# Aquatic Plant Management Plan

## Minocqua and Kawaguesaga Lakes

**(Along with the Minocqua Thoroughfare and a portion of Tomahawk Thoroughfare)**

**2008**

Sponsored by: Minocqua-Kawaguesaga Lakes Protection Assoc.
Wisconsin Department of Natural Resources

Prepared by: Ecological Integrity Service, LLC and the
Minocqua-Kawaguesaga Lakes Aquatic
Plant Management Committee

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# Introduction

This Aquatic Plant Management Plan is for Kawaguesaga Lake, Minocqua Lake, Minocqua Thoroughfare, and a portion of the Tomahawk Thoroughfare, which are located in Oneida County, Wisconsin (see Figures 1,2, and 3). It presents data about the plant community, fisheries, watershed, and water quality of Kawaguesaga and Minocqua Lake Chain. Based on this data and public input, this plan provides goals as well as strategies for the sound management of aquatic plants in the lakes. These goals include preservation of native species for their benefits to the lake ecosystem, reduction of Eurasian water milfoil, maintenance of good water quality, and reduction/prevention aquatic invasive species such as Eurasian water milfoil (EWM). The plan reviews public input, summarizes data, discusses management options and alternatives, and recommends action items. This plan will guide the Minocqua/Kawaguesaga Lake Protection Association (MKLPA), Oneida County, and the Wisconsin Department of Natural Resources in aquatic plant management over the next five years (2008-2012). After 2012, this plan will be evaluated and revamped as necessary.

## Public Input for Development

In June 2006, the Kawaguesaga/Minocqua Lake Association voted to apply for a large scale Lakes Planning Grant to complete a baseline macrophyte survey and an aquatic plant management plan.[1] Upon receiving the grant, an Aquatic Plant Management Committee was formed. In August of 2007, information was provided to the trustees of the Lake Association about what a macrophyte study and an aquatic plant management plan entail. The importance of plants in the lake ecosystem was discussed as well as the biology and impacts of EWM. A brief description of EWM management was also presented.

The Aquatic Plant Management Committee was comprised of members from the Lake Association, and representatives from the Oneida County Conservation Department and the Wisconsin Department of Natural Resources. This committee developed goals based on collected data as well as comments from concerned citizens. Based on public input, the Aquatic Plant Management Committee recognizes the importance of plant management in Minocqua and Kawaguesaga Lakes. They also understand the importance of aquatic plants in the lake ecosystem and the need for education about this issue.

The Aquatic Plant Management Committee met in August 2007 to review the concerns about plant management and the lake ecosystem. At this first meeting, goals for management were established. These goals were then shared with the Lake Association membership and were also reported in the local newspaper.

In January 2008, the Aquatic Plant Management Committee met for a second time. This meeting involved the development of objectives as well as specific management practices and actions toward reaching set goals. The various management options were reviewed and discussed. Comments and suggestions were provided for the draft management plan.

[1] From minutes of June 2006 Minocqua-Kawaguesaga Lake Protection Association Annual meeting.

A final meeting occurred in February of 2008. In this meeting the final objectives were developed and the draft of the plan was reviewed.

In June 2008, the plan was presented in summary at the Minocqua/Kawaguesaga Lakes Protection Association's annual meeting. The macrophyte survey results were discussed and the management goals and objectives were summarized. A question and answer session followed the presentation.

A final draft of the Aquatic Plant Management Plan was made available in July 2008 for public review at the Town of Minocqua Public Library. Anyone that wanted to make public comment was to submit his or her comments to Sally Murwin, Lake Association President. The plan was available for a 2 week time period.

Aquatic Plant Management Committee members:

| | |
|---|---|
| Adam Aleskauskas | Board Member |
| Jim Beckwith | Board Member |
| Richard Bergman | At Large |
| Doris Eberlein | At Large |
| Dick Garrett | Board Vice President |
| Jack Knuese | At Large |
| Tony Kovacik | At Large |
| Sally Kovacik | Board Secretary |
| Tom McCallum | Board Member |
| Sally Murwin | Board President |
| Russ Rabjohns | At Large |
| Dale Sharine | At Large |
| Joel Wells | At Large |
| Brooke Towey | Board Treasurer |

**Public Survey**[2]

A property owners survey does not appear in any files with the Wisconsin DNR. However, in 2002, a lake boat use survey was conducted to assess boat traffic on Minocqua and Kawaguesaga Lakes. This survey demonstrated the extensive use of the lakes As a result, the spread of invasive species is a high risk associated with the Minocqua Chain. This risk is both the introduction of new species and the spread of EWM to other lakes.

In January 2007 a report entitled Community Lake Survey Final Report was released. This report written from data generated during a survey of the lakeshore owners on Minocqua and Kawaguesaga Lakes. This sociological survey was sent out to lake residents in September of 2006. Of the 834 surveys sent, 41% or 344 were returned. The results of the survey reported here will focus on aquatic plant management issues.

[2] Boat Survey conducted by Blue Water Science for the Minocqua-Kawaguesaga Lakes Protection Association. 2002.

When asked about lake appearance, 51% stated it was clear, 29% cloudy, 17 % green, with other and blank responses accounting for other percentages.

| **Question/concern** | **Better** | **Worse** | **Same** |
|---|---|---|---|
| Fishing in the last 5 years. | 5.2% | 28.8% | 27% |
| Fishing in the last 20 years | 4.1% | 36% | 8.7% |
| Rate the "health" of the lake compared to 1 year ago | 4.1% | 34% | 55.8% |
| Rate the "health" of the lake compared to 10 years ago | 5.5% | 50.6% | 21.8% |

| **Question/concern** | **Yes** | **No** | **Unsure** |
|---|---|---|---|
| Should controlling aquatic invasive species be top priority? | 78.5% | 2.6% | 11.3% |
| Support the use of chemicals to control invasive species | 66.9% | 7.6% | 18.9% |
| Has the amount of aquatic plants increased in the last 15 years? | 68% | 6.1% | 20.1% |

| **Actions needed to improve water quality** | **%** |
|---|---|
| Enforce fertilizer ordinance | 76.4% |
| Enforce zoning and town ordinance | 57.7% |
| Enforce vegetative buffer ordinance | 24.2% |
| Keep people informed | 65.3% |
| Monitor lake water quality | 80.7% |
| Watch for/report aquatic invasive species | 82.2% |
| Financially support programs | 50.9% |

From this survey it appears many people believe fishing is getting worse. In addition a majority of people responding feel the water quality is declining. They also appear to be very concerned about aquatic plant growth and invasive species. Furthermore, water quality is a big concern based upon these results.

This plan needs to consider management practices that will maintain and/or improve water quality as well as combat invasive species. In addition, fishing habitat improvements are important as the public has a noticeable concern about the fisheries. Aquatic plants provide an important function in fish management.

**Lake Management Concerns**

This Aquatic Plant Management Plan addresses the top concerns of the Aquatic Plant Management Committee, representing the Lake Association:

- The presence and increased growth of Eurasian water milfoil and its effect on the lake ecosystem and use of the lakes.

- The introduction of other aquatic invasive species.

- The preservation/restoration of native shorelines.

- The protection of important fish/wildlife habitats.

- Water quality degradation.
- The lack of understanding in lake ecology among lake residents

**Importance of Aquatic Plants**

The lake ecosystem relies extensively on the littoral zone, which is the area of the lake where the water is shallow enough to hold plants. As a result, the aquatic plant community plays a very important role in maintaining a healthy lake ecosystem.

Emergent plants (the ones sticking above the water surface) can help filter runoff that enters the lake from the watershed area. Their extensive root networks can stabilize sediments on the lake bottom. Wave energy can be reduced by emergent plants, thus reducing shoreline erosion. Many of these beds provide important fish habitat and spawning areas, as well as key wildlife habitat. Many birds, waterfowl, and some mammals rely on these plants for nesting materials as well as food.

Floating-leaf plants such as water lily provide shade and cover for invertebrates and fish. Although they appear thick on the surface, the underwater area beneath them is more open. This allows fish and other animals to move about hidden by the leaves above.

Submergent plants provide many benefits to the lake ecosystem. These plants are nature's aerators, producing the essential oxygen byproduct from photosynthesis. Submersed plants absorb nutrients through their roots and in some cases through their leaves, decreasing the nutrients that would otherwise be available for nuisance algae growth. Roots stabilize bottom sediments thus reducing re-suspended sediments. As a result, these plants help maintain water clarity.

Aquatic plants take on many shapes and sizes and provide excellent habitat. Many of the plants, such as the milfoils or water marigold, have fine leaves that provide key invertebrate habitat. These invertebrates comprise a very important level in the food chain and result in excellent forage opportunities for fish. Other plants are adapted to grow in low nutrient substrates such as sand and gravel. These plants maintain important fish and wildlife cover for areas that would otherwise be devoid of plants.

Many fish rely on aquatic plants for reproduction. *Esox sp.* often spawn amongst submergent plants. The Northern Pike even has eggs that are adapted for attachment to the plants themselves. Once fish emerge from their eggs, the plants provide important cover and foraging areas.

# Lake Information

Kawaguesaga Lake is a 670 acre lake located in Oneida County, Wisconsin in the Town of Minocqua (T39N R06E Sections 9,10,15,16,21,22); the water body identification code (WBIC) is1542300. Its main drainage inlet is Minocqua Lake (Minocqua Chain). Its outflow is the Tomahawk River and the level controlled by a dam. The maximum depth is 44 feet, with a mean depth of 18 feet.

Minocqua Lake is a 1360 acre lake located in Oneida County, Wisconsin and is connected to Kawaguesaga Lake. It is located in the Town of Minocqua (T39N R 06E Sections 11-15,22); the water body identification code (WBIC) is 1542400. This is also a drainage lake with the main inflow from the upstream chain of lakes through the Tomahawk and Minocqua Thoroughfares. The lake outflows to Kawaguesaga Lake and its level is indirectly controlled by the same dam as Kawaguesaga Lake. The maximum depth is 60 ft, and has a mean depth of 23 feet.

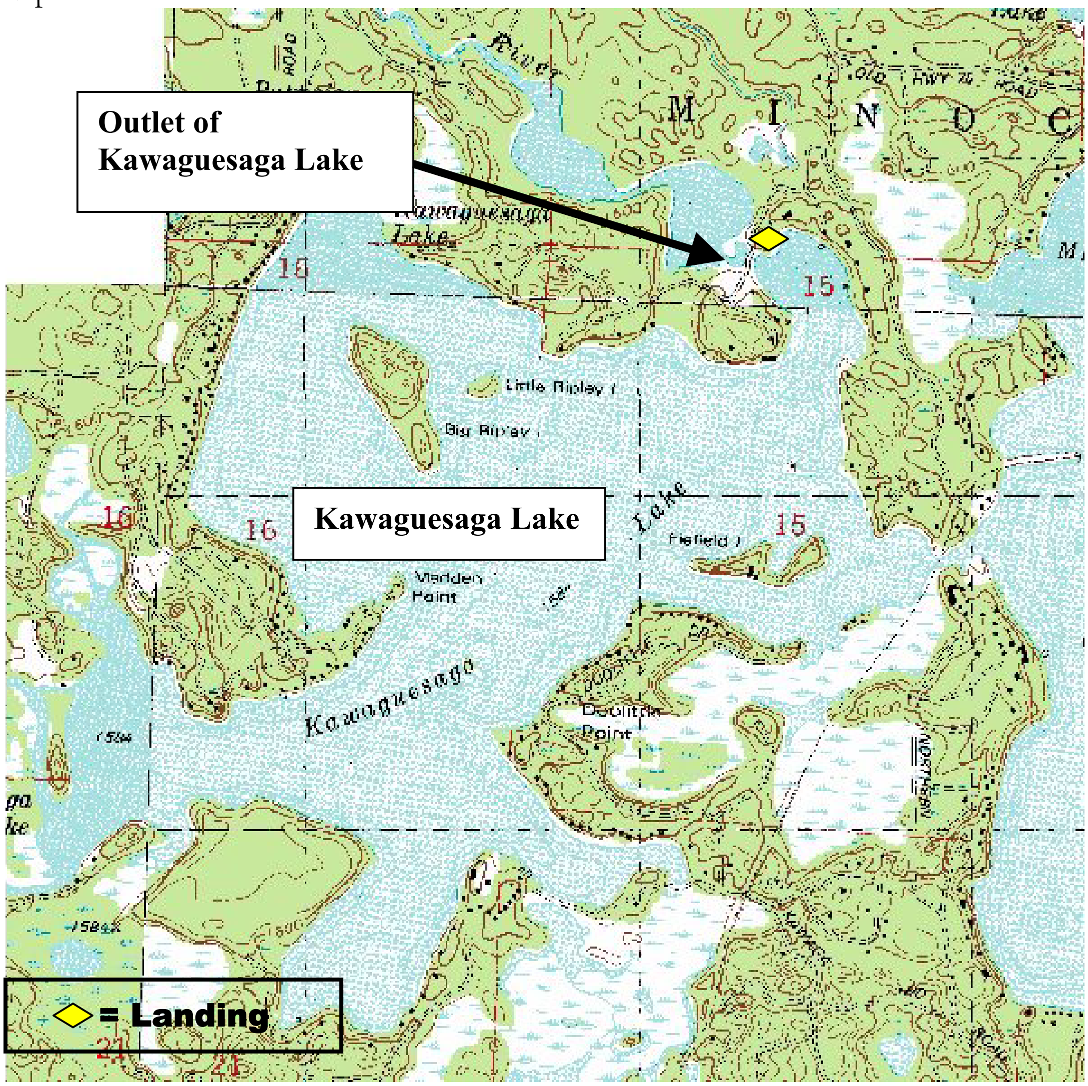


***Figure 1: Topographical map of Kawaguesaga Lake***

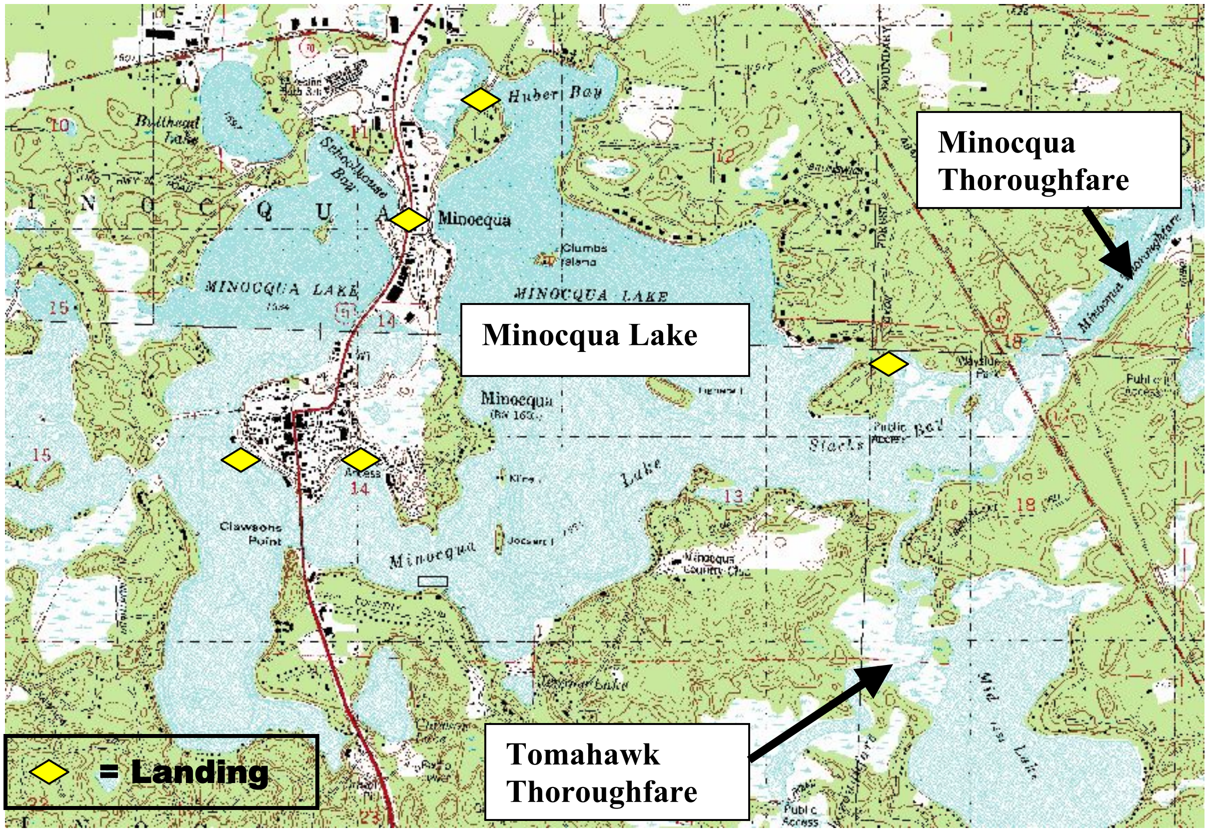


*Figure 2: Topographical map of Minocqua Lake*

This plan includes waters outside of the Minocqua Lake proper. They include the Minocqua Thoroughfare (see labeled in Figure 2). Also a portion of the Tomahawk Thoroughfare is included. Figure 3 shows the cutoff for the boundary of this plan. The bridge at Thoroughfare Road is the landmark that ends the coverage of this plan.

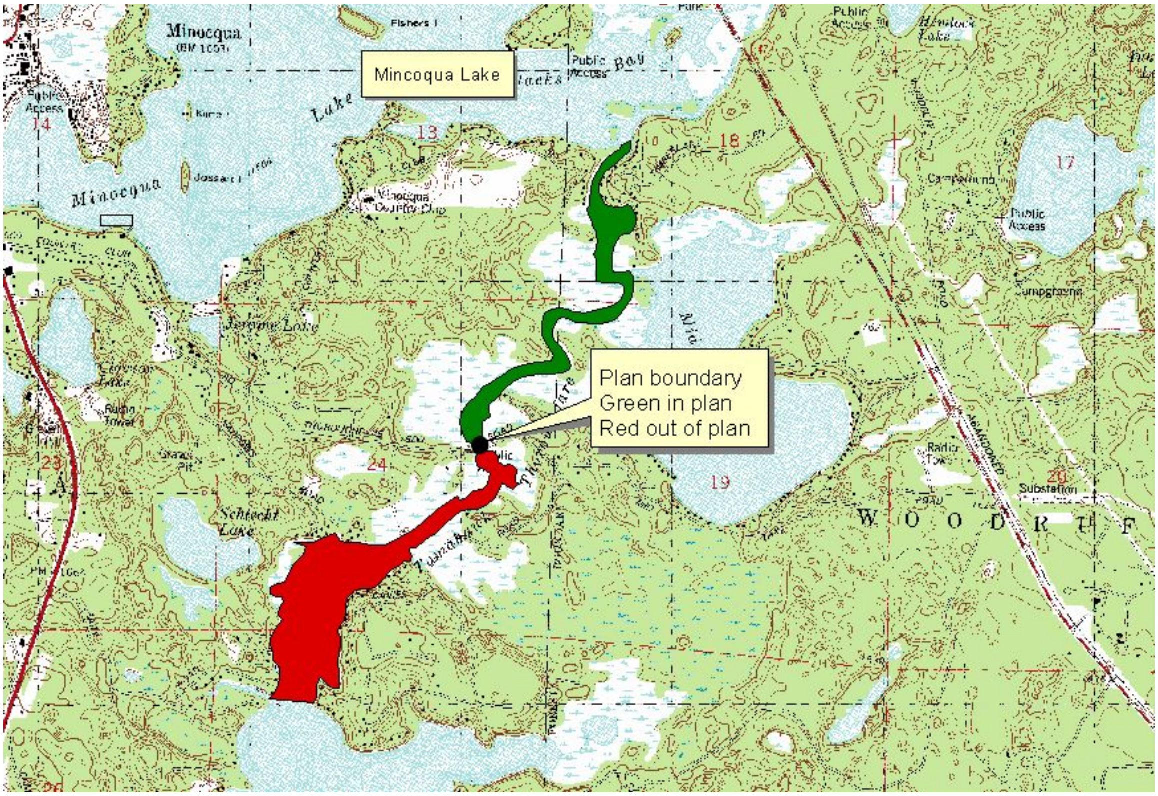


***Figure 3: Boundary of this plan in the Tomahawk Thoroughfare.***

## Fisheries[3]

Both Kawaguesaga and Minocqua Lakes contain many significant sport fish species. These include:

**Kawaguesaga Lake**-Black crappie, bluegill, largemouth bass, muskellunge, northern pike, pumpkinseed, smallmouth bass, walleye, and yellow perch.

**Minocqua Lake**-Black crappie, bluegill, largemouth bass, muskellunge, northern pike, pumpkinseed, smallmouth bass, walleye, and yellow perch.

Other species have also been surveyed in these two lakes. In Kawaguesaga Lake these include: bluntnose minnow, rock bass, Johnny darter, grass pickerel, creek chub, mottled sculpin, and white sucker. In Minocqua Lake the following species have been surveyed: bluntnose minnow, rock bass, grass pickerel, golden shiner, Johnny darter, roseyface shiner, yellow bullhead, spottail shiner, bowfin and white sucker.

It is important to consider fisheries in any lake when developing a plant management scheme. Both Kawaguesaga Lake and Minocqua Lake have very desirable fisheries. For this reason, fish habitat, water quality, and reproduction need to be protected. The following table presents spawning information for some of the sport fish. Since

[3] Information provided by John Kubisiak, Wisconsin DNR Fisheries Manager, Rhinelander, Wisconsin.

management of plants may involve early season chemical treatment, spawning times and needs are important. The highlighted areas point out species that spawn at temperatures similar to early season treatment. It is important to consider this during treatment since some herbicides (such as 2,4-D) can be toxic to fish.

***Table 1: Fish species of Kawaguesaga and Minocqua Lakes.***

| **Fish species**[4] | **Spawning Temp in °F** | **Spawning substrates** |
|---|---|---|
| Black crappie | Upper 50's to lower 60's | Build nests in 1-6 feet of water in fine sand or gravel |
| Bluegill, Largemouth bass and Pumpkin seed | Mid 60's to lower 70's | Build nests in less than 3 feet of gravel or hard bottom |
| Muskellunge[5] | Mid 50's to near 60. | Broadcast eggs over organic sediment, woody debris and submerged vegetation. |
| Northern Pike | Upper 30's to mid 40's soon after ice-out | Broadcast eggs onto vegetation (eggs attach) |
| Smallmouth Bass | Usually between 62 and 64 but recorded as low as 53 | Nests in circular, clean gravel |
| Walleye | Low 40's to 50 degrees. | Gravel/rocky shoals with moving or windswept water 1-6 feet deep |
| Yellow perch | Mid 40's to lower 50's | Broadcast eggs in submergent vegetation or large woody debris |

Spawning temperatures in the same range as recommended herbicide application. Any areas determined to be key spawning areas for these fish should be carefully considered when treating with herbicides. This could include treating at slightly higher temperatures when the spawning has been determined to be complete.

The Minocqua Lake fishery is managed for muskellunge, walleye, bass and panfish. Historically, muskellunge were stocked in Minocqua Lake, but that was ceased and last occurred in 2001, largely due to catch and release ethics. Walleye were last stocked in 2000 and there appears to be good natural recruitment. All bag limits are the same as the statewide regulations except walleye bag limits change to accommodate tribal harvest.

Muskellunge and walleye spawning success are very sensitive to the water quality and habitat quality. In the case of walleye, the high-quality spawning habitat is limited and although recruitment is strong, any loss of this habitat could have a negative affect on walleye spawning success. Basically, there is no habitat to spare.

[4] Information from Heath Benike. Wisconsin DNR Fisheries Biologist. 2006

[5] Information from: Rust, Ashely J., James Diana, Terry L. Margenau, and Clayton J. Edwards. Lake Characteristics Influencing Spawning Success of Muskellunge in Northern Wisconsin Lakes. *North American Journal of Fisheries Management*. 2002. p834.

From a plant management perspective, maintaining muskellunge spawning habitat, as well as rearing habitat is crucial. Major reductions in plant density could have a very negative impact and therefore targeting AIS only is paramount. This can be obtained through early season application of herbicides, if necessary. Other means of controlling AIS where applicable could be beneficial. Finally, maintaining a healthy native plant community will help facilitate habitat for muskellunge recruitment.

When treating plants with herbicides, fish can be negatively impacted as fish and their eggs are susceptible to the herbicides. Two fish could potentially have newly distributed eggs during an early season herbicide treatment (muskellunge and black crappie). One treatment to eradicate AIS such as EWM could be justified even if it reduced fish recruitment for that year. However, a series of annual treatments could have a serious impact on fish populations, even if it caused only a partial loss of each year's hatch. As a result, herbicide use must be used with extreme caution and to a very limited extent in spawning areas[6].

At this point, no areas that have been indicated by the a sensitive area study on Minocqua Lake as spawning areas for muskellunge or northern pike have EWM reaching the herbicide application threshold (see management recommendations). However, no such study has been conducted on Kawaguesaga Lake, so each area recommended for treatment should be evaluated for spawning potential.

## Sensitive areas/rare species and species of special concern

In 2003 a sensitive area survey was conducted by the Wisconsin Department of Natural Resources on Minocqua Lake (not Kawaguesaga). Sensitive areas are areas that contain aquatic/wetland plant species, terrestrial vegetation, gravel/rubble lake substrate, or areas that contain downed woody cover. These areas can provide water quality benefits, reduce shoreline erosion, and provide habitat for seasonal and/or life stage requirements for fish, invertebrates, and wildlife. An area is designated 'sensitive' to alert interested parties that it contains habitat that is critical to a healthy lake ecosystem, or that it features an endangered plant or animal. As a result, management personnel will carefully scrutinize any management activities proposed within a sensitive area. In this survey 15 sites in Lake Minocqua were identified as sensitive due to their habitat importance.

In the sensitive area report, the following recommendations were listed for whole-lake management:

1. Promote the use of bioengineering, bio-logs, and native vegetation rather than rip rap for shoreline protection and erosion control.

2. Minimize shoreline disturbances (grading, cutting, mowing, placement of structures, etc.) below the ordinary high water mark, and within the 35-foot shoreland buffer and shoreland zone.

[6] Personal communication from John Kubsiak, Fish Biologist, Wisconsin DNR. 2008.

3. If using fertilizers on lawns, limit the applications and use only phosphorus free recipes.

4. Minimize the chance of additional invasions of exotic plants by protecting native aquatic plants.

5. Restore shoreland buffers on developed properties where near-shore upland vegetation has been removed.

6. Protect snag trees, large woody cover, and live den trees in the upland and shallow water habitat zone.

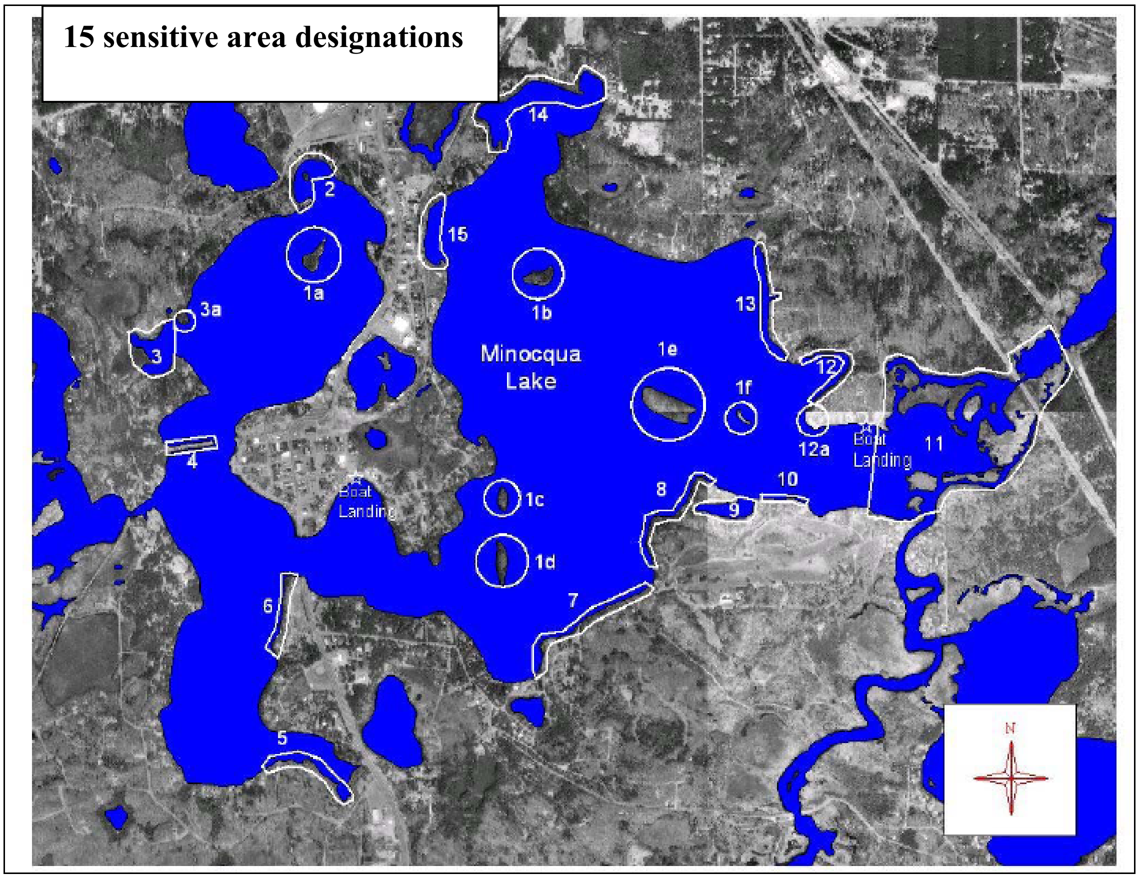


***Figure 4: Map of designated sensitive areas Minocqua Lake***

The following are special mention to consider for each area:

<u>Site 1</u>
The islands-The primary reasons for designation:

A) Aquatic vegetation, wildlife habitat, and natural scenic beauty. Existing vegetation will reduce erosion and very little development.

B) Aquatic vegetation, wildlife habitat, and natural scenic beauty. Existing vegetation will reduce erosion and very little development.
C) Wildlife habitat and vegetation that will reduce erosion. Buffer zone with native vegetation will reduce invasive species.
D) Fisheries habitat, wildlife habitat, and natural scenic beauty. A biological buffer zone will reduce likelihood of exotic infestation. Sand with gravel/rubble substrate is present.
E) Fisheries habitat, wildlife habitat, aquatic vegetation, and natural scenic beauty. Buffer vegetation reduces likelihood of invasive infestation. Aquatic vegetation stabilizes sediments reducing nutrient recycling and algae blooms. Northern portion has gravel/rubble substrate.
F) Aquatic vegetation, wildlife habitat, and natural scenic beauty. Buffer vegetation reduces exotic infestation and aquatic vegetation stabilizes sediment reducing nutrient recycling. Substrate is primarily sand and gravel.

<u>Site 2:</u> The primary reasons for designation at site 2 are fisheries habitat, wildlife habitat, and aquatic vegetation. Aquatic plants provide nutrient buffer zone, reducing nuisance algae blooms. Native plant beds reduce the chances of invasive infestation. Northern pike, muskellunge, largemouth bass, bluegill, pumpkinseed, yellow perch and bullhead may all use this site for spawning, rearing, feeding, and protective cover. Emergent vegetation, submergent vegetation, snag trees and perch trees provide valuable habitat for furbearers, birds, amphibians, and reptiles. The aquatic plant community is very diverse and one of the few areas where floating and emergent plants are common. Purple loosestrife, curly leaf pondweed, and for-get-me-nots are common at this site.

<u>Site 3 and 3a</u>: The primary reasons for site 3 are fisheries habitat (due to large woody debris presence), wildlife habitat, aquatic vegetation, and natural scenic beauty. Site 3a was chosen since it is a gravel/rubble substrate point, thus providing valuable fish habitat. Walleye, smallmouth bass, and white sucker may all use this site for spawning since it is silt free.

<u>Site 4</u>: Fisheries habitat, wildlife habitat and natural scenic beauty are the reasons for designation. A variety of game and non-game fish may use the submergent vegetation and gravel substrate for spawning, rearing, feeding and protective cover. There were numerous spawning beds present. Walleye, smallmouth bass, largemouth bass, bluegill, yellow perch and pumpkin seed likely use this site for spawning, rearing, feeding and protection. Muskellunge and Northern pike may use the large woody debris at this site for cover and protection. The aquatic vegetation was not very diverse and contains a large amount of curly leaf pondweed.

Site 5: The primary reason for this site is wildlife habitat. The shoreline is mostly wooded with large amounts of large woody cover.

<u>Site 6:</u> The primary reasons for site 6 are for fisheries and wildlife habitat. This area contains a steep drop off of gravel/rubble substrate. This area is an excellent spawning site for walleye, smallmouth bass and crappie. Walleye may also rely on this area for rearing. Shrubs, tress, and fallen logs provide important wildlife habitat.

Site 7: Fisheries and wildlife habitat are why site 7 was designated. Gravel and rubble substrate provide valuable spawning grounds for walleye, smallmouth bass, and white sucker. These species may also rely on this area for rearing with the large woody cover and aquatic plants. Emergent vegetation, shrubs, trees and large woody cover provide good wildlife habitat.

Site 8: This site was designated due to fisheries and wildlife habitat. The gravel substrate provides quality spawning habitat for walleye, smallmouth bass, and white sucker. Shrubs, brush, trees, and large woody cover provide quality wildlife habitat.

Site 9: The reasons for designation were fisheries habitat, wildlife habitat, and aquatic vegetation. Aquatic plant beds provide a buffer from exotic infestations and reduce erosion. The extensive herbaceous, shrub and tree layers provide valuable wildlife habitat. Gravel substrate, submergent, emergent and floating vegetation provide key habitat for many game and non-game fish species. This site has one of the few large floating plant beds on the lake.

Site 10: Fisheries habitat is the main concern at site 10. The substrate primarily consists of gravel and rubble. The shoreline is 20% natural and 80% developed. This area could provide important spawning habitat for walleye, smallmouth bass, and white sucker. Walleye and smallmouth bass may also use this area for rearing and feeding. This rock substrate is an area habitable for rusty crayfish, an exotic species.

Site 11: The primary reasons are fisheries habitat, wildlife habitat, aquatic vegetation and natural scenic beauty for site 11 designation. Aquatic plants provide a nutrient buffer zone where existing vegetation at or within the lake takes up nutrients, potentially reducing nuisance algae blooms. These aquatic plant beds can also provide a biological buffer zone where native plants can reduce the risk exotic invasive species. Healthy plant communities can reduce shoreline erosion. This site has well defined herbaceous, shrub and tree layers with 70% of the shoreline natural and 30% developed.

This area (Stacks Bay) has the most valuable muskellunge and northern pike spawning habitat in the entire lake. Muskellunge seek shallow, mucky bays covered with dead vegetation for spawning. Northern Pike rely on shallow bays with emergent vegetation for spawning. This site also contains valuable habitat for walleye feeding and protection. The shoreline near the boat launch contains some smallmouth bass spawning habitat. Largemouth bass, bluegill, pumpkinseed, yellow perch, black crappie, and bullheads may rely on this area for spawning, rearing, feeding and protection as well.

Stacks Bay contains valuable habitat such as aquatic vegetation, shrubs, brush and snag trees and perch trees for many different species of furbearers, birds, amphibians, and reptiles.

A special note is made regarding the concern over *Sparangium eurycarpum* (bur-reed). The plant looks similar to sterile flowering rush plants, which are non-native. Care should be taken to avoid inadvertently eliminating bur-reed during a flowering rush management program.

