Aquatic Plant Management Plan
Cranberry Lake / Flowage
Douglas County, Wisconsin

2012

Prepared by Cranberry Lake / Flowage Association with assistance from Ecological Integrity Service, LLC

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Introduction

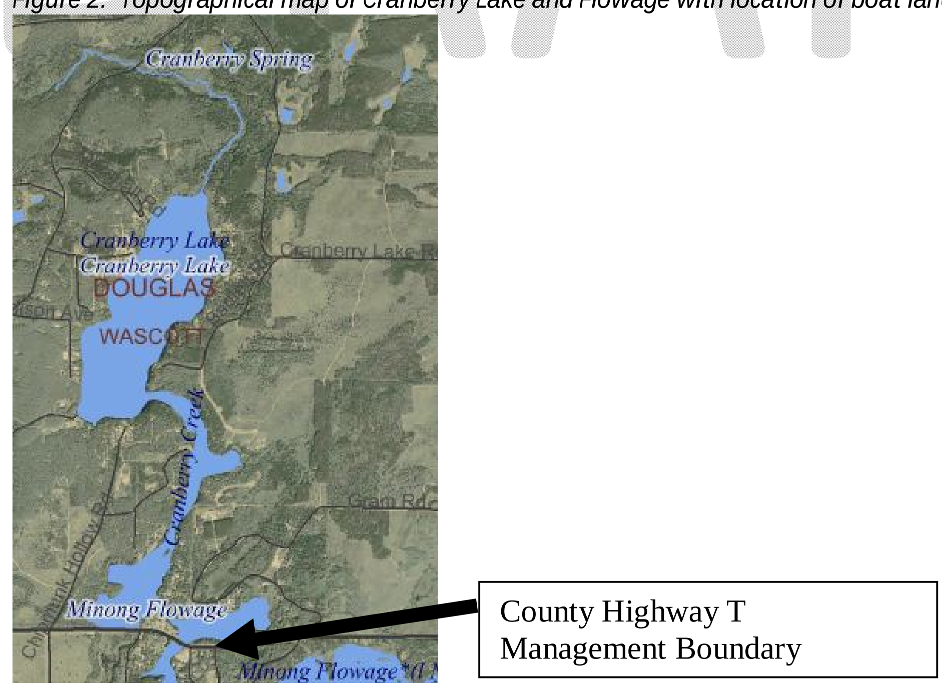
This aquatic plant management plan is developed for Cranberry Lake/Flowage for the management of aquatic plants. Eurasian water milfoil was discovered in Cranberry Lake in 2007. Since then, herbicide treatments and hand-pulling have been implemented to reduce the spread of this invasive plant. The development of this plan has been on-going during this time. It will provide for an established plan that can be utilized in the future management of EWM, reduce the introduction of future AIS, and provide a plan should new AIS be introduced.

This plan will be effective from 2012 until 2017, at which time it should be reevaluated and/or adjusted to reflect those aspects that have been effective and change those that have not been effective.

Public Input

In June, 2007, it was determined that the Cranberry Lake Association would be separate from the Minong Flowage for management purposes. An agreement was approved by both the Cranberry Lake/Flowage Association and the Minong Flowage Association to use County Highway T as the defined boundary for management and designation of the Cranberry Lake/Flowage Association. All waters north of this location would be managed by the Cranberry Lake/Flowage Association and all waters south by the Minong Flowage Association.

Figure 2: Topographical map of Cranberry Lake and Flowage with location of boat landing.



An Aquatic Plant Management Plan committee was formed and met in October, 2008 to review the aquatic plant community based upon the aquatic plant survey results. Aquatic plant management plan basics were then discussed. In April, 2009 the committee met to develop goals for management purposes. Subsequent meetings were used to develop objectives as well as ongoing EWM management options. Association annual meetings have been used, as well was written communication to members to communicate the status of the Plan and EWM issues.

In December 2012, this plan (will be) was made available for public review for the purpose of public input.

No public survey has been completed to date but is recommended.

Management concerns

In meetings with the plant committee and annual meeting comments, the major management concern is the EWM. Since Cranberry Lake is a small, shallow lake with many areas conducive to EWM growth habitat, there is major concern of the this AIS plant overtaking the plant community in Cranberry Lake, adversely affecting the fisheries, recreation use and lake aesthetics. It is also a high concern of how long and effective reduction can be maintained with the travel of boats between Cranberry Lake and the Minong Flowage. Furthermore, the financial burden of managing EWM is of high concern.

The Cranberry Lake/Flowage Association also understands the importance of native aquatic plants. They are concerned over maintaining a highly diverse, healthy native plant community.

The following management goals were established reflecting these concerns:

1. *Protect native plant community and fish habitat.*
2. *Reduce EWM coverage and limit the spread.*
3. *Prevent introduction of other invasive species.*
4. *Maintain and enhance native shoreline community.*
5. *Educate citizens about importance of aquatic plants and lake ecology.*
6. *Investigate and then establish funding mechanisms.*

Functions and Values of Native Aquatic Plants

Naturally occurring native plants are extremely beneficial to the lake. They provide a diversity of habitats, help maintain water quality, sustain fish populations, and support common lakeshore wildlife such as loons and frogs.

Water Quality/Watershed

Aquatic plants can improve water quality by absorbing phosphorus, nitrogen, and other nutrients from the water that could otherwise fuel nuisance algal growth. Some plants can even filter and break down pollutants. Plant roots and underground stems help to prevent re-suspension of sediments from the lake bottom. Stands of emergent plants (whose stems protrude above the water surface) and floating plants help to blunt wave action and prevent erosion of the shoreline. Poor water clarity can limit aquatic plant growth by limited light penetration.

Shallow lakes typically have two alternative stable states—phytoplankton (algae)-dominated or macrophyte (plant)-dominated (Newton and Jarrell, 1999). In moderate densities, macrophytes are beneficial in these lakes. Macrophytes keep sediment from being resuspended by the wind and, therefore, help keep the water less turbid. Macrophytes also provide a place for attached algae to grow and remove phosphorus from the water column. If the macrophytes are removed or if external phosphorus inputs increase, the lake can shift from a macrophyte-dominated state to an algal-dominated state. Once a lake is in the algal-dominated state, macrophytes have a difficult time re-establishing themselves because algae reduce the penetration of light. Of these two conditions, it is commonly believed that the macrophyte-dominated state, which is present in Cranberry Lake (although moderate in amount), is more desirable for human and biological use than the algal-dominated state (Newton and Jarrell, 1999).

Cranberry Lake is contained is the Totagatic watershed as it flows into the Minong Flowage. Only a small portion of this watershed flows into Cranberry Lake as it is at the northern region of this southern flowing watershed. There is one tributary that feeds Cranberry Lake, known as Cranberry Springs. As the name implies, this tributary originates from a series of springs found in a wetland area just to the north and west of the lake. The main landuse around Cranberry Lake is wooded and wetland. Depending on the nutrients that naturally occur in Cranberry Springs, the most likely human activity that leads to nutrient loading is development on the lake.

The flowage portion of Cranberry Lake occurs between Cranberry Lake and the Minong Flowage. Its water arrives from a net flow from Cranberry Lake and the surrounding watershed. The surrounding watershed is largely forested with limited development. As a result, the nutrient loading is most likely due to natural occurrences.

Cranberry Lake nutrient loading has never been analyzed historically. It is probable that the majority of the nutrients come from Cranberry Springs and the residential development immediately on the lake. Since nearly the entire immediate water shed is forested and wetlands, this loading mostly likely is not large in mass of phosphorus or nitrogen. The total phosphorus measurements support this speculation.

There are approximately XX permanent structures on Cranberry Lake/Flowage. Most of these are part-time residents. The age of septic systems and their sizes is unknown. There is one large campground on the northwest end of Cranberry Lake and another large campground between Cranberry Lake and Crystal Lake, which may be in the Cranberry Lake watershed. It is understood that both campgrounds have private septic systems that are designed to accommodate the requirement by law.

Fishing
Habitat created by aquatic plants provides food and shelter for both young and adult fish. Invertebrates living on or beneath plants are a primary food source for many species of fish. Other fish, such as bluegills, graze directly on the plants themselves. Plant beds in shallow water provide important spawning habitat for many fish species.

Waterfowl
Plants offer food, shelter, and nesting material for waterfowl. Birds eat both the invertebrates that live on plants and the plants themselves.[1]

Protection against Invasive Species
Non-native invasive aquatic species threaten native plants in Northern Wisconsin. The most common are Eurasian water milfoil (EWM) and curly leaf pondweed (CLP). These species are described as opportunistic invaders. This means that they take over openings in the lake bottom where native plants have been removed. Without competition from other plants, these invasive species may successfully become established and spread in the lake. This concept of opportunistic invasion can also be observed on land, in areas where bare soil is quickly taken over by weeds.

Removal of native vegetation not only diminishes the natural qualities of a lake, but it increases the risk of non-native species invasion and establishment. The presence of invasive species can change many of the natural features of a lake and often leads to expensive annual control plans. Allowing native plants to grow may not guarantee protection against invasive plants, but it can discourage their establishment. Native plants may cause localized concerns to some users, but as a natural feature of lakes, they generally do not cause harm.[2]

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[1] Above paragraphs summarized from *Through the Looking Glass*. Borman et al. 1997.
[2] *Aquatic Plant Management Strategy. DNR Northern Region.* Summer 2007.

