2012 - 2017 Aquatic Plant Management Plan for the Chetek Lakes

Chetek Lakes AIS Education, Prevention, & Planning Project

Chetek, Ojaski, Prairie, Pokegama, & Tenmile Lakes
Barron County, Wisconsin

DNR No. AEPP-266-11
SEH No. CHLPA 115161

November 2012

(Insert Wisconsin Department of Natural Resources Letter of Approval)

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Barron County, Wisconsin

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Chetek Lakes Protection Association
Chetek, Wisconsin

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Executive Summary

The Chetek Lakes are a very productive (nutrient rich) system. A long history of excessive nutrients has lead to an ongoing problem of nuisance algal blooms, particularly in the many small, shallow bays located throughout the lakes. Historic management activities have treated the symptoms of over-fertilization (excessive algae and excessive plant growth) rather than the cause (non-point sources and in-lake sources of nutrients). The rehabilitation of the Chetek Lakes requires many activities including monitoring and management of aquatic invasive species (AIS), native plant restoration, and the implementation of Best Management Practices (BMPs) and Agricultural Conservation Practices (ACPs) throughout the watershed.

The Chetek Lakes Protection Association (CLPA) is a local non-profit volunteer based organization whose vision is to preserve and protect the Chetek Lakes and their surroundings and to enhance the water quality, fishery, boating, safety, and aesthetic values of the Chetek Lakes as a public recreational facility for today and for future generations. In 2011 the CLPA received a Wisconsin Department of Natural Resources Aquatic Invasive Species Grant to complete an Aquatic Plant Management (APM) Plan for the Chetek Lakes: Prairie, Mud (Ojaski), Pokegama, Tenmile, and Chetek. This plan is intended to establish long-term and realistic objectives for managing non-native and nuisance native plant growth while protecting and rehabilitating valuable native species and their important habitat functions. To accomplish this, the aquatic plant communities were investigated, possible management alternatives were evaluated to determine preferred management options, and an implementation plan was developed which includes a mechanism to monitor and modify this management plan as needed.

This plan supports sustainable practices to protect, maintain and improve the native aquatic plant community, the fishery, and the recreational and aesthetic values of the lakes. This plan also lays out a strategy to prevent the introduction of new aquatic invasive species (AIS) like Eurasian watermilfoil (EWM) not currently found in the lakes, and lays out a monitoring program to aid in early detection of any new AIS. Although considered a five-year plan for management, it is not intended to be a static document; rather, it is a living document which will be evaluated on an annual basis and can be revised to ensure goals and community expectations are being met.

Aquatic plant management in the Chetek Lakes will follow six goals, each with a number of objectives and actions, over the course of the next five years. While the goals are inclusive of all of the Chetek Lakes, some of the objectives and actions vary between lakes. Appendix F is an outline of the aquatic plant management goals and activities, and Appendix G is a five-year timeline for completion of the activities included in this APM Plan. Any major change in activities or management philosophy will be presented to the CLPA and the WDNR for approval. The six goals for this plan are as follows:

1. Increase native aquatic plant diversity, distribution, and density in the Chetek Lakes.
2. Complete aquatic invasive species management that: encourages greater native plant growth; reduces phosphorus inputs caused by decaying vegetation; does not negatively impact the fishery; and provides nuisance and navigation relief for lake users.
3. Provide late season (native aquatic plant) nuisance and navigation relief for lake users and riparian owners.
4. Sponsor and support education, fundraising, monitoring, and prevention activities.
5. Increase appreciation for aquatic ecosystems and habitat in the Lake Community
6. Reduce total nutrient inputs from non-point sources to the Chetek Lakes

This APM Plan will be implemented by the Chetek Lakes Protection Association, their consultants, and through partnerships formed with the WDNR, Barron County, local townships, other federal, state, and Tribal agencies, and local clubs and organizations. Annual reports and end of project assessments will be completed throughout the duration of this 5-year plan.

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2012 - 2017 Aquatic Plant Management Plan for the Chetek Lakes

Chetek Lakes AIS Education, Prevention, & Planning Project

Prepared for Chetek Lakes Protection Association

1.0 Introduction

The Chetek Lakes are located in southwestern Barron County, Wisconsin (Figure 1). The chain of lakes is an impoundment of Pokegama Creek, Moose Ear Creek, and Tenmile Creek. The lakes cover approximately 3,563 acres and are comprised of five lakes: Prairie Lake, 1,619 acres; Ojaski (Mud) Lake, 578 acres; Pokegama Lake, 506 acres; Lake Chetek, 770 acres; and Tenmile Lake, 376 acres. The dam creating the Chetek Lakes was first constructed in 1865 and used for logging of the area. Prior to that time, Prairie Lake, Pokegama Lake, and Chetek Lake were distinct separate basins and Ojaski Lake and Tenmile Lake were riverine wetlands. The dam was used for power generation until the 1960s, after which ownership was transferred to Barron County. There is also a levee on the southwest side of Tenmile Lake managed by Barron County that is completed to an elevation higher than the Chetek Dam, essentially shutting off the surface water flow to Tenmile Creek.

The Chetek Lakes are a very productive (nutrient rich) system. A long history of excessive nutrients has lead to an ongoing problem of nuisance algal blooms, particularly in the many small, shallow bays located throughout the lakes. Historic management activities have treated the symptoms of over-fertilization (excessive algae and excessive plant growth) rather than the cause (non-point sources and in-lake sources of nutrients).

The fishery of the Chetek Lakes is very important to the local economy with a number of small business and resorts relying on the sport fishery. The lakes experiencing heavy fishing pressure during both the summer and winter months. It has an outstanding reputation as one of the top panfish producing lakes around the area, and as such the lake is largely fished for panfish species such as bluegill and black crappie. The lake is also a popular bass tournament destination during the summer months due to the strong largemouth bass population.

The Chetek Lakes Protection Association (CLPA) is a local non-profit volunteer based organization whose vision is to preserve and protect the Chetek Lakes and their surroundings and to enhance the water quality, fishery, boating, safety, and aesthetic values of the Chetek Lakes as a public recreational facility for today and for future generations. This plan is intended to establish long-term and realistic objectives for managing non-native and nuisance native plant growth while protecting and rehabilitating valuable native species and their important habitat functions. To accomplish this, the aquatic plant communities were investigated, possible management alternatives were evaluated to determine preferred management options, and an implementation plan was developed which includes a mechanism to monitor and modify this management plan as needed.

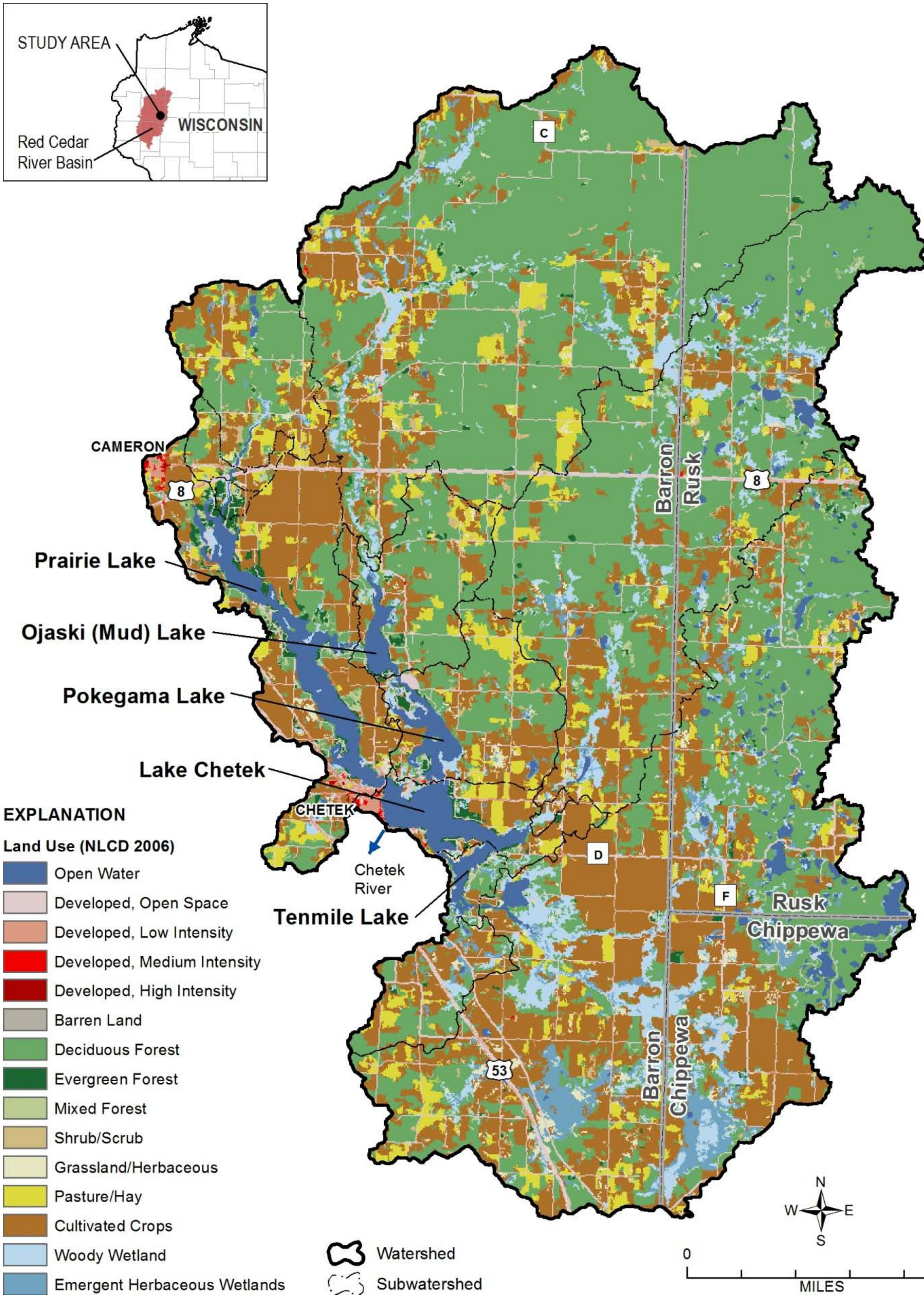


Figure 1 – The Chetek Lakes Watershed

The rehabilitation of the Chetek Lakes requires many activities including monitoring and management of aquatic invasive species (AIS), native plant restoration, and the implementation of Best Management Practices (BMPs) and Agricultural Conservation Practices (ACPs) throughout the watershed. This plan supports sustainable practices to protect, maintain and improve the native aquatic plant community, the fishery, and the recreational and aesthetic values of the lakes. This plan also lays out a strategy to prevent the introduction of new aquatic invasive species (AIS) like Eurasian watermilfoil (EWM) not currently found in the lakes, and lays out a monitoring program to aid in early detection of any new AIS. Although considered a five-year plan for management, it is not intended to be a static document; rather, it is a living document which will be evaluated on an annual basis and can be revised to ensure goals and community expectations are being met.

This Aquatic Plant Management (APM) Plan was developed under the sponsorship of the CLPA and was funded through a Wisconsin Department of Natural Resources (WDNR) Aquatic Invasive Species Education, Prevention, and Planning Grant and in-kind donations by CLPA volunteers.

2.0 Aquatic Plant Management Strategy

The WDNR aquatic plant management guidelines and the Northern Region Aquatic Plant Management Strategy (Appendix A) formed the framework for the development of this APM plan. All existing and new APM plans and the associated management permits (chemical or harvesting) are reviewed by the WDNR. APM plans developed for northern Wisconsin lakes are evaluated according to the Northern Region APM Strategy goals that went into effect in 2007. Additional review may be completed by the Voigt Intertribal Task Force (VITF) in cooperation with the Great Lakes Indian Fish and Wildlife Commission (GLIFWC). The review by VITF and GLIFWC is done to address matters related to the treaty rights of member tribes, particularly potential impacts to wild rice during management activities.

All five of the Chetek Lakes are on the Wisconsin 303(d) list of impaired waters. The pollutant of concern is excessive total phosphorus, which fuels nuisance algal blooms and is degrading habitat. The eutrophication appears to be largely due to cultural inputs from the primarily agricultural watershed. The WDNR has placed a low priority on developing a TMDL for the system.

Curly-leaf pondweed (*Potamogeton crispus*) (CLP), an aquatic invasive plant species present in the lakes, is an internal source of phosphorus to the system; curly-leaf senescence during the height of the growing season releases phosphorus into the water column which is then used by algae. Curly-leaf pondweed was first noted in the Chetek Lakes in 1975 during a WDNR aquatic nuisance control inspection. It was found in southern Prairie Lake near Cartwright Point and is now wide-spread and well established in the Chetek Lakes. This plan evaluates CLP management strategies as well as native plant restoration as a means to reduce the phosphorus load in the system and presents a strategy to switch to a clear water, plant-dominated system rather than an algae-dominated system.

It is important for APM plans to include yearly monitoring and assessment to document impacts on water quality, fish and wildlife, native plants, and control results for the targeted species. It is equally important for APM plans to evaluate the potential for restoring the natural plant community within a lake. If needed, shifting the plant community toward more native species through a reduction of targeted aquatic invasive species can prevent plant management from becoming endless, routine maintenance. This plan will follow an adaptive management approach by evaluating results and adjusting actions on the basis of what has been learned. This plan is therefore a living document, successively evolving and improving to meet environmental, social, and economic goals, to increase scientific knowledge, and to reduce tensions among stakeholders.

2.1 Shallow Lake Management Considerations

Lake management requires consideration of the differences between deep and shallow lakes. Shallow lakes are those lakes with a maximum depth of less than 20 feet or with an average depth of less than 10 feet [1]. Only Chetek Lake is considered a deep lake and the others can be classified as shallow lakes. Shallow lakes generally exist in one of two alternative states: the algae-dominated turbid water state and the plant-dominated clear water state (Figure 2). The turbid water state is characterized by dense algae (phytoplankton) populations, an undesirable bottom feeding fish community, and few aquatic plants whereas the clear water state is characterized by abundant aquatic plant growth, a greater number of zooplankton, and a diverse and productive gamefish community [2]. The majority of respondents of the 2011 survey indicated they prefer a plant-dominated system over an algae-dominated system.

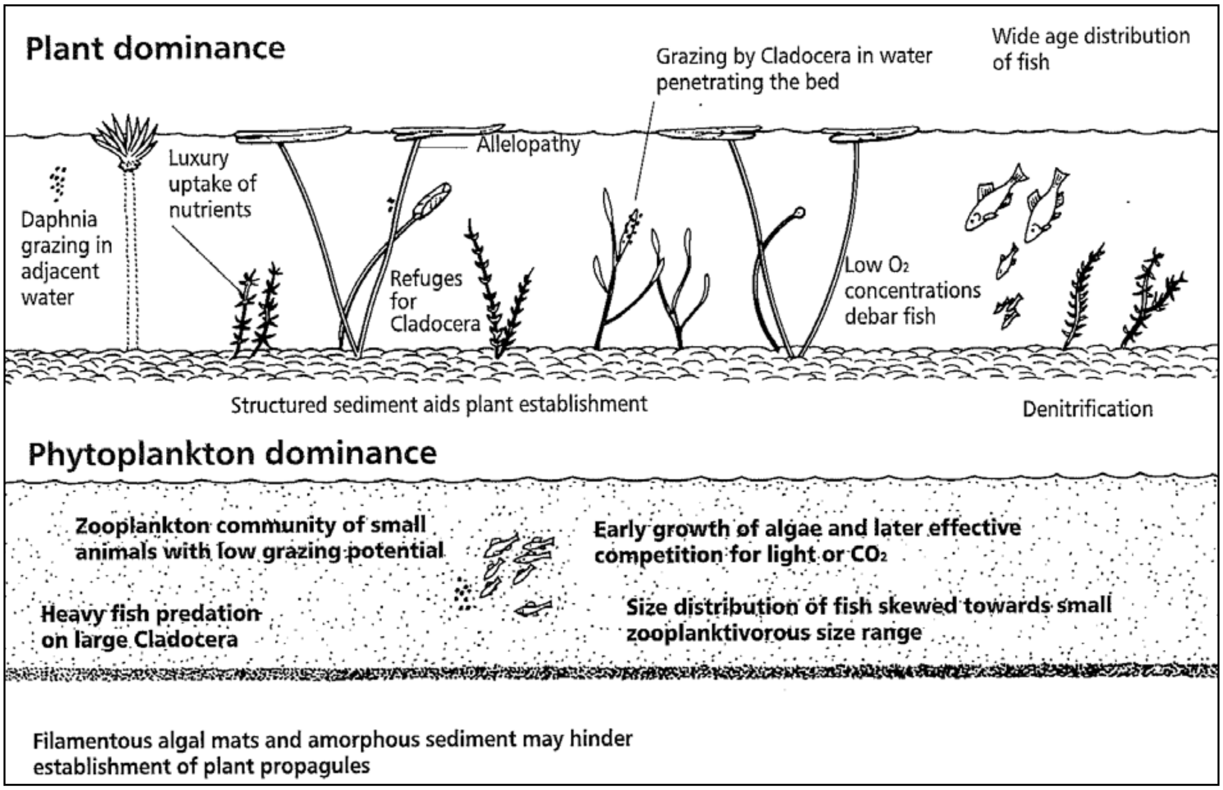


Figure 2 – Shallow Lake Alternative States and Stabilizing Mechanisms.

Aquatic plants are the key to clear water in shallow lakes. A shallow lake that is free of both aquatic plants and algae is uncommon and it is unrealistic to expect such a lake to occur without a large investment in money and energy [1]. The chance of macrophyte-free clear water is much higher with deep lakes. Shallow lakes are more susceptible to internal nutrient loading (e.g. lake sediment phosphorus release) and biomanipulation (additions or removals of fish that affect the entire aquatic food web) than deep lakes, which are more responsive to changes in the external nutrient load from the watershed [1].

The addition or removal of nutrients can change the composition of an aquatic plant community, but can't displace aquatic plants altogether. The mechanism that displaces the plants and allows for algae to take over is called a forward switch. Forward switches include the direct loss of plants through harvesting or herbicide use, repeated boat passage damaging the plants beyond recovery, runoff of herbicides from the surrounding watershed, static water levels, the introduction of carp, and a fish community that favors zooplanktivorous (fish that eat the Daphnia that eat the algae).

A reverse switch is a process or management option that restores and stabilizes the plant community by overcoming the buffers stabilizing the algae. The most common techniques are biomanipulation, which is a manipulation of the fish community to reduce the number of zooplanktivores (often by adding piscivorous fish), and by re-establishing plants under conditions in which they can thrive. An important aspect of plant restoration is the re-establishment of wetland fringes (cattails, rushes, water lilies) that utilize nutrients, buffer wave action, provide refuge for Daphnia and other algae grazers, and add to the lake's aesthetic appeal.

Each alternative state can persist over a wide range of nutrient concentrations. Aquatic plants can dominate without threat at total phosphorus concentrations below about 25 to 50µg/L (or total nitrogen below about 250 to 500 mg/L). At total phosphorus levels greater than about 50 µg/L, such as found in the Chetek Lakes, either plant- or algae-dominated systems can exist, though at these higher nutrient levels there is a greater risk of the system switching from plant to algae dominance. Plant diversity also decreases at higher nutrient levels and filamentous algae can be common. Native plants can become a nuisance at high nutrient concentrations as highly competitive species such as coontail and water lilies become dominant.

The steps for shallow lake restoration follow a series of graded steps [2]:

1. Forward switch detection and removal
2. External and internal nutrient control
3. Restructuring the ecosystem by a reverse switch (biomanipulation)
4. Plant establishment, including wetland fringe
5. Stabilizing and managing the restored system

Identifying the historic forward switch that moved a lake from the plant-dominated to algae-dominated state can be difficult. It is more important to identify the switch mechanisms currently in operation. Once forward switches have been identified and removed, over-fertilization can be addressed through nutrient management strategies. External and internal nutrient sources should be reduced as much as possible (preferably to < 50 µg/L) to buffer against a forward switch and establish conditions favorable for the next steps: biomanipulation and plant re-establishment [2]. A well established plant community can withstand moderate impacts without further active management; however, the lakes and watershed should be monitored for changes and activities that might destabilize the system.

3.0 Public Participation and Input

The CLPA provided input, support, and review of draft and final documents during the development of this APM Plan. The CLPA has been and remains very active in the stewardship of the Chetek Lakes since the group first established in 1985. The group became a qualified lake association in 1995 and has since initiated several studies examining the water quality of the lakes. The purpose of CLPA is to "preserve and protect the Chetek Lakes and their surroundings, and to enhance the water quality, fishery, boating, safety, and aesthetic values of the Chetek Lakes, as a public recreational facility for today and for future generations."

Further public input was collected through a public input survey developed and distributed by the CLPA with the help of their consultant and the WDNR during the summer of 2011. Surveys were mailed to 400 randomly selected property owners around the lakes and an additional 400 surveys were made available for general pickup at local establishments (restaurants, sport shops, gas stations, grocery stores, taverns). Of the 800 surveys distributed, 358 were returned (nearly a 45% return rate), representing approximately one-quarter of all the property owners. The public input survey provided a strong foundation for the development of this plan and identified community awareness and support of various lake issues and management strategies (Figures 3 and 4).

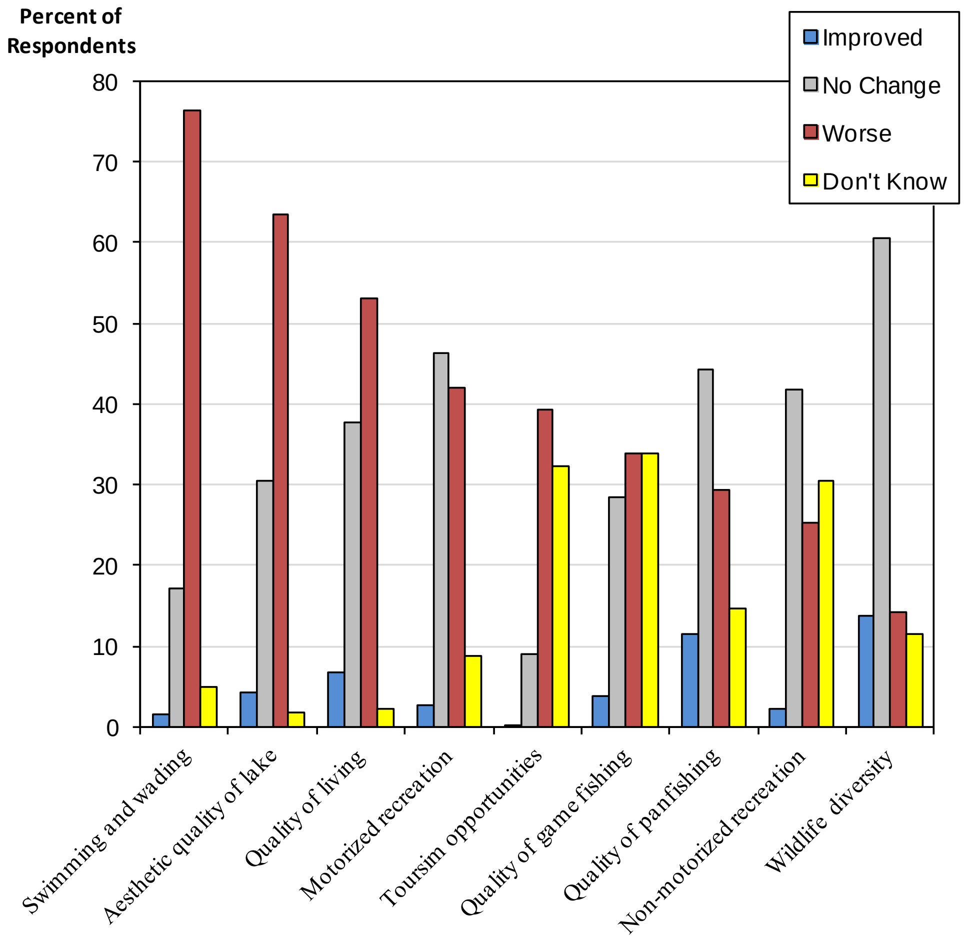


Figure 3 – Perceived Changes to Lake Quality Characteristics Since Living on Lake

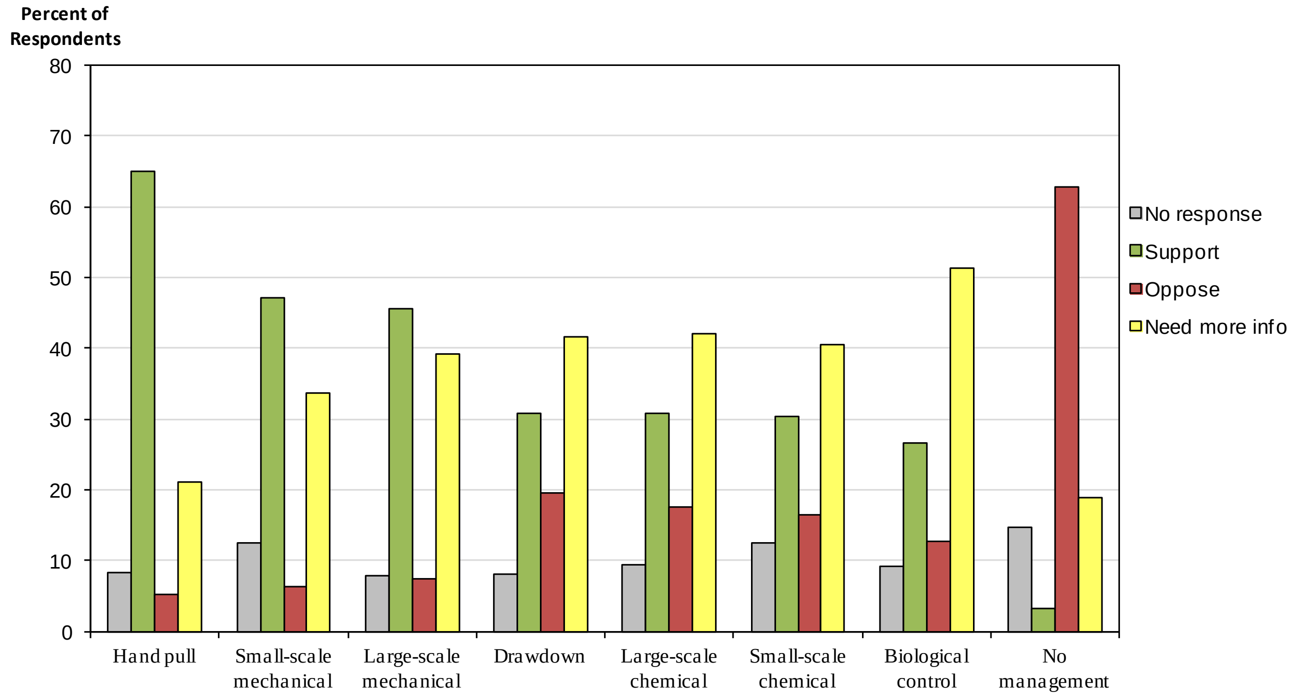


Figure 4 – Public Support of Aquatic Plant Management Alternatives

The desired outcome of lake management activities the majority (46%) of the community would like see is a lake system with a healthy combination of aquatic plants, decent water quality (poor water quality defined as low clarity, high nutrients and an over-abundance of algae) and an abundant fishery. Fortunately, this is an attainable stable state in the shallow lake system of the Chetek Lakes. 22% of the respondents would be happy with fewer days when the back bays are full of algae and noxious odors and 16% would like water suitable for swimming, but not necessarily algae free. Clear water with few aquatic plants is an outcome 14% of respondents would like to see; this state is uncommon in shallow lake systems and only achievable with a very large investment in money and energy. 2% of the respondents would most like to see no change to the fishery, but fewer days with really poor water quality. None of the respondents felt that no change is needed the lakes are fine as they are. The public input survey and a complete results summary further exploring the needs, knowledge base, and support of the lake community can be found in Appendix B.

4.0 Documentation of Problems and Need for Aquatic Plant Management

The following lays out the justification for completing aquatic plant management on the Chetek Lakes. The ultimate goal of aquatic plant management is to switch the lake from an algae-dominated state to a plant-dominated state.

4.1 Management History

A number of aquatic plant management techniques have been used in the Chetek Lakes with records tracing back to the 1940s. Aquatic plant management likely occurred earlier, but was not recorded. Individual land owners have participated in aquatic plant control, primarily via individual chemical treatments and by physical removal of aquatic plants.

The use of herbicides and algaecides for aquatic nuisance control has an extensive history on the Chetek Lakes. Throughout the 1950s and 1960s, 24,660 pounds of sodium arsenite were used for aquatic plant control and from the 1940s through the mid-1970s 171,525 pounds of copper sulfate were used for algae control at a rate of about 10,000 pounds per year. These control activities were sponsored by business groups, sportsman's clubs, and home owner groups. A number of the areas treated were hundreds of acres in size and required multiple chemical applications to maintain clear water conditions for any appreciable time. The high amounts of chemical use indicate the Chetek Lakes have historically suffered from both heavy aquatic plant growth and algal blooms.

Copper sulfate fell out of favor as an algaecide because it was found that long-term use can increase the frequency and severity of algal blooms. Copper sulfate also accumulates within the sediment as a heavy metal precipitate and essentially sterilizes the lakebed. Later herbicide applications on the Chetek Lakes utilized a number of organic herbicides such as endothal, Silvex, 2,4-D, and diquat. These applications were smaller scale, often less than an acre in size.

Other attempts at algae control noted in WDNR files and newspaper clippings include using fire hoses to wash algae away from the shore and using outboard motors for aeration. These experimental efforts were unsuccessful and were likely more detrimental to the system than beneficial due to sediment re-suspension and shoreland erosion.

Historic control efforts were short-term fixes, and with little understanding of shallow lake ecology at the time, were often competing against each other to achieve opposite ends of the shallow lake spectrum (i.e., clear-water plant dominated versus turbid-water algae dominated). Currently, the Chetek Lakes are listed on the 303(d) list as a low priority impaired water; there has yet to be any action on this listing. Other than county-led efforts focused on individual farms, there have been no concerted efforts to address the overlying nutrient loading issues.

4.2 Aquatic Invasive Species

Curly-leaf pondweed, purple loosestrife (*Lythrum salicaria*), Japanese knotweed (*Polygonum cuspidatum)*, and reed canary grass (*Phalaris arundinacea*) are non-native aquatic invasive plant species found in and around the Chetek Lakes. Narrow leaved cattail (*Typha angustifolia*), which is native to southern Wisconsin but often invasive in the northern part of the state, was observed along the shore of Mud (Ojaski) Lake. This plan presents management activities for these invasive species for which there is currently little or no active management. Non-native aquatic animal species known to be in the lakes are the Chinese mystery snail (*Cipangopaludina chinensis*) and the banded mystery snail (*Viviparus* *georgianus*). This plan focuses on plant management; nonetheless, monitoring and response activities targeting plants can include and may be suitable for some invasive animal species.

A spring 2011 CLP distribution and bed mapping survey found the plant well-established and dispersed throughout the lakes. Presently, CLP is not the issue of greatest concern in the lakes. However, it is causing some impairment of navigation and riparian access to open water, and preventing native plant growth in certain areas of the lakes leading to areas devoid of vegetation once curly-leaf senescence occurs in late-June to early-July. The senescence also releases nutrients into the water column which promotes algal blooms, particularly in those lakes that have the most CLP. As an example, in Mud (Ojaski) Lake in 2011, dense growth CLP was present in nearly 35% of the total surface area of the lake. The 1999 Lake Management Plan estimated that senescing CLP comprised 30% of the total Mud Lake phosphorus budget.

Purple loosestrife and reed canary grass are aquatic plants most often found in the shallow margins of the lakes and in surrounding wetlands. Biological control and manual removal of purple loosestrife has been done in and around the Chetek Lakes. The status of purple loosestrife management activities should be revisited. Reed canary grass, which has been labeled perhaps the worst invasive species in Wisconsin to date, is nearly ubiquitous in the Chetek Lakes watershed. It can be found along the lake shore, in ditches and wetlands, and in open forest areas along streams. Reed canary grass forms dense, nearly monotypic stands that displace all other species, constricts waterways, and limits tree regeneration in riparian areas by shading out seedlings.

A substantial patch of Japanese knotweed is present on the east shore immediately upstream of the Chetek dam (Figure 5). Japanese knotweed may be present in other areas of the lake, but it has not been officially identified. The Barron County Soil and Water Conservation Department has been working to control/eradicate this patch for many years. Japanese knotweed management includes close monitoring, physical removal, and application of herbicides.

Figure 5 – Japanese Knotweed by Chetek Dam Before (left) and After (right) Management Actions by Barron County

The exceptional fishery and wide range of recreational opportunities provided by the Chetek lakes makes it a popular destination in the region. With 18 public boat launches, the lakes are a prime candidate for the introduction of aquatic invasive species. The lakes may also act as a regional source of currently established and any new aquatic invasive species due to their heavy recreational use. Near several of the most used landings, dense beds of CLP are present in the spring impeding access and potentially spreading the invasive species to other lakes in the area.

4.3 Algae

Letters and comments in the WDNR aquatic nuisance control files dating back to the early 1950s indicate that the Chetek Lakes have remained nearly the same for the past 70 years—a highly eutrophic lake with severe algal blooms. Numerous historic accounts describe the lakes as having a “green latex paint” appearance with a distinct “pig sty” smell, observations which pertain to the current condition of the lakes. Filamentous algae also pose a problem throughout the lakes. In Mud Lake, large, floating mats of algae several inches thick make fishing nearly impossible, and boating extremely difficult as the algae clogs water intakes on motors (Figure 6). Not only are these beds a nuisance for lake users, they also negatively impact the lake habitat. During the July 2011 plant survey, it was noted that algal mats blocked out sunlight and the macrophytes underneath were either dead or dying.

Reducing algal blooms in the Chetek Lakes requires both nutrient control (at the lake and watershed scale) and detecting and removing forward switches (for example, excessive power boat use in shallow waters, static year-round water levels). Reduced or no till practices on agricultural lands, fencing cattle away from stream banks, and other ACPs should be implemented to reduce the sediment and nutrient load from the watershed.

