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LOWER TURTLE LAKE BARRON COUNTY, WISCONSIN

2016 NATIVE AQUATIC PLANT MANAGEMENT ADDENDUM TO THE 2010 AQUATIC PLANT MANAGEMENT PLAN

WDNR WBIC: 2079700

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October 2015

Google Earth, August 2015

LOWER TURTLE LAKE
MANAGEMENT DISTRICT
ALMENA, WI 54805

TABLE OF CONTENTS

TABLE OF FIGURES

APPENDICES

LOWER TURTLE LAKE BARRON COUNTY, WISCONSIN

NATIVE AQUATIC PLANT MANAGEMENT ADDENDUM TO THE 2010 AQUATIC PLANT MANAGEMENT PLAN

INTRODUCTION

Lower Turtle Lake (WBIC 2079700) is a hard-water drainage lake in west-central Barron County, Wisconsin about 2.5 miles east of the Village of Turtle Lake (Figure 1). According to the Wisconsin Lakes bulletin, the lake covers 276 acres, has a maximum depth of 24 feet and an average depth of 14 feet (Sather & Threinen, 1964). A LIDAR survey of Barron County completed in May 2005 indicates the lake covers 294 acres. Physical characteristics of the lake are provided in Table 1. Turtle Creek, which flows from Upper Turtle Lake, is the main tributary to Lower Turtle Lake. The stream enters at the north end of the lake and exits at the south end. The lake is also fed by three intermittent streams and wetland drainage.

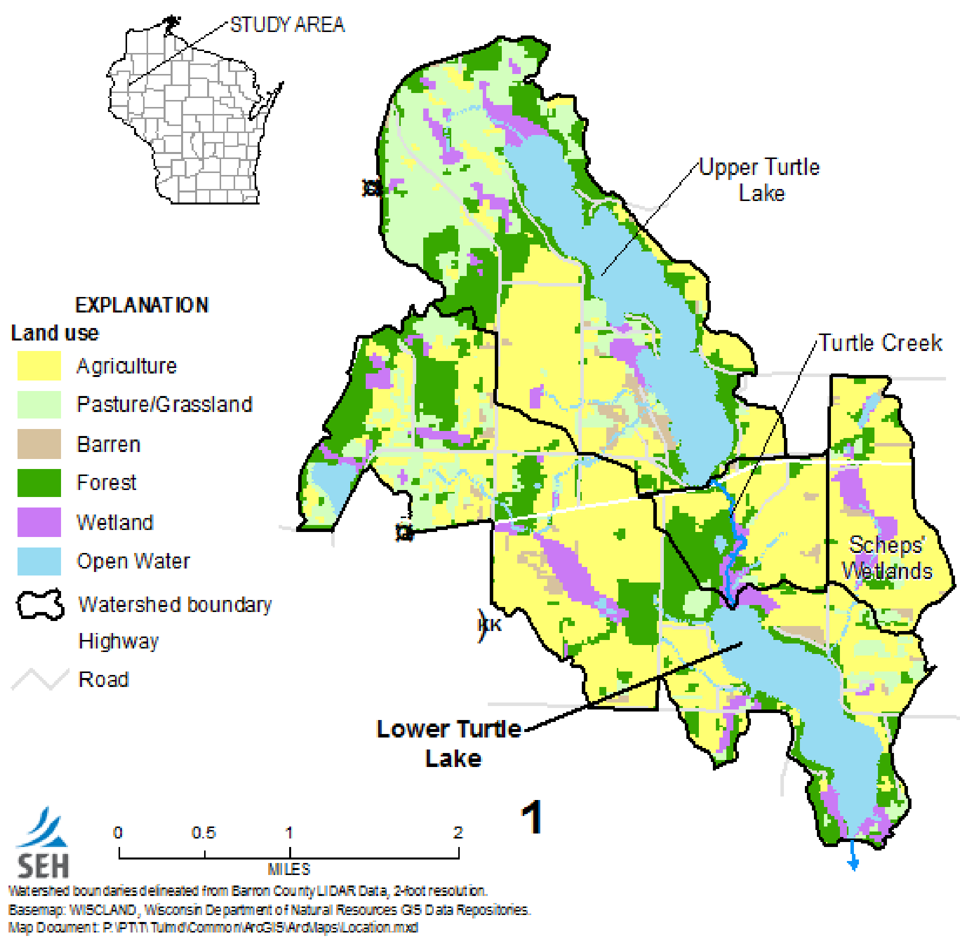


Figure 1: Lower Turtle Lake and its watershed

Table 1: Physical characteristics of Lower Turtle Lake

Lake Area (acres)	294
Watershed Area (acres)	5,569
Watershed to Lake Ratio	18:1
Maximum Depth (feet)	24
Mean Depth (feet)	13.4
Volume (acre-feet)	3,933.7
Elevation (feet AMSL)	1,172
Maximum Fetch (miles)	1.5
Miles of Shoreline	4.42
Lake Type	Drainage

Beginning in 2008, the Lower Turtle Lake Management District (District) began evaluating the benefits of aquatic plant management for Lower Turtle Lake and the property owners and users of the lake. In 2008 a whole-lake, aquatic plant survey was completed using the point-intercept method where by a number of points or locations on the lake, based on GPS coordinates, are sampled and all the vegetation located at each of these points is recorded along with the density of plant growth, depth, and bottom substrate. This survey included both an early season cold water survey and a mid-season warm water survey. An early season survey is done primarily to identify early growing plant species like CLP and EWM, both of which are considered non-native, aquatic invasive species. The warm water survey is done to identify all plant species in a lake and to give an idea as to the density and distribution of those plants in the lake.

The data from the 2008 survey was combined with other available lake and plant data to prepare an Aquatic Plant Management Plan (APMP) for the lake. An APMP is a document that is created to guide current and future aquatic plant management actions in a given body of water. It reviews aquatic plant data that is available for a lake; determines if there is a need for management for one purpose or another; lays out management alternatives that could be employed to successfully implement management if it is needed; discusses the possible implications of a given management action on other aspects of lake health, and identifies what is necessary if management is to be completed.

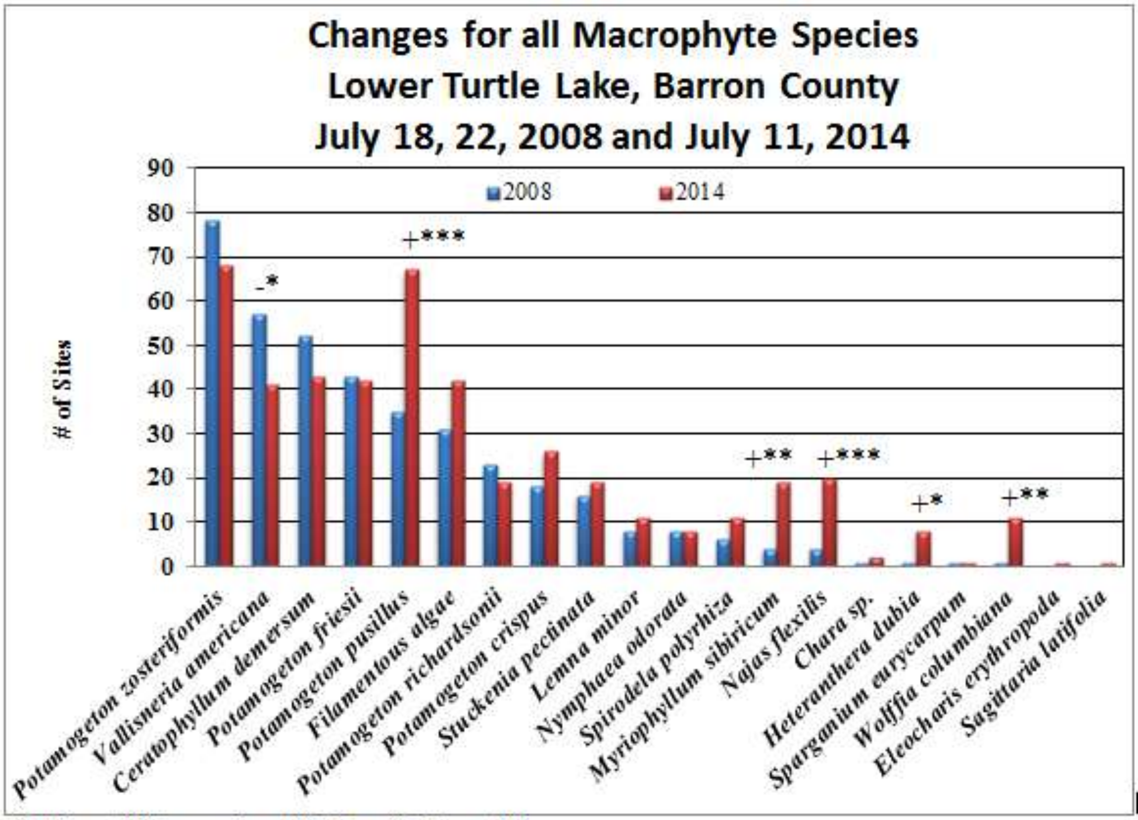
An APMP was written for Lower Turtle Lake in 2010 (Blumer & Macholl, 2010) and was focused on the management of curly-leaf pondweed (CLP), an aquatic plant species considered invasive in Wisconsin lakes. It is unknown how long CLP has been in the lake, but the first official documentation of it was in an aquatic plant treatment permit submitted to the WDNR in 1984 (personal communication Mark Sundeen, WDNR). The current extent of CLP in the lake (approximately 15-25 acres) has been pretty consistent for at least the last 15 years.

