June 24, 2013

Sponsored By:
Big Doctor Lake Association

Aquatic Plant Advisory Committee Members:

- Bill Brice
- Grace Haines
- Helen Wilke
- Dawn Richter
- John Magnuson
- Lynn Foss
- Mary Munn
- Mickey Nickelson
- Tom Nickelson
- Kathy Nickelson

Advisory Committee

Dave Ferris	Burnett County Land and Water Conservation Department
Pamela Toshner	Lakes & Rivers Management Water Quality Biologist/Statewide
Kathy Bartilson	Aquatic Plant Management Coordinator WI DNR

Prepared By

Burnett County Land and Water Conservation Department	Plan Writing and Facilitation Brad Morris, AIS Coordinator
Proofing and editing	Ann Lane, Administrative Assistant

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Introduction

The Aquatic Plant Management Plan for Big Doctor Lake is sponsored by the Big Doctor Lake Association. The planning phase of the project is funded, in part, by the Burnett County Land and Water Conservation Department and the Big Doctor Lake Association.

Knowing that Eurasian water milfoil (*Myriophyllum spicatum*) is found in several lakes in Burnett and Washburn County, concerned members of the Big Doctor Lake Association authorized an extensive assessment of Big Doctor Lake aquatic macrophytes using the Wisconsin Department of Natural Resources statewide guidelines for conducting systematic point intercept macrophyte sampling. This Aquatic Plant Management Plan for Big Doctor Lake presents a strategy for managing aquatic plants by protecting native plant populations and preventing the establishment of invasive species. The plan includes data about the plant community, watershed, and water quality, as well as other non plant species. Based on this data and public input, goals and strategies for the sound management of aquatic plants in Big Doctor Lake are presented. This plan will guide the Big Doctor Lake Association, Burnett County, and the Wisconsin Department of Natural Resources in aquatic plant management for Big Doctor Lake over the next five years (from 2013 through 2018).

Public Input for Plan Development

On June 16th, 2012, members of the Big Doctor Lake Association met to discuss the process of creating an Aquatic Plant Management (APM) Plan. At this meeting, a tentative Aquatic Plant Advisory Committee was established. Furthermore, the recommendation of additional committee members was discussed with the assumption that additional members would be added in the near future. During this meeting a date was established (August 13, 2011) to hold a kick-off meeting. An announcement was sent to each lake home resident informing them about the meeting, including time and location. Additionally, at the first meeting, those present reviewed aquatic plant management planning requirements and discussed initial concerns.

On July 14, 2012, a Public meeting was held to discuss the concerns of Big Doctor Lake and to establish those concerns as the primary focus of writing the Aquatic Plant Management Plan for the lake. Prior to the meeting date, a Public Notice was advertised for three weeks in the Burnett County Sentinel and Inter County Leader. A total of 16 people were present for the meeting. Minutes of the meeting were recorded. A summary of the concerns are listed below:

- Protect, prevent and control the spread of aquatic invasive species such as Zebra mussels and Eurasian water milfoil
- Control and prevent nutrient run-off/shore land preservation/restoration
- Mass education on various subjects related to protecting and preserving this natural resource, including wildlife and fish species enhancement
- Boat landing inspections
- Issues concerning the amount of Eurasian water milfoil in Burnett County

In addition to the kick-off meeting, a survey was sent out to all Riparian land owners. A total of 34 surveys were sent out and a total of 29 were returned. See Appendix A for survey details.

A brief meeting was held immediately after the Kick-off meeting to establish a committee.
The Big Doctor Lake Association board announced the availability of the draft Aquatic Plant Management Plan for review by June 24, 2013. Copies will be available at the following locations: Burnett County Government Center Land and Water Conservation Department Room 21, online at the Burnett County Website, and from Big Doctor Lake Aquatic Plant Management committee members. Comments and suggestions can be mailed or emailed to the address/addresses below.

Schedule for Plan Completion:	June 24, 2013
Final draft for DNR and public review by	Janrurary 13, 2014
Comments accepted on the plan through	July 15, 2013

Send comments via mail or email to:

Brad Morris
Burnett County Land and Water Conservation Department
7410 County Road K, #109
Siren, WI 54872
bmorris@burnettcounty.org

Board meeting to review comments	TBD

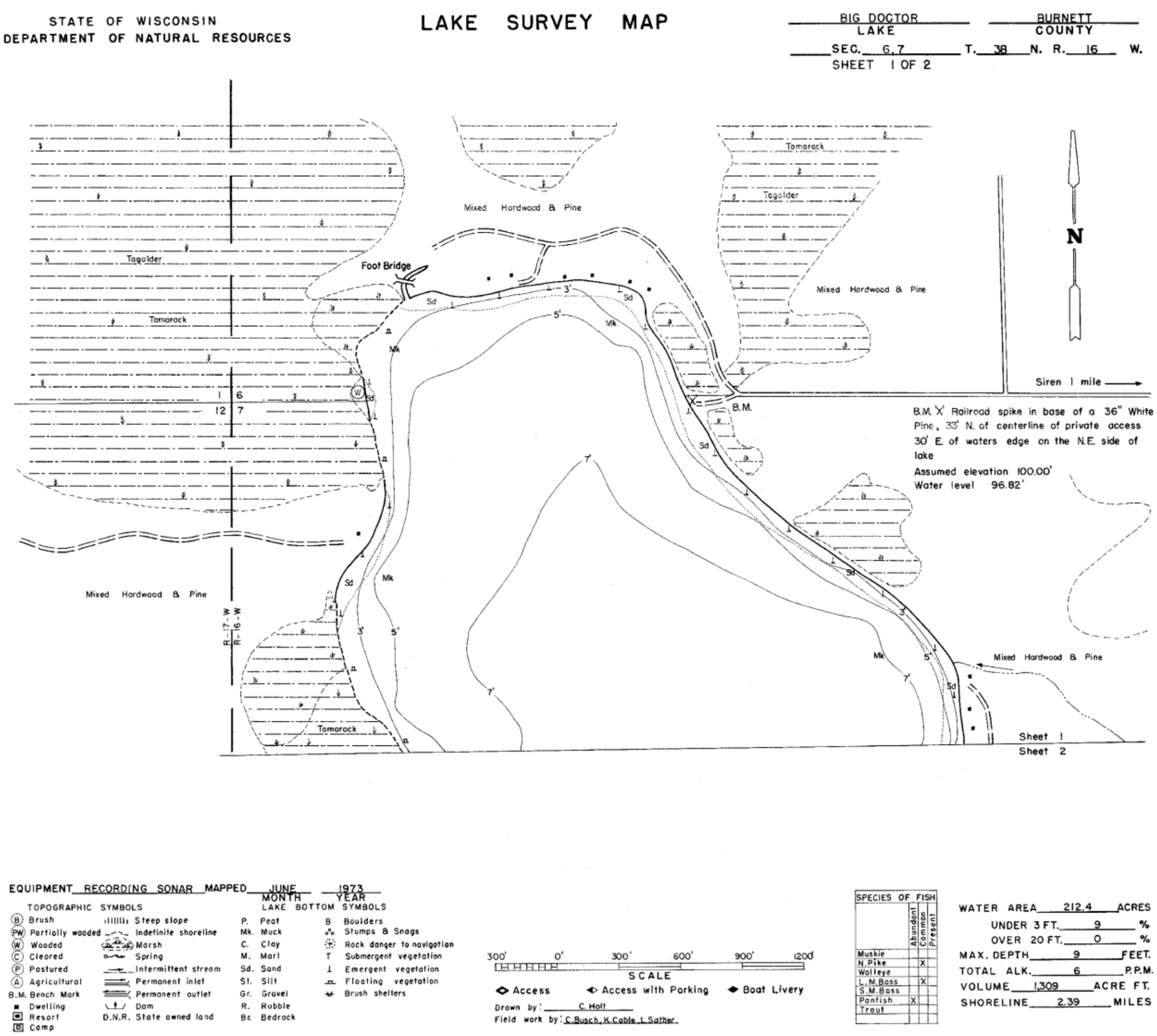
Lake Information

Big Doctor Lake (WBIC 2453400) is a 213.2 acre seepage lake located in Burnett County, T38N R16W. It has a maximum depth of 9 FEET and a MEAN depth of 6 FEET. The substrate of the lake bottom is comprised of 50% sand and 50% muck. Features include a public boat landing. Fish in the lake include Panfish, Largemouth Bass, Northern Pike. Secchi disk readings have not been recorded; therefore, water clarity is not certain. Chemistry data has not recently been collected and during a presentation on June 16th, the association members were encouraged to start collecting data.

Table 1: Lake Information

	Big Doctor Lake
Size (acres)	213.2
Mean depth (feet)	6
Maximum depth (feet)	9
Littoral zone depth (feet)	7

A Map of Big Doctor Lake can be found on the following page in Figure 1.



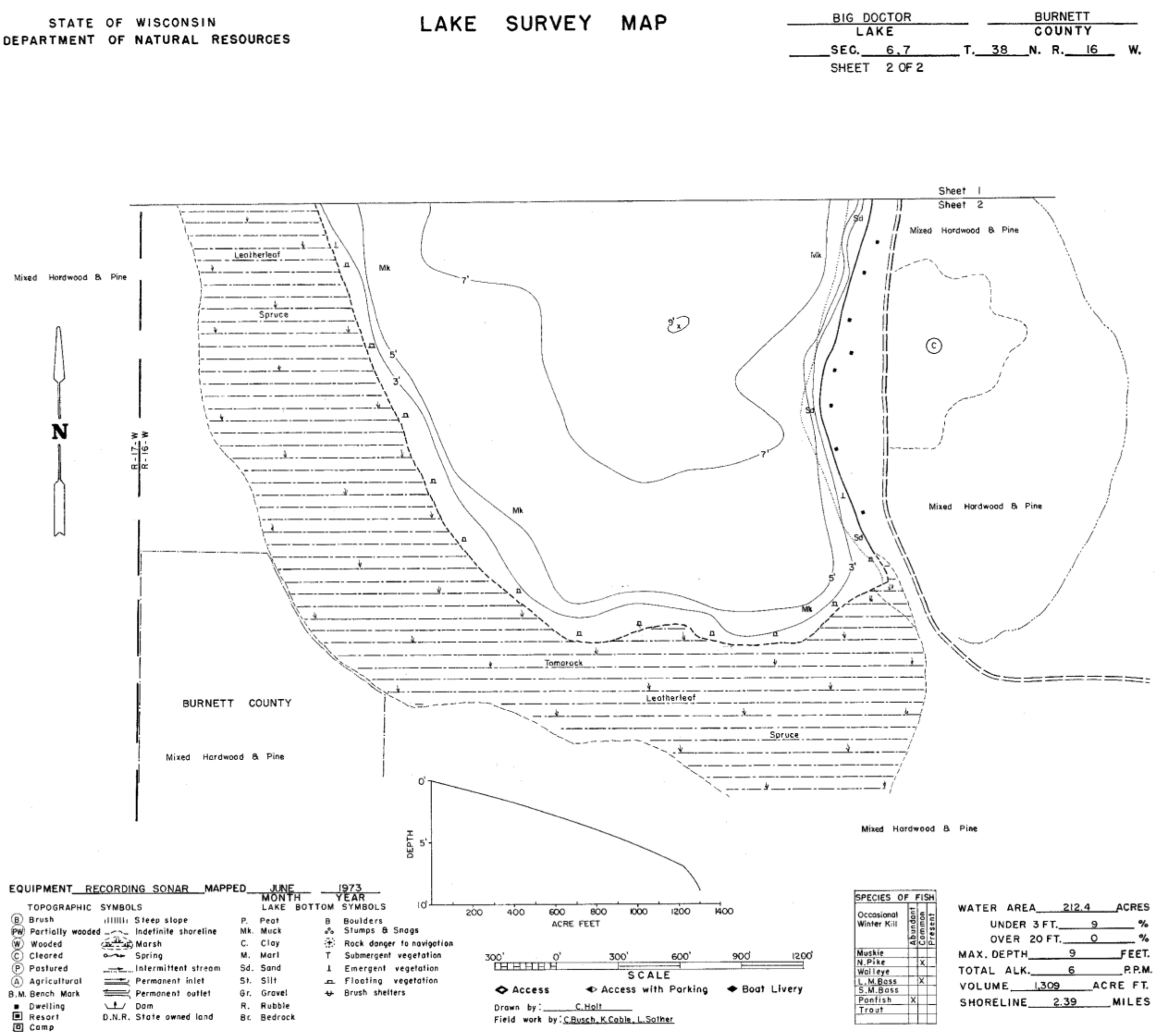


Figure 1: Big Doctor Lake Map Figure 1: Mudhen Lake Map (WI DNR)

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. 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.

In 2009, Big Doctor Lake established a Lake Association and in 2012 organized a citizen lake monitoring network to collect Secchi and water chemistry data. Below is a narrative of the 2012 results.

Big Doctor Lake - Deep Hole *was sampled* ***16*** *different days during the 2012 season. Parameters sampled included:*

- *water clarity*
- *temperature*
- *dissolved oxygen*
- *total phosphorus*
- *chlorophyll*

The average summer (July-Aug) secchi disk reading for Big Doctor Lake - Deep Hole (Burnett County, WBIC: 2453400) was 2.39 feet. The average for the Northwest Georegion was 7.5 feet. Typically the summer (July-Aug) water was reported as ***MURKY*** *and* ***BROWN****. With this particular lake, it is important to note that the Secchi disc hit the bottom of the lake for 2 of the Secchi readings during the 2012 monitoring season. This indicates that the water clarity was actually greater than the Secchi readings imply. This suggests that the secchi depth may have been mostly impacted by suspended sediments, tiny particles of soil or organic matter that are suspended in the water. Shallow lakes are often turbid because wind stirs up sediment from the bottom. High suspended sediments are often found in flowages and impoundments where precipitation runoff from the watershed transports solids via an incoming stream.*

Chemistry data was collected on Big Doctor Lake - Deep Hole. The average summer Chlorophyll was 94.6 µg/l (compared to a Northwest Georegion summer average of 110.7 µg/l). The summer Total Phosphorus average was 107 µg/l. 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.
The overall Trophic State Index (based on chlorophyll) for Big Doctor Lake - Deep Hole was 69. The TSI suggests that Big Doctor Lake - Deep Hole was ***eutrophic****. This TSI usually suggests blue-green algae become dominant and algal scums are possible, extensive plant overgrowth problems possible.* (WI DNR)

Table 2: Secchi Readings on Big Doctor Lake from 2001-2012

Year	Secchi Mean	Secchi Min	Secchi Max	Secchi Count
2001	2	2	2	3
2012	2.4	1.25	4	9

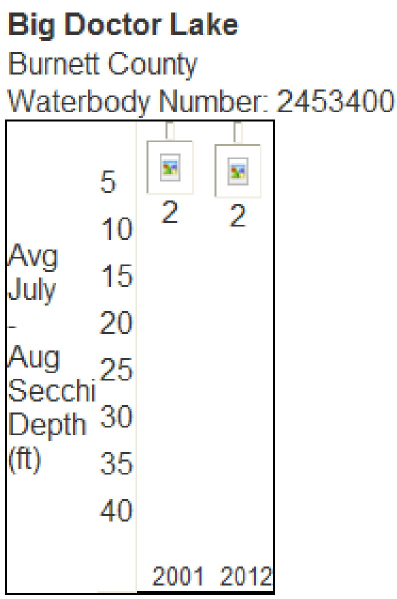


Figure 2: Past Secchi Readings of Big Doctor Lake

Waste Water Treatment Plant Effluent Study

The following is a narrative written by Craig Roesler, WI DNR Lakes Biologist
SIREN WWTP EFFLUENT FLOW PATH EVALUATION
MAY 8, 2012

The Siren (Burnett Co.) wastewater treatment plant outfall and the surrounding area were observed on May 8, 2012 by Craig Roesler and Kathy Bartilson of the DNR. The goal of the visit was to determine the path of effluent flow from the outfall point. The effluent discharges to a large wetland area so it is not possible to continuously follow the effluent from the outfall. Past assessments have produced varying results. Some have concluded effluent flows north through the wetland toward Big Doctor Lake. Others have concluded effluent flows south through the wetland to two small ponds near the northwest corner of Clear Lake.

Frequent and substantial precipitation had occurred prior to May 8, 2012 and water levels in wetlands other surface waters were fairly high. Clear Lake was at the level of its overflow point along STH 35. A meter was used to measure conductivity at various points to help determine how water and effluent was moving. Visual observations of flow direction were also made. A water sample was collected at the unnamed tributary to Big Doctor Lake at the STH 70 culvert (site 2, below). The sample was tested for total phosphorus, chloride, and sulfate.

Conductivity was measured at 12 sites (figure 3). Conductivities and site descriptions are listed below:

Table 3: **Conductivity and Site Descriptions**

Site No.	Conductivity (umhos/cm)	Site Description
1	753	Siren WWTP effluent outfall
2	269	Unnamed tributary to Big Doctor L. @ STH 70
3	235	Highway ditch 30 ft west of site 2
4	220	Highway ditch 30 ft east of site 2
5	85	Wetland 150 ft east and 40 ft south of site 2
6	40	Clear Lake @ northwest and northeast corners
7	125	West shore of south pond
8	133	Culvert draining wetland on west side of Gandy Dancer trail
9	48	Wetland edge east of Gandy Dancer Trail
10	156	Outlet channel of north pond
11	55	Wetland ½ way between outlet channel and wetland edge
12	157	West shore of north pond

Flow for the unnamed tributary to Big Doctor Lake at STH 70 (site 2) was estimated at 0.55 cfs, and was moving northward toward the lake. A slight odor of wastewater effluent was noticeable. Wastewater effluent discharge was reported to be 0.158 cfs. Flow was also observed in a small short channel at the northeast end of the north pond (site 10). A slight flow was moving to the northeast, out of the pond. The water levels in Clear Lake and in the south pond were observed from the Gandy Dancer trail. The water level in the south pond was clearly a few feet lower than the water level in Clear Lake. The watershed for the ponds (figure 2) is about 150 acres, most of which is upland area with loamy sand soils, and is likely to be contributing groundwater inflow to the ponds.

The ponds cannot be the receiving waters for the wastewater effluent because:

- There is no flow path for water to travel southward beyond the ponds, except as infiltration to groundwater and this appears unlikely.
- Clear Lake has a higher water level than the ponds. Some seepage from Clear Lake may flow to the ponds.
- Flow was observed to be leaving the ponds and moving to the northeast.

Conductivity measurements also indicate wastewater effluent is flowing northward toward STH 70 and Big Doctor Lake, rather than south to the ponds. Wastewater effluent has a very high conductivity (753 umhos/cm; site 1). Wetland conductivities were low (48-85 umhos/cm; sites 5, 9, 11).

Conductivity at sites within the pool area of the two ponds had moderate conductivities (125-157 umhos/cm; sites 7, 8, 10, 12). The ponds are probably receiving groundwater inflow from their watershed (figure 2). Groundwater generally has higher conductivities than surface water drainage.

Conductivity was high (269 umhos/cm) at site 2 at STH 70, which suggests effluent has been diluted with water of lower conductivity at that point. Based on the wastewater effluent flow rate and the flow rate observed at site 2, 28% of the flow at site 2 was composed of effluent. Mixing calculations indicate the background water that is mixed with effluent has a conductivity of about 74 umhos/cm. This is within the range of conductivities found within the upgradient wetland area, including the ponds (48- 157). This is further evidence that effluent is flowing northward toward STH 70.

Conductivity at the road ditch sites (220-235 umhos/cm; sites 3 and 4) were similar to that in the tributary channel at the culvert, suggesting that tributary channel water had diffused or back-flowed into the ditch.

The water sample collected at the STH 70 culvert also indicates wastewater effluent is flowing to that location. The total phosphorus concentration (1.39 mg/l) and the chloride concentration (59.6) were very high. The total phosphorus concentration is very close to what would be expected if wastewater effluent with an assumed total phosphorus concentration of 5.0 mg/l composed 28% of the flow at the site. Wastewater effluent often has a chloride concentration of about 100 mg/l. The very high chloride concentration suggests both wastewater effluent and road salt from STH 70 and 35 are sources. The sulfate concentration was 16.8 mg/l. The sulfate concentration of the wastewater effluent is not known.

Big Doctor Lake (WBIC 2452400), which is receiving the wastewater effluent, has an area of 212 acres and a maximum depth of 9 feet. Two lake samples are on record from 2001:

May 10, 2001

- total phosphorus = 57 ug/l
- Secchi depth = 3.5 ft.

August 27, 2001

- total phosphorus = 46 ug/l
- chlorophyll a = 87 ug/l
- Secchi depth = 2 ft.
- Color = 60 Pt-Co units
- Total nitrogen = 1.74 mg/l

These values indicate highly eutrophic conditions. The recreational impairment thresholds for listing shallow lakes on the 303d list of impaired waters are 40 ug/l for total phosphorus, and 25 ug/l for chlorophyll a. Three total phosphorus samples collected in each of 2 years is the minimum documentation currently required to place a lake on the 303d list. It is very likely that Big Doctor Lake would qualify for 303d listing if the required monitoring was done.