The effects of nutrient control activities have the potential to cascade down the chain of lakes. Nutrient budget evaluations in the 1999 Lake Management Plan found that 88% of the phosphorus that enters Mud Lake flows to Pokegama Lake (58%) and Prairie Lake (30%). Pokegama Lake loses 69% of its phosphorus load to Chetek Lake and Prairie Lake loses 55% to Chetek Lake. With Chetek Lake receiving the majority of its water and nutrients from the adjoining lakes, improvements to water quality in Chetek Lake will not be realized until system-wide reductions in nutrient loading have been made.

The fertile nature of the lakes supports the fishery; however, the current condition also has negative impacts. Prairie Lake has a history of winterkill caused by low oxygen levels. To combat the low oxygen levels, a winter aeration system has been used in the lake since 1992. The aeration system is maintained under a cooperative agreement between the WDNR, Barron County, the City of Chetek, and Towns of Chetek, Dovre, Stanley, and Prairie Lake. Since the aeration system blows an open hole in the ice, a protective rope barrier with reflectors and black cards (for added visibility) is constructed. The aerator system and barrier is set up by WDNR Fisheries staff and CLPA volunteers. The average annual operating costs of this system are about $1,750. Although there have been no documented winterkills since the installation of the aeration system, the underlying problem of excessive nutrient loading to the lake has not been fully addressed.

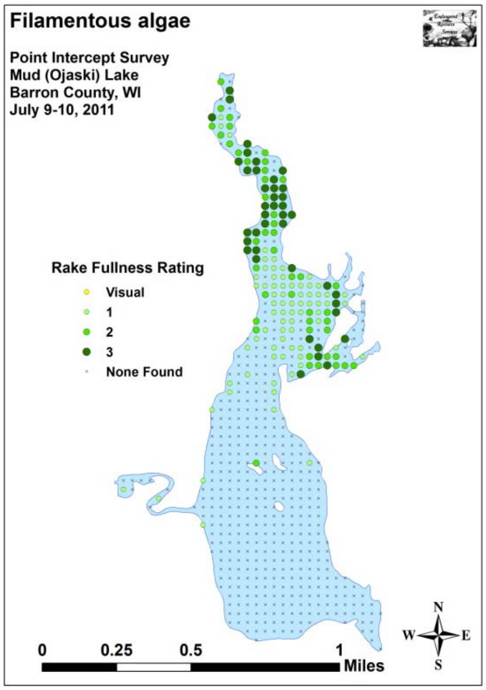


Figure 6 – Filamentous Algae in Mud Lake (Berg, 2011)

4.4 Native Aquatic Macrophytes

An important aspect of this management plan is protecting the native plants in the water and along the shoreline while maintaining recreational uses. There are some localized problem areas on the lakes where dense native aquatic plants interfere with lake access and use. This plan provides a means of identifying the need for and appropriately managing common use navigation channels and individual riparian access lanes.

Shoreland restoration is also included in this plan. The majority of respondents to the 2011 survey desire a managed natural or unmanaged natural shoreline. Managing shorelands to maintain or improve water quality and habitat will help to increase aquatic plant diversity and quality which in turn will also help to prevent certain native plants from becoming a problem. Restoring or re-establishing the wetland fringe around the lakes will also benefit water quality. Not knowing where to begin with a shoreland restoration is often the main hurdle preventing implementation. Over 50% of the survey respondents stated they are willing to participate in a shoreland restoration training session.

4.5 Water Level Management

The impoundment of the Chetek River to form the lakes is approaching its 150th anniversary, the projected lifespan of many reservoirs. Over this time, sedimentation has reduced water depths and deposited sediments containing nutrients, trace metals, agricultural pollutants, and other pollutants, including 24,660 pounds of sodium arsenite and 171,525 pounds of copper sulfate used during historic plant and algae control efforts. The amorphous sediment found throughout the lakes may be hindering the establishment of native aquatic plants. Some portions of the lake that were once aquatic bed wetlands are now mud-flats of sediment and plant detritus. Selective dredging should be considered to increase the amount and diversity of habitat in the lakes, remove nutrient-rich (and potentially pollutant-rich) accumulated sediments, improve recreational opportunities, and improve the lake aesthetic.

The water level of the Chetek Lakes is constricted within very narrow limits for the benefit of recreational users. Records of the water levels measured at the Chetek Dam show a nearly constant lake elevation with variations of less than 1 foot over the course of the year. Restoration of more natural water-level regimes would likely lead to the enhancement of water quality and biodiversity [3,4]. These natural fluctuations are an inherent feature of lake ecosystems, essential for the survival and well-being of many species that have evolved to suit their life cycle to those fluctuations, and needed for a range of ecosystem services [5].

A monitoring study completed in the mid-1970s proposed a dam operation schedule to utilize available groundwater and to time water level fluctuations with periods of minimum and maximum nutrient concentration. The plan called for a 1-foot drawdown from early to mid summer—June (0 to 6 inches), July (6 to 10 inches), and August (10 to 12 inches)—with recovery in September (12 to 6 inches) and October (6 to 0 inches). This plan, which was not implemented, should be further developed with consideration to the ecological impacts of lake level management decisions (e.g. amplitude of fluctuation, timing schedule). It is important for the water management schedule for the Chetek Lakes to allow flexibility in order to deal with issues as they develop as well as deal with the changing needs of all the resource users.

There are several other dams within the Red Cedar River Basin. There is currently little to no coordination between the different dam operators, even though water level manipulations impact downstream waterbodies. Reductions or increases in normal outflow from any one of these impoundments can dramatically affect downstream waterbodies if other dam operators are not informed of the change. Interrupted flows can impact fish and wildlife and recreational uses, and the multitude of independent operating plans can lead to similar issues.

4.6 Education and Outreach

Results of the survey distributed to property owners around the lakes in 2011 show the majority of respondents (nearly 70%) supported some form of aquatic plant management (primarily hand-pulling and mechanical harvesting), but also requested more information on the various alternatives, particularly biological-based methods. Education and outreach are needed in order to implement community supported aquatic plant management alternatives.

Membership in the Chetek Lakes Protection Association is voluntary. Approximately 500 out of 1,400 property owners on the Chetek Lakes are currently members of the CLPA. Although only 36% of the property owners are members, 63% of survey respondents felt that the CLPA is responsible for lake management. This means that the burdens related to protecting and improving the lakes falls on the shoulders of only a few. Many of the management activities appropriate for the Chetek Lakes would benefit from a relatively secure source of funding. This funding could also be used to address issues that may crop up, like the floating island in Prairie Lake. Survey respondents were asked if they supported the formation of a Lake District: 52% of survey respondents were in favor, 30% were unsure, and 18% were against. A lake district is considered a governmental body and has taxing authority over the properties included when it was formed. A taxing mill rate is established each year by the Lake District Board, and must be approved by the membership. There are limitations on how high a mill rate can be set, but there is no limit to how low it can be set. Therefore, a lake district can forego assessing the tax without disbanding should conditions warrant.

5.0 Lake Information

Identifying appropriate aquatic plant management recommendations for the Chetek Lakes requires a basic understanding of its physical characteristics, including its morphology (size, structure, and depth), critical habitat, and the fishery, as well as factors influencing water quality, such as soils and land use. All of these factors have the potential to influence aquatic plant growth. Aquatic plant management will impact certain aspects of a lake including water quality, fish and wildlife habitat, and both target and non-target aquatic plants. Water quality and plant survey data were collected within Chetek Lakes during the development of this plan. These data along with data collected in the past and future will provide the information necessary to evaluate the effects of aquatic plant management and other management activities on the lakes and their ecosystem.

The Chetek Lakes are considered a great fishery and a significant resource by the CLPA, the WDNR, and area residents. A survey completed as part of the 1999 Management Plan identified fishing as the primary use of the lakes. Other major uses include observing wildlife, enjoying the view, motor boating, and swimming. Desired uses of the lakes indicate respondents would participate in similar recreational activities if water clarity improved and swimming in the lakes would likely increase.

The CLPA has sponsored a number of studies to evaluate the water quality of the lakes. A Lake Management Plan completed in 1999 documented background information and provided a strategy to manage, improve, and protect the water quality of the lakes. The information that follows is summarized from this and other historic reports, some of which has been updated from more recent sources and investigations related to this project (for example, lake areas were obtained from the 2005 Barron County LiDAR survey, volumes were computed in ArcGIS from aquatic plant survey data, and sediment phosphorus release rates were evaluated as part of this project).

5.1 Physical Characteristics

Lake Chetek (WBIC 2094000) (Figure 7) has a surface area of 943 acres and a volume of approximately 11,100 acre-feet (Table 1). The average depth of the lake is 11.8 feet and the maximum depth is 22 feet. Water enters the lake from the north via Moose Ear Creek and from outflow from Prairie Lake, Pokegama Lake and Tenmile Lake. Outflow is over a dam in Chetek, Wis. to the Chetek River, which joins the Red Cedar River 5 miles southwest of the lakes.

Ojaski Lake, or Mud Lake, (WBIC 2094600) (Figure 8) has a surface area of 359 acres and a volume of approximately 1,850 acre-feet (Table 1). The average depth of the lake is 5.2 feet and the maximum depth is 15 feet. The Lake receives water from Pokegama Creek on the northern end of the shore and from an unnamed ephemeral stream on the southeastern shore. There is likely diffuse flow between Mud and Prairie Lake through narrows known as “the Draw” which has not been quantified. Outflow is primarily south to Pokegama Lake.

Pokegama Lake (WBIC 2094300) Figure 7) has a surface area of 521 acres and a volume of approximately 5,300 acre-feet (Table 1). The average depth of the lake is 10.2 feet and the maximum depth is 19 feet. Water enters the lake from Mud Lake to the north and from an unnamed ephemeral tributary draining Jacobson Lake near the southern end of the lake. Outflow from the lake is to the south to Lake Chetek.

Prairie Lake (WBIC 2094100) (Figure 8) has a surface area of 1,488 acres and a volume of approximately 12,870 acre-feet (Table 1). The average depth of the lake is 8.7 feet and the maximum depth is 16 feet. The lake receives water from Rice Creek and an unnamed spring near at the northern end of the lake, and from two ephemeral tributaries along the eastern shore. There is likely diffuse flow between Mud and Prairie Lake through narrows known as “the Draw” which has not been quantified. Outflow is likely primarily south to Lake Chetek.

Tenmile Lake (WBIC 2089500) (Figure 7) has a surface area of 253 acres and a volume of about 1,350 acre-feet (Table 1). The average depth of the lake is 5.4 feet and its maximum depth is 12 feet. The majority of the water entering the lake is from Tenmile Creek entering from the east. Water also enters from the south via Short Creek, which is primarily wetland drainage. Short Creek at times acts as an outlet, as was noted during the summer of 2012 when water was flowing from Tenmile Lake into Short Creek. Water primarily flows out of Tenmile Lake north to Lake Chetek.

Table 1
Physical Characteristics of the Chetek Lakes

Lake	Area[1] (acres)	Volume[2] (acre-feet)	Shoreline[1] (miles)	Maximum Depth[3] (feet)	Average Depth[4] (feet)	Residence Time[5] (days)
Chetek	942.9	11,100.6	11.36	22	11.8	44
Ojaski (Mud)	358.5	1,850.8	10.08	15	5.2	31
Pokegama	520.8	5,307.6	13.41	19	10.2	73
Prairie	1,487.8	12,870.1	31.20	16	8.7	172
Tenmile	252.7	1356.1	7.74	12	5.4	15
Total	**3,562.6**	**32,485.3**	**73.78**	**22**	**9.1**	

[1]Barron County LiDAR (2005) [2]Aquatic Plant Survey Data [3]WDNR Lakes Bulletin
[4]Computed, volume divided by area [5]1999 Lake Management Plan

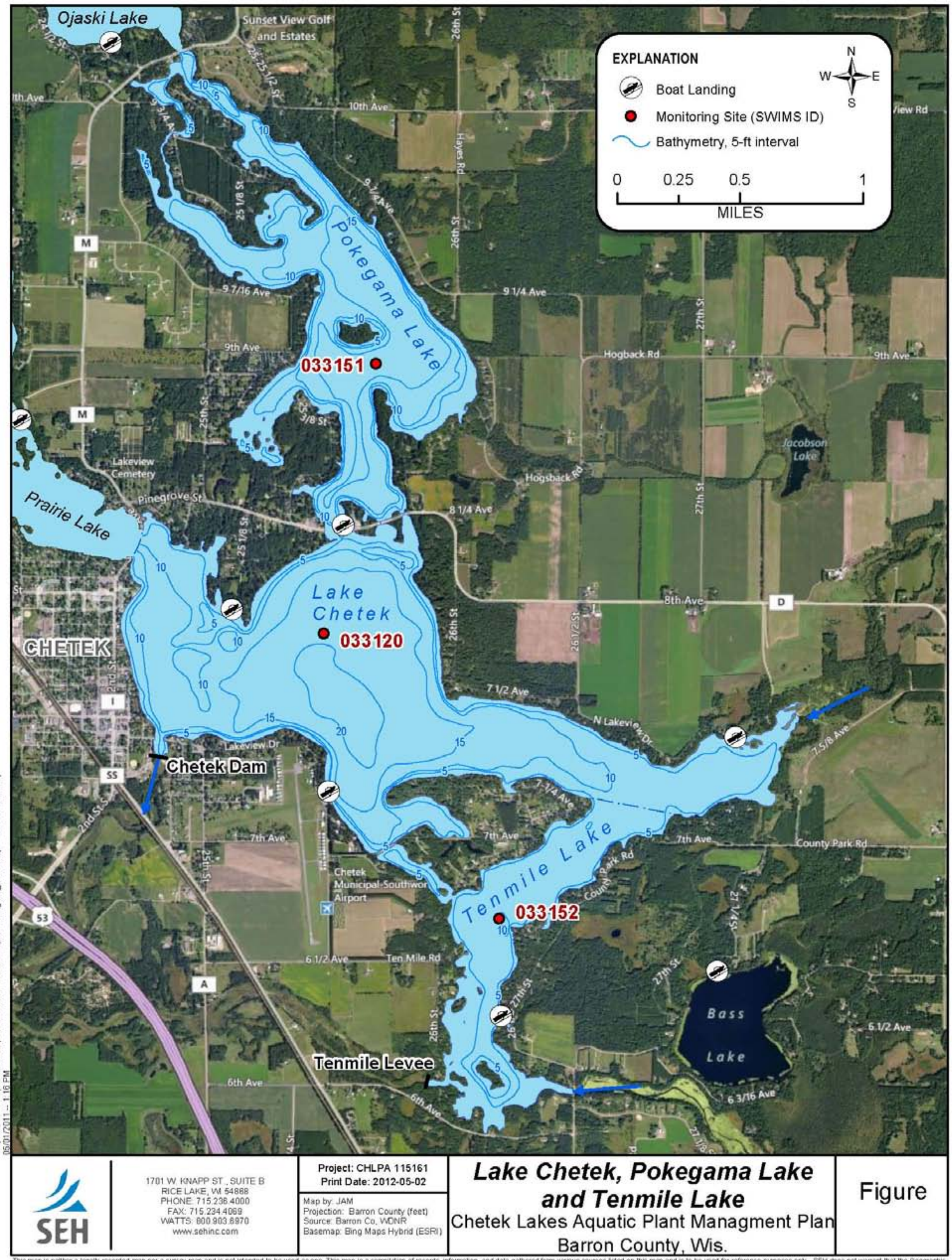


Figure 7 – Map of Lake Chetek, Pokegama Lake, and Tenmile Lake

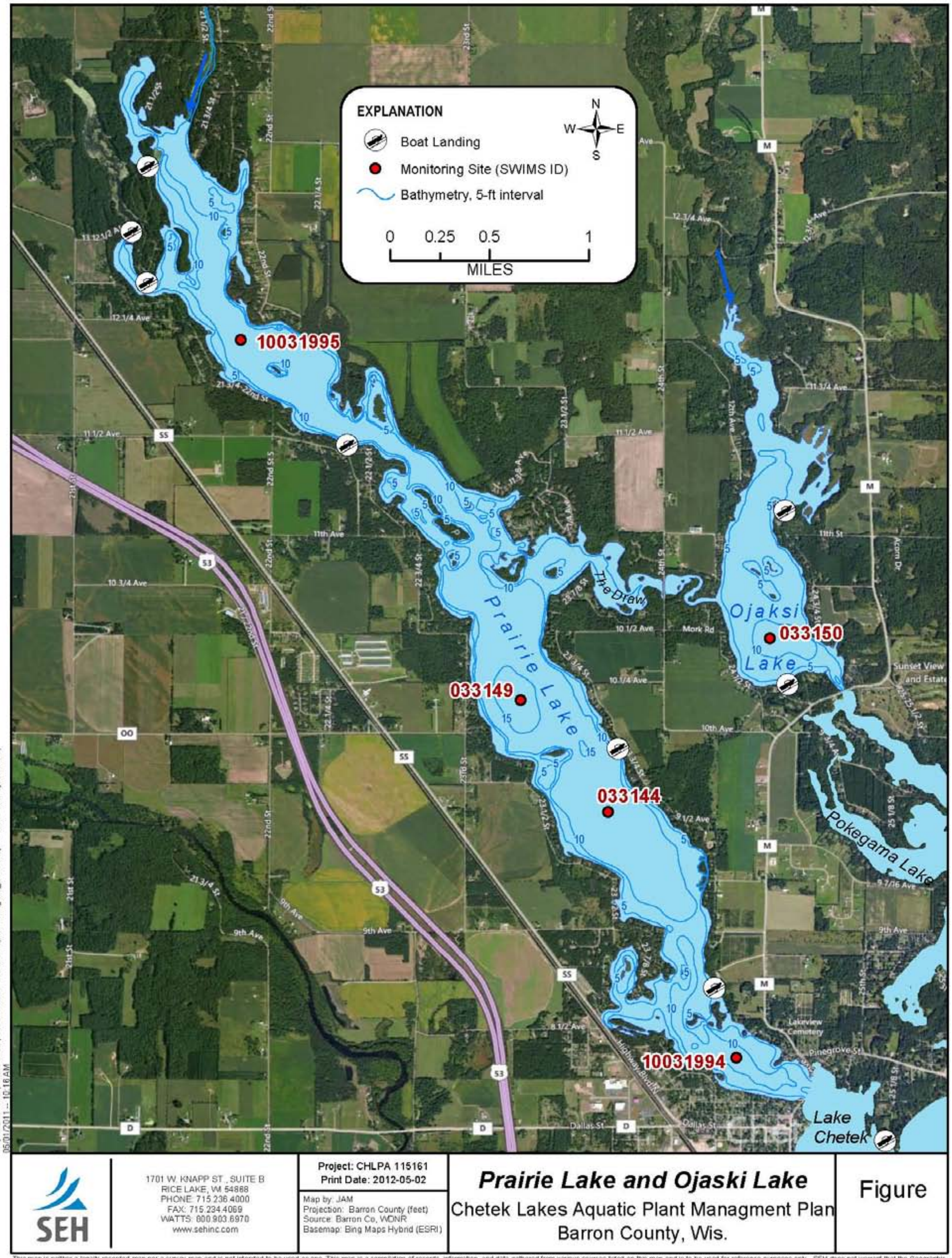


Figure 8 – Map of Prairie Lake and Ojaski Lake

5.2 Watershed

A watershed is an area of land from which water drains to a common surface water feature, such as a stream, lake, or wetland. The watershed boundary for the Chetek Lakes was delineated using the Soil and Water Assessment Tool and 10-meter USGS digital elevation model. The total watershed area for all the lakes is about 200 mi^2 with the majority of the land use comprised of forests (47%), followed by agriculture (32.8%) (Figure 1 and Table 2). Although urban areas are only identified near the outlet (the City of Chetek) and northwest of Prairie Lake (the Village of Cameron), areas of relatively high-density residential development are present around portions of the Chetek Lakes.

Table 2
Land Use in the Chetek Lakes Watershed

Land Use	Square Miles	Percent of Total
Urban	10.53	5.3
Agriculture	65.77	32.8
Forest	94.16	47.0
Grassland/shrubland	5.07	2.5
Barren	.01	< 0.1
Wetland	16.05	8.0
Water	8.77	4.4
Total	**200.35**	**100.0**

Source: 2006 National Land Cover Database

Land cover and land use management practices within a watershed have a strong influence on water quality and water quantity. Increases in impervious surfaces, such as roads, rooftops and compacted soils associated with residential and agricultural land uses, can reduce or prevent the infiltration of runoff. This leads to an increase in the volume and rate of stormwater runoff and pollutant loading to the lakes and their tributary streams. The removal of riparian (near-shore) vegetation causes an increase in the amount of nutrient-rich soil particles transported directly to a waterbody during rain events.

The primary agricultural land use in the watershed is row crops (corn and beans) and potatoes. There are also a number of dairy and cattle operations. During the synoptic sampling in the summer of 2012, a number of sites were found to have cattle in the streams. The adverse effects of cattle grazing on stream habitat and water quality have been well documented. Livestock can damage riparian areas by trampling or grazing streamside and lakeside vegetation, negatively impact the macro-invertebrate community and fishery, elevate nitrate and fecal coliform levels, and erode stream banks and lake shores [6].

All of the soils in the nearshore area of the Chetek Lakes are rated Very Limited for septic tank absorption fields. A Very Limited rating indicates that the soil has one or more features that are unfavorable for the specified use and poor performance and high maintenance can be expected [7]. The limitations generally cannot be overcome without major soil reclamation, special design (for example, tertiary systems), or expensive installation procedures. It is important to note that septic systems contribute nutrient and other chemicals to groundwater and lakes even if they are working properly; septic systems are designed to remove solids and pathogens. Phosphorus is initially retained in the soil, but once the soil retention capacity is exceeded, septic system can and often do discharge high concentrations of phosphorus to the groundwater which ultimately reaches the lakes.

5.3 Water Quality

The water quality of a lake influences the aquatic plant community, which in turn can influence the chemistry of a lake. Water clarity, total phosphorus, and chlorophyll *a* are measures of water quality that can be used to determine the productivity or trophic status of a lake. The Carlson trophic state index (TSI) is a frequently used biomass-related index. The trophic state of a lake is defined as the total weight of living biological material (or biomass) in a lake at a specific location and time. Eutrophication is the movement of a lake's trophic state in the direction of more plant biomass. Eutrophic lakes tend to have abundant aquatic plant growth, high nutrient concentrations, and low water clarity due to algae blooms. Oligotrophic lakes, on the other end of the spectrum, are nutrient poor and have little plant and algae growth. Mesotrophic lakes have intermediate nutrient levels and only occasional algae blooms.

Water quality data are available online in the WDNR Surface Water Integrated Monitoring System (SWIMS) database. Data are available for Chetek Lake beginning in 1973, Prairie Lake in 1979, and Mud Lake, Pokegama Lake and Tenmile Lake since 1987. Parameters that have been collected include temperature and dissolved oxygen profiles, nutrient concentrations, and Secchi depths.

5.3.1 Temperature and Dissolved Oxygen

The Chetek Lakes are discontinuous cold polymictic lakes, meaning the lakes are ice-covered part of the year and stratified during the warm season for periods of several days to weeks, but have irregular interruption by mixing. Low dissolved oxygen concentrations (less than 5 mg/liter) were usually found at depths greater than about 11 feet during July and August in 2011. Dissolved oxygen levels below 5 mg/liter stresses many fish species. Hypoxic conditions (less than 2 mg/liter) existed at slightly deeper depths during the summer months.

The minimum oxygen level of 2 mg/L is an important criterion of sediment phosphorus release. When near-bottom dissolved oxygen is at 2 mg/liter 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 (for example, during a mixing event), it can provide a significant internal source of phosphorus to fuel algae blooms. In 2011, Chetek Lake completely mixed twice during the growing season, Mud Lake, Pokegama Lake, and Prairie Lake mixed once, and Tenmile Lake was only stratified during August.

5.3.2 Water Clarity

The depth to which light can penetrate a lake is a factor that limits aquatic macrophyte growth. Water clarity is measured by lowering a black and white Secchi disk. The disk is lowered into the water and the depth of disappearance is recorded. The disk is then lowered further and slowly raised until it reappears. The Secchi depth is the mid-point between the depth of disappearance and the depth of reappearance. Because light penetration is usually associated with algae growth, a lake is considered eutrophic when Secchi depths are less than 6.5 feet. Secchi depths vary throughout the year, with shallower readings in summer when algae become dense and limit light penetration and deeper readings in spring and late fall.

The average summer (June – August) Secchi depth of all sites in 2011 was 1.4 feet, over half a foot less than the overall summer average of 2.1 feet. In 2012, the average Secchi depth was 1.7 feet, not including Tenmile Lake for which no data was available. Annual variations in water clarity are about 3 feet in the lakes, with the highest water clarity generally measured in May and the lowest in August (Figure 9).

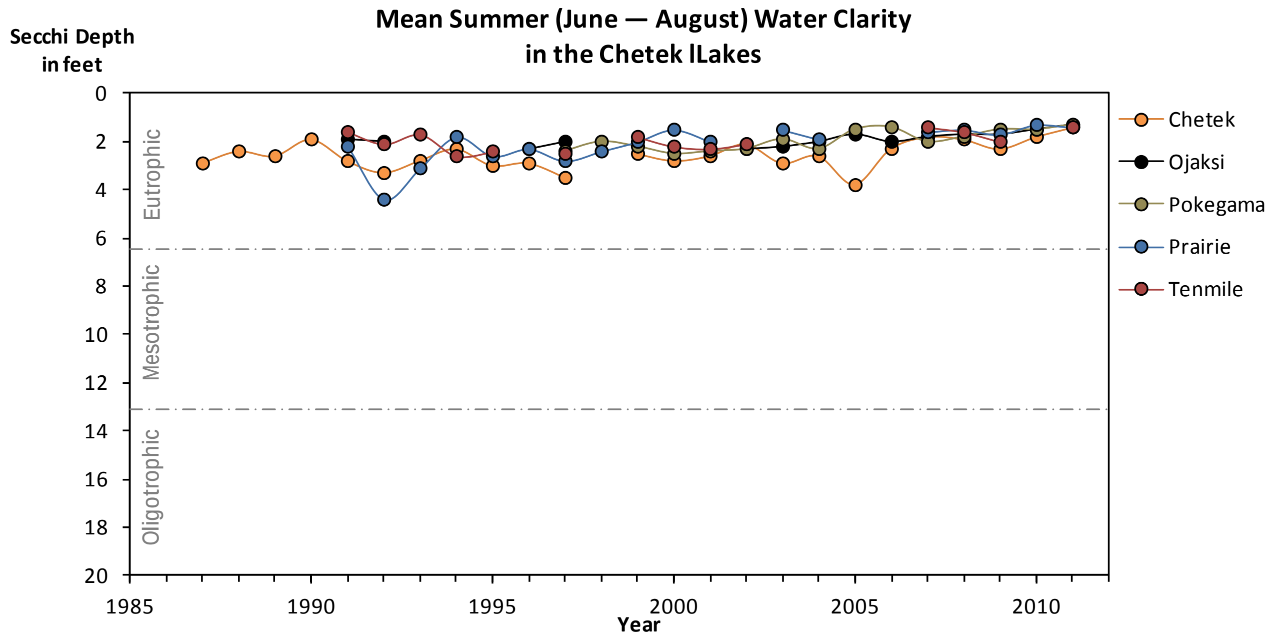


Figure 9 – Mean Summer Water Clarity in the Chetek Lakes

5.3.3 Phosphorus

Phosphorus is an important nutrient for plant growth and is commonly the nutrient limiting plant production in Wisconsin lakes. A total phosphorus concentration below 20 µg/L is necessary to prevent nuisance algal blooms in most lakes [8]. When a nutrient is limiting production, small additions of the nutrient to a lake can cause dramatic increases in plant and algae growth and should therefore be the focus of management efforts to improve water quality. The ratio of the total nitrogen to total phosphorus (N:P) is used to determine the nutrient that likely limits aquatic plant growth in a lake. When N:P is greater than 17:1, phosphorus is interpreted as the limiting nutrient and when the ratio is less the 10:1, nitrogen is likely the limiting nutrient.

Water quality data indicate that the nutrient enriched Chetek Lakes appear to experience periods of both phosphorus and nitrogen limitation throughout the growing season. Phosphorus was the limiting nutrient the majority of the time in 1996 but in 2011, the N:P was in a “gray” area (between 10:1 and 17:1) where it is unclear whether nitrogen or phosphorus is limiting the growth of algae When phosphorus is limiting, one pound of phosphorus can grow up to 500 pounds of algae [9].

Chetek Lake total phosphorus concentrations ranged from 72 to 198 µg/L in the 2011 growing season. The summer (July-August) average was 68 µg/L, much higher than the mean for northwest Wisconsin lakes of 28.0 µg/L [10], but lower than the 1996 average of 77 µg/L.

Mud Lake total phosphorus concentrations ranged from 73 to 225 µg/L in the 2011 growing season. The summer (July-August) average was 197 µg/L, much higher than the mean for northwest Wisconsin lakes of 28.0 µg/L [10], and also much higher than the 1996 average of 114.3 µg/L.

Pokegama Lake total phosphorus concentrations ranged from 84 to 288 µg/L in the 2011 growing season. The summer (July–August) average was 249 µg/L, much higher than the mean for northwest Wisconsin lakes of 28.0 µg/L [10], and also much higher than the 1996 average of 86 µg/L.

Prairie Lake total phosphorus concentrations ranged from 77 to 350 µg/L in the 2011 growing season. The summer (July–August) average was 327 µg/L, much higher than the mean for northwest Wisconsin lakes of 28.0 µg/L [10], and higher than the overall summer mean (1994 to present) of 192 µg/L.

Tenmile Lake total phosphorus concentrations ranged from ranged from 92 to 288 µg/L in the 2011 growing season. The summer (July–August) average was 232.5 µg/L, much higher than the mean for northwest Wisconsin lakes of 28.0 µg/L [10].

5.3.3.1 Phosphorus Sources

The sources of phosphorus to the Chetek Lakes were investigated as part of the 1999 management plan and updated with new information collected as part of this project (Figure 10). The majority of the phosphorus is from drainage from the watershed (52.3%), followed by internal sediment loading (18.3%), and agricultural land in the direct drainage area of the lakes (17.2%). Agricultural BMPs throughout the watershed will likely lead to the greatest reduction in phosphorus loading to the lakes at the least expense.

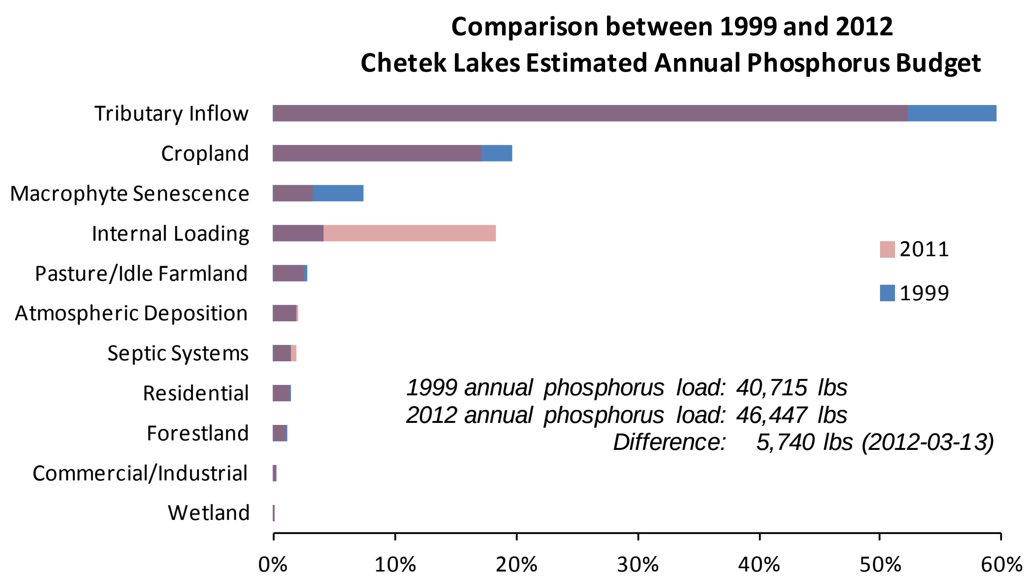


Figure 10 – Phosphorus Sources to the Chetek Lakes

PA sediment phosphorus release study completed in 2011 as part of this project determined that approximately 8,500 pounds of phosphorus is released to the water column. This is substantially greater than the 1,700 pounds estimated in the 1999 Lake Management Plan. The contribution of curly-leaf pondweed senescence to the phosphorus budget was re-evaluated using CLP bed mapping data from 2011 and updated phosphorus content information. Assuming all phosphorus is released directly to the water column (worst case scenario), the CLP contribution is about 1,520 pounds of phosphorus (3.3% of the phosphorus budget), half of the original estimate provided in the 1999 Management Plan.

The septic system contribution was also re-evaluated as part of this project. The public input survey results and analysis of 6-inch orthophotos were used to determine the number of capita-years. Air photo analysis identified 56 dwellings within 50 feet of the shoreline and 1109 dwellings between 50 and 300 feet of the shoreline outside of the area served by the City of Chetek sewer. Orthophotos were not evaluated beyond 300 feet of the shoreline. All of the houses outside of the sewered area were assumed to have septic systems. 85% of septic systems within 50 feet of the shoreline were categorized as short-circuiting and 15% were categorized as normal systems. Between 50 and 300 feet of the shoreline, 20% of septic systems were categorized as short-circuiting and 80% categorized as normal. This evaluation equated to a septic system contribution of 864 pounds, higher than the 1999 Management Plan estimate of 607 pounds, but still only a small fraction (1.9%) of the overall phosphorus budget.

hosphorus loading from the nearshore area (within 300 feet of the lakes) was evaluated as part of this project. Land uses and land cover including mowed lawn, impervious surfaces, agricultural lands, forests, wetlands, and open water were mapped using ArcGIS and high-resolution air photos (Table 3). Natural lands dominate the nearshore area, covering 61.4% of the 2049.9 acres, followed by developed lands covering 36.7%, and agricultural land uses covering 1.9%. Phosphorus loading to the lakes from this area is an estimated 694.5 pounds per year (1.5% of the total phosphorus load) (Table 3), computed using the "most likely" export coefficients in the Wisconsin Lake Modeling Suite [11].

