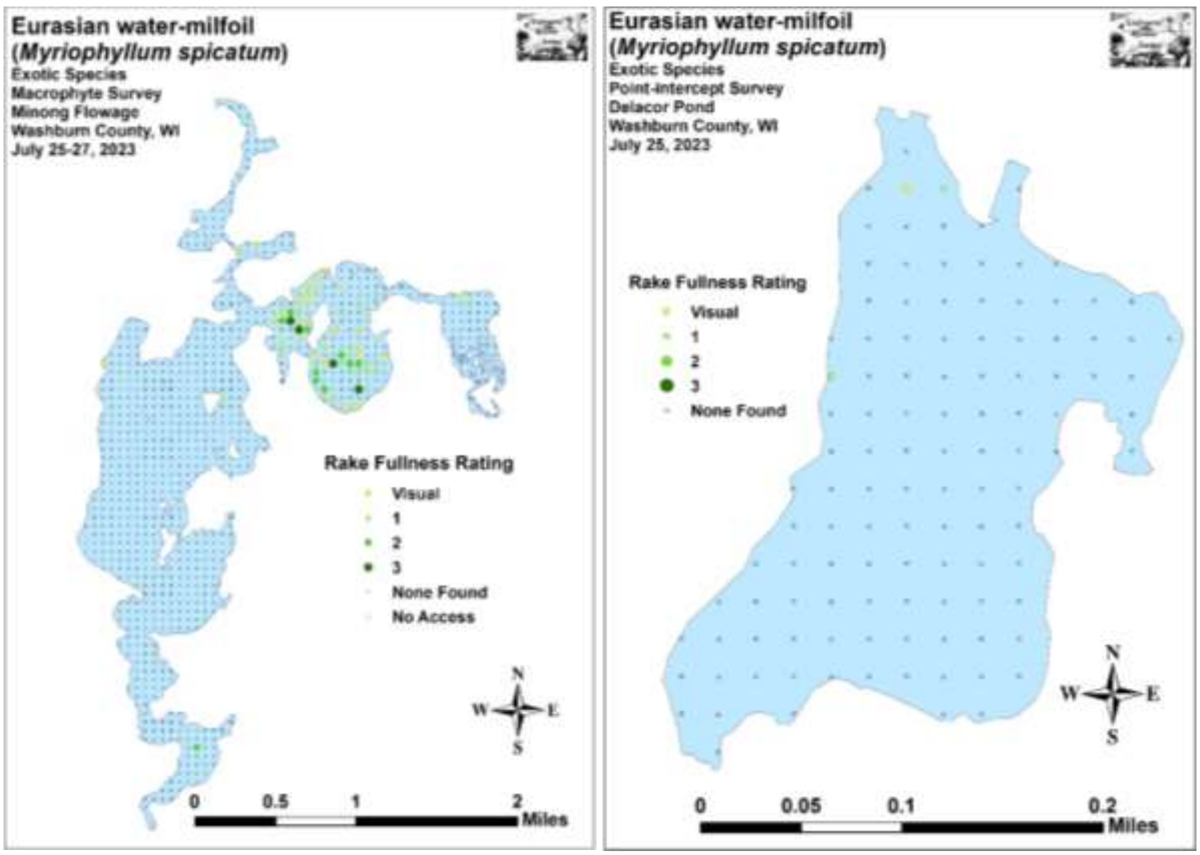


Figure 84: 2023 summer PI survey results for EWM on Minong Flowage and Delcore Pond (ERS)

2023 FALL EWM BED MAPPING

Figure 85 shows the results of 2023 EWM bed mapping on both the Minong Flowage and Delcore Pond.

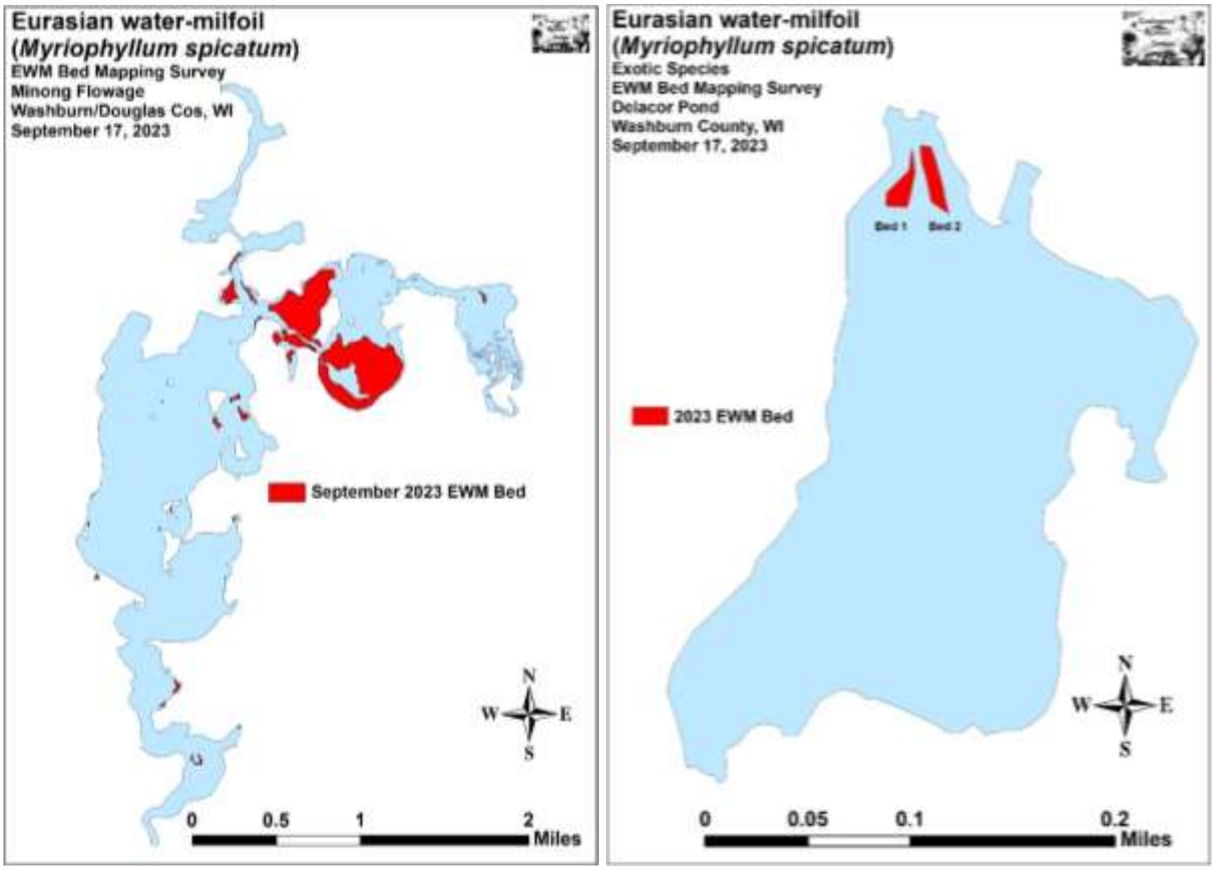


Figure 85: 2023 fall bed mapping results for EWM on Minong Flowage and Delcore Pond (ERS)

WISCONSIN'S AQUATIC PLANT MANAGEMENT STRATEGY

There are many techniques for managing aquatic plants in Wisconsin. Often management may mean protecting desirable aquatic plants by selectively hand pulling the undesirable ones. Sometimes more intensive management may be needed using harvesting equipment, herbicides, or biological control agents. Because aquatic plants are recognized as a natural resource to be protected, managed, and used wisely, the development of long-term, integrated aquatic plant management strategies to identify important plant communities and manage nuisance aquatic plants in lakes, ponds or rivers is often required by the State of Wisconsin.

The Public Trust Doctrine is the driving force behind all management, plant or other, in Wisconsin lakes. Protecting and maintaining Wisconsin's lakes for all of Wisconsin's people are at the top of the list in determining what is done and where. Two other factors that reflect Wisconsin's changing attitude toward aquatic plants. One is a realization of the importance of a strong, diverse community of aquatic plants in a healthy lake ecosystem; and the other is the concern over the spread of AIS.

INTEGRATED PEST MANAGEMENT

Integrated Pest Management (IPM) is an ecosystem-based management strategy that focuses on long-term prevention and/or control of a species of concern. Adapted for aquatic plant management, IPM considers all the available control practices such as: prevention, biological control, biomanipulation, nutrient management, habitat manipulation, substantial modification of cultural practices, pesticide application, water level manipulation, mechanical removal, and population monitoring (Figure 86). In addition to monitoring and considering information about the target species' life cycle and environmental factors, groups can decide whether the species' impacts can be tolerated or whether those impacts warrant control. Then, an IPM-based plan informed by current, comprehensive information on pest life cycles and the interactions among pests and the environment can be formed. If control is needed, data collected on the species and the waterbody will help groups select the most effective management methods and the best time to use them.

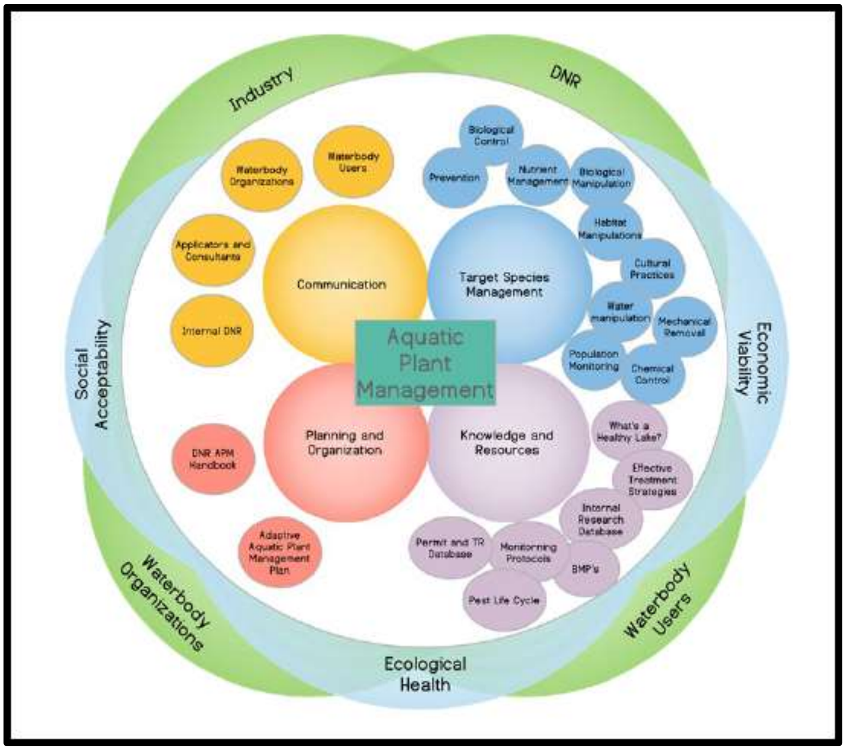


Figure 86: Wisconsin Department of Natural Resources: Wisconsin Waterbodies – Integrated Pest Management March 2020

The most effective, long-term approach to managing a species of concern is to use a combination of methods. Approaches for managing pests are often grouped in the following categories:

- **Assessment** – is the use of learning tools and protocols to determine a waterbodies' biological, chemical, physical and social properties, and potential impacts. Examples include point-intercept (PI) surveys, water chemistry tests and boater usage surveys. This is the most important management strategy for every single waterbody.
- **Biological Control** – is the use of natural predators, parasites, pathogens, and competitors to control target species and their impacts. An example would be beetles for purple loosestrife control.
- **Cultural controls** – are practices that reduce target species establishment, reproduction, dispersal, and survival. For example, a Clean Boats, Clean Waters program at boat launches can reduce the likelihood of the spread of species of concern.
- **Mechanical and physical controls** – can kill a target species directly, block them out, or make the environment unsuitable for it. Mechanical harvesting, hand pulling, and diver assisted suction harvesting are all examples.
- **Chemical control** – is the use of pesticides. In IPM, pesticides are used only when needed and in combination with other approaches for more effective, long-term control. Groups should use the most selective pesticide that will do the job and be the safest for other organisms and for air, soil, and water quality.

IPM is a process that combines informed methods and practices to provide long-term, economic pest control. A quality IPM program should adapt when new information pertaining to the target species is provided or monitoring shows changes in control effectiveness, habitat composition and/or water quality. While each situation is different, eight major components should be established in an IPM program:

1. Identify and understand the species of concern.
2. Prevent the spread and introduction of the species of concern.
3. Continually monitor and assess the species' impacts on the waterbody.
4. Prevent species of concern impacts
5. Set guidelines for when management action is needed.
6. Use a combination of biological, cultural, physical/mechanical, and chemical management tools.
7. Assess the effects of target species' management.
8. Change the management strategy when the outcomes of a control strategy create long-term impacts that outweigh the value of target species control.