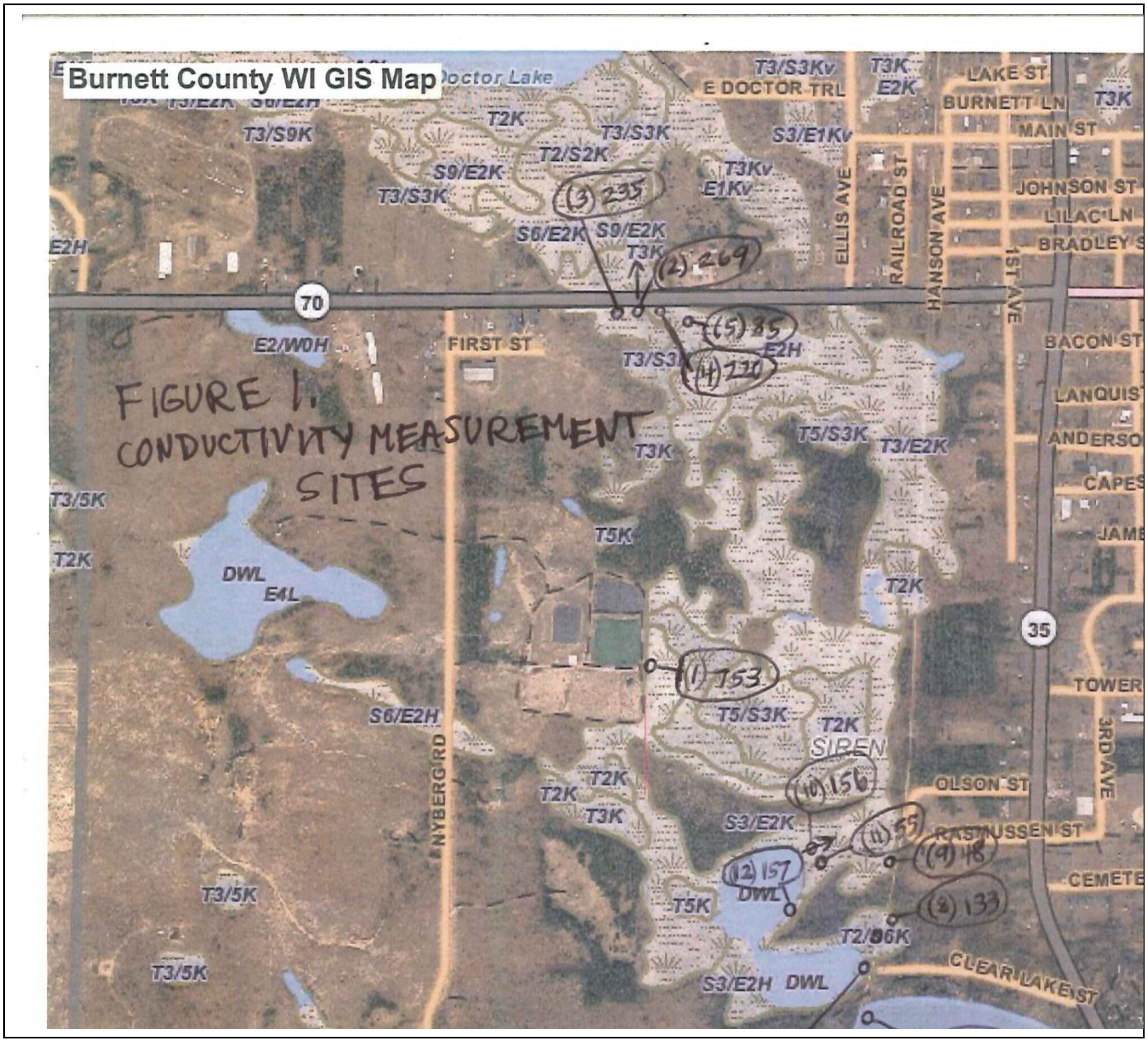


Figure 3: Site Number and Conductivity Values

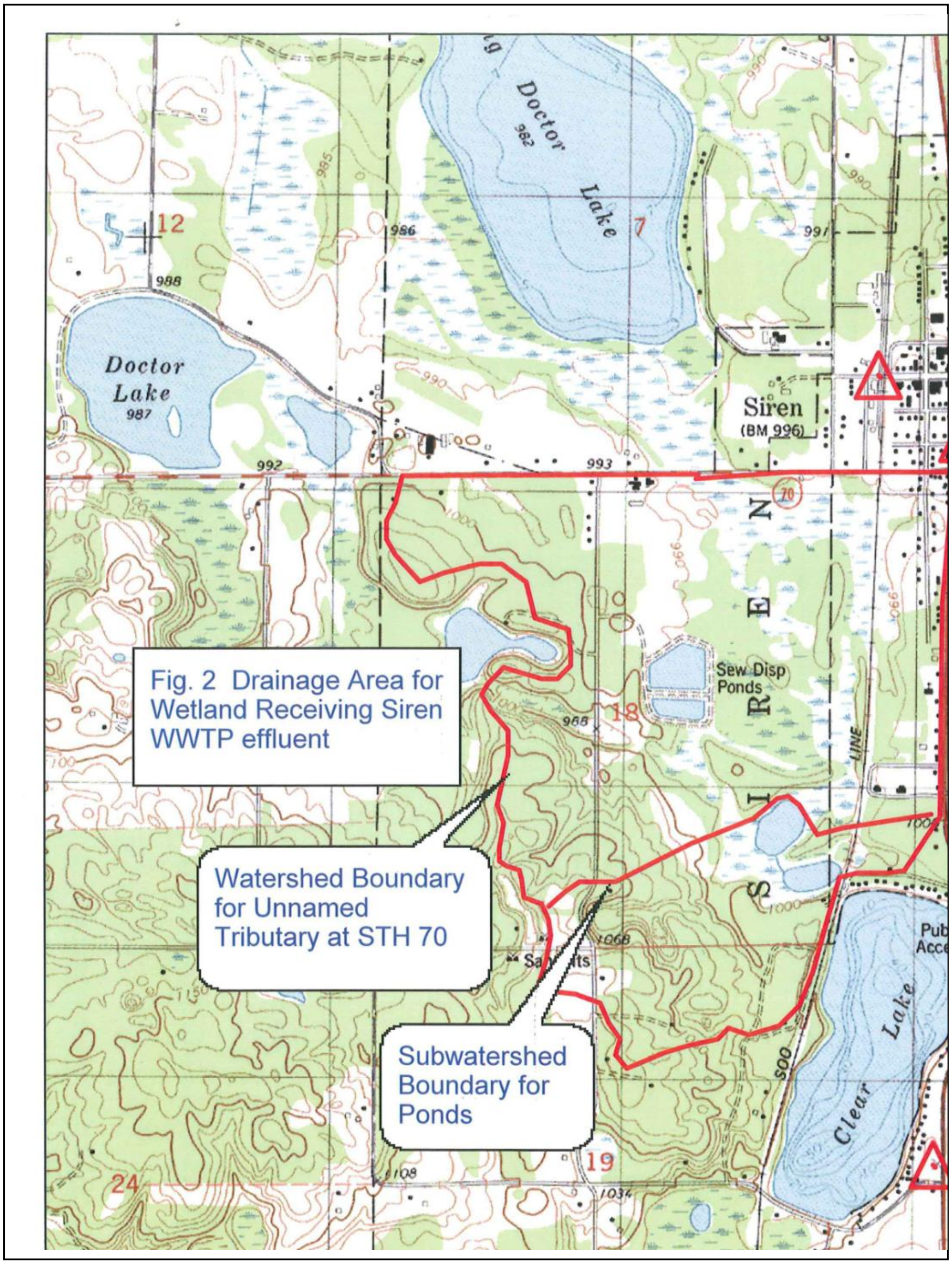


Figure 4: Watershed Boundaries of WWTP

Paleolimnology Study

Additionally, in the fall of 2013, a paleolimnological analysis was conducted to help understand the water quality changes that have occurred on the lake. Below is a summary of the study conducted by Paul Garrison, Lakes Biologist with the Wisconsin Department of Natural Resources.

RESULTS OF SEDIMENT CORE TAKEN FROM BIG DOCTOR LAKE- AUGUST 29, 2012, BURNETT COUNTY, WISCONSIN

Paul Garrison , Wisconsin Department of Natural Resources
April 2013

Aquatic organisms are good indicators of a lake's water quality because they are in direct contact with the water and are strongly affected by the chemical composition of their surroundings. Most indicator groups grow rapidly and are short lived so the community composition responds rapidly to changing environmental conditions. One of the most useful organisms for paleolimnological analysis are diatoms. These are a type of algae which possess siliceous cell walls, which enables them to be highly resistant to degradation and are usually abundant, diverse, and well-preserved in sediments. They are especially useful, as they are ecologically diverse. Diatom species have unique features as shown in Figure 1, which enable them to be readily identified. Certain taxa are usually found under nutrient poor conditions while others are more common under elevated nutrient levels. Some species float in the open water areas while others grow attached to objects such as aquatic plants or the lake bottom.

By determining changes in the diatom community it is possible to determine water quality changes that have occurred in the lake. The diatom community provides information about changes in nutrient concentrations, water clarity, and pH conditions as well as alterations in the aquatic plant (macrophyte) community.

On 29 August 2012 a sediment core were taken from near the deep area (N45.74348° W92.39800°) of Big Doctor Lake using a gravity corer. Samples from the top of the core (0-1 cm) and a section (35-37 cm) deeper in the core were kept for analysis. It is assumed that the upper sample represents present conditions while the deeper sample is indicative of water quality conditions at least 100 years ago. A radiochemical analysis of the bottom sample will be conducted to determine if the sample was deposited at least 100 years ago. This analysis will not be completed until the fall of 2013.

Results

In Big Doctor Lake the presettlement diatom community was dominated by diatoms of the group *Eunotia* (Figure 2). These diatoms are typically found in pH environments that are slightly acidic and often are dominant in northern WI wetlands. In the top sample these diatoms were much less common. Instead the community was dominated by taxa that are more common at higher pH values. Common diatoms were *Aulacoseira ambigua* (Figure 1a), *Achnanthidium minutissima*, and the group benthic *Fragilaria* (Figure 2). The latter two diatoms are typically found attached to macrophytes.

The diatom community indicates that the present day pH level is higher than the historical level. This may be the result of increased sediment and nutrient inputs to the lake. A study in north central WI found that a consequence of shoreland development was increased delivery sediment materials which resulted in an increase in the lake's pH. This seems to have occurred in Big Doctor Lake. The increase in benthic *Fragilaria* and *A. minutissima* indicate there are more submerged aquatic plants (SAV) at the present time.

In northern WI, many lakes with shoreline development have experienced an increase in SAV. Dr. Susan Borman recently conducted a study in lakes in the northwestern part of WI where she compared the SAV community in the 1930s with the present day community. She found that lakes with cottages have more plants and the species have shifted to those that are larger and grow closer to the lake's surface. This same thing has occurred in southern and central WI but often these lakes have higher phosphorus loading rates and planktonic diatoms become more important. The change in the plant community appears to have happened in Big Doctor Lake as the top sample has more diatoms that typically are associated with aquatic plants.

Diatom assemblages historically have been used as indicators of nutrient changes in a qualitative way. In recent years, ecologically relevant statistical methods have been developed to infer environmental conditions from diatom assemblages. These methods are based on multivariate ordination and weighted averaging regression and calibration. Ecological preferences of diatom species are determined by relating modern limnological variables to surface sediment diatom assemblages. The species-environment relationships are then used to infer environmental conditions from fossil diatom assemblages found in the sediment core.

Such a model was applied to the diatom community in the core from Big Doctor Lake. The model estimates a summer phosphorus concentration of about 25 $\mu g\ L^{-1}$ which is much lower than has been measured in the last few years. The concentration measured in 2012 was generally between 80-90 $\mu g\ L^{-1}$. The model significantly underestimates the present day phosphorus levels so the modeled estimates of historical phosphorus concentrations of 13-15 $\mu g\ L^{-1}$ are suspect. Judging from the change in the diatom community I would speculate that present day phosphorus levels are higher than historical ones but I do not know how much higher they are.

In summary, the sediment core indicates that there has been an increase the pH level in the lake and at the present time the aquatic plant community is greater than it was historically. Although the modeling indicates summer phosphorus levels have increased from 13 to 25 $\mu g\ L^{-1}$ this is suspect since the present day concentration is underestimated. It is likely that phosphorus levels have increased but it is difficult to know what the historical levels were.

Figure (5). Photomicrographs of the diatoms commonly found in the Big Doctor Lake sediment core. The top diatom, *Aulacoseira am*bigua (A), is found in the open water environments, the bottom left diatoms are part of the benthic *Fragilaria* (B), while the bottom right diatom (*Eunotia incisa*) is found in lower pH environments. Benthic *Fragilaria* are commonly found attached to substrates such as aquatic plants.

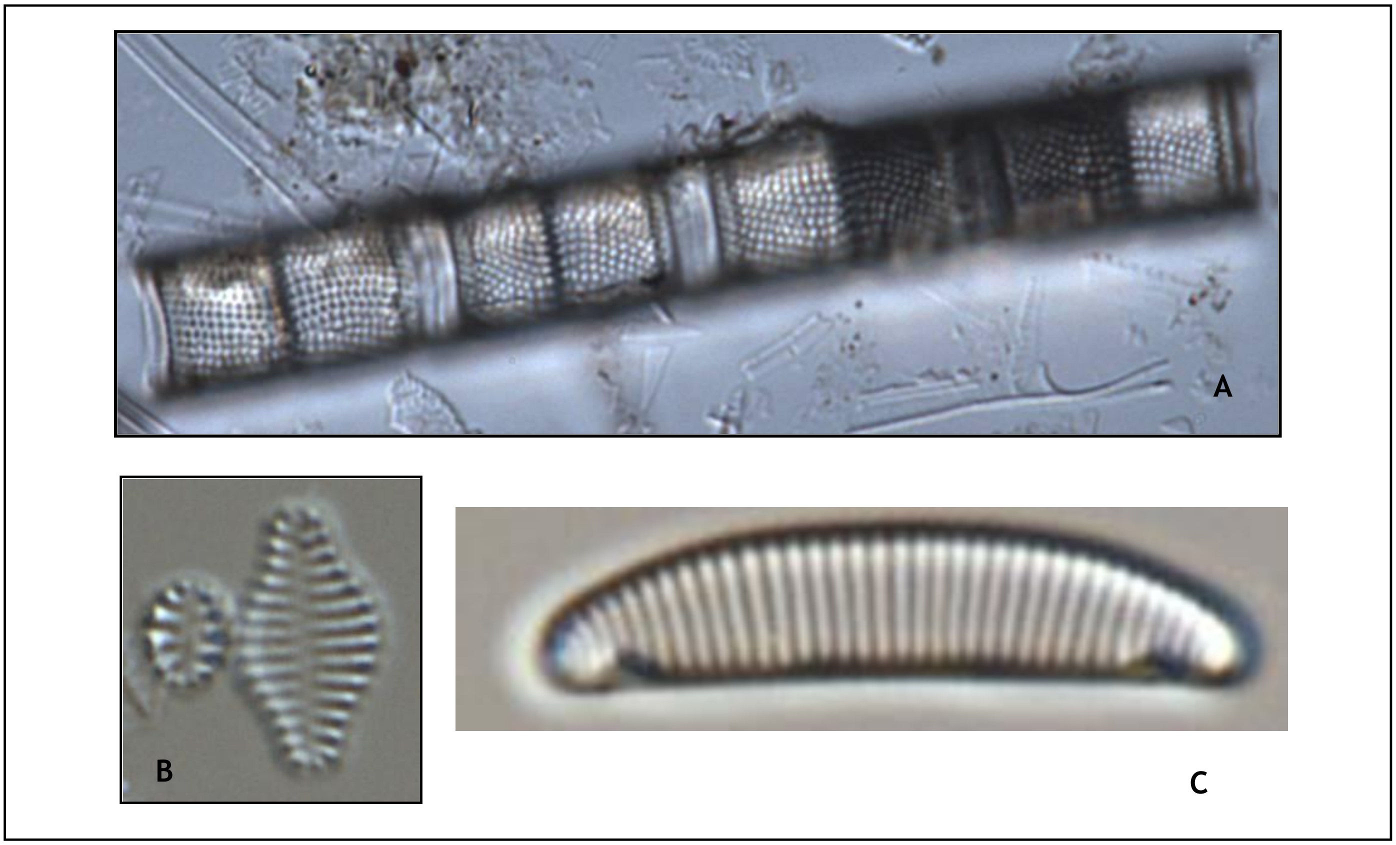


Figure 5: Common Diatoms found in Big Doctor Lake

Figure (6). Changes in the abundance of important diatoms found at the top and bottom of the Big Doctor Lake sediment core. The dominant diatoms at the bottom of the core were *Eunotica* which are typically found in lower pH environments. At the top of the core the diatoms that grow attached to aquatic plants are more common. This indicates an increase in growth of submerged aquatic vegetation. *Aulacoseira* are found floating the open water and probably indicate higher nutrient levels.

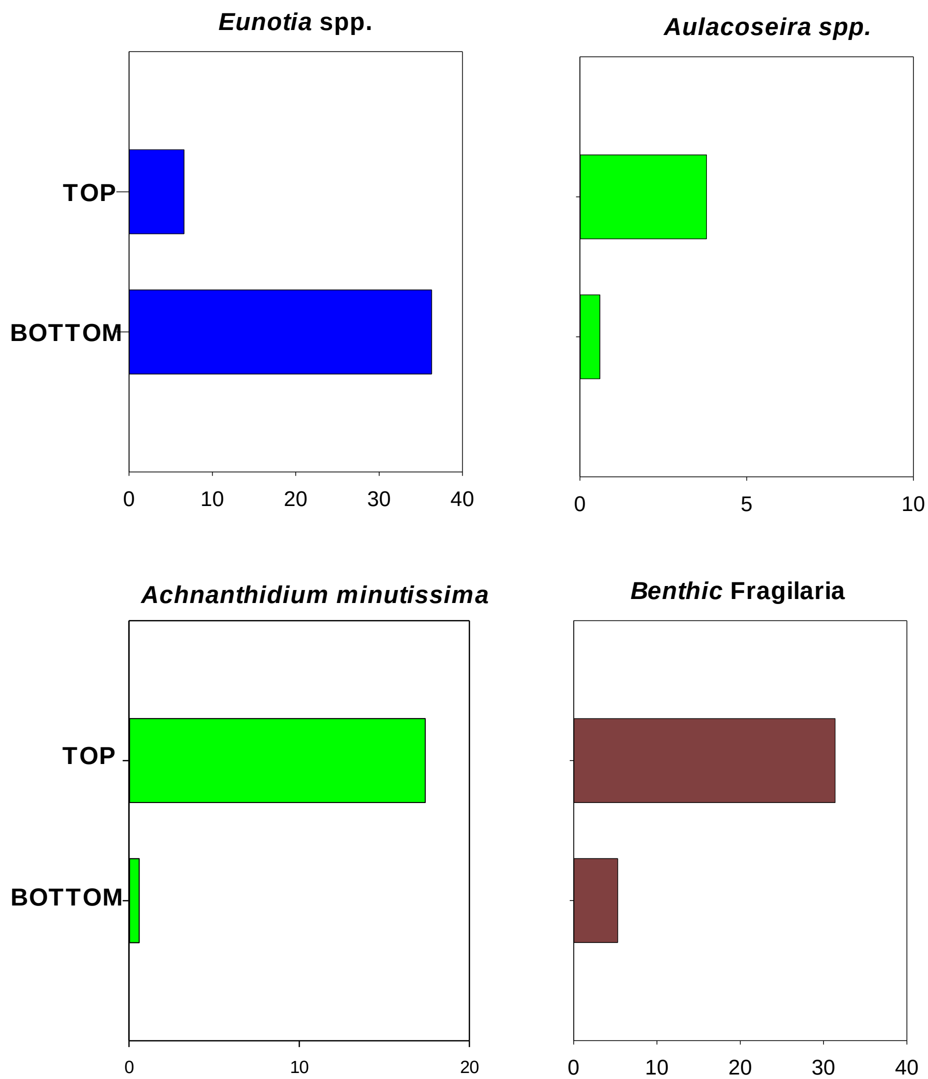


Figure 6: Comparison of Species Abundances'

Table 4: Diatoms of BIG DOCTOR LAKE (0-2)
Burnett County

Top (0-2 cm)

TAXA	COUNT TOTAL Number	Prop.
Achnanthidium altergracillima (Lange-Bertalot) Round et Bukhtiyarova	2	0.004
Achnanthidium minutissimum (Kützing) Czarnecki	87	0.174
Achnanthidium rivulare Potapova et Ponader	2	0.004
Aulacoseira ambigua (Grunow in Van Heurck) Simonsen	13	0.026
Aulacoseira distans (Ehrenberg) Simonsen	1	0.002
Aulacoseira italica (Ehrenberg) Simonsen	5	0.010
Aulacoseira spp.	2	0.004
Brachysira microcephala (Kützing) Compère	5	0.010
Brachysira serians (Brébisson) Round et Mann	1	0.002
Brachysira spp.	1	0.002
Cavinula pseudoscutiformis (Hustedt in Schmidt et al.) Mann et Stickle in Round, Crawford and Mann	1	0.002
Cocconeis placentula Ehrenberg	9	0.018
Cocconeis spp.	6	0.012
Cymbella mesiana Cholnoky	2	0.004
Cymbella naviculiformis Auerswald ex Heiberg	1	0.002
Cymbella spp.	2	0.004
Discostella stelligera (Cleve et Grunow in Cleve) Houk et Klee	1	0.002
Encyonema minutum (Hilse in Rabenhorst) Mann in Round, Crawford and Mann	5	0.010
Eunotia bilunaris (Ehrenberg) Souza in Souza and Moreira-Filho	1	0.002
Eunotia circumborealis Lange-Bertalot et Nörpel in Lange-Bertalot	6	0.012
Eunotia incisa Smith ex Gregory	13	0.026
Eunotia minor (Kützing) Grunow in Van Heurck	4	0.008
Eunotia parallela Ehrenberg	2	0.004
Eunotia serra Ehrenberg	1	0.002
Eunotia spp.	6	0.012
Fragilaria radians (Kützing) Williams et Round	9	0.018
Fragilaria sepes Ehrenberg	1	0.002
Fragilaria tenera (Smith) Lange-Bertalot	4	0.008
Gomphonema anjae Lange-Bertalot & Reidhardt	1	0.002
Gomphonema exilissimum (Grunow in Van Heurck) Lange-Bertalot et Reichardt in Lange-Bertalot and Metzeltin	3	0.006
Gomphonema parvulum (Kützing) Kützing	2	0.004
Gomphonema parvulum fo. saprophilum Lange-Bertalot et Reichardt in Lange-Bertalot	1	0.002
Gomphonema spp.	3	0.006
Hantzschia amphioxys (Ehrenberg) Grunow in Cleve and Grunow	1	0.002
Navicula joubaudii Germain	4	0.008

Table 4: Continued
Burnett County

Top (0-2 cm)

TAXA	COUNT TOTAL Number	Prop.
Navicula leptostriata Jørgensen	4	0.008
Navicula minima Grunow in Van Heurck	2	0.004
Navicula spp.	7	0.014
Navicula subminuscula Manguin	7	0.014
Navicula utermoehlii Hustedt in A. Schmidt	4	0.008
Neidium bisulcatum (Lagerstedt) Cleve	2	0.004
Neidium spp.	2	0.004
Nitzschia dissipata var. media (Hantzsch) Grunow in Van Heurck	2	0.004
Nitzschia palea var. debilis (Kützing) Grunow in Cleve and Grunow	1	0.002
Nitzschia spp.	7	0.014
Nupela fennica (Hustedt) Lange-Bertalot in Krammer and Lange-Bertalot	2	0.004
Nupela impexiformis (Lange-Bertalot in Lange-Bertalot and Krammer) Lange-Bertalot	5	0.010
Nupela sp. 1 ?	6	0.012
Nupela vitiosa (Schimanski) Siver et Hamilton	10	0.020
Nupela wellneri (Lange-Bertalot in Lange-Bertalot and Krammer) Lange-Bertalot in U. Rumrich, Lange-Bertalot and M. Rumrich	2	0.004
Pinnularia rupestris Hantzsch in Rabenhorst	1	0.002
Pinnularia spp.	7	0.014
Psammothidium subatomoides (Hustedt in Schmidt) Bukhtiyarova et Round	2	0.004
Pseudostaurosira brevistriata (Grunow in Van Heurck) Williams et Round	63	0.126
Punctastriata mimetica Morales	2	0.004
Sellaphora disjuncta (Hustedt) Mann	2	0.004
Sellaphora laevissima (Kützing) Mann	2	0.004
Sellaphora pupula (Kützing) Meresckowsky	2	0.004
Sellaphora rectangularis (Gregory) Lange-Bertalot et Metzeltin	1	0.002
Sellaphora seminulum (Grunow) Mann	9	0.018
Sellaphora sp. 1 ?	1	0.002
Stauroforma exiguiformis (Lange-Bertalot) Flower, Jones et Round	2	0.004
Stauroneis anceps fo. gracilis Rabenhorst	1	0.002
Stauroneis spp.	2	0.004
Staurosira construens var. venter (Ehrenberg) Hamilton in Hamilton, Poulin, Charles and Angell	38	0.076
Staurosirella pinnata (Ehrenberg) Williams et Round	52	0.104
Synedra delicatissima var. angustissima Grunow in Van Heurck	5	0.010
Synedra minuscula Grunow in Van Heurck	4	0.008
Synedra rumpens Kützing	4	0.008
Synedra spp.	2	0.004
Tabellaria flocculosa (strain III) sensu Koppen (Roth) Kützing	7	0.014
Tabellaria flocculosa var. linearis Koppen	1	0.002

Table 4: Continued
Burnett County

Top (0-2 cm)

TAXA	COUNT TOTAL Number	Prop.
Tabellaria spp.	2	0.004
Tabellaria ventricosa Kützing	1	0.002
Tryblionella scalaris (Ehrenberg) Siver et Hamilton	1	0.002
unknown pennate	15	0.030
TOTAL	500	1.000

Table 5: Diatoms of BIG DOCTOR LAKE (35-37)
Burnett County

Bottom (35-37 cm)

lots of diatoms fragments; sponge spicules and phytoliths

TAXA	COUNT TOTAL Number	Prop.
Achnanthidium altergracillima (Lange-Bertalot) Round et Bukhtiyarova	1	0.002
Achnanthidium minutissimum (Kützing) Czarnecki	3	0.006
Aulacoseira italica (Ehrenberg) Simonsen	2	0.004
Aulacoseira nygaardii (Camburn in Camburn and Kingston) Camburn et Charles	1	0.002
Cymbella mesiana Cholnoky	2	0.004
Cymbella spp.	3	0.006
Encyonema minutum (Hilse in Rabenhorst) Mann in Round, Crawford and Mann	7	0.014
Encyonema silesiacum (Bleisch in Rabenhorst) Mann in Round, Crawford and Mann	4	0.008
Encyonopsis sp. 1 ?	11	0.021
Eunotia bilunaris (Ehrenberg) Souza in Souza and Moreira-Filho	1	0.002
Eunotia carolina Patrick	38	0.074
Eunotia circumborealis Lange-Bertalot et Nörpel in Lange-Bertalot	1	0.002
Eunotia faba (Ehrenberg) Grunow in Van Heurck	3	0.006
Eunotia flexuosa (Brébisson ex Kutzing) Kützing	24	0.047
Eunotia formica Ehrenberg	7	0.014
Eunotia hexaglyphis Ehrenberg	4	0.008
Eunotia implicata Nörpel, Alles et Lange-Bertalot in Alles, Nörpel and Lange-Bertalot	2	0.004
Eunotia incisa Smith ex Gregory	79	0.154
Eunotia intermedia (Krasske ex Hustedt) Nörpel et Lange-Bertalot in Lange-Bertalot	6	0.012
Eunotia parallela Ehrenberg	1	0.002
Eunotia praerupta Ehrenberg	6	0.012
Eunotia rhomboidea Hustedt	3	0.006
Eunotia spp.	11	0.021
Fragilaria famelica (Kützing) Lange-Bertalot	1	0.002
Fragilaria vaucheriae (Kützing) Petersen	2	0.004
Gomphonema acuminatum Ehrenberg	7	0.014
Gomphonema auritum Braun & Kutzing	1	0.002
Gomphonema exilissimum (Grunow in Van Heurck) Lange-Bertalot et Reichardt in Lange-Bertalot and Metzeltin	3	0.006
Gomphonema gracile Ehrenberg	11	0.021