Lake Information

Fisheries

Cranberry Lake is listed to contain panfish (which include bluegill, pumpkin seed and black crappie), largemouth bass, northern pike and walleye. All of these fish are quite common in the lake with the exception of walleye.
In plant management, it is important to consider fisheries as they relay heavily on plants for recruitment and rearing of young fish, as well as feeding areas. The following table outlines spawning needs for the fish in the lake so that it may be considered if an early spring herbicide treatment (or some other management tool) is utilized.

Table 1: Summary of game fish species spawning behavior (those present in Cranberry Lake/Flowage).

Fish Species	**Spawning Temp. (Degrees F)**	**Spawning Substrate / Location**	**Comments**
Northern Pike	Upper 30s – mid 40s (right after ice-out)	Emergent vegetation 6-10 inches of water	Eggs are broadcast
Walleye	Low to upper 40s – (about one week after ice-out)	Rocky shorelines with rubble/gravel 0.5 – 3 feet of water	Eggs are broadcast
Black Crappie	Upper 50s to lower 60s	Nests are built in 1-6 feet of water.	Nest builders
Largemouth Bass Bluegills	Mid 60s to lower 70s	Nests are built in water less than 3 feet deep.	Nest builders

In a 2002 fish survey conducted by the Wisconsin DNR (using electrofishing and fyke nets) and produced the following results[3]:

Table 2: Fish survey results, 2002.

Summary of Combined Gamefish and Panfish Totals Collected during 2002 Spring Electrofishing Events on April 24th and May 30th.					
Species	**# Caught**	**Mean Size (In.)**	**Size Range (In.)**	**# ≥14 inches**	**# ≥ 18 inches**
Walleye	13	17.6	14.4 – 21.6	13	5
Largemouth Bass	88	12.1	5.2 – 18.7	26	4
Smallmouth Bass	1	3.8	3.8	0	0
Species	**# Caught**	**Mean Size (In.)**	**Size Range (In.)**	**# ≥ 26 inches**	**# ≥ 34 inches**
Northern Pike	14	16.0	9.6 – 20.7	0	0
Species	**# Caught**	**Mean Size (In.)**	**Size Range (In.)**	**# ≥ 7 inches**	**# ≥ 10 inches**
Bluegill	797	5.1	1.2 – 8.5	26	0
Yellow Perch	61	2.6	2.2 – 5.2	0	0
Pumpkinseed	29	5.9	3.3 – 7.3	3	0
Black Crappie	22	7.4	3.7 – 10.1	10	1
Rock Bass	24	8.2	2.9 – 11.1	16	9

[3] Data provided by the Wisconsin DNR through Scott Toshner, Wisconsin DNR Fish Biologist, 2012.

In addition to the species listed in the table, the following species were also sampled in the survey: thirty-two spottail shiners, thirteen white suckers, twelve yellow bullheads, nine bluntnose minnows, eight central mudminnows, four bowfin (dogfish), three brook silversides, black bullheads, and golden shiners each, and one shorthead redhorse, common shiner, blacknose shiner, and native lamprey species each.

The results of the survey have led the Wisconsin DNR to manage the fisheries in Cranberry Lake for largemouth bass, panfish and northern pike. The following statement is taken directly from the survey summary:

Analyses of data collected from baseline monitoring surveys conducted in 2002 appear to warrant the continued approach of managing Cranberry Lake for largemouth bass, northern pike, and panfish species. Habitat types available are also more conducive for reproduction in these fish species, whereas walleye spawning areas are generally considered poor in Cranberry Lake. Good water quality and healthy macrophyte and macroinvertebrate communities provide quality living space, young-of-year habitat, and food items for fish, as well as other animals found within the Cranberry Lake ecosystem. Current daily bag limits for northern pike are five/day, with no minimum size limit; bag limits for bass species are five in total/day, with a minimum size of 14 inches; bag limits for walleye are five/day, with a minimum size of 15 inches; and bag limits for panfish is twenty-five in total, with no size restrictions.

It was also recommended in this analysis to protect vital habitat in and around the lake. These include but are not limited to: development of native shoreline buffers to reduce erosion, sedimentation and nutrient loading, leaving large woody debris in the lake as it provides important habitat, and take precaution with any future human development.

Since the native beds are considered moderate, it is important to maintain a healthy native plant community. Many goals put forth in this plan (found later in the management section) should reflect the needs of the Cranberry Lake fishery. This includes native plant preservation, careful control of AIS such as EWM, and reduction of nutrient loading and sedimentation through shoreline restoration.

Rare, Endangered, or Protected Species Habitat

Cranberry Lake/Flowage is located in the town of Wascott (T43N, R13W) in section 25. Natural Heritage Inventory records are provided to the public by town and range rather than section, so there is no indication if the incidences of these species occur in and immediately surrounding Cranberry Lake.[4]

Species listed in the Town of Wascott (T43N, R13W):

Alasmidonta marginata Elktoe SC/P Mussel
Canis lupus Gray Wolf SC Mammal
Cyclonaias tuberculata Purple Wartyback END Mussel
Emydoidea blandingii Blanding's Turtle THR Turtle
Etheostoma microperca Least Darter SC Fish
Haliaeetus leucocephalus Bald Eagle SC/P Bird
Littorella uniflora var.americana American Shoreweed SC Plant
Moxostoma valenciennesi Greater Redhorse THR Fish
Oeneis chryxus Chryxus Arctic SC Butterfly
Oporornis agilis Connecticut Warbler SC Bird

Note: SC=species of special concern; THR=threatened; END=endangered

The proposed actions within the plan are not anticipated to affect native plants and wildlife including the natural heritage species listed above.

Plant Community

In August 2007, 265 points were sampled (from a 300 point grid) for macrophytes on Cranberry Lake (see Figure 1). Of those 265 points, 157 had plants. This results in a plant coverage of 52% in the entire lake, and 90.8% in the littoral zone (Figure 2). The flowage portion of Cranberry Lake was surveyed as part of the Minong Flowage macrophyte survey as the boundary for management was not established at that time. Upon review of that survey, no significant results other than the presence of EWM were observed that would need to be used for management purposes (endangered, threatened or species of concern).

[4] Natural Heritage data for Wisconsin is found at http://dnr.wi.gov/org/land/er/nhi. (data current as of 11/04/11)

Figure 3: Map of sample point grid for Cranberry Lake

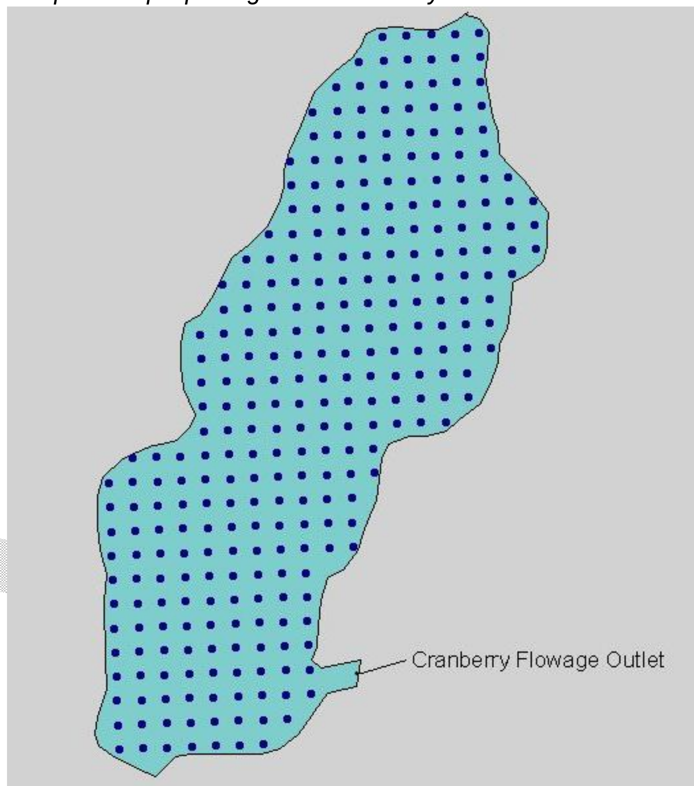
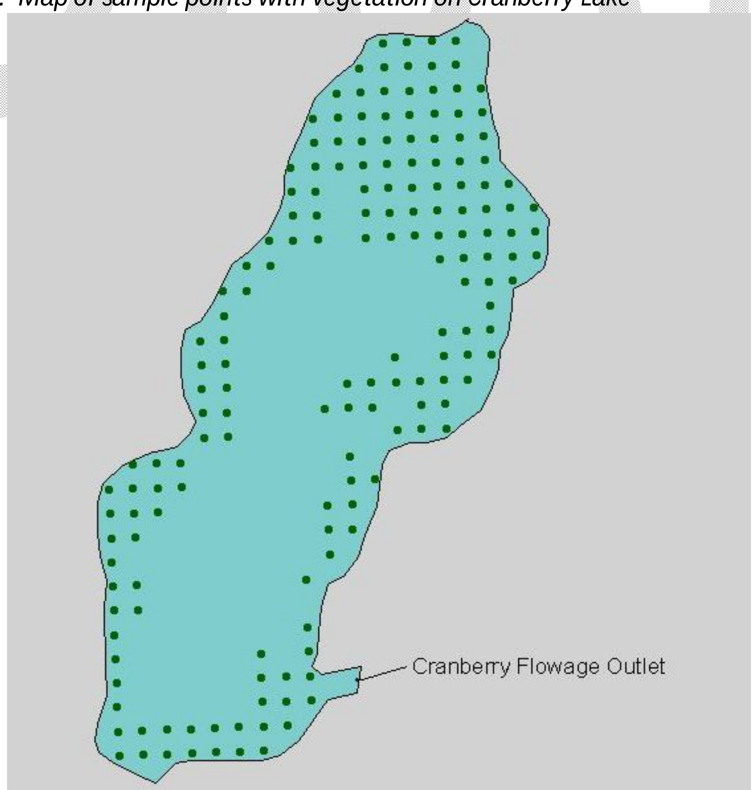


Figure 4: Map of sample points with vegetation on Cranberry Lake



The results of the 2007 macrophyte survey on Cranberry Lake indicate a very healthy and diverse plant community (see Table 1 to see statistical summary). Three species of algae were surveyed along with 34 species of vascular plants. Of these vascular plants, all but two were native. The two non-native species were Eurasian watermilfoil (*Myriophyllum spicatum*) and curly leaf pondweed (*Potamogeton crispus*). The Eurasian watermilfoil presence is a major concern. The coverage of curly leaf pondweed is of question since this survey took place in late August when curly leaf is generally not present since it dies off in July.