Site 12: Site 12 was designated due to wildlife habitat and aquatic vegetation. Site 12a (adjacent to Site 12) was designated because of fisheries. The aquatic plants can provide a buffer by reducing exotic species. The shoreline is 40% wooded and 60% developed. Although the main reasons were not fisheries related, the area in site 12 does provide emergent and submergent vegetation as valuable habitat for a variety of game fish and non-game fish species. Site 12a has a rock bar that extends out from the point. This gravel/rubble bar provides excellent spawning opportunities for walleye, smallmouth bass, and white suckers. It is also suitable habitat for rusty crayfish.

Aquatic vegetation, shrubs, brush, snag trees, perch trees, large woody cover and rocks provide valuable habitat for a variety of upland wildlife, furbearers, birds, amphibians, and reptiles.

Site 13: The primary reason for designation is wildlife habitat. The shoreline area is approximately 60% wooded and 40% developed. Large woody cover is present. Homes are fairly well buffered from the lake, but piers are abundant. The shoreline area contains shrubs, brush, snag trees and perch trees that provide habitat for a variety of wildlife species. Ducks and loons may feed at this site as well.

Site 14: Designation occurred at site 14 for wildlife habitat and aquatic vegetation. The aquatic plant community is very diverse and is one of the few areas with floating and emergent vegetation. Again, avoid eliminating bur-reed when targeting the non-native flowering rush. The emergent, submergent, and floating leaf vegetation does provide valuable habitat for a variety of game and non-game fish species.

Valuable wildlife habitat such as emergent vegetation, floating leaf vegetation, shrubs, brush, snags and perch trees provide an area that is useful for a variety of upland wildlife, furbearers, birds, amphibians and reptiles. Loons and geese may feed in this bay also.

Site 15: The reasons for designation are fisheries habitat and wildlife habitat. The shoreline area is approximately 80% wooded and 20% developed. The aquatic plant community is fairly diverse. Flowering rush (an exotic species) is noted as a concern due to a large bed that is stated to be in need of management (reduction). Emergent vegetation, shrubs, brush, snag trees, and perch trees provide valuable habitat for a variety of upland wildlife, furbearers, birds, and amphibians and reptiles.

**Endangered, threatened, and species of concern**

The following species are listed as endangered, threatened, or of special concern in the Town Range T39 06E as determined by the Natural Heritage Survey. Records are provided to the public by Town rather than section, so there is no indication whether or not these species occur in or immediately surrounding Kawaguesaga Lake and Minocqua Lake:

| | | |
|---|---|---|
| Animals | | |
| *Haliaetus leucephalus* | Bald Eagle | special concern |
| *Pandion haleatus* | Osprey | threatened |
| *Sarex palustris* | Water Shrew | special concern |
| | | |
| Plants | | |
| *Callitriche heterophylla* | Large water starwort | threatened |
| *Clematis accidentalis* | Purple clematis | special concern |

*Potamogeton vaseyi* (Vasey's pondweed) wa sampled in Kawaguesaga Lake and Minocqua Lake. This aquatic plant is a species of special concern, which does not indicate it is threatened or endangered, but has habitat needs that are very specific and can be susceptible to decline.

## Water quality

When evaluating lake water quality, the trophic status of a lake indicates its nutrient levels. Based on its nutrient level, a lake may be oligotrophic, mesotrophic or eutrophic. Oligotrophic lakes lack productivity and are usually characterized by clear water with little algae and plant growth. Mesotrophic lakes have intermediate nutrient levels and result in more plant growth and occasional algae blooms. Eutrophic lakes are nutrient rich. They are characterized by abundant aquatic plant growth and low water clarity due to algae growth or blooms. The more eutrophic the lake, the more plant and algae growth that occurs.

Secchi depth readings involve lowering a black and white disk into the water until it is no longer visible. This depth is recorded and reflects the clarity of the water. The higher the Secchi reading, the greater the water clarity. Factors other than algae growth can affect Secchi depth results, so while this test may be used to indicate production (algae growth), it is not specific to algae production.

Chlorophyll-a is one of the photosynthetic pigments in plants. Its levels can be tested in water samples, directly reflecting the amount of algae in a water sample. More algae present results in more chlorophyll-a measured, therefore representing high algae abundance. This value can be coupled with the Secchi depth to indicate algae production. If the Secchi depth is low and the chlorophyll-a value is high, algae production is occurring.

Phosphorus is usually the limiting nutrient in lakes. An increase in phosphorus loading into a lake is the main culprit in excess production (eutrophication). As a result, the monitoring of phosphorus is paramount. Generally the total phosphorus (TP) concentration is monitored. This measures all available forms of phosphorus in the lake that could eventually be available for plant growth. Small increases in this nutrient can lead to large increases in production (plant and algae growth)

Large amounts of data have been collected by citizen lake monitoring volunteers and submitted to the Citizen Lake Monitoring Data of the Wisconsin DNR. The key components of the Trophic State Index (TSI) were collected. They include Secchi disk, chlorophyll-a, and total phosphorus. The TSI considers all of these parameters and calculates an index to determine the trophic status of the lake. The lower the TSI the less productive the lake. Oligotrophic lakes have a TSI value below 30, mesotrophic values are in the 40 range, and eutrophic lakes have values between 50 and 60. Any TSI above 70 is considered hyper-eutrophic which means the nutrient levels of the lake are very excessive.

Kawaguesaga Lake has a shorter history of data collection. However, these data show that Kawaguesaga is mesotrophic for chorophyll a and Secchi disk. Total phosphorus is in the eutrophic range, but water clarity remains quite high. The plants in Kawaguesaga could be helping retain water clarity by taking up the phosphorus.

Minocqua Lake has consistently had Secchi depth and chlorophyll a values in the mesotrophic (medium production) levels. However, the total phosphorus values have been consistently higher, approaching the eutrophic range. The water clarity is the lake is quite high, despite this apparent phosphorus loading. It is possible that the macrophyte community is helping the lake water clarity by absorbing excess nutrients from the sediments and water column, as is the case with plants such as *Ceratophyllum demersum* (coontail).

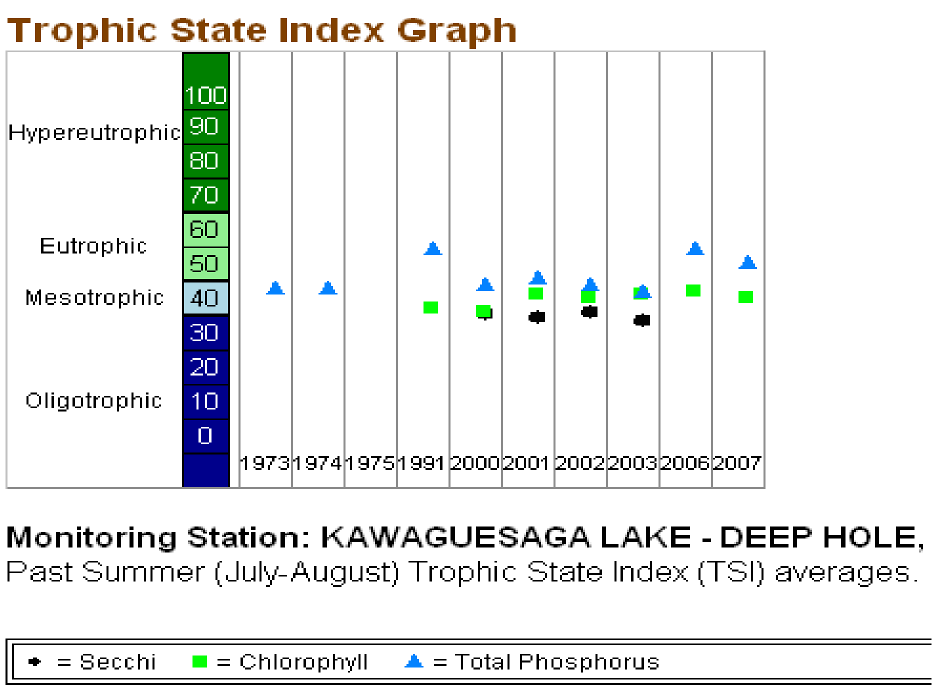


***Figure 5: Trophic State Index Graph-Kawaguesaga Lake 1973-2007***

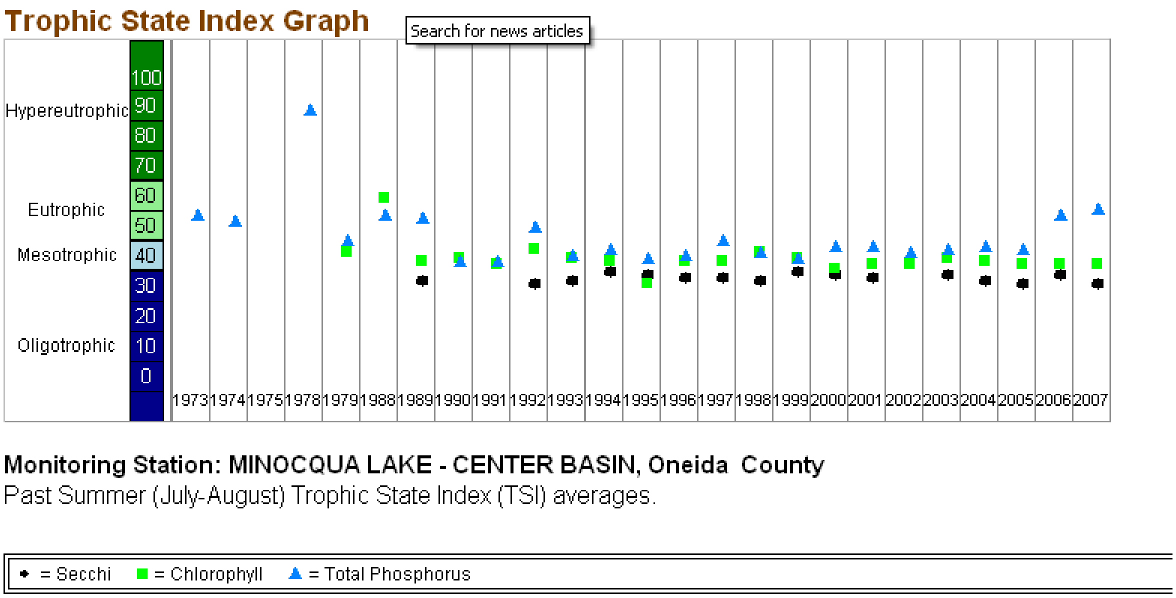


***Figure 6: Trophic State Index Graph-Minocqua Lake 1973-2007.***

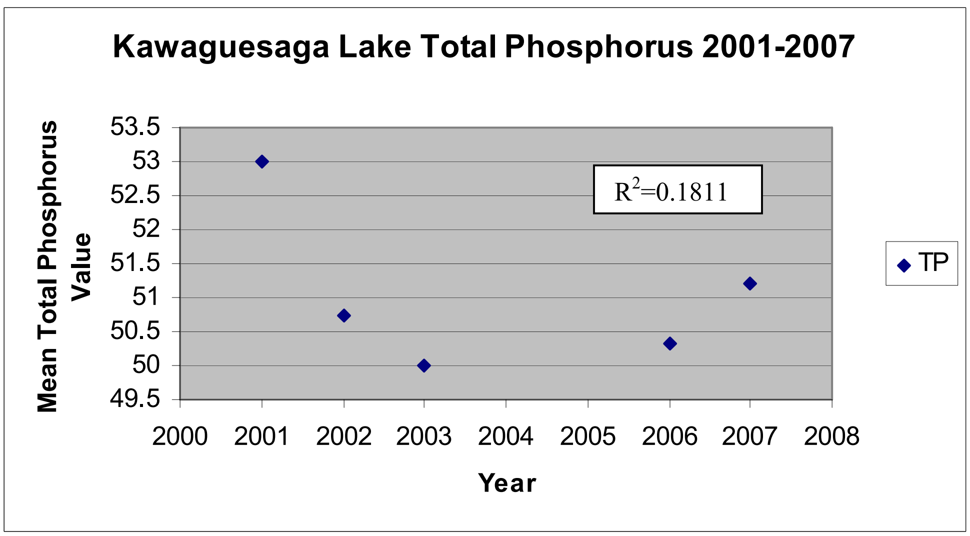


***Figure 7: Total Phosphorus trends for Kawaguesaga 2001-2007***

The trend lines for phosphorus are not necessarily valid. For Kawaguesaga Lake, there appears to be a slightly downward trend in total phosphorus since 2000. However the correlation is low and therefore this potential trend should used with caution. As for Minocqua Lake, the total phosphorus readings since 1998 have been very erratic with no real correlation to a trend (although the trend line appears to be decreasing slightly).

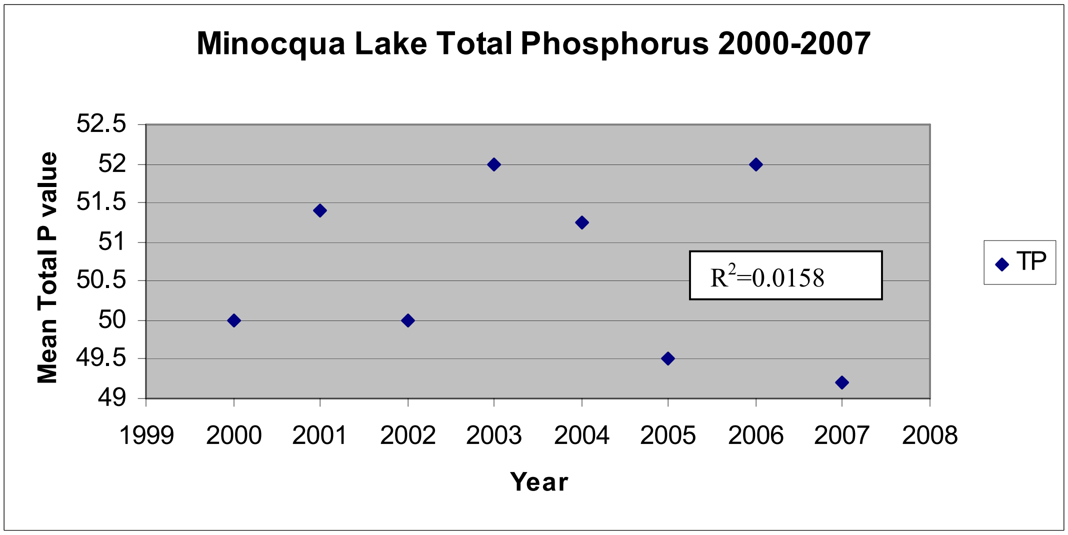


***Figure 8: Total phosphorus trends Minocqua Lake 1998-2007***

Recently sediment cores were obtained and analyzed for historical sedimentation rates. The results suggest that sedimentation rates were relatively stable for many decades until about 40 years ago. From that point on, the sedimentation rates have increased immensely. This is most likely due to increased development on and near Kawaguesaga Lake and Minocqua Lake during the last few decades[7].

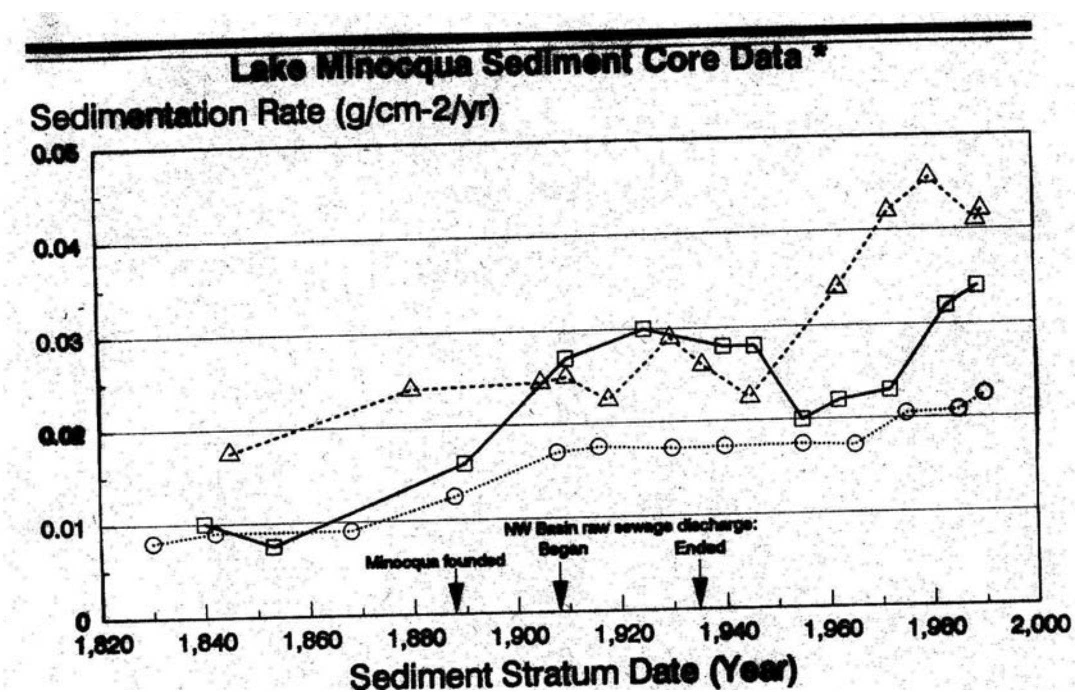


***Figure 9: Sediment core graph[8]. Line differences are unknown.***

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[7] From Wisconsin DNR files kept in Rhinelander WI. Reviewed January 2008.
[8] From a letter reviewing sediment core results from Paul Garrison on file with Wisconsin DNR.

## Watershed[9]

The watershed for Kawaguesaga/Minocqua Lakes is very extensive when considering all water sources. The land cover map indicates that the vast majority of land cover in the watershed is forested.

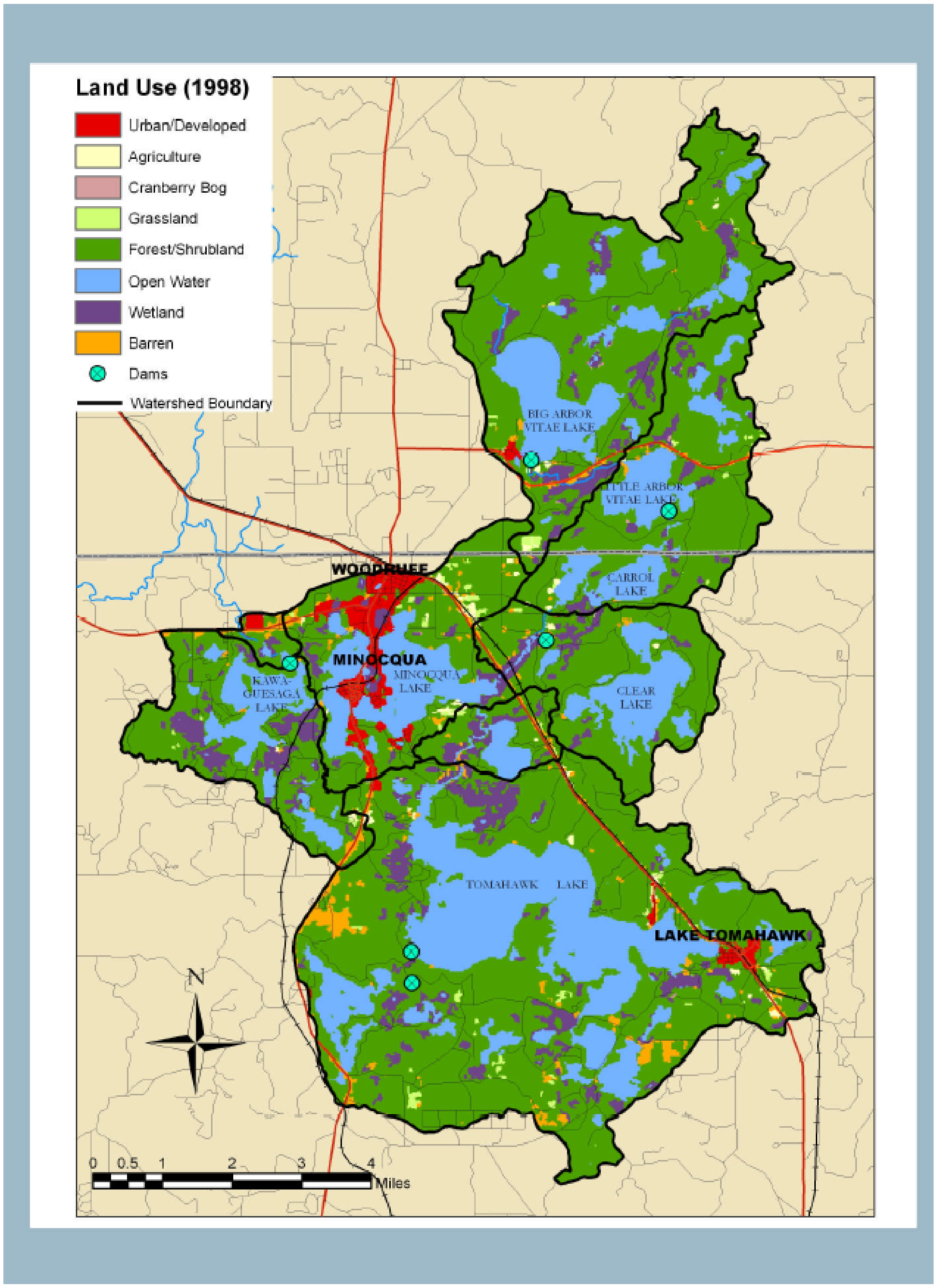


***Figure 10: Map of Minocqua Chain watershed with land cover.***

[9] Watershed maps from Cedar Corp., Menomonie, WI. Cedar Corp prepared these maps for a Lake Management Plan they prepared in 2006.

In the immediate watershed, it is evident that various land uses are having varying impacts on the lakes. Observed on the map, there is extensive urban development adjacent to these lakes. Furthermore, single-family residential development in the riparian zone is extensive. As a result, the runoff volume and nutrient content of the runoff increases. Native vegetation that would normally remove sediments and nutrients from the runoff is replaced with lawns and/or impervious surfaces. The runoff increases in volume and little or no sediment is removed. The result is phosphorus-bound sedimentation into the lakes, which increases phosphorus concentrations and allows more plant and algae production.

It is important to maintain the remaining areas of natural vegetation, and restore as much of the developed riparian areas back to native plants as possible. This will mitigate the nutrient runoff into the lake to a large degree.

When evaluating the predicted future land use, it is evident that a large increase in development is probable. This could result in further conversion from land covers that have less impact on the lakes, to land covers that has a much greater impact. This again warrants extensive work on implementing best management practices (BMP's) in the watershed. It also is important to maintain a healthy native plant community in the riparian zone in Kawaguesaga/Minocqua Lakes.

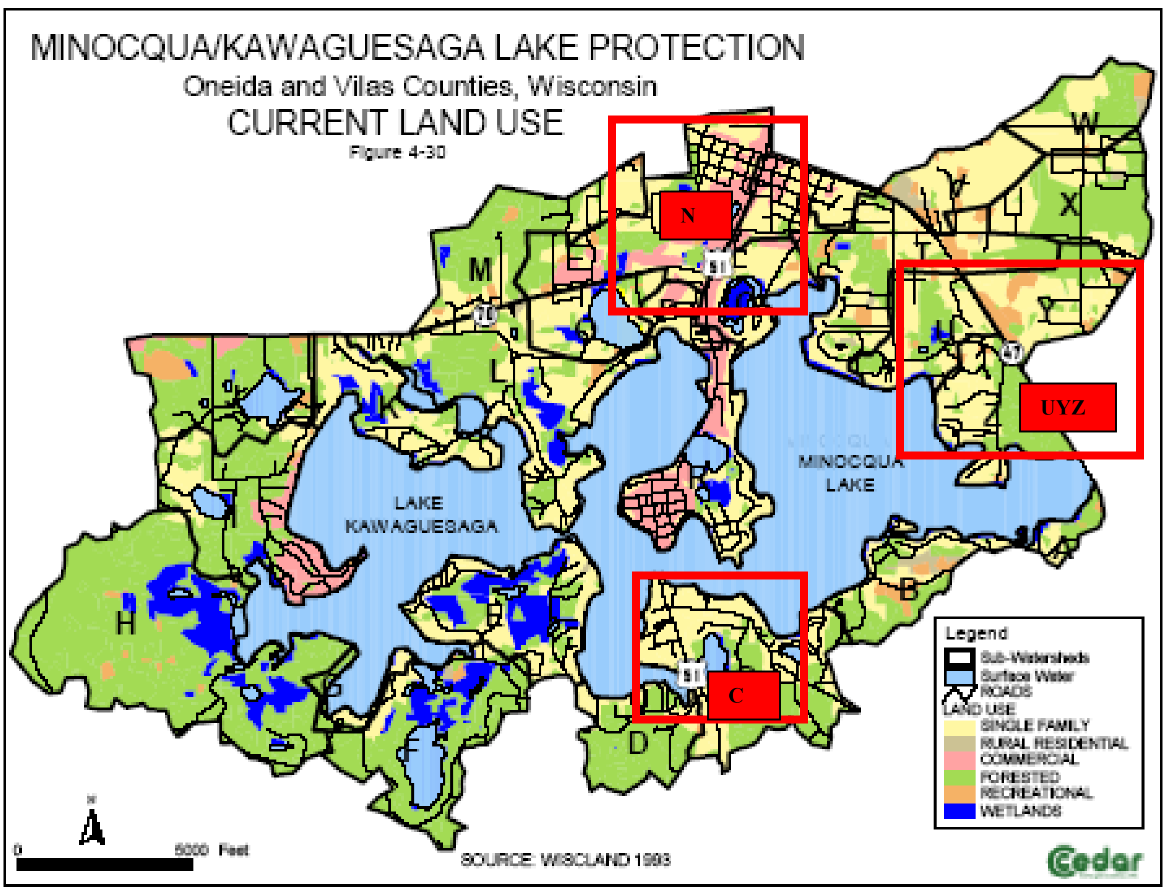


***Figure 11: Current land use (1993) for Kawaguesaga and Minocqua Lakes.***

Each sub-watershed (A to Z) contributes to the total phosphorus load. Table XX shows the area of each sub-watershed. Figure 12 graphically shows the highest phosphorus contributing sub-watersheds. Sub-watersheds N, C and UYZ (collectively) contribute the most respectively. Sub-watershed N makes up only 5.84% of the total watershed, yet has the most phosphorus load by a rather significant amount.

***Table 2: Watershed areas.***

| Watershed | Acres | % of total | Watershed | Acres | % of total |
|---|---|---|---|---|---|
| A | 41.7 | 0.68% | O | 143.5 | 2.34% |
| B | 172.5 | 2.82% | P | 54.4 | 0.89% |
| C | 399.7 | 6.53% | Q | 128.3 | 2.10% |
| D | 169.6 | 2.77% | R | 242 | 3.95% |
| E | 283 | 4.62% | S | 126.1 | 2.06% |
| F | 347.9 | 5.68% | T | 333.6 | 5.45% |
| G | 41.8 | 0.68% | U | 171.5 | 2.80% |
| H | 752.5 | 12.29% | V | 140.1 | 2.29% |
| I | 335.3 | 5.48% | W | 147.8 | 2.41% |
| J | 285.2 | 4.66% | X | 227.6 | 3.72% |
| K | 188 | 3.07% | Y | 178.7 | 2.92% |
| L | 402.7 | 6.58% | Z | 200.2 | 3.27% |
| M | 250.3 | 4.09% | Total | 6121.2 | 100.00% |
| N | 357.2 | 5.84% | | | |

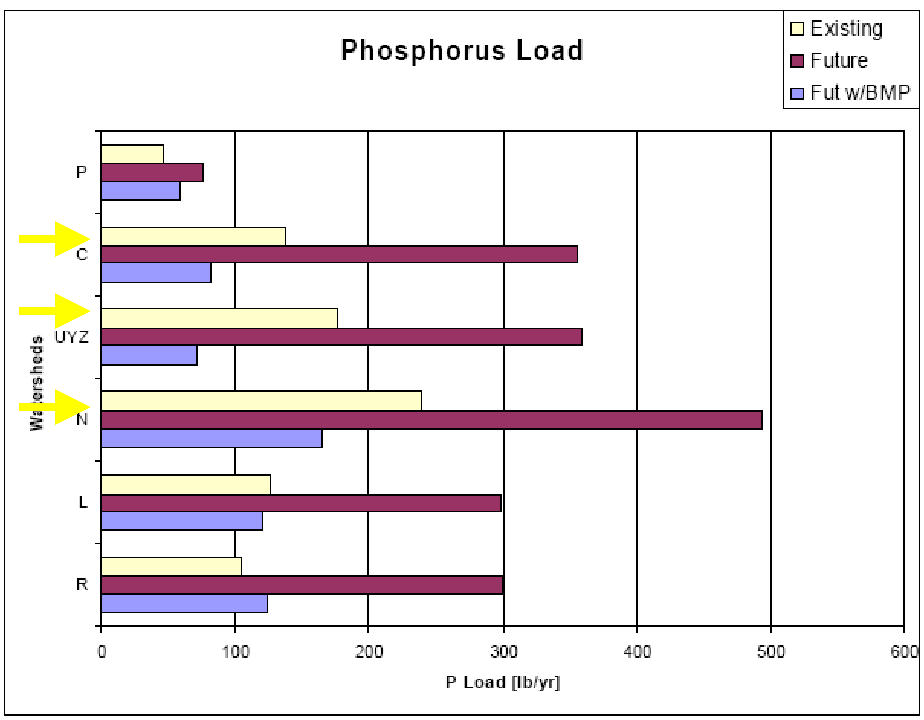


***Figure 12: Phosphorus loading (lb/yr) by watershed (highest 3 marked).***

The future landuse predictions show that all of these (as well as others) may increase phosphorus loading significantly, with N reaching nearly 500 lbs per year.

Sub-watersheds L, P and R are also significant contributors. All of these watersheds, along with C and N are adjacent to dense EWM stands. This nutrient influx can contribute to high nutrient sediments and exacerbate EWM growth.

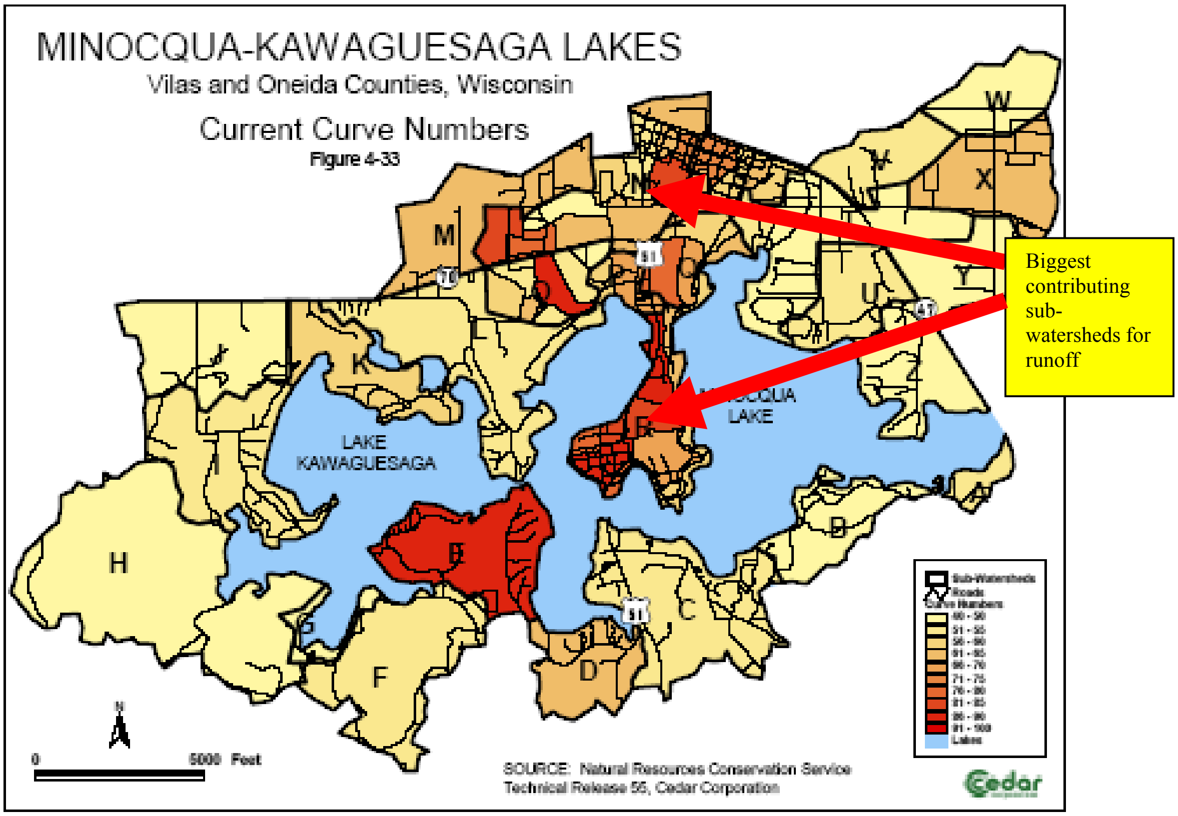


***Figure 13: Runoff curve numbers from Natural Resources Conservation Service. Darker shades provide more runoff.***

Figure 13 shows substantial areas in the immediate watershed that have a significant impact. The darker shaded regions indicate higher curve numbers, which represent the amount of runoff occurring from those areas. Sub-watersheds E and R are two large areas that have the highest curve rating and are immediately adjacent to the lakes. These areas most likely contribute a large portion of the nutrients/sediments that enter both lakes (on a per acre basis).

The future phosphorus loading without BMP's is predicted to increase by 196%. However, if BMP's are implemented, this can be reduced significantly (by 65+%). Sub-watersheds N and S appear to contribute the highest annual phosphorus loads overall (239 and 214 lbs of phosphorus respectively). Sub-watersheds E and R, which have the highest curve rating for runoff, are predicted to increase immensely without BMP's. Rating curve is the amount of runoff contributed to the lake. In both cases (phosphorus contribution and runoff contribution) the sub-watersheds with the most contribution are in urban landuse. As a result, these are areas that should be the focus for reduction and/or removal of suspended solids, phosphorus, and reduction of runoff volume. Many practices can be implemented to do this, but these are beyond the scope of this plan. However, nutrient control can be important in reducing growth of EWM.

Presently the USGS is doing an in-depth water quality study on Mincoqua and Kawaguesaga Lakes and was not completed at the time of this plan development (estimated to be completed in 2009). This study will provide a good update of the major areas that contribute nutrients to these lakes and allow for a more valid identification of key areas to implement management practices in relation to EWM management.

# Plant Community

## 2007 Survey Results

**Minocqua Lake**

The Lake Minocqua grid contained 2,153 points . Of the total, 917 points were 20 feet deep or less, and thus could support plant growth (littoral zone).