Table 3
Land Use and Cover in the Chetek Lakes Nearshore Area

Land Use (Level 1)	Land Use (Level 2)	Acres	Percent	Annual Phosphorus Load (pounds)
Natural	Open Water	17.19	.8	2.2
Agricultural	Agricultural	38.90	1.9	28.7
Developed	Impervious	256.99	12.5	343.9
Developed	Lawn	495.46	24.2	220.5
Natural	Wetland	74.99	3.7	6.6
Natural	Forest	1166.37	56.9	92.6
TOTAL		**2049.90**	**100.0**	**694.5**

5.3.4 Chlorophyll *a*

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. Concentrations greater than about 10 µg/L are considered indicative of eutrophic conditions and concentrations 20 µg/L or higher are associated with algal blooms. For trophic state classification, preference is given to the chlorophyll *a* trophic state index because it is the most accurate at predicting algal biomass.

Lake Chetek chlorophyll *a* concentrations ranged from 48.2 to 76.8 µg/L during the 2011 growing season. The summer (July-August) average was 65.7 µg/L, higher than the summer average in 1996 of 51.1 µg/L.

Ojaski Lake chlorophyll *a* concentrations ranged from 35.1 to 191 µg/L during the 2011 growing season. The summer (July-August) average was 147 µg/L, higher than the summer average in 1996 of 72.1 µg/L.

Pokegama Lake chlorophyll *a* concentrations ranged from 49.7 to 192 µg/L during the 2011 growing season. The summer (July-August) average was 165 µg/L, higher than the summer average in 1996 of 52.6 µg/L.

Prairie Lake chlorophyll *a* concentrations ranged from 38.6 to 147 µg/L during the 2011 growing season. The summer (July-August) average was 143 µg/L, higher than overall (1994 to present) summer average 88.5 µg/L.

Tenmile Lake chlorophyll *a* concentrations ranged from 9.23 to 110 µg/L during the 2011 growing season. The summer (July-August) average was 65.5 µg/L.

The 2011 chlorophyll *a* concentrations classify each of the Chetek Lakes as a hypereutrophic system, where dense algae limit light and therefore lake productivity. Based on the long term continuous data available (Secchi depths for all lakes, phosphorus and chlorophyll *a* for Prairie Lake), 2011 was one of the most productive years in the Chetek Lakes for the period of record (Figure 11 and Figure 12).

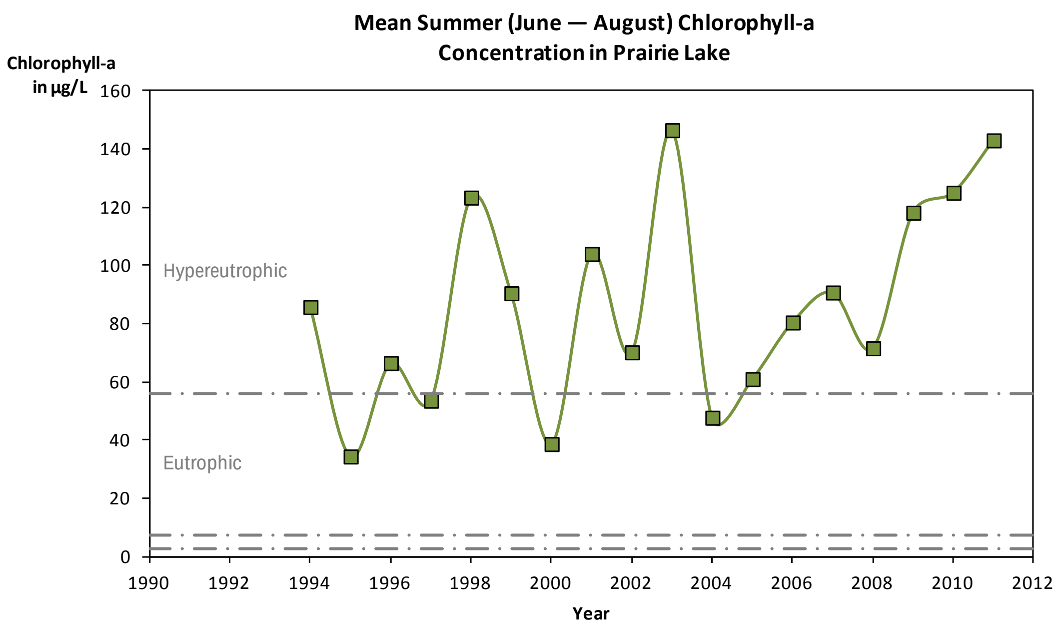


Figure 11 – Mean Summer Chlorophyll-a in Prairie Lake near South End

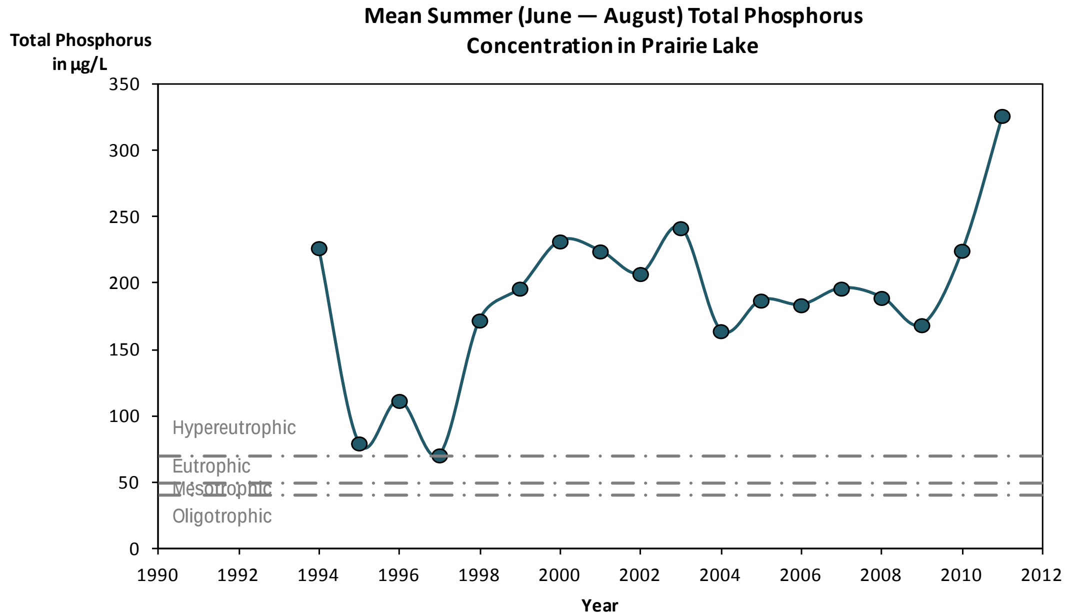


Figure 12 – Mean Summer Total Phosphorus in Prairie Lake Near South End

5.3.5 Water Quality Summary

Overall, there has been little change in the water quality of the Chetek Lakes since consistent data collection began in the late 1980s. Analysis of the water clarity data found a slight significant ($p \leq 0.05$) decreasing trend in water clarity since the late 1980s of about 0.5 inch per year; over the 25 years of data collection, that equates to more than one foot of water clarity lost.

Data collected in the mid 1970s, 1990s and in 2011 all indicate the lakes are eutrophic. The eutrophic nature of the lakes can be attributed to both natural characteristics of the lakes and to human stresses on the system. Water quality generally decreases with an increasing ratio of watershed area to lake area. A lake with a ratio greater than 20:1 is likely to be naturally eutrophic. This is because as the watershed area increase, so do the number of potential sources of runoff and nutrients. The Chetek Lakes have a watershed to lake ratio of 35 to1.

The naturally-occurring nutrient loading (for example, sediment phosphorus release) to the system is compounded by human land use practices such as development and agriculture. Leaking and failing septic systems, agricultural runoff, and pollution provide additional strains on the system to assimilate nutrients. In order to improve water quality now and for the long-term, it is important to identify and remove forward switches in the lakes, like the stagnant water levels, and implement best management practices throughout the watershed.

5.4 Lake Levels

Water level fluctuations are major driving forces for shallow lake ecosystems [2]. A seasonal lowering of the water level can buffer the plant-dominated state or even induce a reverse switch from algal-dominance to a plant-dominated state [12]. It has been recommended that shallow lake managers consider a combined strategy of restoring natural water level fluctuations along with managed biomanipulations [2].

Restoration of natural water level regimes in the Chetek Lakes, which is likely to lead to enhanced water quality and biodiversity, primarily entails expanding the limits between which the water level is allowed to fluctuate annually. Currently, the target summer water level at the dam staff gauge is 96.0 feet and the winter draw down level is 0.3 feet (about 3.5 inches) to a gauge reading of 95.7 feet.

Stage data collected by the City of Chetek shows operation of the Chetek Dam is currently done such that these goals are met and fluctuations of only a few inches over the course of the year are typical (Figure 13). Natural variation in lake stage is also shown in Figure 13. Yellow Lake in Burnett County was selected for comparison as it has similar morphology and a similar sized watershed as the Chetek Lakes. Larger variations in water level have been noted in the Chetek Lakes upstream of major constrictions, for example in Mud Lake upstream of County Road M.

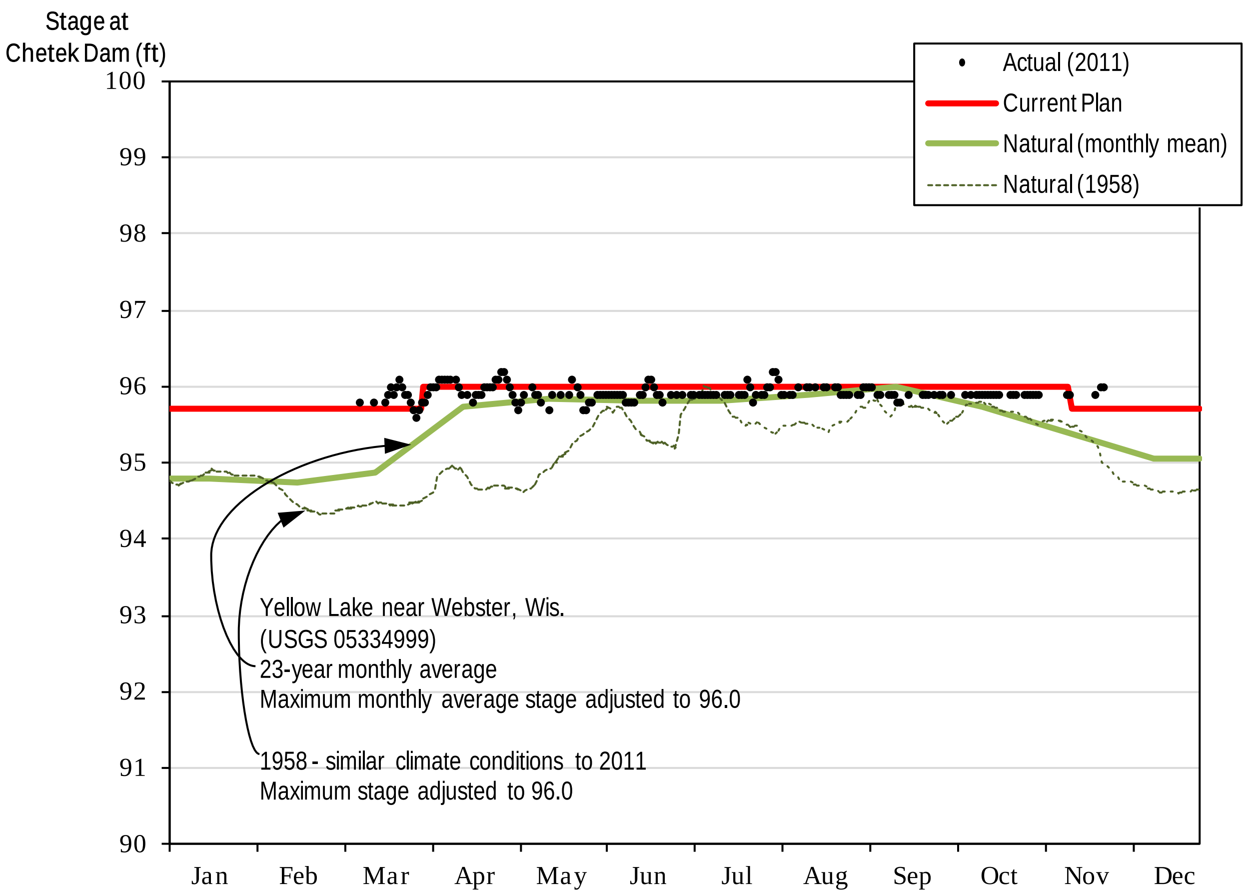


Figure 13 – Water Level Variation at Chetek Dam (2011) compared to Natural Variation

Surface water flow-through lakes like the Chetek Lakes have a 50 percent probability that the annual stage fluctuation will exceed 1.5 feet [13]. Maximum levels are most commonly in May and minimums in March. The high May levels result from storm runoff and increased ground-water discharge carried by the tributaries. The lowest levels occur in late winter when the upland areas are still frozen and inflow is reduced. [13].Dam-controlled lakes often experience a low at this time because they are drawn down in preparation for storage of spring runoff. Surface water flow-through lakes also experience large short-term water level fluctuations following snowmelt or intense storms.

5.5 Aquatic Ecosystems

Aquatic plants are a natural part of most lake communities and provide many benefits to fish, wildlife, and people. Native macrophytes have many important functions and values to a lake ecosystem. They are the primary producers in the aquatic food chain, converting the basic chemical nutrients in the water and soil into plant matter, which becomes food for all other life.

Aquatic plants provide valuable fish and wildlife habitat. More food for fish is produced in areas of aquatic vegetation than in areas where there are no plants. Insect larvae, snails, and freshwater shrimp thrive in plant beds. Panfish eat aquatic plants in addition to aquatic insects and crustaceans. Plants also provide shelter for young fish. Northern pike spawn in marshy and flooded areas in early spring and bass, sunfish, and yellow perch usually nest in areas where vegetation is growing.

Many submerged plants produce seeds and tubers (roots) which are eaten by waterfowl. Bulrushes, sago pondweed, wild celery, and wild rice are especially important duck foods. Submerged plants also provide habitat to a number of insect species and other invertebrates that are, in turn, important foods for brooding hens and migrating waterfowl.

Aquatic plants improve water clarity and water quality. Certain plants, like bulrushes, can absorb and break down polluting chemicals. Nutrients used by aquatic plants for growth are not available to algae, thus reducing algae abundance and improving water clarity. Algae, which thrive on dissolved nutrients, can become a nuisance when too many submerged water plants are destroyed. Aquatic plants also maintain water clarity by preventing the re-suspension of bottom sediments. Aquatic plants, especially rushes and cattails, dampen the force of waves and help prevent shoreline erosion. Submerged aquatic plants also weaken wave action and help stabilize bottom sediment.

Native aquatic plant communities also offer protection from non-native aquatic invasive species. Current scientific literature generally accepts the concept that invasions of exotic plants are encouraged, and in some cases induced, by the disruption of natural plant communities. Curly-leaf pondweed, which is present in the Chetek Lakes, is an opportunistic plant. Much like lawn and agricultural weeds that germinate in newly disturbed soil, curly-leaf pondweed is more likely to invade areas in which the native plant community has been disturbed or removed. Removing the natural competition from native plants may also open up the door to new invasive species and less desirable plant communities.

The lake aesthetic valued by so many is enhanced by the aquatic plant community. The visual appeal of a lakeshore often includes aquatic plants, which are a natural, critical part of a lake community. Plants such as water lilies, arrowhead, and pickerelweed have flowers or leaves that many people enjoy.

As a natural component of lakes, aquatic plants support the economic value of all lake activities. Wisconsin's $13 billion tourism industry is anchored by 15,081 lakes and 12,600 rivers and streams which draw residents and tourists to hunt, fish, camp, and watch wildlife on and around lakes. According to the WDNR, the world class fishery lures more than 1.4 million licensed anglers each year, supports more than 30,000 jobs, generates a $2.75 billion annual economic impact, and $200 million in tax revenues for state and local governments

5.5.1 Wetlands

In Wisconsin, a wetland is defined as an area where water is at, near, or above the land surface long enough to be capable of supporting aquatic or hydrophytic vegetation, and which has soils indicative of wet conditions (Wisconsin Statue 23.32(1)). Wetlands contain a unique combination of terrestrial and aquatic life and physical and chemical processes. Wetlands are protected under the Clean Water Act and state law and in some places by local regulations or ordinances. Landowners and developers are required to avoid wetlands with their projects whenever possible; if the wetlands can't be avoided, they must seek the appropriate permits to allow them to impact wetlands (for example, fill, drain or disturb soils).

According to the National Wetland Inventory, emergent, forested/shrub and aquatic bed (lake and freshwater pond) wetlands are present in the Chetek Lakes watershed. A number of these wetlands border the lakes and tributary streams or have a direct hydrologic connection to the lakes (Figure 1). Emergent wetlands are wetlands with saturated soil and are dominated by grasses such as redtop and reed canary grass, and by forbs such as giant goldenrod. Forested/shrub wetlands are wetlands dominated by mature conifers and lowland hardwood trees. Forested/shrub wetlands are the dominant form of wetlands in the watershed and are important for stormwater and floodwater retention and provide habitat for various wildlife. Aquatic bed wetlands are wetlands characterized by plants growing entirely on or within a water body that is no more than six feet deep.

Wetlands serve many functions that benefit the ecosystem surrounding the Chetek Lakes. Wetlands support a great variety of native plants and are more likely to support regionally scarce plants and plant communities. Wetlands provide fish and wildlife habitat for feeding, breeding, resting, nesting, escape cover, travel corridors, spawning grounds for fish, and nurseries for mammals and waterfowl. Contrary to popular belief, healthy wetlands reduce mosquito populations; natural enemies of mosquitoes (dragonflies, damselflies, backswimmers, and predacious diving beetles) need proper habitat (that is, healthy wetlands) to survive.

Wetlands provide flood protection within the landscape by retaining stormwater from rain and melting snow and capturing floodwater from rising streams. This flood protection minimizes impacts to downstream areas. Wetlands provide groundwater recharge and discharge by allowing the surface water to move into and out of the groundwater system. The filtering capacity of wetland plants and substrates help protect groundwater quality. Wetlands can also stabilize and maintain stream flows, especially during dry months.

Wetland plants and soils provide water quality protection by storing and filtering pollutants ranging from pesticides to animal wastes. Wetlands also provide shoreline protection by acting as buffers between the land and water. Wetland plants protect against erosion by absorbing the force of waves and currents and by anchoring sediments. This is important in waterways such as the Chetek Lakes where high boat traffic, water currents, and wave action may cause substantial damage to the shore.

Although some small (two acres or less) wetlands may not appear to provide significant functional values when assessed individually, they may be very important components of a larger natural system. Not only do small wetlands provide habitat functions, they also store phosphorus and nitrogen and trap pollutants such as heavy metals and pesticides. Draining these small wetlands, which often do not appear on maps, not only requires the proper permits, but can also release the once-stored pollutants and nutrients into lakes and streams.

5.5.2 Critical Habitat

Every body of water has areas of aquatic vegetation or other features that offer critical or unique aquatic plant, fish and wildlife habitat. Such areas can be mapped by the WDNR and designated as Critical Habitat. Critical Habitat areas include important fish and wildlife habitat, natural shorelines, physical features important for water quality (for example, springs) and navigation thoroughfares. These areas, which can be located within or adjacent to the lake, are selected because they are particularly valuable to the ecosystem or would be significantly and negatively impacted by most human induced disturbances or development. Critical Habitat areas include both Sensitive Areas and Public Rights Features. Sensitive Areas offer critical or unique fish and wildlife habitat, are important for seasonal or life-stage requirements of various animals, or offer water quality or erosion control benefits.

The WDNR completed critical habitat data collection on the Chetek Lakes in the mid-2000s but have not determined critical habitat areas. Proposed critical aquatic plant, coarse woody debris, and coarse rock/rubble spawning habitat are included in Appendix C. Management restrictions to protect these areas during plant management operations are included in this plan. In some cases, short-term disruptions to habitat during the removal of monotypic stands of aquatic invasive species such as curly-leaf pondweed may lead to positive long-term improvements to the habitat of the lake. Disruptions to the areas of critical habitat may also be warranted when responding to the discovery of a new invasive species.

5.5.3 Fishery

The main fish species in the Chetek Lakes include walleye, black crappie, bluegill, northern pike, largemouth bass. Other fish that have been documented include smallmouth bass, yellow perch, pumpkinseed, black bullheads, yellow bullheads, warmouth, bowfin, white suckers, golden shiners, common shiners, trout perch, bluntnose minnows, Darter minnows, central mud minnows, log perch, and hornyhead chubs. Fish stocking has occurred in the lake since 1933 with walleye being the primary focus of stocking efforts. Walleye stocking efforts were increased in the 1970s and beginning in the 1980s stocking was done on alternate years at a rate of about 35 walleye fingerlings per acre.

The last comprehensive fisheries study was conducted in 2001 and was limited to Prairie Lake and Pokegama Lake due to the extensive amount of shoreline in the system and a limited fisheries crew. A comprehensive study is anticipated to be completed on the entire chain in the spring of 2012, contingent on funding and fisheries personal availability. Results from this study will be available from the WDNR sometime late in 2012 or early 2013.

Each year a locally-led, season-long fishing contest called “Fish-O-Rama” is held to help determine the exploitation rate of the local panfish population. Before the gamefish season opens, volunteer anglers catch panfish (targeting larger fish), attach floy tags (small, spaghetti-like tags that do not affect the fish), and release them to be caught by other anglers from the gamefish opener to mid-October. The prizes for harvesting a tagged fish range from $25-500. In 2001, tagged fished exploitation was at 43%, and in the past has ranged anywhere from 31%-56%, with a mean average of 40% of the fish harvested each year.

To increase walleye spawning and deep-water habitat, two man-made rock reefs have been placed in Prairie Lake, one on the north shore of Burnham's Island and another along the eastern shore of the lake. The Burnham's Island reef was constructed in 1995 to increase spawning habitat. It is made up of about 120 cubic yards of field rock, varying from 2-8 inches in diameter, spread over an area 250 feet long and 15-20 feet wide. The rock was placed on the ice in winter and allowed to fall to the bottom during the spring melt. The eastern shore reef was constructed similarly in 2009 by a partnership between Walleyes for Tomorrow and the CLPA. This deep-water habitat reef is about 70 feet long and located in about 12 feet of water with arms extending out to water about 14 feet deep. Another ongoing fishery improvement project has been the installation of hundreds of fish cribs (constructed from wooden pallets) throughout the chain of lakes.

5.5.4 Rare and Endangered Species

The Wisconsin Natural Heritage Inventory (NHI) program is part of an international network of programs that focus on rare plants and animals, natural communities, and other rare elements of nature. Each species has a state status including Special Concern (SC), Threatened (THR) or Endangered (END). Species are listed by township: Prairie Lake is in the Townships of Stanley (T34N, R11W), Prairie Lake (T33N, R11W), and Chetek (T33N, R10W); Ojaski, Pojegama, Chetek and Tenmile Lakes are in the Township of Chetek (T33N, R10W) with Tenmile Lake extending to the Township of Dovre (T32N, R10W).

No endangered species are listed for these Townships, but a number threatened and special concern species are present (Table 4). Descriptions of these species can be found at http://dnr.wi.gov/topic/EndangeredResources/biodiversity.html/ (last accessed 2012-05-10). The 2011 aquatic plant survey of the lakes found no additional federally listed plant species. It is important for lake management to consider impacts to these valuable species, nearly all of which can be directly affected by aquatic plant management. Choosing the proper management techniques and the proper timing of management activities can greatly reduce or prevent negative impacts.

Table 4
Natural Heritage Inventory Listing for the Chetek Lakes

Scientific Name	Common Name	State Status	Group Name	Stanley T34N R11W	Prairie Lake T33N R11W	Chetek T33N R10W	Dovre T32N R10W
Alasmidonta marginata	Elktoe	SC/P	Mussel	X	X		
Artemisia dracunculus	Dragon wormwood	SC	Plant		X		
Asclepias ovalifolia	Dwarf milkweed	THR	Plant		X		
Canis lupis	Gray Wolf	SC/FL	Mammal	X		X	
Ehteostoma microperca	Least darter	SC/N	Fish				X
Haliaeetus leucocephalus	Bald eagle	SC/P	Bird	X	X	X	X
Moxostoma valenciennesi	Greater redhorse	THR	Fish	X	X		
Ophiogomphus howei	Pygmy snaketail	THR	Dragonfly	X			
Pleurobema sintoxia	Round pigtoe	SC/P	Mussel	X	X		

THR, threatened; SC, special concern; /FL, federally protected as endangered or threatened
/P, fully protected; /N, no laws regulating use, possession or harvest.
Data current as of 2009-10-06

The Natural Heritage Inventory Program tracks examples of all types of Wisconsin's natural communities that are deemed significant because of their undisturbed condition, size, what occurs around them, or for other reasons. Natural communities listed for the Townships include: alder thicket, emergent marsh, northern sedge meadow, lake—shallow soft drainage, northern wet forest, dry mesic prairie, and open bog. Full descriptions of these communities including current threats can be found on the WDNR website at: http://dnr.wi.gov/topic/endangeredresources/communities.asp (last accessed 2012-05-10).

6.0 Aquatic Plant Communities

Aquatic plants play an important role in lakes. They anchor sediments, buffer wave action, oxygenate water, and provide valuable habitat for aquatic animals. The amount and type of plants in a lake can greatly affect nutrient cycling, water clarity, and food web interactions. Furthermore, plants are very important for fish reproduction, survival, and growth, and can greatly impact the type and size of fish in a lake.

Unfortunately, healthy aquatic plant communities are often degraded by poor water clarity, excessive plant control activities, and the invasion on non-native nuisance plants [14]. These disruptive forces alter the diversity and abundance of aquatic plants in lakes and can lead to undesirable changes in many other aspects of a lake's ecology (Figure 14). Consequently, it is very important that lake managers find a balance between controlling nuisance plant growth and maintaining a healthy, diverse plant community.

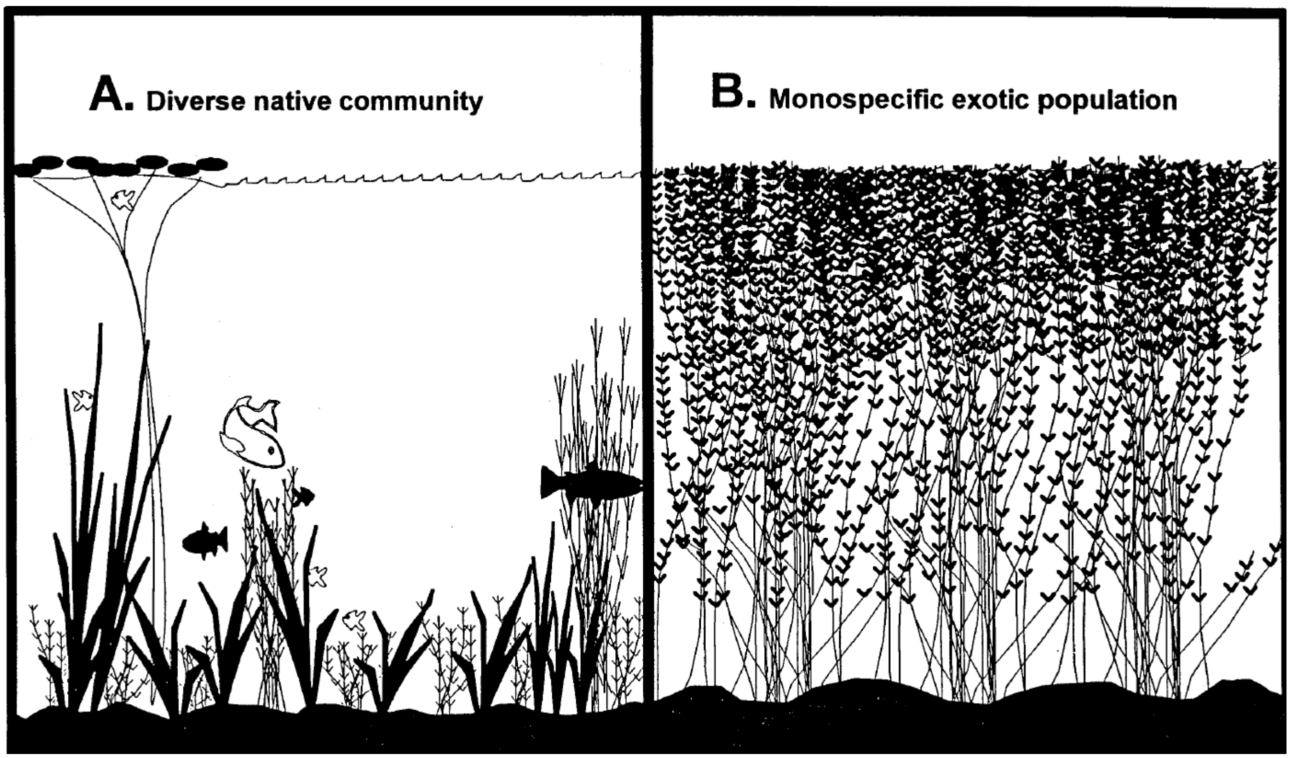


Figure 14 – Submersed Aquatic Plant Communities

6.1 Aquatic Plant Surveys in the Chetek Lakes

Surveys of the plant communities in the lakes were completed on three different occasions. The first evaluation was done by the WDNR in August of 1997, the second by the Beaver Creek Reserve (Fall Creek, Wis.) in 2009 during a five-county invasive species study, and the third by Endangered Resources Services, LLC (ERS) (St. Croix Falls, Wis.) in 2011. In each of the surveys, all five lakes in the system were found supporting diverse native aquatic plant communities rated as average or slightly above average for the region; however the plants had a relatively limited distribution. The 2011 ERS investigations (the most recent and extensive plant surveys) were used to develop this plan and are discussed in more detail below.

ERS conducted two lake-wide plant surveys on each of the five lakes in 2011. The first investigation was an early-season curly-leaf distribution and bed mapping survey completed in late May and the second a whole-lake point intercept survey in July. The surveys provide detailed statistical assessments of the aquatic plant communities in the Chetek Lakes and establish a baseline for evaluating any changes in the plant community over the coming years which will help guide responsible aquatic plant management planning. A detailed report was written for each lake by ERS and distributed to project partners in early 2012.

The point intercept surveys were completed following standardized WDNR methods. A sample point grid was generated for each lake by WDNR personnel using a standard formula that accounts for lake morphology (size, depth, shape) and water clarity. For the Chetek Lakes, this amounted to over 3,200 sample points with the distance between sample points ranging from 83 meters in Prairie Lake to 45 meters in Tenmile Lake (Table 5). Mud (Ojaski) Lake and Tenmile Lake had the highest occurrence of aquatic plants with 67% of littoral zone sites vegetated. The other lakes were moderately vegetated; in Chetek Lake, 53% of the littoral zone sample points were vegetated, Pokegama Lake had 43%, and Prairie Lake had 37%.

Table 5
Chetek Lakes Point Intercept Sample Sites

Lake	Sample points	Point-intercept resolution (m)
Prairie	833	83
Mud	570	48
Pokegama	640	56
Chetek	697	73
Tenmile	529	45
TOTAL	**3,269**	

The littoral zone (maximum depth of plant growth) decreased in the lakes as the growing season progressed (Table 6 and Figure 15). This is attributed to the increase in algae growth which decreases light penetration and limits plant growth. The average summer littoral zone depth in the lakes of about 7 feet is half that of other nearby impoundments with clearer water. The Red Cedar Lakes, for example, have a summer littoral zone to depths up to 15 feet.

Table 6
Littoral Zone Depth and Species Richness & Diversity in Chetek Lakes, 2011

Lake	Max. Depth of Rooted Plants (feet)		No. Species Present[1]	Simpsons Diversity Index
	May	July		
Prairie	9.5	7.5	26	0.82
Ojaski	7.5	6.0	39	0.90
Pokegama	7.5	7.5	24	0.83
Chetek	9.0	6.5	26	0.91
Tenmile	9.0	7.0	34	0.89

[1] Includes visuals and boat survey.

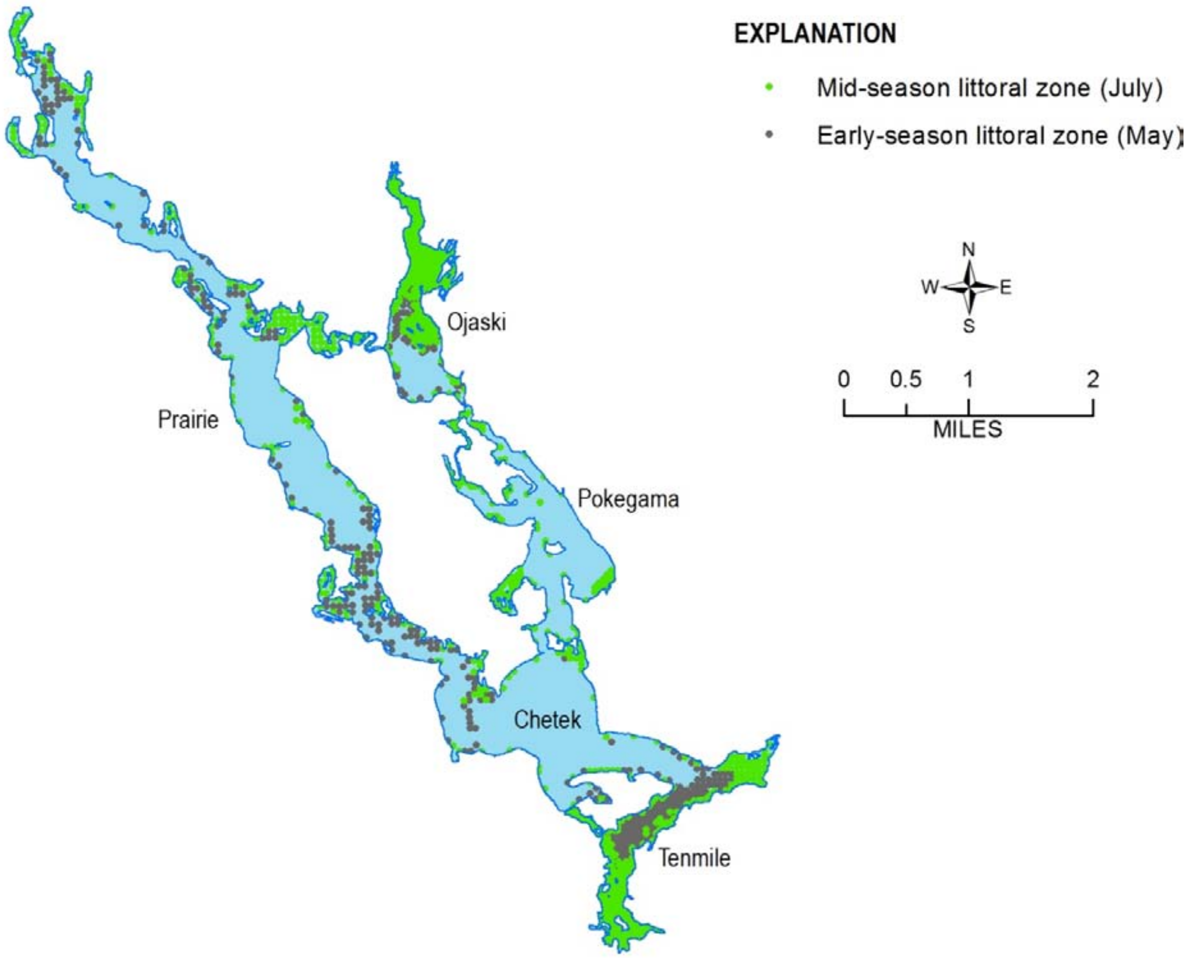


Figure 15 – Seasonal Variation in the Chetek Lakes Littoral Zone

The point intercept surveys found a total of 51 aquatic plant species (not including filamentous algae and aquatic moss) in the Chetek Lakes with 16 species common to all five lakes (Table 7). Small duckweed, large duckweed, and coontail were in the top five most frequently encountered plants in the littoral zone of each lake. As free floating (duckweeds) and lacking roots (coontail), these plants must absorb nutrients from the surrounding water and therefore grow best in high-nutrient lakes.