MANAGEMENT ALTERNATIVES

Nuisance aquatic plants can be managed in a variety of ways in Wisconsin. The best management strategy will be different for each lake and depends on which nuisance species needs to be controlled, how widespread the problem is, and the other plants and wildlife in the lake. In many cases, an integrated pest management (IPM) approach to aquatic plant management that utilizes several control methods is necessary. The eradication of non-native aquatic invasive plant species like CLP and EWM is generally not feasible but preventing them from becoming a more significant problem is an attainable goal. Sometimes no manipulation of the aquatic plant community is the best management option. Plant management activities can be disruptive to a lake ecosystem and should not be done unless it can be shown they will be beneficial and occur with minimal negative ecological impacts.

Management alternatives for nuisance aquatic plants can be grouped into four broad categories:

- Manual and mechanical removal
- Chemical application
- Biological control
- Physical habitat alteration.

Manual and mechanical removal methods include pulling, cutting, raking, harvesting, suction harvesting, and other means of removing the physical plant from the water. Chemical application uses herbicides that kill or impede the growth of the aquatic plant. It is illegal to put any chemical into the waters of Wisconsin without a chemical application permit from the WDNR. Some forms of physical removal, specifically suction harvest, and mechanical harvesting, also require a WDNR permit. Biological control methods include organisms that use the plant for a food source or parasitic organisms that use the plant as a host, killing or weakening it. Biological control may also include the use of species that compete successfully with the nuisance species for available resources. This activity may require a WDNR permit. Physical habitat alteration includes dredging, installing lake-bottom covers, manipulating light penetration, flooding, and drawdown. These activities may require WDNR permits. They may also include making changes to or in the watershed of a body of water to reduce nutrients going in.

Informed decision-making related to aquatic plant management implementation requires an understanding of plant management alternatives and how appropriate and acceptable each alternative is for a given lake. The following sections list scientifically recognized and approved alternatives for controlling aquatic vegetation.

NO MANAGEMENT

When evaluating the various management techniques, the assumption is erroneously made that doing nothing is environmentally neutral. In dealing with non-native species like EWM, the environmental consequences of doing nothing may be high, possibly even higher than any of the effects of management techniques. Unmanaged, these species can have severe negative effects on water quality, native plant distribution, abundance and diversity, and the abundance and diversity of aquatic insects and fish. Nonindigenous aquatic plants are the problem, and the management techniques are the collective solution. Non-native plants are a biological pollutant that increases geometrically, a pollutant with a very long residence time and the potential to "biomagnify" in lakes, rivers, and wetlands (Madsen J. , 2000).

The following information about EWM and the issues it can cause in a waterbody comes from Michigan Tech Research Institute and can be viewed at https://www.mtu.edu/mtri/research/project-areas/environmental/water/eurasian-watermilfoil/impacts/.

- EWM has many characteristics that contribute to its tendency to become a nuisance and is considered one of the most problematic submerged aquatic plant species in North America. The primary issue with EWM is the amount of biomass the plant will produce, not necessarily its presence—not all EWM populations will become major infestations. When EWM is moved to a suitable habitat, it has the propensity to accumulate biomass quickly and rapidly expand in population size. Although EWM prefers warmer water temperatures, it can tolerate and photosynthesize in low temperatures. Cold tolerance allows it to grow earlier in the season and out-compete other aquatic plants for space and subsequently light once a canopy is formed. It has a wide tolerance range for many environmental attributes, so it can colonize a variety of habitats. It can colonize previously unvegetated habitats, and fragments from nearby populations can quickly establish and grow in habitats where native aquatic plants are disturbed or removed by ice scour, sedimentation, bioturbation, herbivory, and water level changes. Once established, it can persist through disturbances.

- Dense EWM populations often lead to major ecological impacts and have ramifications toward native habitats and native organisms. EWM can disrupt food-webs in both estuarine and freshwater water bodies. Invasive species are an important threat to biological diversity, second only to habitat losses. EWM has been shown to displace native species in a span of two to three years.

- EWM can alter the chemical and physical properties of water when it grows in dense stands. EWM decomposition has been shown to accelerate eutrophication by releasing nutrients, especially phosphorous that was translocated from the sediment into plant tissue during growth, into the water column. Since EWM self-prunes its leaves and dies back in the fall, large populations of EWM result in the buildup of biomass on the sediment. EWM biomass decomposition and the increased respiration rates of microbes will lead to lower dissolved oxygen levels in the water column. EWM's restriction on flow and mixing of the water column can also result in an alteration of the temperature profile by up to 10°C per meter, further reducing dissolved oxygen.

- EWM can form dense canopies, especially in turbid waters, that will block the light from reaching the substrate restricting the growth of macrophytes underneath it. EWM grows early and elongates rapidly, thus giving it a competitive advantage for light over native plants, including the native northern watermilfoil.

- EWM can have major implications on aquatic food webs. EWM's primary contribution to the food web is through decomposing material in the detritus. However, EWM is allelopathic. Allelopathy is the ability of one plant (or other organism) to chemically inhibit the growth of another, due to the release into the environment of substances acting as germination or growth inhibitors (dictionary definition). Therefore, the presence of released allelopathic compounds by EWM could directly affect the algal and periphyton community, thus reducing productivity. The allelopathic compounds contained within senesced EWM also reduce the quality of detritus. The changes in microbial communities and the quality of detritus then affect the invertebrate community.

- EWM and the epiphyton that grows on it do not contribute much energy or nutrients to higher trophic levels; fish prefer prey that originates from native plant communities. Even fish that use EWM stands for harborage have been shown to get their energy and nutrients from native plant communities. Dense stands of EWM also influence the predation rates of piscivorous fish. Largemouth bass, for example, have difficulty entering and foraging for prey in dense EWM stands, which can result in an increase of bluegill and a decrease in bass. EWM will also reduce spawning success by covering the spawning grounds.

- Dense infestations will alter the hydrology of the water body slowing currents and wave action. The standing water then provides habitat for mosquitoes and Schistosomatidae parasites that cause swimmers itch (cercarial dermatitis). The reduction in dissolved oxygen in the water column through decreases in mixing and increased decomposition can also displace fish and other animals.

- EWM is a low-quality food source, so although it may be edible, it is not preferred by waterfowl. Dense populations of EWM will displace desirable vegetation species, leading to low-quality habitat for waterfowl.

- The presence of EWM has been shown to have a major impact on land values. According to data collected in Wisconsin, property owners are willing to pay an average of approximately $30,000 more for a property on an EWM-free lake, and EWM presence decreases property value (land and structures) an average of eight percent and land value by 13 percent.

Dense growth EWM has had a more recent and more disturbing impact on the Minong Flowage. In October 2023, a canoe in Serenity Bay capsized and two men drowned. Recovery of the persons was delayed and made more difficult by the dense growth EWM in the area where they disappeared[5].

Foregoing any management of EWM in the Minong Flowage is not a recommended action. Regardless of the area, some form of EWM management will be needed. In 2008 EWM beds covered more than 330 acres or greater than 20% of the Flowage. Since that time the amount of EWM in the Flowage has fluctuated between 14 acres after the 2013-14 extended drawdown to more than 200 acres in 2021, prior to the first winter drawdown done to control EWM. If left unmanaged, EWM will again reach levels documented in 2008 and 2009.

HAND-PULLING/MANUAL REMOVAL

Manual or physical removal of aquatic plants by means of a hand-held rake or cutting implement; or by pulling the plants from the lake bottom by hand is allowed by the WDNR without a permit per NR 109.06. As a rule, though, these activities can only occur in a zone that is no more than 30-ft wide and adjacent to a pier or lake use area (Figure 87). There is no limit as to how far out into the lake the 30-ft zone can extend. Any aquatic plants removed, cut, or dislodged by the management effort must be removed from the water and not left to float away or sink to the bottom. If the water clarity in a body of

[5] https://www.nujournal.com/news/local-news/2023/11/10/new-ulm-canoeists-body-recovered-from-lake/

water is such that aquatic plants can be seen in deeper water, pulling aquatic plants while snorkeling or scuba diving is also allowable without a permit according to the conditions in NR 106.06(2). Physical removal of aquatic plants does require a permit if the removal area is in a “sensitive” or critical habitat area previously designated by the WDNR.

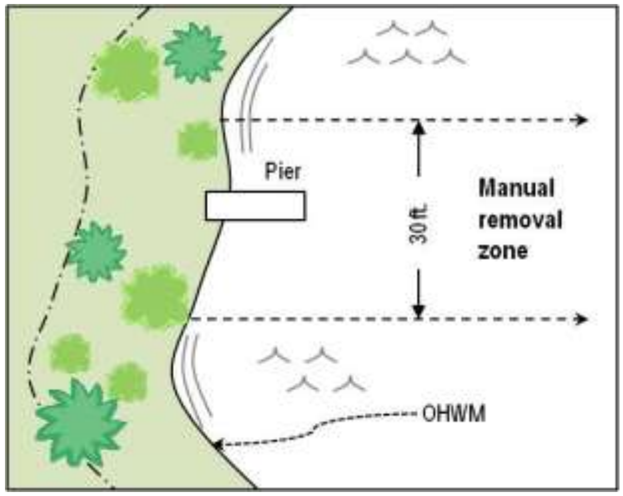


Figure 87: Aquatic vegetation manual removal zone

Manual or physical removal can be effective at controlling individual plants or small areas of plant growth and can be effective at slowing the spread of a new AIS infestation within a lake when done properly. It limits disturbance to the lake bottom, is inexpensive, and can be practiced by many lake residents. Although up to 30 feet of aquatic vegetation can be removed, removal should only be done to the extent necessary. Clearing large swaths of aquatic plants not only disrupts lake habits, but it also creates open areas for non-native species to establish (Figure 88). When completing physical removal of aquatic plants, care should be taken to continually monitor the removal site for AIS.

Figure 88: A “cleared” area adjacent to a dock and lift and the presence of EWM

FREE DIVING, SNORKELING, AND/OR SCUBA DIVER REMOVAL OF AIS

Larger physical removal projects involving free diving, snorkeling, or scuba divers can be effective at removing small areas of AIS. Free diving involves identifying AIS from a boat and then having a swimmer wearing goggles hold their breath while diving to the bottom to pull the plant and bring it to the surface where it is collected by a person in the boat. Long-handled nets are usually available to help pick up fragments dislodged by the free-diver. This method works best when AIS is mostly individual plants or small beds that are widespread, in clearer water, and in areas without other underwater obstructions. How deep a free diver goes depends on the swimmer, but 6-8ft is generally a good limit. Free diving is not without risks. One concern is shallow water blackout. Shallow water blackout occurs when a free diver loses consciousness due to a lack of oxygen. This can happen at any depth but is most common in shallow water. Shallow water blackout is extremely dangerous, as the free diver may drown before they are able to be rescued. As such, it is crucial that the person in the boat also acts as a spotter, keeping an eye on the diver to make sure they are safe. It is also important to have a free diver take their time and relax and rest between dives. Trying to do too much too fast increases the danger.

Snorkeling works best as a shallow water “inspect and remove” activity. Using a snorkel to breathe, a swimmer patrols shallow areas looking for AIS. When found, and if in shallow water, removal follows.

Scuba diving makes it possible to spend more time under water looking for and then hand removing AIS. Often a scuba diver will carry a fine mesh bag along with them to put the plant material that they remove into to minimize the number of fragments that are dislodged or that simply break away from a pulled plant.

In all these methods, it is important for the diver to remove as much of the plant and the root from the bottom of the lake as possible. When targeting AIS, none of these methods require a permit to complete. Under water obstructions like stumps and other woody debris, and poor water clarity issues increase the danger of this form of removal and make it less effective. Inexperienced divers should have multiple precautions in place to help ensure the safety of the diving experience.

All three of these physical removal actions have been completed in the Minong Flowage and will continue where appropriate. AIS growing near shore and on shallow, sandy bottom flats free of underwater obstructions may be best managed by hand-pulling/manual removal.

BOTTOM BARRIERS AND SHADING/WATER COLORANTS

Bottom barriers are constructed from a variety of materials including polyvinyl chloride (PVC) liners, coated fiberglass mesh screen and other materials. Sheets of these fabrics are anchored to the bottom of the lake or pond. All plants beneath the fabric are controlled except for free-floating plants and algae. In some cases, bottom fabrics are used to provide a more favorable swimming area. These types of barriers can interfere with fish spawning and other lake/pond wildlife. Over time, barriers may require maintenance due to siltation, ice damage, bubbling up and normal wear and tear. Barriers are usually sold on a square foot basis and range from $0.20/sq. foot for the material to $1.00 or more, including professional installation. Although they cost more initially, they can last 5 to 10 years and are useful for pond areas near small piers and beaches. Permits are required on public lakes and streams, but no permits are required to install bottom barriers in private ponds.