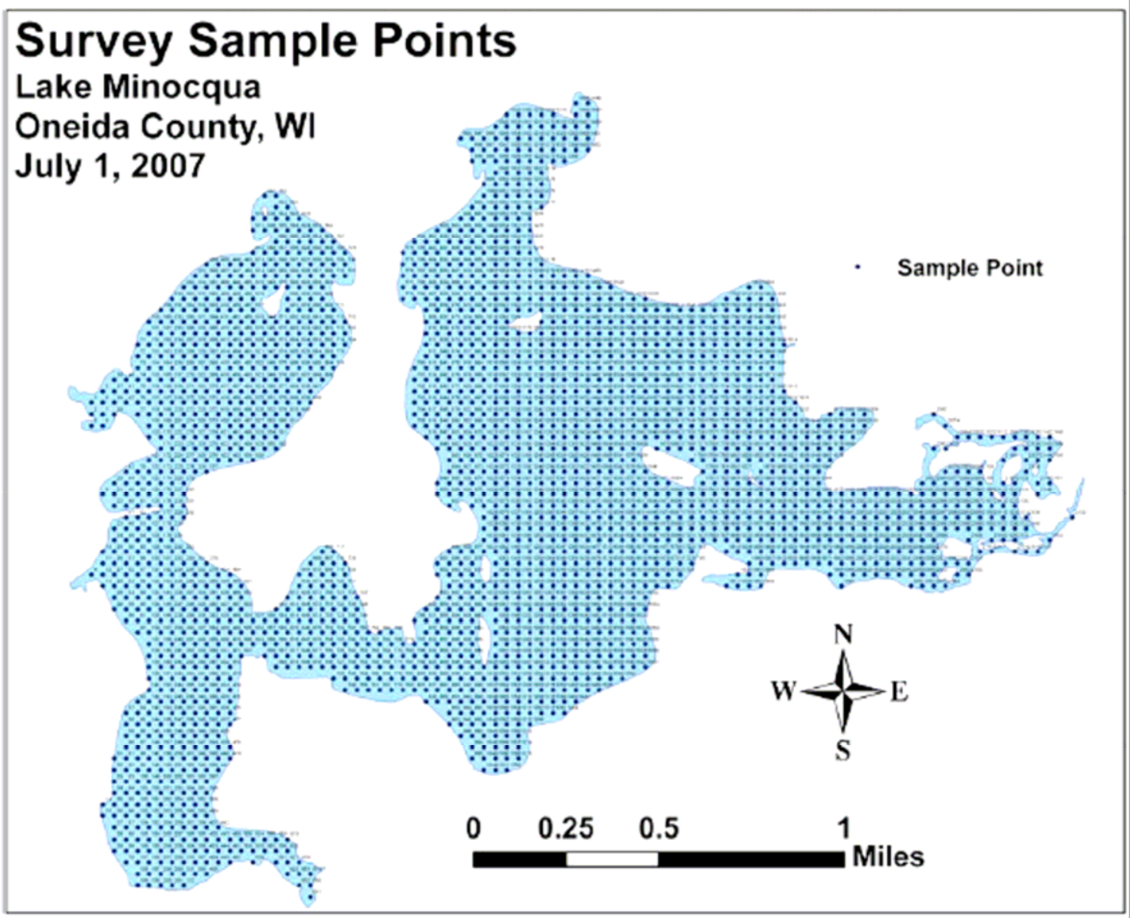


*Figure 14: Sample point grid for Minocqua Lake.*

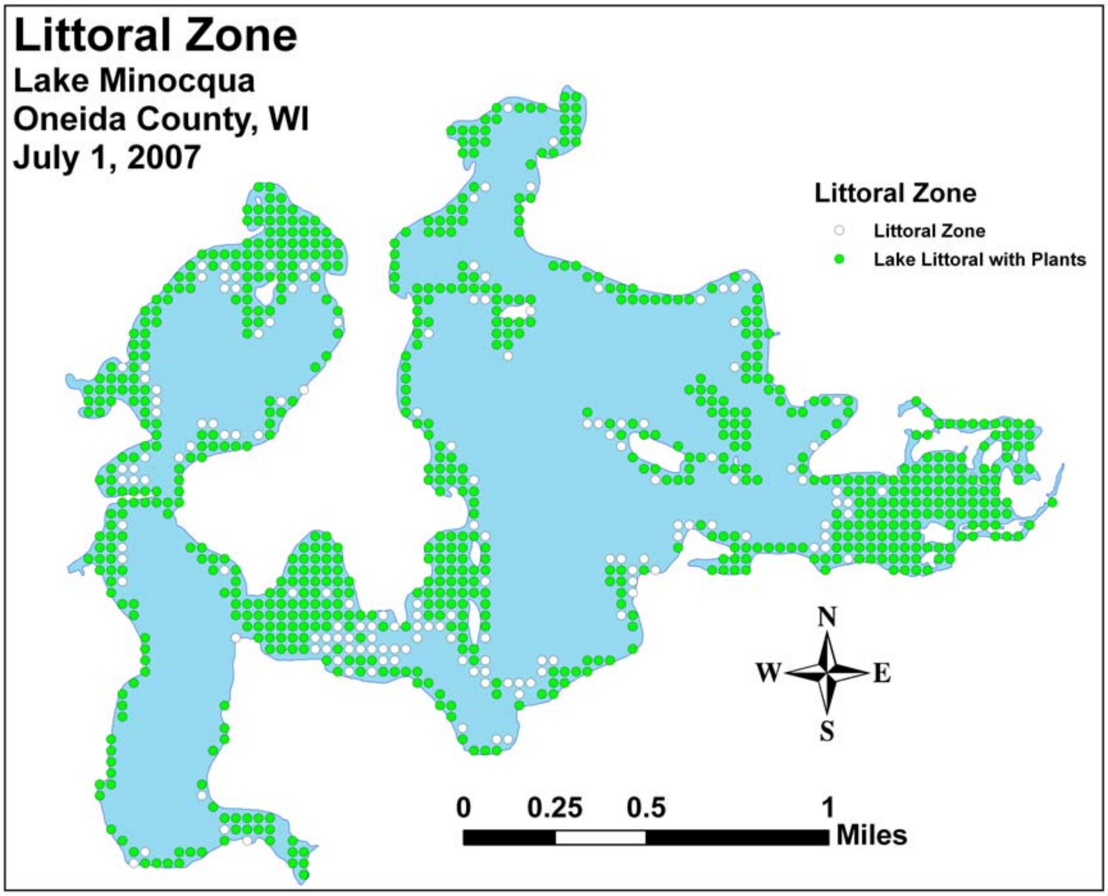


***Figure 15: Minocqua Lake littoral zone and points in littoral zone with plants.***

In Lake Minocqua, plants were found growing on approximately 37% of the entire lake bottom, and 87% of the littoral zone. Diversity was extremely high with a Simpson Diversity Index value of 0.94. Species richness was also high with 54 total macrophyte species (including filamentous algae) found growing in and immediately adjacent to the lake that were sampled. The majority of aquatic macrophytes were found growing in water with an average depth of 8ft. At these depths, there was high diversity and evenness with no one species dominating. Although we determined the littoral zone out to 20 feet, in most parts of Lake Minocqua, the "weedline" ended at 17ft. Coontail (*Ceratophyllum demersum*), Robbins (fern) pondweed (*Potamogeton robbinsii*), flat-stem pondweed (*Potamogeton zosteriformis*), and small pondweed (*Potamogeton pusillus*) were the most common species being found at 51.64%, 37.91%, 37.28% and 30.23% of the survey points with vegetation respectively.

***Table 3: Summary of survey statistics-Minocqua Lake.***

**Summary Statistics:**

| | |
|---|---|
| Total number of points sampled | 1308 |
| Total number of sites with vegetation | 794 |
| Total number of sites shallower than the maximum depth of plants | 917 |
| Frequency of occurrence at sites shallower than maximum depth of plants | 86.59 |
| Simpson Diversity Index | 0.94 |
| Maximum depth of plants (ft) | 20.00 |
| Average number of all species per site (veg. sites only) | 4.00 |
| Average number of native species per site (veg. sites only) | 3.86 |
| Species Richness | 54 |
| Species Richness (including visuals) | 56 |
| Mean depth of plants (ft) | 8.35 |

In addition to the more common species, a single "Special Concern"** species Vasey's pondweed (*Potamogeton vaseyi*) was sampled. The presence of this species along with other species that are susceptible to poor water quality such as floating-leaf bur-reed (*Sparganium fluctuans*), dwarf water milfoil (*Myriophyllum tenellum*), and water lobelia (*Lobelia dortmanna*) is a testament to the history of good water quality in the Minocqua Chain.

***Table 4: Species richness with frequency data-Minocqua Lake.***

| Species | Common Name | Total Sites | Relative Freq. | Freq. in Veg. |
|---|---|---|---|---|
| Submergent Floating Emergent | | | | |
| *Ceratophyllum demersum* | Coontail | 410 | 12.92 | 51.64 |
| *Potamogeton robbinsii* | Robbins (fern) pondweed | 301 | 9.48 | 37.91 |
| *Potamogeton zosteriformis* | Flat-stem pondweed | 296 | 9.33 | 37.28 |
| *Potamogeton pusillus* | Small pondweed | 242 | 7.62 | 30.48 |
| *Elodea canadensis* | Common waterweed | 224 | 7.06 | 28.21 |
| *Myriophyllum sibiricum* | Northern water-milfoil | 186 | 5.86 | 23.43 |
| *Vallisneria americana* | Wild celery | 160 | 5.04 | 20.15 |
| *Ranunculus aquatilis* | Stiff water crowfoot | 123 | 3.88 | 15.49 |
| Filamentous algae | Filamentous algae | 118 | 3.72 | 14.86 |
| *Potamogeton amplifolius* | Large-leaf pondweed | 107 | 3.37 | 13.48 |
| *Lemna trisulca* | Forked duckweed | 105 | 3.31 | 13.22 |
| *Potamogeton praelongus* | White-stem pondweed | 105 | 3.31 | 13.22 |
| *Potamogeton crispus* | Curly-leaf pondweed | 98 | 3.09 | 12.34 |
| *Potamogeton richardsonii* | Clasping-leaf pondweed | 97 | 3.06 | 12.22 |
| *Potamogeton gramineus* | Variable pondweed | 82 | 2.58 | 10.33 |
| *Megalodonta beckii* | Water marigold | 71 | 2.24 | 8.94 |
| *Najas flexilis* | Bushy pondweed | 60 | 1.89 | 7.56 |
| *Chara* sp. | Muskgrass | 50 | 1.58 | 6.30 |
| *Heteranthera dubia* | Water star-grass | 38 | 1.20 | 4.79 |
| *Eleocharis acicularis* | Needle spikerush | 37 | 1.17 | 4.66 |
| *Nymphaea odorata* | White water lily | 28 | 0.88 | 3.53 |
| *Sagittaria rigida* | Sessile-fruited arrowhead | 27 | 0.85 | 3.40 |
| *Myriophyllum spicatum* | Eurasian water milfoil | 24 | 0.76 | 3.02 |

| (Table 4 continued) Species | Common Name | Total Sites | Relative Freq. | Freq. in Veg. |
|---|---|---|---|---|
| *Nuphar variegata* | Spatterdock | 22 | 0.69 | 2.77 |
| *Potamogeton friesii* | Fries' pondweed | 21 | 0.66 | 2.64 |
| Aquatic moss | Aquatic moss | 14 | 0.44 | 1.76 |
| *Isoetes echinospora* | Spiny-spored quillwort | 13 | 0.41 | 1.64 |
| *Sparganium emersum* | Narrow-leaved bur-reed | 13 | 0.41 | 1.64 |
| *Utricularia vulgaris* | Common bladderwort | 11 | 0.35 | 1.39 |
| *Pontederia cordata* | Pickerelweed | 10 | 0.32 | 1.26 |
| *Decodon verticillatus* | Swamp loosestrife | 8 | 0.25 | 1.01 |
| *Lemna minor* | Small duckweed | 8 | 0.25 | 1.01 |
| *Potamogeton obtusifolius* | Blunt-leaf pondweed | 8 | 0.25 | 1.01 |
| *Brasenia schreberi* | Watershield | 6 | 0.19 | 0.76 |
| *Spirodela polyrhiza* | Large duckweed | 6 | 0.19 | 0.76 |
| *Potamogeton vaseyi* | Vasey's pondweed | 5 | 0.16 | 0.63 |
| *Eleocharis palustris* | Creeping spikerush | 4 | 0.13 | 0.50 |
| *Potamogeton natans* | Floating-leaf pondweed | 4 | 0.13 | 0.50 |
| *Carex comosa* | Bottle brush sedge | 3 | 0.09 | 0.38 |
| *Nitella* sp. | Nitella | 3 | 0.09 | 0.38 |
| *Sagittaria cuneata* | Arum-leaved arrowhead | 3 | 0.09 | 0.38 |
| *Sparganium eurycarpum* | Common bur-reed | 3 | 0.09 | 0.38 |
| *Wolffia columbiana* | Common watermeal | 3 | 0.09 | 0.38 |
| *Juncus effusus* | Common rush | 3 | 0.09 | 0.38 |
| *Juncus pelocarpus f. submersus* | Brown-fruited rush | 2 | 0.06 | 0.25 |
| *Potamogeton illinoensis* | Illinois pondweed | 2 | 0.06 | 0.25 |
| *Potamogeton spirillus* | Spiral-fruited pondweed | 2 | 0.06 | 0.25 |
| *Dulichium arundinaceum* | Three-way sedge | 1 | 0.03 | 0.13 |

| (Table 4 continued) Species | Common name | Total Sites | Rel Freq. | Freq. in veg. |
|---|---|---|---|---|
| *Potamogeton alpinus* | Alpine pondweed | 1 | 0.03 | 0.13 |
| *Potamogeton epihydrus* | Ribbon-leaf pondweed | 1 | 0.03 | 0.13 |
| *Sagittaria latifolia* | Common arrowhead | 1 | 0.03 | 0.13 |
| *Schoenoplectus tabernaemontani* | Softstem bulrush | 1 | 0.03 | 0.13 |
| *Stuckenia pectinata* | Sago pondweed | 1 | 0.03 | 0.13 |
| *Typha latifolia* | Broad-leaved cattail | 1 | 0.03 | 0.13 |
| *Butomus umbellatus* | Flowering rush | 1 | 0.03 | 0.13 |
| *Cicuta bulbifera* | Bulb-bearing water hemlock | ** | ** | ** |
| *Lythrum salicaria* | Purple loosestrife | ** | ** | ** |
| *Acorus calamus* | Sweetflag | *** | *** | *** |
| *Calla palustris* | Wild arum | *** | *** | *** |
| *Carex crawfordii and Carex aquatilis* | Sedge | *** | *** | *** |
| *Elatine minima* | Waterwort | *** | *** | *** |
| *Equisetum fluviatile* | Water horsetail | *** | *** | *** |
| *Glyceria canadensis* | Rattlesnake manna grass | *** | *** | *** |
| *Lobelia dortmanna* | Water lobelia | *** | *** | *** |
| *Myriophyllum tenellum* | Dwarf water-milfoil | *** | *** | *** |
| *Phalaris arundinacea* | Reed canary grass | *** | *** | *** |
| *Typha angustifolia* | Narrow-leaved cattail | *** | *** | *** |
| | | | | |

** Visual Only
*** Boat Survey Only

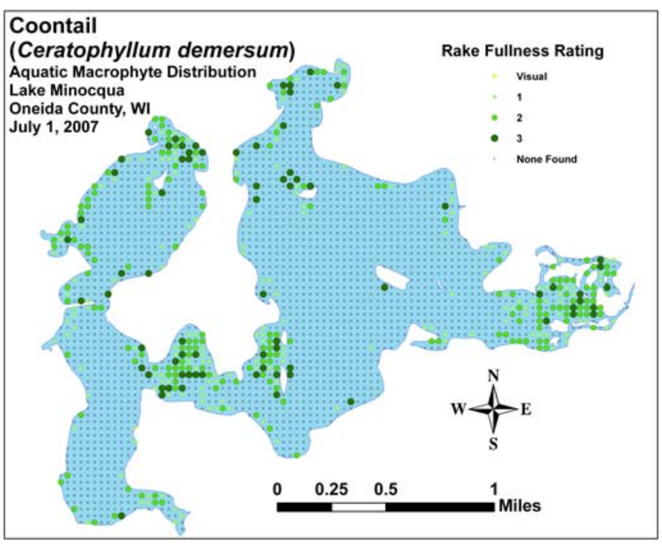


***Figure 16: Distribution of coontail-most common plant in Minocqua Lake.***

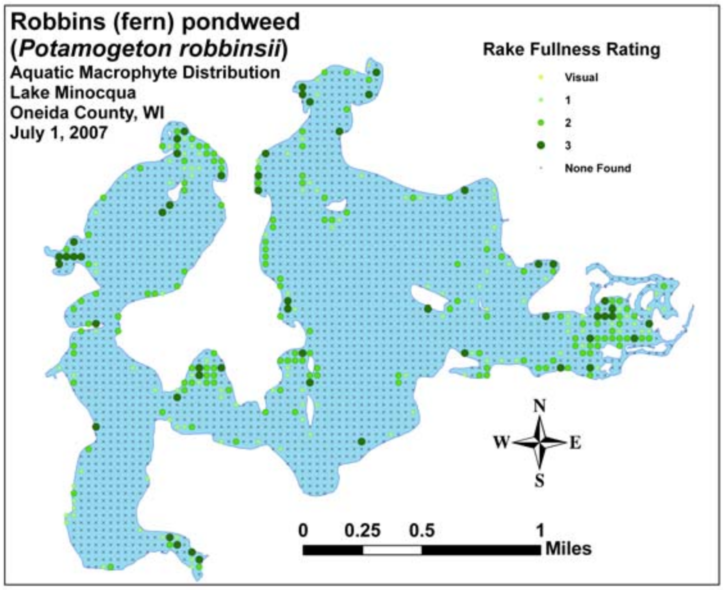


***Figure 17: Distribution of Robbin's pondweed-second most common plant sampled.***

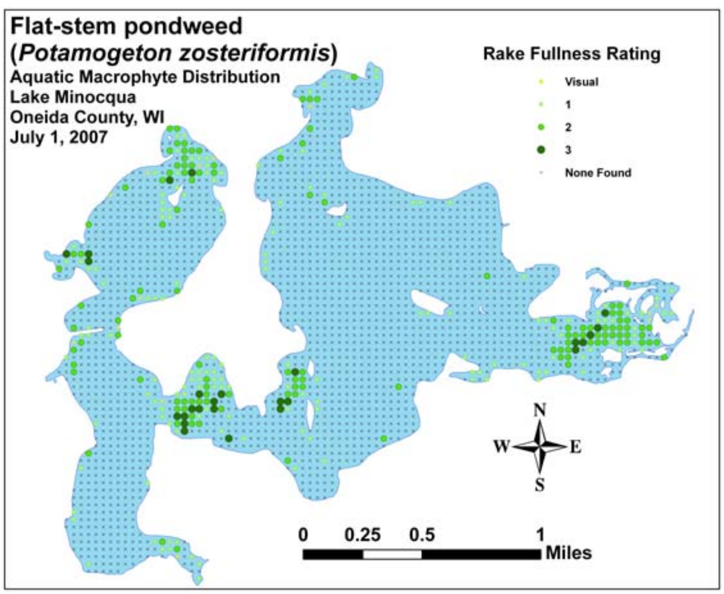


***Figure 18: Distribution of flat-stem pondweed-third most common plant sampled.***

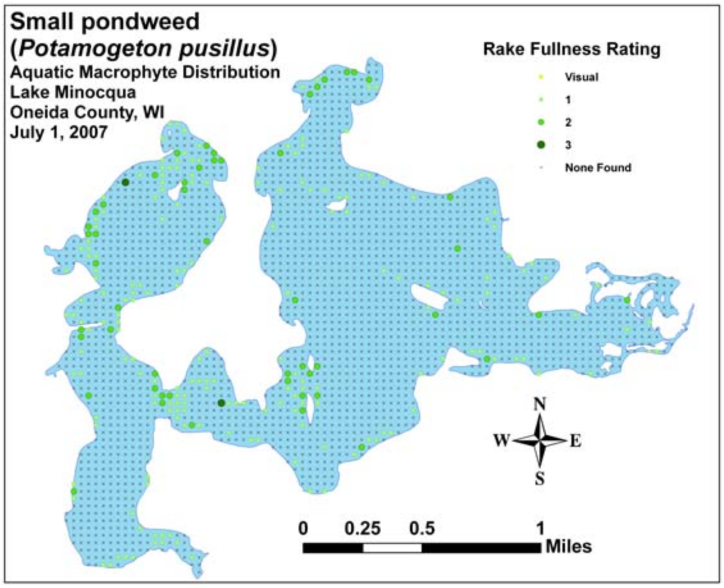


***Figure 19: Distribution of small pondweed-fourth most common plant sampled.***

**Kawaguesaga Lake**

The Lake Kawaguesaga grid contained 1,009 points. Of the total sample points, 577 points were 18.5 feet deep or less, and thus could support plant growth (littoral zone). Kawaguesaga's western (muck and boggy) bays supported high plant diversity.

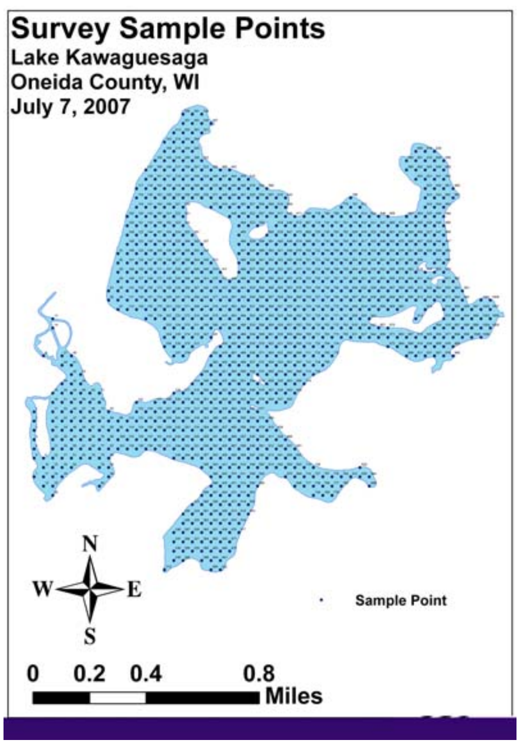


***Figure 20: Sample point grid for Kawaguesaga Lake***

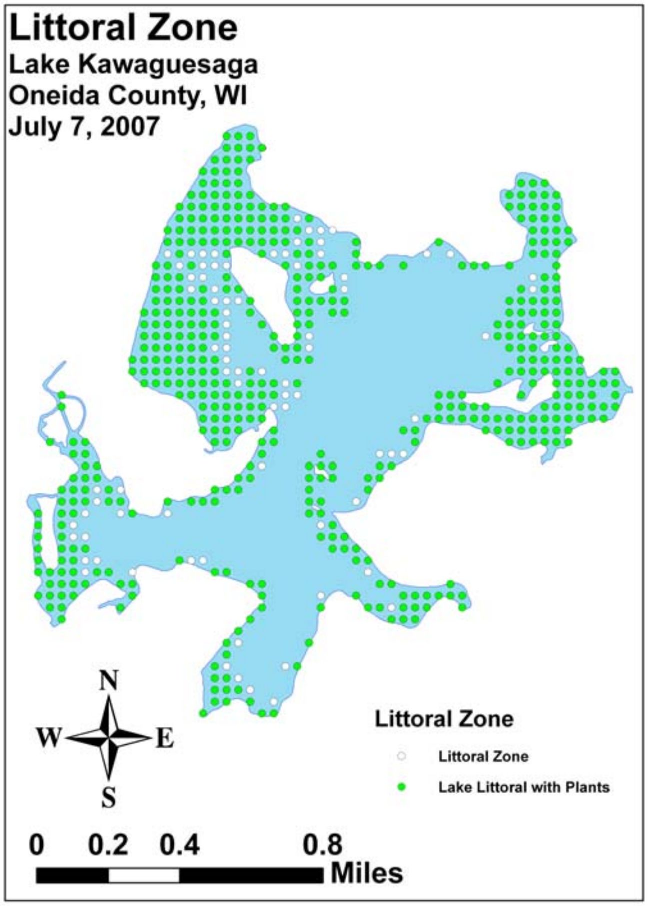


***Figure 21: Points with plants in littoral zone Kawaguesaga Lake***

In Lake Kawaguesaga, plants were sampled growing on approximately 49% of the entire lake bottom, and 86% of the littoral zone. Diversity was extremely high with a Simpson's Diversity Index value of 0.93. Species richness was also high with 50 total macrophyte species (55 including viewed) found growing in and immediately adjacent to the lake. The majority of aquatic macrophytes were found growing in relatively deep water with an average depth of almost 10ft. These 12-18ft. areas of Kawaguesaga Lake, especially the flats surrounding Big and Little Ripley Islands in the northwest bay, were dominated by four species: Coontail, flat-stem pondweed, small pondweed, and Robbins (fern) pondweed. These plants were found at 44.85%, 44.85%, 42.42% and 36.36% of survey points with vegetation respectively.

***Table 5: Survey statistics from Kawaguesaga Lake***

**Summary Statistics:**

| | |
|---|---|
| Total number of points sampled | 739 |
| Total number of sites with vegetation | 495 |
| Total number of sites shallower than the maximum depth of plants | 577 |
| Frequency of occurrence at sites shallower than maximum depth of plants | 85.79 |
| Simpson Diversity Index | 0.93 |
| Maximum depth of plants (ft) | 18.50 |
| Average number of all species per site (veg. sites only) | 3.66 |
| Average number of native species per site (veg. sites only) | 3.49 |
| Species Richness | 50 |
| Species Richness (including visuals) | 55 |
| Mean depth of plants (ft) | 9.68 |

The far southwest bay of Kawaguesaga Lake represents a unique ecological community in the chain as it contained plants not found anywhere else. The main bay was bordered by a series of smaller bays, many of which contained bogs. This likely increased the acidity of the water here thus explaining the additional diversity. Plants unique to this area included marsh cinquefoil (*Potentilla palustris*), narrow-leaved bur-reed (*Sparganium angustifolium*), creeping bladderwort (*Utricularia gibba*), and flat-leaf bladderwort (*Utricularia intermedia*). Also observed were other highly sensitive obligate bog species such as sundews (*Drosera* sp.) and pitcher plants (*Sarracenia purpurea*) further in from the lake margin.

***Table 6: Species richness with frequency statistics-Kawaguesaga Lake***

| Species | Common Name | Total Sites | Relative Freq. | Freq. in Veg. |
|---|---|---|---|---|
| Submergent Floating Emergent | | | | |
| *Ceratophyllum demersum* | Coontail | 222 | 12.24 | 44.85 |
| *Potamogeton zosteriformis* | Flat-stem pondweed | 222 | 12.24 | 44.85 |
| *Potamogeton pusillus* | Small pondweed | 214 | 11.80 | 43.13 |
| *Potamogeton robbinsii* | Robbins (fern) pondweed | 180 | 9.92 | 36.36 |
| *Vallisneria americana* | Wild celery | 123 | 6.78 | 24.85 |
| *Elodea canadensis* | Common waterweed | 110 | 6.06 | 22.22 |
| *Myriophyllum sibiricum* | Northern water-milfoil | 105 | 5.79 | 21.21 |
| *Potamogeton crispus* | Curly-leaf pondweed | 84 | 4.63 | 16.97 |
| *Najas flexilis* | Bushy pondweed | 59 | 3.25 | 11.92 |
| *Potamogeton richardsonii* | Clasping-leaf pondweed | 57 | 3.14 | 11.52 |
| *Potamogeton amplifolius* | Large-leaf pondweed | 53 | 2.92 | 10.71 |
| Filamentous algae | Filamentous algae | 39 | 2.15 | 7.88 |
| *Ranunculus aquatilis* | Stiff water crowfoot | 35 | 1.93 | 7.07 |
| *Megalodonta beckii* | Water marigold | 34 | 1.87 | 6.87 |
| *Potamogeton praelongus* | White-stem pondweed | 33 | 1.82 | 6.67 |
| *Potamogeton gramineus* | Variable pondweed | 27 | 1.49 | 5.45 |
| *Chara* sp. | Muskgrass | 26 | 1.43 | 5.25 |
| *Potamogeton friesii* | Fries' pondweed | 26 | 1.43 | 5.25 |
| *Nymphaea odorata* | White water lily | 19 | 1.05 | 3.84 |
| *Brasenia schreberi* | Watershield | 14 | 0.77 | 2.83 |
| *Heteranthera dubia* | Water star-grass | 12 | 0.66 | 2.42 |

| (Table 6 continued) Species | Common Name | Total Sites | Relative Freq. | Freq. in Veg. |
|---|---|---|---|---|
| *Nuphar variegata* | Spatterdock | 12 | 0.66 | 2.42 |
| Aquatic moss | Aquatic moss | 10 | 0.55 | 2.02 |
| *Sagittaria rigida* | Sessile-fruited arrowhead | 9 | 0.50 | 1.82 |
| *Myriophyllum spicatum* | Eurasian water milfoil | 8 | 0.44 | 1.62 |
| *Lemna trisulca* | Forked duckweed | 8 | 0.44 | 1.62 |
| *Eleocharis acicularis* | Needle spikerush | 7 | 0.39 | 1.41 |
| *Potamogeton alpinus* | Alpine pondweed | 7 | 0.39 | 1.41 |
| *Potamogeton vaseyi* | Vasey's pondweed | 7 | 0.39 | 1.41 |
| *Isoetes echinospora* | Spiny-spored quillwort | 5 | 0.28 | 1.01 |
| *Nitella* sp. | Nitella | 5 | 0.28 | 1.01 |
| *Potamogeton natans* | Floating-leaf pondweed | 5 | 0.28 | 1.01 |
| *Sparganium eurycarpum* | Common bur-reed | 5 | 0.28 | 1.01 |
| *Utricularia vulgaris* | Common bladderwort | 5 | 0.28 | 1.01 |
| *Utricularia intermedia* | Flat-leaf bladderwort | 4 | 0.22 | 0.81 |
| *Utricularia gibba* | Creeping bladderwort | 3 | 0.17 | 0.61 |
| *Eleocharis palustris* | Creeping spikerush | 2 | 0.11 | 0.40 |
| *Juncus pelocarpus f. submersus* | Brown-fruited rush | 2 | 0.11 | 0.40 |
| *Pontederia cordata* | Pickerelweed | 2 | 0.11 | 0.40 |
| *Potamogeton obtusifolius* | Blunt-leaf pondweed | 2 | 0.11 | 0.40 |
| *Sagittaria cuneata* | Arum-leaved arrowhead | 2 | 0.11 | 0.40 |
| *Sparganium emersum* | Narrow-leaved bur-reed | 2 | 0.11 | 0.40 |
| *Lemna minor* | Small duckweed | 1 | 0.06 | 0.20 |
| *Potamogeton illinoensis* | Illinois pondweed | 1 | 0.06 | 0.20 |
| *Schoenoplectus tabernaemontani* | Softstem bulrush | 1 | 0.06 | 0.20 |
| *Sparganium fluctuans* | Floating-leaf-bur-reed | 1 | 0.06 | 0.20 |
| *Spirodela polyrhiza* | Large duckweed | 1 | 0.06 | 0.20 |
| *Typha latifolia* | Broad-leaved cattail | 1 | 0.06 | 0.20 |
| *Butomus umbellatus* | Flowering rush | 1 | 0.06 | 0.20 |
| *Calla palustris* | Water arum | 1 | 0.06 | 0.20 |
| *Carex comosa* | Bottle brush sedge | ** | ** | ** |
| *Decodon verticillatus* | Swamp loosestrife | ** | ** | ** |
| *Dulichium arundinaceum* | Three-way sedge | ** | ** | ** |
| *Lythrum salicaria* | Purple loosestrife | ** | ** | ** |
| *Potentilla palustris* | Marsh cinquefoil | ** | ** | ** |
| *Cicuta bulbifera* | Bulb-bearing water hemlock | *** | *** | *** |
| *Equisetum fluviatile* | Water horsetail | *** | *** | *** |
| *Glyceria canadensis* | Rattlesnake manna grass | *** | *** | *** |
| *Phalaris arundinacea* | Reed canary grass | *** | *** | *** |
| *Scirpus cyperinus* | Woolgrass | *** | *** | *** |
| *Sparganium angustifolium* | Narrow-leaved bur-reed | *** | *** | *** |
| *Stuckenia pectinata* | Sago pondweed | *** | *** | *** |
| | | | | |

** Visual Only

*** Boat Survey Only

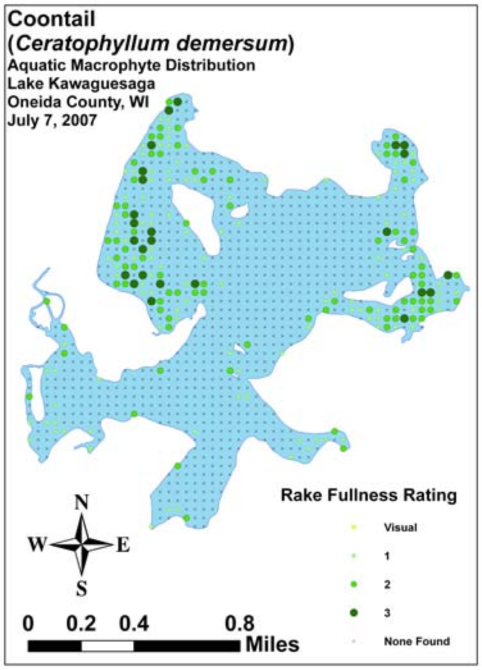


***Figure 22: Distribution of coontail-most common plant sampled on Kawaguesaga Lake.***

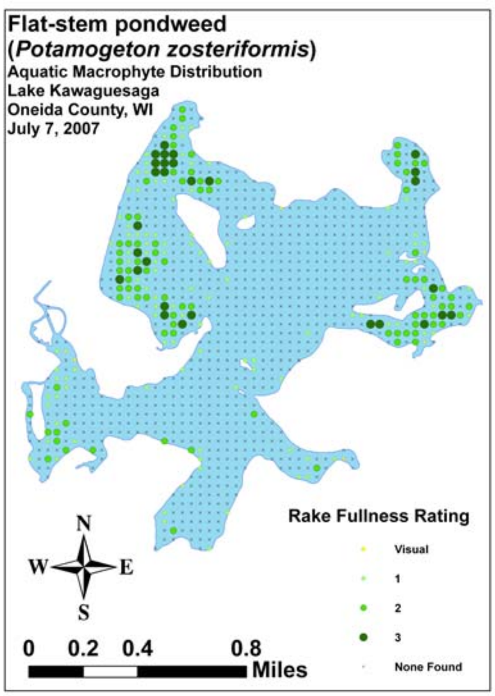


***Figure 23: Distribution of flat-stem pondweed-second most common plant Kawaguesaga Lake.***

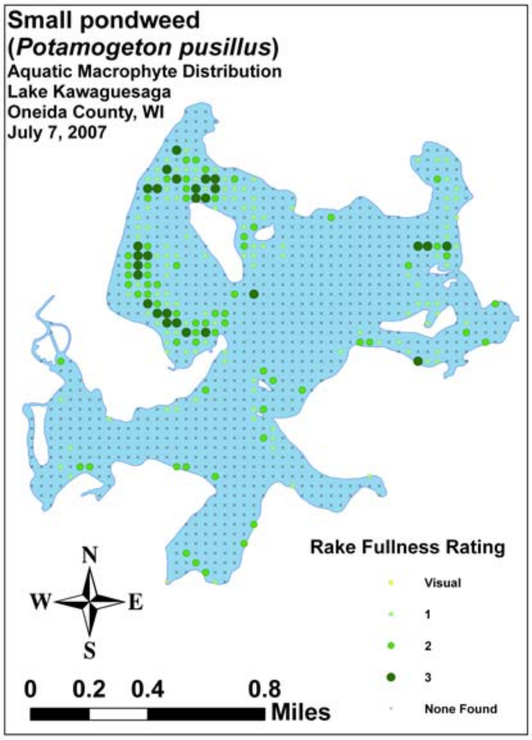


***Figure 24: Distribution of small pondweed-third most common plant Kawaguesaga Lake.***

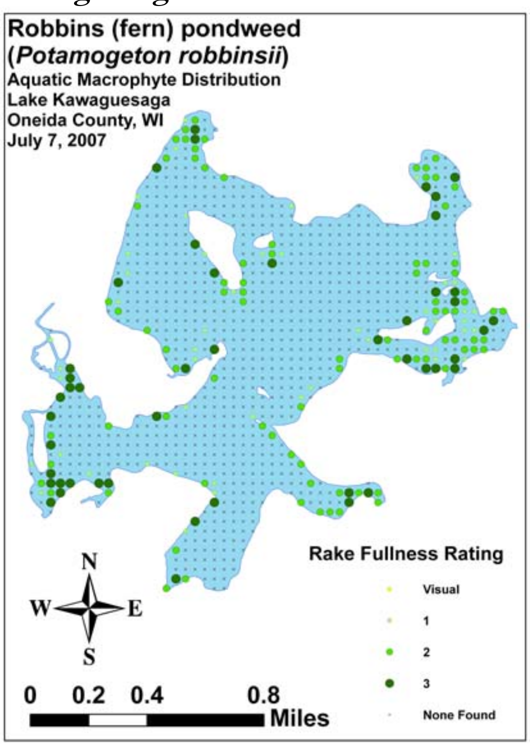


***Figure 25: Distribution of Robbin's pondweed-fourth most common plant Kawaguesaga Lake.***

**Minocqua Thoroughfare**

The Minocqua Thoroughfare grid contained only 80 points, and none of them were over 8ft deep. The substrate was organic muck throughout, and plants were located at all points.