Table 5: Continued

Burnett County

Bottom (35-37 cm)

lots of diatoms fragments; sponge spicules and phytoliths

TAXA	COUNT TOTAL Number	Prop.
Gomphonema hebridense Gregory	1	0.002
Gomphonema maclaughlinii Reichardt	4	0.008
Gomphonema minutum (Agardh) Agardh	16	0.031
Gomphonema minutum fo. curtum (Hustedt) Lange-Bertalot et Reichardt in Krammer and Lange-Bertalot	7	0.014
Gomphonema parvulius (Lange-Bertalot et Reichardt) Lange-Bertalot et Reichardt in Lange-Bertalot and Metzeltin	9	0.018
Gomphonema parvulum (Kützing) Kützing	2	0.004
Gomphonema sp. 1 Big Doctor	3	0.006
Gomphonema sp. 26 NAWQA EAM	1	0.002
Gomphonema spp.	10	0.020
Gomphonema truncatum Ehrenberg	3	0.006
Hantzschia amphioxys (Ehrenberg) Grunow in Cleve and Grunow	1	0.002
Navicula spp.	4	0.008
Navicula vulpina Kützing	21	0.041
Neidium ampliatum (Ehrenberg) Krammer in Krammer and Lange-Bertalot	1	0.002
Neidium spp.	13	0.025
Neidium temperei Reimer	3	0.006
Pinnularia maior (Kützing) Rabenhorst	2	0.004
Pinnularia microstauron (Ehrenberg) Cleve	2	0.004
Pinnularia pseudogibba Krammer	4	0.008
Pinnularia spp.	7	0.014
Pinnularia subgibba Krammer	3	0.006
Pinnularia viridiformis Krammer	6	0.012
Pinnularia viridis (Nitzsch) Ehrenberg	1	0.002
Sellaphora americana (Ehrenberg) Mann	2	0.004
Sellaphora laevissima (Kützing) Mann	5	0.010
Sellaphora pupula (Kützing) Meresckowsky	3	0.006
Sellaphora rectangularis (Gregory) Lange-Bertalot et Metzeltin	9	0.018
Sellaphora rugula (Hohn & Hellerman) Potapova & Ponader	1	0.002
Sellaphora spp.	3	0.006
Stauroneis anceps Ehrenberg	3	0.006
Stauroneis gracilior (rabenhorst) Reichardt	1	0.002

Table 5: Continued		
Burnett County		
Bottom (35-37 cm)		
lots of diatoms fragments; sponge spicules and phytoliths		
	COUNT TOTAL	
	Number	Prop.
TAXA		
Stauroneis phoenicenteron (Nitzsch) Ehrenberg	5	0.010
Stauroneis spp.	10	0.020
Staurosira construens var. venter (Ehrenberg) Hamilton in Hamilton, Poulin, Charles and Angell	27	0.053
Synedra delicatissima Smith	2	0.004
Synedra rumpens Kützing	2	0.004
Synedra spp.	1	0.002
Synedra ulna var. danica (Kützing) Grunow in Van Heurck	1	0.002
Tabellaria flocculosa (strain III) sensu Koppen (Roth) Kützing	12	0.023
Tabellaria flocculosa var. linearis Koppen	9	0.018
Tabellaria spp.	6	0.012
Undetermined Pennate	41	0.080
TOTAL	512	1.000

Waste Water Treatment Plant Effluent Dye Test

In addition to the paleolimnolgical study, a dye test was conducted in May of 2013 to help determine the flow pat from the Siren Waste Water Treatment Plant. Below is a summary given by Craig Roesler of his findings:

May 13, 2013 Narrative from Craig Roesler
I tried to follow the flow path of the Siren WWTP effluent in the wetland north of highway 70 on 5-13-13. Big Doctor Lake is the receiving water down-gradient from the wetland. Flow was passing through the culvert (45.78452, 92.39239), northward, at about 0.15 cfs. Conductivity was 197 umhos/cm. I hiked through the wetland to the powerline path that runs SW -NE through the wetland, and walked the length of the path across the wetland.

An area of standing water on the path at the west edge of the wetland (45.78576, 92.39499; obscured by label on attached map) had a conductivity of 115. There was extremely minimal northward flow. There was no distinct channel. I think this is probably where any surface drainage of effluent is crossing the path. Dilution with wetland water would have lowered the conductivity.

I checked a second area of standing water on the trail near the center of the wetland (45.78617, 92.39378). Conductivity at this site was 66, indicating this was wetland derived water.

I also found a culvert passing under the trail on the east side of the wetland. There was a slight flow of water northward. Conductivity at this site was 137. This site is separated by upland areas from the large wetland to the west, and cannot be receiving effluent. I think this site receives runoff from road ditches at the west end of Main St. in Siren. There was no flow in these ditches at the time to measure conductivity.

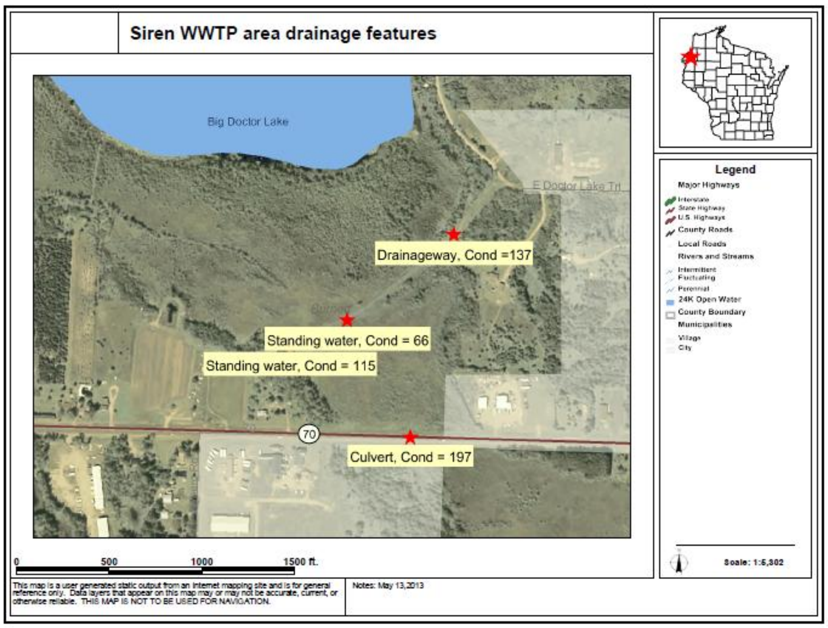


Figure 7: May 13, 2013 Dye & Conductivity Test

It tells us that effluent flow to the lake through the wetland is fairly diffuse and not channelized, so we are probably getting the best treatment the wetland can provide. However, some surface flow is likely to be reaching the lake at times. Also, softwater wetlands, like this one, often do a poor job of long term phosphorus capture. Anaerobic conditions in the wetland soils and underlying groundwater may be allowing phosphorus transport to the lake via groundwater flow. Monitoring wells would be needed to assess this.

Watershed

The Clam River Watershed consists of a long narrow strip of land that extends through the center of Burnett County and includes a portion of northeastern Polk County. It is approximately 132,392 acres in size and contains 218 miles of streams and rivers, 5,389 acres of lakes and 24,387 acres of wetlands. The watershed is dominated by forest (51%), grassland

(19%) and wetlands (18%), and is ranked medium for nonpoint source issues affecting lakes (WI DNR)

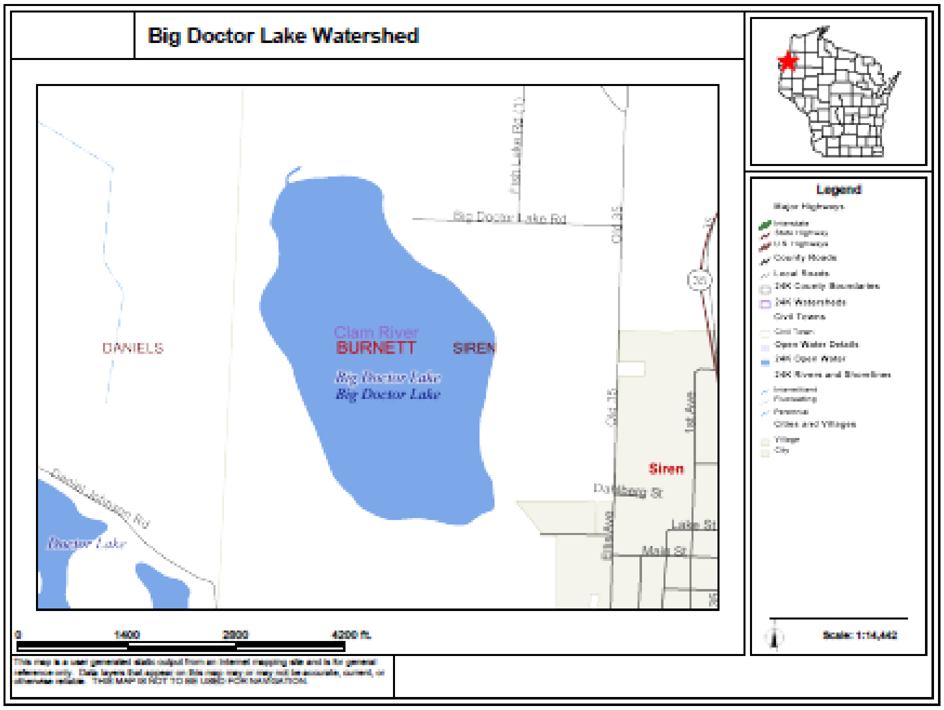


Figure 8: Clam River Watershed (WI DNR)

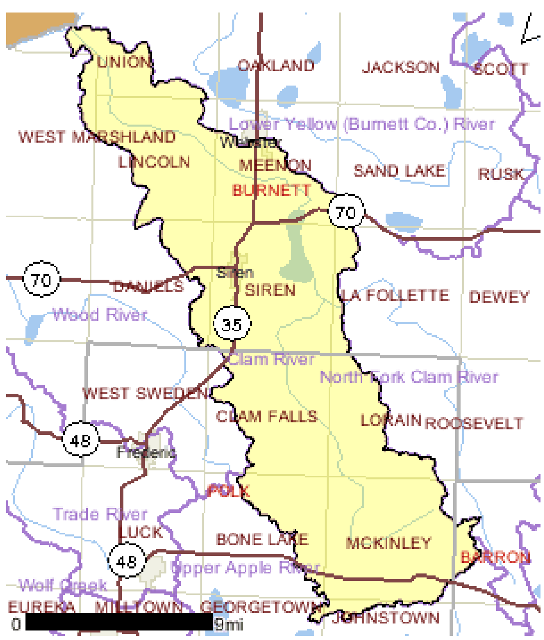


Figure 9: Clam River Watershed (WI DNR)

Watershed Runoff

Land cover plays a critical role in a watershed. The type of land cover that exists in the watershed determines the amount of phosphorus (and sediment) that runs off the land and eventually makes its way to the lake. The actual amount of pollutants (nutrients, sediment, toxins, etc.) depends greatly on how the land within the watershed is used. Vegetated areas, such as forests, grasslands, and meadows, allow the water to permeate the ground and do not produce much surface runoff. On the other hand, agricultural areas, particularly row crops, along with residential/urban areas, minimize infiltration and increase surface runoff. The increased surface runoff associated with these land cover types leads to increased phosphorus and pollutant loading; which, in turn, can lead to nuisance algal blooms, increased sedimentation, overabundant macrophyte populations, and decreased dissolved oxygen levels.(WI DNR) Land that is maintained in a natural, vegetated state is beneficial to soil and water quality.

According to the Wisconsin DNR 2002 State of the St. Croix River Basin report, four key priorities for the basin are identified, all of which are directly associated with water quality:

1. Protection and restoration of shoreland habitat
2. Control of nonpoint source runoff contamination of surface waters
3. Restoration of grasslands, prairies, and wetlands to protect soil and water quality, and to enhance wildlife habitat
4. Implementation of a Northwest Sands Integrated Ecosystem Management Plan

Below is a list of Land Cover Classifications and percentages for each found in the St. Croix Basin (see St. Croix Basin Land Cover Map), followed by a short discussion of the major land cover types.

Table 6: Land Cover Classification found in the St. Croix Basin (WI DNR)

Forest	48.01%
Grassland	16.64%
Wetland	14.02%
Agriculture	12.85%
Water	4.55%
Shrubland	3.18%
Urban/Developed	0.43%
Barrens	0.32%

The majority of Burnett County's land cover is made up of forest, while grassland, open water and wetlands make up approximately one-third. Figure 10 below represents the land cover of the Clam River Watershed.

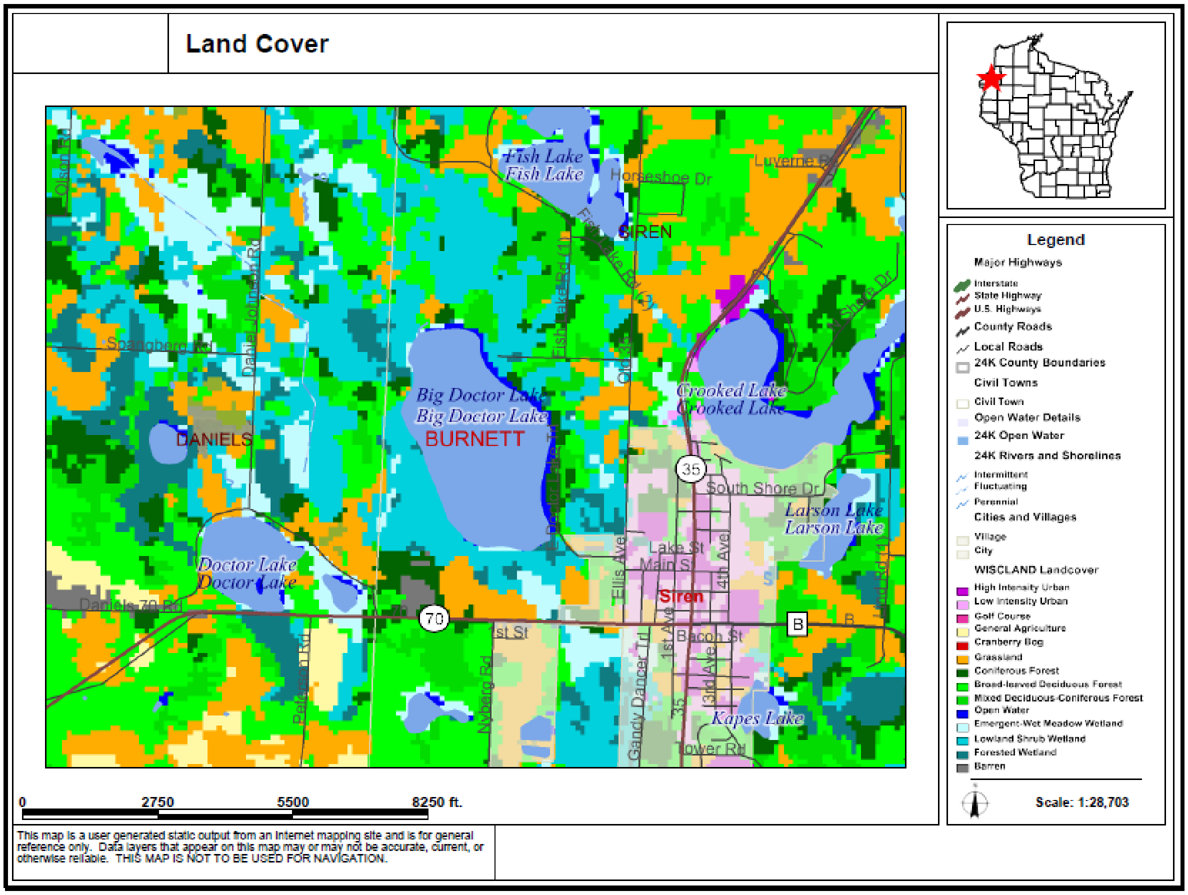


Figure 10: Clam River Watershed Land Cover

Aquatic Habitats

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 shoreline plant populations around Big Doctor Lake 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 bulrush present on Big Doctor 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. During both the late May and July plant surveys, a very diverse population of bird species was observed on and around the lake.

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 concerns to some users, but as a natural feature of lakes, they generally do not cause harm.[7]

Aquatic Invasive Species Status

Reed canary grass (Phalaris arundinacea), and curly leaf pondweed (Potamogeton crispus) have been observed on Big Doctor Lake. No Eurasian water milfoil (Myriophyllum spicatum) was found on the lake, but it has been found in three nearby lakes in Burnett County: Ham Lake, Round Lake and Trade Lake. The EWM has also been found in Long Trade Lake, just across the border in Polk County. It is therefore of paramount importance that the Big Doctor Lake Association takes measures to avoid the introduction of EWM into the lake.

Rare and Endangered Species Habitat

According to the Wisconsin Natural Heritage Inventory the following is a list of species on and around Big Doctor Lake that are listed as being endangered, threatened or of special interest (Table 7).

Table 7: Natural Heritage Inventory (NHI) Species Found in Big Doctor Lake Area (T.38N. – R.16W.)

Common Name	**Scientific Name**	**WI State Status**
Trumpeter Swan	*Cygnus buccinator*	SC/M
Bald Eagle	*Haliaeetus leucocephalus*	SC/P
Diving Beetle	*Hygrotus sylvanus*	SC/N
Karner Blue Butterfly	*Lycaeides melissa samuelis*	NA
Pugnose Shiner	*Notropis anogenus*	THR
Torrey's Bulrush	*Scirpus torreyi*	SC
Sand Violet	*Viola fimbriatula*	END

WDNR and federal regulations regarding Special Concern species range from full protection to no protection. The current categories and their respective level of protection are as follows:

Key: **END** = endangered **SC/P** = fully protected
THR = threatened **SC/N** = no laws regulating use, possession, or harvesting
SC = Special Concern **SC/H** = take regulated by establishment of open /closed seasons
SC/FL = Federally protected as endangered or threatened, but not so designated by state
SC/M = fully protected by federal and state laws under the Migratory Bird Act

Big Doctor Lake Fishery (Jameson, WI DNR)

Table 8: BIG DOCTOR LAKE SPECIES LIST

Common Name	**Scientific Name**	**Relative Abundance**
Gamefish		
Northern pike	Esox lucius	Abundant
Largemouth Bass	Micropterus salmoides	Abundant
Panfish		
Bluegill	Lepomis macrochirus	Abundant
Black crappie	Pomoxis nigromaculatus	Abundant
Pumpkinseed	Lepomis gibbosus	Common
Rock bass	Amblopites rupestris	Common
Yellow perch	Perca flavecens	Common
Yellow bullhead	Ictalurus natalis	Present

Table 8: Continued

Forage and other species		
White sucker	Catostomus commersoni	Common
Blackchin shiner	Notropis heterodon	Present
Bluntnose minnow	Pimephales notatus	Present

Plant Community

METHODS:

Using a standard formula that takes into account the shoreline shape and distance, islands, water clarity, depth and total lake acres, Michelle Nault (WDNR) generated a sampling grid for Big Doctor Lake (Figure 11). In May, we conducted a Curly-leaf pondweed (CLP) survey to check for the presence of this invasive species. During this survey, we went to each of the 298 points on Big Doctor Lake. We sampled just for Curly-leaf pondweed at each site. This type of survey should result in both detection and approximate mapping of any infestation that may have occurred. During the May survey, we discovered that almost the entire lake was covered with CLP. (See Figure 12)

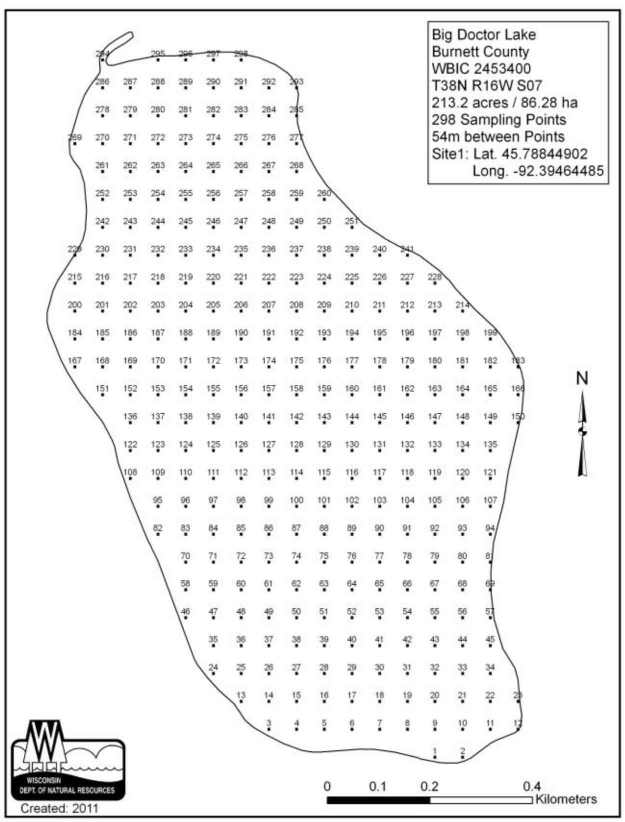


Figure 11: Big Doctor Lake Sample Grid

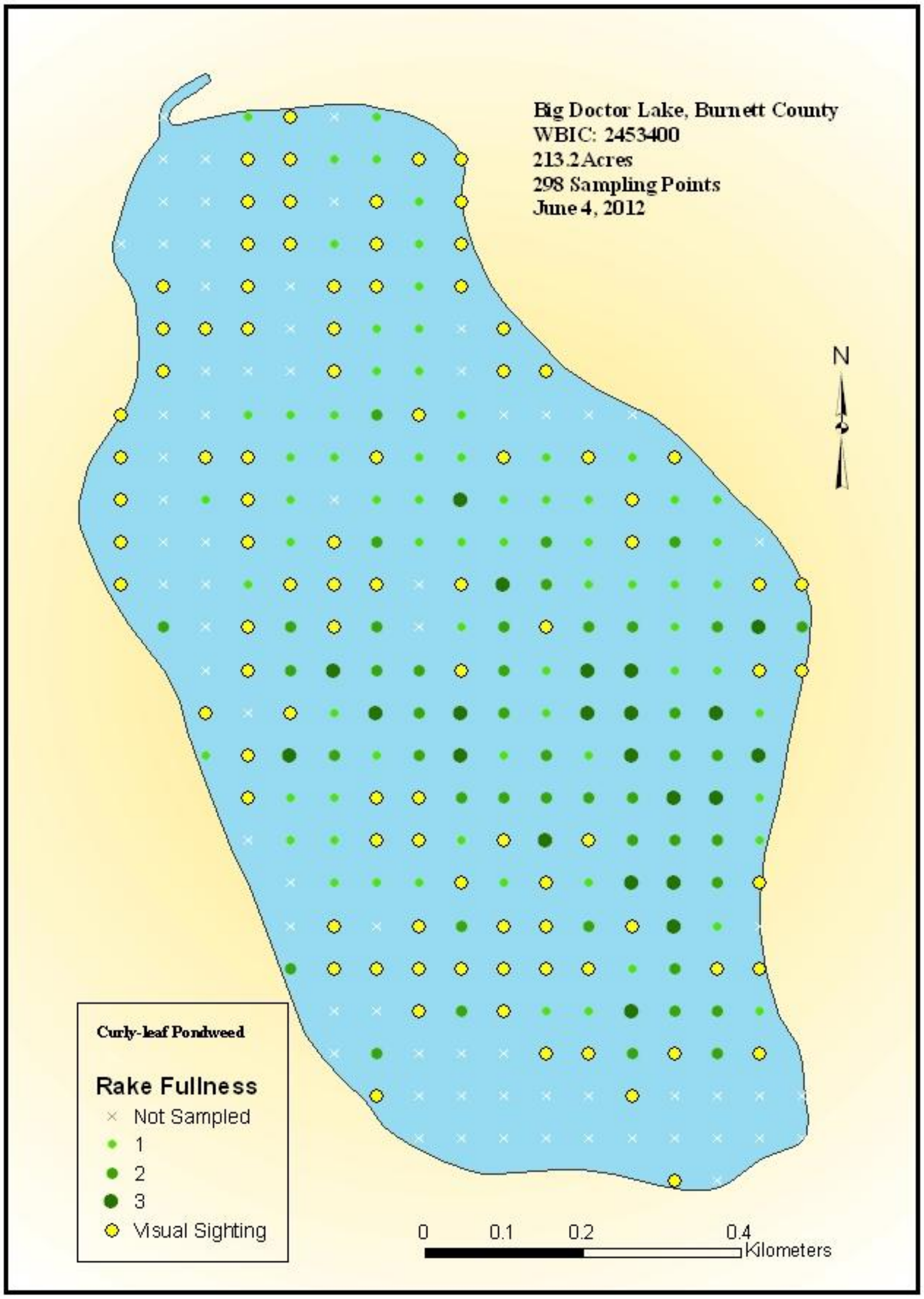


Figure 12: May Curly-leaf Pondweed Distribution Map

During the May survey, a general idea for the lake and plant communities was established and more detailed summary during the July survey. All plants found were identified (Boreman et al. 1997; Chadde 2002; Crow and Hellquist 2006), and two vouchers were pressed and retained for herbarium specimens – one to be retained by the Big Doctor Lake Association, and one to be sent to the state for identification confirmation. During the point intercept survey, we located each survey point using a handheld mapping GPS unit (Garmin 76CSx). At each point, we recorded a depth reading with a Hummingbird depth finder unit. After sampling numerous depths at numerous sites, we were able to establishment the littoral zone at a maximum of 7 feet. We sampled for plants within the depth range of plant growth. At each of these points, we used a rake (either on a pole or a throw line depending on depth) to sample an approximately 2.5ft. section of the bottom. All plants on the rake, as well as any that were dislodged by the rake were identified, and assigned a rake fullness value of 1-3 as an estimation of abundance (Figure 13). We also recorded visual sightings of plants within six feet of the sample point. Substrate (lake bottom) type was assigned at each site where the bottom was visible or it could be reliably determined using the rake. The substrate is defined as either being sand, muck or rock.