A number of different water colorants or dyes are widely available. The dyes are generally blue and are designed to reduce the amount of light penetrating the surface of a water body, thereby reducing plant and algae growth. The dyes are usually non-toxic, water-soluble and degrade over a period of weeks. Permits are required for the use of dyes that have United States Environmental Protection Agency (USEPA) registration numbers. Dyes that do not claim to control plants or algae have not been required to complete the USEPA toxicity testing or product registration. Dyes may reduce the need for other management strategies but are usually not a "cure-all." If the water body has an occasional outflow, it will be difficult to use a dye without discharging the colored water downstream causing complaints and possibly resulting in enforcement actions.

Shading occurs naturally in many water bodies including the Minong Flowage. Tannins in the Flowage create water that is stained brown which limits light penetration to some degree. In the Minong Flowage, plant growth substantially declines once water depth exceeds 7-ft. In years of limited water clarity, plant growth stops when water depths exceed 6-ft. Bottom barriers and attempts to further reduce light penetration in the Flowage are not recommended.

MECHANIZED AQUATIC PLANT MANAGEMENT

Mechanical management involves the use of devices not solely powered by human means to aid in removal of aquatic plants. This includes gas and electric motors, ATV’s, boats, tractors, etc. Using these instruments to pull, cut, grind, or rotovate aquatic plants is illegal in Wisconsin without a permit. To implement mechanical removal of aquatic plants a Mechanical/Manual Aquatic Plant Control Permit or other task-specific permit is required from the WDNR. Applications are reviewed by the WDNR, and other entities and a permit awarded if required criteria are met. All the following mechanical forms of aquatic plant management require WDNR permits.

DIVER ASSISTED SUCTION HARVESTING

Diver assisted suction harvesting or DASH, as it is often called, involves scuba divers who swim along the bottom of the lake with a hydraulic suction tube and when a target plant is found, it is dislodged by the diver and fed into the suction tube. Hydraulic suction brings the removed plant to the surface of the lake and deposits into a bag or bin on the boat (Figures 89 & 90). It is called "harvesting" rather than "dredging" because, although a specialized small-scale dredge is used, bottom sediment is not removed from the system. DASH increases the ability of a diver to remove offending vegetation from a larger area, faster. A DASH boat consists of a pontoon boat equipped with a water pump, catch basin, suction hose, and other apparatus (Figure 90). In addition, many DASH boat setups include an air compressor, hose, and regulator system on board that can support 1-3 divers without scuba tanks.

Like with other diver removal efforts, underwater obstructions and poor water clarity can make DASH less effective as a removal technique.

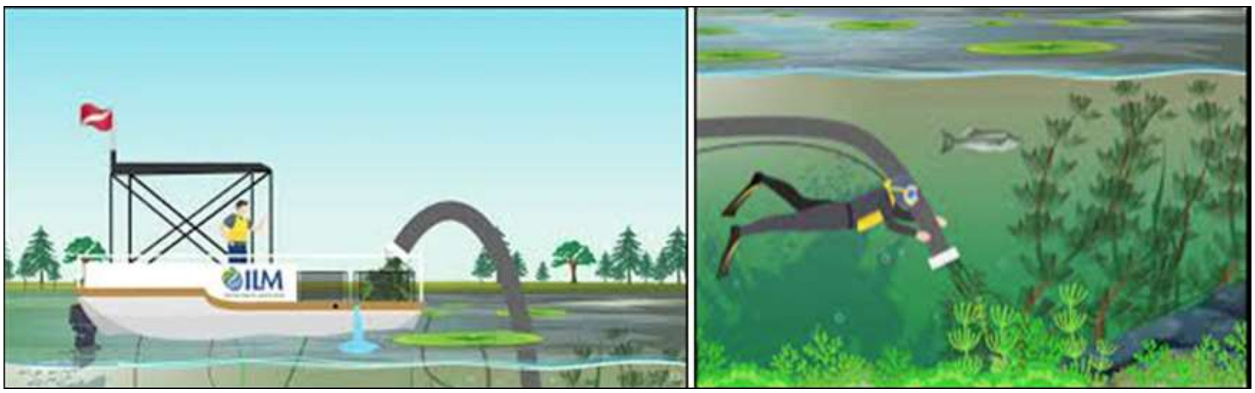


Figure 89: DASH boat and underwater operation (ILM Environments)
https://www.youtube.com/watch?v=YQmLMKzc1UM

Figure 90: DASH – Feeding EWM into the underwater Suction Hose (Marinette Co.); and a sample DASH Pontoon Boat (Beaver Dam Lake Management District)

Access to DASH services in northern WI is limited, with only one private company offering services in all northern WI. Contracted DASH services usually run in the $2,500.00 to $3,500.00 per day range with no guarantees on how much EWM can be removed in a day. The estimated costs to build a custom DASH boat range from $15,000.00 to $20,000.00.

DASH may work well in areas of the Minong Flowage where small, dense beds of EWM have been identified. It is less effective when used to remove individual and small clumps of plants spread out over a large area due to the time it takes to travel with the DASH boat to all these sites.

CONTINUED MECHANICAL DISTURBANCE TO CONTROL AQUATIC PLANTS

Mechanical disturbance devices such as bottom rollers, automated rakes or sweepers, and Aqua-Thrusters are not illegal in WI, but do require a WDNR Waterway and Wetland General or Individual Permit from the WDNR to legally place in a lake.[6]

Weed rollers are slow-moving pivot beams attached to a pier or wharf that slowly roll along a lake bottom, agitating lakebed material to prevent aquatic plant growth. Because these are submerged structures, they can potentially cause navigation concerns and can limit habitat availability for fish and aquatic life. For these reasons, rollers are not generally permitted in Wisconsin's waters. A miscellaneous structure individual permit is required if a riparian owner wishes to pursue a roller.[7]

A weed rake is a device that attaches to an existing structure such as a pier or piling, designed to mechanically remove aquatic plants by the movement of rake tines attached to a floating boom without grubbing, lifting, or rolling of the bottom sediments. A weed rake general permit is available for qualifying weed rake projects.[8] Projects that cannot meet the eligibility requirements of the general permit must apply for a miscellaneous structure individual permit.

Jetting is a process of forcefully shooting water toward the lakebed to dislodge sediment and/or plants. Aqua-Thrusters are a common site on many Wisconsin lakes and are an example of “jetting”. The dislodged sediment typically moves from one area of a lake to another and can cause several environmental concerns including declining water clarity, nutrient release, destruction of fish and wildlife habitat, and increased sedimentation of neighboring properties or channels. Due to these potentially severe side effects, the jetting of sediment is classified as dredging and requires a DNR dredging-jetting aquatic plants permit.[9]

SMALL-SCALE MECHANICAL HARVESTING

There are a wide range of small-scale mechanical harvesting techniques, most of which involve the use of boat mounted rakes, scythes, and electric cutters. As with all mechanical harvesting, removing the cut plants is required. Commercial rakes and cutters range in prices from $200 for rakes to around $3000 for electric cutters with a wide range of sizes and capacities. Using a weed rake or cutter that is run by human power is allowed without a permit, but the use of any device that includes a motor, gas or electric, would require a permit. Dragging a bed spring or bar behind a boat, tractor, or any other motorized vehicle to remove vegetation is also illegal without a permit.

Although not truly considered mechanical management, incidental plant disruption by normal boat traffic is a legal method of management. Active use of an area is often one of the best ways for riparian owners to gain navigation relief near their docks. Most aquatic plants won’t grow well in an area actively used for boating and swimming. It should be noted that purposefully navigating a boat to clear large

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[6] https://dnr.wisconsin.gov/topic/Waterways/construction/intake_outfall.html
[7] https://dnr.wisconsin.gov/sites/default/files/topic/Waterways/checklist/IP/IndividualPermitAll.pdf
[8] https://apps.dnr.wi.gov/doclink/forms/3500-143.pdf
[9] https://apps.dnr.wi.gov/doclink/forms/3500-154.pdf

areas is not only potentially illegal it can also re-suspend sediments, encourage aquatic invasive species growth, and cause ecological disruptions.

LARGE-SCALE MECHANICAL HARVESTING

Large-scale mechanical harvesting can be an effective way to reduce aquatic plant biomass in a water body. It is typically used to open channels through existing plant beds (native or non-native) to improve access for both human related activities like boating, and natural activities like fish distribution and mobility on lakes in maintenance mode.

Aquatic plant harvesters are floating machines that cut and remove vegetation from the water (Figure 91). The size and harvesting capabilities of these machines vary greatly. As they move, harvesters cut a swath of aquatic plants that is between 4 and 20 feet wide and can be up to 10 feet deep. The on-board storage capacity of a harvester ranges from 100 to 1,000 cubic feet (by volume) or 1 to 8 tons (by weight). Most harvesters can cut between 2 and 8 acres of aquatic vegetation per day. The expected average lifetime of a mechanical harvester is about 10 years with proper maintenance.

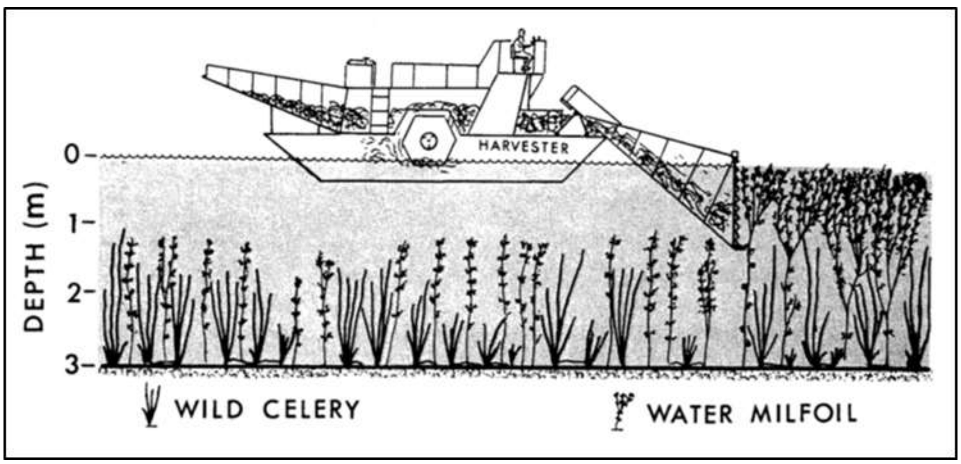

Figure 91: How a mechanical harvester works *(Engle, 1987)*

Mechanical harvesting of aquatic plants presents both positive and negative consequences to any lake. Its results—open water and accessible boat lanes—are immediate and can be enjoyed without the restrictions on lake use which follow herbicide treatments. In addition to the human use benefits, the clearing of thick aquatic plant beds may also increase the growth and survival of some fish. By eliminating the upper canopy, harvesting reduces the shading caused by aquatic plants. The nutrients stored in the plants are also removed from the lake, and the sedimentation that would normally occur because of the decaying plant matter is prevented. Additionally, repeated harvesting may result in thinner, more scattered growth.

Of negative consequence, the removal of aquatic species during harvesting is non-selective. Native and invasive species alike are removed from the target area. This loss of plants results in a subsequent loss of the functions they perform, including sediment stabilization and wave absorption. Other organisms such as fish, reptiles, and insects are often displaced or removed from the lake in the harvesting process. This may have adverse effects on these organisms' populations as well as the lake ecosystem. Harvesting activities in shallow water can re-suspend bottom sediments into the water column releasing nutrients and other accumulated compounds (Madsen J. , 2000). Even the best aquatic plant harvesters leave some cutting debris in the water to wash up on the shoreline or create loose mats of floating vegetation on the surface of the lake. This “missed” cut vegetation can potentially spread invasive plant species as it floats around the lake and establishes in new sites. Floating mats of “missed” cut vegetation can pile up on shorelines creating another level of nuisance that property owners may have to deal with

Disposal sites are a key component when considering the mechanical harvesting of aquatic plants. The sites must be on shore and upland to make sure the plants and their reproductive structures don’t make their way back into the lake or to other water bodies. The number of available disposal sites and their distance from the targeted harvesting areas will determine the efficiency of the operation, in terms of time and cost.

Timing is also important. To maximize the efficiency of the harvester, the ideal time to harvest is just before the aquatic plants break the surface of the lake and prior to the formation of reproductive structures like flower/seeds and turions. If the harvesting work is contracted, the equipment should be inspected before and after it enters the lake. Since these machines travel from lake to lake, they may carry plant fragments with them, and facilitate the spread of aquatic invasive species.

Mechanical harvesting is expensive. Costs per acre vary with the number of acres harvested, accessibility of disposal sites to the harvested areas, density, and species of the harvested plants, and whether a private contractor or public entity does the work. Costs as low as $250 per acre have been reported. Private contractors generally charge $500 to $800 per acre or $2500 to $3500 per day. The purchase price of new harvesters ranges from $75,000 to $300,000. There are several harvester manufacturers in the United States (including at least two in Wisconsin) and some lake groups may choose to operate and purchase their own machinery rather than contracting for these services.