The non-native invasive species curly-leaf pondweed was found in all lakes during the early season survey. Reed canary grass and narrow-leaved cattail are invasive species found in the shallow margins of the lakes which can form dense stands that displace all other species from wetlands.

The Simpson's Diversity Index is used to quantify biodiversity. The value of the index increases as both the number of species and the evenness of species distribution increases. The Simpson's Diversity Index for each of the Chetek Lakes indicates that plant species are relatively evenly distributed in areas of the littoral zone with plants. The index is interpreted as the probability that two plants taken at random from a lake will be different. For example, there is an 82% chance that two randomly selected plants in Prairie Lake will be different (or an 18% chance that they will be the same).

Table 7
Aquatic Plant Species Found in the Chetek Lakes

Scientific Name	Common Name	Chetek	Ojaski	Pokegama	Prairie	Tenmile
Calla palustris	Wild calla		O	O	X	X
Callitriche hermaphroditica	Autumnal water-starwort		X			
Carex comosa	Bottle brush sedge		O	O	X	
Ceratophyllum demersum	Coontail	X	X	X	X	X
Comarum palustre	Marsh cinquefoil		O			
Decodon verticillatus	Swamp loosestrife				X	
Dulichium arundinaceum	Three-way sedge		O	X		
Eleocharis acicularis	Needle spikerush			X	X	
Eleocharis erythropoda	Bald spikerush		X	X		X
Eleocharis intermedia	Matted spikerush				O	
Elodea canadensis	Common waterweed	X	X	X	X	X
Heteranthera dubia	Water star-grass	X	X		X	X
Juncus effusus	Common rush		O			
Leersia oryzoides	Rice cut-grass				O	
Lemna minor	Small duckweed	X	X	X	X	X
Lemna trisulca	Forked duckweed		X			X
Myriophyllum sibiricum	Northern water milfoil	X	O			
Myriophyllum verticillatum	Whorled water-milfoil					X
Najas flexilis	Slender naiad	X	X			X
Nitella sp.	Nitella	X	X			X
Nuphar variegata	Spatterdock	X	X	X	X	X
Nymphaea odorata	White water lily	X	X	X	X	X
Phalaris arundinacea	Reed canary grass	O	X	O	O	O
Potamogeton amplifolius	Large-leaf pondweed	X	X	O	O	X
Potamogeton crispus	Curly-leaf pondweed	X	X	X	X	X
Potamogeton epihydrus	Ribbon-leaf pondweed		X			X
Potamogeton friesii	Fries' pondweed					X
Potamogeton natans	Floating-leaf pondweed		X			
Potamogeton nodosus	Long-leaf pondweed	X	X		O	X
Potamogeton obtusifolius	Blunt-leaf pondweed					X
Potamogeton pusillus	Small pondweed	X	X	X		X
Potamogeton richardsonii	Clasping-leaf pondweed	X		X	X	X
Potamogeton robbinsii	Fern pondweed	X	X	X	X	X
Potamogeton spirillus	Spiral-fruited pondweed	X				
Potamogeton strictifolius	Stiff pondweed	O	X			X
Potamogeton zosteriformis	Flat-stem pondweed	X	X	X		X
Ranunculus aquatilis	White water crowfoot		O			
Sagittaria cristata	Crested arrowhead			X		
Sagittaria latifolia	Common arrowhead	X	O		O	O
Sagittaria rigida	Sessile-fruited arrowhead	X	X	X	X	X
Schoenoplectus tabernaemontani	Softstem bulrush	O	X		O	O
Sparganium americanum	American bur-reed		X			
Sparganium eurycarpum	Common bur-reed	X	X	X	X	X
Spirodela polyrhiza	Large duckweed	X	X	X	X	X
Typha angustifolia	Narrow-leaved cattail		O			
Typha latifolia	Broad-leaved cattail	O	X	O	O	O
Utricularia vulgaris	Common bladderwort		X	X		X
Vallisneria americana	Wild celery	X	X	O	X	X
Wolffia columbiana	Common watermeal	X	X	X	X	X
Zizania palustris	Northern wild rice					X
	Filamentous algae	X	X	X	X	X
	Aquatic moss					X

X, sample collected; O, visually observed.

The mean Coefficient of Conservatism (C) and the Floristic Quality Index (FQI) are two measures of aquatic plant community health determined from the plant survey results. Together these metrics form the basis of a Floristic Quality Assessment. C values range from 0 to 10, with higher values assigned to plant species that only thrive in pristine, undisturbed environments and are very susceptible to human disturbances that degrade water quality and overall lake health. These plants disappear from the community if disturbance is too great. Lower C-value species generally do well is a multitude of conditions including pristine and degraded environments. Many of these species remain in a lake even under severely degraded conditions and sometimes cause growth and density related issues themselves. The FQI is the mean C times the square root of the total number of native species; this formula combines the conservatism of the species present with a measure of the species richness of the site.

The FQA indicates that the health and quality of the native aquatic plant community in the Chetek Lakes is similar to other impoundments in the Northern Lakes and Forests ecoregion (Figure 16). All mean C values were close to the statewide and ecoregion median values (note: the conceptual difference between a C value of 0 and a value of 1, or between 9 and 10, is slight, while the difference between a value of 0 and a value of 3 is more distinct). The FQI values for all of the Chetek Lakes were above the statewide average of 22.2, but only Mud Lake (32.0) and Tenmile Lake (33.4) had values above the ecoregion median FQI of 28.3 for impoundments [15].

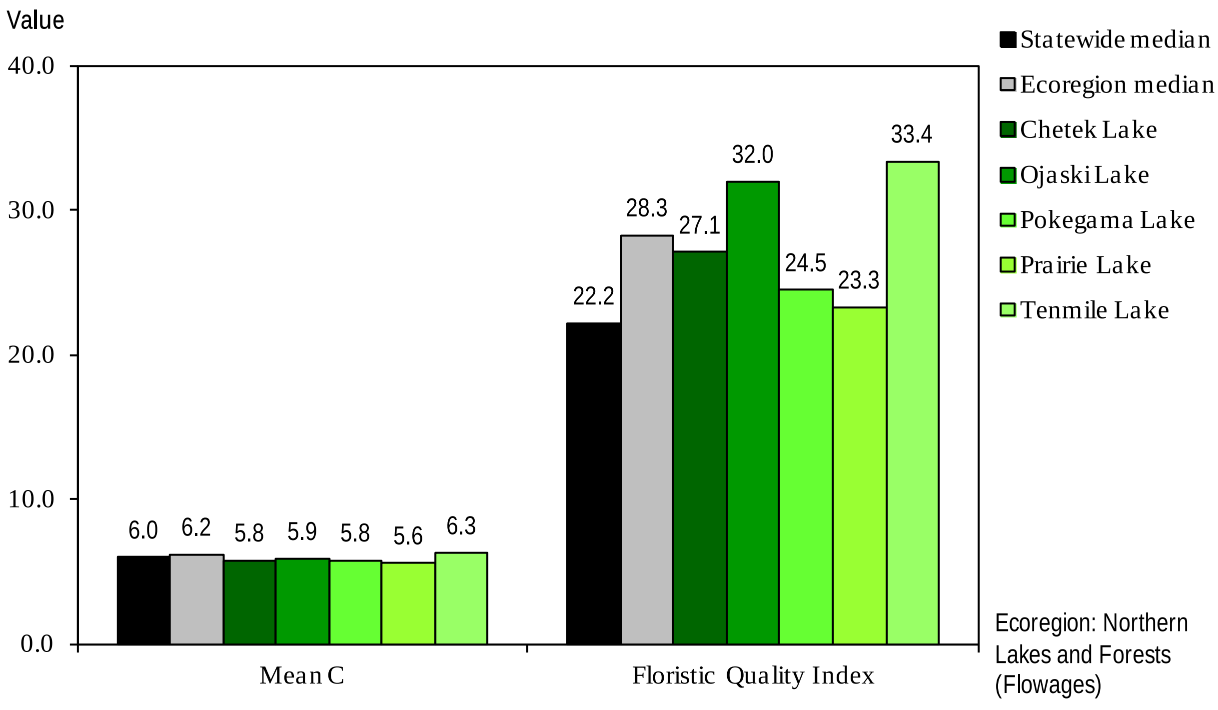


Figure 16 – Floristic Quality Assessment for the Chetek Lakes, 2011

6.2 Chetek Lake

During the July survey, there were macrophytes found growing at 52 sample points which extrapolated to approximately 7.5% of the entire lake and in 53.1% of the littoral zone (Figure 17). Overall aquatic plant diversity was high with a Simpson Diversity Index value of 0.91. Species richness, however, was quite low for such a large lake with only 26 total species found growing in and immediately adjacent to the water.

The mean and median depths of plant growth were both shallow at 3.6 ft and 3.5 ft respectively. In general, species richness, diversity, and total rake biomass declined rapidly at depths greater than 3 feet. Of the 27 species found growing in and immediately adjacent to the lake, small duckweed, large duckweed, coontail, and curly-leaf pondweed were the most common macrophytes being found at 55.8%, 55.8%, 40.4%, and 40.4% of survey points with vegetation, respectively. Other than curly-leaf, reed canary grass was the only other non-native species found. Reed canary grass was well established in undeveloped lowland areas around the perimeter of the lake.

Almost all of the plants growing in the lake were located in the shallow, organic muck bottom bay at the Moose Ear Creek inlet. Relatively high water clarity due to inflow from the creek likely accounts for the relatively rich plant community in the bay. Notable species found growing here and nowhere else on the lake included common elodea , fern pondweed, flat-stem pondweed, large-leaf pondweed, long-leaf pondweed, stiff pondweed , spiral-fruited pondweed, and northern water milfoil. These submergent species coupled with floating-leaved species like white water lily and spatterdock provided fish and other aquatic life with the best macrophyte habitat in the entire lake.

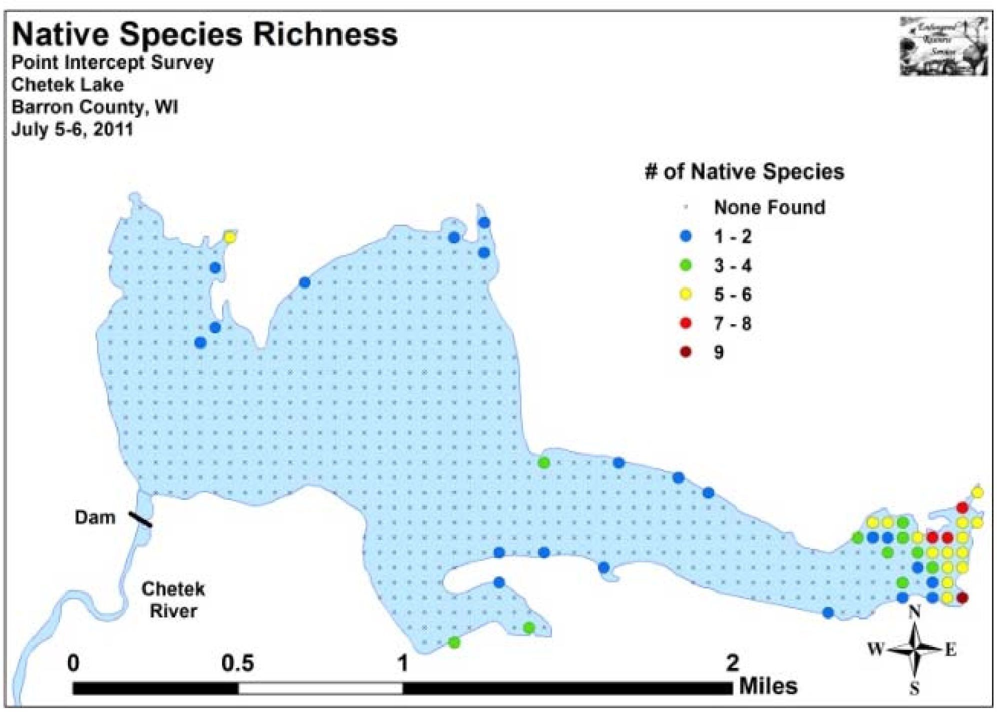


Figure 17 – Native Species Richness in Chetek Lake, July 2011

6.3 Mud (Ojaski) Lake

During the July survey, there were macrophytes growing at 203 sites or approximately 36% of the entire lake and in 67% of the littoral zone (Figure 18). Overall aquatic plant diversity was high with a Simpson Diversity Index value of 0.90.

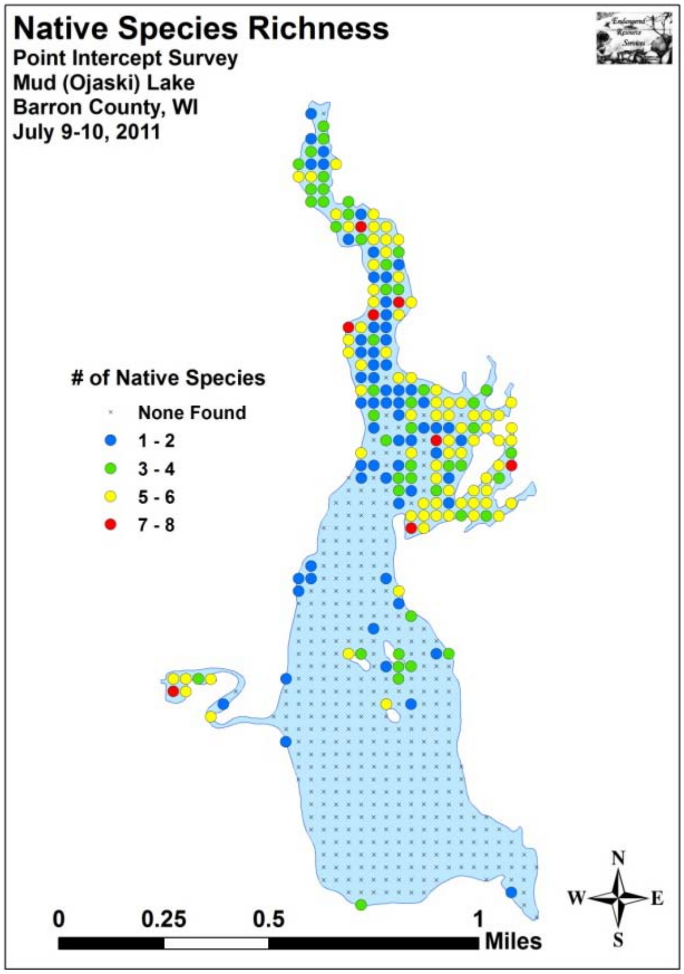


Figure 18 – Native Species Richness in Mud (Ojaski) Lake, July 2011

The mean and median depths of plant growth were both quite shallow at 3.0ft. In general, species richness, diversity and total rake biomass declined rapidly at depths greater than 3ft of water Of the 39 species found growing in and immediately adjacent to the lake, small duckweed , large duckweed, common watermeal, and coontail were the most common macrophytes being found at 56.7%, 56.2%, 46.3%, and 39.4% of survey points with vegetation, respectively. Other than curly-leaf, reed canary grass was the only other exotic species found. Reed canary grass was well established in undeveloped lowland areas around the perimeter of the lake

The shallow organic muck areas of the northeast bay supported the densest submergent and floating plant beds in the lake. The relatively clear waters in the bay provided habitat for high quality species such as fern pondweed, flat-stem pondweed, large-leaf pondweed, floating-leaf pondweed, small pondweed, spatterdock, white water lily, and common bladderwort.

6.4 Pokegama Lake

During the July survey, there were macrophytes growing in approximately 8% of the whole lake and in 43% of the littoral zone (Figure 19). Overall diversity was moderate with a Simpson Diversity Index value of 0.83. Species richness, however, was quite low for such a large lake with only 23 total species found growing in and immediately adjacent to the water.

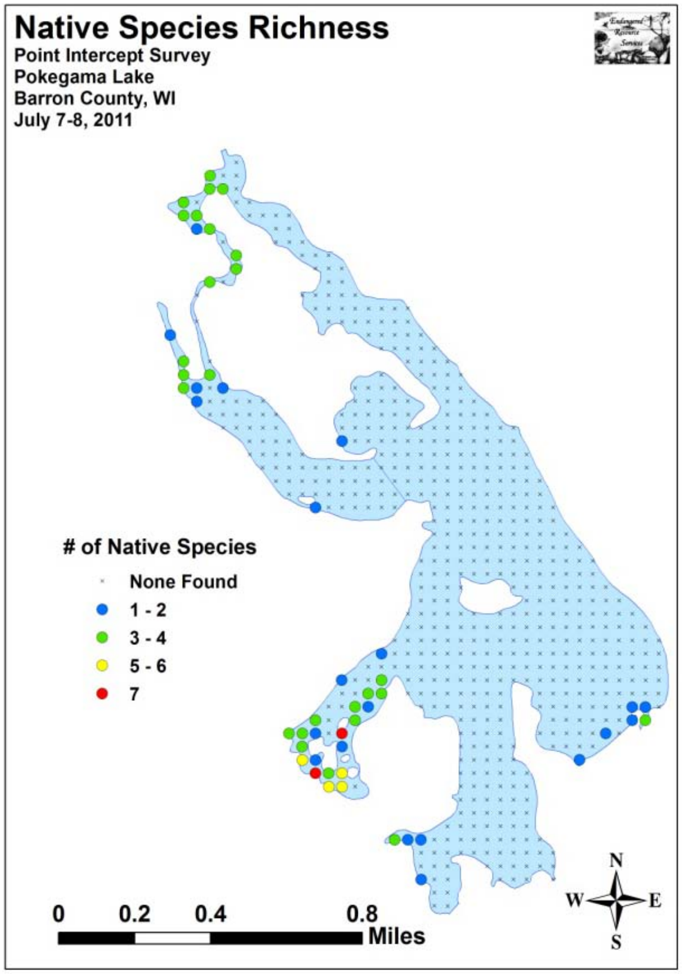


Figure 19 – Native Species Richness in Pokegama Lake, July 2011

The mean and median depths of plant growth were both shallow at 3.6 feet and 3.5 feet, respectively. In general, species richness, diversity and total rake biomass declined rapidly in water depths greater than 4 feet. Of the 23 species found growing in and immediately adjacent to the lake, white water lily, small duckweed , large duckweed, and coontail were the most common macrophytes being found at 79.3%, 60.4%, 58.5%, and 20.8% of survey points with vegetation, respectively. Other than curly-leaf, Reed canary grass was the only other exotic species found. Reed canary grass was well established in undeveloped lowland areas around the perimeter of the lake.

In most lakes, shallow organic muck areas have the densest plant beds. However, in Pokegama, the shallow organic muck bottom areas in the lake's northwest channel and in the northwest end of Pike Slough had few macrophytes as white water lily and the duckweeds made up the vast majority of the plant community. The only exception in the lake was near the spring holes in the south end of Six Lakes Bay. The clear waters in the bay supported a rich community that included many high quality species such as fern pondweed, flat-stem pondweed, large-leaf pondweed, spatterdock, and common bladderwort. These dense submergent and floating plant beds provided the best macrophyte habitat in the entire lake.

6.5 Prairie Lake

During the July survey, there were macrophytes growing at 73 sample points which extrapolated to approximately 9% of the entire lake and in 37% of the littoral zone (Figure 20). Overall diversity was moderate with a Simpson Diversity Index value of 0.82. Species richness was low for such a large lake with only 26 total species found growing in and immediately adjacent to the water.

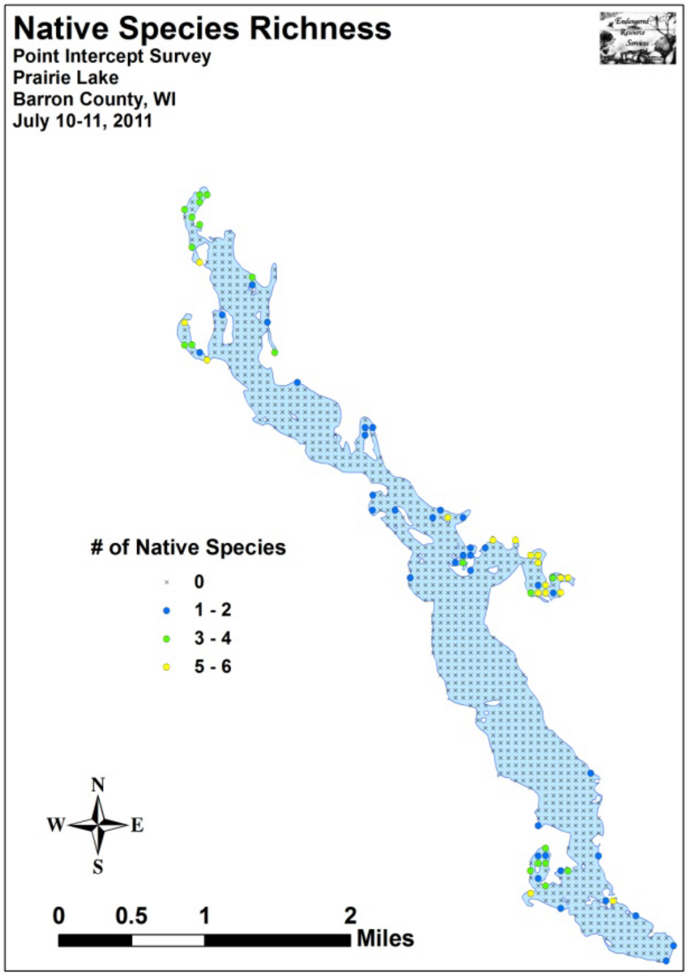


Figure 20 – Native Species Richness in Prairie Lake, July 2011

The mean and median depths of plant growth were both shallow at 3.5 feet. In general, species richness, diversity and total rake biomass declined rapidly at depths greater than 4 feet. Of the 26 species found growing in and immediately adjacent to the lake, white water lily, small duckweed, large duckweed, and common watermeal were the most common macrophytes being found at 79.5%, 52.1%, 49.3%, and 46.6% of survey points with vegetation, respectively. Other than curly-leaf, reed canary grass was the only other exotic species found. Reed canary grass was well established in undeveloped lowland areas around the perimeter of the lake.

In Prairie Lake, shallow organic muck areas were dominated by nearly monotypic stands of curly-leaf pondweed early in the growing season. In other lakes, these areas generally have the densest and richest native plant beds. After curly-leaf senesced in June, little grew back to take its place. Other than the duckweeds and scattered patches of coontail, white water lily, spatterdock, and common elodea, these areas were essentially devoid of plants by early July. Plants were also nearly completely absent from the narrow sandy/rocky bottom margins of the lake.

6.6 Tenmile Lake

During the July survey, there were macrophytes growing at 210 sample points which extrapolated to approximately 40% of the entire lake and in 67% of the littoral zone (Figure 21). Overall diversity was moderately high with a Simpson Diversity Index value of 0.89.

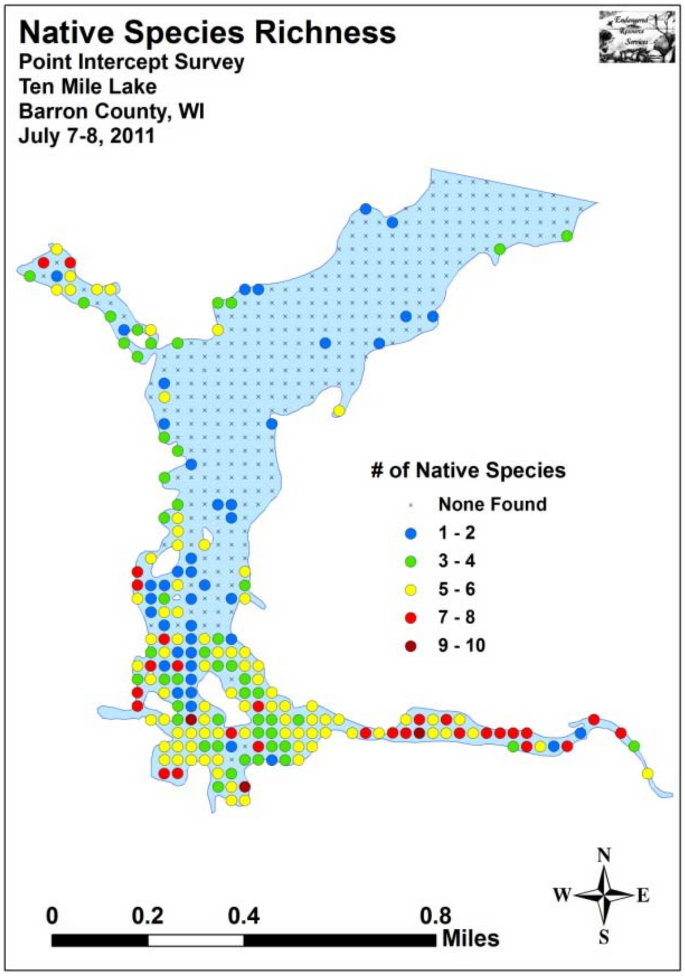


Figure 21 – Native Species Richness in Tenmile Lake, July 2011

The mean and median depths of plant growth were both quite shallow at 3.3 feet. In general, species richness, diversity and total rake biomass declined rapidly at depths greater than 4 feet and little to no plant growth deeper than 5 feet for much of the lake. Of the 34 species found growing in and immediately adjacent to the lake, small duckweed, large duckweed, common watermeal, and coontail were the most common macrophytes being found at 76.2%, 72.9%, 72.4%, and 58.1% of survey points with vegetation, respectively. Other than curly-leaf pondweed, reed canary grass was the only other exotic species found. Reed canary grass was well established in undeveloped lowland areas around the perimeter of the lake

The densest plant beds were found in shallow, organic muck areas of the lake. Throughout the south bays, coontail, white water lily, and the duckweeds were abundant. High quality native species such as fern pondweed, flat-stem pondweed, large-leaf pondweed, spatterdock, small pondweed, and blunt-leaf pondweed provided the best macrophyte habitat in the entire lake. Many of these high quality species including wild rice were largely restricted to the south bays and the Tenmile Creek inlet.

7.0 Wild Rice (*Zizania palustris*)

During the 2011 aquatic plant surveys, wild rice was found only in Tenmile Lake, specifically in the narrows of the Tenmile Creek inlet (Figure 22). According to the Great Lakes Indian Fish and Wildlife Commission (GLIFWC), there have been wild rice harvests on Lake Chetek. When present in a lake, wild rice is afforded numerous protections due to its ecological and cultural significance and management is therefore focused on harvest goals and protection of the resource rather than removal. Any activity included in a comprehensive lake or aquatic plant management plan that could potentially impact the growth of wild rice in any body of water that has in the past, currently has, or potentially could have wild rice in the future requires consultation with the Tribal Nations. This consultation is usually completed by the WDNR in cooperation with GLIFWC during their review of lake management documents.

Wild rice is an annual aquatic grass that produces seed that is a nutritious source of food for wildlife and people. As a native food crop, it has a tremendous amount of cultural significance to the Wisconsin and Minnesota Native American Nations. Wild rice pulls large amounts of nutrients from the sediment in a single year and the stalks provide a place for filamentous algae and other small macrophytes to attach and grow. These small macrophytes pull phosphorous in its dissolved state directly from the water. Wild rice can benefit water quality, provide habitat for wildlife, and help minimize substrate re-suspension and shoreland erosion.

In Wisconsin, wild rice has historically ranged throughout the state. Declines in historic wild rice beds have occurred statewide due to many factors, including dams, pollution, large boat wakes, and invasive plant and animal species. Renewed interest in the wild rice community has led to large-scale restoration efforts to reintroduce wild rice in Wisconsin's landscape. Extensive information is available on wild rice from GLIFWC and the WDNR.

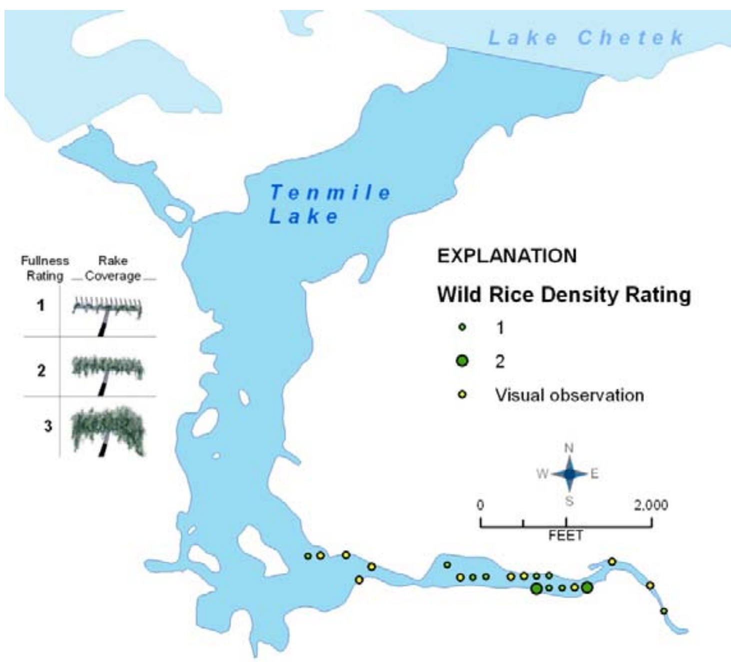


Figure 22 – Distribution of Wild Rice in Tenmile Lake, 2011

8.0 Non-native Aquatic Invasive Species Present in the Lakes

Curly-leaf pondweed, purple loosestrife, Japanese knotweed, banded mystery snail, and Chinese mystery snail, have been documented in the Chetek Lakes. Of these, CLP has the potential to be the most problematic for lake users. Purple loosestrife is being effectively managed in the lakes through the use of physical removal and biological control. There have been no management efforts directed at reed canary grass. Mystery snails are not being managed. The CLPA is currently involved in aquatic invasive species monitoring and water craft inspection aimed at preventing the introduction of other AIS in cooperation with WDNR and UW-Extension Lakes programs. These programs will continue into the foreseeable future.

8.1 Curly-leaf Pondweed

Curly-leaf pondweed is an invasive aquatic perennial that is native to Eurasia, Africa, and Australia. It was introduced to United States waters in the mid-1880s by hobbyists who used it as an aquarium plant and has been documented throughout the U.S. The leaves are reddish-green, oblong, and about 3 inches long, with distinct wavy edges that are finely toothed (Figure 23). The stem of the plant is flat, reddish-brown and grows from 1 to 3 feet long. Curly-leaf is commonly found in alkaline and high nutrient waters, preferring soft substrate and shallow water depths. It tolerates low light and low water temperatures.

Figure 23 – Curly-leaf Pondweed

Curly-leaf pondweed spreads through burr-like winter buds called turions (Figure 24). 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 one of the first nuisance aquatic plants to emerge in the spring, often starting to grow late in the fall and staying green under the ice. Growth is accelerated in spring when light and temperature conditions are best suited for growth. Turions begin to grow in June and by late June and early July, the warm water conditions cause curl-leaf to senesce, dropping turions to the sediment while the rest of the plant decays (Figure 24).