The large number of plants surveyed (37 including viewed species) and a Simpson's diversity index of 0.89 (highly probable two random plants are different) indicate a highly diverse plant community.

The maximum depth of plants is 16 feet, which demonstrates that water clarity is quite high throughout most of the growing season. The number of sites with vegetation was 157 out of the entire lake 300-point grid or 52% of the entire lake covered with plant growth. The number of points at 16 feet or less (maximum plant growth depth) was 173, and 157 of those points had plants (91%). This indicates that the plant coverage is high at depths plants can grow. Since there are very few if any rocky areas in the lake, the substrate is conducive for plant growth nearly everywhere.

Table 3: Survey statistics

SUMMARY STATS:	
Total number of points in grid	**300**
Total number of points sampled	**265**
Total number of sites with vegetation	**157**
Total number of sites shallower than maximum depth of plants	**173**
Frequency of occurrence at sites shallower than maximum depth of plants	**90.75**
Simpson Diversity Index	**0.89**
Maximum depth of plants (ft)	**16.00**
Average number of all species per site (shallower than max depth)	**3.08**
Average number of all species per site (veg. sites only)	**3.39**
Average number of native species per site (shallower than max depth)	**3.03**
Average number of native species per site (veg. sites only)	**3.36**
Species Richness	**33**
Species Richness (including visuals)	**37**

The species richness (total number of plant species sampled or viewed) is quite high in Cranberry Lake. The most common plants surveyed were Common waterweed (*Elodea canadensis*), Robbin's (fern) pondweed (*Potamogeton robbinsii*) and Large-leaf pondweed (*Potamogeton amplifolius*) respectively. All of these plants are common plants found in Wisconsin lakes and all are desirable. These three plants are all submergent forms and provide key habitat for invertebrates and fish species. See Table 2 for the species richness and Figures 3-5 for the distribution maps of these species.

Table 4: Species richness with frequency data.

Species	Freq in vegetated	Freq in littoral	Relative freq	Sites located
Elodea canadensis,Common waterweed	66.24	60.12	19.55	104
Potamogeton robbinsii,Robbins pondweed	61.15	55.49	18.05	96
Potamogeton amplifolius,Large-leaf pondweed	39.49	35.84	11.65	62
Vallisneria americana,Wild celery	36.31	32.95	10.71	57
Ceratophyllum demersum,Coontail	35.67	32.37	10.53	56
Myriophyllum sibiricum,Northern water milfoil	19.75	17.92	5.83	31
Bidens beckii,Water marigold	9.55	8.67	2.82	15
Potamogeton pusillus,Small pondweed	8.28	7.51	2.44	13
Potamogeton zosteriformis,Flat-stem pondweed	7.01	6.36	2.07	11
Nuphar variegata,Spatterdock	6.37	5.78	1.88	10
Najas flexilis,Bushy pondweed	5.73	5.20	1.69	9
Potamogeton illinoensis,Illinois pondweed	5.73	5.20	1.69	9
Chara sp. ,Muskgrasses	5.10	4.62	1.50	8
Heteranthera dubia,Water star-grass	4.46	4.05	1.32	7
Nitella sp.,Nitella	3.18	2.89	0.94	5
Potamogeton strictifolius,Stiff pondweed	3.18	2.89	0.94	5
Brasenia schreberi,Watershield	2.55	2.31	0.75	4
Potamogeton gramineus,Variable pondweed	2.55	2.31	0.75	4
Potamogeton richardsonii,Clasping-leaf pondweed	2.55	2.31	0.75	4
Myriophyllum spicatum,Eurasian water milfoil	1.91	1.73	0.56	3
Filamentous algae	1.91	1.73	0.56	3
Potamogeton praelongis,White-stem pondweed	1.91	1.73	0.56	3
Elodea nuttallii,Slender waterweed	1.27	1.16	0.38	2
Ranunculus aquatilis,Stiff water crowfoot	1.27	1.16	0.38	2
Potamogeton crispus,Curly-leaf pondweed	0.64	0.58	0.19	1
Eriocaulon aquaticum,Pipewort	0.64	0.58	0.19	1
Juncus paleocarpus f. submersus,Brown-fruited rush	0.64	0.58	0.19	1
Myriophyllum tenellum,Dwarf water milfoil	0.64	0.58	0.19	1
Potamogeton epihydrus,Ribbon-leaf pondweed	0.64	0.58	0.19	1
Potamogeton foliosus,Leafy pondweed	0.64	0.58	0.19	1
Potamogeton friesii,Frie's pondweed	0.64	0.58	0.19	1
Sparganium fluctuans ,Floating-leaved bur-reed	0.64	0.58	0.19	1
Utricularia vulgaris,Common bladderwort	0.64	0.58	0.19	1
Eleocharis acicularis, Needle spikerush	Viewed			
Lemna minor,Small duckweed	Viewed			
Nymphaea odorata,White water lily	Viewed			
Sagittaria graminea,Grass-leaved arrowhead	Viewed			
Sparganium eurycarpum, Common bur-reed	Viewed			
Typha latifolia,Broad-leaved cattail	Viewed			

Figure 5: Map of Elodea canadensis distribution-most common plant surveyed

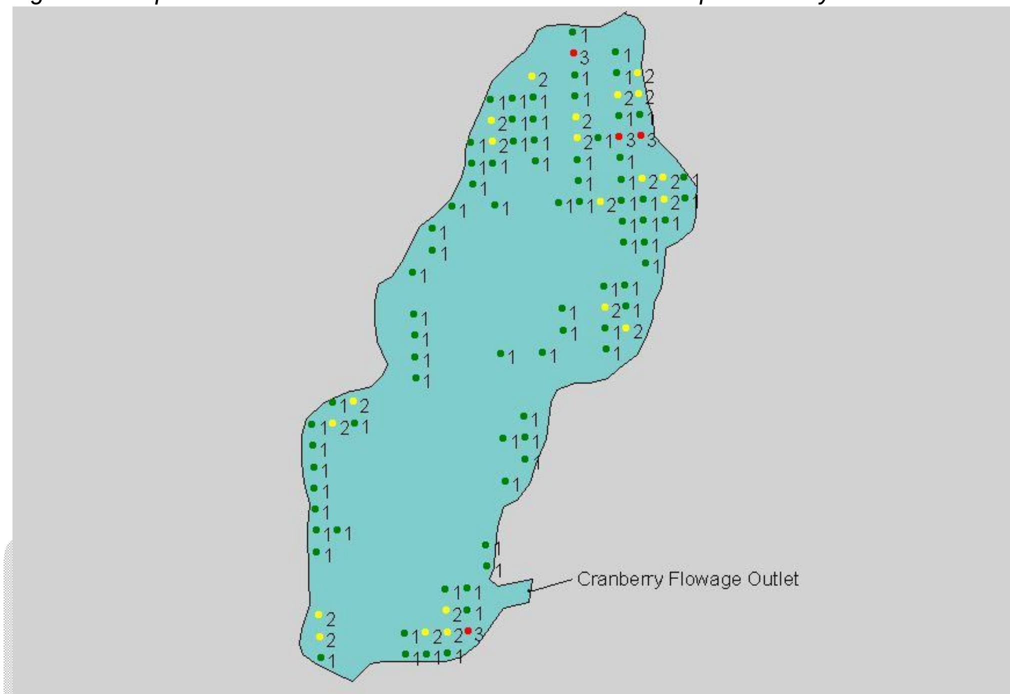


Figure 6: Map of Potamogeton robbinsii distribution-second most common plant.