Figure 13: Rake Fullness Ratings (UWEX, 2007)

DATA ANALYSIS:

We entered all data collected into the standard APM spreadsheet (UWEX, 2007). From this, we calculated the following:

<u>Total number of points sampled:</u> This included the total number of points on the lake coverage that were within the littoral zone (0-maximum depth where plants are found) Initially, we continued to sample points whose depth were several feet beyond the littoral zone, but once we established this maximum depth with confidence, most points beyond this depth were not rake sampled.

Total number of sites with vegetation: These included all sites where we found vegetation after doing a rake sample. For example, if 20% of all sample sites have vegetation, it suggests that 20% of the lake has plant coverage.

Total number of sites shallower than the maximum depth of plants: This is the number of sites that are in the littoral zone. Because not all sites that are within the littoral zone actually have vegetation, we use this value to estimate how prevalent vegetation is throughout the littoral zone. For example, if 60% of the sites shallower than the maximum depth of plants have vegetation, then we estimate that 60% of the lake's littoral zone has plants.

Frequency of occurrence: The frequency of all plants (or individual species) is generally reported as a percentage of occurrences at all sample points. It can also be reported as a percentage of occurrences at sample points within the littoral zone.

Frequency of occurrence example:

Plant A is sampled at 70 out of 700 total points = 70/700 = .10 = 10%

This means that Plant A's frequency of occurrence = 10% considering the entire lake sample.

Plant A is sampled at 70 out of 350 total points in the littoral zone = 70/350 = .20 = 20%

This means that Plant A's frequency of occurrence = 20% when only considering the littoral zone.

From these frequencies, we can estimate how common each species was throughout the lake, and how common the species was at depths where plants were able to grow. Note the second value will be greater as not all the points (in this example, only ½) occur at depths shallow enough for plant growth.

Simpson's diversity index: A diversity index allows the entire plant community at one location to be compared to the entire plant community at another location. It also allows the plant community at a single location to be compared over time thus allowing a measure of community degradation or restoration at that site. With Simpson's diversity index, the index value represents the probability that two individuals (randomly selected) will be different species. The index values range from 0 -1 where 0 indicates that all the plants sampled are the same species to 1 where none of the plants sampled are the same species. The greater the index value, the higher the diversity in a given location. Although many natural variables like lake size, depth, dissolved minerals, water clarity, mean temperature, etc. can affect diversity, in general, a more diverse lake indicates a healthier ecosystem. Perhaps most importantly, plant communities with high diversity also tend to be **more resistant** to invasion by exotic species.

Maximum depth of plants: This indicates the deepest point that vegetation was sampled. In clear lakes, plants may be found at depths of over 20ft, while in stained or turbid locations, they may only be found in a few feet of water. While some species can tolerate very low light conditions, others are only found near the surface. In general, the diversity of the plant community decreases with increased depth.

Number of sites sampled using rope/pole rake: This indicates which rake type was used to take a sample. Protocol suggests a 15ft pole rake, and a 25ft rope rake for sampling (Wagoner personal communication).

Average number of species per site: This value is reported using four different considerations. 1) **shallower than maximum depth of plants** indicates the average number of plant species at all sites in the littoral zone. 2) **vegetative sites only** indicate the average number of plants at all sites where plants were found. 3) **native species shallower than maximum depth of plants** and 4) **native species at vegetative sites only** excludes exotic species from consideration.

Species richness: This value indicates the number of different plant species found in and directly adjacent to (on the waterline) the lake. Species richness alone only counts those plants found in the rake survey. The other two values include those seen during the point intercept survey and the initial boat survey.

Mean and median depth of plants: The mean depth of plants indicates the average depth in the water column where plants were sampled. Because a few samples in deep water can skew this data, median depth is also calculated. This tells us that half of the plants sampled were in water shallower than this value, and half were in water deeper than this value.

Relative frequency: This value shows a species' frequency relative to all other species. It is expressed as a percentage, and the total of all species' relative frequency will add up to 100%. Organizing species from highest to lowest relative frequency value (Table 2) gives us an idea of which species are most important within the macrophyte community.

Relative frequency example:

Suppose that we sample 100 points and found 5 species of plants with the following results:

Plant A was located at 70 sites. Its frequency of occurrence is thus 70/100 = 70%
Plant B was located at 50 sites. Its frequency of occurrence is thus 50/100 = 50%
Plant C was located at 20 sites. Its frequency of occurrence is thus 20/100 = 20%
Plant D was located at 10 sites. Its frequency of occurrence is thus 10/100 = 10%

To calculate an individual species' relative frequency, we divide the number of sites a plant is sampled at by the total number of times all plants were sampled. In our example that would be 150 samples (70+50+20+10).

Plant A = 70/150 = .4667 or 46.67%
Plant B = 50/150 = .3333 or 33.33%
Plant C = 20/150 = .1333 or 13.33%
Plant D = 10/150 = .0667 or 6.67%

This value tells us that 46.67% of all plants sampled were Plant A.

Floristic Quality Index (FQI): This index measures the impact of human development on a lake's aquatic plants. Species in the index are assigned a Coefficient of Conservatism (C) which ranges from 1-10. The higher the value assigned, the more likely the plant is to be negatively impacted by human activities relating to water quality or habitat modifications. Plants with low values are tolerant of human habitat modifications, and often exploit these changes to the point where they may crowd out other species. The FQI is calculated by averaging the conservatism value for each species found in the lake. Consequently, a higher index value indicates a healthier macrophyte community. Nichols (1999) identified four eco-regions in Wisconsin: Northern Lakes and Forests, Northern Central Hardwood Forests, Driftless Area and Southeastern Wisconsin Till Plain. He recommended making comparisons of lakes within ecoregions to determine the target lake's relative diversity and health. Big Doctor Lake is in the Northern Lakes and Forests Ecoregion.

RESULTS:

Aquatic Plant Survey Results for Big Doctor Lake

An aquatic plant survey was completed for Big Doctor Lake in 2012. Prior to the whole lake monitoring, a curly leaf pondweed (CLP) survey was conducted to confirm the presence of this aquatic invasive species. Since CLP grows earlier than native species, it typically dies in early July; therefore, the CLP survey is done in May or early June while the plant is still robust. A general boat survey was also conducted prior to the point intercept survey to gain familiarity with the lake and the plant species found on the lake. The results discussed below are taken from these two surveys.

Using a standard formula based on a lake's shoreline shape and distance, islands, water clarity, depth, and size in acres, the Wisconsin Department of Natural Resources (WDNR) generated the sampling point grid of 298 points for Big Doctor Lake. Figure 11 above shows the locations of these sampling points.

As mentioned before, Big Doctor Lake survey grid is comprised of 298 points of which, 292 sites were sampled. Of these points, we found plants at 255sites in less than 7 feet of water (Figure 8: littoral zone). Areas that were shallow and had a mucky substrate supported more plants than those with sandy or rocky bottoms. Figure 9 below illustrates the substrate of Big Doctor Lake. Plants were found growing on approximately 88% of the entire lake bottom, and in 87% of the littoral zone. Diversity was moderate with a Simpson Diversity Index value of 0.66. Species richness was relatively high with 23 total species found growing in and immediately adjacent to the lake. Due to the fact that the maximum depth of the lake was approximately 7 feet, the aquatic macrophytes were found growing throughout the entire lake in water with a mean depth of 4.8 ft, and a median depth of 5 ft. These zones of plant growth are extremely important in helping to control algal growth and they support diverse plant beds that provide important underwater habitat. Tables 9, 10, and 11 summarize data from the completed survey.

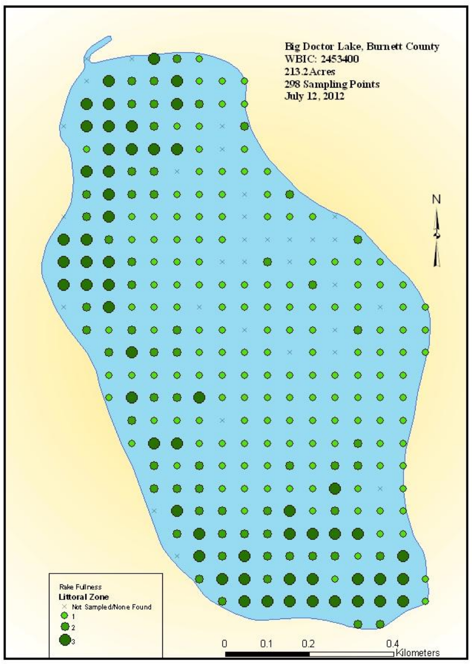


Figure 14: Littoral Zone – Region of Plant Growth

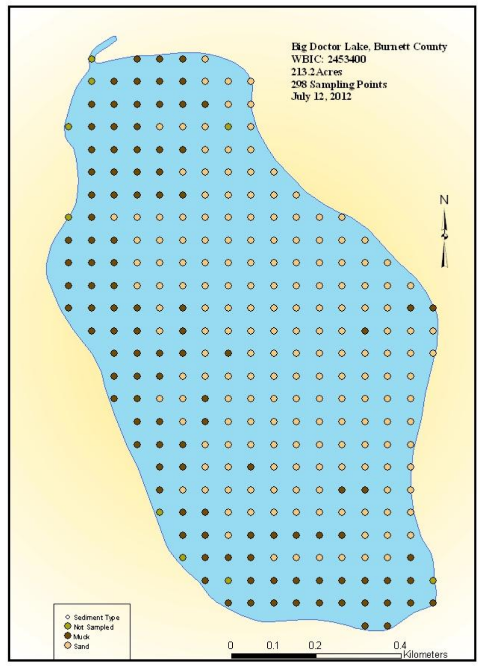


Figure 15: Sediment Type

The following plant species where the most frequently observed on the lake: Fern pondweed (*Potamogeton robbinsii*), (*Drepanocladus sp*.) Aquatic moss, (Potamogeton crispus) Curly-leaf pondweed, (*Elodea nuttallii*) Slender waterweed (Table 11). The four species were found at 87.06%, 24.31%, 23.92%, and 11.37% of the survey points with vegetation respectively (Figure 16). All four species were widely distributed throughout the lake over muck and sandy bottoms (Figure 15). Although many other species were widely distributed, none were found with a relative frequency over 5.88%.

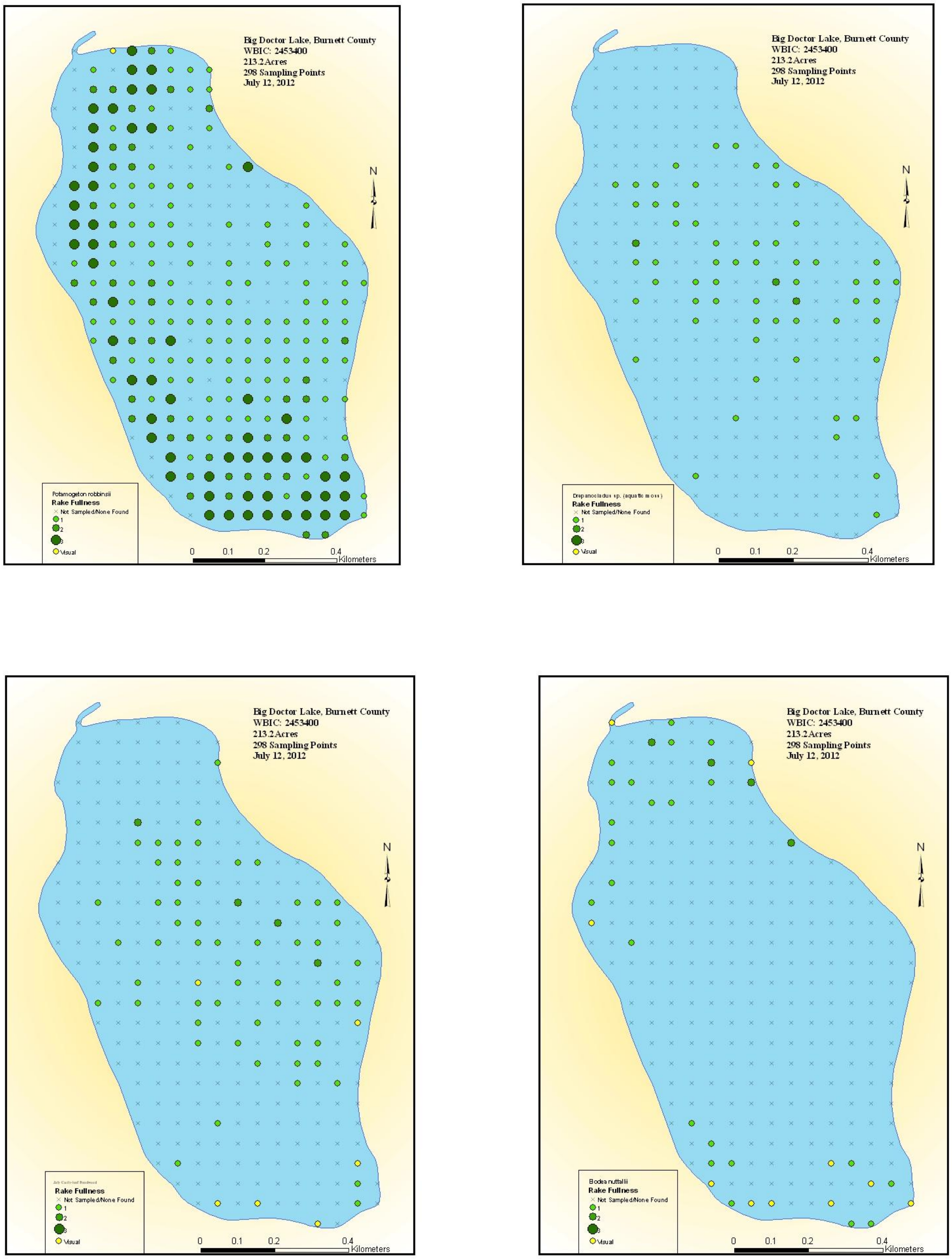


Figure 16: Four Most Common Aquatic Plant Species in Big Doctor Lake

Curly Leaf Pondweed Survey Results

On June 4, 2012, we conducted a point intercept survey for Curly-leaf pondweed. Most of the sites within the littoral zone were discovered to have Curly-leaf pondweed (CLP), an exotic invasive species. Two hundred and thirty one of the two hundred and ninety two points surveyed had CLP. During the full survey in July, we found CLP at several sites, 61 of the 292 points sampled. Below is a map of the July survey which indicates the locations of the known CLP sites (Figure 17) On June 10, 2014 a CLP survey was conducted and the following results are found on Figure 20. Of the 298 points sampled in 2014, only 26 sites were found to have CLP. This is a significant decline from the past years.

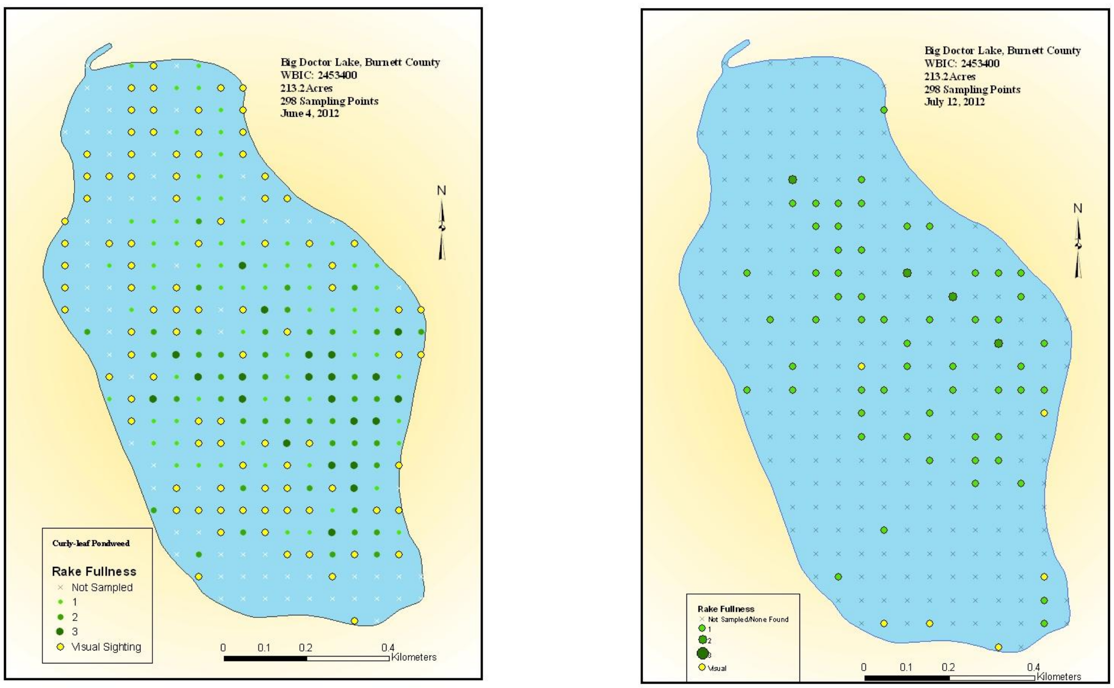


Figure 17: Curly-leaf Pondweed Distribution June and July 2012

During the June and July survey, no Eurasian water-milfoil (*Myriophyllum sibiricum*) was detected. Several sites adjacent to the littoral zone had Reed canary grass, a common invasive species. We did not find any Purple loosestrife (PLS) in the littoral zone or adjacent to littoral zone; however, PLS had been spotted on a lake nearby. Members of the lake association have been trained in Citizen Lake Monitoring Network aquatic invasive species and have been monitoring the lake. Several members of the Lake Association were trained in 2013 and more members will be trained in the future to monitor aquatic invasive species and will continue to survey the lake for purple loosestrife.

Summary of Recommendations:

- Preserve and maintain Big Doctor Lake's diverse native plant community.
- Continue to educate lakeshore owners and boaters about the importance of aquatic plants and the negative impacts AIS can have on the entire lake ecosystem.
- Preserve the lake's many rush/reed/rice beds and the lake's sensitive habitat areas.
- Whenever possible, refrain from removing native plants from the lake.
- Reduce and, wherever possible, eliminate fertilizer and pesticide applications near the lakeshore.
- Encourage shoreline restoration.
- Establish native vegetation buffer strips along the lakeshore.
- Consider transect monitoring for aquatic invasive species at and near the boat landing at least once a month during the summer months.
- Complete a full shoreline inspection in mid-August to locate and eliminate any beds of Purple loosestrife plants where beetles are not present.
- Establish a Clean Boats/Clean Water and Aquatic Invasive Species program.
- Conduct Citizen Lake Monitoring for aquatic invasive species from May through October.
- Consider conducting a study to determine internal loading of phosphorus.

Table 9: Big Doctor Lake Aquatic Macrophytes Survey Summary Statistics

Summary Statistics	
Total number of sites visited	292
Total number of sites with vegetation	255
Total number of sites shallower than maximum depth of plants	292
Frequency of occurrence at sites shallower than maximum depth of plants	87.33
Simpson Diversity Index	0.66
Maximum depth of plants (ft)**	7.00
Number of sites sampled using rake on Rope (R)	292
Number of sites sampled using rake on Pole (P)	0
Average number of all species per site (shallower than max depth)	1.38
Average number of all species per site (veg. sites only)	1.58
Average number of native species per site (shallower than max depth)	1.17
Average number of native species per site (veg. sites only)	1.41
Species Richness	18
Species Richness (including visuals)	23
Mean Depth of Plants (ft)	4.8
Median Depth of Plants (ft)	5

Table 10: Big Doctor Lake FQI Species and Conservatism Values

Species	Common Name	C
Brasenia schreberi	Watershield	6
Chara	Muskgrasses	7
Elatine minima	Waterwort	9
Eleocharis acicularis	Needle spikerush	5
Elodea nuttallii	Slender waterweed	7
Isoetes sp.	Quillwort	8
Lemna minor	Small duckweed	4
Nitella	Nitella	7
Nuphar variegata	Spatterdock	6
Nymphaea odorata	White water lily	6
Potamogeton epihydrus	Ribbon-leaf pondweed	8
Potamogeton pulcher	Spotted pondweed	10
Potamogeton pusillus	Small pondweed	7
Potamogeton robbinsii	Fern pondweed	8
Utricularia gibba	Creeping bladderwort	9
Vallisneria americana	Wild celery	6
Number of Plants		16
mean C		7.0625
FQI		28.25

We identified a total of 22 native species in Big Doctor Lake, of which, 16 species were used to calculate the Coefficient of Covservation. They produced a mean Coefficient of Conservation 7.06 and a Floristic Index of 28.25 (Table 11). Nichols (1999) reported an Average mean C for the Northern Lakes and Forest Region of 6.7 putting Big Doctor Lake slightly above average for this part of the state. However, the FQI was higher than the mean FQI of 24.3 for the Northern Lakes and Forest Region (Nichols 1999). The high FQI is a result of Big Doctor Lake's above average plant diversity and the fact that there are several species of plants in the lake with high Coefficient of Conservation values.

Table 11: Frequencies and Mean Rake Sample of Aquatic Macrophytes Big Doctor Lake, Burnett County July 2012

Scientific Name	Common Name	Total Sites	Relative Frequency (%)	Frequency of occurrence vegetated (%)	Mean Rake Fullness
Potamogeton robbinsii	Fern pondweed	222	55.087	87.059	1.7027
Drepanocladus sp.	Aquatic moss	62		24.314	1.0484
Potamogeton crispus	Curly-leaf pondweed	61	15.136	23.922	1.0656
Elodea nuttallii	Slender waterweed	29	7.196	11.373	1.1379
Nymphaea odorata	White water lily	15	3.7221	5.8824	1.6
Chara sp.	Muskgrasses	14	3.4739	5.4902	1
Brasenia schreberi	Watershield	13	3.2258	5.098	2.2308
Nitella sp.	Nitella	12	2.9777	4.7059	1
Vallisneria americana	Wild celery	11	2.7295	4.3137	1.1818
Utricularia gibba	Creeping bladderwort	7	1.737	2.7451	1
Potamogeton pusillus	Small pondweed	6	1.4888	2.3529	1
Eleocharis acicularis	Needle spikerush	4	0.9926	1.5686	1
Lemna minor	Small duckweed	2	0.4963	0.7843	1
Nuphar variegata	Spatterdock	2	0.4963	0.7843	1
Decodon verticillatus	Swamp loosestrife	1	0.2481	0.3922	1
Elatine minima	Waterwort	1	0.2481	0.3922	1
Isoetes sp.	Quillwort	1	0.2481	0.3922	1
Potamogeton epihydrus	Ribbon-leaf pondweed	1	0.2481	0.3922	1
Potamogeton pulcher	Spotted pondweed	1	0.2481	0.3922	1
Eleocharis palustris	Creeping spikerush				
Pontederia cordata	Pickerelweed				
Sagittaria sp.	Arrowhead				
Schoenoplectus pungens	Three-square bulrush				
Schoenoplectus tabernaemontani	Softstem bulrush				

Aquatic Plant Management

This section reviews the potential management methods available, and reports recent management activities on the lakes. The application, location, timing, and combination of techniques must be considered carefully.

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 Big Doctor Lake, 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 (WDNR).

Manual Removal

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 twenty feet wide.

SCUBA divers may engage in manual removal for invasive species like Eurasian water milfoil. Care must be taken to ensure that all plant fragments are removed from the lake. Manual removal with divers is recommended for shallow areas with sporadic EWM growth.