In the last several years, more companies have started offering contracted mechanical harvesting, DASH, and physical removal services. Several companies are in the northern half of Wisconsin including TSB Lakefront Restoration and Diving (New Auburn, WI) and Aquatic Plant Management (Minocqua, WI). Several other companies exist in southeastern WI, the Twin Cities area, and northern Illinois.

Using mechanical harvesting to manage EWM or CLP is not recommended on the Minong Flowage due to the many submerged snags and tree stumps in shallow areas all over the system. Damage to expensive harvesting equipment would most certainly be substantial almost daily. The initial cost of purchasing one or more harvesters for the lake and the continuous repairs bills would likely make the costs for this alternative prohibitive based on the benefits that would be gained.

DREDGING

Dredging is the removal of bottom sediment from a lake. Its success is based on altering the target plant’s environment. It is not usually performed solely for aquatic plant management but rather to restore lakes that have been filled in with sediment, have excess nutrients, inadequate pelagic and hypolimnetic zones, need deepening, or require removal of toxic substances (Peterson, 1982). In shallow lakes with excess plant growth, dredging can make areas of the lake too deep for plant growth. It can also remove significant plant root structures, seeds turions, rhizomes, tubers, etc. Dredging projects to remove material from lakebeds or streambeds can pose a risk to the aquatic environment. As such, permit authorization typically requires input from multiple WDNR programs. Dredging projects can be logistically challenging and expensive to implement. Projects may require contaminated sediment sampling, in-water sediment control practices, and dredge spoil disposal techniques.

Dredging is not a recommended management action for the Minong Flowage. There aren't any areas of the Minong Flowage where dredging would have other benefits aside from aquatic plant control and EWM is too widespread to single out specific places to dredge.

DRAWDOWN

Drawdown, like dredging, alters the plant environment by removing all water in a water body to a certain depth, exposing bottom sediments to seasonal changes including temperature and precipitation. A winter drawdown is a low cost and effective management tool for the long-term control of certain susceptible species of nuisance aquatic plants. Winter drawdown has been shown to be an effective control measure for EWM, but typically only provides 2-3 years of relief before EWM levels return to pre-drawdown levels. A winter drawdown controls susceptible aquatic plants by dewatering a portion of the lake bottom over the winter, and subsequently exposing vascular plants to the combined effect of freezing and desiccation (drying). The effectiveness of drawdown to control plants hinges on the combined effect of the freezing and drying. If freezing and dry conditions are not sustained for 4-6 weeks, the effectiveness of the drawdown may be reduced.

DESIRABLE EFFECTS OF A DRAWDOWN

Aside from being a cost-effective means to control certain species of unwanted aquatic vegetation, a drawdown may offer several other benefits including increasing shoreline emergent vegetation, consolidation of some lake sediments, making shoreline improvements easier (subject to WDNR permits), identifying possible septic system issues, and when used as a part of an integrated management, may reduce the amount of herbicides needed to control an unwanted species (Cooke, 2005). Another possible benefit would be the concentration of forage fish and game fish in the same area. This could lead to reduced forage fish through predation and larger game fish (Cooke, 2005). In addition, the last two drawdowns of the Minong Flowage (2013/14 & 2021/22) have increased wild rice distribution and density.

UNDESIRABLE EFFECTS OF DRAWDOWN

Possible undesirable side effects include negative impacts to benthic fauna, loss or reduction of desirable plant species, invasion by drawdown resistant undesirable plants, reduced attractiveness to waterfowl, possible fishkills if oxygen demand exceeds aeration efforts, loss of aesthetic appeal during drawdown, possible algal blooms after refill, reduction in water supply to wells, and impairment of recreational activities during the drawdown (Cooke, 2005). Amphibians and reptiles could also be impacted depending on their ability to move around and how fast lake level changes are made. An inability to rapidly refill a drawn down lake is a basic concern in evaluating the potential for a drawdown. By completing a winter drawdown, many of these side effects can be avoided. On the Minong Flowage, a winter drawdown also means a possible reduction in hydro-electric capacity and the revenue associated with it.

TARGET VS NON-TARGET SPECIES

Should a winter drawdown be completed again at some time in the future, the target species for control would be EWM. Past drawdowns on the Minong Flowage have shown that the distribution and density of EWM is reduced during a drawdown. However, a winter drawdown also impacts other aquatic plants. Cooke et al (2005) presents a list of 74 aquatic plant species and their suggested susceptibility to a winter drawdown according to existing peer reviewed documents. During the 2008 and 2014 whole-lake point-intercept surveys 28 of the 74 species on the Cooke list were identified in the Minong Flowage.

How each of these species were expected to change (decrease, increase, or stay the same) because of the 2013-14 drawdown is summarized in Table 19 along with the number of points in the survey where each individual species was identified and its relative frequency from before the drawdown (2008) and after the drawdown (2014). Of the 17 species expected to decrease after the drawdown, 13 did and 4 did not. Of the 9 species expected to increase after the drawdown, 4 did and 5 did not.

Table 19: Predicted changes in aquatic plant growth after a winter drawdown (Cooke et al, 2005). Aquatic plant data from 2008 and 2014 Summer PI Surveys (ERS)

Species	Common Name	2008 Total Sites	2008 Relative Freq.	Winter Drawdown (Cooke et al, 2005)			2014 Total Sites	2014 Relative Freq.	Did as Expected?
				Decrease	Increase	Same			
Brasenia schreberi	Watershield	35	2.38	x			2	0.32	y
Ceratophyllum demersum	Coontail	187	12.71	x			28	4.48	y
Eleocharis acicularis	Needle spikerush	1	0.07	x			6	0.96	n
Eleocharis palustris	Creeping spikerush	**	**	x			4	0.64	n
Eleocharis robbinsii	Robbins spikerush	***	***	x			3	0.48	n
Elodea canadensis	Common waterweed	130	8.84	x			33	5.28	y
Myriophyllum sibiricum	Northern water-milfoil	25	1.7	x			**	**	y
Myriophyllum spicatum	Eurasian water-milfoil	166	11.28	x			6	0.96	y
Myriophyllum verticillatum	Whorled water-milfoil	6	0.41	x			5	0.80	y
Nuphar variegata	Spatterdock	23	1.56	x			20	3.20	y
Nymphaea odorata	White water lily	57	3.87	x			68	10.88	n
Potamogeton amplifolius	Large-leaf pondweed	35	2.38	x			2	0.32	y
Potamogeton crispus	Curly-leaf pondweed	2	0.14	x					y
Potamogeton robbinsii	Robbins (fern) pondweed	83	5.64	x			11	1.76	y
Spirodela polyrhiza	Large duckweed	33	2.24	x			17	2.72	y
Utricularia intermedia	Flat-leaf bladderwort	16	1.09	x			10	1.60	y
Utricularia vulgaris	Common bladderwort	27	1.84	x			18	2.88	y
Megalodonta beckii	Water marigold	25	1.7		x				n
Najas flexilis	Bushy pondweed	20	1.36		x		27	4.32	y
Polygonum amphibium	Water smartweed	2	0.14		x		2	0.32	n
Potamogeton epihydrus	Ribbon-leaf pondweed	4	0.27		x		3	0.48	n
Potamogeton gramineus	Variable pondweed	12	0.82		x		19	3.04	y
Potamogeton natans	Floating-leaf pondweed	5	0.34		x		7	1.12	y
Potamogeton richardsonii	Clasping-leaf pondweed	14	0.95		x				n
Potamogeton zosteriformis	Flat-stem pondweed	61	4.15		x		3	0.48	n
Sagittaria latifolia	Common arrowhead	4	0.27		x		11	1.76	y
Chara sp.	Muskgrass	9	0.61			x	2	0.32	n
Sagittaria graminea	Grass-leaved arrowhead	2	0.14			x			n

The same comparison was made before (2021) and after (2023) the 2021-22 winter drawdown (Table 20). Of the 17 species expected to decrease after the drawdown, 10 did and 7 did not. Of the 9 species expected to increase after the drawdown, 5 did and 4 did not.

Table 20: Predicted changes in aquatic plant growth after a winter drawdown (Cooke et al, 2005). Aquatic plant data from 2021 and 2023 Summer PI Surveys (ERS)

Species	Common Name	2021 Total Sites	2021 Relative Frequency (%)	Winter Drawdown (Cooke et al, 2005)			2023 Total Sites	2023 Relative Frequency (%)	Did as expected?
				Decrease	Increase	Same			
Brasenia schreberi	Watershield	25	2.13	x			5	0.42	y
Ceratophyllum demersum	Coontail	114	9.72	x			87	7.29	y
Eleocharis acicularis	Needle spikerush	7	0.60	x			7	0.59	n
Eleocharis palustris	Creeping spikerush	7	0.60	x			1	0.08	y
Eleocharis robbinsii	Robbins' spikerush	1	0.09	x			1	0.08	n
Elodea canadensis	Common waterweed	76	6.48	x			100	8.38	n
Myriophyllum sibiricum	Northern water-milfoil	3	0.26	x			3	0.25	n
Myriophyllum spicatum	Eurasian water milfoil	88	7.50	x			37	3.10	y
Myriophyllum verticillatum	Whorled water-milfoil	9	0.77	x			14	1.17	n
Nuphar variegata	Spatterdock	35	2.98	x			16	1.34	y
Nymphaea odorata	White water lily	45	3.84	x			36	3.02	y
Potamogeton amplifolius	Large-leaf pondweed	11	0.94	x			9	0.75	y
Potamogeton crispus	Curly-leaf pondweed	11	0.94	x			4	0.34	y
Potamogeton robbinsii	Fern pondweed	42	3.58	x			29	2.43	y
Spirodela polyrhiza	Large duckweed	16	1.36	x			32	2.68	n
Utricularia intermedia	Flat-leaf bladderwort	9	0.77	x			4	0.34	y
Utricularia vulgaris	Common bladderwort	12	1.02	x			21	1.76	n
Megalodonta beckii	Water marigold	10	0.85		x		7	0.59	n
Najas flexilis	Slender naiad	28	2.39		x		56	4.69	y
Polygonum amphibium	Water smartweed	1	0.09		x		1	0.08	n
Potamogeton epihydrus	Ribbon-leaf pondweed	14	1.19		x		11	0.92	n
Potamogeton gramineus	Variable pondweed	9	0.77		x		8	0.67	n
Potamogeton natans	Floating-leaf pondweed	6	0.51		x		7	0.59	y
Potamogeton richardsonii	Clasping-leaf pondweed	6	0.51		x		7	0.59	y
Potamogeton zosteriformis	Flat-stem pondweed	46	3.92		x		59	4.95	y
Sagittaria latifolia	Common arrowhead	3	0.26		x		6	0.50	y
Chara sp.	Muskgrass	17	1.45			x	21	1.76	n
Sagittaria graminea	Grass-leaved arrowhead	2	0.17			x	2	0.17	y

Table 21 compares the changes in the same 28 plant species in Tables 19 & 20 from 2008-2014 and from 2014-2021. It shows that in the period between the two drawdowns (2014-2021) most of the species that decreased after the first drawdown were recovering, although few were back to the level they were in 2008.

Table 21: Changes in 28 aquatic plant species between the 2013/14 and 2021/22 drawdowns and how they compare to 2008.

