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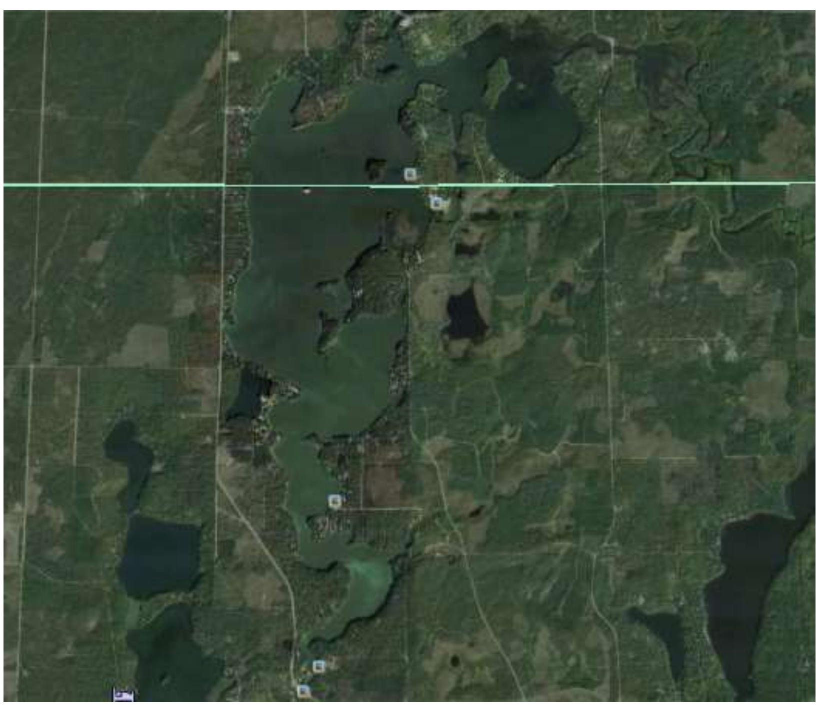
MINONG FLOWAGE, WASHBURN AND DOUGLAS COUNTIES

2016-20 AQUATIC PLANT MANAGEMENT PLAN
WDNR WBIC: 2692900

Prepared by: Dave Blumer, Lake Educator

Final Revision – February 4, 2016



MINONG FLOWAGE ASSOCIATION
MINONG, WI 54859

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PREPARED FOR THE MINONG FLOWAGE ASSOCIATION

INTRODUCTION

In 2002, Eurasian water milfoil (EWM), an aquatic invasive plant species, was found in the Minong Flowage in Washburn and Douglas Counties. A subsequent plant survey and a sediment survey determined that it was likely present in the Flowage several years before being detected. Some predictions were made at that time that EWM would only grow to nuisance levels in about 100 acres in any given year. In 2008, the amount of moderate to dense growth EWM exceeded 300 acres and it was predicted that it could invade another 200 acres before claiming all available habitat.

An Aquatic Plant Management 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 and 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 project required by the State to bring it up to current code. A whole-lake point-intercept aquatic plant survey was completed in 2012 because of the expected drawdown in 2013, a year prior to when it was originally scheduled to be completed; and another whole-lake point-intercept survey was completed in 2014 the year after the drawdown. From 2012 through 2014 no other EWM management was implemented.

This document is a summary of all management actions that occurred from 2009 to 2014, expands on management alternatives that could be implemented in the Minong Flowage to control EWM and other AIS for the next five years. It also set up the criteria under which any aquatic plant management on the Minong Flowage is to be implemented.

The development of this document was guided by a Stakeholders Group made up of Minong Flowage Association representatives and their primary consultant, WDNR representatives (water resources, aquatic plant management, fisheries, and dam safety), Tribal representatives (GLIFWC and St. Croix Tribal Resources), and Washburn County representatives. This document strives to address the concerns of all these stakeholders to come up with a plan that identifies the best management practices to implement to control EWM and other AIS without harming the native flora and fauna.

The waters of Wisconsin belong to all people. Their management becomes a balancing act between the rights and demands of the public and those who own property on the water's edge. This legal tradition called the Public Trust Doctrine dates back hundreds of years in North America and thousands of years in Europe. Its basic philosophy with respect to the ownership of waters was adopted by the American colonies. The US Supreme Court has found that the people of each state hold the right to all their navigable waters for their common use, such as fishing, hunting, boating and the enjoyment of natural scenic beauty.

The Public Trust Doctrine is the driving force behind all management in Wisconsin lakes. Protecting and maintaining that resource for all of the State's people is at the top of the list in determining what is done and where. In addition to the public trust doctrine, two other forces have converged that reflect Wisconsin's changing attitudes toward aquatic plants. One is a growing realization of the importance of a strong, diverse community of aquatic plants in a healthy lake ecosystem. The other is a growing concern with the spread of Aquatic Invasive Species (AIS), such as Eurasian water milfoil (EWM). These two forces have been behind more recent changes in Wisconsin's aquatic plant management laws and the evolution of stronger support for the control of invasive plants.

To some, these two issues may seem in opposition, but on closer examination they actually strengthen the case for developing an Aquatic Plant Management (APM) Plans as part of a total lake management picture. Planning is a lot of work, but a sound plan can have long-term benefits for a lake and the community living on and using the lake.

The impacts of humans on State's waters over the past five decades have caused Wisconsin to evolve a certain philosophy toward aquatic plant management. This philosophy stems from the recognition that aquatic plants have value in the ecosystem, as well as from the awareness that, sometimes, excessive growth of aquatic plants can lessen our recreational opportunities and our aesthetic enjoyment of lakes. In balancing these, sometimes competing objectives, the Public Trust Doctrine requires that the State be responsible for the management of fish and wildlife resources and their sustainable use to benefit all Wisconsin citizens. Aquatic plants are also recognized as a natural resource to protect, manage, and use wisely.

Aquatic plant protection begins with human beings. We need to work to maintain good water quality and healthy native aquatic plant communities. The first step is to limit the amount of nutrients and sediment that enter the lake. There are other important ways to safeguard a lake's native aquatic plant community. They may include developing motor boat ordinances that prevent the destruction of native plant beds, limiting aquatic plant removal activities, designating certain plant beds as Critical Habitat sites and preventing the spread of non-native, invasive plants, such as EWM.

If plant management is needed, it is usually in lakes that humans have significantly altered. If we discover how to live on lakes in harmony with natural environments and how to use aquatic plant management techniques that blend with natural processes rather than resist them, the forecast for healthy lake ecosystems looks bright. To assure no harm is done to the lake ecology, it is important that plant management is undertaken as part of a long range and holistic plan.

In many cases, the State requires 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. To promote the long-term sustainability of our lakes, the State of Wisconsin endorses the development of APM Plans and supports that work through various grant programs.
There are many techniques for the management of 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 such as using harvesting equipment, herbicides or biological control agents. These methods require permits and extensive planning.

While limited management on individual properties is generally permitted, it is widely accepted that a lake will be much better off if plants are considered on a whole lake scale. This is routinely accomplished by lake organizations or units of government charged with the stewardship of individual lakes.

MINONG FLOWAGE ASSOCIATION

The Minong Flowage Association (MFA) was founded in 1989 and became incorporated as a non-profit organization in 2003. The MFA is a membership based organization with annual dues supporting an aggressive lake management plan, providing educational awareness of invasive species and creating opportunities for the young and old alike to have fun and create memories to last a life time.

The Mission of the MFA is to promote a high quality social and ecological environment for property owners, residents and users within the environs by identifying and facilitating the resolution of issues and undertaking initiatives for the common good.

As stated in the MFA by-laws, the Association was organized for the betterment and preservation of the Flowage. A seven-member volunteer board of directors, comprised of permanent and seasonal residents of the Flowage, is devoted to finding solutions to problems and promoting positive activities affecting the Minong Flowage and the members of the association. The MFA's annual meeting is the second Saturday of June at the Minong Town Hall and other open board meetings are held throughout the year along with an annual event in August.

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

While most folks accept the idea of planning, it does not necessarily mean they will participate in, or accept the results of that planning. An expansive and open approach is prudent to help folks understand the planning process. A broad cross-section of people and interests should be involved in the planning process from beginning to end allowing all ideas and opinions to be voiced. Though this can be time consuming and arduous, the process allows differences and conflicts to be reconciled, resulting in a plan (and decision-making) that is more likely to be accepted by the community.

Responsibility for lake management does not lie solely with any one group. Successful management efforts may require cooperation among local government, lake organizations, state, and sometimes federal, agencies. Businesses, sportsmen and organized lake recreationists may also hold considerable sway over the management of some lakes. Identifying stakeholders that are concerned about the issues; have interests that are affected or that they believe will be affected, and that believe their power will be enhanced or diminished should be at the table.

Ultimately a discussion group or advisory planning committee which should contain a cross-section of the lake neighborhood with folks from all sides of the issue: property owners, passive and active lake users, businesses, clubs, agencies and local government. Participants should be interested in bringing the lake community together to solve common issues. Even if people decline the offer to play a role, an effort has been made to solicit their input, and let them know they are welcome to participate in a community effort to create an APM plan. On some lakes government bodies and agencies may have an interest in your plan, and have their own priorities or mandates to deal with. Planners need to become aware of these roles and what regulations or ordinances may already be in place. Each organization will have a role. It may be a lead role, an advisory role or supportive role.

Committee members have a two-way responsibility: to report to their constituent group, and to provide feedback to the committee. This should be made clear from the outset. The planning committee will provide input and recommendations to the elected officials, regulators, Lake District or lake association boards which may have the final decision-making responsibilities.

One significant question that needs to be asked is, "What are the best ways to find and reach the people that need to provide input?" The best ways are varied and depend on the number of people needed to be reached, the complexity of the issue, size of lake and the assets available.

MINONG FLOWAGE STAKEHOLDERS DISCUSSION GROUP

The need to revise/rewrite the existing Aquatic Plant Management (APM) Plan written in 2009 was determined back in 2013. Due to the pending drawdown of the Minong Flowage in 2013, rewriting the APM Plan was delayed until late 2014 and early 2015. To assist in the process of rewriting the APM Plan, and to make sure that all stakeholders were represented in that rewriting process, Stakeholders Discussion Meetings were held on a quarterly basis in 2014 and early 2015. Stakeholders invited to be a part of the Stakeholders Discussion Group included representatives from the WDNR, GLIFWC and Voigt Task Force, St. Croix Tribal Resources, Washburn County, Douglas County, Cranberry Lake Association, and the Minong Flowage Association and their consultant.

Meetings were held in the Spooner WDNR office on April 30, October 29, and December 3 in 2014; and on January 28 and April 15 in 2015. A tour of the Flowage was planned for August 2014, but was cancelled and rescheduled several times, and eventually did not happen due to weather. Much discussion was had during these meetings on varying topics from impacts to wild rice, chemical and other EWM management alternatives, curly-leaf pondweed, native plants and plant survey results, impacts to the fishery and other native fauna, and what could be included in the new APM Plan that would satisfy the requirements of the WDNR; the needs of Tribal Resources, GLIFWC, and Voigt Task Force; and the needs of the Minong Flowage Association and Douglas and Washburn Counties. Notes from these meetings were incorporated into drafts of the new APM Plan. The

Stakeholders Discussion Group also reviewed and added comment to the draft versions of the APM Plan and the Goals, Objectives, and Actions contained within it.

The Stakeholders Discussions Group was also a place for open and honest dialogue about the Minong Flowage, the process of rewriting the APM Plan, and the process gone through to be allowed to move forward with management planning and implementation. There were many different points of view expressed and not all were readily accepted by all of the Stakeholders. Regardless of this, the dialogue remained civil and accomplished what it was supposed to accomplish.

Agendas and minutes from the Stakeholders Discussions are included in Appendix A.

PUBLIC INPUT

In addition to the Stakeholders Discussion Group, property owners, users, and interested parties were involved in the planning process. All meetings of the Minong Flowage Association were open to the public. Correspondences, meeting notes, agendas, and draft documents were posted on the Minong Flowage Association webpage at www.minongflowage.org. The most current draft of the new Minong Flowage APM Plan was and remains posted on the website for public review and comment. Not many comments have been generated despite it being posted for several months. Current and past MFA Board Members have worked very hard to keep the public informed, and where necessary made one on one direct contact a priority. One such example of this is with the Cranberry Lake Association. A lot of effort has been made to include them in the plans being formed for the Minong Flowage, as it is expected that for the first time, the Minong Flowage and the Cranberry Flowage will be considered together in management planning and implementation.

Public input related to the inclusion of the Cranberry Flowage and potentially even Cranberry Lake in management planning and implementation led by the Minong Flowage Association included comments from several current members of the Cranberry Lake Association (CLA) and the consultant the Cranberry Lake Association has worked with for several years to do their own EWM management planning and implementation. Charles Chesney, a MFA member and former Board Member of the CLA, attended the June 13, 2015 MFA Annual Meeting. His primary interest was in the Cranberry Flowage aspect of the plan because his property is on the Cranberry Flowage. He was quite complimentary of MFA efforts to include the Cranberry Flowage in their management planning. He has high hopes that this will bring better EWM control to the Cranberry Flowage and would like to see Cranberry Lake property owners included too.

Steve Schieffer, owner and consultant with Ecological Integrity Services LLC has indicated his support for management in at least the Cranberry Flowage being led by the MFA. Steve has acted as the management consultant for the CLA since EWM was first identified there. In an email in May 2015, Steve states that he is encouraging them (CLA) to let the MFA take care of the flowage between Cranberry Lake and the Minong and just manage the lake. He also encourages the CLA to have at least one representative on the MFA Board. Other Cranberry Lake/Flowage contacts including property owners Larry Carlson, Bob Fritzke, Ellen Codner, and Brad White, had varying degrees of contact with the President of the MFA during this process. Impressions from these individuals suggest that they all hope for MFA support in controlling EWM in the Cranberry Flowage and Cranberry Lake, but are not willing to lead in organizing that additional effort. The CLA is currently experiencing a drop in leadership and overall effectiveness but it is expected that they will overcome this to become a strong partner and ally in managing EWM in the entire system. The conversations had so far, appear to be a great start on a long path.

Another set of comments that came out of the public review period was the desire to have landowner requests for EWM management included in the new APM Plan. In the old plan, landowners were given the opportunity to request spring treatment of presumably EWM. Those requests were evaluated in person and on the water by a resource professional, and if allowed were added to the larger MFA treatment plan. If they were denied, the landowner received a letter explaining why.

The public review process also contained some comments from constituents about the possibility of future drawdowns to control EWM. Two constituents voiced support for periodic drawdowns to control EWM as they saw it as the most effective management method to be employed since management began. One person liked the low financial cost associated with a drawdown, and the need for fewer chemicals to kill the EWM. Another person also supported periodic drawdowns but wondered if the MFA should be responsible for reimbursing the power company. This property felt that the concept of reimbursing the power company "never seemed right…as there is more at stake here than their bottom line".

During the annual meeting where a final constituency discussion related to the APM Plan was had, at least one person voiced great concern over the use of a drawdown to control EWM. This constituent stated that his neighbor encountered significant expense as a result of the 2013 drawdown when his well went dry. There were rumors around the lake of wells being impacted and trees dying. To substantiate these rumors a survey of the constituency is being planned for 2015 to determine the level of hardship caused by the drawdown. The results of this survey will be used in future planning of any drawdown, should one be proposed.

During the discussion of the APM Plan at the Annual Meeting there was some confusion as to whether the APM document was a plan set in stone, or a list of options to consider under certain circumstances. The President of the MFA clarified the APM Plan as a document to guide management implementation in the future. Not everything in the plan would necessarily be implemented, but it would not necessarily not be implemented either. In each year of management, the conditions that are present go a long way in determining what management actions to take that are defined in the APM Plan.

Several other property owners have commented about other issues, like marking hazards in the Flowage so people know about them. This is not typically something the MFA does, simply because once it has been identified and marked, then there is the possibility of assumed liability should an accident occur. The APM Plan is also used by folks to aid in their decision to purchase property on the Minong Flowage. Several other folks just had general comments commending the MFA in their efforts to manage EWM in the Flowage. Several folks from the Minong Flowage have read the APM Plan in its entirety and have been complimentary of the content therein.

Preliminary approval of the new APM Plan for the Minong Flowage was passed at the June 13, 2015 MFA Annual Meeting after a short presentation by the MFA's consultant writing the plan.

A summary of the public input is included 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 existed after the 2013 drawdown. 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 once again becoming the primary aquatic plants in the system. Prior to the management actions implemented from 2009 to 2011, EWM had expanded in distribution and density to impact more than 335 surface water acres (>21%) in the Flowage. It did this over a period of 5-7 years. During this time native aquatic plants were established and healthy, providing some competition likely slowing the spread. With the extended drawdown in 2013-14, most of the EWM was eliminated from the system, but so were most of the native plants that previously may have helped slow the spread of EWM. This management plan presents a strategy that strives to keep EWM and other AIS in check while giving native aquatic plants more time to recover and reestablish after the drawdown and is considered restorative in nature.

IMPLEMENTATION GOALS

The following nine goals form the basis of the APM Plan. Each goal is accompanied by several objectives and many action items. For more information, go to the Goals, Objectives, and Management Actions section of this document on page 115.

Goal 1 – Increase the involvement of Stakeholders in EWM and CLP Management planning and implementation.

Goal 2 – Protect and enhance the native aquatic plant community.

Goal 3 – Minimize the negative impact of EWM to the native aquatic plant community through the implementation of management actions.

Goal 4 – Minimize the negative impact of CLP and purple loosestrife to the native aquatic plant community through monitoring and the implementation of management actions.

Goal 5 – 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 6 - Improve the level of knowledge property owners and lake users have related to aquatic invasive species and their impact to the lake.

Goal 7 - 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 8 - Complete APM Plan implementation and maintenance for a period of five years following adaptive management practices.

Goal 9 - Evaluate and summarize the results of management actions implemented during the entire 5-year timeframe of this plan

The Minong Flowage (WBIC 2692900) is a 1,564-acre eutrophic/mesotrophic drainage flowage 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 1). It reaches a maximum depth of 21.5ft near the dam on the far south end and has an average depth of approximately 9ft. The bottom is predominately sand and sandy muck in the south basin and organic muck in the northern bays. Secchi readings from 1994-2012 averaged no more than 3-6ft under normal summer conditions (WDNR 2012). This poor to very poor clarity produced a maximum depth of plant growth the ranged from 7.5-ft to 9.5-ft documented in three whole-lake, point-intercept, aquatic plant surveys (2008, 2012, and 2014). This creates a littoral zone that averages 805.5 acres (51.5% of the total surface area) from 2008 to 2014, with a max area of 924 acres in 2008 and a minimum in 2012 of 667.7 acres.

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 Totagatic River from the east and Cranberry Lake in Douglas County to the north via the Cranberry Flowage. 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 1: Minong Flowage, Washburn-Douglas Counties, WI

MINONG FLOWAGE DAM

The Minong Flowage was created in 1937 when a dam with an 18-ft head was installed on the Totagatic River. The dam is currently leased by Renewable Worldwide Resources and operated by North American Hydro and generates hydroelectric power for the region. In 2010 an assessment of the dam changed the state hazard rating for the dam from “significant” to “high” (Ayres Associates, 2012). The assessment further 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 chosen. In 2013, the old dam was replaced by a new dam (Figure 2) with a structural height of 27-ft with the goal of keeping the water level in the Flowage at the normal pool elevation previously established. The hydro-electric dam on the Minong Flowage produces upwards of around 2400 volts and 75 amps of electricity.

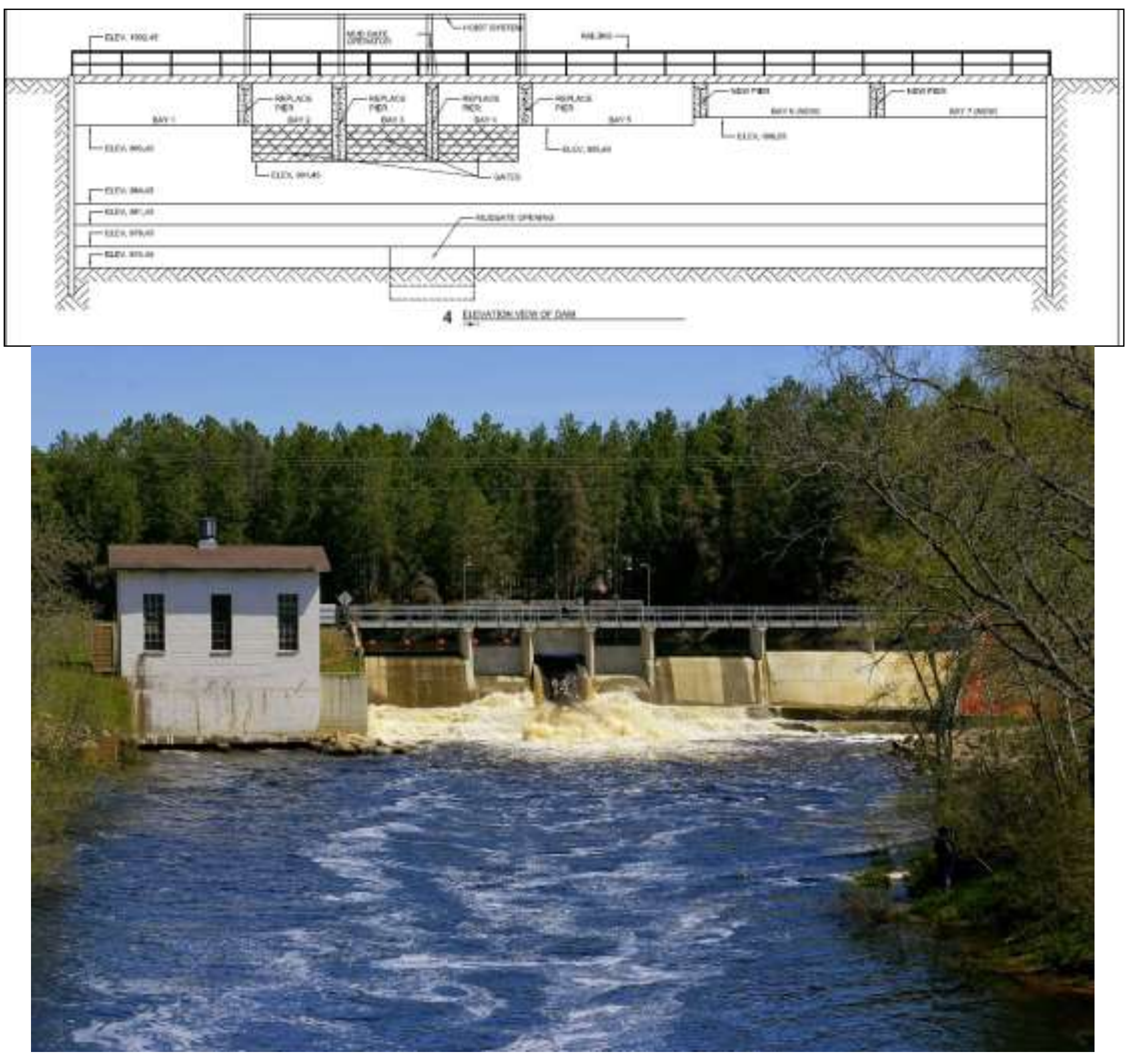


Figure 2: Elevation view of new dam (top) (Ayres Associates, 2012); New dam on the Minong Flowage, May 2014 (bottom)(http://www.panoramio.com/photo/107414410)

The Minong Flowage is currently listed on the Wisconsin 303d impairment list for mercury contamination. Atmospheric deposition is the main contributor, and it has a low priority listing. The Minong Flowage is known to have Eurasian water milfoil, curly-leaf pondweed, purple loosestrife, and rusty crayfish.

The lake has approximately 300 property owners and is home to the Totagatic County Park which is open to the public for camping, swimming, fishing, and boating. This is a 75 site campground with a designated swimming area, pavilion, numerous picnic areas, children's play area, fishing pier, fish cleaning house, nature trail, and public boat launch. There is a shower house, toilets, dump station, and electric water stations located throughout the park for drinking water. The lake is also home to the Swift Nature Camp which is 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 annually with a restaurant/bar. There is one restaurant/bar with a campground, and one bar that also supplies lake users with bait, ice, and convenience items. Approximately 85% of the shoreline around the Flowage slopes steeply to the lake, and is well developed in those areas open to development. Shoreland erosion is occurring around the Flowage, particularly on some of the larger islands that are used for summer recreational purposes.

The Minong 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 Totagatic County Park. There are two other public access points, one on Smiths Bridge Road on the east side, and 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 just south of the Hwy T Bridge. There are numerous other unregulated, private access points at people's homes or cottages.

LAKE USE AND MANAGEMENT AREAS

The Minong Flowage is considered to be above average for walleye production, and is a popular destination for local and visiting fishermen. The large open-water areas are popular for boating, water-skiing, and tubing, with several sand bar areas that are popular swimming destinations. Smaller back water areas and the shoreline are popular canoe and kayak areas. There are two "camps" on the Flowage: the Totagatic County Park, and Swift Nature Camp which bring in visitors from near and far to enjoy what the Minong Flowage has to offer. The Minong 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 (Figure 3) is popular with local duck hunters.

There are many different management areas on the Minong Flowage, each with its own set of issues (Figure 3). The East Basin and the north end of Serenity Bay are where the majority of wild rice is located. Serenity Bay, North Basin, the North Shore, and several areas north of the DNR Bay contain large submerged and emergent stump fields. The Totagatic River flows into the Minong Flowage through the East Basin, with additional flow coming from the Cranberry Flowage through the Channel to Cranberry. The Central Basin is a wide open flat approximately 10-15 ft. deep with several islands popular to lake users. The Deep Hole Near Dam area is an area of steep shores and deeper water, up to 20+ feet, with the exception of a large shallow flat as you enter the area. DNR Bay is home to the Swift Nature Camp and the DNR owned public boat access. The County Park area is home to the other public boating access, campground, and popular swimming areas. The West Shore has several shallow flats, but is generally deeper water and steeper shores. There is no label for the east shore, but at least one area, the East Bay, will be referred to during management recommendations. All of the labeled areas are locations where EWM has been managed in the past.

Prior to and through 2014, the Cranberry Flowage was not considered part of the management area under the responsibility and guidance of the MFA and their consultants. A different consultant works with Cranberry Lake and the Cranberry Lake Association (CLA), to address EWM management concerns. Although this was the understanding when the 2009 APM Plan was drafted, a different understanding is being suggested in this plan. The WDNR considers the Cranberry Flowage area to be part of the greater Minong Flowage, as does the Great Lakes Fish and Wildlife Commission (GLIFWC), and all previous aquatic plant mapping survey work done in the Minong Flowage has included the area. As such, the Cranberry Flowage area will be considered part of the management area in this APM Plan. The MFA will work with representatives of the CLA to include management in the Cranberry Flowage as a part of this plan.

Figure 3: Management areas of the Minong Flowage

WATERSHED CHARACTERISTICS

The watershed of the Minong Flowage has a direct drainage basin of approximately 8.3 square miles. The total drainage area is approximately 233.62 square miles and is part of the Totagatic River Watershed (Appendix B). The Totagatic River Watershed is part of the Namekagon River Watershed, which in turn is part the larger St. Croix Basin watershed (Clemens 2005). The Totagatic River flows through the Flowage and then empties into the Namekagon River and then into the St. Croix River. In 1966, 100% of the watershed was considered in a natural state with various forested cover, and a little grassland (Sather and Busch, 1976). Other than some additional shoreline development, the watershed is in a similar state today. Only 52 acres of wetland are adjacent to the Flowage. Soils in this part of Washburn and Douglas County are primarily upland and outwash types from glacial drift. Soils along the various river watersheds are mostly sand, and the uplands soils are of loam and silty materials (NRCS 2008).

FISHERIES

The Minong Flowage has primarily a warm water fishery. Walleye, northern pike, largemouth (and some smallmouth) bass, panfish, bullheads, white suckers, and redhorse are common. Rock bass, carp, and various forage minnow species are also present. In 1994, the DNR conducted a species-presence survey which identified 33 different species of fish. In the 1940's the Minong Flowage was stocked with walleye fingerlings or fry on a yearly basis. No stocking has occurred since. The walleye population is naturally producing and abundant. In 2010, a WDNR fisheries survey consisting of a walleye population estimate and a late spring electrofishing run for gamefish and panfish was completed, however at this time the data has not been compiled into a completed survey report. There is a completed Game Fish Survey and Analysis Report for walleye, northern pike and large-mouth bass that was conducted in 2005 (Bass 2006).

Results from the 2005 survey were compared to a similar survey done in 1989. The estimated walleye population in 2005 was 25% higher than in 1989. There are abundant numbers of smaller walleyes, but the report noted a decline in the number of fish greater than or equal to 20 inches in length. The same report suggests walleye growth rates have decreased dramatically. It takes more than five full seasons for walleyes to reach 15 inches and 10 seasons to reach 20 inches. There are still a lot of old fish, but they are not growing as rapidly as they used to. Northern pike and large-mouth bass populations in the Flowage appear to be stable but also reflect slower than average growth for fish greater than five years old. This report mentions the discovery of EWM in the Flowage in 2002, but does not comment on the impact the EWM could be having on the fish population.

The population of carp in the Minong Flowage has not been estimated, but it is generally accepted that the population is stable and not problematic. In the spring of 2011, many carp were noted spawning in the midst of a dense CLP bed in the area of the east basin (east of Smith's Bridge) where a fall EWM treatment had occurred the previous year. Visual survey work done in this area noted that between CLP, EWM, and carp much of the wild rice had been crowded out or uprooted.

Before and during the drawdown in 2013-14, there were many concerns related to the fishery and the impacts the drawdown would have: over fishing due to concentrated fish in smaller areas; oxygen depletion; fish caught in pools separated from the rest of the lake; passage of fish through the open dam; lack of spawning grounds for panfish, walleyes, and other fish species; and the potential for the carp population to increase. Oxygen concerns were addressed by regular winter dissolved oxygen monitoring below the ice. Results indicated no drop in DO levels while in the drawn-down state. Throughout the drawdown and dam repair project, the WDNR maintained that it was their expectation that the fishery would not suffer. A full fishery analysis is expected in 2016.

FISH AND AQUATIC PLANTS

Based on an assessment of the literature (Dibble et al. 1997) there are predictable responses by fish in relation to aquatic plants. Vegetated areas support fish densities from 15,000 to over 2 million fish/ha, higher than un-vegetated areas. Structurally oriented fish exploit aquatic plant beds, with juvenile sunfishes being numerically dominant in vegetation in most North American water bodies. In contrast, open water species and benthic omnivores often decline in abundance as plants increase in areal coverage. At least 19 families of freshwater fishes have been documented to occupy vegetated habitats during at least one of their life stages. Aquatic plants, like other sources of structural complexity in habitats, reduce risk of predation by providing refuge for smaller fish and mediating the extent to which fish interact with prey. Both sight and bottom feeders are hampered by interference from plants and stems.

Phytophilic (bluegills, sunfish) fishes increase rapidly during the plant growing season, but if plants occupy an entire water body, growth becomes stunted because food resources are depleted. 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.

Fish responses are more predictable at the extremes of plant coverage. When aquatic plants cover an entire water body, foraging by piscivores (examples: bass, walleye, northern) is hampered by stems and leaves, small phytophilic insectivores 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 (Aboul and Downing 1994). 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.

During the 2014 whole lake point intercept survey, the littoral zone of the Minong Flowage was approximately 825 acres. Approximately 49% of that had aquatic plant growth in it, with only about 34% having moderate to dense growth vegetation. These numbers equate to plant growth only in 26% of the entire Minong Flowage, and moderate to dense growth vegetation in only 18% of the entire Minong Flowage. If the sites with wild rice are removed from these numbers, only 17.8% of the entire Minong Flowage had aquatic vegetation present in 2014, and only 10.6% of the Minong Flowage had moderate to dense growth aquatic vegetation in 2014. Increasing the distribution and abundance of aquatic plant growth in the Minong Flowage is important to maintaining a healthy fishery. While open-water fish species may see little change as a result of increased aquatic plant growth, panfish likely will. A limited amount of habitat for panfish could mean fewer panfish in the next couple of years. Fewer panfish could lead to other fishery issues like an increase in the carp population (Bajer et al. 2012). If left unmanaged, more adventitious plants like EWM and CLP will likely continue to spread into or colonize areas without abundant native vegetation assuming appropriate growing conditions. Efforts to restore the native plant community, or just giving native plants more time after the drawdown to recover on their own without competition from non-native, aquatic plant species would be beneficial in the Minong Flowage.

It is generally accepted that in pioneering stages, EWM may actually improve fish habitat, but that benefit is short-lived if the EWM becomes the dominant plant with dense growth. When it reaches this point, it may be detrimental to the fishery. In the Minong Flowage, there is some anecdotal evidence from past walleye surveys done in the lake (2001, 2002, 2005, 2009, 2010, 2011, & 2012) by both the WDNR and Tribal Resources that high density and distribution of EWM and other aquatic vegetation may have had an impact on the walleye population based on walleye/mile of shoreline (Figure 4). When EWM was first identified in the Minong Flowage in 2003, it covered approximately 100 surface water acres. By the fall of 2008 that number had increased to 325 surface water acres most of which was dense growth with a rake fullness rating of 3 on a 1-3 scale. With management implementation from 2009-11, the surface water area and density of EWM in the fall of 2011 had been reduced to approximately 81 acres. With no management in 2012, the fall surface water area had increased to approximately 93 acres.

During this same time frame, the walleye population based on walleyes per mile went from 180.6 in 2002, to a low in 2010 of 32.3. In 2011 and 2012, the walleye population had started an upward trend to 65.8 in 2011 and 68.7 in 2012. In 2013, the drawdown year, the walleye population declined slightly but then went up again in 2014 nearly doubling the population per mile of shoreline identified in 2012. Between 2012 and 2014 EWM and other aquatic vegetation was severely reduced by the 2013 drawdown. While there has been no data collected that can definitively connect the two trends, it may warrant further discussion and investigation.

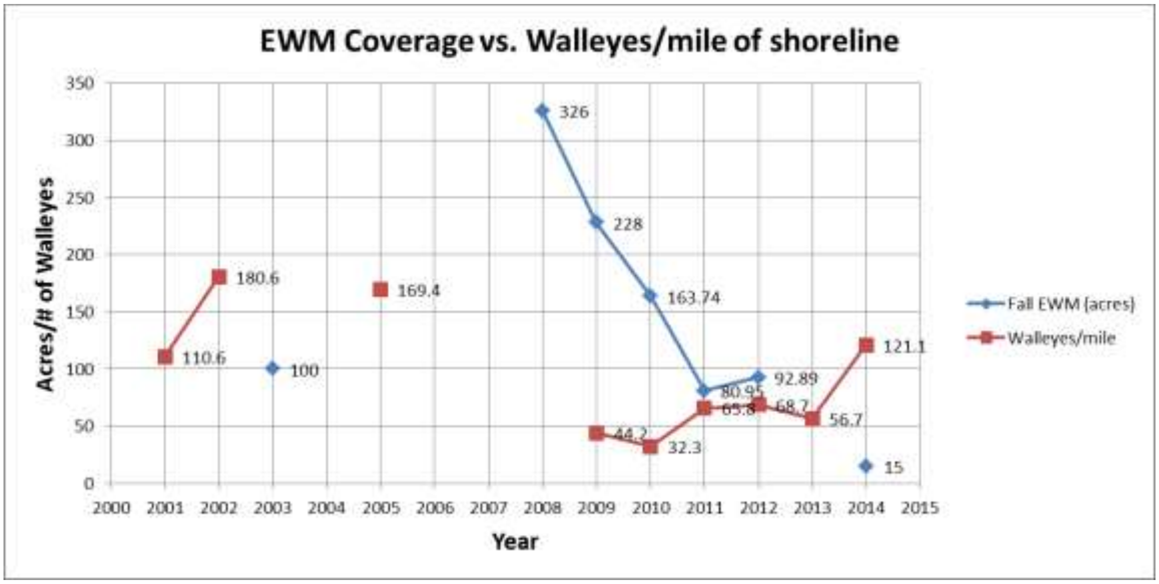


Figure 4: EWM/walleye interaction (Dan Maxwell MFA, WDNR, and GLIFWC)

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. Endothall, 2,4-D, triclopyr, 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 in the Minong Flowage. Diquat is the suggested herbicide for use in areas of the Minong Flowage where there is substantial water movement. Diquat can kill the target plant species in only a few hours, whereas the other herbicides require a longer contact time to be effective. It is expected that the toxicity of diquat will be reduced based on the amount of flow moving through diluting and dissipating the herbicide. Care should be taken to minimize the impact of herbicide carried from upstream sites to other treated sites downstream. One possibility is to reduce the concentration of herbicide applied in beds downstream of other treatment areas.

DIQUAT

Of all these herbicides, diquat has been shown to be the most toxic to fish species. 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. Hyalella azteca, an amphipod or freshwater scud, is one of the most sensitive aquatic organisms tested with a 96 hour LC50 of 0.048 mg/L. Hyalella is a widespread and
abundant species of amphipod crustacean in North America. It reaches 3–8 mm (0.12–0.31 in) long, and is found in a range of fresh and brackish waters. It feeds on algae and diatoms and is a major food of waterfowl. Studies researched that involved different fish species found a 96-hr LC50 of 35 mg/L to bluegills and a 96-h LC50 of 289 mg/L to mosquitofish. According to Paul et al. many other aquatic organisms have been tested and fall between the extremes of 0.048 mg/L and 289 mg/L.

Young walleyes are the most sensitive fish species tested. It was found that half of the 8-10 day old walleye fry exposed to 0.29-0.86 ppm of diquat over a 96 hour period died (LC50). Two month old walleye reached an LC50 after 96 hours of exposure to 1.2 mg/L of diquat. Small and large mouth bass had a 96-h LC50 at around 1.7

mg/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 1.5 mg/L cation in one foot and 0.75 mg/L cation in two feet of water. Both of these concentrations are greater than the 96-h LC50s for young walleyes, and in violation of the maximum 0.37 ppm that accompanies application of two gallons per acre to water 4-ft deep. The concentrations represented here assume complete mixing of diquat in the water column. If incomplete mixing occurs, some areas of a lake will have even higher concentrations of diquat, and even greater toxicity (Paul et al. 1994).

The suggested label application method for dense, submersed aquatic plant growth is to use subsurface injection of dilute spray. When planning to use diquat for aquatic plant management, caution should be had regarding water depth, likely not applying the herbicide in water less than 3-ft deep unless at very reduced concentrations. If at all possible, the use of diquat should be discouraged in lakes containing sensitive fish species at times when early life stages will be present. The most sensitive stage for walleye is in the first 8-10 after hatch. Female walleyes will typically begin spawning when water temperatures reach the mid to upper 40's Fahrenheit. 1-3 weeks after spawning occurs walleye fry will be moving back toward open water.

The label for Reward suggests applying once water temperatures have reached or exceeded 50°F. If diquat is to be applied it should be when water temperature reaches 48°F (just prior to walleye spawning). If water temperature exceeds this level, application should be postponed for at least three weeks to protect walleye larvae. Time wise, application should occur after the spawn has been completed, typically no earlier than mid-May.

Endothall, 2,4-D, and triclopyr have been shown to be much less toxic than diquat to fish and other aquatic life when applied at label rates.

CARP AND AQUATIC PLANTS

The common carp (*Cyprinus carpio*), 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 et al. 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 period and data collected on the lakes suggested there was no seed bank to recover (Johnson 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 of these 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. Although there has not been a documented decline in the wild rice on the Minong Flowage due to the 2013-14 drawdown, there is still a concern. The 2013 summer and winter drawdown did have an effect on the abundance of aquatic vegetation, and may have impacted the panfish population. The carp population in the Minong Flowage should be monitored for possible changes that could have resulted from the 2013-14 drawdown. A formal fish population survey is planned by the WDNR in 2016.

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 eastern most bay 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. At least one pair of loons nest and have young every year on the Flowage. Eagles can be seen just about any time and there is at least one nesting pair. Muskrats and beaver are common.

MUSSELS

At least eight different freshwater mussel species are found in the Minong Flowage although none of them are threatened or endangered species (Matt Berg, Endangered Resource Services LLC, personal communication, December 2014). Prior to the drawdown, there was no survey of the mussels in the Minong Flowage. During the drawdown, many empty and crushed mussel shells were present on the exposed lake bed, prompting some concern. An impromptu survey was completed by the Grantsburg, WI High School Research Biology Class in 2013 to determine if any of the species were threatened or endangered and if the drawdown may have caused the death of the mussels. Final results have not been published yet.

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.

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 oxygen profiles have been collected by Wisconsin Citizen Lake Monitoring Network (CLMN), formerly the Self-help Lake Monitoring Program, volunteers since 1994.