The 2010 APMP laid out six broad goals, each with a number of objectives and actions, which were to guide aquatic plant management efforts and lake health on Lower Turtle Lake over the course of five years. Actual aquatic plant management actions centered around reducing the amount of CLP in the lake to create better conditions for early season native plant growth and to eliminate some of the phosphorus that is contributed to the system when CLP senesces in early summer. In the 2010 APMP native plant management was not recommended because at the time of the 2008 survey, native plants were not overly abundant in the system even after CLP dropped out of the system. Eurasian watermilfoil (EWM) had not been found in the lake so aquatic invasive species (AIS) education, prevention, and planning was also a large part of the 2010 APMP. The six goals for the 2010 APMP were as follows:

1. Monitor, control, and manage aquatic invasive species;
2. Educate residents and users about and prevent the introduction of aquatic invasive species;
3. Monitor lake water quality;
4. Promote and implement shoreland best management practices;
5. Preserve, protect, and enhance native species;
6. Evaluate the APM plan yearly and revise as necessary.

At the same time that the 2010 APMP was being developed, the District began supporting the implementation of a much larger watershed based lake protection project. This project tied up many of the resources the District had for implementing the management recommendations in the 2010 APMP. As a result, management of CLP was put off until the lake protection project was mostly completed (2014). CLP management was first implemented in Lower Turtle Lake in 2015 with chemical treatment of 5.27 acres of CLP.

In 2014, the early and mid-season whole-lake, point-intercept survey completed in 2008 was repeated showing non-significant change in CLP distribution and density, but significant changes in the growth and distribution of several native aquatic plants, particularly Potamogeton pusillus or small pondweed (Figure 2) which is now causing navigational issues that were not present in 2008.



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

Figure 2: Significant changes in aquatic vegetation from 2008 to 2014 (Berg, 2014)

LTL continues to be free of EWM, so AIS education, prevention, and planning is still extremely important. There is also some concern about maintaining water levels in the lake. A large area of CLP is located near the outlet of the lake at the south end. CLP and native vegetation is generally very dense in this area of the lake and it is believed that this dense vegetation is helping to keep water levels in the lake a little higher. There is considerable concern among property owners about removing this vegetation as it may lead to lower water level.

PURPOSE OF THIS ADDENDUM

The purpose of this addendum to the existing Lower Turtle Lake Aquatic Plant Management Plan is to review changes in the aquatic plant community that have occurred in the last 5 years and to modify aquatic plant management recommendations in the existing plan accordingly, particularly as they pertain to management of native aquatic plants.

2008 AND 2013 AQUATIC PLANT SURVEY COMPARISONS

Four official aquatic plant surveys have been completed in Lower Turtle Lake in the last 20 years. The Blue Water Science (BWS) consulting firm completed surveys in 1994 (McComas & Stuckert, 1995) and 2004 (McComas S. , 2005) using a transect method previously accepted by the WDNR. In 2008 and 2014, Endangered Resource Services (ERS) completed aquatic plant surveys using a point-intercept method, which is currently required by the WDNR. Both surveys included an early season cold water survey and a mid-season warm water survey.

Aquatic plant management recommendations in the existing APMP are based on the 2008 survey. Modifications to those recommendations in this document are based on the 2014 aquatic plant survey results. The WDNR recommends that APMPs extend no more than five years beyond the last plant survey. In addition, it is recommended that changes in the aquatic plant community that may be due to the management actions implemented should be evaluated at least every 5 years after management begins. The 2014 aquatic plant survey data is needed to re-evaluate the management recommendations made in 2010 however, since actual aquatic plant management did not begin until 2015, the latter is not a reason for creating this Addendum.

Much of the following aquatic plant data is taken from the 2014 Aquatic Plant Survey Report prepared by Endangered Resource Sciences (Berg, 2014).

Summary statistics from the 2014 point-intercept survey are presented in Table 2 along with those available from the 1994 & 2004 transect surveys and the 2008 point-intercept survey. Aquatic plants were found growing at 113 sites or on approximately 23.6% of the entire lake bottom and in 64.2% of the littoral zone. Despite a littoral upper limit of 12.0ft, most plant growth ended in 7-8ft of water. The mean and median depths of plants were nearly identical at 4.1ft and 4.0ft respectively (Table 2).

Depth values showed a slight increase over 2008 when the mean and median depths were 3.7ft and 3.5ft, and plants were found at 109 points (22.7% of the bottom). Although the recorded 2008 littoral zone only extended to 8.0ft and resulted in a littoral coverage of 83.2% (nearly 20% greater than 2014), it was noted that, as in 2014, most plant growth ended in 7-ft and plant coverage in both years was actually near identical.

Plant diversity was very high in 2014 with a Simpson Index value of 0.90 – up from 0.87 in 2008. However, total richness was found to be low with only 27 species found growing in and directly adjacent to the lake – this was up from 26 in 2008. Mean native species richness at sites with native vegetation was also up from 3.13/site in 2008 to 3.50/site in 2014. Mean total rake fullness declined from a very high 2.49 (estimated) in 2008 to a moderate 1.99 in 2014.

Table 2: 1994, 2004, 2008 and 2014 aquatic plant survey statistics

Statistic	Survey Year			
	1994	2004	2008	2014
Points sampled	66	75	479	479
Number of sites with vegetation	*46	60	109	113
Maximum depth of plants (ft)	8	8	8	12
Mean depth of plants (ft)	NA	NA	3.7	4.1
Median depth of plants (ft)	NA	NA	3.5	4
Percent of lake bottom coverage	31	NA	22.7	23.6
Sites shallower than maximum depth of plants	66	75	131	176
Frequency of occurrence at sites shallower than max depth of plants	88.5	80	85.5	64.2
Simpson Diversity Index	**0.88	**0.90	0.88	0.9
Sites sampled using rope rake (R)	0	0	0	0
Sites sampled using pole rake (P)	66	75	142	200
Average number of all species per site (shallower than max depth)	*2.4	3.32	2.72	2.38
Average number of all species per site (veg. sites only)	*2.72	4.15	3.27	3.7
Average number of native species per site (shallower than max depth)	*2.38	3.25	2.58	2.23
Average number of native species per site (veg. sites only)	*2.7	4.07	3.13	3.5
Species Richness	17	19	17	19
Species Richness (including visuals)	NA	NA	18	21
Species Richness (including visuals and boat survey)	NA	NA	26	27

*Does not include all transect data

**Calculated by ERS, 2010

COMPARISON OF NATIVE SPECIES IN 2008 AND 2014

In July 2008, flat-stem pondweed, wild celery, coontail, and Fries' pondweed were the most common native species (Table 3). They were found at 71.56%, 52.29%, 47.71%, and 39.45% of survey points with vegetation respectively and accounted for 64.61% of the total relative frequency. Relative frequency shows a particular plant species' frequency relative to all other plant species. It is expressed as a percentage, and the total of all species' relative frequencies will add up to 100%. Organizing species from highest to lowest relative frequency value gives an idea of which species are most important within the macrophyte (large plant) community. Small pondweed (9.83), Clasping-leaf pondweed (6.46), and Curly-leaf pondweed (5.06) were the only other species with relative frequencies over 5.0 in 2008.

In July 2014, flat-stem pondweed, small pondweed, coontail, and Fries' pondweed were the most common species being found at 60.18%, 59.29%, 38.05%, and 37.17% of sites with vegetation and representing 52.63% of the total relative frequency (Table 4). This lower total for the top four species suggested a more diverse and even plant community existed in July 2014 when compared to 2008. Wild celery (9.81) and CLP (6.22) also had relative frequencies over 5.0.

Table 3: Partial list of frequencies and mean rake sample of aquatic macrophytes
Lower Turtle Lake, Barron County
July 18, 22, 2008

Species	Common Name	Total Sites	Relative Freq.	Freq. in Veg.	Freq. in Lit.	Mean Rake	Visual Sight.
Potamogeton zosteriformis	Flat-stem pondweed	78	21.91	71.56	59.54	1.79	5
Vallisneria americana	Wild celery	57	16.01	52.29	43.51	2.21	0
Ceratophyllum demersum	Coontail	52	14.61	47.71	39.69	1.35	6
Potamogeton friesii	Fries' pondweed	43	12.08	39.45	32.82	1.70	0
Potamogeton pusillus	Small pondweed	35	9.83	32.11	26.72	1.57	1
	Filamentous algae	31	*	28.44	23.66	2.42	0
Potamogeton richardsonii	Clasping-leaf pondweed	23	6.46	21.10	17.56	1.43	1
Potamogeton crispus	Curly-leaf pondweed	18	5.06	16.51	13.74	1.00	2
Stuckenia pectinata	Sago pondweed	16	4.49	14.68	12.21	1.88	1
Lemna minor	Small duckweed	8	2.25	7.34	6.11	1.63	0
Nymphaea odorata	White water lily	8	2.25	7.34	6.11	1.63	7
Spirodela polyrhiza	Large duckweed	6	1.69	5.50	4.58	2.00	0
Myriophyllum sibiricum	Northern water-milfoil	4	1.12	3.67	3.05	1.00	5
Najas flexilis	Slender naiad	4	1.12	3.67	3.05	1.25	0
Chara sp.	Muskgrass	1	0.28	0.92	0.76	1.00	0
Heteranthera dubia	Water star-grass	1	0.28	0.92	0.76	1.00	0
Sparganium eurycarpum	Common bur-reed	1	0.28	0.92	0.76	3.00	0
Wolffia columbiana	Common watermeal	1	0.28	0.92	0.76	1.00	0