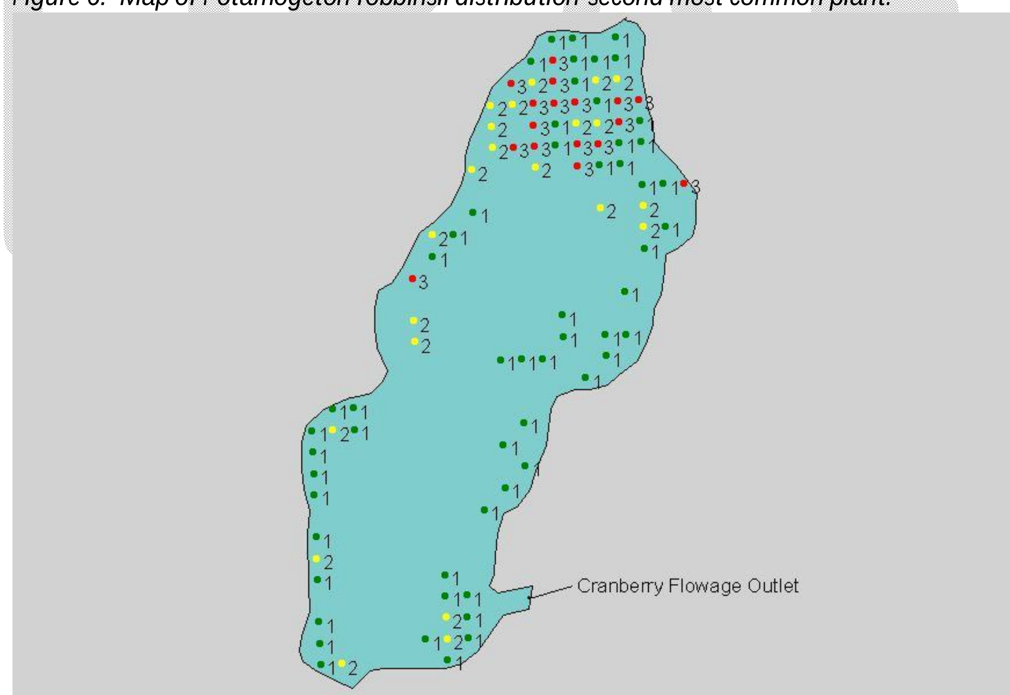
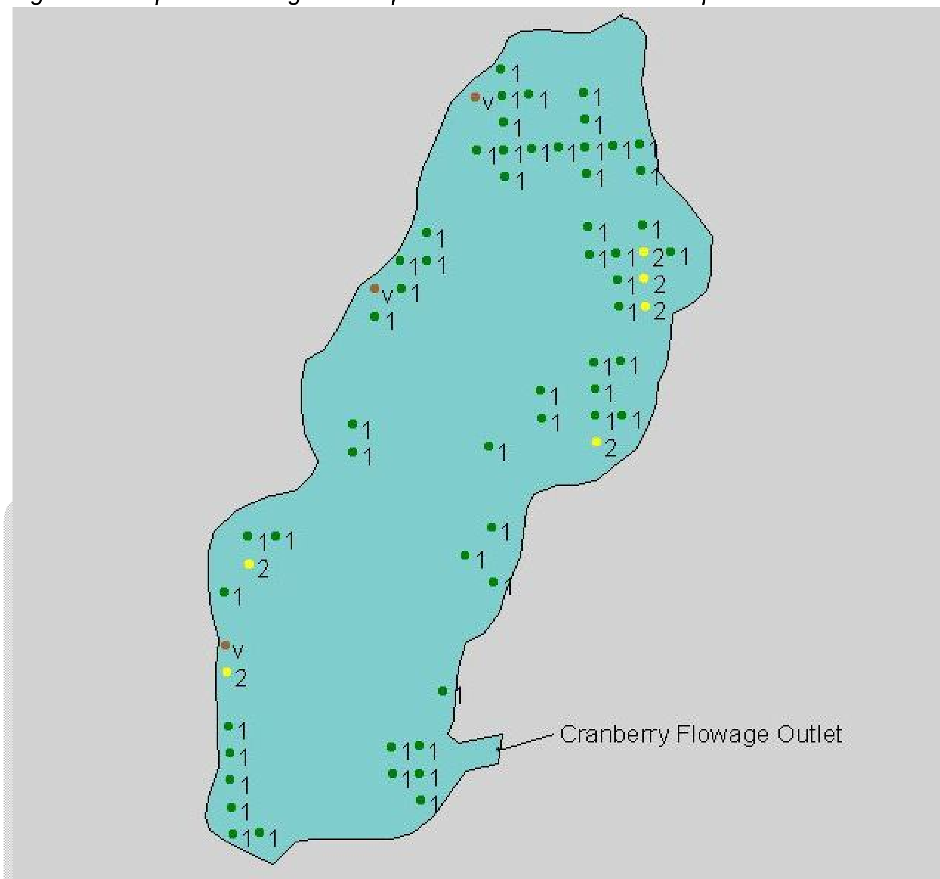


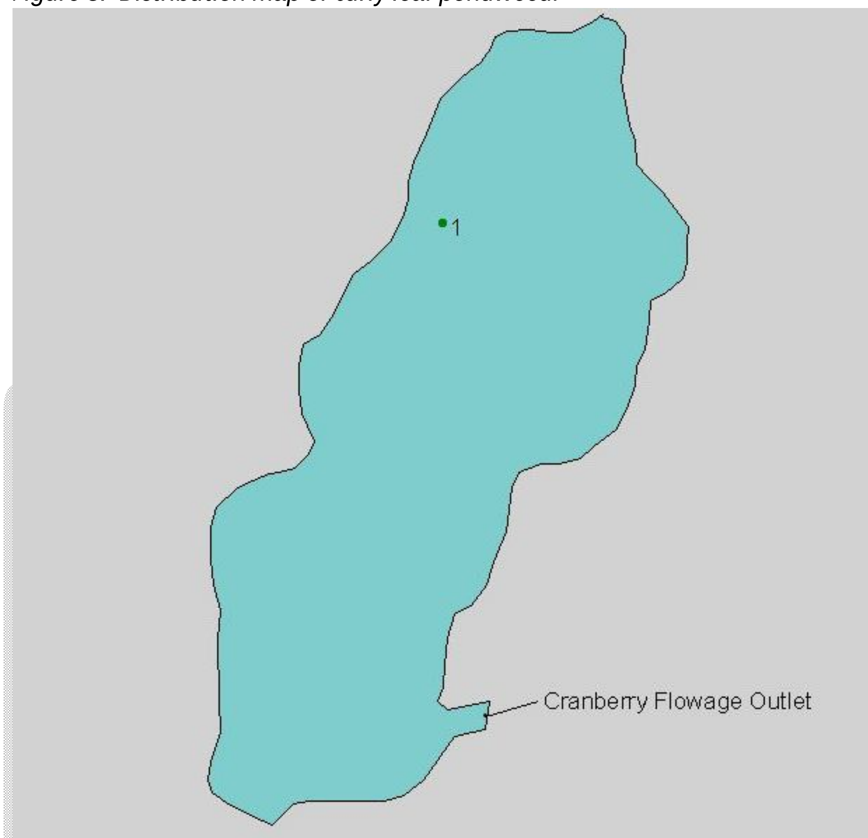
Figure 7: Map of Potamogeton amplifolius-third most common plant.



Invasive species

Two non-native, invasive species were sampled. One is curly leaf pondweed which is a cold-water plant that grows in early spring and dies off in early July. This was only found in one location, however the time of the survey is most certainly the reason it was not found in more locations. It is probable that curly leaf is not extremely abundant since more would have been sampled even in late summer. See Figure 6 to view the location of curly leaf pondweed surveyed.

Figure 8: Distribution map of curly leaf pondweed.



The other plant surveyed that is of higher concern is Eurasian water milfoil. It was only surveyed in a few locations and observed in a few additional locations not surveyed. See Figure 5 and 6 to see these locations. Eurasian water milfoil should be managed in this lake soon.

Figure 9: Distribution map of Eurasian water milfoil from survey.