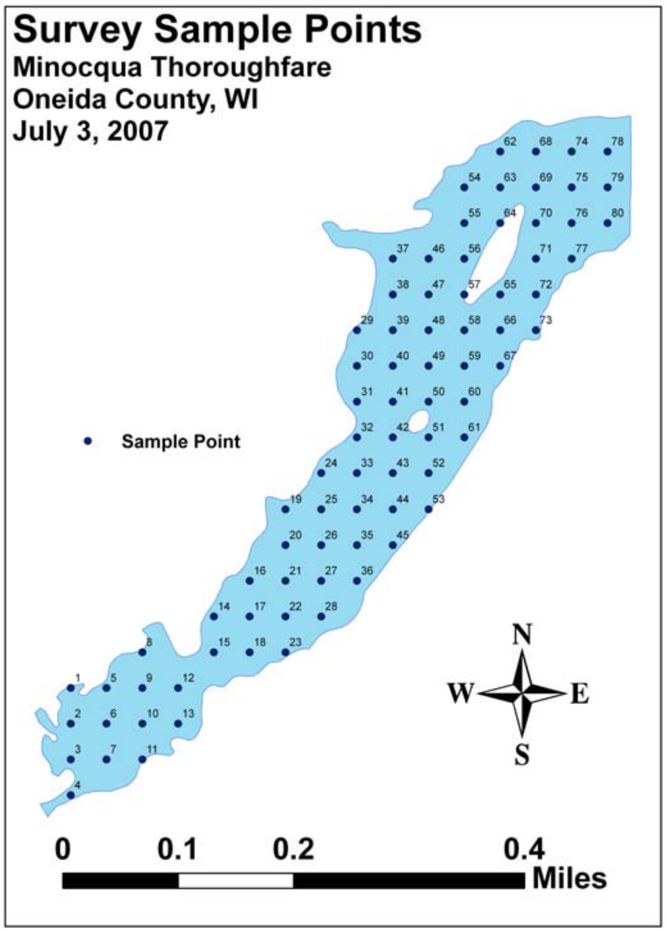


***Figure 26: Sample point grid-Minocqua Thoroughfare***

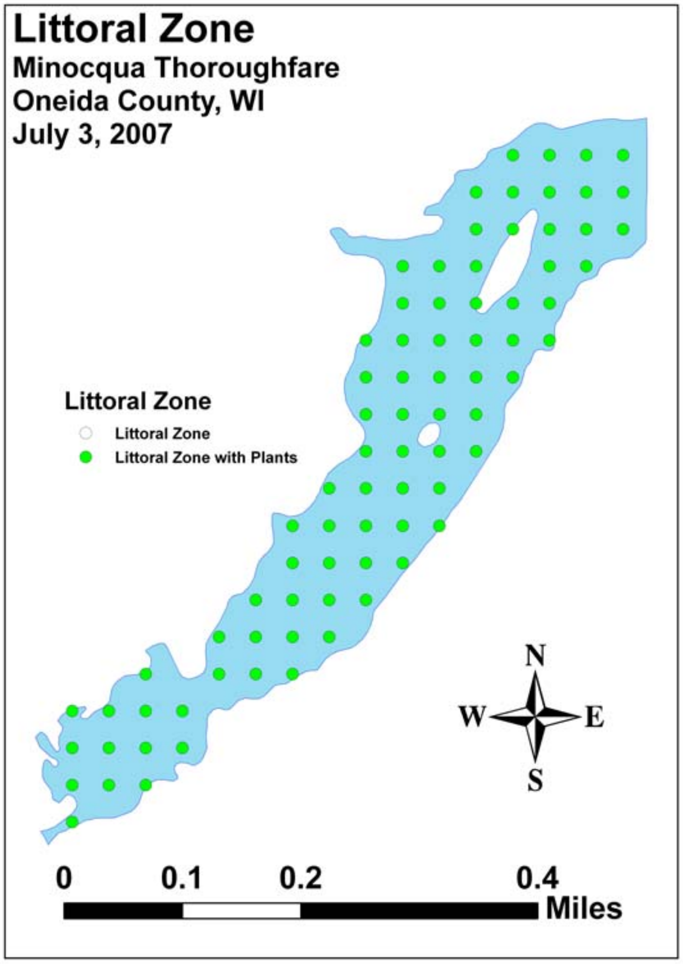


***Figure 27: Points with vegetation in littoral zone-Minocqua Thoroughfare***

In the Minocqua Thoroughfare, plants were sampled at 100% of the survey points. Somewhat surprisingly, diversity was similar to the two large lakes with an extremely high Simpson Diversity Index value of 0.93. There were 42 (43 with viewed) species found here, which is lower than the two lakes, but still very high diversity. The reduction in diversity is likely due to a single bottom type and a smaller total area. Plant density was greater here than at any other point in the chain. It was a struggle to get to many sites as the plants had canopied or the site was actually in the middle of a cattail "forest". Coontail was again the dominant species being found at 70.00% of the sites. Common waterweed (*Elodea canadensis*), flat-stem pondweed, and forked duckweed (*Lemna trisulca*) represented the three other most frequently encountered species being found at 66.25%, 42.50%, and 26.25% of survey points respectively.

### *Table 7: Survey statistics-Minocqua Thoroughfare*

**Summary Statistics:**

| | |
|---|---|
| Total number of points sampled | 80 |
| Total number of sites with vegetation | 80 |
| Total number of sites shallower than the maximum depth of plants | 80 |
| Frequency of occurrence at sites shallower than maximum depth of plants | 100.00 |
| Simpson Diversity Index | 0.93 |
| Maximum depth of plants (ft) | 8.00 |
| Average number of all species per site (veg. sites only) | 4.78 |
| Average number of native species per site (veg. sites only) | 4.78 |
| Species Richness | 42 |
| Species Richness (including visuals) | 43 |
| Mean depth of plants (ft) | 3.20 |

### *Table 8: Species richness and frequency data-Minocqua Thoroughfare*

| Species | Common Name | Total Sites | Relative Freq. | Freq. in Veg. |
|---|---|---|---|---|
| Submergent Floating Emergent | | | | |
| *Ceratophyllum demersum* | Coontail | 56 | 14.66 | 70.00 |
| *Elodea canadensis* | Common waterweed | 53 | 13.87 | 66.25 |
| *Potamogeton zosteriformis* | Flat-stem pondweed | 34 | 8.90 | 42.50 |
| *Lemna trisulca* | Forked duckweed | 21 | 5.50 | 26.25 |
| *Potamogeton obtusifolius* | Blunt-leaf pondweed | 20 | 5.24 | 25.00 |
| *Potamogeton robbinsii* | Robbins (fern) pondweed | 18 | 4.71 | 22.50 |
| *Lemna minor* | Small duckweed | 16 | 4.19 | 20.00 |
| *Nymphaea odorata* | White water lily | 16 | 4.19 | 20.00 |
| *Nuphar variegata* | Spatterdock | 15 | 3.93 | 18.75 |
| *Typha latifolia* | Broad-leaved cattail | 11 | 2.88 | 13.75 |
| *Eleocharis palustris* | Creeping spikerush | 9 | 2.36 | 11.25 |
| *Potamogeton amplifolius* | Large-leaf pondweed | 9 | 2.36 | 11.25 |
| *Lythrum salicaria* | Purple loosestrife | 8 | 2.09 | 10.00 |
| *Myriophyllum sibiricum* | Northern water-milfoil | 8 | 2.09 | 10.00 |
| *Najas flexilis* | Bushy pondweed | 8 | 2.09 | 10.00 |
| *Pontederia cordata* | Pickerelweed | 8 | 2.09 | 10.00 |
| Filamentous algae | Filamentous algae | 6 | 1.57 | 7.50 |
| *Decodon verticillatus* | Swamp loosestrife | 6 | 1.57 | 7.50 |
| *Megalodonta beckii* | Water marigold | 6 | 1.57 | 7.50 |
| *Nitella* sp. | Nitella | 5 | 1.31 | 6.25 |
| *Ranunculus aquatilis* | Stiff water crowfoot | 5 | 1.31 | 6.25 |
| *Typha angustifolia* | Narrow-leaved cattail | 5 | 1.31 | 6.25 |
| *Utricularia vulgaris* | Common bladderwort | 5 | 1.31 | 6.25 |
| *Sagittaria cuneata* | Arum-leaved arrowhead | 4 | 1.05 | 5.00 |
| *Vallisneria americana* | Wild celery | 4 | 1.05 | 5.00 |
| *Carex comosa* | Bottle brush sedge | 3 | 0.79 | 3.75 |
| *Potamogeton richardsonii* | Clasping-leaf pondweed | 3 | 0.79 | 3.75 |
| *Chara* sp. | Muskgrass | 2 | 0.52 | 2.50 |

| (Table 8 continued) Species | Common Name | Total Sites | Relative Freq. | Freq. in Veg. |
|---|---|---|---|---|
| *Potamogeton gramineus* | Variable pondweed | 2 | 0.52 | 2.50 |
| *Schoenoplectus tabernaemontani* | Softstem bulrush | 2 | 0.52 | 2.50 |
| *Sparganium emersum* | Narrow-leaved bur-reed | 2 | 0.52 | 2.50 |
| *Calla palustris* | Water arum | 2 | 0.52 | 2.50 |
| *Brasenia schreberi* | Watershield | 1 | 0.26 | 1.25 |
| *Heteranthera dubia* | Water star-grass | 1 | 0.26 | 1.25 |
| Aquatic moss | Aquatic moss | 1 | 0.26 | 1.25 |
| *Potamogeton friesii* | Fries' pondweed | 1 | 0.26 | 1.25 |
| *Potamogeton natans* | Floating-leaf pondweed | 1 | 0.26 | 1.25 |
| *Potamogeton pusillus* | Small pondweed | 1 | 0.26 | 1.25 |
| *Stuckenia pectinata* | Sago pondweed | 1 | 0.26 | 1.25 |
| *Eriophorum angustifolium* | Cottongrass | 1 | 0.26 | 1.25 |
| *Cicuta bulbifera* | Bulb-bearing water hemlock | 1 | 0.26 | 1.25 |
| *Carex lasiocarpa* | Sedge | 1 | 0.26 | 1.25 |
| *Potamogeton praelongus* | White-stem pondweed | ** | ** | ** |
| *Phalaris arundinacea* | Reed canary grass | *** | *** | *** |
| | | | | |

** Visual Only

*** Boat Survey Only

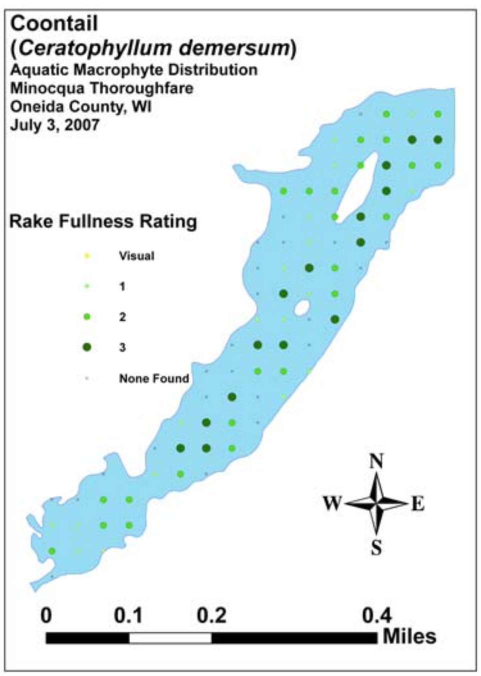


***Figure 28: Distribution of coontail-most common plant sampled on Minocqua Thoroughfare.***

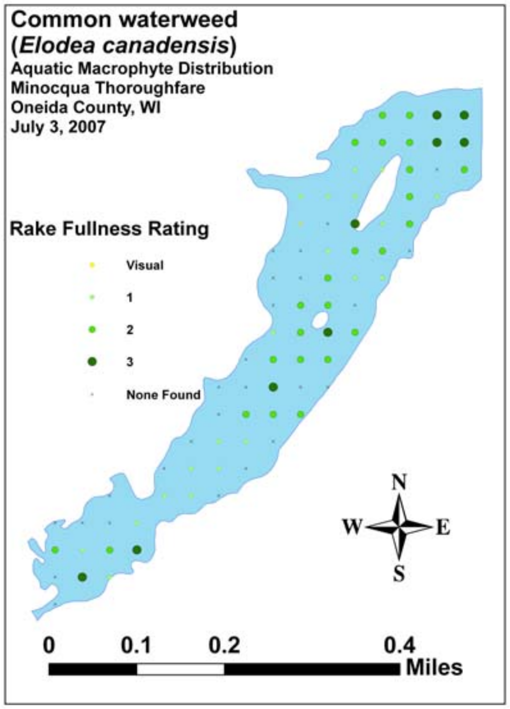


***Figure 29: Distribution of common waterweed-second most common plant in Minocqua Thoroughfare.***

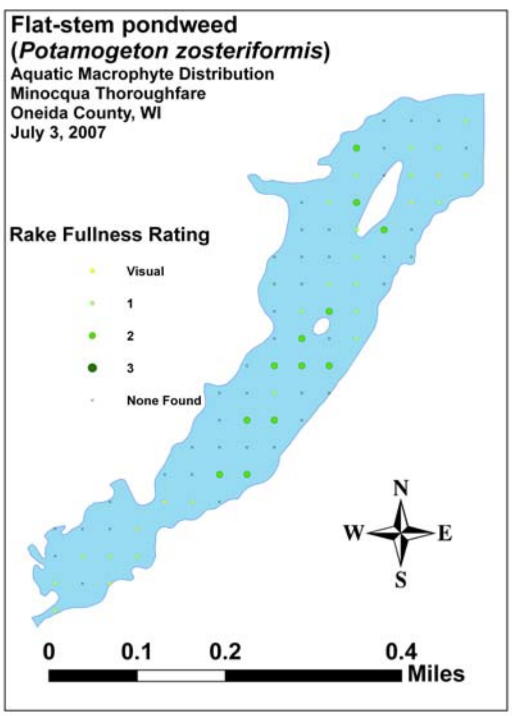


***Figure 30: Distribution of flat-stem pondweed-third most common plant in Minocqua Thoroughfare.***

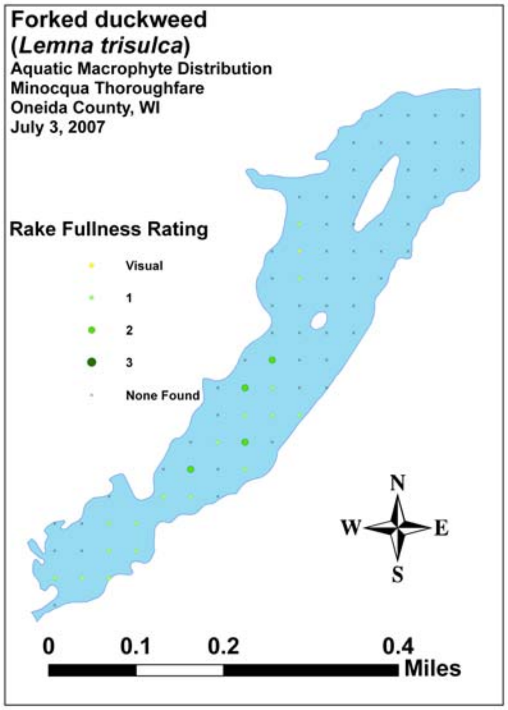


***Figure 31: Distribution of forked duckweed-fourth most common plant in Minocqua Thoroughfare.***

## Tomahawk Thoroughfare

The Tomahawk Thoroughfare grid contained 134 points, and all the points were located in water <13ft. deep. The bottom was primarily muck, but some rocky areas increased diversity; plants were found at almost all sites.

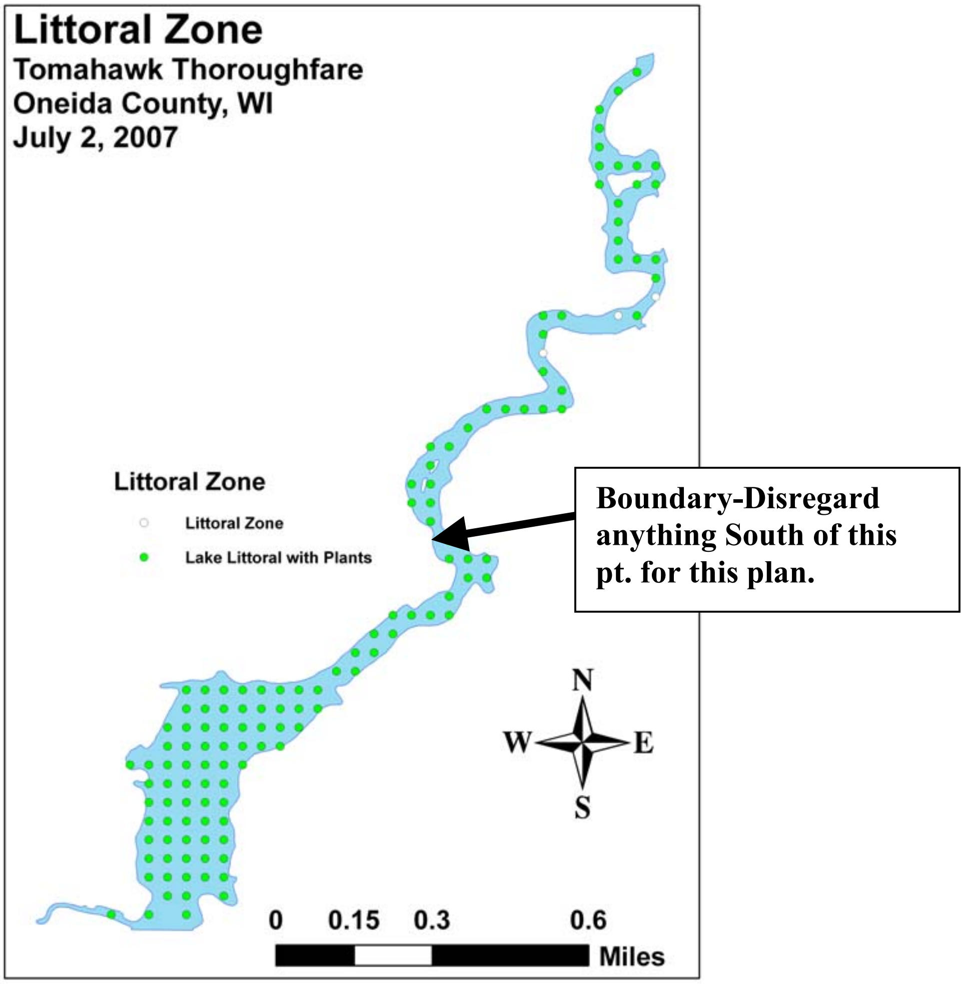


***Figure 31a: Sample points and points with vegetation in littoral zone-Tomahawk Thoroughfare. Note the location of the boundary for this plan. All points south are not part of this plan.***

Plants covered approximately 98% of the Tomahawk Thoroughfare bottom. The Simpson Diversity Index value of 0.95 exceeded all other lakes. Species richness was also extremely high with 44 (47 including viewed) total macrophyte species found growing in and immediately adjacent to the lake. The majority of aquatic macrophytes were found growing in relatively deep water with an average depth of almost 6ft. Even though the survey did not capture it, there were several sandy/gravel points throughout which many species were only found during the boat survey. The four most common species encountered included Robbins (fern) pondweed, elodea, coontail, and flat-stem pondweed. These plants were found at 50.00%, 49.23%, 34.62% and 31.54% of survey points with vegetation respectively.

### *Table 9: Survey statistics-Tomahawk Thoroughfare*

**Summary Statistics:**

| | |
|---|---|
| Total number of points sampled | 134 |
| Total number of sites with vegetation | 130 |
| Total number of sites shallower than the maximum depth of plants | 133 |
| Frequency of occurrence at sites shallower than maximum depth of plants | 97.74 |
| Simpson Diversity Index | 0.95 |
| Maximum depth of plants (ft) | 11.00 |
| Average number of all species per site (veg. sites only) | 4.61 |
| Average number of native species per site (veg. sites only) | 4.57 |
| Species Richness | 44 |
| Species Richness (including visuals) | 47 |
| Mean depth of plants (ft) | 6.02 |

### *Table 10: Species richness with frequency data-Tomahawk Thoroughfare*

| Species | Common Name | Total Sites | Relative Freq. | Freq. in Veg. |
|---|---|---|---|---|
| Submergent Floating Emergent | | | | |
| *Potamogeton robbinsii* | Robbins (fern) pondweed | 65 | 10.85 | 50.00 |
| *Elodea canadensis* | Common waterweed | 64 | 10.68 | 49.23 |
| *Ceratophyllum demersum* | Coontail | 45 | 7.51 | 34.62 |
| *Potamogeton zosteriformis* | Flat-stem pondweed | 41 | 6.84 | 31.54 |
| *Lemna trisulca* | Forked duckweed | 38 | 6.34 | 29.23 |
| *Potamogeton amplifolius* | Large-leaf pondweed | 33 | 5.51 | 25.38 |
| *Najas flexilis* | Bushy pondweed | 25 | 4.17 | 19.23 |
| *Potamogeton vaseyi* | Vasey's pondweed | 25 | 4.17 | 19.23 |
| *Potamogeton pusillus* | Small pondweed | 23 | 3.84 | 17.69 |
| *Potamogeton praelongus* | White-stem pondweed | 18 | 3.01 | 13.85 |
| *Vallisneria americana* | Wild celery | 18 | 3.01 | 13.85 |
| *Nuphar variegata* | Spatterdock | 17 | 2.84 | 13.08 |
| *Ranunculus aquatilis* | Stiff water crowfoot | 17 | 2.84 | 13.08 |
| Aquatic moss | Aquatic moss | 16 | 2.67 | 12.31 |
| *Utricularia vulgaris* | Common bladderwort | 16 | 2.67 | 12.31 |
| *Nymphaea odorata* | White water lily | 15 | 2.50 | 11.54 |
| *Megalodonta beckii* | Water marigold | 14 | 2.34 | 10.77 |
| *Myriophyllum sibiricum* | Northern water-milfoil | 14 | 2.34 | 10.77 |
| *Brasenia schreberi* | Watershield | 13 | 2.17 | 10.00 |
| *Heteranthera dubia* | Water star-grass | 12 | 2.00 | 9.23 |
| *Sparganium emersum* | Narrow-leaved bur-reed | 10 | 1.67 | 7.69 |
| *Potamogeton illinoensis* | Illinois pondweed | 9 | 1.50 | 6.92 |
| *Pontederia cordata* | Pickerelweed | 7 | 1.17 | 5.38 |
| *Potamogeton natans* | Floating-leaf pondweed | 6 | 1.00 | 4.62 |

| (Table 10 continued) Species | Common Name | Total Sites | Relative Freq. | Freq. in Veg. |
|---|---|---|---|---|
| *Potamogeton epihydrus* | Ribbon-leaf pondweed | 4 | 0.67 | 3.08 |
| *Potamogeton gramineus* | Variable pondweed | 4 | 0.67 | 3.08 |
| *Potamogeton richardsonii* | Clasping-leaf pondweed | 4 | 0.67 | 3.08 |
| *Sagittaria cuneata* | Arum-leaved arrowhead | 4 | 0.67 | 3.08 |
| *Myriophyllum spicatum* | Eurasian water milfoil | 3 | 0.50 | 2.31 |
| *Potamogeton spirillus* | Spiral-fruited pondweed | 3 | 0.50 | 2.31 |
| *Potamogeton crispus* | Curly-leaf pondweed | 2 | 0.33 | 1.54 |
| *Nitella* sp. | Nitella | 2 | 0.33 | 1.54 |
| *Carex comosa* | Bottle brush sedge | 1 | 0.17 | 0.77 |
| *Chara* sp. | Muskgrass | 1 | 0.17 | 0.77 |
| *Elatine minima* | Waterwort | 1 | 0.17 | 0.77 |
| *Eleocharis acicularis* | Needle spikerush | 1 | 0.17 | 0.77 |
| *Eleocharis palustris* | Creeping spikerush | 1 | 0.17 | 0.77 |
| *Equisetum fluviatile* | Water horsetail | 1 | 0.17 | 0.77 |
| *Isoetes echinospora* | Spiny-spored quillwort | 1 | 0.17 | 0.77 |
| *Lemna minor* | Small duckweed | 1 | 0.17 | 0.77 |
| *Potamogeton alpinus* | Alpine pondweed | 1 | 0.17 | 0.77 |
| *Schoenoplectus subterminalis* | Water bulrush | 1 | 0.17 | 0.77 |
| *Sparganium fluctuans* | Floating-leaf-bur-reed | 1 | 0.17 | 0.77 |
| *Typha latifolia* | Broad-leaved cattail | 1 | 0.17 | 0.77 |
| *Polygonum amphibium* | Water smartweed | ** | ** | ** |
| *Schoenoplectus tabernaemontani* | Softstem bulrush | ** | ** | ** |
| *Juncus effusus* | Common rush | ** | ** | ** |
| *Butomus umbellatus* | Flowering rush | *** | *** | *** |
| *Cicuta bulbifera* | Bulb-bearing water hemlock | *** | *** | *** |
| ** viewed only | | | | |
| *** boat survey only | | | | |

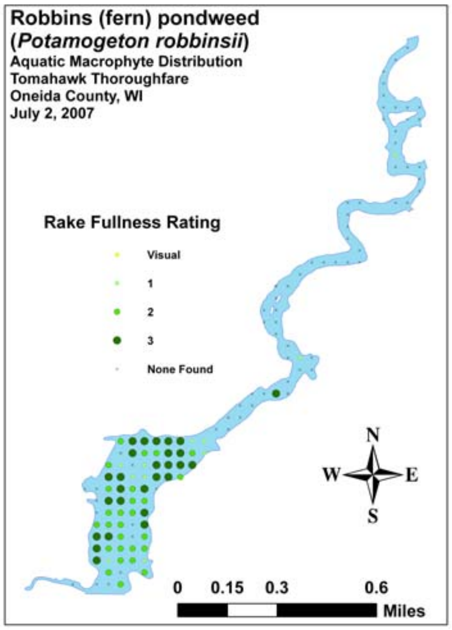


***Figure 32: Distribution of Robbin's pondweed-most common plant sampled in Tomahawk Thoroughfare.***

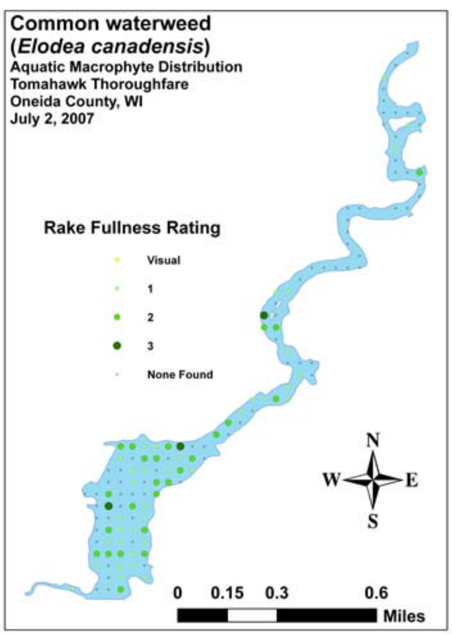


***Figure 33: Distribution of common waterweed-second most common plant in Tomahawk Thoroughfare.***

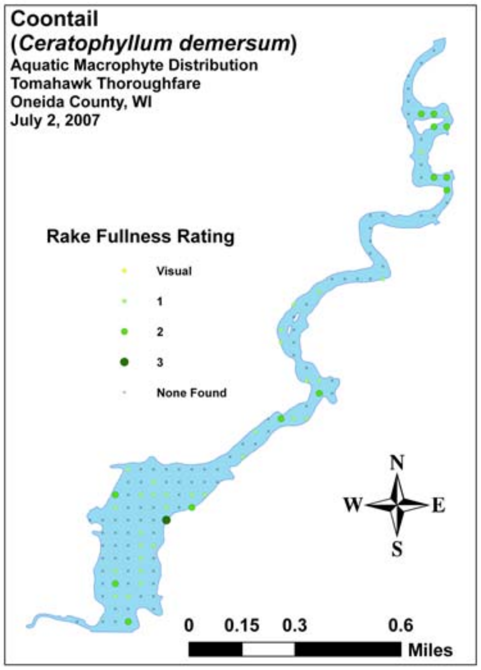


***Figure 34: Distribution of coontail-third most common plant in Tomahawk Thoroughfare.***

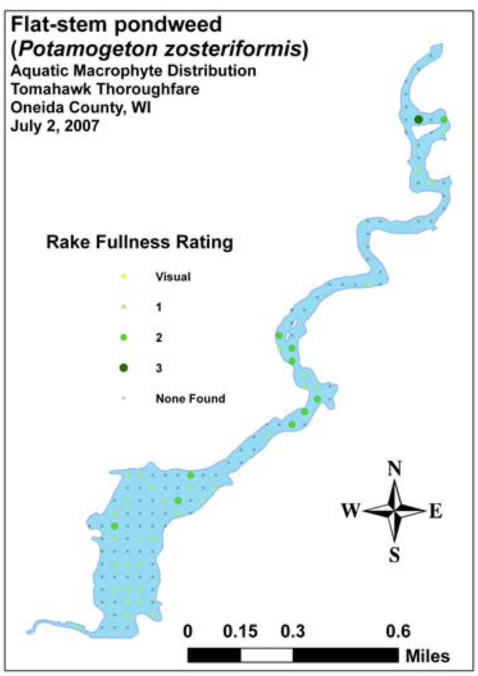


***Figure 35: Distribution of flat-stem pondweed-fourth most common plant in Tomahawk Thoroughfare.***

The sinuous northern part of the thoroughfare wound through marshes and bogs and provided continually changing habitat. The deeper flat leading to Lake Tomahawk also added greatly to the area's diversity. Water bulrush (*Schoenoplectus subterminalis*), and water smartweed (*Polygonum amphibium*) were the only species found unique to this area, but several other sensitive species that were uncommon elsewhere such as southern naiad (*Najas guadalupensis*), Vasey's pondweed (*Potamogeton vaseyi*), narrow-leaved bur-reed (*Sparganium emersum*) and waterwort (*Elatine minima*), were common to abundant here.

## Aquatic Invasives

**Minocqua Lake**

During the point intercept survey, Eurasian water milfoil was found scattered throughout the western half of Lake Minocqua. The denser stands occurred in Kennedy Bay near the boat landing and on the shoreline directly across from the landing. From these areas near the Hwy-51 bridge, plants have spread to all nearby bays. The north end of School House Bay, and the west end of South Bay had particularly large stands that indicate original satellite plants arrived there several years ago. Single plants were located on a regular basis among the extensive beds of northern water milfoil that grows in approximately 7 feet of water throughout the western side of the lake. No beds or individual plants were located in the eastern 1/2 to 1/3 of the lake all the way to the thoroughfares although there are many places that would provide ideal habitat. Curly-leaf pondweed (*Potamogeton crispus*), purple loosestrife (*Lythrum salicaria*), flowering rush (*Butomus umbellatus*), and reed canary grass (*Phalaris arundinacea*) were also distributed around and in Lake Minocqua.