Species	Common Name	2008 Total Sites	2008 Relative Freq.	2014 Total Sites	2014 Relative Freq.	2021 Total Sites	2021 Relative Frequency (%)
Brasenia schreberi	Watershield	35	2.38	2	0.32	25	2.13
Ceratophyllum demersum	Coontail	187	12.71	28	4.48	114	9.72
Eleocharis acicularis	Needle spikerush	1	0.07	6	0.96	7	0.60
Eleocharis palustris	Creeping spikerush	**	**	4	0.64	7	0.60
Eleocharis robbinsii	Robbins' spikerush	***	***	3	0.48	1	0.09
Elodea canadensis	Common waterweed	130	8.84	33	5.28	76	6.48
Myriophyllum sibiricum	Northern water-milfoil	25	1.7	**	**	3	0.26
Myriophyllum spicatum	Eurasian water milfoil	166	11.28	6	0.96	88	7.50
Myriophyllum verticillatum	Whorled water-milfoil	6	0.41	5	0.80	9	0.77
Nuphar variegata	Spatterdock	23	1.56	20	3.20	35	2.98
Nymphaea odorata	White water lily	57	3.87	68	10.88	45	3.84
Potamogeton amplifolius	Large-leaf pondweed	35	2.38	2	0.32	11	0.94
Potamogeton crispus	Curly-leaf pondweed	2	0.14			11	0.94
Potamogeton robbinsii	Fern pondweed	83	5.64	11	1.76	42	3.58
Spirodela polyrhiza	Large duckweed	33	2.24	17	2.72	16	1.36
Utricularia intermedia	Flat-leaf bladderwort	16	1.09	10	1.60	9	0.77
Utricularia vulgaris	Common bladderwort	27	1.84	18	2.88	12	1.02
Megalodonta beckii	Water marigold	25	1.7			10	0.85
Najas flexilis	Slender naiad	20	1.36	27	4.32	28	2.39
Polygonum amphibium	Water smartweed	2	0.14	2	0.32	1	0.09
Potamogeton epihydrus	Ribbon-leaf pondweed	4	0.27	3	0.48	14	1.19
Potamogeton gramineus	Variable pondweed	12	0.82	19	3.04	9	0.77
Potamogeton natans	Floating-leaf pondweed	5	0.34	7	1.12	6	0.51
Potamogeton richardsonii	Clasping-leaf pondweed	14	0.95			6	0.51
Potamogeton zosteriformis	Flat-stem pondweed	61	4.15	3	0.48	46	3.92
Sagittaria latifolia	Common arrowhead	4	0.27	11	1.76	3	0.26
Chara sp.	Muskgrass	9	0.61	2	0.32	17	1.45
Sagittaria graminea	Grass-leaved arrowhead	2	0.14			2	0.17

SEVERITY OF THE WINTER

The severity of the winter weather can affect the results of a winter drawdown. A mild winter, especially one with persistent precipitation, may not provide the freezing and/or drying required for plant destruction. Conversely, a cold winter with lots of snow might also lead to disappointing results. Snow is an excellent insulator, so exposed bottom sediments that are constantly covered by snow may not experience the low temperatures required to kill overwintering structures. High levels of groundwater seepage may also reduce or negate the destructive effects on target species by keeping the area moist and unfrozen. Ideally, the sediments should be exposed for at least 6-8 weeks, with temperatures below freezing (0° C/ 32° F) for two weeks or more.[10]

WINTER DRAWDOWNS ON THE MINONG FLOWAGE

Whole-lake PI data shows that a winter drawdown can be used effectively to control EWM in the Minong Flowage and while the same management action may also negatively impact the native aquatic plant community, that community can recover over time. And since there are areas of the Flowage where EWM is established and implementation of other forms of management (herbicides, harvesting, physical removal) is difficult or not advised, completing a winter drawdown remains a reasonable

[10] Read more at: https://haywood.ces.ncsu.edu/winter-drawdown-as-a-pond-management-tool/

management action. There is some concern that winter conditions may not be severe enough to provide the results expected. It has also been shown that a 5ft drawdown may not impact EWM in deeper water. As long as planning for a winter drawdown also includes planning for "what if" scenarios like those mentioned, it will remain in the EWM management toolbox for the Minong Flowage. If a winter drawdown is implemented the following guidelines should be followed.

FREQUENCY

How frequently a winter drawdown occurs should be dependent on the total acreage of EWM growth in the Flowage as determined by late summer EWM bed mapping.

DEWATERING

Dewatering should commence on or about October 1 at a rate of not to exceed 2 inches per day to provide sufficient time for affected wildlife (fish, turtles, amphibians, mussels, etc.) to move prior to the formation of ice cover.

WATER LEVEL MAINTENANCE

The lake level should be maintained at the desired drawdown level (approximately 105.5 local datum) from late October through spring ice out.

REFILL

Refilling of the lake should begin with ice out in the spring. A minimum outflow of at least 83cfs should be maintained during the refill period to accommodate for the required flow downstream and operation of at least one power generator. Refill to normal pool elevation should occur within two weeks under most circumstances. Starting the refill at ice out eliminates conflicts with ice fisherman, prevents free floating ice sheets from damaging shoreline, and prevents the tearing up of sediment and other bottom material that may be frozen to the bottom of the ice sheet.

AERATION

Aeration is not expected to be needed.

VOLUNTARY BAG LIMITS

During the period of the drawdown, voluntary bag limits on walleye, panfish, bass, and northern should be promoted.

MONITORING PROGRAMS

The following monitoring actions should be considered when planning a winter drawdown. A couple are required, several are optional and would be implemented based on MFA constituent and other stakeholders' concern.

Aquatic Vegetation Monitoring (required) – Whole-lake, PI surveys will be completed prior to and after the planned drawdown.

Water Quality Monitoring (required) – Water quality monitoring including water clarity, total phosphorus, and chlorophyll-a will be monitored at least once monthly throughout the open water season following the drawdown. Dissolved oxygen monitoring can be completed at least monthly during the winter drawdown.

Lake Level Monitoring (optional) – Lake level monitoring can be set up just prior to the implementation of a drawdown. Suggested locations would be at the dam, Hwy T Bridge/Channel to Cranberry, and Smiths Bridge. Installation of permanent staff gauges is recommended. Lake level readings would be recorded at least once a week while there is open water adjacent to the gauges.

Well Monitoring (optional) – During the period of drawdown residents can periodically monitor water levels in their wells, or check water flows to ensure that sufficient water is available. If adverse impacts are noted the MFA should be notified immediately.

Amphibian Monitoring (optional) – Amphibian monitoring can be completed by volunteers following guidelines provided by the Citizen-based Monitoring Network. (https://wiatri.net/CBM/WhosWho/results.cfm?OrgID=218 , last accessed 1/25/2024).

WDNR Boom Shocking (optional) – A boom shocking survey should be completed in the year following the drawdown to determine if there were any noticeable negative impacts to the fishery.

BIOLOGICAL CONTROL

Biological control involves using one plant, animal, or pathogen to control a target species in the same environment. The goal of biological control is to weaken, reduce the spread, or eliminate the unwanted population so that native or more desirable populations can make a comeback. Care must be taken however, to ensure that the control species does not become as big a problem as the one that is being controlled. A special permit is required in Wisconsin before any biological control measure can be introduced into a new area.

EWM WEEVILS

While many biological controls have been studied, only one has proven to be effective at controlling EWM under the right circumstances. Euhrychiopsis lecontei is an aquatic weevil native to Wisconsin that feeds on aquatic milfoils (Figure 92). Their host plant is typically northern watermilfoil; however, they seem to prefer EWM when it is available. Milfoil weevils are typically present in low numbers wherever northern or Eurasian watermilfoil is found. They often produce several generations each year and over winter in undisturbed shorelines around the lake. All aspects of the weevil's life cycle can affect the plant. Adults feed on the plant and lay their eggs. The eggs hatch and the larva feed on the plant. As the larva mature, they eventually burrow into the stem of the plant. When they emerge as adults later, the hole left in the stem reduces buoyancy often causing the stem to collapse. The resulting interruption in the flow of carbohydrates to the root crowns reduces the plant's ability to store carbohydrates for over wintering reducing the health and vigor (Newman, 1996).

Figure 92: EWM Weevil (https://klsa.wordpress.com/published-material/milfoil-weevil-guide/)

The weevil is not a silver bullet. They do not work in all situations. The extent to which weevils exist naturally in a lake, adequate shore land over wintering habitat, the population of bluegills and sunfish in a system, and water quality characteristics are all factors that have been shown to affect the success rate of the weevil.

WEEVILS IN THE MINONG FLOWAGE

Weevil surveys were completed by MFA volunteers and campers and staff from the Swift Nature Camp from 2009-2012. It was determined that there was a decent population of weevils, although not enough that they could be counted on to provide additional management. To increase the weevil population in the Flowage, the Swift Nature Camp participated in an experimental weevil rearing project in 2011 and 2012 under the guidance of Amy Thorstenson of the Golden Sands RC&D (Figure 93). In 2011, the Swift Nature Camp set up 10 weevil rearing tanks. 720 weevils were initially stocked into the 10 rearing tanks. The expected return rate for weevils was 9.6 new weevils out of each weevil stocked. The actual return rate for the Minong Flowage was 1.8 with an estimated total production of 1300 weevils. Another station was set up in 2012, with relatively poor results, producing only a 1.3 weevil return rate.

Figure 93: 2011 EWM weevil rearing setup; 2012 weevil monitoring (Swift Nature Camp) (Photos by Dave Blumer)

It is possible for E. lecontei weevils to be used in the Minong Flowage as part of an integrated management program to control EWM however, other than for education purposes, it is not recommended that a formal weevil monitoring program and/or weevil rearing project be implemented.

GALERUCELLA BEETLES

Two species of Galerucella beetles are currently approved for the control of purple loosestrife in Wisconsin (Figure 94). The entire lifecycle of Galerucella beetles is dependent on purple loosestrife. In the spring, adults emerge from the leaf litter below old loosestrife plants. The adults then begin to feed on the plant for several days until they begin to reproduce. Females lay their eggs on loosestrife leaves and stems. When the larvae emerge from these eggs they begin feeding on the leaves and developing shoots. When water levels are high these larvae will burrow into the loosestrife stems to pupate into adult beetles. These new adults emerge and begin feeding on the loosestrife again (Sebolt, 1998). Galerucella beetles do not forage on any plants other than purple loosestrife. Because of this the populations, once established, are self-regulating. When the purple loosestrife population drops off, the beetle population also declines. When the loosestrife returns, the beetle numbers will usually increase.

Figure 94: Galerucella beetle

These beetles will not eradicate purple loosestrife entirely. This is true of almost all forms of biological control. Galerucella beetles will help regulate loosestrife which will allow native plants to also become re-established. Raising Galerucella beetles does not require a lot of skill or material. Materials consist of 3–5-gallon pails, kids wading pool, fine mesh nets, and a net supporting structure. The cooperator must also have access to purple loosestrife plants and a source of “starter beetles”. Because rearing these beetles requires the cultivation of a restricted species, a permit from the WDNR is necessary. Purple loosestrife rootstock and starter beetles can be obtained from the WDNR, private vendors, or many of the public wetlands around Wisconsin.

OTHER BIOLOGICAL CONTROLS

There are other forms of biological control being used or researched. It was thought at one time that the introduction of plant eating carp could be successful. It has since been shown that these carp have a preference list for certain aquatic plants. EWM is very low on this preference list (Pine, 1991). Use of “grass carp” as they are referred to in Wisconsin is illegal as there are many other environmental concerns including what happens once the target species is destroyed, removal of the carp from the system, impacts to other fish and aquatic plants, and preventing escapees into other lakes and rivers.

Several pathogens or fungi are currently being researched that when introduced by themselves or in combination with herbicide application can effectively control EWM and lower the concentration of chemical used or the time of exposure necessary to kill the plant (Sorsa, 1988). None of these have currently been approved for use in Wisconsin and are not recommended for use on the Minong Flowage.

NATIVE PLANT RESTORATION

A healthy population of native plants might slow invasion or reinvasion of non-native aquatic plants. It should be the goal of every management plan to protect existing native plants and restore native plants after the invasive species has been controlled. In many cases, a propagule bank probably exists that will help restore native plant communities after the invasive species is controlled (Gettsinger, 1997). This is certainly the case in the Minong Flowage. If EWM can be controlled, enough native plants currently still exist to begin repopulating treatment areas.

CHEMICAL CONTROL

Aquatic herbicides are granular or liquid chemicals specifically formulated for use in water to kill plants or retard plant growth. Herbicides approved for aquatic use by the U.S. Environmental Protection Agency are considered compatible with the aquatic environment when used according to label directions.

The WDNR evaluates the benefits of using a particular chemical at a specific site vs. the risk to non-target organisms, including threatened or endangered species, and may stop or limit treatments to protect them. The Department frequently places conditions on a permit to require that a minimal amount of herbicide is needed and to reduce potential non-target effects, in accordance with best management practices for the species being controlled. For example, certain herbicide treatments are required by permit conditions to be in spring because they are more effective, require less herbicide and reduce harm to native plant species. Spring treatments also mean that, in most cases, the herbicide will be degraded and gone by the time peak recreation on the water starts.

The advantages of using chemical herbicides for control of aquatic plant growth are the speed, ease and convenience of application, relatively low cost, and the ability to control plant types somewhat selectively with certain herbicides. Disadvantages of using chemical herbicides include possible toxicity to aquatic animals or humans, oxygen depletion after plants die and decompose which can cause fishkills, a risk of increased algal blooms as nutrients are released into the water by the decaying plants, adverse effects on desirable aquatic plants, loss of fish habitat and food sources, water use restrictions, and a need to repeat treatments due to existing seed/turion banks and plant fragments. Chemical herbicide use can also create conditions favorable for non-native AIS to outcompete native plants (for example, areas of stressed native plants or devoid of plants).

EFFICACY OF AQUATIC HERBICIDES

The efficacy of aquatic herbicides is dependent on both application concentration and exposure time, and these factors are influenced by two separate but interconnected processes - dissipation and degradation. Dissipation is the physical movement of the active herbicide within the water column both vertically and horizontally. Dissipation rates are affected by wind, water flow, treatment area relative to untreated area, and water depths. Degradation is the physical breakdown of the herbicide into inert components. Depending on the herbicide utilized, degradation occurs over time either through microbial or photolytic (chemical reactions caused by sunlight exposure) processes.