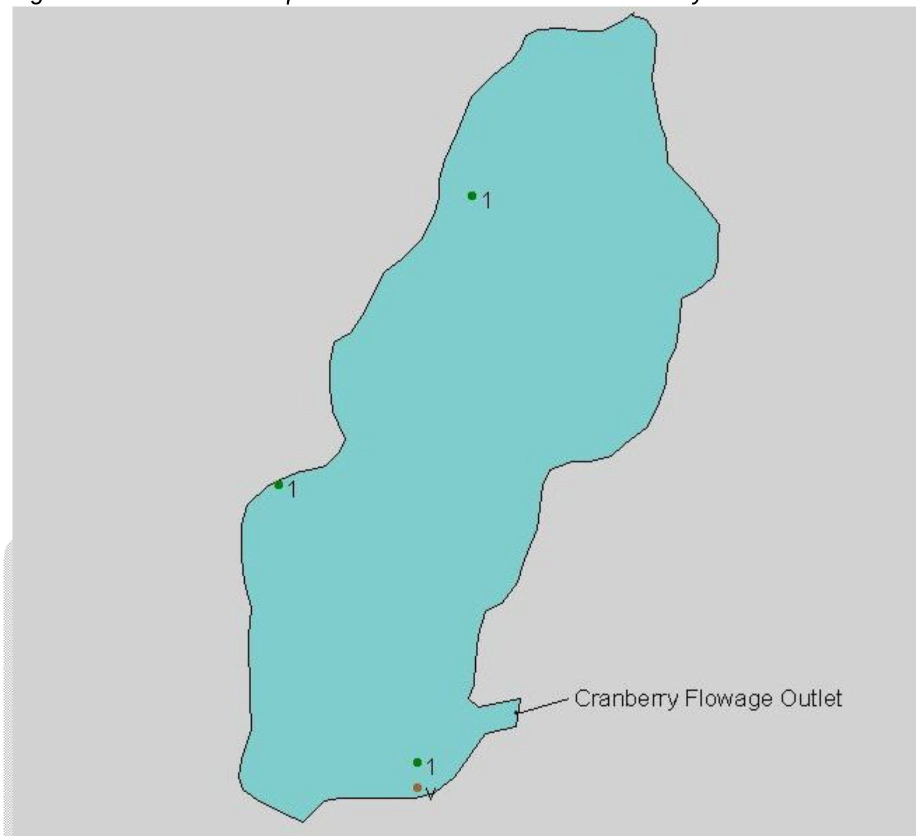
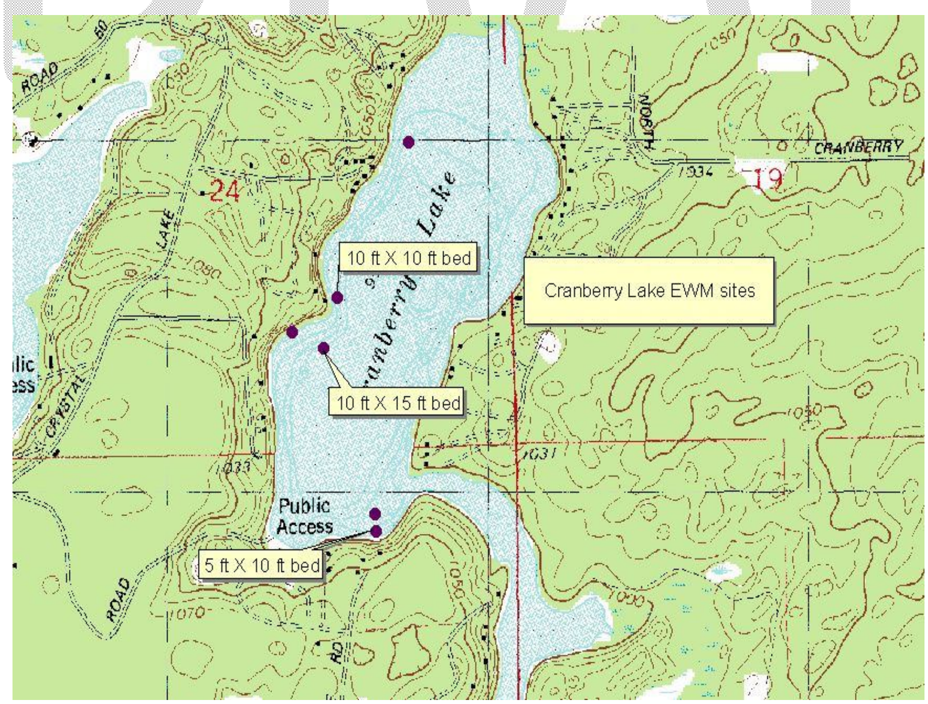


Figure 10: Eurasian watermilfoil locations observed in 2007.



Floristic quality is a calculation that measures the disturbance to the plant community from human development and/or sediment changes. The plants that have tolerance values are used. The higher the tolerance value, the less change the plant can withstand. Those with the highest tolerance value of "10" require habitat similar to what was present in the lake prior to human development around the lake.

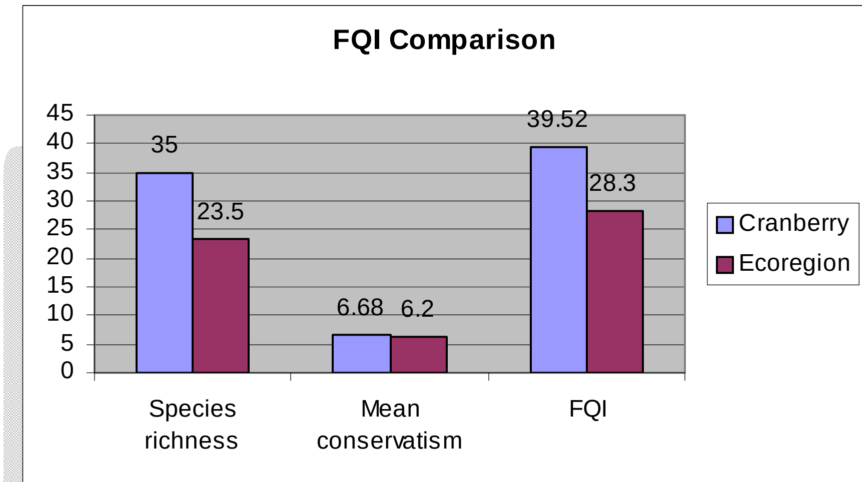
The number of species used in the FQI, the mean conservatism, and the actual FQI value are all much higher than the median for lakes in this eco-region (Nichols 1999). This shows that Cranberry Lake's plant community indicates a healthy habitat for plants and changes in sediment do not appear to be degraded (in terms of plant growth). Table 3 has the list of species used for the FQI and the conservatism (tolerance) values for each. Figure 7 shows the comparison between Cranberry Lake and the median for lakes in this ecoregion.

Table 5: Floristic quality index species and data

Species	**Common Name**	**C**
Brasenia schreberi	Watershield	**7**
Ceratophyllum demersum	Coontail	**3**
Chara sp.	Muskgrasses	**7**
Eleocharis acicularis	Needle spikerush	**5**
Elodea canadensis	Common waterweed	**3**
Elodea nuttallii	Slender waterweed	**7**
Eriocaulon aquaticum	Pipewort	**9**
Juncus palocarpus f. submersus	Brown-fruited rush	**8**
Lemna minor	Small duckweed	**5**
Megalodonta beckii	Water marigold	**8**
Myriophyllum sibericum	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**
Potamogeton amplifolius	Large-leaf pondweed	**7**
Potamogeton epihydrus	Ribbon-leaf pondweed	**8**
Potamogeton foliosus	Leafy pondweed	**6**
Potamogeton friesii	Frie's pondweed	**8**
Potamogeton gramineus	Variable pondweed	**7**
Potamogeton illinoensis	Illinois pondweed	**6**
Potamogeton praelongis	White-stem pondweed	**8**
Potamogeton pusillus	Small pondweed	**7**
Potamogeton robbinsii	Robbins pondweed	**8**
Potamogeton strictifolius	Stiff pondweed	**8**
Potamogeton zosteriformis	Flat-stem pondweed	**6**
Ranunculus aquatilis	Stiff water crowfoot	**7**
Sagittaria graminea	Grass-leaved	**9**
Sparganium eurycarpum	Common bur-reed	**5**

Sparganium fluctuans	Floating-leaf-bur-reed	**10**
Typha latifolia	Broad-leaved cattail	**1**
Utricularia vulgaris	Common bladderwort	**7**
Vallisneria americana	Wild celery	**6**
Heteranthera dubia	Water star-grass	**6**
Number of species (N)	**35**	
Mean conservatism (Mean C)	**6.68**	
FQI	**39.52**	

Figure 11: Comparison of FQI values



The survey results indicate that Cranberry Lake has a healthy and diverse plant community. There were two non-native, invasive species surveyed, curly leaf pondweed and Eurasian watermilfoil (EWM). EWM is of the most concern on this lake. The presence of high nutrient sediments, along with many sites with Northern watermilfoil (a native milfoil species) present indicates that EWM could spread extensively in Cranberry Lake.

Water quality/Watershed Characteristics

Cranberry Lake has a fairly short history of water quality data. However, in more recent years, volunteers have done a good job collecting data through the self-help monitoring program.

The data that is available shows that Cranberry Lake is a mesotrophic lake. These means that there is a moderate amount nutrients, leading to moderate plant growth and moderate amounts of algae growth leading to water clarity that is in the mesotrophic level. This indicates that Cranberry Lake does not have excessive nutrient loading and therefore future loading of nutrients should be minimized.

Since Eurasian water milfoil flourishes in high nutrient environments, it is important to keep the nutrients low as a management tool. By keeping nutrients low, it can help reduce nutrients available to plants such as EWM.

Table 6: Summary of historical water quality data.

Year	***Mean Total P (ppb)***	***Mean Chl-a (ppb)***	***Mean Secchi (ft)***	***Bottom DO (mg/L)***
2007	N/a	N/a	7.66	N/a
2008	13	1.9	N/a	5.5
2009	18	5.53	N/a	N/a
2010	12.6	5.6	N/a	N/a
2011	17.25	6.01	5.56	N/a
2012	12.25	4.39	N/a	N/a

Figure XX shows an estimate of the immediate watershed around Cranberry Lake/Flowage. County T is used as a southern boundary. Cranberry Lake and Flowage fall within the northwest most portion of the Totagatatic River watershed. The water from Cranberry Lake and Flowages flows into the Minong Flowage which is an impoundment of the Totagatatic River. Although this is a large watershed, the watershed that directly flows into the Cranberry Lake and then the flowage is quite small, as portrayed on the estimated map.

Cranberry Creek, a cold water stream, is the main inlet of water into Cranberry Lake. This does not appear to be any historical data as to water quality of flow amounts available. The creek has been listed to harbor brook trout so one could speculate the water quality is quite high as brook trout are intolerant fish. The water quality reflects a small watershed and limited nutrient loading.

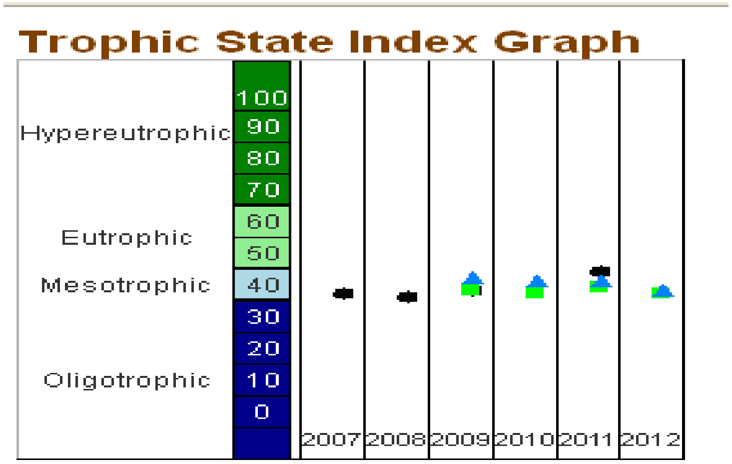
Figure 12: Estimated immediate watershed of Cranberry Lake.

