Aquatic Plant Harvesting Plan
Little Yellow Lake and Danbury Flowage

Burnett County, Wisconsin

March 2017

Sponsored By

Yellow Lakes and River Association

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Introduction

This Harvesting Plan for Little Yellow Lake and the Danbury Flowage is prepared to meet the requirements of NR 109.08. It is sponsored by the Yellow Lakes and River Association (YLRA). The plan includes data about the plant community, watershed, and water quality of the lakes.

An aquatic macrophyte survey was conducted on Little Yellow Lake and the Danbury Flowage in August 2014, and a curly leaf pondweed bed mapping survey was completed for the same water bodies in June 2014. The aquatic plant surveys found that Little Yellow Lake and the Danbury Flowage have a healthy, abundant, and diverse plant community. Native plants provide fish and wildlife habitat, stabilize bottom sediments, reduce the impact of waves against the shoreline, and prevent the spread of non-native invasive plants – all critical functions for the lake.

This harvesting plan, developed with input from an advisory committee, will help the Yellow Lakes and River Association manage harvesting operations.

This plan will guide the Yellow Lakes and River Association, Burnett County, and the Wisconsin Department of Natural Resources in aquatic plant management through harvesting for Yellow and Little Yellow Lakes and the Yellow River over the next five years (from 2018 through 2022).

Public Input for Plan Development

The YLRA Aquatic Plant Management (APM) Advisory Committee provided input for the development of this harvesting plan. The APM Advisory Committee met on February 19, 2016. At this meeting, the committee reviewed the aquatic plant management planning process and objectives, plant survey results, previous aquatic plant management and plan goals, and discussed potential harvesting operations.

The YLRA board announced the availability of the draft harvesting plan for review with a public notice in the Burnett County Sentinel the week of February 20, 2017. Copies of the plan were made available to the public on the YLRA web site: YLRA.org and at Larsen Family Public Library in Webster. Comments were accepted through March 15. No comments were received.

Lake Information

The project area includes Yellow Lake, Little Yellow Lake, and the Danbury Flowage - a portion of the Yellow River from the outlet of Little Yellow Lake to the dam near Danbury. Yellow Lake (WBIC 2675200) and Little Yellow Lake (WBIC 2674800) combine to form a 2,635-acre drainage lake in north-central Burnett County. Both lakes are eutrophic with maximum summer Secchi (water clarity) readings around six feet and littoral zones that reach a depth of 10 to 13. The littoral zone is the lake depth to which plants grow. See Table 1 below for further information.

Table 1. Lake Information

	Yellow (2007)[2]	**Little Yellow (2014)**[3]
Size (acres)	2,287	348
Mean depth (feet)	19	10
Maximum depth (feet)	31	21
Littoral zone depth (feet)	13	10

A map of the lakes is found in Figures 1, and a flowage map is shown in Figure 2.

[2] Berg, Matthew S., Endangered Resources Services, LLC. *Aquatic Macrophyte Survey for Yellow Lake and Little Yellow Lake, Burnett County, Wisconsin.* July 2007.

[3] *Curly-leaf pondweed (Potamogeton crispus) Point-intercept and Bed Mapping Surveys, and Warm-water Macrophyte Point-intercept Survey Little Yellow Lake – WBIC: 2674800 Burnett County, Wisconsin.* June and July 2014.

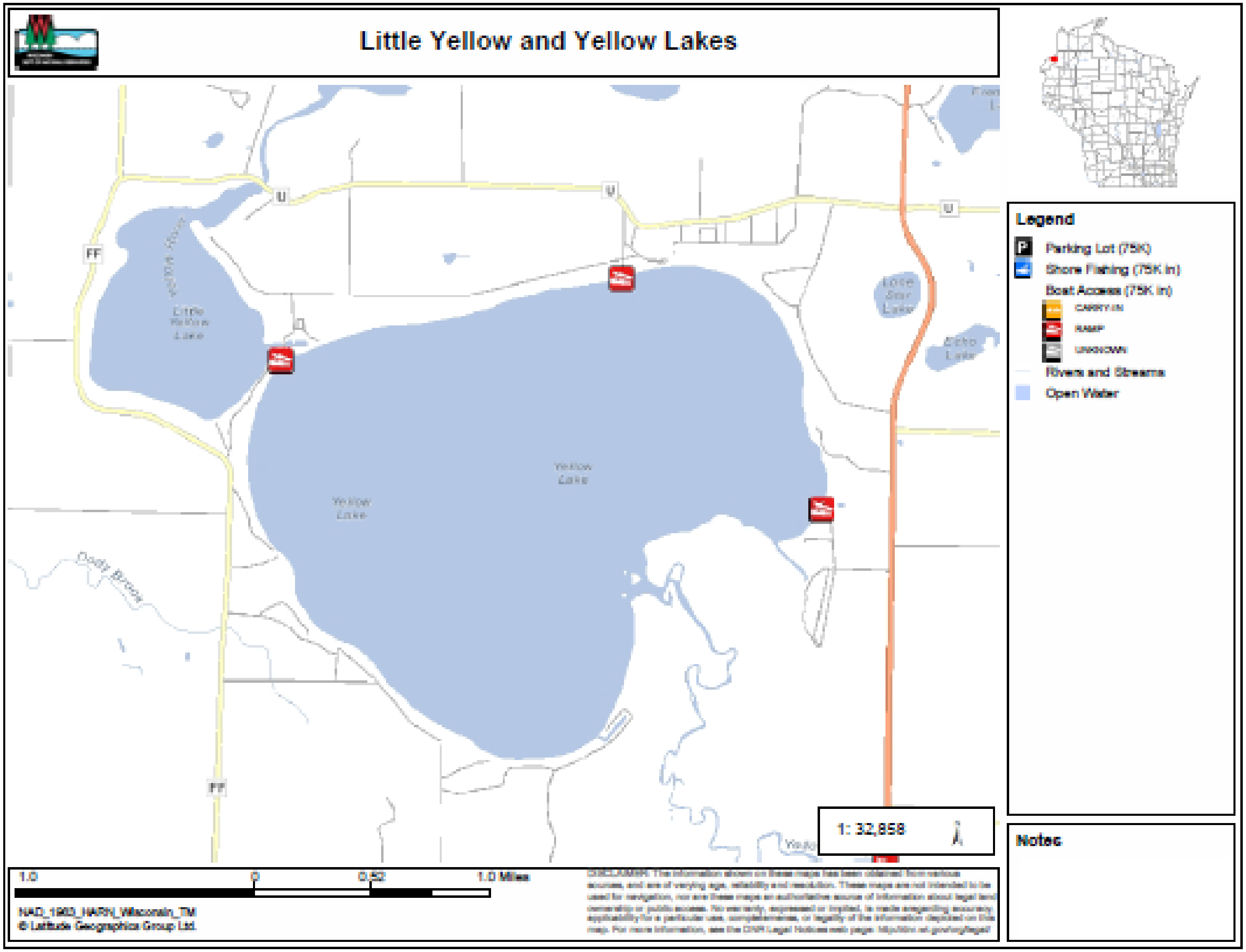

Figure 1.Yellow and Little Yellow Lake Map

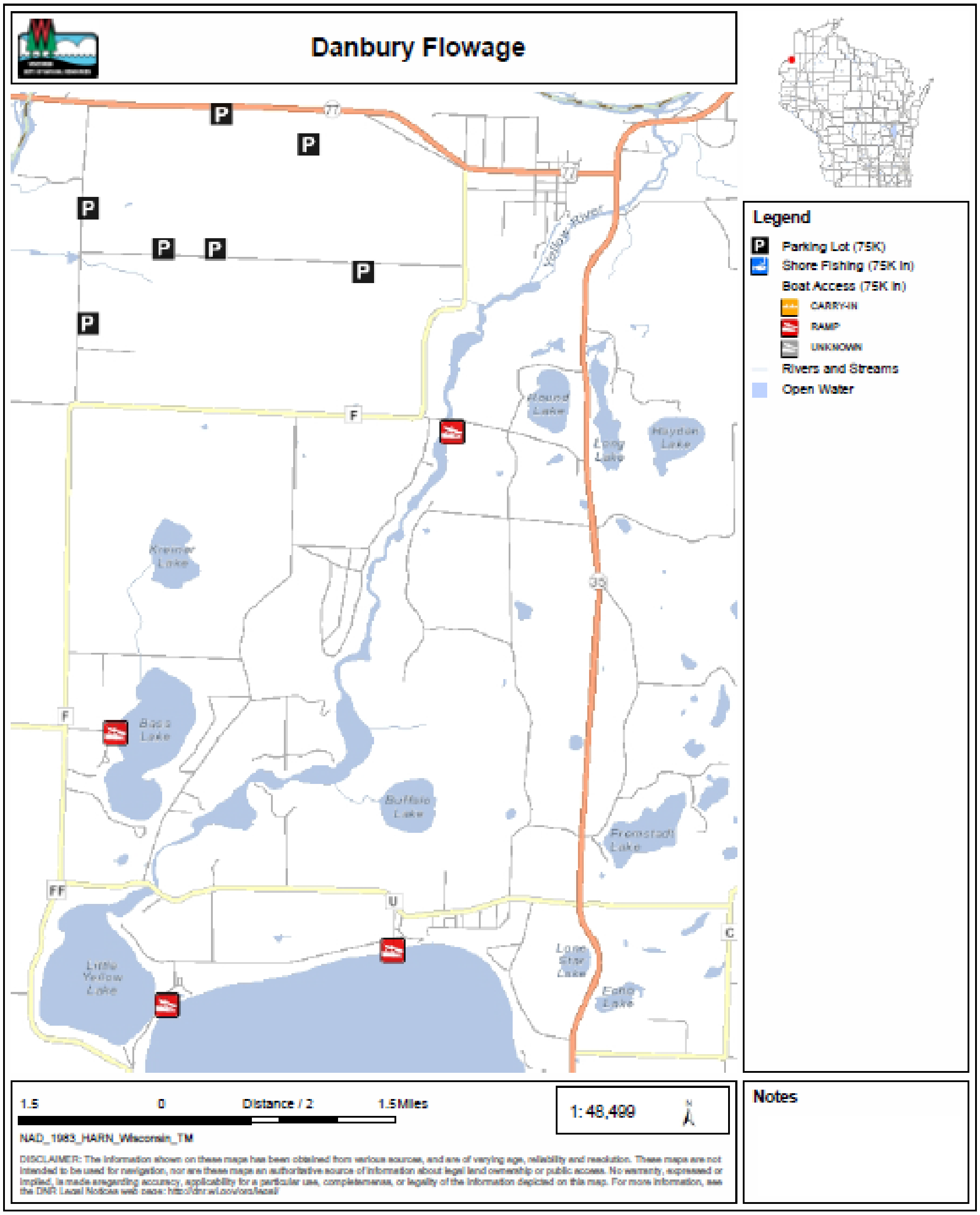

Figure 2. Danbury Flowage Map

Water Quality

Water quality is frequently reported by the trophic state or nutrient level of the lake. Nutrient-rich lakes are classified as eutrophic. These lakes tend to have abundant aquatic plant growth and low water clarity due to algae blooms. Mesotrophic lakes have intermediate nutrient levels and only occasional algae blooms. Oligotrophic lakes are nutrient-poor with little growth of plants and algae.

Secchi depth readings are one way to assess the trophic state of a lake. The Secchi depth is the depth at which the black and white Secchi disk is no longer visible when it is lowered into the water. Greater Secchi depths occur with greater water clarity. Secchi depth readings, phosphorus concentrations, and chlorophyll measurements can each be used to calculate a Trophic State Index (TSI) for lakes.[3] TSI values range from 0 – 110. Lakes with TSI values greater than 50 are considered eutrophic. Those with values in the 40 to 50 range are mesotrophic. Lakes with TSI values below 40 are considered oligotrophic.

Citizen lake monitoring volunteers have collected data from the lakes at four sites. There are two data collection sites on Yellow Lake: Site A, near the lake's center (collected 92, 96-2015), and Site B, on the northeast part of the lake (collected 92, 96-08, 2011). Little Yellow Lake is also sampled in two locations: Site A, near the lake's deepest point (collected 92-99, 02, 03, 05-13, 2015), and Site B, in the North Bay (collected 2000-03, 06, 2008).

Annual results are available from the WDNR website. Results from 2015 are averaged and recorded in Table 2 below. The parameters sampled included water clarity, dissolved oxygen, total phosphorus, and chlorophyll. Trophic State Index classifications were then determined based on the chlorophyll values. Lakes that have more than 20 µg/l and impoundments that have more than 30 µg/l of total phosphorus may experience noticeable algae blooms.

Table 2. Citizen Lake Monitoring Results 2015[4]

	Yellow Lake Site A	Little Yellow Lake Site A
Number of samples	5	2
Secchi Depth (ft)	6	NA
Total Phosphorus (µg/l)	35	40.8
Chlorphyll (µg/l)	24.6	28.3
Trophic State Index (TSI)	82.5	57.5
TSI Classification (based on Chl.)	Eutrophic	Eutrophic

Yellow and Little Yellow Lake are both classified as eutrophic. A eutrophic TSI usually suggests decreased clarity, fewer algal species, oxygen-depleted bottom waters during the summer, evident plant overgrowth, and only warm-water fisheries (pike, perch, bass, etc.).[5]

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[3] TSI = 60 – 14.41 (ln * Sechhi depth in meters) and TSI = (9.81) (ln Chl a + 30.6).

[4] Reports and Data: Burnett County. WDNR website. February 2016. <http://www.dnr.state.wi.us/lakes/CLMN/>

[5] Reports and Data: Burnett County. WDNR website. February 2016. <http://www.dnr.state.wi.us/lakes/CLMN/>

Figure 3 illustrates the Secchi depth averages for Yellow Lake Site A. Figure 4 graphs the Trophic State Index for Yellow Lake Site A, based upon Secchi depth, chlorophyll, dissolved oxygen, and total phosphorus results. Figures 5 and 6 depict Little Yellow Lake Site A's Secchi depth and Trophic State Index, respectively.

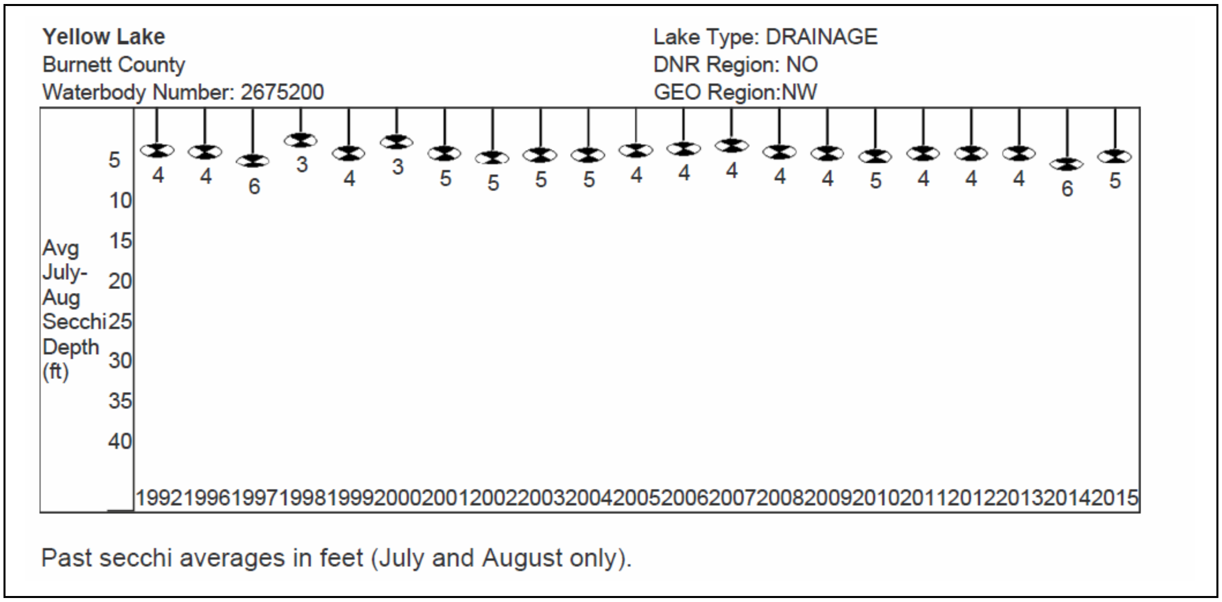

Figure 3. Yellow Lake Secchi Depth 1992-2015

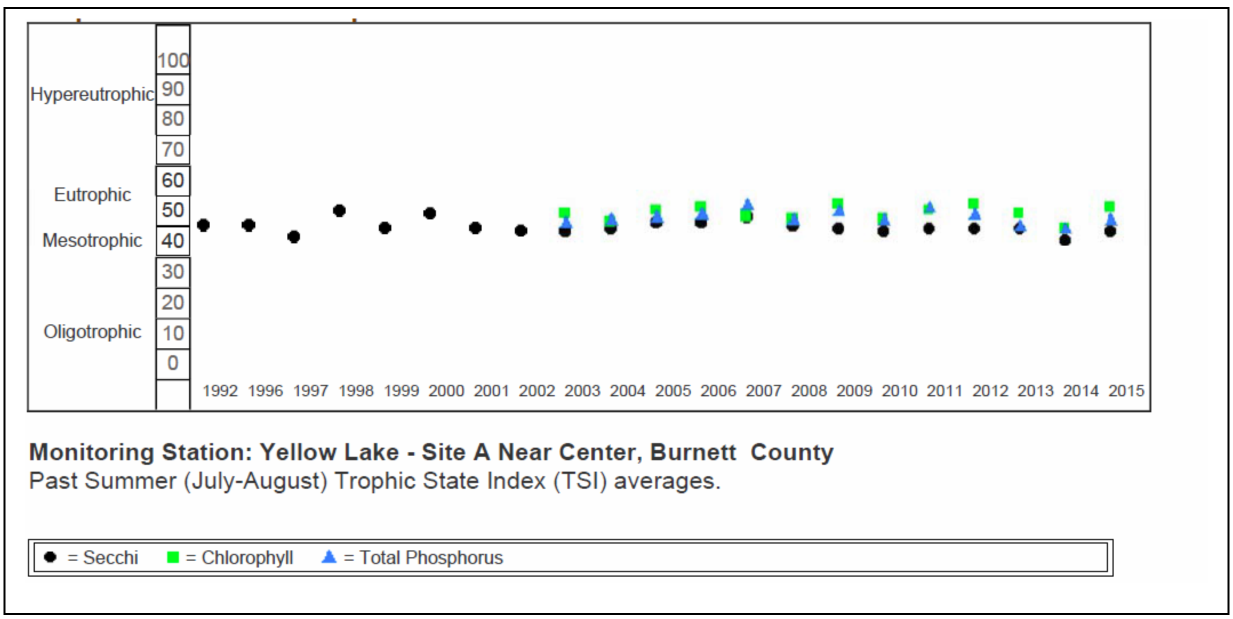

Figure 4. Yellow Lake Trophic State Index 1992-2015

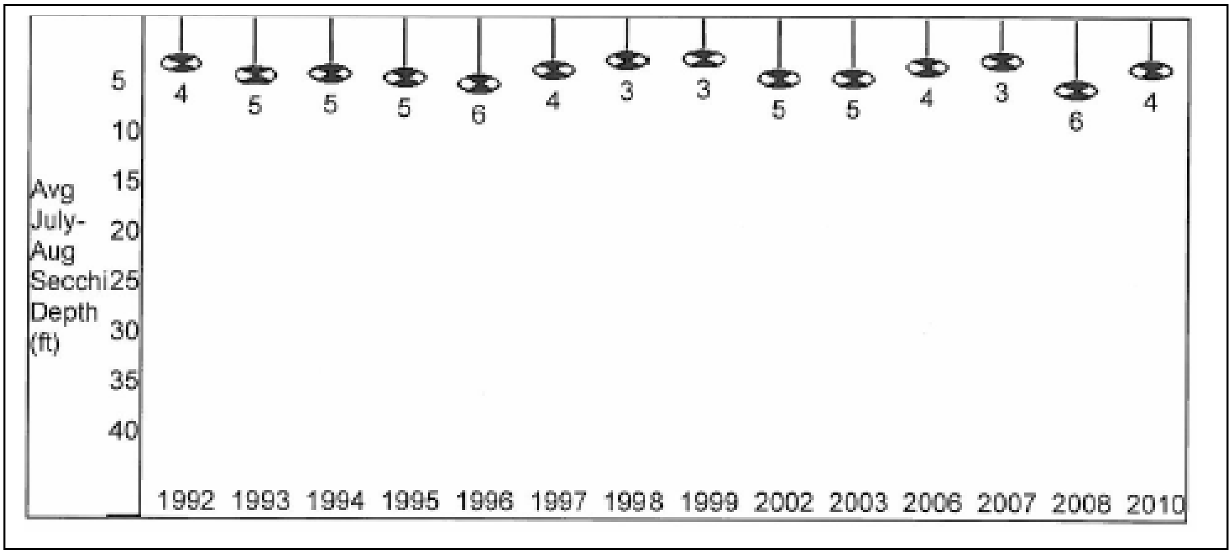

Figure 5. Little Yellow Lake Secchi Depth (July and August) 1992-2015

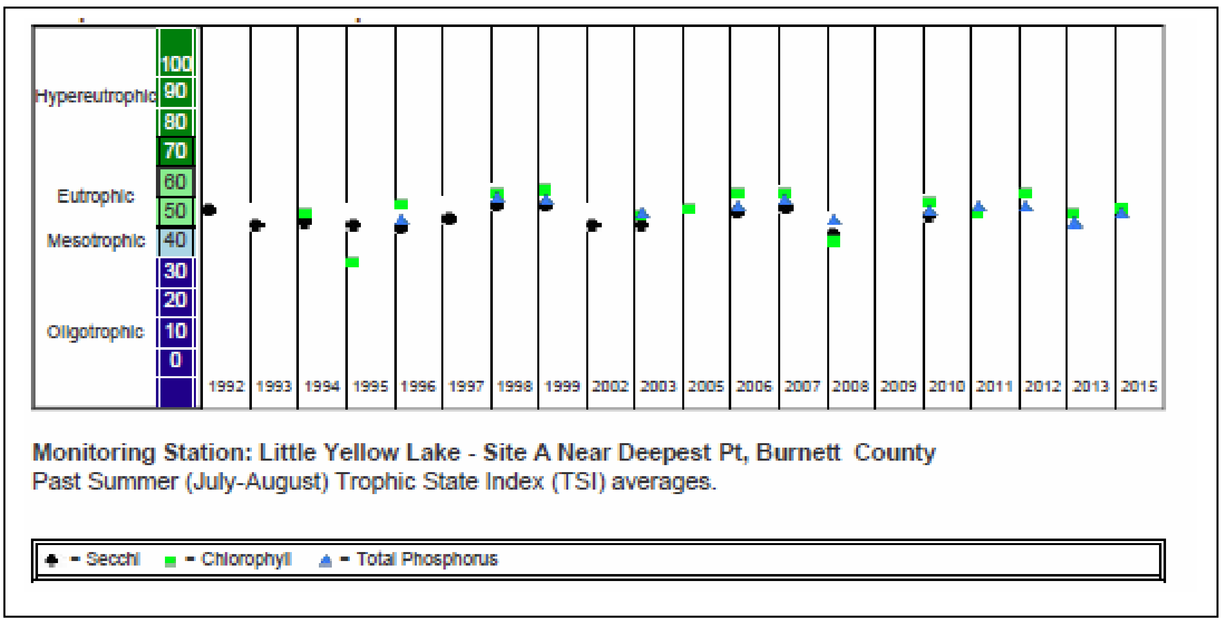

Figure 6. Little Yellow Trophic State Index 1992-2015

Watershed

Yellow and Little Yellow Lake are part of the 240,262 acre Yellow River watershed. It is shown in Figure 7.