SMALL-SCALE HERBICIDE APPLICATION

Small-scale herbicide application involves treating areas less than 10 acres in size. Small-scale chemical applications are usually completed in the early season (April through May). Concern on the part of the WDNR regarding the use of small-scale herbicide applications to control CLP or EWM has been expressed for several years. The concerns are based on data that shows that small-scale applications of aquatic herbicides tend to dissipate rapidly and/or dilute quickly minimizing effective results. WDNR research has also shown that granular herbicides do not provide any greater contact time than liquid herbicides. As such, when using common herbicides like endothall for CLP control and 2,4D or triclopyr for EWM control, the WDNR recommends that individual treatment areas be at least 5 acres in size. The desired target species contact time for these herbicides is between 18 and 36 hours. Dissipation and dilution in small treatment areas makes this level of contact difficult to achieve. Smaller treatment areas are likely to be less effective and possibly denied by the WDNR when considering chemical permit applications and/or requests for grant funding.

ProcellaCOR, used more and more for the control of EWM, requires a much lower target species/herbicide contact time – down to only 2-4 hours. The effective bed size for the use of ProcellaCOR has not been defined by the WDNR.

Installation of a Limno-Barrier

Small-scale herbicide applications can be made more effective by installing a limno-barrier or curtain around a treatment area to help hold the applied herbicide in place longer. By doing so, the herbicide/target species contact time is increased. The curtain is generally a continuous sheet of plastic that extends from the surface to the bottom of the lake (Figure 95). The surface edge of the curtain is supported by floatation devices. The bottom of the curtain is held in place by some form of weighting. The curtain or barrier, sometimes thousands of feet of it, is installed around the proposed treatment area holding the herbicide in place longer by preventing dilution and drift away from the treated area (Figure 96).

Figure 95: Limno-curtain material on a roll before installation (photo from Marinette Co. LWCD)

Figure 96: Limno-curtain installed on Thunder Lake (photo from Marinette Co. LWCD)

In a limno-curtain trial completed in Thunder Lake, Marinette County in 2020, a curtain was installed around two small areas (0.9 and 2.9 acres) of dense growth EWM prior to chemical treatment. Liquid 2,4-D was applied at 4.0ppm inside the barrier. The barriers stayed in place until 48 hours after treatment. Herbicide concentration testing was completed within the treated areas to determine how long the herbicide stayed in place and at what concentration. Figure 97 reflects what happened to the herbicide that was applied. Herbicide concentrations stayed relatively high for a longer period (48hrs). Once the curtain was removed, the herbicide dissipated rapidly.

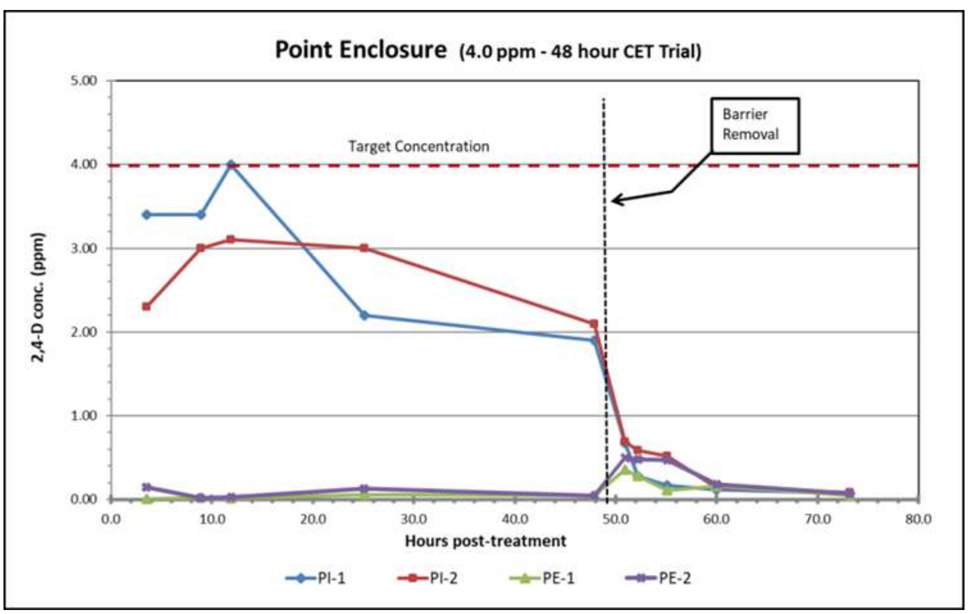

Figure 97: Herbicide concentration results from 2020 Thunder Lake limno-curtain trial (Marinette Co LWCD)

LARGE-SCALE HERBICIDE APPLICATION

Large-scale herbicide application involves treating areas more than 10 acres in size. Like small-scale applications, this is usually completed in the early season (April through May) for control of non-native invasive species like CLP or EWM while minimizing impacts on native species. It is generally accepted that with large-scale applications the likelihood of the herbicide staying in contact with the target plant for a longer time is greater. If the volume of water treated is more than 10% of the volume of the lake, or the treatment area is ≥160 acres, or 50% of the lake's littoral zone, effects can be expected at a whole-lake scale. Large-scale herbicide application can be extended in some lakes to include whole bay or even whole lake treatments. The size of the treatment area, the more contained the treatment area, and the depth of the water in the treatment area, are factors that impact how whole bay or whole lake treatments are implemented.

COMMON AQUATIC HERBICIDES

ProcellaCOR® (PCOR) is a relatively new systemic, selective herbicide that can be used to target EWM with limited impact to most native species. It is also very fast acting, making it an effective control measure on smaller beds that may be too large for DASH, especially ones in high boat traffic areas and/or deeper water. In addition, applications rates are measured in ounces, not gallons as is common with almost all other liquid herbicides. And while it is more expensive to use than 2,4-D equivalents, it has been shown to provide two or more years of control without re-application.

2,4-D and triclopyr are active ingredients in several selective herbicides including 2,4-D Amine 4®, Navigate®, DMA 4®, Renovate®, and Renovate Max G®. These herbicides stimulate plant cell growth causing them to rupture, but primarily in narrow-leaf plants like milfoil. These herbicides are considered selective as they have little to no effect on monocots in treated areas. ProcellaCOR, fluridone, 2,4-D, and triclopyr are all considered systemic. When applied to the treatment area, plants in the treatment area draw the herbicide in through the leaves, stems, and roots killing all the plant, not just the part that comes in contact with the herbicide.

Sonar®, whose active ingredient is fluridone, is a broad-spectrum herbicide that interferes with the necessary processes in a plant that creates the chlorophyll needed to turn sunlight into plant food through a process called photosynthesis. Sonar is generally applied during a whole-lake application and is expected to be in the lake at very low concentrations for weeks or months once applied.

Aquathol® whose active ingredient is endothall and Reward® whose active ingredient is diquat are considered broad spectrum contact herbicides. They destroy the outer cell membrane of the material they come in contact with and therefore kill a plant very quickly. Neither of these is considered selective and has the potential to kill all the plant material that they come in contact with regardless of the species. As such, great care should be taken when using these products. Certain plant species like CLP begin growing very early in the spring, even under the ice, and are often the only growing plant present at that time. This is a good time to use a contact herbicide like Aquathol, as few other plants would be impacted. Using these products later in the season, will kill all vegetation in contact with the herbicide and can provide substantial nuisance relief from a variety of aquatic plants. Endothall based herbicides are the most used herbicides for CLP control, but diquat can be used under the appropriate circumstances.

It is possible to apply more than one herbicide at a time when trying to establish control of unwanted aquatic vegetation. An example would be controlling EWM and CLP at the same time with an early season application and controlling aquatic plants and algae at the same time during a mid-season nuisance relief application. Applying systemic and contact herbicides together has a synergistic effect leading to increased selectivity and control. Single applications of the two could result in reduced environmental loading of herbicides and monetary savings via a reduction in the overall amount of herbicide used and of the manpower and number of application periods required to complete the treatment.

INCIDENTAL IMPACTS OF AQUATIC HERBICIDES ON WILD RICE

Of great concern to Wisconsin's Tribal Resources and the WDNR is the potential impact of aquatic herbicides on wild rice. The following is a summary of studies compiled by the WDNR that identify possible negative effects.

Nelson et al. (2003) examined the effects of diquat, endothall, fluridone, and 2,4D on the growth and survival of seedling, young, and mature northern wild rice. The degree of herbicide damage varied with growth stage. Younger stages of wild rice were more sensitive than later growth stage plants. Mature wild rice plants were not impacted by any of the products or rates tested. Wild rice was most sensitive to 2,4D, with rates as low as 1.0 parts per million (ppm) significantly inhibiting tiller, seed head, and biomass production. Biomass of wild rice was also reduced following exposure to endothall, diquat, and fluridone, however seed head and tiller production was not impacted. Results of this study suggest that wild rice is most resistant to herbicides applied to the water column when plants are mature or in the late flowering stages.

Madsen et al. (2008) investigated the sensitivity of seedling, young, and mature northern wild rice to liquid triclopyr. Concentrations were 0, 0.75, 1.5, and 2.5 ppm and plants were exposed to the herbicide for 72 hours. Rice exposed to the highest concentration (2.5 ppm) exhibited reduced biomass and height regardless of growth stage. Declines in biomass, height, seed head density, and tiller formulation were not observed at lower concentrations (0.75 ppm), though seedlings appeared more sensitive to this exposure rate.

Miller (1994) studied the impacts of Fluridone and 2,4D on the floating leaf growth stage of southern wild rice. Fluridone applied to water at higher rates (i.e., ≥ 8 ppb) caused significant decreases in biomass, while lower rates (i.e., 2 and 4 ppb) did not impact biomass. 2,4D applied at rates as low as 0.4 ppm significantly reduced biomass weight by 24%, while higher rates (i.e., 0.8, 1.6, & 3.2 ppm) resulted in even greater biomass losses (67, 88, & 94%, respectively).

Clay and Oelke (1990) evaluated applications of 2,4D amine salt for weed control in commercial rice populations. 2,4D rates as low as 1.1 kg/ha applied at the two-aerial-leaf growth stage severely injured wild rice plants, and higher rates significantly reduced grain yield.

Oelke and McClellan (1991) similarly observed that 2,4D rates ≥ 0.84 kg/ha applied to wild rice in the mid- to late-tillering growth stage significantly injured plants and reduced grain yields.

To date there have been no published studies on the impact of ProcellaCOR on wild rice.

FISH AND AQUATIC HERBICIDES

The amount of vegetation present in a body of water is just one of the parameters that can impact fish populations. Another is the use of aquatic herbicides. Any herbicide, if misapplied, can cause negative impacts to fish and many other living creatures in the water. The herbicides that have been approved for aquatic use have had extensive research done on them to determine what is considered a "safe" amount to apply. ProcellaCOR, 2,4-D, triclopyr, endothall, and diquat are the herbicides most likely to be used in the Minong Flowage to control dense growth EWM or CLP. Of these herbicides, diquat is the most toxic to fish species.

Diquat

According to a paper by Paul et al. (1994), a review of the toxicity literature for diquat indicates that diquat is highly toxic to some aquatic animals. Studies that involved different fish species found a 96-hr LC50 of 35mg/L to bluegills and a 96-hr LC50 of 289mg/L to mosquitofish. Young walleyes are the most sensitive fish species tested. It was found that half of the 8–10-day walleye fry exposed to 0.29-0.86 ppm of diquat over a 96-hr period died (LC50). Two-month-old walleye reached an LC50 after 96 hours of exposure to 1.2mg/L of diquat. Small and large mouth bass had a 96-hr LC50 at around 1.7mg/L. Some research suggests that the toxicity of diquat is greater when water temperatures are higher.

The diquat label has a maximum application rate of 2 gallons/acre in 4-ft of water to control certain species of aquatic vegetation. For water depths of 2 feet or less including shorelines, the label says not to exceed 1 gallon per surface acre. In the Paul et al. paper, two gallons per surface acre was applied resulting in concentrations of 1.5mg/L cation in one foot and 0.75mg/L cation in two feet of water. Both concentrations are greater than the 96-hr LC50s for young walleyes.

The label also recommends applying diquat once water temperatures reach or exceed 50°F. Female walleyes will typically begin spawning when water temperatures reach the mid to upper 40s°F. One to three weeks after spawning occurs walleye fry will be moving back toward open water. If diquat is to be applied, it should be when water temperature reaches 48°F (just prior to walleye spawning). If the water temperature exceeds this level, application should be postponed for at least three weeks to protect walleye larvae. Ideally, application should occur after the spawn has been completed, typically no earlier than mid-May.

PRE AND POST TREATMENT AQUATIC PLANT SURVEYING

When introducing new chemical treatments to lakes where the treatment size is greater than 10 acres or greater than 10% of the lake littoral area and more than 150-ft from shore, the WDNR may require pre- and post-chemical application, aquatic plant surveying.

The number of pre- and post-treatment sampling points required is based on the size of the treatment area. Ten to twenty acres generally requires at least 100 sample points. Thirty to forty acres requires at least 120 to 160 sampling points. Areas larger than 40 acres may require as many as 200 to 400 sampling points. Regardless of the number of points, each designated point is sampled by rake, recording depth, substrate type, and the identity and density of each plant pulled out, native or invasive.