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. (APIS, Army Corps of Engineers)

Aquatic plant harvesters are floating machines that cut and remove vegetation from the water. The cutter head uses sickles similar to those found on farm equipment, and generally cut to depths from one to six feet. A conveyor belt on the cutter head brings the clippings onboard the machine for storage. Once full, the harvester travels to shore to discharge the load of weeds off of the vessel.

The size, and consequently the harvesting capabilities, of these machines vary greatly. As they move, harvesters cut a swath of aquatic plants that is between 4 and 20 feet wide, and can be up to 10 feet deep. The on-board storage capacity of a harvester ranges from 100 to 1000 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 (the nutrient content of composted aquatic plants is comparable to that of cow manure) or to an upland landfill for proper disposal. Most harvesters can cut between 2 and 8 acres of aquatic vegetation per day, and the average lifetime of a mechanical harvester is 10 years.

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

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

While the enjoyed 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 to avoid spreading of 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, 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, be sure to inspect the equipment before and after it enters the lake. Since these machines travel from lake to lake, they may carry plant fragments with them, and facilitate the spread of aquatic invasive species from one body of water to another. One must also consider prevailing winds, since cut vegetation can be blown into open areas of the lake or along shorelines.

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

Plant fragments can result from this type of operation, 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.

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

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

Weevils

Weevils have potential for use as a biological control agent against Eurasian water milfoil. There are several documented "natural" declines of EWM infestations. In these cases, EWM was not eliminated but its abundance was reduced enough so that it did not achieve dominance. These declines are attributed to an ample population of native milfoil weevils (Euhrychiopsis lecontei). Weevils feed on native milfoils but will shift preference over to EWM when it is present. Lakes where weevils can become an effective control have an abundance of native Northern water milfoil and fairly extensive natural shoreline where the weevils can over winter. Because native milfoils are susceptible to higher doses of herbicides, 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 above, 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 not currently proposed for management of aquatic plants in Big Doctor Lake, although it will be considered for purple loosestrife control should an infestation arise.

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 Big Doctor Lakes because a healthy, diverse native plant population is present.

Physical Control

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

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.

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 Big Doctor Lake.

Herbicide and Algaecide Treatments

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

An important caveat is that these products are considered safe when used according to the label. The U.S. Environmental Protection Agency (EPA)-approved label gives guidelines protecting the health of the environment, the humans using that environment, and the applicators of the herbicide. WDNR permits under Chapter NR 107 are required for herbicide application.

General descriptions of herbicide classes are included below.

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.

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.

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.

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 Use 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, 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 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 middle 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 (APIS). 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. Staff from the Minnesota Department of Natural Resources and the U.S Army Engineer Research and Development Center is conducting trials of this method.

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.

Burnett County Land and Water Conservation (LWCD)

Burnett County assists the Big Doctor Lake Association in management of aquatic invasive species. They have individuals available to assist with the following tasks:

- Conduct watercraft inspection at public access points.
- Complete in-lake monitoring for Eurasian Water Milfoil (EWM) and other invasive species.
- Carry out public outreach and education events related to invasive species 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 (CBCW) program.
- Train lake residents and others in Citizen Lake Monitoring, which includes CBCW, Secchi, Water Chemistry, and Aquatic Invasive Species identification.
- 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, and offer assistance with clipping and herbicide application for individual infestations.

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. All Burnett County boat landings are monitored each year.

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

The Rapid Response Plans 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 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.

Plan Goals and Strategies

Overall Purpose

This section of the plan lists goals for aquatic plant management for Big Doctor Lakes. It also presents a detailed strategy of actions that will be used to reach Aquatic Plant Management Plan goals. Educational strategies that outline audience, messages, and methods are included under each goal.

Plan Goals

The APM committee established six goals and prioritized them in the following order:

1. Maintain and improve water quality conditions.
2. Identify and educate the Big Doctor Lake community regarding aquatic plant management, management strategies found in the plan and appropriate plant management actions.
3. Prevent the introduction and spread of aquatic invasive species.
4. Reduce and control the population of curly leaf pondweed
5. Enhance and maintain the diverse populations of native aquatic plants.
6. Create and maintain navigable channels for fishing and boating.

Goal 1: Maintain and improve water quality conditions.

Objectives

A. Continue to sample and record both water samples and Secchi readings to ensure water quality.

B. Encourage lake residents to restore and preserve shoreline buffers of native vegetation.

Messages

1. Shoreline buffers protect water quality and provide fish and wildlife habitat. Describe ways to restore shoreline buffers (natural recovery, stop mowing, and plant natives).
2. Cost sharing for restoration shoreline buffers is available from Burnett County.
3. Describe the Burnett County shoreline buffer requirements and how to report violations of these requirements.
4. Highlight good examples of shoreline buffers on private waterfront property.

C. Reduce phosphorus and sediment loads from immediate watershed.

D. Encourage Riparian land owners to adopt and implement storm water runoff controls for existing structures and all new constructions.

Adaptive Management Approach

Big Doctor Lake has a relatively small watershed draining to it and as a result, the impacts that are most controllable at this time originate along the lake's immediate shoreline. These sources include faulty septic systems, the use of phosphorus-containing fertilizers, shoreland areas that are maintained in an unnatural manner, and impervious surfaces. To reduce these impacts, the Big Doctor Lake Association will conduct an educational initiative aimed at raising awareness among shoreland property owners concerning their impacts on the lake. This will include news letter articles and guest speakers at Association meetings. This Management Action will be completed in conjunction with the Shoreland Restoration Action listed below.

Action Steps:
1. Recruit facilitators
2. Facilitators summarize educational material collected from WDNR, UW-Extension, and County Land and Water Conservation sources for the creation of informative materials
3. Facilitators disperse materials to stakeholders

***Actions*:**

1. Continue to monitor water quality through WDNR Citizens Lake Monitoring Network advanced water chemistry program and Secchi disk sampling and record data in the Surface Water Integrated Monitoring System (SWIMS) system. (OBJ A)

2. Incorporate the Adaptive Management Approach to reduce phosphorus and sediment loads from immediate watershed. (OBJ B, C)

3. Educate and assist Big Doctor Lake community members in the restoration and preservation of shoreland buffers and shoreland vegetation. Continue implementation of shoreline owners' education program. (OBJ B, C, D)

Goal 2: Educate the Big Doctor Lake community regarding aquatic plant management, management strategies found in the plan and appropriate plant management actions.

Audience: Big Doctor Lake Community
A. All lake residents
B. Business owners
C. Lake users
D. Residents who treated waterfront with herbicides in the past

Messages

1. Summary of APM plan, notice of public meeting, and how to get full APM plan
2. List of APM dos and don'ts
3. Contact list for APM include web resources
4. Native aquatic plant values
5. Limit impacts to native aquatic plants by traveling with no wake in shallow areas, using hand removal methods near docks and swimming areas, etc.
6. Explain procedure for individual corridor herbicide applications and describe conditions where herbicide treatment may be allowed.
7. Explain location and procedures for curly leaf pondweed herbicide treatment
8. Identification of CLP and methods for removal (include illustrations)
9. Identification of PL and methods for removal (include illustrations)
10. Identification of EWM and contact if suspected (include illustrations)
11. Locations of nearby lakes with EWM
12. Describe new potential invasive species and why they are a threat
13. Native plant identification
14. Inspect, clean, and drain boats and equipment.
15. Burnett County has an ordinance that makes it illegal to transport aquatic plants on public roads.

Methods

Summary of APM plan
AIS education workshops for all lake users
Improvements to signage at boat landings
Updates to AIS handouts
Newsletter articles
Mailings to lake residents
Update Facebook site
Clean Boats, Clean Waters monitoring/education
Annual meeting/special meetings
Door-to-door distribution of information
Plastic peel-off stickers for boats

Method	**Audience**	**Message**
APM plan summary	A - D	1
AIS workshops	A – C	4, 8-15
Signage	A – C	14, 15
AIS handouts	A – D	4, 6-15
Newsletter articles	A – B	1–15

Mailings	A – B	1 –15
Facebook site updates	A – D	1 -15
Clean Boats, Clean Waters	C	8-11, 14, 15
Annual and special meetings	A – B	1-15
Door-to-door distribution	A	4-15
Plastic peel-off stickers	A – C	14, 15

Goal 3: Prevent the introduction and spread of aquatic invasive species

Objectives

A. 100% of boaters inspect, clean, and drain boats, trailers and equipment.

B. 100% enforcement of Burnett County's Do Not Transport Ordinance.

C. Big Doctor Lake is monitored regularly for AIS introduction.

D. Big Doctor Lake Association is ready to rapidly respond to identified AIS in the lakes and river.

E. Enhance the reputation of the Big Doctor Lake community as being proactive and robust as it relates to aquatic plant management strategies and enforcements.

Actions

1. Conduct Clean Boats Clean Waters monitoring and education at the boat landing using paid and/or volunteer staff. (OBJ A,C)

2. Work with the Burnett County Sheriff's Department to encourage increased enforcement and potentially increased fines for the Do Not Transport Ordinance. (OBJ B, E)

3. Monitor boat landings and other areas with high potential for introduction of AIS. (OBJ A, E)

4. Train volunteer monitors to identify and monitor for aquatic invasive species through the University of Wisconsin Extension Citizen Lake Monitoring Network Aquatic

Invasive Species program. (Burnett County Land and Water Conservation Department will train volunteers with support from BDLA.) (OBJ C, E)

5. Review and update the existing rapid response plan for Eurasian water milfoil found in Appendix D. (OBJ D)

Goal 4: Reduce the growth of and control the population of curly leaf pondweed.

Objectives

A. Monitor the growth of curly leaf pondweed.

B. Implement control efforts to reduce the population of Curly-leaf pondweed by at least 10% based on the 2012 baseline mapping data.

Actions

1. Provide information to the Big Doctor Lake community so they can identify Curly-leaf pondweed (CLP) and they know who to contact if they have a suspected plant. (Burnett County LWCD will provide volunteer training for plant identification. Burnett County AIS coordinator and lake association AIS representative will provide identification assistance.) (OBJ B)

2. Map all beds of curly leaf pondweed (CLP) on the lake every other year. (OBJ A)

3. Consider CLP control efforts using early season chemical treatment or other accepted methods, if CLP spreads to an unacceptable level. (OBJ B)

Goal 5: Enhance and maintain the diverse populations of native aquatic plants.

Objectives

A. Implement strict adherence with treatment standards and monitoring methods prior to and following herbicide treatment.

B. Prevent removal of native plants using herbicides.

C. Educate and communicate to the community members of Big Doctor Lake the role and importance of aquatic plants and their impacts on them.

Discussion

The plant community in the Big Doctor Lake is diverse and extensive. It is important to understand that these plants play a very important role in the lake ecosystem. Aquatic plants in the lake provide habitat for a diverse fish population. They also provide protection from shoreline erosion. Removing native plants could lead to adverse effects in the lakes such as but not limited to the increase in the algal populations. Healthy native plant populations prevent colonization by invasive plants. Erosion and runoff from waterfront property may alter sediment characteristics encouraging spread of invasive plants. Boating disturbance near the shoreline can remove aquatic plants and the valuable functions they provide. Boating disturbance near shore also creates sediment disturbance and the release of excess phosphorus, which can lead to access algal blooms.

Actions

1. Consider alternative methods for removing native plants, other than using herbicide treatment, for individual access corridors. Encourage hand removal as a viable method of helping control nuisance species. (OBJ B)

2. Conduct a point intercept survey of the lake every five to ten years, or as needed. (OBJ C)

3. Update the aquatic plant management plan every five to ten years, or as needed. (OBJ A, B and C)

Educational activities are detailed in the discussion for Goal 5.

Goal 6: Create and maintain navigable channels for fishing and boating.

Objectives

A. Allow individual riparian landowners the right to maintain navigation channels through dense beds of curly leaf pondweed on Big Doctor Lake.

B. All herbicide treatments are conducted legally. Permits are required for aquatic application of herbicides in Wisconsin.

Action

1. Follow all Wisconsin DNR requirements for obtaining permits for the herbicide treatment for individual access corridors. **(See Appendix F for specific details of management options for aquatic plants)**

2. Hand removal methods will be recommended for navigation impairment created by native plants.

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, curlyleaf 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.* ***The state is required to consult with Great Lakes Indian Fish and Wildlife Commission prior to any removal of wild rice.***

Individual Access Corridors are the openings from a waterfront property owner's shoreline out into the lake. These corridors may be a maximum of thirty feet wide.

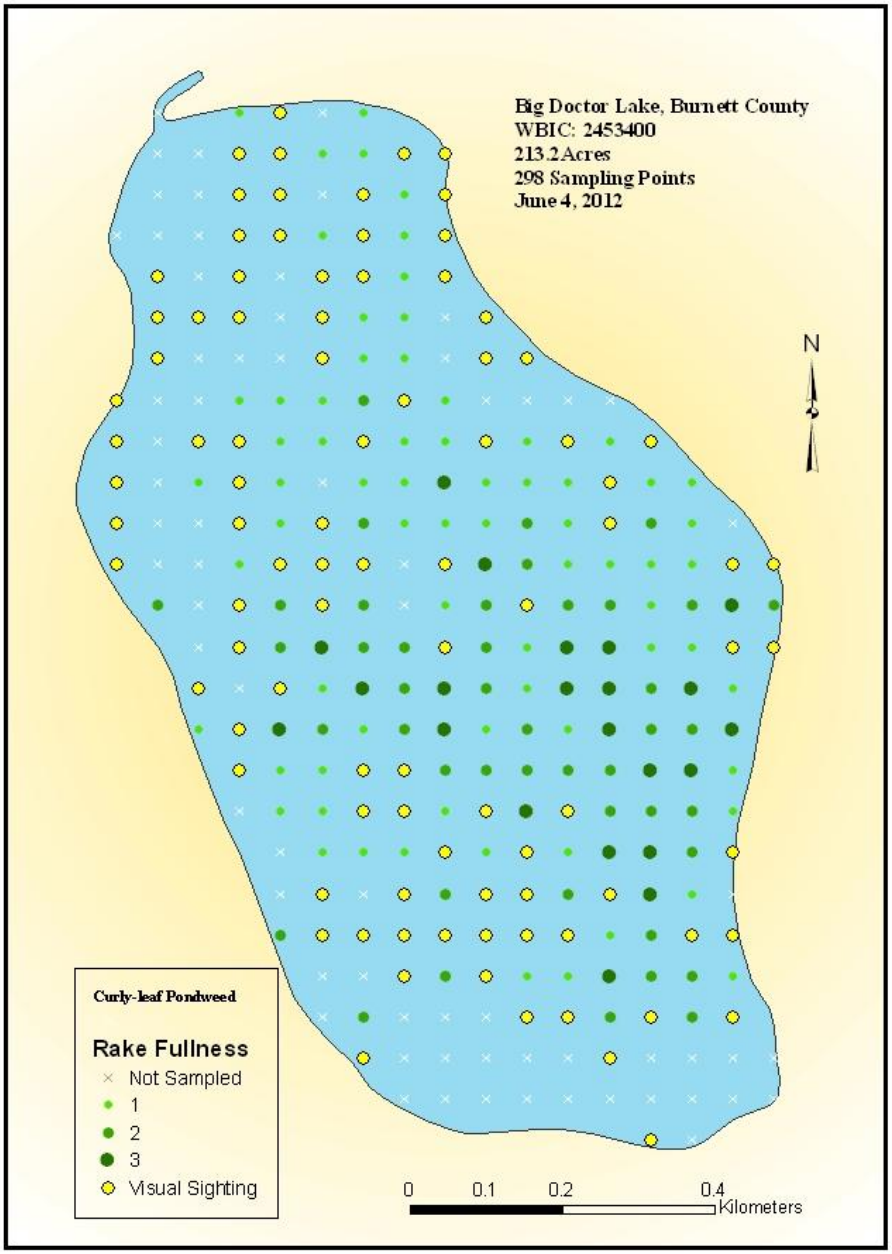


Figure 18: June CLP Survey Results

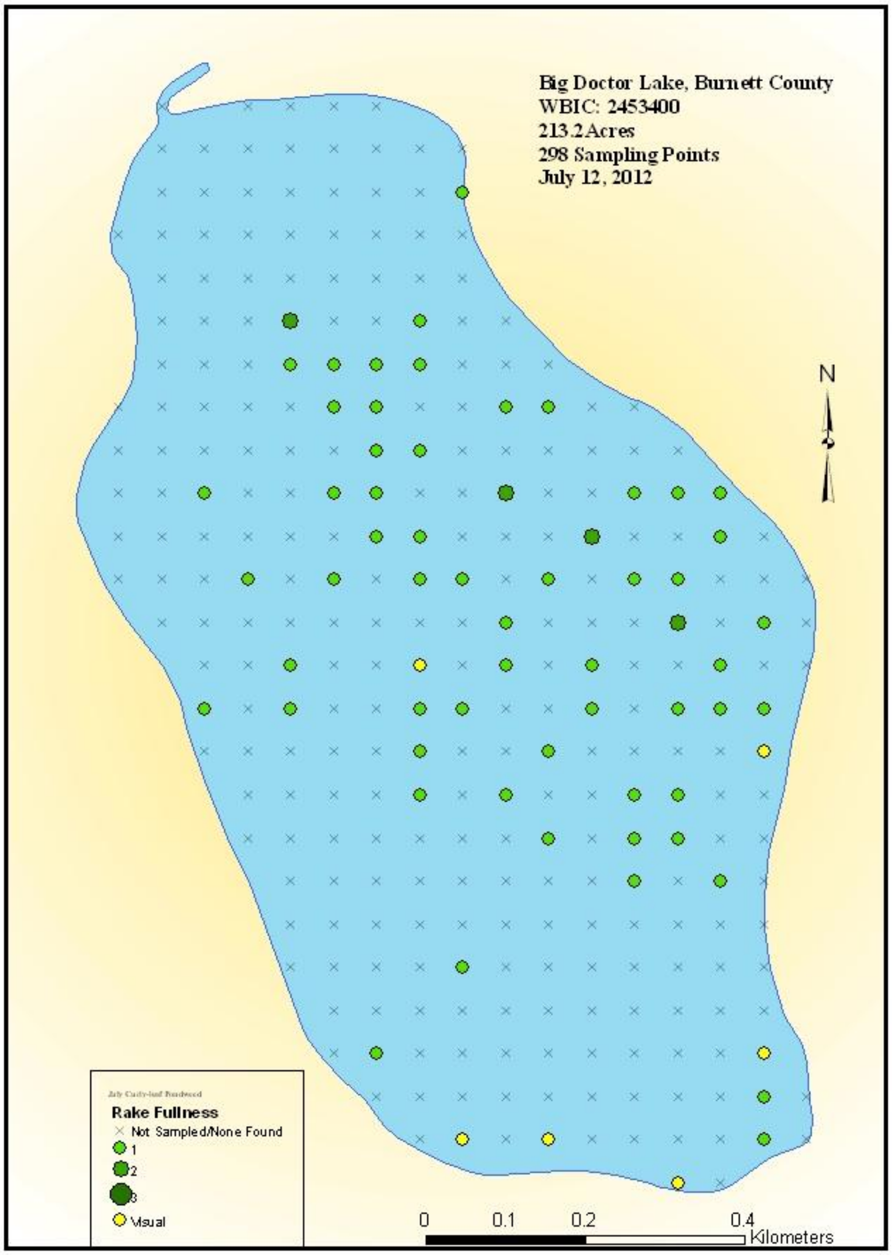


Figure 19: July CLP Survey Results

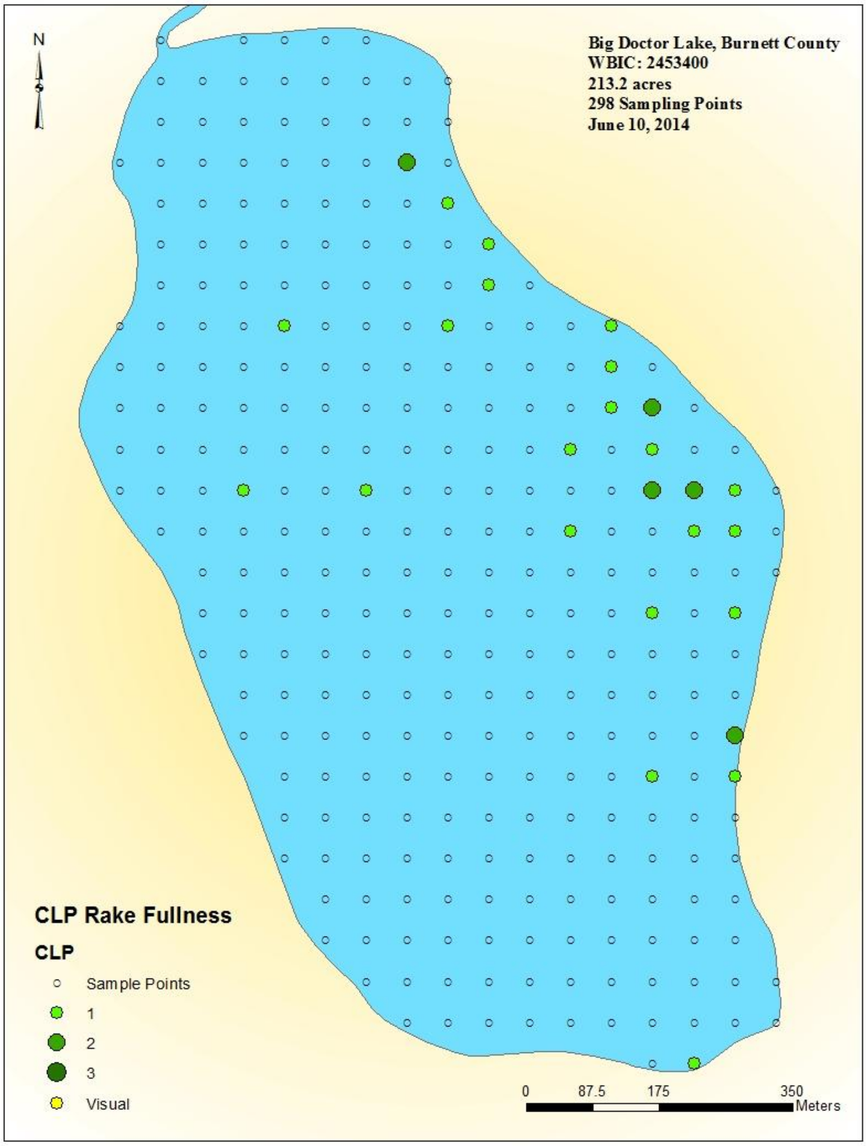


Figure 20: CLP Survey June 10, 2014

Procedure for Individual Corridor Permitting and Monitoring

Document nuisance conditions (landowner/contractor provide in permit application in February/March)

- Indicate when plants cause problems and how long problems persist
- Include dated photos of nuisance conditions from previous season (or location relative to curly leaf pondweed bed map)
- List depth at end of dock
- Provide examples of specific activities that are limited because of presence of nuisance aquatic plants

    - Describe practical alternatives to herbicide use that were considered. These might include:
        - Hand removal/raking of aquatic plants
        - Extending dock to greater depth
        - Altering the route to and from the dock
        - Use of another type of watercraft or motor i.e., is the type of watercraft used common to other sites with similar conditions on this lake?
    - Spraying for curly leaf pondweed may occur along the entire length of a waterfront property owner's shoreline. Spraying areas with wild rice will not be permitted.
    - Aquatic herbicide applicator to provide this information in permit application based on information from the landowner.

- **<u>Verify/refute nuisance conditions/navigation impairment</u>**
    - Landowners will document conditions with photographs and submit request for treatment to WDNR.
    - For curly leaf pondweed treatment, verification must occur the year before treatment in May or June. Once CLP nuisance is verified and a permit is approved, additional verification is not needed for three subsequent years (although permit applications must be completed each year).
    - Treatment for CLP must occur with water temperatures from 50 - 58 degrees F.
    - WDNR will contact herbicide applicator and owner with a notice to proceed with treatment.