WATER CLARITY

Water clarity is a measurement of how deep sunlight can penetrate into the waters of a lake. It can be measured in a number of ways, the most common being an 8” disk divided into four sections, two black and two white, lowered into the lake water from the surface by a rope marked in measurable increments (Figure 5). The water clarity reading is the point at which the Secchi disk when lowered into the water can no longer be seen from the surface of the lake. Water color (like dark water stained by tannins from nearby bogs and wetlands), particles suspended in the water column (like sediment or algae), and weather conditions (cloudy, windy, or sunlight) can impact how far a Secchi disk can be seen down in the water. Some lakes have Secchi disk readings of water clarity 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 from view.

Figure 5: Black and white Secchi disk

Figure 6 shows the average summer (July-August) Secchi disk readings since CLMN began. In 2014, the average summer (July-Aug) Secchi disk reading for Minong Flowage at the Deep Hole Near Dam was 4.06 feet. The average for the Northwest Georegion was 8.4 feet. Typically the summer (July-Aug) water was reported as CLEAR and BROWN. This suggests that the Secchi depth may have been mostly impacted by tannins, stain from decaying matter. Tannins are natural and not a result of pollution. Tannins can be distinguished from suspended sediment because the water, even though it's brown, it looks clear, like tea. Though tannins are not harmful per se, they are often not perceived as aesthetically pleasing as clear water. Tannins can also be important for decreasing light penetration into the water and decreasing algal growth.

The average summer Secchi disk reading of water clarity from 2008 to 2012 was 3.79 feet, less than what was indicated in 2014. In 2009, average summer Secchi disk readings of water clarity were the best they had ever been since data has been collected. This outstanding water clarity led to an increase in the littoral zone that allowed EWM growth is as much as 8-9 feet of water in 2010, far deeper than had been recorded before. Declines in water clarity in 2010 and 2011 led to a more limited littoral zone in 2012 reducing the habitat for both native and non-native aquatic plants.

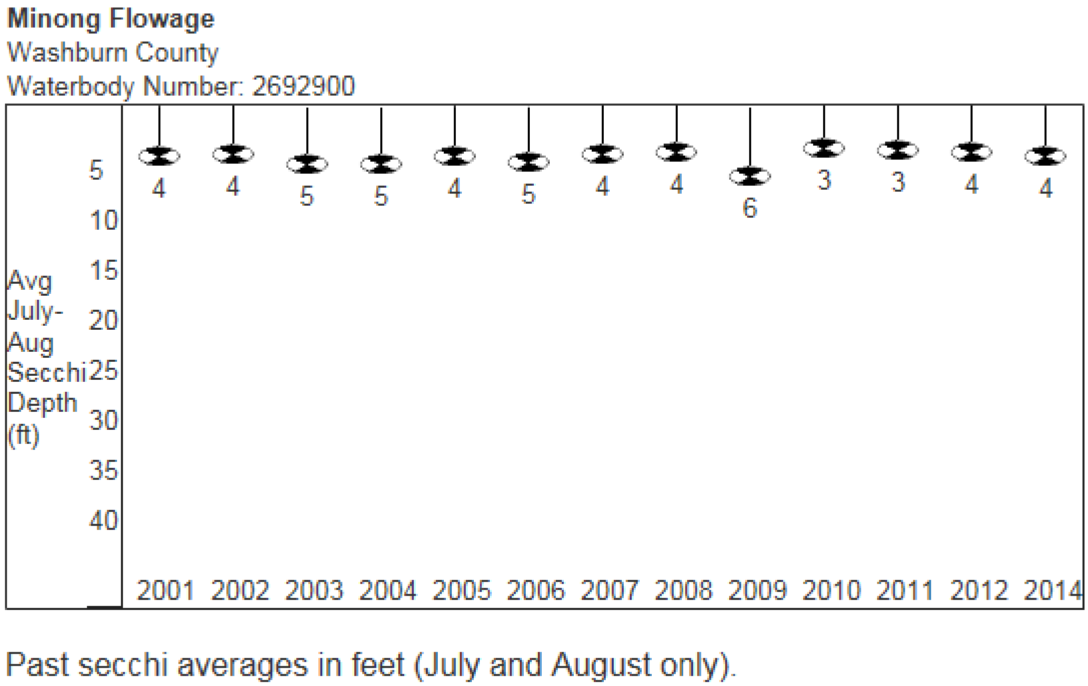


Figure 6: Average summer Secchi disk readings at the Deep Hole Near Dam

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. Chlorophyll-a is the green pigment found in plants and algae. The chlorophyll-a 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. Preference is given to the chlorophyll-a trophic state index for classification because it is the most accurate at predicting algal biomass.

Chemistry data collected in 2014 at the Deep Hole Near Dam on Minong Flowage showed an average summer Chlorophyll level of 13.3 µg/l (compared to a Northwest Georegion summer average of 16.6 µg/l). The summer Total Phosphorus average for 2014 was 28.4 µg/l. Impoundments like the Minong Flowage that have more than 30 µg/l of total phosphorus may experience noticeable algae blooms. This did not happen in 2014.

The average summer chlorophyll level from 2008 to 2012 was 20.1 µg/l; and the average total phosphorus level for the same time frame was 40.0 µg/l. Both 2014 values were substantially less than the summer average since 2008. Based on these numbers the average summer Secchi reading of water clarity should have been higher, again supporting the claim that tannins in the water, not excess algae or total phosphorus has more influence on water clarity and aquatic plant growth. As is indicated in the Secchi data, 2009 was an outstanding year for high water clarity and low phosphorus and chlorophyll levels, leading to a deeper littoral zone in 2010 that supported deep water EWM growth that had previously not been documented.

Figure 7 shows the average summer Trophic State Index (TSI) value for total phosphorus, chlorophyll, and Secchi disk readings. The overall Trophic State Index (based on chlorophyll) for Minong Flowage Near Dam was 54. The TSI suggests that Minong Flowage at the Deep Hole Near Dam was eutrophic. This TSI usually suggests decreased clarity, fewer algal species, oxygen-depleted bottom waters during the summer, plant overgrowth evident, and a warm-water fishery (pike, perch, bass, etc.) only.

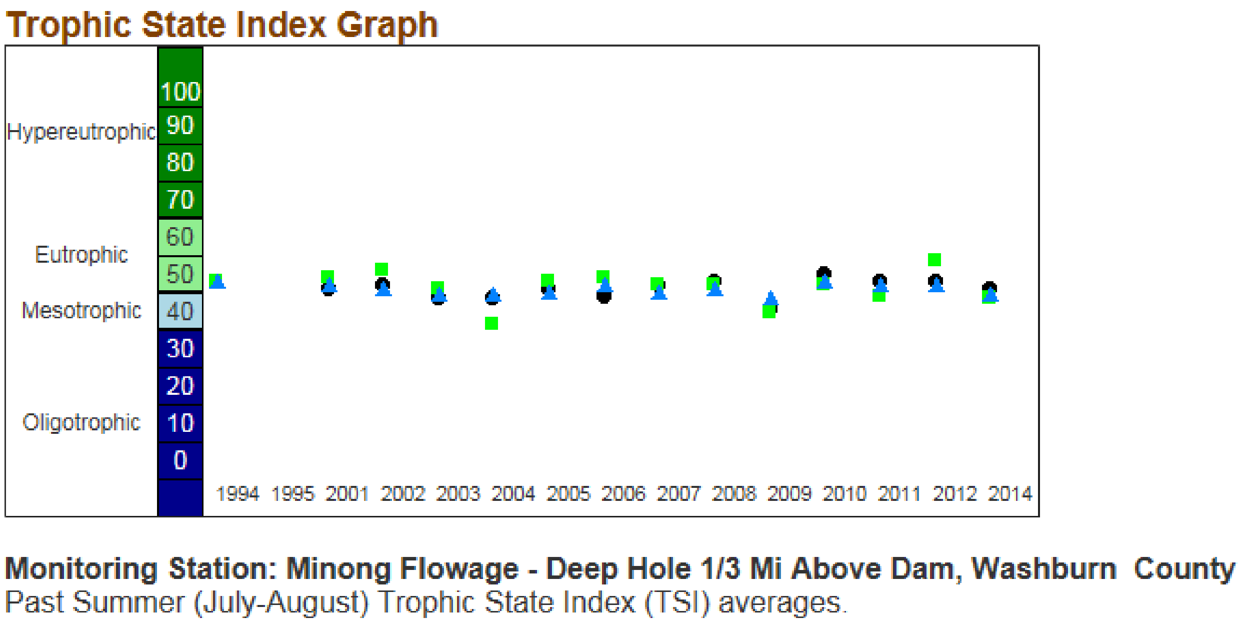


Figure 7: Summer TSI values for total phosphorus and chlorophyll a at the Deep Hole Near Dam

Additional water quality data was collected in the Central Basin, North Basin, and Serenity Bay. More data exists for the Central Basin than either the North Basin or Serenity Bay, but it is not as complete as the data collected for at the Deep Hole Near Dam. Central Basin data reflects similar trends to what is seen with the Deep Hole Near Dam data. Tannins limit the overall water clarity more so than excess algae. The limited water clarity holds pretty steady at nearly 4-ft, but can fluctuate from year to year. A year where the average water clarity exceeds 4-ft usually leads to increased EWM and other aquatic plant growth. Average water clarity below 4-ft usually limits the littoral zone and plant growth in general.

TEMPERATURE AND DISSOLVED OXYGEN

Temperature and dissolved oxygen 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 8. 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.

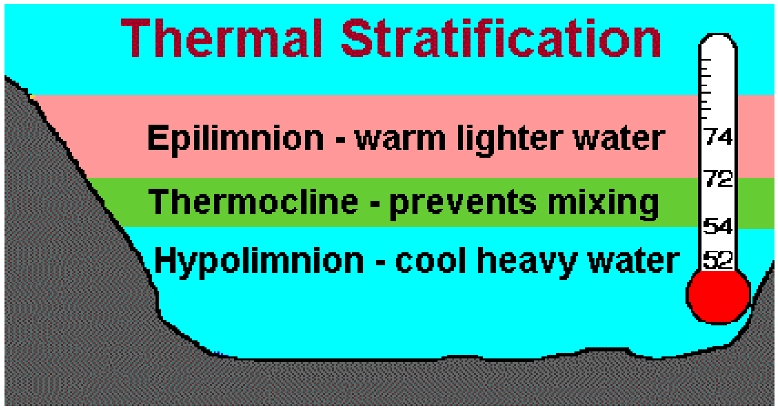


Figure 8: Summer thermal stratification

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 temperature and dissolved oxygen are greatest. This middle layer acts as a barrier that prevents warmer, oxygen rich waters in the upper layer from mixing with colder, deeper waters It is common for dissolved oxygen levels to be depleted in the lower layer, called the hypolimnion, as there is no source of new oxygen and the decomposition of organic matter consumes oxygen.

A dissolved oxygen level of 2 mg/L or less, called hypoxia, is an important criterion of sediment phosphorus release. When near-bottom dissolved oxygen is at 2 mg/L or less, the sediment-water interface is likely anoxic (no oxygen) and therefore releasing phosphorus. 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 the stratification. Inflow from the Totagatic River brings in oxygen year round. Oxygen levels lower than 2 mg/L generally only occur at the Deep Hole Near Dam below 15-ft from June through early September. Data suggest that healthy fish populations require 2-5 mg/l for moderately tolerant warm water species and 5-9 mg/l for cold-water species (10). In the Minong Flowage, during periods of oxygen depletion, most fish species will vacate deeper water that has less oxygen than they need.

Winter dissolved oxygen testing during the 2013-14 extended drawdown did not show evidence of oxygen depletion under the ice.

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 1.

Table 1: 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

2009

Herbicide application to manage EWM was begun in 2009. In 2009, the EWM treatment proposal was based on 2008 late summer EWM survey work and was considered an opportunity to further refine future herbicide management actions. Five smaller beds of EWM located on/in the West Shore, East Bay, County Park, and the Channel from Cranberry ranging in size from 1.79 to 8.93 acres; and three larger navigation lanes 120-ft wide and ranging in size from 8.78 to 22.85 acres in the DNR Bay, North Basin, and Serenity Bay were chemically managed using granular 2,4-D (Navigate) at different concentrations (Figure 9, Table 2).

The Association sponsored spring treatment was administered by Midwest Aquacare over the course of four days; May 18-21. Actual treated area was just shy of 68 acres. Of the seven areas treated in 2009, five had almost no plants found or much reduced levels of plants found during the post treatment survey and throughout the remaining open water season. Within the treated areas only beds 21 and 22 had limited success. Treatment within these beds consisted of narrow channels through much larger beds at only 100 lbs./acre of herbicide. Other treated areas used 125 to 150 lbs./acre. From early on, it appeared that the channel treatments in beds 21 and 22 were not going to be as successful as was hoped. It was expected that a clear channel through the EWM would be established where the treatment occurred. This generally was not the case. The treatment areas could be discerned, but they were not as "clearly defined" as was the goal.

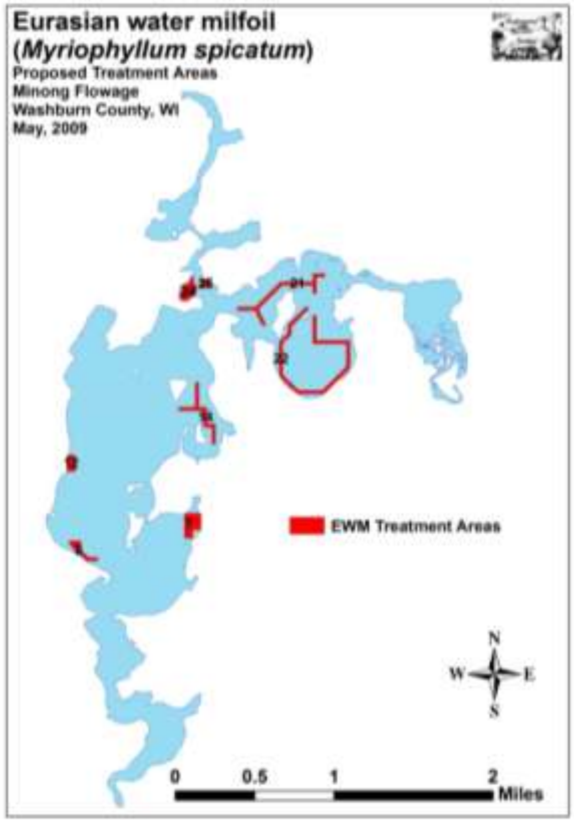


Figure 9: 2009 EWM treatment areas

Table 2: 2009 Herbicide Application Rates

	Treatment Area (acres)	100 lbs/acre	125 lbs/acre	150 lbs/acre
Bed 7-East Bay	8.93			X
Bed 8-County Park	4.45			X
Bed 12-West Shore	3.57		X	
Bed 14-DNR Bay	8.78		X	
Bed 21-North Basin	12.08	X		
Bed 22-Serenity Bay	22.85	X		
Bed 24-Ch.from Cran	6.05			X
Bed 25-Ch.from Cran	1.79		X	

Chemical residual or concentration testing was completed at thirteen sites in 2009. Sampling consisted of the day prior to herbicide application, and then 1,4,7, and 14 days after treatment. Water samples were collected by volunteers under the guidance of SEH. Water samples were processed by the Wisconsin State Laboratory of Hygiene (SLOH). At the time, the SLOH was not specifically set up to handle concentration testing for 2,4-D. The 2,4-D Immunoassay Screen used by the SLOH could only record concentrations between 0.7 and 50 ug/L. If a water sample had no detectable residual, lab results came back as <0.7. If residual concentrations were higher than 50 ug/L, results came back as >50 ug/L. Only a few samples actually went above 50-ug/L. On day one, 3 of 13 sites went above 50, on day four 2 of 13 sites went above 50, and on day seven 1 of the four sites stayed above 50, and one new site went above 50. By day fourteen, all concentrations were below 50 ug/l and all except the Deep Hole Near Dam and Near Wild Rice North Basin had downward trends from the previous sample period.

EWM weevil monitoring was also completed in 2009. Nine locations were monitored by volunteers and the MFA consultant at four different times during the season (late June, mid-July, early August, & late August). Each time lake volunteers would collect the required EWM fragments from the lake and take them back to a location where other volunteers would complete the task of looking through all the fragments for signs of weevil activity and actual life stages of the weevil. The average number of weevil life stages including adults, larva, pupa and eggs per 100 stems of milfoil examined was 7.05. The average number of stems with weevil damage including blast holes and broken stems per 100 stems examined was 27.5. If any indicator of the EWM weevil is included then the number increases to 34.55 per 100 stems examined. More than one third of all stems examined had indications of weevil activity.

A full report on the results of the 2009 herbicide application program and monitoring actions is available in two documents: 2009 Eurasian Water Milfoil Pre/Post Herbicide and Bed Mapping Surveys, Minong Flowage, Washburn County, Wisconsin (Berg 2009); and 2009 Revised Eurasian Water Milfoil Education and Control Project for the Minong Flowage, Washburn County End of Project Summary (Blumer 2010).

2010

Herbicide application was again used in 2010 to control EWM. The final 2010 early season EWM treatment proposal was based on 2009 late summer EWM survey work, the results of the 2009 treatments, and results from the 2010 pre-treatment aquatic plant survey. Nine beds of EWM ranging in size from 2.14 to 49.35 acres were targeted for chemical treatment using granular 2,4-D (Navigate) applied at 125-150 lbs./acre depending on depth and size of the treatment area. Beds less than 8 acres were treated Near Dam, East Bay, County Park, DNR Bay, North Shore, and the Channel from Cranberry. Two beds exceeding 40 acres were treated in Serenity Bay and the North Basin (Figure 10, Table 3). The total planned application was 122.27 acres. No navigation channels were treated in 2010, as the focus of management shifted to restoration aided by additional grant funding awarded by the WDNR.

A pre-treatment within the survey of 296 points completed by Endangered Resource Services (ERS) identified EWM at 144 total sites. Of these, 70 had a rake fullness rating of 3, 36 rated a 2, and 35 a 1. Eurasian water milfoil was found growing at a maximum of 9.0 ft. during the pre-treatment survey and 7.5ft during the post-treatment survey.

The MFA sponsored a spring treatment that was administered by Northern Aquatic Services over the course of three days; May 11-13. The actual treated area was just shy of 119 acres. Water temperature was at 51°F on the days of application. During the post treatment survey, EWM was found at only 68 total sites. Of those, only four rated a 3, 10 rated a 2, and 54 rated a 1 with eight additional visual sightings, providing a highly significant reduction in EWM overall (Figure 11).

Within treated beds 1, 5, 7, 8, 18 and 24 the treatment appeared to provide effective control. Regularly scattered individual plants were found in Beds 1 and 8, but they were generally in poor condition. Bed 8 had the most residuals with some otherwise dead root balls with small side shoots starting to regrow. In Bed 5, EWM continued to be scattered throughout, although it didn't appear to be taking over. There was almost no evidence of residual plants in Beds 7, 18 or 24.

The treatment in Beds 14A&B showed moderately effective control. There were regularly scattered plants all around the perimeter of the treatment area, suggesting the treatment size was not adequate, as these plants were actively fragmenting and appeared to be recolonizing the treatment area.

Bed 21 in the North Basin showed moderate control on the east side that improved to the west and north. This treatment area was directly adjacent to a large area of untreated EWM contained within a stump field. Even though EWM within the treated area was significantly reduced it seemed likely that the area would get recolonized. However, 2010 was the first time in several years that the North Basin was truly navigable. The treatment completed in Bed 22 (Serenity Bay) only scratched the surface of the total EWM in that area. However, the 2010 treatment was much more effective than the 2009 treatment. The bay had large clumps of dead floating

EWM, was easily navigable, and showed widespread recolonization by native plants. Specifically, beds of Large-leaf pondweed (*Potamogeton amplifolius*) were expanding into areas previously dominated by monotypic EWM on the south and east sides of the bay.

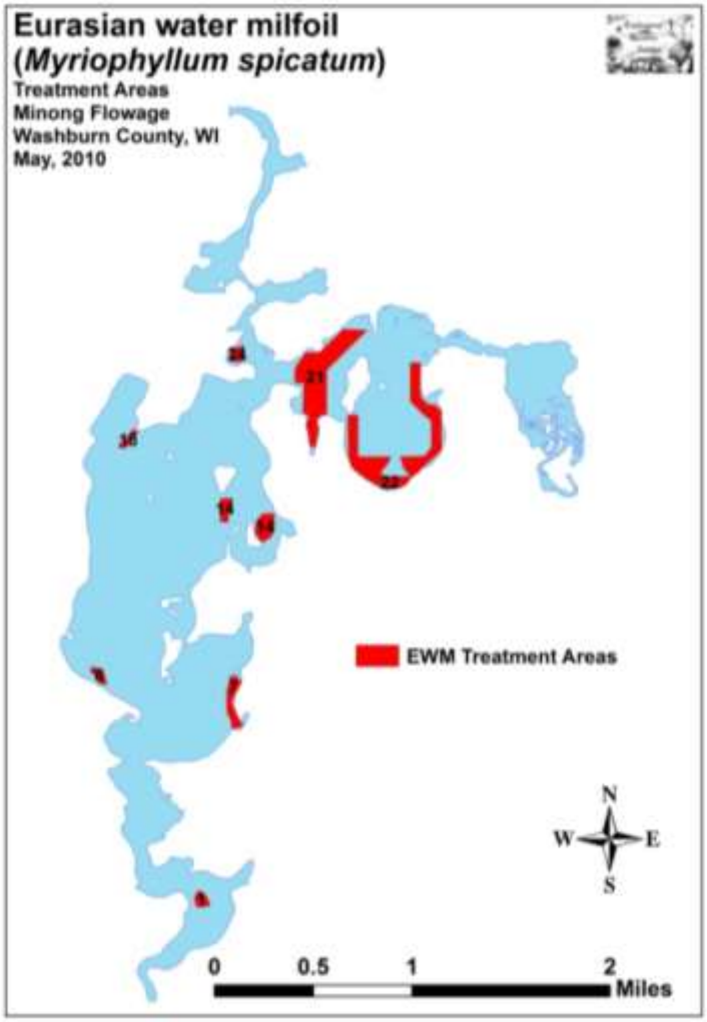
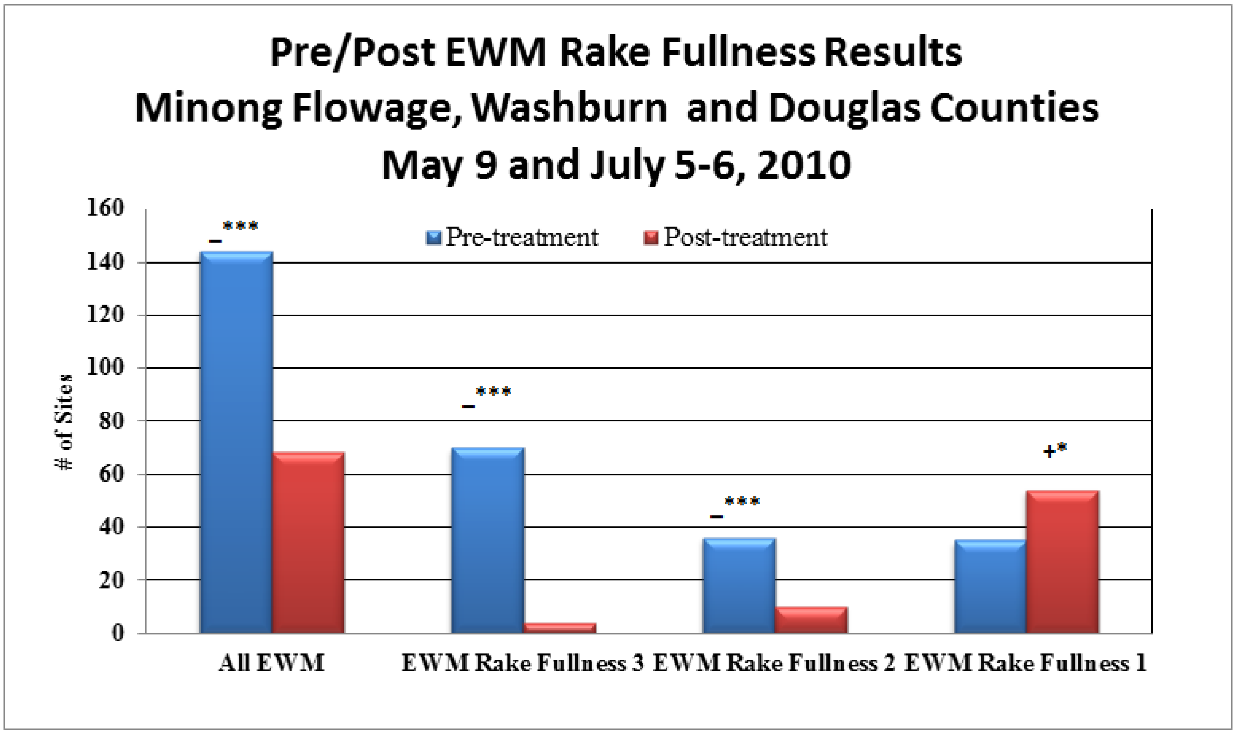


Figure 10: 2010 EWM treatment areas

Table 3: 2010 Herbicide Treatment Areas and Application Rates

Bed Number	Bed Size (Acres)	2,4-D Treatment Rate (#/Acre)
1-Near Dam	2.95	150
7-East Bay	7.65	125
8-County Park	2.5	150
14-DNR Bay	7.11	125
14A-DNR Bay	3.84	125
18-North Shore	2.14	150
21-North Basin	43.78	125
22-Serenity Bay	49.35	125
24-Chan from Cran	2.95	150
TOTAL	122.27	



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

Figure 11: Significant reductions in EWM after 2010 spring treatment

In the initial 2010 treatment proposal a bed of EWM just inside the East Basin (east of Smith Bridge) was proposed. From 2008 to 2010, a bed of EWM inside the East Basin was slowly expanding until in 2010 it was actually competing with the wild rice in the area. A 2010 early season treatment was cancelled in this area because of concerns about the wild rice. In its seedling stage, wild rice plants are susceptible to mortality from 2,4-D herbicide. Discussions were held through the 2010 season with St. Croix Tribal Resources about the possibility of a fall EWM treatment in the area, after wild rice had completed its growing season. Tribal Resources donated 12 50# bags of Navigate (granular 2,4-D) (Appendix C) and a treatment was completed on September 28 when water temperatures were at 58°F. Three small beds totaling 6.31 acres were chemically treated at the max label rate of 200 lbs./acre (Figure 12).

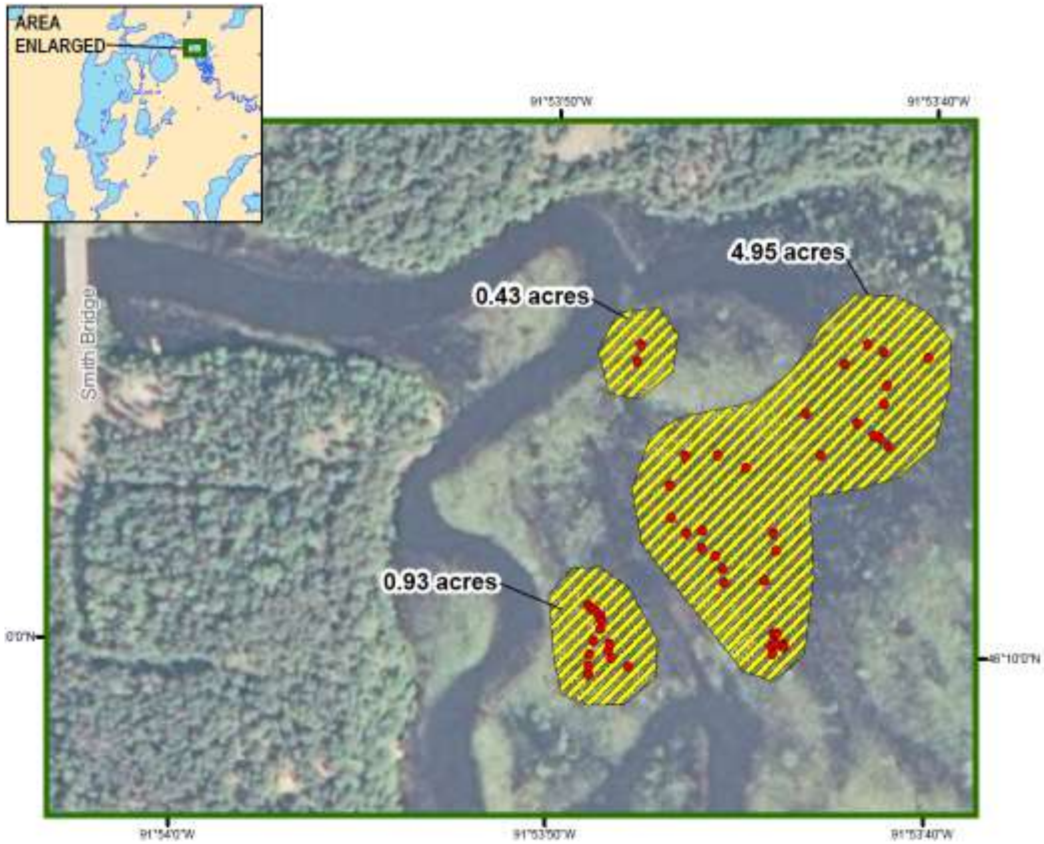


Figure 12: 2010 Fall EWM treatment in the East Basin

During 2010 fall EWM bed mapping, 34 beds of EWM ranging in size from 0.04 acres to a combined 144.35 acres were mapped. In total, these beds covered 163.74 acres. This represented a decline of 64.05 acres over 2009's 227.79 acres and a total decline of 162.01 acres over 2008's initial 325.75 total acres. Herbicide application over two years resulted in an approximately 50% reduction in the total EWM bed acreage on the Minong Flowage.

During the 2010 fall EWM bed mapping, those areas chemically treated in 2009 were revisited. In some cases, the 2010 treatment included the same area as was treated in 2009. In other cases, no chemical management was done in 2010. Despite the overall decline in acreage, many new beds appeared in 2010 including places where EWM had reestablished on beds that were treated in 2009. Specifically, beds along the County Park, West Shore, and in the DNR Bay were recolonizing, although in much less abundance and density. Beds in the Channel from Cranberry and East Bay were treated in both 2009 and 2010 and continued to show very low levels of EWM. The areas treated in the North Basin, Serenity Bay, and the DNR bay showed improvements over 2009, but still had pioneering clusters all over. It is not surprising that these beds still existed given that these areas had very limited chemical management in 2009. Chemical management in 2010 was the first large-scale treatment done in these areas with the goal of restoring native plants. All the other beds identified in the 2010 fall bed mapping survey were new beds in new areas (Figure 13). Water clarity in the Minong Flowage was better in 2009 and 2010, likely aiding the establishments of new beds. In addition to the main flowage area, the "pond" which is attached to the flowage near the county park campground was searched for EWM. Despite having canopied milfoil, it was almost all native Northern water milfoil rather than EWM.

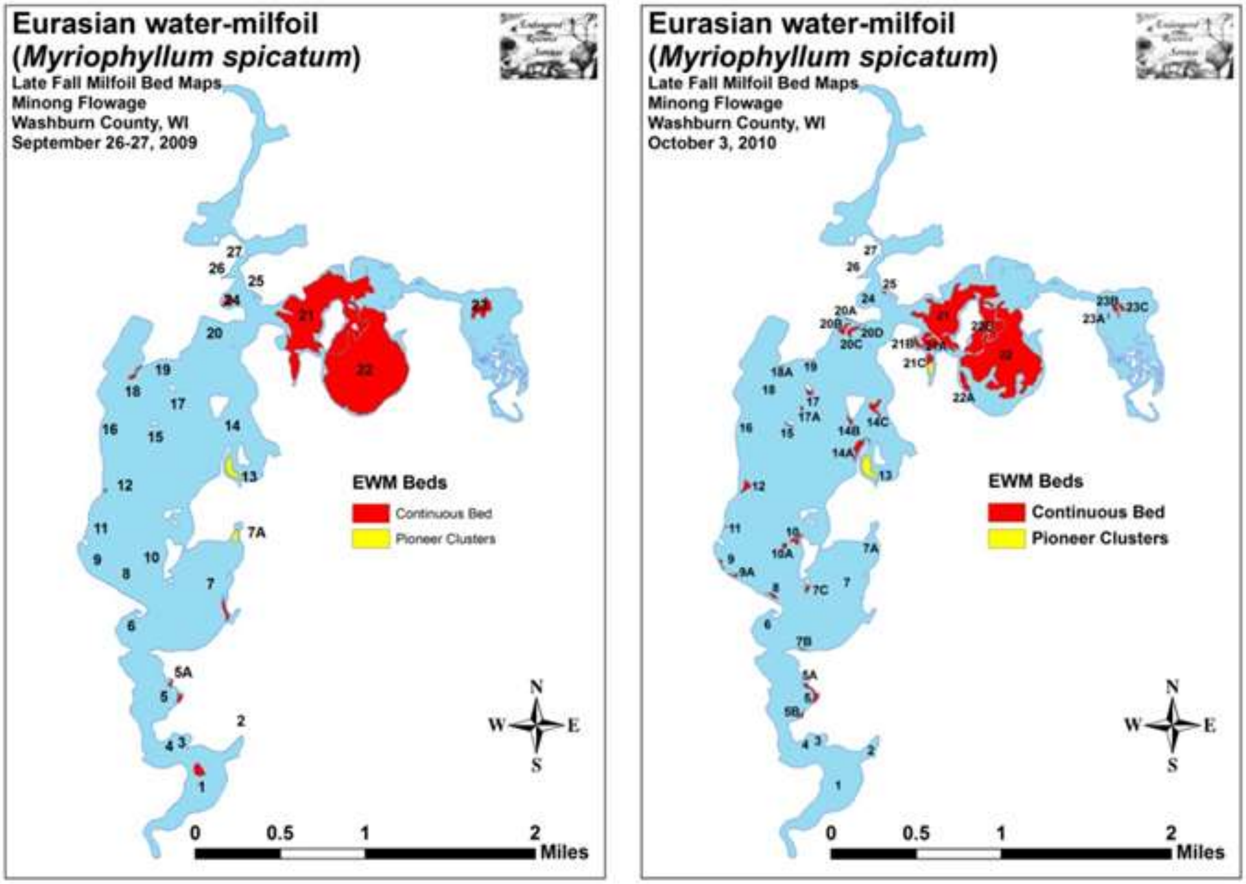


Figure 13: 2009 and 2010 fall bed mapping results

Monitoring for EWM weevils was completed in 2010 once a month at six sites from June through August in cooperation with the Swift Nature Camp and the Minong Flowage Association. During these events, Citizen Lake Monitoring Network (CLMN) weevil monitoring protocol was followed. A fourth weevil monitoring event was held in early September in cooperation with the Northwoods/Solon Springs 5th grade Outdoor Education Camp, but this was not completed according to CLMN protocol as it was primarily a learning event for the students, not an attempt to scientifically document weevil activity. During the first three inspection events, 180 EWM fragments were collected; separated by site and sub-site and placed in zip lock bags for transport back to the camp facility where the rest of the students and their counselors would gather outside to complete the fragment inspection.

The first event was held on June 24 with a density of only 0.24 signs of weevil activity per stem collected. The second event was held on July 13 with a density of 2.54 signs of weevil activity per stem collected. The last event was held on August 4 with 0.84 signs of weevil activity per stem collected. These numbers are likely low, given the number of inexperienced "stem searchers" there were for each event, but still indicate decent weevil activity in Serenity Bay and the North Basin.

Chemical concentration testing was also completed in 2010. Water samples were collected at 11 sites within and outside of treatment areas before treatment, and at 1,4,7,14 and 21 days after treatment. Modifications were made in the SLOH capability to process the samples with the immunoassay they were using. Samples were diluted to give more accurate estimates of the chemical concentration in the samples. Only three sites out of eleven exceeded the irrigation standard for 2,4-D of 100 parts per billion (ppb). All sites were below the limit set for human drinking water by day fourteen (Figure 14).

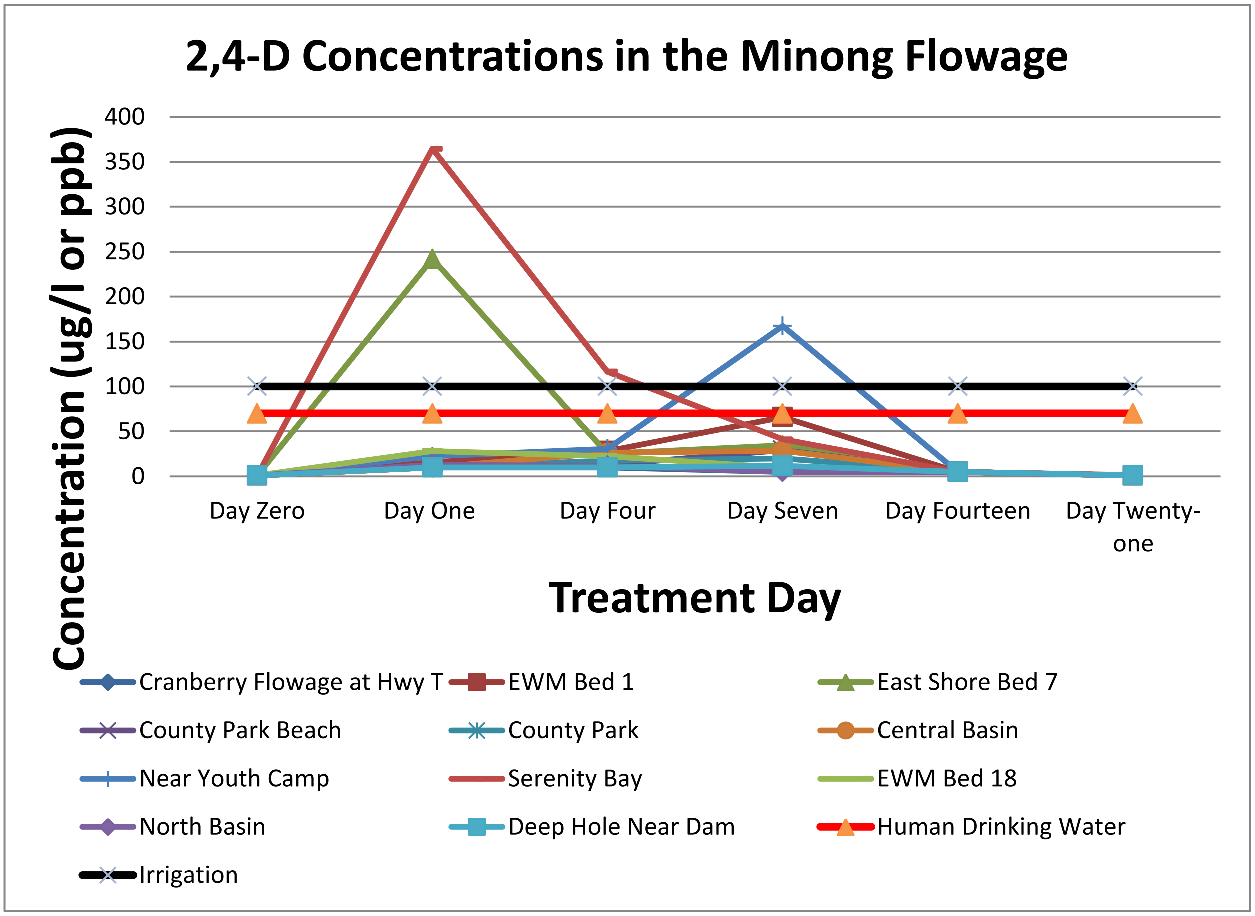


Figure 14: 2010 chemical concentration results

A full report on the results of the 2010 herbicide application program and monitoring actions is available in two documents: Eurasian Water Milfoil Pre/Post Herbicide and Bed Mapping Surveys - Minong Flowage, Washburn County, Wisconsin (Berg 2010).

2011

Herbicide application was again used in 2011 to control EWM. The final 2011 early season EWM treatment proposal was based on 2010 late summer EWM survey work, the results of the 2010 treatments, and results from the 2011 pre-treatment aquatic plant survey. Eleven beds of EWM ranging in size from 0.88 to 43.30 acres were targeted for chemical treatment using granular 2,4-D (Navigate) applied at 125-150 lbs./acre depending on depth and size of the treatment area. Beds less than 4 acres were treated Near Dam, County Park, DNR Bay, and North Shore at 150-lbs/acre. Four beds of 8.66, 11.68, 12.18, and 43.3 acres were treated in the North Basin and Serenity Bay at 125-lbs/acre (Figure 15, Table 4). The total planned application was 87.08 acres. No navigation channels were treated in 2011, as EWM management continued to focus on restoration verses nuisance relief.

A pre-treatment survey of 375 points completed by Endangered Resource Services identified EWM at 95 total sites. Of these, 24 had a rake fullness rating of 3, 32 rated a 2, and 39 a 1. Eurasian water milfoil was found growing at a maximum of 8.0-ft during the pre-treatment survey and 7.5-ft during the post-treatment survey.