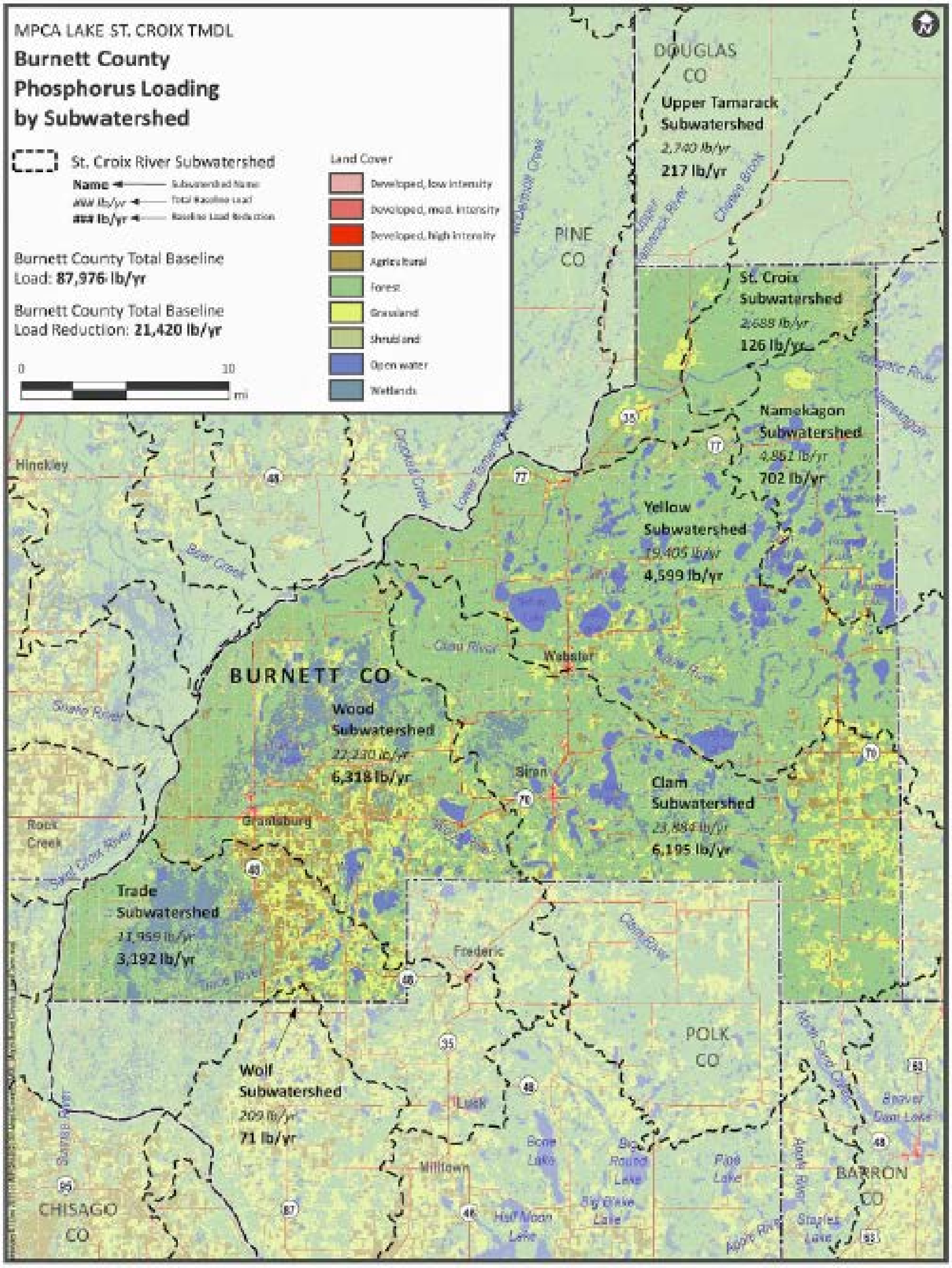

Figure 7. Burnett County Subwatersheds with Land Uses

Phosphorus from Watershed Runoff

Phosphorus is a primary nutrient, essential for healthy plant and algae growth. However, increased phosphorus levels speed up the process of eutrophication, where excess nutrients stimulate plant growth and cause extensive algae blooms. Prolific plant growth may lower dissolved oxygen levels due to plant decay and oxygen consumption.

Phosphorus loading in Yellow and Little Yellow Lakes is the result of non-point sources. Non-point sources include rain falling on the lake and runoff from within the watershed. With watershed runoff, phosphorus can be dissolved in the water as well as carried in soil particles that erode from bare soil. Erosion is of particular concern with the sandy soil that surrounds both Yellow and Little Yellow Lake.

The amount of phosphorus runoff from the watershed is determined by land use in the lake's watershed along with watershed soils and topography. Shoreland areas are particularly important areas of a lake's watershed. Agricultural and residential development tends to increase runoff and the amount of phosphorus that makes its way to the lake as a result. Land maintained in a natural, vegetated state, on the other hand, is beneficial to soil and water quality. With natural vegetation, soil erosion is reduced and fewer pollutants are able to enter and impact the lake via runoff. Tall vegetation slows the flow of water, while forest groundcover and fallen leaves allow runoff water to soak into the soil.

Yellow River Watershed Land Cover is reported in the Total Maximum Daily Load Report for the St. Croix Basin. The data reflects baseline conditions in the early 1990s. Over 60% of the watershed is forested with agriculture the next largest area land cover at 13.5%. Because agricultural land delivers a high amount of phosphorus per acre of land, it provides the largest phosphorus load in the watershed. In the Burnett County portion of the Yellow River watershed alone (a portion extends into Washburn County), the St. Croix Basin TMDL Implementation Plan calls for a reduction of 4,599 pounds of phosphorus. In the Washburn County portion of the watershed the reduction goal is an additional 4,488 pounds of phosphorus.

Table 3. Yellow River Watershed Land Cover

Cover	Agricultural	Forest	Grassland	Shrubland	Urban	Water	Total
Area (Hectares)	32,465	151,823	25,752	1,548	2,087	26,588	240,262
% of Total	13.5	63.2	10.7	1	1	11.1	

Table 4. Yellow River Watershed Phosphorus Loading

Cover	Agricultural	Forest	Grassland	Shrubland	Urban	Water
lbs./Year	18,201	13,331	5,071	136	1,170	166
lbs./Acre/Year	0.560653	0.087808	0.196926	0.087808	0.560653	0.006228

When compared with other tributaries to the St. Croix River, the Yellow River delivers a moderate phosphorus load as shown in Figure 8.

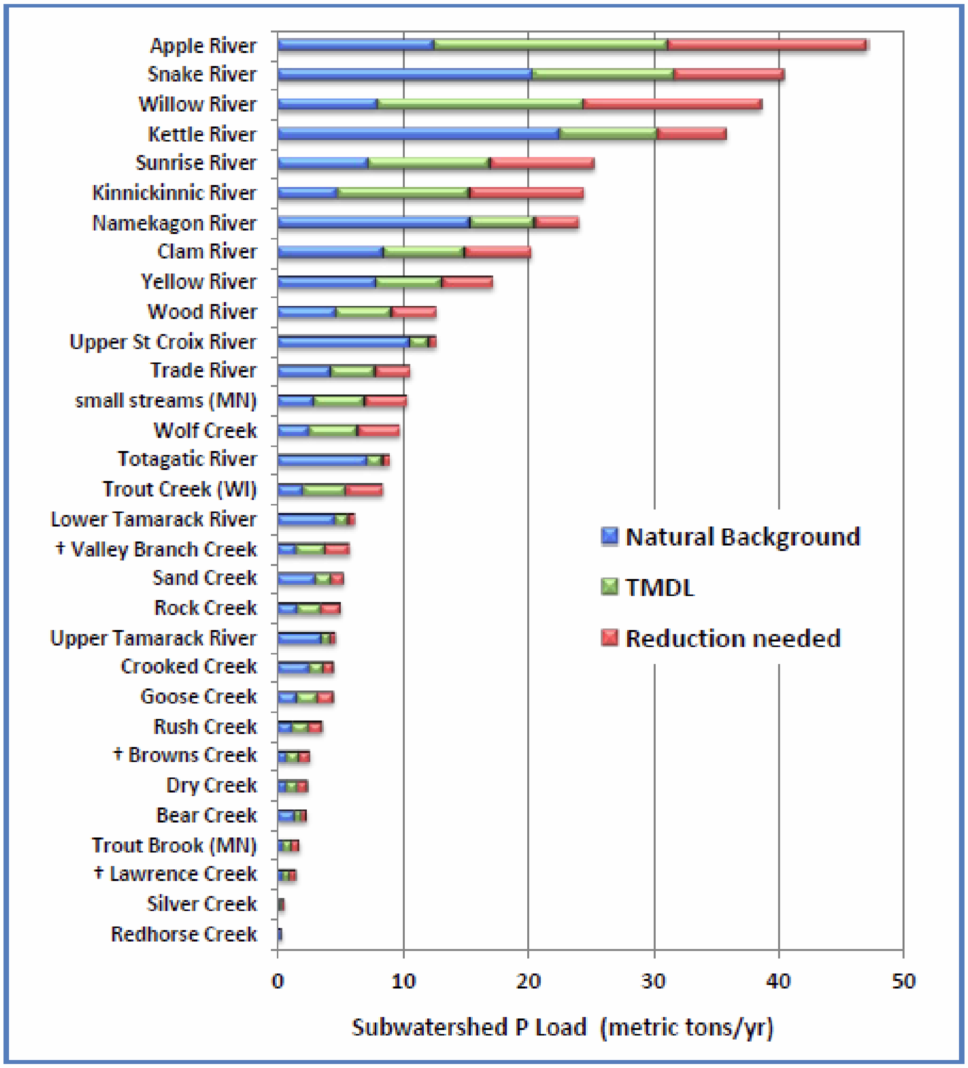

Figure 8. Lake St. Croix Subwatershed Phosphorus Loads (from St. Croix Basin TMDL 2012)

Water Levels

The water level in Yellow and Little Yellow Lake is controlled by the Renewable World Energies dam at Danbury. It is licensed to pass a given volume of water, and must maintain a specific target level in the reservoir. The lake levels are set at 929.7 mean sea level (MSL). Lake levels fluctuate with precipitation changes, and response time is required to reset the gate height.

The river's floodplains and late season weed growth contribute to the slow response of the lake levels to compensatory changes in the gate height. In a hydraulic study of the flowage, "weeds" were identified as restricting flow and slowing lake level reductions after storms. The flow was reduced from 220 cfs without "weeds" to 170 cfs with "weeds" in late summer. The "middle reach of the flowage" which begins near the base of the second (more northerly) map segment shown in the plant survey results for the flowage (Figure 9) and extends about one mile to the north, is identified as the stretch where there is greatest friction resistance. (Polaris, 2004)

The hydraulic study provided several potential solutions to lake level problems including "weed removal." Concerns raised with this recommendation were river access; stumps, logs, and boulders in the river, and the long haul. It also mentions that when weed cutting was performed in the past, weeds were not collected, but were allowed to float downstream (Polaris, 2004). An additional concern for harvesting on the river is water depth. One contractor indicated that minimum water depth for moving their harvester is 18 inches to 24 inches.[6] A public operator indicated 24 inches was a minimum depth for navigation of an 8 foot harvester when empty, but that 4 feet of depth was necessary when the harvester was full.[7]

The Federal Energy Commission (FERC) describes the Yellow River as a "small, slowly rolling, quiet river rich in history and quality wildlife and wild rice habitat." As a result, FERC does not condone the removal of obstructions or the increase of flow since such actions have the potential to disturb this natural environment. [8]

[6] Personal communication Cliff Schmidt, 2/15/16.
[7] Personal communication Dave Schleusner, 2/16/16.
[8] From *YLRA Statement*. http://ylra.org/ (2/16/16)

Aquatic Habitats

Primary Human Use Areas

Residential development is prevalent on the lakes. There are a total of 218 residences built on the shores of Yellow Lake, and another 84 surrounding Little Yellow Lake. Another 158 residences are built along the Danbury Flowage—the six-mile stretch from the outlet of Little Yellow Lake to the dam near Danbury. The construction, presence, and human use that result from these structures have significant impacts on the lake and river. Waterfront property owners and the general public utilize Yellow and Little Yellow Lake for a wide variety of activities including fishing, boating, swimming, and viewing wildlife.

Yellow Lake has three developed public landings: Yellow Lake Lodge on the narrows between the two lakes, Ike Walton's on the north shore of Yellow Lake, and Jeffrey's Landing on the east shore. The boat accesses have 10, 6, and 20 parking spaces for boats and trailers, respectively. Jeffrey's Landing is county-owned and includes a public park.

Public boat landings increase the use of the lakes, but also increase the risk of introduction of invasive species. In order to decrease the possibility of Aquatic Invasive Species (AIS) and contaminated bait, the YLRA no longer sponsors fishing contests and has placed cameras at the boat landings. Clean Boats, Clean Waters staff are also in place to educate boaters to prevent the introduction of aquatic invasive species.

There is no public boat landing on Little Yellow Lake, and access between the lakes is currently limited to fishing boats. Pontoons, for example, are not able to navigate between the lakes because of the bridge on Yellow Lake Road.

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

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. The rush, reed, and rice populations around Yellow and Little Yellow Lakes are particularly important to reducing erosion along the shoreline, but these populations are also vulnerable to the nutrient loading and the resultant algae growth in the lakes.

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, such as the wild rice present on Yellow Lake, provide important spawning habitat for many fish species.

Waterfowl

Plants offer food, shelter, and nesting material. Birds eat both the invertebrates that live on plants and the plants themselves.[9]

Protection against Invasive Species

Non-native invasive 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 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. Invasive species can change many of the natural features of a lake and often lead to expensive annual control plans. Allowing native plants to grow may not guarantee protection against invasive plants, but it can discourage their establishment. Native vegetation may cause localized nuisances to some users, but as a natural feature of lakes, they generally do not cause harm.[10]

Aquatic Invasive Species Status

Purple loosestrife (*Lythrum salicaria*), reed canary grass (*Phalaris arundinacea*), and curly leaf pondweed (*Potamogeton crispus*) have been observed on both Yellow and Little Yellow Lake. Purple loosestrife was recorded by Burnett County staff in locations along the Yellow River, both upstream and downstream of the lakes. No Eurasian water milfoil (*Myriophyllum spicatum*) was found on either lake, but it has been found in two nearby lakes in Burnett County: Ham Lake and Round Lake.[11] It is important that the YLRA takes measures to avoid the introduction of EWM and other aquatic invasive species into the lakes and flowage.

Sensitive Areas

The Wisconsin Department of Natural Resources completed sensitive area surveys to designate areas within aquatic plant communities that provide important habitat for game fish, forage fish, macroinvertebrates, and wildlife, as well as important shoreline stabilization functions. The Department of Natural Resources has transitioned to designations of *critical habitat areas* that include both *sensitive areas* and *public rights features*. The *critical habitat area* designation provides a holistic approach to ecosystem assessment and protection of those areas within a lake that are most important for preserving the very character and qualities of the lake.

Critical habitat areas include *sensitive areas* that offer critical or unique fish and wildlife habitat (including seasonal or life stage requirements) or offer water quality or erosion control benefits to the area (Administrative code 107.05(3)(1)(1)). The Wisconsin Department of Natural

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[9] Above paragraphs summarized from *Through the Looking Glass*. Borman et al. 1997.
[10] *Aquatic Plant Management Strategy. DNR Northern Region.* Summer 2007.
[11] According to the WDNR *Surface Water Data Viewer*. February 2016.

Resources is given the authority for the identification and protection of sensitive areas of the lakes. *Public rights features* are areas that fulfill the right of the public for navigation, quality and quantity of water, fishing, swimming, or natural scenic beauty. Protecting these *critical habitat areas* requires the protection of shoreline and in-lake habitat. The *critical habitat area* designation provides a framework for management decisions that impact the ecosystem of the lake.

There are no *critical habitat* or *sensitive area* designations for Yellow Lake or Little Yellow Lake. Due to the presence of wild rice beds, however, Yellow Lake and the Danbury Flowage are considered an Area of Special Natural Resource Interest (ASNRI). Yellow Lake is also listed as an "Endangered, Threatened, or Special Concern Area."[12] As a result, the Wisconsin Department of Natural Resources (WDNR) limits and may require special permits for particular activities on the lakes.

Yellow and Little Yellow Lakes Fishery

The sport fishery in Yellow Lake provides a variety of fish species and is considered to be one of the premier fisheries in the area. The WDNR conducted a fisheries assessment on Yellow Lake in the spring of 2014 (from late April to early June).[13] The assessment included population profiles of the following gamefish species: walleye, largemouth bass, and smallmouth bass. Data was not collected for northern pike or muskellunge. Other species that were sampled during the assessment included bluegill, pumpkinseed, black crappie, yellow perch, and rock bass. Lake Sturgeon are sampled annually during their spawning run into the Yellow River.

The walleye and lake sturgeon fisheries in the lakes are sustained by natural reproduction. Muskellunge have been stocked regularly in Yellow Lake since 1983. The lakes are stocked with fingerlings, averaging 9 to 12 inches in length for muskellunge. The adult walleye population estimates for Yellow Lake are higher than those of comparable area lakes, while those of Little Yellow Lake are lower than most.

[12] According to the Wisconsin Department of Natural Resources' *Designated Waters* Surface Water Data Viewer. February 2016.
[13] *Email communication Craig Roberts, Wisconsin DNR. February 2016.*

Table 5. Yellow Lake Stocking History

Year	Number of fish stocked	
	Muskellunge	*Walleye*
1983	2,260	
1984	2,309	
1985	2,500	
1986	2,300	580,460
1987	2,300	50,022
1988	2,300	79,819
1989	2,300	440,342
1990		27,608
1991	3,300	16,368
1992	20,000	199,639
1993	2,500	
1994		55,780
1995	2,289	
1996	148,568	
1997	4,250	
1998		100,000
1999	1,500	
2000		124,345
2002	1,444	114,330
2004	1,445	182,552
2006	801	
2008	1,444	
2010	1,392	
2012	2,287	
2014	1,143	

Table 6. Little Yellow Lake Stocking History

Year	Muskellunge	Walleye
1992	696	
1993	350	
1996	350	
1998	350	
2000		3,491
2005		15,705

Table 7. Fishing Regulations for Yellow and Little Yellow Lakes, 2015

Fish Species	Open Season	Daily Limit	Minimum Length (inches)
Walleye	May 3 — March 1	3	15, 20-24" protected, 1> 24"
Largemouth and Smallmouth Bass	May 3 — March 1	5	none
Muskellunge	May 24 — November 30	1	40
Northern Pike	May 3 — March 1	5	none

Fishing Tournaments

Fishing tournaments have served as important fund raisers for the Yellow Lakes and River Association in the past. Profits were used to carry out the goals and objectives of the YLRA. At a board meeting on September 6, 2008, however, the YLRA Board of Directors decided to discontinue sponsorship of the events. They decided that the financial incentives were not worth the risks posed to the lakes by invasive species and contaminated bait.

Viral hemorrhagic septicemia (VHS) was one of the cited concerns. VHS is a fish disease that was discovered in Wisconsin lakes in 2007. The pathogen is contained in fish urine, and can persist in the water for up to two weeks.[5] VHS is transferred from lake to lake via infected baitfish.[6] The prevention of Eurasian water milfoil (EWM) infestation was another motivating factor, since it had already been found in two lakes in Burnett County and could potentially pose a threat to the tourist and fishing economy surrounding Yellow and Little Yellow Lakes.[7]

In a memo to the BCHS Board of Directors, a YLRA Board member articulated the rationale for their decision: "The action taken by YLRA was not because they are against fishermen, sport contests, tourism, etc. It was, to the contrary, to try and protect our natural environment in a sustainable way so that fishermen, sportsmen, tourists, our children, and grandchildren can have beautiful lakes and rivers for their use and enjoyment for years to come." [8]

This conservation mentality is also apparent in the catch-and-release philosophy that many Yellow Lake anglers choose to employ, especially with regards to the sturgeon fishery. This culture of sustainability is one of the reasons that the Yellow and Little Yellow Lakes fishery is so unique and popular.[9]

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[5] Anne Hraychuck. *Invasive Species Month*. Inter-County Leader. June 13, 2007.
[6] *Boaters and anglers taking steps to prevent spread of invasive species*. Burnett County Sentinel. February 4, 2009.
[7] Beckmann, Todd. *Aquatic invasives still a concern in Burnett County*. Burnett County Sentinel. May 28, 2008.
[8] Memo. To: BCHS Board of Directors. By: Ken Schultz. Date: February 3, 2009. Subject: Fishing Contests/Invasive Species.
[9] Seeger, Marty. *Sturgeon still thriving in Yellow Lake*. Inter-County Leader. September 10, 2008.

Plant Community

Aquatic Plant Survey Results

Aquatic plant inventory were completed for Yellow and Little Yellow Lakes in July of 2007, according to the WDNR-specified point intercept method. Prior to the main inventory in late June, a curly leaf pondweed (CLP) survey was conducted. (Since CLP typically dies in early July, CLP surveys are usually done in early June while the CLP is robust.) A general boat survey was also conducted prior to the point intercept survey to gain familiarity with the lakes and the species present on them. The survey was updated for Little Yellow Lake and completed for the Danbury Flowage in 2014. Results from the 2007 Yellow Lake survey are summarized in the 2009 Aquatic Plant Management Plan, and Table 9 provides a brief overview of the results. The Yellow Lake survey was not updated in 2014 because no active plant management is planned for Yellow Lake. The 2014 plant survey results are discussed in following pages.

Table 8. Yellow Lake Macrophyte Survey Summary (Berg 2007)

Survey Summary	
Total number of points sampled	491
Total number of sites with vegetation	332
Total number of sites shallower than the maximum depth of plants	358
Frequency of occurrence at sites shallower than maximum depth of plants	92.74
Simpson Diversity Index	0.93
Maximum depth of plants (ft)	13.00
Number of sites sampled using rope rake (R)	12
Number of sites sampled using pole rake (P)	364
Average number of all species per site (shallower than max depth)	4.72
Average number of all species per site (vegetated sites only)	5.09
Average number of native species per site (shallower than max depth)	4.28
Average number of native species per site (vegetated sites only)	5.07
Species Richness	38
Species Richness (including visuals)	38
Species Richness (including visuals and boat survey)	43
Mean depth of plants (ft)	4.3
Median depth of plants (ft)	4.0

The survey and data analysis methods for the aquatic macrophyte surveys can be found in the following report: *Aquatic Macrophyte Survey for Yellow Lake and Little Yellow Lake Burnett County, Wisconsin*, conducted and written by Matthew S. Berg of Endangered Resource Services, LLC.

Little Yellow Lake Aquatic Plant Survey Results[14]

All 340 points where visited during the 2014 survey. Resulting maps of lake depth and bottom substrate are shown in Figure 9 below.