* Excluded from the Relative Frequency Calculation

Table 4: Partial list of frequencies and mean rake sample of aquatic macrophytes
Lower Turtle Lake, Barron County
July 11, 2014

Species	Common Name	Total Sites	Relative Freq.	Freq. in Veg.	Freq. in Lit.	Mean Rake	Visual Sight.
Potamogeton zosteriformis	Flat-stem pondweed	68	16.27	60.18	38.64	1.51	5
Potamogeton pusillus	Small pondweed	67	16.03	59.29	38.07	1.42	2
Ceratophyllum demersum	Coontail	43	10.29	38.05	24.43	1.28	4
Potamogeton friesii	Fries' pondweed	42	10.05	37.17	23.86	1.74	1
	Filamentous algae	42	*	37.17	23.86	1.76	0
Vallisneria americana	Wild celery	41	9.81	36.28	23.30	1.56	2
Potamogeton crispus	Curly-leaf pondweed	26	6.22	23.01	14.77	1.08	5
Najas flexilis	Slender naiad	20	4.78	17.70	11.36	1.15	0
Myriophyllum sibiricum	Northern water-milfoil	19	4.55	16.81	10.80	1.26	4
Potamogeton richardsonii	Clasping-leaf pondweed	19	4.55	16.81	10.80	1.53	3
Stuckenia pectinata	Sago pondweed	19	4.55	16.81	10.80	1.47	4
Lemna minor	Small duckweed	11	2.63	9.73	6.25	1.36	0
Spirodela polyrhiza	Large duckweed	11	2.63	9.73	6.25	1.73	0
Wolffia columbiana	Common watermeal	11	2.63	9.73	6.25	1.27	0
Heteranthera dubia	Water star-grass	8	1.91	7.08	4.55	1.00	1
Nymphaea odorata	White water lily	8	1.91	7.08	4.55	1.75	2
Chara sp.	Muskgrass	2	0.48	1.77	1.14	1.00	0
Eleocharis erythropoda	Bald spikerush	1	0.24	0.88	0.57	1.00	1
Sagittaria latifolia	Common arrowhead	1	0.24	0.88	0.57	2.00	1
Sparganium eurycarpum	Common bur-reed	1	0.24	0.88	0.57	3.00	1

* Excluded from the Relative Frequency Calculation

Lake wide, six species experienced significant changes from 2008 to 2014 (Figure 2). Wild celery showed a significant decline while small pondweed and slender naiad demonstrated highly significant increases; northern water milfoil and common watermeal moderately significant increases; and water stargrass a significant increase. As no active management was occurring in the lake between 2008 and 2014, the most likely explanation for this is annual differences in growing conditions.

Flat-stem pondweed, the most common species in both 2008 and 2014, continues to be widespread throughout the lake (Figure 3). Found at 78 sites in 2008, it declined in distribution to 68 sites in 2014. It also declined in density from a mean rake fullness value of 1.79 in 2008 to 1.51 in 2014. Along with coontail, it appeared to be filling in many areas that were vacated by CLP's late June senescence. This was especially true in the south bay.

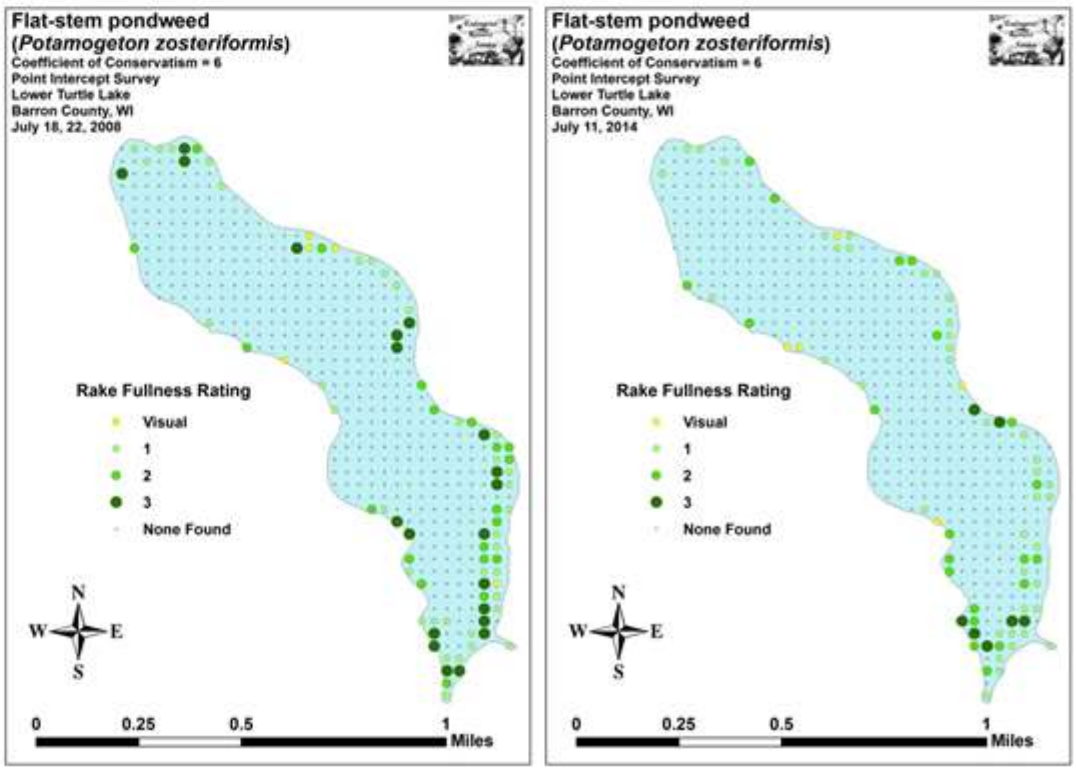


Figure 3: 2008 and 2014 flat-stem pondweed density and distribution

Wild celery, the second most common species in 2008 but only the fifth most common in 2014, showed a significant decline in distribution as it was found at 57 sites in 2008 but only 41 sites in 2014 (Figure 4). It also declined sharply in density with an average rake fullness of 2.21 in 2008, but just 1.56 in 2014. A late spring/start to the growing season in 2014 is the most likely explanation for this observation as celery often doesn't reach its peak growth until late July/early August.

Mirroring Wild celery's decline was the highly significant increase in small pondweed's distribution (35 in 2008 to 67 in 2014). The fifth most common species in 2008, it jumped to be the second most common in 2014 (Figure 4). Despite this increase in distribution, it did suffer a slight decline in density (mean rake fullness of 1.57 in 2008 to 1.42 in 2014).

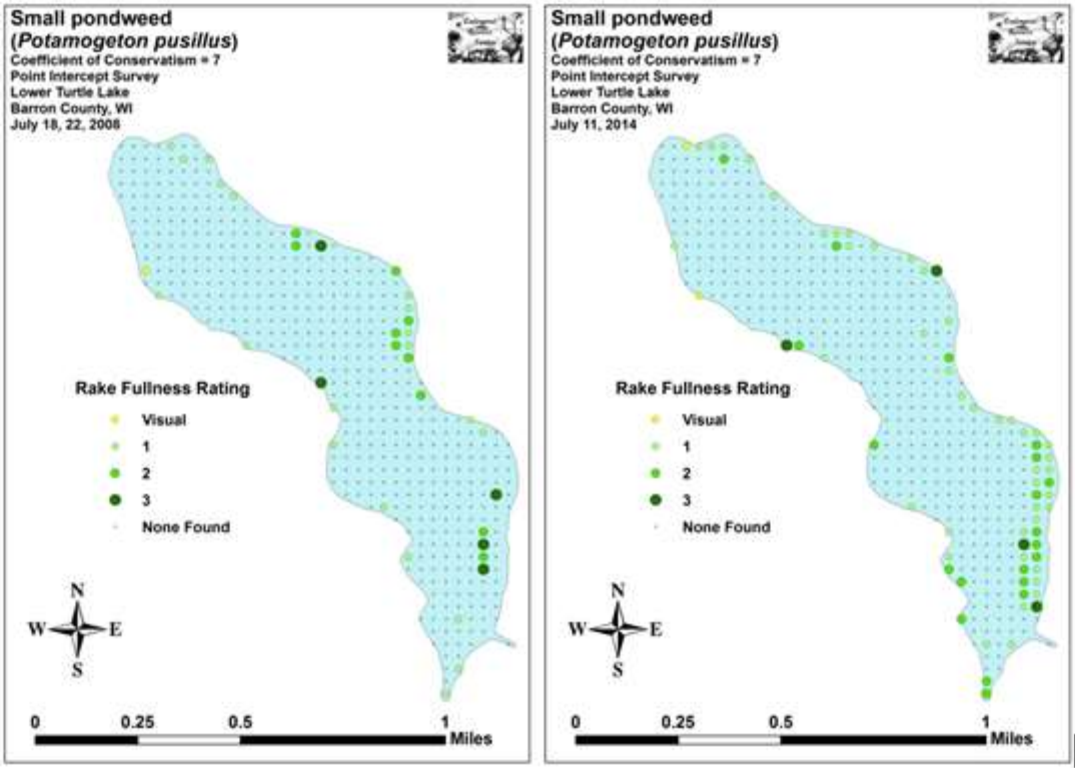


Figure 4: 2008 and 2014 small pondweed density and distribution

AQUATIC PLANT DENSITY

The areas of greatest summer aquatic plant density are in the north and south ends of the lake and along the east shore of the lake, particularly that area of the east shore in the southern lobe of the lake (Figure 5). The plant beds in the north and south ends are for the most part not adjacent to developed property, and therefore are not considered to be a nuisance or navigational impairment. However, the dense vegetation along the east shore is. Due to a long and shallow slope from the shoreline to deeper water, large flats of dense vegetation exist in this area.