The MFA sponsored a spring treatment was administered by Northern Aquatic Services over the two days; June 7-8. The actual treated area was 87.08 acres. Water temperature was between 69 and 73°F on the days of application. During the post treatment survey, EWM was found at only 22 total sites. Of those, only one rated a

3, 10 rated a 2, and 11 rated a 1 with only one additional visual sighting, providing a highly significant reduction in EWM overall (Figure 16). Of all the post treatment sites with EWM, only one was actually in the treated area.

Within treated beds, only one point actually had EWM for a nearly 100% control of EWM in these areas. The herbicide concentrations applied in 2011 were the same as those applied in 2010 however results were much more complete in 2011. Conditions during application were warmer than usual, as on June 7th ambient air temperatures exceeded 90°F after several weeks of cooler than normal spring temperatures. It is speculated that the sudden and extreme change in air temperature may have stimulated a sudden burst of plant growth, just when the herbicide was applied. There is no way to substantiate this idea though.

This treatment also had more negative impacts on native plant growth than previous treatments as coontail, fern-leaf pondweed, common waterweed, and needle spikerush all experienced significant declines from pre to post. Several other plant species including large-leaf pondweed and northern water milfoil also declined from pre to post, although their decline was not significant.

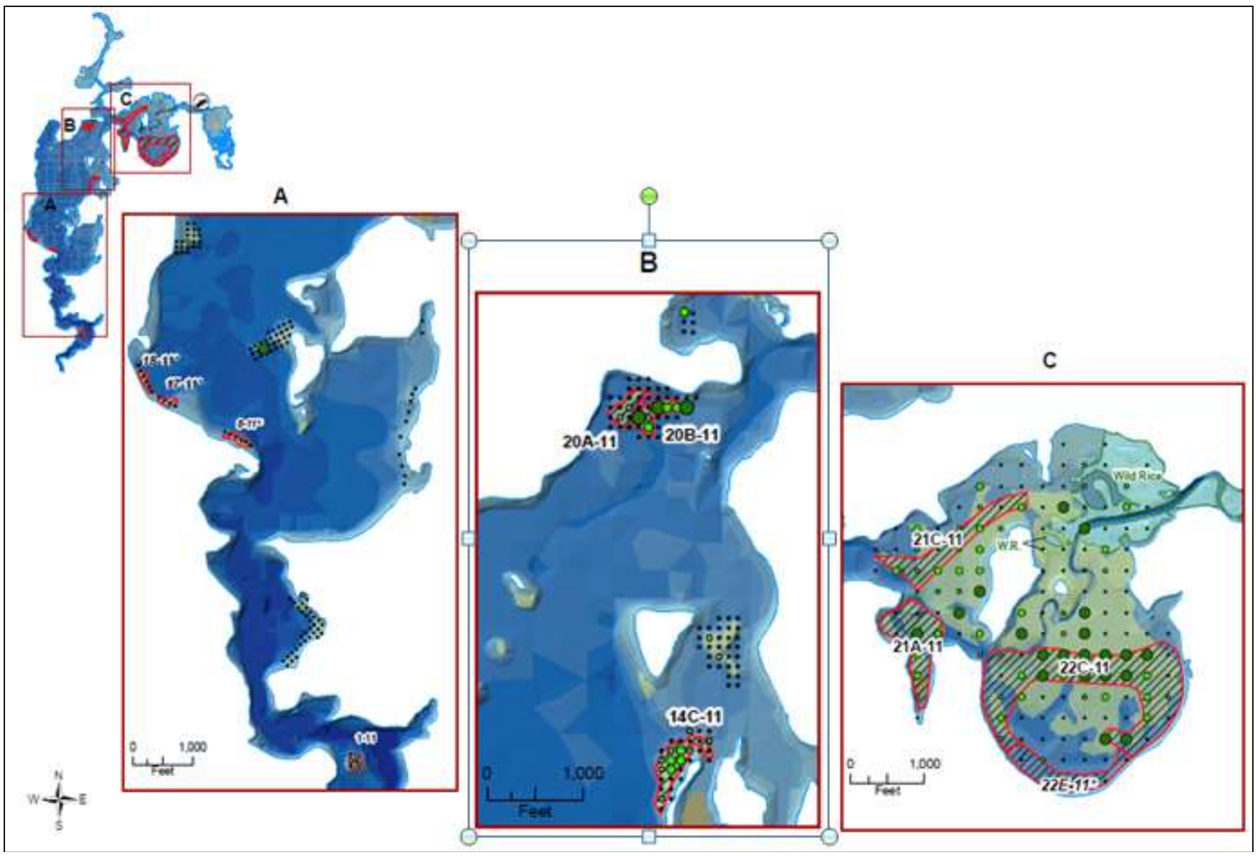
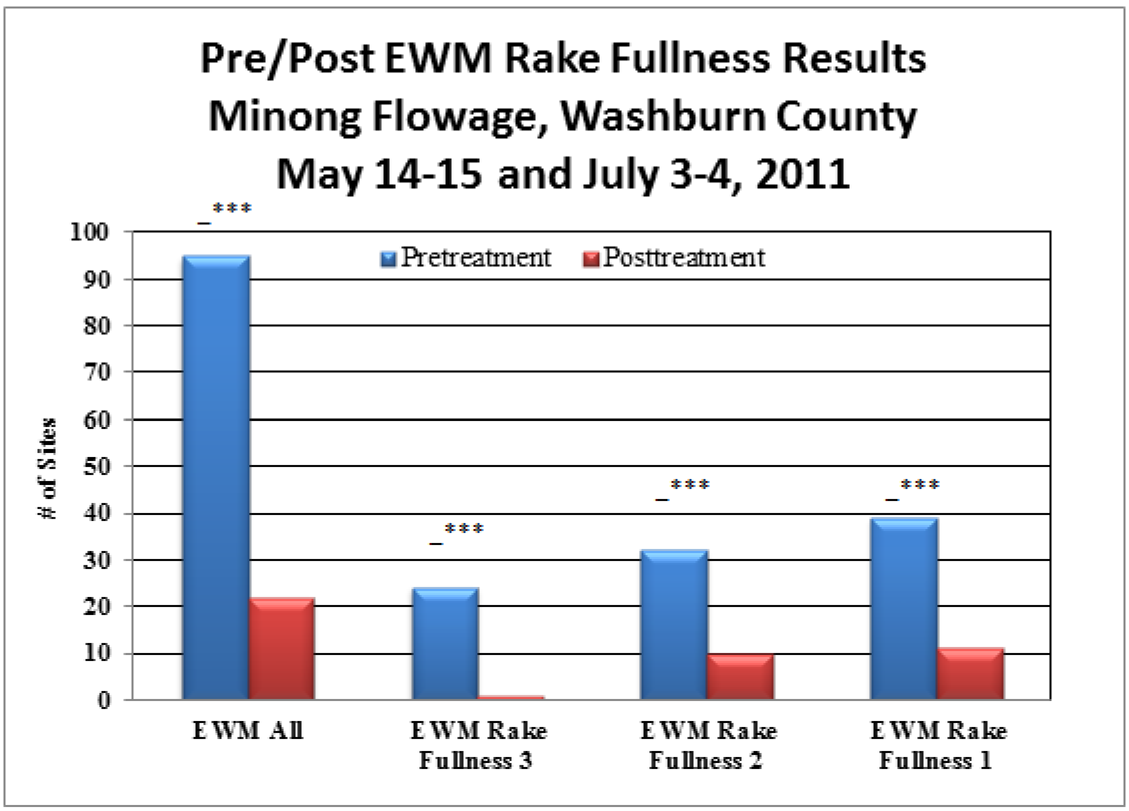


Figure 15: 2011 EWM treatment areas

Table 4: 2011 Herbicide Treatment Areas and Application Rates

Bed Number	Bed Size (Acres)	2,4-D Treatment Rate (#/Acre)
1-11 Near Dam	1.07	150
8-11 County Park	1.05	150
14C-11 DNR Bay	3.7	150
17-11 County Park	0.88	150
18-11 County Park	0.88	150
20A-11 North Shore	1.8	150
20B-11 North Shore	1.88	150
21A-11 North Basin	12.18	125
21C-11 North Basin	11.68	125
22C-11 Serenity Bay	43.3	125
22E-11 Serenity Bay	8.66	125
TOTAL	87.08	



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

Figure 16: Significant reductions in EWM after 2011 spring treatment

Despite the total acreage decline in 2010, by the October 2010 bed mapping survey, an expanded littoral zone apparently due to improved water clarity throughout the growing season had allowed EWM to expand into many areas where it had not previously been seen. Following a winter with deep snow cover and a return to more "normal" clarity on the flowage throughout the 2011 growing season, EWM disappeared from most of the areas it had newly colonized the previous fall. It also showed a marked pull back along the littoral edges of historic beds regardless of whether they were treated with herbicide in 2011 or not.

During the October 2011 fall bed mapping survey, 28 EWM beds ranging in size from 0.05 acre (Beds 17A, 18 and 18B) to a combined 77.22 acres (Beds 21 and 22) were mapped (Figure 17). In total, these beds covered 80.95 acres. This represented a decline of 82.79 acres over 2010's 163.74 acres and a total decline of 244.80 acres over 2008's initial 325.75 total acres. After three years of herbicide application, there had been an approximately 75% reduction in the total EWM bed acreage on the flowage. Despite this continued positive change, it should be kept in mind that at least some of this reduction must be attributed to 2011 growing conditions.

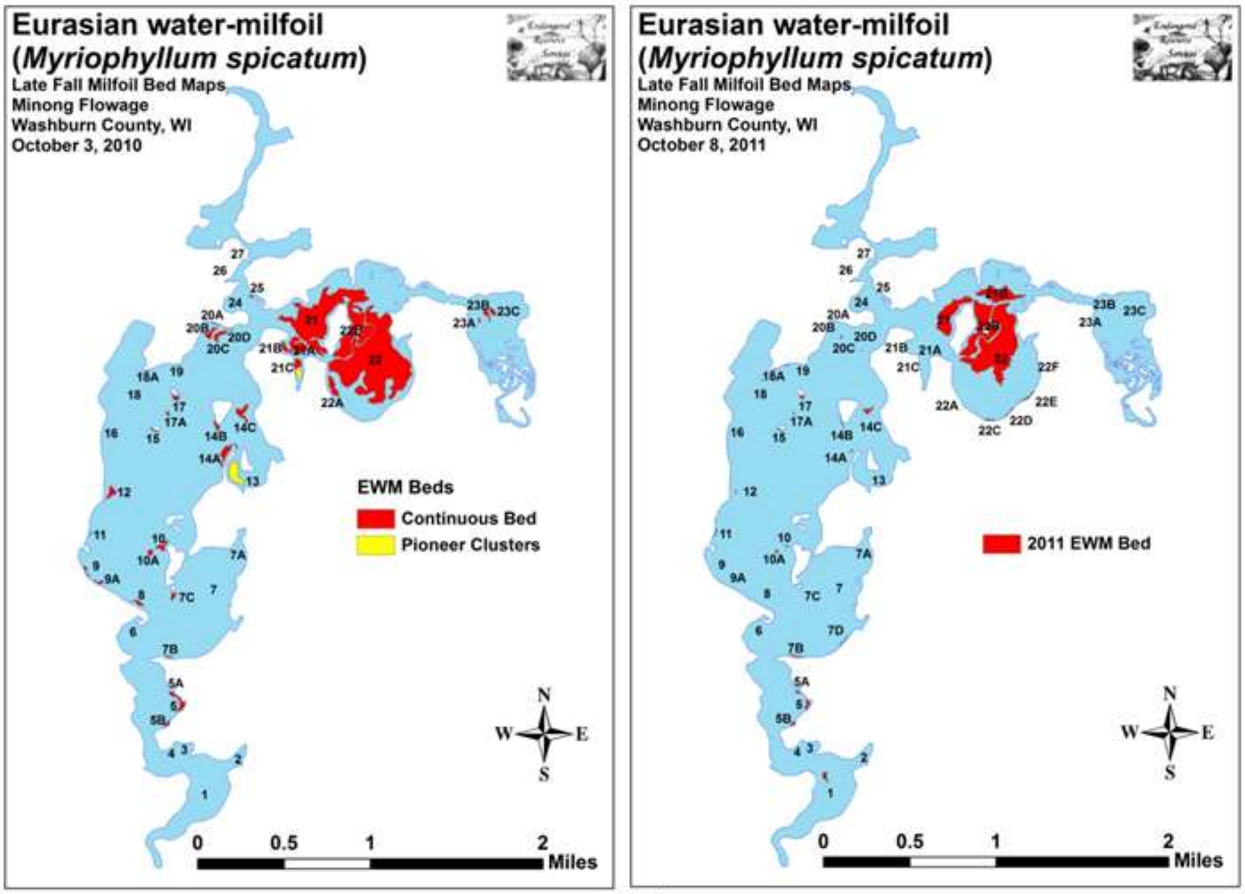


Figure 17: 2010 and 2011 Fall Bed Mapping Results

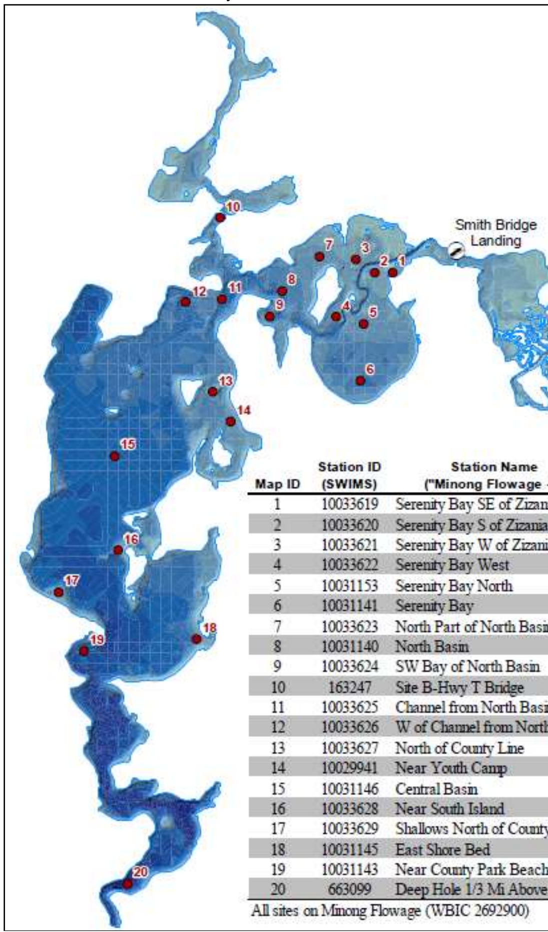
In the south basin, Bed 1 Near Dam continued to provide suitable habitat for EWM to establish on. Beds 5, 5A, and 5B along the east shore were mixed with natives and were between an EWM bed and just a "high density area". Beds 7B, 7D, 10, 10A, 15, 17, and 17A in the Central Basin and along the East Shore were small EWM beds that, although not significant on their own, continue to source out fragments to surrounding areas. Along the West Shore and in the DNR Bay (Beds 11, 12, 14A, 14B, 14C) continue to trap fragments and reestablish each year. Beds 9, 9A, 7, 7A, 20A&B, 24, and 25 along the County Park, in the East Bay, along the North Shore, and in the Channel to Cranberry were essentially free of EWM after three years of treatment.

The "super bed" (so called by the Plant Surveyor) in Serenity Bay (Bed 22) shrank inward in 2010 and in 2011 with the North Basin (Beds 21A,B&C) and treated areas of Serenity Bay remaining clear into the fall of 2011. EWM continued to expand into the rice beds on the northeast end of Bed 21B and expand along the majority of the south and southeast shoreline of Serenity Bay (Beds 22A, 22C-F). In the East Basin, a handful of plants were found in the core of the former Bed 23C. The rest of the area appeared clear of EWM by the fall of 2011.

In 2011, the MFA and Swift Nature Camp were one of three groups in the state who participated in a pilot project with Amy Thorstenson of Golden Sands RC&D to set up a volunteer weevil rearing project. Ten 100 gallon stock tanks were set up at the Nature Camp with the assistance of the MFA consultant and Amy

Thorstenson. Each tank was filled with well water, given a specified amount of EWM in small bundles, covered with "no-see-um" netting, monitored for temperature. Each tank was inoculated with approximately 72 starter weevils, and was maintained for approximately 55 days to allow at least two full generations of weevils to be produced. Fresh EWM was placed in the tanks at specified times to provide a fresh food source for the weevils. Prior to the EWM in the tanks (and hence the weevils) being distributed in the Minong Flowage, a 10% subsample was taken by Ms. Thorstenson and analyzed for average return rate and total estimated production based on the 10% subsamples. The expected return rate for the MFA set-up was 9.6 weevils out per each weevil stocked. The estimated return rate for the Minong Flowage was only 1.8; 720 weevils were initially stocked to the10 rearing tanks, and total production was estimated at 1,300 weevils. For more information on the EWM weevil rearing project can be found in the report written by Ms. Thorstenson - Mass Rearing of Milfoil Weevils (*Euhrychiopsis lecontei*) by Volunteers: Pilot Study Phase I (Thorstenson 2012).

Chemical concentration testing was again completed in 2011. Twenty sites throughout the Flowage (Figure 18) were sampled with sites 1-9 sites being sampled prior to, and 1,2,3,4,5,6,7,14&21 days after treatment, and sites 10-20 being sampled prior to, 1,4,7,&14 days after treatment.



Map ID	Station ID (SWIMS)	Station Name ("Minong Flowage - ")	Latitude	Longitude
1	10033619	Serenity Bay SE of Zizania	46.16755	-91.90717
2	10033620	Serenity Bay S of Zizania	46.16751	-91.90898
3	10033621	Serenity Bay W of Zizania	46.16841	-91.91095
4	10033622	Serenity Bay West	46.16428	-91.91283
5	10031153	Serenity Bay North	46.16383	-91.91000
6	10031141	Serenity Bay	46.15973	-91.91020
7	10033623	North Part of North Basin	46.16856	-91.91470
8	10031140	North Basin	46.16603	-91.91843
9	10033624	SW Bay of North Basin	46.16419	-91.91962
10	163247	Site B-Hwy T Bridge	46.17116	-91.92500
11	10033625	Channel from North Basin	46.16535	-91.92458
12	10033626	W of Channel from North Basin	46.16507	-91.92828
13	10033627	North of County Line	46.15869	-91.92529
14	10029941	Near Youth Camp	46.15659	-91.92340
15	10031146	Central Basin	46.15392	-91.93520
16	10033628	Near South Island	46.14720	-91.93461
17	10033629	Shallows North of County Park	46.14409	-91.94062
18	10031145	East Shore Bed	46.14099	-91.92633
19	10031143	Near County Park Beach	46.13992	-91.93787
20	663099	Deep Hole 1/3 Mi Above Dam	46.12333	-91.93279

All sites on Minong Flowage (WBIC 2692900)

Figure 18: 2011 Chemical Concentration Testing Locations

Figure 19 reflects the concentration results for all 20 sites. Sites 1-3 in the north end of Serenity Bay were closest to the wild rice beds and results show that the herbicide never reached detectable levels in this area. Concentrations in the lower half of Serenity Bay (Site 6, Figure 20) and in the North Basin (Site 9, Figure 20) were highest reaching and maintaining150-180 ppb for three days between Days 3 & 6. Chemical concentration levels in the rest of the treated areas remained under 50 ppb and was mostly gone by Day 14, and completely gone by Day 21 (Figure 20).

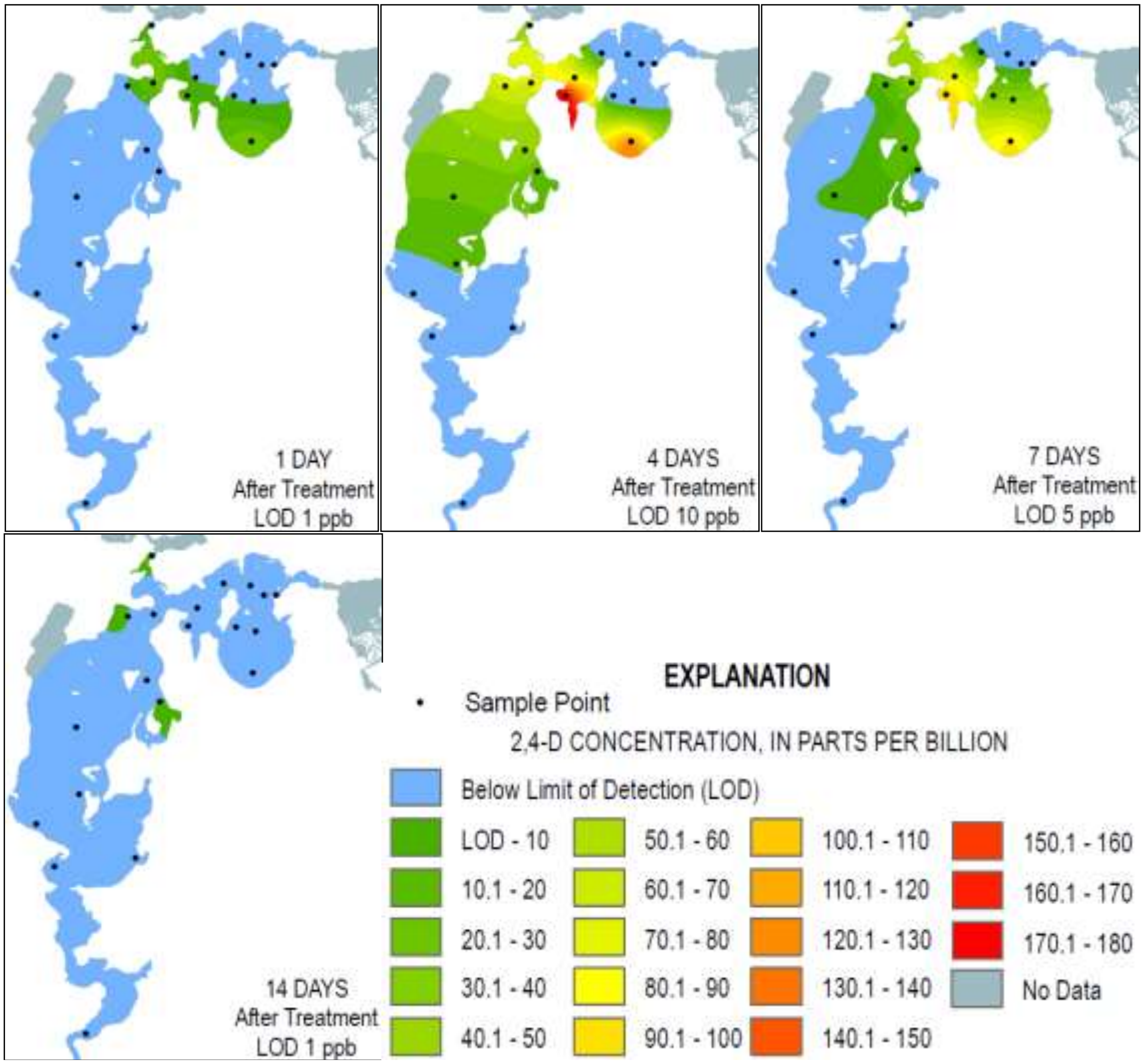


Figure 19: 2011 partial chemical concentration results Days 1,4,7&14

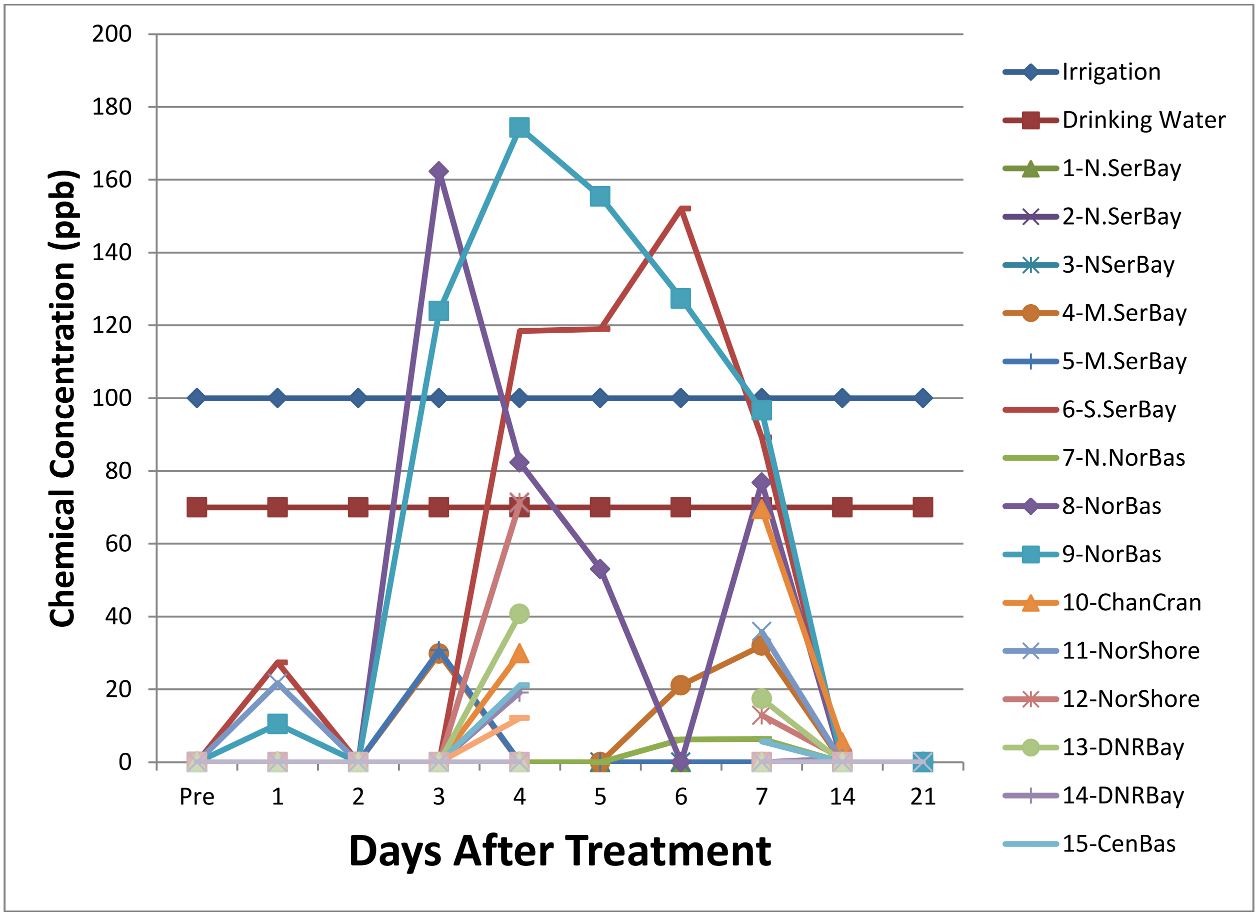


Figure 20: 2011 chemical concentration results

In 2011, the Voigt Inter-Tribal Task Force, an Ojibwe Nation Committee that addresses matters that affect the treaty rights of the member tribes in the 1837 and 1842 Treaty ceded territories recommending policy regarding inland harvest seasons, resource management issues, and budgetary matters, voiced concern over the use of herbicides in the Minong Flowage on behalf of the St. Croix Band of Ojibwe. Discussions between the St. Croix Band, MFA, and WDNR were had in an attempt to show that aquatic herbicides were being used in a safe and appropriate manner on the Minong Flowage with added efforts to make sure wild rice was not being negatively impacted, but in the end the St. Croix Band did not approve it use. On May 26, 2011, a letter was sent GLIFWC by the WDNR recognizing the Task Force's concern and reasons for not endorsing the use of herbicides, but stating that the permit for chemical application would be approved (Appendix D).

2012

Based on the results of the 2011 treatment and fall bed mapping survey, a EWM management proposal was made to treat 24 beds of EWM ranging in size from 0.18 – 8.31 acres and totaling 19.79 acres. Only three of the proposed treatment areas exceeded 1.0 acres (DNR Bay-1.10 ac, Near Dam-2.31ac, and Serenity Bay-8.31 acres). The rest were scattered around the Flowage (Figure 21). Labeling changed on products using 2,4-D from application based on lbs. per surface acre, to application based on parts per million (ppm) per acre-foot of water. The initial 2012 proposal was based on 1.5 ppm of herbicide applied per acre-foot using granular 2,4-D (Navigate). When compared to past treatments based on lbs. per surface acre, concentration ranged from 51.1 – 255.6 lbs./acre (Figure 21).

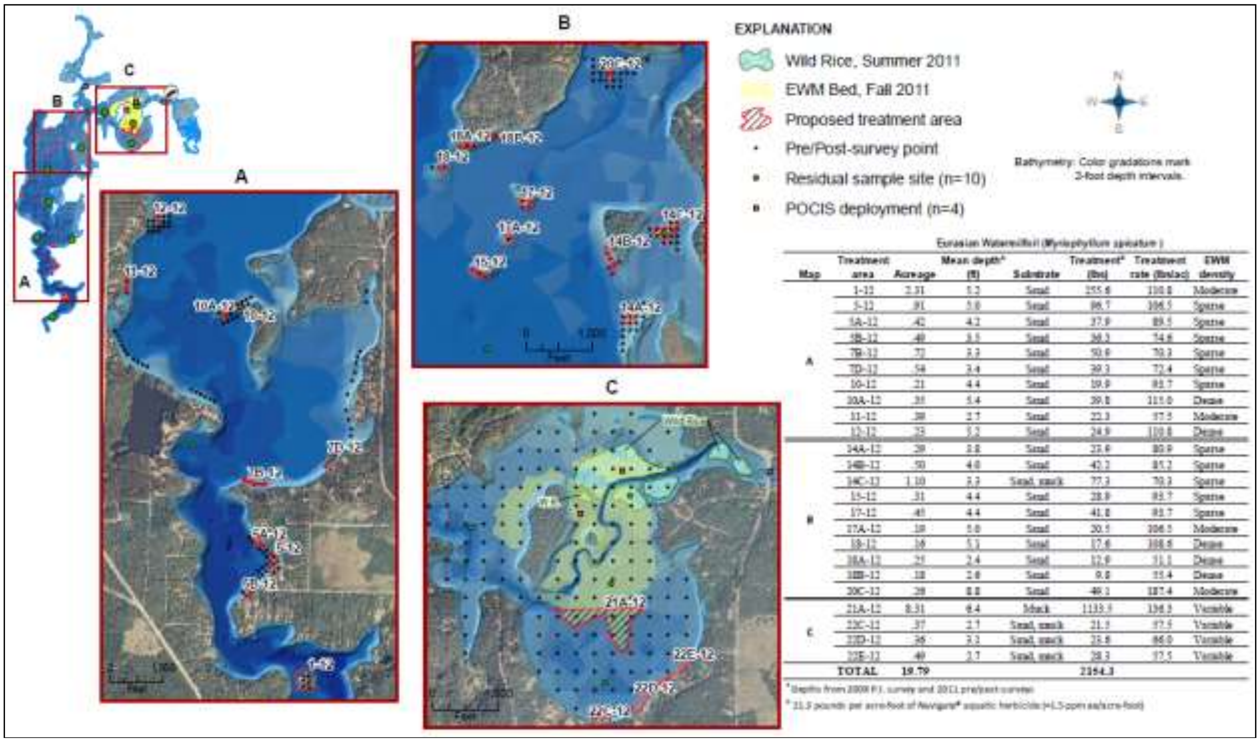
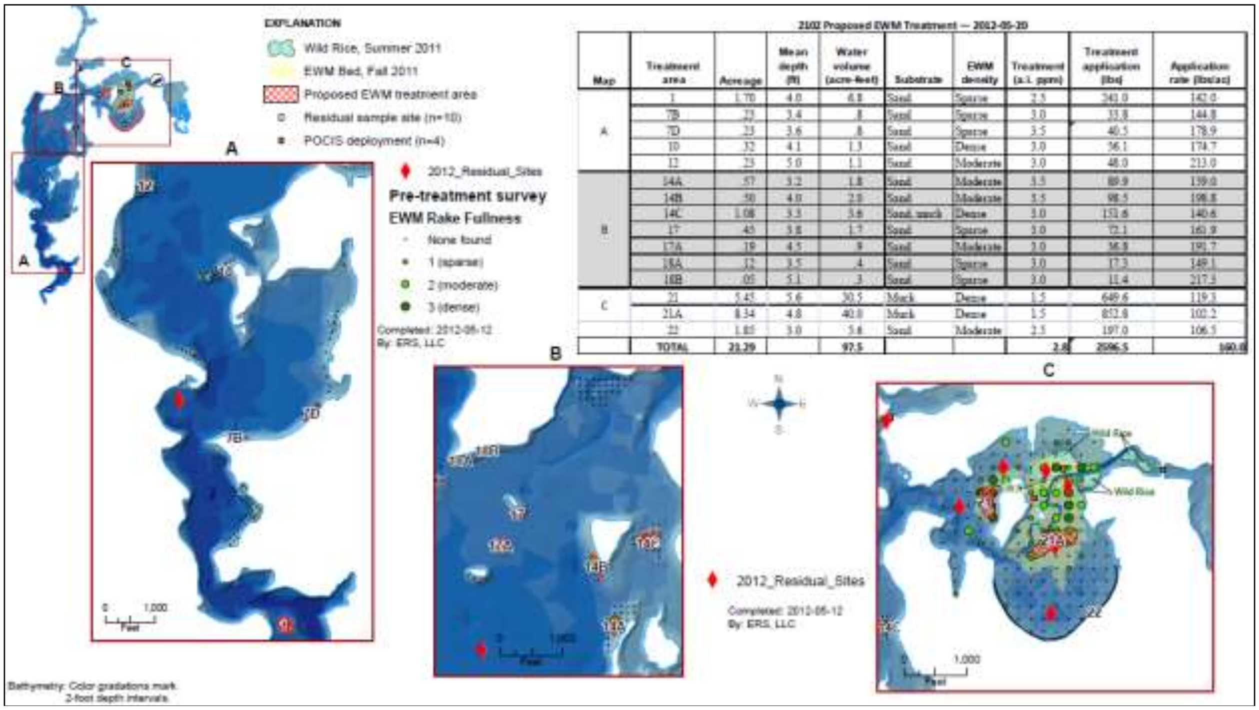


Figure 21: 2012 Preliminary EWM Herbicide Management Proposal 3/23/2012

A pre-treatment aquatic plant survey of 375 points was completed on May 12. During the survey, EWM was found growing at a maximum of 7.5-ft however, most EWM was in <6ft of water. EWM was found at 70 total sites during the pretreatment survey. Of these, 13 had a rake fullness rating of 3, 20 rated a 2, and 37 a 1. EWM was also recorded as a visual at 18 additional points. Collectively, it was the most common species being found at 55.91% of points with vegetation and accounting for 31.84% of the total relative frequency. Curly-leaf pondweed (*Potamogeton crispus*), another exotic invasive species, was found at 35 points of which two rated a 3, 13 rated a 2, and 20 rated a 1 with six additional visual sightings. It was the second most common species being found at 27.56% of points with vegetation and accounting for 15.70% of the total relative frequency. During the pre-treatment survey, fern-leaf pondweed and Coontail were found to be the most common native plant species. They were present at 18.11% and 15.75% of sites with vegetation and collectively accounted for 19.28% of the relative frequency. Northern wild rice was found at four points and was a visual at two others. All of these points were well away and upstream from the treatment areas.

Based on these results, the 2012 proposed treatment areas were modified, as were the proposed concentrations used in each individual treatment area. The changes resulted in 15 EWM beds ranging in size from 0.05 to 8.34 acres totaling 21.29 acres (Figure 22). Five areas (Near Dam, DNR Bay, North Basin, and Serenity Bay (two areas)) exceeded 1.0 acres in size. Treatment concentrations based on ppm per acre-foot were modified to account for size of treatment area and ranged from 1.5 to 3.5 ppm (102.2 to 217.3 lbs./acre). The average concentration for all proposed treatment areas was 2.8 ppm or 160 lbs./acre.

To address Tribal concerns related to wild rice, ten chemical concentration testing sites were proposed as was the installation of four Polar Organic Chemical Integrative Sampler (POCIS) devices to monitor pesticide concentrations in and around the wild rice beds (Figure 22). POCIS devices (Figure 23) 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 that have been done before. 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. For more information about POCIS devices and how they can be used, refer to Appendix E.



Map	Treatment area	Acreage	Mean depth (ft)	Water volume (acre-feet)	Substrate	EWM density	Treatment (a.i. ppm)	Treatment application (lbs)	Application rate (lbs/ac)
A	1	1.70	4.0	6.8	Sand	Sparse	2.5	241.0	142.0
	7B	.23	3.4	.8	Sand	Sparse	3.0	33.8	144.8
	7D	.23	3.6	.8	Sand	Sparse	3.5	40.5	178.9
	10	.32	4.1	1.3	Sand	Dense	3.0	56.1	174.7
	12	.23	5.0	1.1	Sand	Moderate	3.0	48.0	213.0
B	14A	.57	3.2	1.8	Sand	Moderate	3.5	89.9	159.0
	14B	.50	4.0	2.0	Sand	Moderate	3.5	98.5	198.8
	14C	1.08	3.3	3.6	Sand, muck	Dense	3.0	151.8	140.6
	17	.45	3.8	1.7	Sand	Sparse	3.0	72.1	160.9
	17A	.19	4.5	.9	Sand	Moderate	3.0	36.8	191.7
	18A	.12	3.5	.4	Sand	Sparse	3.0	17.3	149.1
	18B	.05	5.1	.3	Sand	Sparse	3.0	11.4	217.3
C	21	5.45	5.6	30.5	Muck	Dense	1.5	649.6	119.3
	21A	8.34	4.8	40.0	Muck	Dense	1.5	852.8	102.2
	22	1.85	3.0	5.6	Sand	Moderate	2.5	197.0	106.5
	TOTAL	21.29		97.5			2.8	2596.5	160.0

Figure 22: 2012 final EWM herbicide management proposal 5/16/2012

Figure 23: POCIS devices (discs with white centers) shown mounted in a deployment canister (Source: www.est-lab.com/pocis.php)

At the beginning of 2012 it was learned that Washburn County would be making modifications to the dam on the Totagatic River that created the Minong Flowage. The dam work would necessitate an extended drawdown of the waters in the Minong Flowage through a good portion of the 2013 season. Tribal concerns also continued related to the use of herbicides in the Minong Flowage and the possible impact on wild rice. As in 2011, discussion was had between the MFA, WDNR, and the Voigt Inter-Tribal Task Force related to the 2012 proposed EWM management plan. In the end, the permit for herbicide application was denied by the WDNR based on Tribal concerns and the pending drawdown and no management involving herbicide was completed. Because of this, the post-treatment survey was cancelled. The 2012 fall bed mapping was completed as scheduled to determine how EWM levels had changed throughout the 2012 growing season. In addition, a whole-lake, point-intercept, aquatic plant survey of the entire Flowage was completed to help determine overall impacts on the Minong Flowage that may have been caused by three years (2009-2011) of active and large-scale herbicide management. This survey would be a repeat of the whole-lake, point-intercept, aquatic plant survey completed in 2008.

A fall EWM bed mapping survey completed on September 8, 2012 identified 19 beds of EWM on the flowage ranging in size from 0.07 acre (Bed 10A) to a combined 76.89 acres (Beds 21 and 22) (Figure 24). In total, these beds covered 92.89 acres. This total represented an increase of 11.96 acres (+14.75%) over the 80.95 acres mapped in October of 2011. It was suggested by the Aquatic Plant Surveyor that this expansion may have been greater if more normal water clarity in 2012 hadn't produced a somewhat narrower littoral zone in 2012, although this cannot be substantiated.

EWM plants/beds in <4ft of water in the central basin of the Flowage showed evidence of continued thickening and expansion since the May pretreatment survey, however in water >4ft, EWM beds had narrowed and/or thinned, and, in many cases, disappeared altogether. In areas of Serenity Bay and the North Basin not treated in 2011 and shallower than 6-ft of water generally showed stability or expansion. This was especially true on the north and west sides of Bed 21B (Figure 24) north of the main river channel. EWM beds in water >6ft showed continued shrinkage.

East of Smith's Bridge, EWM showed continued expansion to the west, south, and east of the former beds that had been nearly eliminated by past treatments. It was noted by the Aquatic Plant Surveyor that this expansion may have been even worse than what was mapped as, out of a desire to not damage the mature rice, binoculars and a laser range finder were used to estimate how far EWM had expanded into the rice bed. It was the determination that EWM had essentially spread throughout the entire rice bed that were bordered by the channels on the west, south, and east sides of the bay. At the core, the bed was canopied and had become monotypic excluding all other species.