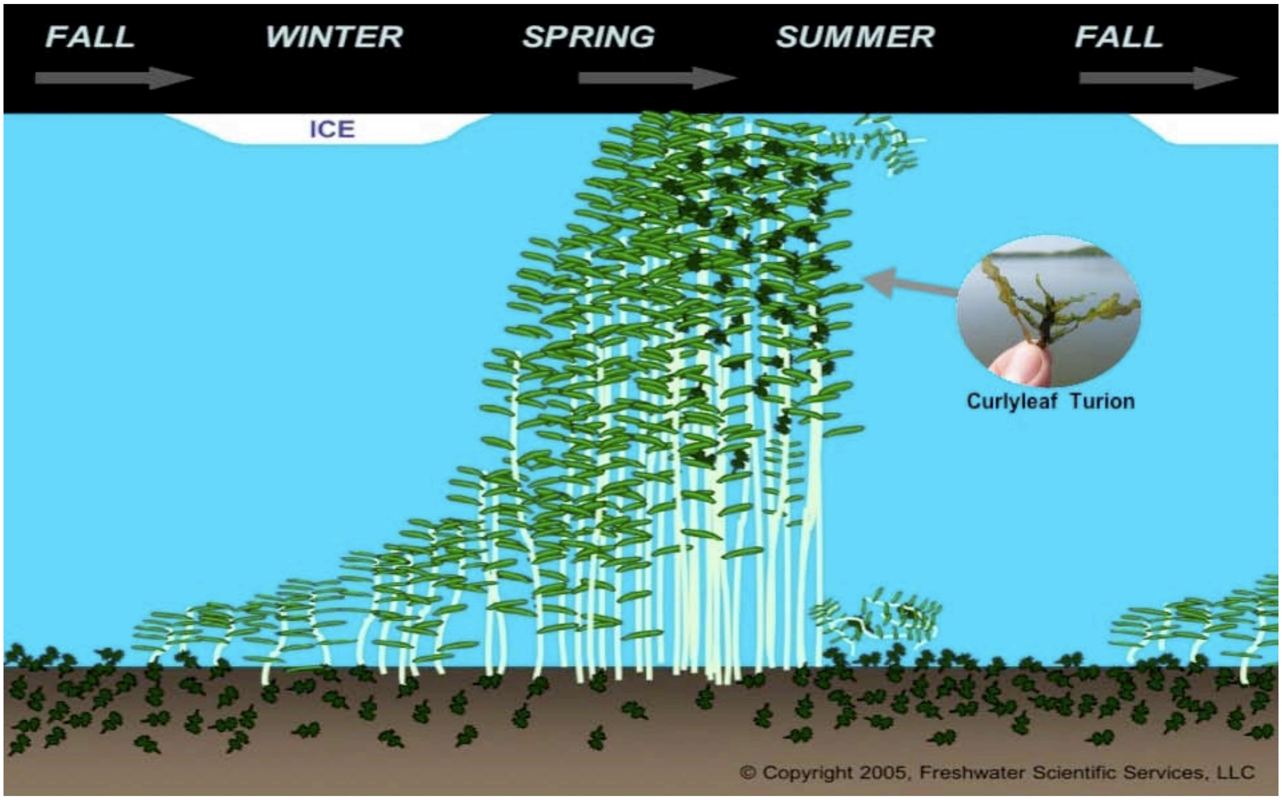


Figure 24 – Curly-leaf Life Cycle

The release of nutrients into the water column from the decaying curly-leaf during the height of the growing season can fuel algal blooms. Phosphorus release rates from the senescence of monotypic curly-leaf beds have been reported as high as nearly 10 pounds per acre and averages about 5 pounds per acre [16, 17, 18].

8.1.1 Curly-leaf Pondweed in Lake Chetek

During the spring bed mapping survey, curly-leaf was found at 36 survey points in Lake Chetek which extrapolates to 5.2% of the entire lake area. Rake fullness values of 2 or 3 were found at 22 of the sample points, suggesting a significant infestation in 3.2% of the lake (Figure 25). Bed mapping identified one 40.02 acre curly-leaf bed covering much of the bay at the Moose Ear Creek inlet (Figure 25). The density of curly-leaf at this site barely qualified as a bed as there were many gaps and a high percentage of native plants (coontail, fern pondweed, flat-stem pondweed, and white water lily) were intermixed with the curly-leaf. A 2.09-acre area of high density curly-leaf growth was also delineated in the northwest part of the lake (Figure 25). While this area was dominated by curly-leaf growth, it had few total plants growing altogether. Outside of these two areas, curly-leaf was rare to completely absent.

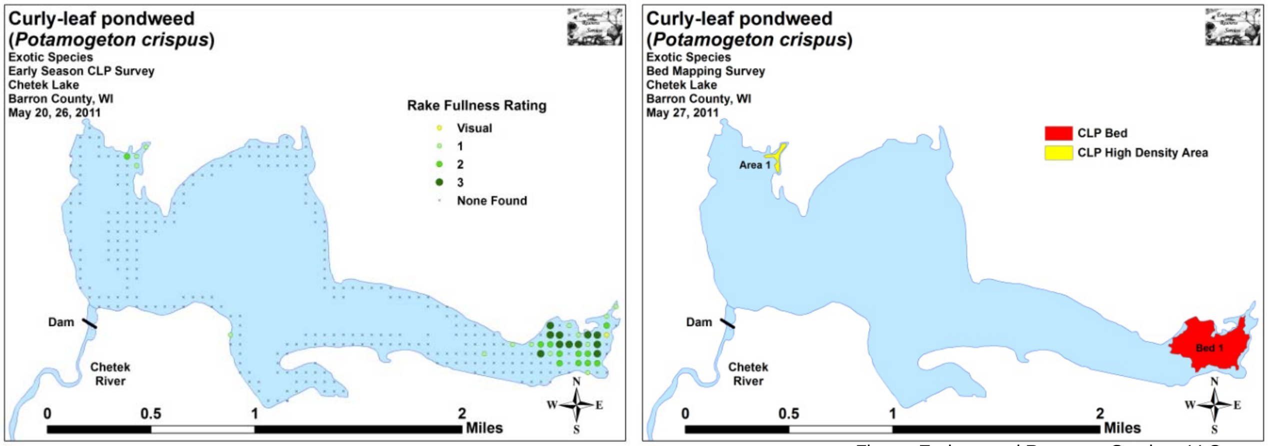


Figure: Endangered Resource Services LLC

Figure 25 – Curly-leaf Pondweed Density and Distribution in Chetek Lake, May 2011

Much of the curly-leaf had died-off by July and native species often found it its place; however, curly-leaf was still the third most frequently found aquatic plant (Figure 26).

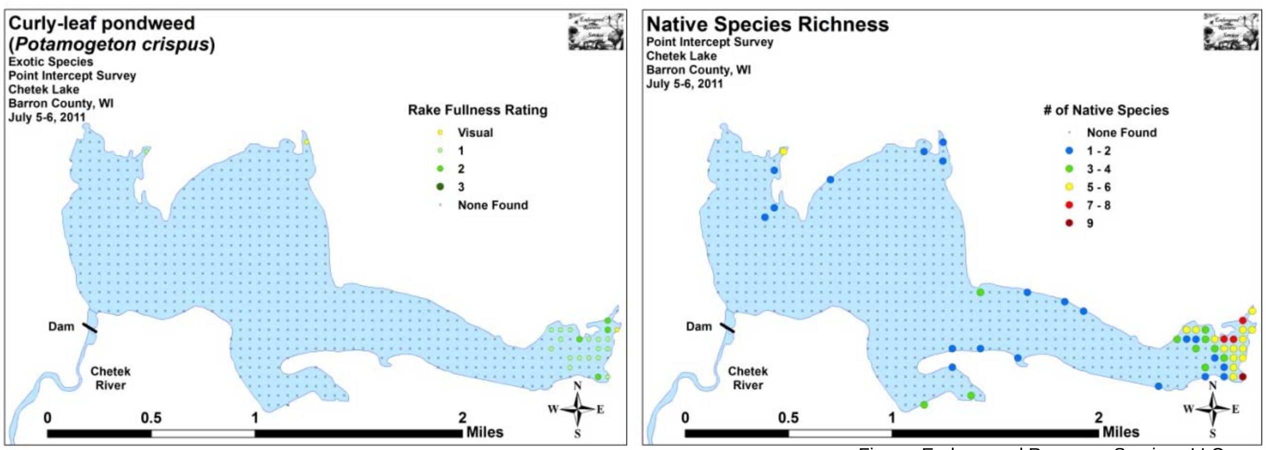


Figure: Endangered Resource Services LLC

Figure 26 – Curly-leaf Pondweed and Native Plant Distribution in Chetek Lake, July 2011

Curly-leaf pondweed is widespread and well established in the Chetek Lakes, but has a fairly limited distribution in Chetek Lake. Currently, curly-leaf is largely restricted to the Moose Ear Creek inlet. This area supports the only sizable plant beds in the whole lake, and there were a large numbers of native species interspersed with the curly-leaf. This area of the lake is more of an ecological asset than a liability as it provides habitat that likely benefits a wide range of aquatic species. This was especially true for the fish; surveyors noted school after school of sunfish and numerous pike hiding and hunting throughout the curly-leaf beds during the cold water survey.

The curly-leaf pondweed beds may be interfering with lake access for some property owners and therefore creating navigation channels may be warranted. A cautious and perhaps limited approach to active management is advisable due to the limited amount of rooted native plants in the lake.

8.1.2 Curly-leaf Pondweed in Mud (Ojaski) Lake

During the spring bed mapping survey, curly-leaf was found at 204 survey points which extrapolates to 35.8% of the entire lake area. Rake fullness values of 2 or 3 were found at 165 of the sample points, suggesting a significant infestation in 28.9% of the lake (Figure 27). Bed mapping identified two beds on the lake: a large 95.9-acre bed dominating the central part of the lake and a much smaller 0.5-acre bed near the south end of the lake (Figure 27). Two areas of high density curly-leaf growth covered much of the northern part of the lake and added an additional 28.1 acres to the curly-leaf coverage.

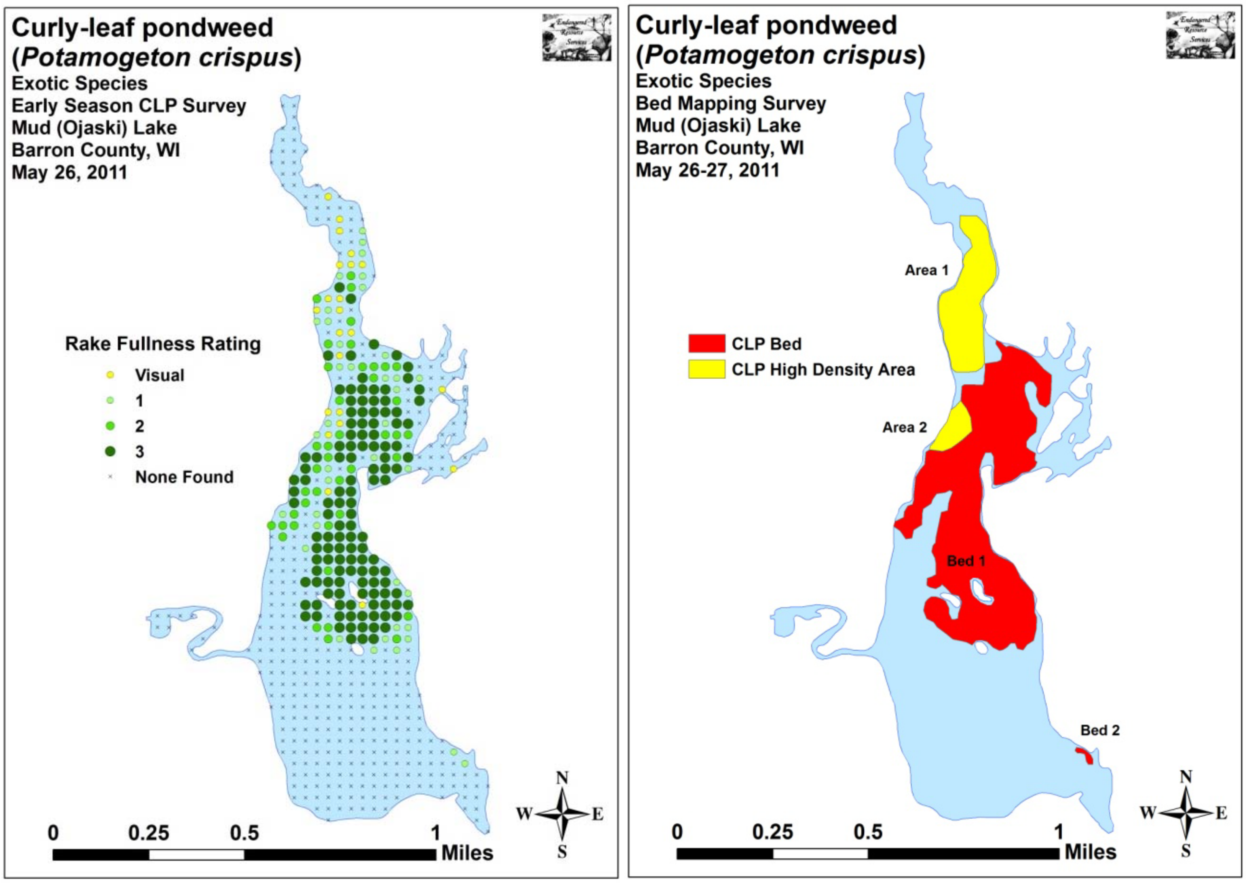


Figure: Endangered Resource Services LLC

Figure 27 – Curly-leaf Pondweed Density and Distribution in Mud (Ojaski) Lake, May 2011

The dense canopied beds of curly-leaf found in May had almost completely senesced by the time of the July survey, and most remaining CLP occurred in scattered clumps on the north end of the lake (Figure 28). Native plants did not populate the entire central area of the lake where the large curly-leaf bed was present. This is likely due the decreasing water clarity from algae growth as the growing season progressing causing a reduction in light penetration. Native plants did, however, grow abundantly in the northern part of the lake.

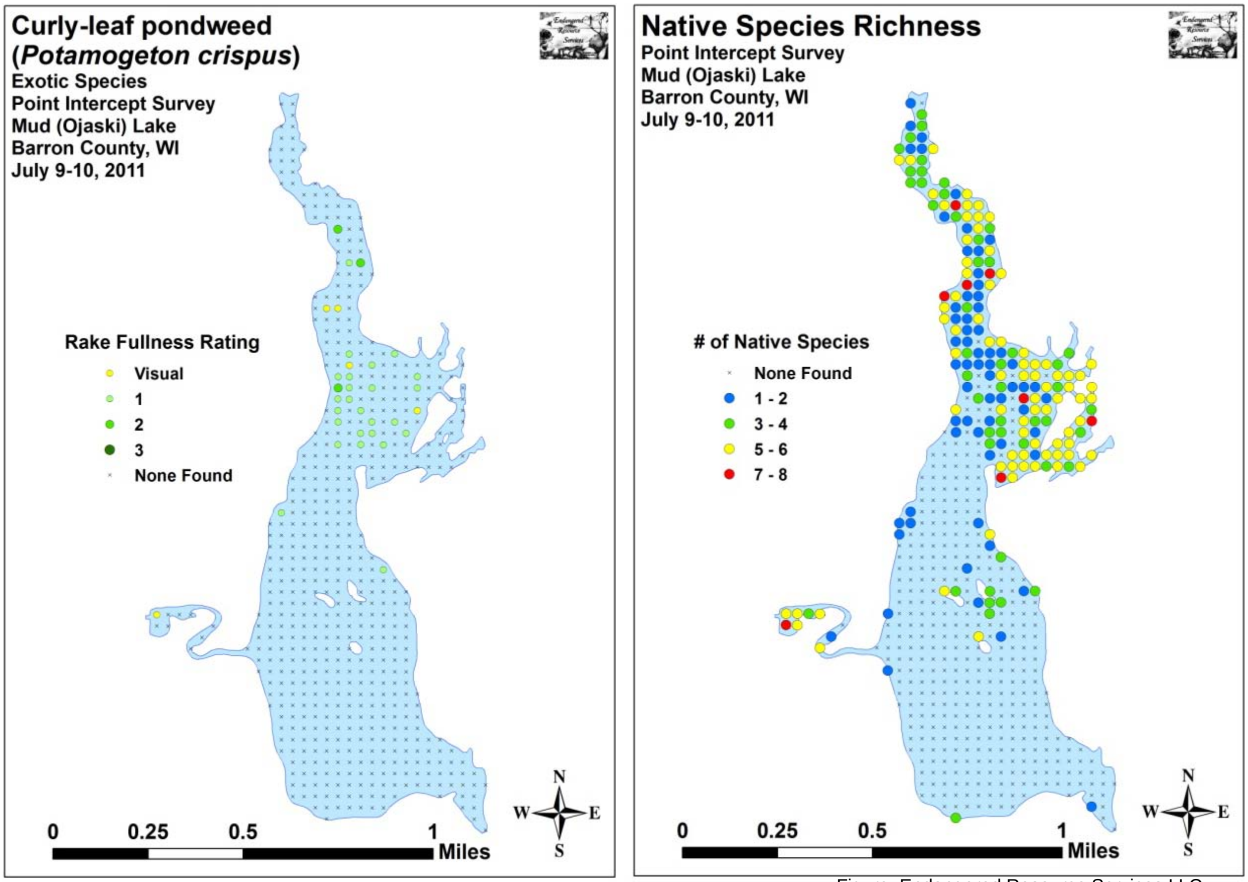


Figure: Endangered Resource Services LLC

Figure 28 – Curly-leaf Pondweed and Native Plant Distribution in Ojaski Lake, July 2011

Curly-leaf pondweed is widespread and well established in the Chetek Lakes and the bed east of the three mid-lake islands on Mud Lake was one of the densest growth areas with monotypic stands of curly-leaf. In this area, few to no native plants grew to replace the curly-leaf later in the growing season. In the past, this area was considered a sensitive area for aquatic plants. Control activities east of the three islands are not likely to impact the lake's vegetation, although it would eliminate early season fish habitat. In the northern two-thirds of the bed, curly-leaf is mixed with high quality native plants which provide habitat for the lake's fish and other wildlife throughout the rest of the growing season. In this area, a cautious and perhaps limited approach to any active management should be taken.

8.1.3 Curly-leaf Pondweed in Pokegama Lake

During the spring bed mapping survey, curly-leaf was found at only 2 survey points which extrapolates to 0.3% of the lake (Figure 29). The curly-leaf pondweed rake fullness values at both points were 1, indicating the lake is not significantly infested. One small bed of 1.17 acres (0.2% of the total lake area) was found in Six Lakes Bay (Figure 29). This area barely qualified as a bed as there were many gaps and a high percentage of native plants (coontail and white water lily) interspersed with the curly-leaf.

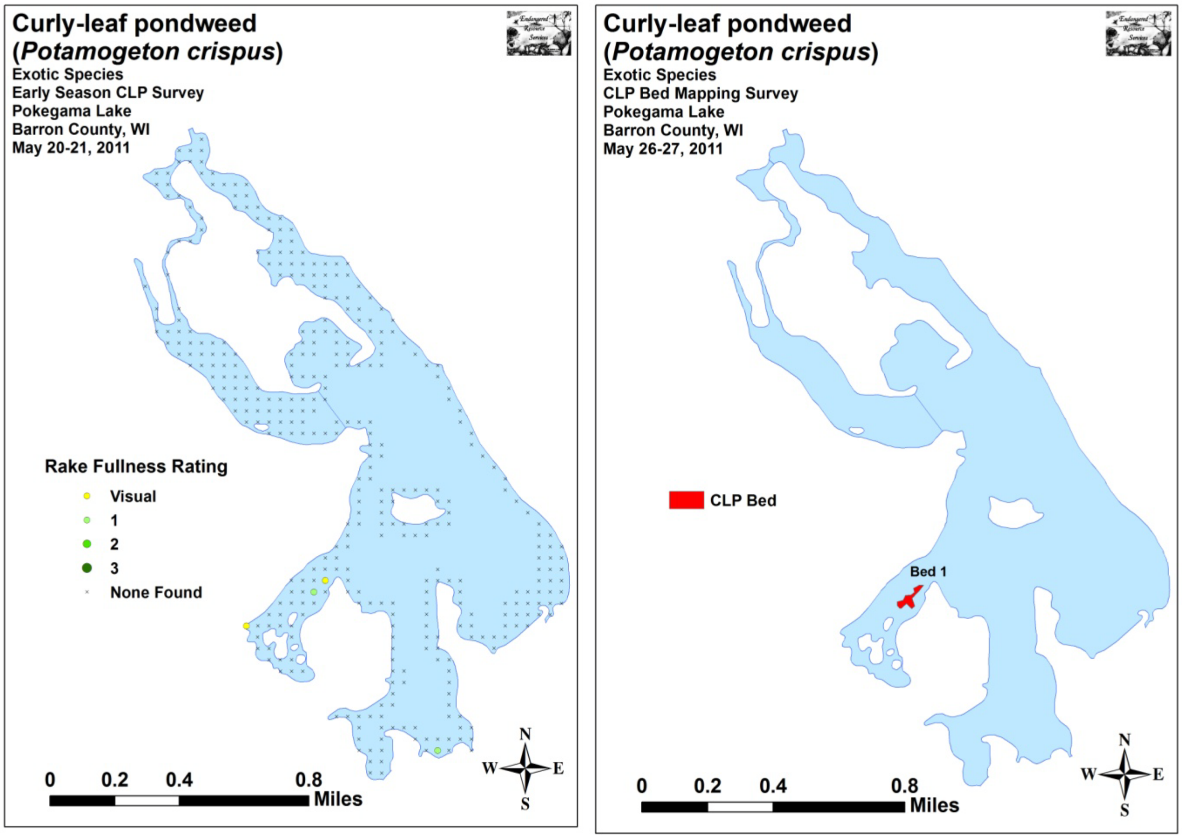


Figure: Endangered Resource Services LLC

Figure 29 – Curly-leaf Pondweed Density and Distribution in Pokegama Lake, May 2011

The limited amount of curly-leaf found in May had completely senesced by the time of the July survey (Figure 30). No curly-leaf pondweed was visually observed or collected on a rake sample and at this time does not appear to be negatively impacting the native aquatic plants.

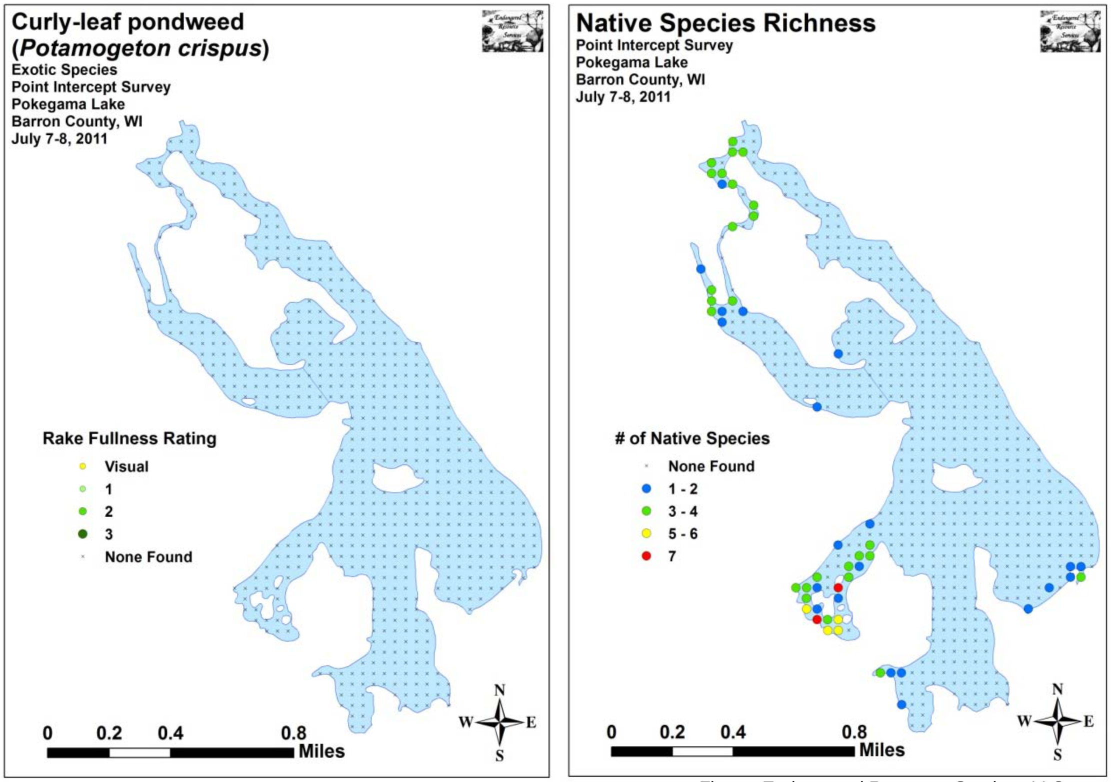


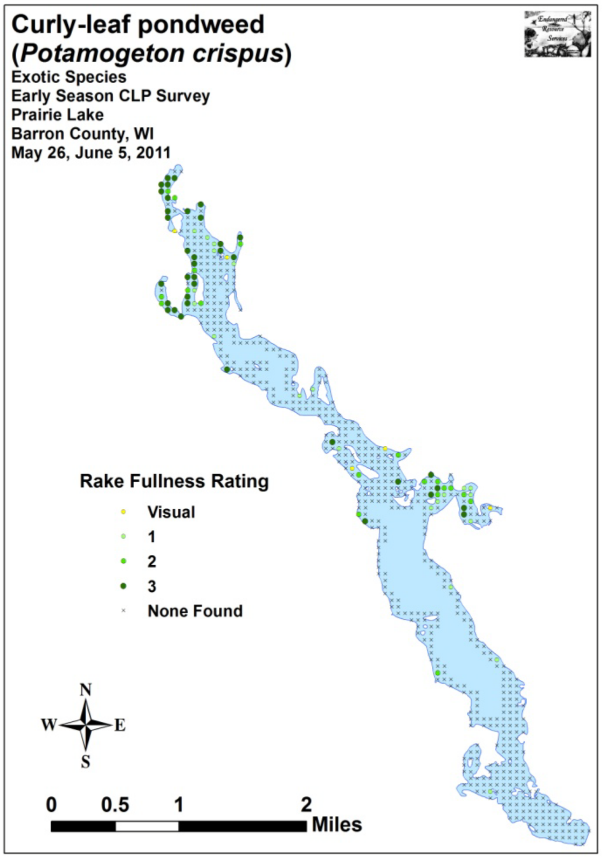
Figure: Endangered Resource Services LLC

Figure 30 – Curly-leaf Pondweed and Native Plant Distribution in Pokegama Lake, July 2011

Curly-leaf pondweed is widespread and well established in the Chetek Lakes, but has a very limited distribution in Pokegama Lake. Curly-leaf pondweed was found only in Six Lakes Bay, and most of the plants were in the stump fields. This area supports the only sizable native plant beds in the whole lake, and there were also large numbers of native species interspersed with the curly-leaf. This area is currently more of an asset to the lake ecosystem than a liability as it provides habitat that likely benefits a wide range of aquatic species. This was especially true for the fish; surveyors noted school after school of sunfish and numerous pike hiding and hunting throughout the curly-leaf beds during the cold water survey. At this time, these beds are not interfering with lake access for property owners and a cautious and limited approach to any active management should be taken.

8.1.4 Curly-leaf Pondweed in Prairie Lake

During the spring bed mapping survey, curly-leaf was found at 77 survey points which extrapolated to 9.2% of the entire lake area (Figure 31). Rake fullness values of 2 or 3 were found at 56 sample points, suggesting a significant infestation in 6.7% of the lake. Bed mapping identified a total of 15 curly-leaf beds, and only one (Bed 15) was located in the southern half of the lake (Figure 31). The beds ranged in size from 0.2 acres (Bed 3) to 29.5 acres (Bed 5) and covered a total of 111.6 acres or 8% of the total lake area.



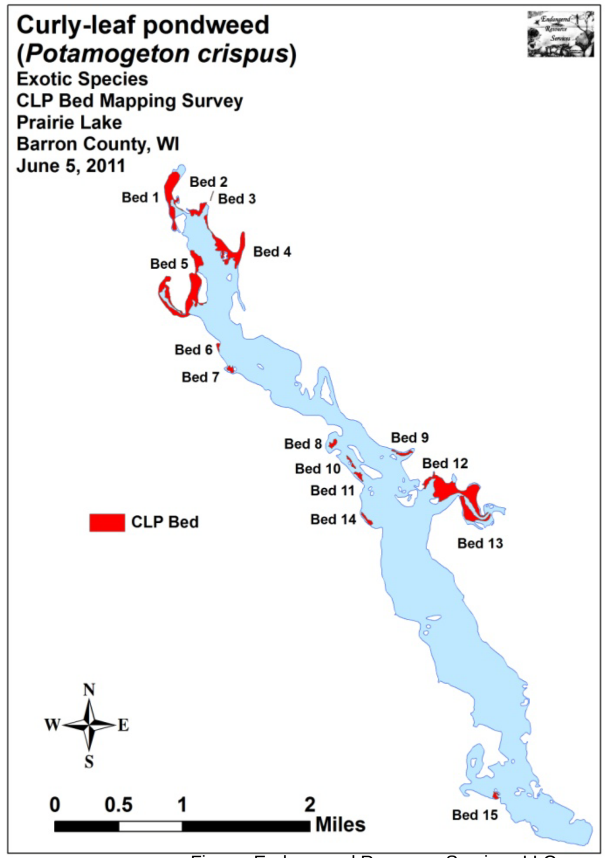
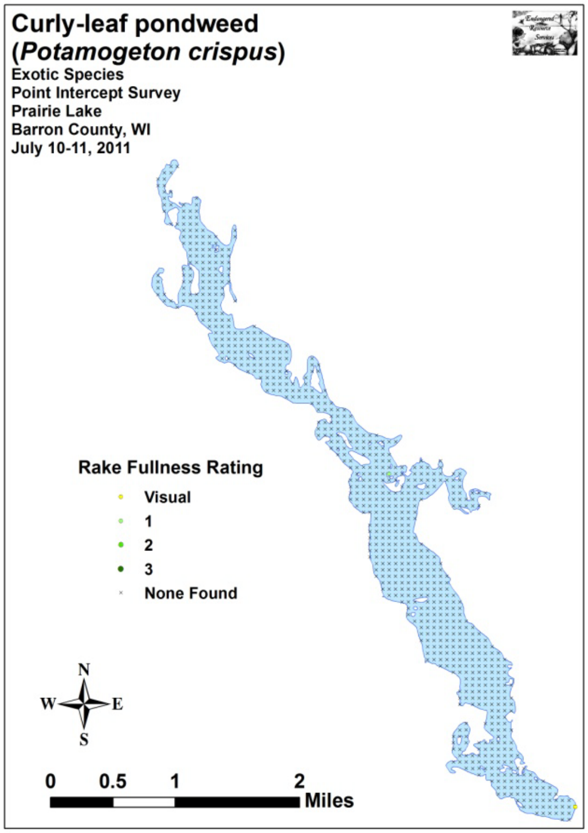


Figure: Endangered Resource Services LLC

Figure 31 – Curly-leaf Pondweed Density and Distribution in Prairie Lake, May 2011

The numerous dense beds of curly-leaf found in May had nearly completely senesced by the time of the July survey and only one visual observation of curly-leaf was made on the southern end of the lake (Figure 32). Few native plants grew in the areas opened after curly-leaf senescence.



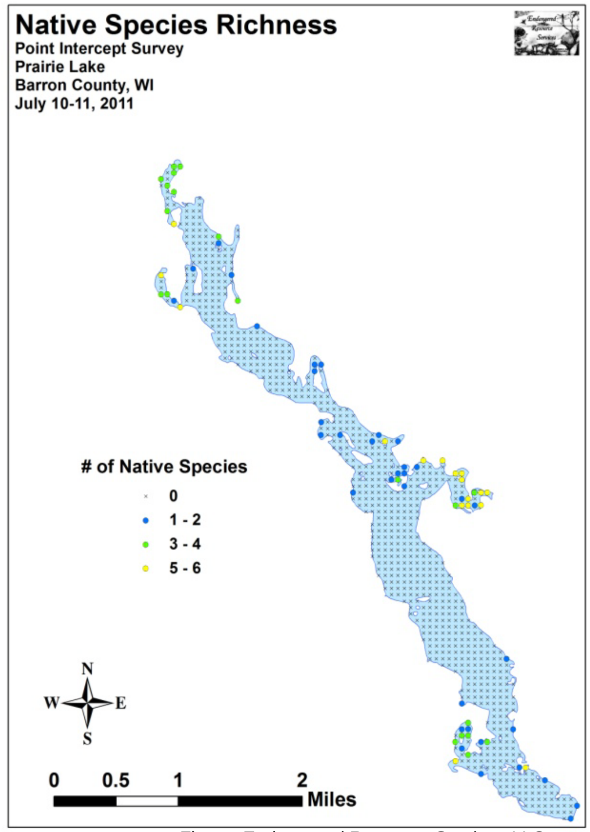


Figure: Endangered Resource Services LLC

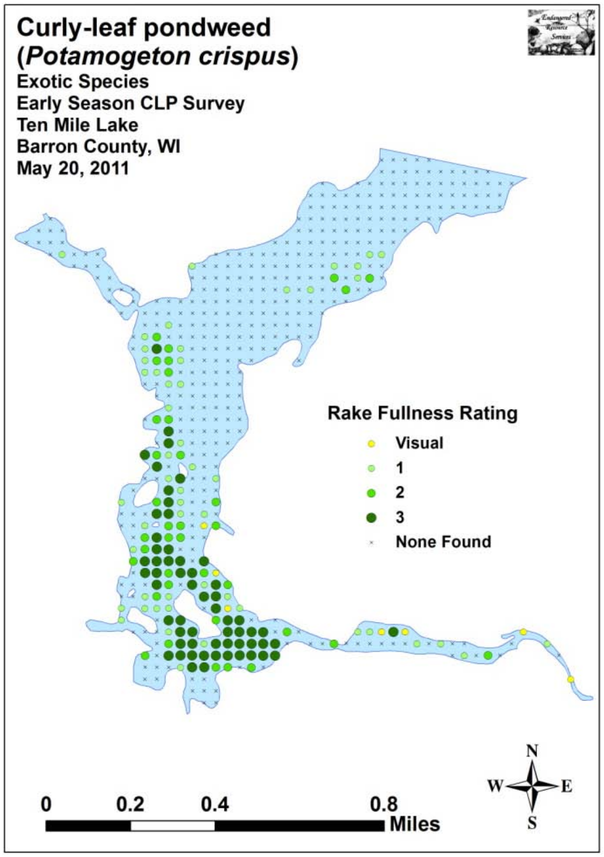
Figure 32 – Curly-leaf Pondweed and Native Plant Distribution in Prairie Lake, July 2011

Curly-leaf pondweed is widespread and well established in the Chetek Lakes, especially in Prairie Lake. In 2011, curly-leaf pondweed was the dominant rooted plant in Prairie Lake, and its presence at 77 points in the early season survey easily outnumbered any native species found in July. Because of this, it currently may be more of an early season asset than a liability as it provides habitat that likely benefits a wide range of aquatic species. This was especially true for the fish; surveyors noted school after school of sunfish and numerous pike hiding and hunting throughout the curly-leaf beds during the cold water survey.

Some of the curly-leaf beds significantly impair navigation and lake access for residents. This is especially true in the sloughs and bays in the far north end of the lake and near the channel between Prairie and Mud lakes. Because of these competing factors, management of curly-leaf should be evaluated on a bed by bed basis following a cautious and perhaps limited approach to active management.