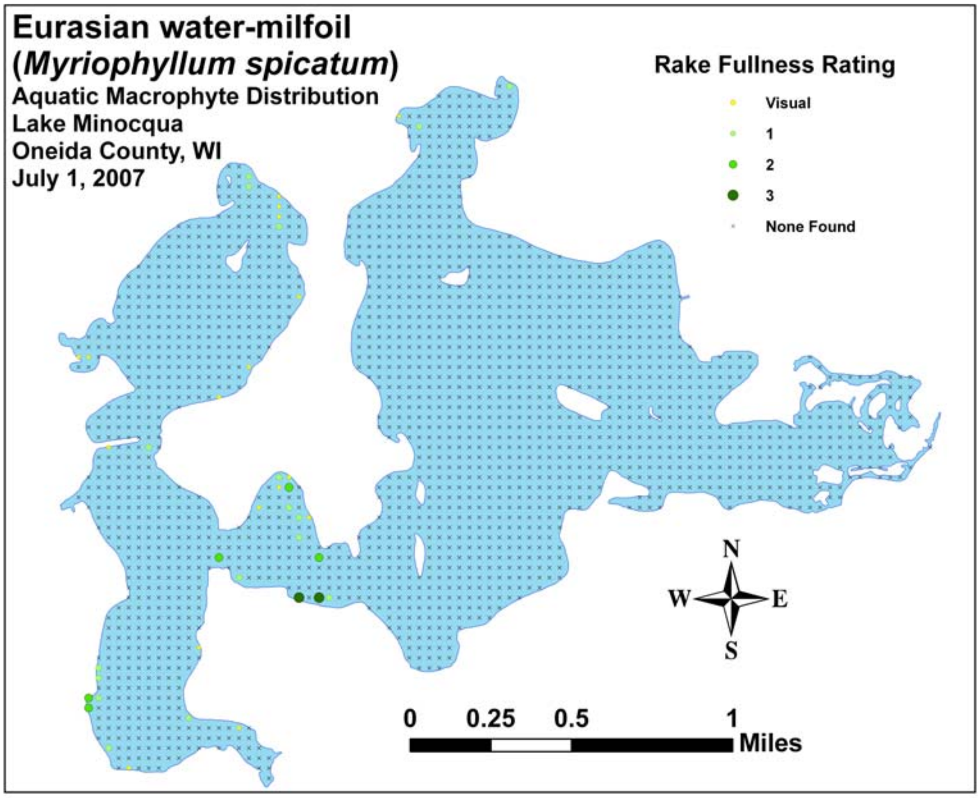


*Figure 36: Map of Eurasian water milfoil distribution-Minocqua Lake*

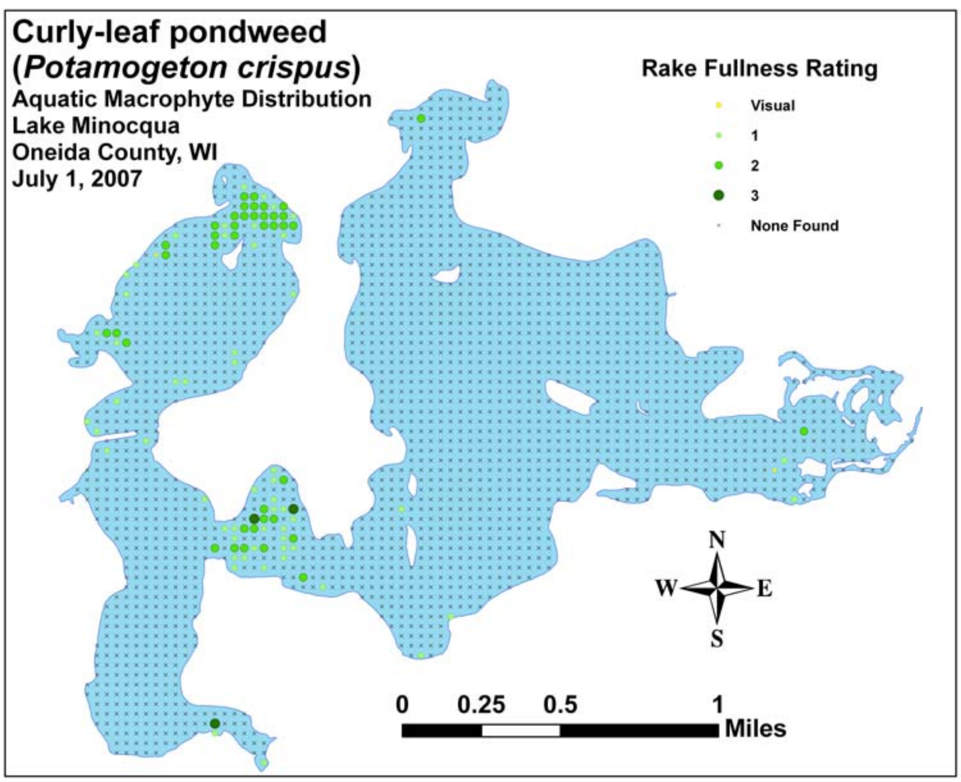


*Figure 37: Map of curly leaf pondweed distribution-Mincoqua Lake*

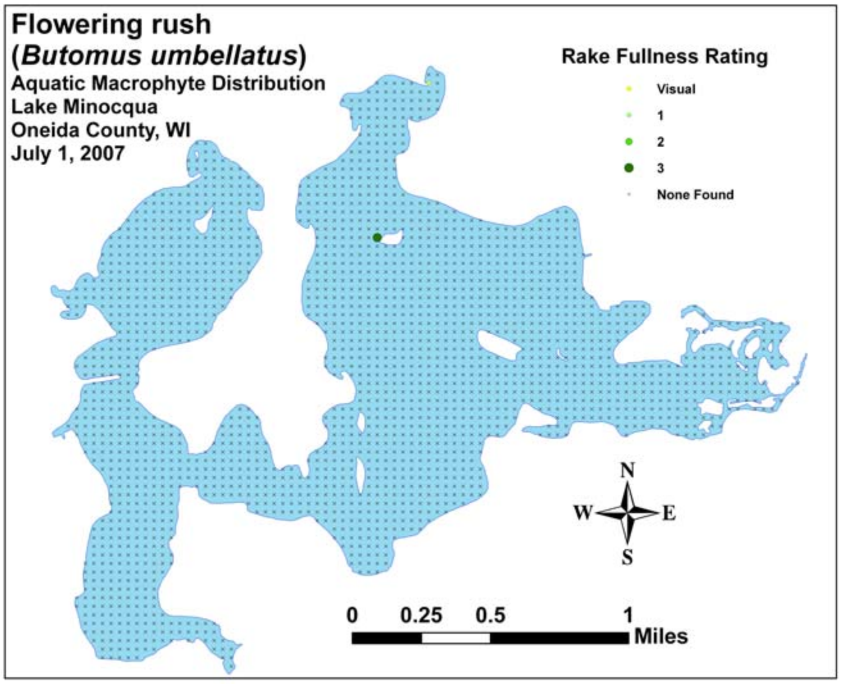


*Figure 38: Map of flowering rush distribution-Mincoqua Lake*

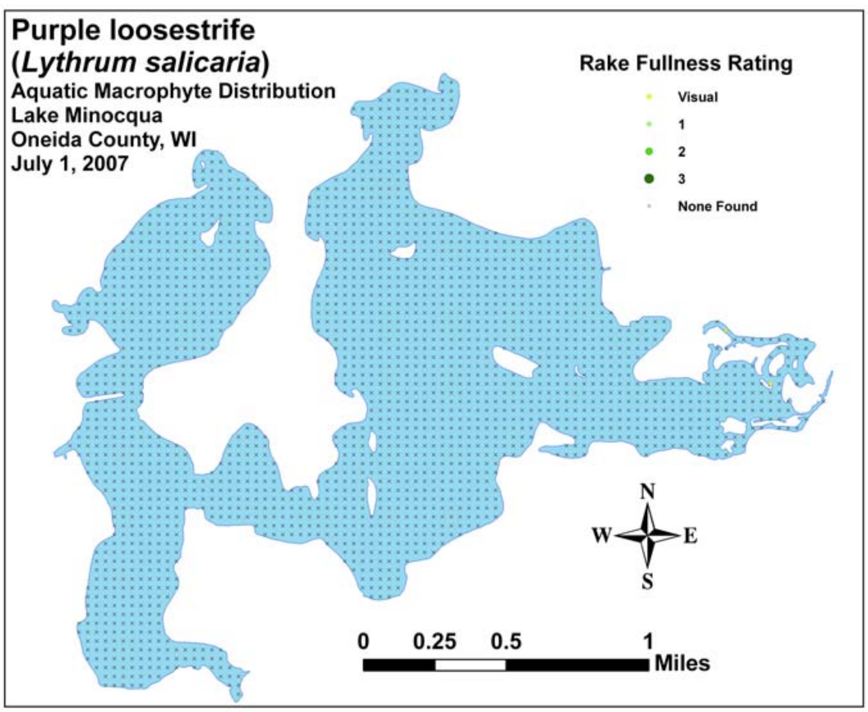


*Figure 39: Map of purple loosestrife distribution-Minocqua Lake*

**Kawaguesaga Lake**

The Eurasian water milfoil infestation was almost entirely limited to the east end of the lake from the channel connecting to Lake Minocqua to the dam. The heaviest infestations were in the bay near the dam, and along the shorelines leading up to this bay. Large continuous beds occurred at the dam with plants being present throughout the bay, but they were not as concentrated as they were at the dam. Only scattered individuals were found around the three eastern islands. Unfortunately, pioneer individuals, usually a single plant, occasionally showed up elsewhere.

Curly-leaf pondweed, purple loosestrife, flowering rush, and reed canary grass were also distributed around and in Lake Kawaguesaga. As in Lake Minocqua, these exotic species were not uncommon, but in most instances, they didn't appear to be invasive to the point that they excluded native species.

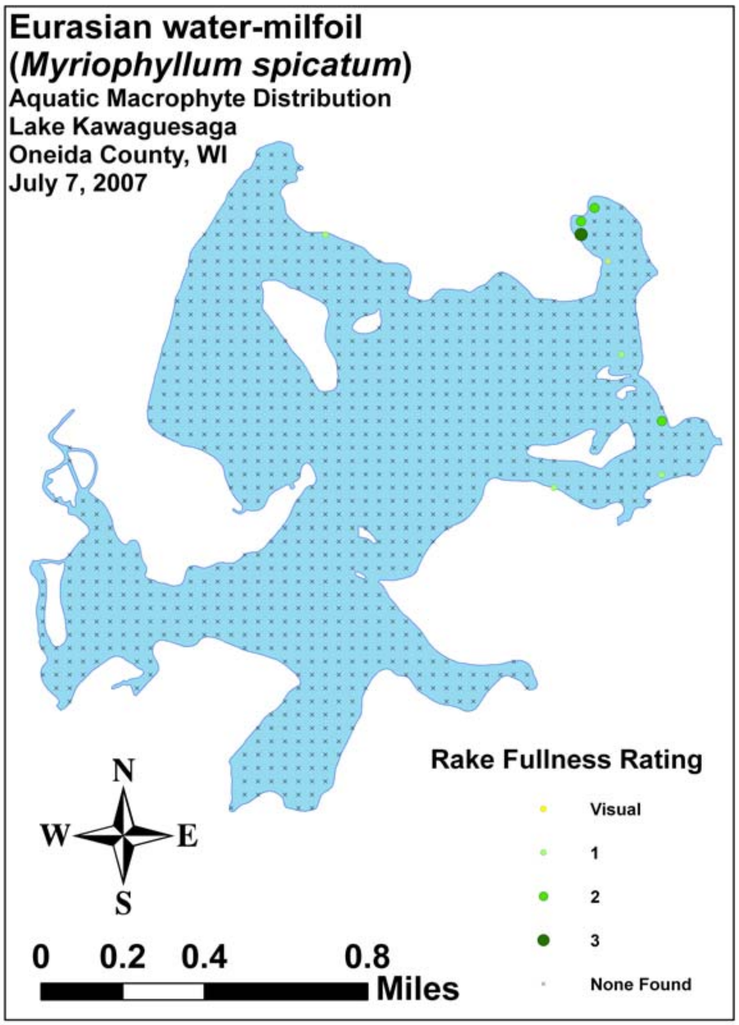


***Figure 40: Map of Eurasian water milfoil distribution-Kawaguesaga Lake***

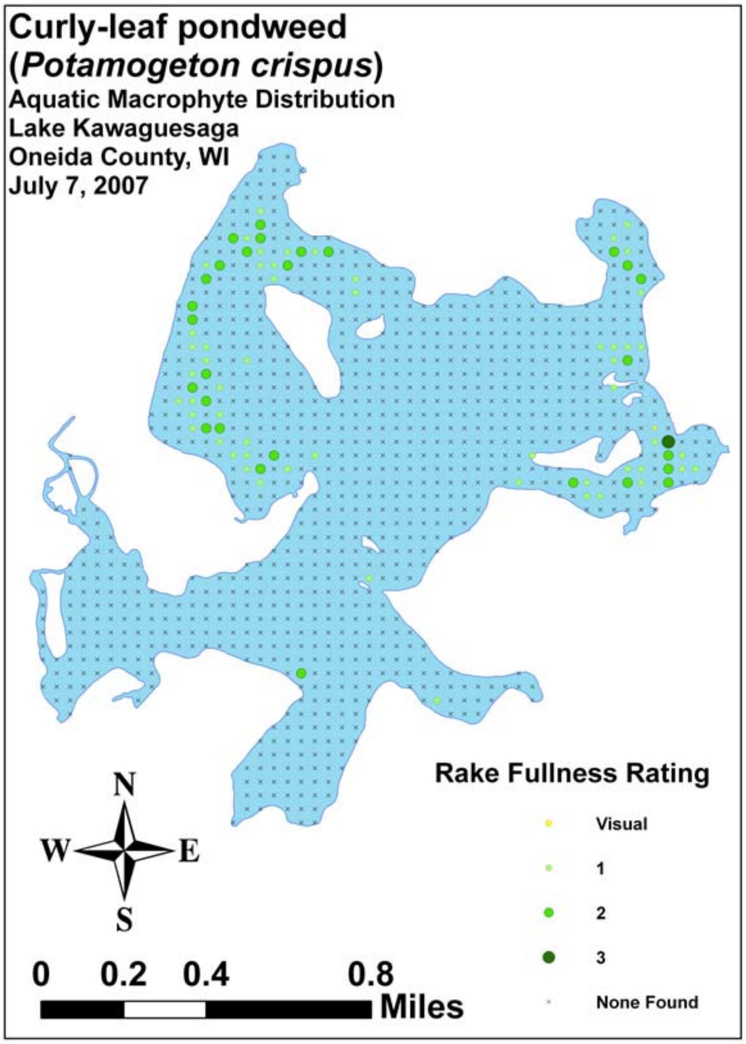


***Figure 41: Map of curly leaf pondweed distribution-Kawaguesaga Lake***

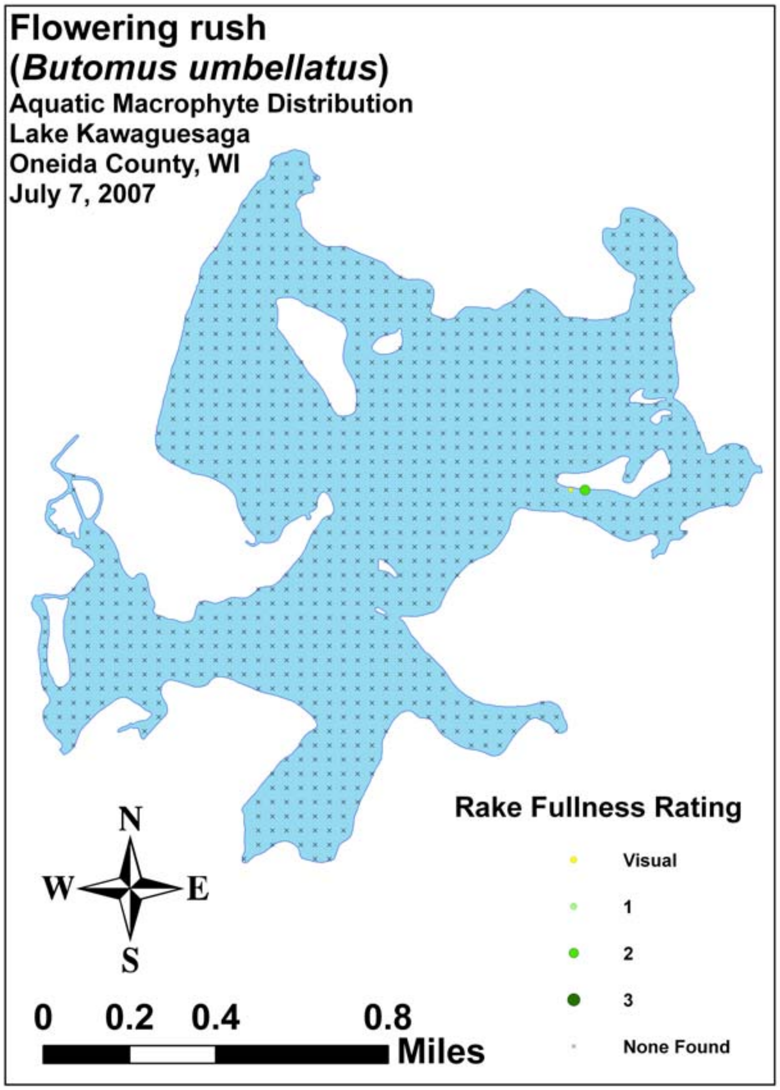


***Figure 42: Map of flowering rush distribution-Kawaguesaga Lake***

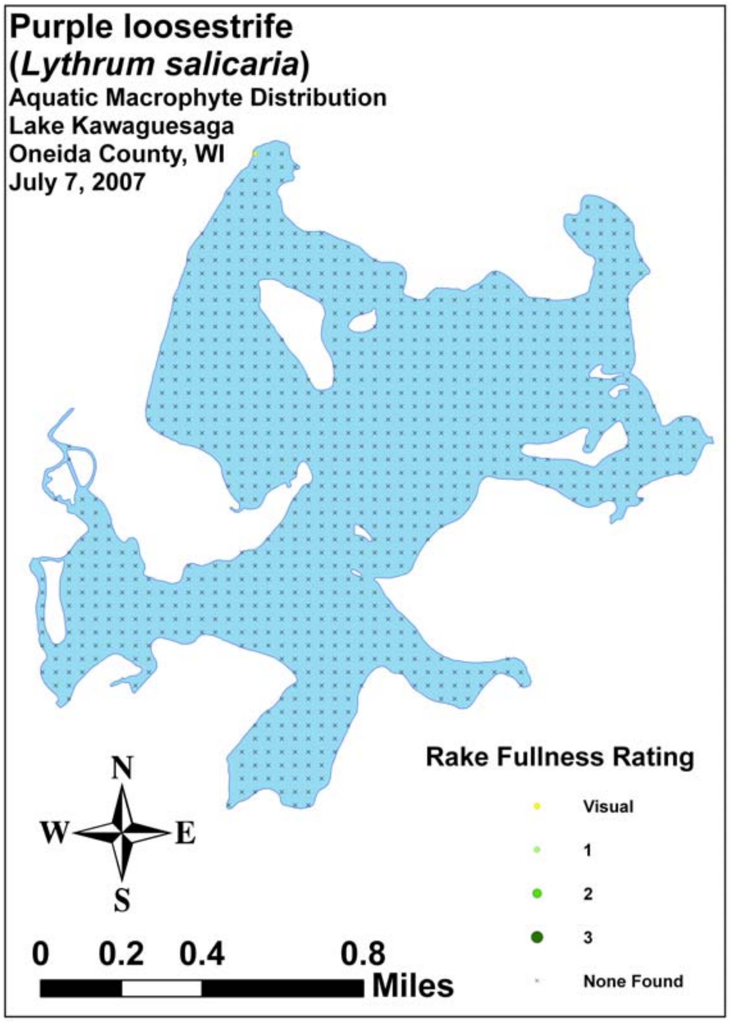


***Figure 43: Map of purple loosestrife distribution-Kawaguesaga Lake***

**Minocqua Thoroughfare**

No Eurasian water milfoil was located in the Minocqua Thoroughfare or in any part of Lake Minocqua near the Thoroughfare. It appears unlikely there are any plants anywhere in this area. Neither curly-leaf pondweed, nor flowering rush were located here. However, the Minocqua Thoroughfare had the highest population of Purple loosestrife of any of the lakes. Evidence of *Gallerucella* beetles (an introduced beetle that only eats Purple loosestrife), and/or leaf feeding damage, was surveyed but there appeared to be none. Reed canary grass was also distributed throughout the shoreline.

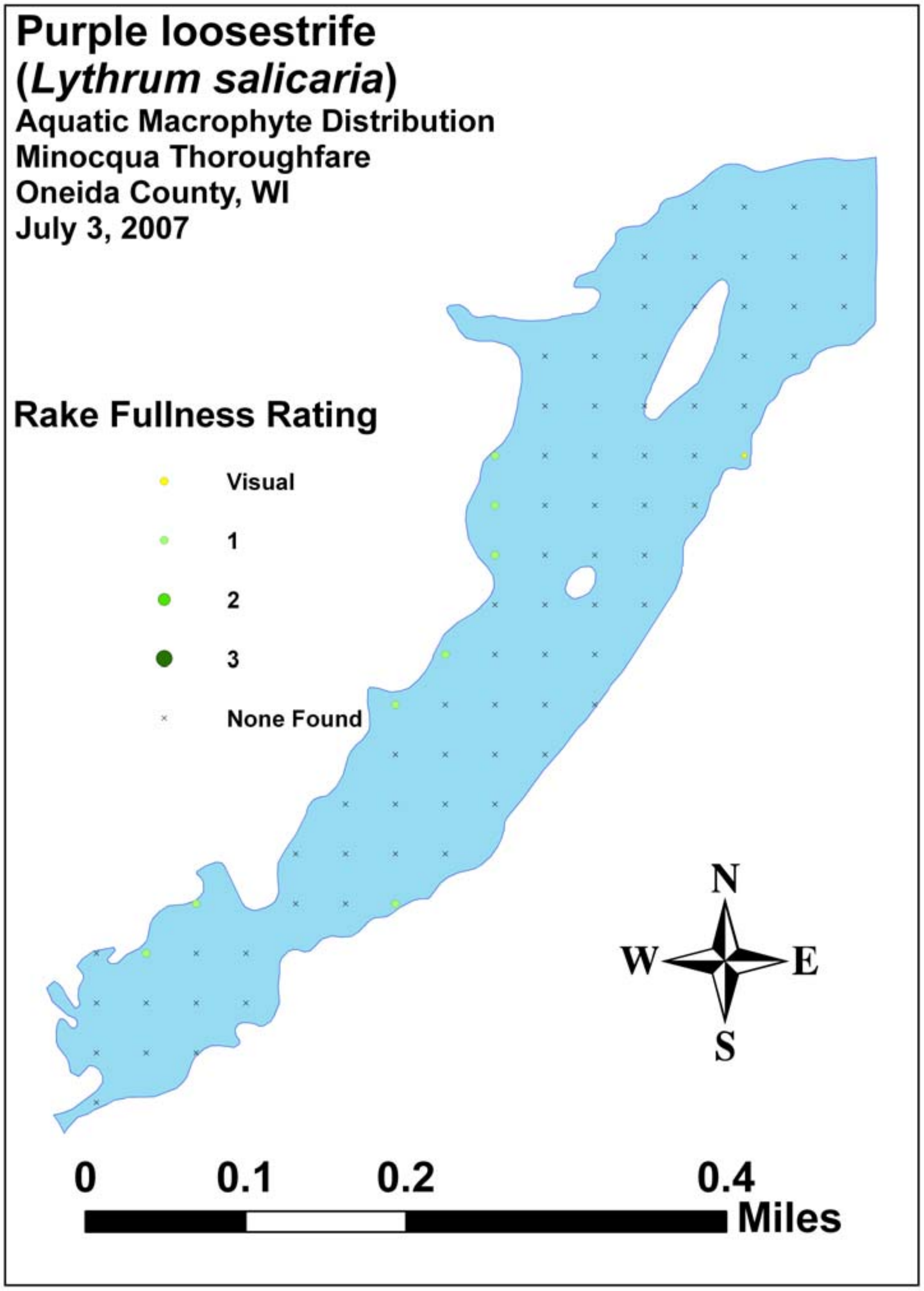


***Figure 44: Map of purple loosestrife distribution-Minocqua Thoroughfare***

**Tomahawk Thoroughfare**

Eurasian water milfoil was abundant at certain locations on the south end of the Tomahawk Thoroughfare; especially in 6 feet of water near point 10 by the boat dock through point 17 by the boat-in restaurant. However, all EWM sites fall outside of the boundaries for this plan. Curly-leaf pondweed, Purple loosestrife, Flowering rush, and Reed canary grass were also distributed around and in the Tomahawk Thoroughfare. Purple loosestrife and Flowering rush were most common in the north end where they were occasionally abundant in mixed stands with cattails (*Typha* sp.).

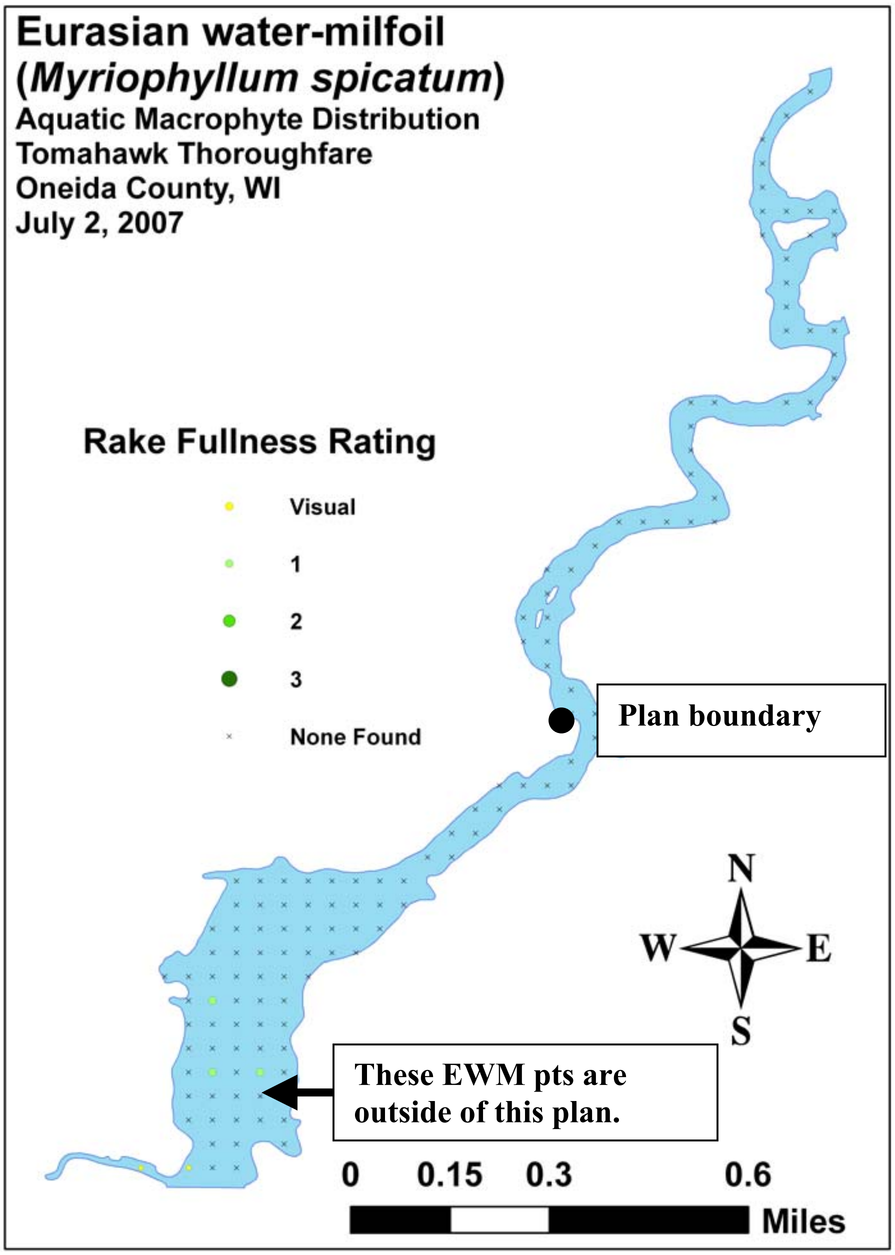


***Figure 45: Map of Eurasian water milfoil distribution-Tomahawk Throughfare***

# Floristic Quality Index

## Minocqua Lake

***Table 11: Floristic quality index species list with conservatism value-Minocqua Lake***

| Species | Common Name | C |
|---|---|---|
| *Acorus calamus* | Sweetflag | 7 |
| *Brasenia schreberi* | Watershield | 7 |
| *Calla palustris* | Water arum | 9 |
| *Carex comosa* | Bottle brush sedge | 5 |
| *Ceratophyllum demersum* | Coontail | 3 |
| *Chara* sp. | Muskgrass | 7 |
| *Cicuta bulbifera* | Bulb-bearing water hemlock | 7 |
| *Decodon verticillatus* | Swamp loosestrife | 7 |
| *Dulichium arundinaceum* | Three-way sedge | 9 |
| *Elatine minima* | Waterwort | 9 |
| *Eleocharis acicularis* | Needle spikerush | 5 |
| *Eleocharis palustris* | Creeping spikerush | 6 |
| *Elodea canadensis* | Common waterweed | 3 |
| *Equisetum fluviatile* | Water horsetail | 7 |
| *Glyceria canadensis* | Rattlesnake manna grass | 7 |
| *Heteranthera dubia* | Water star-grass | 6 |
| *Iris versicolor* | Northern blue flag | 5 |
| *Isoetes echinospora* | Spiny-spored quillwort | 8 |
| *Juncus effusus* | Common rush | 4 |
| *Juncus pelocarpus f. submersus* | Brown-fruited rush | 8 |
| *Lemna minor* | Small duckweed | 5 |
| *Lemna trisulca* | Forked duckweed | 6 |
| *Lobelia dortmanna* | Water lobelia | 10 |
| *Megalodonta beckii* | Water marigold | 8 |
| *Myriophyllum sibiricum* | Northern water-milfoil | 7 |
| *Myriophyllum tenellum* | Dwarf water-milfoil | 10 |
| *Najas flexilis* | Bushy pondweed | 6 |
| *Nitella* sp. | Nitella | 7 |
| *Nuphar variegata* | Spatterdock | 6 |
| *Nymphaea odorata* | White water lily | 6 |
| *Pontederia cordata* | Pickerelweed | 9 |
| *Potamogeton alpinus* | Alpine pondweed | 9 |
| *Potamogeton amplifolius* | Large-leaf pondweed | 7 |
| *Potamogeton epihydrus* | Ribbon-leaf pondweed | 8 |
| *Potamogeton friesii* | Fries' pondweed | 8 |
| *Potamogeton gramineus* | Variable pondweed | 7 |
| *Potamogeton illinoensis* | Illinois pondweed | 6 |
| *Potamogeton natans* | Floating-leaf pondweed | 5 |
| *Potamogeton obtusifolius* | Blunt-leaf pondweed | 9 |
| *Potamogeton praelongus* | White-stem pondweed | 8 |
| *Potamogeton pusillus* | Small pondweed | 7 |
| *Potamogeton richardsonii* | Clasping-leaf pondweed | 5 |

| (Table 11 continued) Species | Common name | C |
|---|---|---|
| *Potamogeton robbinsii* | Robbins (fern) pondweed | 8 |
| *Potamogeton spirillus* | Spiral-fruited pondweed | 8 |
| *Potamogeton vaseyi* | Vasey's pondweed | 10 |
| *Potamogeton zosteriformis* | Flat-stem pondweed | 6 |
| *Ranunculus aquatilis* | Stiff water crowfoot | 7 |
| *Sagittaria cuneata* | Arum-leaved arrowhead | 7 |
| *Sagittaria latifolia* | Common arrowhead | 3 |
| *Sagittaria rigida* | Sessile-fruited arrowhead | 8 |
| *Schoenoplectus tabernaemontani* | Softstem bulrush | 4 |
| *Sparganium emersum* | Narrow-leaved bur-reed | 8 |
| *Sparganium eurycarpum* | Common bur-reed | 5 |
| *Sparganium fluctuans* | Floating-leaf-bur-reed | 10 |
| *Spirodela polyrhiza* | Large duckweed | 5 |
| *Stuckenia pectinata* | Sago pondweed | 3 |
| *Typha angustifolia* | Narrow-leaved cattail | 1 |
| *Typha latifolia* | Broad-leaved cattail | 1 |
| *Utricularia vulgaris* | Common bladderwort | 7 |
| *Vallisneria americana* | Wild celery | 6 |
| *Wolffia columbiana* | Common watermeal | 5 |
| | | |
| N | | 61 |
| mean C | | 6.56 |
| FQI | | 51.24 |

A total of 61 native species in and immediately adjacent to Lake Minocqua were identified (that are used in a FBI calculation). This produced a mean Coefficient of Conservation of 6.56 and a Floristic Index of 51.24. Nichols (1999) reported a median Mean C for the Northern Lakes and Forest Region of 6.7 putting Lake Minocqua slightly below the median for lakes in this part of the state. However, the FQI was more than double the median FQI of 24.3 for the Northern Lakes and Forest Region (Nichols 1999). This high number is a result of not only the sensitive plants that live here, but the spectacular diversity of plants.

**Kawaguesaga Lake**

***Table 12: Floristic quality index species list with conservatism value-Kawaguesaga Lake***

| Species | Common Name | C |
|---|---|---|
| *Brasenia schreberi* | Watershield | 7 |
| *Calla palustris* | Water arum | 9 |
| *Carex comosa* | Bottle brush sedge | 5 |
| *Ceratophyllum demersum* | Coontail | 3 |
| *Chara* sp. | Muskgrass | 7 |
| *Cicuta bulbifera* | Bulb-bearing water hemlock | 7 |
| *Decodon verticillatus* | Swamp loosestrife | 7 |
| *Dulichium arundinaceum* | Three-way sedge | 9 |
| *Eleocharis acicularis* | Needle spikerush | 5 |
| *Eleocharis palustris* | Creeping spikerush | 6 |
| *Elodea canadensis* | Common waterweed | 3 |

| (Table 12 continued) Species | Common name | C |
|---|---|---|
| *Equisetum fluviatile* | Water horsetail | 7 |
| *Glyceria canadensis* | Rattlesnake manna grass | 7 |
| *Heteranthera dubia* | Water star-grass | 6 |
| *Isoetes echinospora* | Spiny-spored quillwort | 8 |
| *Juncus pelocarpus f. submersus* | Brown-fruited rush | 8 |
| *Juncus effusus* | Common rush | 4 |
| *Lemna minor* | Small duckweed | 5 |
| *Lemna trisulca* | Forked duckweed | 6 |
| *Megalodonta beckii* | Water marigold | 8 |
| *Myriophyllum sibiricum* | Northern water-milfoil | 7 |
| *Najas flexilis* | Bushy pondweed | 6 |
| *Nitella* sp. | Nitella | 7 |
| *Nuphar variegata* | Spatterdock | 6 |
| *Nymphaea odorata* | White water lily | 6 |
| *Pontederia cordata* | Pickerelweed | 9 |
| *Potamogeton alpinus* | Alpine pondweed | 9 |
| *Potamogeton amplifolius* | Large-leaf pondweed | 7 |
| *Potamogeton friesii* | Fries' pondweed | 8 |
| *Potamogeton gramineus* | Variable pondweed | 7 |
| *Potamogeton illinoensis* | Illinois pondweed | 6 |
| *Potamogeton natans* | Floating-leaf pondweed | 5 |
| *Potamogeton obtusifolius* | Blunt-leaf pondweed | 9 |
| *Potamogeton praelongus* | White-stem pondweed | 8 |
| *Potamogeton pusillus* | Small pondweed | 7 |
| *Potamogeton richardsonii* | Clasping-leaf pondweed | 5 |
| *Potamogeton robbinsii* | Robbins (fern) pondweed | 8 |

| (Table 12 continued) Species | Common name | C |
|---|---|---|
| *Potamogeton vaseyi* | Vasey's pondweed | 10 |
| *Potamogeton zosteriformis* | Flat-stem pondweed | 6 |
| *Potentilla palustris* | Marsh cinquefoil | 8 |
| *Ranunculus aquatilis* | Stiff water crowfoot | 7 |
| *Sagittaria cuneata* | Arum-leaved arrowhead | 7 |
| *Sagittaria rigida* | Sessile-fruited arrowhead | 8 |
| *Schoenoplectus tabernaemontani* | Softstem bulrush | 4 |
| *Scirpus cyperinus* | Woolgrass | 4 |
| *Sparganium angustifolium* | Narrow-leaved bur-reed | 9 |
| *Sparganium emersum* | Narrow-leaved bur-reed | 8 |
| *Sparganium eurycarpum* | Common bur-reed | 5 |
| *Sparganium fluctuans* | Floating-leaf-bur-reed | 10 |
| *Spirodela polyrhiza* | Large duckweed | 5 |
| *Stuckenia pectinata* | Sago pondweed | 3 |
| *Typha latifolia* | Broad-leaved cattail | 1 |
| *Utricularia gibba* | Creeping bladderwort | 9 |
| *Utricularia intermedia* | Flat-leaf bladderwort | 9 |
| *Utricularia vulgaris* | Common bladderwort | 7 |
| *Vallisneria americana* | Wild celery | 6 |
| | | |
| N | | 56 |
| mean C | | 6.66 |
| FQI | | 49.83 |

A total of 56 native species in and immediately adjacent to Kawaguesaga Lake were identified (that are used in a FBI calculation). This produced a mean Coefficient of Conservation of 6.66 and a Floristic Index of 49.83. Nichols (1999) reported median Mean C for the Northern Lakes and Forest Region of 6.7, putting Lake Kawaguesaga right at the median for this part of the state. However, the FQI was more than double the median FQI of 24.3 for the Northern Lakes and Forest Region (Nichols 1999). Like Minocqua Lake, this high number represents spectacular diversity of plants, including numerous sensitive plants.