Four native aquatic plant species make up the majority of plant biomass (actual plant material) on these flats during the summer months. They are flat-stem pondweed, small pondweed, Fries pondweed, and wild celery. Of these species, small pondweed showed highly significant increases in distribution and density in 2014 when compared to 2008. Wild celery actually showed a somewhat significant decline, and Fries and flat-stem showed little change from 2008 to 2014. All of these species can cause issues because of the type of plant they are: long and stringy. "Stringy" pondweed is a generic term for several different pondweeds including but not limited to small, flat-stem, and Fries (Figure 6). While these species provide excellent food and habitat in a lake, their growth characteristics (many long narrow stems with limited large leafy material) makes them easy to get wrapped around boat motor propellers, paddles, fishing lures, and limbs, impairing boating, fishing, swimming, and other lake uses. Along the southeastern shore these beds of vegetation are located between docks and the open water, making navigation difficult. Water celery is not a pondweed, but has similar characteristics: long and stringy with no large, leafy material, so it to can impair lake use and open water access (Figure 7).

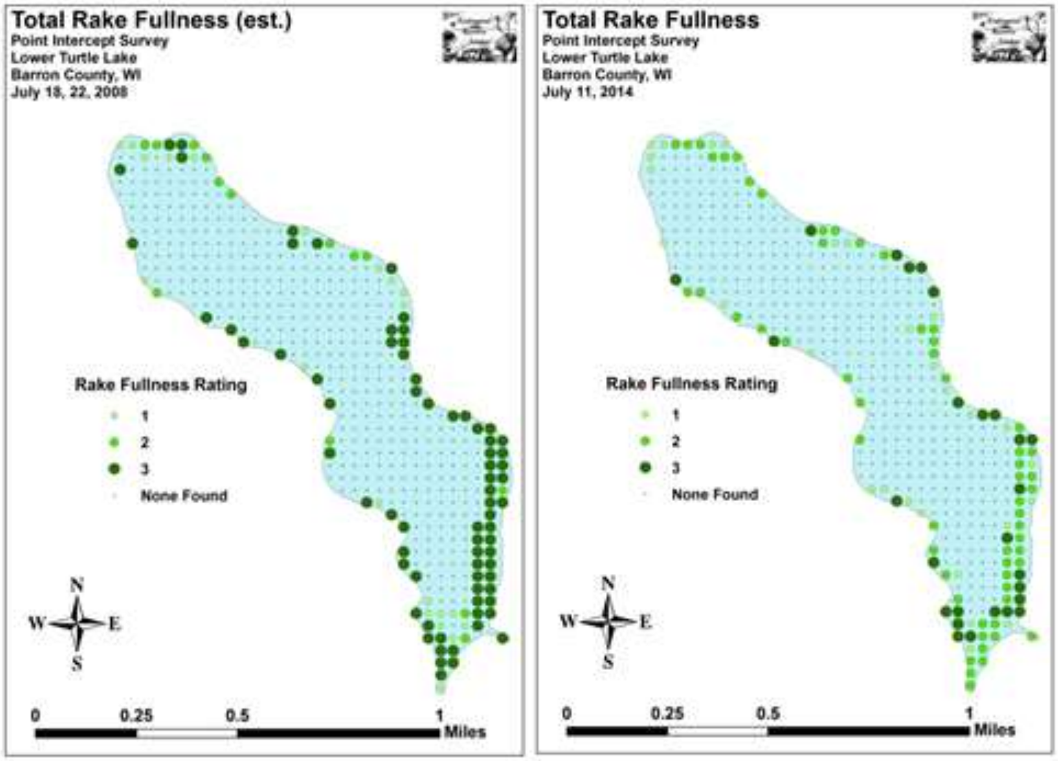


Figure 5: 2008 and 2014 total rake density comparison

Figure 6: Stringy pondweeds – flat-stem (left), Fries (center), and small (right)

Figure 7: Water celery (USGS photo)

CURLY-LEAF PONDWEED

The 2008 spring Curly-leaf pondweed survey found CLP at 51 sites which approximated to 10.6% of the entire lake. Of these, a rake fullness value (Figure 8) of 3 at 21 points, 2 at eight points, and a 1 at 22 points was recorded. This extrapolated to 6.1% of the lake having a significant infestation (rake fullness of 2 or 3) (Figure 8).

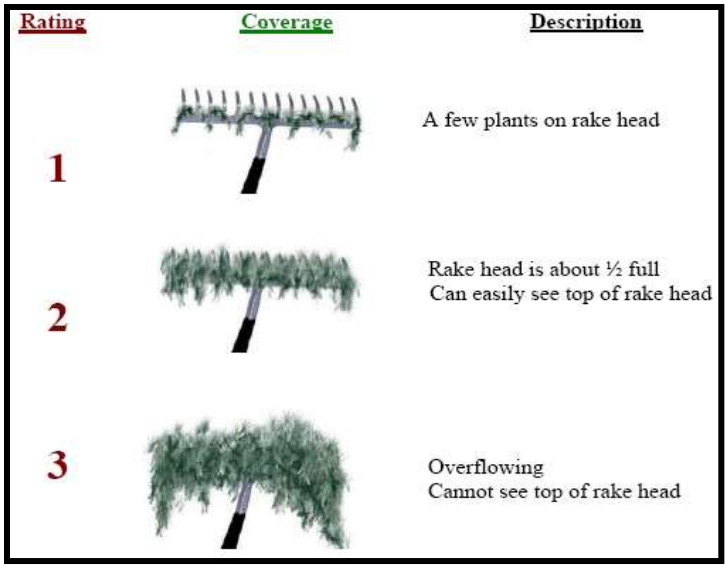


Figure 8: Rake fullness values

In 2014, following the establishment of the littoral zone at approximately 9.5ft of water, CLP was sampled for at all points in and adjacent to this zone. CLP was present in the rake at 40 sample points which approximated to 8.4% of the entire lake. Of these, a rake fullness value of 3 at nine points, 2 at 14 points, and a value of 1 at 17 points was recorded. This extrapolates into 4.8% of the lake having a significant infestation (rake fullness of 2 or 3) of CLP (Figure 9).

These results suggest a significant reduction in rake fullness 3 and a significant increase in visual sightings (Figure 10). As no active CLP management was occurring between 2008 and 2014, these changes are likely simply the result of differences in annual growing conditions.