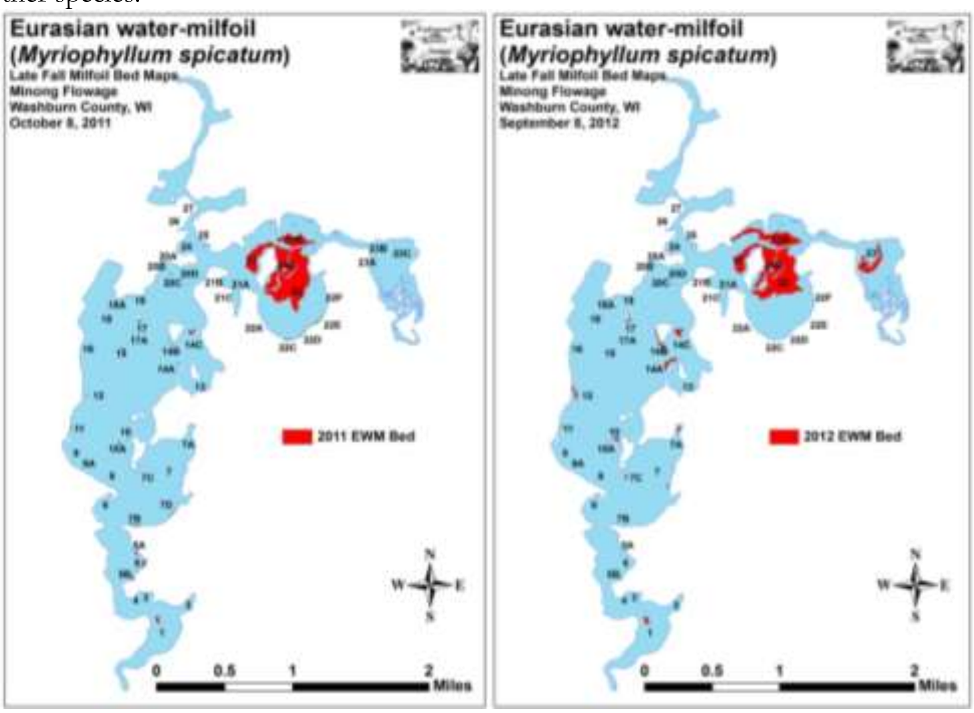


Figure 24: 2011 and 2012 Fall EWM Bed Maps

In 2012, weevil monitoring, in cooperation with Swift Nature Camp Directors, Counselors, and Campers, was completed on two different dates; July 9th, and July 30th. The procedures used to monitor for the presence of weevils on the Minong Flowage did not follow official weevil monitoring guidelines as established by the Citizen Lake Monitoring Network. There are several reasons for this. First, the activity, done in cooperation with the Nature Camp is intended to be an education experience for the entire camp to be involved in. When fragments are brought into the camp on the day of the count, time is taken in front of the entire camp to explain what the issue is; talk about the invasive plant; discuss management actions on the Flowage; lay out the reasons why this kind of monitoring is beneficial; and explain how the individual person and the larger group can take part.

Once this is done, the goal is for campers to find adult weevils, and identify secondary life stages and stem damage if possible. Hundreds of fragments are examined in a short period of time. This educational practice had been happening for 4 years, and many of the returning camp counselors and a few of the returning campers have experienced it for several years.

Data recording is completed during these events. Each set of campers is given a record sheet where they are to use hash marks to keep track of the number of fragments they look at, the number of each life stage they identify, and the amount of stem damage they encounter. These sheets are then collected at the end of the event and numbers tallied. When working with 40-80 students ranging in age from 10-20 years, it is difficult to make sure they all record their data appropriately, so the recording sheets are at best a representative sample of what was actually found. During the two 2012 sampling events, weevil life stages and stem damage occurred on approximately 55% of the fragments inspected.

In addition to the two weevil counts, the Swift Nature Camp set up and managed a weevil rearing project in cooperation with Amy Thorstenson of the Golden Sands RC&D. This was the second year that the camp has been involved in this rearing project. In 2011, 10 100-gallon stock tanks were set up. The 2012 project only set up 5 tanks, and was much easier to manage. The 2012 station was set up on June 19 under the guidance of Ms. Thorstenson. Throughout the summer season, several camp counselors took responsibility for keeping the rearing tanks full of water, taking temperature measurements, and completing additional bundling when necessary. The weevils reared, were released into the North Basin in early August. Ms. Thorstenson collected samples from several of the tanks to take back to her lab and do an official count. There were issues with the setup including low sun, not enough quality EWM for food, and a minnow in one of the tanks, so results were low only producing 1.5 weevils per weevils put in at the start.

For more information about 2011 Management efforts consult the following documents: 2012 Minong Flowage Task Update: Minong Flowage AIS Management Implementation (Blumer 2012), and Eurasian Water Milfoil Pretreatment and Fall Bed Mapping Surveys Minong Flowage - Washburn and Douglas Counties, Wisconsin (Berg 2012).

2012 WHOLE-LAKE, COLD AND WARM WATER POINT-INTERCEPT SURVEY

Following the confirmation of EWM in 2002 and the development of an Aquatic Plant Management Plan in 2008, the Minong Flowage Association began managing the infestation with herbicide applications that totaled approximately 284 acres from 2009 to 2011. As a prerequisite to updating the flowage's APMP and to compare how the flowage's vegetation had changed since the last point-intercept survey in 2008, CLP density and bed mapping surveys on May 27th and June 2nd, and a full point intercept survey from July 21-23, 2012 were completed. The cold water survey found CLP at 38 points which extrapolated to 4.3% of the flowage – a highly significant increase over 2008 totals (Figure 25). In June 2012, 15 CLP beds totaling 27.04 acres and covering 1.7% of the flowage were mapped.

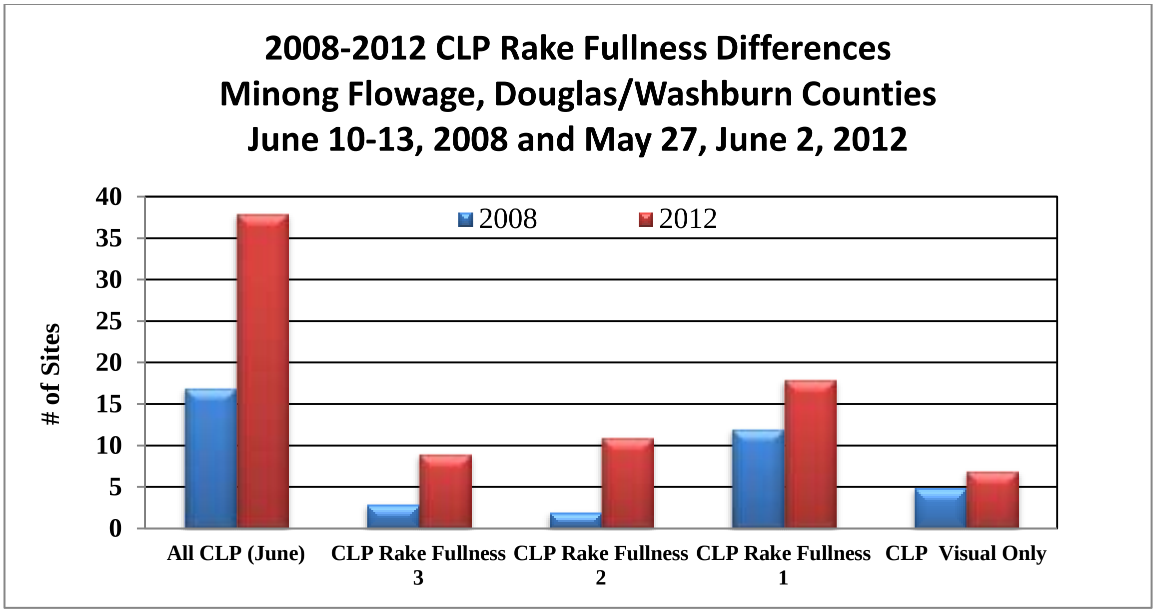


Figure 25: 2008 and 2012 change in CLP rake fullness

EWM, the second most common species in the July 2012 survey, was found at 57 points and accounted for 6.59% of the rel. freq. This represented a highly significant decline from the 2008 survey when it was found at 166 points/11.59% of the relative frequency. EWM density had also shrunk as only six points rated a rake fullness rating of 3, and 14 points rated a 2. The remaining 37 points were a 1, and EWM was documented as a visual at only 24 additional points. These results demonstrated a highly significant reduction in total EWM as well as rake fullness values 3 and 2 (Figure 26).

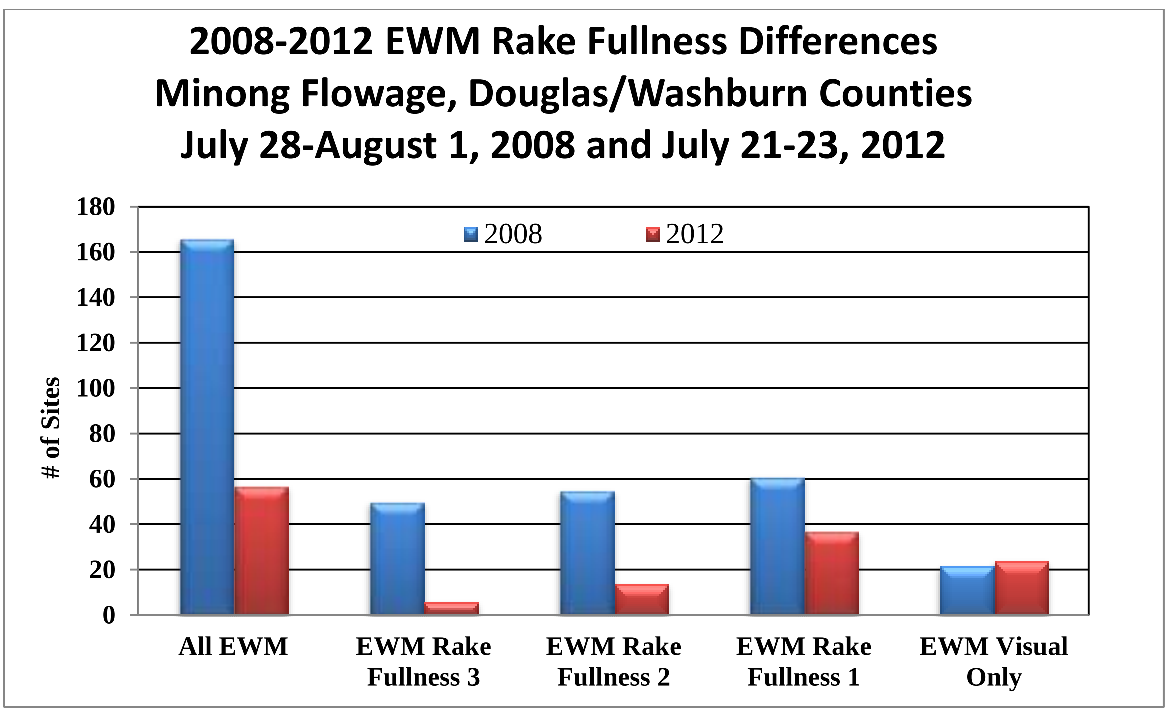


Figure 26: 2008 and 2012 change in EWM rake fullness

During the July 2012 full point intercept survey, there were aquatic plants growing at 242 sites or 27.6% of the entire flowage bottom and in 64.7% of the littoral zone. Overall diversity was exceptionally high with a Simpson Diversity Index value of 0.95. Of the 69 species found growing in and immediately adjacent to the water in 2012, coontail, common waterweed, white water lily, and fern-leaf pondweed were the most common native plant species being found at 38.43%, 23.55%, 22.31%, and 22.31% of survey points with vegetation, and they accounted for 29.82% of the total relative frequency. Northern wild rice (*Zizania palustris*) was present at 47 points in 2012. Although not significant, this was down from 72 points in 2008. The 52 native index species found in the rake during the July 2012 survey produced a slightly below average mean Coefficient of Conservatism of 6.6 and a Floristic Quality Index of 47.3 that was nearly double the median FQI for this part of the state. All of these values (richness, diversity, mean C, and FQI) were similar to the 2008 survey. Other than CLP and EWM, a few Purple loosestrife (*Lythrum salicaria*) plants were the only other exotic species found. More information related to the 2012 whole-lake, point-intercept survey is found beginning on page 61.

Chemical management actions implemented from 2009-2011 continuously focused on protecting wild rice from possible negative or unintended consequences related to chemical management of EWM. Chemical application areas were intentionally kept downstream and away from existing rice beds, with the exception of 6.3 acres treated in the fall of 2010 east of Smith Bridge with full cooperation of St. Croix Tribal Resources. Chemical concentration and residual testing to determine whether or not the applied herbicide was getting into the rice beds was completed every year. Wild rice bed mapping was completed in each year of management as well, so that it was known where the rice beds were, in order to stay away from them. Tracking of non-native invasive species within the rice beds was also completed.

2013 AND 2014

Management actions in 2013 and 2014 only involved the 5-1/2 foot extended drawdown and aquatic plant surveying.

2013-14 DRAWDOWN

In the 2009 APM Plan, drawdown of the Minong Flowage was not a recommended EWM management option, unless it was part of some other project, like dam repair. Such was the case in 2013. All proposed management of EWM was suspended in 2012 as it was expected that the drawdown would have significant impact to the EWM and other plants in the system, potentially nullifying any benefit that completed management in 2012 might have provided. A whole-lake, point-intercept aquatic plant survey originally planned for 2013 was moved up to 2012 to determine impacts to the aquatic plant community in the Minong Flowage that could be attributed to prior management verses what would be caused by the drawdown. Another whole-lake, point-intercept aquatic plant survey was planned for 2014 to determine the impacts of the drawdown on the aquatic plant community. Comparisons between the 2008 and 2012 aquatic plants surveys were made in Curly-leaf pondweed (*Potamogeton crispus*) Point Intercept and Bed Mapping and Warm Water Point Intercept Surveys Minong Flowage – WBIC: 2692900 Washburn and Douglas Counties, WI (Berg 2012a). Additional comparisons are made between the 2012 and 2014 surveys in the 2014 Early-season Exotic Species and Warm-water Point-intercept Surveys, and Northern Wild Rice and Fall Eurasian Water Milfoil Bed Mapping Surveys, Minong Flowage, Washburn/Douglas Counties, WI (Berg 2014).

In 2012 much discussion was had with Stakeholders related to the drawdown. There were concerns about the fishery, wild rice, non-native and native aquatic plants, wildlife, local drinking wells, water quality, plant life along the edge of the shore, and public access to the Flowage during the drawdown. Further discussions were had about extending the drawdown past the expected completion date and to include a winter component to the drawdown. However, due to concerns expressed by the WDNR, Renewable World Resources (operators of the dam for hydro-electric power), and the potential additional costs that the MFA would have to cover, it was decided not to pursue an extended drawdown into the winter between 2013 and 2014.

In April 2013, the Minong Flowage was drawn down by approximately 5-1/2 feet to allow Washburn County to update the dam to current standards. Originally, it was planned that the dam repair work would be completed by October/November 2013 and the Flowage water level returned to normal prior to winter freeze up.

MANAGEMENT IMPACTS CAUSED BY THE DRAWDOWN

When the dam on the Minong Flowage was updated in 2013, it was expected that the water level would be lowered by 5-1/2 feet for an extended period of time (8 months, April-November 2013). Because of issues with the dam repair project however, it was necessary to extend the drawdown by several months to 11 months that began in April of 2013 and extended into February 2014. Aerial photos taken in mid-June show the Minong Flowage with the water level decreased by 5-1/2 feet (Figure 27). Due to certain weather events associated with the 11 month time period, it was possible to evaluate the impact of a summer drawdown, a summer refill, and a winter drawdown on EWM and other aquatic plants.

Several EWM surveys were completed during the 2013 season, the first on June 19, 2013. The survey documented EWM growth colonizing new areas previously too deep to grow EWM, and surviving on the water/land edge, and even growing on now dry beds (Figure 28). At this time a total of 12 beds of EWM totaling 64.71 acres were mapped (Figure 29).

Figure 27: June 18, 2013 aerial photos of the Minong Flowage drawdown: UL-DNR Bay, UR-Serenity Bay, BL-East Basin, BR-County Park (Photos by Dan Maxwell)

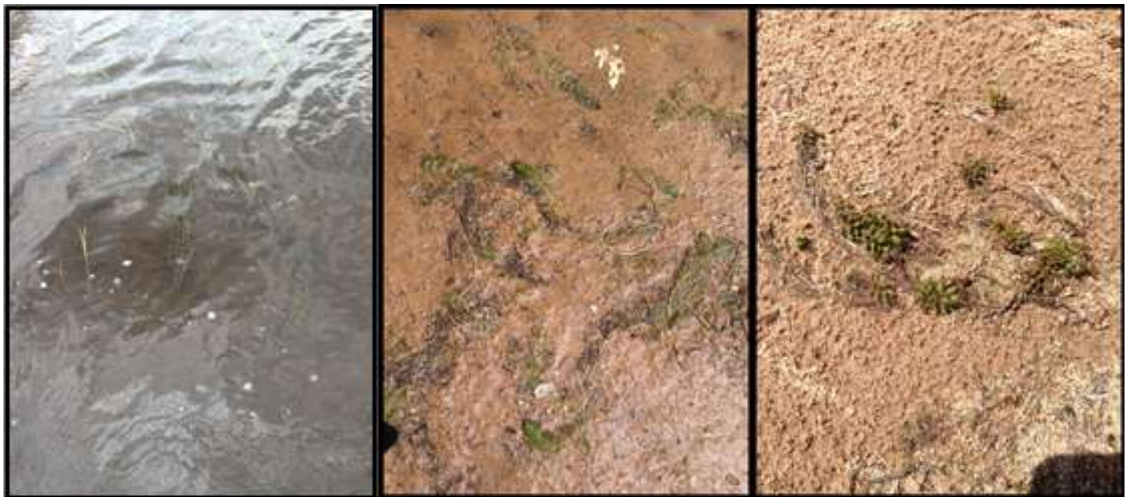


Figure 28: EWM growth in shallow water, shore/water interface, and dry ground June 19, 2013 (Photos by ERS)

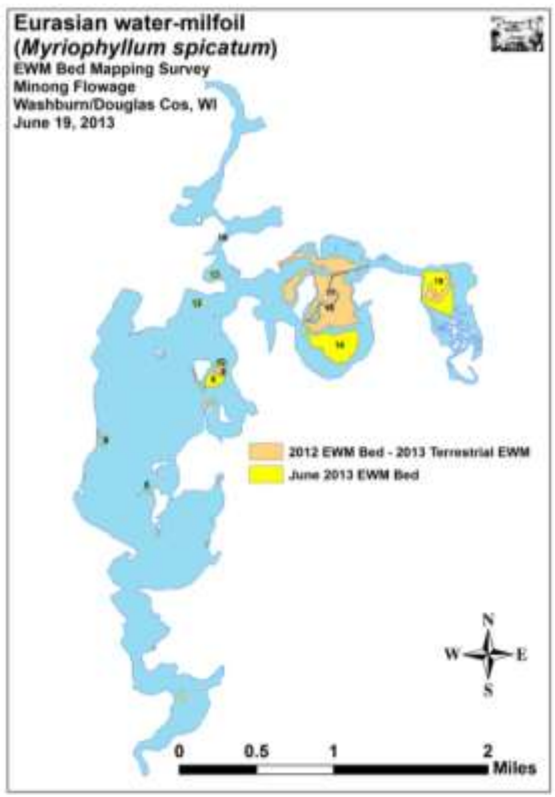


Figure 29: EWM beds on June 19, 2013 (ERS)

Near the end of June, a heavy rainstorm caused the water level in the Flowage to rise by two feet or more in less than a week. The water level remained high for several days providing an opportunity to see what would happen to EWM if water levels were returned to normal during the growing season. An informal survey of parts of the Flowage was completed on June 28 when the consultant retained by the MFA canoed the Totagatic River ending in the East Basin at Smith's Bridge. Photo documentation shows an explosion in EWM growth in almost all areas that on June 18th had just small plants (Figure 30).

Figure 30: Dense EWM growth in the East Basin June 28, 2013 (Photos by Dave Blumer)

On July 19th, 2013, the Flowage was surveyed again for EWM. The high water in late June was gone with the water level back down to the target drawdown level of 5 ½ ft. The dense beds of EWM that had been in two or more feet of water were again stranded on dry land (Figure 31). The survey documented the expansion of EWM beds marked in June, and located four new beds making 15 beds that covered 79.82 acres (Figure 32). A survey of the now exposed lakebed where EWM had grown so rapidly when the water was high, now showed carpets of rosettes, and, at most locations, appeared much denser than they had in June (Figure 33).

During the July survey, curly-leaf pondweed, which normally completes its life cycle and senesces by late June, was still relatively common throughout the Flowage. Although not present at nuisance levels anywhere, its continued presence at moderate levels was unusual and noteworthy. Very few native aquatic plant species were found during either the June or July surveys. Those that were found occurred at very low densities. Common waterweed and coontail, two species that are capable of reproducing from vegetative fragments, were the most common species encountered.

Figure 31: EWM stranded on dry ground in the East Basin (L) and Serenity Bay (R) on July 19, 2013 (Photos by ERS)

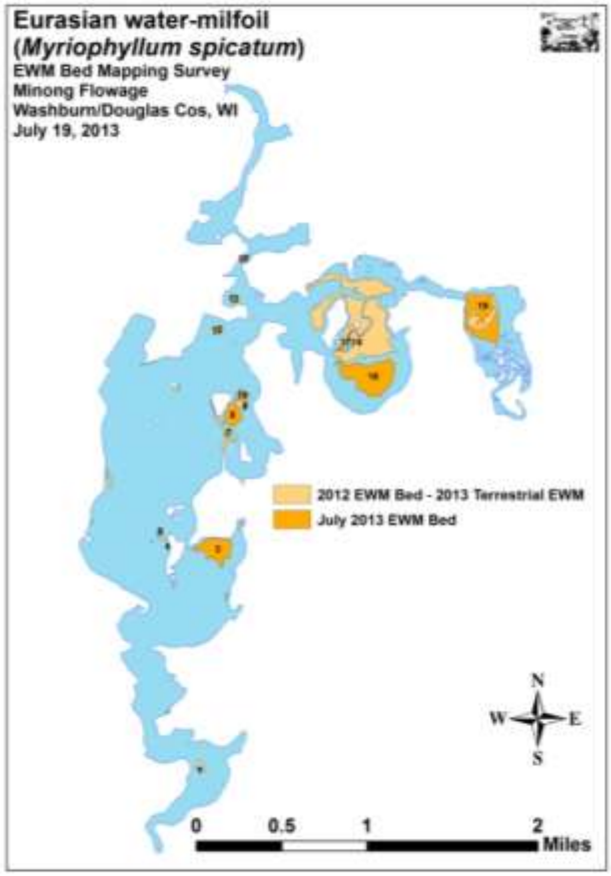


Figure 32: EWM Beds on July 19, 2013 (ERS)

Figure 33: EWM Rosette Carpets on Exposed Lakebed July 19, 2013 (Photos by ERS)

The final 2013 EWM survey was completed on September 21, 2013. Three additional EWM beds were documented and mapped making a total of 18 EWM beds covering 115.22 acres (Figure 34). Combining this with the approximately 90 terrestrial acres with EWM coverage made it possible for the Flowage to have over 200 acres of EWM if water levels were returned to normal during the current growing season.

Curly-leaf pondweed appeared to have produced a second "crop" as it was again common, mixed with EWM in most locations, and occasionally canopied to the point it was a minor navigation impairment (Figure 35). Native species continued to be quite rare when considering both bottom coverage and species richness. Wild celery was the only native species that appeared to have become consistently more common since the July survey and that was primarily in the south basin where it occurred in widely scattered shoreline locations. The most diverse native plant areas occurred in very limited patches of Serenity Bay where limited numbers of water star-grass, fern pondweed, and spiral-fruited pondweed were found. More information related to the plant surveys completed in 2013 to document how EWM would respond to the drawdown is available in the 2013 Eurasian Water Milfoil (Myriophyllum spicatum) Drawdown Bed Mapping Surveys Report by ERS (Berg 2013).

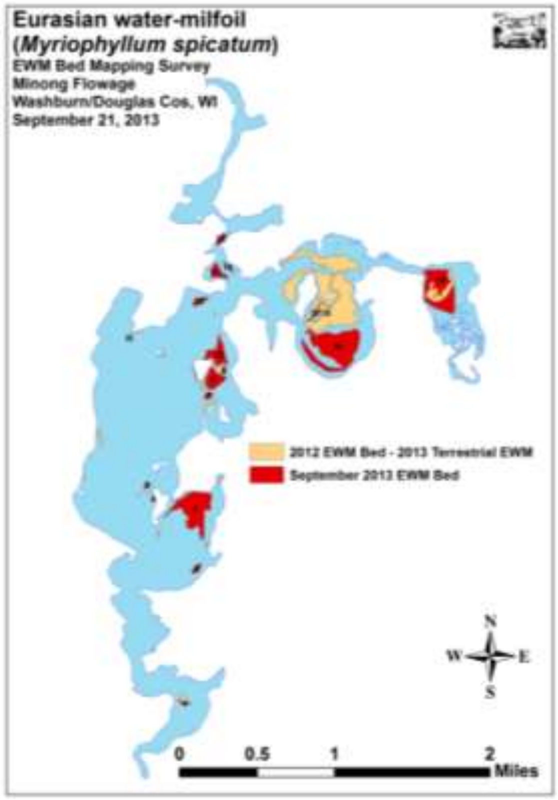


Figure 34: EWM Beds on September 21, 2013 (ERS)

Figure 35: CLP Beds in the Channel to Cranberry, September 21, 2013 (Photo by ERS)

At the time the 2013 EWM Drawdown Bed Mapping Surveys Report was completed, it was expected that the dam repair project would be finished and the Minong Flowage refilled by late 2013. Had this been the case, it was expected that distribution and density of EWM in the Flowage would have been back up to 200+ acres with moderate to dense levels of growth. It is generally accepted and borne out by these results, that a spring to fall drawdown would not be expected to control EWM. It was initially expected that the Minong Flowage drawdown would end in October or November of 2013, so no benefits were expected from a winter continuation of the drawdown. This was not the case, as the drawdown lasted until the end of February 2014.

Back in 2012 when discussions were being had about extending the drawdown through the winter months, the expected costs associated with doing so were considered too great to make it happen. Since it happened anyway, the effects of a winter drawdown were able to be somewhat quantified. The next official aquatic plant survey completed on the Minong Flowage after September 2013 was on June 24 & 25, 2014. At that time, EWM was documented at only 9 out of 876 points (Figure 36). None of these points rated a rake fullness rating of 3, 3 rated a density of 2, 5 rated a density of 1, and it was identified as a visual at one additional point. This resulted in barely 16 acres with any amount of EWM. During this survey, only 15 EWM plants in total were identified by the Aquatic Plant Surveyor. The extended winter drawdown significantly reduced the amount of EWM in the Flowage.

During the June 24 & 25, 2014 survey, CLP was identified at only two sites, both in the East Basin (Figure 37).

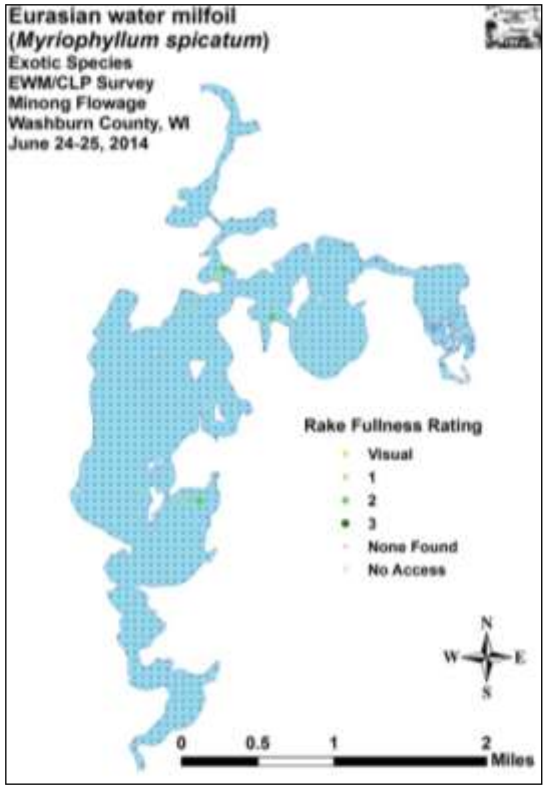


Figure 36: EWM in the Minong Flowage, June 2014

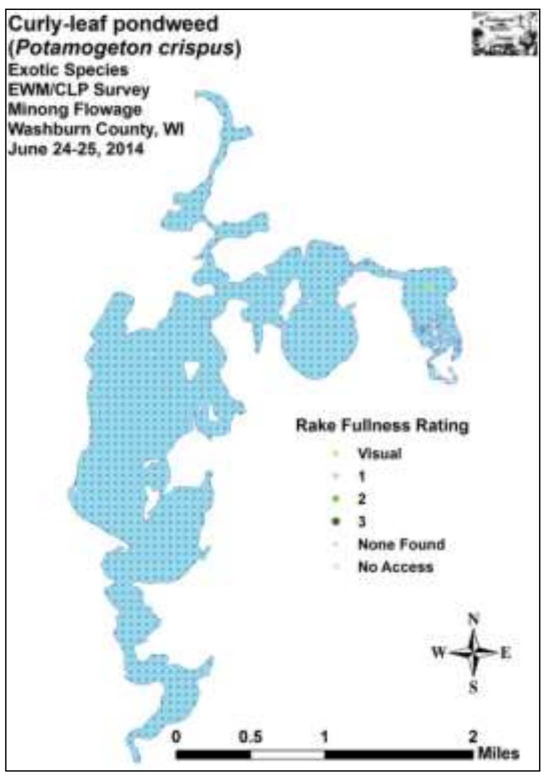


Figure 37: CLP in the Minong Flowage, June 2014

2012 AND 2014 WHOLE-LAKE, POINT-INTERCEPT AQUATIC PLANT SURVEYS

Since the last whole-lake, point-intercept aquatic plant survey completed in 2008, many different aquatic plant surveys have been completed. In each year of management (2009-2011) pre-treatment, post-treatment, and fall EWM bed-mapping surveys were completed by an aquatic plant survey specialist. A pre-treatment aquatic plant survey was completed in 2012 prior to learning that the herbicide application permit would not be awarded. Fall bed-mapping was also completed in 2012, 2013, and 2014 to help assess the extent of EWM prior to, during, and after the drawdown and dam repair. Additional EWM survey work was completed during the summers of 2013 and 2014 to again help assess the status of EWM in the Flowage. Early (cold-water) and mid-season (warm water) whole-lake, point-intercept surveys were completed in 2008, 2012, and 2014. The 2012 and 2014 surveys were in direct response to the 2013 drawdown. Early surveys were done to document the extent of curly-leaf pondweed (CLP) in the system, and mid-season surveys were done to document non-native and native aquatic plants.

EURASIAN WATER MILFOIL (EWM)

In 2012, the year prior to the extended drawdown and after three years of active management including large and small-scale herbicide application, physical removal, and the rearing and releasing of EWM Weevils, EWM occupied only 93 acres, down significantly from the 330+ acres in 2008. Most of this EWM was located in the Serenity Bay (Stump Bay) basin in an area very difficult to do any management except drawdown. In 2014, the first year following the extended drawdown, a June EWM survey turned up only 15 plants in the entire flowage. A comparison made between 2012 summer EWM levels and 2014 summer EWM levels showed a nearly 90% reduction in the density of EWM. EWM in 2014 was still being found in most of the areas from 2012, but only as a few isolated plants. By the fall of 2014, EWM beds covered about 14 surface acres and dozens of individual plants were scattered in areas known to have had dense EWM in the past (Figure 38).

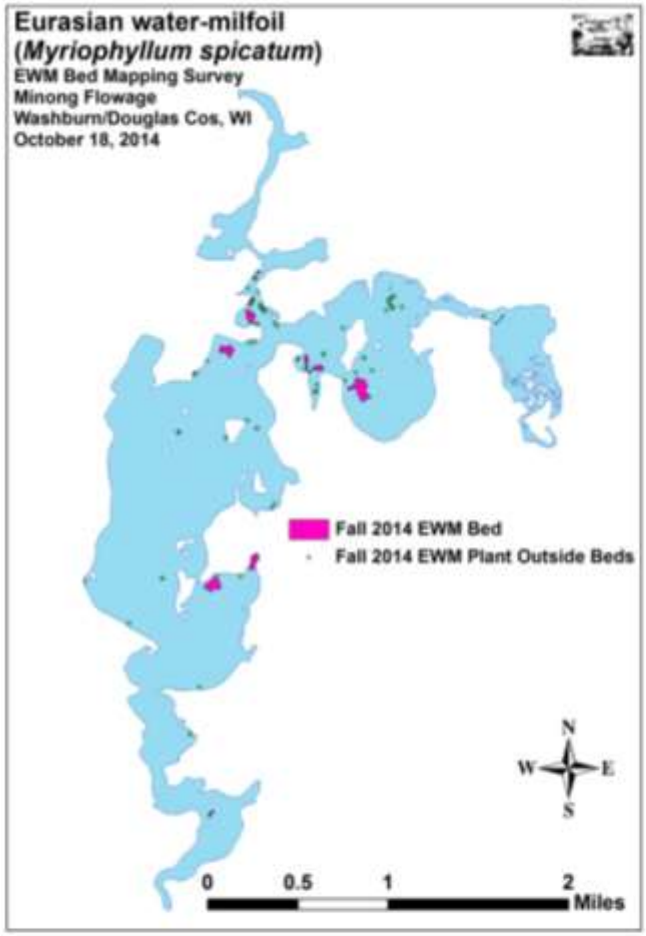


Figure 38: 2014 EWM survey and fall bed-mapping

CURLY-LEAF PONDWEED (CLP)

In 2008, CLP was present in the Minong Flowage, but only at 22 sites with only a few places that could be classified as a bed (Figure 39). With its distribution and density in 2008, it was not considered a major management issue that needed to be addressed. Instead, the 2009 APM Plan recommended monitoring to track the expansion of CLP. In the spring of 2011, CLP became a bigger issue, when a large, dense bed appeared in the East Basin in the middle of the rice beds. As a result, CLP bed-mapping was completed in 2012. Fifteen beds totaling 27.04 acres were identified (Figure 40). The biggest bed (7.78 Bed 8) was located in the area just north of the WDNR public access. Two beds of 5 and 3 acres were mapped in the middle of the rice beds in the area east of Smith Bridge. CLP was especially common in areas that had been disturbed by boat traffic such as the channel leading away from the WDNR boat landing (Beds 7 and 8), along the river channel in the north bays (Beds 10-13), and in areas where EWM had been eliminated by past herbicide treatments like in the bay east of Smith's Bridge (Beds 14 and 15) and on the flat near the dam (Bed 1). Away from these areas, CLP was generally uncommon or absent and not bed forming.

In 2014, the year after the extended drawdown, CLP distribution and density was almost non-existent with only two points with CLP (Figure 37).

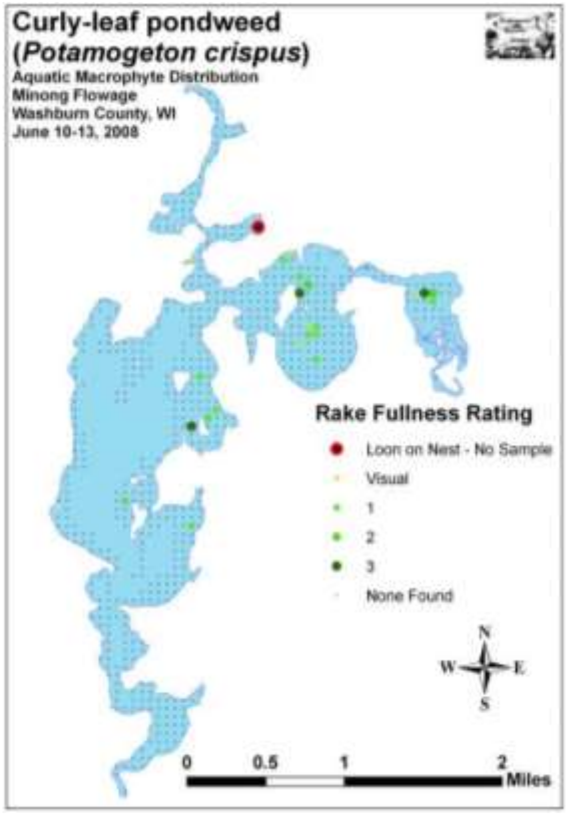


Figure 39: Curly-leaf pondweed distribution in 2008

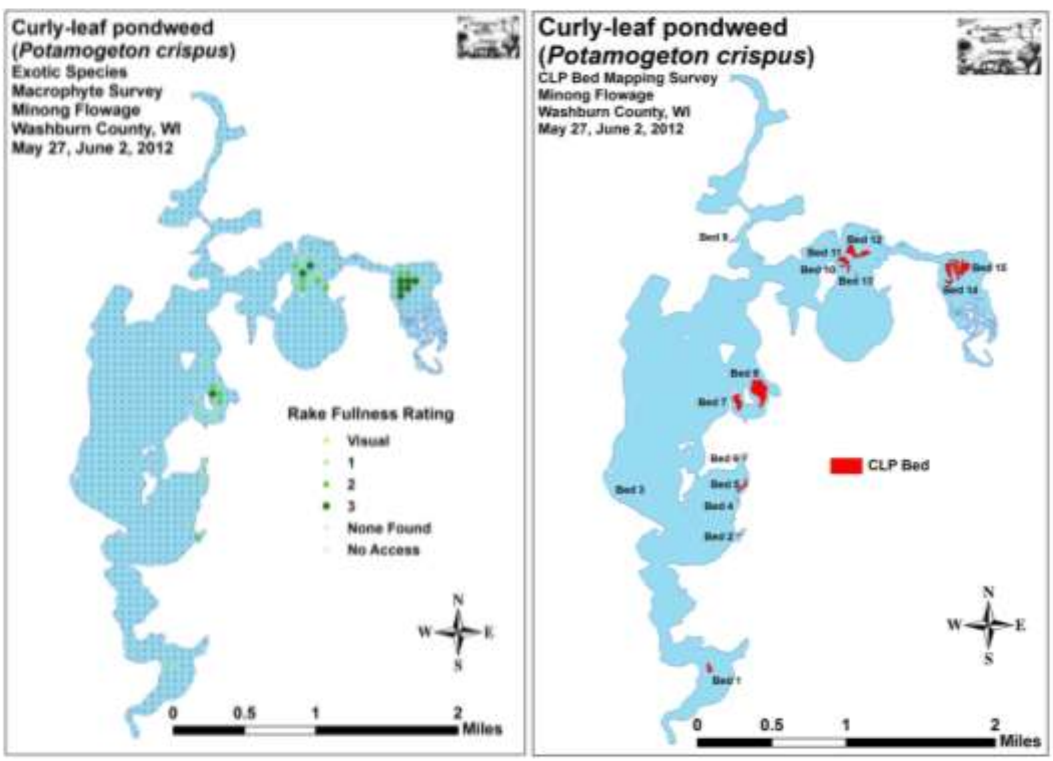


Figure 40: 2012 CLP PI and bed-mapping results

NATIVE AQUATIC PLANTS

During this same time frame, the warm-water point-intercept survey completed in August 2014 showed the distribution and density of native plants to be lower than what it was in both 2008 and 2012 (Figure 41). Table 5 compares the point-intercept summer survey statistics from 2008, 2012, and 2014. Frequency of occurrence, average species per site in all categories, and mean rake fullness are all lower in 2014. In 2012, 14 aquatic plant species were present at 20 or more points: coontail, common waterweed, EWM, white water lily, fern-leaf pondweed, wild rice, flat-stem pondweed, small pondweed, large-leaf pondweed, water celery, watershield, large duckweed, and spatterdock. In August 2014, all but two of these species (white water lily and wild rice) had declined significantly. White water lily and wild rice were more abundant in 2014 than in 2012, but not by a significant amount.