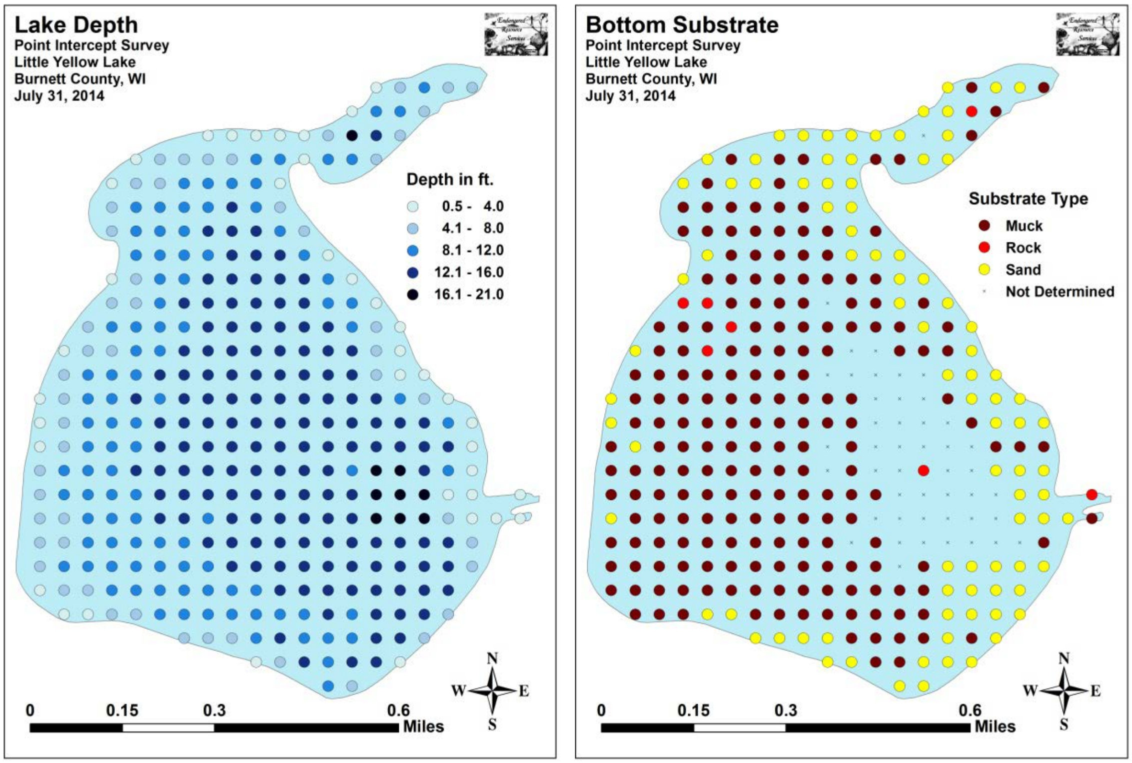
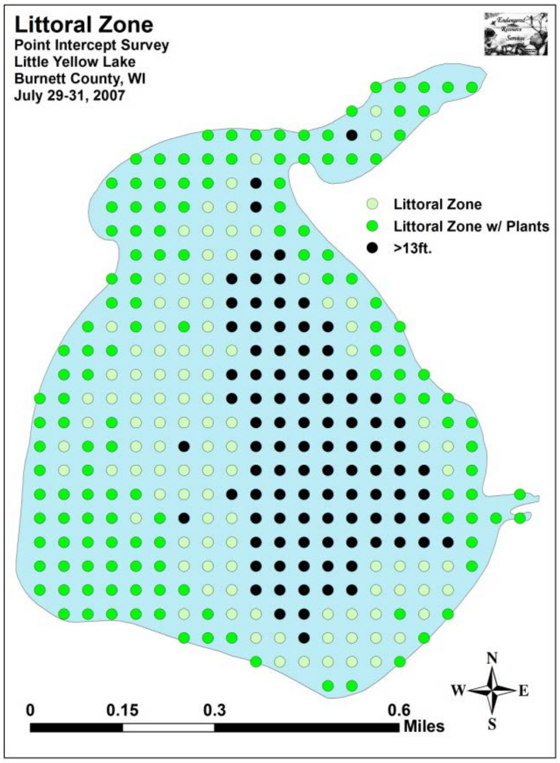


Figure 7. Little Yellow Lake Depth and Bottom Substrate (2014)

Of the 294 survey points where substrate was observed, 67.3% had muck and sandy muck, 30.3% had pure sand, and 2.4% had rock and gravel. Most pure sand substrates occurred immediately along the northern, eastern, and southern shorelines. Along the western shoreline, sandy areas quickly transitioned to nutrient-poor sandy muck which dominated the majority of the lake's basin. Patches of more nutrient-rich organic muck were largely restricted to the far corners of the northeast and northwest bays.

In 2014, plants were growing at 96 sites or on approximately 28.2% of the entire lake bottom and in 82.8% of the littoral zone. Plant growth ended rather abruptly in 10.0ft of water, and both the mean and median depths of plants were 5.0ft respectively. This was a significant decline over 2007 when the mean and median depths were 6.5ft and 6.0ft and plants were found at 139 points. In 2007 there was approximately 40.9% plant coverage of the total lake bottom and 57.2% of the then 13.0ft deep littoral zone (the depth at which plants grow in a lake).

[14] Curly-leaf pondweed (*Potamogeton crispus*) Point-intercept and Bed Mapping Surveys, and Warm-water Macrophyte Point-intercept Survey Little Yellow Lake – WBIC: 2674800 Burnett County, Wisconsin. June and July 2014.



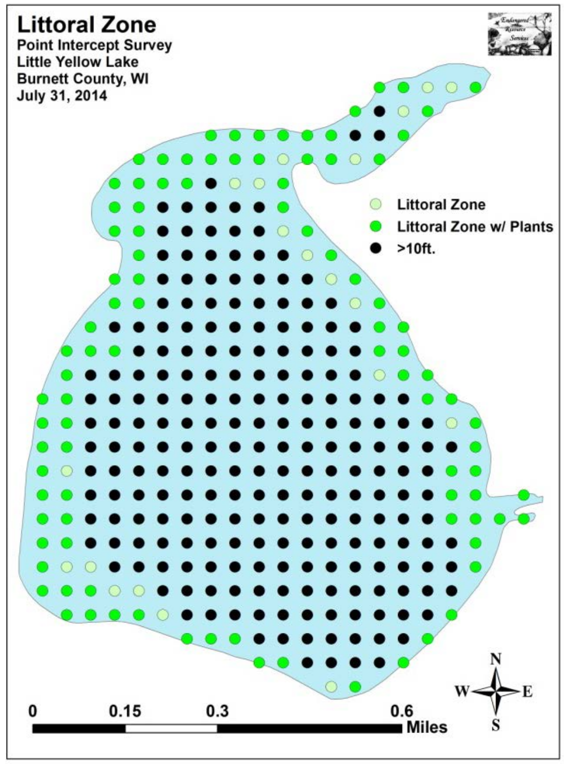


Figure 8. 2007 and 2014 Littoral Zone (Berg 2014)

A summary of aquatic plant survey statistics in included as Table 10. A full list of species along with survey results is shown in Table 11. Plant diversity was very high in 2014 with a Simpson Index value of 0.90 – up slightly from 0.88 in 2007. There were 27 species found in the rake each year. Mean native species richness at sites with native vegetation was 3.84 per site in 2014 - up sharply from 3.29 per site in 2007. Mean total rake fullness also increased from a moderate 1.89 in 2007 to a moderately high 2.23 in 2014. Both the increase in mean species and mean rake fullness are likely best explained by a shrinking littoral zone that resulted in few low density/low richness samples in deep water during the 2014 survey.

Measures of floristic quality for 2007 and 2014 are reported in Table 9. Differences between 2007 and 2014 may indicate differences in annual growing conditions, the lake's habitat, statistical chance, or a combination of these factors. Nichols (1999) reported an average mean C for the Northern Lakes and Forest Region of 6.7 putting Little Yellow Lake below average for this part of the state. The FQI was slightly higher than the median FQI of 24.3 for the Northern Lakes and Forest Region (Nichols 1999).

Table 9. Little Yellow Lake Floristic Quality

	2007	2014	Median Region
Number of Species	25	26	
Coefficient of Conservatism	5.8	5.5	6.7
Floristic Quality Index	29.2	28.2	24.3

Table 10. Little Yellow Lake Macrophyte Survey Summary (Berg 2014)

Summary Statistics	**2007**	**2014**
Total number of points sampled	263	340
Total number of sites with vegetation	139	96
Total number of sites shallower than the maximum depth of plants	243	116
Frequency of occurrence at sites shallower than maximum depth of plants	57.20	82.76
Simpson Diversity Index	0.88	0.90
Maximum depth of plants (ft)	13.0	10.0
Mean depth of plants (ft)	6.5	5.0
Median depth of plants (ft)	6.0	5.0
Number of sites sampled using rake on rope (R)	4	0
Number of sites sampled using rake on pole (P)	259	293
Average number of all species per site (shallower than max. depth)	1.78	3.19
Average number of all species per site (veg. sites only)	3.11	3.85
Average number of native species per site (shallower than max. depth)	1.67	3.11
Average number of native species per site (sites with native veg. only)	3.29	3.84
Species richness	27	27
Species richness (including visuals)	29	29
Species richness (including visuals and boat survey)	35	33
Mean rake fullness (veg. sites only – 2007 estimated)	1.89	2.23

Little Yellow Lake Plant Community

The Little Yellow Lake ecosystem is home to an abundant and diverse plant community that is typical of high nutrient lakes with good water quality. This community can be subdivided into four distinct zones (emergent, floating leaf, shallow submergent, and deep submergent) with each zone having its own characteristic functions in the aquatic ecosystem. Depending on the local bottom type (sand, rock, sandy muck or nutrient rich organic muck), these zones often had somewhat different species present. Photos of some of the species are shown in the aquatic plant survey report.

<u>Emergent.</u> In shallow areas, beds of emergent plants prevent erosion by stabilizing the lakeshore and breaking up wave action, provide a nursery for baitfish and juvenile gamefish, offer shelter for amphibians, and give waterfowl and predatory wading birds like herons a place to hunt. These areas also provide important habitat for invertebrates like dragonflies and mayflies.

Along sandy and rocky shorelines, the emergent community was dominated by Hardstem bulrush (*Schoenoplectus acutus*) and Common reed (*Phragmites australis*) while sandy muck areas supported beds of Common bur-reed (*Sparganium eurycarpum*) and Softstem bulrush (*Schoenoplectus tabernaemontani*). In areas where the soil was a more nutrient rich organic muck, River bulrush (*Bolboschoenus fluviatile*), Common arrowhead (*Sagittaria latifolia*), Sessile-fruited arrowhead (*Sagittaria rigida*), and Broad-leaved cattail (*Typha latifolia*) were present. These areas also supported patches of Reed canary grass (*Phalaris arundinacea*) and Northern wild rice (*Zizania palustris*).

Floating Leaf. Just beyond the emergents, in muck-bottomed areas in up to 5ft of water, the floating-leaf species Spatterdock (*Nuphar variegata*) and White-water lily (*Nymphaea odorata*) were common throughout the lake, while Arum-leaved arrowhead (*Sagittaria cuneata*) tended to be rare and local. The canopy cover they provide is often utilized by panfish and bass for protection. A large number of "duckweeds" were found floating among both the lilypads and the emergents.

Shallow Submergent. Growing amongst these floating-leaf species, we also noted the submergent species Coontail (*Ceratophyllum demersum*), Common waterweed (*Elodea canadensis*), and Small pondweed (*Potamogeton pusillus*).

Deep Submergent. Floating-leaf and many shallow submergent species disappeared on Little Yellow Lake in water over 5ft. These deeper areas were dominated by Coontail, Common waterweed, Small pondweed, Curly-leaf pondweed, White-stem pondweed (*Potamogeton praelongus*), and Flat-stem pondweed (*Potamogeton zosteriformis*). Predatory fish like the lake's northern pike and muskies are often found along the edges of these beds waiting in ambush.

Comparison of Species in 2007 and 2014

In 2014, the most common species were Coontail, Small pondweed, Flat-stem pondweed, and Forked duckweed (see Table 11). In 2007, Small pondweed, Coontail, Flat-stem pondweed, and Wild celery were the most common species. Survey results suggest a slightly more diverse and even plant community existed in 2014 than in 2007 (Species accounts for all plants found in 2007 and 2014, and maps for all species found in 2014 can be found in Appendixes VII and VIII of the plant survey report).

Lakewide, six species showed significant changes from 2007 to 2014. As no active management has occurred on the lake, the most likely explanation for these differences is fluctuations in annual growing conditions such as water clarity and mean temperature.

Table 11. Little Yellow Lake Species Frequency and Mean Rake Fullness (Berg 2014)

Species	Common Name	Total Sites	Relative Freq.	Freq. in Veg.	Freq. in Lit.	Mean Rake	Visual Sight.
Ceratophyllum demersum	Coontail	68	18.38	70.83	58.62	1.60	3
Potamogeton pusillus	Small pondweed	52	14.05	54.17	44.83	1.46	2
Potamogeton zosteriformis	Flat-stem pondweed	45	12.16	46.88	38.79	2.09	6
Lemna trisulca	Forked duckweed	43	11.62	44.79	37.07	1.42	0
Vallisneria Americana	Wild celery	40	10.81	41.67	34.48	1.68	2
Myriophyllum sibiricum	Northern water-milfoil	23	6.22	23.96	19.83	1.26	10
	Filamentous algae	23	*	23.96	19.83	1.35	0
Najas flexilis	Slender naiad	16	4.32	16.67	13.79	1.56	1
Elodea Canadensis	Common waterweed	15	4.05	15.63	12.93	1.27	0
Nymphaea odorata	White water lily	10	2.70	10.42	8.62	1.90	1
Potamogeton crispus	Curly-leaf pondweed	9	2.43	9.38	7.76	1.00	0
Potamogeton richardsonii	Clasping-leaf pondweed	8	2.16	8.33	6.90	1.38	5
Heteranthera dubia	Water star-grass	7	1.89	7.29	6.03	1.14	1
Stuckenia pectinata	Sago pondweed	7	1.89	7.29	6.03	1.29	0
Ranunculus aquatilis	White water crowfoot	5	1.35	5.21	4.31	1.00	0
Spirodela polyrhiza	Large duckweed	5	1.35	5.21	4.31	1.40	0
Lemna minor	Small duckweed	3	0.81	3.13	2.59	1.00	0
Nuphar variegate	Spatterdock	2	0.54	2.08	1.72	1.00	1
Potamogeton praelongus	White-stem pondweed	2	0.54	2.08	1.72	1.50	2
Sparganium eurycarpum	Common bur-reed	2	0.54	2.08	1.72	2.00	0
Chara sp.	Muskgrass	1	0.27	1.04	0.86	1.00	0
Nitella sp.	Nitella	1	0.27	1.04	0.86	1.00	0
Phragmites australis	Common reed	1	0.27	1.04	0.86	3.00	2
Sagittaria cuneate	Arum-leaved arrowhead	1	0.27	1.04	0.86	2.00	0

* Excluded from the Relative Frequency Calculation

Species	Common Name	Total Sites	Relative Freq.	Freq. in Veg.	Freq. in Lit.	Mean Rake	Visual Sight.
Sagittaria rigida	Sessile-fruited arrowhead	1	0.27	1.04	0.86	2.00	2
Schoenoplectus acutus	Hardstem bulrush	1	0.27	1.04	0.86	2.00	1
Typha latifolia	Broad-leaved cattail	1	0.27	1.04	0.86	3.00	0
Zizania palustris	Northern wild rice	1	0.27	1.04	0.86	2.00	1
Bolboschoenus fluviatilis	River bulrush	**	**	**	**	**	1
Schoenoplectus tabernaemontani	Softstem bulrush	**	**	**	**	**	1
Phalaris arundinacea	Reed canary grass	***	***	***	***	***	***
Potamogeton friesii	Fries' pondweed	***	***	***	***	***	***
Potamogeton gramineus	Variable pondweed	***	***	***	***	***	***
Sagittaria latifolia	Common arrowhead	***	***	***	***	***	***

** Visual Only *** Boat Survey Only

Danbury Flowage/Yellow River Aquatic Plant Survey Results[15]

Depth soundings taken at the Danbury Flowage's 517 survey points revealed most of the channelized areas of the flowage were <4ft while broader areas and side bays often had areas that reached 4-10ft in depth. The only areas over 12ft occurred in the channel directly behind the dam (Figure 9).

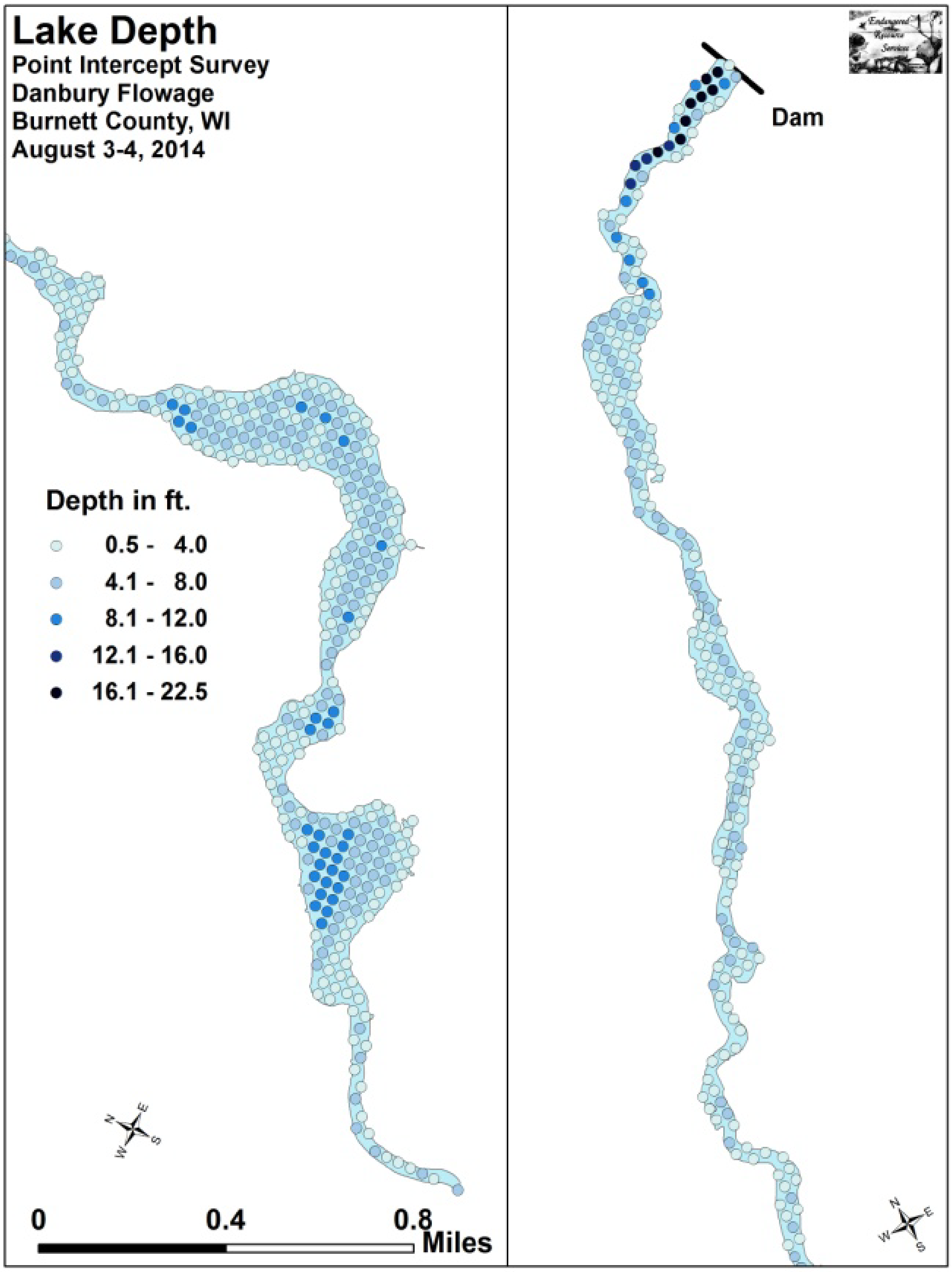


Figure 9. Survey Sample Points and Lake Depth (Berg, 2014)

[15] *Curly-leaf pondweed (Potamogeton crispus) Point-intercept and Bed Mapping Surveys, and August Full Point-intercept Macrophyte Survey*
Danbury Flowage (WBIC: 2674500) - Burnett Co., WI

Of the 508 survey points where substrate was identified, 63.4% had organic and sandy muck, 32.1% had pure sand, and 4.5% had rock. Nutrient rich organic muck dominated the flowage bottom in the many side bays while sandy muck was common in areas of slow flow in the channelized areas. The narrowest channelized areas tended to be pure sand, gravel, cobble, or a combination of the three (Figure 10). Plants grew at 462 sites which approximated to 89.4% of the entire flowage bottom and in 92.6% of the 10ft August littoral zone.

Species richness was moderate with 38 species growing in and adjacent to the flowage. Overall diversity was very high with a Simpson Diversity Index value of 0.90. Localized species richness was moderate with an average of 3.33 native species per/site with native vegetation. Most areas had moderately dense vegetative cover as the mean total rake fullness averaged 2.24 at sites with vegetation. In general, mucky side bays supported the most species while sandy/rocky channelized areas had the fewest (Figure 11).