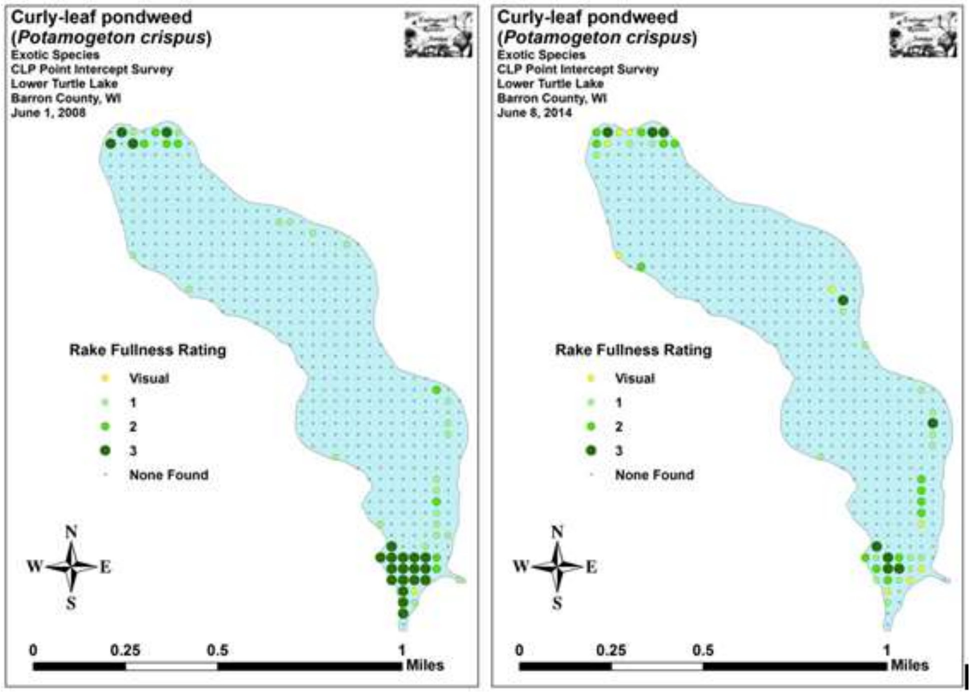
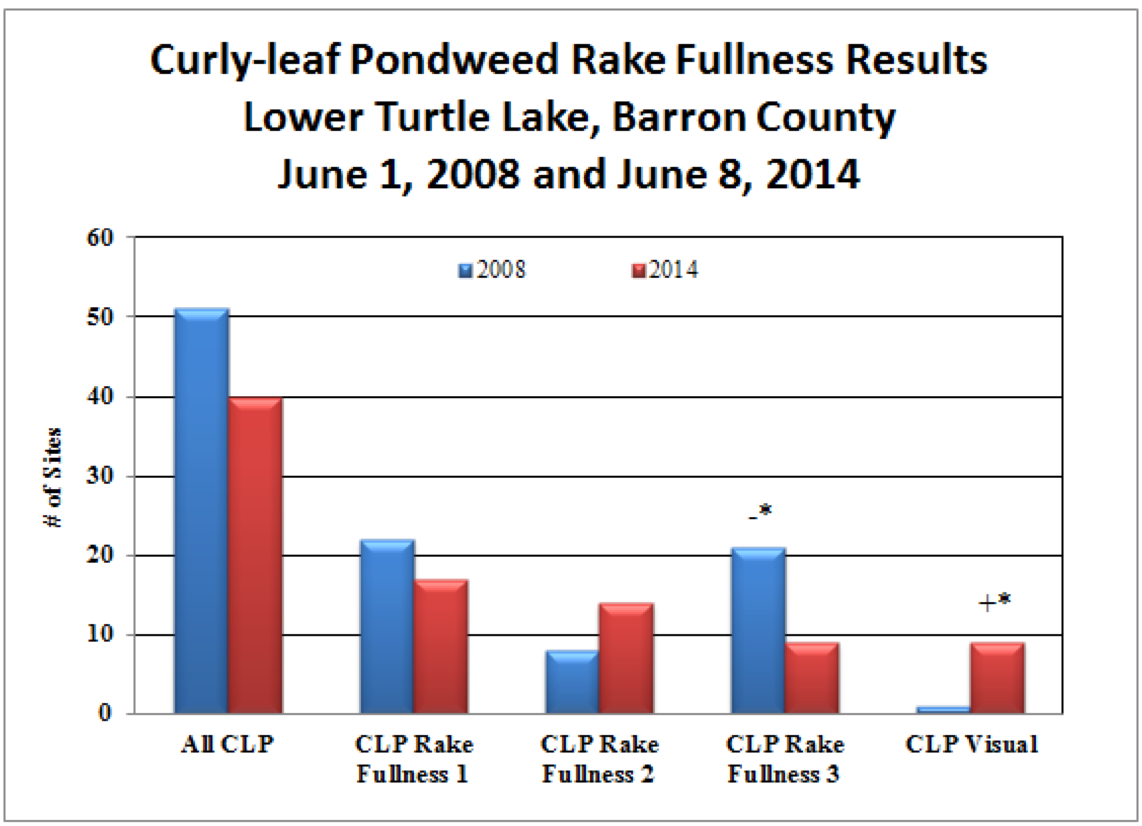


Figure 9: 2008 and 2014 June CLP density and distribution



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

Figure 10: 2008 and 2014 changes in June CLP rake fullness ratings

CLP BED MAPPING

Bed mapping is an extension of the early season point-intercept survey. Sites where CLP was located during the point-intercept survey are surveyed a little later in the spring to determine the total surface area of the lake impacted. Bed mapping for CLP was not done in 2008, but it was done in 2014. During the 2014 point-intercept survey CLP was found throughout the lake but occurred at low densities or in a narrow band along the east/west shorelines where the majority of lake residences were found. Lake wide, nine beds totaling 9.42 acres (3.3% of the lake's 286 acres) with the biggest being 4.90 acres and the smallest being 0.07 acre were located and mapped (Figure 11, Appendix C). Each of these beds was canopied or near canopy, and, although some of them were scattered to 7.0ft, most growth ended abruptly at 5-6ft forming a hard outer edge. The inner edges often extended to 3ft, but tended to be more fragmented as CLP was almost always mixed with native plants.

The densest and largest beds (1, 2, 5, and 9) were located next to undeveloped shorelines or well away from shore where they were unlikely to interfere with lake access or most recreational navigation. Beds 3, 4, 6, 7, and 8 were located in front of residences. In the case of Beds 3 and 4, plants were patchy enough and the beds narrow enough that it was unlikely that a resident would require more than one prop clear to reach open water. However, Beds 6, 7, and 8 did appear to moderately impair navigation. Although they weren't particularly wide, these beds also had dense stands of native vegetation with scattered CLP growing on the shallow flat that extended from their inner edge to the eastern shoreline.

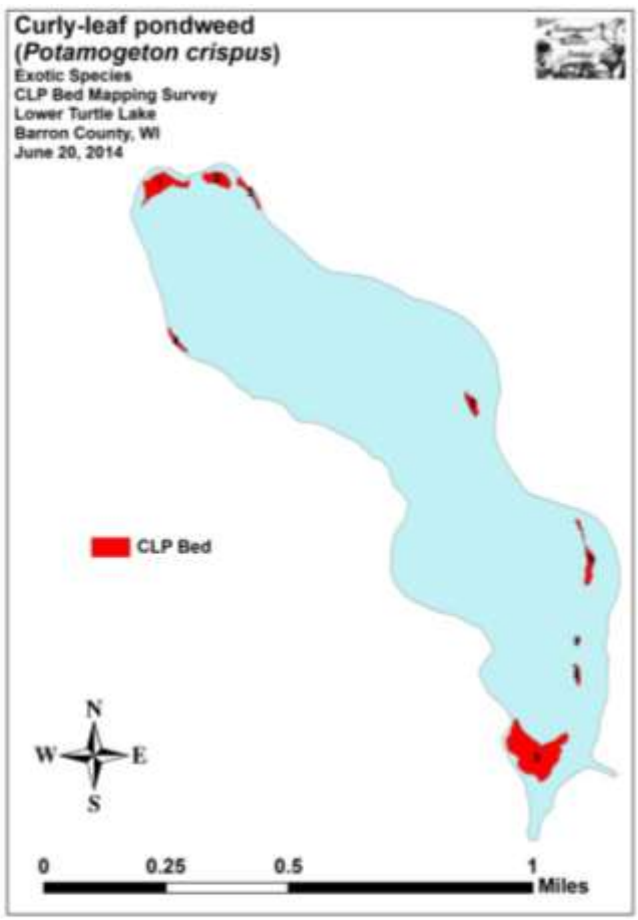


Figure 11: June 2014 CLP Bed Mapping Results

Results of the 2008 aquatic plant survey prompted the surveyor to suggest that Lower Turtle Lake needs to re-establish and enhance its native plant community. Survey results showed that native aquatic plants were not abundant in the lake and that their diversity and distribution was poor. Results from the 2014 found that aquatic plant diversity was very high in 2014 with a Simpson Index value of 0.90 – up from 0.87 in 2008. Total species richness is still considered to be low with only 27 species found growing in and directly adjacent to the lake, but this was up from 26 in 2008. Mean native species richness at sites with native vegetation was also up from 3.13/site in 2008 to 3.50/site in 2014. In July 2014, flat-stem pondweed, small pondweed, coontail, and Fries' pondweed were the most common species being found at 60.18%, 59.29%, 38.05%, and 37.17% of sites with vegetation and representing 52.63% of the total relative frequency (Table 4). This lower total for the top four species suggested a more diverse and even plant community existed in July 2014 when compared to 2008 (Berg, 2014).

As is explained in the 2010 APMP, reducing the amount of dense growth CLP early in the season will continue to support the recovery of native plants in the system. Reducing the amount of CLP in the system will also reduce the amount of phosphorus loading attributed to the senescence of CLP. It may also reduce early season nuisance and navigation issues. The 2010 APMP recommends chemically treating all of the CLP in the lake to gain the most benefit. However, because there are Lake Resident concerns about losing water level if vegetation in the south end of the lake is somehow removed, this addendum recommends that there be no management of CLP in this area.

Aquatic vegetation has been shown to reduce discharge in lowland rivers by increasing the Manning roughness coefficient in a complex interaction with discharge and mean velocity (Vereecken, Baetens, Viaene, Mostaert, & Meire, 2006). Lower Turtle Lake is a drainage lake. Water comes in regularly at the north end from Upper Turtle Lake via Turtle Creek and through several tributaries that feed the lake, and then goes out at the south end where the most dense aquatic vegetation beds exist. According to Vereecken et al, increased aquatic biomass results in an increasing Manning-n, and increasing fall (water level), and a decreasing discharge capacity, so it is reasonable to assume that at least some increase in water level is being maintained as a result of the dense vegetation.

Changes in the distribution and density of native aquatic plants since 2008 and documented in the 2014 survey, has also prompted concerns among many residents related to nuisance and navigational impairments caused by native aquatic plants, particularly in the southeast area of the lake where large shallow flats exist, and where certain native plant species that are particularly dense interfere with lake use. The 2010 APMP recommends efforts to protect existing native plants. This recommendation still holds true, but in certain areas, lake use and accessibility can be improved with limited native aquatic plant management, that would be done in a way as not to negatively impact the positive changes in the plant community noted between 2008 and 2014.