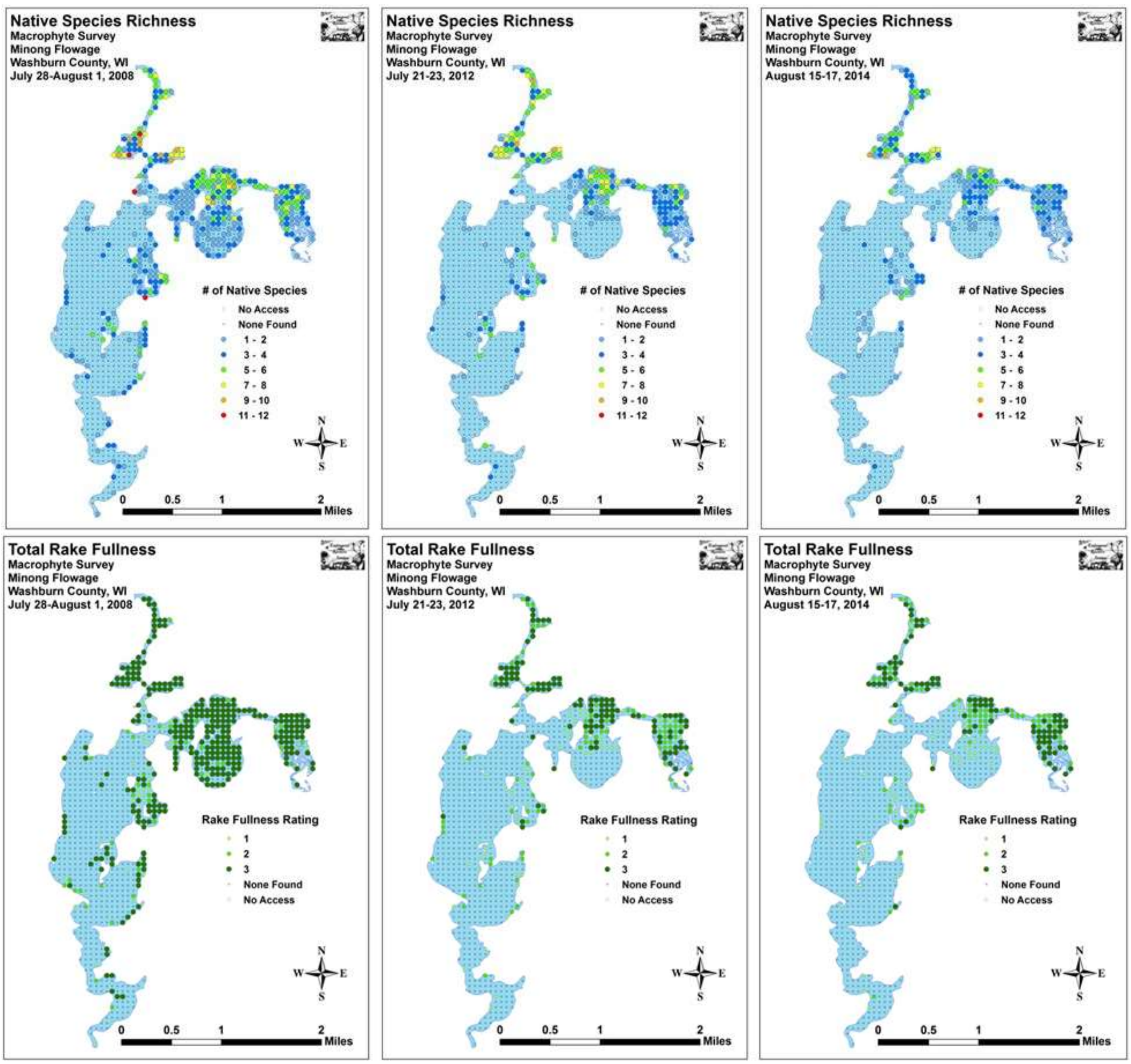


Figure 41: Native Species Richness (diversity/distribution) and Total Rake Fullness (density) 2008, 2012, & 2014

Table 5: aquatic Macrophyte P/I Survey Summary Statistics 2008, 2012, & 2014

Summary Statistics:	2008	2012	2014	*p*
Total number of points sampled	875	876	875	n.s.
Total number of sites with vegetation	377	242	227	n.s.
Total number of sites shallower than the maximum depth of plants	517	374	461	n.s.
Frequency of occurrence at sites shallower than maximum depth of plants	72.92	64.71	49.24	-***
Simpson Diversity Index	0.94	0.95	0.96	n.s.
Maximum depth of plants (ft)	9.5	7.5	9.0	n.s.
Mean depth of plants (ft)	4.0	3.1	3.2	n.s.
Median depth of plants (ft)	4.0	3.0	3.0	n.s.
Average number of all species per site (shallower than max depth)	2.77	2.31	1.36	-***
Average number of all species per site (veg. sites only)	3.80	3.57	2.75	-***
Average number of native species per site (shallower than max depth)	2.44	2.15	1.33	-***
Average number of native species per site (sites with native veg. only)	3.48	3.48	2.75	-***
Species richness	58	55	52	n.s.
Species richness (including visuals)	60	59	55	n.s.
Species richness (including visuals and boat survey)	65	68	64	n.s.
Mean rake fullness (veg. sites only)	2.69	2.19	2.10	n.s.

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

In 2014, plant diversity was exceptionally high with a Simpson Diversity Index value of 0.96 (up slightly from 0.95 in 2012 and 0.94 in 2008). However, mean native species richness at sites with vegetation, which had been relatively high at 3.48/site in both 2012 and 2008, suffered a highly significant decline to 2.75 post-drawdown (Table 5).

Mean total rake fullness was a very high 2.69 in 2008. This was primarily due to the dense Eurasian water milfoil and Coontail in the north bays and the dense Northern wild rice and other emergent plant species east of Smith's Bridge. With the elimination of most dense EWM growth, mean rake fullness experienced a highly significant decline to a moderately dense 2.19 in 2012. Following the drawdown, the mean declined further to a moderate value of 2.10, although this was not significant (Table 5).

In 2008, plants were found growing at 377 points with a mean and median depth of growth of 4.0ft. This extrapolated to 43.0% of the total flowage and 72.9% of the then 9.5-ft littoral zone having plant coverage. In 2012, following three years of active management, plants were found growing at 242 sites or on approximately 27.6% of the entire flowage bottom and in 64.7% of the littoral zone. With a 2012 littoral upper limit of 7.5-ft, the mean and median depths of plants were 3.0-ft and 3.1-ft respectively, and most plant growth ended in 4.5-5.0-ft of water; especially in the southern basin. This was a nearly 36% reduction in the number of vegetated sites – a highly significant reduction when compared to 2008. In 2014 plants were found growing at 228 sites or on approximately 26.1% of the entire flowage bottom and in 49.5% of the littoral zone. The mean and median depths of plants were 3.2-ft and 3.0-ft with a littoral zone that extended to 9.0-ft. Although not significant, these values represented a further 6% decline in the number of vegetated sites when compared to 2012 values.

In 2008, coontail, common waterweed, wild celery, and fern-leaf pondweed were the most common native species (Table 6). They were found at 49.60%, 34.48%, 23.87%, and 22.02% of survey points with vegetation respectively and accounted for 34.22% of the total relative frequency. In 2012, coontail, common waterweed, white water lily, and fern-leaf pondweed were the most common native species being found at 38.43%, 23.55%, 22.31%, and 22.31% of sites with vegetation, and accounting for 29.82% of the total relative frequency. These results suggested a more diverse and even plant community existed in 2012 than in 2008. However, many species showed significant changes in both distribution and density.

The 2014 survey found white water lily, northern wild rice, nitella, and short-stemmed bur-reed were the most common species (Table 6). They were present at 29.82%, 25.44%, 15.35%, and 14.91% of points with vegetation, and combined to account for 31.15% of the total relative frequency. Common waterweed (5.27), Coontail (4.47), and Slender naiad (4.31) were the only other species with a relative frequency over 4.

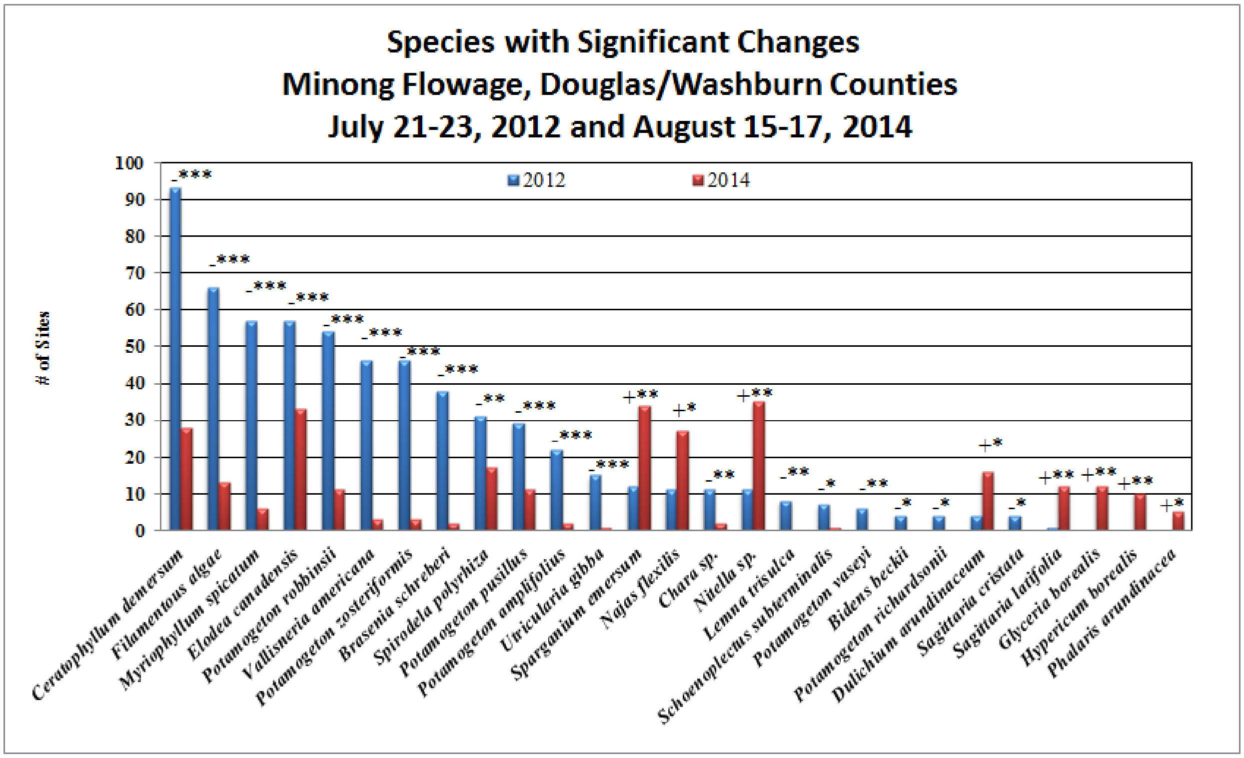
Table 6: Most Common Species

Species	Year	Total Sites	Most Common Species Rank
Coontail	2008	187	1
	2012	93	1
	2014	28	6
Common waterweed	2008	130	3
	2012	54	5
	2014	33	5
Wild celery	2008	90	4
	2012	46	8
	2014	3	36(T)
Fern-leaf pondweed	2008	83	5
	2012	54	4
	2014	11	21(T)
Small pondweed	2008	82	6
	2012	29	11
	2014	11	21(T)
Flat-stem pondweed	2008	61	8
	2012	46	7
	2014	3	36(T)
White water lily	2008	57	9
	2012	57	3
	2014	68	1
Northern wild rice	2008	72	7
	2012	47	6
	2014	58	2
EWM	2008	166	2
	2012	57	2
	2014	6	33(T)

Between 2008 and 2012 there was a highly significant decline in EWM. Coontail, common waterweed, small pondweed and northern water milfoil also showed highly significant declines; and water marigold experienced a moderately significant decline. Conversely, filamentous algae and small bladderwort demonstrated highly significant increases; Sago pondweed a moderately significant increase, and common bur-reed a significant increase.

In total, 27 species demonstrated significant changes pre to post-drawdown (Figure 42). In addition to Eurasian water milfoil, coontail, filamentous algae, common waterweed, fern-leaf pondweed, wild celery, flat-stem pondweed, watershield, small pondweed, large-leaf pondweed, and creeping bladderwort experienced highly significant reductions; large duckweed, muskgrass, forked duckweed, and Vasey's pondweed moderately significant reductions; and softstem bulrush, water marigold, and crested arrowhead significant reductions.

No species demonstrated highly significant increases, but short-stemmed bur-reed, nitella, common arrowhead, northern manna-grass, and northern St. John's-wort demonstrated moderately significant increases; while slender naiad, three-way sedge, and reed canary grass showed significant increases.



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

Figure 42: Species with Significant Changes, ERS 2014

From 2008 to 2012, changes in aquatic vegetation were likely brought about by a combination of factors including EWM management and the use of herbicides; changes in water clarity/quality which impacted the extent of the littoral zone; and seasonal growing conditions. The reductions in distribution, density, and number of species in 2014 are likely the direct result of the extended drawdown.

The following excerpt and photo (Figure 43) is taken from the 2010 WI Ceded Territory Manoomin Inventory prepared by GLIFWC.

"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 43: 2007 wild rice beds in the Minong Flowage (east and west of Smith Bridge)

While GLIFWC generally completes an aerial photo documentation of the wild rice beds, on the water monitoring began in 2008 with the whole-lake, point-intercept survey. At that time, wild rice was found at 72 points in the survey area (Figure 44) equating to approximately 128 acres. Comments made by the aquatic plant survey specialist indicated that the rice was very dense, with an average rake fullness rating of 2.36. On the water bed-mapping was included in the 2009 APM Plan to aide in tracking EWM and EWM management impacts on wild rice. Bed-mapping consists of identifying areas of wild rice where greater than 50% of the plants present are the target plant, and the area has a definable edge. Bed-mapping was not completed in 2008.

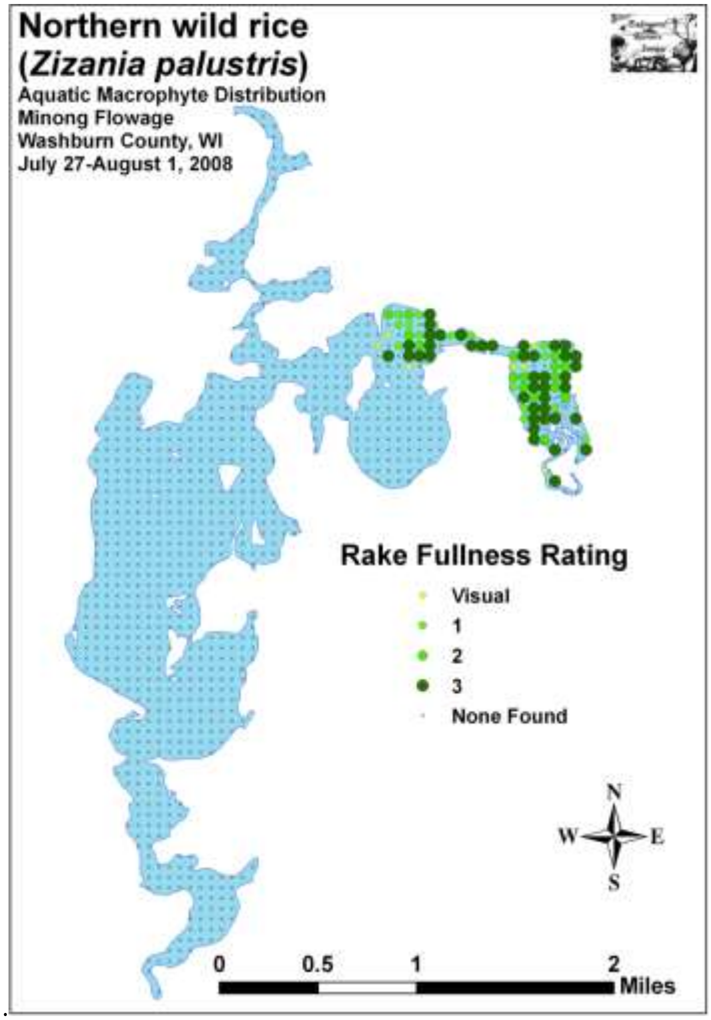


Figure 44: 2008 wild rice distribution (from 2008 PI Survey)

In 2009, 2010, and 2011 wild rice bed mapping was completed, however in about the southern half of the East Basin was not mapped due to access issues. Approximately 85 acres of dense growth wild rice was mapped in 2009, with nearly the same amount mapped in 2010, although it was less dense than in 2009 (Figure 45). By 2009, EWM had invaded the rice beds east of Smith Bridge (Figure 45). Expanding EWM in the rice bed east of Smith Bridge became a concern in 2010, and working with St. Croix Tribal Resources who donated 12 50# bags of Navigate herbicide (Appendix C), 6.3 acres of EWM was treated in the fall.

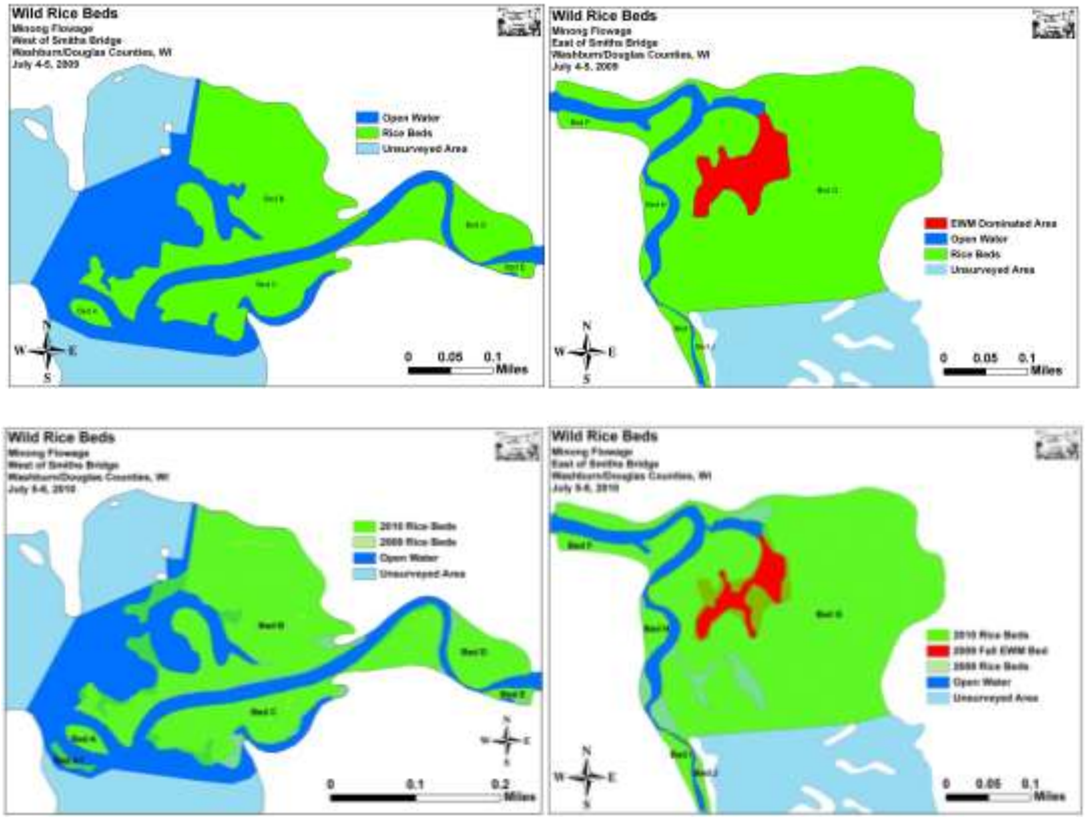


Figure 45: 2009 & 2010 wild rice bed-mapping results

Wild rice appeared to be most impacted by non-native invasive species including CLP, EWM, and common carp in 2011. The fall 2010 treatment of EWM reduced the EWM, but in its place, a large bed of dense growth CLP developed. Within the bed of CLP, common carp were spawning in much greater density than had been seen before. Unlike 2007-2010, wild rice beds east of Smiths Bridge were spotty, barely meeting the definition of a bed (Figure 46) and only covering about 70 acres.

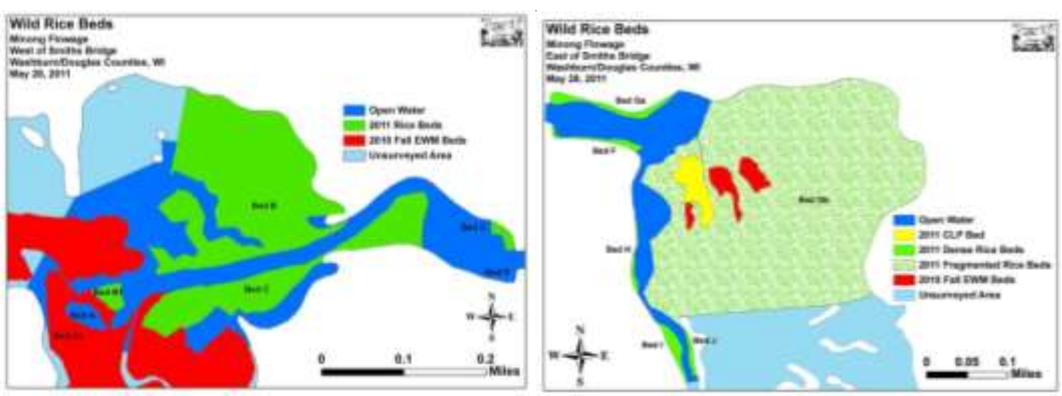


Figure 46: 2011 wild rice bed-mapping results

In 2012, as a part of the pre-drawdown whole-lake, point-intercept aquatic plant survey, wild rice was identified at 47 points equating to approximately 84 acres, but only with an average rake fullness rating of 1.66 (Figure 47). As in the 2008 PI survey, this included the entire East Basin, not just the northern half. Bed mapping was not completed in 2012.

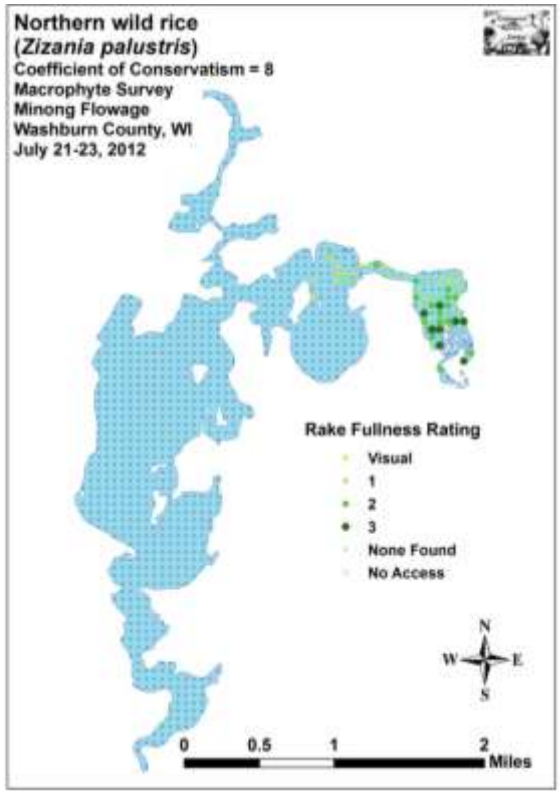


Figure 47: 2012 PI mapping of wild rice

One explanation for the low density of wild rice in 2012 is the presence of CLP and EWM early in the season. In June, 38 points in the survey had moderate to dense growth CLP, mostly in the same areas where wild rice was present, and moderate to dense growth EWM was identified at 45 points (Figure 48).

Survey work completed in 2014 showed a somewhat different story. Wild rice was identified at 58 points equating to approximately 103 acres with a rake fullness rating of 2.10 (Figure 49). Bed mapping was also done, identifying approximately 87 acres of wild rice. Great Lakes Indian Fish and Wildlife Commission (GLIFWC) rice experts confirmed that the 2014 distribution and density of wild rice in the Flowage were up substantially from several prior years. A summary of all wild rice PI and bed mapping surveys is in Table 7.

Based on 2014 survey results, wild rice only benefitted from the extended drawdown. One possible reason for this is the lack of competition rice had with both non-native and native plants in 2014. Early season distribution and density of CLP, EWM, and native plants were at much lower levels in 2014 than they were in 2012 (Figure 50).

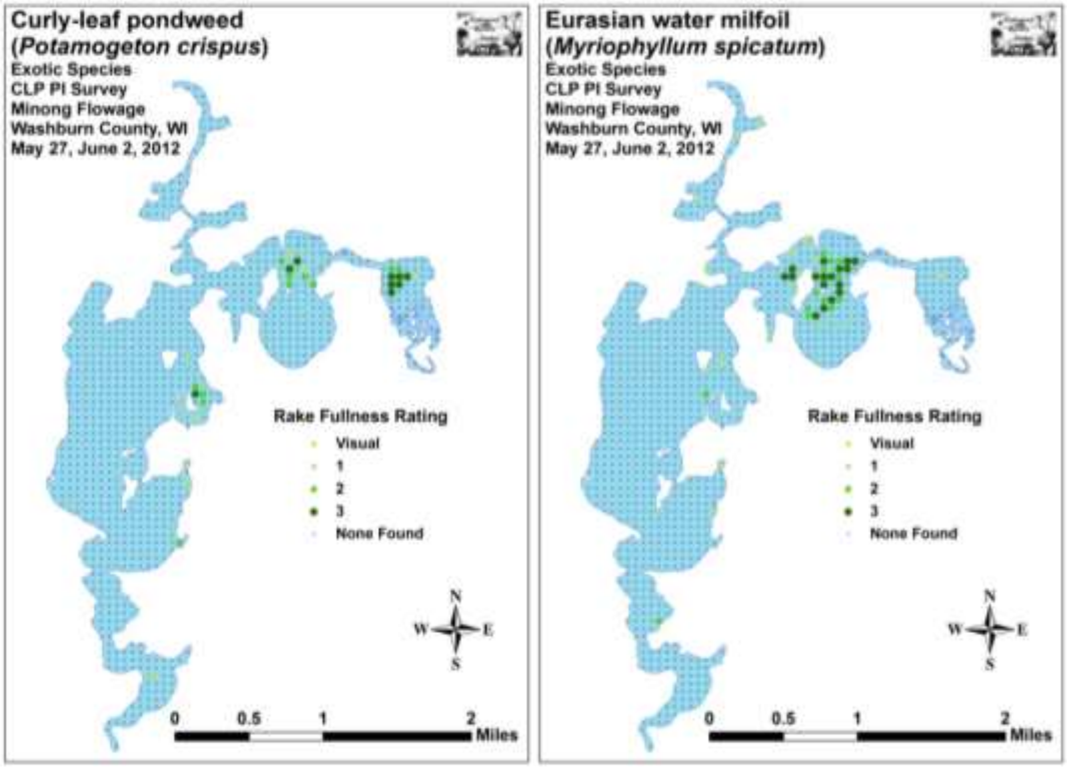


Figure 48: Early season CLP and EWM distribution and density in 2012

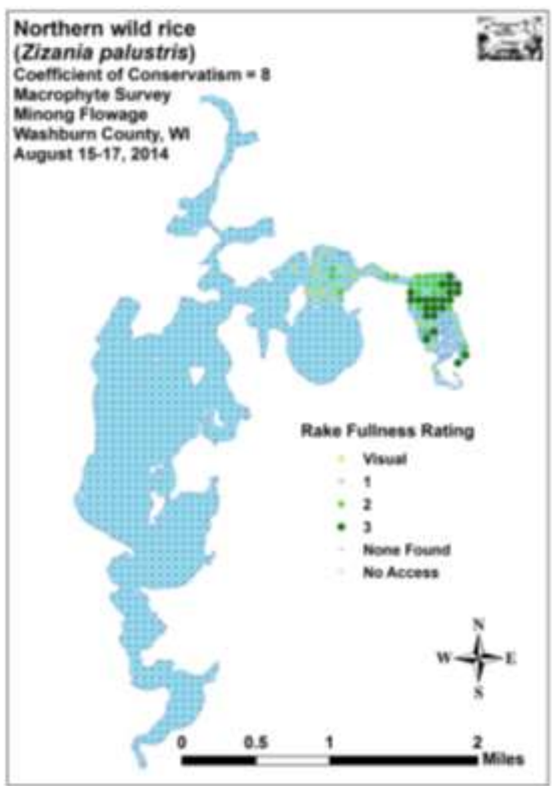
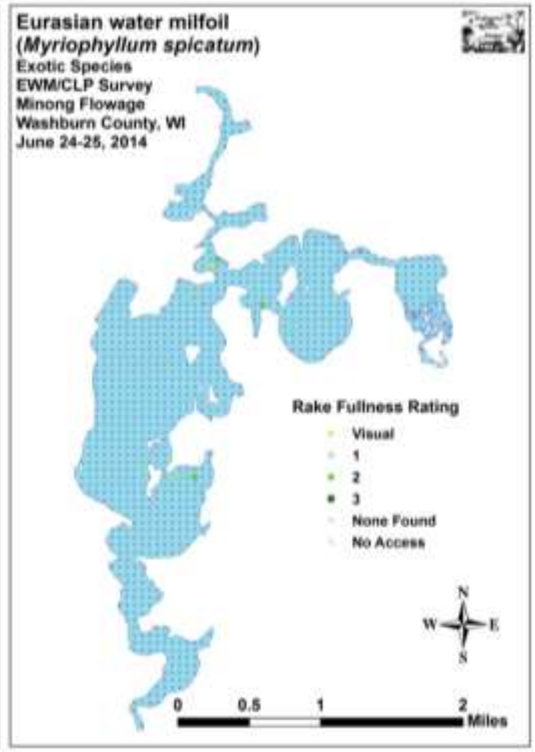


Figure 49: Wild rice distribution and density in 2014

Table 7: Summary of all Wild Rice PI/Bed Mapping Surveys 2008-2014

2008-2014 Wild Rice Monitoring/Mapping Results					
When	**How**	**# of Points**	**Estimated PI Acreage**	**Bed Mapping Acreage**	**Density**
2008	PI-Survey	72	128	NA	dense
2009	Bed Mapping	NA	NA	84.82	dense
2010	Bed Mapping	NA	NA	85.8	moderate
2011	Bed Mapping	NA	NA	70	sparse-moderate
2012	PI-Survey	47	84	NA	moderate
2013	NA	NA	NA	NA	NA
2014	PI Survey/Bed Mapping	58	104	87	moderate-dense



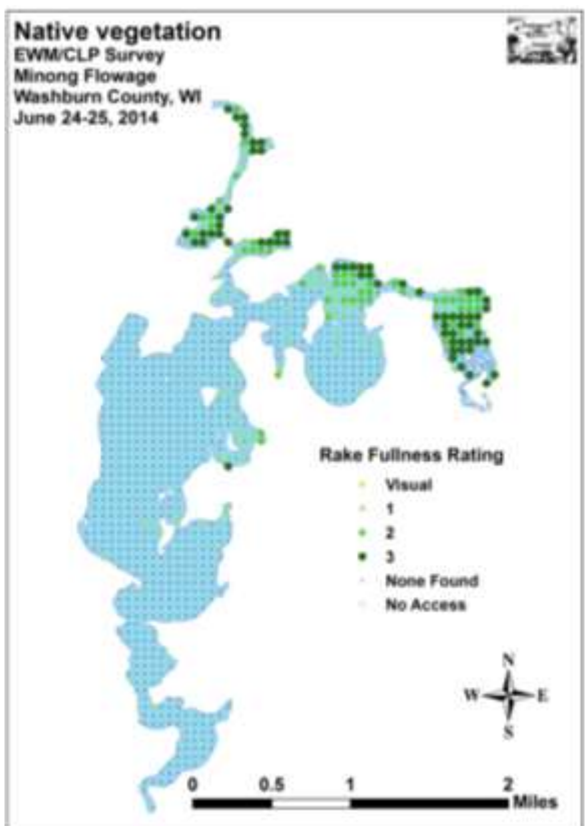


Figure 50: Early season CLP, EWM, and native plant distribution and density in 2014

AQUATIC INVASIVE SPECIES

Past invasive species monitoring efforts have identified several different plant and animal non-native, invasive species in the Minong Flowage. Most of these species are considered aquatic, although some are also considered shoreland or wetland type invasive species.

NON-NATIVE, AQUATIC INVASIVE PLANT SPECIES

Eurasian watermilfoil and curly-leaf pondweed are the most problematic non-native, aquatic invasive species in the lake. Both are submerged vegetation species (rooted to the bottom of the lake and growing under the surface of the water) that have the potential to outcompete more desirable native aquatic plants. Purple loosestrife, Japanese knotweed, and reed canary grass are shoreland or wetland plants not generally problematic within the lake, but can be very problematic on the shores and in the wetlands adjacent to the lake. More information is given for each non-native species in the following sections.

EURASIAN WATERMILFOIL

EWM is a submersed aquatic plant native to Europe, Asia, and northern Africa (Figure 51). It is the only non-native milfoil in Wisconsin. Like the native milfoils, the Eurasian variety has slender stems whorled by submersed feathery leaves and tiny flowers produced above the water surface. The flowers are located in the axils of the floral bracts, and are either four-petaled or without petals. The leaves are threadlike, typically uniform in diameter, and aggregated into a submersed terminal spike. The stem thickens below the inflorescence and doubles its width further down, often curving to lie parallel with the water surface. The fruits are four-jointed nut-like bodies. Without flowers or fruits, EWM is difficult to distinguish from Northern water milfoil. EWM has 9-21 pairs of leaflets per leaf, while Northern milfoil typically has 7-11 pairs of leaflets. Coontail is often mistaken for the milfoils, but does not have individual leaflets.

EWM grows best in fertile, fine-textured, inorganic sediments. In less productive lakes, it is restricted to areas of nutrient-rich sediments. It has a history of becoming dominant in eutrophic, nutrient-rich lakes, although this pattern is not universal. It is an opportunistic species that prefers highly disturbed lake beds, lakes receiving nitrogen and phosphorous-laden runoff, and heavily used lakes. Optimal growth occurs in alkaline systems with a high concentration of dissolved inorganic carbon. High water temperatures promote multiple periods of flowering and fragmentation.

Unlike many other plants, EWM does not rely on seed for reproduction. Its seeds germinate poorly under natural conditions. It reproduces by fragmentation, allowing it to disperse over long distances. The plant produces fragments after fruiting once or twice during the summer. These shoots may then be carried downstream by water currents or inadvertently picked up by boaters. EWM is readily dispersed by boats, motors, trailers, bilges, live wells, and bait buckets; and can stay alive for weeks if kept moist.

Once established in an aquatic community, milfoil reproduces from shoot fragments and stolons (runners that creep along the lake bed). As an opportunistic species, EWM is adapted for rapid growth early in spring. Stolons, lower stems, and roots persist over winter and store the carbohydrates that help milfoil claim the water column early in spring, photosynthesize, divide, and form a dense leaf canopy that shades out native aquatic plants. Its ability to spread rapidly by fragmentation and effectively block out sunlight needed for native plant growth often results in monotypic stands. Monotypic stands of EWM provide only a single habitat, and threaten the integrity of aquatic communities in a number of ways; for example, dense stands disrupt predator-prey relationships by fencing out larger fish, and reducing the number of nutrient-rich native plants available for waterfowl.

Dense stands of EWM also inhibit recreational uses like swimming, boating, and fishing. Some stands have been dense enough to obstruct industrial and power generation water intakes. The visual impact that greets the lake user on milfoil-dominated lakes is the flat yellow-green of matted vegetation, often prompting the perception that the lake is "infested" or "dead". Cycling of nutrients from sediments to the water column by EWM may lead to deteriorating water quality and algae blooms in infested lakes.

Figure 51: Eurasian Watermilfoil from the Minong Flowage

CURLY-LEAF PONDWEED

Curly-leaf pondweed (CLP) is an invasive aquatic perennial that is native to Eurasia, Africa, and Australia (Figure 52). One theory is that it was accidentally introduced to United States waters in the mid-1880s by hobbyists who used it as an aquarium plant. The leaves are reddish-green, oblong, and about 3 inches long, with distinct wavy edges that are finely toothed. The stem of the plant is flat, reddish-brown and grows from 1 to 3 feet long. The plant usually drops to the lake bottom by early August. CLP is commonly found in alkaline and high nutrient waters, preferring soft substrate and shallow water depths. It tolerates low light and low water temperatures. It has been reported in all states but Maine.

CLP spreads through burr-like winter buds (turions), which are moved among waterways. These plants can also reproduce by seed, but this plays a relatively small role compared to the vegetative reproduction through turions. New plants form under the ice in winter, making curly-leaf pondweed one of the first nuisance aquatic plants to emerge in the spring. It becomes invasive in some areas because of its tolerance for low light and low water temperatures. These tolerances allow it to get a head start on and out compete native plants in the spring. In mid-summer, when most aquatic plants are growing, CLP plants are dying off. Plant die-offs may result in a critical loss of dissolved oxygen. The decaying plants can increase nutrients which contribute to algal blooms, as well as create unpleasant messes on beaches. CLP can forms surface mats that interfere with aquatic recreation.

Figure 52: Curly-leaf Pondweed in the Minong Flowage and Turions (not from the Minong Flowage)

PURPLE LOOSESTRIFE

Purple loosestrife (Figure 53) is a perennial herb 3-7 feet tall with a dense bushy growth of 1-50 stems. The stems, which range from green to purple, die back each year. Showy flowers that vary from purple to magenta possess 5-6 petals aggregated into numerous long spikes, and bloom from August to September. Leaves are opposite, nearly linear, and attached to four-sided stems without stalks. It has a large, woody taproot with fibrous rhizomes that form a dense mat. By law, purple loosestrife is a nuisance species in Wisconsin. It is illegal to sell, distribute, or cultivate the plants or seeds, including any of its cultivars.

Purple loosestrife is a wetland herb that was introduced as a garden perennial from Europe during the 1800's. It is still promoted by some horticulturists for its beauty as a landscape plant, and by beekeepers for its nectar-producing capability. Currently, more than 20 states, including Wisconsin have laws prohibiting its importation or distribution because of its aggressively invasive characteristics. It has since extended its range to include most temperate parts of the United States and Canada. The plant's reproductive success across North America can be attributed to its wide tolerance of physical and chemical conditions characteristic of disturbed habitats, and its ability to reproduce prolifically by both seed dispersal and vegetative propagation. The absence of natural predators, like European species of herbivorous beetles that feed on the plant's roots and leaves, also contributes to its proliferation in North America.

Purple loosestrife was first detected in Wisconsin in the early 1930's, but remained uncommon until the 1970's. It is now widely dispersed in the state, and has been recorded in 70 of Wisconsin's 72 counties. Low densities in most areas of the state suggest that the plant is still in the pioneering stage of establishment. Areas of heaviest infestation are sections of the Wisconsin River, the extreme southeastern part of the state, and the Wolf and Fox River drainage systems.

This plant's optimal habitat includes marshes, stream margins, alluvial flood plains, sedge meadows, and wet prairies. It is tolerant of moist soil and shallow water sites such as pastures and meadows, although established plants can tolerate drier conditions. Purple loosestrife has also been planted in lawns and gardens, which is often how it has been introduced to many of our wetlands, lakes, and rivers.

Purple loosestrife can germinate successfully on substrates with a wide range of pH. Optimum substrates for growth are moist soils of neutral to slightly acidic pH, but it can exist in a wide range of soil types. Most seedling establishment occurs in late spring and early summer when temperatures are high.

Purple loosestrife spreads mainly by seed, but it can also spread from root or stem segments. A single stalk can produce from 100,000 to 300,000 seeds per year. Seed survival is up to 60-70%, resulting in an extensive seed bank. Mature plants with up to 50 shoots grow over 2 meters high and produce more than two million seeds a year. Germination is restricted to open, wet soils and requires high temperatures, but seeds remain viable in the soil for many years. Even seeds submerged in water can live for approximately 20 months. Most of the seeds fall near the parent plant, but water, animals, boats, and humans can transport the seeds long distances. Vegetative spread through local disturbance is also characteristic of loosestrife; clipped, trampled, or buried stems of established plants may produce shoots and roots. Plants may be quite large and several years old before they begin flowering. It is often very difficult to locate non-flowering plants, so monitoring for new invasions should be done at the beginning of the flowering period in mid-summer.

Any sunny or partly shaded wetland is susceptible to purple loosestrife invasion. Vegetative disturbances such as water drawdown or exposed soil accelerate the process by providing ideal conditions for seed germination. Invasion usually begins with a few pioneering plants that build up a large seed bank in the soil for several years. When the right disturbance occurs, loosestrife can spread rapidly, eventually taking over the entire wetland. The plant can also make morphological adjustments to accommodate changes in the immediate environment; for example, a decrease in light level will trigger a change in leaf morphology. The plant's ability to adjust to a wide range of environmental conditions gives it a competitive advantage; coupled with its reproductive strategy, purple loosestrife tends to create monotypic stands that reduce biotic diversity.

Purple loosestrife displaces native wetland vegetation and degrades wildlife habitat. As native vegetation is displaced, rare plants are often the first species to disappear. Eventually, purple loosestrife can overrun wetlands thousands of acres in size, and almost entirely eliminate the open water habitat. The plant can also be detrimental to recreation by choking waterways.

Purple loosestrife has been identified and removed from several locations on the Minong Flowage including Sand Island and Sawdust Island in the DNR Bay.

Figure 53: Purple Loosestrife on Sand Island in the Minong Flowage, Berg 2012

JAPANESE KNOTWEED

Japanese knotweed (Figure 54) is an herbaceous perennial, growing up to 10-ft tall. Hollow reddish, arching, bamboo-like stems are smooth and stout, and they can persist after the plant dies back each year. The base of the stem above each joint is swollen and surrounded by a membranous sheath. It has alternate, egg-shaped to almost triangular 4-6" long, 3-4" wide leaves that are dark green on the upper surface and pale green on the lower. Numerous tiny, creamy white or greenish flowers that are highly branched and found where the leaf attaches to the stem bloom in late summer. Small, winged, triangular fruits carry very small shiny seeds. Plants growing from seed have a taproot up to 6-ft deep. Stout rhizomes can reach 65-ft or more from the parent plant, and give rise to new stalks.
Japanese knotweed invades upland and lowland sites that are disturbed and undisturbed, often posing significant threat to riparian areas where it can rapidly spread. It tolerates shade, high temperatures, high salinity, and drought. It can be transported to new sites as a contaminant in fill dirt or on equipment. During floods, it can spread downstream by shoot fragments, rhizomes, or seeds. Escapees from neglected gardens and discarded cuttings are common routes of dispersal from more urban areas.