8.1.5 Curly-leaf Pondweed in Tenmile Lake

During the spring bed mapping survey, curly-leaf was found at 146 sample points which extrapolates to approximately 27.6% of the total lake area (Figure 33). Rake fullness values of 2 or 3 were found at 95 of the sample points, suggesting a significant infestation in 18% of the lake. Bed mapping identified 5 beds scattered throughout the lake ranging in size from 0.91 acres to 54.9 acres and totaling 64.55 acres (24.3% of the total lake area) (Figure 33). Two areas of high density curly-leaf grow were also identified in the Tenmile Creek inlet, covering a total of 3.55 acres.



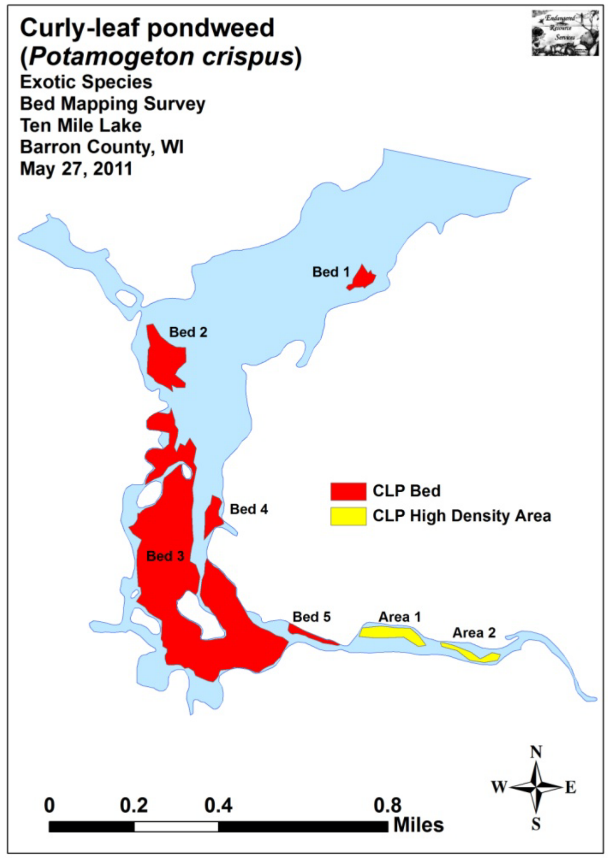


Figure: Endangered Resource Services LLC

Figure 33 – Curly-leaf Pondweed Density and Distribution in Tenmile Lake, May 2011

By July, the large beds of curly-leaf had mostly senesced although plants were still common in the Ten Mile Creek inlet where cooler water seems to have delayed its growth and maturation (Figure 34).

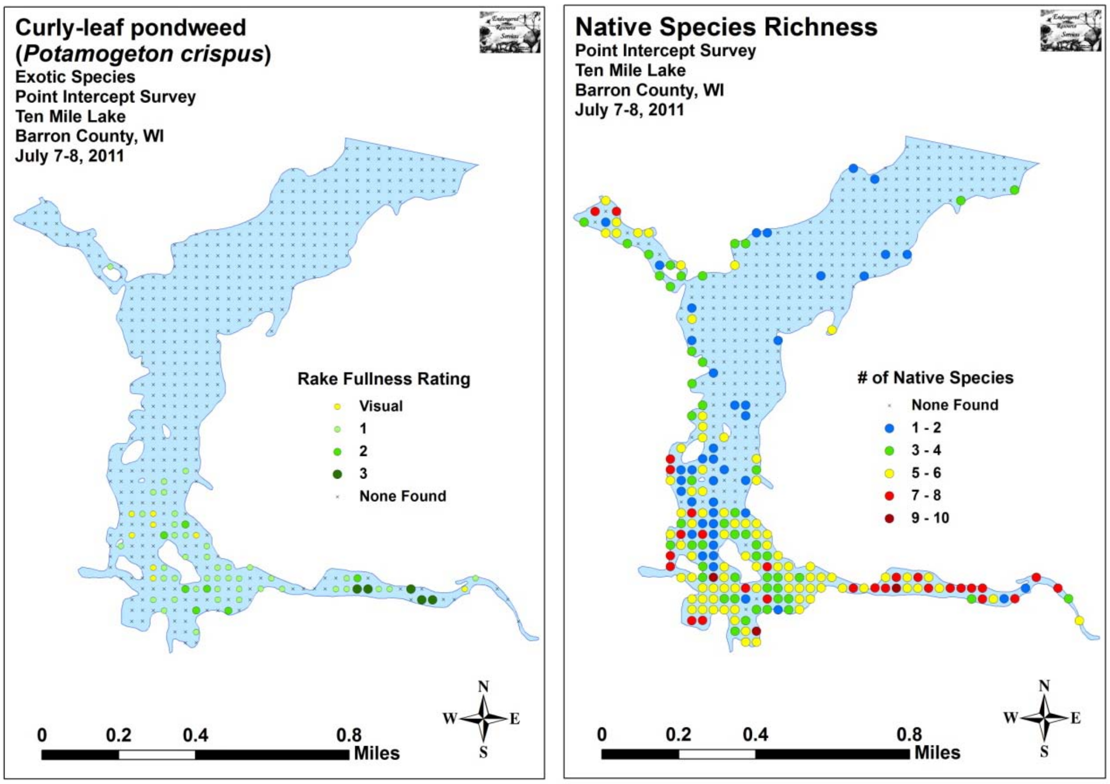


Figure: Endangered Resource Services LLC

Figure 34 – Curly-leaf Pondweed and Native Plant Distribution in Tenmile Lake, July 2011

Curly-leaf pondweed is widespread and well established in the Chetek Lakes and the southern end of Tenmile Lake had some of the densest curly-leaf growth observed in 2011. The areas dominated by curly-leaf in the early growing season were also the primary areas of the lake supporting significant numbers of native plants, including wild rice. Because of this, a cautious and perhaps limited approach to any active management should be taken. Providing boat access via navigation channels while maintaining the native vegetation may be the best compromise between habitat and human usage.

8.2 Purple Loosestrife (Lythrum salicaria)

Purple loosestrife is a perennial herb 3 to 7 feet tall with a dense bushy growth of 1 to 50 stems. The stems, which range from green to purple, die back each year. Showy flowers vary from purple to magenta, possess 5 to 6 petals aggregated into numerous long spikes, and bloom from July 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 (Figure 35).

Figure 35 – Purple Loosestrife

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. 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 wetlands, lakes, and rivers. 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 distribution is limited in the Chetek Lakes watershed. It may be found in the wetlands adjacent to the lake and distributed along the shore as single plants, small patches, or in large beds. It is easiest to distinguish in late July and August as it has a very distinctive flowering head.

8.3 Japanese Knotweed (*Polygonum cuspidatum*)

Knotweeds are robust, bamboo-like perennials introduced from Asia that are spreading throughout the Great Lakes states. The main species is Japanese knotweed. Knotweed grows in dense stands 6-12 feet tall. Its stems are hollow, green to reddish in color and bamboo-like. Its leaves are bright green, broad, egg or heart shaped, with a pointed tip. Small white flowers in branched spray appear July through August (Figure 36).

Figure 36 – Japanese Knotweed

The dead reddish-brown stems often remain standing while the plant is dormant in winter. New growth emerges from root crowns in April and reaches full height in June. The heaviest concentrations of knotweed are usually along rivers and roads, but are also found in parks, backyards, along lake shores, in forests and on farms. Japanese knotweed reproduces occasionally by seed, but spreads primarily by extensive networks of underground rhizomes, which can reach 6 feet deep, 60 feet long, and become strong enough to damage pavement and penetrate building foundations. Controlling Japanese knotweed is difficult and requires persistence and diligence. It can be dug, cut, covered, chemically sprayed, or have herbicide injected into individual stems. Japanese knotweed is known to exist by the Chetek Dam, but has not been documented anywhere else in the lakes or along the shoreline.

9.0 Other Non-Native Aquatic Invasive Species

Introduction of new AIS to a lake system is a constant threat to lakes and rivers. The non-native species of most concern are EWM, zebra and quagga mussels, spiny water flea, giant reed grass, New Zealand mudsnails, and hydrilla. AIS monitoring recommended in this APM Plan and supported by the CLPA will be watching for the introduction of these and other AIS in hopes of early detection.

9.1 Eurasian Watermilfoil (*Myriophyllum spicatum*)

Eurasian watermilfoil is a submergent aquatic plant native to Europe, Asia, and northern Africa (Figure 37). Although EWM was not found in the Chetek Lakes during extensive surveying in 2011, its introduction remains a concern. As one of the most popular fishing destinations in northwestern Wisconsin, the Chetek Lakes are a prime candidate for the introduction of EWM via boat traffic.

Figure 37 – Eurasian Watermilfoil

Eurasian watermilfoil first arrived in Wisconsin during the 1960s and is the only non-native milfoil in the state. During the 1980s it began to move from several counties in southern Wisconsin to lakes and waterways in the northern half of the state. Eurasian watermilfoil grows best in alkaline systems with a high concentration of dissolved inorganic carbon and fertile, fine-textured, inorganic sediments. In less productive lakes EWM 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 nutrient-laden runoff, and heavy-use lakes.

Unlike many other plants, EWM is not dependant on seed for reproduction. In fact, its seeds germinate poorly under natural conditions. EWM reproduces by fragmentation, allowing it to disperse over long distances by currents and inadvertently by boats, motors, and trailers. The fragments, which are produced after the plant fruits once or twice during the summer and by destruction of the plant (for example by propellers), can stay alive for weeks if kept moist.

Once established in an aquatic community, EWM reproduces from shoot fragments and stolons (runners that creep along the lake bed). Stolons, lower stems, and roots persist over winter and store the carbohydrates that help EWM claim the water column early in spring. The rapid growth can form a dense leaf canopy that shades out native aquatic plants. Its ability to spread rapidly by fragmentation and effectively block the 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 reduce 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 EWM-dominated lakes is the flat yellow-green of matted vegetation, often prompting the perception that the lake is “infested” or “dead”. The cycling of nutrients from sediments to the water column by EWM may lead to deteriorating water quality and algae blooms in infested lakes.

Although the Chetek Lakes are prime candidates for the introduction of EWM, establishment once introduced may be limited. Milfoils (Myriophyllum spp.) are very uncommon in the Chetek Lakes, suggesting that the lakes do not provide very good habitat for milfoils. Northern watermilfoil was found at only one site in Chetek Lake and whorled watermilfoil at one site in Tenmile Lake. This may be aiding in protecting the lakes from the introduction and subsequent establishment of EWM.

9.2 Rusty Crayfish and Chinese Mystery Snail

Rusty crayfish (Figure 38) may be present in the Chetek Lakes, but have not been documented. Rusty crayfish are omnivores, meaning they forage on both plant and animal material. Originally from parts of the United States south of Indiana, they are larger and more aggressive than species of crayfish native to Wisconsin. Rusty crayfish prefer hard bottoms and tend to avoid soft sediment or mucky areas of lakes. When introduced they tend to replace native populations of crayfish, and then multiply rapidly. As omnivores they eat many things, including plant material, fish eggs, minnows, invertebrates and other crustaceans. In some lakes, they have devastated the aquatic plant community. Often, after reaching large populations, the number of rusty crayfish in the system declines rapidly. Some research suggests that this is because of a parasite infecting the crayfish. Management of this invasive species is limited, focusing on trapping or removal by residents.

Chinese mystery snails (Figure 38) and banded mystery snails have been documented in the Chetek Lakes. Little is known about the ecological impact of these snails, except that large die-offs are particularly offensive to the nose and impair lake aesthetics. Management is limited and basically consists of landowner removal and disposal of snails and empty shells washed up on shore.

Figure 38 – Rusty Crayfish (left) and Chinese Mystery Snail (right)

9.3 Zebra Mussel and Spiny Water Flea

To date, no evidence of zebra mussels or spiny water fleas has been found in the Chetek Lakes. According to the WDNR SWIMS database, zebra mussel veliger (free-swimming larvae) and spiny water-flea sampling was completed by the WDNR and the Beaver Creek Reserve in 2009. In addition, volunteers from the CLPA have monitored for zebra mussels using plate samplers since the late 1980's. This monitoring has continued through 201 and is expected to continue.

10.0 Aquatic Plant Management Alternatives

Problematic aquatic plants in a lake can be managed in a variety of ways. The eradication of non-native aquatic invasive plant species such as CLP is generally not feasible, but preventing them from becoming a more significant problem is an attainable goal. Aquatic invasive species can negatively impact the native plant species that are beneficial to the lake ecosystem. Targeted early- and mid-season removal or treatment can minimize some of these impacts by preventing the AIS from becoming the dominant plant species in the lake which allows for the growth of more desirable native aquatic plants.

Control methods for nuisance aquatic plants can be grouped into four broad categories:

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

Manual and mechanical removal methods include pulling, cutting, raking, harvesting and other means of removing the plants from the water. Chemical application is typified by the use of herbicides. Biological control methods include organisms that use the plants for a food source or parasitic organisms that use the plants as hosts. Biological control may also include the use of species that compete successfully with the nuisance species for resources. Physical habitat alteration includes dredging, flooding, and drawdown. In many cases, an integrated approach to aquatic plant management that utilizes a number of control methods is necessary.

Regardless of the target plant species, native or non-native, sometimes no manipulation of the aquatic plant community is the best management option. Plant management activities can be disruptive to areas identified as critical habitat for fish and wildlife and should not be done unless it can occur without ecological impacts.

Not all plant management alternatives can be used in a particular lake. What other states accept for aquatic plant management may not be acceptable in Wisconsin. What is acceptable and appropriate in southern Wisconsin lakes may not be acceptable and appropriate in northern Wisconsin lakes. Informed decision-making on aquatic plant management options requires an understanding of plant management alternatives and how appropriate and acceptable each alternative is for a given lake. Possible aquatic plant management alternatives are described below, beginning with those most appropriate for the Chetek Lakes.

10.1 No Manipulation

No manipulation of the aquatic plant community is often the easiest, cheapest, and in some cases most effective aquatic plant management alternative even for non-native invasive species like curly-leaf pondweed. Not actively managing plants in the Chetek Lakes is considered a viable alternative, particularly in areas where excess aquatic plant growth does not impact lake uses, where the benefit of management is far out-weighed by the cost of management, where water quality or other lake characteristics limit nuisance growth conditions, and where highly valued native plants or habitat would be negatively impacted if management was implemented.

10.2 Manual Removal

Except for wild rice, manual removal of aquatic plants by means of a hand-held rake or by pulling the plants from the lake bottom by hand is allowed by the WDNR without a permit per NR 109 (Appendix D). The zone of manual removal cannot exceed 30 shoreland feet and all raked or pulled plant material must be taken completely out of the lake and removed from the shoreline (Figure 39). Plant fragments can be composted or added directly to a garden.

Although up to 30 feet of shoreland vegetation can be removed, removal should only be done to the extent necessary. Clearing large swaths of macrophytes not only disrupts lake habits, it also creates open areas for non-native species to establish. If an aquatic invasive species such as CLP is the target species, then removal by this means is unrestricted as long as native plants are not damaged or eliminated.

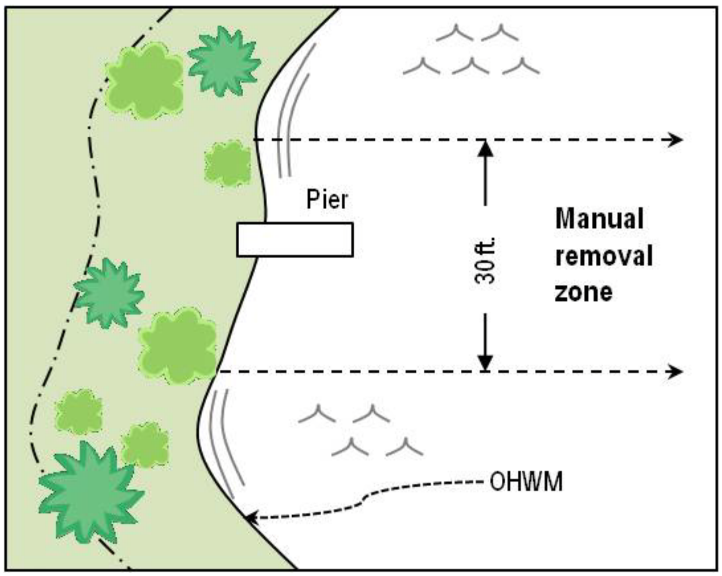


Figure 39 – Aquatic Vegetation Manual Removal Zone

Manual 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. Pulling aquatic invasive species while snorkeling or scuba diving in deeper water is also allowable without a permit and can be effective at slowing the spread of a new aquatic invasive species infestation within a lake when done properly.

10.2.1 Large-scale Physical Removal

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 a 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 [19] 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 from 16% of the littoral zone to 3%.

Overall costs ranged from a high of $796 per hectare of EWM removed during the three years of intensive management effort, to about $300 per hectare during the three year maintenance period [19]. In the first two years of intensive management, the cost per kilogram of EWM removed was relatively low. As the efforts reduced 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 reducing the effort allowed for the EWM to make a comeback [19].

Several local lake groups have and continue to use large-scale physical removal to manage EWM. Horseshoe Lake in Barron County uses diver removal on small or isolated areas of EWM, and uses chemical herbicides on larger, more expansive sites. Early in the management phase, Sand Lake in Barron County participated in diver removal, but stopped using divers as the EWM expanded too rapidly for the divers to keep up with. For several years the St Croix Flowage in Douglas County attempted to control the spread of EWM by diver removal. While successful in the first couple of years, the use of small-scale herbicide application has been added to the control regime.

In 2011, the Red Cedar Lakes Association performed diver removal on a dense, isolated one acre bed of CLP in Red Cedar Lake. This large-scale effort was conducted by a group of local high school students (members of the Conservation Club) and an RCLA representative (Figure 40). Water depths and inexperience made removal difficult; however, the effort was fairly successful and the divers were able to remove a large boat load of CLP.

Figure 40 – Diver Removal of Curly-leaf Pondweed in Red Cedar Lake, 2011

10.3 Native Plant Restoration and Enhancement

Restoring native shoreland plant communities is undertaken on many lakes to reduce erosion, increase and improve native habitat, reduce shoreland runoff, improve water quality, and compliment the lake aesthetic. The restoration or re-establishment of aquatic plants in the shallow waters adjacent to the shore, which focuses on emergent plant species like rushes, sedges, pickerel weed, wild rice, and other plants that make up the wetland fringe, is less frequently completed. These species hold sediments in place, fend off the invasion of non-native species, buffer against shoreland erosion, and improve fish and wildlife habitat.

Restoring the entire wetland fringe (both on the land and in the water) not only protects the lake, it may improve the lake aesthetic enjoyed by many. The importance of native plants preventing the establishment of invasive species cannot be underplayed. An analysis of 55 lakes in west-central Wisconsin found the mean occurrence of non-native aquatic invasive species to be significantly greater at disturbed shoreline sites than at natural shorelines [20]. The study also found that the occurrence of non-native aquatic plant species and filamentous algae increased with the amount of disturbed shoreline on a lake.

There are many sources for more information regarding shoreland restoration, improving buffers, and reestablishing native aquatic plants in shallow water. One such resource is the Langlade County Land Records and Regulations Department, which maintains a Shoreland Restoration Web Site which provides a great deal of information for re-establishing native plants: http://lrrd.co.langlade.wi.us/shoreland/index.asp (last accessed: October 2012). A review of this and other techniques should be done before undertaking a planting project.

10.4 Chemical Control and Management

Aquatic herbicides are chemicals specifically formulated for use in water to kill or control aquatic plants. Herbicides approved for aquatic use by the United States Environmental Protection Agency (EPA) have been reviewed and are considered compatible with the aquatic environment when used according to label directions. Some individual states, including Wisconsin, also impose additional constraints on their use.

10.4.1 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 pellet 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, which leaves the roots alive and able to re-grow.

Herbicides are classified as broad-spectrum (or non-selective) or selective. Broad-spectrum herbicides will generally kill or injure all plants contacted. Selective herbicides will affect only some plants. Often dicots (broad-leafed plants like EWM) will be affected by selective herbicides whereas monocots, such as common elodea (*Elodea canadensis*) may not be affected. The selectivity of an herbicide can be influenced by the method, timing, formulation, and concentration used.

Applying some systemic and contact herbicides together has a synergistic effect leading to increase selectivity and control [21]. 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 required for application.

10.4.2 Timing and Impacts

When properly applied, herbicides can control aquatic vegetation without harming fish and wildlife. A WDNR permit is required for the use of aquatic herbicides and a certified pesticide applicator is required for application on most Wisconsin lakes. Full-season control can be achieved with herbicide application and control may extend into the following year. Because the plants remain in the lake and decay, treating too much plant matter can lead to a depletion of dissolved oxygen. Also, algal blooms may occur as nutrients are released into the water by the decaying plants. Spring and early summer are preferred for application because exotic species such as CLP and EWM are actively growing, whereas many native plants are not, fish spawning has ceased, and recreational use is generally low thereby limiting human contact.

10.4.3 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 feet from shore, the WDNR requires pre and post chemical application aquatic plant surveying. The purpose of the pre and post surveys is to satisfy grant funded treatments conditions where restoration is a goal or where performance results are needed. The protocol for pre and post treatment survey is applicable for chemical treatment of CLP or EWM.

The WDNR protocol assumes that an Aquatic Plant Management 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. More details related to pre- and post-chemical treatment survey protocol can be found at: http://www4.uwsp.edu/cnr/uwexlakes/ecology/APM/Appendix-D.pdf (last accessed October 2012).

10.4.4 Concentration (Residual) Testing

Chemical concentration testing is often done in conjunction with treatment to track the fate of the chemical herbicide used in a particular lake. Concentration 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. Water samples are collected prior to treatment and for a period of hours or days following chemical application (for example, 1, 4, 7, 14, 21, and 28 days after application). 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.

10.4.5 Liquid vs. Granular Formulations

Rapid dissipation of aquatic herbicides due to various water exchange processes can lead to poor submersed macrophyte control in a variety of situations. The ability to target herbicide placement and maintain the desired concentration in the plant mass within the 3-dimensional aquatic environment is critical to maximize efficacy of herbicides. Variables such as temperature, flow, and plant density can alter herbicide distribution. Liquid formulations are less efficient in relatively deep areas with low growing vegetation, areas with the potential for rapid water exchange, and areas adjacent to or surrounded by large volumes of water (e.g. drop-offs) [22]. Application systems consisting of subsurface trailing hoses are now being used to improve the delivery of liquid herbicides in deeper water areas.

Granular formulations have been developed to assist in delivering aquatic herbicides in flowing waters, on very small treatment areas, or in waters where dilution of the herbicide is expected to be rapid. The active ingredient is added to inert ingredients like clay particles that in theory dissolve more slowly, thereby releasing the herbicide more slowly. These formulations may help to maintain placement of the herbicide longer or increase the exposure time of the target plant to the herbicide. Granular formulations sink to the bottom of the lake in and around submersed aquatic plant communities (depending on plant density and frequency) and are less vulnerable to dilution [22].

Granular formulations are generally more expensive than their liquid counterparts. Granular applications are usually broadcast on the surface of the treatment area in a sufficient quantity to reach a designated target concentration within a certain volume of water. Liquid herbicides can be applied on the surface, but subsurface injection is most supported by the industry. Liquid application is based on the volume of water in the treatment area, and in general is used when flowing water or additional dilution are not factors.

More recent comparisons between liquid and granular herbicide applications suggest that dispersal rates for both liquid and granular herbicides are not significantly different. Using liquid herbicides, particularly in larger areas (1/2 to many acres), will be more cost efficient than their granular counterparts.

10.4.6 Large-scale Herbicide Application

Large-scale herbicide application involves chemical treatment of more than 10 acres combined on a given body of water. These applications are usually completed in the early season, when few native plants have started to grow but both CLP and EWM are actively growing, to minimize impacts on native plants. Pre- and post-treatment aquatic plant surveying is required by the WDNR when completing large-scale chemical treatments. Concentration testing is not required by the WDNR, but highly recommended to gain a better understanding of the impact and fate of the chemical used.

10.4.7 Small-scale Herbicide Application

Small-scale herbicide application involves treating small areas < 10 acres combined on a given body of water. Small-scale chemical application can be completed in the early season or used as a follow up treatment to areas missed or not impacted by large-scale applications. Pre- and post-treatment aquatic plant surveying is not required by the WDNR for small-scale treatments. Testing for herbicide concentrations is also not required by the WDNR when completing small-scale treatments. Even though not required, this monitoring is recommended as it helps to gain a better understanding of the impact and fate of the chemical used.

10.4.8 EPA-approved Aquatic Herbicides in Wisconsin

There are a number of aquatic herbicides registered for use in Wisconsin. A brief summary of each is presented below. Factsheets for each can be found on the WDNR website at http://dnr.wi.gov/lakes/plants/factsheets/ (last accessed October 2012).

10.4.8.1 Endothall

Trade names for endothall include Aquathol K or Super K, and Hydrothol 191. Endothall is a fast-acting non-selective contact herbicide which destroys the vegetative part of the plant but generally does not kill the roots. Endothall may be applied in a granular or liquid form. Typically endothall compounds are used primarily for short term (one season) control of a variety of aquatic plants. However, there has been some recent research that indicates that when used in low concentrations, endothall can be used to selectively remove exotic weeds; leaving some native species unaffected. Because it is fast acting, endothall can be used to treat smaller areas effectively. Endothall is not effective in controlling Canadian waterweed or Brazilian elodea. Endothall can impact early season wild rice growth so should not be used in areas where the target species and wild rice cohabitate.

10.4.8.2 Diquat

A trade name for diquat is Reward®. Diquat is a fast-acting non-selective contact herbicide which destroys the vegetative part of the plant but does not kill the roots. It is applied as a liquid. Typically diquat is used primarily for short term (one season) control of a variety of submersed aquatic plants. It is very fast-acting and is suitable for spot treatment. However, turbid water or dense algal blooms can interfere with its effectiveness. Diquat is strongly attracted to clay particles in the water and thus is not effective in lakes or ponds with muddy water or plants covered with silt. For this reason, care must be taken to not disturb bottom sediments during application.

10.4.8.3 Glyphosate

Trade names for aquatic products with glyphosate as the active ingredient include Rodeo®, AquaMaster®, and AquaPro®. This systemic broad spectrum herbicide is used to control floating-leaved plants like water lilies and shoreline plants like purple loosestrife. It is generally applied as a liquid to the leaves. Glyphosate does not work on underwater plants such as Eurasian watermilfoil. Although glyphosate is a broad spectrum, non-selective herbicide, a good applicator can somewhat selectively remove targeted plants by focusing the spray only on the plants to be removed. Plants can take several weeks to die and a repeat application is often necessary to remove plants that were missed during the first application.

10.4.8.4 2,4-D

There are two formulations of 2,4-D approved for aquatic use. The granular formulation contains the low-volatile butoxy-ethyl-ester formulation of 2,4-D (2,4-D BEE; trade names include AquaKleen® and Navigate®). The liquid formulation contains the dimethylamine salt of 2,4-D (2,4-D DMA). Trade names include DMA*4. 2,4-D is a relatively fast-acting, systemic, selective herbicide used for the control of Eurasian watermilfoil and other broad-leaved species. 2,4-D has been shown to be selective to Eurasian watermilfoil when used at the labeled rate, leaving native aquatic species relatively unaffected. It is not effective against elodea or hydrilla. 2,4-D can impact early season wild rice growth so should not be used in areas where the target species and wild rice cohabitate.

10.4.8.5 Triclopyr

Common trade names for triclopyr are Renovate 3 and Garlon 3A. There are two formulations of triclopyr. It is the TEA formation of triclopyr that is registered for use in aquatic or riparian environments. Triclopyr, applied as a liquid, is a relatively fast-acting, systemic, selective herbicide used for the control of Eurasian watermilfoil and other broad-leaved species such as purple loosestrife. It is also available in a granular formulation under the trade name Renovate OTF. Triclopyr can be effective for spot treatment of Eurasian watermilfoil and is relatively selective to Eurasian watermilfoil when used at the labeled rate. Desirable native species that may be affected include native milfoils, water shield, pickerelweed and lilies. Triclopyr is very useful for purple loosestrife control since native grasses and sedges are unaffected by this herbicide. Triclopyr degrades quickly in an aquatic environment making its use most effective in systems with low water-exchange where contact with target plants can be maintained for longer periods of time. .

10.4.8.6 Fluridone

Trade names for fluridone products include Sonar® and Whitecap®. Fluridone is a slow-acting systemic herbicide used to control Eurasian watermilfoil and other underwater plants. It may be applied as a pellet or as a liquid. Fluridone can show good control of submersed plants where there is little water movement and an extended time for the treatment. Its use is most applicable to whole-lake or isolated bay treatments where dilution can be minimized. It is not effective for spot treatments of areas less than five acres. It is slow-acting and may take six to twelve weeks before the dying plants fall to the sediment and decompose. When used to manage Eurasian watermilfoil, fluridone is applied several times during the spring/summer to maintain a low, but consistent concentration in the water. Granular formulations of fluridone are proving to be effective when treating areas of higher water exchange or when applicators need to maintain low levels over long time periods. Although fluridone is considered to be a broad spectrum herbicide, when used at very low concentrations, it can be used to selectively remove Eurasian watermilfoil. Some native aquatic plants, especially pondweeds, are minimally affected by low concentrations of fluridone.

10.4.8.7 Copper Complexes

Copper sulfate and chelated coppers have been widely used as non-selective, fast-acting, contact herbicides or algaecides. These chemicals have been used to control aquatic plants and algae, often in conjunction with endothall and diquat. Copper compounds are primarily used for algae control but can be effective against certain submerged plant species. Copper can build up in sediments, can be toxic to fish and invertebrates, and certain species of algae can build up a resistance [23]. The use of copper compounds to control algae was once widely accepted in Wisconsin, but in recent years it has not been supported as a viable control method because of the potential negative impacts inherent in its use.

10.5 Mechanical Control and Management

Mechanical removal of aquatic plants involves the use of motorized accessories to assist in vegetation removal. Mechanical control can be used for both small- and large-scale control efforts. WDNR permits are required regardless of the size of the area to be managed with mechanical control.

When using mechanical control methods, plant fragments must be removed from the water to the extent practical. A benefit of this management alternative is that plant material and the nutrients contained in it some are removed completely from the water. Herbicide application kills the plant, but does not remove it from the lake, making nutrients released from the dying plants available in the water column to be used for renewed plant growth. Early season or cool water plants like curly-leaf pondweed that senesce in early summer can be a significant source of phosphorous loading which could promote algae blooms and low dissolved oxygen in severely infested lakes. In shallow water systems impacted by an over-abundance of aquatic plants, removing as much of the cut plants as possible is best for the lakes. When harvesting CLP it is important that all material is removed as free-floating CLP fragments can remain viable and produce turions for up to two weeks after being cut.

10.5.1 Mechanical Harvesting

The most common form of mechanical control is the use of large-scale mechanical weed harvesters on the lake. The harvesters are generally driven by modified paddle wheels and include a cutter that can be raised and lowered to different depths, a conveyor system to capture and store the cut plants, and the ability to off-load the cut plants. The depth at which these harvesters cut generally ranges from skimming the surface to as much as five-feet deep.

Harvesters can remove thousands of pounds of vegetation in a relatively short period of time. They are not, however, species specific. Everything in the path of the harvester will be removed including the target species, other plants, macro-invertebrates, semi-aquatic vertebrates, forage fishes, young-of-the-year fishes, and even adult game fish found in the littoral zone [24].

Large-scale plant harvesting in a lake is similar to mowing the lawn. Plants are cut at a designated depth, but the root of the plant is often not disturbed. Plant composition can be modified by cutting away dense cover which may increase sunlight penetration enough to stimulate growth of underlying species (Figure 41) [25]. Cut plants will usually grow back after time, just like the lawn grass. Re-cutting during the growing season is often required to provide adequate annual control [26]. Harvesting activities in shallow water can re-suspend bottom sediments into the water column releasing nutrients and other accumulated compounds [26]. Some research indicates that after cutting, reduction in available plant cover causes declines in fish growth and zooplankton densities. Other research finds that creating deep lake channels by harvesting increases the growth rates of some age classes of bluegill and largemouth bass [27].

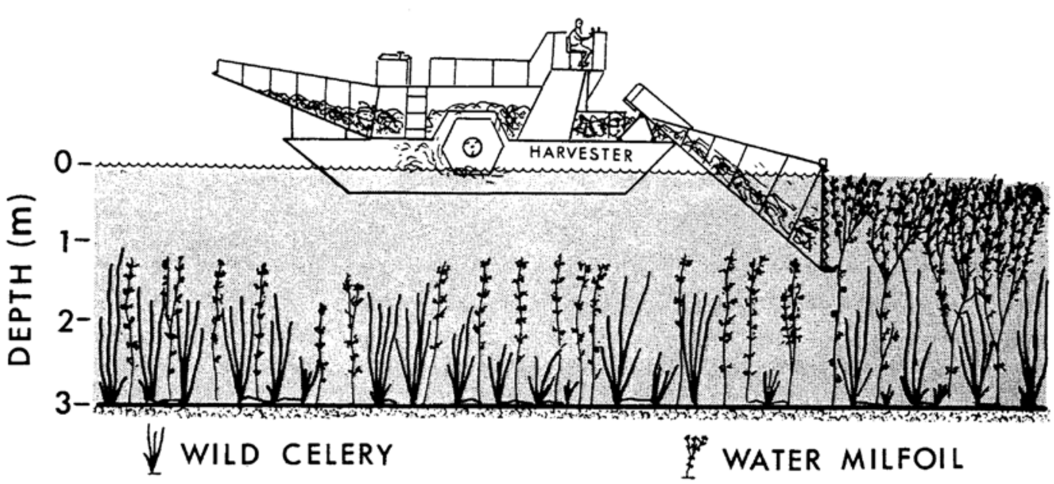


Figure 41 – Harvesting Surface Foliage to Maintain Habitat and Stimulate Basal Plant Growth

10.5.1.1 Harvesting Costs

Developing a harvesting program for a lake requires a cost analysis of the two primary implementation options, one being contracted harvesting services and the other purchasing the harvesting equipment and taking on the responsibilities of operation and maintenance. Cost estimates must take several factors into account including the cost to purchase equipment and the cost to operate, store, and maintain that equipment, the cost of transportation and disposal of harvested plant material, and the total acreage to be harvested annually. Contracting harvesting services removes the purchase, operation, storage, and maintenance costs, but does not necessarily remove the cost of plant disposal.