Problematic aquatic plants in a lake can be managed in a variety of ways. The eradication of non-native invasive plants such as CLP is generally not feasible, but preventing them from becoming a more significant problem is an attainable goal. Targeted early season chemical treatment or removal can minimize impacts by preventing the AIS from becoming the dominant plant species in the lake and encouraging the growth of more desirable native aquatic plants. Less CLP also means less phosphorus loading mid-summer when it senesces or decays.

Sometimes it is necessary to manage native aquatic plants that grow to such a level as to cause their own nuisance and navigational impairments. Generally, a diverse plant community will prevent certain native plants from becoming a nuisance. For example, submersed aquatic plants like coontail, northern watermilfoil, and common waterweed may be beneficial native plants, but can become an issue when they are the predominant species in a lake. These plants do well in the presence of man-made disturbances and poor water quality, often increasing when other plants more sensitive to human disturbances are disappearing. In Lower Turtle, these plants are present, but are not the ones causing nuisance conditions, suggesting that water quality is still supporting a more diverse aquatic plant community.

Protecting native plants should be a primary focus of plant management in Lower Turtle Lake due to the benefits they offer including providing fish and wildlife habitat, keeping aquatic invasive plant species at bay, maintaining water quality, protecting the shoreline from erosion, improving lake aesthetics, and increasing land owner privacy. Continued management efforts to improve water quality in the lake will help increase both aquatic plant diversity and quality.

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

- Mechanical/physical control;
- Chemical control;
- Biological control; and
- Aquatic plant habitat manipulation.

Mechanical and physical control methods include pulling, cutting, raking and harvesting. Chemical control is typified by the use of herbicides. Biological control methods include organisms that use the plants for a food source or parasitic organisms that use the plants as hosts. Biological control may also include the use of species that compete successfully with the nuisance species for resources. Examples of plant habitat manipulation include dredging, flooding and drawdown. In many cases, an integrated approach to aquatic plant management is necessary.

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

Not all plant management alternatives can be used in a particular lake. What other states accept for aquatic plant management may not be acceptable in Wisconsin. What is acceptable and appropriate in one Wisconsin lake may not be acceptable and appropriate in another Wisconsin lake.

All existing APMPs and the management permits (chemical or harvesting) that accompany them are reviewed by the WDNR. It has become increasingly important for new and existing APMPs to include yearly monitoring and assessment to document impacts on water quality, fish and wildlife, native plants, and control results for the targeted species. It is equally important for new APMPs to evaluate the potential for restoring the lake's natural plant community. Shifting the plant community toward more diverse native species through a reduction of targeted aquatic invasive species and nuisance level native plants prevents plant management from becoming endless, routine maintenance.

WDNR NORTHERN REGION AQUATIC PLANT MANAGEMENT STRATEGY

The WDNR has a Northern Region Aquatic Plant Management Strategy that went into effect in 2007. All aquatic plant management plans developed for northern Wisconsin lakes are evaluated according to the following goals:

- Preserve native species diversity which, in turn, fosters natural habitat for fish and other aquatic species, from frogs to birds;
- Prevent openings for invasive species to become established in the absence of the native species;
- Concentrate on a whole-lake approach for control of aquatic plants, thereby fostering systematic documentation of conditions and specific targeting of invasive species as they exist;
- Prohibit removal of wild rice. WDNR-Northern Region will not issue permits to remove wild rice unless a request is subjected to the full consultation process via the Voigt Tribal Task Force. The WDNR discourages applications for removal of this ecologically and culturally important native plant.
- To be consistent with WDNR Water Division Goals (work reduction/disinvestment), established in 2005, to "not issue permits for chemical or large scale mechanical control of native aquatic plants – develop general permits as appropriate or inform applicants of exempted activities." This process is similar to work done in other WDNR Regions, although not formalized as such.

For the purposes of this addendum, the management options discussed in the next section have been arranged in order of appropriateness and acceptability for management of nuisance level native aquatic plants in Lower Turtle Lake. The analysis of management alternatives for CLP remains consistent with what is in the 2010 APMP.

PHYSICAL/MANUAL REMOVAL

Except for wild rice, manual removal of aquatic plants by means of a hand-held rake or by pulling the plants from the lake bottom by hand is allowed by the WDNR without a permit provided the area of removal does not exceed 30 shoreland feet and all raked or pulled plant material is taken completely out of the lake (NR 109) (Appendix A). There is no limit as to how far out into the lake this management activity can occur provided the area cleared is no more than 30-ft wide. If an aquatic invasive species like EWM or CLP is the target species, then removal by this means is unrestricted. Manual removal can be effective at controlling individual plants or small areas of plant growth. It limits disturbance to the lake bottom, is inexpensive, and can be practiced by many lake residents. In shallow, hard bottom areas of a lake, or where impacts to fish spawning habitat need to be minimized, this may be the best form of control. Pulling aquatic invasive species while snorkeling or scuba diving in deeper water is also allowable without a permit and can be effective at slowing the spread of a new aquatic invasive species infestation within a waterbody when done properly.

Many property owners along the shores of Lower Turtle Lake already implement this management action. Small areas around a dock or in a swimming area are kept open by some residents through raking and/or cutting. This activity should continue in those areas that are conducive to it. For residents along the southeastern shore (or other areas), where dense beds of aquatic vegetation can extend several hundred feet out into the lake this method of management is more difficult. In many cases, a dock area is cleared out, and then daily boat traffic from that area to the open water keeps a channel open.

MECHANICAL HARVESTING

Mechanical harvesting assumes that vegetation is cut and removed from the waterbody after cutting. Mechanical harvesting machines can be relatively simple or highly technical. Machines can be purchased that mount to the front of a pontoon boat that just cut the plant material and then require additional effort to remove the cut material from the water. More complex machines can be purchased that cut, store, and remove the plant material from the water all at the same time. Cutting widths can be from 3-4 ft to as much as 10 or more feet. Depending on the size of the unit, the harvesters may be driven by paddle wheel, regular boat motor, or depend on an external source to move around. The depth at which these machines can cut and operate depends on the type of machine it is. Most will allow for skimming of the surface and/or cutting down to as much as five or more feet into the water (Figure 12).

Figure 12: Examples of different size and type of aquatic plant harvesters (Aquarius Systems, Eco-Harvester, Jenson Lake Mower, Hockney Weed Cutter)

Depending on the size, harvesters can remove thousands of pounds of vegetation in a relatively short time period. They are not, however, species specific. Everything in the path of the harvester will be removed including the target species, other plants, macro-invertebrates, semi-aquatic vertebrates, forage fishes, young-of-the-year fishes, and even adult game fish found in the littoral zone (Booms, 1999). Large-scale plant harvesting in a lake is similar to mowing the lawn. Plants are cut at a designated depth, but the root of the plant is often not disturbed. Cut plants will usually grow back after time, just like the lawn grass. Re-cutting several times a season is often required to provide adequate annual control (Madsen, 2000). Harvesting activities in shallow water can re-suspend bottom sediments into the water column releasing nutrients and other accumulated compounds (Madsen, 2000). Even the best aquatic plant harvesters leave some cutting debris in the water to wash up on the shoreline or create loose mats of floating vegetation on the surface of the lake. This "missed" cut vegetation can cause hardship of its own. Some research indicates that after cutting, reduction in available plant cover causes declines in fish growth and zooplankton densities. Other research finds that creating deep lake channels by harvesting increases the growth rates of some age classes of bluegill and largemouth bass (Greenfield, David, Hunt, Wittmann, & Siemering, 2004).

One benefit of aquatic plant harvesting is the removal of large amounts of plant biomass from a water body. Plants use up nutrients including phosphorous in the water and sediment. However, they often re-deposit that phosphorous back into the lake water and sediment when they die. Early season or cool water plants like CLP, that complete their life cycle, die, and senesce (decay) in early summer can be a source of significant phosphorous loading and may negatively affect dissolved oxygen levels.

All harvesting operations necessitate a disposal plan as well. When first removed from the water, aquatic plants are very heavy, but as they drain and dry out they get much lighter. Depending on how much vegetation is being removed, it is often necessary to have a dump site, and a way to get the cut plants from the lake to that dump site. Once disposed of, the cut plant material is terrific mulch or garden fertilizer. As mentioned earlier though, mechanical harvesting will remove all vegetation in the path. It will also pick up aquatic insects, some small fishes, snails, and other aquatic life. This may be an issue when disposing of the harvested material.

SMALL-SCALE MECHANICAL HARVESTING

Small-scale harvesting is considered removing only a limited amount (less than an acre or two) of aquatic vegetation. A boat mounted mower like the Jenson Lake Mower (Figure 12) that only cuts a narrow path 3-4 ft wide could be used. Mowers like this are generally attached to the bow of a boat or pontoon and run on battery power, like a trolling motor. The depth at which these mowers cut is set by the operator and is only limited by the depth of the lake, and the pole attached to the mower blade. However, it would not be expected that this kind of mower would be operated in deep water, and is likely most effective in water depth below five or six feet. In addition, this type of mower would cut the vegetation, but not remove it from the system. A second boat or pontoon would have to follow to remove the cut vegetation. Cutting equipment of this nature can be purchased for just a few thousand dollars.

A mid-range aquatic plant cutter boat is manufactured by the Hockney Company in WI (Figure 12). This unit has a 10-ft cutting blade and side cutters and can cut several feet into the water and plants emerging from the water. It is self-propelled, but like the smaller boat-mounted units, does not remove what is cut from the lake. It does however come with a rake-like attachment to make it easier to push cut aquatic plants to the shore where they are more easily removed. This particular unit is small enough to fit on a small flat-bed roller trailer, and sells new in the $20,000-$25,000.00 range. Used ones are available for less than $10,000.00.