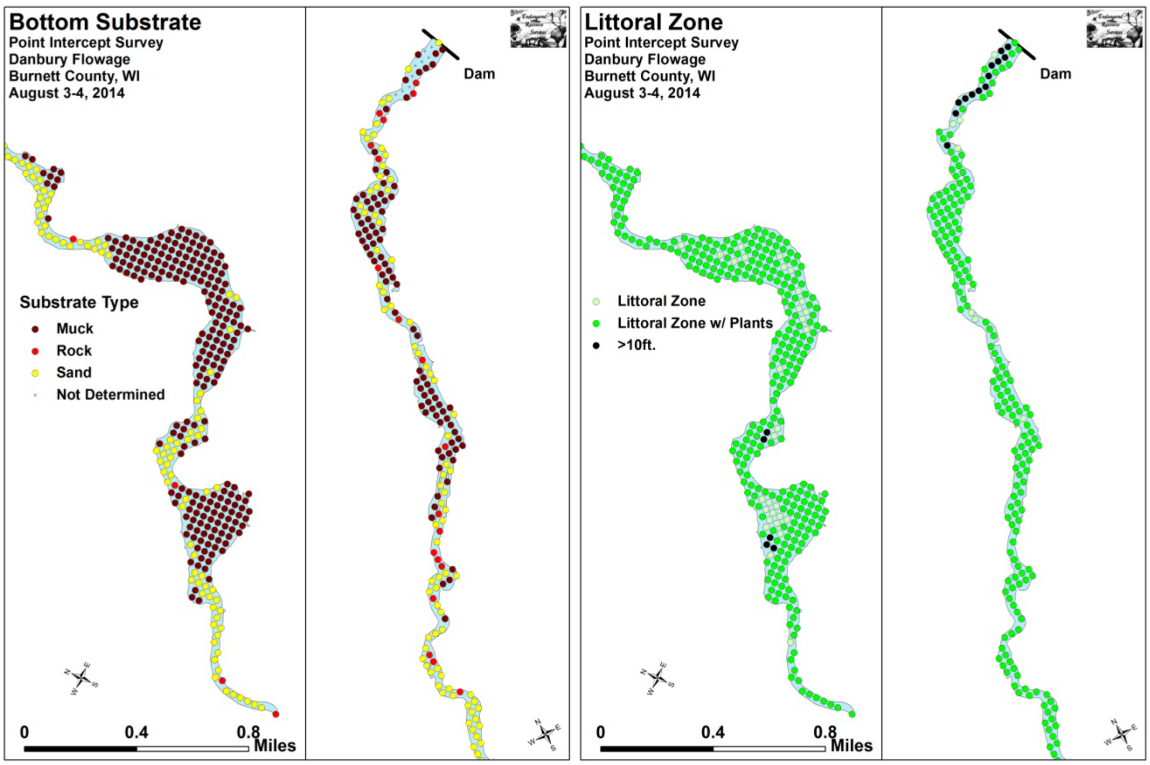


Figure 10. Bottom Substrate and Littoral Zone (Berg 2014)

Table 12. Aquatic Macrophyte P/I Survey Summary Statistics Danbury Flowage, Burnett County August 3-4, 2014

Total number of points sampled	517
Total number of sites with vegetation	462
Total number of sites shallower than the maximum depth of plants	499
Frequency of occurrence at sites shallower than maximum depth of plants	92.59
Simpson Diversity Index	0.90
Maximum depth of plants (ft)	10.0
Mean depth of plants (ft)	4.2
Median depth of plants (ft)	4.0
Number of sites sampled using rope rake (R)	0
Number of sites sampled using pole rake (P)	508
Average number of all species per site (shallower than max. depth)	3.10
Average number of all species per site (veg. sites only)	3.35
Average number of native species per site (shallower than max. depth)	3.07
Average number of native species per site (sites with native vegetation only)	3.33
Species richness	36
Species richness (including visuals)	37
Species richness (including visuals and boat survey)	38
Average rake fullness (veg. sites only)	2.24

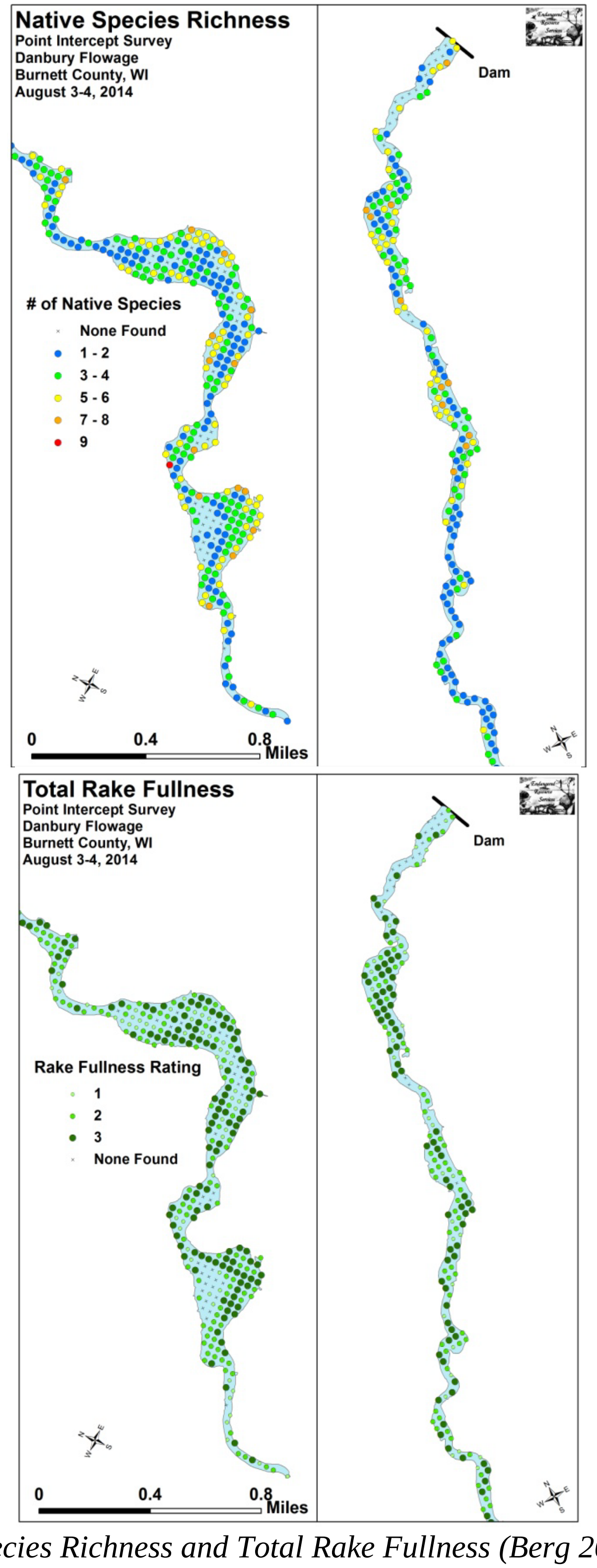


Figure 11. Native Species Richness and Total Rake Fullness (Berg 2014)

Danbury Flowage Plant Community

The Danbury Flowage ecosystem is home to a diverse plant community that is primarily a function of the local water depth and substrate. This community can be subdivided into four distinct zones (emergent, shallow submergent, floating-leaf, and deep submergent) with each zone having its own characteristic functions in the aquatic ecosystem. Depending on the local bottom type (sand, rock, sandy muck or nutrient rich organic muck), these zones often had somewhat different species present.

Emergent. In shallow areas, beds of emergent plants prevent erosion by stabilizing the lakeshore, break up wave action, provide a nursery for baitfish and juvenile gamefish, offer shelter for amphibians, and give waterfowl and predatory wading birds like herons a place to hunt. These areas also provide important habitat for invertebrates like dragonflies and mayflies.

Along sandy and rocky shorelines, the emergent community was dominated by Hardstem bulrush (*Schoenoplectus acutus*) while sandy muck areas supported beds of Common bur-reed (*Sparganium eurycarpum*) and Softstem bulrush (*Schoenoplectus tabernaemontani*). In areas where the soil was a more nutrient rich organic muck, River bulrush (*Bolboschoenus fluviatile*), Bottle brush sedge (*Carex comosa*), Swamp loosestrife (*Decodon verticillatum*), Bald spikerush (*Eleocharis erythropoda*), Needle spikerush (*Eleocharis acicularis*), Rice cut-grass (*Leersia oryzoides*), Purple loosestrife (*Lythrum salicaria*), Common arrowhead (*Sagittaria latifolia*), Sessile-fruited arrowhead (*Sagittaria rigida*), and Cattails (*Typha* spp.) were documented. In water up to 3.5ft deep, dense beds of Northern wild rice (*Zizania palustris*) dominated the lower half of the flowage's emergent community.

Floating Leaf. Just beyond the emergents, in muck-bottomed areas in up to 5ft of water, the floating-leaf species Spatterdock (*Nuphar variegata*) and White-water lily (*Nymphaea odorata*) were common in side bays throughout the flowage. The canopy cover they provide is often utilized by panfish and bass for protection.

Shallow Submergent. Growing amongst these floating-leaf species, we also noted the submergent species Coontail, Common waterweed (*Elodea canadensis*), and Small pondweed (*Potamogeton pusillus*). In addition to these rooted plants, a large number of "duckweeds" were found floating among both the lilypads and the emergents; especially in the wild rice beds.

In calm areas adjacent to alders (*Alnus incana*) and Tamaracks (*Larix laricina*), we also found a limited number of carnivorous Common bladderwort (*Utricularia vulgaris*) floating among the lilypads. Bladderworts trap microscopic plankton and insect larvae in their bladders, digest the bodies of their prey, and use the minerals to further their growth.

Sand and sandy muck bottomed habitats supported few floating-leaf species. In pure sand areas, in water up to 5ft deep, we noted the plant community was dominated by generally finer leaved submergent plants like Muskgrass (*Chara* sp.), Slender naiad

(*Najas flexilis*), White water crowfoot (*Ranunculus aquatilis*), and Sago pondweed (*Stuckenia pectinata*). These species tend to form a carpet that stabilizes the bottom.

Shallow sandy muck areas tended to support slightly broader-leaved species like Water star-grass (*Heteranthera dubia*), Northern water milfoil, Fries' pondweed, Clasping-leaf pondweed (*Potamogeton richardsonii*), and Wild celery (*Vallisneria americana*). The roots, shoots, and seeds of these species are heavily utilized by both resident and migratory waterfowl for food. They also provide important habitat for the flowage's fish throughout their lifecycles, as well as a myriad of invertebrates like scuds, dragonfly and mayfly nymphs, and snails.

<u>Deep Submergent.</u> Floating-leaf and many shallow submergent species disappeared on the Danbury Flowage in water over 5ft. These deeper areas were dominated by Coontail, Common waterweed, Small pondweed, Curly-leaf pondweed, White-stem pondweed, and Flat-stem pondweed. Predatory fish like the flowage's musky and northern pike are often found along the edges of these beds waiting in ambush.

When considering the flowage's entire plant community, Coontail, Forked duckweed (*Lemna trisulca*), Flat-stem pondweed, and Wild celery were the most common species being found at 55.19%, 44.81%, 40.48%, and 38.31% of survey points with vegetation respectively (Table 3) (Figure 11). Together, they combined for 53.39% of the total relative frequency. Large duckweed (*Spirodela polyrhiza*) (9.24), White water lily (6.14), Common watermeal (*Wolffia columbiana*) (5.95), and Common waterweed (5.56) were the only other species with relative frequencies over 5.0 (Species accounts and distribution maps for all plants found are located in the plant survey report Appendixes VI and VII).

Table 13. Frequencies and Mean Rake Sample of Aquatic Macrophytes Danbury Flowage, Burnett County August 3-4, 2014

Species	Common Name	Total Sites	Relative Freq.	Freq. in Veg.	Freq. in Lit.	Mean Rake	Visual Sightings
Ceratophyllum demersum	Coontail	255	16.48	55.19	51.10	1.61	8
Lemna trisulca	Forked duckweed	207	13.38	44.81	41.48	1.34	0
Potamogeton zosteriformis	Flat-stem pondweed	187	12.09	40.48	37.47	1.67	13
Vallisneria Americana	Wild celery	177	11.44	38.31	35.47	1.93	12
Spirodela polyrhiza	Large duckweed	143	9.24	30.95	28.66	2.10	0
Nymphaea odorata	White water lily	95	6.14	20.56	19.04	1.84	33
Wolffia Columbiana	Common watermeal	92	5.95	19.91	18.44	1.35	0
Elodea Canadensis	Common waterweed	86	5.56	18.61	17.23	1.43	2
Zizania palustris	Northern wild rice	57	3.68	12.34	11.42	1.91	24
	Filamentous algae	55	*	11.90	11.02	1.36	1
Lemna minor	Small duckweed	48	3.10	10.39	9.62	1.40	0
Potamogeton pusillus	Small pondweed	40	2.59	8.66	8.02	1.35	3
Najas flexilis	Slender naiad	36	2.33	7.79	7.21	1.28	1
Potamogeton richardsonii	Clasping-leaf pondweed	16	1.03	3.46	3.21	1.13	5
Typha X *glauca*	Hybrid cattail	15	0.97	3.25	3.01	2.47	5
Potamogeton crispus	Curly-leaf pondweed	14	0.90	3.03	2.81	1.00	2
Potamogeton praelongus	White-stem pondweed	13	0.84	2.81	2.61	1.38	12
Sparganium eurycarpum	Common bur-reed	11	0.71	2.38	2.20	2.36	3
Potamogeton friesii	Fries' pondweed	10	0.65	2.16	2.00	1.10	3
Sagittaria rigida	Sessile-fruited arrowhead	7	0.45	1.52	1.40	1.71	0
Chara sp.	Muskgrass	6	0.39	1.30	1.20	1.33	0
Ranunculus aquatilis	White water crowfoot	5	0.32	1.08	1.00	1.20	0
Nuphar variegate	Spatterdock	4	0.26	0.87	0.80	2.25	1

* Excluded from Rel. Freq. Calc.

Table 3. (cont.): Frequencies and Mean Rake Sample of Aquatic Macrophytes Danbury Flowage, Burnett County August 3-4, 2014

Species	Common Name	Total Sites	Relative Freq.	Freq. in Veg.	Freq. in Lit.	Mean Rake	Visual Sightings
Myriophyllum sibiricum	Northern water-milfoil	3	0.19	0.65	0.60	1.33	2
Schoenoplectus tabernaemontani	Softstem bulrush	3	0.19	0.65	0.60	1.33	3
Typha latifolia	Broad-leaved cattail	3	0.19	0.65	0.60	2.67	2
Bolboschoenus fluviatilis	River bulrush	2	0.13	0.43	0.40	2.00	1
Schoenoplectus acutus	Hardstem bulrush	2	0.13	0.43	0.40	2.00	0
Utricularia vulgaris	Common bladderwort	2	0.13	0.43	0.40	2.00	1
Carex comosa	Bottle brush sedge	1	0.06	0.22	0.20	1.00	1
Decodon verticillatus	Swamp loosestrife	1	0.06	0.22	0.20	3.00	0
Heteranthera dubia	Water star-grass	1	0.06	0.22	0.20	2.00	1
Leersia oryzoides	Rice cut-grass	1	0.06	0.22	0.20	2.00	1
Lythrum salicaria	Purple loosestrife	1	0.06	0.22	0.20	1.00	0
Nitella sp.	Nitella	1	0.06	0.22	0.20	1.00	0
Sagittaria latifolia	Common arrowhead	1	0.06	0.22	0.20	1.00	1
Stuckenia pectinata	Sago pondweed	1	0.06	0.22	0.20	2.00	0
Eleocharis erythropoda	Bald spikerush	**	**	**	**	**	1
Eleocharis acicularis	Needle spikerush	***	***	***	***	***	***

** Visual Only *** Boat Survey Only

Northern Wild Rice

Wild rice is an aquatic plant with special significance to Native American Tribes.

Little Yellow Lake

A map from the 2014 Little Yellow Lake aquatic plant survey is included below where it was found at one point 2014 (it was also found there in 2007). The site, located in the middle of a small (estimated at <1 acre), but moderately dense bed (mean rake fullness 2), occurred on the north end of the point along the southern shoreline at the river outlet to the Danbury Flowage (Figure 12). The only other rice seen in the lake was a few individual plants scattered along the northern shoreline. These plants were never bed forming.

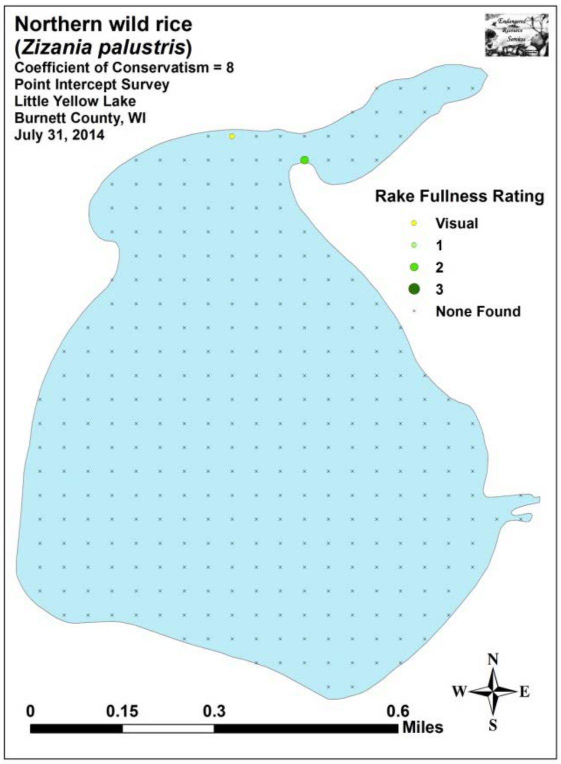


Figure 12. 2007 and 2014 Northern Wild Rice Density and Distribution (Berg, July 2014)

Yellow River Flowage

Wild rice was found at 57 points in the 2014 point intercept survey. Of these, 14 had a rake fullness of 3, 24 were a 2, and 19 were a 1 for a mean rake fullness of 1.91. Rice was also seen at 24 additional points (Figure 13). Rice was scattered throughout the flowage, but the largest and densest beds occurred in the lower third nearest the dam. Stands in this area provided exceptional habitat for wildlife, and they were also large enough and dense enough to offer significant human harvest potential.

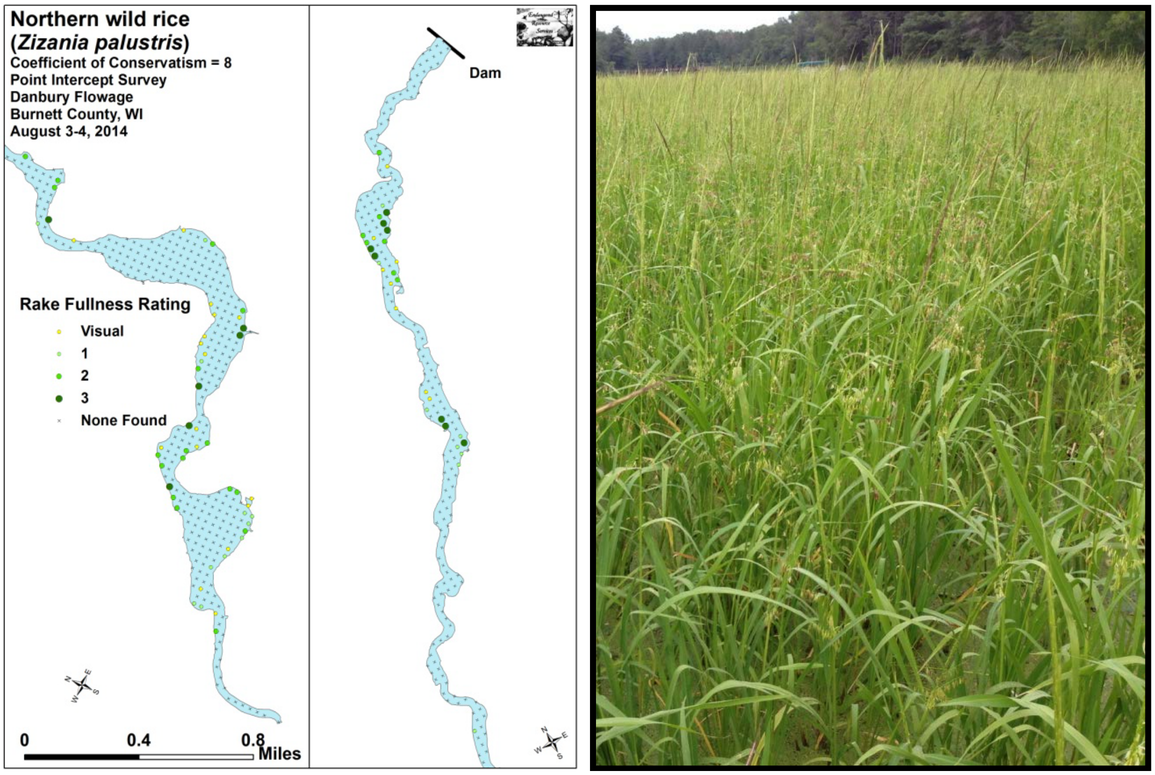


Figure 13. Danbury Flowage Northern Wild Rice Density and Distribution (Berg 2014)

The St. Croix Tribal Natural Resource Department surveyed the Yellow River flowage for wild rice beds on August 12, 14, and 18, 2008.[16] Data was collected from the outflow of Little Yellow Lake to the dam at Danbury. Rice beds and remnants were found along the entire length of the survey. At each stand, the following physical parameters were measured and recorded: stand density, sediment type, sediment depth, water depth, turbidity, dissolved oxygen, pH, temperature, and conductivity. Table 14 below includes the measurements taken at the quality wild rice beds.

[16] Mattison, Cody, Thompson, Jamie, Taylor, Don and FryeLake, Tom. *Report: Yellow River Burnett County*. St. Croix Tribal Natural Resource Department. August 2008.

Table 14. Wild Rice Bed Physical Parameter Data

Stand Density	Sediment Type	Sediment Depth (in) start	end	total	Water Depth (in)	Turbidity (secchi-ft.)	Time (24 hr)	DO (ppm)	pH	Temp (C°)	Conductivity (mV)
August 12, 2008											
Sparse	Muck/Sand	9	12.5	3.5	35	Bottom	13:25	7.16	9.33	23.1	-142.6
M-D	Muck/Sand	1	2.5	1.5	18	Bottom	13:53	7.74	9.42	23.0	-147.2
S-D	Muck/Sand	10	13.5	3.5	28	Bottom	13:39	6.89	8.16	22.8	-99
August 14, 2008											
Sparse	Muck/Sand	8	8.5	.5	28	bottom	9:58	9.55	10.34	22.2	-199.3
S-D	Muck	11	14.75	3.75	23.5	Bottom	11:10	4.96	9.57	22.0	-152.4
Dense	Muck	8	13.5	5.5	22.5	8	9:44	5.9	8.17	22.2	-100
S-M	Muck	4	7	3	30	Bottom	10:13	5.85	8.23	22.3	-103
S-D	Muck	7.5	12	4.5	23.5	N/A	11:40	3.3	7.47	22.2	-62

The majority of the sediment observed was a mix of muck and sand, and the water was mostly clear. Docks were located in many of the wild rice beds, but the amount of destruction they caused to the beds varied. There were very few signs of grazing on the wild rice beds. Competing aquatic plants were observed, including bur-reed, bulrush, cattails, coontail, filamentous algae, pondweeds, and many water lilies. The high rate of development and boat traffic are the river's main disturbances. Despite the observed disturbances, the wild rice was green, flowering, and appeared healthy.

Management recommendations

The tribal report provided no recommendations for management of the wild rice on the Yellow River at the time of their report. They summarize as follows:

> It is clear that the rice is growing to a great extent on the river, and due to high boat traffic and development, it is believed the rice would not grow in other places on the river. The beds that do already exist are growing rice that seems healthy and take up most of the suitable habitat. Continued monitoring and mapping of these beds may be the best alternative for management.

Invasive Species

Three invasive species were located in the lakes aquatic plant surveys. They include purple loosestrife, curly leaf pondweed, and reed canary grass. More information about these species is included in Appendix B. Inventory results from the point intercept aquatic survey and other sources are included below. Eurasian water milfoil has not been discovered in the system including during meandering surveys for aquatic invasive species in Yellow Lake, Little Yellow Lake and the Danbury Flowage in August 2014.

Purple Loosestrife

A map of purple loosestrife locations compiled by the Burnett County Land and Water Conservation Department (LWCD) is included as Figure 14. Locations where purple loosestrife is reported are summarized below. Beetles are released to control purple loosestrife (Appendix B provides more information.)

<u>Yellow River upstream (south) of Yellow Lake</u>

Burnett County LWCD has mapped extensive areas of purple loosestrife upstream of Yellow Lake.

<u>Yellow Lake</u>

Burnett County LWCD conducted a purple loosestrife survey in 2005 in Yellow Lakes and did not find any. Endangered Resource Services found purple loosestrife on Yellow Lake near the inlet on a boggy island just north of where the Yellow River enters the lake (2007). A Burnett County LWCD AIS survey found purple loosestrife near Jamison Road on the south side of Yellow Lake in August 2015.