**Minocqua Thoroughfare**

***Table 13: Floristic quality index species list with conservatism value-Minocqua Thoroughfare***

| Species | Common Name | C |
|---|---|---|
| *Brasenia schreberi* | Watershield | 7 |
| *Calla palustris* | Water arum | 9 |
| *Carex comosa* | Bottle brush sedge | 5 |
| *Ceratophyllum demersum* | Coontail | 3 |
| *Chara* sp. | Muskgrass | 7 |
| *Cicuta bulbifera* | Bulb-bearing water hemlock | 7 |
| *Decodon verticillatus* | Swamp loosestrife | 7 |
| *Eleocharis palustris* | Creeping spikerush | 6 |
| *Elodea canadensis* | Common waterweed | 3 |
| *Heteranthera dubia* | Water star-grass | 6 |

| (Table 13 continued) Species | Common name | C |
|---|---|---|
| *Lemna minor* | Small duckweed | 5 |
| *Lemna trisulca* | Forked duckweed | 6 |
| *Megalodonta beckii* | Water marigold | 8 |
| *Myriophyllum sibiricum* | Northern water-milfoil | 7 |
| *Najas flexilis* | Bushy pondweed | 6 |
| *Nitella* sp. | Nitella | 7 |
| *Nuphar variegata* | Spatterdock | 6 |
| *Nymphaea odorata* | White water lily | 6 |
| *Pontederia cordata* | Pickerelweed | 9 |
| *Potamogeton amplifolius* | Large-leaf pondweed | 7 |
| *Potamogeton friesii* | Fries' pondweed | 8 |
| *Potamogeton gramineus* | Variable pondweed | 7 |
| *Potamogeton natans* | Floating-leaf pondweed | 5 |
| *Potamogeton obtusifolius* | Blunt-leaf pondweed | 9 |
| *Potamogeton praelongus* | White-stem pondweed | 8 |
| *Potamogeton pusillus* | Small pondweed | 7 |
| *Potamogeton richardsonii* | Clasping-leaf pondweed | 5 |
| *Potamogeton robbinsii* | Robbins (fern) pondweed | 8 |
| *Potamogeton zosteriformis* | Flat-stem pondweed | 6 |
| *Ranunculus aquatilis* | Stiff water crowfoot | 7 |
| *Sagittaria cuneata* | Arum-leaved arrowhead | 7 |
| *Schoenoplectus tabernaemontani* | Softstem bulrush | 4 |
| *Sparganium emersum* | Narrow-leaved bur-reed | 8 |
| *Stuckenia pectinata* | Sago pondweed | 3 |
| *Typha angustifolia* | Narrow-leaved cattail | 1 |
| *Typha latifolia* | Broad-leaved cattail | 1 |
| *Utricularia vulgaris* | Common bladderwort | 7 |
| *Vallisneria americana* | Wild celery | 6 |
| | | |
| N | | 38 |
| mean C | | 6.16 |
| FQI | | 37.96 |

A total of 38 native species in and immediately adjacent to the Minocqua Thoroughfare were identified. This produced a mean Coefficient of Conservation of 6.15 and a Floristic Index of 37.96. This is slightly below the average of 6.7 for this part of the state. However, the FQI was slightly more than 50% greater than the median FQI of 24.3 for the Northern Lakes and Forest Region (Nichols 1999).

## Tomahawk Thoroughfare

### *Table 14: Floristic quality index species list and conservatism value-Tomahawk Thoroughfare*

| Species | Common Name | C |
|---|---|---|
| *Brasenia schreberi* | Watershield | 7 |
| *Carex comosa* | Bottle brush sedge | 5 |
| *Ceratophyllum demersum* | Coontail | 3 |
| *Chara* sp. | Muskgrass | 7 |
| *Cicuta bulbifera* | Bulb-bearing water hemlock | 7 |
| *Decodon verticillatus* | Swamp loosestrife | 7 |
| *Elatine minima* | Waterwort | 9 |
| *Eleocharis acicularis* | Needle spikerush | 5 |
| *Eleocharis palustris* | Creeping spikerush | 6 |
| *Elodea canadensis* | Common waterweed | 3 |
| *Equisetum fluviatile* | Water horsetail | 7 |
| *Heteranthera dubia* | Water star-grass | 6 |
| *Isoetes echinospora* | Spiny-spored quillwort | 8 |
| *Juncus effusus* | Common rush | 4 |
| *Lemna minor* | Small duckweed | 5 |
| *Lemna trisulca* | Forked duckweed | 6 |
| *Megalodonta beckii* | Water marigold | 8 |
| *Myriophyllum sibiricum* | Northern water-milfoil | 7 |
| *Najas flexilis* | Bushy pondweed | 6 |
| *Nitella* sp. | Nitella | 7 |
| *Nuphar variegata* | Spatterdock | 6 |
| *Nymphaea odorata* | White water lily | 6 |
| *Polygonum amphibium* | Water smartweed | 5 |
| *Pontederia cordata* | Pickerelweed | 9 |
| *Potamogeton alpinus* | Alpine pondweed | 9 |
| *Potamogeton amplifolius* | Large-leaf pondweed | 7 |
| *Potamogeton epihydrus* | Ribbon-leaf pondweed | 8 |
| *Potamogeton gramineus* | Variable pondweed | 7 |
| *Potamogeton illinoensis* | Illinois pondweed | 6 |
| *Potamogeton natans* | Floating-leaf pondweed | 5 |
| *Potamogeton praelongus* | White-stem pondweed | 8 |
| *Potamogeton pusillus* | Small pondweed | 7 |
| *Potamogeton richardsonii* | Clasping-leaf pondweed | 5 |
| *Potamogeton robbinsii* | Robbins (fern) pondweed | 8 |
| *Potamogeton spirillus* | Spiral-fruited pondweed | 8 |
| *Potamogeton vaseyi* | Vasey's pondweed | 10 |
| *Potamogeton zosteriformis* | Flat-stem pondweed | 6 |
| *Ranunculus aquatilis* | Stiff water crowfoot | 7 |
| *Sagittaria cuneata* | Arum-leaved arrowhead | 7 |
| *Schoenoplectus subterminalis* | Water bulrush | 9 |
| *Schoenoplectus tabernaemontani* | Softstem bulrush | 4 |
| *Sparganium emersum* | Narrow-leaved bur-reed | 8 |
| *Sparganium fluctuans* | Floating-leaf-bur-reed | 10 |
| *Typha latifolia* | Broad-leaved cattail | 1 |

| (Table 14 continued) Species | Common name | C |
|---|---|---|
| *Utricularia vulgaris* | Common bladderwort | 7 |
| *Vallisneria americana* | Wild celery | 6 |
| *Ranunculus aquatilis* | Stiff water crowfoot | 7 |
| *Sagittaria cuneata* | Arum-leaved arrowhead | 7 |
| *Schoenoplectus subterminalis* | Water bulrush | 9 |
| *Schoenoplectus tabernaemontani* | Softstem bulrush | 4 |
| *Sparganium emersum* | Narrow-leaved bur-reed | 8 |
| *Sparganium fluctuans* | Floating-leaf-bur-reed | 10 |
| *Typha latifolia* | Broad-leaved cattail | 1 |
| *Utricularia vulgaris* | Common bladderwort | 7 |
| *Vallisneria americana* | Wild celery | 6 |
| | | |
| N | | 46 |
| mean C | | 6.57 |
| FQI | | 44.56 |

A total of 46 native species in and immediately adjacent to the Tomahawk Thoroughfare were identified (that are used in calculating the FBI). This produced a mean Coefficient of Conservation of 6.57 and a Floristic Index of 44.56. Like the other three lakes, the mean C was slightly below median, and the FQI was much above the median.

## Sensitive Plants

A number of very sensitive plants were sampled or viewed in the aquatic macrophyte survey. Since these plants are very intolerant of habitat changes, it would be prudent to indentify the location of these sensitive plants and monitor any changes in their frequency and/or distribution. The following plants all have a conservatism value of "10". This means they are very intolerant. The lake(s) they are located within as well as the maps of those locations follow.

| **Plant** | **Lake sampled or viewed** |
|---|---|
| *Lobelia dortmanna*, water lobelia | Minocqua |
| *Myriophyllum tenellum*, dwarf water milfoil | Minocqua |
| *Potamogeton vaseyi,* Vasey's pondweed | Kawaguesaga, Minocqua, Tomahawk Thor. |
| *Sparganium fluctuans*, floating bur-reed | Kawaguesaga, Minocqua |

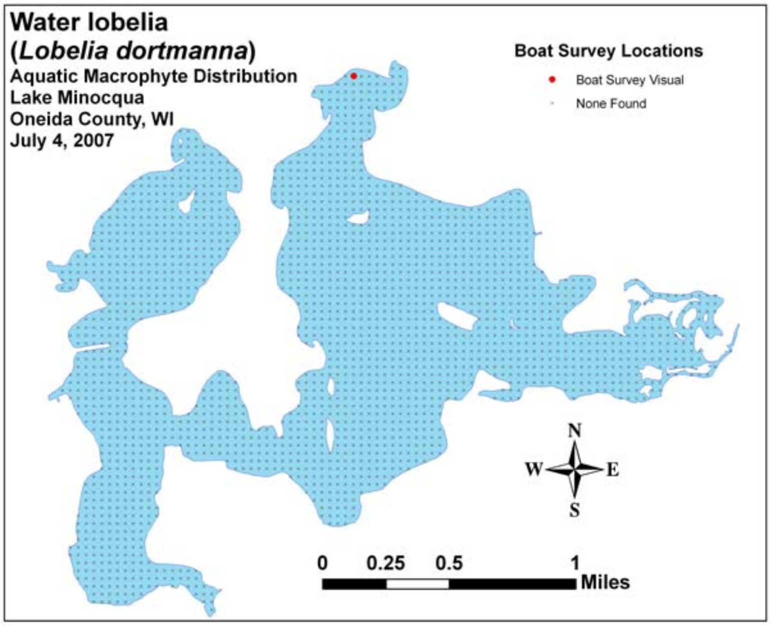


***Figure 46: Water lobelia in Minocqua Lake***

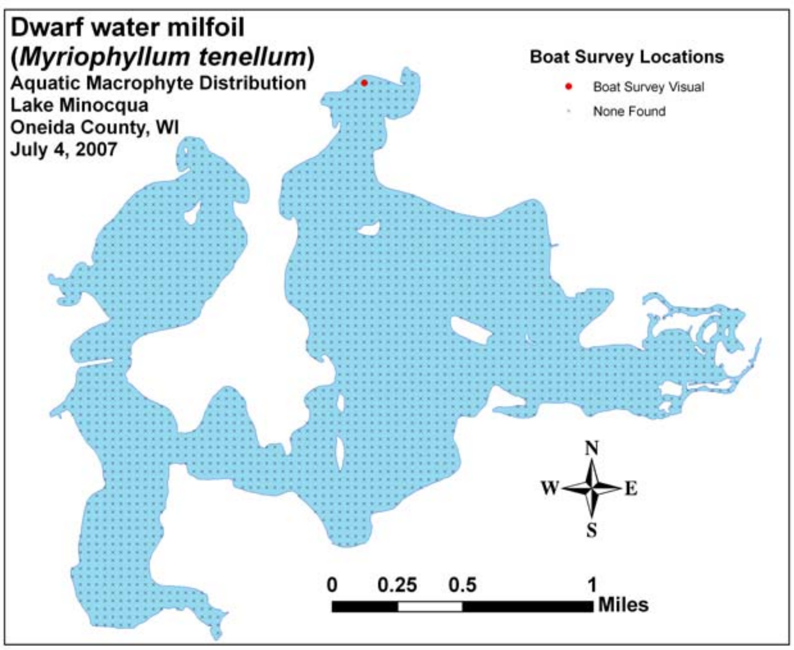


***Figure 47: Dwarf water milfoil Minocqua Lake***

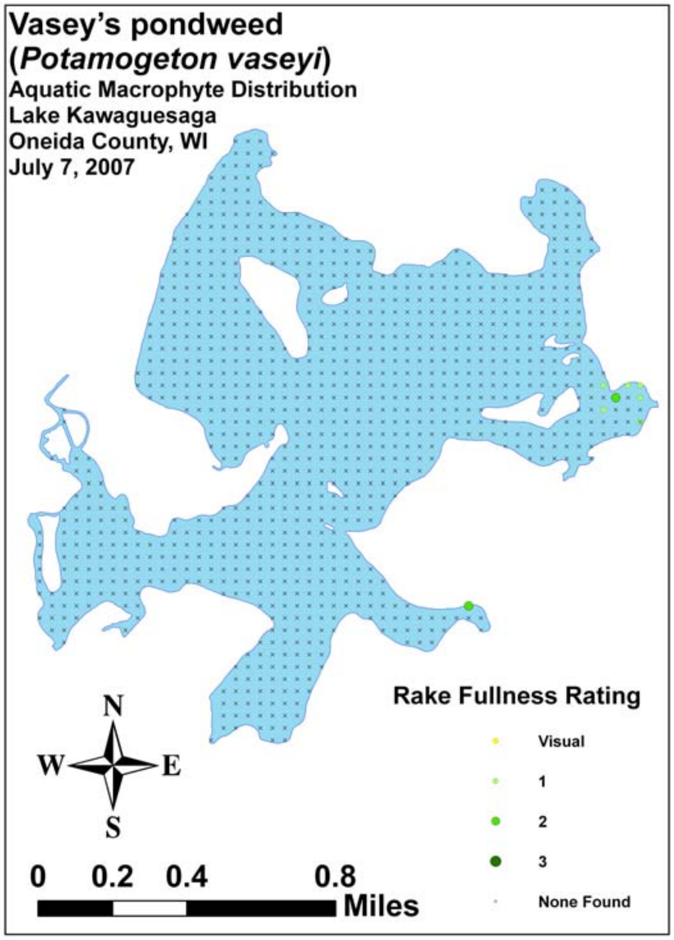


*Figure 48: Vasey's pondweed in Kawaguesaga Lake*

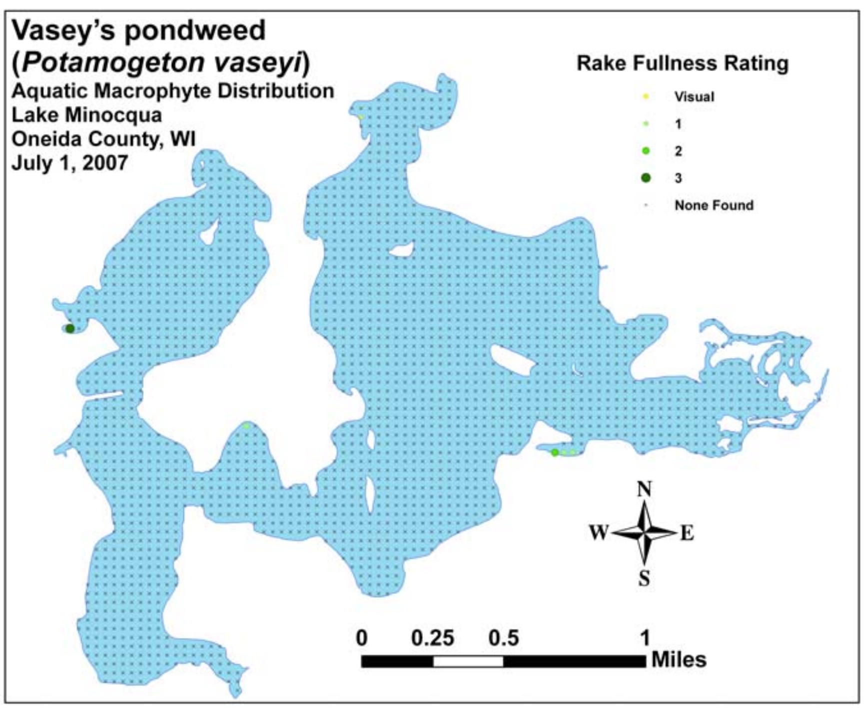


*Figure 49: Vasey's pondweed in Minocqua Lake*

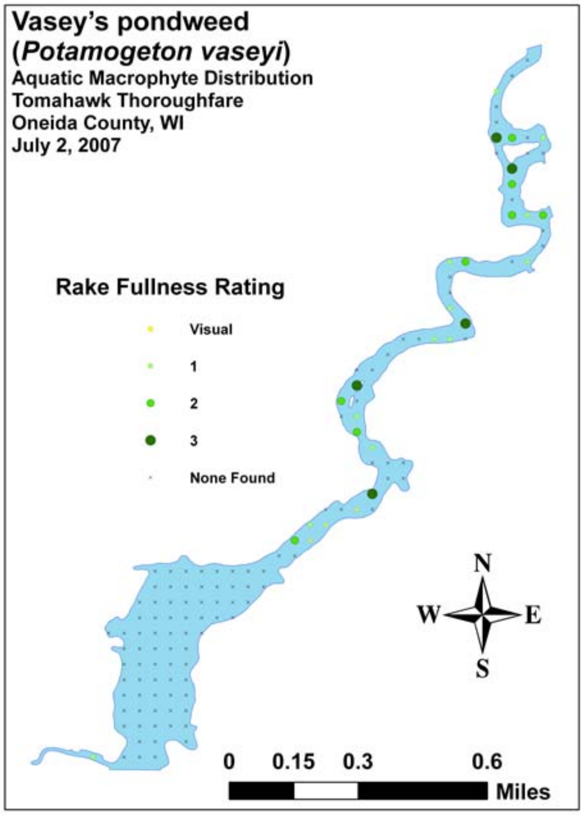


*Figure 50: Vasey's pondweed in Tomahawk Thoroughfare.*

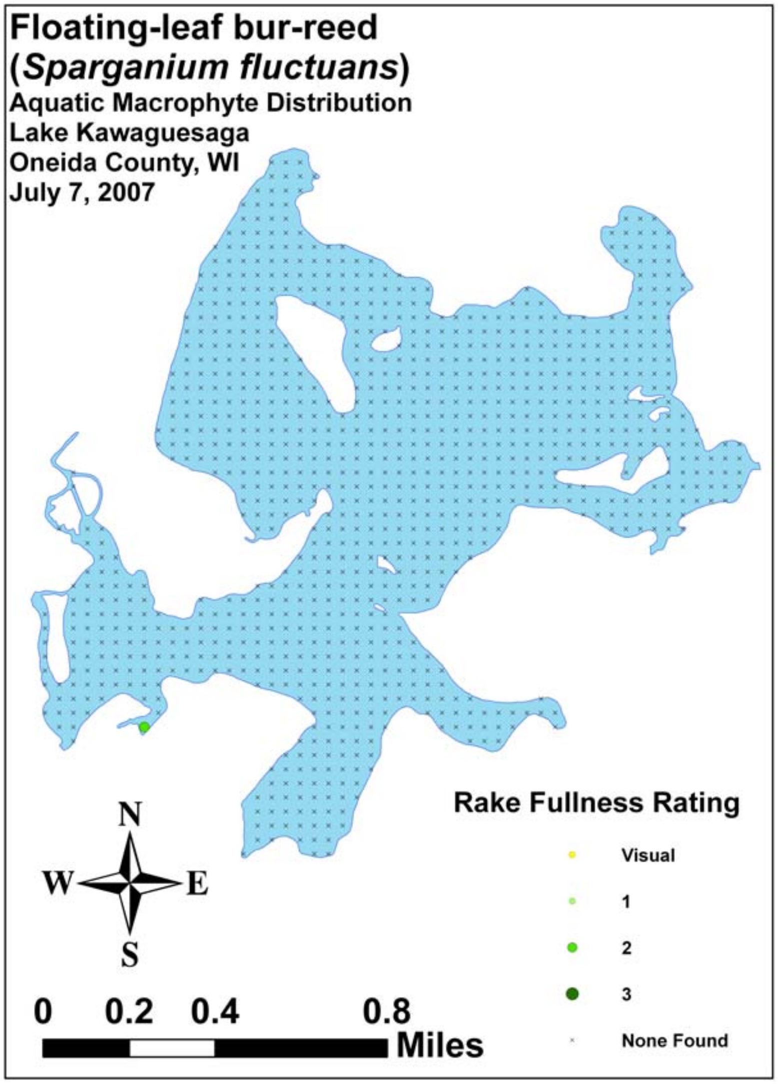


***Figure 51: Floating bur-reed in Kawaguesaga Lake***

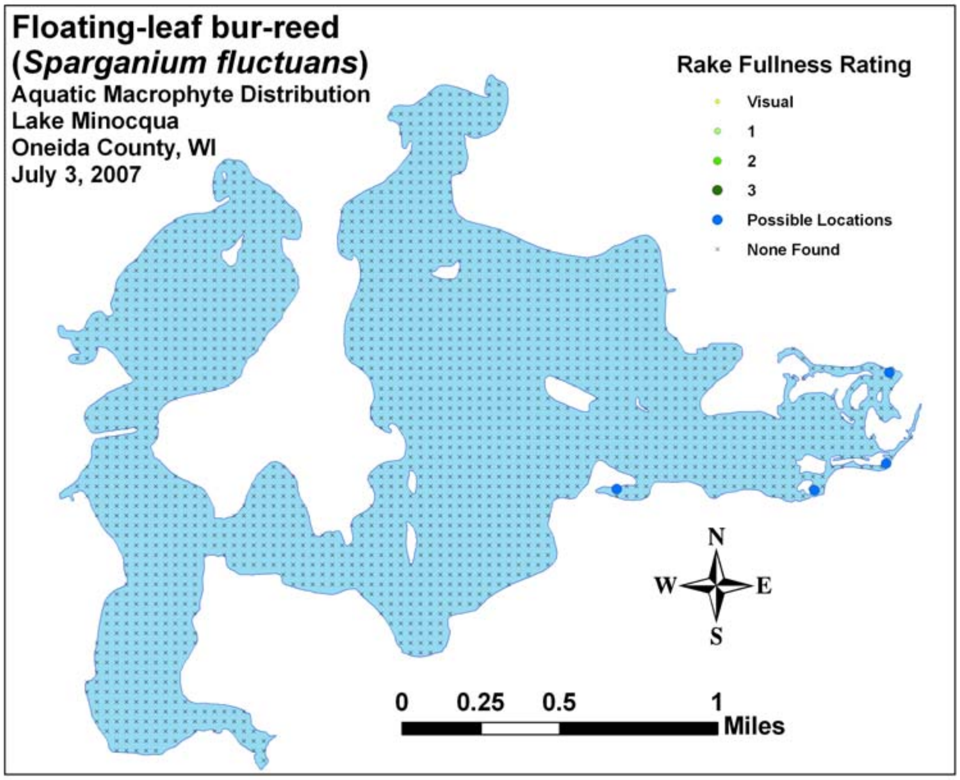


***Figure 52: Float bur-reed Minocqua Lake.***

## Invasive Species of Concern

**Eurasian watermilfoil**[10] ***(Myriophyllum spicatum)***
The ecological risks associated with an infestation of Eurasian water milfoil appear to surpass those associated with curly leaf pondweed. As a result, management of Eurasian water milfoil is the species of highest concern for this management plan (although other invasives are present in the lakes).

There is one public boat landing on Kawaguesaga Lake and four landings on Minocqua Lake. Many anglers travel to these lakes for fishing and access the lake at these boat landings. With Eurasian water milfoil present in Minocqua and Kawaguesaga Lakes, the danger of transporting plant fragments on boats and motors is very real. The lakes are part of a very highly used tourism area, with easy access to many lakes with EWM. The risk of transport to lakes with EWM is high.

The Wisconsin Department of Natural Resource EWM distribution lists Eurasian water milfoil in the following Oneida County Lakes (other than Kawaguesaga and Minocqua): Bridge Lake, Eagle River, Hancock Lake, Kathan Lake, Manson Lake, Oneida Lake, Rainbow Flowage, Sugar Camp Creek, Tomahawk Lake, Tomahawk River, Willow Flowage, Willow Lake, and the Wisconsin River. In nearby Vilas County, the following locations are listed: Arrowhead Lake, Big Sand Lake, Boot Lake, Catfish Lake, Duck Lake, Cranberry Lake, Eagle Lake, Forest Lake, Little St. Germain Lake, Long Lake, Lynx Lake, North Twin Lake, Otter Lake, Scattering Rice Lake, Silver Lake, South Twin Lake, Upper Gresham Lake, Voyager Lake, and Watersmeet Lake[11].

The following Eurasian water milfoil information is taken from a Wisconsin DNR fact sheet. Both Northern milfoil and coontail, mentioned below as frequently mistaken for Eurasian water milfoil are present in Kawaguesaga and Minocqua Lakes.

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

[10] Wisconsin DNR Invasive Species Factsheets from www.dnr.state.wi.us.
[11] Taken from the 2006 list of waterbodies with EWM. Wisconsin DNR Website.

**Characteristics**
Eurasian water milfoil grows best in fertile, fine-textured, inorganic sediments. In less productive lakes, it is usually 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 lakebeds, lakes laden with nitrogen and phosphorous, and heavily used lakes. Optimal growth occurs in alkaline systems with a high concentration of dissolved inorganic carbon. High water temperatures promote multiple periods of flowering and fragmentation.

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

Once established in an aquatic community, milfoil reproduces from shoot fragments and stolons (runners that creep along the lake bed). As an opportunistic species, Eurasian water milfoil is adapted for rapid growth early in spring.

**Ecological impacts**
Eurasian water milfoil's ability to spread rapidly by fragmentation and effectively block out sunlight needed for native plant growth often results in monotypic stands. Monotypic stands of Eurasian milfoil provide only a single habitat, and threaten the integrity of aquatic communities in a number of ways; for example, dense stands disrupt predator-prey relationships by fencing out larger fish, and reducing the number of nutrient-rich native plants available for waterfowl.

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

**Control methods**
Preventing a Eurasian water milfoil invasion requires various efforts. The first component is public awareness of the necessity to remove weed fragments at boat landings. Inspection programs should provide physical inspections as well as a direct educational message. Native plant beds must be protected from disturbance caused by boaters and indiscriminate plant control that disturbs these beds. The watershed management program will keep nutrients from reaching the lake and reduce the likelihood that Eurasian milfoil colonies will establish and spread.

Monitoring is also important, so that introduced plants can be controlled immediately. The lake association and lakeshore owners should check for new colonies and control them before they spread. The plants can be hand pulled or raked. It is imperative that all fragments be removed from the water and the shore.

As always, prevention is the best approach to invasive species management. Since Eurasian water milfoil has already been introduced, though, additional control methods should be considered, including mechanical control, chemical control, and biological control.

With Eurasian water milfoil found in nearby lakes, and in small amounts in Kawaguesaga and Minocqua Lakes themselves, it is prudent to provide a contingency plan to be best control milfoil. A contingency plan should include a systematic monitoring program and a fund to provide timely treatments.

This plant is often confused with Northern water milfoil (*Myriophyllum sibiricum*), which is native and found in Kawaguesaga and Minocqua Lakes. Northern milfoil is a desirable plant that tends to grow in similar habitat as EWM. It has fine leaves that provide habitat for small planktonic organisms, which make up a key part of the food chain.

# Aquatic Plant Management

This section presents aquatic plant management goals for Kawaguesaga Lake and Minocqua Lake, the potential management methods available to reach these goals, and selection of action items for plant management. These goals were developed by the plant committee and reflect the concerns resulting from public involvement, the Lake Association Board of Directors, and suggestions from the Wisconsin Department of Natural Resources.

Techniques to control the growth and distribution of aquatic plants are discussed in the fooloing text. In most cases, a combination of techniques must be used to reach plan goals. The application, location, timing and combination of techniques must be considered carefully.

## Kawaguesaga Lake and Minocqua Lake Aquatic Plant Management Goals

1. Reduce Eurasian water milfoil in Kawaguesaga Lake and Minocqua Lake and the designated thoroughfares.
2. Preserve the native plant community in Kawaguesaga Lake and Minocqua Lake and the designated thoroughfares.
3. Prevent the introduction of new aquatic invasive species and develop a rapid response plan, should such an introduction occur.
4. Monitor existing aquatic invasives such as purple loosestrife, curly leaf pondweed, and flowering rush.
5. Restore native shoreline vegetation.
6. Preserve and/or enhance water quality.
7. Provide extensive education on lake ecology.

## Permitting requirements

The Wisconsin Department of Natural Resources regulates the removal of aquatic plants when chemical and mechanical methods are used or when plants are removed manually from an area greater than thirty feet in width along the shore. The requirements for chemical plant removal are described in Administrative Rule NR 107-Aquatic Plant Management. A permit is required for any aquatic chemical application in Wisconsin.

The requirements for manual and mechanical plant removal are described in NR 109-Aquatic Plants: Introduction, Manual Removal & Mechanical Control Regulations. A permit is required for manual and mechanical removal except when a riparian (waterfront) landowner manually removes or gives permission to someone to manually remove plants, (with the exception of wild rice) from his/her shoreline limited to a 30-foot corridor. A riparian landowner may also manually remove the invasive plants Eurasian water milfoil, curly leaf pondweed, and purple loosestrife along his or her shoreline without a permit. Manual removal means the control of aquatic plants by hand or hand-held devices without the use or aid of external or auxiliary power.

The Northern Region of the Wisconsin DNR has established a management strategy for future plant management and can affect permitting for management. Their approach is as follows:[12]

1. After January 1, 2009, no individual permits for control of native aquatic plants will be issued. Treatment of native species may be allowed under the auspices of an approved lake management plan, and only if the plan clearly documents "impairment of navigation" and/or "nuisance conditions." Until January 1, 2009, individual permits will be issued to previous permit holders, only with adequate documentation of "impairment of navigation" and/or "nuisance conditions." No new individual permits will be issued during the interim.

2. Control of aquatic plants (if allowed) in documented sensitive areas will follow the conditions specified in the report. (Note: Minocqua Lake has several documented sensitive areas)

3.Invasive species must be controlled under an approved lake management plan, with two exceptions:

a. Newly discovered infestations: If found on a lake with an approved plan, the invasives can be controlled via an amendment to the approved plan. Without an approved plan, they can be controlled under the WDNR's Rapid Response protocol.

b. Individuals holding past permits for control of invasive aquatic plants and/or "mixed stands" of native and invasive species will be allowed to treat via individual Permit until January 1, 2009, if "impairment of navigation," and/or "nuisance conditions" is (are) adequately documented.

4. Control of invasive stands or "mixed stands" of invasive and native plants will follow current best management practices approved by the Department and contain an explanation of the strategy to be used. Established stands of invasive plants will generally use a control strategy based on spring treatment (water temperatures of less than 60 degrees F).

5. Manual removal (by definition) is allowed. However, wild rice may not be removed.

## Biological control[13]

Biological control is the purposeful introduction of parasites, predators, and/or pathogenic microorganisms to reduce or suppress populations of plant or animal pests. Biological control counteracts the problems that occur when a species is introduced into a new region of the world without a complex or assemblage of organisms that feed directly upon it, attack its seeds or progeny through predation or parasitism, or cause severe or debilitating diseases (i.e., pathogenic microorganisms). With the introduction of native pests to the target invasive organism, the exotic invasive species may be maintained at lower densities.

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[12] Aquatic Plant Management Strategy. Northern Region of Wisconsin DNR. 2007.
[13] Information from APIS(Aquatic Plant Information System) U.S. Army Corps of Engineers. 2005.

While this theory has worked in application for control of some non-native aquatic plants, results have been varied (Madsen, 2000). Beetles are commonly used to control purple loosestrife populations in Wisconsin with good success. Weevils are used as an experimental control for Eurasian water milfoil once the plant is established. Tilapia and carp are used to control the growth of filamentous algae in ponds. Grass carp, and herbivorous fish are sometimes used to feed on pest plant populations. Grass carp introduction is not allowed in Wisconsin.

There are advantages and disadvantages to the use of biological control as part of an overall aquatic plant management program. Advantages include longer-term control relative to other technologies, lower overall costs, and plant-specific control. On the other hand, there are several disadvantages to consider, including longer control times (years instead of weeks), a lack of available agents for particular target species, and relatively strict environmental conditions required for success.

Biological control is not without risks; new non-native species introduced to control a pest population may cause problem of its own. Biological control is going to be explored for Eurasian water milfoil reduction.

**Weevil augmentation**

A potential management method for EWM is the use of the native weevil *Euhrychiopsis lecontei*. This weevil has a larvae stage that feeds on both native milfoils and Eurasian water milfoil. The larvae tunnel into the stem and the plant presumably loses the ability to tranport nutrients and gases. *E. lecontei* adults swim and climb from plant to plant, feeding on leaflets and stem material. After mating, the female lays an average of 1.9 eggs a day, usually one egg per watermilfoil apical meristem (growing tip). One female may lay hundreds of eggs in her lifetime. The eggs hatch, and the larvae first feed on the apical meristem, and then mine down into the stem of the plant, consuming internal stem tissue. Weevils pupate inside the stem in the pupal chamber, a swelled cavity in the stem. Adults emerge from the pupal chamber to mate and lay eggs. In the autumn, adults travel to the shore where they over-winter on land. In the laboratory, *E. lecontei* take from 20 to 30 days to complete one life cycle, depending on water temperatures. For complete development, weevils require about 310 degree-days with temperatures above 10 degrees C. In the field, generally 2 to 4 generations per year are observed.[14]

Since this weevil naturally occurs in many Wisconsin Lakes, its use involves the augmentation of the natural population of weevils present in the lake. This augmentation significantly increases the population of larvae per stem of milfoil. The premise is that this increase will lead to more destruction of the plants.

Results of weevil augmentation on control of EWM in actual lakes are mixed. Some documentation suggests reduction of EWM density in Wisconsin lakes. Other studies have shown little reduction. There does not seem to be any standard indicating the stem count of larvae needed. Also, the wide variation of seasonal changes and the affects on the weevils

[14] *Euhrychiopsis lecontei* fact sheet. Cornell University Research Ponds Facility.
< http://www.eeb.cornell.edu/ponds/weevil.htm>

seem to play a role in long-term decline of the EWM. This could be linked to the shoreline habitat and fish feeding on the larvae. It is known that a good leaf litter and shrub layer is needed for over-winter habitat of adults. Also, it is known that bluegills (present in Minocqua and Kawaguesaga Lakes) eat this weevil when present.

The Minocqua and Kawaguesaga Lakes Protection Association is considering using weevil augmentation in the lakes. The rationalization is to control EWM with limited use of chemical herbicides. There are mixed results documented in the field, therefore if weevil augmentation is used, it should involve limited sites and be conducted using sound scientific protocols. This would include careful selection of sites that meet shoreline requirements and valid monitoring of the EWM beds in terms of coverage and density. The marking of the augmentation sites would also be important to reduce boat traffic and human influence on the study sites.

If MKLPA is to pursue weevil augmentation, research being conducted by Amy Thorstensen of Portage County should be reviewed. Also, it is important that shorelines in areas to be treated be restored if needed to provide good over-winter habitat. An agreement would need to be established with landowners in order to not disturb this habitat. Extensive education efforts will also be needed to educate landowners and boaters/lake users at landings so the treatment areas remain undisturbed.

**Re-vegetation with native plants**
Another aspect to biological control is native plant restoration. The rationale for re-vegetation is that restoring a native plant community should be the end goal of most aquatic plant management programs (Nichols, 1991; Smart and Doyle, 1995). However, in communities that have only recently been invaded by non-native species, a propagule bank probably exists that will restore the community after non-native plants are controlled (Madsen, Getsinger, and Turner, 1994). Re-vegetation following plant management implementation should not be necessary as both lakes have extensive native populations and any management will involve selection for target species only.

## Physical control[15]

In physical management, the environment of the plant is manipulated, which in turn acts upon the plants. Several physical techniques are commonly used: dredging, draw down, benthic (lake bottom) barriers, and shading or light attenuation. Because they involve placing a structure on the bed of a lake and/or affect lake water level, a Chapter 30 or 31 DNR permit is required.

**Dredging** removes accumulated bottom sediments that support plant growth. Dredging is usually not performed solely for aquatic plant management but is used to restore lakes that have been filled in with sediments, have excess nutrients, need deepening, or require removal of toxic substances (Peterson, 1982). Dredging is not a viable option for Kawaguesaga and

[15] Information from APIS (Aquatic Plant Information System) U.S. Army Corps of Engineers. 2005.

Minocqua Lakes since this isn't recognized as an aquatic plant management tool alone and is not regarded as an effective tool for these lakes.

**Drawdown,** or significantly decreasing lake water levels can be used to control nuisance plant populations. Essentially, the water body has all of the water removed to a given depth. It is best if this depth includes the entire depth range of the target species. Drawdowns, in order to be effective, need to be at least 1 month long to ensure thorough drying (Cooke 1980). In northern areas, a drawdown in the winter that will ensure freezing of sediments is also effective. Although drawdown may be effective for control of hydrilla for 1 to 2 years (Ludlow 1995), it is most commonly applied to Eurasian watermilfoil (Geiger 1983; Siver et al. 1986) and other milfoils or submersed evergreen perennials (Tarver 1980). Drawdown requires that there be a mechanism to lower water levels.

Although it is inexpensive and has long-term effects (2 or more years), it also has significant environmental effects and may interfere with use and intended function (e.g., power generation or drinking water supply) of the water body during the drawdown period. Lastly, species respond in very different manners to draw down and often not in a consistent fashion (Cooke 1980a). Drawdowns may provide an opportunity for the spread of highly weedy or adventive species, particularly annuals. When drawbacks are compared to the benefits, other options appear better for Kawaguesaga and Minocqua Lakes as the primary management tools. However, if there may be a need for lowering the lake level for dam repair, drawdown may be evaluated as an option. In order to be considered, the possible amount of drawdown would need to be determined. This would need to be compared to the bathymetry of the lake to see how much of the littoral zone and where in the littoral zone plants would be exposed. These areas that would be affected would have to correlate to the EWM sites. Although this would be a small possibility, it should not be completely ruled out for the future.