Although it is very hard to kill, consistent management over five or more years can eradicate it. Management includes both non-chemical and chemical control. Non chemical controls include physical removal, mowing, prescribed burning, grazing, and manipulation of the growing environment. Chemical control includes application of a pre-emergent herbicide directly to the soil, and foliar application applied directly to individual plants. Cut stump application of herbicide has also been effective. If a combination of all of these management options is used, control/eradication may be possible in 3-5 years.

Japanese knotweed has not been identified in the Minong Flowage.

Figure 54: Japanese Knotweed (not from the Minong Flowage)

REED CANARY GRASS

Reed canary grass (Figure 55) is a large, coarse grass that reaches 2 to 9 feet in height. It has an erect, hairless stem with gradually tapering leaf blades 3 1/2 to 10 inches long and 1/4 to 3/4 inch in width. Blades are flat and have a rough texture on both surfaces. The lead ligule is membranous and long. The compact panicles are erect or slightly spreading (depending on the plant's reproductive stage), and range from 3 to 16 inches long with branches 2 to 12 inches in length. Single flowers occur in dense clusters in May to mid-June. They are green to purple at first and change to beige over time. This grass is one of the first to sprout in spring, and forms a thick rhizome system that dominates the subsurface soil. Seeds are shiny brown in color.

Both Eurasian and native ecotypes of reed canary grass are thought to exist in the U.S. The Eurasian variety is considered more aggressive, but no reliable method exists to tell the ecotypes apart. It is believed that the vast majority of our reed canary grass is derived from the Eurasian ecotype. Agricultural cultivars of the grass are widely planted.

Reed canary grass also resembles non-native orchard grass (*Dactylis glomerata*), but can be distinguished by its wider blades, narrower, more pointed inflorescence, and the lack of hairs on glumes and lemmas (the spikelet scales). Additionally, bluejoint grass (*Calamagrostis canadensis*) may be mistaken for reed canary in areas where orchard grass is rare, especially in the spring. The highly transparent ligule on reed canary grass is helpful in distinguishing it from the others. Ensure positive identification before attempting control.

Reed canary grass is a cool-season, sod-forming, perennial wetland grass native to temperate regions of Europe, Asia, and North America. The Eurasian ecotype has been selected for its vigor and has been planted throughout the U.S. since the 1800's for forage and erosion control. It has become naturalized in much of the northern half of the U.S., and is still being planted on steep slopes and banks of ponds and created wetlands.

Reed canary grass can grow on dry soils in upland habitats and in the partial shade of oak woodlands, but does best on fertile, moist organic soils in full sun. This species can invade most types of wetlands, including marshes, wet prairies, sedge meadows, fens, stream banks, and seasonally wet areas; it also grows in disturbed areas such as bergs and spoil piles.

Reed canary grass reproduces by seed or creeping rhizomes. It spreads aggressively. The plant produces leaves and flower stalks for 5 to 7 weeks after germination in early spring and then spreads laterally. Growth peaks in mid-June and declines in mid-August. A second growth spurt occurs in the fall. The shoots collapse in mid to late summer, forming a dense, impenetrable mat of stems and leaves. The seeds ripen in late June and shatter when ripe. Seeds may be dispersed from one wetland to another by waterways, animals, humans, or machines.

This species prefers disturbed areas, but can easily move into native wetlands. Reed canary grass can invade a disturbed wetland in just a few years. Invasion is associated with disturbances including ditching of wetlands, stream channelization, and deforestation of swamp forests, sedimentation, and intentional planting. The difficulty of selective control makes reed canary grass invasion of particular concern. Over time, it forms large, monotypic stands that harbor few other plant species and are subsequently of little use to wildlife. Once established, reed canary grass dominates an area by building up a tremendous seed bank that can eventually erupt, germinate, and recolonize treated sites.

Reed canary grass is located in many locations along the shoreland of the Minong Flowage.

Figure 55: Reed Canary Grass (not from the Minong Flowage)

NON-NATIVE AQUATIC INVASIVE ANIMAL SPECIES

Several non-vegetative, aquatic, invasive species are also present in the Minong Flowage. Common carp, Chinese mystery snails, and rusty crayfish are listed by the WDNR as being in the Flowage.

COMMON CARP

The common carp (Figure 56) is a large omnivorous fish. It has large scales, a long dorsal fin base, and two pairs of long barbels (whiskers) in its upper jaw. Native to Europe and Asia, it was intentionally introduced into Midwest waters as a game fish in the 1880s. Common carp may cause many negative impacts in a lake. Common carp are one of the most damaging aquatic invasive species due to its wide distribution and severe impacts in shallow lakes and wetlands. Their feeding disrupts shallowly rooted plants muddying the water, which in turn releases phosphorus that may increase algae abundance, which can cause water quality to deteriorate, and cause a loss of aquatic plants needed by other fish and waterfowl.

Figure 56: Common Carp, MN DNR

CHINESE MYSTERY SNAILS

The Chinese mystery snails and the banded mystery snails (Figure 57) are non-native snails that have been found in a number of Wisconsin lakes. There is not a lot yet known about these species, however, it appears that they

have a negative effect on native snail populations. The mystery snail's large size and hard operculum (a trap door cover which protects the soft flesh inside), and their thick hard shell make them less edible by predators such as rusty crayfish.
The female mystery snail gives birth to live crawling young. This may be an important factor in their spread as it only takes one impregnated snail to start a new population. Mystery snails thrive in silt and mud areas although they can be found in lesser numbers in areas with sand or rock substrates. They are found in lakes, ponds, irrigation ditches, and slower portions of streams and rivers. They are tolerant of pollution and often thrive in stagnant water areas. Mystery snails can be found in water depths of 0.5 to 5 meters (1.5 to 15 feet). They tend to reach their maximum population densities around 1-2 meters (3-6 feet) of water depth. Mystery snails do not eat plants. Instead, they feed on detritus and in lesser amounts algae and phytoplankton. Thus removal of plants in your shoreline area will not reduce the abundance of mystery snails.

Lakes with high densities of mystery snails often see large die-offs of the snails. These die-offs are related to the lake's warming coupled with low oxygen (related to algal blooms). Mystery snails cannot tolerate low oxygen levels. High temperatures by themselves seem insufficient to kill the snails as the snails could move into deeper water.

Many lake residents are worried about mystery snails being carriers of the swimmer's itch parasite. In theory they are potential carriers, however, because they are an introduced species and did not evolve as part of the lake ecosystem, they are less likely to harbor the swimmer's itch parasites.

Figure 57: Chinese Mystery Snails (not from the Minong Flowage)

RUSTY CRAYFISH

Rusty crayfish (Figure 58) live in lakes, ponds and streams, preferring areas with rocks, logs and other debris in water bodies with clay, silt, sand or rocky bottoms. They typically inhabit permanent pools and fast moving streams of fresh, nutrient-rich water. Adults reach a maximum length of 4 inches. Males are larger than females upon maturity and both sexes have larger, heartier, claws than most native crayfish. Dark "rusty" spots are usually apparent on either side of the carapace, but are not always present in all populations. Claws are generally smooth, with grayish-green to reddish-brown coloration. Adults are opportunistic feeders, feeding upon aquatic plants, benthic invertebrates, detritus, juvenile fish and fish eggs.

The native range of the rusty crayfish includes Ohio, Tennessee, Kentucky, Indiana, Illinois and the entire Ohio River basin. However, this species may now be found in Michigan, Massachusetts, Missouri, Iowa, Minnesota, New York, New Jersey, Pennsylvania, Wisconsin, New Mexico and the entire New England state area (except Rhoda Island). The rusty crayfish has been a reported invader since at least the 1930's. Its further spread is of great concern since the prior areas of invasion have led to severe impacts on native flora and fauna. It is thought to have spread by means of released game fish bait and/or from aquarium release. Rusty crayfish are also raised for commercial and biological harvest.

Rusty crayfish reduce the amount and types of aquatic plants, invertebrate populations, and some fish populations--especially bluegill, smallmouth and largemouth bass, lake trout and walleye. They deprive native fish of their prey and cover and out-compete native crayfish. Rusty crayfish will also attack the feet of swimmers. On the positive side, rusty crayfish can be a food source for larger game fish and are commercially harvested for human consumption.

Rusty crayfish may be controlled by restoring predators like bass and sunfish populations. Preventing further introduction is important and may be accomplished by educating anglers, trappers, bait dealers and science teachers of their hazards. Use of chemical pesticides is an option, but does not target this species and will kill other aquatic organisms.

It is illegal to possess both live crayfish and angling equipment simultaneously on any inland Wisconsin water (except the Mississippi River). It is also illegal to release crayfish into a water of the state without a permit.

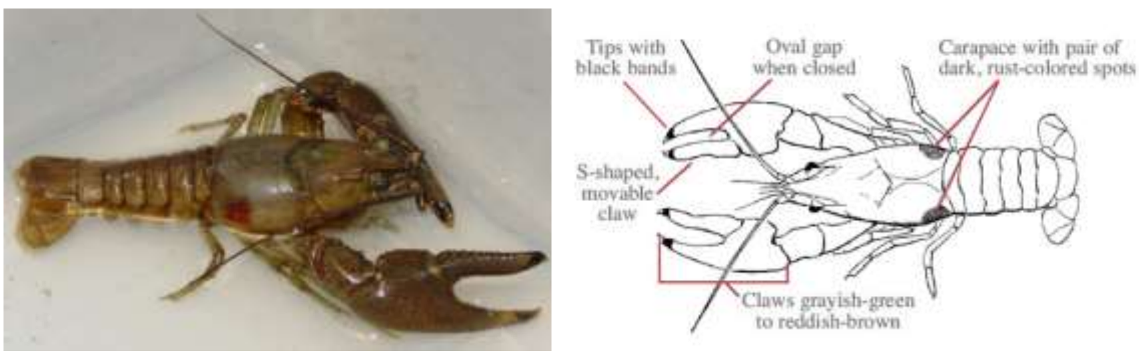


Figure 58: Rusty Crayfish and identifying characteristics

ZEBRA MUSSELS

Zebra mussels have not been identified in the Minong Flowage.

Zebra Mussels (Figure 59) are an invasive species that have inhabited Wisconsin waters and are displacing native species, disrupting ecosystems, and affecting citizens' livelihoods and quality of life. They hamper boating, swimming, fishing, hunting, hiking, and other recreation, and take an economic toll on commercial, agricultural, forestry, and aquacultural resources. The zebra mussel is a tiny (1/8-inch to 2-inch) bottom-dwelling clam native to Europe and Asia. Zebra mussels were introduced into the Great Lakes in 1985 or 1986, and have been spreading throughout them since that time. They were most likely brought to North America as larvae in ballast water of ships that traveled from fresh-water Eurasian ports to the Great Lakes. Zebra mussels look like small clams with a yellowish or brownish D-shaped shell, usually with alternating dark- and light-colored stripes. They can be up to two inches long, but most are under an inch. Zebra mussels usually grow in clusters containing numerous individuals.

Zebra Mussels feed by drawing water into their bodies and filtering out most of the suspended microscopic plants, animals and debris for food. This process can lead to increased water clarity and a depleted food supply for other aquatic organisms, including fish. The higher light penetration fosters growth of rooted aquatic plants which, although creating more habitat for small fish, may inhibit the larger, predatory fish from finding their food. This thicker plant growth can also interfere with boaters, anglers and swimmers. Zebra mussel infestations may also promote the growth of blue-green algae, since they avoid consuming this type of algae but not others.

Once zebra mussels are established in a water body, very little can be done to control them. It is therefore crucial to take all possible measures to prevent their introduction in the first place. Some of the preventative and physical control measures include physical removal, industrial vacuums, and back flushing.

Figure 59: Zebra Mussels (not from the Minong Flowage)

AIS PREVENTION STRATEGY

The Minong Flowage already has several established AIS. However there are many more that could be introduced to the lake. The MFA will implement a watercraft inspection and AIS Signage program at the three public access points on the lake (East Basin, DNR Bay, and County Park). Information will be shared with lake residents and users in an effort to expand the watercraft inspection message. In addition to the watercraft inspection program, an in-lake and shoreland AIS monitoring program will be implemented. Both of these programs will follow UW-Extension Lakes and WDNR protocol through the Clean Boats, Clean Waters program and the Citizen Lake Monitoring Network Aquatic Invasive Species Monitoring program.

Additionally, having an educated and informed lake constituency is the best way to keep non-native aquatic invasive species 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; distribute education and information materials to lake property owners and lake users through the newsletter, webpage, and general mailings.

AQUATIC PLANT MANAGEMENT IMPLEMENTATION IN THE MINONG FLOWAGE

All aquatic plant management techniques have positive and negative attributes. None of the techniques is without some adverse environmental impact; all have both strengths and weaknesses. No management technique is intrinsically superior to another, nor will one management technique be sufficient for all situations in a management program. Rather, all techniques should be considered tools in the manager's toolbox. Some are more expensive but will better control dense populations in larger areas. For small nuisance plant populations or new colonies, hand picking may actually be the best approach. Each site should be evaluated and management techniques selected based on the desired level of control, and environmental and economic constraints (Madsen 2000).

Management should be tailored to the priority and goals of each site. All areas within the lake should be categorized as to use, restrictions, and priority. Based on these categories, management techniques can then be selected. For instance, swimming beaches and boat launches are high-use areas, and should have a high priority. Wildlife areas (e.g., refuges) have lower intensity use, and some restrictions to management. The high-priority, high-intensity use sites might justify high-cost management techniques such as benthic barriers or diver-operated suction harvesting. Low-intensity use areas might either remain untreated if resources are low, or would be categorized for less expensive techniques such as herbicides. Likewise, areas with higher concentrations of plants should receive more resources than areas with no plants or with acceptable levels of infestation (Madsen 2000).

As dense colonies are brought under control, maintenance management approaches can be used. After a target plant species has entered a system, continuous management will be required. However, under no circumstances should management be discontinued once plant densities are low. If management techniques are very successful, management may entail only monitoring the system and hand-removing individuals that are occasionally found. Scale the control technique to the level of infestation, the priority of the site, the use, and the availability of resources (Madsen 2000).

LOCATION CHARACTERISTICS OF EWM AND CLP BEDS

EWM and CLP are established in many places in the Minong Flowage. The characteristics of each location differ but can be placed in several common habitat descriptions. Management actions can be initially defined based on these specific habitat descriptions.

WILD RICE BEDS

Expansive wild rice beds are present in the northern third of Serenity Bay and in the East Basin (Figure 60). Since first discovered in the Minong Flowage and up to the 2013 drawdown, EWM had increased in its distribution and density in this area and in some locations competing with wild rice in its seedling and floating leaf stages. More recently, CLP in these areas has been increasing in distribution and density also competing with seedling and floating leaf stages of wild rice. Because of moving water, stump fields, and the presence of wild rice, limited management actions were completed in this area from 2009 to 2012. The winter portion of the 2013-14 drawdown significantly reduced the level of AIS in this area in 2014.

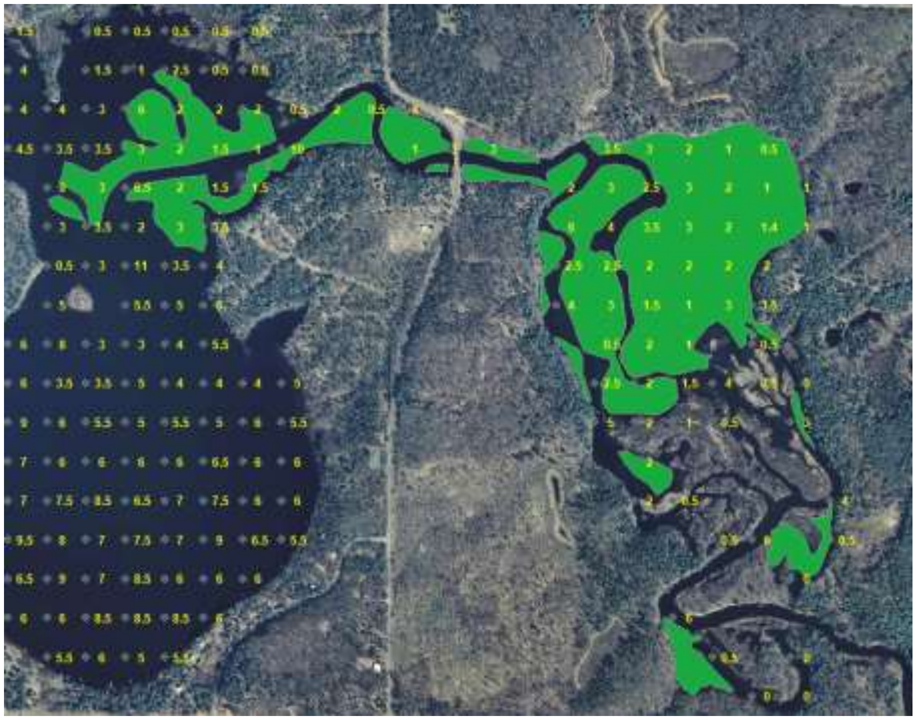


Figure 60: 2014 Wild rice beds

SHALLOW WATER STUMP FIELDS

There are several shallow water stump fields in the Minong Flowage that harbor EWM and CLP. Shallow water stump field are defined as areas in the Flowage where the density of stumps and other woody debris is such that motorized boating is difficult at best, impossible at worst, and water depth is no more than 6-ft deep (Figure 61). The total acreage within the shallow water stump fields is estimated at 120 acres. Within these areas past EWM management was limited to physical removal, biological control, and the limited use of herbicides due to hazardous boating. The winter portion of the 2013-14 drawdown significantly reduced the level of AIS in these areas in 2014.

Figure 61: Shallow water stump fields

NEARSHORE, SHALLOW, HARD BOTTOM AREAS

Nearshore, shallow, hard bottom areas are defined as the area immediately adjacent to the shoreline that has a solid, sandy bottom and a maximum depth of three feet; essentially the entire shoreline of the Minong Flowage so a map is not provided. The majority of property owner's docks are in this area. Past management actions in this area have included physical removal by property owners and the use of herbicides. The winter portion of the 2013-14 drawdown significantly reduced the level of AIS in these areas in 2014.

SHALLOW, HARD BOTTOM FLATS

Shallow, hard bottom, flats are defined as large, flat areas that extend away from the shoreline, where the water depth is no more than 3-ft and the bottom is hard, usually sandy (Figure 62). These flats cover approximately 12 acres within the Flowage. Past EWM management in these areas included physical removal and the use of aquatic herbicides. The winter portion of the 2013-14 drawdown significantly reduced the level of AIS in these areas in 2014.

Figure 62: Shallow, hard-bottom flats

DEEP WATER EDGES OFF FLATS

The shallow, hard bottom flats mentioned in the previous description, drop off quickly at their edges into deep water (Figure 63). These areas cover approximately 17 acres and are located adjacent to the shallow, hard bottom flats. Past EWM management in these areas was completed with the use of herbicides. Annual water clarity is one of the determining factors for EWM growth in these areas. The winter portion of the 2013-14 drawdown had less impact on growth in these areas in 2014.

Figure 63: Deep water edges off shallow flats

SHALLOW, SOFT BOTTOM, BACK BAYS

Large areas of the Minong Flowage are covered by somewhat shallow water over a more organic or soft bottom. Most of these areas are in back bays off the main body of the Flowage that cover approximately 58 acres with a water depth of 3-7 feet (Figure 64). The largest of these areas extends from the State-owed boating access around both sides of what is often referred to as Sawdust Island and up past the Swift Nature Camp. Past EWM management in these areas included limited physical removal, the use of herbicides, and biological control. The

2013-14 winter drawdown did take out much of this EWM given that the water level was drawn down more than 5-ft. A lesser drawdown would likely have fewer impacts in these areas.

Figure 64: Shallow, soft-bottom, back bays

DEEP WATER AREAS

EWM has been identified in several deep water areas over the last five years. These areas cover approximately 127 acres and have a water depth greater than 6-ft (Figure 65). In these areas, EWM is found in a range between 6 and 10 feet, but is subject to annual variation due to water clarity and growing conditions. The southern half of Serenity Bay, most of the North Basin, and several other large deep water areas are included in this description. Past EWM management has been completed using early season small and large-scale herbicide application. The 2013-14 extended drawdown had little impact in these areas due to water depth.


Figure 65: Deep water areas

MANGEMENT ZONES

To further define what and where various management actions should be implemented, the Minong Flowage has been divided into different management zones based on lake use. These management zones may contain one or more of the location characteristics defined in the previous section.
The uses within each of these zones are listed along with special concerns, possible restrictions or conditions that will impact management decisions (Figure 66, Table 8).

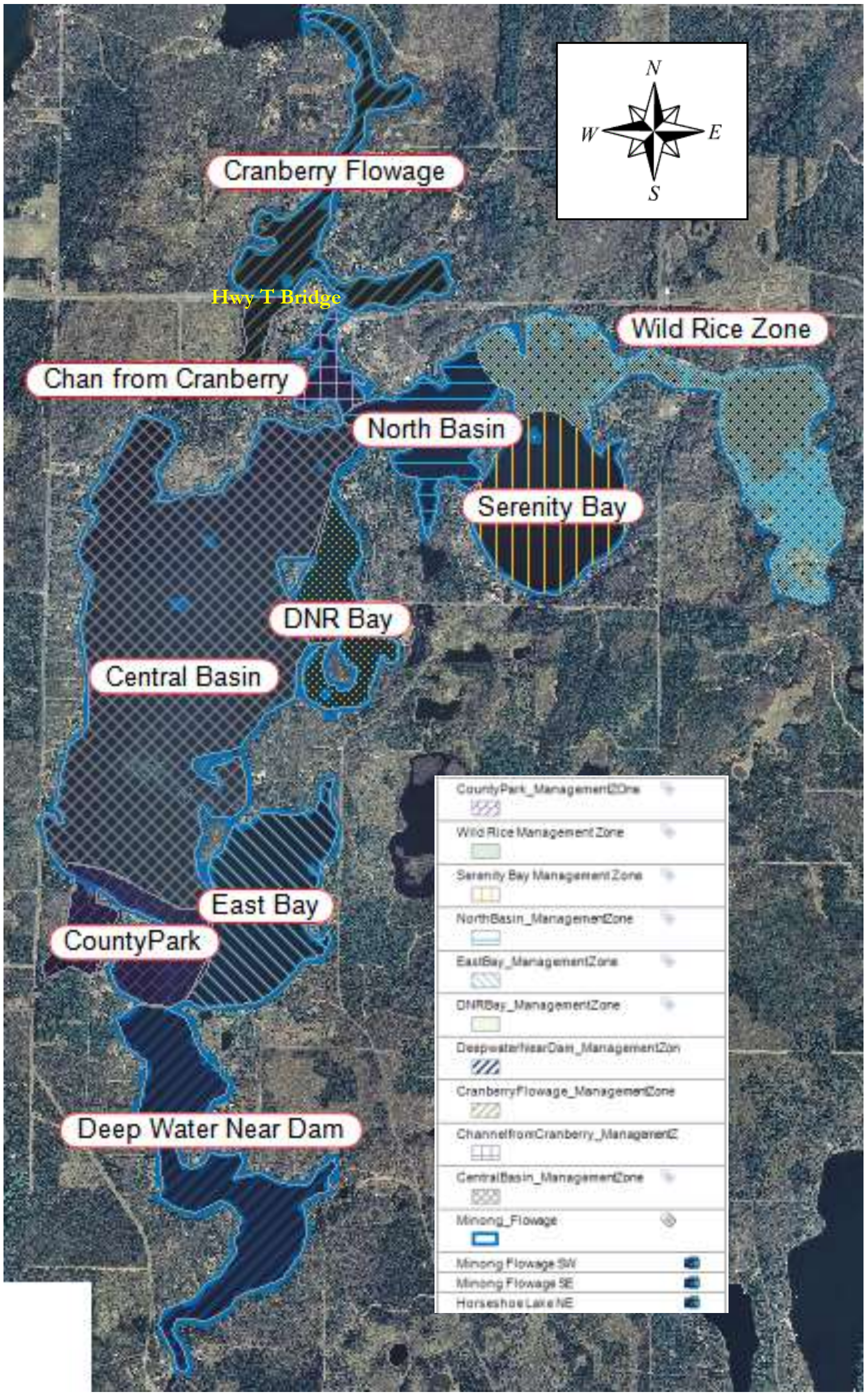


Figure 66: Minong Flowage Management Zones

Table 8: Minong Flowage Management Zones

Management Zone	Area (acres)	Uses	Special Concerns	Restrictions	Location Characteristics	Priority
Cranberry Flowage	112.9	Shoreland development, navigation, natural areas	Herbicide drift from Cranberry Lake	stump fields, water flow	stump fields, shallow soft-bottom areas	med
Channel from Cranberry	24.9	Shoreland development, boat access, navigation	Herbicide drift from Cranberry Flowage	water flow	shallow soft-bottom areas	med
Wild Rice (North Serenity Bay and East Basin)	223	Wild rice harvest, natural area, boat access, navigation	wild rice beds, CLP	wild rice, stump fields, water flow	stump fields, wild rice beds	low
Serenity Bay	145.7	Shoreland development, navigation	EWM source beds in stump fields	stump fields, water flow	stump fields, nearshore shallow hard-bottom areas, deep water areas	high
North Basin	81.8	Shoreland development, navigation, natural areas	EWM source beds in stump fields	stump fields, water flow	stump fields, deep water beds, shallow soft-bottom areas	high
Central Basin	605.1	Shoreland development, open water sports, island beaches, natural areas	swimming areas associated with the islands in the basin	public swimming, deep water	nearshore shallow hard-bottom areas, shallow hard-bottom flats, deep water edges, deep water areas	high
County Park	87.8	County Campground, swimming beaches, public boat access	swimming areas associated with the County Park, public access	public swimming, deep water	nearshore shallow hard-bottom areas, shallow hard-bottom flats, deep water edges, deep water areas	high
DNR Bay	73.2	Swift Nature Camp, boat access, navigation, shoreland development, natural area	Swift Nature Camp waterfront area, public access, CLP	public swimming	shallow soft-bottom areas, shallow flats	high
East Bay	137.8	Shoreland development, open water sports		deep water	nearshore shallow hard-bottom areas, shallow soft-bottom areas, deep water beds	high
DeepwaterNearDam	159.5	Shoreland development, navigation	Last hump before the dam (bed 1)	deep water, water flow	shallow hard-bottom flats, deep water edges	med
	1651.7					

CRANBERRY FLOWAGE

When the 2010 Aquatic Plant Management Plan for the Minong Flowage was written, it was a conscious decision to separate the waters of the Cranberry Flowage from those of the Minong Flowage at the Hwy T bridge (Figure 66) for management purposes, even though both bodies of water are considered by the WDNR and GLIFWC to be part of the Minong Flowage. This sentiment is reflected in the 2012 Aquatic Plant Management Plan prepared for the Cranberry Lake/Flowage by Ecological Integrity Services, LLC (Schieffer 2012).

The Cranberry Flowage extends from the outlet on Cranberry Lake south to the County Hwy T Bridge. Since 2009 when herbicide management was first implemented in the Cranberry Flowage and the Minong Flowage, management in the Cranberry Flowage has been the responsibility of the Cranberry Lake/Flowage Association. In 2009, seven beds of EWM totaling approximately 0.75 acres were chemically treated in the Cranberry Flowage. No chemical management was completed in 2010. In 2011, six beds of EWM totaling 2.84 acres were chemically treated. In 2012, sixteen beds of EWM totaling 1.86 acres were chemically treated. No chemical management was completed in 2013 or 2014. The winter portion of the 2013-14 drawdown had some positive impact in this area.

Other than the large bay to the southwest, much of the shoreline along the Cranberry Flowage is developed with homes along both shores. The area is mostly shallow water with a soft bottom and supports a tremendous amount of native vegetation with areas of EWM mixed in. Navigation is important in this area as boats travel both upstream and downstream between Cranberry Lake and the Minong Flowage when water levels are high enough. Boating access from individual properties to an open channel is of concern. In addition, EWM beds left unmanaged serve as source beds for fragmentation into the greater body of the Minong Flowage. Water movement and the risk of negatively impacting native plants through management actions are of concern.

Beginning in 2015, the Minong Flowage Association will work with the Cranberry Lake/Flowage Association to plan and implement EWM management in the Cranberry Flowage. For the next five years, all aquatic plant surveys, grant applications, and the like will include the waters of the Cranberry Flowage.

CHANNEL FROM CRANBERRY

The Channel from Cranberry extends from the plunge pool below the Hwy T Bridge to the North Basin on the Minong Flowage (Figure 66). Management locations are mostly shallow soft-bottom areas that have supported moderate to dense EWM growth in the past. There is a small EWM bed mixed with CLP that usually forms on the northwest side of the plunge pool immediately downstream of the Hwy T Bridge. The current in this area is fairly strong due to water moving under the bridge from the Cranberry Flowage. There is a private access point called Pogo's Landing on the northeast side of the plunge pool. The 2013-14 drawdown had limited results in this zone. The shoreland along the Channel from Cranberry is mostly developed. The Channel from Cranberry acts as a catch basin for some of the vegetative fragments (native and non-native) that come down from the Cranberry Flowage. Other than what accumulates to either side of the plunge pool, a large bay just before reaching the North Basin supports the greatest amount of EWM growth. Water movement is the greatest concern in this management zone.

WILD RICE (NORTH SERENITY BAY & EAST BASIN)

The northern third of Serenity Bay, the East Basin, and the area between Serenity Bay and Smith's Bridge provide the bulk of the habitat for wild rice in the Minong Flowage and is designated the Wild Rice Zone (Figure 66). Moderate to dense growth EWM and CLP have historically been present in this zone. Both species begin by establishing a foothold in the deeper water areas where wild rice typically does not grow as dense, and then early season growth out-competes wild rice seedlings, allowing both AIS to encroach upon and invade the wild rice beds. Much of the zone is identified as shallow, soft-bottom with large shallow stump fields in several locations. The Totagatic River Channel is generally easy to define through this area as it provides a deep water area where aquatic plants do not grow. Moderate to dense EWM and CLP growth often extends right up to the edge of the channel.

There are several developed properties along the northern shore of this zone and in the East Bay, but for the most part the shoreline is undeveloped. Property owners in this zone have generally had to rely on their own boat use to keep access channels to open water free of both non-native and native vegetation. There is a public boating access at Smith Bridge used primarily by duck hunters, wild rice harvesters, and canoe and kayak enthusiasts.

According to GLIFWC information published in 2010, EWM likely represents the greatest threat to the rice beds in this zone. This information further states that areas within this zone will be important 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. In 2010, the watch status set by GLIFWC was medium-high because of the need to monitor both the possible expansion of the wild rice beds, and the possible negative impacts of invasive aquatics.

The application of early season aquatic herbicides will not be implemented in this zone as it can be detrimental to wild rice in its seedling stage. The winter portion of the 2013-14 drawdown had the greatest positive outcome in this zone, significantly reducing EWM and CLP, and reducing competition between native plants (specifically pickerel weed) and wild rice. Being an annual plant growing from seed each year, wild rice itself was not negatively impacted by either portion of the extended drawdown (summer or winter). The presence of wild rice, stump fields, and water movement are of the most concern in this zone.

NORTH BASIN

The North Basin extends from the Channel from Cranberry on the west, to the main or Central Basin on the south, and the large island and Serenity Bay on the east (Figure 66). Within this zone, shallow soft-bottom bays, shallow stump fields, and deep water areas are present. There is some developed shoreline particularly within the narrow finger bay that extends south from the main area of the North Basin. Historically, the entire area has supported moderate to dense EWM growth particularly north and south of the deeper water river channel that runs through it. The large, shallow stump field immediately adjacent to the big island has historically harbored a large and dense bed of EWM and acted as a source bed for fragments to the rest of the Flowage. EWM in this location has generally not been managed due to the density of emerged and submerged stumps that are present. Weevil monitoring and release has been implemented in this area, and the 2013-14 winter drawdown significantly reduced EWM. Areas outside of the stump field have been chemically treated with very positive results.

The northern most end of the North Basin is included in the Wild Rice Zone because of concerns related to the movement of water and potentially herbicides to the north and east around the island and into the wild rice beds. A dye study simulating small-scale application of herbicides in this area did not definitively determine if this movement of herbicides might happen. A larger, dye study simulating a whole bay treatment was completed in 2015.

Navigation, unimpeded by EWM is a concern in this zone, although in most years the river channel passing through the North Basin maintains open water. Deeper water adjacent to the river channel has supported moderate to dense EWM growth, but the extent varies with annual water clarity. Water movement and the presence of stump fields are of most concern in this zone.

SERENITY BAY

Serenity Bay, also referred to as "stump bay", is the large open water area east of the North Basin and big island (Figure 66). The northern third of Serenity Bay is included in the Wild Rice Zone. Nearshore shallow hard-bottom areas, shallow stump fields, and deep water areas are located within Serenity Bay. The shoreline of the bottom third of Serenity Bay is heavily developed. EWM historically forms a narrow, but dense ring all around this area. The middle third of Serenity Bay contains a large shallow stump field that historically harbored a large and dense bed of EWM and acted as a source bed for fragments to the rest of the Flowage. EWM in this location has generally not been managed due to the density of emerged and submerged stumps that are present. Weevil monitoring and release has been implemented in this area, and the 2013-14 winter drawdown significantly reduced EWM. Between the stump field and southern shoreline, there is a large, deep water area that depending on annual water clarity supports varied levels of EWM and/or native plant growth. In 2010, large-leaf pondweed and several other native aquatic plant species responded very well in Serenity Bay due to increased water clarity and reduced levels of EWM.

Navigation, water movement, and stump fields are of greatest management concern in this zone.

CENTRAL BASIN

The Central Basin is the largest management zone in the Minong Flowage (Figure 66). The area is the primary recreation use area including power boating, fishing, swimming, water skiing, and tubing. The Central Basin is home to the Totagatic County Park including the main public access point. Much of the western shoreline of the Central Basin is developed. Less of the North Shore and east shoreline is developed, and there are a number of islands within the Central Basin that have natural shorelines. Nearshore shallow hard-bottom areas, shallow hard-bottom flats, deep water edges, and deep water areas are all located in the Central Basin. The main locations for EWM in the Central Basin include the County Park, West Shore, North Shore, central Islands, and along the east shore. Many of the EWM beds that have historically been present in the Central Basin extend out into navigational areas. In most years, these beds are marked by buoys in an attempt to make boaters aware of them. A great deal of physical removal has been implemented in this zone, particularly along the west shore. Early season application of herbicide has been used in all EWM locations in the Central Basin in an effort to keep the level of EWM low.

Improving recreational opportunities, deep water dissipation of the herbicide and reducing navigational impairments caused by EWM are the biggest concerns in this area.

COUNTY PARK

The County Park Zone (Figure 66) is immediately adjacent to property owned by Washburn County and maintained for public camping and recreation as the Totagatic County Park. The immediate shoreline area extends from the northwest edge of the campground, around the eastern point, and to the south edge of the campground. This area includes the north beach, campground bay, swimming beach, and the county boat landing. The small inland lake is also included. EWM management areas include nearshore shallow hard-bottom areas, shallow hard-bottom flats, deep water edges off the flat, and soft-bottom back bays (inland lake). Except for the campground this shoreland is undeveloped however there are multiple access points to the lakeshore throughout the campground. There is a public fishing pier in the inland lake. Sparse to moderate growth of EWM has historically been presence along the north beach, particularly on a large shallow flat that extends out from the shore.

Maintaining unimpeded swimming and boating access along the north beach and keeping the public access free of EWM fragments is the biggest concern in this area.

DNR BAY

The DNR Bay extends from the state-owned public access behind what is known locally as "sawdust island" to an area between a large island and the mainland where the Swift Nature Camp is located north of that landing (Figure 66). Most of the shoreline is undeveloped. The waterfront along the Swift Nature Camp is used for camp activities including swimming, canoeing, kayaking, and sailing. This entire zone is considered a shallow soft-bottom area with a small shallow water flat, and limited nearshore shallow hard-bottom areas. Moderate to dense beds of EWM and CLP have historically been present in this zone. These beds have impeded navigation from the state-owned boating access to the open water of the Central Basin, and negatively impacted the waterfront along the camp. Several locations within the DNR Bay and immediately adjacent to it on the edge of the Central Basin have been repeatedly treated early season with herbicides to reduce their impact on navigation and native aquatic plants. The winter portion of the 2013-14 drawdown significantly reduced the amount of EWM and CLP in this zone.

Improving the lakefront along the Swift Nature Camp, fragments carried away from the lake by boats launched at the state-owned access, and reducing navigational impairments caused by EWM are the biggest concerns in this area.

EAST BAY

The East Bay is south and east of the Central Basin (Figure 66) and is considered deep water with nearshore shallow hard-bottom areas. Historically EWM has been present in several locations along the east shore, and in deeper water in the northern portion of the zone. Like the Central Basin, this zone is primarily used for recreational purposes including power boating, fishing, swimming, water skiing, and tubing. The zone is directly across the lake from the main swimming beach of the Totagatic County Park and public access. The eastern shore is mostly developed and there are two small shallow water soft-bottom bays, one at the northeast end, and one midway down the east shore. Both have supported moderate to dense EWM growth in the past. In the deep water area of this zone EWM growth is dependent on water clarity, but has persisted, even through the 2013-14 drawdown.

Reducing navigational impairments caused by EWM and deep water dissipation of herbicides are the biggest concerns in this zone.

DEEP WATER NEAR DAM

The Deep Water Near Dam zone extends from the south end of the Central Basin and East Bay zones to the dam (Figure 66). The majority of this zone is deep water with the exception of a shallow hard-bottom flat with deep water edges on the west shore at the inside arc of the last bend in the waterway prior to the dam that has persistently provided suitable habit for moderate to dense EWM growth. Despite repeated management actions, the EWM at this location seems to reestablish every year, probably because it is the last site before the dam the does provide suitable habitat. The winter portion of the 2013-14 drawdown did significantly reduce the amount of EWM in this area. Because of its location, buoys are placed annually marking this shallow flat as it creates a significant navigation hazard, with or without the EWM. There is a fairly large, shallow soft-bottom bay on the east side of this zone, but it historically has not provided good habitat for EWM growth. Except these two areas, the shoreline is steep and the littoral zone very narrow, providing little habitat for EWM.

Water movement, reestablishment of EWM, and deep water dissipation of herbicides are the biggest concerns in this area.

MANAGEMENT ALTERNTIVES

Nuisance aquatic plants can be managed 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 approach to aquatic plant management that utilizes a number of control methods is necessary. The eradication of non-native aquatic invasive plant species such as EWM or CLP is generally not feasible, but preventing them from becoming a more significant problem is an attainable goal. It is important to remember however, that regardless of the plant species targeted for control, 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, and 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 is typified by the use of herbicides that kill or impede the growth of the aquatic plant. 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 resources. Physical habitat alteration includes dredging, installing lake-bottom covers, manipulating light penetration, flooding, and drawdown. It may also include making changes to or in the watershed of a body of water to reduce nutrients going in.

Each of the above control categories are regulated by the WDNR and most activities require a permit from the WDNR to implement. Mechanical harvesting of aquatic plants and under certain circumstances, physical removal of aquatic plants, is regulated under Wisconsin Administrative Rule NR 109 (Appendix). The use of chemicals and biological controls are regulated under Administrative Rule NR 107 (Appendix F). Certain habitat altering techniques like the installation of bottom covers and dredging require a Chapter 30/31 waterway protection permit. In addition, anytime wild rice is involved one or more of these permits will be required.

Informed decision-making on 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 nonnative 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. Nonnative plants are a biological pollutant that increases geometrically, a pollutant with a very long residence time and the potential to "bio magnify" in lakes, rivers, and wetlands (Madsen 2000).

Foregoing any management of EWM in the Minong Flowage is not an option. Regardless of the area, some form of EWM management will need to be implemented. In certain places, management action may only be implemented when “determined necessary”, but it will eventually take place. At the end of 2014, EWM beds only covered about 15 acres, or less than 1% of the entire surface area of the Flowage. In 2008 EWM beds covered more than 330 acres or greater than 20% of the Flowage. Allowing EWM to reach this level again is not an option.