<u>Little Yellow Lake</u>

Endangered Resource Services found purple loosestrife on Little Yellow Lake near where the river exits the lake along an undeveloped point on the south shore near a narrow spot on the northeast corner of the lake (2007).

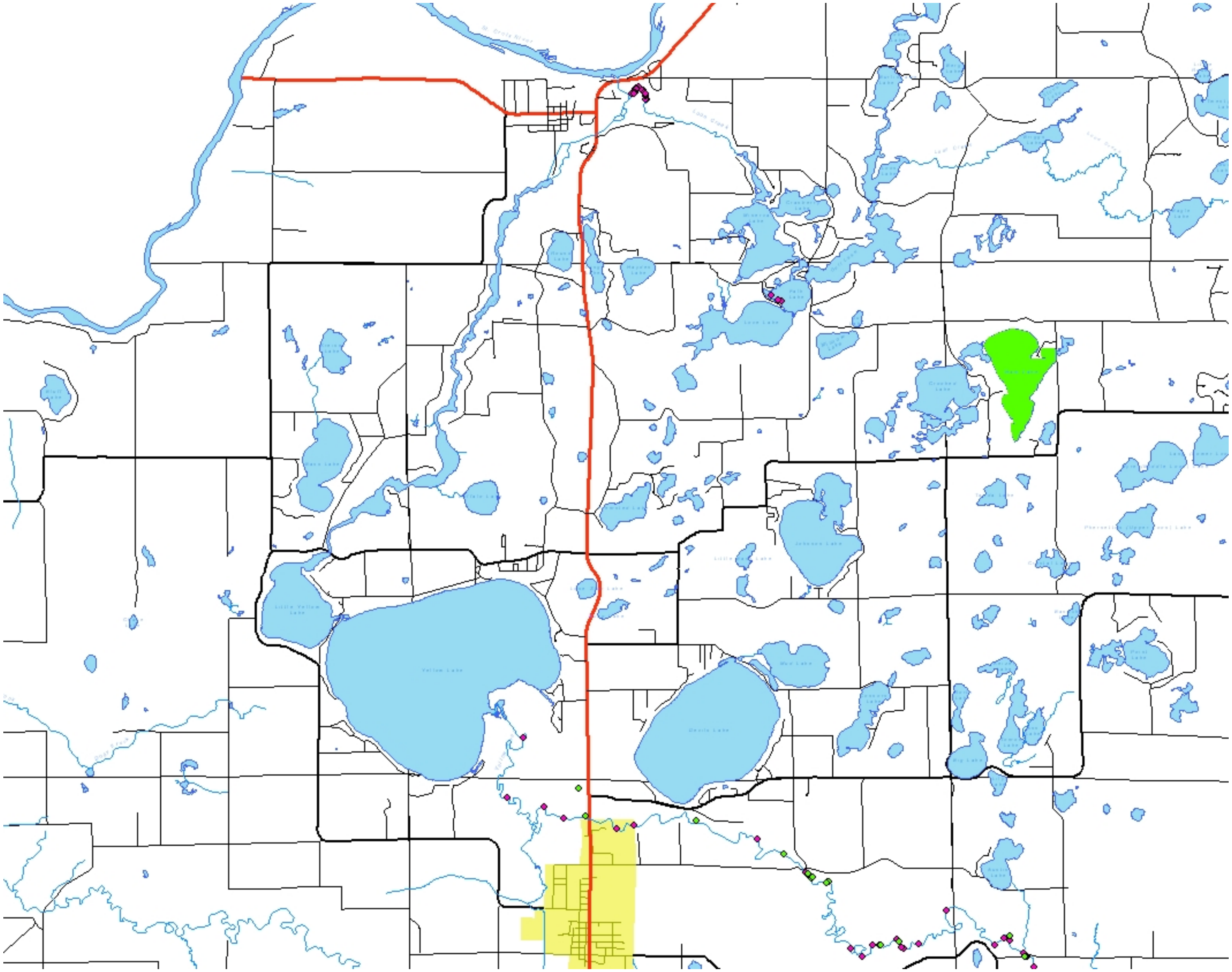


Figure 14. Purple Loosestrife (purple dots) and Beetle Release (green dots) Locations (Burnett County)

Yellow River downstream (north) of Little Yellow Lake

North American Hydro conducted a purple loosestrife survey on the river between Little Yellow and the dam in 2007 and 2008. One plant was found and removed in 2007. No purple loosestrife was found in 2008.

Curly Leaf Pondweed

Endangered Resource Services conducted a curly leaf pondweed bed mapping survey on June 1st and 6th, 2009 for both Yellow and Little Yellow Lakes.[17] The CLP survey included mapping CLP beds, taking rake samples, and recording plant abundance. The latter portion of the survey is referred to as a rapid assessment.

For the purpose of this study, a CLP bed was defined by the following criteria: 1) CLP plants made up greater than 50% of all aquatic plants in the bed, and 2) the CLP had canopied at the surface or was close enough to the surface that the growth would likely interfere with normal boat traffic.

The locations and abundance of CLP were far greater in 2009 than in 2007. The 2007 CLP study was conducted in late June and the CLP had already begun to senesce. The results of the 2007 CLP survey were therefore necessarily determined by making conservative abundance estimates based on the presence of rotten stems.

In 2009 CLP was almost completely absent along the north shore of Yellow Lake — in areas where it was common in 2007. Dense native plant beds at depths of 1.5-2 meters also seemed much reduced. Water clarity was significantly improved, and there was almost no filamentous algae observed, whereas it had almost entirely covered the bottom of Yellow Lake in 2007.

[17] Berg, Matthew S. *Curly-leaf Pondweed Bed Mapping Survey, Yellow Lake and Little Yellow Lake, Burnett County, Wisconsin.* Endangered Resource Services, LLC. June 2009.

Yellow Lake CLP Results

Yellow Lake CLP beds were mapped in 2009-2011. In 2009 three small beds were located and mapped on the southeast end of Yellow Lake (Figure 15). They covered a total of 13.7 acres or 0.6% of the lake's 2,287 total acres (Table 15). In 2010 these same three beds were present, but covered a greater area of 21.51 acres. In 2011, CLP was present, but did not top out at the surface and form beds except in one small area as shown in Figure 17.

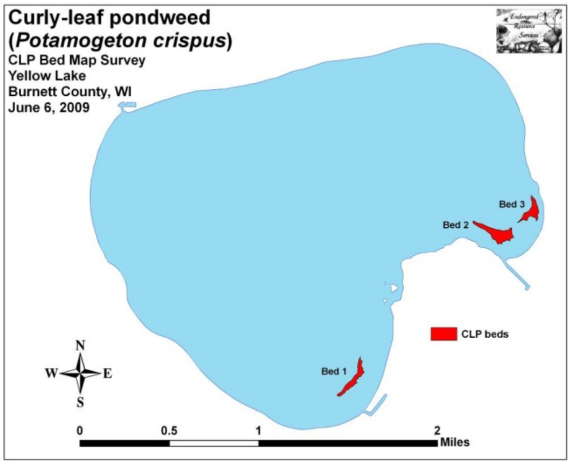


Figure 15. Yellow Lake CLP Beds (Berg 2009)

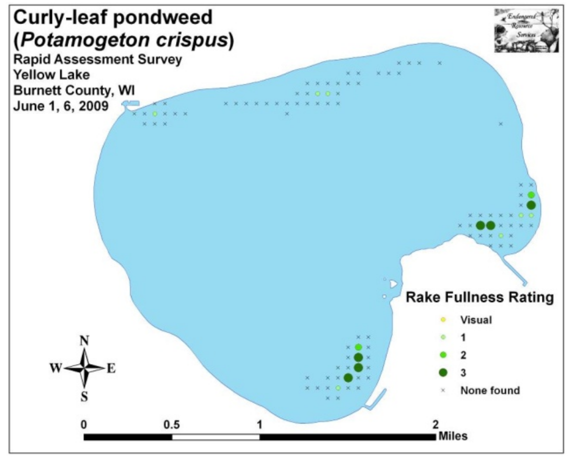


Figure 16. Yellow Lake 2009 CLP Rapid Assessment Survey

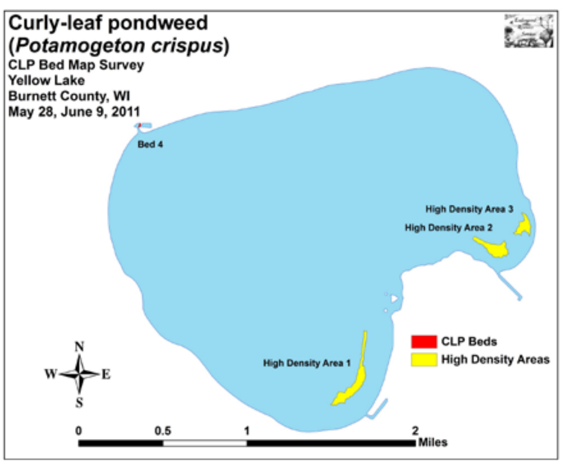


Figure 17. Yellow Lake CLP Beds (Berg 2011)

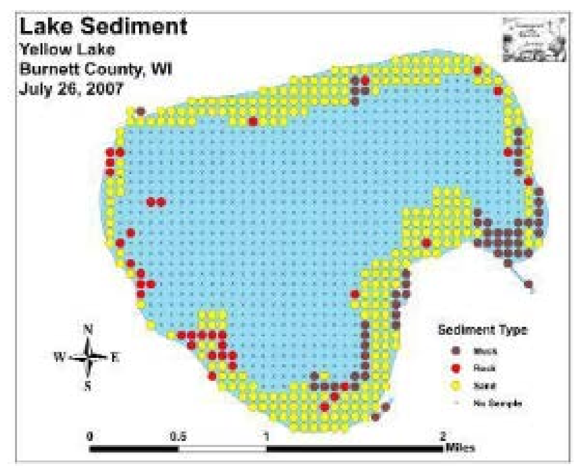


Figure 18. Yellow Lake Sediment (Berg 2009)

Table 15. Yellow Lake CLP Bed Summary (Berg 2011)

Bed Number	Acreage (2011)	Acreage (2010)	Acreage (2009)	Change in Area
1	0.0	10.70	3.81	-10.70
2	0.0	6.83	6.32	-6.83
3	0.0	3.98	3.64	-3.98
4	0.15	0.0	0.0	0.15
Total Acres	0.15	21.51	13.77	-21.36

Rake samples were also taken along the north and northeast shores, where CLP growth was present during the 2007 survey. Despite the mucky substrate in these areas, the presence of CLP was very limited. There were no beds or significant CLP populations found in 2007.

Little Yellow Lake CLP Results

Curly Leaf Pondweed (CLP) was mapped in the 2014 and 2007 June point intercept surveys. Little Yellow Lake has extensive muck bottomed areas on the north and west sides of the lake that offer CLP an ideal habitat to grow. The results suggest there were no significant changes in CLP coverage or density when comparing 2007 with 2014. In 2014 CLP was present in the rake at 80 sample points which approximated to 23.5% of the entire lake. Of these, a rake fullness value of 3 was recorded at 34 points, 2 at 15 points, and a value of 1 at 31 points. This extrapolated to 14.4% of the lake having a significant infestation (rake fullness of 2 or 3).

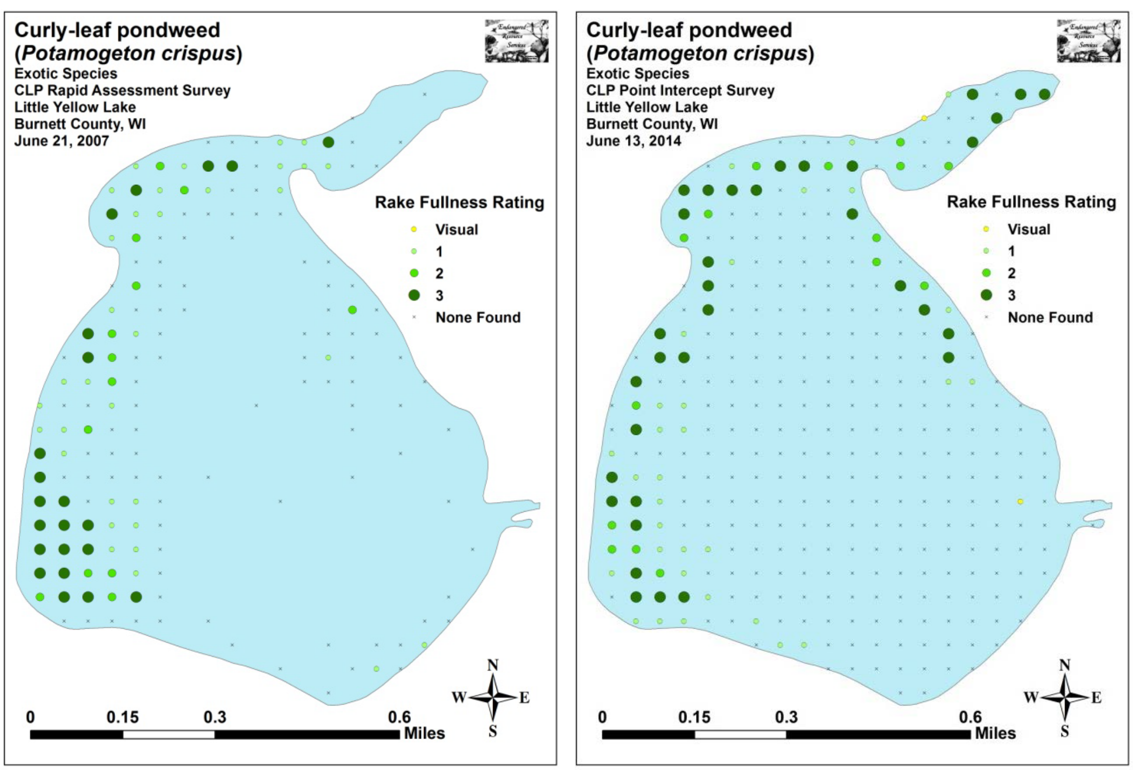


Figure 19. 2007 and 2014 June CLP Density and Distribution (Berg 2014)

CLP Bed Mapping Survey

Six beds totaling 39.72 acres (12.0% of the lake's 332 acres) were mapped in 2014. The beds ranged in size from 28.53 acres (Bed 1) to 0.09 acre (Bed 7). Each of these beds was canopied, began in approximately 3-4ft of water, and extended to 8-9ft. The inner edges tended to be more fragmented as CLP was frequently mixed with a high percentage of native plants. However, beyond 5-6ft, CLP tended to become increasingly monotypic. Individual bed descriptions are found in the plant survey report. The worst navigation impairment was identified in Bed 1 and the southern half of Bed 5.

CLP bed criteria:

1) CLP plants made up greater than 50% of all aquatic plants in the area, and
2) CLP canopied at the surface or was close enough to the surface that it would likely interfere with normal boat traffic.

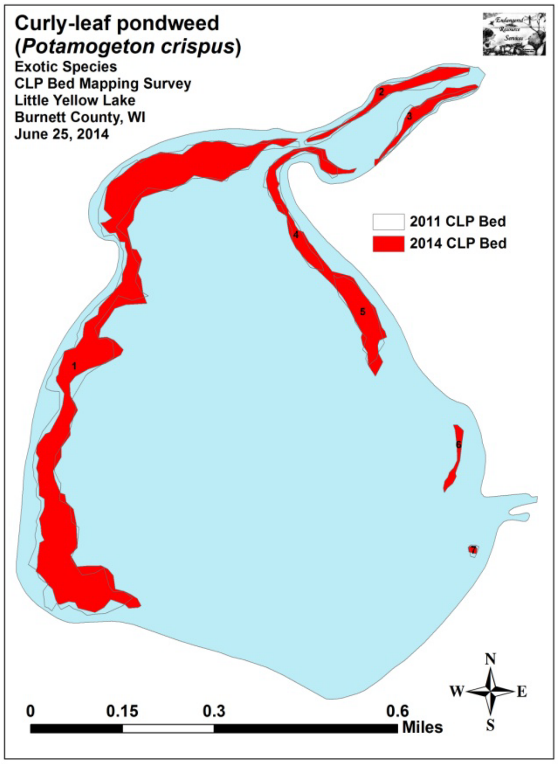


Figure 20. Little Yellow Curly-leaf Pondweed Beds 2014- Canopied CLP in Bed 3 (Berg)

Previous CLP bed survey results are summarized in Table 16. While 2014 and 2011 bed results are similar, previous results show a large fluctuation in CLP growth as is common in area lakes.

Table 16. CLP Bed Summary Little Yellow Lake, Burnett County (Berg 2014)

Bed Number	2014 (Acres)	2011 (Acres)	2010 (Acres)	2009 (Acres)	Rake Range	Mean Rake Fullness	Max Depth (ft)	Potential Navigation Impairment
1	28.53	30.37	0	64.95	2-3	2	9	Severe
2	2.14	2.83	0	3.56	1-3	3	9	Minor
3	1.64	1.79	0	1.05	1-3	3	9	Minor
4 and 5	6.70	5.84	0	6.98	1-3	2	8	Moderate
6	0.63	0	0	1.84	2-3	3	9	Minor
7	0.09	0.15	0.02	0.46	1-2	2	8	None
Total Acres	**39.72**	**40.97**	**0.02**	**78.84**				

Danbury Flowage CLP Results

Endangered Resource Services conducted a CLP point intercept survey and bed mapping in June 2014 Although rare or absent in most sandy and rocky areas, CLP was common to abundant in 2-10ft of water in most of the flowage's bays over areas with thick organic muck and adjacent to the channel in sandy muck. CLP was found in the rake at 146 sample points or approximately 28.2% of the flowage. Collectively, these samples averaged a rake fullness of 2.41 with 65 points rating a 3, 28 points a 2, and the remaining 37 a 1. This extrapolated to 18.0% of the flowage having a significant infestation (rake fullness 2 and 3).

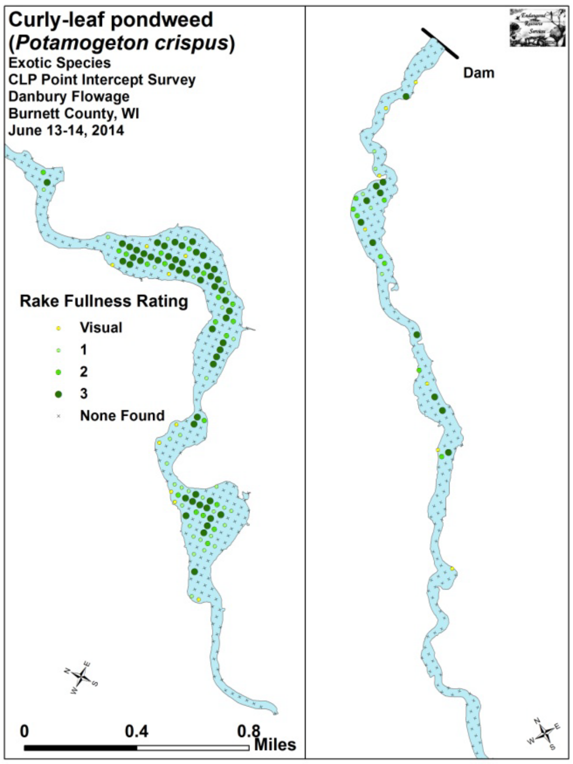


Figure 21. Danbury Flowage's June CLP Density and Distribution

Danbury Flowage CLP Bed Mapping

CLP beds totaling 45.15 acres (18.7% of the flowage's 242 acres) were mapped. The largest bed was 27.94 acres (merged Beds 10 and 12) and the smallest was 0.03 acre (Bed 15) (Figure 22) (Table 17). This was down from 22 beds that covered 46.07 acres in 2011, but much above the 14 beds covering 5.29 acres in 2010 (it should be noted that both of these previous surveys ended at the Glendening Bridge as directed by WDNR). Each of these beds was canopied or near canopy, and, although scattered plants occasionally extended to 11.0ft, the densest monotypic growth was generally found from 4-9ft. Although CLP was found in as little as 2ft of water, the inner edges of beds tended to be more fragmented as they were often mixed with at least some natives species.

Table 17. CLP Bed Summary Danbury Flowage, Burnett Co. - June 25, 2014

Bed Number	2014 Acreage	2011 Acreage	2010 Acreage	Rake Range	Mean Rake Fullness	Max Depth	Adjacent Rice Noted	Landing Access Potential	Potential Navigation Impairment Level
1	0.41	0.07	0	1-3	2	4			Minor
2	0	0.13	0	-	-	-			None
3	0.04	0.53	0.14	1-3	2	4			None
4 and 6	8.68	9.37	0.02	2-3	3	8			**Severe**
5	0.09	0.54	0	2-3	3	5			None
7	0	4.17	1.71	-	-	-			None
8	0	0.08	0.14	-	-	-			None
9	0.12	0.10	0	2	2	3			Minor
10 and 12	27.94	29.13	3.01	1-3	2	9			**Severe**
11	0	0.04	0	-	-	-			None
13	0	0.05	0	-	-	-			None
14	0.12	0.63	0	2-3	3	3			None
15	0.03	0.03	0	2-3	2	3			None
16	0	0.11	0	-	-	-			None
17 and 18	0.46	0.44	0.12	2-3	2	3	Yes		Minor
19	0	0.11	0.07	-	-	-			None
20	0.27	0.17	0	1-3	2	6	Yes		Minor
20A	0.28	0	0	2-3	2	4	Yes		Minor
21 and 22	1.61	0.38	0.10	2-3	2	4	Yes		Minor
23	0.88	Not Surveyed	Not Surveyed	1-3	2	4	Yes	NO	None
24	1.27	Not Surveyed	Not Surveyed	1-3	2	6	Yes	NO	Minor
25	1.56	Not Surveyed	Not Surveyed	1-3	2	6		NO	**Severe**
26	1.39	Not Surveyed	Not Surveyed	2	2	3		NO	**Severe**
Total Acres	**45.15**	**46.07**	**5.29**						

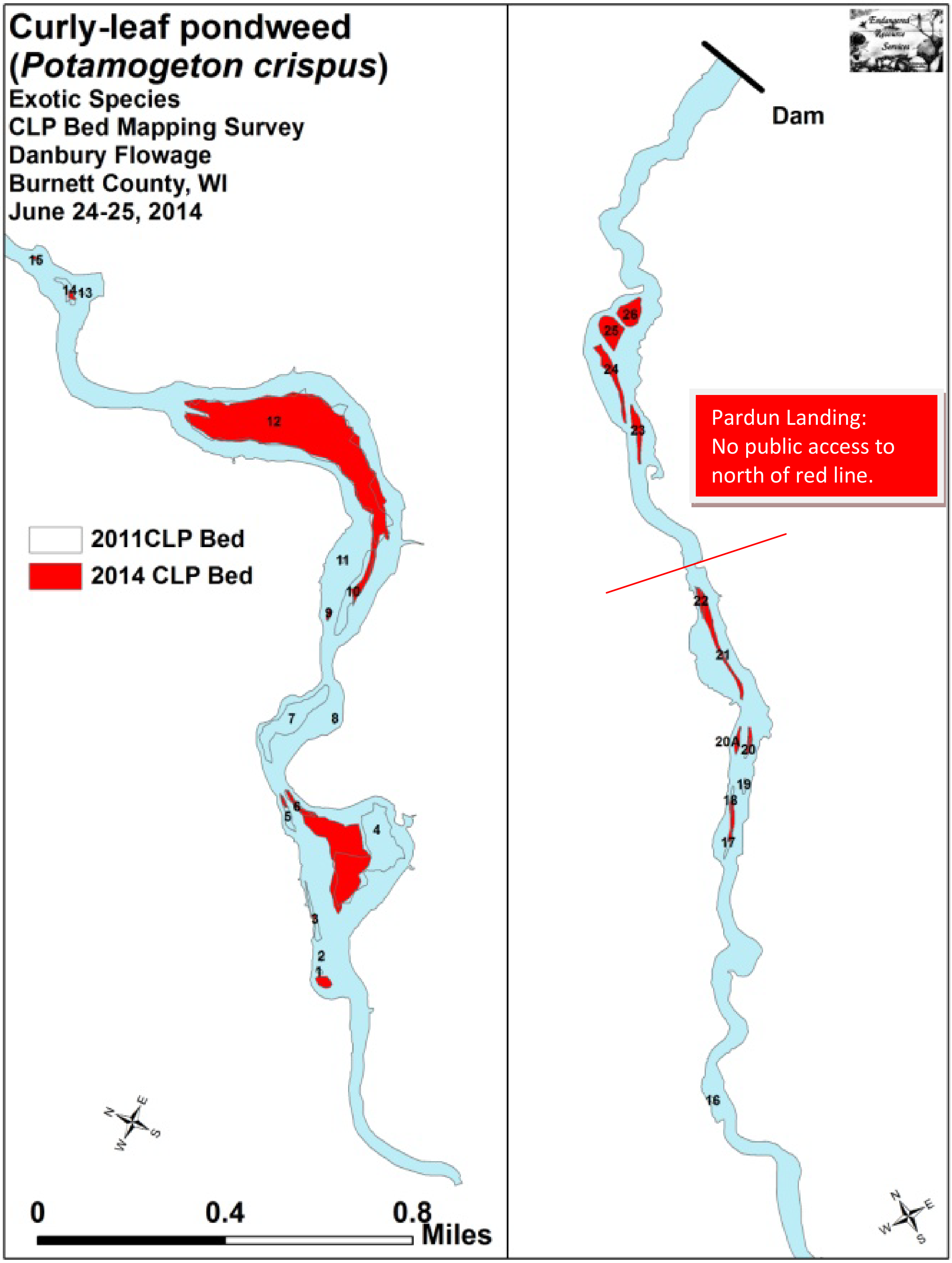


Figure 22. Danbury Flowage June CLP Bed Map

Aquatic 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. Additional requirements exist when a lake is considered an ASNRI (Area of Special Natural Resource Interest) due, in the case of Yellow Lakes, to the presence of wild rice.