**Benthic barriers** or other bottom-covering approaches are another physical management technique. 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 materials (Cooke 1980b; Nichols 1974; Perkins 1984; Truelson 1984). The problem with using sediments is that new plants establish on top of the added layer (Engel and Nichols 1984). The problem with synthetic sheeting is that the gasses evolved from decomposition of plants and sediment decomposition collects under and lifts the barrier (Gunnison and Barko 1992). Benthic barriers will typically kill plants under them within 1 to 2 months, after which time they maybe removed (Engel 1984). Sheet color is relatively unimportant; opaque (particularly black) barriers work best, but even clear plastic barriers will work effectively (Carter et al. 1994). Sites from which barriers are removed will be rapidly re-colonized (Eichler et al. 1995). In addition, synthetic barriers may be left in place for multi-year control but will eventually become sediment-covered and will allow colonization by plants. Benthic barriers, effective and fairly low-cost control techniques for limited areas (e.g., <1 acre), may be best suited to high-intensity use areas such as docks, boat launch areas, and swimming areas. However, they are too expensive to use over widespread areas, and heavily affect benthic communities by removing fish and invertebrate habitat. A Department of Natural Resources permit would be required.

Although a benthic barrier may be a potential option for riparian owners, there is no plan to use this as a management tool for Kawaguesaga and Minocqua Lakes. Since the main use of management tools will be to reduce EWM, benthic barriers are not prudent; the coverage is too extensive and would be too labor intensive.

**Shading or light attenuation** reduces the light plants need to grow. Shading has been achieved by fertilization to produce algal growth, by application of natural or synthetic dyes, shading fabric, or covers, and by establishing shade trees (Dawson 1981, 1986; Dawson and Hallows 1983; Dawson and Kern-Hansen 1978; Jorga et al. 1982; Martin and Martin 1992; Nichols 1974). During natural or cultural eutrophication, algae growth alone can shade aquatic plants (Jones et al. 1983). Although light manipulation techniques may be useful for narrow streams or small ponds, in general these techniques are of only limited applicability. As a result, management of Kawaguesaga Lake and Minocqua Lake will not use this management tool.

## Manual removal[16]

Manual removal involving hand pulling, cutting, or raking plants will remove plants from small areas. It is likely that plant removal will need to be repeated during the growing season. Best timing for hand removal of herbaceous plant species is after flowering but before seed head production. For plants that possess rhizomatous (underground stem) growth, pulling roots is not generally recommended since it may stimulate new shoot production. Hand pulling is a strategy recommended for rapid response to a Eurasian water milfoil infestation. If curly leaf pondweed or Eurasian water milfoil is present at or near shore locations in low density, hand pulling by residents may be effective. Caution needs to be exercised in removing the entire plant and any fragments to reduce spreading through fragmentation.

## Mechanical control

Larger-scale control efforts require more mechanization. Mechanical cutting, mechanical harvesting, diver-operated suction harvesting, and rotovating (tilling) are the most common forms available. Department of Natural Resources permits under Chapter NR 109 are required for mechanical plant removal.

**Aquatic plant harvesters** are floating machines that cut and remove vegetation from the water. The cutter head uses sickles similar to those found on farm equipment, and generally cuts from 1 to 6 feet deep. A conveyor belt on the cutter head is always in motion, bringing the clippings onboard the machine for storage. Once full, the harvester travels to shore to discharge the load of weeds off of the vessel.

Harvesters come in a variety of sizes, with cutting swaths ranging from 4 to 12 feet in width. The onboard storage capacity varies as well, and is measured in both volume and weight. Harvester storage capacities generally range from 100 to 1000 cubic feet of vegetation by

[16] Information from APIS (Aquatic Plant Information System) U.S. Army Corps of Engineers. 2005.

volume, or from one to eight tons. They are usually propelled by two paddle wheels that provide excellent maneuverability and will not foul in dense plant growth.

Because large-scale mechanical control tends to be nonselective and leaves plant fragments in the lake, this method is not recommended for Kawaguesaga Lake or Minocqua Lake. Also, for established invasive species control, mechanical harvesting would be largely for aesthetic reasons. Since spreading of the plant is likely, it would reduce plant density for a brief time, only to have the plants return in the near future. A resident has expressed a concern about plant growth that may potentially be considered at nuisance level (though it has not yet been determined to be native or invasive). It is located in the Minocqua Thoroughfare, and affects navigation. If this area is considered a nuisance for navigation, harvesting may be an option.

**Diver dredging** operations use pump systems to collect plant and root biomass. The pumps are mounted on a barge or pontoon boat. The dredge hoses are from 3 to 5 inches in diameter and are handled by one diver. The hoses normally extend about 50 feet in front of the vessel. Diver dredging is especially effective against pioneering infestations of submersed invasive plant species. When a weed is discovered in a pioneering state, this methodology should be considered. To be effective, the entire plant, including the subsurface portions, should be removed.

Plant fragments can be formed from this type of operation. Fragmentation is not as great a problem when infestations are small. Diver dredging operations can be an ongoing mission. When applied toward a pioneering infestation, control can be complete. However, periodic inspections of the lake should be performed to ensure that all the plants have been found and collected.

Lake substrates can play an important part in the effectiveness of the operation. Soft substrates are very easy to work in. Divers can remove the plant and root crowns with little difficulty. Hard substrates, however, pose more of a problem. Divers may need hand tools to help dig the root crowns out of hardened sediment. Many areas of Minocqua Lake that need management are far too large for this method. However, in some regions of sporadic Eurasian water milfoil infestation, this method may be useful. Since actual dredging calls for separate permits for the removal of lake basin material, dredging would not be performed. Instead, the use of a suction device to move plants to the surface without removing bottom material would be utilized.

**Rotovation** involves using large underwater rototillers to remove plant roots and other plant tissue. Rotovators can reach bottom sediments to depths of 20 feet. Rotovating may significantly affect non-target organisms and water quality as bottom sediments are disturbed. However, the suspended sediments and resulting turbidity produced by rotovation settles fairly rapidly once the tiller has passed. Tilling sediments that are contaminated could possibly release toxins into the water column. If there is any potential of contaminated sediments in the area, further investigation should be performed to determine potential impacts from this type of treatment. Tillers do not operate effectively in areas with many underwater obstructions such as trees and stumps. There may be a need to collect the plant material that is tilled from the bottom. If operations are releasing large amounts of plant material, harvesting equipment should be on hand to collect this material and transport it to shore for disposal.

Rotovation would release too much sediment and too many plant fragments and therefore would not be a good method for Kawaguesaga and Minocqua Lakes. Also, potential treatment of non-native plants by rotovation is not a good option as it could increase spreading of non-native plants while not selecting the target species.

## Herbicide and algaecide treatments

Herbicides are chemicals used to kill plant tissue. Currently, no product can be labeled for aquatic use if it poses more than a one in a million chance of causing significant damage to human health, the environment, or wildlife resources. In addition, it may not show evidence of biomagnification, bioavailability, or persistence in the environment (Joyce, 1991). Thus, there are a limited number of active ingredients that are assured to be safe for aquatic use (when used according to the label) (Madsen, 2000).

An important caveat is that these products are safe when used according to the label. The U.S. Environmental Protection Agency (EPA)-approved label gives guidelines protecting the health of the environment, the humans using that environment, and the applicators of the herbicide. In most states, additional permitting or regulatory restrictions on the use of these herbicides also apply. Most states require these herbicides be applied only by licensed applicators. Wisconsin Department of Natural Resources permits under Chapter NR 107 are required for herbicide application.

Herbicide use will likely be the main management tool for Kawaguesaga and Minocqua Lakes. Considering the potential treatment areas, costs, location and time of season, this option is most viable.

General descriptions of chemical control are included below.

## Contact Herbicides

Contact herbicides act quickly and are generally lethal to all plant cells that they contact. Because of this rapid action, or other physiological reasons, they do not move extensively within the plant and are effective only where they contact plants directly. For this reason, they are generally more effective on annuals (plants that complete their life cycle in a single year). Perennial plants (plants that persist from year to year) can be defoliated by contact herbicides but they quickly resprout from unaffected plant parts. Submersed aquatic plants that are in contact with sufficient concentrations of the herbicide in the water for long enough periods of time are affected, but regrowth occurs from unaffected plant parts, especially plant parts that are protected beneath the sediment. Because the entire plant is not killed by contact herbicides, retreatment is necessary, sometimes two or three times per year. **Endothall, diquat** and **copper** are contact aquatic herbicides.

**Systemic Herbicides**

Systemic herbicides are absorbed into the living portion of the plant and move within the plant. Different systemic herbicides are absorbed to varying degrees by different plant parts. Systemic herbicides that are absorbed by plant roots are referred to as "soil active herbicides" and those that are absorbed by leaves are referred to as "foliar active herbicides". Some soil active herbicides are absorbed only by plant roots. Other systemic herbicides, such as glyphosate, are only active when applied to and absorbed by the foliage. **2,4-D, dichlobenil, fluridone, and glyphosate** are systemic aquatic herbicides. When applied correctly, systemic herbicides act slowly in comparison to contact herbicides. They must move to the part of the plant where their site of action is. Systemic herbicides are generally more effective for controlling perennial and woody plants than contact herbicides. Systemic herbicides also generally have more selectivity than contact herbicides. This will be the preferred type of chemical treatment for Kawaguesaga and Minocqua Lakes, since it is best at targeting the EWM as an herbicide for dicot plants (most aquatic plants are monocots).

### Broad spectrum herbicides

Broad spectrum (sometimes referred to as nonselective) herbicides are those that are used to control all or most species of vegetation. This type of herbicide is often used for total vegetation control in areas such as equipment yards and substations where bare ground is preferred. **Glyphosate** is an example of a broad spectrum aquatic herbicide. **Diquat, Endothall, and fluridone** are used as broad spectrum aquatic herbicides, but can also be used selectively under certain circumstances. While glyphosate, diquat and endothall are considered broad spectrum herbicides, they can also be considered selective in that they only kill the plants that they contact. Thus, you can use them to selectively kill an individual plant or plants in a limited area such as a swimming zone.

### Selective herbicides

Selective herbicides are those that are used to control certain plants, but not others. 2,4-D, which can be used to control water hyacinth with minimum impact on eel grass, is a good example of a selective aquatic herbicide. Herbicide selectivity is based upon the relative susceptibility or response of a plant to an herbicide. Many related physical and biological factors can contribute to a plant's susceptibility to an herbicide. Physical factors that contribute to selectivity include herbicide placement, formulation, and rate of application. Biological factors that affect herbicide selectivity include physiological factors, morphological factors, and stage of plant growth.

## Environmental Considerations

Aquatic communities consist of aquatic plants including macrophytes (large plants) and phytoplankton (free floating algae), invertebrate animals (such as insects and clams), fish, birds, and mammals (such as muskrats, otters, and manatees). All of these organisms are interrelated in the community. Organisms in the community require a certain set of physical and chemical conditions to exist such as nutrient requirements, oxygen, light, and space. Aquatic weed control operations can affect water chemistry, or one or more of the organisms in the community. Both of these can in turn affect other organism. The effects of aquatic plant control on the aquatic community can be separated into direct effects of the herbicides or indirect effects. Direct effects would include the actual killing of aquatic organisms themselves such as fish or fish eggs. Indirect effects could include adversely affecting the food chain through reduction of small invertebrates that fish may feed on.

General descriptions of the breakdown of commonly used aquatic herbicides are included below.[17]

**Copper compounds**
Copper is a naturally occurring element that is essential at low concentrations for plant growth. It does not break down in the environment, but forms insoluble compounds with other elements and is bound to charged particles in the water. It rapidly disappears from water after application as an herbicide. Because it is not broken down, it can accumulate in lake bottom sediments after repeated high application rates. Accumulation rarely reaches levels that are toxic to organisms or significantly above background concentrations in the sediment.

**2,4-D**
2,4-D photodegrades on leaf surfaces after being applied to leaves and is broken down by microbial degradation in water and sediments. Complete decomposition usually takes about 3 weeks in water but can be as short as 1 week. 2,4-D breaks down into naturally occurring compounds.

**Diquat**
When applied to enclosed ponds for submersed weed control, diquat is rarely found longer than 10 days after application and is often below detection 3 days after application. The most important reason for the rapid disappearance of diquat from water is that it is rapidly taken up by aquatic vegetation and binds tightly to particles in the water and bottom sediments. When bound to certain types of clay particles diquat is not biologically available. When it is bound to organic matter, microorganisms can degrade it slowly. When diquat is applied foliarly it is degraded to some extent on the leaf surfaces by photodegradation, and because it is bound in the plant tissue, a proportion is probably degraded by microorganisms as the plant tissue decays.

**Endothall**
Like 2,4-D, endothall is rapidly and completely broken down into naturally occurring compounds by microorganisms. The by-products of endothall dissipation are carbon dioxide and water. Complete breakdown usually occurs in about 2 weeks in water, and 1 week in bottom sediments. This will be the chemical of choice for early season CLP treatments.

**Fluridone**
Dissipation of fluridone from water occurs mainly by photodegradation. Metabolism by tolerant organisms and microbial breakdown also occurs, and microbial breakdown is probably the most important method of breakdown in bottom sediments. The rate of breakdown of fluridone is variable and may be related to time of application. Applications made in the fall or winter, when the sun's rays are less direct and days are shorter, result in longer half-lives. Fluridone usually disappears from pond water after about 3 months but can remain up to 9 months. It may remain in bottom sediment between 4 months and 1 year.

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[17]These descriptions are taken from Hoyer/Canfield: Aquatic Plant Management. North American Lake Management Society. 1997.

**Glyphosate**
Glyphosate is not applied directly to water for weed control, but when it does enter the water it is bound tightly to dissolved and suspended particles and to bottom sediments and becomes inactive. Glyphosate is broken down into carbon dioxide, water, nitrogen, and phosphorus over a period of several months.

### Algaecide treatments for filamentous algae
Copper-based compounds are generally used to treat filamentous algae. Common chemicals used are copper sulfate and Cutrine Plus, a chelated copper algaecide.

## Herbicide use to manage invasive species

**Curly leaf pondweed**
The Army Corps of Engineers Aquatic Plant Information System (APIS) identifies three herbicides for control of curly leaf pondweed: Diquat, Endothall, and Fluridone. Fluridone requires exposure of 30 to 60 days making it infeasible to target a discreet area in a lake system. The other herbicides act more rapidly. Herbicide labels provide water use restriction following treatment. Diquat (Reward) has the following use restrictions: drinking water 1-3 days, swimming and fish consumption 0 days. Endothall (Aquathol K) has the following use restrictions: drinking water 7 – 25 days, swimming 0 days, fish consumption 3 days.

Early season herbicide treatment:[18]
Studies have demonstrated that curly leaf can be controlled with Aquathol K (a formulation of Endothall) in 55 - 60 degree F water, and that treatments of curly leaf this early in its life cycle can prevent turion formation. Staff from the Minnesota Department of Natural Resources and the U.S Army Engineer Research and Development Center are conducting further trials of this method. Balsam Lake (Polk County, Wisconsin) treated two sites totaling 13 acres in early June of 2004, and will follow up with ongoing treatment and monitoring of the effectiveness of this method.

Because the dosage is at lower rates than dosage recommended on the label, a greater herbicide residence time is necessary. To prevent drift of herbicide and allow greater contact time, application in shallow bays is likely to be most effective. Herbicide applied to a narrow band of vegetation along the shoreline is likely to drift, rapidly decrease in concentration, and be rendered ineffective.[19]

**Eurasian water milfoil**
The Army Corps of Engineers Aquatic Plant Information System (APIS) identifies the following herbicides for control of Eurasian water milfoil: complexed copper, 2,4-D, diquat, endothall, fluridone and triclopyr. Early season treatment of Eurasian water milfoil is also recommended by the Department of Natural Resources to limit the impact on native aquatic plant populations. The choice for treatment at these lakes for this plan will be 2,4-D used in an early season application.

[18] Research in Minnesota Control of Curly Leaf Pondweed. Wendy Crowell, Minnesota Department of Natural Resources. Spring 2002.
[19] Personal communication, Frank Koshere. Wisconsin DNR. March 2005.

## Historical Plant Management

Chemical treatment for aquatic plants in these lakes has a long history. Chemical control of plants in Kawaguesaga and Minocqua Lakes dates back to 1967. During these early years, records indicate a few private riparian owners (largely resorts and camps) treated plants mainly for swimming use. No pre and post treatment surveys were conducted. Acreage was quite limited in coverage, with no areas listed greater than an acre[20]. As a result, the long-range impact, if any, has not been established. In addition, the target species were not indicated and one might assume it was plant reduction in general and not to treat invasive species specifically.

In July 2005, after Eurasian water milfoil was determined to be present, a permit was granted to chemically treat 25.5 acres for EWM on Kawaguesaga Lake and Minocqua Lake. The treatment was with 2,4-D at the locations highlighted on the map below.

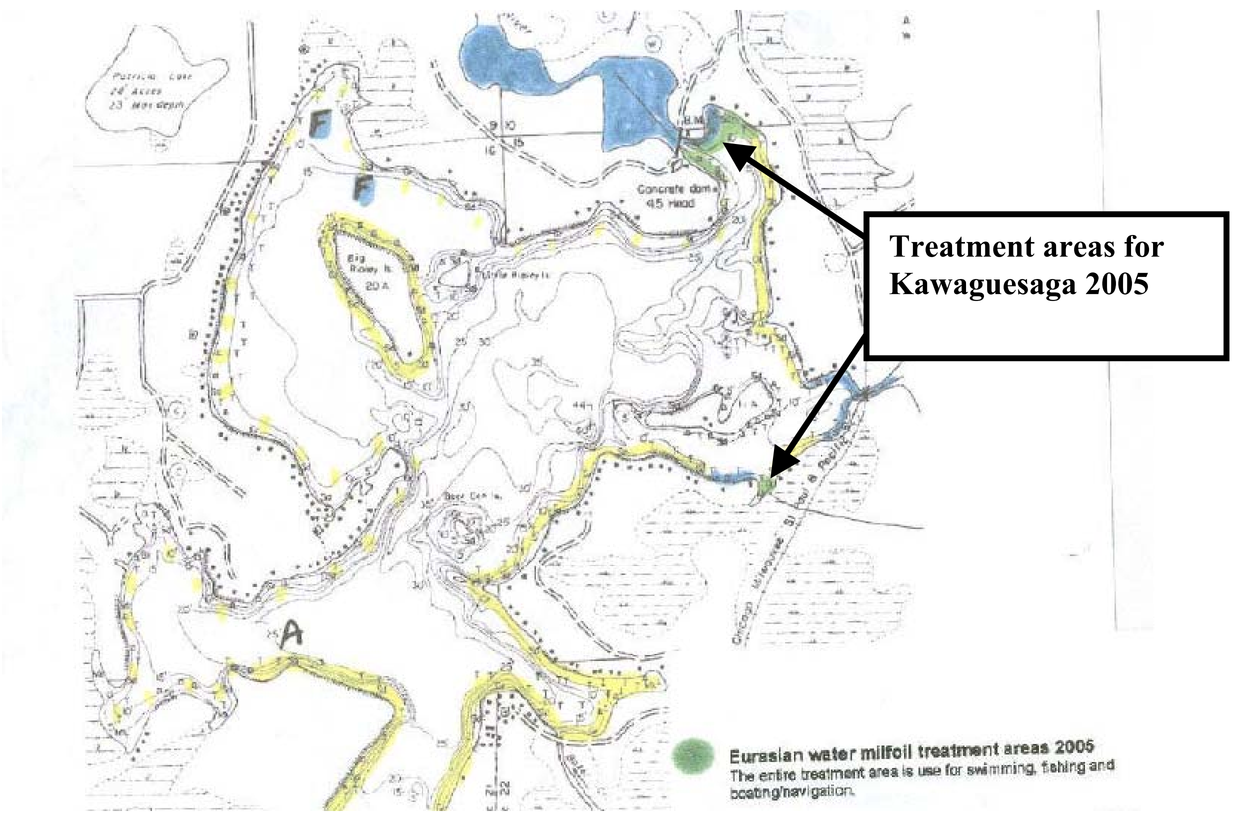


***Figure 53: Map of EWM treatment locations-Kawaguesaga Lake, 2005***

[20] Records provided by Wisconsin DNR, Rhinelander Office. Reviewed January, 2008.

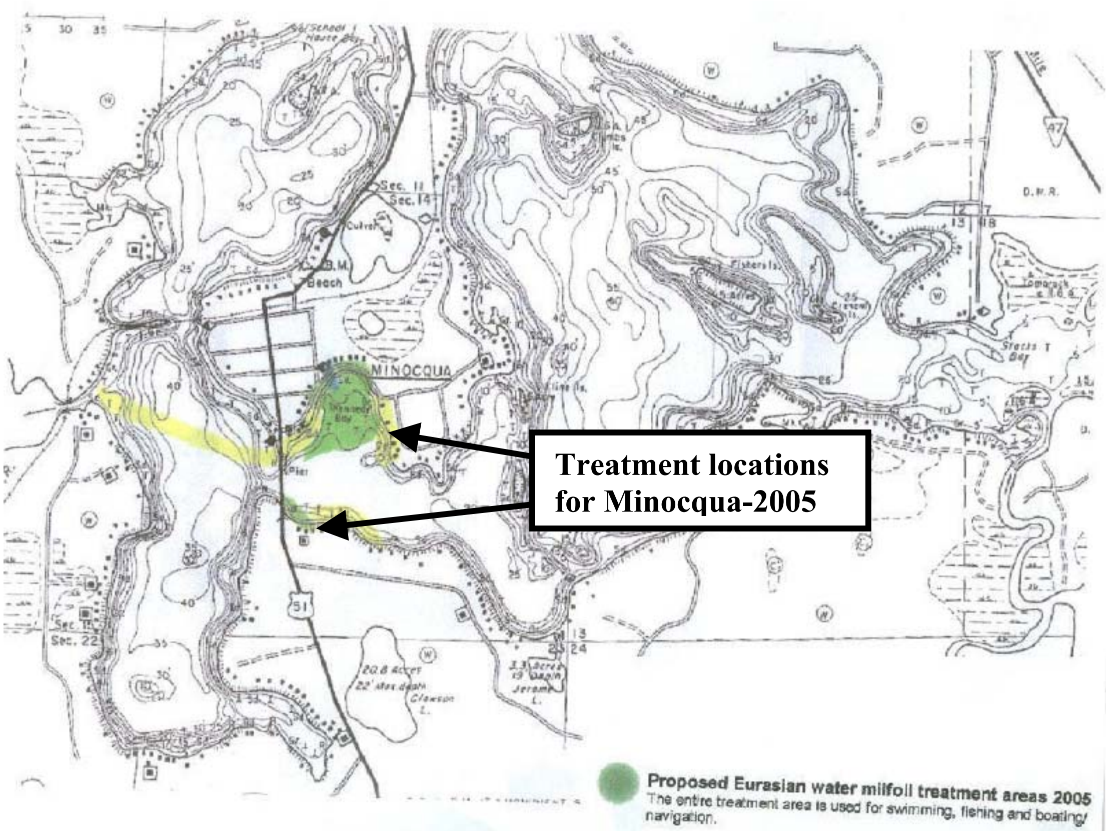


***Figure 54: Map of EWM treatment locations-Minocqua Lake, 2005***

A letter in the treatment file from the Lake Association described the treatment as successful, reducing EWM by 95 to 99%, based on a post treatment survey[21]. However, it did not indicate the protocol for the survey or any data to substantiate this claim. Therefore, there is no data to support or not support his claim.

In June 2006, another permit was issued. This permit was for the treatment of 0.7 acres near the Kennedy Bay boat landing. Again the target species was EWM. In July 2007, a 0.5 acre treatment in front of the same boat landing was permitted.

Summary of EWM treatments:

| Date | Location | Acres | Chemical Applied |
|---|---|---|---|
| 5/2005 | Various (see Figure 30 &31) | 25.5 | 2,4-D 100 lbs/acre |
| 5/2006 | Various (see figure 32) | 21 | 2,4-D (application rate unknown) |
| 6/2006 | Kennedy Landing | 0.7 | 2,4-D (application rate unknown) |
| 7/2007 | Kennedy Landing | 0.5 | 2,4-D (application rate unknown) |
| 4/2008 | Various | 12 | 2,4-D early season at application rate outlined in this plan |

[21] Letter to Mr. Kevin Gauthier, Wisconsin DNR from Minocqua-Kawaguesaga Lakes Protection Association. January 12, 2006.

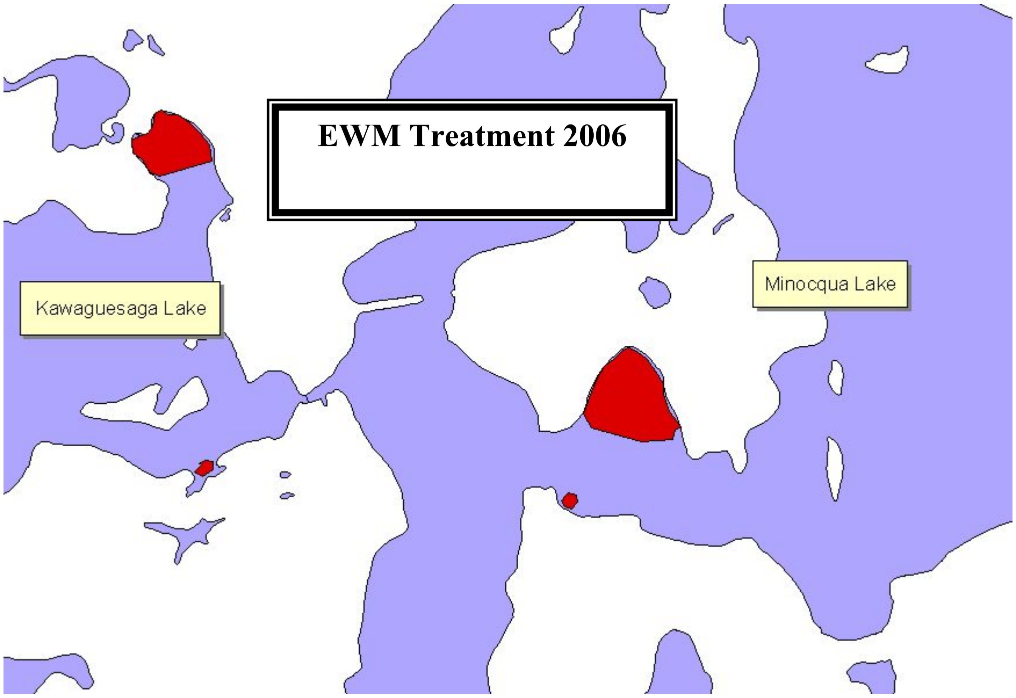


*Figure 55: EWM treatment sites-2006*

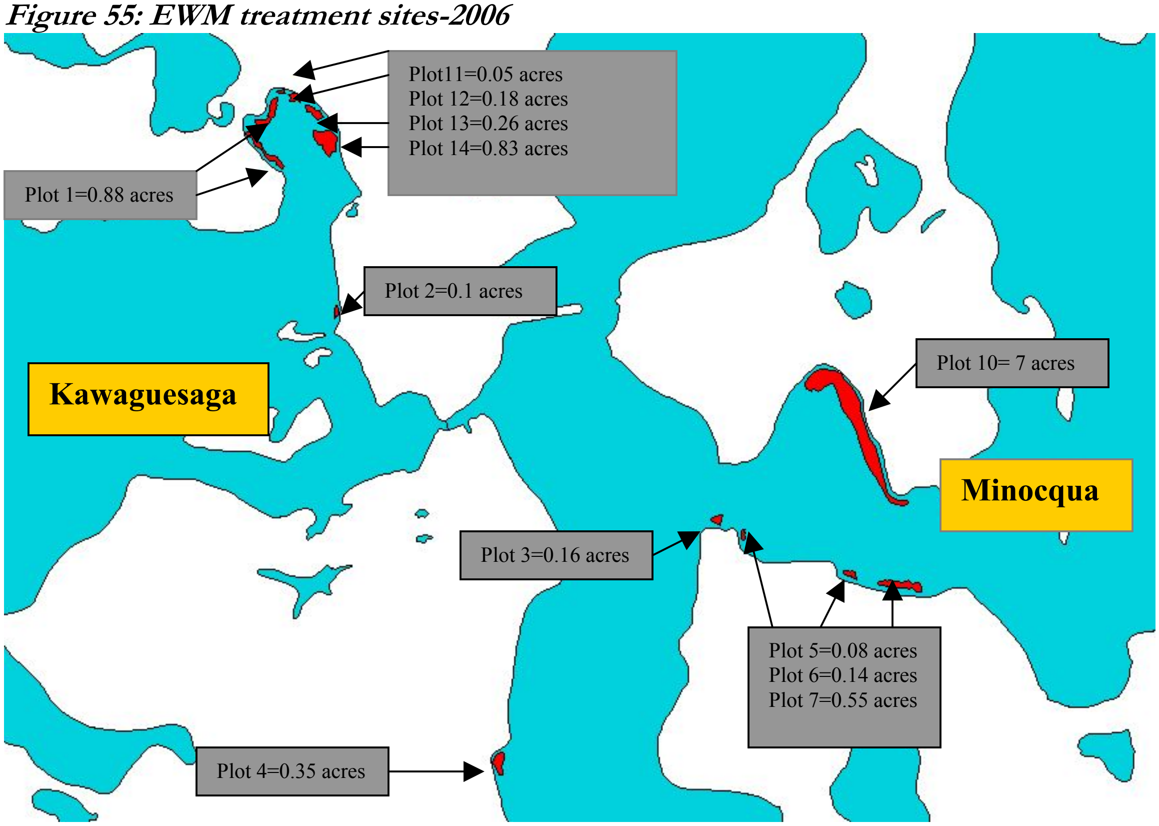


*Figure 56: EWM treatment sites-2008*

Note: The post treatment survey for the 2008 treatment is in Appendix I.

# Management Recommendations

There are several invasive species present in Kawaguesaga Lake and Minocqua Lake. The ability to manage all of these to an extensive level is not possible, largely due to budget constraints and volunteer limitations. For this reason, the first priority is to manage the Eurasian water milfoil since it could have the greatest impact on the lakes. Curly leaf pondweed, flowering rush and purple loosestrife are of concern, but management of these will have to occur after the Eursian water milfoil management scheme is implemented.

## Goal 1: Reduce Eurasian watermilfoil (EWM) in Kawaguesaga Lake and Minocqua Lake.

The coverage of EWM in Kawaguesaga Lake is more limited than in Minocqua Lake. In both cases the coverage contains some dense stands that are easily identified and mapped. In other areas, the coverage is sporadic lacking any easily defined boundaries. This latter situation causes more difficult management, as it is very important to target only the EWM without harming native plants.

**Plan Action Item-1:**

Any plot that has consistent density of 2 or higher throughout, has a defined boundary, and is navigable to map (or 400 sq ft or more), will be considered for herbicide application. The plot will be surveyed following the pre-treatment protocol outlined by the Wisconsin DNR.

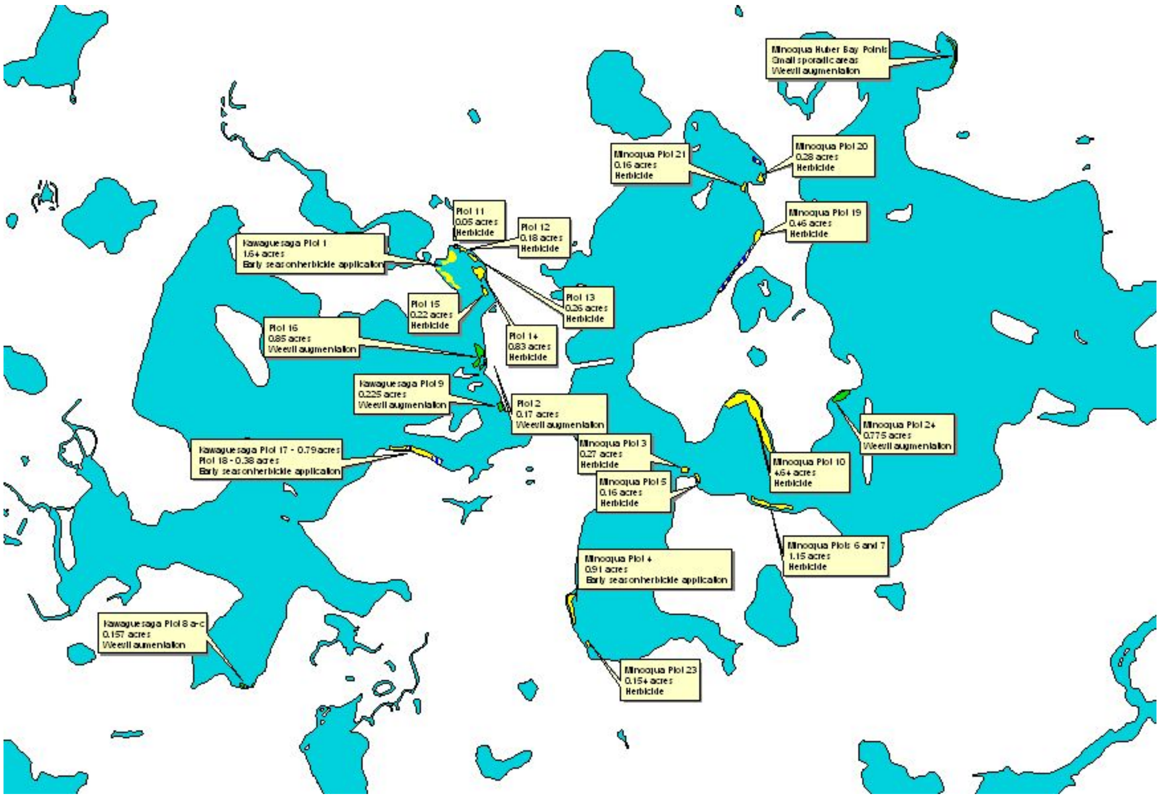


***Figure 57: EWM locations with treatable beds-verified Sept. 2008***

The plots mapped have been surveyed using the year one prior to treatment protocol[22]. These plots will be using an early season (water temperature of 55-60 degrees F) application of 2,4-D which will select for the target species *Myriophyllum spicatum*. Since 2,4-D is selective for dicots, *Myriophyllum spicatum* will be affected along with other dicots. However, most aquatic plants are monocots and so this treatment will help select mostly the target species. Also, other dicots such as *Myriophyllum sibiricum* (northern watermilfoil) may be more dormant and not affected to a large extent. *Ceratophyllum demersum*, also a dicot, could be affected, but its density is rather high and should not adversely affect this population of plants. The plots to be treated are enlarged on maps that follow.

[22] Wisconsin DNR, March 2007.

**Plan Action Item-2:**

All plots treated will be treated with 2,4-D at a dosage listed below in early season when the water temperatures are 55-60 degrees.