In the year prior to an actual treatment, the area to be treated should have a mid-season/summer/warm water point-intercept survey completed that identifies the target plant and other plant species that are present. A pre-treatment aquatic plant survey is done in the year the herbicide is to be applied, prior to application to confirm the presence and level of growth of the target species. A post-treatment survey is done in the same year as the chemical treatment was completed or in the year after a chemical treatment was completed, sometimes both. A post-treatment survey should be scheduled when native plants are well established, generally mid-July through mid-August. For the post-treatment survey, the same points sampled in the pre-treatment survey will again be sampled. For whole-lake scale treatments, a full lake-wide PI survey should be conducted.

Continued implementation of pre- and post-chemical treatment aquatic plant surveying is an important tool in determining the impacts of management actions on both the target and non-target species. Results from pre- and post-treatment surveying are used to improve consistency in analysis and reporting, and in making the next season's management recommendations.

CHEMICAL CONCENTRATION TESTING

Chemical concentration testing is often done in conjunction with treatment to track the fate of the chemical herbicide used. Concentration testing can help to determine if target concentrations are met, to see if the chemical moved outside its expected zone, and to determine if the chemical breaks down in the system as expected. Monitoring sites are located both within and outside of the treatment area, particularly in areas that may be sensitive to the herbicide used, where chemical drift may have adverse impacts, where movement of water or some other characteristic may impact the effect of the chemical, and where there may be impacts to drinking and irrigation water. Water samples are collected prior to treatment and for a period of hours, days, weeks, or even months following chemical application.

OVERUSE OF AQUATIC HERBICIDES

Concerns exist when herbicide treatments using the same herbicide are done over multiple and subsequent years. Target plant species may build up a tolerance to a given herbicide making it less effective, susceptible plant species may be damaged and/or disappear from the lake (ex. water lilies), concerns over fish and other wildlife might occur, and concern over recreational use in chemically treated water may be voiced. By using several different aquatic herbicides interspersed with physical removal efforts between treatments, many of these concerns are minimized.

ProcellaCOR is classified as an auxin herbicide (WSSA Group 4; HRAC Group O), like other systemic herbicides including 2,4D and triclopyr. If herbicides with the same mode of action are used repeatedly in the same body of water, resistant plant biotypes may eventually dominate the weed population and may not be controlled by these products. To delay development of herbicide resistance, the following practices are recommended:

- Alternate use of products containing ProcellaCOR EC with other products with different mechanisms of action.
- ProcellaCOR EC can be tank mixed or used sequentially with other approved products to broaden the spectrum of weed control, provide multiple modes of action and control weeds that ProcellaCOR EC does not control.
- Herbicides should be used based on an IPM program.
- Monitor treated areas and control escaped weeds.

CONCERNS RELATED TO WHOLE-LAKE/LARGE-SCALE CHEMICAL TREATMENTS

In 2020, the WDNR published a paper (Mikulyuk, et al., 2020) comparing the ecological effects of the invasive aquatic plant EWM with the effects of lake-wide herbicide treatments used for EWM control using aquatic plant data collected from 173 lakes in Wisconsin. First, a pre-post analysis of aquatic plant communities found significant declines in native plant species in response to lake-wide herbicide treatment. Second, multi-level modeling using a large data set revealed a negative association between lake-wide herbicide treatments and native aquatic plants, but no significant negative effect of invasive EWM alone. Taken together, their results indicate that lake-wide herbicide treatments aimed at controlling EWM had larger effects on native aquatic plants than did the target of control-EWM.

This study reveals an important management tradeoff and encourages careful consideration of how the real and perceived impacts of invasive species like EWM in a lake and the methods used for their control are balanced.

HERBICIDE USE IN THE MINONG FLOWAGE

The use of aquatic herbicides is necessary in the Minong Flowage. Except for a winter drawdown, there is no other management action that could efficiently control as much EWM for a comparable cost. Ideally, the use of herbicides would be limited in nature, used only when the level of EWM exceeds what is manageable by other means. Through aquatic plant surveys, dye studies, chemical concentration testing, and careful management planning, the fate of the chemical placed in the water can be determined and its impact on both target and non-target species documented.

MANAGEMENT DISCUSSION

Physical removal of EWM by individual property owners is best in the shallow nearshore areas around docks and swimming areas. If volunteers can be organized, or a team of individuals hired, physical removal could occur in select larger areas still in shallow water.

On large shallow flats where the water is no more than 5-7ft deep, winter drawdowns, herbicide application, diver/DASH removal, and mechanical harvesting are all possible. Which one is best depends on the conditions that exist in any given year. If a winter drawdown is already scheduled, it should be effective at controlling EWM in these areas. In between drawdowns, diver/DASH removal on smaller areas and application of aquatic herbicides on larger areas will be effective. If at some point, the use of mechanical harvesting is employed it would likely be most effective in these areas.

In water greater than 6-7ft, application of aquatic herbicides is likely the best management alternative. EWM in deeper water is less impacted by a winter drawdown. Dark water may limit the ability to do diver/DASH removal. Mechanical harvesting would be able to remove surface mats of EWM but would not prevent rapid regrowth of the cut stems.

In those areas of the Flowage with water no more than 5-7ft deep and where submerged stumps and other woody debris, a winter drawdown is likely the best management alternative. The stump fields limit boat use, would damage mechanical harvesters, and increase the risk level for diver/DASH removal. It is also in these areas that wild rice is most abundant, further limiting any management alternative that might involve the application of aquatic herbicides.

APPLICATION OF AQUATIC HERBICIDES

In an integrated approach to EWM management, smaller scale management actions should be completed between larger scale management actions to increase the amount of time between large disturbances caused by the management. Physical removal and diver/DASH can be incorporated to manage individual pioneering or reemergent plants and small beds, but larger areas of EWM will require the application of aquatic herbicides. If the application of aquatic herbicide is used, there are several ways to approach it.

2,4D

If a spring or early summer application is to use 2,4D-based products, treatment areas should be at least 5ac in size and be located downstream of any wild rice beds. Smaller areas could be treated if a limno-curtain was installed prior to treatment. The herbicide should be applied at 2-4ppm depending on the size of the treatment area and expected target species contact time. A target species contact time of 18-36 hours or longer is necessary to provide results that can be expected to last more than one season.

TRICLOPYR

Like 2,4D-based herbicides, if spring or early summer application is planned, treatment areas should be at least 5ac in size. The herbicide should be applied at 0.75 to 2.5ppm, again depending on the size of the treatment area and expected target species contact time. Some research suggests that when applied at its lowest recommended concentration (0.75ppm), triclopyr should have “negligible effect on all wild rice growth stages” Madsen et al. (2008). With this finding, it may be possible to apply a triclopyr-based aquatic herbicide to control EWM closer to, within, or upstream of a wild rice bed in a spring or early summer application. The caveat to this is that at a 0.75ppm application rate for triclopyr, the same research suggests that at least 42 hours of contact time is necessary to achieve an 85% control rate of EWM.

PROCELLACOR

If ProcellaCOR is used, then treatment areas can be <5ac with or without a limno-curtain. However, until more research into the impacts of the herbicide on different stages of wild rice growth is completed, treatment areas should still be located downstream of any wild rice beds. The herbicide should be applied at 3-5pdus per acre-foot of water. Larger treatment areas could be treated on the low end, small areas in deeper water should be treated on the high end.

LATE SUMMER OR FALL HERBICIDE APPLICATION

The USACOE study on the impacts of aquatic herbicides on wild rice (2003) concluded that "wild rice is most resistant to aquatic herbicides applied to the water column when plants are mature or in the late flowering stages of development. Coordinating chemical applications for milfoil control with resistant growth stages of wild rice may minimize herbicide injury to this desirable plant species." This study looked at the impacts of fluridone, endothall, diquat, and 2,4D – all of which had less impact on the later stages of wild rice growth than on the early stages of growth. This suggests that a late summer or fall application of aquatic herbicide adjacent to, within, or upstream would have less negative impact on wild rice than a spring or early summer application.

In 2010, a fall application using a granular form of 2,4D was completed on September 28 when water temperatures were at 58°F. Three small areas of EWM totaling 6.31 acres and located in the wild rice beds east of Smiths Bridge were chemically treated at the maximum label rate of 4.0ppm (Figure 98). At the time, this treatment was supported by the WDNR and St. Croix Tribal Resources, with Tribal Resources donating the granular herbicide used. The treatment appeared to be effective at controlling EWM in the area, however, 2010 fall EWM bed mapping was completed before the impacts of the treatment could be discerned. Fall EWM bed mapping in 2011 found only a handful of plants in the core of the largest bed, the rest of the area appeared clear of EWM by the fall of 2011.

The biggest drawback of completing an herbicide application in the fall versus the spring, is the amount of EWM to be controlled. A fall treatment would target fully established EWM with a lot of biomass, while a spring or early summer application targets beds when EWM is still low in biomass.

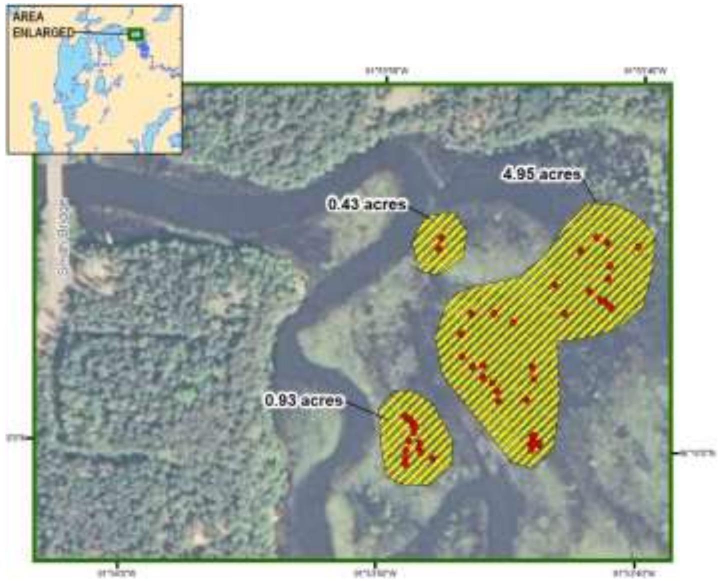

Figure 98: 2010 Fall EWM treatment in the East Basin (east of Smiths Bridge)

MONITORING FOR PESTICIDES

If aquatic herbicides are applied near any wild rice bed, and normal herbicide concentration testing and completed dye studies are not enough to ease Tribal concerns about contaminated rice, it may be possible to complete a study that would more definitively prove or disprove that the pesticide applied reached the wild rice.

In 2009, a study was completed on the St. Croix River that included monitoring for pesticides. The study came about because owners of a cranberry bog were using water from the St. Croix River for crop irrigation and for flooding during harvest, and then were discharging the water through runoff from precipitation and irrigation, or through groundwater discharge back into the river. Stakeholders from the area were concerned about pesticide contamination from the cranberry bog.

After several attempts to monitor pesticides in the river via sediment samples and water samples grabbed from the river were inconclusive, researchers installed Polar Organic Chemical Integrative Sampler (POCIS) devices to monitor pesticide concentrations (Figure 99). POCIS devices were selected because they can accumulate water soluble compounds in low concentrations, provide qualitative and quantitative measurements of compounds, and are more logistically sound than grab samples. POCIS devices can remain in-stream for extended periods of time, generally one month, which provides time-weighted average concentrations of compounds. This extended sampling period also captures low concentrations and episodic events that could otherwise be missed in grab samples and can provide an exposure assessment of aquatic organisms. In short, these devices could potentially determine more definitively, if the herbicide applied to control EWM ends up in the wild rice.

Figure 99: POCIS devices (discs with white centers) shown mounted in a deployment canister. (Source: www.est-lab.com/pocis.php)

WINTER DRAWDOWN

From Table 10 on p. 60, the average size of the littoral zone of the Flowage over six PI surveys was 832 acres. Using the average littoral zone, EWM covered between 3.2% (2014) and 40.3% (2008) from 2008 to 2023. When asked how many acres of EWM should lead to a winter drawdown proposal, members of the MFA felt the tipping point should be kept relatively high. The MFA Board and its constituency were comfortable with the winter drawdown following a year when mapping identified 208 acres or 25% of the average littoral zone with EWM but felt lesser amounts would lead to drawdowns occurring too frequently. This Plan recommends a winter drawdown be proposed when EWM reaches 200 acres or 24% of the average littoral zone.

DRAWDOWN PERMIT

The current Drawdown Permit issued to Washburn County Highway Department expires on November 1, 2024. Working with Washburn County, the MFA should either request another 5yr extension to the existing drawdown permit or apply for a new drawdown permit that will cover the next five years. A current WDNR permit will make the implementation of a winter drawdown if EWM reaches a designated level easier.