Once these estimates have been made, it is possible to calculate a critical acreage where the cost per acre associated with purchased equipment would be lower than for contracting harvesting services. If the acreage harvested is not expected to exceed the critical acreage, then contracting mechanical harvesting services is likely the best option. The costs supporting a harvesting program administered by a given lake group may be reduced by purchasing smaller or used equipment, determining a local, low cost disposal site, increasing the amount of acreage harvested, and through other cost analyses.

A recent comparison between the costs associated with each option based on case studies in Minnesota was completed by Freshwater Scientific Services [28]. Cost per acre for contracting harvesting services averaged $410 per acre whereas costs for purchasing, operating, and maintaining a harvester averaged $567 per acre. In general, the cost of harvesting decreased with increasing total acreage harvested, from about $500 per acre at 40 acre sites to about 250 per acre at 160 acre sites [28]. Locally, the Rice Lake Protection and Rehabilitation District owns and operates several harvesters at a cost of approximately $420 per acre on approximately 220 acres.

When contracting harvesting, an equipment inspection program should be conducted to ensure that the unintentional spread of an invasive plant species does not occur. Often contractors are moving from lake to lake. Before a machine comes into a lake, it should be inspected and any plant material present removed. This will help protect the lake from the introduction of problematic aquatic plants and AIS. It also helps to know what lake the contractors have recently worked on and what problem plants might be present there. Upon leaving the lake, it is also a good idea to require that the equipment be cleaned before moving to the next project. These precautions help stop the spread of AIS to other lakes in the region.

Large-scale harvesting can also be used to create channels through dense growth CLP beds to provide landowner access to open water, and general watercraft navigation through areas impacted by CLP. Maintaining these channels later in the season to provide general watercraft navigation and landowner access to open water through areas of dense growth native vegetation is also a viable management action.

10.6 Small-Scale Mechanical Management

There are a wide range of small-scale mechanical management techniques, most of which involve the use of boat mounted rakes, scythes, and electric cutters. As with large-scale mechanical harvesting, removing the cut plants is required and often accomplished with a rake. 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.

One of the best ways for riparian property owners to gain navigation relief near their docks is to actively use their watercraft to open channels. Although not truly considered mechanical management, plant disruption by normal boat traffic is a legal method of management. Most macrophytes do not grow well in an area actively used for boating and swimming. It should be noted that purposefully navigating a boat in circles to clear large areas is not only potentially illegal, but it can also re-suspend sediments, clear paths for aquatic invasive species growth and cause ecological disruptions.

10.7 Restoring Natural Water Level Fluctuations

Restoring more natural water level fluctuations in the Chetek Lakes can help to improve native plant distribution and density. An example ecologically-based lake level regime (developed for Lake Puckaway in Green Lake County) is shown in Figure 42. This plan considers fish, wildlife, habitat development and recreational uses. Lake levels are managed to include a two-month recession of water to stimulate expansion of submersed vegetation in spring. Once submersed aquatic plants establish, water levels are be raised to accommodate recreational uses.

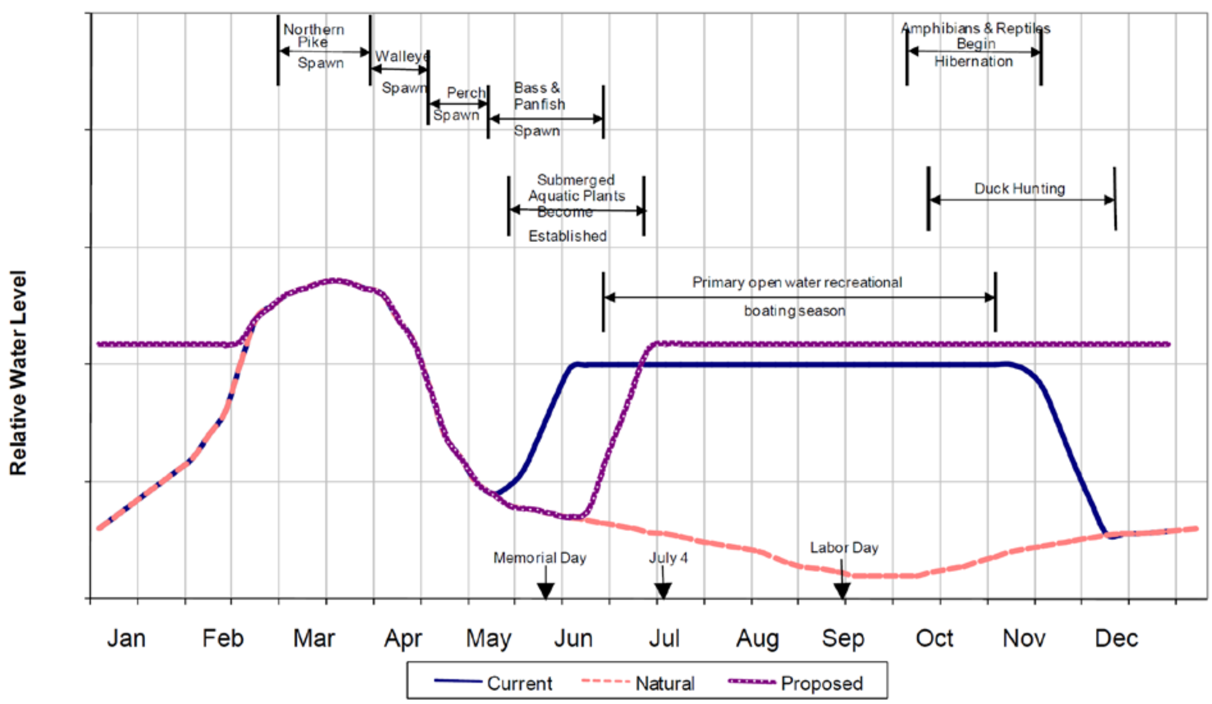


Figure 42 – Example Water Level Management Strategy - Lake Puckaway, Green Lake Co.

Ecologically-based water level management could do many things to help improve the lakes including: passing nutrient laden water through the system, exposing portions of the shoreline that may in turn stimulate new aquatic plant growth, and creating better habitat for plants, fish, and aquatic wildlife throughout. At the present time, the water level in the Chetek Lakes remains almost constant, eliminating the benefits provided by variable water levels.

Altering the water level maintenance plan at the Chetek Dam and potentially adding another lake outlet through the dike that currently blocks the by-pass of water from Tenmile Creek directly to the Chetek River would enable greater changes to be made that may help make improvements. Raising water levels to flood out aquatic plants is uncommon and has a number of negative effects including the potential for shoreland flooding, shoreland erosion, and nutrient loading.

10.8 Winter Drawdown for AIS Control

Winter drawdown of several feet or more has been used in other lakes to control non-native invasive species. Lowering the water level in the winter exposes the sediment to both freezing and loss of water. Freezing can have a dramatic impact on aquatic plants (such as Eurasian watermilfoil or Brazilian elodea) that have no overwintering structures such as viable seeds, turions, tubers, or winter buds.

Use of winter drawdown for AIS control is not currently recommended for the Chetek Lakes. There is low probability of success in controlling curly-leaf pondweed with the use of drawdown. Also, because of a lack of deepwater refugia in the lakes, winter drawdown to the depths necessary to impact curly-leaf would likely cause great harm to the fish and wildlife.

Although extended winter drawdown is not appropriate at this time, large-scale drawdown can aid in the control fish populations (for example, carp removal), make it easier to carry out dredging projects, consolidate flocculent sediments, pass high nutrient water, or provide opportunities to repair or modify existing structures [1].

10.9 Biological Control and Management

Biological control for aquatic plant management involves using animals, fungi, insects, or pathogens as a means to control nuisance plants. The goal of biocontrol is to weaken, reduce the spread, or eliminate the unwanted population so that native or more desirable populations can make a comeback. A special permit is required in Wisconsin before any biocontrol measure can be introduced into a new area.

Biological control of nuisance plants in aquatic systems has both positive and negative attributes. One positive is that control agents are often host specific, so effects to non-target species may be reduced. Control agents can also reproduce in response to increases in nuisance species density often without reapplication of the agent. Development and registration (where necessary) of biological control agents is generally less expensive than chemical agents.

Bio-control can have many potential disadvantages. A substantial risk is involved when new species are introduced as bio-control agents. To be considered successful, these species are expected to persist indefinitely in the environment where they are used, and may spread to new locations. Therefore, if there are any adverse effects resulting from the bio-control agent, these effects may be difficult or impossible to control. Other drawbacks include unpredictable success and rates of control that are slower than with chemical methods. Resistance in host species is unlikely to develop but can occur. Finally, agents that work in one area may not be suitable in all ecosystems. Climate, interference from herbicidal application, hydrological conditions, and eutrophication of the system can influence the effectiveness of bio-control agents. The goal of bio-control is to develop a predator-prey relationship where the growth of nuisance plants is reduced, but not eliminated.

10.9.1 Biological Controls in Wisconsin

Many herbivorous insects have been and continue to be studied for their impacts on unwanted aquatic plant species. An herbivorous aquatic moth (*Acentria ephemerella*), two native herbivorous weevils (*Euhrychiopsis lecontei* and *Phytobius* spp.), and a midge species (*Cricotopus* spp.) have been associated with the decline of EWM in lakes. Two *Galerucella* beetle species are being used to control purple loosestrife infestations very effectively in Wisconsin. The *Galerucella* beetles are easy to rear and can be extremely effective at reducing large populations of purple loosestrife. After nearly 20 years of use, *Galerucella* appear to have no negative effect on the areas in which they are introduced.

There are currently no biological controls for CLP, but research to identify and establish biological control is on-going. Studying naturalized and native herbivores and pathogens that impact nuisance aquatic and wetland plants increases the number of potential biological control agents that could be incorporated into invasive plant management programs. The groundwork has been laid for conducting future biological control research and experimentation. Although not all of the native and naturalized organisms researched can be successful, the information and expertise is now available for potential insects and pathogens to be collected, analyzed, and studied. A continuation of the work that has been started is needed to make available for the future more successful native bio-control agents [29].

There are several forms of biological control that have been used in other states, but are not approved for use in Wisconsin. The grass carp (*Ctenopharyngodon idella*), also known as the white amur, feeds on aquatic plants and has been used as a biological tool to control nuisance aquatic plant growth in other states. In addition to grass carp, common carp and tilapia (a fish species) have been added to ecosystems to reduce aquatic vegetation. Wisconsin does not permit the use of these fish for aquatic plant control.

Plant fungi and pathogens are currently still in the research phase. Certain species for control of hydrilla and EWM have shown promise, but only laboratory tests in aquariums and small ponds have been conducted. Methods are not available for widespread application. Whether these agents will be successful in flowing waters or large-scale applications remains to be tested [22].

10.9.1.1 Purple Loosestrife Beetles

There are several insects that have been studied and approved for biological control purposes of purple loosestrife. However, only one of them has been proven to be extremely effective for control of purple loosestrife. *Galerucella* beetles (*G. calmariensis* and *G. pusilla*) (Figure 43) have been used extensively across North America to help manage this aggressive wetland plant.

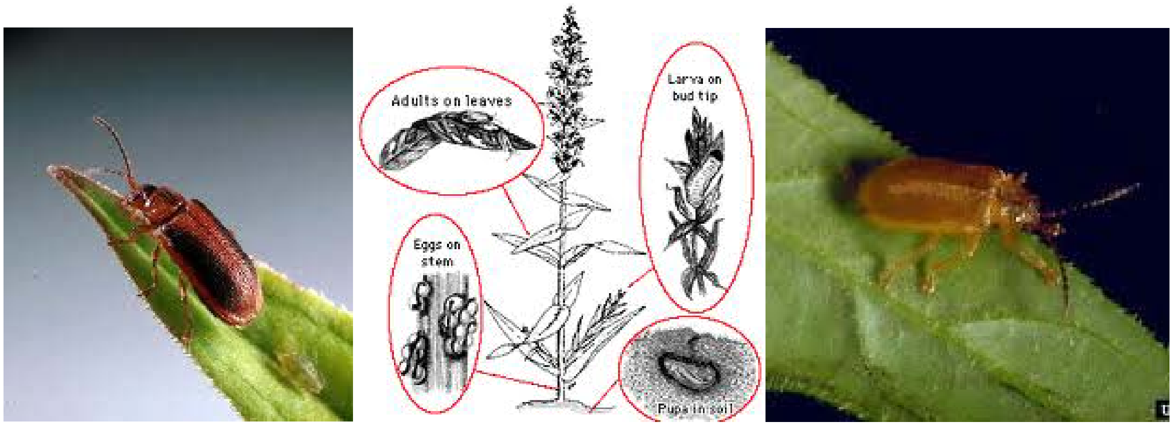


Figure 43 – *Galerucella calmariensis* (left), life cycle, and *G. pusilla* (right)

These insects are prolific breeders, feed only on purple loosestrife, are easy to rear in captivity, can fly, and tolerate cold winters. Generally, after introducing even just a few insects into a new area, a self-sustaining population can be established. Once established, a balanced predator/prey relationship between the beetles an purple loosestrife develops. Once the beetles have reduced the plant population the beetle population declines but never disappears. Figure 44 shows a purple loosestrife infestation in Barron County, Wisconsin before (1999) and after (2003) beetle introduction. In just four years almost all the purple loosestrife in this location was reduced to small, non-flowering, unhealthy plants.

Figure 44 – Before (right) and After (left) Beetle Introduction at Prairie Lake Township Marsh, Barron County, WI

10.9.1.2 Milfoil Weevils

While many biological controls have been studied, only one has proven to be effective at controlling EWM under the right circumstances. The milfoil weevil (*Euhrychiopsis lecontei*) is a native aquatic weevil that feeds on aquatic milfoils. Their host plant is typically northern watermilfoil, but they prefer EWM when it is available. Milfoil weevils are typically present in low numbers wherever northern or Eurasian watermilfoil is found. They often produce several generations 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. Both adults and larva feed on the plant. As the larva mature they 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, reduce the plants ability to store carbohydrates for over wintering reducing the health and vigor [30].

10.9.1.2.1 Purchasing Weevils

EnviroScience,Inc. has taken a patent on rearing and distributing the weevil. They call the program Milfoil Solution and bill it as the only environmentally sound and effective long-term control for EWM. Recent information indicates they have successfully introduced weevils to more than 100 lakes in the United States and Canada in the last ten years. According to EnviroScience, costs for using the Milfoil Solution program run about $1.50 per weevil purchased, but includes the costs of mapping, stocking, and monitoring of effects.

10.9.1.2.2 Rearing Weevils

More recently, researchers in Wisconsin have been developing a protocol for layperson rearing of the milfoil weevil. This process involves setting up large tanks with EWM and purchasing starter weevils from EnviroScience. With proper care and management, it is anticipated that this rearing method may be able to produce a 10 to 100 fold increase in weevils to be released into an affected area.

10.9.1.2.3 Success of Weevils

The milfoil weevil is not a silver bullet and they do not work in all situations. The extent to which weevils exist naturally in a lake, adequate shoreland 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. For example, in Washington State weevils were found in EWM-infested lakes with a higher pH (about 8.7) and harder water (132.4 mg $CaCO_3$/liter) than infested lakes without weevils [31].

In-lake weevil densities in Wisconsin have been found to be positively correlated with percent natural shoreline and negatively correlated to percent sandy shoreline [32]. Undisturbed grasses may be more important than forested areas for providing good over wintering habitat for weevils [33]. Dry sites available as opposed to areas that are affected by rising fall or winter lake levels are likely important for weevil habitat as well. While smaller populations of weevils in a lake may not be impacted by the amount of over wintering habitat, at a larger scale, such as would be created by artificial stocking, over wintering habitat could be a limiting factor.

Bluegill and sunfish populations can impact the success of milfoil weevils in a lake through predation [34]. If there is an over-abundant population of these fish species in a water body it is possible that introduced weevils could become fodder before ever having an impact on the EWM.

10.10 Top-down Biomanipulation

Biomanipulation involves techniques to manipulate the biological structure in the lake to improve water quality and centers around nutrient availability and the trophic structure or food web of the lake [35]. This approach has been used to lessen or eliminate nuisance blue-green algal populations, change the fisheries to a more desirable population, and alter the macrophyte community for fisheries or recreation. To successfully implement biological manipulations, it is important to understand the interaction between species traits and environmental conditions.

Usually one trophic level is manipulated and the effects of restructuring one level cascade to lower levels of the biological community. For example, small often microscopic critters called zooplankton feed on algae, like cows feed on grass. If there is a significant decline in zooplankton, perhaps because an over-abundance of small panfish eat them, then it is possible for the levels of algae to go up in a lake. It may be possible to reduce the number of small panfish by introducing larger predator fish, or by upping the exploitation limits. If panfish are reduced, then zooplankton can rebound again reducing the amount of algae in a system. The milfoil weevil is another favorite food source for small panfish. Reducing the number of panfish may support greater survival of the weevils and other biological control agents.

Another trophic relationship was found between snails and EWM, suggesting the presence of snails can limit EWM growth [36]. EWM produces biochemicals that prevent epiphytic algae from growing around it, giving EWM a competitive advantage over native plants in eutrophic waters (where algae are common). Snails, which are algal consumers, may reduce the competitive advantage of EWM by reducing algal blooms that would otherwise shade and compete for nutrients with native plants. In the absence of snails, both EWM and algae (epiphytic and filamentous) achieved greater biomass [36].

10.11 Dredging

Dredging is usually not performed solely for aquatic plant management but to restore lakes that have been filled in with sediments, have excess nutrients, have inadequate pelagic and hypolimnetic zones, need deepening for navigation, or require removal of toxic substances. Small dredging projects that would accomplish many of the previously mentioned objectives could benefit the Chetek Lakes. Historically, high levels of copper arsenate have been used to control aquatic plants and algae. In the areas where this type of management was practiced, there may be sediment characteristics preventing aquatic plant growth. Undoubtedly, testing of the sediments in these areas would have to be completed to determine if it was toxic, requiring special disposal conditions. The Chetek Lakes are an impoundment created some 150 years ago and there are areas that have been filled in by sediment washed in or areas where organic material has been deposited for decades that would benefit from dredging.

A WDNR permit is required to perform any dredging in a waterbody or wetland. Part of the permit application requires information on the method, location, initial and final depths, and conditions under which dredging will be completed. Due to the history of the Chetek Lakes sediment analysis will likely be required to determine the proper disposal method of dredged materials.

10.12 Nutrient Management to Reduce Less Desirable Aquatic Plant Growth

Research has shown that as human development on the lake shore increases, the amount of aquatic plant growth near that lake shore decreases. A study of 44 lakes in Minnesota with varying amounts of developed shoreline found an average loss of aquatic plants in developed areas of 66% [37]. On a lake wide basis, this loss of aquatic plant growth can lead to higher levels of phosphorus and an increase in the growth of algae.

Runoff from a developed property may increase the amount of available phosphorus in the littoral zone immediately adjacent to that property causing greater algae growth in place of plant growth. Casual observations during plant survey work completed in the region suggests a relationship between developed shorelines (specifically, those properties with mowed and apparently fertilized lawns to the edge of the lake) and an increase in more problematic native plant species like coontail, duckweeds, and filamentous algae. While it is not clear if the installation of buffer strips and other runoff reducing best management practices can directly improve conditions within the littoral zone immediately adjacent to a property, it is known that if enough of these best management practices are installed around an entire lake system, nutrient levels within the lake can be reduced [38, 39].

10.13 Algae Control

Many of the back bays on the Chetek lakes are impacted by mat-forming filamentous algae (Figure 45). These floating mats often form where existing plant beds provide structure for holding them in place. Large areas can impact navigation, prevent native plants from flourishing, and are aesthetically very displeasing. Reducing the inputs of phosphorus to the lakes is the long-term solution to this problem and is and will continue to be pursued and expanded, however limited management in the short-term should also be considered. Aquatic plant harvesting and selective use of herbicides will alleviate some but not all of the issues caused by mat-forming filamentous algae.

Figure 45 – Filamentous Algae

Two methods have been found to be helpful in managing filamentous algae. However, neither of these methods is wholly supported by the WDNR or this lake consultant. They are both tools that are available and that may be used under certain circumstances, but are not recommended.

10.13.1 Copper

Copper is an effective algicide and is registered for use in potable water supplies. Management of filamentous algae using copper sulfate has long been a tool in a lake manager's toolbox. In the Chetek Lakes from the 1940's to 1970's tens of thousands of pounds of copper sulfate were used to provide control of algae growth. Since that time, its use has been mostly discontinued as the short term benefits provided by its use are heavily out-weighed by the negative impacts it has on the lake ecosystem. Several U.S. states, including Wisconsin, have started to restrict or phase out copper as a management tool, or only permit its use at very low concentrations [1]. The effectiveness of copper has been enhanced by either complexing copper with a carrier molecule, or by chelating it to non-metal ions, to keep copper in solution. These formulations allow more effective treatments at lower doses [1].

There are many different species of algae, and copper has been shown to be more effective on some than others. Some algae species have even been shown to be copper resistant. Water conditions such as pH effect the efficacy of the herbicide as do certain chemical processes, biological uptake, and adsorption on materials such as clay [1]. As a result, effective doses vary among lakes. Although the effect of copper on filamentous algae can be rapid, it is generally short-lived. After use, species other than the target algae may become dominant, or algal biomass may "rebound" to levels similar or higher than the original bloom condition [1]. Where significant nutrient enrichment continues, increasingly frequent and heavier doses of copper may be needed [1]. It also has many other negative drawbacks.

A tremendous amount of research has shown that copper sulfate negatively impacts aquatic communities including benthic invertebrates, zooplankton (including daphnia), and fish (including bluegills). Resistance may develop in the target algae, and algae grazing by zooplankton may be eliminated. Dissolved oxygen depletion can occur when large volumes of dead algal cells decompose creating more problems. And high levels of copper could also create human health problems [1]. Copper build up in sediments could delay or greatly increase the cost of any sediment removal (dredging) project that may be considered on the lakes in the future.

The use of copper in any form to provide short-term and limited control of algae should only be considered in extreme cases. Although copper has been used in the Chetek Lakes in the past, and its use now could benefit a limited number of people for a short period of time, it is not an aquatic plant management recommendation in this plan at this time.

10.13.2 Barley Straw

Organic materials, such as peat and barley straw, have been used for control of rooted aquatic plants and algae. There are several theories for why barley straw may work. One theory suggests that decomposing straw uses up nutrients in the water so they are not available for algae growth. Another suggests that decomposing straw gives off compounds toxic to algae [12]. Although mixed results have been reported, it is known that the decomposition of the straw requires oxygen, and the application of excessive amounts of straw could reduce the oxygen content of the water to levels that stress or kill fish.

Questions still remain as to whether barley straw is an algicide (kills existing algae) or an algistatic (inhibits algae growth). This designation is an important one for if it is considered an algicide it is also considered a pesticide. Because barley straw is not an EPA- registered pesticide, it cannot be sold as a pesticide or recommended for algae control; this would be the same as distributing an unregistered pesticide [40]. Although there is little evidence that barley acts like typical clarifiers such as alum (which causes the precipitation of phosphorus or removes particles from the water), this is one way in which the direct claim or implication of “algae control” can be avoided [40].

More research is required before any recommendations regarding barley straw can be made. Placement of any barley straw in waters of Wisconsin may require a permit from the WDNR. This plan does not recommend or prohibit the use of barley straw. If the CLPA or individual property owners wish to incorporate barley straw in management actions for the lakes, it would be considered an individual choice and any WDNR permitting or other information needed would be the responsibility of the one choosing to incorporate it.

11.0 Other Aquatic Plant Management Alternatives

Not all aquatic plant management alternatives available are effective and appropriate for every lake. It is important for a group considering aquatic plant management to be aware of other alternatives and why they are not appropriate. This awareness enables the group to make informed decisions and answer potential questions regarding the aquatic plant management strategy being implemented. The following management alternatives are not appropriate for the Chetek Lakes at this time, but some may be utilized in the future should the need arise.

11.1 Suction Dredging

Suction dredging is a form of mechanical harvesting where diver-operated suction tubes connected to a barge- or pontoon-mounted pumps and strainer devices with hoses, are used to vacuum plants uprooted by hand. This management technique is called harvesting because even though a specialized small-scale dredge is used, sediments are not removed from the system. Sediments can be re-suspended during the operation but use of a sediment curtain would mitigate these effects. Plants are removed directly from the sediments by divers operating this device. Suction dredging is mostly used for control of isolated, new infestations of AIS, and therefore not appropriate at the present time in the Chetek Lakes.

11.2 Other Mechanical Management

Cutting without plant removal, grinding and returning the vegetation to the water body, and rotovating (tilling) are also methods employed to control nuisance plant growth in some lakes. Cutting is just like harvesting except the plants are left in the waterbody. Grinding incorporates cutting and then grinding to minimize the biomass returned to the lake. Smaller particles disperse quicker and decay more rapidly. Rotovating works up bottom sediments dislodging and destroying plant root crowns and bottom growth.

Bottom rollers and surface sweepers are devices usually attached to the end of a dock or pier and sweep through an area adjacent to the dock. Continued disruption of the bottom area causes plants to disappear and light sediments to be swept out. The use of rollers may disturb bottom dwelling organisms and spawning fish. Plant fragmentation of nuisance weeds may also occur. In soft bottom areas, sediment disturbance can be significant. These devices are generally not permitted in Wisconsin. A permit under Section 30.12(3) is required which governs the placement of structures in navigable waters.

Aquatic plant removal is sometimes done by riparian land owners using a bed spring, sickle mower blade, or other contraption attached to the back of a boat, lawn mower, or ATV which is dragged back and forth across the lake bottom. This type of management is considered mechanical and is generally not permitted by the WDNR.

11.3 Aquatic Plant Habitat Disruption

Aquatic plant habitat disruption involves management activities that alter the environment in which aquatic plants are growing. Several techniques are commonly used: drawdown or flooding, dredging, benthic barriers, shading or light attenuation, and nutrient inactivation. While not prohibited in Wisconsin, these plant management alternatives will undergo much greater scrutiny by the WDNR, and in most cases will not be permitted.

11.3.1 Benthic Barriers and Light Reduction

Benthic barriers or other bottom-covering approaches are another physical management technique that has been in use for many years. The basic idea is that the plants are covered over with a layer of a growth-inhibiting substance. Many materials have been used, including sheets or screens of organic, inorganic and synthetic materials, sediments such as dredge sediment, sand, silt or clay, fly ash, and combinations of the above. WDNR approval is required and screens must be removed each fall and reinstalled in the spring to be effective over the long term.

12.0 Aquatic Plant Management Discussion

There are three main objectives in the aquatic plant management plan for the Chetek Chain of Lakes. First, is increasing the distribution and diversity of native aquatic plants in the Chain; second, is reducing the impacts of CLP and other AIS on native plants, fish and wildlife, and water quality; and third is to provide navigation and access relief to lake users and property owners.

12.1 Managing Native Aquatic Plants

Aquatic plant survey work completed in 2011 in general, indicates very limited aquatic vegetation (emergent, floating-leaf, and submerged) in the Chetek lakes. Prairie, Chetek, and Pokegama lakes in particular have very limited aquatic vegetation, native or non-native, through most of the open water season. Littoral zones in the lakes start out deeper in the spring and then quickly decline as algae begins to dominate the water column, reducing clarity (Table 6). In 2011, Prairie and Chetek lakes lost 2-ft or more of littoral zone between May and July. Pokegama Lake supported little vegetation throughout the open water season. In these three lakes, small and large duckweed, and coontail (free-floating species that need little water clarity to thrive) dominate the summer littoral zone. In many of the back bays throughout the system, floating leaf species like white-water lily and spatterdock extend out to about 4-ft of water, but beyond that, almost no aquatic vegetation remains.

Mud Lake, Tenmile Lake, and the eastern end of Chetek Lake have the most diverse and dense areas of native aquatic vegetation in the entire system. Most of this plant growth occurs in areas with higher water clarity supported by water coming in from tributaries including Moose Ear Creek, Tenmile Creek, and Pokegama Creek. Upon leaving the area of the lakes immediately impacted by inflow from the tributaries, summer aquatic plant growth basically disappears. Summer mean and median depths of aquatic plant growth in Mud and Tenmile lakes is actually lower (range 3.0-3.3 ft) than in the rest of the system (range 3.5-3.6 ft).

Many of the areas in the system that are dominated by CLP in the spring recover a tremendous amount of native plant growth after the CLP senesces in late June and early July. This is most prevalent in water less than 5-ft deep, as limited water clarity after CLP senescence prevents native plants from thriving in deeper water. In these same areas, early season native plant growth consisting of fern-leaf, flat-stem, and large-leaf pondweed successfully compete with CLP.

Management of native plants in this plan focuses on protecting and expanding existing native plant beds by reducing early season competition with CLP in deeper water (> 5-ft). An effort to re-establish native aquatic plants (particularly emergent species) along areas of the shoreline currently void of vegetation is also recommended. Appropriate aquatic plants can be purchased or moved into the restoration zone from other areas of the lake. Placing in-lake structures to protect new plantings is also recommended. Wild rice is currently present only in the mouth of Tenmile Creek and immediately upstream. Rice seed from this area could be used to attempt establishment of wild rice in other areas of the lakes with suitable habitat.

Efforts to improve water clarity in the system by reducing nutrient loading and increasing flushing will also promote greater aquatic plant growth throughout the system. Altering the current water level management program in the system to reflect a more natural regime may also increase the distribution, diversity, and density of native aquatic plants.

In Mud and Tenmile lakes, native vegetation in water < 5-ft deep does cause navigation issues both for landowners wanting to access open water, and general boat traffic later in the season. This plan does not support the use of herbicides to manage any native aquatic plants, but does recommend opening of navigation and access channels through these areas via mechanical harvesting and physical removal. In a shallow lake system, aquatic plant management needs to focus on removing problematic aquatic plants rather than just killing them and leaving them to decay in the lake. Decay of any aquatic plant releases nutrients into the system and adds to the build-up of organic material in the bottom of the lake. Harvested vegetation is completely removed from the lake eliminating both these potentially negative consequences. Furthermore, harvesting does not permanently remove growing vegetation; it only cuts that portion of it causing navigation issues, leaving the growing plant to continue providing habitat and using up nutrients.

The overall goal of native plant management is to increase the diversity, distribution, and density of native aquatic plants throughout the entire system with the purpose of affecting a change from a more algae dominated state to a more plant dominated state. By doing so, more nutrients get used up, fish and wildlife habitat is improved, and eventually water clarity improves when a switch from algae dominance to a more diverse aquatic plant community is made. It is recognized though, that dense native aquatic plant growth can also inhibit lake use, so conditions are set up to provide relief when necessary.

12.2 Managing Algae

Both filamentous and planktonic algae impact the Chetek Lakes. Copper sulfate has been used in the past to manage algae growth in the system, but has been discontinued for some time due to negative impacts that could result. Harvesting of navigation channels and selective use of herbicides to control CLP may reduce the negative impacts caused by filamentous algae. Reducing the level of planktonic algae will be achieved by reducing the overall phosphorus load into the lake, by selective nutrient management actions within the lakes, and by increasing the distribution, diversity, and density of aquatic plants throughout the system. Reductions in the amount of algae growing in the lakes are not expected to be immediate, but will hopefully decline over time.

12.3 Managing Curly-leaf Pondweed

CLP is present in about 10% of the surface water in the entire Chetek Lakes. Based on this, the overall negative impact to system caused by CLP is limited. However, each lake is impacted differently by the CLP that is present. CLP is one of the few early season plants present in Prairie Lake covering nearly 8% of the total surface area, providing essential early season habitat for fish and wildlife. At the same time it negatively affects native plant growth, adds nutrients to the lake when it senesces, and in certain areas, causes nuisance and navigation issues for landowners. Dense growth CLP covers 35% and 26% of the surface area in Mud and Tenmile Lake respectively. Here too, it affects native plant growth, adds nutrients, and causes nuisance and navigation issues for landowners. However, it is not as essential for providing early season habitat for fish and wildlife, as native plants are also abundant during this time frame. Both Chetek and Pokegama lakes have limited amounts of CLP covering only 4.6% and < 1% of the surface area in each lake respectively. In Chetek Lake, CLP does inhibit native plant growth, while in Pokegama Lake, there is little native plant growth to impact. Decay of CLP adds nutrients to the lakes, but this impact is very limited in Pokegama Lake due to the low density therein. CLP does not really impact landowner access or navigation in these two lakes, with the exception of the extreme eastern end of Chetek Lake.

Since the impacts caused by CLP in each lake are different, CLP management recommendations are different for each lake. However, three main objectives drive all the CLP management recommendations for the lakes. The first is to reduce competition between CLP and early season native aquatic plants without negatively impacting essential habitat. The second is to reduce nutrient loading from decaying CLP without negatively impacting essential habitat, and the third is providing early season landowner access to open water and general navigation relief from dense growth CLP, again without negatively impacting essential habitat.

In Mud and Chetek Lakes, larger beds of CLP will be chemically treated as early as possible in the spring for a minimum of two years, and preferably three. The areas to be chemically treated are in water greater than 5-ft deep, away from designated sensitive areas, and large enough to reduce growing competition with CLP enabling native plants to flourish earlier when water clarity is best, maintaining their presence longer into the summer season. At the same time, early season chemical treatment will prevent significant amounts of CLP from growing, reducing nutrient loading and turion production later in the season. If this management strategy successfully increases the amount of desirable native vegetation in the treated areas, it may be expanded to include addition areas, possibly even areas currently designated as sensitive areas.

If the suggested recommendations for aquatic plant management in Mud Lake fail to reduce the level of filamentous algae, the limited use of algicides like copper sulfate will be reevaluated.