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.[18]

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[19]

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.

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

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

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. Manual removal with divers is recommended for shallow areas if sporadic EWM growth occurs.

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[20] 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. A harvester can also be used to gather dislodged, free-floating plant fragments such as from coontail or wild celery. 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 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

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

stabilization and wave absorption. Sediment suspension and 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 contracted 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. One must also consider prevailing winds, since cut vegetation can be blown into open areas of the lake or along shorelines.

Harvesting on Little Yellow and the Danbury Flowage

Key considerations for harvesting on the Little Yellow Lake and the Danbury Flowage are

- access for a harvester on Little Yellow (permission from private owner)
- access for harvester on the Danbury Flowage (being investigated with homeowner's association)
- distance of travel for harvesting and disposal
- availability of disposal/beneficial use sites for harvested plant materials
- depth for harvester navigation
- timing of harvesting
- contracted harvester availability and cost
- cost of harvester purchase
- operation and maintenance cost and logistics

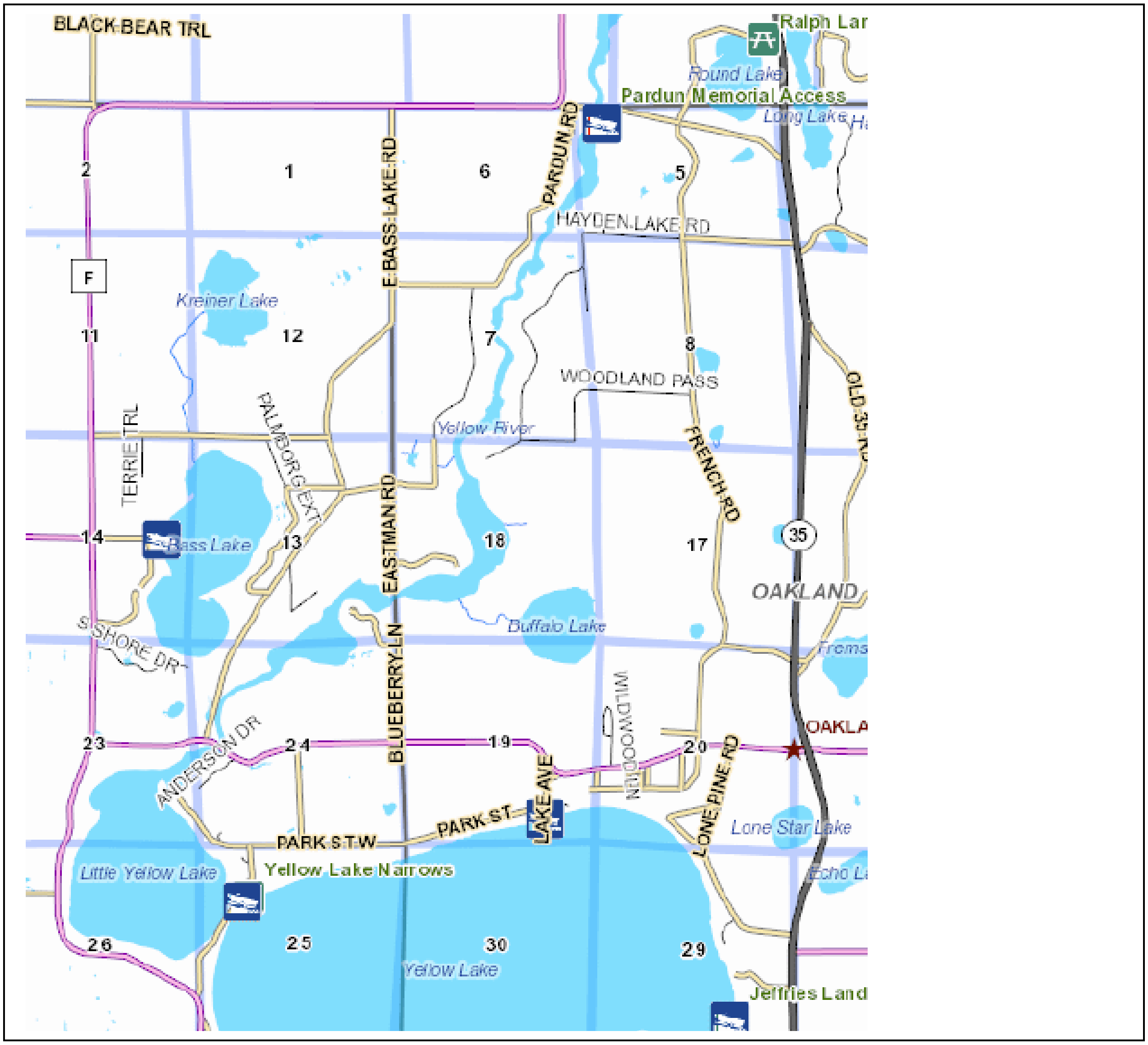


Figure 23. Public Access Sites: Yellow Lake

<u>Access for harvester</u>

There is no public access on Little Yellow Lake. The Yellow Lake Narrows Landing is just to the east of the road between the lakes. However, there is not enough clearance under the road to allow passage for a harvester. The clearance depends upon water depth and is around 3-4 feet – depending on lake water depth.

Small harvesters are available for access through areas with low clearance, but they still may not be able to navigate under the bridge. An alternative would be to develop a public access or obtain permission for private access for a harvester. Such access would also be necessary for off-loading collected plant material. An agreement for access through private land is currently under development and expected by the 2017 harvesting season.

The public access for the Danbury Flowage is Pardun Memorial Park which is about 1.25 miles south of the dam. However it is very steep, and might provide the best access. Additional access points may be available on the flowage through a homeowner's association. An access width of 8 feet is needed for the off load conveyor.[21] Beds of curly leaf pondweed are found just south of the dam, between 2 and 3 miles south of the dam, and between about 3.5 and 3.7 miles south of the dam.

A harvester will travel about 2 miles per hour, so considerable time would be required to simply get the harvester to the harvesting and disposal location.

Figure 24. Aerial Photo Showing Farm Fields near Harvesting Area

<u>Availability of disposal/beneficial use sites</u>

Harvested aquatic plants can be land applied and/or composted as a soil amendment. It is possible to find sites where plant material is accepted at no charge, but there are generally costs for hauling. There are a few farm fields near the landings as shown in the aerial photo above. County and state "do not transport" regulations restrict moving aquatic plants on roadways, but transport is allowed for disposal as part of a harvest or control activity conducted under an aquatic plant management permit issued under ch. NR 109.

[21] Personal communication, Cliff Schmidt 2/15/16

Depth for Harvester Navigation

Harvester access and passage can be limited by lake depth. About 18” to 24” of depth is needed to simply navigate the harvester.[22] A public operator indicated 24” was a minimum depth for transport of an 8 foot harvester when empty, but that 4 feet of depth was necessary for transport when the harvester was full.[23] WDNR permit conditions generally allow cutting in water to a minimum depth of 3 feet. Harvester heads should be kept at least 2 feet off the bottom no matter the water depth to prevent disturbing sediment (dredging), damaging heads (stumps, logs,) and to maintain some vegetated habitat.

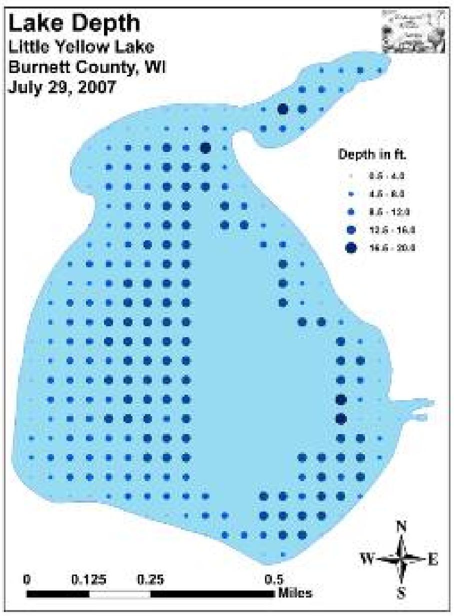
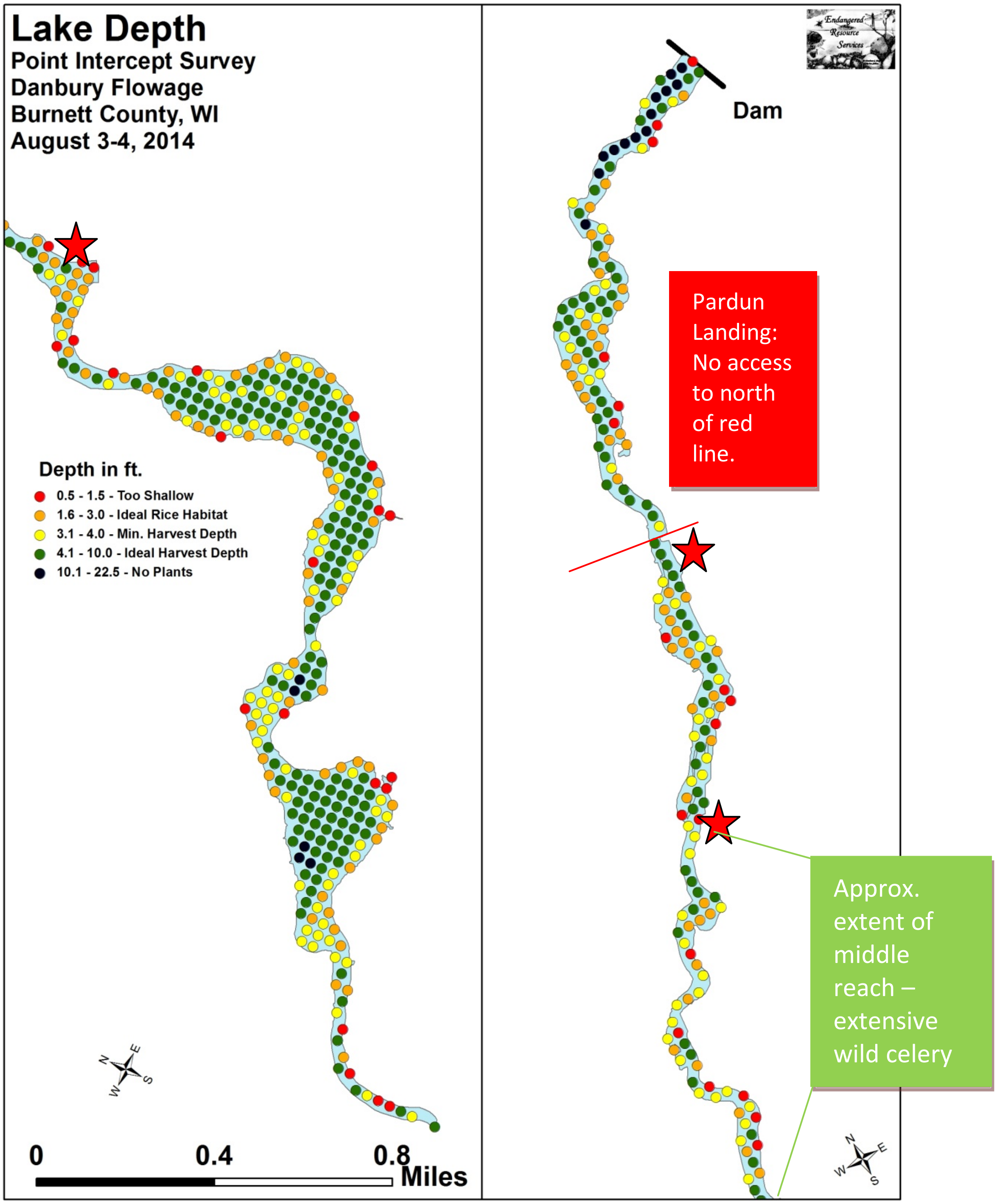


Figure 25. Little Yellow Lake Depth

[22] Personal communication, Cliff Schmidt 2/15/16

[23] Personal communication Dave Schleusner, 2/16/16.



= Potentially available access sites (with 8 foot ramp)

Figure 26. Danbury Flowage Lake Depth and Potentially Available Access

Contracted harvesting

Availability of contracted harvesting is limited.

The YLRA accepted a bid to harvest a 30 foot wide channel through curly leaf pondweed beds on Little Yellow Lake for a cost of around $10,000 in 2017.

Cost of harvester purchase

Because contracted aquatic plant harvesting is not readily available, purchase of a harvester could be at least considered. Grants may be available to help with purchase through the Wisconsin Waterways Commission which has recently offered grants at 35% of total cost. The cost of a harvester with an 8 foot blade along with related equipment (conveyor and trailer) is estimated to cost around $150,000 to $200,000. A small harvester with a 4 foot blade cost $75,000. Costs for additional equipment with the 4 foot unit are estimated to be $35,000.[24]

An example cost estimate from the Balsam Lake Protection and Rehabilitation District is provided below. They were able to purchase this equipment with help from a grant from the Waterways Commission.

Estimated capital costs of harvesting program[25]

Harvester with options:	$154,120
Trailer:	$17,500
Shore Conveyor:	$32,000
Freight:	$500
SUBTOTAL	**$204,120**
Transport Barge:	$129,450
Trailer:	$17,500
Freight:	$500
SUBTOTAL	$**147,450**
	$351,570

Operation and maintenance

Employees are needed to operate and maintain harvesting equipment. Employment would be seasonal and would depend upon the management strategy selected. The Yellow Lakes and River Association currently does not have employees. It might be possible to find a contractor willing to operate and maintain lake association-owned equipment.

Timing of harvesting

Selecting the timing and depth of harvesting would be critical and would vary depending upon aquatic plant management objectives. Curly leaf pondweed harvesting should occur when plants have grown enough for harvester blades to reach and cut the plants and prior to turion formation.

[24] Aquarius Systems. March 2011.

[25] 2015 Balsam Lake Protection and Rehabilitation District Annual Meeting presentation

Permitting

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 manual and mechanical plant removal are described in *NR 109 – Aquatic Plants: Introduction, Manual Removal & Mechanical Control Regulations*.[26]

An initial harvesting permit application will be submitted for 2017. The YLRA plans to harvest a 30 foot channel through CLP beds in 2017. The permit application will include maps (CLP and wild rice), other target plants, selected contractor, plan for ensuring equipment is AIS-free, access and disposal sites, harvest objectives. This proposal will be submitted to Pamela Toshner and Mark Sundeen (Wisconsin Department of Natural Resources).

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

Figure 27. Aerial photos of the Danbury Flowage. GLIFWC 2014.

Light green areas indicate wild rice growth according to Peter David, GLIFWC.

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 part 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 if discovered in the lakes or river.

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[27]

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.

Weevils[28] have potential for use as a biological control agent against Eurasian watermilfoil. There are several documented "natural" declines of EWM infestations. In these cases, EWM

[27] Information from APIS (Aquatic Plant Information System) U.S. Army Corps of Engineers. 2005.
[28] *Control of Eurasian Water Milfoil & Large-scale Aquatic Herbicide Use.* July 2006. Wisconsin Department of Natural Resources.

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 does not appear to be effective.

The effectiveness of biocontrol efforts varies widely (Madsen, 2000). Beetles are commonly used to control purple loosestrife populations in Wisconsin with good success. As mentioned previously, 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.

There are advantages and disadvantages to the use of biological control as part of an overall aquatic plant management program. Advantages include longer-term control relative to other technologies, lower overall costs, and plant-specific control. On the other hand there are several disadvantages to consider, including very long control times (years instead of weeks), a lack of available 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. Biological control is proposed and currently used for purple loosestrife control along Yellow and Little Yellow Lake and the Yellow River.

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). Re-vegetation following plant removal is probably not necessary on Yellow and Little Yellow Lakes because a healthy, diverse native plant population is present.

Physical Control[29]

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

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

the bed of a lake and/or affect lake water level, a Chapter 30 or 31 WDNR permit would be required.

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. Dredging is not suggested for the Yellow and Little Yellow Lake as part of the aquatic plant management plan.

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

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 often not in a consistent fashion (Cooke 1980a). Drawdowns may provide an opportunity for the spread of highly weedy species, particularly annuals.

Drawdown may at first glance appear to be an option for management of curly leaf pondweed in Yellow and Little Yellow Lake due to the dam. However, there are several reasons that drawdown for aquatic plant control is not a viable option for the lakes. 1) It is not clear how much the lakes could be drawn down with changes to the dam. There is an extensive stretch of river (six miles) between the outlet of Little Yellow Lake and the dam. The dam does not precisely or effectively control lake levels. 2) A drawdown would result in an unknown depth in both lakes. This depth may not completely cover the area where curly leaf pondweed grows and turions are found. 3) Curly leaf pondweed is found in the entire littoral zone area. So, a drawdown that would decrease curly leaf pondweed growth would have an unknown impact on native aquatic plants and other aquatic organisms. 4) Drawdown would dramatically change the use and appearance of the lakes. 5) North American Hydro would expect compensation for revenue lost from power generation. 6) It would take an undetermined amount of time to refill the lakes following drawdown.[30]

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 using sediments is that new plants establish on top of the added layer (Engel and Nichols 1984). The problem with synthetic sheeting is that the gasses evolved from plant and sediment decomposition collect underneath and lift the barrier (Gunnison and Barko 1992). 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 light plants need to grow. Shading has been achieved by fertilization to produce algal growth, by application of natural or synthetic dyes, shading fabric, or covers, and by establishing shade trees (Dawson 1981, 1986; Dawson and Hallows 1983; Dawson and Kern-Hansen 1978; Jorga et al. 1982; Martin and Martin 1992; Nichols 1974). During natural or cultural eutrophication, algae growth alone can shade aquatic plants (Jones et al. 1983). Although light manipulation techniques may be useful for narrow streams or small ponds, in general these techniques are of only limited applicability. Physical control is not currently proposed for management of aquatic plants in Yellow and Little Yellow 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.

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[30] Chamberlin, Melissa. Northwest Regional Manager. North American Hydro. Email communication. July 11, 2009 and Polaris Group Report. February 2004.

General descriptions of herbicide classes are included below.[31]

Contact herbicides

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

Systemic herbicides

Systemic herbicides are absorbed into the living portion of the plant and move within the plant. Different systemic herbicides are absorbed to varying degrees by different plant parts. Systemic herbicides that are absorbed by plant roots are referred to as soil active herbicides and those that are absorbed by leaves are referred to as foliar active herbicides. **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.

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

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 18. Herbicides Used to Manage Aquatic Plants in Yellow and Little Yellow Lakes

Brand Name(s)	Chemical	Target Plants
Cultrine Plus, Komeen, $CuSO_4$	Copper compounds	Filamentous algae, coontail, wild celery, elodea, and pondweeds
Reward	Diquat	Coontail, duckweed, elodea, water milfoil, and pondweeds
Aquathol, Aquathol 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	2, 4-D	Water milfoils, water lilies, and bladderwort

General descriptions of the breakdown of commonly used aquatic herbicides are included below.[32]

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.

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32 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: 2,4-D, diquat, endothall, fluridone, and triclopyr.[33] 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. 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. 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 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. 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.

Curly leaf pondweed

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

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.[34] 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.

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[33] Additional information provided by John Skogerboe, Army Corps of Engineers, personal communication. February 14, 2008.

[34] Research in Minnesota on Control of Curly Leaf Pondweed. Minnesota Wendy Crowell, Minnesota Department of Natural Resources. Spring 2002.

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.[35] 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.

[35] Personal communication, Frank Koshere. March 2005.

Current and Past Aquatic Plant Management

According to WDNR permit records, chemical treatment of algae and aquatic macrophytes (plants) was conducted on Yellow Lake at least since 1985 through 2006 (see Table 19 below). These treatments occurred along the developed, northeastern shoreline, and were completed for 3 to 16 individual properties per year. Emergent, floating, and submerged water plants were targeted, along with algae. The purpose of these treatments was threefold: to maintain shoreline access for boating, swimming, fishing, etc.; to control invading plants; and to improve lake aesthetics by eliminating nuisances.

Table 19. Past Waterfront Herbicide Treatments on Yellow Lake

Year	Individual Properties	Maximum Acres Allowed for Treatment
1985	16	2.84
1986	16	2.8
1987	16	2.8
1988	13	4.09
1989	14	2.98
1990	6	1.14
1991	3	0.53
1992	3	0.46
1993	10	0.51
1994	5	0.64
2006	3	0.52

Much like Yellow Lake, some waterfront properties on Little Yellow Lake had undergone regular chemical treatment for at least the 2½ decades prior to 2007 for the removal of algae and aquatic plants. The number of waterfront properties treated varied from 1 to 18 per year. These treatments occurred either along the southern shoreline, or on the northwest corner of the lake, near the outlet of the Yellow River. Again, algae and all types of aquatic macrophytes were targeted for the purpose of recreational access, invasive control, and aesthetics.