Several companies are building smaller, assembly line harvesting machines (Figure 12). These machines are generally about the size of an 18-20 foot pontoon boat, can be moved about like a small pontoon boat, and can remove, store, and transport the vegetation that is cut immediately. They require a driver to operate the machine and additional costs associated with trailering, maintenance, and storage. The estimated cost for a harvester like this is in the $40,000 to $60,000 range.

Small-scale aquatic plant harvesting in Lower Turtle Lake is likely the best management option assuming the goal is to provide limited navigational relief during the summer months. It would be expected that once the first round of harvesting was done, that regular boat traffic would keep navigation lanes open. By doing so, the amount of effort needed to open the lanes, particularly when using a mower blade attached to a pontoon or boat, would be minimized. If the District were to decide to purchase a small harvester, navigation lanes and access corridors would be easy to maintain, and the same machine could be used to manage CLP instead of using herbicides.

LARGE-SCALE MECHANICAL HARVESTING

Large-scale harvesting is removing several acres or more of aquatic vegetation potentially at multiple times during a season. A mechanical harvester that would cut, remove, store, and transport aquatic vegetation would be needed. The size of the machine is less important than having the ability to do all the things just mentioned. Mechanical harvesters capable of managing multiple acres of vegetation come in many different sizes and operation modes. Cutting paths could be as little as 4-ft or as much as 10 or 12 feet. They might run on gas or diesel motors, be moved by paddle wheel or propeller driven motors, and may or may not be easily trailered and transported. Large-scale harvesting would occur much the same as small-scale harvesting; only the amount harvested changes. Machines like this are typically custom built when an order comes in, not taken off an assembly line. Estimated costs could be anywhere from $100,000 to $300,000 or more. There are used mechanical harvesters available which may be somewhat less expensive.

Large-scale harvesting is not recommended for Lower Turtle Lake unless the goal is to remove CLP early in the season as well as to open navigation lanes later in the season. But even under this scenario, a smaller, potentially less expensive harvester could be used.

AQUATIC HERBICDES

One of the bullet points in the WDNR Northern Region Aquatic Plant Management Strategy clearly states that "…not issuing permits for chemical or large scale mechanical control of native aquatic plants…" is a goal the state has. As such, it is unlikely that the use of aquatic herbicides to treat native aquatic plants in Lower Turtle Lake would be permitted by the WDNR. Furthermore, during the summer months different types of aquatic plants that are present may require different types of herbicide to be applied for effective results.

The main focus of limited native aquatic plant harvesting on Lower Turtle Lake would be to provide navigation relief by opening designated navigation and access lanes to improve access to open water. The most problematic area of the lake is the fully developed southeast shoreline where a large shallow (1-5 feet) flat extends 200-300 feet out into the lake before dropping off to 10 feet or more (Figure 13). It is on this flat that dense growth native aquatic vegetation creates navigational impairments for lake users throughout July and August. These impairments are exacerbated when water levels in the lake are low due to weather conditions.

Secondary benefits of limited native aquatic plant harvesting would be improving fishing access in the shallow flats, possibly improving the fishery, and reducing nutrient loading from decaying vegetation.

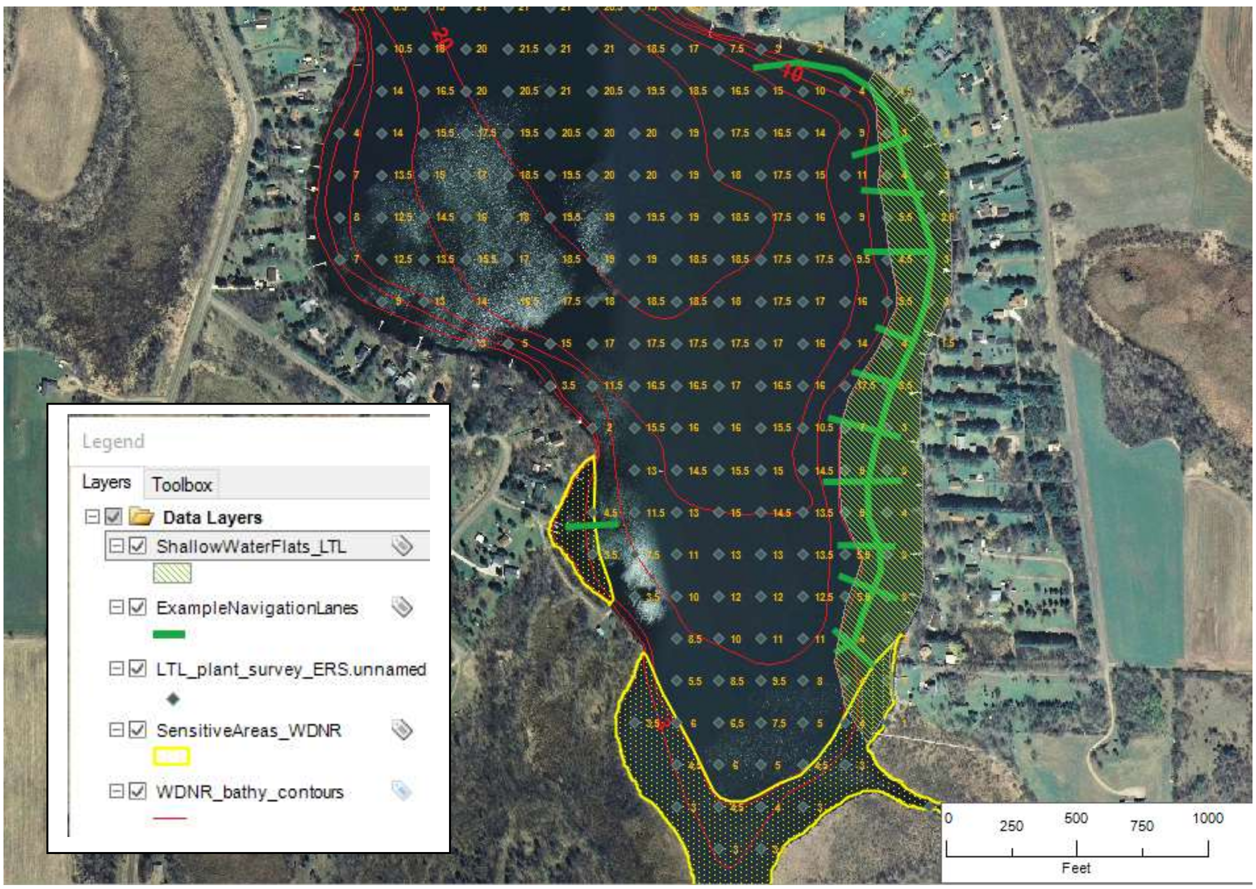


Figure 13: Southern half of Lower Turtle Lake showing the "shallow water flat" along the southeast shoreline

To provide navigational relief and access to open water, navigation and access lanes 10-20 feet wide, covering 1.5 - 3.0 acres of total surface area would be opened and maintained (Appendix B). Harvesting depth in the channels would not exceed 2/3 of the water depth and at least 2 feet of vegetation will be left on the bottom. Harvesting will not be implemented in water less than 3 feet deep. Harvesting would only occur in those areas identified ahead of time and included in a WDNR harvesting permit. Final approval of the harvesting permit will be dependent on verification by

WDNR Staff of nuisance/navigation impairment conditions. It would be expected that once the navigation and access lanes were opened, that regular use would maintain them, and regular harvesting would not be necessary. If the channels did not remain open due to use, then the need for them would be re-evaluated. If it was determined that a given channel is not needed, harvesting of it would be stopped.

No clear cutting of native aquatic vegetation would be completed, and any proposed cutting in sensitive areas would be kept at a minimum.

Limited harvesting of native aquatic plants in the summer months would likely not negatively impact the overall abundance and diversity of native aquatic vegetation in the lake. Within the channels, rooted vegetation would not be removed, only cut deep enough to allow unimpeded navigation to open water.

Off-loading and disposal sites would be identified prior to beginning any harvesting operation, but it would be expected that the public access sites on the east and west side of the lake would be used. There is an abundance of agricultural land around Lower Turtle Lake where harvested plant material could potentially be disposed of. It would also be possible to identify a dump site, where local residents could go to pick up harvested material to use as mulch on gardens. One such site could be the Barron County public access on the west side of the lake (Figure 14).