Table 12: Implementation Plan

Action Items	Timeline	Cost 2013	Cost 2014	Cost 2015	Responsible Parties
Prevent AIS Introduction					
Identify and organize volunteer workers/employers for CBCW program		20 hours	15 hours	15 hours	BDLA Executive Board
Conduct CBCW program	ongoing	10 hours	10 hours	10 hours	BDLA President
Increase enforcement of BC Do Not Transport Ordinance	ongoing	10 hours	10 hours	10 hours	BDLA President
Monitor boat landings	Ongoing	100-125 hours	100-125 hours	100-125 hours	BDLA, BC Sheriff Dept. and LWCD
Train Volunteer monitors in CLMN	Annually	$0	$0	$0	BDLA, Burnett County LWCD
Rapid Response plan review	As needed	$0	$0	$0	Burnett County LWCD
	Ongoing	3 hours	3 hours	3 hours	BDLA, Burnett County LWCD
AIS Reduction and Prevention					
Provide Identification information and encourage volunteer monitoring		20 hours	15 hours	15 hours	BDLA Executive Board
Monitor Lake for PL growth	May - August	20 hours	20 hours	20 hours	BDLA AIS Committee, BC LWCD
Cut and Spray plants as needed	July/August	20 hours	20 hours	20 hours	BDLA/community
Map all CLP beds	Mid June		$600		BC LWCD
Consider if CLP control is warranted	September	TBD			BDLA
Pre & Post Mapping of CLP			TBD	TBD	BC LWCD
Preserve Native Plants					
Conduct a point intercept survey of the lake	2017-2022		$4000		BDLA
Update APM plan	2018-2023		$4000		BDLA

Action Items	Timeline	Cost 2013	Cost 2014	Cost 2015	Responsible Parties
Water Quality					
Water chemistry and Secchi sampling	ongoing	30 hours	30 hours	30 hours	BDLA
Reduce phosphorus and sediment loads from immediate watershed	Ongoing	TBD			BDLA, BC LWCD
Educate and assist Big Doctor Lake community members in the restoration and preservation of shoreland buffers and shoreland vegetation	Ongoing	TBD			BDLA, BC LWCD
Continue implementation of shoreline owners' education program	Ongoing	TBD			BDLA, BC LWCD
Educate Big Doctor Lake Community					
AIS workshops	Ongoing	$0	$0	$0	BC LWCD
AIS signage	As needed	$0	$0	$0	BC LWCD
Additional AIS signage		$500	$100	$100	BDLA
BDLA emails and Social Media	Ongoing	40 hours	40 hours	40 hours	BDLA
BDLA Facebook updates	Ongoing	30 hours	30 hours	30 hours	BDLA
Annual and special meetings	Ongoing	$200	$200	$200	BDLA
Maintain Navigable Channels					
Individual Riparian Owners estimate the need for navigable channels	Mid June				Riparian Land Owners (RLO)
Develop a Request for Proposal (RFP) for CLP treatment and select applicator as needed	January				RLO
Apply for permits	February	$270 4 hours	$270 4 hours	$270 4 hours	RLO WDNR
Conduct treatment	Late May				Authorized Applicator
Monitor for effectiveness of treatment	Late June				Riparian Land Owners
Provide information to guide individual corridor treatment permits	January	4 hours Vol			BDLA, BC LWCD
Encourage hand removal methods of individual corridor clearing	January & April-June				RLO

Appendix A: Big Doctor Lake Survey Results

BIG DOCTOR LAKE USER SURVEY

SECTION 1 – Residency

These first few questions will help to determine who is responding to this survey and how those people would like to use Big Doctor Lake. If you have more than one property on the lake, please comment on the one property that you have had the longest.

1. What type of property do you have on Big Doctor Lake? If you have more than one type of property, please report on only the property you have had the longest. ***(please select one)***

___ permanent residence
___ seasonal residence
___ weekend visitors
___ business
___ undeveloped land
___ other ______________________________

2. How long have you owned your property on Big Doctor Lake? ***(If less than 1 year, please write '1' in the space provided. If you own multiple properties, please comment on the one you have owned or rented for the longest period of time.)***

I have owned the property for ___ year(s).

3. During a 12-month period (Jan. 1 – Dec. 31) how many days are you, members of your family, or guests at the property indicated in Question 1? ***(please provide your best estimate in the space below)***

There are people at the property approximately ________ days a year.

4. On average, about how many people are at the property each time it is being used?
____

SECTION 2 – Lake Use

The purpose of this section is to gather information on how Big Doctor Lake is used by its residents.

1. From the list below, check all activities on Big Doctor Lake that you, your family, or guests participate in.

___ A. fishing from the shore
___ B. fishing from a boat
___ C. pontoon boating
___ D. rest/relaxation
___ E. swimming/wading
___ F. ice fishing
___ G. speed boating
___ H. jet skiing
___ I. wild rice harvest
___ J.sailing
___ K. wildlife viewing
___ L. canoe/kayak/paddle boat
___ M. water skiing/tubing
___ N. other (please list) ________________

2. Which 3 activities from the above list do you or members of your family or guests participate in most often? ***(write the letters of the corresponding activities in the spaces below)***

I (We) participate in ___ most often, ___ second most often, and ___ third most often.

3. During the open-water (no ice) season, how frequently do you use the lake for the activities listed in Question 1, this section?

___ daily
___several times per week
___ 3 or 4 times per month
___ once or twice per month
___once or twice per open-water season

4. What type(s) of watercraft do you own, rent, or use on Big Doctor Lake? ***(Check all that apply. If you do not use any watercraft on Big Doctor Lake, please check the last box.)***

___ motorized boat (0-50hp)
___ motorized boat (greater than 50hp)
___ paddle boat
___ pontoon boat
___ canoe or kayak
___ sailboat
___ other (please specify) __________________
___ I do not own, rent, or use a boat or other personal watercraft – PWC (jet-ski) on Big Doctor Lake

<u>SECTION 3 – Lake Stewardship</u>

This section of the survey will provide information about the lake stewardship practices of lake property owners and renters.

1. Which of the following do you consider the most desirable shoreline for your property? ***(please check one)***

___ mowed/manicured lawn to shoreline
___ mowed lawn with landscaped shoreline
___ mowed lawn to sand beach
___ managed natural vegetation along shoreline
___ unmanaged natural vegetation along shoreline
___ other ***(please describe)*** ___________________

2. Which of the following water quality/landscaping practices are you familiar with? (***check all that apply)***

___ rain garden
___ shoreline buffers
___ native prairie restoration
___ not fertilizing
___ using zero phosphorus fertilizers
___ diversion of surface water runoff away from the lake
___ not familiar with any of these
___natural shoreline restoration
___ septic system upgrade
___ runoff reduction practices
___ native flower/tree planting
___ other ***(please describe)*** ________________

3. Which, if any, of the following water quality/landscaping practices have you installed on your property on Big Doctor Lake? (***check all that apply)***

___ rain garden
___ shoreline buffers
___ native prairie restoration
___ not fertilizing
___ using zero phosphorus fertilizers
___ diversion of surface water runoff away from the lake
___ I have not installed any of the above water quality/landscaping practices.
___natural shoreline restoration
___ septic system upgrade
___ runoff reduction practices
___ native flower/tree planting
___ other ***(please describe)*** _______________

4. Which, if any, of the following outcomes do you consider a motivator to install a water quality/landscaping practice on your property? ***(check all that apply)***

___ increasing the natural beauty of your property
___ improving the water quality of Big Doctor Lake
___ improving the water quality around your property's shoreline
___ providing better habitat for fish
___ providing better habitat for birds and wildlife
___ setting an example for other lake residents
___ less lawn mowing time
___ a property tax rebate
___ financial assistance that pays a portion of the cost/installation
___ technical assistance that would evaluate my property for water quality concerns
___ technical assistance that would identify appropriate practices to install
___ other ***(please describe)*** ____
___ I have no interest in installing a water quality/landscaping practice on my property

5. What type of septic system do you have on your property? ***(select all that apply)***

___ mound system
___ at-grade system
___ conventional system
___ holding tank
___ lift pump system
___ none ***(skip to Section 4)***
___ other ***(please list)*** ______________
____

6. How many years ago was your septic system last inspected? ***(please provide your best recall)***

___ 1-5 years ___ 6-10 years ___ 11+ years ___ Never ___ Not Sure

7. When was your septic system last 'pumped' or 'sewered'? ***(please provide your best recall)***

___ 1-5 years ___ 6-10 years ___ 11+ years ___ Never ___ Not Sure

SECTION 4 – Lake Issues

The questions in this section pertain to various issues in Big Doctor Lake including water quality, lake level, and aquatic plant growth.

1. Below are numerous issues that may negatively affect your use of Big Doctor Lake. From the list below, please mark all of the issues that are of concern to you.

___ A. poor quality fishing
___ B. too much public use
___ C. not enough weed growth
___ D. poorly maintained boat access
___ E. low water level in the lake
___ F. foul or offensive odor
___ G. too much weed growth
___ H. overdevelopment of the shoreline
___ I. "icky" or "green" water
___ J. too much shoreline lighting
___ K. high water level in the lake
___ L. too much wild rice
___ M. not enough wild rice
___ N. introduction of undesirable aquatic plants and animals
___ O. nuisance wildlife (please specify) _______
___ P. other (please specify) _________________
___ Q. not concerned about any of these issues

2. Which **three** issues from the above list are of the most concern to you? ***(write the letters of the corresponding issues in the spaces below)***

I am most concerned about issues _____, _____, and _____.

3. In this survey, clean and clear water is considered *good* water quality while green (algae) water is considered *poor* water quality. In your opinion, the water quality in the summer (June – September) in Big Doctor Lake is:

___excellent ___ good ___ fair ___ poor ___ very poor ___ I don't know

4. Please check the answer that best completes the following sentence: "In my opinion, the overall level of the lake, given fluctuation with rainfall, seems to be …."

___ too high ___ just right ___ too low ___ I don't know

5. Has low water ever prevented you from using Big Doctor Lake?

___ yes ___ no ___ I don't use the lake

6. Aquatic plants (rooted and floating) are an important part of any healthy lake system. In the time that you have owned/rented the property indicated in Section 1, Question 1, would you say the amount of visible aquatic plant growth in the lake, **excluding algae**, has:

___ increased
___ decreased
___ stayed the same
___ unsure

7. Aquatic plant growth varies throughout the open water season. Which month(s) of the season do you consider aquatic plant growth, excluding algae, to be problematic in Big Doctor Lake? ***(check all that apply)***

___ May ___ June ___ July ___ August ___September ___ October
___ It is never a problem ___ I don't know

<u>SECTION 5 – Aquatic Invasive Species in Big Doctor Lake</u>
This section of the survey seeks to determine how much lake residents know about aquatic invasive species. Aquatic invasive species are plants and animals that are foreign to Big Doctor Lake and do not belong there.

<u>Curly-leaf pondweed (CLP)</u>
Curly-leaf pondweed has not been documented in Big Doctor Lake but could be a threat in the future. CLP can create nuisance levels of plant growth and negatively impact water quality in a lake.

1. How much do you know about CLP and the problems it can cause in a lake?

___ a lot ___ some ___ very little ___ just what I have read here

2. Do you think you would recognize CLP in the lake if you saw it?

___ definitely yes ___ probably yes ___ unsure ___ probably not ___ definitely not

<u>Eurasian Watermilfoil (EWM)</u>
Eurasian watermilfoil has not been documented in Big Doctor Lake but could be a threat in the future. EWM can form dense beds of vegetation that interfere with many lake uses.

3. How much do you know about EWM and the problems it can cause in a lake?

___ a lot ___ some ___ very little ___ just what I have read here

4. Do you think you would recognize EWM in the lake if you saw it?

___ definitely yes ___ probably yes ___ unsure ___ probably not ___ definitely not

<u>Purple Loosestrife</u>
Purple loosestrife, an invasive shoreline/wetland plant species, has not been documented in Big Doctor Lake but could be a threat in the future. Purple loosestrife can take over shorelines and wetlands displacing more beneficial native plants.

5. How much do you know about purple loosestrife and the problems it can cause in a lake?
___ a lot ___ some ___ very little ___ just what I have read here
6. Do you think you would recognize purple loosestrife in the lake if you saw it?

___ definitely yes ___ probably yes ___ unsure ___ probably not ___ definitely not

Other Aquatic Invasive Species

7. Below is a list of additional aquatic invasive species. Please check all of those that you have heard of before.

___ zebra mussels	___ rusty crayfish	___ spiny waterflea
___ Chinese mystery snail	___ banded mystery snail	___ hydrilla
___ New Zealand mudsnail	___ freshwater jellyfish	___ phragmites (giant reed grass)
___ Japanese knotweed	___ carp	___I have not heard of any of these

8. In order to gauge potential interest, would you be willing to take part in a training session to help you identify aquatic invasive species in the lake?

___ definitely yes ___ probably yes ___ unsure ___ probably not ___ definitely not

SECTION 6 – Aquatic Plant Management

Currently aquatic plant growth in Big Doctor Lake is not managed. Algae growth is also not managed. A benefit of aquatic plant management strategies is that they can also help reduce algae growth. Aquatic plants in a lake can be managed in many different ways. Sometimes no aquatic plant management may be the best option.

1. Do you think that management of aquatic plants in Big Doctor Lake is necessary?

___ definitely yes ___ probably yes ___ unsure ___ probably not ___ definitely not

(skip to Question 3)

(skip to Question 3) ***(skip to Question 3)***

2. Which type(s) of aquatic plants do you think should be managed on Big Doctor Lake? ***(check all that apply)***

___ grow below the water's surface ___ float on the surface of the water
___ stick out of the water ___ grow on the shoreline, out of the water
___ other ***(please explain)*** ____

Common Aquatic Plant Management Methods

If plant management is recommended for Big Doctor Lake, what methods might you support? Please assume that the following management methods are safe and legal, and would only be performed by professionals and only be used if approved by the State of Wisconsin. Total removal or eradication of aquatic plants is not possible.

3. Please mark whether you would support, oppose, or need more information about the use of these aquatic plant management methods on Big Doctor Lake.

Small-scale (less than 10 acres) mechanical harvesting:
___ Support ___ Oppose ___ Need more information
Large-scale (10 acres or greater) mechanical harvesting:
___ Support ___ Oppose ___ Need more information
Hand-pulling and raking in shallow waters:
___ Support ___ Oppose ___ Need more information
Small-scale (less than 10 acres) of chemical herbicide application:
___ Support ___ Oppose ___ Need more information
Large-scale (greater than 10 acres) of chemical herbicide application:
___ Support ___ Oppose ___ Need more information
Biological control (using one live species to control another):
___ Support ___ Oppose ___ Need more information
No Management:
___ Support ___ Oppose ___ Need more information

4. Have you made any attempts to remove or control aquatic plants in Big Doctor Lake by your shore property? ***(check one)***

___ no ***(skip to Section 7)***
___ yes, I did it myself
___ yes, I hired someone
___ yes, I did some myself and I hired someone

5. What have you done to remove aquatic plants from the lake by your property? ***(Check all that apply)***

___ hire someone to hand-pull or rake
___ self hand pull or rake
___ hire someone to apply chemical herbicide
___ self-application of chemical herbicide
___ mechanical plant removal with boat and motor or other apparatus
___ other (please specify)____

SECTION 7 –Community Support

Local, county, state, and federal resources will be sought in addition to Lake Association funds to implement management recommendations for Big Doctor Lake. Donations of volunteer time, services, materials, and equipment can be used as match funding for many grant programs reducing the overall financial burden to the Lake Association. The following questions will help to determine your willingness to support future projects involving the implementation of aquatic plant and lake management recommendations.

1. Following are activities that lake residents could participate in. ***Please check all those activities you might be willing to volunteer your time if additional assistance is needed. This is not a commitment but rather a measure of possible assistance if needed.***

___ watercraft inspection at the boat landings
___ on the water monitoring for aquatic invasive species
___ shore land monitoring for aquatic invasive species
___ raising beetles for purple loosestrife control
___ native aquatic plant monitoring and identification
___ water quality monitoring
___ wildlife monitoring (ex. frogs, turtles, loons, other waterfowl, mussels & clams)
___ I am not interested in volunteering any time ***(skip to question 3)***

2. How much time would you be willing to contribute to support any of the activities in Question 1 above?
___ a few hours a year ___ a few days a year ___ longer periods of time

3. Donated service needs are varied and somewhat unknown, but could include any of the options listed below. Do you think you would be willing to provide any of the services that may be necessary? This is not a commitment but rather a measure of possible assistance if needed. ***(check all that apply)***

___ GPS use	___ graphic design	___ web development
___ grant writing	___ legal services	___ scuba diving
___ printing services	___ construction services	___ outdoor sign design
___ physical labor	___ gardening/landscaping design	
___ sewing	___ gardening/landscaping implementation	
___ other (please specify) __________		___I am not interested or not able to provide assistance

4. Have you ever attended a Big Doctor Lake Association (BDLA) meeting?

___ yes ***(skip to Question 6)*** ___ no

5. If you answered "no" in Question 4, why haven't you attended a BDLA meeting?

___not interested ___I don't have time ___I never know when they are occurring ___other ***(please explain)***____

6. The Big Doctor Lake Association annual meeting is generally held in the morning on the Saturday of Memorial Day Weekend. ***In the following list of meeting dates and times, please check up to three meeting dates that would work for you.***
___ The current date and time works for me
___ Hold the meeting in the afternoon on the Saturday of Memorial Day
___ Hold the meeting in the evening on the Saturday of Memorial Day
___ Hold the meeting the Saturday before Memorial Weekend
___ Hold the meeting the Saturday after Memorial Weekend

___ Hold the meeting a different day (please indicate when) ______________________________

___ I am not interested in the Big Doctor Lake Association annual meeting

7. What is your affiliation with the Big Doctor Lake Association?

___ current member ***(skip to Question 9)*** ___ former member ___ I've never been a member

8. If you are not a member of the BDLA, please indicate why. ***(check all that apply)***

___ not interested
___ dues are too high
___ I did not know it existed
___ I do not have enough time
___ I disagree with what they are doing
___ I haven't been asked to be a member
___ I feel there is no benefit for being a member
___ Other ______________________________

9. How satisfied are you with the following aspects of Lake Association activity?

	Very Satisfied	Somewhat Satisfied	Unsure	Somewhat Dissatisfied	Very Dissatisfied
Communication with community	☐	☐	☐	☐	☐
Meeting frequency	☐	☐	☐	☐	☐
Meeting atmosphere (parliamentary procedure)	☐	☐	☐	☐	☐
Executing Lake Association business	☐	☐	☐	☐	☐
Promoting cooperation to achieve goals and objectives	☐	☐	☐	☐	☐
Management of Association finances	☐	☐	☐	☐	☐
Listening to property owners' needs and concerns	☐	☐	☐	☐	☐

10. How would you prefer to be contacted by the BDLA? ***(please check one)***

___ mail ___ email ___ phone ___ in person ___ I do not want to be contacted

11. If there are any additional issues you would like the Lake Association to address, please use the space below to explain.

____
____
____
____

Thank you for your time and your answers! Providing your contact information is *OPTIONAL* but if you wish to, please do! Contact information will be used for follow up if needed.

Name: ____
Address: _______________________________City____________ State___ Zip _____
Phone number: ______________ Email address ______________________________

December 2, 2012
Compiled by Helen Wilkie

Big Doctor Lake User Survey Findings

Introduction

In August 2012, the Big Doctor Lake Association sent a Lake User Survey to all lake property owners of record. Of the 34 surveys distributed, 29 were returned. Currently, there are roughly 34 properties on the lake with an estimated 68 people. The following summarizes the responses. (Not every survey question was completed by respondents.)

Section 1: Residency

Types of property

3	Permanent residence
11	Seasonal residence
5	Weekend visitors
1	Other (garage)

Length of Ownership in years

1, 2, 4, 9, 12, 13, 17, 20, 27, 35, 36, 43, 45, 50, 50, 53, 58, 63

Estimates of occupancy during a 12-month period

0 – 10
10 – 20
20 – 30
30 – 60
60 – 120
120
250
360

Average number of people using property per visit:

1	One
5	Two
1	Three
6	Four
1	Five
2	Six
1	Seven

Section 2: Lake Use

1. Activity types

15	Fishing from shore
16	Fishing from boat

16 Pontoon
16 Rest/relaxation
17 Swimming/wading
7 Ice fishing
5 Speed boating
3 Jet skiing
0 Wild rice harvest
2 Sailing
16 Wildlife viewing
14 Canoe/kayak/paddle boat
10 Water skiing/tubing
1 Other (annual youth trash pickup; snowmobile, ice skating)

2. Most frequent activities
    1 Fishing from shore
    8 Fishing from boat
    7 Pontoon boat
    9 Rest/relax
    13 Swim
    2 Ice fish
    1 Speed boat
    0 Jet Ski
    1 Wild Rice
    2 Sailing
    5 Wild Life Viewing
    6 Canoe/kayak
    3 Skiing/Tubing
    1 Other – winter sports

3. Activity frequency
    3 Daily
    4. Several times per week
    5. 3 or 4 times per month
    6. Once or twice per month

4. Watercraft types
    12 Motorized (0-50 hp)
    3 Motorized (greater than 50 hp)
    9 Paddle boat
    14 Pontoon boat
    3 Personal watercraft PWC (jet-ski)
    14 Canoe or kayak

3 Sailboat
2 Other (rowboat)

Section 3: Lake Stewardship
Shoreline desirability

1 Mowed/manicured lawn to shoreline
2 Mowed lawn with landscaped shoreline
2 Mowed lawn to sand beach
12 Managed natural vegetation along shoreline
3 Unmanaged natural vegetation along shoreline

Knowledge of water quality/landscaping practices

9 Rain garden
10 shoreline buffers
10 Native prairie restoration
15 Not fertilizing
12 Using zero phosphorus fertilizers
7 Diversion of surface water runoff away from the lake
7 Natural shoreline restoration
8 Septic system upgrade
8 Runoff reduction practices
8 Native flower/tree planning

Implemented water quality/landscaping practices

9 Shoreline buffers
16 Not fertilizing
8 Using zero phosphorus fertilizers
2 Diversion of surface water runoff away from the lake
5 Natural shoreline restoration
6 Septic system upgrade
2 Runoff reduction practices
7 Native flower/tree planting
1 Other (Rip rock)
1 I have not installed any of the above water quality/landscaping practices

Incentives or water quality/landscaping practices

9 Increasing natural beauty
20 Improving water quality
9 Improving water quality around property shoreline
12 Providing better habitat for fish
12 Providing better habitat for birds & wildlife

8 Setting an example for other lake residents
3 Less lawn mowing time
8 Property tax rebate
7 Financial assistance that pays a portion of the cost/installation
5 Technical assistance to evaluate property for water quality
7 Technical assistance to id appropriate installment practices

5. What type of septic system do you have on your property
   8 Mound
   8 Holding tank
   1 At-grade
   1 Lift pump
   1 Conventional
   2 Other (drain field)

6. How many years ago was your septic system last inspected
   14 One to five years
   2 Six to 10 years
   1 11 plus years
   2 Not sure

7. Time since septic system was pumped/sewered
   13 One to five years
   1 Six to 10
   1 11 plus
   2 Never
   1 Not sure

Section 4: Lake Issue

1. Lake issues that negatively affect lake use

Section 5: Aquatic Invasive Species in Big Doctor Lake

1. Lake issues that negatively affect lake use

Section 6: Aquatic Plant Management

1. Do you think management of aquatic plants is necessary?
   13 Definitely yes
   5 Probably yes
   4 Unsure
   2 Probably not

2. Preferred types of aquatic plants do you think should be managed?

12 Grow below the water’s surface
10 Stick out of the water
13 Float on the surface of the water
6 Grow on the shoreline, of out of the water

Common Aquatic Plant Management Methods

3. Mechanical harvesting small scale (less than 10 acres)
   - 9 Support
   - 2 Oppose
   - 8 Need more information
4. Mechanical harvesting large scale (10 acres or more)
   - 8 Support
   - 1 Oppose
   - 9 Need more information
5. Hand pulling in shallow water
   - 16 Support
   - 1 Oppose
   - 2 Need more information
6. Herbicide applications small scale (less than 10 acres)
   - 7 Support
   - 4 Oppose
   - 9 Need more information
7. Herbicide applications large scale (more than 10 acres)
   - 6 Support
   - 6 Oppose
   - 9 Need more information
8. Biological control (1 live species controls another)
   - 10 Support
   - 1 Oppose
   - 7 Need more information
9. No management
   - 1 Support
   - 9 Oppose
   - 6 Need more information

Section 7: Community Support

1. Activities that lake residents might be willing to volunteer time to assist
   - 3 Watercraft inspection at boat landing
   - 11 On the water monitoring for aquatic invasive species
   - 11 Shore land monitoring for aquatic invasive species
   - 2 Raising beetles for purple loosestrife control
   - 4 Native aquatic plant monitoring and identification
   - 11 Water quality monitoring

5 Wildlife monitoring (frogs, turtles, loons, other waterfowl, mussels & clams)
1 I am not interested in volunteering any time

2. How much time would you be willing to contribute to support any of the activities in question 1 above?

5 A few hours a year
10 A few days a year
2 Longer periods of time

3. Donated service needs are varied and somewhat unknown, but could include….do you think you would be willing to provide any of the services that may be necessary?