In Tenmile Lake, almost all the area dominated by CLP in the spring is replaced by diverse and abundant native vegetation after CLP dies. Early season chemical treatment of CLP in Tenmile Lake risks negatively impacting native vegetation already present. However, navigation through portions of Tenmile Lake and landowner access to open water is severely impacted by dense growth CLP. Harvesting of 40-60 ft wide channels for navigation purposes and 20-ft wide channels for improving landowner access to open water is recommended. Harvesting will not be allowed in water less than 3-ft deep and will be completed when CLP is visible within a foot or two of the surface. Cutting can occur that is no more than 2/3 the depth of the water.

In Prairie Lake, CLP is one of the few early season aquatic plants present providing essential fish and wildlife habitat. After it dies, very few native aquatic plants take its place. For this reason, large-scale removal of CLP using either chemical herbicides or harvesting is not desirable, even though it would reduce the nutrient load to the lake. Since very few native plants exist in the waters of Prairie Lake dominated by CLP, early season management will not increase native plant growth. Dense growth CLP does cause serious nuisance and navigation issues, particularly in the area of Gopher Point and the channel between Prairie and Mud lakes. Harvesting of 40-60 ft wide channels for navigation purposes and 20-ft wide channels for improving landowner access to open water is recommended. Harvesting will not be allowed in water less than 3-ft deep and will be completed when CLP is visible within a foot or two of the surface. Cutting can occur that is no more than 2/3 the depth of the water.

Since there is no significant CLP growth documented in Pokegama Lake, no management is recommended at this time.

In all of the lakes, restoring or reestablishing beds of emergent wetland fringe plant species is recommended.

12.4 Managing Purple Loosestrife

Purple loosestrife can be effectively controlled by physically removing new or isolated individual plants and small beds of plants. Pulling and digging are both effective but can leave root parts in the ground that will often grow new plants. AIS monitoring that includes purple loosestrife should be completed annually in July and August. Small-scale herbicide use can also be an effective management alternative. A foliar spray or dabbing of cut stems with glyphosate can be effective particularly when coupled with flower head removal, but a WDNR permit may be required for its use over, in, or near water.

Biological control using Galerucella beetles has been used in other areas of Barron County by the WDNR and Barron County Soil and Water Conservation Department to control the spread of this plant. Hundreds of thousands of beetles have been distributed around Barron County and neighboring counties since the mid 1990s resulting in documented established populations of the beetles throughout the county. If areas of purple loosestrife are identified where physical removal or the use of herbicides is impractical or difficult to implement, beetles could be collected and distributed in these areas.

12.5 Managing Other AIS

Japanese knotweed is difficult to control, and Barron County has been working on a bed near the Chetek dam for many years. The CLPA should partner with Barron County and the WDNR to continue that control project. An integrated approach to control Japanese knotweed is best. Incorporating early cutting with later herbicide application allows for more options and flexibility. Digging, pulling, or tilling before herbicide application may increase the effectiveness of herbicides. Herbicides can be applied by foliar spraying, dabbing of cut stems, and injecting stems with herbicide. Both glyphosate and triclopyr have been used in varying concentrations to treat Japanese knotweed. The best time to apply foliar sprays is when the plant is 3-6 feet tall either in the early summer or when new growth occurs shortly after cutting.

Biological controls for Japanese knotweed are being researched in Europe. Several insects and a leafspot fungus are currently undergoing safety and efficacy testing, but none have been approved for use in the United States at the present time.

A reed canary grass management guide was developed by the Wisconsin Reed Canary Grass Management Working group and is available online as a downloadable PDF at: ftp://ftp-fc.sc.egov.usda.gov/WA/Tech/RCG_management_0509.pdf

Other AIS including EWM will continue to be monitored for, but no specific management is recommended at this time. Should monitoring activities identify EWM in the system, procedures established in an EWM Rapid Response Plan (Appendix E) will be followed.

12.6 Formation of a Lake Protection and Rehabilitation District

Data from the 2011 Property Owners Survey indicated that 63% of all survey respondents felt that the Chetek Lakes Protection Association should be responsible for management of the Chetek Lakes. Only a third of all property owners are actually members of the CLPA. This suggests that nearly two-thirds of the total property owners on the lake feel that one-third of the total property owners should foot the bill for management. This is a wholly unfair breakdown of the potential costs to make substantial improvements to the lakes. CLPA annual membership dues are only $15.00, so even with 100% voluntary landowner membership the funds available to the CLPA to make changes are limited.

One way to ensure more substantial funding for making improvements to the lakes is to form a Lake District. In WI, a Lake District is considered a governmental body and therefore has taxing authority over the constituency represented by the Lake District. Also in WI, a Lake District may set a taxing mill rate as high as 2.5 mills (0.0025) based on property value which equates to a $250.00 for every $100,000.00 worth of value a property has. If a home on the Chetek Lakes is valued at $500,000, that homeowner would pay $1,250.00 annually to support the Lake District.

Although a Lake District can set its mill rate as high as 2.5, it does not have to. A mill rate high enough to cover expected annual costs for management would more likely be set. In the case of the Rice Lake Protection and Rehabilitation District supporting management activities on Rice Lake in Barron County, their mill rate is 0.00013 or just $13.00 for every $100,000 of property value. For a $500,000.00 home on Rice Lake the annual tax is only $65.00.

Every property within the boundaries set when a Lake District is first formed would be required to pay the mil rate, so 100% of those directly benefitting from the lake would be taxed, spreading the burden of management on all, rather than just a few. Each year a Lake District must propose a mill rate to its constituency and justify the need for it. The constituency may vote to accept, modify, or decline the proposed mil rate. Once accepted, the tax is included in the regular property tax bill. Once collected, the entire tax paid by the constituency is passed to the Lake District in cash. None of the tax is removed for local, state, or federal entities, it all goes to the Lake District for use as they deem necessary.

Many people feel that the taxes incurred by forming a Lake District would be too much given most lake property owners already pay more in taxes than any other property owners. Many complain that more of the money already taken out for taxes should go to supporting the lake. While this sentiment may sound appropriate, the reality is that the money taken out through regular taxes goes to support many more of the services that most people want: schools, public safety, etc leaving little left for the lake. Taxes collected through a Lake District stay with the lake and can only be used for lake related actions.

Another common complaint from property owners is that they are not the only ones to benefit from the lakes. Many people who do not own property on the lake use the lake and are not required to support management actions as would be the case for property owners included in the Lake District. This dynamic also seems unfair. Some of this concern can be minimized if lake users are asked to support management actions in other ways, or have their costs to use the lake go up, as could be the case with increased resort fees for cabin rental. Lake users could be asked to pay a launch fee as well. Donations to support lake management actions could be solicited as well. Perhaps the best way to offset the unbalanced financial support is to take advantage of local, county, state, and federal grant programs to obtain funding for management actions. Wisconsin lake grant programs are funded by taxes that are already paid by residents from across the entire state.

Forming a Lake District is not easy therefore the task should not be taken lightly. It requires the support of at least 51% of all the properties to be included if formed. Once this is obtained it must be taken to the local authority (in this case, Barron County) for approval. Lake District boundaries must be legally drawn, a Lake District Board established, and a mil rate decided on. It generally takes several years from first planning to actually being established. Once established the Lake District is a governmental body. It will have representatives from the local counties, townships, and municipalities represented in the District Boundaries. It requires regular meetings of the board, and at least one annual meeting for the constituency.

A Lake District that would serve the Chetek Lakes would go a long way toward implementing management actions to improve the lakes and is recommended in this APM Plan.

13.0 Aquatic Plant Management Goals, Objectives, and Actions

As previously established, aquatic plant management is necessary in the Chetek lakes. A combination of management alternatives will be used to help minimize the negative impacts of CLP on native plants and water quality, and provide navigation and nuisance relief. Aquatic plant management options to be utilized include small-scale physical removal, targeted use of aquatic herbicides, and large-scale mechanical harvesting. Purple loosestrife management will consist of physical removal, limited use of herbicides, and biological controls. The Chetek Lakes Protection Association (CLPA) will partner with Barron County to continue management of Japanese knotweed in the system. Other AIS will continue to be monitored, but no specific management is recommended at this time.

Aquatic plant management in the Chetek Lakes will follow six goals, each with a number of objectives and actions, over the course of the next five years. While the goals are inclusive of all of the Chetek Lakes, some of the objectives and actions vary between lakes. Appendix F is an outline of the aquatic plant management goals and activities, and Appendix G is a five-year timeline for completion of the activities included in this APM Plan. Any major change in activities or management philosophy will be presented to the CLPA and the WDNR for approval. The six goals for this plan are as follows:

1. Increase native aquatic plant diversity, distribution, and density in the Chetek Lakes.
2. Complete aquatic invasive species management that: encourages greater native plant growth; reduces phosphorus inputs caused by decaying vegetation; does not negatively impact the fishery; and provides nuisance and navigation relief for lake users.
3. Provide late season (native aquatic plant) nuisance and navigation relief for lake users and riparian owners.
4. Sponsor and support education, fundraising, monitoring, and prevention activities.
5. Increase appreciation for aquatic ecosystems and habitat in the Lake Community
6. Reduce total nutrient inputs from non-point sources to the Chetek Lakes

This APM Plan will be implemented by the Chetek Lakes Protection Association, their consultants, and through partnerships formed with the WDNR, Barron County, local townships, other federal, state, and Tribal agencies, and local clubs and organizations. Annual reports and end of project assessments will be completed throughout the duration of this 5-year plan.

13.1 Goal 1 – Increase Native Plant Diversity, Distribution, and Density

The density and distribution of aquatic plants in the Chetek Chain of Lakes is extremely low. Aside from a few shallow water species including coontail, small and large duckweed, and white water lily very few native plants exist in most of the system. The few exceptions to this are the dense beds of native aquatic vegetation where Pokegama, Moose Ear, and Tenmile Creeks enter the lakes. Diversity and density are very good in these areas, with density actually causing navigation and open water access issues. CLP growth is most dense in water 5-7 feet deep excluding native vegetation from the areas it dominates in the spring. By the time the CLP senesces, the water clarity has declined far enough to prevent recovery of the native species in these areas. Promoting the expansion of the more desirable native plants in the system, as well as trying to reestablish new beds of native aquatic vegetation is the cornerstone of plant management for the Chetek Lakes.

13.1.1 Protect and Enhance Native Plant Beds

This plan strives to protect existing native plants beds throughout the system. Management recommendations are made to ensure no or very limited impact to the native aquatic plant beds that currently exist. Not only are these beds beneficial to the lake system overall, they also serve as a potential source of aquatic vegetation that may be used to reestablish new beds. Some of these beds cause navigation and open water access issues which will be remedied in a manner that reduces the negative impacts to them.

13.1.2 Increase and Expand the Depth of the Summer Littoral Zone

The spring littoral zone in the Chetek Lakes ranges from 7.5 to 9.5 ft. By early summer those numbers drop to < 6-ft to 7.5 ft. If the depth of the spring littoral zone could be held longer into the summer, more native plants would have a chance to recover after the CLP senesces and the before the water clarity declines. More plants would lead to greater clarity, and additional native plant growth.

13.1.3 Reestablish the Wetland Fringe

Encouraging existing plant beds to spread will not be enough in the Chetek system. There are many areas where little to no native vegetation exists even before CLP takes over, and little to no vegetation recovers after the CLP senesces. Property owners willing to try and reestablish native plant beds will be identified and efforts to restore wetland fringe plants (rushes, sedges, cattails, and flowering plants like pickerel weed) will be planted and certain protection structures put in place to guard restoration sites against wave action that would tear out the newly planted beds.

13.1.4 Protect and Enhance Wild Rice Beds

Wild rice currently exists only in Tenmile Creek where it empties into Tenmile Lake. Wild rice seed in Tenmile Creek is seldom harvested for consumption, but could be harvested for introduction in others areas of the lakes. Similar conditions may exist in other tributary inlets including Moose Ear, Pokegama, and Rice creeks. Wild rice is considered a wetland fringe plant, and will be introduced in areas deemed appropriate by wild rice resource personnel from the Great Lakes Indian Fish and Wildlife Commission and the WDNR. Landowner support will be sought before wild rice restoration projects are implemented as the existence of wild rice generally complicates management efforts.

13.1.5 Restore More Natural Water Level Fluctuations

By creating more natural water level fluctuations the distribution, density, and diversity of aquatic plant growth could be improved. The water level in the Chetek lakes currently fluctuates less than a few inches throughout the year from the level set by the operation plan for the Chetek Dam. Reducing the water level further through the winter and holding it at that level through the late spring could increase the amount of the littoral zone that becomes and remains vegetated. In addition, passing water from snowmelt and runoff through the system both over the existing dam and through a new regulated outlet established in the dike where the natural flow of Tenmile Creek was interrupted could reduce the level of nutrients that remain in the lake. Reducing water level during periods of high nutrient inputs such as immediately following large rain events and after CLP senesces could also help to reduce algae growth to be replaced by native plant growth. Restoring more natural water fluctuation in the Chetek system would require a huge education effort to get people to understand the benefits of changing water levels. Barron County owns the Chetek Dam and the dike that was built at the Tenmile Creek one time outlet. They would have to be convinced that changing the dam operation plant would not cause tremendous amounts of complaints from property owners and lake users.

13.1.6 Assessment

Determining the success of the management recommendations made to increase the native aquatic plant distribution, diversity, and density will be accomplished by comparing the results of annual pre- and post-treatment aquatic plant surveying and wild rice bed mapping, and five year mid-season aquatic plant surveying, to existing data.

13.2 Goal 2 – Complete Aquatic Invasive Species Management

13.2.1 CLP Management

13.2.1.1 Physical Removal

An integrated approach to managing certain areas of CLP in the system is recommended. Physical removal of CLP by residents and users is unlimited and does not require a permit from the WDNR. Physical removal is somewhat self limiting due to the work involved. CLP can be pulled or cut using divers, wading, or from a boat provided all pulled or cut plant material is removed from the water. Raking CLP fragments washed into the shoreline can reduce the amount of vegetation left to decay in the bottom of the lake. Landowners practicing raking can use their time as match if an AIS Control grant is used to help implement CLP management.

13.2.1.2 Herbicide Application

Early spring, low dose herbicide application will be used to control larger areas of dense CLP growth. Herbicide application will be targeted to areas large areas in 4.5-7.5 feet of water where native plants fail to re-colonize after CLP senesces. The purpose of this management action is two-fold. First by preventing CLP from dominating deeper water areas early in the season native plants may be able to take advantage of the clearer water and deeper littoral zone that spring provides. The areas targeted for treatment are on the edge of larger areas where native plants make a strong recovery after CLP senesces. It is expected that the existing beds of native vegetation will expand into areas where CLP is chemically treated. Second, by treating large areas of CLP early in the spring when CLP plants are only a few inches tall, CLP biomass is reduced, turions are depleted over time, and fewer nutrients are dumped back into the system when CLP senesces. Large-scale herbicide applications will not occur in areas currently listed as potential “sensitive” or with high habitat value, at least not until it is proven in the Chetek lakes that native plants do recover more rapidly when CLP is removed. After several years of herbicide application, if positive results are shown continuing this management practice within sensitive areas will be considered.

Herbicide application will also occur in small areas that are adjacent to public access sites that are more heavily used by fishermen during the CLP, if dense CLP growth impacts the use of the landing.

13.2.1.3 Mechanical Harvesting

Dense growth CLP also causes severe navigation issues in certain areas. Some of these areas are within sensitive areas, or in places where very few aquatic plants remain after CLP senesces. In these areas, CLP provides habitat for young of the year fishes and other wildlife. Removing large swaths of CLP could damage the fishery that is the mainstay of the Chetek lakes. In these areas, contracted harvesting, or at some point in the future, harvesting completed by the Chetek Lakes Protection Association itself, is recommended. Mechanical harvesting removes biomass without permanently killing desirable vegetation.

In dense areas of CLP growth where navigation is impacted, a single boating channel up to 40-ft wide will be harvested. In sensitive areas, or in areas near shore where property owner access to open water is impaired by dense CLP growth, channels up to 20-ft wide will be harvested. These channels should be parallel to shore and the ends of docks so that more property owners can get relief with fewer cut channels. No harvesting will occur in water <3-ft deep and cutting depth cannot exceed 2/3 of the water depth. All navigation and open water access channels will be pre-determined. One time spring harvesting of CLP navigation and open water access channels will be completed between May 15th and June 15th. Additional requests for harvesting consideration can be made by property owners, but actual harvesting may not occur until the following year.

13.2.1.3.1 Off-loading and Dumping Sites

The CLPA, its consultant, local towns, and Barron County will determine appropriate off-loading sites and dumping sites for vegetation harvested during this project. Preferably, sites will be located close to the areas of the lakes where the majority of mechanical harvesting is completed. All dumping sites will be approved local landowners, town governments, Barron County, and the WDNR.

13.2.1.4 Herbicide and Harvesting Permits

All herbicide and harvesting permit applications will be applied for by the CLPA and include all predetermined chemical treatment and mechanical harvesting areas. Individual landowner permit applications are discouraged as it becomes more difficult to track management overall when multiple permits are applied for by multiple parties. By including all proposed management areas in single permit applications prepared by the CLPA (or their retainers) management is more easily tracked, as are the impacts of management. This also saves individual property owners fees that are associated with the applications. The CLPA will do its best to accommodate property owner requests for management and as such will keep communication channels open and inform its membership when management requests need to be made. Actual management costs may be covered by the CLPA, individual landowners, or shared by both.

13.2.2 CLP Monitoring and Management Assessment

13.2.2.1 Pre- and Post-Treatment Aquatic Plant Survey

Because large-scale herbicide application will be used to control CLP in the Chetek Lakes, pre- and post-treatment aquatic plant surveys will be used to do a couple of things: 1) confirm CLP treatment areas set up the previous fall based on spring bed mapping the year prior to the treatment year, and 2) to determine the impact the treatment has on the target species (CLP) and non-target species. As previously mentioned the main goal of these larger herbicide application areas is to encourage expansion of native plant growth in the treated areas. Post-treatment survey is one way to quantify this. Pre and post treatment points will be established by resource professionals contracted by the CLPA for this purpose. Pre-Post will follow guidelines established by the WDNR (Appendix H).

13.2.2.2 Spring Bed Mapping of CLP

Spring bed mapping of CLP beds in the Chetek lakes will be completed annually by trained mapping crews from the CLPA. The purpose of the mapping is to determine the extent of CLP in the system annually. This information will be used to set up treatment plans for the following year. Pre treatment survey work in the spring (as mentioned above) would confirm the presence of CLP before actual treatment. The same data would serve as measurement of the success had by managing CLP over time.

13.2.2.3 Turion Density Monitoring

Turion density sampling of at least 200 points randomly established within designated management areas the areas will be completed in the fall of the year and annual comparisons made. Turion results will be incorporated into annual management planning. The first turion sampling survey, completed in the fall of the first year of management actions taken as a part of this APM Plan will serve as a baseline for all future comparisons. The purpose of the turion density sampling is to determine if management actions taken actually reduce the amount of CLP in the management areas. It is not to determine a system wide evaluation of the distribution and density of CLP.

13.2.2.4 Assessment

The ultimate goal of CLP management is to reduce the negative impacts it has on the overall system. All of the previously mentioned actions will be used to determine if management has accomplished this goal.

13.2.3 Purple Loosestrife Management

The objective of purple loosestrife management is to prevent it from becoming monotypic stands along the shoreline and in adjacent wetlands. Success will be measured by keeping this plant at levels equal to or below current levels.

Monitoring of the entire system for new plants will be done at least monthly from July to September by CLPA volunteers. Physical removal and occasional use of herbicides applied by hand will be used to control individual plants or isolated pioneering sites. If necessary, CLPA volunteers will collect biological control agents (beetles) from nearby established populations and transferred to designated management areas on the Chetek lakes.

13.2.4 Japanese Knotweed Management

Barron County has been working on a Japanese knotweed bed near the Chetek dam for many years. The CLPA will partner with Barron County and the WDNR to continue that control project. CLPA volunteers will monitor the entire system for new stands of Japanese knotweed annually, and if identified, will report them to the Barron County Soil and Water Conservation Department. Management alternatives will then be determined that best fit the characteristics of the new site.

13.3 Goal 3 – Provide Native Plant Nuisance and Navigation Relief

Although dense growth native aquatic plant beds are generally few and far between on the Chetek lakes, there are a few areas that pose potential nuisance and navigation issues. Dense, mid-season, native aquatic plant growth in Mud, Tenmile, and the extreme eastern end of Chetek Lakes does pose navigation issues, both for general boat traffic going from one point to another, and for landowners needing to access open water from their docks. As mentioned before, maintaining and enhancing existing aquatic plant beds is a chief goal of this APM Plan. Management in these areas will be limited, but not prohibited.

13.3.1 Determining Nuisance Level Aquatic Plant Growth

Appendix I identifies criteria under which landowners can make requests for management that provides navigation or access to open water relief from dense growth native vegetation. Certain areas already shown to cause access and navigation issues will be included in annual management planning, as will any new landowner requests made in the previous year. All sites predetermined for mid-season native aquatic plant management will be visited by trained CLPA volunteers or CLPA retainers prior to actual management to determine if the proposed management is necessary. An effort will be made to accommodate landowner requests for management that are made before June 30 in the year of management, but management is not guaranteed.

13.3.2 Aquatic Plant Management

If mid-season native aquatic plant management is determined to be necessary, physical removal will be the first consideration for management. If physical removal is not feasible or effective, then mechanical harvesting of navigation and open water access channels will be considered. Mechanical harvesting of designated navigation and open water access channels are subject to the similar conditions placed on CLP harvesting (up to 40-ft wide for navigation and up to 20-ft wide for open water access, not in water < 3-ft deep). Mid-season harvesting will only be completed once in a given year and must be completed before July 31. Cutting depths must not exceed 2 feet or 1/3 of the water depth, whichever is less. Wherever possible, navigation and open water access channels will follow those channels harvested earlier in the year.

13.3.2.1 <u>Off-loading and Dumping Sites</u>

The CLPA, its consultant, local towns, and Barron County will determine appropriate off-loading sites and dumping sites for vegetation harvested during this project. Preferably, sites will be located close to the areas of the lakes where the majority of mechanical harvesting is completed. All dumping sites will be approved local landowners, town governments, Barron County, and the WDNR.

13.3.3 Herbicide and Harvesting Permits

All herbicide and harvesting permit applications will be applied for by the CLPA and include all predetermined chemical treatment and mechanical harvesting areas. Individual landowner permit applications are discouraged as it becomes more difficult to track management overall when multiple permits are applied for by multiple parties. By including all proposed management areas in single permit applications prepared by the CLPA (or their retainers) management is more easily tracked, as are the impacts of management. This also saves individual property owners fees that are associated with the applications. The CLPA will do its best to accommodate property owner requests for management and as such will keep communication channels open and inform its membership when management requests need to be made. Costs may be covered by the CLPA, individual landowners, or shared by both.

13.4 Goal 4 – Education, Monitoring, Prevention, and Fundraising

Aquatic invasive species can be transported via a number of pathways or vectors, but most invasions are associated with human activity. Having and educated constituency will aid in the identification, planning, and prevention necessary to keep other undesirable AIS out of the lakes as long as possible. Providing opportunities for the constituency to become educated and informed and making AIS materials available to them will improve the knowledge base and participation in protecting the lakes. Using signs and actively inspecting watercraft at public launches can educate boaters about what they can do to prevent the spread of AIS. Monitoring general parameters associated with water quality and sharing that information with the constituency can also promote greater understanding and increase participation in planning and management. Additional funds will be needed as the CLPA moves forward with aquatic plant and comprehensive lake management actions.

13.4.1 AIS Education

The objective of AIS education is to create a lake community that is aware of the problems associated with AIS, and that has enough knowledge about certain species to aid in detection, planning, and implementation of management alternatives. The CLPA will distribute informational materials to its constituency and will provide educational opportunities for its constituency to learn more about AIS and other factors that affect the Chetek lakes. The success of this objective will be measured by the length of time other AIS can be kept out of the Chetek Lakes system.

13.4.2 AIS Monitoring

The CLPA has and will continue an active in-lake and shoreline AIS monitoring program. Trained CLPA volunteers patrol the shoreline and associated littoral zone looking for AIS including CLP, EWM, purple loosestrife, Japanese knotweed, giant reed grass, zebra mussels, and other AIS at least three times during the season as a part of the UW-Extension Lakes/WDNR CLMN AIS Monitoring Program. If a suspect AIS is found, it will be reported to the CLPA and/or County and WDNR resources. All data will be recorded annually and submitted to the WDNR SWIMS database.

A EWM Rapid Response Plan has also been established for the Chetek lakes. The plan contains information on what to do if a suspect AIS is found, who to contact, and what should be done if a positive ID is made. A copy of this plan is in Appendix E.

13.4.3 Watercraft Inspection and Signage

The CLPA has and will continue an active water craft inspection program following WDNR/UW-Extension Clean Boats, Clean Waters guidelines. They have and will continue to participate in the statewide 4th of July Landing Blitz. All watercraft inspection data collected annually is submitted to the WDNR SWIMS database by CLPA volunteers.

The CLPA maintains and updates AIS signage located at each of the public access on the lakes. Currently there is no automated inspection system such as is offered through the I-lids camera and audio monitoring system. The installation of these systems at any of the Chetek lakes public access sites is not recommended. They are expensive, and although they can remind boaters to implement preventative measures (audio component and signage) they offer little in the way of compliance with state laws and preventing new AIS from being introduced. The time and resources required to operate and provide analysis of videos produced by these camera systems is in the opinion of this consultant, better used for actual bodies on the ground.

13.4.3.1 AIS Coordinator

It is understood that organizing volunteer efforts, inputting data, and providing education and training requires a great deal of time. To address this, it is recommended that the CLPA hire an AIS Coordinator for nearly full time work throughout the late spring, summer, and early fall season. The criteria under which this person would be hired will be decided by the CLPA should they choose to implement this recommendation.

13.4.4 Monitoring Water Quality

CLPA volunteer have and will continue to participate in the CLMN Water Quality Monitoring Program. This APM Plan recommends completing all CLMN expanded monitoring parameters (Secchi, temperature, dissolved oxygen, total phosphorus, and chlorophyll a) at three sites in Prairie Lake, and at one site each in Chetek, Mud, Pokegama, and Tenmile Lakes. As the CLPA implements aquatic plant management and comprehensive lake management recommendations, it is expected that water quality in the lakes will change. By collecting basic, long-term trend water quality monitoring data such that is included in the CLMN program, those changes may be identified.

13.4.5 Formation of a Lake District

The CLPA will need more funding than it currently has to implement aquatic plant and comprehensive lake management recommendations. Portions of the needed finances can come from existing lake association dues, private citizen donations, and through grant funds awarded through the State. However, as larger and more comprehensive lake management actions are implemented, these funds will be inadequate, and large sums granted by the State come with large requirements for sponsor match. For this reason, it is recommended that the CLPA consider the formation of a Lake District which would provide an avenue for acquiring funds from all property owners benefitting from the lakes through taxing authority. All funds collected by the Lake District would go directly to making improvements in the lake, and not to outside or non-related entities.

Forming a Lake District takes time and a great deal of effort. Therefore prior to actual formation, it is recommended that a committee of affected stakeholders be formed to navigate through the process. In the end, forming a Lake District prior to the end of the five years included in this APM Plan is a realistic and worthwhile goal.

13.5 Goal 5 – Increase the Level of Appreciation for Aquatic Ecosystems

Increasing the level of appreciation for aquatic ecosystems will improve the knowledge base and interest of the lake community in how management actions in and around the lakes affect the living species found there. Success will be measured in the amount of interest and participation CLPA members have in numerous monitoring programs.

13.5.1 Aquatic Plants

Aquatic plants are an extremely important part of any lake ecosystem. Despite the documented lack of abundant aquatic plants in the Chetek lakes, many property owners and lake users still are concerned about what they see as a problem. In order to effectively implement actions aimed at increasing the distribution, density, and diversity of aquatic plants the lake community needs to understand the importance of aquatic plants and the role they play in helping to make improvements to the system overall. The CLPA will provide information and educational opportunities to the lake community through its newsletter, on the webpage, lake fairs or other public events, and through other efforts aimed at increasing interest and participation in aquatic plant and comprehensive lake management planning and implementation.

13.5.2 Wildlife

The CLPA will provide education and informational materials related to wildlife and wildlife monitoring programs during public events, in newsletters, on the webpage, and during public meetings. CLPA volunteers are already participating in the Loon Watch program sponsored by the Sigurd Olson Institute. Other programs sponsored by the Citizen Based Monitoring Network of Wisconsin will be promoted by the CLPA and member participation encouraged. Annual reports by members participating in monitoring programs will be included in annual meetings of the CLPA. The CLPA will help make arrangements with the sponsoring resource agencies for training opportunities for these and other wildlife monitoring and appreciation events.

13.6 Goal 6 – Reducing Total Non-Point Nutrient Inputs

In the end, significant improvements to water quality in the Chetek lakes will be dependent on reducing the annual nutrient (phosphorus and nitrogen) load into the lakes. Aquatic plant management is just one of the tools to be incorporated in what will be a very long and arduous process. Recommendations made in this section of the APM Plan are related to larger comprehensive lake management recommendations that are still under development.

13.6.1 Comprehensive Lake Management Planning

Comprehensive lake management planning must be completed and scientifically based, affordable, and effective recommendations made. Short- and long-term management goals need to be clearly spelled out in an in depth Comprehensive Lake Management Plan. This project recommends that aquatic plant management actions be implemented immediately, but also that a formal Comprehensive Lake Management Plan be completed in the next 12 to 18 months. Many of the following recommendations made in this plan will be further developed in the Comprehensive Plan.

13.6.2 Agricultural Inputs

Sediment and nutrient runoff and pesticides from agricultural lands lead to an increase in algae, decreases in dissolved oxygen and other negative water quality impacts. Vegetative buffer strips along lakes, stream, and wetlands can limit inputs. The CLPA should promote and support County efforts to educate famers and develop nutrient management plans. Public support and recognition should be offered to farmers who implement Best Management Practices to protect water quality.

13.6.3 Septic Systems

In shoreland areas it is particularly important to maintain septic system properly because soil and water conditions near shore may make the system less efficient in treating wastewater. Incomplete treatment can result in health risks for humans and water quality problems. The CLPA will provide information and educational opportunities for lake property owners to learn what should be done to maintain on-site waste water treatment systems and how. Property owners will be encouraged to get their septic systems tested for proper function. Property owners will be encouraged to redirect gray water from washing machines and sinks that is currently disposed of overland, through wastewater treatment systems. Many other things can be done if property owners are actively thinking about and have been educated about what can be done when the opportunity presents itself. The installation of new drainfields as far from the lake shore as possible; installation of alternative or additional treatment system that can remove nutrients (nitrogen and phosphorus); and consideration of community or other group wastewater treatment options are just a few possibilities.

13.6.4 Shoreland Development

The CLPA will provide riparian owners with general shoreland improvement information and education through methods previously stated. In expensive or free professional site evaluation and site planning may be offered as well. Increased efforts by the CLPA will be made to determine property owners willing to complete projects that will reduce runoff to the lakes and improve shoreland habitat. The CLPA will strive to recognize riparian owners who implement shoreland restoration and habitat improvement projects or already have outstanding shorelines at their annual organizational meetings. The CLPA will continue to sponsor the distribution of trees and other native plants annually for the purpose of making shoreland improvements.

13.6.5 Motorized watercraft

Motorized watercraft cause sediment disturbances in shallow water and disturb aquatic plant beds and littoral vegetation which leads to decreased water clarity and nutrient resuspension. The CLPA will attempt to educate lake users about the impacts of motorized boat use in shallow water through information passed out during watercraft inspection, posted on public access signs, and in public media. Such material could be maps of suggested “no wake” areas provided to boaters. Although it is not likely that a formal ordinance prohibiting motor use or requiring “no wake” operation in shallow waters, all lake users will be encourage to voluntarily comply with such recommendations. It is also recommended that the CLPA work with local law enforcement and WDNR representatives to better enforce Wisconsin “No wake” laws as they pertain to the shoreline of the lake.

14.0 Five-year Timeline of Activities

All management recommendations in this APM Plan are to be implemented over the course of five years with the first year of implementation expected to occur in 2013. A five year implementation timeline can be found in Appendix G.

15.0 2012 Curly-leaf Pondweed Management

See Appendix J.

16.0 APM Plan Implementation Maintenance Plan

This APM Plan is a working document guiding management actions on the Chetek Lakes over the next five years. Annual and end of project assessment reports are necessary to monitor progress and justify changes to the management strategy. The following activities will support APM Plan maintenance.

16.1 Successful Reporting and Data Sharing

The objective here is to complete project reporting that meets the requirements of all stakeholders, gains proper approval, allows for timely reimbursement of expenses, and provides the appropriate data for continued management success. Success will be measured by the efficiency and ease in which these actions are completed.

16.2 End of Year and Annual Management Proposals

The CLPA and their retainers will compile, analyze, and summarize management operations, public education, and other pertinent data and report it in paper and digital formats to the members of the CLPA, Barron County, and the WDNR. These reports will also serve as a vehicle to propose following year management recommendations. These reports will be completed by the CLPA and their retainers prior to implementing following year management actions (approximately March 31st annually).

16.3 Update of the Point Intercept Aquatic Plant Survey

It is recommended that another whole-lake point intercept aquatic plant survey be completed in 2016. Results will be compared to the 2011 survey to determine the impacts of management activities on both target and non-target aquatic plants.

16.4 End of Project Five-Year Project Evaluation and Assessment

At the end of this five year project, all management efforts and related activities will be compiled, analyzed, and put in report form. This document will form the basis for revising the APM Plan, and discussing the successes and failures of the plan. The report will be compiled by the CLPA and their retainers and distributed to the CLPA membership, Barron County, and the WDNR. The report will be completed June 30th in the year after the final year of this APM Plan.

17.0 References

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Appendix A

WDNR Northern Region Aquatic Plant Management Strategy

Appendix B

2011 Lake User and Property Owner Survey Summary

Appendix C

WDNR Proposed Sensitive Area Habitat Maps

Appendix D

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Appendix E

Eurasian Watermilfoil Rapid Response Plan

Appendix F

Aquatic Plant Management Goals, Objectives, and Actions

Appendix G

Five-Year Implementation Time Line

Appendix H

WDNR Pre- and Post-Treatment Survey Guidelines

Appendix I

Native Plant Management Guidelines

Appendix J

2013 CLP Management Recommendations