AIS POPULATION CONTROL GRANT APPLICATION

If annual EWM bed mapping identifies 200 or more acres of EWM in the Flowage in any given year and a decision is made to pursue a winter drawdown, the MFA should immediately develop an AIS Population Control Grant to help fund its implementation. The largest expenses associated with a winter drawdown are expected to be pre- and post-drawdown PI aquatic plant survey work and reimbursement for the loss of hydro-power generation during the drawdown.

PRE- AND POST-DRAWDOWN WHOLE-LAKE PI AQUATIC PLANT SURVEY

Since a winter drawdown will impact the entire Flowage, a pre-drawdown, whole-lake, PI survey should be completed in the summer season immediately following the mapping, unless for other reasons a similar survey has already been completed within 18 months. All 878 points in the Minong Flowage and the 108 points in Delcore Pond should be included following WDNR protocol. Advance notice should be given to the Cranberry Lake Association so they may complete a PI survey if they choose to. A post-drawdown survey should be completed in the summer season following the winter drawdown unless a PI survey is already scheduled within 18 months of the drawdown for another reason.

SCENARIO-BASED MANAGEMENT

This APM Plan recommends a scenario-based approach to managing EWM in the Flowage. In a scenario-based approach to EWM management, there is no set minimum or maximum amount of EWM that is "OK" in the lake, or a "trigger" for management. Any amount of EWM at any time can be managed in the lake, albeit using different management alternatives. Determining when to use a particular management alternative or to move to a different alternative is the basis of a scenario-based approach to control EWM. Doing so minimizes negative impacts to native aquatic vegetation caused by the continued spread of EWM or by the management used to control EWM.

To support a scenario-based approach to EWM management in the Minong Flowage, the following monitoring and control activities are recommended.

1) EWM will be monitored by volunteers throughout the growing season.
2) Summer bed mapping will be completed annually by a Resource Professional.
3) Areas of EWM with sparse, isolated plants will be hand pulled or raked by volunteers in shallow water (≈ 3 feet) around docks and along shorelines.
    a. These services can be completed at any time during the open-water season and do not require a WDNR permit.
4) Free diving, snorkel, and/or scuba diver removal of EWM in deeper water will take place in areas with isolated plants, small clumps, or small beds of plants where practical and if resources are available.
    a. Used on areas of EWM <0.01 acre (not definitive, use as a guideline)
    b. Could be done by MFA volunteers or contracted by the lake organization, can be completed at any time during the open water season.
    c. Does not require a WDNR permit.
5) DASH can be used in place of or in combination with free diving, snorkel, and/or scuba diver removal of EWM where practical and if resources are available. DASH may allow larger areas of EWM to be managed without the use of herbicides.
    a. Used on areas >0.01 acre (not definitive, use as guideline)
    b. Would be contracted by the MFA, can be completed at any time during the open water season.
    c. Requires a WDNR Mechanical Harvesting permit.
6) Aquatic herbicides can be considered in any area under the following guidelines.
    a. Conditions exist that are likely to make other management alternatives less effective.
        i. Bed size and density of EWM in the area (>0.5 acres, not definitive – use as a guideline)
            1. Up to a 50-ft buffer can be extended around any mapped bed.
            2. Small beds within 100-ft of each other can be combined to make larger beds.
        ii. Location of the area in relation to lake access and usability
            1. Example: Adjacent to the WDNR public boat landing
        iii. Water depth and clarity
        iv. Limited or unavailable access to contracted diver or DASH services
        v. Limited financial resources
        vi. Less than a majority constituent support for a proposed management action.
    b. Areas that are <5.00 acres should be treated with PCOR.

        i. Only to be applied in the main basin of the lake, not the North Bay, Serenity Bay, or the East Basin until more research on its impact to wild rice is completed.
        ii. Application rates will be limited to 5pdus/acft or less, unless discussion with the Company dealing PCOR, the Consultant/lake organization, the WDNR, and the Applicator recommend and agree on higher rates.
        iii. 2,4D or triclopyr-based herbicides can be considered if a limno-curtain is installed around the treatment area.
    c. Areas ≥5.0 acres may be treated with PCOR, 2,4D-based herbicides, 2,4D/triclopyr blends, triclopyr, or contact herbicides (endothall and diquat) depending on available resources.
        i. Suggested application rates for PCOR are 3-5pdus/acft.
            1. Only to be applied in the main basin of the lake, not the North Bay, Serenity Bay, or the East Basin.
        ii. Suggested application rates for 2,4D-based herbicides are 2-4ppm/acft depending on size (larger treatment areas could be managed with <4ppm/acft).
            1. May be applied to the southern halves of the North Bay and Serenity Bay.
            2. Fall applications can be considered if near wild rice.
        iii. Suggested application rates for other herbicides – follow label instructions.
        iv. Treatments >5 acres using any aquatic herbicide may have a basin-wide or lakewide impact, so the following monitoring is <u>suggested</u>.
            1. Pre (prior year and/or year of) and post (year of and/or year after) treatment aquatic plant surveys within the proposed treatment areas.
            2. Herbicide concentration monitoring.
        v. Treatments >10 acres using any aquatic herbicide may have a basin-wide or lakewide impact, so the following monitoring is <u>required</u>.
            1. Pre (prior year and/or year of) and post (year of and/or year after) treatment aquatic plant surveys within the proposed treatment areas.
            2. Herbicide concentration monitoring.
    d. The same area will not be chemically treated two years in a row with the same herbicide or any herbicide with the same mode of action as determined by Weed Science Society of America (WSSA) Groups.[11]
        i. PCOR, 2,4D, and triclopyr are all Group 4 herbicides.
        ii. Diquat is a Group 22 herbicide.
        iii. Endothall is a Group 31 herbicide.
7) Winter Drawdown can be considered when EWM in a late summer bed mapping survey reaches 24% (200 acres) of the average littoral zone (832 acres).
    a. Work with the Washburn County Highway Department to either extend the existing drawdown permit (end date 11/01/2024) or apply for a new 5-yr drawdown permit (through 2029).
    b. Prepare a WDNR Population Control Grant to help defray expenses associated with the drawdown.
        i. Primary expenses would include a whole-lake PI survey and reimbursement for lost power generation during the drawdown.
        ii. Pre-grant due September 15th of the given year.
        iii. Final grant due November 15th of the given year.

[11] https://wssa.net/weed/herbicides/

c. Complete a whole-lake, PI survey work.
    i. In the summer/late summer season prior to the planned drawdown
    ii. In the summer season following the planned drawdown
d. Implement other monitoring programs as determined in planning.

AQUATIC PLANT SURVEY WORK

A late summer EWM bed-mapping survey of the entire littoral zone of the Minong Flowage will be completed annually. If beds of EWM are identified that reach or exceed 3 acres, have not been chemically treated in that year, and there is reason to consider herbicide application the following year, new points will be created and a point-intercept, aquatic plant survey within the newly identified area will be completed to document the presence of EWM and native plants. Management proposals will be made based on the results of this survey. If an herbicide proposal is made and approved for the following season, a pre-treatment readiness survey will be completed to determine if an appropriate amount of EWM growth has been attained to implement the treatment. The result of the treatment will be documented by repeating the point-intercept survey in the summer following the treatment year. As mentioned, the same area will not be treated two years in a row, providing an opportunity to see longer term impacts of the treatment if there are any.

WILD RICE

Wild rice will be monitored annually via aerial photography completed by GLIFWC. In years of large-scale management action pre- and post-treatment PI surveys will be completed following WDNR guidelines. At least every five years, whole-lake PI surveys will be completed. Bed mapping of wild rice is not recommended in this Plan. In any given year, it can be added if requested by Tribal Resources, and if Tribal Resources are willing to share in the cost of the survey, or the survey is funded by WDNR grants.

CLP

Early season, cold water PI surveys focusing on CLP should be completed in the same year that summer, whole-lake, PI surveys are completed, roughly every five years. CLP should be monitored annually in mid to late June by trained volunteers following a meandering survey approach. During the survey, if it is determined that there is more CLP than what is normally identified, more formal CLP bed mapping should be considered. A bed is defined as an area where the target species makes up >50% of all aquatic plants and has a definable edge. In high-density areas, the target species may not have a definable edge but is still present. The level of target species growth within each area will be ranked using the WDNR's standard 1-3 rake fullness scale. A bed will be recorded by placing a string of waypoints around the edges of the bed using a Garmin GPS unit. These data will then be mapped, and the acreage of each bed determined to the nearest hundredth of an acre. If moderate to dense beds of CLP exceeding 5 acres are found and appear to be negatively impacting native aquatic plants including wild rice and/or are posing significant navigational impairment are identified, management of those beds could be proposed in the following year.

PURPLE LOOSESTRIFE

MFA volunteers will continue to monitor purple loosestrife in and around the shores and wetlands adjacent to the Flowage. If found, attempts will be made to physically remove the individual plants, or at least remove the flowering heads to reduce seed production. In addition, campers and counselors at the Swift Nature Camp have raised Galerucella beetles as a part of their nature curriculum. While the numbers of beetles raised by the Camp far outweighs the current need for beetles, there are many other places in Washburn County where beetles can be released. To that end, the MFA will work with Washburn County to identify beetle releases sites not on the Flowage.

OTHER AIS

Zebra mussels, spiny waterflea, and other AIS will be monitored by MFA volunteers following WDNR CLMN AIS monitoring guidelines. MFA volunteers will continue to place zebra mussel plate samplers at strategic places in the Flowage under the guidance of the Washburn County AIS Coordinator. If monitoring finds any AIS not already in the Flowage, it will be reported to the WDNR, at which point appropriate management actions will be taken.

WATER QUALITY TESTING

There is a substantial amount of water clarity and water quality data courtesy of the Citizen Lake Monitoring Network and MFA volunteers. This data is used to compare changes in water quality in the Minong Flowage over time and to help determine if EWM and EWM management actions are affecting water quality. The MFA will continue monitoring both the Central Basin and the Deep Hole near the dam. In addition, a site in the North Basin or Serenity Bay will be added. All sites will collect Secchi disk readings of water clarity, total phosphorus, and chlorophyll-a data. Temperature and dissolved oxygen data may be collected as well.

2024-2028 AQUATIC PLANT MANAGEMENT GOALS, OBJECTIVES, AND ACTIONS

There are seven goals associated with this Aquatic Plant Management Plan. Each goal has several objectives and a list of actions to complete to help meet the objective and accomplish the goal (Appendix B). Each of these goals is important for keeping the Minong Flowage healthy and maintaining its expected uses over at least the next five years. The objectives included in this plan are measurable and presumed to be reachable and reasonable. The actions in this plan are intended to be implemented by the MFA with input and assistance from its lake constituency and from the WDNR, private consultants, and other resource professionals.

- Goal 1 – Maintain open and involved stakeholder participation in EWM management planning, implementation, and evaluation.
- Goal 2 – Protect and enhance the native aquatic plant community.
- Goal 3 – Minimize the negative impact of EWM on the native aquatic plant community, lake use and access, and the investment of property owners.
- Goal 4 – Reduce the threat that a new aquatic invasive species will be introduced and go undetected in the Minong Flowage and that existing AIS will be carried to other lakes.
- Goal 5 – Improve the level of knowledge property owners and lake users have related to aquatic invasive species and how they can impact the lake.
- Goal 6 – Improve the level of knowledge property owners and lake users have related to how their actions impact the aquatic plant community, lake community, water quality.
- Goal 7 – Complete APM Plan implementation and maintenance for a period of five years following adaptive management practices.

IMPLEMENTATION AND EVALUATION

This plan is intended to be a tool for use by the MFA to move forward with aquatic plant management actions that will maintain the health and diversity of the Minong Flowage and its aquatic plant community. This plan is not intended to be a static document, but rather a living document that will be evaluated on an annual basis and updated as necessary to ensure goals and community expectations are being met. This plan is also not intended to be put up on a shelf and ignored. Implementation of the actions in this plan through funding obtained from the WDNR and/or MFA funds is highly recommended. An Implementation and Funding Matrix is provided in Appendix D.

Since many actions occur annually, a calendar of actions to be implemented was created in Appendix E.

WISCONSIN DEPARTMENT OF NATURAL RESOURCES GRANT PROGRAMS

There are several WDNR grant programs that may be able to assist the MFA in implementing its new APM Plan. AIS grants are specific to actions that involve education, prevention, planning, and in some cases, implementation of AIS management actions. Lake Management Planning grants can be used to support a broad range of management planning and education actions. Lake Protection grants can be used to help implement approved management actions that would help to improve water quality.

Management actions included in this APM Plan could be supported by WDNR Surface Water grant funding should the MFA wish to apply for it. Grant funding is not a guarantee but will not be awarded if it is not applied for. More information about WDNR grant programs can be found at: https://dnr.wisconsin.gov/aid/SurfaceWater.html

OUTSIDE RESOURCES TO HELP WITH FUTURE MANAGEMENT PLANNING

Appendix F lists resources other than those available from the WDNR, Douglas and Washburn counties, Tribal Resources, LEAPS, or various other stakeholders that may be available to help the MFA implement this APM Plan.

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