3 GPS Use	0 Graphic design	1 Web development
3 Grant writing /editing	0 Legal services	1 Scuba diving
0 Printing Services	3 Construction services	1 Outdoor sign design
11 Physical labor	3 Gardening/landscape design	0 Other
2 Sewing	4 Gardening/landscape implementation	

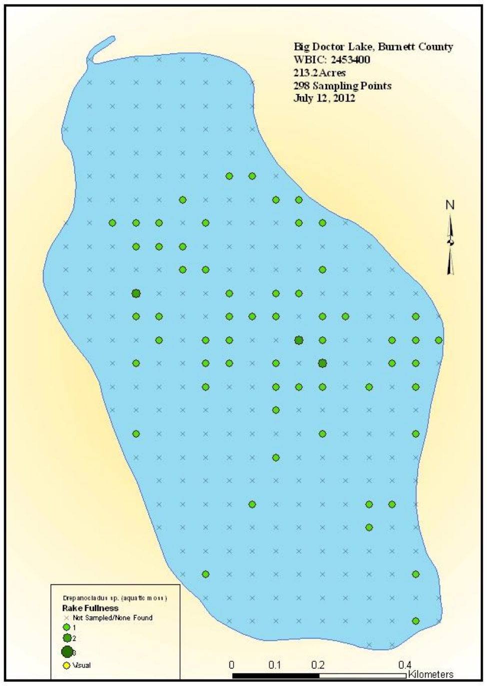
4. Have you ever attended a Big Doctor Lake Association (BDLA) meeting?

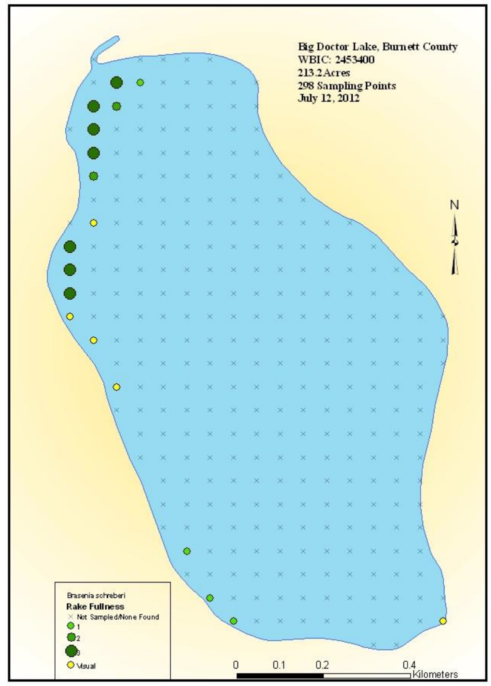
16 Yes 3 No

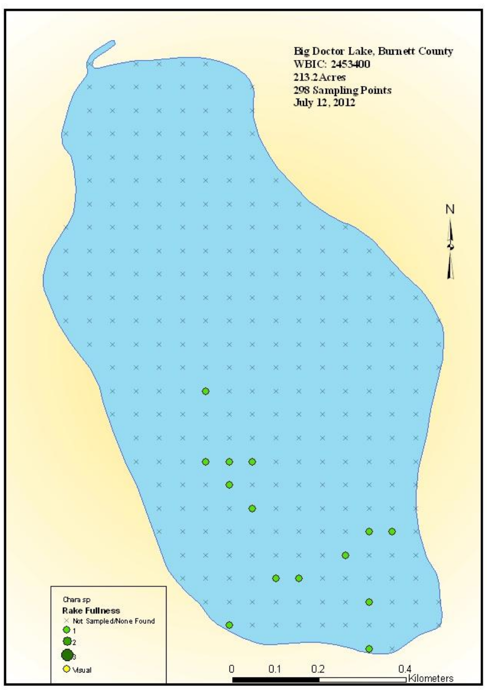
5. If you answered "no" in question 4, why haven't you attended a BDLA meeting

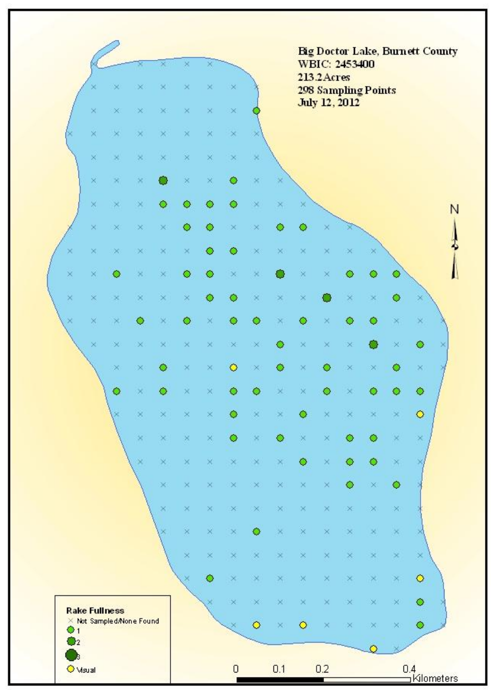
0 Not interested 0 I don't have time 1 Never know when occurring
3 Other "scheduling hasn't worked"

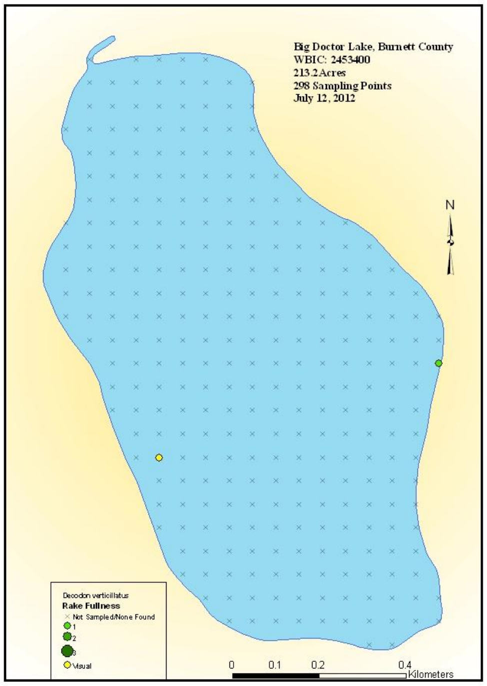
Appendix B
Aquatic Macrophyte Maps of Big Doctor Lake










Big Doctor Lake, Burnett County
WBIC: 2453400
213.2 Acres
298 Sampling Points
July 12, 2012
N
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1
2
3
Visual
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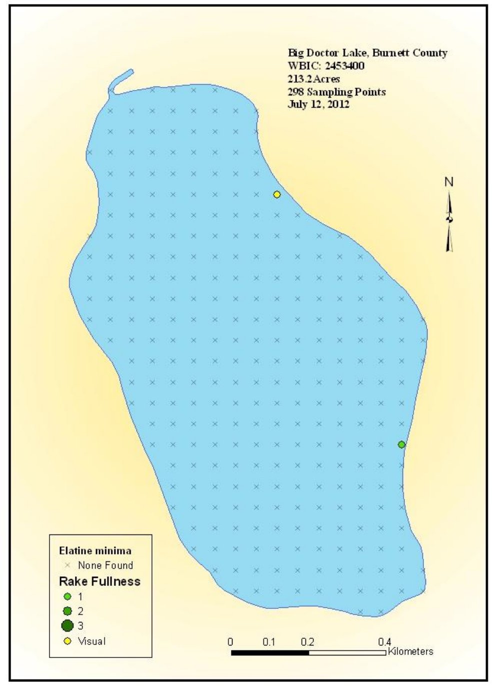
Kilometers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2
3
Visual
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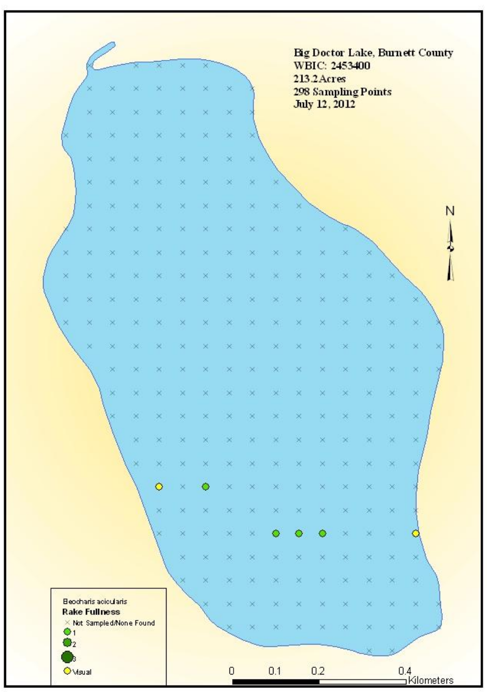
Kilometers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Rake Fullness
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1
2
3
Visual
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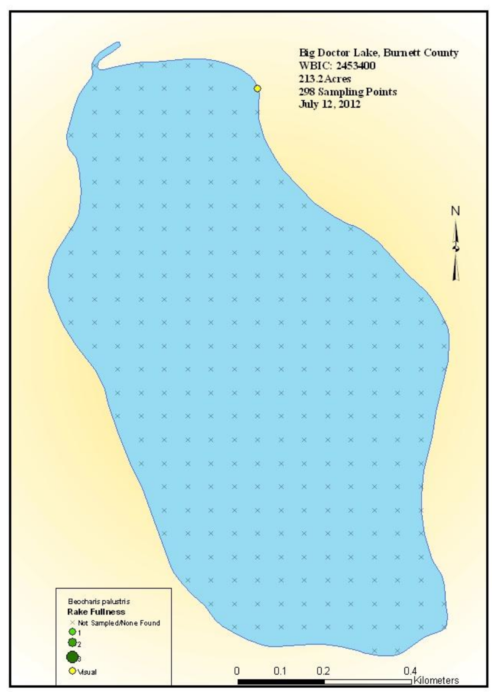
Kilometers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298 Sampling Points
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Rake Fullness
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1
2
3
Visual
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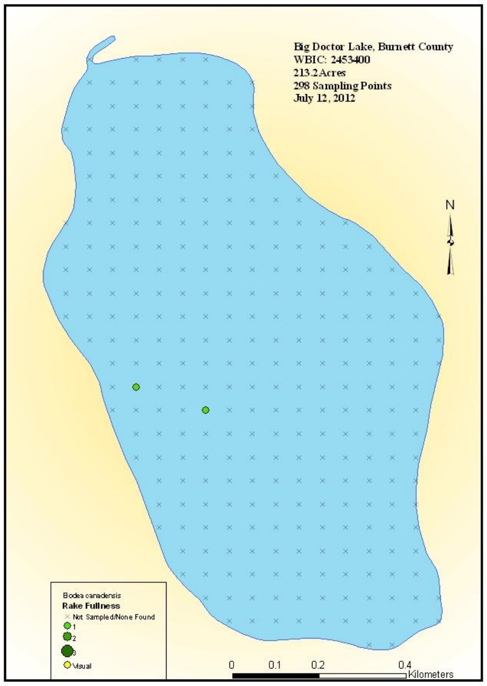
Kilometers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2
3
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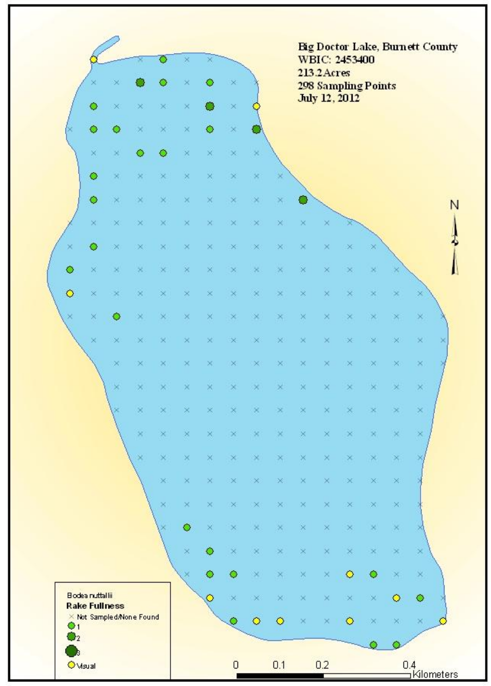
Kilometers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298 Sampling Points
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2
3
Visual
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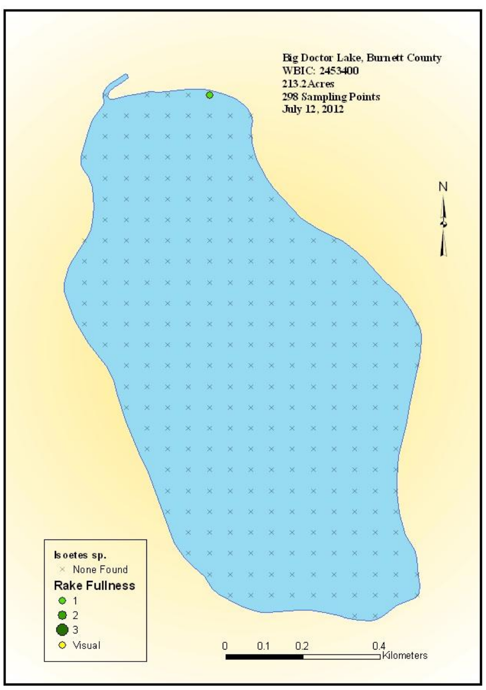
Kilometers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2
3
Visual
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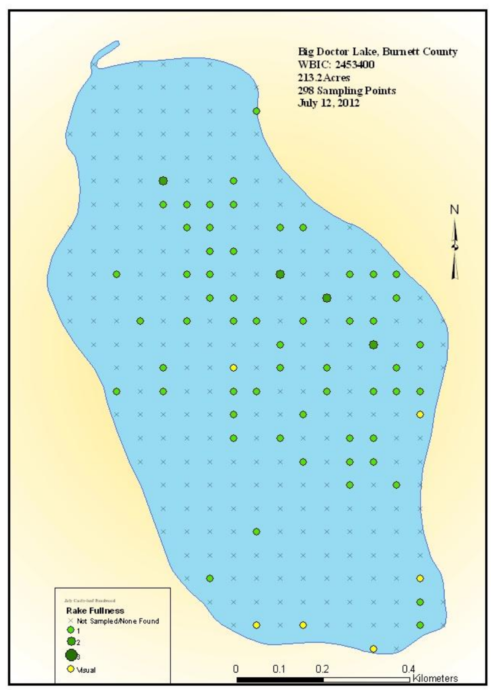
Kilometers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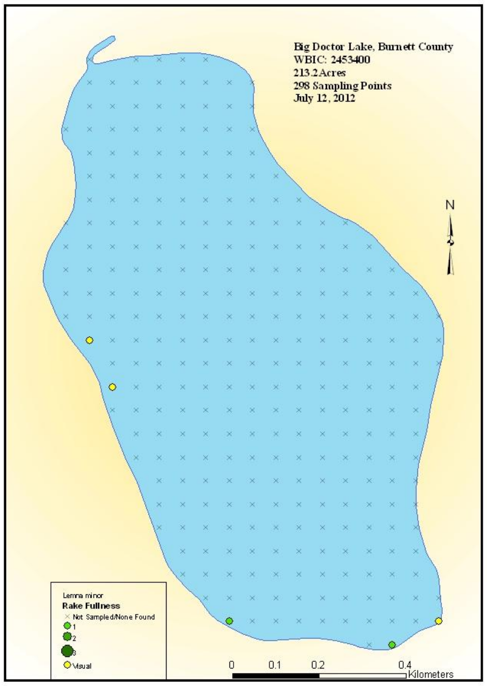
Kilometers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2
3
Visual
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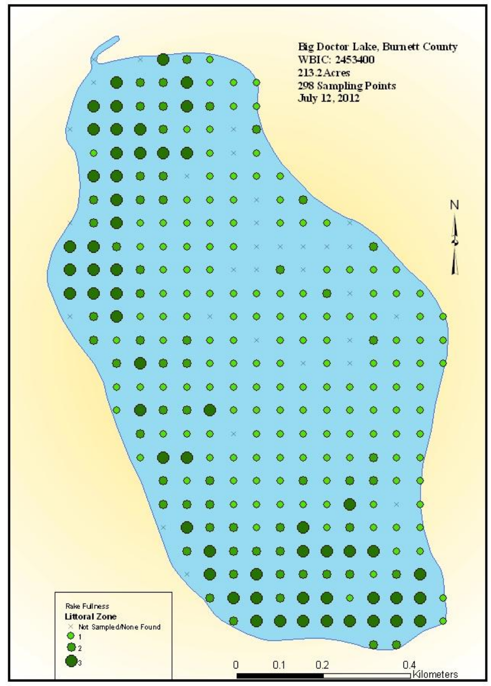
0.2
0.4
Kilometers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2
3
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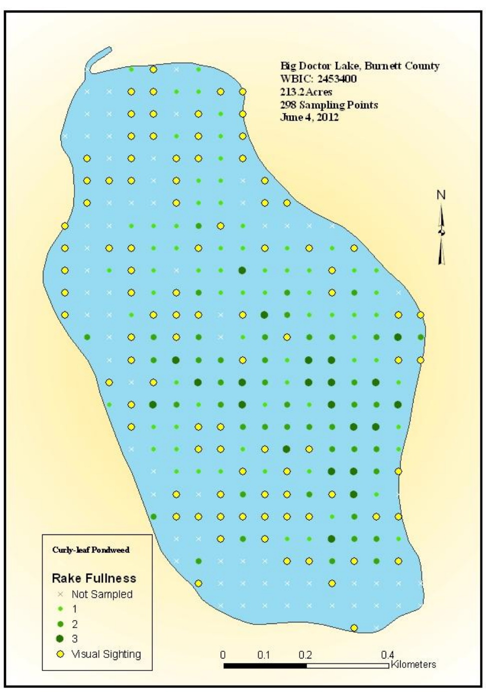
0.2
0.4
Kilometers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298 Sampling Points
June 4, 2012
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2
3
Visual Sighting
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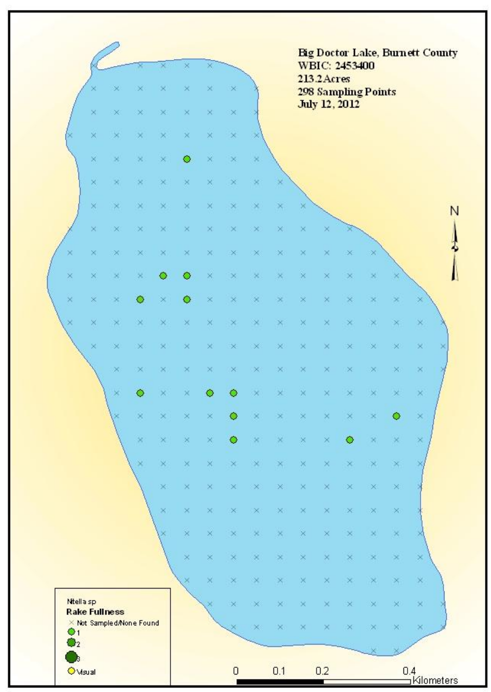
0.2
0.4
Kilometers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July 12, 2012
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2
3
Visual
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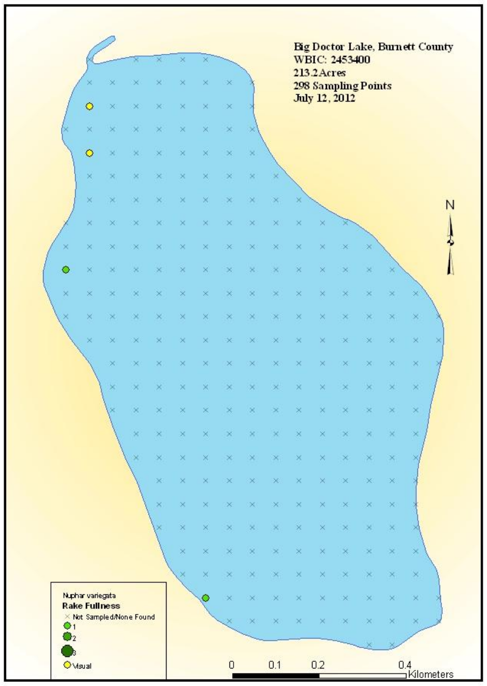
0.2
0.4
Kilometers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July 12, 2012
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2
3
Visual
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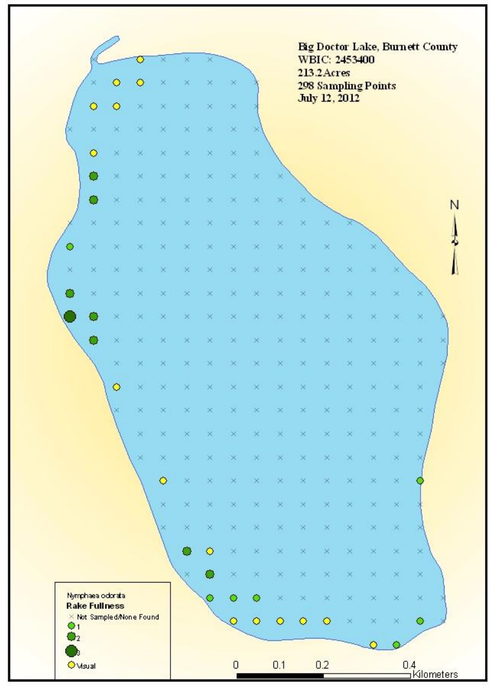
0.1
0.2
0.4
Kilometers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213.2 Acres
298 Sampling Points
July 12, 2012
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2
3
Visual
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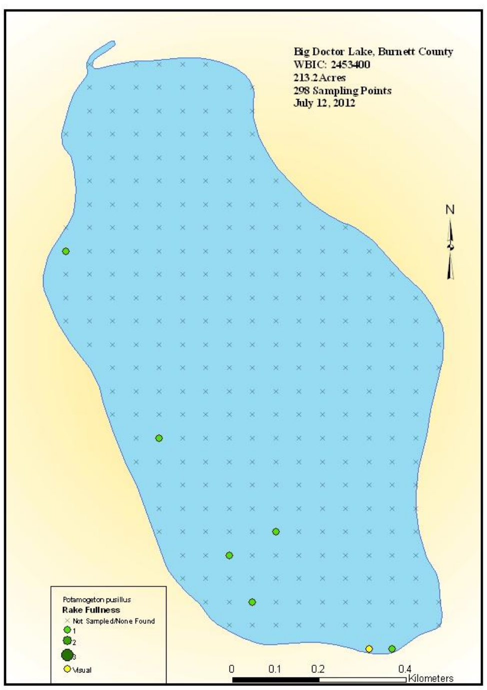
0.1
0.2
0.4
Kilometers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213.2 Acres
298 Sampling Points
July 12, 2012
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2
3
Visual
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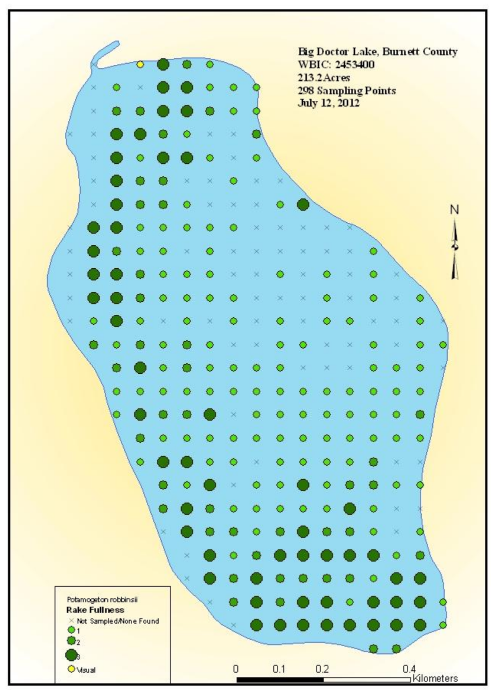
0.1
0.2
0.4
Kilometers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213.2 Acres
298 Sampling Points
July 12, 2012
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2
3
Visual
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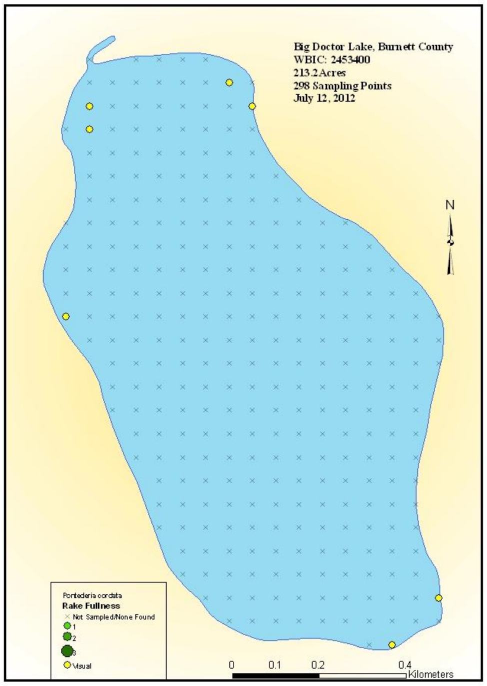
0.1
0.2
0.4
Kilometers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213.2 Acres
298 Sampling Points
July 12, 2012
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2
3
Visual
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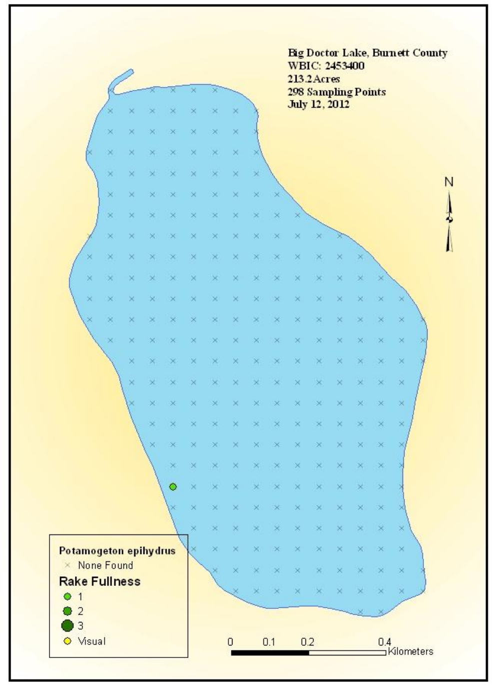
0.2
0.4
Kilometers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213.2 Acres
298 Sampling Points
July 12, 2012
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2
3
Visual
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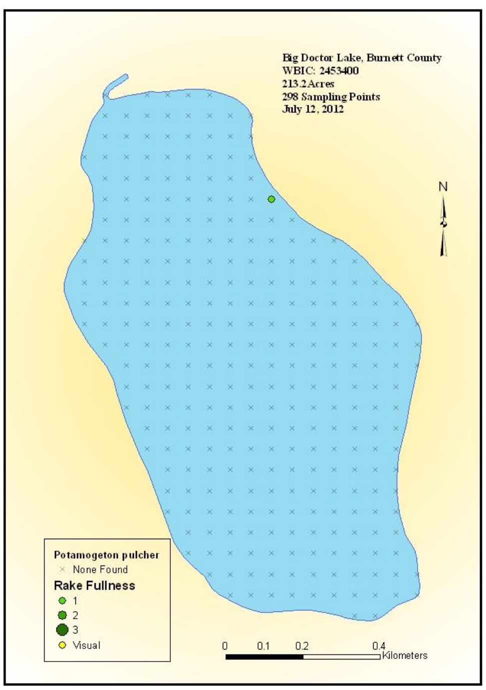
0.2
0.4
Kilometers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213.2 Acres
298 Sampling Points
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Rake Fullness
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2
3
Visual
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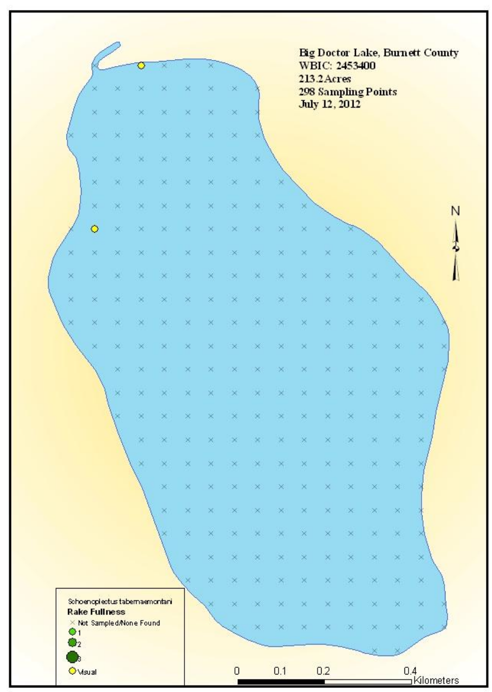
0.2
0.4
Kilometers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213.2 Acres
298 Sampling Points
July 12, 2012
N
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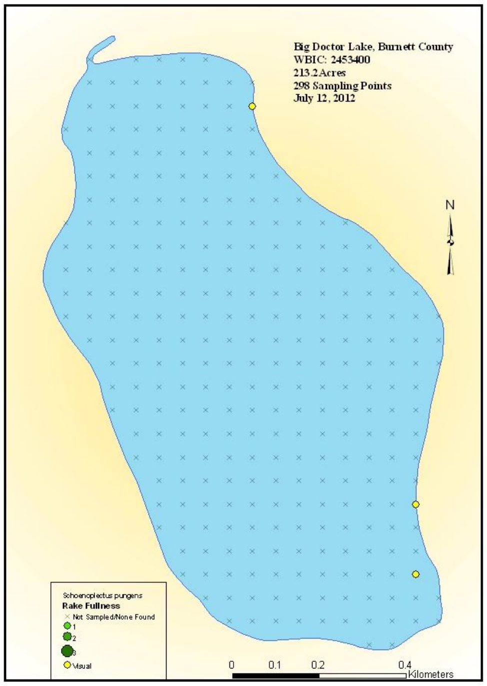
1
2
3
Visual
0
0.1
0.2
0.4
Kilometers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WBIC: 2453400
213.2 Acres
298 Sampling Points
July 12, 2012
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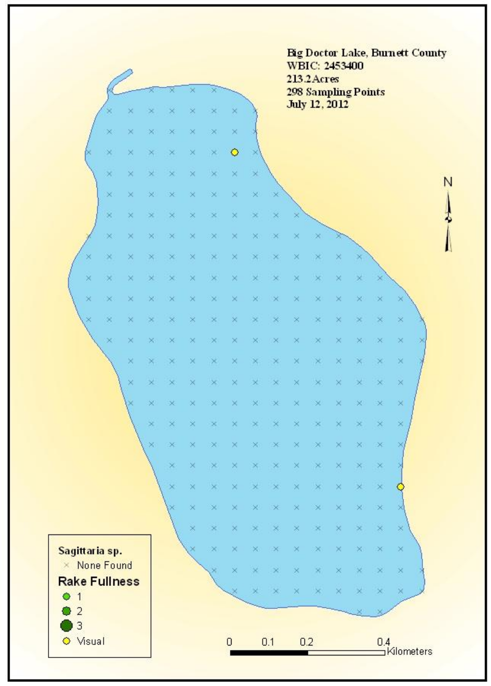
1
2
3
Visual
0
0.1
0.2
0.4
Kilometers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213.2 Acres
298 Sampling Points
July 12, 2012
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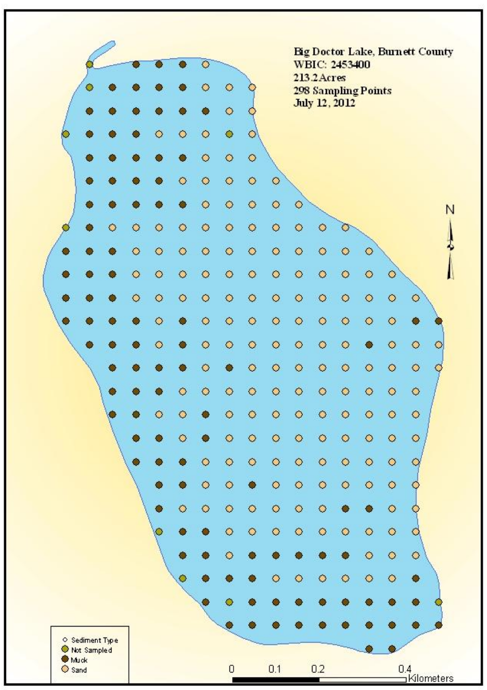
Rake Fullness
1
2
3
Visual
0
0.1
0.2
0.4
Kilometers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213.2 Acres
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July 12, 2012
N
Sediment Type
Not Sampled
Muck
Sand
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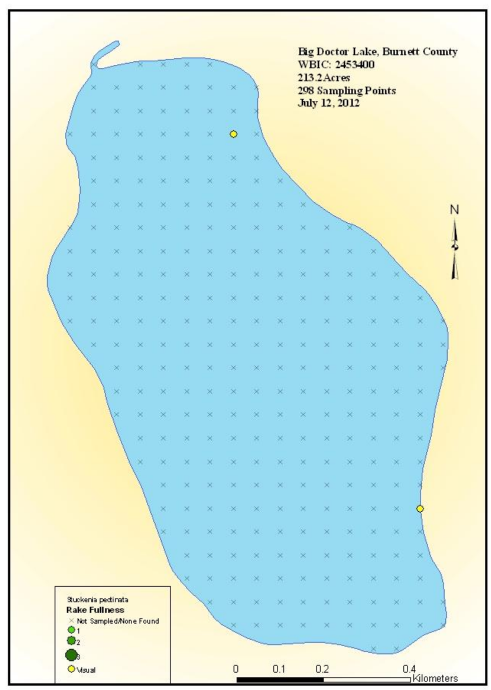
0.2
0.4
Kilometers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WBIC: 2453400
213.2 Acres
298 Sampling Points
July 12, 2012
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1
2
3
Visual
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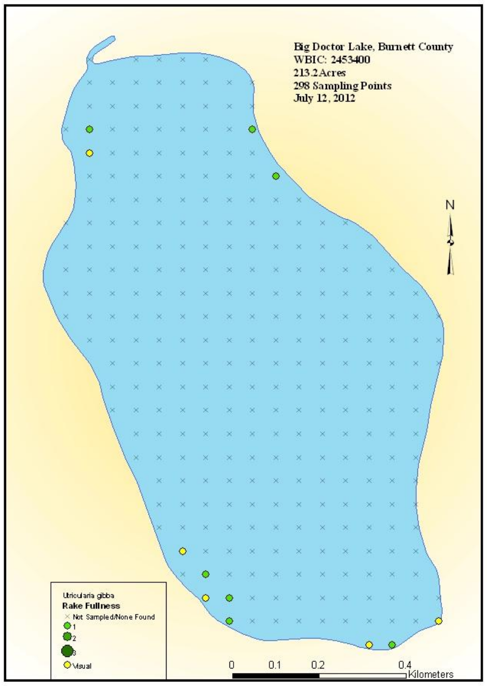
0.1
0.2
0.4
Kilometers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213.2 Acres
298 Sampling Points
July 12, 2012
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2
3
Visual
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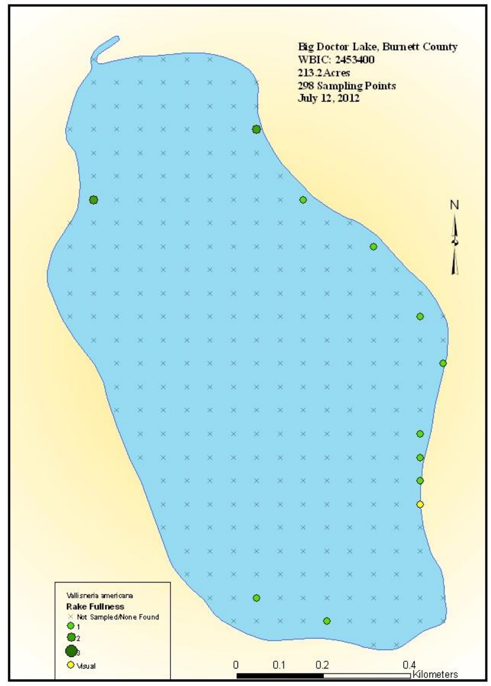
0.2
0.4
Kilometers