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 Waivers under the following conditions:

- Removal of native plants is limited to a single area with a maximum width of no more than 30 feet measured along the shoreline provided that any piers, boatlifts, swim rafts and other recreational and water use devices are located within that 30-foot wide zone and may not be in a new area or additional to an area where plants are controlled by another method (Figure 67)
- Removal of nonnative or invasive aquatic plants as designated under s. NR 109.07 is performed in a manner that does not harm the native aquatic plant community
- Removal of dislodged aquatic plants that drift on-shore and accumulate along the waterfront is completed.
- The area of removal is not located in a sensitive area as defined by the department under s. NR 107.05 (3) (i) 1, or in an area known to contain threatened or endangered resources or floating bogs
- Removal does not interfere with the rights of other riparian owners
- If wild rice is involved, the procedures of s. NR 19.09 (1) are followed.

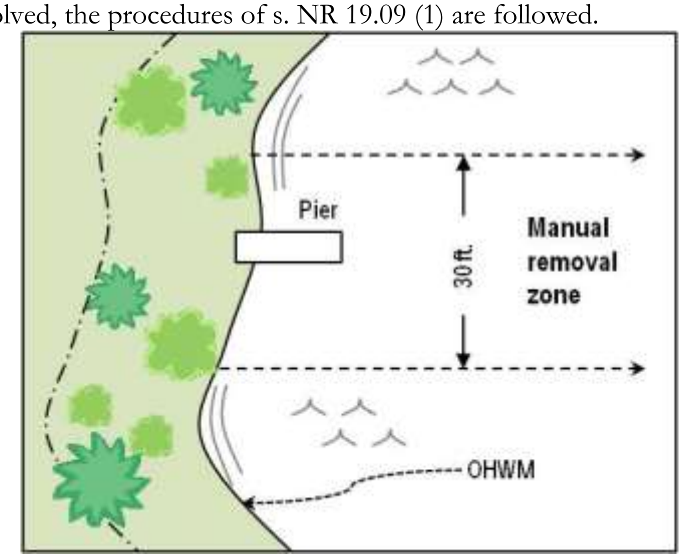


Figure 67: Aquatic vegetation manual removal zone

Although up to 30 feet of aquatic vegetation can be removed, removal should only be done to the extent necessary. There is no limit as to how far out into the lake the 30-ft zone can extend, however clearing large swaths of aquatic plants not only disrupts lake habits, it also creates open areas for non-native species to establish. Physical removal of aquatic plants requires a permit if the removal area is located in a "sensitive" or critical habitat area previously designated by the WDNR. Manual or physical removal can be effective at controlling individual plants or small areas of plant growth. It limits disturbance to the lake bottom, is inexpensive, and can be practiced by many lake residents. In shallow, hard bottom areas of a lake, or where impacts to fish spawning habitat need to be minimized, this is the best form of control. If water clarity in a body of water is such that aquatic plants can be seen in deeper water, pulling aquatic invasive species while snorkeling or scuba diving is also allowable without a permit according to the conditions in NR 106.06(2) and can be effective at slowing the spread of a new aquatic invasive species infestation within a lake when done properly.

Larger scale hand or diver removal projects have had positive impacts in temporarily reducing or controlling aquatic invasive species. Typically hand or diver removal is used when an AIS has been newly identified and still exists as single plants or isolated small beds, but at least in one lake in New York State, it was used as a means to control a large-scale infestation of EWM. Kelting and Laxson (2010) reported that from 2004 to 2006 an "intensive management effort" which involved "the selective removal of Eurasian water milfoil using diver hand harvesting of the entire littoral zone of the lake at least twice each summer for three years" followed by three years of maintenance management successfully reduced the overall distribution of EWM in the lake.

Overall costs ranged from a high of $796 per hectare ($322 per acre) of EWM removed during the three years of intensive management effort, to about $300 per hectare during the three year maintenance period. In the first two years of intensive management effort, the cost per kg of EWM removed was relatively low. As the efforts proved to be successful at knocking down the distribution and density of the EWM, the cost per kilogram of EWM went up as it took an equal amount of time and money to find and remove a much lower amount of EWM. The authors also commented that during the maintenance period the amount of EWM trended back up, indicating that limiting intensive management effort allowed for the EWM to make a comeback.

In the Minong Flowage, AIS growing in nearshore shallow hard-bottom areas or shallow hard-bottom flats may be best managed by hand-pulling/manual removal. In a survey conducted in 2008, 57% of the respondents said they already do this. The MFA will continue to work with residents on the lake to teach them how to identify non-native aquatic plant species and how to properly remove them from around their docks and in their swimming areas. In addition, the MFA will consider a partnership with authorities in the Gordon Correctional Facility to involve inmates in a physical removal campaign in shallow water. The MFA will also consider supporting a team of physical removers to aid property owners in their efforts, and to remove EWM and other AIS adjacent to undeveloped property. Scuba diver removal in deep water edge areas is possible, but may be restricted due to poor water clarity, submerged debris, inexperienced divers, and the resources available to the MFA.

DIVER ASSISTED SUCTION HARVESTING

Diver assisted suction harvesting or DASH, as it is often called, is a fairly recent aquatic plant removal technique. It is called "harvesting" rather than "dredging" because, although a specialized small-scale dredge is used, bottom sediment is not removed from the system. The operation involves hand-pulling of weeds from the lake bed and inserting them into an underwater vacuum system that sucks up plants and their root systems taking them to the surface. It requires water pumps on the surface (generally on a pontoon system) to move a large volume of water to maintain adequate suction of materials that the divers are processing (Figure 68). Only clean water goes through the pump. The material placed by the divers into the suction hose along with the water is deposited into mesh bags on the surface with the water leaving through the holes in the bag. The bags have a large enough 'mesh' size so that silts, clay, leaves and other plant material being collected do not immediately clog them and block water movement. If a fish or other living marine life is sucked into the suction hose it comes out the discharge unharmed and is returned to the body of water. It can have some negative impacts to other nearby non-target plants if not done carefully, particularly those plants that are perennials and expand their populations by sub-sediment runners (Eichler et al. 1993).

In Wisconsin and Michigan, suction harvesting of unwanted aquatic plants is gaining popularity as a treatment method. There are several companies in the mid-west that are offering DASH services. Some of these companies are also building equipment that lake organizations and consultants can purchase to start up their own DASH program. Aquacleaner Environmental, out of Lancaster, NY sells a DASH system with a 5" suction hose for about $30,000.00 plus extras. The same company offers DASH services at a rate of $200.00/hour, with an acre of vegetation removal averaging $15,000.00. Another company, Naturally DASH and Dredge, LLC (http://www.naturallydash.com), builds a system with a single pump and 3" hose for about $6,000.00.

More locally, Many Waters, LLC (http://www.manywatersconsulting.com) out of Iron River, MI has been providing DASH services in northeastern WI. During the Northern Great Lakes Invasive Species Conference in Marquette, MI on November 4, 2014, Many Waters, LLC presented DASH results from Lac Vieux Desert in Vilas County (http://www.uprcd.org/downloads/diver_assisted_suction_harvesting_of_aisgajewski.pdf). During that presentation it was reported that 1,033.5 lbs. of EWM was removed from the lake with 17 hours of DASH. During the harvest, there was a14.6% bi-catch of other plants sucked up at the same time. No report of costs was given. In this presentation, Many Waters, LLC reported that the efficiency of DASH was negatively impacted by obstacles/structures in the water, water clarity, sediment type, EWM density, native aquatic plant density, and time of year.

In a similar report filed for 2013 DASH services on Lake Elwood in Florence County, 2,322 lbs. of hybrid EWM was removed from the lake in 21 hours. In this lake, there was only a 1.85% bi-catch of native plants. According to documents on the Lake Ellwood Association webpage (http://www.leassoc.org/index.htm) $4,530.00 was spent on DASH services in 2013. Four areas in the lake totaling 0.7 acres were included in the DASH project. Based on these numbers, cost per lb. of EWM harvested was $1.95; cost per hour for DASH services was $215.71; and cost per acre was $6,471.43. Lake Ellwood is a clear-water lake, however, the report mentions that DASH results were hampered by the presence of woody debris in the area of EWM harvest.

From a 2014 report for DASH services on Virgin Lake in Oneida County, 144 lbs. of EWM were removed in 2.5 hours with a bi-catch of 23%. On Virgin Lake, dense growth native vegetation and water clarity issues impacted the success of the DASH project. No report of cost was given.

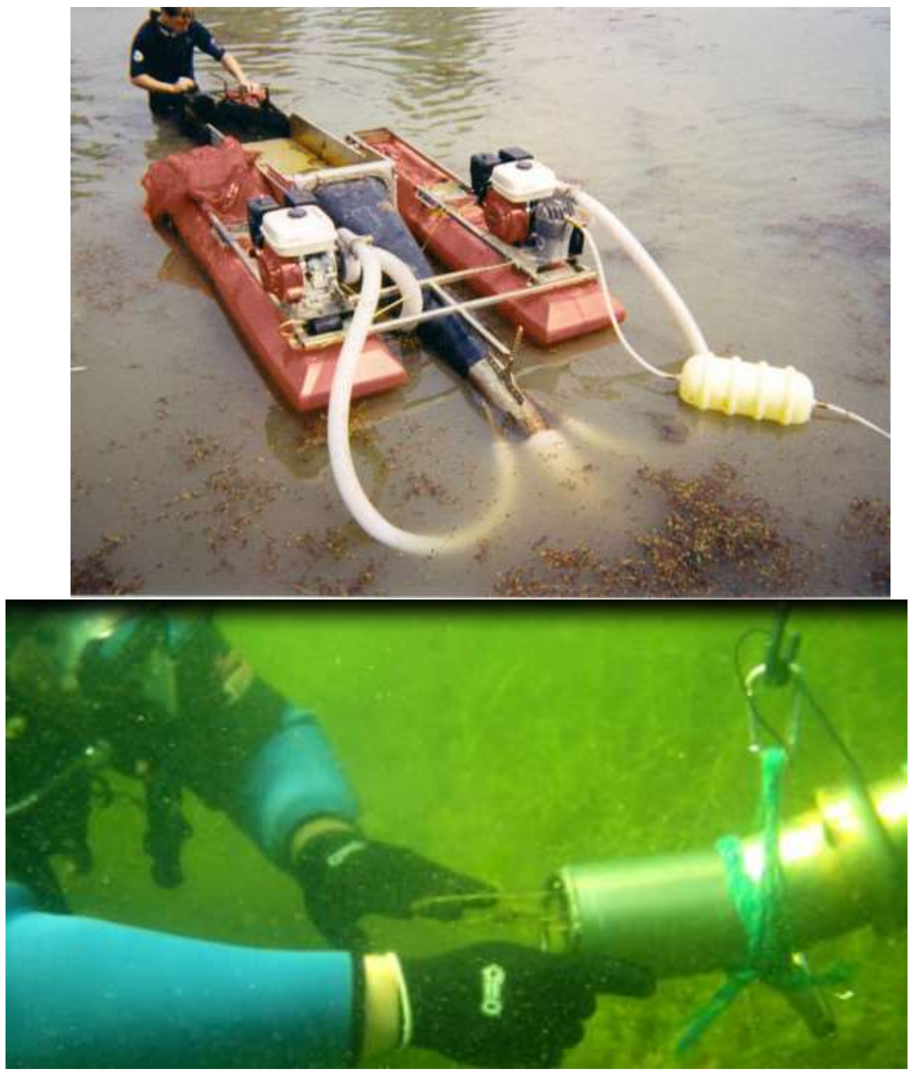


Figure 68: DASH - Diver Assisted Suction Harvest (Aquacleaner Environmental, http://www.aquacleaner.com/index.html); Many Waters, LLC)

DASH can be an effective way to manage small areas of EWM and CLP under the right conditions. In 2015, the MFA contracted with a DASH firm from Upper Michigan. DASH management of EWM was attempted on Cranberry Lake, the Cranberry Channel, and on the Minong Flowage. While this management alternative was able to remove a fair amount of EWM, the cost was prohibitive for future application unless the MFA were to purchase their own equipment or contract with a more local company. At the same time DASH was implemented, another private company was brought in to do physical removal without the aid of the DASH system. For the cost, the physical removal team was much more effective than the DASH process. After the results of the 2015 DASH and physical removal contracted services, it was decided that more could be done with contracted physical removal than DASH. A Summary Report prepared by the MFA is included as an Appendix at the end of the APM Plan.

MECHANICAL REMOVAL

Mechanical management involves the use of devices not solely powered by human means to aid removal. 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. DASH is also considered mechanical removal. To implement mechanical removal of aquatic plants a Mechanical/Manual Aquatic Plant Control Application is required annually. The application is reviewed by the WDNR and other entities and a permit awarded if required criteria are met. Using repeated mechanical disturbance such as bottom rollers or sweepers can be effective at control in small areas, but in Wisconsin these devices are illegal and generally not permitted.

LARGE-SCALE MECHANICAL HARVESTING

Large-scale mechanical harvesting is more traditionally used for control of CLP, but can be an effective way to reduce EWM biomass in a water body. It is typically used to open up channels through existing beds of EWM to improve access for both human related activities like boating, and natural activities like fish distribution and mobility on lakes in maintenance mode where EWM is well-established and restoration efforts have been discontinued.

Aquatic plant harvesters are floating machines that cut and remove vegetation from the water. The size, and consequently the 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, and the average lifetime of a mechanical harvester is 10 years.

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 as a result of the decaying of this plant matter is prevented. Additionally, repeated treatments may result in thinner, more scattered growth.

Aside from the obvious effort and expense of harvesting aquatic plants, there are many environmentally-detrimental consequences to consider. 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. Shoreline erosion may therefore increase. 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 as a whole.

While the results of harvesting aquatic plants may be short term, the negative consequences are not so short lived. Much like mowing a lawn, harvesting must be conducted numerous times throughout the growing season. Although the harvester collects most of the plants that it cuts, some plant fragments inevitably persist in the water. This may allow the invasive plant species to propagate and colonize in new, previously unaffected areas of the lake. Harvesting may also result in re-suspension of contaminated sediments and the excess nutrients they contain.

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 lakes. 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 as well as cost.

Timing is also important. The ideal time to harvest, in order to maximize the efficiency of the harvester, is just before the aquatic plants break the surface of the lake. For CLP, it should also be before the plants form turions (reproductive structures) to avoid spreading the turions within the lake. 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 from one body of water to another. Harvesting contractors are not readily available in northern Wisconsin, so harvesting contracts are likely to be very expensive.

Using mechanical harvesting to manage EWM or CLP is not recommended on the Minong Flowage. The nature of a shallow flowage in Wisconsin is to have many snags and tree stumps submerged all over the system. This is the case in the Minong Flowage. Damage to expensive harvesting equipment would most certainly be substantial almost on a daily basis. 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. In addition, management that leads to a restoration of the native aquatic plant community in the Minong Flowage is still considered an attainable goal.

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

BOTTOM BARRIERS AND SHADING

Physical barriers, fabric or other, placed on the bottom of the lake to reduce EWM growth would eliminate all plants, inhibit fish spawning, affect benthic invertebrates, and could cause anaerobic conditions which may release excess nutrients from the sediment. Gas build-up beneath these barriers can cause them to dislodge from the bottom and sediment can build up on them allowing EWM to re-establish. Bottom barriers are typically used for very small areas and provide only limited relief. Currently the WDNR does not permit this type of control.

Creating conditions in a lake that may serve to shade out EWM growth has also been tried with mixed success. The general intention is to reduce light penetration in the water which in turns limits the depth at which plants can grow. Typically dyes have been added to a small water body to darken the water. Shading occurs naturally in many water bodies including the Minong Flowage. Tannins in the Flowage create water that is stained brown colored water 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.

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. In Collins Lake, New York the biomass of curly-leaf pondweed remained significantly lower than pre-dredging levels 10-yrs after dredging (Tobiessen et al. 1992). Dredging is very expensive, requires disposal of sediments, and has major environmental impacts. It is not a selective procedure so it can't be used to target any one particular species with great success except under extenuating circumstances. Dredging at any level must be permitted by the WDNR. It should not be performed for aquatic plant management alone. It is best used as a multipurpose lake remediation technique (Madsen 2000).

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 include dredging.

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 et al. 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 et al. 2005).

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 et al. 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.

From the 2009 APM Plan, "Loss of power generation at the dam would also be expected to be great. An estimate back in 2003 predicted revenue losses to be around $17,000.00 for a winter drawdown." During the discussions in 2012 on whether or not to extend the drawdown through the winter months, the MFA was unnerved to hear that they might have to help off-set reduced power generation costs estimated to be about $20,000.00. This number has not been corroborated, but was the primary reason no official request was made by either the MFA or GLIFWC to formally extend the 2013 drawdown.

More recent investigation suggests that it would be possible to maintain enough flow through the power house during a winter drawdown to operate at least one of the power generating turbines. A minimum flow through the power house of at least 50 cfs must be maintained if power generation is to continue uninterrupted. Even though a 5-ft drawdown through the winter month would still allow power generation, the total power generated would be reduced by 50-67% because of less hydraulic pressure pushing water through the turbines.

TARGET VS NON-TARGET SPECIES

The plant species that would be targeted by winter drawdown in the Minong Flowage is EWM. A winter drawdown can be effective in reducing the amount of EWM in a body of water provided freezing and drying occurs for at least a 4-6 week time period. However, EWM has been shown to be able to withstand low temperatures if the plant remains moist or if the exposed hydrosoil is not frozen for several weeks. EWM is also well adapted to rapid vegetative spread and may recolonize areas dominated by native plants prior to drawdown (Cooke et al. 2005).

There are several areas in the Minong Flowage where EWM is established and implementation of other forms of management is difficult or not advised. There are several stump fields located in water approximately 5-6 feet deep that make the application of herbicides from a boat and physical or diver/DASH removal difficult. 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. Whether it is expected that these species would decrease, increase, or stay the same after a winter drawdown is summarized in Table 9 along with the number of points in the survey where each individual species was identified and its relative frequency from both 2008 (before the drawdown) and 2014 (after the drawdown). There are of course many more aquatic plant species in the Minong Flowage, but Table 9 provides a summary as to the impact of the winter drawdown on aquatic plants, at least in 2014. PI surveys in additional years would show if those plants that decreased would recover to their 2008 levels.

Table 9: Predicted changes in aquatic plant growth after a winter drawdown (Cooke et al, 2005). Aquatic plant data from 2008 and 2014 Summer PI Surveys (Berg, 2008 & 2014)

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

If implemented on an annual basis, the effectiveness of a drawdown may diminish over time. The diminished effectiveness is associated with the replacement of drawdown-susceptible species by drawdown-tolerant species after repetitive drawdown. A start up program that employs drawdown for two to three consecutive years, followed by a staggered program of drawdown every other year or two may minimize the risk of developing a dominant plant community that is dominated by species resistant to drawdown.

2013-14 DRAWDOWN IMPLEMENTATION

The manner in which the 2013-14 extended drawdown was implemented caused many of the undesirable effects to occur. Some of undesirable effects were associated with the open water season of the drawdown and some with the winter portion of the drawdown. The level to which the drawdown occurred, maintained at 5 ½ feet for the majority of the 11 month period stressed many trees, particularly White Birch and Aspen, which then died of disease and drought. Many property owners complained that their water wells went dry. Though not wholly quantified as of yet, many mussels died as well. Whether they died as a direct result of the drawdown or because they were easier pickings for scavengers can only be speculated. Most property owners did not put their docks in the lake in 2013 or use their pontoons and/or other boats. The only access point where trailered boats could be launched was the County Park Landing. When the water level was down, there was great concern voiced over exposed woody debris, and perhaps worse, unseen woody debris lurking just below the surface.

Surprisingly, the County Park did not suffer greatly because of the drawdown. With the water level down, tremendous sand beaches were exposed all over the Flowage. Open water recreation was limited but swimming, beach combing, and quiet water sports continued. Swift Nature Camp stayed open in 2013 however their swimming beach and normal boating area were abandoned due to low water. Open water fishing pressure was limited due to poor access, but those who were able to fish felt it was a good year. As mentioned before, the summer drawdown appeared to have minimal impact on EWM as it simply went into a dormant state until water levels increased. Wild rice also appeared to be minimally impacted during the summer season.

The winter portion of the drawdown however, had tremendous impacts, nearly eliminating both EWM and CLP. This was most evident in the shallow water stump fields, formerly considered the major source beds for EWM fragments throughout the Flowage. In these areas, other forms of EWM management were not implemented due to the inaccessibility of those areas. By the end of 2014 though, EWM had already begun to re-establish itself in most of the areas it previously had been.

The winter portion of the drawdown also severely impacted all but a few native plant species. Aquatic plants that grew from seed or turions came back after the water level was raised in 2014, but many others whose growth depends on vegetative fragments, dormant but not frozen root crowns, runners, or stolons did not recover as fast, or not at all in 2014. It was feared that low water levels under the ice would congregate the fish population making it easier to exploit by ice fishing pressure. This did not happen, as poor ice conditions also limited ice fishing pressure.

When the water level was restored again in late February, floating ice lodged loose many logs, stumps, and other woody debris formerly stuck in the bottom on the lake. It is speculated that during the summer months, logs previously too water-logged to float dried out enough to be re-suspended in the water column. Then the hydraulic action of ice frozen to stumps during the refilling was just enough to pull this debris out of the bottom. For several months after the refill, the Minong Flowage Dam operator documented many days when coarse woody debris including whole trees were hung up in the dam. During the summer of 2014, greater than 50% of property owners had issues with large woody debris washed up on their shorelines. Being an annual plant growing from seed each year, there were no apparent negative impacts on the wild rice (Figure 69).

Figure 69: Wild rice beds July 19, 2013 (L-ERS) and from the air August 15, 2013(R-GLIFWC)

The extended time period and level to which the Minong Flowage was drawn down provided an extreme example of what could be accomplished with this management practice. Under normal conditions, a drawdown to control aquatic invasive species or EWM in this case would only be done through the winter months. However, the level to which the water is drawn down would likely need to be similar to what was done in 2013-14 to have the most effect on the target EWM (Figures 70- 72). A drawdown of <5-ft would have little impact on EWM other than in the wild rice beds themselves. The shortened time period, would likely reduce the negative impacts caused by the 2013-14 drawdown.

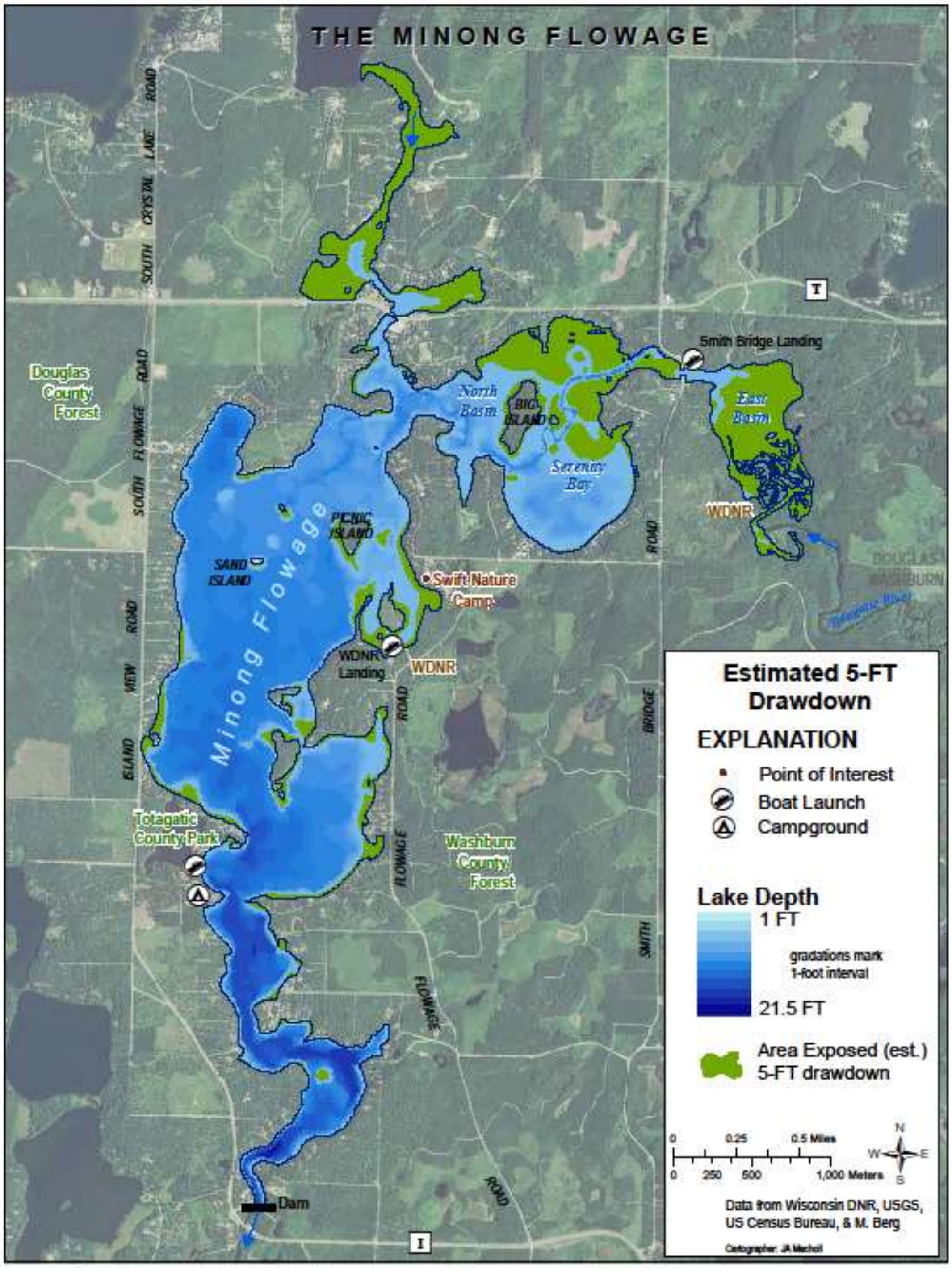


Figure 70: Estimated 5-ft drawdown (Macholl, 2015)

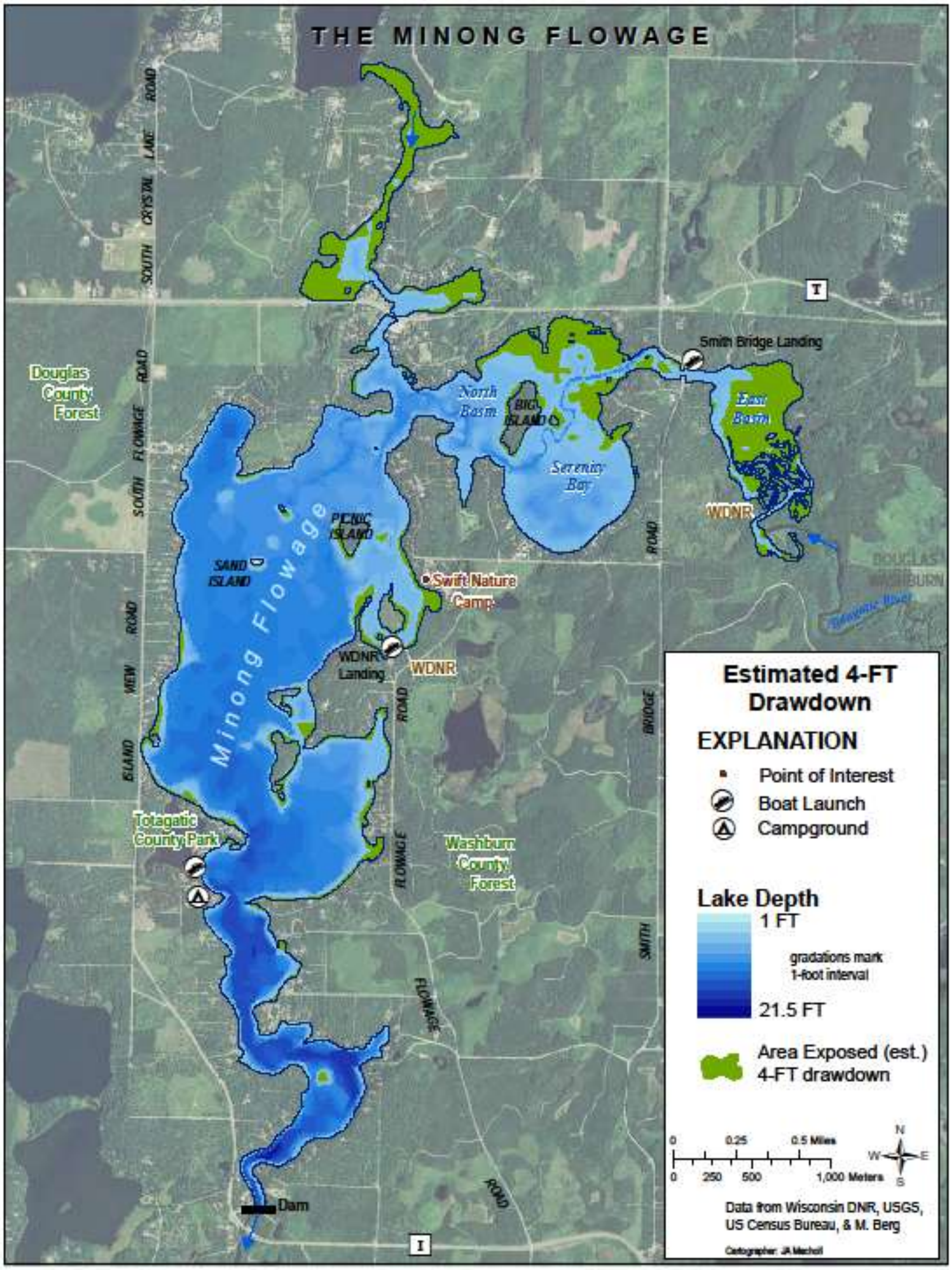


Figure 71: Estimated 4-ft drawdown (Macholl, 2015)

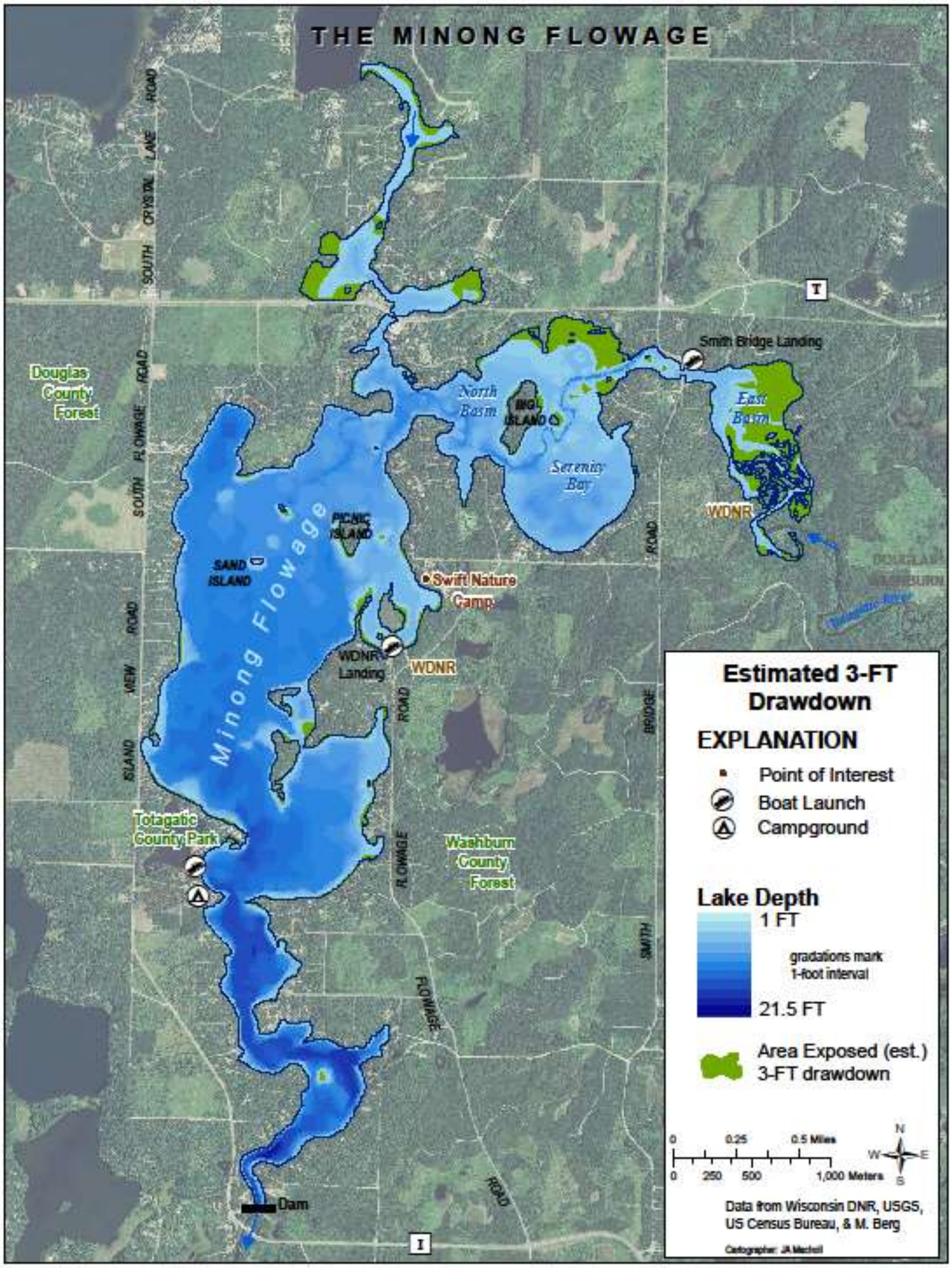


Figure 72: Estimated 3-ft Drawdown (Macholl, 2015)

DAM STRUCTURE

The following information is taken from the Minong Dam Reconstruction Drawing Index from Washburn County and Ayres Associates, February 2013. The new dam constructed in 2013 consists of a hydro-electric power generating house and seven concrete bays. The 1st and 5th bays have a top elevation of 995.45 feet and are each approximately 23-ft wide and have a 2x12 splash boards on top. Bays 6 & 7 have a top elevation of 996.55 feet and are each 23-ft wide. Bays 2-4 are each 11.3-ft wide with an elevation at the crest of the concrete of 991.45 feet. Mechanical lift gates are in each bay and can be lifted from the top to allow water to pass through underneath. When closed, the gates can raise the level of the flowage to 997.9 feet. Normal pool elevation is between 995.45 feet and 996.45 feet, or on the local datum between 110 and 111 feet with a 110.8 target level. A mudgate is in place between the third and fourth bays set at an elevation of 975.45 feet. This gate can be opened to lower the water level below the elevation of bays 2-4.

A 5-ft drawdown would necessitate opening the gates in bays 2-4 all the way lowering the water level by 4-ft to an elevation of 991.45 feet. The mud gate would then have to be opened to lower the water the remaining 1-ft to an elevation of approximately 990.45 feet. The bottom of the headworks that lets water flow into the powerhouse is set at 984.95 feet so it is expected that power generation would be able to continue even with the drawdown, however it might be limited. Data collected in 2014 through July shows power generation between 250 and 500 kw between two turbines (Johnson, 2014). At normal pool elevation, there is no water flow over the dam, only through the power house running two turbines in the summer and one in the winter. A minimum of at least 33 cfs through the dam must be maintained for downstream purposes, and a flow of >50 cfs is needed to maintain operation of at least one of the two power generating turbines (Johnson, J.A. email communication March 2015).

HYDROLOGY

As was already mentioned, the flow going through the dam is approximately 240 cfs and it is assumed under normal conditions (no rain fall) that the same amount of water is coming into the Minong Flowage. A drawdown of 5-ft would remove approximately 1,245.5 acre-feet of water or about 9.7% of the total volume of 12,840.44 acre-feet. The time it would take to draw down the Flowage by 5-ft could be controlled by how far and/or how many of the three gates are opened.

As an example, if all three gates were opened 6 inches, the general weir equation, $Q=3.0 \times L \times H^{1.5}$, where Q is the flow in cfs, L is the length of the combined gates in feet (33.9 feet), and H is the head over the structure in feet (0.5-ft if gates were opened 6 inches) can be used to estimate the time it would take to draw down the lake. Using this equation, it is estimated that opening all three gates by six inches would remove the required volume in about 17.44 days at about 3.44 inches a day. If one gate was opened instead of three, the drawdown would take three times as long at 52.33 days at 1.15 inches a day. If two of the three gates were opened 6 inches it would take about 35 days at 1.71 inches per day to draw it down 5-ft. These calculations do not include the water that is passed through the hydroelectric power house so are only estimates.

According to information provided by the Washburn County Highway Department, a minimum flow of 33 cfs must be maintained for downstream purposes during any refilling event. To ensure minimum flow is achieved, the gates would be closed over a period of time and outflow would be visually monitored during refill. Maintaining the minimum flow is not anticipated to be problematic. At the end of the 2013-14 extended drawdown it only took a couple of weeks to refill the Minong Flowage.

REDUCED DISSOLVED OXYGEN

During a drawdown, the lake's volume is reduced thus increasing the density of fish within the remaining volume. This can in some instances result in oxygen depletion and subsequent fishkills. Such impacts are mitigated by maintaining a sufficient volume of water, and also by the magnitude and frequency of inflows that will renew oxygen depleted waters. Oxygen depletion did not occur during the 2013-14 drawdown and is not expected to occur with subsequent drawdowns.

SUGGESTED DRAWDOWN PLAN

The use of a 5-ft winter drawdown for control of EWM in the Minong Flowage is feasible and would be without significant adverse impacts if implemented in a carefully controlled and monitored setting. The following program is suggested to optimize control and minimize potential impacts:

Frequency

Exactly when the next drawdown of the Minong Flowage for EWM control should take place is dependent on the level of EWM growth in the Wild Rice Zone and shallow water stump fields in the North Basin and Serenity Bay Zones. It is estimated that the stump fields provide supportive habitat for 70-80 acres of moderate to dense EWM growth. Once the EWM in these areas has reached or exceeded this level and has a rake fullness rating >1.9, a 5-ft drawdown could be proposed and implemented by the MFA. If it is determined that a lesser drawdown may actually benefit the wild rice beds before the conditions mentioned above are reached, a proposal to implement it would be initiated by GLIFWC or Tribal Resources. It is not anticipated that a winter drawdown would be implemented in two or more successive years.

Dewatering

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

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 83 cfs 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 implemented.

Monitoring and Inspections

The following program of inspections and monitoring could be conducted in conjunction with the implementation of a winter drawdown.

Well Monitoring
During the period of drawdown residents should 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.

Vegetation Surveys
Annual vegetation surveys should be completed to document the areal coverage and distribution of aquatic plants. Plant surveys should be conducted in mid to late summer to assess conditions under maximum plant coverage.

Water Quality Testing
Dissolved oxygen testing should be completed at least monthly during the winter drawdown. Expanded water quality testing including water clarity, total phosphorus, and chlorophyll a should be monitored at least once monthly throughout the open water season following the drawdown.

Volunteer Amphibian Monitoring
Amphibian monitoring by volunteers should be completed annually following guidelines provided by the Citizen-based Monitoring Network (http://wiatri.net/CBM/WhosWho/subject.cfm, last accessed 3-4-2015).

WDNR Boom Shocking
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 as a means 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 insure 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 feed on aquatic milfoils (Figure 73). Their host plant is typically northern watermilfoil (*Myriophyllum sibiricum*), however they seem to prefer EWM when it is available. Milfoil weevils are typically present in low numbers wherever northern or Eurasian water milfoil is found. They often produce several generations in a given 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 et al. 1996).

Figure 73: 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. In a 2011 Report, Menninger researched available literature on the efficacy of using the EWM weevil for control of EWM (Menninger 2011).

Under controlled experimental conditions, feeding by the adult and larval weevils can significantly reduce EWM plant buoyancy, shoot biomass and height, and root and carbohydrate stores, suppressing its growth and potentially affecting EWM's ability to overwinter and grow the following spring. However, evidence of good EWM control in the field has been equivocal, and when control is observed, it is often localized in effect.

Weevil density appears to be a significant factor determining the degree of EWM control. Weevil densities > 0.5 per stem were associated with EWM decline and suppression in Vermont. Others suggest a higher density, 1.5 weevils per stem, might be necessary to effect EWM control, as observed in a Minnesota lake. Predation by sunfish, lack of suitable over-wintering habitat, and impacts on host plants from mechanical harvesting or herbicide control may all reduce natural milfoil weevil population densities. Attempts have been made to augment natural weevil populations in lakes to achieve densities of 1-2 weevils per stem. The augmentation process involves attaching clusters of milfoil containing eggs and larvae to EWM stems in an infested lake, with the expectation that newly hatched larvae will move over to the lake's resident EWM.

Formal evaluations of weevil augmentation are rarely published in the peer-reviewed, scientific literature. Most information evaluating the efficacy of augmentation remains bound up in unpublished annual reports. Only one peer-reviewed paper considers the effectiveness of the augmentation process (Reeves et al. 2008). Using data from 30 augmented lakes in Michigan (n=29) and Wisconsin (n=1) collected over multiple years, Reeves et al. (2008) report no significant difference in EWM plant density at augmented versus control sites; moreover, their results indicate no significant relationship between final beetle density at augmented sites and proportion EWM plant density change. In Lake Bonaparte, NY, other researchers consistently found no significant increase in either milfoil weevil populations or EWM plant damage at augmented sites compared to controls over six years of monitoring (2003-2008). Taken together, these results suggest that augmenting milfoil weevil populations with the egg/larvae stage is an ineffective approach.