Since much of the land use around Cranberry Lake is forested and wetland, the nutrient loading from the watershed should be low. This could mean that the residential area around the lake would then have a greater impact on the nutrient loading, since this type of land use typically has a higher loading of nutrients. This is due to sheet flow of runoff over lawns increasing runoff, erosion, fertilizer use and sedimentation.

There are approximately 82 residential properties on Cranberry Lake/Flowage. There is also one large campground and one smaller campground on Cranberry Lake. There is another large campground that is adjacent to Cranberry Lake is most likely in the Cranberry Lake watershed, but is not directly on the lake. The septic system design and age is unknown for residential and campgrounds for this plan[5].

Figure 13: Trophic status graph, 2007 to 2012.

[5] This data has not been collected but may be available through Douglas County zoning.



Plant Management

This section reviews the potential management methods available and reports recent management activities on the lakes.

Discussion of Management Methods

Permitting Requirements

The Department of Natural Resources regulates the removal of aquatic plants when chemicals are used, when plants are removed mechanically, and 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 for 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 up 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 refers to the control of aquatic plants by hand or hand–held devices without the use or aid of external or auxiliary power.[6]

The *Department of Natural Resources Northern Region Aquatic Plant Management Strategy* (May 2007) requires documentation of impaired navigation or nuisance conditions before native plants may be managed with herbicides. Severe impairment or

[6] More information regarding DNR permit requirements and aquatic plant management contacts is found on the DNR web site: www.dnr.state.wi.us.

nuisance will generally mean that vegetation grows thickly and forms mats on the water surface.

Techniques to control the growth and distribution of aquatic plants are discussed in the following text. The application, location, timing, and combination of techniques must be considered carefully. A summary table of Management Options for Aquatic Plants from the WDNR is found in Appendix E.

Manual Removal[7]

Manual removal—hand pulling, cutting, or raking—will effectively remove plants from small areas. It is likely that plant removal will need to be repeated more than once during the growing season. The best timing for hand removal of herbaceous plant species is after flowering but before seed head production. For plants with 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 establishment and for private landowners who wish to remove small areas of curly leaf pondweed growth. Raking is recommended to clear nuisance growth in riparian area corridors up to thirty feet wide. SCUBA divers may engage in manual removal for invasive species like Eurasian water milfoil. Care must be taken to ensure that all plant fragments are removed from the lake.

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 of mechanical control available. WDNR 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 cut to depths from one to six feet. A conveyor belt on the cutter head brings the clippings onboard the machine for storage. Once full, the harvester travels to shore to discharge the load of weeds off of the vessel.

The size, and consequently the harvesting capabilities, of these machines vary greatly. As they move, harvesters cut a swath of aquatic plants that is between 4 and 20 feet wide, and can be up to 10 feet deep. The on-board storage capacity of a harvester ranges from 100 to 1,000 cubic feet (by volume) or 1 to 8 tons (by weight).

In some cases, the plants are transported to shore by the harvester itself for disposal, while in other cases, a barge is used to store and transport the plants in order to increase the efficiency of the cutting process. The plants are deposited on shore, where

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[7] Information from APIS (Aquatic Plant Information System). U.S. Army Corps of Engineers. 2005. and the *Wisconsin Aquatic Plant Management Guidelines.*

they can be transported to a local farm to be used as compost (the nutrient content of composted aquatic plants is comparable to that of cow manure) or to an upland landfill for proper disposal. Most harvesters can cut between 2 and 8 acres of aquatic vegetation per day, and the average lifetime of a mechanical harvester is 10 years.

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

Aside from the obvious effort and expense of harvesting aquatic plants, there are many environmentally-detrimental consequences to consider. The removal of aquatic species during harvesting is non-selective. Native and invasive species alike are removed from the target area. This loss of plants results in a subsequent loss of the functions they perform, including sediment stabilization and wave absorption. Shoreline erosion may therefore increase. Other organisms such as fish, reptiles, and insects are often displaced or removed from the lake in the harvesting process. This may have adverse effects on these organisms' populations as well as the lake ecosystem as a whole.

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

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

Timing is also important. The ideal time to harvest, in order to maximize the efficiency of the harvester, is just before the aquatic plants break the surface of the lake. For curly leaf pondweed, it should also be before the plants form turions (reproductive structures) to avoid spreading the turions within the lake. If the harvesting is conducted too early, the plants will not be close enough to the surface, and the cutting will not do much damage to them. If too late, turions may have formed and may be spread, and there may be too much plant matter on the surface of the lake for the harvester to cut effectively.

If the harvesting work is contracted, the equipment should be inspected before and after it enters the lake. Since these machines travel from lake to lake, they may carry plant fragments with them, and facilitate the spread of aquatic invasive species from one body of water to another. Harvesting contractors are not readily available in northern Wisconsin, so harvesting contracts are likely to be very expensive. One must also consider prevailing winds, since cut vegetation can be blown into open areas of the lake or along shorelines.

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 the pioneering establishment of submersed invasive plant species. When a weed is discovered in a pioneering state, this methodology can be considered. To be effective, the entire plant, including the subsurface portions, should be removed.

Plant fragments can result from diver dredging, but fragmentation is not as great a problem when infestations are small. Diver dredging operations may need to be repeated more than once to be effective. When applied to 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 play an important role in the effectiveness of a diver dredging 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. Diver dredging will be considered as a rapid response control measure for Eurasian water milfoil as new areas are discovered.

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 contaminated sediments 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 the potential impacts from this type of treatment. Tillers do not operate effectively in areas with many underwater obstructions such as trees and stumps. 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.

Biological Control[8]

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. With the introduction of pests to the target invasive organism, the exotic invasive species may be maintained at lower densities.

The effectiveness of bio-control efforts varies widely (Madsen, 2000). Beetles are commonly and successfully used to control purple loosestrife populations in Wisconsin. 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, an herbivorous fish, is sometimes used to feed on pest plant populations, but grass carp introduction is not allowed in Wisconsin. As a result, grass carp is not a viable bio-control in Wisconsin lakes and won't be utilized.

***Weevils*[9]** *have potential for use as a biological control agent against Eurasian water milfoil. There are several documented "natural" declines of EWM infestations with weevil present. In these cases, EWM was not eliminated but its abundance was reduced enough so that it did not achieve dominance. These declines are attributed to an ample population of native milfoil weevils (Euhrychiopsis lecontei). Weevils feed on native milfoils but will shift preference over to EWM when it is present. Lakes where weevils can become an effective control have an abundance of native northern water milfoil and fairly extensive natural shoreline where the weevils can over winter. Any control strategy for EWM that would also harm native milfoil may hinder the ability of this natural bio-control agent. Lakes with large bluegill populations are not good candidates for weevils because bluegills feed on the weevils. The presence and efficacy of stocking weevils in EWM lakes is being evaluated in Wisconsin lakes. So far, stocking weevils does not appear to be effective.*

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

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

9 *Control of Eurasian Water Milfoil & Large-scale Aquatic Herbicide Use*. Wisconsin Department of Natural Resources. July 2006.

other hand there are several disadvantages to consider, including very long control times (years instead of weeks), a lack of available biological control agents for particular target species, and relatively specific environmental conditions necessary for success. Biological control is not without risks; new non-native species introduced to control a pest population may cause problems of its own.

Re-vegetation with Native Plants

Another aspect to biological control is native aquatic 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 nonnative species, a propagule (seed) bank probably exists that will restore the community after nonnative plants are controlled (Madsen, Getsinger, and Turner, 1994).

Physical Control[10]

In physical management, the environment of the plants is manipulated, which in turn acts upon the plants. Several physical techniques are commonly used: dredging, drawdown, 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 WDNR permit would be required. Such permits are not commonly granted.

Dredging removes accumulated bottom sediments that support plant growth. Dredging is usually not performed solely for aquatic plant management but to restore lakes that have been filled in with sediments, have excess nutrients, need deepening, or require removal of toxic substances (Peterson 1982). Lakes that are very shallow due to sedimentation tend to have excess plant growth. Dredging can form an area of the lake too deep for plants to grow, thus creating an area for open water use (Nichols 1984). By opening more diverse habitats and creating depth gradients, dredging may also create more diversity in the plant community (Nichols 1984). Results of dredging can be very long term. However, due to the cost, environmental impacts, and the problem of disposal, dredging should not be performed for aquatic plant management alone. It is best used as a lake remediation technique.

Drawdown, or significantly decreasing lake water levels can be used to control nuisance plant populations. With drawdown, the water body has water removed to a given depth. It is best if this depth includes the entire depth range of the target species. Drawdowns need to be at least one month long to ensure thorough drying and effective removal of target plants (Cooke 1980a). 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 one to two years (Ludlow 1995), it is most commonly

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

applied to Eurasian water milfoil (Geiger 1983; Siver et al. 1986) and other milfoils or submersed evergreen perennials (Tarver 1980).