Table 20. Past Waterfront Herbicide Treatments on Little Yellow Lake

Year	Individual Properties	Maximum Acres Allowed for Treatment
1985	1	0.18
1986	4	n/a
1987	4	0.65
1988	4	0.65
1990	18	2.27
1991	13	1.98
1992	13	1.98
1993	13	1.98
1994	4	0.73
1995	4	0.73
1996	4	0.73
1999	1	0.09
2005	1	0.17
2006	3	0.51
2007	4	0.68

Monitoring and Education Activities

Video Launch Monitoring Report (I-LIDS program)[36]

Yellow Lake uses a video camera at three boat landings to prevent the introduction of aquatic invasive species (AIS). The cameras were installed as part of a WDNR-approved Aquatic Invasive Species Education and Prevention grant for the Burnett County Lakes and Rivers Association (BCLRA). This two-year initiative focused on the automated video monitoring of seven boat launches on five lakes in Burnett County (Johnson, Lake 26, Mud Hen, Big Wood, and **Yellow Lake (3 launches)**. The monitoring equipment is manufactured, installed, and maintained by Environmental Sentry Protection, LLC (ESP). The five lake associations, BCLRA, Burnett County, and ESP committed to providing fifty percent of the resources for this project through a combination of volunteer effort, resources, and payments.

This project used traditional Clean Boats, Clean Waters (CBCW) practices as well as remote video surveillance. Educational materials were distributed in this multi-pronged effort to prevent the advance of aquatic invasive species from boats and trailers into these lakes.

[36] Yellow Lake and Little Yellow Lake, Burnett County Aquatic Invasive Species Education, Prevention and Planning Grant application. February 2009.

Project objectives:
1) Develop and present educational information to anglers visiting bait stores
2) Identify a clear aquatic invasive species (AIS) clean off zone at each launch
3) Educate visiting boaters on procedures that they should follow to clean their boats
4) Install Internet Landing Installed Device Sensors (I-LIDS) to capture launch usage statistics
5) Determine compliance of visitors with removal of AIS prior to launching
6) Evaluate the effectiveness of the monitoring tool in ensuring visitors follow procedures
7) Identify specific boaters who violate laws regarding transport of AIS

The main goals of the program were to:

- Reduce the risk of AIS introduction through education and a continuous presence.
- Modifying boater behaviors to not launch with aquatic plants on equipment.
- Identify AIS violators who had attached weeds on their boat and trailer while launching.
- Improve public education on AIS, including notifying violators of illegal launching.

Camera use continued under a lease program from 2007 through 2009. Cameras were then purchased by the YLRA. Results of monitoring are reported in Table 21 and Table 22 below. The video sequences captured allow reviewers to identify not only the number of launches and potential aquatic invasive species transport violations, but also the day of the week and time of day of launches occurring at each landing. Suspected violations are reported to the Burnett County Sheriff's Department. However, concerns regarding enforcement of these reported violations are expressed in project reports.

Table 21. Launches at Yellow Lake Landings (Lindberg)

Landing	2010	2011	2012	2013	2014	2015
Jeffries Landing	286	486	423	135	509	1350
Yellow Lake Lodge	529	701	1091	796	1146	1736
Ike Walton	100	16	62	63	350	?

Table 22. Potential Aquatic Invasive Species (Plant) Violations (Lindberg)

Landing	2010	2011	2012	2013	2014	2015
Jeffries Landing	0	4	2	0	3	4
Yellow Lake Lodge	?	0	5	1	3	2
Ike Walton	0	0	0	0	0	?

Burnett County Land and Water Conservation (LWCD)

Burnett County assists the YLRA in management of aquatic invasive species and may be available to assist the YLRA with the following tasks:

- Conduct watercraft inspection at public access points.
- Complete limited in-lake monitoring for EWM and other invasive species.
- Carry out public outreach and education related to invasive species at events including lake meetings, fishing tournaments, county fairs, and local festivals.
- Post signs at boat landings and other public lake access points to inform residents of the new Burnett County "do not transport" ordinance.
- Train local lake residents and others to monitor their own boat landings as part of the WDNR "Clean Boats, Clean Waters" program.
- Assist in "rapid response" actions to identify and respond to new invasive species infestations reported by the public.
- Conduct integrated pest management for purple loosestrife control including beetle rearing and release.
- Assist volunteers with identification of aquatic invasive species, and provide limited supplies for their removal.

In-lake monitoring focuses on searching for potential establishment of Eurasian water milfoil and other aquatic invasive species at boat landings and other areas with high public use. Grab samples are taken at regular intervals at these high public use areas and at random locations around the littoral zone of selected lakes. All Burnett County boat landings are monitored each year. The littoral zone of each lake in the county is not monitored each year, and supplemental monitoring is recommended.

Workshops and trainings include Clean Boats, Clean Waters training, plant identification, and whole lake monitoring workshops. Staff generally travel to local lakes to encourage participation and provide more focused training.

The Rapid Response Plan will involve a team of resource professionals from various agencies who can directly assist the lake organization in managing newly discovered invasive species and develop a plan to restore the native plant community. This rapid response SWAT team will assist with identifying appropriate management methods, coordinating and, in some instances, carrying out control measures, grant writing, and completing or hiring consultants to complete aquatic plant surveys and management plans.

Lake organization assistance

County staff will assist the Burnett County Lakes and Rivers Association and county lake organizations in their efforts to prevent and control aquatic invasive species. This assistance will include technical support for the I-LIDS monitoring program and help with permit and grant applications.

Plan Goals and Strategies

Current Harvesting Goal
Maintain navigable channels for fishing and boating.

Objectives

A. Maintain navigation channels through dense beds of curly leaf pondweed on Little Yellow Lake.

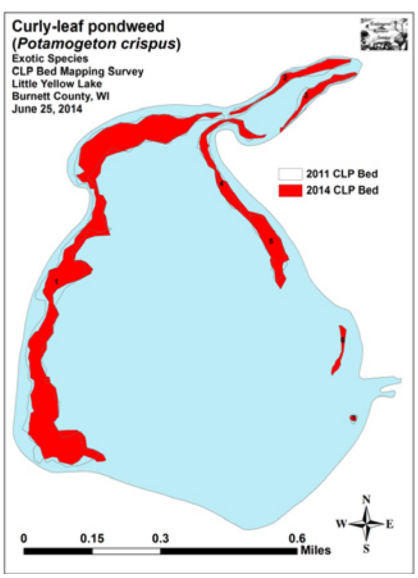
B. Maintain navigation channels through dense beds of curly leaf pondweed on the Danbury Flowage.

Note that CLP harvesting will not alleviate navigation concerns that arise later in the growing season. CLP naturally dies back in early July when native plants take its place. These plants can grow densely and impair navigation in Little Yellow Lake and the Danbury Flowage.

C. Consider maintaining navigation channels by harvesting in areas of dense native plant growth where navigation is severely impaired.

Actions

1. Hire a contract harvester to cut and harvest a 30-50 foot channel through dense beds of curly leaf pondweed on Little Yellow Lake. (Objective A)
   <u>2017</u>
   a. Seek bids from harvesting contractors (completed and contractor selected by YLRA board January 2017).
   b. Secure harvester access with written permission from private landowner (Jan 2017).
   c. Apply for a permit (Jan/Feb 2017)
   d. Secure disposal sites and transport of harvested aquatic plants. (Contractor will do: March-April 2017)
   e. Coordinate harvesting time with nearly peak growth of CLP. CLP growth should be just below surface. Anticipated harvest time is mid-June.



The channel will be 30 feet wide and cut through the CLP bed approximately parallel to the shore in 2017.

2018 and future

   a. Evaluate channel width and consider a wider channel with potential spur channels toward the shore for future years.
   b. Review projected increased costs with YLRA residents to evaluate expansion.

2. Hire a contract harvester to cut and harvest a 30-50 foot wide channel through dense beds of curly leaf pondweed on the Danbury Flowage. (Objective B)
   a. Follow steps outlined for Action 1 above.

3. Consider harvesting to alleviate mid to late season navigation impairment. (Objective C)

4. Hand removal methods will be recommended for navigation impairment created by native plants. Native plants provide an important shield against invasion by Eurasian water milfoil and other invasive aquatic plant species.

   Information about individual access corridors
   The only time a permit is not required to control aquatic plants is when a waterfront property owner manually removes (i.e. hand-pulls or rakes), or gives permission to someone to manually remove, plants (except wild rice) from his/her shoreline in an area that is 30 feet or less in width along the shore and is not within a designated Sensitive Area. The non-native invasive plants (Eurasian watermilfoil, curly leaf pondweed, and purple loosestrife) may be manually removed beyond 30 feet without a permit, as long as native plants are not harmed. Wild rice removal always requires a permit.

Potential Future Harvesting Goal
Reduce growth of curly leaf pondweed

1. Consider expanded harvesting of all CLP beds on Little Yellow Lake. Evaluate cost of contracting compared with purchase if this option is pursued.

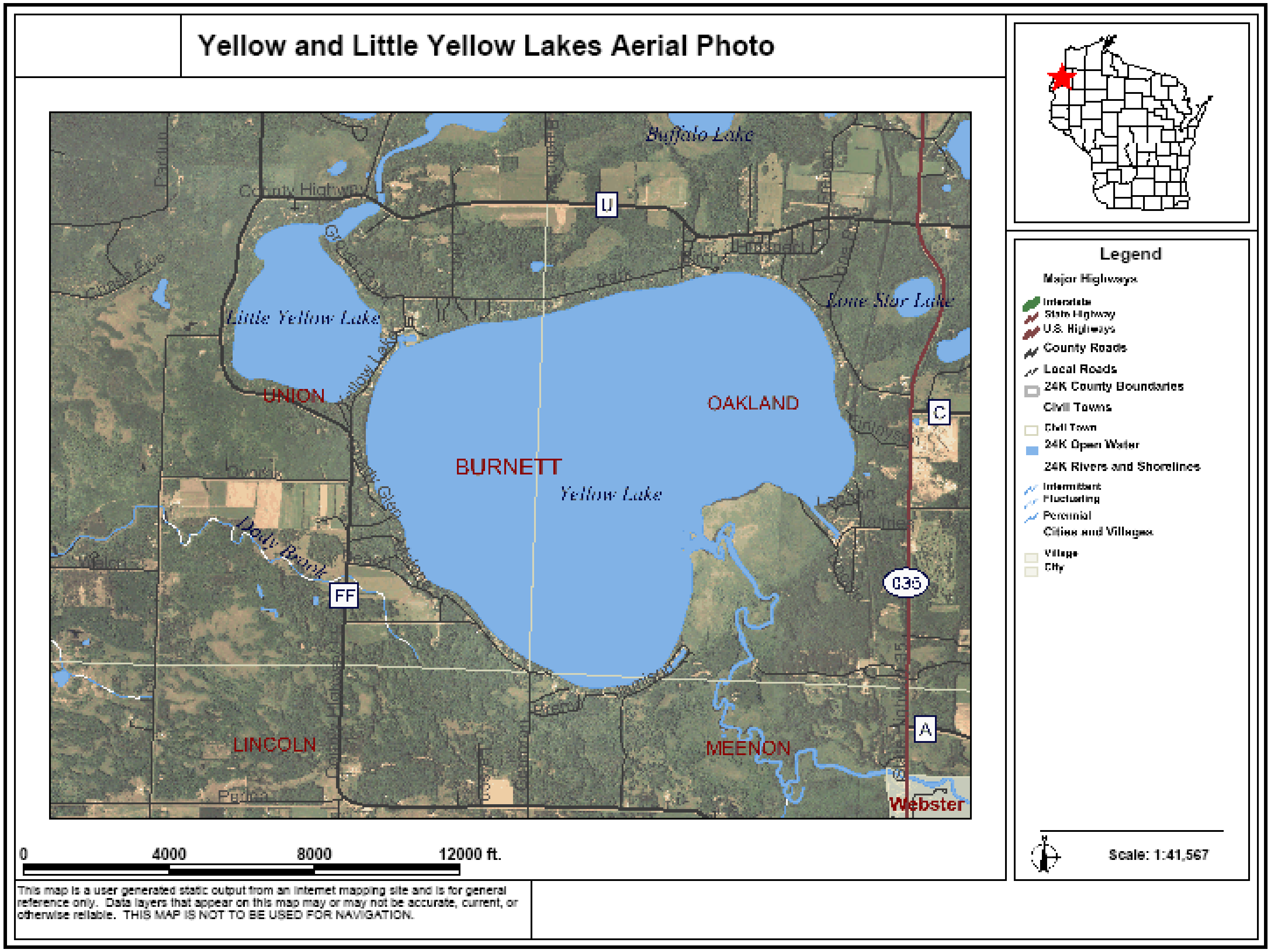
2. If full-scale harvesting is initiated, map all beds of curly leaf pondweed (CLP) on Little Yellow Lake each year to assess progress.

Information and Education Strategy

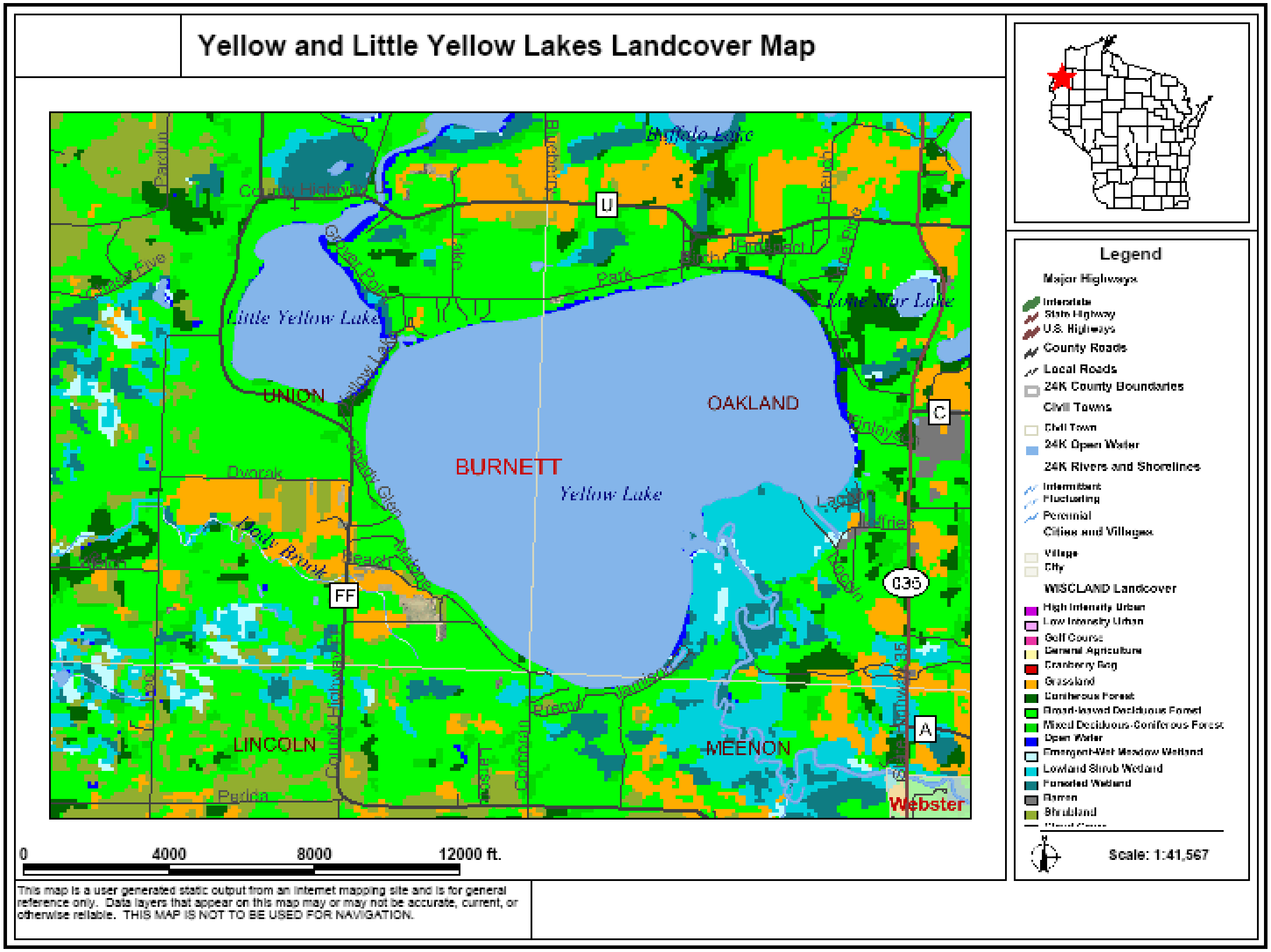
Information will be provided to YLRA members on the web site and at annual meetings. It will include:

- Rationale for aquatic plant harvesting
- Harvesting goals, objectives and actions
- Limits for homeowner removal of native plants
- Program costs and financing
- Values of native plants
- Invasive aquatic plant concerns

Appendix A. Plan Maps



Yellow and Little Yellow Lakes Aerial Photo
Buffalo Lake
Little Yellow Lake
Lone Star Lake
Yellow Lake
UNION
OAKLAND
BURNETT
LINCOLN
MEENON
Webster
U
C
FF
A
035
0
4000
8000
12000 ft.
Legend
Major Highways
Interstate
State Highway
U.S. Highways
County Roads
Local Roads
24K County Boundaries
Civil Towns
Civil Town
24K Open Water
24K Rivers and Shorelines
Intermittent
Fluctuating
Perennial
Cities and Villages
Village
City
Scale: 1:41,567
This map is a user generated static output from an Internet mapping site and is for general reference only. Data layers that appear on this map may or may not be accurate, current, or otherwise reliable. THIS MAP IS NOT TO BE USED FOR NAVIGATION.


Yellow and Little Yellow Lakes Landcover Map
Buffalo Lake
Little Yellow Lake
Lone Star Lake
Yellow Lake
BURNETT
UNION
OAKLAND
LINCOLN
MEENON
Webster
U
C
FF
A
Legend
Major Highways
Interstate
State Highway
U.S. Highways
County Roads
Local Roads
24K County Boundaries
Civil Towns
Civil Town
24K Open Water
24K Rivers and Shorelines
Intermittent
Fluctuating
Perennial
Cities and Villages
Village
City
WISCLAND Landcover
High Intensity Urban
Low Intensity Urban
Golf Course
General Agriculture
Cranberry Bog
Grassland
Coniferous Forest
Broad-leaved Deciduous Forest
Mixed Deciduous-Coniferous Forest
Open Water
Emergent-Wet Meadow Wetland
Lowland Shrub Wetland
Forested Wetland
Barren
Shrubland
Scale: 1:41,567
0
4000
8000
12000 ft.
This map is a user generated static output from an internet mapping site and is for general reference only. Data layers that appear on this map may or may not be accurate, current, or otherwise reliable. THIS MAP IS NOT TO BE USED FOR NAVIGATION.

Appendix B. Invasive Species Information

Curly Leaf Pondweed

Curly leaf pondweed is specifically designated as an invasive aquatic plant (along with Eurasian water milfoil and purple loosestrife) to be the focus of a statewide program to control invasive species in Wisconsin. Invasive species are defined as a “non-indigenous species whose introduction causes or is likely to cause economic or environmental harm or harm to human health (23.22(c).”

The Wisconsin Comprehensive Management Plan for Aquatic Invasive Species describes curly leaf pondweed impacts as follows:

> It is widely distributed throughout Wisconsin lakes, but the actual number of waters infested is not known. Curly-leaf pondweed is native to northern Europe and Asia where it is especially well adapted to surviving in low temperature waters. It can actively grow under the ice while most plants are dormant, giving it a competitive advantage over native aquatic plant species. By June, curly-leaf pondweed can form dense surface mats that interfere with aquatic recreation. By mid-summer, when other aquatic plants are just reaching their peak growth for the year, it dies off. Curly-leaf pondweed provides habitat for fish and invertebrates in the winter and spring when most other plants are reduced to rhizomes and buds, but the mid-summer decay creates a sudden loss of habitat. The die-off of curly-leaf pondweed also releases a surge of nutrients into the water column that can trigger algal blooms and create turbid water conditions. In lakes where curly-leaf pondweed is the dominant plant, the summer die-off can lead to habitat disturbance and degraded water quality. In other waters where there is a diversity of aquatic plants, the breakdown of curly-leaf may not cause a problem.[38]

The state of Minnesota DNR web site explains that curly leaf pondweed often causes problems due to excessive growth. At the same time, the plant provides some cover for fish, and some waterfowl species feed on the seeds and winter buds.[39]

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[38] Wisconsin’s Comprehensive Management Plant to Prevent Further Introductions and Control Existing Populations of Aquatic Invasive Species. Prepared by Wisconsin DNR. September 2003.

[39] Information from Minnesota DNR (www.dnr.state.mn.us/aquatic_plants).

The following description is taken from a Great Lakes Indian Fish and Wildlife Commission handout.

Curly Leaf Pondweed (Potamogeton crispus)[40]

Identification

Curly leaf pondweed is an invasive aquatic species found in a variety of aquatic habitats, including permanently flooded ditches and pools, rivers, ponds, inland lakes, and even the Great Lakes. Curly leaf pondweed prefers alkaline or high nutrient waters one to three meters deep. Its leaves are strap-shaped with rounded tips and undulating and finely toothed edges. Leaves are not modified for floating, and are generally alternate on the stem. Stems are somewhat flattened and grow to as long as two meters. The stems are dark reddish-green to reddish-brown, with the mid-vein typically tinged with red. Curly leaf pondweed is native to Eurasia, Africa, and Australia and is now spread throughout most of the United States and southern Canada.

Characteristics

New plants typically establish in the fall from freed turions (branch tips). The winter form is short, with narrow, flat, relatively limp, bluish-green leaves. This winter form can grow beneath the ice and is highly shade-tolerant. Rapid growth begins with warming water temperatures in early spring – well ahead of native aquatic plants.

Reproduction and Dispersal

Curly leaf pondweed reproduces primarily vegetatively. Numerous turions are produced in the spring. These turions consist of modified, hardened, thorny leaf bases interspersed with a few to several dormant buds. The turions are typically 1.0 – 1.7 cm long and 0.8 to 1.4 cm in diameter. Turions separate from the plant by midsummer, and may be carried in the water column supported by several leaves. Humans and waterfowl may also disperse turions. Stimulated by cooler water temperatures, turions germinate in the fall, over-wintering as a small plant. The next summer plants mature, producing reproductive tips of their own. Curly leaf pondweed rarely produces flowers.

Ecological Impacts

Rapid early season growth may form large, dense patches at the surface. This canopy overtops most native aquatic plants, shading them and significantly slowing their growth. The canopy lowers water temperature and restricts absorption of atmospheric oxygen into the water. The dense canopy formed often interferes with recreational activities such as swimming and boating.

In late spring, curly leaf pondweed dies back, releasing nutrients that may lead to algae blooms. Resulting high oxygen demand caused by decaying vegetation can adversely affect fish

[40] Information from GLIFWC Plant Information Center (http://www.glifwc.org/epicenter).