Another group attempted to release adult weevils. Comparing late summer weevil density (all stages) at adult-augmented and egg/larvae-augmented sites, significantly greater weevil density at adult-release sites was reported. Moreover, weevil densities significantly increased the year after adult augmentation, while sites augmented with eggs/larvae exhibited no change. Adult weevil augmentation might result in the production of multiple generations during a field season and would increase prospects for more successful biological control.

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 fairly decent population of weevils, although not enough that they could be counted on to provide additional management. In an effort 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 74). 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 1.3 weevil return rate.

Figure 74: 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.

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 and Anderson 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 et al. 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 (Getsinger et al. 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. The goal of this plan is to enhance, protect, and restore native plant populations while controlling EWM and other non-native invasive species.

CHEMICAL CONTROL

Aquatic herbicides are granules or liquid chemicals specifically formulated for use in water to kill plants or cease plant growth. Herbicides approved for aquatic use by the U.S. Environmental Protection Agency (EPA) are considered compatible with the aquatic environment when used according to label directions. Some individual states, including Wisconsin, also impose additional constraints on herbicide use.

The Wisconsin Department of Natural Resources 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 means that, in most cases, the herbicide will be degraded by the time peak recreation on the water starts.

The WDNR encourages minimal herbicide use by requiring a strategic Aquatic Plant Management (APM) Plan for management projects over 10 acres or 10% of the water body or any projects receiving state grants. WDNR also requires consideration of alternative management strategies and integrated management strategies on permit applications and in developing an APM plan, when funding invasive species prevention efforts, and by encouraging the use of best management practices when issuing a permit. The Department also supervises treatments, requires that adjacent landowners are notified of a treatment and are given an opportunity to request a public meeting if they want, requires that the water body is posted to notify the public of treatment and usage restrictions, and requires reporting after treatment occurs.

The advantages of using chemical herbicides for control of aquatic plant growth are the speed, ease and convenience of application, the relatively low cost, and the ability to somewhat selectively control particular plant types 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 aquatic invasive species to outcompete native plants (for example, areas of stressed native plants or devoid of plants).

When properly applied, the possible negative impacts of chemical herbicide use can be minimized. Early spring to early summer applications are preferred because exotic species are actively growing and many native plants are dormant, thus limiting the loss of desirable plant species; plant biomass is relatively low minimizing the impacts of de-oxygenation and contribution of organic matter to the sediments; fish spawning has ceased; and recreational use is generally low limiting human contact. One important exception to this statement is with wild rice. Wild rice seedlings are susceptible to the effects of herbicide very early in the season. In areas where wild rice is known to grow, herbicides should not be used. The concentration and amount of herbicides can be reduced because colder water temperatures enhance the herbicidal effects. Selectivity of herbicides can be increased with careful selection of application rates and seasonal timing (Madsen 2000). Lake hydrodynamics must also be considered; steep drop-offs, inflowing waters, lake currents and wind can dilute chemical herbicides or increase herbicide drift and off-target injury. This is an especially important consideration when using herbicides near environmentally sensitive areas or where there may be conflicts with various water uses in the treatment vicinity.

HOW CHEMICAL CONTROL WORKS

Aquatic herbicides are sprayed directly onto floating or emergent aquatic plants or are applied to the water in either a liquid or granular form. Herbicides affect plants through either systemic or direct contact action. Systemic herbicides are capable of killing the entire plant. Contact herbicides cause the parts of the plant in contact with the herbicide to die back, leaving the roots alive and able to re-grow.

Herbicides can be classified as broad-spectrum (kill or injure a wide variety of plant species) or selective (effective on only certain species). Non-selective, broad spectrum herbicides will generally affect all plants that they come in contact with. Selective herbicides will affect only some plants. Often dicots, like Eurasian water milfoil, will be affected by selective herbicides whereas monocots, such as common waterweed will not be affected. The selectivity of a particular herbicide can be influenced by the method, timing, formulation, and concentration used.

Sonar® whose active ingredient is fluridone, is a broad spectrum herbicide that interferes with the necessary processes in a plant that create the chlorophyll needed to turn sunlight into plant food through a process called photo-synthesis. Rodeo® whose active ingredient is glyphosate is another broad spectrum herbicide that prevents an aquatic plant from making the protein it needs to grow. As a result the treated plant stops growing and eventually dies.

2,4-D and triclopyr are active ingredients in several selective herbicides including Navigate®, DMA 4®, and Renovate®. These herbicides stimulate plant cell growth causing them to rupture, but primarily in dicots. These herbicides are considered selective as they have little to no effect on monocots in treated areas. Fluridone, glyphosate, 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 of the plant, not just the part that comes in contact with the herbicide.

Aquathol whose active ingredient is endothall; Reward whose active ingredient is diquat; and Cutrine whose active ingredient is a form of copper 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. None of these three are considered selective and have the potential to kill all of 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 curly-leaf pondweed 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.

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 (Skogerboe and Getsinger 2006). 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.

MICRO AND SMALL-SCALE HERBICIDE APPLICATION

The determining factor in designating chemical treatments as micro or small-scale is the size of the area being treated. Small-scale herbicide application involves treating areas less than 10 acres in size. The dividing line between small-scale and micro treatments is not clearly defined, but is generally considered to be less than an acre.

Small-scale chemical application is usually completed in the early season (April through May). Micro treatments are as well, but may be used as follow-up spot treatments after an early season application, or in instances where a new infestation has been identified in a lake with EWM already or a in a completely new lake. Recent research related to micro and small-scale herbicide application generally shows that these types of treatment are less effective than larger scale treatments due to rapid dilution and dispersion of the herbicide applied. Some suggested ways to increase the effectiveness is to increase the concentration of herbicide used, use a contact herbicide like diquat that does not require as long a contact time to effective, or in some manner contain the herbicide in the treated area by artificial means. If combined micro or small-scale treatments exceed 10 acres or 10% of the littoral zone of a lake it is considered a large-scale treatment.

Pre- and post-treatment aquatic plant surveys and testing for herbicide residuals are not required by the WDNR for small-scale treatments. Nor is an approved Aquatic Plant Management Plan if the organization sponsoring the application is not using grant funding to help defer the costs. Even though not required by the WDNR, participating in these activities is recommended as it helps to gain a better understanding of the impact and fate of the chemical used.

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 EWM and CLP while minimizing impacts on native species. It is generally accepted that lower concentration of herbicide can be used in large-scale applications as 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 lakes 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 bigger 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.

Pre- and post-treatment aquatic plant surveying and having an approved Aquatic Plant Management Plan are required by the WDNR when completing large-scale chemical treatments. Residual testing is not required by the WDNR, but highly recommended to gain a better understanding of the impact and fate of the chemical used.

PRE AND POST TREATMENT AQUATIC PLANT SURVEYING

When introducing new chemical treatments to lakes where the treatment size is greater than ten acres or greater than 10% of the lake littoral area and more than 150-ft from shore, the WDNR requires pre and post chemical application aquatic plant surveying. The protocol for pre and post treatment survey is applicable for chemical treatment of CLP and EWM.

The WDNR protocol (Appendix G) assumes that an APM Plan has identified specific goals for non-native invasive species and native plants species. Such goals could include reducing coverage by a certain percent, reducing treatments to below large-scale application designations, and/or reducing density from one level to a lower level. A native plant goal might be to see no significant negative change in native plant diversity, distribution, or density. 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.

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 must 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 should be scheduled when native plants are well established, generally mid-July through mid-August. If treating CLP a post treatment survey needs to be completed before seasonal growth ends (i.e. mid-June). For the post-treatment survey, repeat the PI for all species in the treatment polygons, as was done the previous summer. For whole-lake scale treatments, a full lake-wide PI survey should be conducted.

CHEMICAL CONCENTRATION TESTING

Chemical concentration testing is often done in conjunction with treatment to track the fate of the chemical herbicide used. Testing is completed 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 and/or days following chemical application.

A dye study was implemented on the Minong Flowage in the fall of 2014 mimicking what could have been a small-scale herbicide application. This method was used during the 2015 diquat application instead of concentration testing to track the fate of the chemical after applied.

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 could 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 to both target and non-target species documented.

MANAGEMENT DISCUSSION

First identified in 2003, EWM had taken over more than 330 surface acres of the Minong Flowage littoral zone by 2008. 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, this reduction, due in large part to the winter portion of the 2013-14 drawdown for dam repairs, included a significant reduction in native aquatic plant distribution and density as well. It is expected that EWM will expand quickly to reclaim the surface area it once occupied, with little competition from native plants. If this happens, the native aquatic plant community will not recover from the drawdown, instead being replaced by dense beds of EWM. CLP is also present in certain areas of the Minong Flowage and could increase in distribution and density if left unchecked, further degrading the native aquatic plant community. For these reasons, EWM management and continued CLP monitoring is recommended.

EWM

The shallow water stump fields are the most difficult area to manage effectively. Other than a periodic winter drawdown, little else can be done in these areas. The shallow water stump fields occupy 70-80 acres of the Minong Flowage (not including those stump fields in the East Basin). It is expected that EWM will eventually take over these areas of the Minong Flowage again. When it does, and reaches a rake fullness rating of 2 or greater, a 5 foot winter drawdown should be implemented. The total amount of moderate to dense growth EWM in the Minong Flowage including that which is in the shallow water stump fields should be prevented from exceeding 10% of the whole-lake littoral zone or around 90-100 acres (Figure 75). Assuming 70-80 acres in the shallow water stump fields; that means more aggressive management of EWM in the rest of the Minong Flowage should be implemented when EWM totals outside of the shallow water stump fields reach or exceed 20 acres of moderate to dense growth.

An integrated approach, using many management alternatives is recommended. Small-scale physical removal by individual property owners, larger scale physical removal by trained teams, diver removal and diver aided suction harvest, biological control, application of herbicides, and winter drawdown should all be combined in an effort to maintain or improve the native aquatic plant community in the Minong Flowage. Not all these management actions can be used in all areas of the Minong Flowage. Physical removal by individual property owners can be implemented in nearshore shallow hard-bottom areas around docks and swimming areas; team removal can be implemented on shallow hard-bottom flats less than 3-ft in depth and those nearshore shallow hard-bottom areas not adjacent to developed property; diver removal or diver aided suction harvest can be implemented on the deep water (greater than 3-ft) edges of hard-bottom flats, application of herbicide is most useful to control deep water beds of EWM, EWM in shallow soft-bottom bays, and when EWM in other areas exceeds the capacity of physical removal; biological controls (weevils) can be released in shallow water stump fields and in areas where other management actions are either difficult to implement or not allowed; and a limited winter drawdown can be implemented to control EWM in shallow water stump fields and wild rice beds when other forms of management have done all they can and/or wild rice beds have been overtaken by EWM or other vegetation.

Beds of EWM in the area of the Flowage outside of the shallow water stump fields should be chemically managed if they reach or exceed 3 acres in size and a rake fullness rating of 2.0 or greater and when all areas are combined reach or exceed 20 acres. EWM beds that are <3 acres or have a rake fullness rating <1.9 should be either managed by other means or left unmanaged, unless they cause navigational impairments or recreational impairments. In the Wild Rice Zone, chemical management will not be utilized unless proposed by Tribal entities.

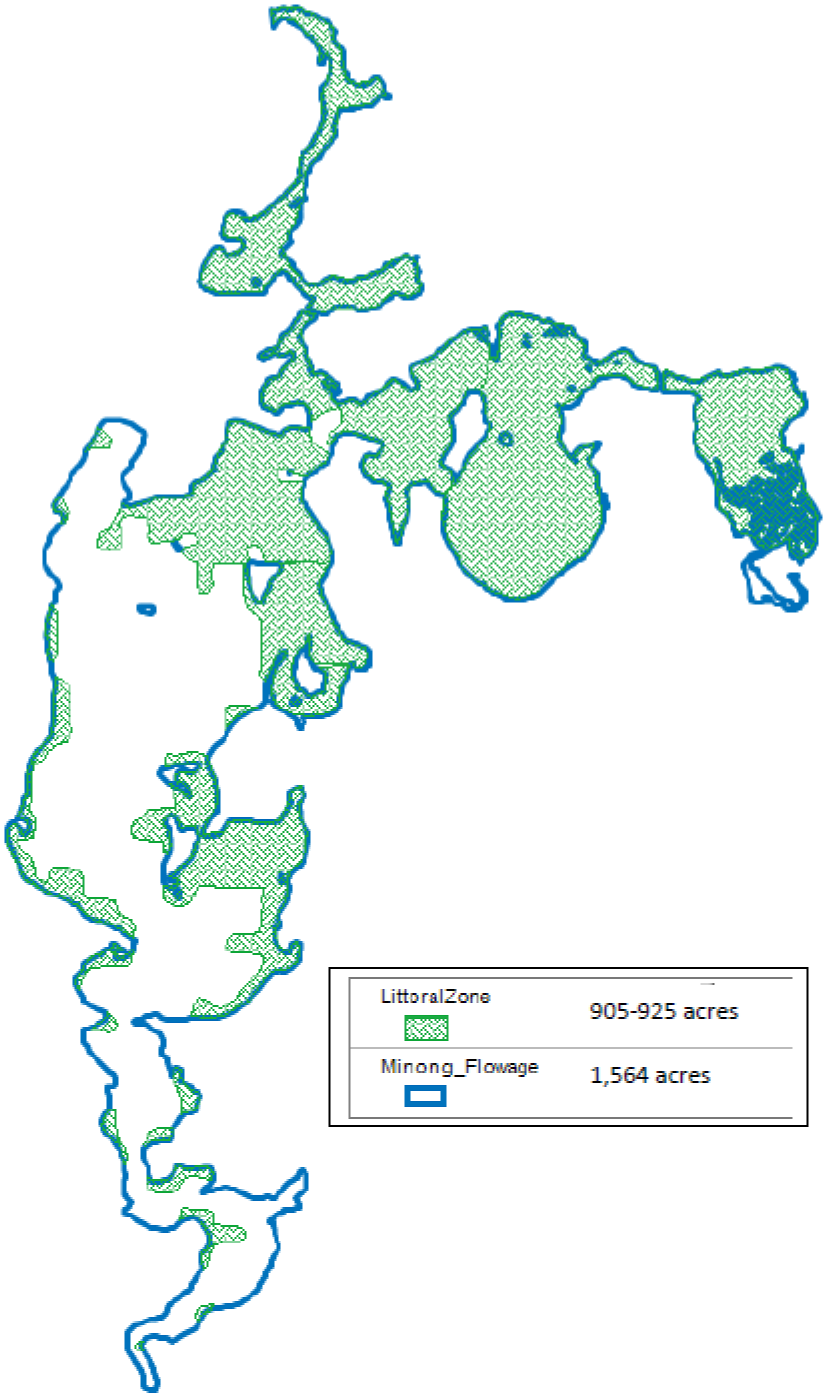


Figure 75: Minong Flowage littoral zone

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, and have not been chemically treated in that 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 survey will be completed to determine if an appropriate amount and level of growth has been attained to implement the treatment. The result of the treatment will be documented in the next summer point-intercept survey of the established points. 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 should be monitored annually, combining aerial photography by GLIFWC and on-the-water monitoring according to the methodology established in the 2014 wild rice survey completed by ERS and sponsored by the WDNR. The entire visible littoral zone of the Cranberry Flowage and Minong Flowage will be searched in late August for the presence of wild rice beds. A bed is defined as an area where wild rice makes up greater than 50% of all aquatic plants or supports continuous rice growth. The level of rice growth within each area will be ranked using the WDNR's standard 1-3 rake fullness scale. An estimate of an identified bed's human harvest potential will be made and representative photos of the rice will be taken at each location. An estimate of the amount of EWM either in or adjacent to each individual rice bed will be made via the standard 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.

CLP

CLP should be monitored annually in mid to late June in a manner similar to the wild rice monitoring. A visual survey of the parts of the littoral zone that have been shown in the past to support CLP growth, will be completed and beds defined in the same manner that wild rice is mapped. If moderate to dense beds of CLP exceeding 3 acres in size that 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. If chemical management is proposed and approved, it will be repeated for a minimum of three years, but no more than five.

INDIVIDUAL PROPERTY OWNER REQUESTS FOR MANAGEMENT

In the previous APM Plan, individual property owners were given the opportunity to request chemical management of EWM adjacent to their property. These areas would be included in the larger MFA chemical management plan, but paid for by the property owner. The WDNR is no longer supporting this management action however a similar but not identical provision is included in this new APM Plan.

Property owners are encouraged to report excessive EWM growth adjacent to their property to the MFA. While it is unlikely that these areas would be included in an herbicide application, if the property owner needs assistance to implement physical removal of EWM, the MFA will help to arrange it through training and if resources are available, through contracted physical removal. In the event contracted physical removal services are provided, the property owner will be asked to cover some or all of the cost to do so. Only physical removal of EWM will be considered for assistance. Removal of native plants or other AIS will not.

GOAL 1 – INCREASE THE INVOLVEMENT OF STAKEHOLDERS IN EWM MANAGEMENT PLANNING AND IMPLEMENTATION

It is a goal of this APM Plan to continue with regular Stakeholders Discussions regarding management actions implemented on the Minong Flowage. Greater involvement by all stakeholders in the planning efforts will increase the support needed to affect implementation. Regular stakeholder discussion also provides a forum to share the results of management.

OBJECTIVE 1: THE MFA WILL PARTICIPATE IN STAKEHOLDERS DISCUSSIONS ON A REGULAR BASIS WHILE THIS PLAN IS BEING IMPLEMENTED.

Action Item: Schedule Stakeholders Discussions 2-3 times per year that include: the MFA, Cranberry Lake Association, St. Croix Tribal Resources, Great Lakes Indian Fish and Wildlife Commission, Washburn County, Douglas County, the WDNR and at least one at large member who could represent local townships, local business interests, or other lake organizations.

Action Item: Hold Stakeholders Discussions at a location central to all parties involved, schedule them to be two hours in length, and provide an agenda and minutes for each Discussion. The MFA will provide notification, agendas, and minutes for these meetings.

OBJECTIVE 2: THE MFA WILL WORK IN COOPERATION WITH THE CRANBERRY LAKE/FLOWAGE ASSOCIATION AND THEIR CONSULTANT TO PLAN AND IMPLEMENT EWM MANAGEMENT IN THE CRANBERRY FLOWAGE.

Action Item: Meet with representatives of the Cranberry Lake Association and their consultant to discuss management planning and implementation in the Cranberry Flowage.

GOAL 2 – PROTECT AND ENHANCE THE NATIVE AQUATIC PLANT COMMUNITY

It is the goal of the management actions in this plan to protect and enhance the native aquatic plant community in the Minong Flowage, causing no decline in measures of a healthy, diverse, and sustainable aquatic plant community. EWM management actions and CLP management actions (if needed) will be completed in ways proven to cause the least harm to non-target plant species. Additional lake data will be collected to further define and support management actions expected to help meet this goal.

OBJECTIVE 1: MAINTAIN OR IMPROVE GENERAL MEASUREMENTS OF AQUATIC PLANT COMMUNITY HEALTH (SIMPSON'S DIVERSITY INDEX, FQI, MEAN COEFFICIENT OF CONSERVATISM, AND MEAN NATIVE SPECIES AT SITES WITH VEGETATION) BASED ON STATISTICS FROM THE 2012 WHOLE-LAKE, POINT-INTERCEPT AQUATIC PLANT SURVEY.

Action Item: Implement aquatic plant management actions that will do the most for protecting and enhancing the native plant population while controlling the target species.

Action Item: Determine appropriate management actions annually based on management and survey results from the previous year.

OBJECTIVE 2: MONITOR THE DISTRIBUTION AND DENSITY OF WILD RICE IN THE MINONG FLOWAGE.

Action Item: Complete wild rice mapping, according to the methodology established in 2014, annually with grant funding, or every three years without grant funding.

Action Item: Establish a wild rice zone within which EWM management may be limited to non-herbicide alternatives.

OBJECTIVE 3: MEASURE THE EFFECTIVENESS AND IMPACTS OF LARGE-SCALE HERBICIDE TREATMENTS ON TARGET AND NON-TARGET PLANTS WITHIN THE TREATED AREAS ON AN ANNUAL BASIS.

Action Item: Complete PI surveys of target and non-target plant species within proposed chemical treatment areas in the summer prior to chemical treatment and the summer the year after chemical treatment according to WDNR protocol.

OBJECTIVE 4: MEASURE THE FIVE YEAR IMPACT OF AIS MANAGEMENT ACTIONS COMPLETED ON THE MINONG FLOWAGE.

Action Item: Repeat a whole lake, point-intercept, aquatic plant survey in 2019.

Action Item: Review and revise the existing APM Plan for implementation in 2020.

GOAL 3 – MINIMIZE THE NEGATIVE IMPACT OF EWM TO THE NATIVE AQUATIC PLANT COMMUNITY THROUGH THE IMPLEMENTATION OF MANAGEMENT ACTIONS

An integrated approach to management including physical removal, the use of herbicides, biological control, and drawdown will be implemented between 2015 and 2019 to prevent moderate to dense growth EWM from reaching or exceeding 10% (90-100acres) of the littoral zone. All herbicide applications are expected to take place in the early season generally expected to be before June 1st unless extenuating circumstances agreed upon by all stakeholders warrant herbicide management at a different time.

Herbicide management will not be implemented unless a designated treatment area is greater than 3 acres in size. Diquat (or an equivalent herbicide) will be used on treatments areas up to 9 acres. Liquid 2,4-D (or an equivalent herbicide) will be used when treatment areas reach or exceed 10 acres. Other management actions may be specific to a localized area and described as such.

Annual management actions will be determined based on previous year results, but will generally follow these guidelines.

OBJECTIVE 1: PREVENT EWM FROM REPLACING NATIVE VEGETATION AND/OR BLOCKING NAVIGATION OUTSIDE THE WILD RICE ZONE ESTABLISHED IN GOAL 2, OBJECTIVE 2.

Action Item: Implement physical removal by property owners or by a physical removal team if the area of EWM is located in a nearshore shallow hard-bottom area and is adjacent to developed property.

Action Item: Encourage and/or support formal or informal monitoring and/or rearing of biological control agents for use on the Minong Flowage.

Action Item: EWM beds reaching or exceeding 3.0 acres but less than 10.0 acres with a rake fullness rating of 2.0 or more will be chemically treated with diquat (Reward® or a comparable formulation) within appropriate label rates and approved Wisconsin guidelines.

Action Item: EWM beds reaching or exceeding 10 acres and a rake fullness rating of 2.0 or more will be chemically treated with a liquid formulation of 2,4-D (DMA4® or a comparable formulation) within appropriate label rates and approved Wisconsin guidelines.

Action Item: Implement a 5-ft winter drawdown when EWM surface area in the North Basin and Serenity Bay combined reaches or exceeds 70 acres and a rake fullness rating of 2.0 or more.

OBJECTIVE 2: PREVENT EWM AND EWM MANAGEMENT FROM REDUCING WILD RICE ABUNDANCE AND DENSITY IN THE WILD RICE ZONE ESTABLISHED IN GOAL 2, OBJECTIVE 2.

Action Item: Coordinate any EWM management action in the Wild Rice Zone with GLIFWC and St. Croix Tribal Resources.

Action Item: Implement physical removal by a physical removal team if the area of EWM is located in a nearshore shallow hard-bottom area or shallow hard-bottom flat.

Action Item: Implement a 5-ft winter drawdown when EWM levels in the wild rice beds reach or exceed a rake fullness rating of 1.9 (no size restriction) and have been documented as encroaching on existing wild rice beds.

OBJECTIVE 3: MONITOR THE DISTRIBUTION AND DENSITY OF EWM IN THE MINONG FLOWAGE

Action Item: Complete annual late summer EWM bed-mapping surveys of the entire littoral zone to identify new and existing beds of EWM that may be proposed for chemical management in the following year.

Action Item: Complete a EWM assessment survey prior to any actual herbicide treatment to verify prior year fall bed-mapping results.

OBJECTIVE 4: ENCOURAGE PROPERTY OWNERS TO REPORT EXCESSIVE EWM GROWTH ADJACENT TO THEIR PROPERTY AND TO REQUEST MFA ASSISTANCE IN MANAGEMENT.

Action Item: Evaluate property owner requests for EWM management assistance based on location of the request, level of impairment, ability of property owner to complete physical removal, and available MFA resources to provide assistance.

Action Item: Provide property owner assistance if the evaluation determines management assistance is needed, and MFA resources are available.

OBJECTIVE 5: QUANTIFY MFA CONSTITUENCY SUPPORT FOR MANAGEMENT ACTIONS IMPLEMENTED ON THE MINONG FLOWAGE.

Action Item: If grant funding is received to support the implementation of this APM Plan, develop, distribute, and analyze results from a paper survey to gather property owner reaction to the management actions implemented.

GOAL 4 – MINIMIZE THE NEGATIVE IMPACT OF CURLY-LEAF PONDWEED AND PURPLE LOOSESTRIFE TO THE NATIVE AQUATIC PLANT COMMUNITY THROUGH MONITORING AND THE IMPLEMENTATION OF MANAGEMENT ACTIONS.

Both curly-leaf pondweed (CLP) and purple loosestrife are present in the Minong Flowage and could at some point negatively impact the density, distribution, and diversity of native vegetation. CLP distribution and density will be mapped at least once in the five year period covered by this APM Plan. Monitoring for purple loosestrife will be completed every year and non-herbicide management implemented when necessary. Management of CLP could be implemented if mapping identifies a bed that is negatively impacting native plants due to density and/or surface area.

OBJECTIVE 1: MONITOR THE DISTRIBUTION AND DENSITY OF PURPLE LOOSESTRIFE IN THE MINONG FLOWAGE.

Action Item: Complete a visual inspection of the shoreland annually in late July or early August and record the location of any purple loosestrife found on a map. Remove any purple loosestrife identified in the survey.

OBJECTIVE 2: MONITOR THE DISTRIBUTION AND DENSITY OF CURLY-LEAF PONDWEED IN THE MINONG FLOWAGE.

Action Item: Complete a June meandering, visual survey of areas where dense growth CLP has been identified in previous aquatic plant survey work.

Action Item: Complete official CLP bed-mapping in the year after a meandering survey indicates the distribution and density of CLP may be problematic.

OBJECTIVE 3: REDUCE THE DISTRIBUTION AND DENSITY OF CLP IF MONITORING IN OBJECTIVE 2 INDICATES CLP LEVELS THAT ARE NEGATIVELY IMPACTING NATIVE VEGETATION.

Action Item: Chemically treat CLP beds that exceed 5.0 acres and that have been determined to be causing negative impacts to native aquatic vegetation using a liquid formulation of endothall (Aquathol K® or a comparable formulation) within appropriate label rates and approved Wisconsin guidelines.

Action Item: Repeat chemical management of CLP for a minimum of three years in an attempt to reduce CLP turion numbers in the sediment that may support new growth.

GOALS 5 - 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.

The Minong Flowage is already a source lake for EWM and CLP being carried out attached to boats and/or trailers and taken to other lakes. The MFA will continue to implement a watercraft inspection program according to WDNR/UW-Extension Lakes protocol. This program will either be paid for by the MFA or through a small-scale CBCW grant. Watercraft inspection data will be entered into the WDNR SWIMS database annually. Appropriate AIS signage will be maintained at the three public accesses on the Minong Flowage to improve the AIS awareness of many lake users. AIS monitoring to track the AIS already present in the Flowage and to monitor for possible new AIS will be completed following WDNR/UW-Extension Lakes protocol through the Citizen Lake Monitoring Network (CLMN) AIS Monitoring Program. Zebra mussels, spiny waterflea, hydrilla, banded mystery snails, and other species will be watched for and survey data entered into the WDNR SWIMS database annually.

OBJECTIVE 1: IMPLEMENT A CLEAN BOATS CLEAN WATERS (CBCW) WATER CRAFT INSPECTION PROGRAM ANNUALLY.

Action Item: Attempt to get 200 hours of paid watercraft inspection at both the County Park and DNR Bay landings, with additional time as warranted at the East Basin (Smith Bridge) landing.

Action Item: Encourage and support volunteer watercraft inspection at Pogo's and other private landings, total time unspecified.

Action Item: Apply for CBCW grants annually to support watercraft inspection efforts.

OBJECTIVE 2: MAINTAIN CURRENT AND COMPLETE AIS SIGNAGE AT PUBLIC ACCESS SITES IN THE MINONG FLOWAGE ANNUALLY.

Action Item: Inspect all public and private access points for appropriate AIS signage annually

Action Item: Repair, replace, and/or install current WDNR AIS signs at three landings: County Park, DNR Bay, and the East Basin (Smiths Bridge).

OBJECTIVE 3: REDUCE THE LIKELIHOOD THAT NEW AIS GOES UNDETECTED IN THE MINONG FLOWAGE AND TRACK EXISTING AIS FOR ADDITIONAL SPREAD.

Action Item: Participate in CLMN AIS Monitoring at least monthly between May and October each year.

GOAL 6 - IMPROVE THE LEVEL OF KNOWLEDGE PROPERTY OWNERS AND LAKE USERS HAVE RELATED TO AQUATIC INVASIVE SPECIES AND THEIR IMPACT TO THE LAKE.

The MFA with or without the cooperation of other stakeholders will continue efforts to educate and inform property owners and lake users about AIS already in the Minong Flowage and AIS not already in the Minong Flowage. Efforts will include annual education events; distribution of AIS publications, placement of buoys to mark EWM that is impeding navigation, and discussion forums of various types related to management actions and alternatives.

OBJECTIVE 1: PLAN, COORDINATE, AND IMPLEMENT AN ANNUAL AIS EDUCATION EVENT(S) ALONE OR IN COOPERATION WITH OTHER STAKEHOLDERS.

Action Item: Seek out other stakeholders including but not limited to the Minong Town Lakes organization, Tribal entities, the Cranberry Lake Association, and Northwest Lakes Conference Planning Committee to explore cooperative education and information events.

Action Item: Continue participation in the Minong Town Lakes Fair, Washburn County Lakes and Rivers Association, Douglas County Association of Lakes and Streams, Wisconsin Lakes, and other supportive organizations.

OBJECTIVE 2: DISTRIBUTE INFORMATION AND EDUCATION MATERIALS TO PROPERTY OWNERS AND LAKE USERS.

Action Item: Research AIS and lake stewardship materials with little or no cost to attain and make available at events including but not limited to Annual Meetings, Lake Fairs, Summer Picnic, etc.

OBJECTIVE 3: PROVIDE INFORMATION ANNUALLY ABOUT THE LOCATIONS OF DENSE GROWTH EWM THAT MAY IMPAIR NAVIGATION.

Action Item: Inventory existing EWM buoys annually and repair or replace if necessary.

Action Item: Determine buoy placement annually based on previous years aquatic plant survey work.

Action Item: Install buoys prior to the MFA annual meeting in June and distribute a map of placement at the Annual Meeting; provide maps for CBCW personnel to distribute at landings.

OBJECTIVE 4: SOLICIT PUBLIC INPUT AND REVIEW OF ANNUAL AIS MANAGEMENT PLANNING EFFORTS.

Action Item: Complete preliminary AIS management planning by January 31 each year and post on the MFA webpage for public comment.

Action Item: Provide a summary of coming year AIS management plans in a spring newsletter to be published and distributed prior to March 31 each year.

Action Item: Present current year AIS management actions at the Annual Meeting held in mid-June each year.

GOAL 7 - 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

An important part of controlling undesirable aquatic plant growth and the production of algae is reducing the amount of nutrients (mainly phosphorus) that enters the lake. The MFA will promote and encourage the implementation of simple and generally inexpensive best management practices including but not limited to shoreland restoration and the installation of rain gardens to reduce nutrient loading from the nearshore area.

Trees and other vegetation that naturally fall into a lake or that is intentionally placed in the lake by permit, is known as coarse woody debris. Coarse woody debris provides many benefits to fish and wildlife. Like aquatic vegetation, coarse woody debris is essential to the overall health of a lake and should be protected and enhanced, not eliminated. The MFA will inventory existing coarse woody debris and identify where additional woody debris might be beneficial. The MFA will then promote and encourage the implementation of Fishsticks and other woody debris projects.

There can never be too much data when it comes to determining the best way to manage a body of water. The MFA will continue to collect water quality data through the CLMN Expanded Water Quality Monitoring program.

OBJECTIVE 1: REDUCE THE AMOUNT OF SHORELAND WITHOUT A NATURAL BUFFER IN PLACE THROUGH SHORELAND RESTORATION AND OTHER BEST MANAGEMENT PRACTICES.

Action Item: Complete a shoreland inventory of all developed properties to determine the amount of shoreland that is not in a natural state.

Action Item: Distribute shoreland improvement education and information materials to lake property owners through the newsletter, webpage, and general mailings.

Action Item: Host and/or sponsor annual lake community events that encourage land owner participation in best management practices.

Action Item: Encourage the use of bio-stabilization practices instead of rock riprap to prevent shoreland erosion.

Action Item: Support property owners who wish to complete shoreland restoration or habitat improvement projects.

Action Item: Recognize property owners who participate in and/or complete shoreland restoration and habitat improvement projects in the newsletter, on the webpage, in local news publications, and/or at the site of the project.

Action Item: Recruit property owners for inclusion in projects to be funded by a WDNR Healthy Lakes grant.

OBJECTIVE 2: MAINTAIN AND/OR INCREASE THE AMOUNT OF COARSE WOODY DEBRIS PRESENT ALONG THE SHORELINE OF THE MINONG FLOWAGE.

Action Item: Complete a shoreline inventory of existing coarse woody debris to determine areas that may benefit from additional coarse woody debris.

Action Item: Provide educational and informational materials to lake property owners that promote the benefits of coarse woody debris in a lake.

Action Item: Encourage property owners not to remove woody debris that falls naturally into the lake from their shoreline unless it presents a dangerous and/or undesirable condition.

Action Item: Work WDNR and other resource professionals to install a Fishsticks demonstration project.

OBJECTIVE 3: CONTINUE TO COLLECT WATER QUALITY DATA IN THE MINONG FLOWAGE.

Action Item: Collect CLMN water quality data (water clarity, total phosphorus, chlorophyll a, and dissolved oxygen and temperature) in the Central Basin and at the Deep Hole Near Dam.

Action Item: Collect CLMN water quality data (water clarity and dissolved oxygen and temperature) in Serenity Bay and the North Basin.

GOAL 8 - COMPLETE APM PLAN IMPLEMENTATION AND MAINTENANCE FOR A PERIOD OF FIVE YEARS FOLLOWING ADAPTIVE MANAGEMENT PRACTICES

This APM Plan is not intended to be a static document, but rather a plan that makes room for management changes that still fall under the guise of the stated goals, but that may make attaining those goals easier and more efficient. Management actions implemented in each year of this plan will be evaluated for how well they helped meet stated goals and objectives. Small changes will be made automatically if it is determined they will improve outcomes. Larger management changes will be presented to the MFA and other Stakeholders for approval before implementation.

OBJECTIVE 1: PREPARE SUMMARY REPORTS FOR ANNUAL AQUATIC PLANT SURVEYS AND MANAGEMENT ACTIONS.

Action Item: Aquatic Plant Survey Results Reports will be completed by the Aquatic Plant Specialist contracted by the MFA.

Action Item: End-of Year Summary Reports will be completed by the Primary Consultant contracted by the MFA.

Action Item: Preliminary management proposals for the following year will be completed by the Primary Consultant contracted by the MFA prior to January 31 each year and posted for public review.

GOAL 9 - EVALUATE AND SUMMARIZE THE RESULTS OF MANAGEMENT ACTIONS IMPLEMENTED DURING THE ENTIRE 5-YEAR TIMEFRAME OF THIS PLAN

An end of project report summarizing the success and failures after five years of management will be completed. This report will be completed by the MFA and its retainers and shared with property owners, lake users, and other Stakeholders. A whole-lake, mid-season, point-intercept, aquatic plant survey will be repeated in five years following the same procedures that were used in 2014. Results from the survey will be compared to 2008, 2012, and 2014 results to determine the impact of management on the aquatic plant community in the Minong Flowage.

OBJECTIVE 1: COMPLETE AN EARLY AND MID-SEASON, WHOLE-LAKE, POINT-INTERCEPT AQUATIC PLANT SURVEY AFTER 5 YEARS OF IMPLEMENTATION.

Action Item: Repeat PI survey that was completed in 2008, 2012, and 2014 in 2019.

Action Item: Compare 2019 PI survey results to 2008, 2012, and 2014 PI survey results.

OBJECTIVE 2: REVIEW MANAGEMENT GOALS, OBJECTIVES, AND ACTIONS IN THE 2015 APM PLAN.

Action Item: Review goals, objectives, and actions from the 2015 APM Plan for successful implementation.

Action Item: Compare 2019 plant survey results to 2015 goals, objectives, and actions to determine success or failure of management actions over a five year period.

OBJECTIVE 3: REVISE/UPDATE 2015 APM PLAN.

Action Item: Contract with a consultant to complete a new APM Plan

WISCONSIN DEPARTMENT OF NATURAL RESOURCES GRANT PROGRAMS

The Aquatic Invasive Species (AIS) Prevention and Control grants are a cost-share effort by the DNR to provide information and education on types of existing and potential aquatic invasive species in Wisconsin, the threats that invasive species pose to the state's aquatic resources, and available techniques for invasive species control. These grants also assist in the planning and implementation of projects that will prevent the introduction of invasive species into waters where they currently are not present, controlling and reducing the spread of invasive species from waters where they are present, and restoring native aquatic communities.

There are five AIS Prevention and Control grants subprograms:

- Early Detection and Response Projects
- Education, Prevention and Planning Projects (including Clean Boats Clean Waters)
- Established Population Control Projects
- Maintenance and Containment Projects
- Research and Demonstration Projects

Early Detection and Response Projects are for new discoveries of AIS in public waters of Wisconsin. As such, the MFA is not eligible for this grant program. Research and Demonstration Projects can be used to collect new data of interest to the WDNR. Both dye studies on the Minong Flowage were paid for by the WDNR, not the MFA. The other projects listed above are applicable to the Minong Flowage and the Minong Flowage Association.

EDUCATION, PREVENTION AND PLANNING PROJECTS

Education projects are intended to broaden the public's awareness and understanding of, and ability to identify, AIS; the threats that AIS pose to the health of aquatic ecosystems; the measures to prevent the spread of AIS; and the management practices used for control of AIS. Prevention projects are intended to prevent the introduction of new AIS into a waterbody/wetland, or prevent the spread of an AIS population from one waterbody to another unpopulated waterbody/wetland. Planning projects are intended to assist in the development of plans for the prevention and control of AIS. Eligible projects include:

- Educational programs including workshops, training sessions, or coordinated volunteer monitors. Projects will be reviewed for consistency with the DNR's statewide education strategy for controlling AIS including the use of existing publications and outreach materials.
- Development of AIS prevention and control plans
- Monitoring, mapping, and assessing waterbodies for the presence of AIS or other studies that will aid in the AIS prevention and control.
- Watercraft inspection and education projects following the guidelines of the DNR's Clean Boats, Clean Waters program.

This subprogram is not intended to provide support for any management action that may be taken.

ESTABLISHED POPULATION CONTROL PROJECTS

Established population control grants are intended to assist applicants in eradicating or substantially reducing established populations of AIS to protect and restore native species communities. Established populations are defined as substantial reproducing populations of AIS that are not pioneer populations. Eligible projects include activities recommended in a DNR-approved control plan including monitoring, education, and prevention activities. Ineligible projects include the following:

- Dredging
- Chemical treatments or mechanical harvesting of aquatic plants to provide single season nuisance or navigational relief.

- Maintenance and operation of aeration systems and mechanical structures used to suppress aquatic plant growth.
- Structural facilities for providing boat washing stations. Equipment associated with boat washing facilities is eligible if included in a management plan.

MAINTENANCE AND CONTAINMENT PROJECTS

Maintenance and containment grants are intended to provide sponsors limited financial assistance for the ongoing control of established AIS population without the assistance of an Established Population Control grant. These projects are intended for waters where management activity has achieved the target level of control identified in an approved plan that meets the criteria of s. NR 198.43, Wis. Adm. Code. Ongoing maintenance is needed to contain these populations so they do not re-establish throughout the waterbody, spread to other waters, or impair navigation and other beneficial uses of the waterbody.

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Appendix A

Stakeholders Meeting Agendas and Minutes

Appendix B

Minong Flowage Subwatershed, Totagatic River Basin, and Namekagon River Watershed Maps

Appendix C

Tribal Donation of Navigate Herbicide

Appendix D

WDNR Letter Regarding 2011 Treatment

Appendix E

St. Croix POCIS Pesticide Write-up

Appendix F

NR 107

Appendix G

Pre-Post Aquatic Plant Treatment Evaluation Protocol

Appendix H

2015 Contracted DASH and Diver Physical Removal Summary Report