Although drawdown can be inexpensive and have 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 drawdown and individual species responses can be inconsistent (Cooke 1980a). Drawdowns may provide an opportunity for the spread of highly weedy species, particularly annuals. Drawdown requires a mechanism to significantly lower water levels. There is the possibility that the dam used to create this flowage will need work for repair. It is possible a drawdown will be necessary. This could help manage the EWM, but would likely be a side effect of the dam repair with the need for plant management being the driving force. However, if inquired about, the association may consider supporting such an action.

Benthic barriers or other bottom-covering approaches are another physical management technique. The basic idea is to cover the plants 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 various combinations of the above materials (Cooke 1980b; Nichols 1974; Perkins 1984; Truelson 1984). The problem with synthetic sheeting is that the gases evolved from plant and sediment decomposition collect underneath and lift the barrier (Gunnison and Barko 1992).
The problem with using sediments is that new plants establish on top of the added layer (Engel and Nichols 1984).

Benthic barriers will typically kill the plants under them within 1 to 2 months, after which time they may be 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). Synthetic barriers, if left in place for multi-year control, will eventually become sediment-covered and will allow colonization by plants. Benthic barriers may be best suited to small, 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 WDNR permit would be required for a benthic barrier, and these barriers are not recommended.

Shading or light attenuation reduces the amount of light plants have available for growth. Shading has been achieved by fertilization to produce algal growth, application of natural or synthetic dyes, shading fabric, or covers, and 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 only of limited applicability. Physical control is not currently proposed for management of aquatic plants in Cranbeery Lake.

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 (Madsen, 2000).

An important caveat is that these products are considered 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. WDNR permits under Chapter NR 107 are required for herbicide application.

General descriptions of herbicide classes are included below.[11]

Contact herbicides

Contact herbicides act quickly and are generally lethal to all plant cells 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. 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

[11] This discussion is taken from: *Managing Lakes and Reservoirs*. North American Lake Management Society.

herbicides. **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.

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.

Selective herbicides

Selective herbicides are those that are used to control certain plants but not others. 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, timing, 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 and otters). 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 one or more of the organisms in the community, and in turn affect other organisms or weed control operations. These operations can also impact water chemistry which may result in further implications for aquatic organisms.

Table 7. Herbicides Used to Manage Aquatic Plants

Brand Name(s)	Chemical	Target Plants
Cutrine Plus, $CuSO_4$, Captain, Navigate, Komeen	Copper compounds	Filamentous algae, coontail, wild celery, elodea, and pondweeds
Reward	Diquat	Coontail, duckweed, elodea, water milfoil, and pondweeds
Aquathol, Aquathol K, Aquathol Super K, Hydrothol 191	Endothall	Coontail, water milfoil, pondweeds, and wild celery as well as other submersed weeds and algae
Rodeo	Glyphosate	Cattails, grasses, bulrushes, purple loosestrife, and water lilies
Navigate, Aqua-Kleen, DMA 4 IVM, Weed-Rhap	2, 4-D	Water milfoils, water lilies, and bladderwort

General descriptions of the breakdown of commonly used aquatic herbicides are included below.[12]

Copper

Copper is a naturally occurring element that is essential at low concentrations for plant growth. It does not break down in the environment, but it 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 bottom sediments after repeated or high rates of application. 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 in 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.

A recent study in Tomahawk Lake in Bayfield County, Wisconsin illustrated a much slower breakdown time of 2,4-D than described above. Following a whole lake treatment of .5 mg/L 2,4-D, the chemical was still present 160 days after treatment. While there was successful removal of the target plant, Eurasian water milfoil, there were also significant declines in native plant biomass. A potential explanation was the low nutrient conditions in Lake Tomahawk which was described as an oligo-mesotrophic lake. (Nault 2010, Toshner 2010)

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

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 levels 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 bound tightly to particles in the water and bottom sediments. When bound to certain types of clay particles, diquat is not biologically available. When diquat is bound to organic matter, it can be slowly degraded by microorganisms. When diquat is applied foliarly, it is degraded to some extent on the leaf surfaces by photodegradation. 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.

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 pondwater after about 3 months but can remain up to 9 months. It may remain in bottom sediment between 4 months and 1 year.

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.

Copper Compounds

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

Herbicide Used to Manage Invasive Species

Eurasian Water Milfoil

The Army Corps of Engineers Aquatic Plant Information System (APIS) identifies the following herbicides for control of Eurasian water milfoil (EWM): 2,4-D, diquat, endothall, fluridone, and triclopyr.[13] All of these herbicides with the exception of diquat are available in both granular and liquid formulations. It is possible to target invasive species by using the appropriate herbicide and timing of application. Diquat is used infrequently in Wisconsin because it is nonspecific.[14] The herbicide 2,4-D is most commonly used to treat EWM in Wisconsin. This herbicide kills dicots including native aquatic species such as northern water milfoil, coontail, water lilies, spatterdock, and watershield. A project in Bayfield County on Lake Tomahawk also found unexpected impacts on pondweeds which are monocots.[15] Early season (April to May) treatment of Eurasian water milfoil is recommended to limit the impact on native aquatic plant populations because EWM tends to grow before native aquatic plants.

Granular herbicide formulations are more expensive than liquid formulations (per active ingredient). However, granular formulations are generally thought to release the active ingredient over a longer period of time. Granular formulations, therefore, may be more suited to situations where herbicide exposure time will likely be limited, as is the case of treatment areas in small bands or blocks. In large, shallow lakes with widespread EWM, a whole lake treatment with a low rate of liquid herbicide may be most cost effective because exposure time is greater. Factors that affect exposure time are size and configuration of treatment area, water flow, and wind.
Application rates for liquid and granular formulations are not interchangeable. A rate of 1 to 1.5 mg/L 2,4-D applied as a liquid is a moderate rate that will require a contact time of 36 to 48 hours. Negative impacts to native plants have occurred at whole-lake dosage rates as low as 0.5 mg/L.[16] Application rates recommended for Navigate (granular 2,4-D) are 100 pounds per acre for depths of 0 to 5 feet, 150 pounds per acre for 5 to 10 feet, and 200 pounds per acre for depths greater than 10 feet. Allowed and recommended application rates are found on herbicide labels.

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

[13] Additional information provided by John Skogerboe, Army Corps of Engineers, personal communication. February 14, 2008.
[14] Frank Koshere. Wisconsin DNR. email communication. 3/03/10.
[15] Nault 2010.
[16] Nault 2010.

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.

Studies have demonstrated that curly leaf pondweed can be controlled with Aquathol K (a formulation of endothall) in 50 to 60 degree F water, and that treatments of CLP this early in its life cycle can prevent turion formation.[17] Since curly leaf pondweed is actively growing at these low water temperatures and many native aquatic plants are still dormant, early season treatment selectively targets curly leaf pondweed. Staffs from the Minnesota Department of Natural Resources and the U.S Army Engineer Research and Development Center have conducted trials of this method. These methods are accepted as standard operating procedures being approved in Wisconsin for aquatic invasive species control projects.[18]

Because the dosage is at lower rates than the 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] Steep drop-off, high winds, and other factors that increase herbicide dilution and contact time can decrease treatment effectiveness.[20] Early season treatment similar to that described above can be used to treat corridors for navigation purposes. Because of potential for drift, a higher concentration of endothall is generally used in navigation corridors.

Efforts are also made to treat as early in the season as possible and to absolutely not treat when temperatures reach 60 degrees F. Lake volunteers help to ensure that specified treatment conditions are followed. Because CLP is a monocot like many other aquatic plants, it is not possible to target its control later in the season when many other native plants are growing.

[17] *Research in Minnesota on Control of Curly Leaf Pondweed.* Wendy Crowell, Minnesota Department of Natural Resources. Spring 2002.
[18] Plan comments, Frank Koshere, September 16, 2010.
[19] Personal communication, Frank Koshere. March 2005.
[20] *Draft Report Following April 2008 Aquatic Herbicide Treatments of Three Bays on Lake Minnetonka*. Skogerboe, John. US Army engineer Research and Development Center.

Cranberry Lake/Flowage Management Goals

1. ***Protect native plant community and fish habitat.***
2. ***Reduce EWM coverage and limit the spread.***
3. ***Prevent introduction of other invasive species.***
4. ***Maintain and enhance native shoreline community.***
5. ***Educate citizens about importance of aquatic plants and lake ecology.***
6. ***Investigate and then establish funding mechanisms.***

Objectives

Goal 1 Objectives-

1.1-Encourage the protection of plants in littoral zone adjacent to riparian owners.

Riparian owners can hand pull aquatic vegetation from and area 30 feet wide without a permit. Since native plants are paramount for competing with EWM, potentially reducing its spread, it is important to maintain the integrity of the native plant community.
Riparian owners are encouraged in this plan, and will be encouraged through public education in newsletters and at meetings to leave native plant stands in tact.

1.2-Manage AIS with early season methods to allow reduction of target species only and minimal affect on native plants.

Historically the EWM has been treated with 2,4-D in an early season time period. This is generally in the early spring when water temperatures range from 50 to 59 degrees F. This early application allows to target the AIS, with limited adverse effects on the native species, since they are generally still in dormancy. Also, 2,4-D typically targets dicot plant species only and therefore, will not affect the monocot species such as those in the genus *Potamogeton.*

The early season application will continue in the future, with the application occurring while water temperatures range from 50-60 degrees F.

1.3-No reduction of native plant species by Lake Association efforts will be conducted.