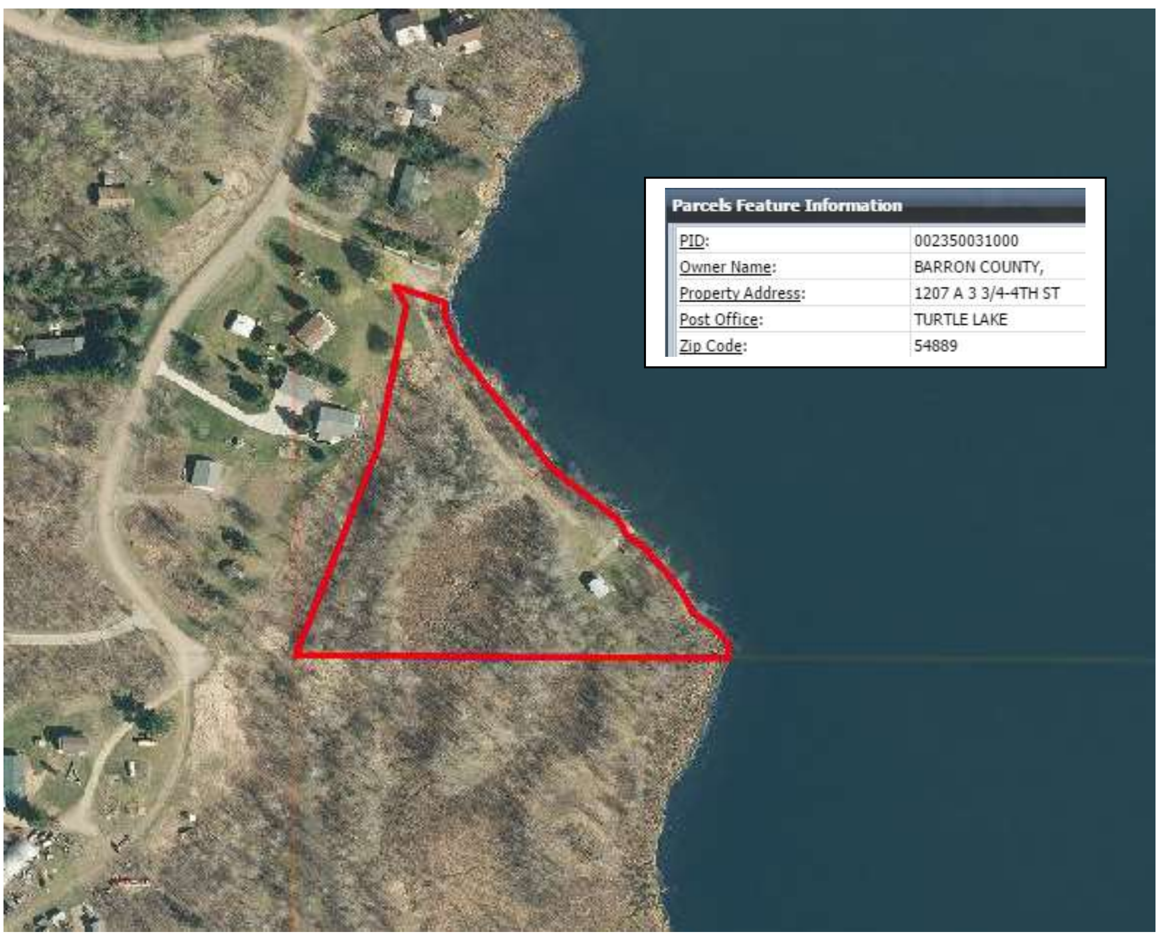


Figure 14: Barron County Public Boating Access on the west side of Lower Turtle Lake (Barron County GIS)

The Rice Lake – Lake Protection and Rehabilitation District harvests native aquatic plants for navigation and nuisance relief. Depending on the aquatic plant growth in a given year they harvest 2.75-3.5 tons of native aquatic vegetation annually (2015 Rice Lake Aquatic Plant Management Plan, LEAPS). It is estimated that as much as 95% of the biomass of aquatic plants is water, so 3 tons of harvested vegetation would only amount to 300 lbs. of actual plant material once it has been dewatered (Aquatic Ecosystems Restoration Foundation (AERF), 2009). A more conservative estimate, based on observations at the Rice Lake Protection and Rehabilitation aquatic plant dump site, is 50-75% of the harvested material goes away, leaving around 1,500 lbs. of actual plant material annually (Figure 15).

Figure 15: Rice Lake Protection and Rehabilitation District harvested aquatic plant dump site (Photo taken on 9/16/2015). Plant material built deposited from the last six weeks of harvesting. The highest pile of vegetation at the back of the photo had been deposited only a day or two before this photo. (LEAPS, 2015)

In the existing Aquatic Plant Management Plan for Lower Turtle Lake written in 2010, there are six broad goals, each with a number of objectives and actions, which guide plant management efforts on Lower Turtle Lake. The plan recommends management of curly-leaf pondweed through the use of aquatic herbicides, but leaves the door open for adding harvesting of CLP as a management tool. The existing plan does not make recommendations for management of native aquatic plants for nuisance and navigation relief during the summer months except for physical removal by property owners. This goal was included in the existing APM Plan in order to protect the diversity and distribution of native plants in the lake, based on 2008 aquatic plant survey results that showed limited native aquatic plant growth during the summer months. At that time, an over-abundance of dense growth native aquatic plant vegetation was not an issue. Since 2008, no management for of aquatic plant, native or non-native, was completed before the spring of 2015 when approximately 6 acres of CLP was chemically treated for the first time.

The goals in the existing APM Plan have not been compromised by any goal, objective, or action in this Addendum. Overall goals still include control and management of non-native aquatic invasive plant species; providing landowner and lake user education and information related to non-native aquatic invasive species and the value of native plant species; promoting shoreland and near shore improvements; and monitoring water quality to track changes that might occur when aquatic plant management is implemented.

This addendum adds a new goal of providing better access to open water in certain parts of the lake where summer growth of native aquatic plant vegetation has become much denser since 2008.

New Goal – Manage dense growth native aquatic vegetation during the summer months (June-September) to provide improved access to open water from developed properties along the shore.

Objective One – Remove up to 3 acres of aquatic vegetation from navigation and access channels totaling no more than 1.25 miles in length.

Action One – Establish navigation and access lanes that are 10-20 ft. wide in areas of the lake where summer native aquatic plant growth reaches or exceeds a rake head density 3 on a 0-3 scale (Figure 16) and is either at or within in 6 inches of the surface.

Figure 16: Rake Head Density 1 (left); 2 (middle); and 3 (right)

Action Two – Document via rake sampling all species of native aquatic vegetation that are causing navigational impairments and/or nuisance level conditions prior to beginning actual management.

Action Three – Implement cutting and removal and/or harvesting of dense growth aquatic vegetation in predetermined navigation and access lanes.

- *Method One* – Manual cutting followed up with immediate removal of cut vegetation by physical, manual, or mechanical means
- *Method Two* – Small-scale mechanical cutting equipment followed up with immediate removal of cut vegetation by physical, manual, or mechanical means
- *Method Three* – Small-scale mechanical harvesting with a machine that simultaneously cuts and removes the aquatic vegetation

Conditions: Mechanical cutting or harvesting of aquatic plants in the channels will not exceed 2/3 of the water depth and at least 2 feet of vegetation will be left on the bottom. Harvesting will not be implemented in water less than 3 feet deep.

Objective Two – Dispose of cut and removed and/or harvested aquatic vegetation at a location that will not impact shoreland fauna and flora, negatively affect nearby property owners, or re-introduce vegetation or nutrients from decaying vegetation back into the waterbody.

Action One – Identify and secure primary off-loading sites for cut and removed and/or harvested aquatic vegetation that will provide easy access to the water's edge, and that will not negatively affect nearby property owners.

Action Two – Identify and secure dump and storage sites for cut and removed and/or harvested aquatic vegetation away from the water's edge that will not negatively impact other water resources or nearby property owners. *Public accessibility to the dump and storage site so removed vegetation could be picked up by community members and used locally for mulch would be supported by this management objective.*

Objective Three - Complete annual native aquatic plant cut and removal and/or harvesting activity and assessment reports.

Action One – Create an Aquatic Plant Removal Activity Record (APRAR) that includes an estimate of the daily amount of aquatic vegetation removed (lbs or tons), an estimate of the total end-of-season amount of vegetation removed (tons), number of harvested loads (if applicable), number of days when removal was completed, estimated surface area with vegetation removed (acres), and the most common aquatic plant species removed in the areas where management took place.

Action Two - Use the APRAR to create annual End-of-Season Assessment Reports to be used to make recommendations for modifying the following year "open water access" management plan.

The actions included in this Addendum will be completed by the LTLMD, their consultants, and through partnerships formed with the WDNR, the Barron County Soil and Water Conservation Department, and other local clubs and organizations.

FUNDING AND PERMITTING

Because cutting and removal and/or harvesting is considered maintenance management by the WDNR, it is expected that the Lower Turtle Lake Management District will cover the costs of any necessary management planning and aquatic plant cutting and removal and/or harvesting through Lake District funds. Recreational Boating Facilities (RBF) grant funding could be applied for by the LTLMD if the decision is made to purchase any mechanical cutting and removal equipment or a harvester. RBF grants can be applied for at any time, but require a request be made in person in front of a five member Waterways Commission Advisory Board which generally convenes quarterly each year. More information about the RBF grant is available at http://dnr.wi.gov/Aid/RBF.html.

A WDNR Mechanical/Manual Aquatic Plant Control Permit is necessary to implement the management actions in this Addendum. Application Form 3200-113 is available on line at http://dnr.wi.gov/lakes/plants/forms/3200113_fillExt.pdf.

A suggested Plan for opening and maintaining access channels to open water is included in Appendix B. The LTLMD still needs to decide how, or if they plan to implement the management actions in this Addendum. It is expected that if they do implement the management actions in this Addendum, that it will be completed by using one or more of the Management Methods identified in Objective One, Action Three.

Physical removal of aquatic plants, that which is done by hand with no motorized mechanical assistance, can be done legally without a permit according to Guidelines found in NR 109 (Appendix A).

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