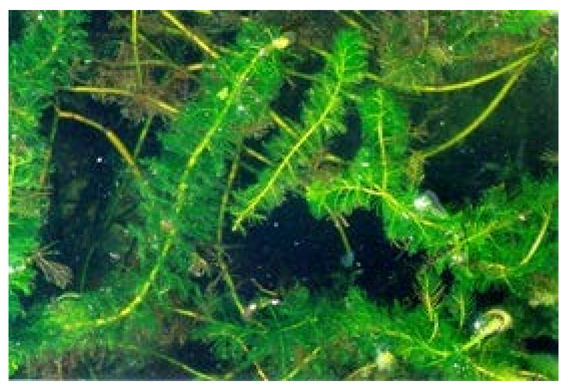
populations. The foliage of curly leaf pondweed is relatively high in alkaloid compounds possibly making it unpalatable to insects and other herbivores.

Control
Small populations of curly leaf pondweed in otherwise un-infested water bodies should be attacked aggressively. Hand pulling, suction dredging, or spot treatments with contact herbicides are recommended. Cutting should be avoided because fragmentation of plants may encourage their re-establishment. In all cases, care should be taken to remove all roots and plant fragments, to keep them from re-establishing.

Control of large populations requires a long-term commitment that may not be successful. A prudent strategy includes a multi-year effort aimed at killing the plant before it produces turions, thereby depleting the seed bank over time. It is also important to maintain, and perhaps augment, native populations to retard the spread of curly leaf and other invasive plants. Invasive plants may aggressively infest disturbed areas of the lake, such as those where native plant nuisances have been controlled through chemical applications.

Eurasian Water Milfoil *(Myriophyllum spicatum)*

Introduction



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

Distribution and Habitat
Eurasian milfoil first arrived in Wisconsin in the 1960's. During the 1980's, it began to move from several counties in southern Wisconsin to lakes and waterways in the northern half of the state. As of 1993, Eurasian milfoil was common in 39 Wisconsin counties (54%) and at least 75 of its lakes, including shallow bays in Lakes Michigan and Superior and Mississippi River pools.

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

Life History and Effects of Invasion

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

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

Dense stands of Eurasian water milfoil also inhibit recreational uses like swimming, boating, and fishing. Some stands have been dense enough to obstruct industrial and power generation water intakes. The visual impact that greets the lake user on milfoil-dominated lakes is the flat yellow-green of matted vegetation, often prompting the perception that the lake is "infested" or "dead". Cycling of nutrients from sediments to the water column by Eurasian water milfoil may lead to deteriorating water quality and algae blooms of infested lakes. [41]

[41] Taken in its entirety from WDNR, 2008 http://www.dnr.state.wi.us/invasives/fact/milfoil.htm

Reed Canary Grass (*Phalaris arundinacea*)

Description

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

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

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

Distribution and Habitat

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

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

Life History and Effects of Invasion

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

This species prefers disturbed areas, but can easily move into native wetlands. Reed canary grass can invade a disturbed wetland in less than twelve years. Invasion is associated with disturbances including ditching of wetlands, stream channelization, deforestation of swamp forests, sedimentation, and intentional planting. The difficulty of selective control makes reed canary grass invasion of particular concern. Over time, it forms large, monotypic stands that harbor few other plant species and are subsequently of little use to wildlife. Once established, reed canary grass dominates an area by building up a tremendous seed bank that can eventually erupt, germinate, and recolonize treated sites.[42]

Purple Loosestrife (Lythrum salicaria)[43]

Description

Purple loosestrife is a non-native plant common in Wisconsin. By law, purple loosestrife is a nuisance species in Wisconsin. It is illegal to sell, distribute, or cultivate the plants or seeds, including any of its cultivars.

Purple loosestrife is a perennial herb 3-7 feet tall with a dense bushy growth of 1-50 stems. The stems, which range from green to purple, die back each year. Showy flowers vary from purple to magenta, possess 5-6 petals aggregated into numerous long spikes, and bloom from July to September. Leaves are opposite, nearly linear, and attached to four-sided stems without stalks. It has a large, woody taproot with fibrous rhizomes (underground stems) that form a dense mat.

Characteristics

Purple loosestrife is a wetland herb that was introduced as a garden perennial from Europe during the 1800's. It is still promoted by some horticulturists for its beauty as a landscape plant, and by beekeepers for its nectar-producing capability. Currently, about 24 states have laws prohibiting its importation or distribution because of its aggressively invasive characteristics. It has since extended its range to include most temperate parts of the United States and Canada. The plant's reproductive success across North America can be attributed to its wide tolerance of physical and chemical conditions characteristic of disturbed habitats, and its ability to reproduce prolifically by both seed dispersal and vegetative propagation. The absence of natural predators, like European species of herbivorous beetles that feed on the plant's roots and leaves, also contributes to its proliferation in North America.

[42] Taken from WDNR, 2008 http://www.dnr.state.wi.us/invasives/fact/reed_canary.htm
[43] Wisconsin DNR invasive species factsheets from http:/dnr.wi.gov/invasives.

Purple loosestrife was first detected in Wisconsin in the early 1930's, but remained uncommon until the 1970's. It is now widely dispersed in the state, and has been recorded in 70 of Wisconsin's 72 counties. This plant's optimal habitat includes marshes, stream margins, river flood plains, sedge meadows, and wet prairies. It is tolerant of moist soil and shallow water sites such as pastures and meadows, although established plants can tolerate drier conditions. Purple loosestrife has also been planted in lawns and gardens, which is often how it has been introduced to many of our wetlands, lakes, and rivers.

Reproduction and Dispersal
Purple loosestrife spreads mainly by seed, but it can also spread vegetatively from root or stem segments. A single stalk can produce from 100,000 to 300,000 seeds per year. Seed survival is up to 60-70%, resulting in an extensive seed bank. Most of the seeds fall near the parent plant, but water, animals, boats, and humans can transport the seeds long distances. Vegetative spread through local disturbance is also characteristic of loosestrife; clipped, trampled, or buried stems of established plants may produce shoots and roots. It is often very difficult to locate non-flowering plants, so monitoring for new invasions should be done at the beginning of the flowering period in mid-summer.

Any sunny or partly shaded wetland is susceptible to purple loosestrife invasion. Vegetative disturbances such as water drawdown or exposed soil accelerate the process by providing ideal conditions for seed germination. When the right disturbance occurs, loosestrife can spread rapidly, eventually taking over the entire wetland.

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

Mechanical Control
Purple loosestrife (PL) can be controlled by cutting, pulling, digging and drowning. Cutting is best done just before plants begin flowering. Cutting too early encourages more flower stems to grow than before. If done too late, seed may have already fallen. Since lower pods can drop seed while upper flowers are still blooming, check for seed. If none, simply bag all cuttings (to prevent them from rooting). If there is seed, cut off each top while carefully holding it upright, then bend it over into a bag to catch any dropping seeds. Dispose of plants/seeds in a capped landfill, or dry and burn them. Composting will not kill the seeds. Keep clothing and equipment seed-free to prevent its spread. Rinse all equipment used in infested areas before moving into uninfested areas, including boats, trailers, clothing, and footwear.

Pulling and digging can be effective, but can also create disturbed bare spots, which are good sites for PL seeds to germinate, or leave behind root fragments that grow into new plants. Use these methods primarily with small plants in loose soils, since they do not usually leave behind large gaps nor root tips, while large plants with multiple stems and brittle roots often do. Dispose of plants as described above.

Mowing has not been effective with loosestrife unless the plants can be mowed to a height where the remaining stems will be covered with water for a full twelve months. Burning has also proven largely ineffective. Mowing and flooding are not encouraged because they can contribute to further dispersal of the species by disseminating seeds and stems.

Follow-up treatments are recommended for at least three years after removal.

Chemical Control
This is usually the best way to eliminate PL quickly, especially with mature plants. The chemicals used have a short soil life. Timing is important. Treat in late July or August, but before flowering to prevent seed set. Always back away from sprayed areas as you go, to prevent getting herbicide on your clothes. The best method is to cut stems and paint the stump tops with herbicide. The herbicide can be applied with a small drip bottle or spray bottle, which can be adjusted to release only a small amount. Try to cover the entire cut portion of the stem, but not let the herbicide drip onto other plants since it is non-selective and can kill any plant it touches.

<u>Glyphosate herbicides:</u> Currently, glyphosate is the most commonly used chemical for killing loosestrife. Roundup and Glyfos are typically used, but if there is any open water in the area use Rodeo, a glyphosate formulated and listed for use over water. Glyphosate must be applied in late July or August to be most effective. Since you must treat at least some stems of each plant and they often grow together in a clump, all stems in the clump should be treated to be sure all plants are treated.

Another method is using very carefully targeted foliar applications of herbicide (NOT broadcast spraying). This may reduce costs for sites with very high densities of PL, since the work should be easier and there will be few other plant species to hit accidentally. Use a glyphosate formulated for use over water. A weak solution of around 1% active ingredient can be used and it is generally necessary to wet only 25% of the foliage to kill the plant.

You must obtain a permit from WDNR before applying any herbicide over water. The process has been streamlined for control of purple loosestrife and there is no cost. Contact your regional Aquatic Plant Management Coordinator for permit information.

Biological Control
Conventional control methods like hand pulling, cutting, flooding, herbicides, and plant competition have only been moderately effective in controlling purple loosestrife. Biocontrol is now considered the most viable option for more complete control for heavy infestations. The WDNR, in cooperation with the U.S. Fish and Wildlife Service, is introducing several natural insect enemies of purple loosestrife from Europe. A species of weevil (*Hylobius transversovittatus*) has been identified that lays eggs in the stem and upper root system of the plant; as larvae develop, they feed on root tissue. In addition, two species of leaf eating beetles (*Galerucella calmariensis* and *G. pusilla*) are being raised and released in the state, and another weevil that feeds on flowers (*Nanophyes marmoratus*) is being used to stress the plant in multiple ways. Research has shown that most of these insects are almost exclusively dependent upon purple loosestrife and do not threaten native plants, although one species showed some

cross-over to native loosestrife. These insects will not eradicate loosestrife, but may significantly reduce the population so cohabitation with native species becomes a possibility.

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Appendix D. Management Options for Aquatic Plants

Management Options for Aquatic Plants

Draft updated Oct 2006

Option	Permit Needed?	How it Works	PROS	CONS
No Management	N	Do not actively manage plants	Minimizing disturbance can protect native species that provide habitat for aquatic fauna; protecting natives may limit spread of invasive species; aquatic plants reduce shoreline erosion and may improve water clarity	May allow small population of invasive plants to become larger, more difficult to control later
			No immediate financial cost	Excessive plant growth can hamper navigation and recreational lake use
			No system disturbance	May require modification of lake users' behavior and perception
			No unintended effects of chemicals	
			Permit not required	
Mechanical Control	May be required under NR 109	Plants reduced by mechanical means	Flexible control	Must be repeated, often more than once per season
		Wide range of techniques, from manual to highly mechanized	Can balance habitat and recreational needs	Can suspend sediments and increase turbidity and nutrient release
a. Handpulling/Manual raking	Y/N	SCUBA divers or snorkelers remove plants by hand or plants are removed with a rake	Little to no damage done to lake or to native plant species	Very labor intensive
		Works best in soft sediments	Can be highly selective	Needs to be carefully monitored
			Can be done by shoreline property owners without permits within an area <30 ft wide OR where selectively removing exotics	Roots, runners, and even fragments of some species, particularly Eurasian watermilfoil (EWM) will start new plants, so all of plant must be removed
			Can be very effective at removing problem plants, particularly following early detection of an invasive exotic species	Small-scale control only

Management Options for Aquatic Plants

Draft updated Oct 2006

Option	Permit Needed?	How it Works	PROS	CONS
b. Harvesting	Y	Plants are "mowed" at depths of 2-5 ft, collected with a conveyor and off-loaded onto shore	Immediate results	Not selective in species removed
		Harvest invasives only if invasive is already present throughout the lake	EWM removed before it has the opportunity to autofragment, which may create more fragments than created by harvesting	Fragments of vegetation can re-root
			Minimal impact to lake ecology	Can remove some small fish and reptiles from lake
			Harvested lanes through dense weed beds can increase growth and survival of some fish	Initial cost of harvester expensive
			Can remove some nutrients from lake	
Biological Control	Y	Living organisms (e.g. insects or fungi) eat or infect plants	Self-sustaining; organism will over-winter, resume eating its host the next year	Effectiveness will vary as control agent's population fluctates
			Lowers density of problem plant to allow growth of natives	Provides moderate control - complete control unlikely
				Control response may be slow
				Must have enough control agent to be effective
a. Weevils on EWM	Y	Native weevil prefers EWM to other native water-milfoil	Native to Wisconsin: weevil cannot "escape" and become a problem	Need to stock large numbers, even if some already present
			Selective control of target species	Need good habitat for overwintering on shore (leaf litter) associated with undeveloped shorelines
			Longer-term control with limited management	Bluegill populations decrease densities through predation

Management Options for Aquatic Plants

Draft updated Oct 2006

	Option	Permit Needed?	How it Works	PROS	CONS
b.	Pathogens	Y	Fungal/bacterial/viral pathogen introduced to target species to induce mortalitiy	May be species specific	Largely experimental; effectiveness and longevity unknown
				May provide long-term control	Possible side effects not understood
				Few dangers to humans or animals	
c.	Allelopathy	Y	Aquatic plants release chemical compounds that inhibit other plants from growing	May provide long-term, maintenance-free control	Initial transplanting slow and labor-intensive
				Spikerushes (*Eleocharis* spp.) appear to inhibit Eurasian watermilfoil growth	Spikerushes native to WI, and have not effectively limited EWM growth
					Wave action along shore makes it difficult to establish plants; plants will not grow in deep or turbid water
d.	Planting native plants	Y	Diverse native plant community established to repel invasive species	Native plants provide food and habitat for aquatic fauna	Initial transplanting slow and labor-intensive
				Diverse native community may be "resistant" to invasive species	Nuisance invasive plants may outcompete plantings
				Supplements removal techniques	Largely experimental; few well-documented cases
					If transplants from external sources (another lake or nursury), may include additional invasive species or "hitchhikers"

Management Options for Aquatic Plants

Draft updated Oct 2006

Option	Permit Needed?	How it Works	PROS	CONS
Physical Control	Required under Ch. 30 / NR 107	Plants are reduced by altering variables that affect growth, such as water depth or light levels		
a. Fabrics/ Bottom Barriers	Y	Prevents light from getting to lake bottom	Reduces turbidity in soft-substrate areas	Eliminates all plants, including native plants important for a healthy lake ecosystem
			Useful for small areas	May inhibit spawning by some fish
				Need maintenance or will become covered in sediment and ineffective
				Gas accumulation under blankets can cause them to dislodge from the bottom
				Affects benthic invertebrates
				Anaerobic environment forms that can release excessive nutrients from sediment
b. Drawdown	Y, May require Environmental Assessment	Lake water lowered with siphon or water level control device; plants killed when sediment dries, compacts or freezes	Winter drawdown can be effective at restoration, provided drying and freezing occur. Sediment compaction is possible over winter	Plants with large seed bank or propagules that survive drawdown may become more abundant upon refilling
		Season or duration of drawdown can change effects	Summer drawdown can restore large portions of shoreline and shallow areas as well as provide sediment compaction	May impact attached wetlands and shallow wells near shore
			Emergent plant species often rebound near shore providing fish and wildlife habitat, sediment stabilization, and increased water quality	Species growing in deep water (e.g. EWM) that survive may increase, particularly if desirable native species are reduced
			Success demonstrated for reducing EWM, variable success for curly-leaf pondweed (CLP)	Can affect fish, particularly in shallow lakes if oxygen levels drop or if water levels are not restored before spring spawning
			Restores natural water fluctuation important for all aquatic ecosystems	Winter drawdawn must start in early fall or will kill hibernating reptiles and amphibians
				Navigation and use of lake is limited during drawdown

Management Options for Aquatic Plants

Draft updated Oct 2006

	Option	Permit Needed?	How it Works	PROS	CONS
c.	Dredging	Y	Plants are removed along with sediment	Increases water depth	Severe impact on lake ecosystem
			Most effective when soft sediments overlay harder substrate	Removes nutrient rich sediments	Increases turbidity and releases nutrients
			For extremely impacted systems	Removes soft bottom sediments that may have high oxygen demand	Exposed sediments may be recolonized by invasive species
			Extensive planning required		Sediment testing may be necessary
					Removes benthic organisms
					Dredged materials must be disposed of
d.	Dyes	Y	Colors water, reducing light and reducing plant and algal growth	Impairs plant growth without increasing turbidity	Appropriate for very small water bodies
				Usually non-toxic, degrades naturally over a few weeks	Should not be used in pond or lake with outflow
					Impairs aesthetics
					Effects to microscopic organisms unknown
e.	Non-point source nutrient control	N	Runoff of nutrients from the watershed are reduced (e.g. by controlling construction erosion or reducing fertilizer use) thereby providing fewer nutrients available for plant growth	Attempts to correct source of problem, not treat symptoms	Results can take years to be evident due to internal recycling of already-present lake nutrients
				Could improve water clarity and reduce occurrences of algal blooms	Requires landowner cooperation and regulation
				Native plants may be able to better compete with invasive species in low-nutrient conditions	Improved water clarity may increase plant growth

Management Options for Aquatic Plants

Draft updated Oct 2006

Option	Permit Needed?	How it Works	PROS	CONS
Chemical Control	Y, Required under NR 107	Granules or liquid chemicals kill plants or cease plant growth; some chemicals used primarily for algae	Some flexibility for different situations	Possible toxicity to aquatic animals or humans, especially applicators
		Results usually within 10 days of treatment, but repeat treatments usually needed	Some can be selective if applied correctly	May kill desirable plant species, e.g. native water-milfoil or native pondweeds; maintaining healthy native plants important for lake ecology and minimizing spread of invasives
		Chemicals must be used in accordance with label guidelines and restrictions	Can be used for restoration activities	Treatment set-back requirements from potable water sources and/or drinking water use restrictions after application, usually based on concentration
				May cause severe drop in dissolved oxygen causing fish kill, depends on plant biomass killed, temperatures and lake size and shape
				Often controversial
a. 2,4-D	Y	Systemic[1] herbicide selective to broadleaf[2] plants that inhibits cell division in new tissue	Moderately to highly effective, especially on EWM	May cause oxygen depletion after plants die and decompose
		Applied as liquid or granules during early growth phase	Monocots, such as pondweeds (e.g. CLP) and many other native species not affected	May kill native dicots such as pond lilies and other submerged species (e.g. coontail)
			Can be selective depending on concentration and seasonal timing	Cannot be used in combination with copper herbicides (used for algae)
			Can be used in synergy with endotholl for early season CLP and EWM treatments	Toxic to fish
			Widely used aquatic herbicide	

Management Options for Aquatic Plants

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	Option	Permit Needed?	How it Works	PROS	CONS
b.	Endothall	Y	Broad-spectrum[3], contact[4] herbicide that inhibits protein synthesis	Especially effective on CLP and also effective on EWM	Kills many native pondweeds
			Applied as liquid or granules	May be effective in reducing reestablishment of CLP if reapplied several years in a row in early spring	Not as effective in dense plant beds; heavy vegetation requires multiple treatments
				Can be selective depending on concentration and seasonal timing	Not to be used in water supplies; post-treatment restriction on irrigation
				Can be combined with 2,4-D for early season CLP and EWM treatments, or with copper compounds	Toxic to aquatic fauna (to varying degrees)
				Limited off-site drift	
c.	Diquat	Y	Broad-spectrum, contact herbicide that disrupts cellular functioning	Mostly used for water-milfoil and duckweed	May impact non-target plants, especially native pondweeds, coontail, elodea, naiads
			Applied as liquid, can be combined with copper treatment	Rapid action	Toxic to aquatic invertebrates
				Limited direct toxicity on fish and other animals	Must be reapplied several years in a row
					Ineffective in muddy or cold water (<50°F)
d.	Fluridone	Y; special permit and Environmental Assessment may be required	Broad-spectrum, systemic herbicide that inhibits photosynthesis	Effective on EWM for 1 to 4 years with aggressive follow-up treatments	Affects non-target plants, particularly native milfoils, coontails, elodea, and naiads, even at low concentrations
			Must be applied during early growth stage	Some reduction in non-target effects can be achieved by lowering dosage	Requires long contact time at low doses: 60-90 days
			Available with a special permit only; chemical applications beyond 150 ft from shore not allowed under NR 107	Slow decomposition of plants may limit decreases in dissolved oxygen	Demonstrated herbicide resistance in hydrilla subjected to repeat treatments
			Applied at very low concentration at whole lake scale	Low toxicity to aquatic animals	In shallow eutrophic systems, may result in decreased water clarity
					Unknown effect of repeat whole-lake treatments on lake ecology

Management Options for Aquatic Plants

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	Option	Permit Needed?	How it Works	PROS	CONS
e.	Glyphosate	Y	Broad-spectrum, systemic herbicide that disrupts enzyme formation and function	Effective on floating and emergent plants such as purple loosestrife	RoundUp is often incorrectly substituted for Rodeo - Associated surfactants of RoundUp believed to be toxic to reptiles and amphibians
			Usually used for purple loosestrife stems or cattails	Selective if carefully applied to individual plants	Cannot be used near potable water intakes
			Applied as liquid spray or painted on loosetrife stems	Non-toxic to most aquatic animals at recommended dosages	Ineffective in muddy water
				Effective control for 1-5 years	No control of submerged plants
f.	Triclopyr	Y	Systemic herbicide selective to broadleaf plants that disrupts enzyme function	Effective on many emergent and floating plants	Impacts may occur to some native plants at higher doses (e.g. coontail)
			Applied as liquid spray or liquid	More effective on dicots, such as purple loosestrife; may be more effective than glyphosate	May be toxic to sensitive invertebrates at higher concentrations
				Control of target plants occurs in 3-5 weeks	Retreatment opportunities may be limited due to maximum seasonal rate (2.5 ppm)
				Low toxicity to aquatic animals	Sensitive to UV light; sunlight can break herbicide down prematurely
				No recreational use restrictions following treatment	Relatively new management option for aquatic plants (since 2003)
g.	Copper compounds	Y	Broad-spectrum, systemic herbicide that prevents photosynthesis	Reduces algal growth and increases water clarity	Elemental copper accumulates and persists in sediments
			Used to control planktonic and filamentous algae	No recreational or agricultural restrictions on water use following treatment	Short-term results
			Wisconsin allows small-scale control only	Herbicidal action on hydrilla, an invasive plant not yet present in Wisconsin	Long-term effects of repeat treatments to benthic organisms unknown
					Toxic to invertebrates, trout and other fish, depending on the hardness of the water
					Clear water may increase plant growth

[1]Systemic herbicide - Must be absorbed by the plant and moved to the site of action. Often slower-acting than contact herbicides.
[2]Broadleaf herbicide - Affects only dicots, one of two groups of plants. Aquatic dicots include waterlilies, bladderworts, watermilfoils, and coontails.
[3]Broad-spectrum herbicide - Affects both monocots and dicots.
[4]Contact herbicide - Unable to move within the plant; kills only plant tissue it contacts directly.
Specific effects of herbicide treatments dependent on timing, dosage, duration of treatment, and location.
References to registered products are for your convenience and not intended as an endorsement or criticism of that product versus other similar products.
This document is intended to be a guide to available aquatic plant control techniques, and is not necessarily an exhaustive list.
Please contact your local Aquatic Plant Management Specialist when considering a permit.