The Cranberry Lake/Flowage Association will not embark on any management efforts that result in the reduction of native plant species. The Association recognizes the importance of native aquatic plant species. As a result, they will take safeguards to preserve this important community. Any changes in the native community will be monitored through periodic full lake point intercept macrophyte surveys.

Action A-A full lake point-intercept macrophyte survey will conducted in 2013 and approximately every 5 years if EWM herbicide application continues.

Goal 2 Objectives-

2.1-Apply herbicides to all stands > 100 sq. ft. and a mean density > 2.

Early season herbicide application will be used to reduce/contain EWM in areas that exceed to established threshold. The herbicide 2,4-D will be used to target the EWM, along with early spring application to reduce the chance native species are out of dormancy. The target concentration will be 1.5 parts per million (ppm) in the treatment beds. This concentration may need to be adjusted depending on effectiveness or adverse effects on native species.

Effectiveness of reduction from herbicide application will be determined using the Wisconsin DNR, pre and post monitoring protocol. A chi-square analysis of the EWM frequency will be compared before and after treatment. Any potential reduction will be deemed statistically significant if $p<0.05$. Density of each EWM will also be compared from the post treatment analysis from the year prior to the post treatment analysis of that current year (if beds are treated in two successive years).

Action B -After delineation and a pre-treatement survey, EWM beds will be treated with 2.4-D at a dosage of 1.5 ppm. A post treatment survey will be conducted in late summer following an early spring treatment.

Action C- The Cranberry Lake/Flowage Association will communicate annually with the Minong Flowage Association about EWM management. Since they are managing EWM in connected waters, this communication is important.

2.2-Monitor EWM in lake and flowage and record any new growth with GPS. A monitoring team will be set up for this.

On key to managing EWM is to keep an updated inventory as to where the plant is growing and the density. This monitoring needs to occur on many occasions beyond to pre and post survey work. A volunteer monitoring team will need to be established, trained and implement a monitoring program. Their data will then be shared with the consultant that delineates the EWM beds for treatment. It is recommended that monitoring occur on a semi-weekly basis from late June to mid August.

Action D - A monitoring team of volunteers will be established and trained. They will monitor as often as they can, with a goal of semi-weekly. All EWM will be marked with GPS coordinates.

2.3-In areas < 100 sq. ft and/or < mean density of 2, use of SCUBA to hand remove EWM will be utilized.

Herbicide use in small beds is not typically effective since the area is too small to apply very precisely and the concentration can be reduced so quickly, making it difficult to reach an effective concentration to kill the plants. In areas small than the threshold, hand pulling (using SCUBA if necessary) will be used to remove as much EWM as possible. Since EWM can spread through fragmentation, it is imperative that safeguards be taken to remove EWM fragments during this practice. Volunteers should be present during hand pulling exercises to remove any fragments during the process.

Action E-Volunteer divers will remove EWM by hand and/or rake. Care will be used to remove plants in their entirety, including roots. Volunteers will be utilized as needed to remove any fragments while hand removal is occurring.

Goal 3 Objectives

3.1-Add AIS education materials at boat landing.

Future introductions of AIS into Cranberry Lake/Flowage need to be avoided. One method is to disseminate information at the boat landing on Cranberry Lake. Education materials about Cranberry Lake/Flowage as well as information on AIS present in the lake and methods to reduce future infestations will be made available.

The Cranberry Lake/Flowage Association will also study the ability of recruiting and training volunteers for the Clean Boats/Clean Waters Program. This will allow volunteers to monitor the boat landing, especially at key, busy times of lake use. This program has proven to be very beneficial on lakes statewide.

Action F-A kiosk will be created with AIS eduction material at the Cranberry Lake boat landing. Also, the Clean Boats/Clean Waters volunteer program will be studied.

3.2-Distribute annual newsletter with information about AIS and update EWM management. Communication is imperative in the managing of EWM.

The Cranberry Lake/Flowage Association has historically provided written publication of their meeting minutes as well as provided newsletter information. This communication will continue annually at least. It is very important that lake residents and lakes users understand the EWM management practices. Maps will be provided showing the most up-to-date locations of EWM beds and smaller clumps of plants. The maps will be labeled accordingly as well as dated.

If other AIS should be introduced into Cranberry Lake/Flowage, such as zebra mussels, a rapid response protocol will be followed. This rapid response protocol is contained in Appendix D at the end of this plan.

Goal 4 Objectives-

4.1-Restore one shoreline and use a showcase for others riparian owners.

Native shoreline buffers are important to create and maintain on lakes. This practice can limit nutrient loading a large amount. They also provide excellent wildlife habitat for lake and near lake organisms.

Since EWM grows well in high nutrient sediment, reducing the sedimentation process in lakes that have EWM is important. As a result, Cranberry Lake/Flowage Association will work with the Douglas County Land and Water Conservation Dept. to try and restore one residential shoreline that is identified as a desirable location. Also, this location will need the residents' commitment as well. With one showcase restoration, the Association can try and demonstrate how restorations look and how they function.

Funding for such a project could be part of a lake grant (either a Lake Planning Grant, Lake Protection Grant, or maybe an AIS Grant).

Action G- The Cranberry Lake/Flowage Association will (with assistance from the Douglas County Land/Water Conservation Dept) evaluate a residential properties that would be a good candidate for restoration. Those property owners will be contacted and one will be chosen for a restoration. This will be funded through a cost share, if a grant is secured.

4.2-Diseminate educational materials on native shoreline benefits.

Upon completion of the restoration showcase, the Cranberry Lake/Flowage Association will obtain and/or create native shoreline information to help encourage other residents to pursue such a practice. Funding options may also be explored.

Action H- Material available from the Douglas County (or others) on shoreline restoration will be sent to all riparian owners on Cranberry Lake/Flowage. A showcase event will be scheduled to show the restoration project.

Goal 5 Objectives-

5.1-Distribute educational materials on lake ecology information.

The Cranberry Lake/Flowage Association is concerned about residents and lake users not understanding basic lake ecology. To help facilitate better understanding the Association will obtain and distribute education materials pertaining to lake ecology. This will include water quality and the importance on the lake ecosystem. Also, the importance native plants have on water quality, fisheries and the lake ecosystem as a whole.

These materials will be made available at the annual meeting, and possibly mailed to residents, depending on annual meeting attendance.

5.2-Invite guest speaker(s) to annual meeting to discuss the importance of aquatic plants and proper management.

One meeting has already been held discussing the importance of aquatic plants. This was done by the entity the completed the plant survey. In the future, more speakers will be used to further residents and interested lake users about these important organisms. The speakers may include DNR personnel, Douglas County Water Quality Specialists, or private consultants.

Action I-Education materials will be gathered and distributed at the annual meetings. A speaker will be secured for each annual meeting to talk about lake ecology and/or aquatic plants.

Goal 6 Objectives-

6.1-Develop finance committee to evaluate revenue sources.

Management of EWM can be very expensive. Even though the Wisconsin DNR has a history of being very supportive financially for the AIS management through Rapid Response and AIS Grants, it is still a cost share arrangement. Since the Cranberry Lake/Flowage Association is so small, financing even a cost share can be a burden. In order to reduce the chance of having management postponed due to lack of money, the Association will plan in advance by reviewing all revenue sources. In addition, they will contact the Town of Wascott to discuss their involvement in this issue as well.

6.2-Implement annual fundraisers (has been ongoing)

6.3-Prepare file on all Wisconsin DNR lake grants available.

Action J-An updated file with all findings of revenue evaluation, fundraiser ideas and Wisconsin DNR grants will be established for present and future use.

Table 8: Implementation plan

Implementation Plan/Information			
Action	**Timeline**	**Estimated costs**	**Volunteer hours (est)**
A-Full lake PI survey every 5 years if herbicide application occurs during that time span.	2013	$3500	n/a
B-EWM beds treated with 2,4-D at 1.5 ppm with pre (where delineated and post monitoring to determine effectiveness	Annually in delineated beds; Spring treatment before water 60 degrees F at a rate of 1.5 ppm with 2,4-D	$140 per acre foot plus $300 trip fee[21]. Pre/post survey approx. $1500.	3-4 hours for permit application
C-Communicate/coordinate with the Minong Flowage Association	Annually	$0	2 hours assuming meeting attendance.
D-Monitor for EWM and other AIS	Semi-weekly from late June to Mid August	$0 if trained by County or $500 if trained by consultant	Approximately 3 hours each session (total of 12 hours)
E-Diver removal of EWM in less dense stands	Annually as needed after treatment; Mid July	$0 if conducted by volunteers; $600-$1200 if by consultant	2-6 hours for fragment removal (for each volunteer)
F-Information distribution at landing	Annually from first weekend in May until September	$300 for kiosk construction; $300 for informational materials	6 hours X 3 volunteers for kiosk; 20-30 hours for each if CBCW Program
G-Evaluate potential shoreline restoration locations and implement one showcase restoration	Evaluate, locate and choose site 2013. If secure funding, begin project 2014	Project (depending on size) would range from $7500-9000.	Evaluation and site location-6 hours estimated.

[21] Based upon 2011 pricing of herbicide applicator used in 2011.

H-Following shoreline restoration project, provide information to help encourage other projects	After showcase completion; 2014-2015	$100-300.	6 hours estimated
I-Education on lake ecology and aquatic plants	Annually with newsletter and annual meeting; ongoing	$0-300	4 hours
J-Update financial methods/sources	Spring/Summer 2013	$0	6-10 hours