Dosage:
0-5 foot depth…….100 lbs/acre

5-10 foot depth…...150 lbs/acre

>10 foot depth……200 lbs/acre

*Note: Application rates may need to be adjusted dependent upon effectiveness with annual evaluation of each treated bed.*

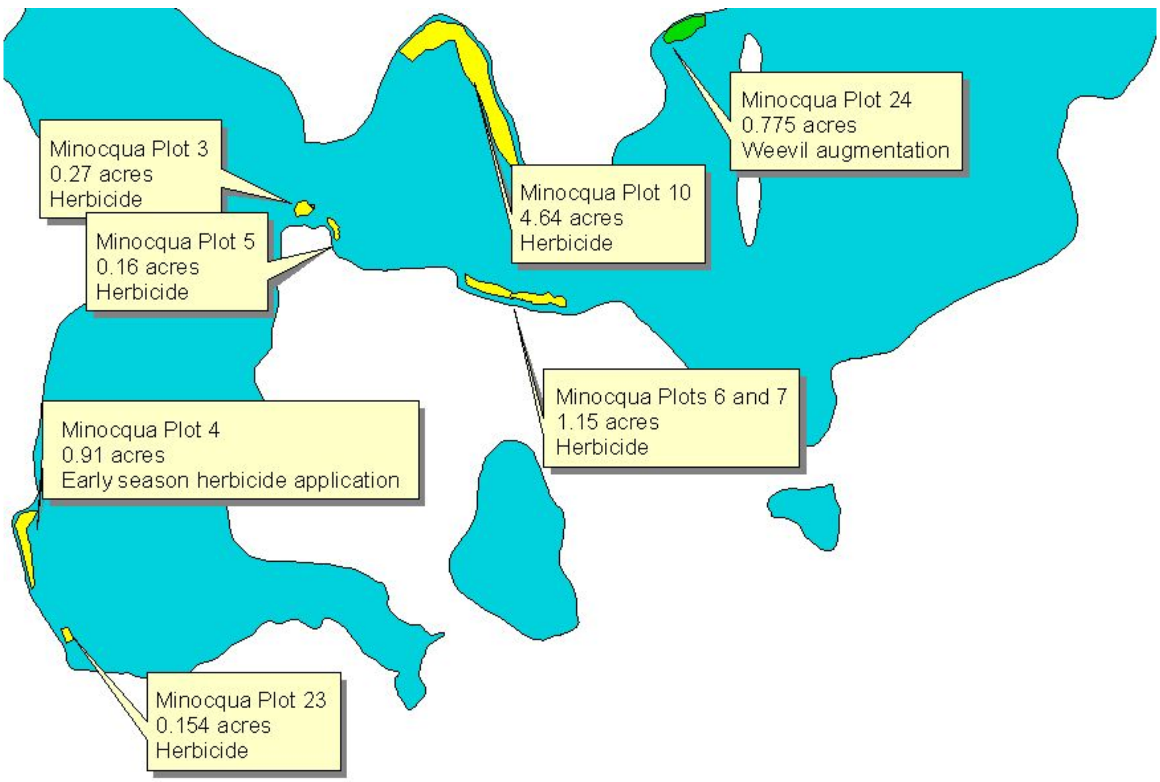


***Figure 58: Map of EWM plots 3,5,6,7, 10, 23 and 24-Minocqua Lake***

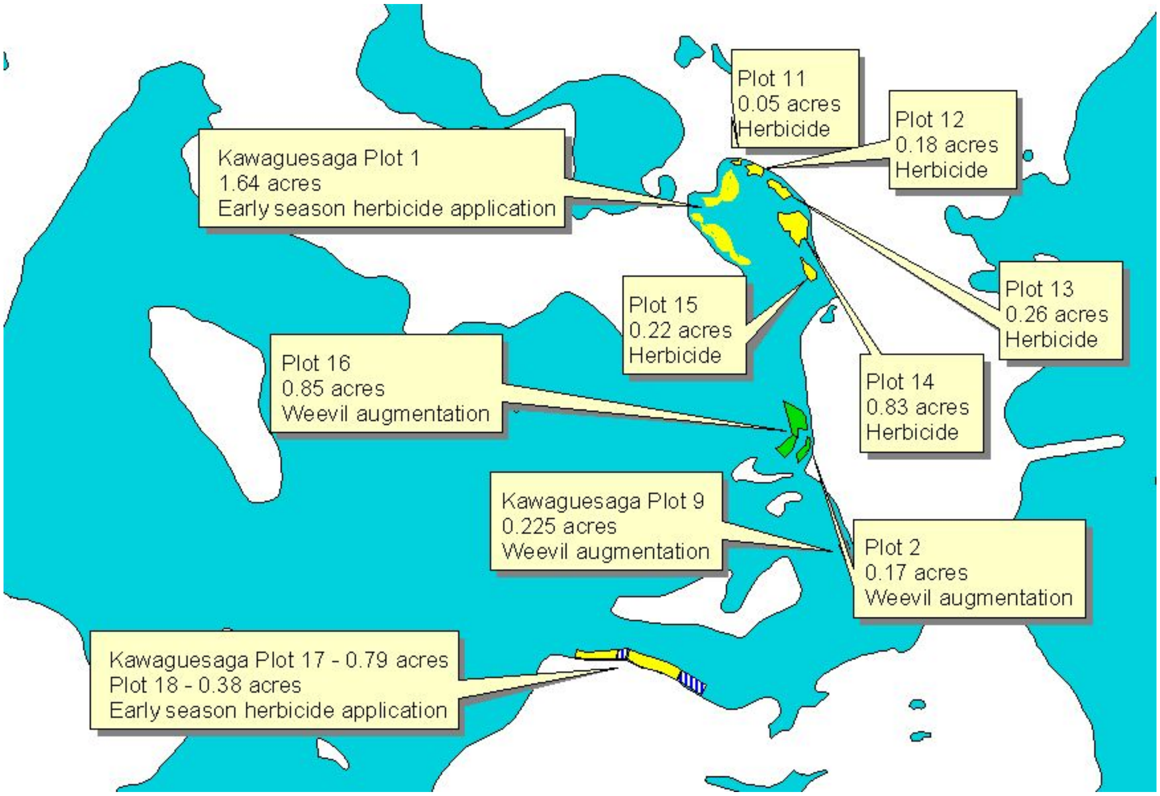


***Figure 59: Map of EWM plots 1,2 and 11-18-Kawaguesaga Lake***

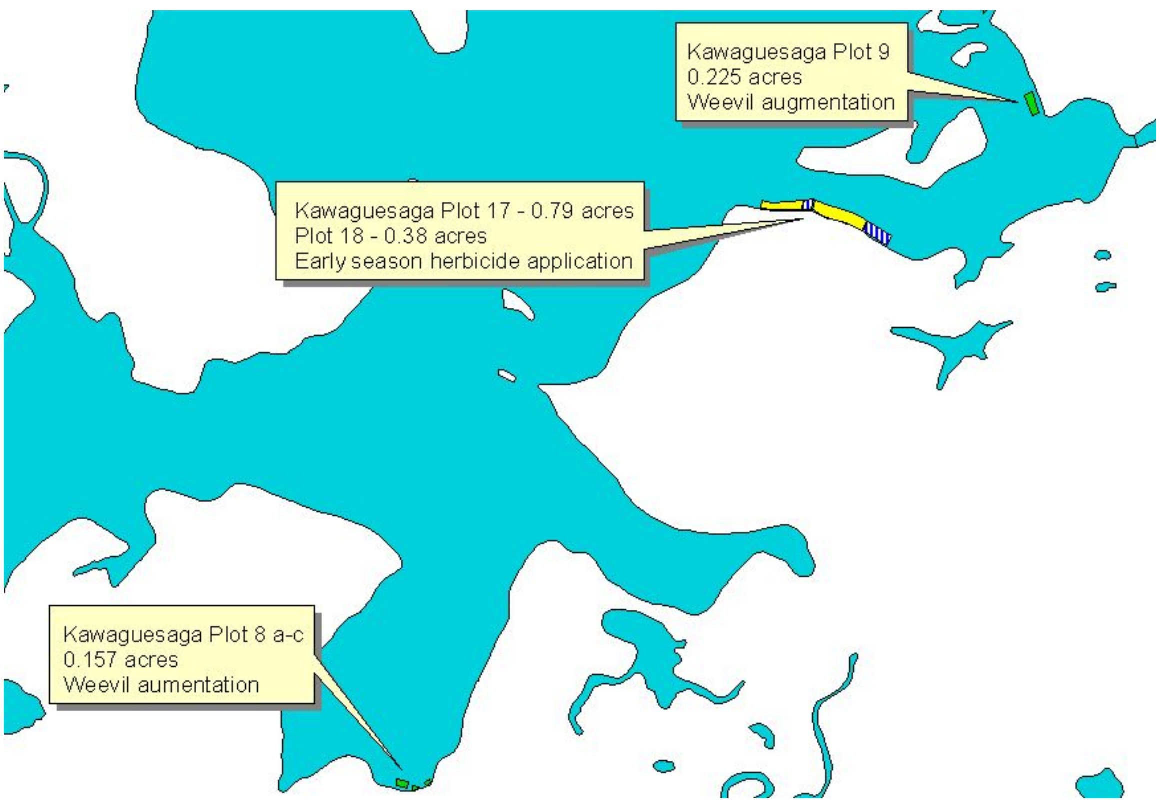


***Figure 60: Map of EWM plot 8, 17, 18 and 9-Kawaguesaga Lake***

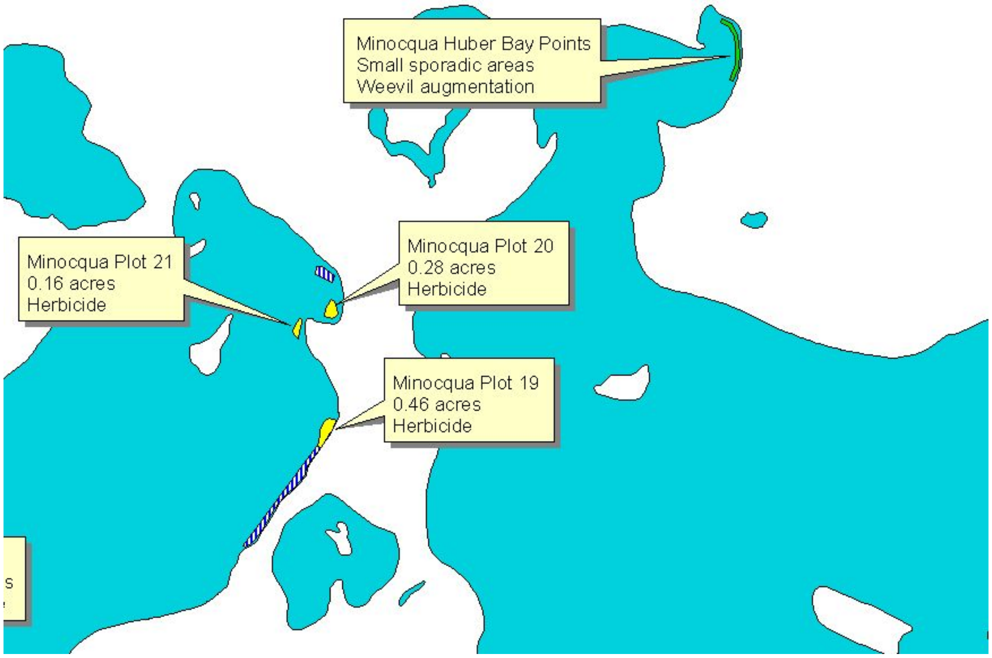


***Figure 61: EWM plots with treatment type 10-21.***

***Table 15: Summary of EWM beds for treatment.***

| Plot | Acres | Description |
|---|---|---|
| 1 | 1.64 | Two part plot by dam on Kawaguesaga |
| 2 | 0.17 | South of dam near double island |
| 3 | 0.27 | Just under and west of Hwy 51 bridge |
| 4 | 0.91 | Long bed along west shoreline in southern Minocqua |
| 5 | 0.16 | Just east of Hwy 51 bridge on south shore |
| 6 | 1.15 | South shore across from Kennedy landing |
| 7 | | Combined with plot 6 |
| 8 | 0.157 | Three small plots (labeled a,b,c) in southern most bay on Kawaguesaga (not professionally verified) |
| 9 | 0.225 | Plot on east shore of Kawaguesaga in front of white boathouse |
| 10 | 4.64 | Kennedy Bay (landing) all along east shore |
| 11 | 0.05 | Small plot near Kawaguesaga dam |
| 12 | 0.18 | Plot in bay by dam |
| 13 | 0.26 | Plot in bay by dam |
| 14 | 0.83 | Plot in bay by dam |
| 15 | 0.22 | Plot in bay by dam |
| 16 | 0.85 | Near plot 2 (to west) north of island |
| 17 | 0.79 | Narrow portion of south shore on Kawaguesaga |
| 18 | 0.38 | Just west of plot 17. Plot 17 gets sporadic with NWM so not recommending treatment between these two. |
| 19 | 0.46 | Plot on east shore along Hwy 51 |
| 20 | 0.28 | In bay just on north end of Minocqua near hwy 51 |
| 21 | 0.16 | Small plot off of point just south of plot 20 |
| 22 | 0.217 | Plot in School House Bay that is sporadic and recommended for SCUBA |
| 23 | 0.154 | Plot south of Plot 4 in southern Minocqua Lake |
| 24 | 0.775 | Plot in front of Slades Resort. Quite sporadic and less than treatment threshold. |
| Huber Bay | toosmall | Several small clumps of plants located by volunteers. All clumps density of 1 except on had a 3. Not professionally verified. |

**Table 15 Cont.**

| | Total acres | |
|---|---|---|
| Summary | 12.534 | **Herbicide treatment NOTE 1: NO TREATMENT AREAS ARE CONTAINED IN ANY DESIGNATED SENSITIVE AREAS** |
| | 2.177 | **Potential weevil treatment recommendation** |
| | 0.217+ | **SCUBA recommendation** (most SCUBA areas are sporadic and are mapped as plots) |
| | | **NOTE 2: OTHER SPORADIC REGIONS THAT ARE DISCOVERED MAY BE ADDED TO THE SCUBA REMOVAL LIST NEEDED AND IF TIME/FINANCES ALLOW FOR MORE REMOVAL.** |

A pretreatment and post-treatment survey regimen has been and will continue be implemented following the protocol established by the Wisconsin DNR (protocol included in appendix ). In early spring prior to treatment, the plots will be evaluated, verifying the presence of the target species EWM. In late summer/early fall, the treatment plots will be surveyed, recording presence, density and coverage of the EWM as well as the presence and density of other native plant species. Each year these results will be statistically analyzed to evaluate the treatment effectiveness.

**Treatment Goal:**

The goal for gauging treatment success is for a reduction in coverage by 90% and a mean density of less than "1" in each treatment plot over a five-year period.

The treatment goal established is aggressive and is as stated, a "goal". If this goal should be attained, treatment can then be scaled back or even eliminated. If after several treatments this goal is not attained, a reassessment of this goal may need to occur. This goal is by no means tied to any DNR AIS grant commitments.

None of the proposed treatment areas fall within any sensitive areas in Minocqua Lake. Lake Kawaguesaga has not had a sensitive area assessment completed at this time. In the future, EWM may spread and lead to a need for consideration of treatment within a designated sensitive area. If that should occur, the situation will be evaluated at that time, with assistance from the Wisconsin DNR, with special consideration for maintaining the integrity of those areas. Site 11 in the sensitive area survey is designated as the most important area for Muskellunge spawning. Because Muskellunge spawn at water temperatures the same as desired herbicide application, it is very important to avoid herbicide application and drift at Site 11 (see sensitive area map in the habitat section).

In addition to treating the designated plots, it is recommended that developed shoreline areas around plots 1 (the whole bay),3,5,6 and 7 be prioritized as areas for restoration. Since EWM grows especially well in high nutrient sediments, shoreline restoration may reduce sedimentation and nutrient loading in highly developed areas. This restoration may allow the treatment to be more effective through long-term nutrient and sediment reduction.

**Plan Action Item-3:**

For EWM treatment plots with highly developed shorelines, shoreline restoration will be encouraged. Potential funding from AIS grants will be explored and with the securing of AIS funds, restoration of these areas will take place. The goal is a minimum of 3 restorations in 2009 and 2 restorations each of the next 4 years after 2009.

The spread of EWM in these waters is a very large concern. There are many sporadic coverage areas of EWM. It is unknown if these colonies are sporadic because they are newly established or because the natives may be competing with the invasives. As a result, there are a number of strategies that will be implemented in order to reduce the spread of the EWM and/or have the sporadic colonies become denser.

**Plan Action Item-4:**

The Minocqua/Kawaguesaga Lakes Protection Association will sponsor training for the identification of EWM and monitoring methods. A volunteer monitoring team will be established and implement periodic monitoring of the lakes for EWM. This will entail determining areas not presently identified as having EWM and changes in coverage and density of present EWM colonies. The training will be occur on an annual basis to maintain an adequate pool of monitors. All data will be submitted to a professional capable of mapping EWM beds in GIS

**Plan Action Item-5:**

In the sporadic coverage areas, hand pulling with divers will be implemented in a few different areas that are determined to be acceptable for hand pulling. These areas will be evaluated each year as to the effectiveness of the hand pulling. Training will need to occur if the divers are not experienced in harvesting EWM.

When handpulling with SCUBA the following criteria must be met:

1. All divers will be trained in identification of EWM and the proper method of removal.
2. No divers will dive alone.
3. All removed plants will be packaged and disposed of far from the lake watershed. Reduction of fragmentation is paramount.
4. Enough volunteers will be recruited with watercraft during removal to completely surround dive team and removal area and collect fragments as they surface.

Another potential management method for EWM is the use of the native weevil *Euhrychiopsis lecontei*. Weevils feed on milfoils, weakening the plant and ultimately leading to the plant's death. Weevils can potentially reduce the coverage of milfoil. Their effectiveness as a bio-control method is varied. In some research it was found to greatly reduce EWM. In other instances the effectiveness was minimal. It has also been found that in many Wisconsin lakes, this weevil already exists.

In the summer of 2008, a consultant with expertise in weevil augmentation conducted a survey of Minocqua and Kawaguesaga Lakes for the presence of the weevil. It was found in both lakes in EWM beds. As a result, the consulting firm suggested weevil augmentation in all EWM beds. Effectiveness of this bio-control has varied in lakes. Therefore it is recommended that weevil augmentation occur, but in limited sites that are chosen based upon success with augmentation. One important component is having an adequate shoreline shrub layer and leaf litter for the weevils to over-winter as well has reduced boat traffic.

Note: A permit is required to stock *Euhrychiopsis lecontei* into a lake.

**Plan Action Item-6:**

Weevil augmentation will take place in specifically chosen beds of EWM. These beds will be marked and public education at landings in the form of posted literature and announcements. Landowners will be contacted and encouraged to begin a shoreline restoration project if shoreline habitat for the weevil is limited.

When weevil augmentation occurs, the plots chosen are based upon DNR recommendations along with other aquatic plant/lake management professionals (see map showing sites). These beds are isolated from herbicide treatment sites and will be marked to keep boat traffic to a minimum. In addition, these beds will be monitored the same as the other EWM sites, following the pre and post treatment monitoring protocol. The augmentation will be performed by a entity the is an expert in using weevils for EWM control.

## Goal 2: Preserve the native plant community in Kawaguesaga Lake and Minocqua Lake.

Kawaguesaga Lake and Minocqua Lake have amazing native plant diversity. This diversity is very important toward maintaining a healthy lake ecosystem. The Minocqua/Kawaguesaga Lake Protection Association recognizes the importance of preserving this native community. To help facilitate this protection the Association will implement the following:

- Extensive public education about the importance of the plant community to the lakes.
- Encourage riparian owners to protect native plant beds in front of their property.

- Monitor invasive species spread into native plant communities.
- Conduct management practices for invasive species that target those species with minimal impact on native species.
- Preserve floating leaf and emergent plant areas. These areas are few in number and high in importance.

It is recommended that a habitat assessment (similar to the sensitive area survey conducted on Minocqua Lake) be conducted on Kawaguesaga Lake. These assessments will help designate the most important habitats in the lake and help raise awareness for their protection.


***Figure 62: Map of floating-leaf and emergent plant areas in Kawaguesaga Lake.***

Figure 62 shows the areas of Kawaguesaga Lake that have floating leaf plants and where emergent plants were sampled. These areas provide important fish, wildlife and bird habitat. Every effort should be used preserve these important areas. These efforts could include educating residents and lake users about their importance and the need for preservation and to avoid herbicide applications in or near these areas. Although a sensitive area survey has not been conducted, the areas highlighted in Figure 62 would be a good start for sensitive area designation.


***Figure 63: Map of floating-leaf and emergent plant areas in Minocqua Lake.***

Figure 63 maps the floating/emergent vegetation beds in Minocqua Lake. These areas should be preserved in any management strategies.

The degree of shoreline destruction from development is unknown. As a result, the Minocqua/Kawaguesaga Lake Protection Association will conduct a shoreline assessment. This assessment will evaluate and quantify the amount of shoreline that is developed and is no longer natural. The protocol and data collection spreadsheet is contained Appendix H of this plan.

## Goal 3: Prevent the introduction of new invasive species and develop a rapid response plan if such an introduction should occur.

Although a few different invasive species are present in Minocqua and Kawaguesaga Lakes, introduction of more invasive species (such as Hydrilla) could be detrimental to the ecosystem. For this reason, a response protocol will be followed, should an introduction occur. In addition, a Clean Boats/Clean Waters program will be implemented to some extent. The degree of involvement will be evaluated based on volunteer interest and funding. At the very least, willing volunteers will become trained in Clean Boats/Clean Waters and a future monitoring program at landings will be evaluated. The landings will be checked for proper information and fishing tournaments will be a focus for public education. It is recommended that either the Mincoqua/Kawaguesaga Lakes Protection

Association or the Town of Minocqua hire an AIS coordinator to oversee all monitoring and educational activities.

**Plan Action Item-7:**
The Minocqua-Kawaguesaga Lakes Protection Association will encourage willing volunteers to become trained in the Clean Boats/Clean Waters program. Education will be implemented at the landings, with fishing tournaments and other high use dates being targeted. Boat landing monitoring will be evaluated, with potential future implementation.

**Plan Action Item-8:**

The rapid response action plan will consist of the following steps:

1. Potential invasive plant sample should be collected and bagged.
2. Mark location with GPS.
3. Notify DNR aquatic plant management specialists for positive identification and vouchering of specimen.
4. Make arrangements with plant (management) professional to evaluate extensiveness of coverage. If extensive enough, removal may be necessary.
5. A rapid response grant may be appropriate at this time. The rapid response protocol developed by the Wisconsin DNR will be followed if this is pursued.

## Goal 4: Monitor other existing aquatic invasive species such as purple loosestrife, curly leaf pondweed, flowering rush, and rusty crayfish.

Presently, Kawaguesaga Lake and Minocqua Lake, as well as the Thoroughfares, have other aquatic invasive species. In the 2007 plant survey, curly leaf pondweed, flowering rush, and purple loosestrife were sampled and/or observed in addition to the Eurasian water milfoil. EWM is the major concern at this point. However, the presence of these other species is a cause for concern. Monitoring these species is paramount to determine if they are spreading. If this spreading should occur, management may become necessary.

**Curly leaf pondweed**
Curly leaf pondweed (CLP) is a common invasive species in Wisconsin Lakes. The coverage of CLP in Kawaguesaga and Minocqua Lakes is quite extensive in some areas. The concern over the impact of CLP is mixed and therefore its management is not clear, unless it reaches nuisance levels. This level of growth has not been documented. As a result, a CLP mapping

survey will be conducted in June 2009. This will map the beds and the densities of the CLP in all areas of the lakes. Once this data is processed, a timeline of potential management will be established.

**Plan Action Item-9:**

A consultant will conduct a more detailed survey of CLP that will allow mapping of all CLP beds. These maps will include mean densities of each bed.

**Purple loosestrife**

In the Minocqua Thoroughfare, the macrophyte survey revealed the most extensive growth of purple loosestrife on the lakes. Purple loosestrife can take over wetland areas and choke out native vegetation. This may be of concern for the Minocqua Thoroughfare area. As a result, a more specific survey needs to be conducted to evaluate the degree of growth and if there is substantial cause for concern. If this plant has sporadic coverage, the plants will be hand pulled prior to flowering and disposed of in a compost or waste receptacle. If the purple loosestrife is determined to be spreading and taking over the area, chemical treatment and use of biological control (*Gallerucella* beetles) will be considered.

Other areas will be monitored for purple loosestrife to determine if it is spreading. It is recommended that individual plants be carefully hand-pulled prior to flowering (July).

**Flowering rush**

Flowering rush locations seem relatively sparse with the exception of an area in Minocqua Lake on the northern most island (Figure 22 ). In the sensitive area survey, this bed of flowering rush is mentioned as an area of concern and management is recommended. Flowering rush can spread and choke out native species (see appendix for flowering rush information). This bed of flowering rush may be hand pulled if not too large. The actual size and density needs to be evaluated to determine if hand pulling is possible. If coverage is too extensive and management is deemed necessary, other options will be considered and implemented.

**Plan Action Item-10:**

A volunteer monitoring team will be formed and trained for the identification of all invasive species in these lakes. The team will monitor for any changes in coverage and density of invasive species. They will also monitor for any new invasive species.

**Monitoring protocol**

When monitoring occurs, the following steps should be taken to adequately monitor invasive species of concern. The main emphasis in the monitoring program the first two years will be for Eurasian water milfoil.

1. Locate present, recorded sites by GPS coordinates July or later.
2. Observe for presence and coverage (single plant, clumps, or bed) of the invasive species.
3. Survey the vicinity of these points for other potential sites. If located, record Lat/Long -GPS coordinates.
4. Survey areas where Northern water milfoil is present and look for EWM embedded amongst native milfoil when milfoil is robust in August (see appendix for points).
5. Survey the littoral zone with in 300 feet of all boat landings each month June through September.
6. If time allows, survey areas of littoral zone that are suitable habitat for EWM. This would include areas with muck/high nutrient sediments up to 15 feet (see appendix for locations of sediment types).

## Goal 5: Restore native shoreline vegetation.

The future projections for phosphorus loading into Kawaguesaga Lake and Minocqua Lake are high. As a result, shoreline restoration on developed shorelines is important. The native shoreline will reduce sediment and phosphorus loads, which would otherwise increase nutrients in lake sediment, in which EWM flourishes. Also, excess nutrients could be available for excess algae growth, which would reduce the water clarity associated with these lakes at this time.

Oneida County has a shoreline restoration cost share program. The existence of this program needs to be communicated to the residents of both lakes. In addition, funds may be applied for in the AIS grant program to restore highly developed shorelines adjacent to EWM treatment plots.

**Plan Action Item-11:**

The Minocqua-Kawaguesaga Lakes Protection Association will work with Oneida County to help enhance utilization of the cost share program for shoreline restoration. The Association will also include education such as newsletter articles and discussion at meetings about the importance of native shoreline restoration.

## Goal 6: Preserve and/or enhance water quality.

The water quality of Minocqua and Kawaguesaga Lakes is good. In order to keep these lakes at a level of high quality, a number of activities will need to be implemented. A management plan for preserving water quality, including strategies has been developed. It is important to implement these strategies.

Minocqua Lake volunteers have been part of an expanded citizen lake monitoring program for many years. This has also been done in Kawaguesaga, but for fewer years. Continued monitoring is very important to evaluate any changes that may occur in water quality. Total phosphorus, secchi depth and chlorophyll-*a* readings should continue to be tested at least during the growing season. A qualified water quality specialist should conduct review of this data.

Predicted nutrient loading for these lakes indicates an increase, largely due to urban influences. The future water quality of Minocqua and Kawaguesaga Lakes will most likely be determined in large part by urban runoff. For this reason, the Town of Minocqua should work with the Minocqua-Kawaguesaga Lakes Protection Association and the Wisconsin DNR to help implement practices to reduce urban runoff.

The preservation of water quality is an issue too large to be encompassed by this plan. However, from a plant management perspective, water quality can be preserved and/or enhanced in the following ways:

- Preserve all native plant communities in Kawaguesaga and Minocqua Lakes to help absorb excess nutrients and compete against invasive species.

- Preserve natural shoreline areas and restore developed shorelines to native vegetation. These shoreline areas will be identified in a shoreline assessment.

- Maintain and protect all floating leaf and emergent plant beds (that are not deemed nuisance or limiting navigation) to reduce wave energy and erosion. These areas are located in numerous areas and maps of such species can be located in the appendix.

- Manage the plant community carefully so as to not adversely affect native plants. Using methods that target only invasive plants with little harm to natives can do this. This would include early season treatment with herbicides and hand pulling of invasive species.

- Encourage retaining native plant beds in front of riparian owners' properties. Education components in newletters and lectures at the annual meeting will can be utilized to help people understand removal of these plants is not recommended.

## Goal 7: Provide extensive education on lake ecology.

One of the plant committee's concerns is the lack of understanding about lake ecology by people living on or using Kawaguesaga and Minocqua Lakes. To address this concern, the Minocqua/Kawaguesaga Lake Protection Association is committed to providing education for the lake residents and users.

Each year the Association publishes three newsletters. Each of these newsletters will be a great opportunity to provide lake ecology information. Furthermore, the local newspaper, the Lakeland Times, has been historically committed to lake issues. The Association will try to facilitate the publication of information about lake ecosystems ranging from water quality preservation to the importance of aquatic plants and other pertinent topics.

**Plan Action Item-12:**

The Minocqua/Kawaguesaga Lake Protection Association will facilitate lake ecology education through various avenues. These will include newsletters, newspaper articles, and public meetings. Partnerships with local schools and other organizations will be developed for public education purposes. More details are listed in the implementation timeline.

Late in the development of this plan, a concern was presented over the potential nuisance level growth of plants in the Minocqua Thoroughfare. The concern is over the reduction of navigation with boats in that area. It is mentioned in the 2007 macrophyte survey that this area is very thick with plant growth. The concern over navigation maybe warranted and should be investigated. If this area of the lake is determined to impede navigation on a consistent basis, potential management will be evaluated. Establishing a navigational channel would be the must probable management scheme, using chemical herbicides or a mechanical harvester. Should the need for management should occur, the pros and cons of the two options will be reviewed.

The Minocqua/Kawaguesaga Lakes Protection Association should work with aquatic plant experts and the Wisconsin DNR to evaluate this area of the lake to determine how much navigation is being affected and a plan for management. If it is decided management is necessary, an addendum to this plan would need to occur.

## Herbicide Environmental Concerns

2,4-D has some environmental concerns associated with its use. The following list contains some considerations when applying this herbicide (label should be followed by applicator and used for public notification prior to application)[23].

- This chemical is toxic to fish and aquatic invertebrates.
- Can become a groundwater contaminant if allowed to enter groundwater table.
- Potable water sources that are treated should be shut off prior to treatment.
- Wait 21 days before using as drinking water and concentration is less than 70ppb.
- Should not swim in treated water for 24 hours after application.

The retention of 2,4-D in the water column is of interest for a couple of reasons. One is the concentration of 2,4-D must be above a particular threshold to be effective. If that concentration is not retained for a long enough period of time, the plants will not be adequately affected by the treatment. Second is the length of time the 2,4-D remains at the treatment site and how those concentrations change.

[23] Information provided by Frank Koshere, Wisconsin DNR. March, 2008.

In order to determine these levels, an assay measuring the 2,4-D concentrations over time can be conducted. This allows these concentration changes to be evaluated and determine the residual 2,4-D that remains as well as the length of time the 2,4-D remains in the treated area.

The Wisconsin DNR is presently working on conducting 2,4-D assays on a few lakes in the area. The protocol of this testing program is being developed. Once this protocol is available, it would be followed for Kawaguesaga and Minocqua Lakes.

**Plan Action Item-13:**

The Mincoqua/Kawaguesaga Lakes Protection Association will work with the Wisconsin DNR and conduct a 2,4-D assay in and around the EWM treatment areas. This testing will begin in 2009 and follow the Wisconsin DNR protocol provided (has not been made available to include in this plan). Concentration profiles will be conducted at DNR designated locations.

**Plan Action Item-14:**

The Minocqua/Kawaguesaga Lake Protection Association along with a consultant and the Wisconsin DNR will evaluate this Aquatic Plant Management Plan. Goals and Plan Action Items will be evaluated for progress and success. An updated plan will potentially provide new goals and Action Items based upon new data and information collected.

This evaluation will include a new whole lake point-intercept macrophyte survey in 2012.

Minocqua/Kawaguesaga Lake Protection Association as well has AIS grant funds from the Wisconsin DNR (through a competitive application process).

***Table 16: Implementation timeline/responsible parties***

| Plan Action Item | Time | Responsible entity |
|---|---|---|
| Chemical treatment of qualifying EWM beds (initial survey completed) | Begin May 2008 and subsequent years as needed | Minocqua-Kawaguesaga Association/Wisconsin DNR |
| Train volunteers- monitoring | May/June 2008 Annual updates | Consultant/Lake Association |
| Pre/Post Monitoring of EWM beds | May and Sept 2008 and any year treatment occurs | Consultant |
| Monitor EWM/other invasives | June-Sept. 2008 and beyond | Volunteers |
| Map all CLP beds | June 2009 | Consultant |
| Hand-pull sporadic EWM stands. | July/August 2009 and each year based on success | Volunteer divers/possible consultant or hired divers |
| Monitor milfoil (EWM and native) for weevil presence | Summer 2008 and subsequent years | Consultant/Volunteer |
| Augment weevil for EWM control if determined beneficial | Summer 2009 and later if needed | Consultant |
| Implement Clean Boats/Clean Waters Program | Summer 2008 | Lake Protection Association/Volunteers |
| 2,4-D assay of EWM treatment areas | Summer 2009 | Lake Protection Association and the Wisconsin DNR |
| Shoreline restoration at EWM treatment sites/other residents | Summer 2009 | Lake Association/Oneida County (cost share)/Wisconsin DNR (through AIS grants) |
| Continue Expanded Self Help Monitoring | Summer 2008 and beyond | Lake Association Volunteers/Wisconsin DNR |
| Lake Ecology Education **(see chart that follows with more specifics)** | Spring 2008 and each year after | Lake Association/Consultants/Oneida County Professionals/Wisconsin DNR |
| Rapid Response to Invasive Species | Spring 2008 as needed | Monitoring volunteers/Consultants/Oneida County AIS Coordinator/Wisconsin DNR |
| Plan evaluation and whole lake survey | Summer 2012 | Consultant/Lake Association/Wisconsin DNR |

***Table 17: Education implementation plan***

| **Restoration** | | | |
|---|---|---|---|
| | Program | Time | Responsible Entity |
| MKLPA Education Restoration Area For Local Lake Property Owners | Modify and update demonstration area on Lake Minocqua | May 2009 | MKLPA Restoration Team |
| Stewardship Information | Monitor sensitive shoreline areas | Throughout the year | MKLPA Monitoring Team |
| | Inform owners of "no mow" regulation | On-going | DNR UW-Extension |
| | Share *Shoreline Owner's Guide* | On-going | |
| Land Conservation | Cost sharing for Restoration Program | To be determined by Oneida County and private owners | Oneida County Land and Water Conservation |

| **Education** | | | |
|---|---|---|---|
| | Program | Time | Responsible Entity |
| Lakeland Union High School | *Clean Boats/Clean Waters* presentation for Biology and Environmental Ed classes. Possible volunteer pool | Spring 2009 | MKLPA AIS Coordinator Oneida County LUHS Science staff |
| | | | |
| Minocqua – Woodruff Community | MKLPA Newsletter *Lakeviews* to businesses and riparian owners | 3 times a year | MKLPA Newsletter Team |
| | <u>Lakeland Times</u> *Lakeviews* column concerning lake information and issues | Summer 2009 Weekly | MKLPA |
| | *Welcome to the Lake* information packet to new lake property | On-going | MKLPA |

| | | | |
|---|---|---|---|
| **Education cont.** | owners<br>AIS information packets at local lodgings | April-November 2009 | MKLPA<br>AIS Coordinator<br>Oneida County |
| | Lake Association Annual Meeting update educational program | June 2009 | MKLPA<br>Guest speaker |
| | Boat landing AIS Inspection | May-Sept 2009 | MKLPA<br>Town of Minocqua |
| | Annual Pig Roast and Information Fair | Fall 2009 | MKLPA<br>DNR |

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