Big Doctor Lake, Burnett County
WBIC: 2453400
213.2 Acres
298 Sampling Points
July 12, 2012
N
Vallisneria americana
Rake Fullness
Not Sampled/None Found
1
2
3
Visual
0
0.1
0.2
0.4
Kilometers

Appendix C

Rapid Response for Early Detection of Eurasian Water Milfoil

1. The Bid Doctor Lake Association (BDLA)) community will be directed to contact the EWM identification (ID) lead Dawn Richter, if they see a plant in the lakes they suspect might be Eurasian water milfoil (EWM). Signs at the public boat landings, web pages, and newsletter articles will provide contact information and instructions.

2. If the plant is likely to be EWM, the AIS ID lead will confirm identification with WDNR and inform the rest of the BDLA board.

3. Mark the location of suspected EWM (AIS ID Lead). Use GPS points, if available, or mark the location with a small float.

4. Confirm identification of EWM (or other AIS) with the WDNR (within 72 hours) (AIS ID Lead). Two entire intact rooted adult specimens of the suspect plants will be collected and bagged and delivered to the WDNR. WDNR may confirm identification with the herbarium at the University of Wisconsin – Stevens Point or the University of Wisconsin – Madison.

5. If the suspect plants are determined to be EWM, the location of EWM will be marked with a more permanent marker. (AIS ID Lead).

6. If identification is positive, inform the board, Burnett County LWCD, herbicide applicator, the person who reported the EWM, lake management consultant, and all lake residents. (AIS ID Lead).

7. If identification is positive, post a notice at the public landing and include a notice in the next newsletter. These notices will inform residents and visitors of the approximate location of EWM and provide appropriate means to avoid spread. (BDLA board)

8. Contact Burnett County LWCD to seek assistance in EWM control efforts. The county has a rapid response plan in place that includes assisting lakes where EWM is discovered. Request that the county determine the extent of the EWM introduction and conduct initial removal efforts. If unavailable to assist within two weeks, proceed to step 9.

9. Hire a consultant to determine the extent of the EWM introduction. A diver may be used. If small amounts of EWM are found during this assessment, the consultant will be directed to identify locations with GPS points and hand pull plants found. All plant fragments will be removed from the lake when hand pulling.

10. Select a control plan in cooperation with Burnett County AIS Coordinator and WDNR (board of directors). Additional guidance regarding EWM treatment is found in DNR's *Response for Early Detection of Eurasian Water Milfoil Field Protocol*.

Control methods may include hand pulling, use of divers to manually or mechanically remove the EWM from the lake bottom, application of herbicides, and/or other effective and approved control methods.

The goal of the control plan will be eradication of the EWM.

11. Implement the selected control plan including applying for the necessary permits. Regardless of the control plan selected, it will be implemented by persons who are qualified and experienced in the technique(s) selected.

12. BDLA funds may be used to pay for any reasonable expense incurred in implementing the selected control plan, and implementation will not be delayed by waiting for WDNR to approve or fund a grant application.

13. The President of the BDLA will work with the WDNR to confirm, as soon as possible, a start date for an Early Detection and Rapid Response AIS Control Grant. Thereafter, the BDLA shall formally apply for the grant.

14. BDLA shall have the authority to accept donations or borrow money for the purpose of paying for control of EWM.

15. Frequently inspect the area of the EWM to determine the effectiveness of the treatment and whether additional treatment is necessary.

16. Contract for professional monitoring to supplement volunteer monitoring in years following EWM discovery.

EXHIBIT A[1]

Big Doctor Lake Association

President	Tom Nickelson-	715-349-5381
EWM ID Lead	Dawn Richter–	715-349-7045

Burnett County Land and Water Conservation Department – 715-349-2186
Brad Morris, AIS Coordinator
Dave Ferris, County Conservationist

WISCONSIN DEPARTMENT OF NATURAL RESOURCES

Grants	Pamela Toshner:	715-635-4073
Permits	Mark Sundeen:	715-635-4074
EWM Notice	Kathy Bartilson:	715-635-4053

LAKE MANAGEMENT CONSULTANT		
Endangered Resource Services	Matt Berg:	715-483-2847
DIVERS		
Endangered Resource Services	Matt Berg:	715-483-2847

[1] This list will be reviewed and updated each year.

Appendix D

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

Draft updated Oct 2006

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

Appendix E

AQUATIC PLANT MANAGEMENT STRATEGY

Northern Region WDNR
Summer, 2007

AQUATIC PLANT MANAGEMENT STRATEGY
Northern Region WDNR

ISSUES

- Protect desirable native aquatic plants.
- Reduce the risk that invasive species replace desirable native aquatic plants.
- Promote "whole lake" management plans
- Limit the number of permits to control native aquatic plants.

BACKGROUND

As a general rule, the Northern Region has historically taken a protective approach to allow removal of native aquatic plants by harvesting or by chemical herbicide treatment. This approach has prevented lakes in the Northern Wisconsin from large-scale loss of native aquatic plants that represent naturally occurring high quality vegetation. Naturally occurring native plants provide a *diversity of habitat* that *helps maintain water quality*, helps *sustain the fishing* quality known for Northern Wisconsin, supports common lakeshore wildlife from loons to frogs, and helps to provide the *aesthetics* that collectively create the "up-north" appeal of the northwoods lake resources.

In Northern Wisconsin lakes, an inventory of aquatic plants may often find 30 different species or more, whereas a similar survey of a Southern Wisconsin lake may often discover less than half that many species. Historically, similar species diversity was present in Southern Wisconsin, but has been lost gradually over time from stresses brought on by cultural land use changes (such as increased development, and intensive agriculture). Another point to note is that while there may be a greater variety of aquatic vegetation in Northern Wisconsin lakes, the vegetation itself is often *less dense*. This is because northern lakes have not suffered as greatly from nutrients and runoff as have many waters in Southern Wisconsin.

The newest threat to native plants in Northern Wisconsin is from invasive species of aquatic plants. The most common include Eurasian Water Milfoil (EWM) and CurlyLeaf Pondweed (CLP). These species are described as *opportunistic invaders*. This means that these "invaders" benefit where an opening occurs from removal of plants, and without competition from other plants may successfully become established in a lake. Removal of native vegetation not only diminishes the natural qualities of a lake, it *may increase the risk that an invasive species can* *successfully invade onto the site where native plants have been removed*. There it may more easily establish itself without the native plants to compete against. This concept is easily observed on land where bared soil is quickly taken over by replacement species (often weeds) that crowd in and establish themselves as new occupants of the site. While not providing a certain guarantee against invasive plants, protecting and allowing the native plants to remain may reduce the success of an invasive species becoming established on a lake. Once established, the invasive species cause far more inconvenience for all lake users, riparian and others included; can change many of the natural features of a lake; and often lead to *expensive annual control plans*. Native vegetation may cause localized concerns to some users, but as a natural feature of lakes, they generally do not cause harm.

To the extent we can maintain the normal growth of native vegetation, Northern Wisconsin lakes can continue to offer the water resource appeal and benefits they've historically provided. A regional position on removal of aquatic plants that carefully recognizes how native aquatic plants benefit lakes in Northern Region can help prevent a gradual decline in the overall quality and recreational benefits that make these lakes attractive to people and still provide abundant fish, wildlife, and northwoods appeal.

GOALS OF STRATEGY:

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

BASIS OF STRATEGY IN STATE STATUTE AND ADMINISTRATIVE CODE

State Statute 23.24 (2)(c) states:
"The requirements promulgated under par. (a) 4. may specify
any of the following:

1. The **quantity** of aquatic plants that may be managed under an aquatic plant management permit.

2. The **species** of aquatic plants that may be managed under an aquatic plant management permit.
3. The **areas** in which aquatic plants may be managed under an aquatic plant management permit.
4. The **methods** that may be used to manage aquatic plants under an aquatic plant management permit.
5. The **times** during which aquatic plants may be managed under an aquatic plant management permit.
6. The **allowable methods** for disposing or using aquatic plants that are removed or controlled under an aquatic plant management permit.
7. The requirements for plans that the department may require under sub. (3) (b). "

State Statute 23.24(3)(b) states:
"The department may require that an application for an aquatic plant management permit contain a plan for the department's approval as to how the aquatic plants will be introduced, removed, or controlled."

Wisconsin Administrative Code NR 109.04(3)(a) states:
"The department may require that an application for an aquatic plant management permit contain an aquatic plant management plan that describes how the aquatic plants will be introduced, controlled, removed or disposed. Requirements for an aquatic plant management plan shall be made in writing stating the reason for the plan requirement. In deciding whether to require a plan, the department shall consider the potential for effects on protection and development of diverse and stable communities of native aquatic plants, for conflict with goals of other written ecological or lake management plans, for cumulative impacts and effect on the ecological values in the body of water, and the long-term sustainability of beneficial water use activities."

AQUATIC PLANT MANAGEMENT STRATEGY
Northern Region WDNR

APPROACH

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

2. Control of aquatic plants (if allowed) in documented sensitive areas will follow the conditions specified in the report.

3. Invasive species must be controlled under an approved lake management plan, with two exceptions (these exceptions are designed to allow sufficient time for lake associations to form and subsequently submit an approved lake management plan):
   a. Newly-discovered infestations. If found on a lake with an approved lake management plan, the invasive species can be controlled via an amendment to the approved plan. If found on a lake without an approved management plan, the invasive species can be controlled under the WDNR's Rapid Response protocol (see definition), and the lake owners will be encouraged to form a lake association and subsequently submit a lake management plan for WNDR review and approval.
   b. Individuals holding past permits for control of *invasive* aquatic plants and/or "mixed stands" of native and invasive species will be allowed to treat via individual permit until January 1, 2009 if "impairment of navigation" and/or "nuisance conditions" is adequately documented, unless there is an approved lake management plan for the lake in question.

4. Control of invasive species or "mixed stands" of invasive and native plants will follow current best management practices approved by the Department and contain an explanation of the strategy to be used. Established stands of invasive plants will generally use a control strategy based on Spring treatment. (typically, a water temperature of less than 60 degrees Fahrenheit, or approximately May 31st, annually).

5. Manual removal (see attached definition) is allowed (Admin. Code NR 109.06).

** Exceptions to the Jan. 1, 2009 deadline will be considered only on a very limited basis and will be intended to address unique situations that do not fall within the intent of this approach.*

AQUATIC PLANT MANAGEMENT STRATEGY
Northern Region WDNR

DOCUMENTATION OF IMPAIRED NAVIGATION AND/OR NUISANCE CONDITIONS

Navigation channels can be of two types:

- Common use navigation channel. This is a common navigation route for the general lake user. It often is off shore and connects areas that boaters commonly would navigate to or across, and should be of public benefit.

- Individual riparian access lane. This is an access lane to shore that normally is used by an individual riparian shore owner.

Severe impairment or nuisance will generally mean vegetation grows thickly and forms mats on the water surface. Before issuance of a permit to use a regulated control method, a riparian will be asked to document the problem and show what efforts or adaptations have been made to use the site. (This is currently required in NR 107 and on the application form, but the following helps provide a specific description of what impairments exist from native plants).

Documentation of *impairment of navigation* by native plants must include:

a. Specific locations of navigation routes (preferably with GPS coordinates)
b. Specific dimensions in length, width, and depth
c. Specific times when plants cause the problem and how long the problem persists
d. Adaptations or alternatives that have been considered by the lake shore user to avoid or lessen the problem
e. The species of plant or plants creating the nuisance (documented with samples or from a Site inspection)

Documentation of the *nuisance* must include:

a. Specific periods of time when plants cause the problem, e.g. when does the problem start and when does it go away.
b. Photos of the nuisance are encouraged to help show what uses are limited and to show the severity of the problem.
c. Examples of specific activities that would normally be done where native plants occur naturally on a site but cannot occur because native plants have become a nuisance.

AQUATIC PLANT MANAGEMENT STRATEGY
Northern Region WDNR

DEFINITIONS

Manual removal: Removal by hand or hand-held devices without the use or aid of external or auxiliary power. Manual removal cannot exceed 30 ft. in width and can only be done where the shore is being used for a dock or swim raft. The 30 ft. wide removal zone cannot be moved, relocated, or expanded with the intent to gradually increase the area of plants removed. Wild rice may not be removed under this waiver.

Native aquatic plants: Aquatic plants that are indigenous to the waters of this state.

Invasive aquatic plants: Non-indigenous species whose introduction causes or is likely to cause economic or environmental harm or harm to human health.

Sensitive area: Defined under s. NR 107.05(3)(i) (sensitive areas are areas of aquatic vegetation identified by the department as offering critical or unique fish and wildlife habitat, including seasonal or lifestage requirements, or offering water quality or erosion control benefits to the body of water).

Rapid Response protocol: This is an internal WDNR document designed to provide guidance for grants awarded under NR 198.30 (Early Detection and Rapid Response Projects). These projects are intended to control pioneer infestations of aquatic invasive species before they become established.

Appendix F

RESULTS OF SEDIMENT CORE TAKEN FROM BIG DOCTOR LAKE, BURNETT COUNTY, WISCONSIN

Paul Garrison , Wisconsin Department of Natural Resources

April 2013

Aquatic organisms are good indicators of a lake's water quality because they are in direct contact with the water and are strongly affected by the chemical composition of their surroundings. Most indicator groups grow rapidly and are short lived so the community composition responds rapidly to changing environmental conditions. One of the most useful organ- isms for paleolimnological analysis are diatoms. These are a type of algae which possess siliceous cell walls, which enables them to be highly resistant to degradation and are usually abundant, diverse, and well-preserved in sediments. They are especially useful, as they are ecologically diverse. Diatom species have unique features as shown in Figure 1, which enable them to be readily identified. Certain taxa are usually found under nutrient poor conditions while others are more common under elevated nutrient levels. Some species float in the open water areas while others grow attached to objects such as aquatic plants or the lake bottom.

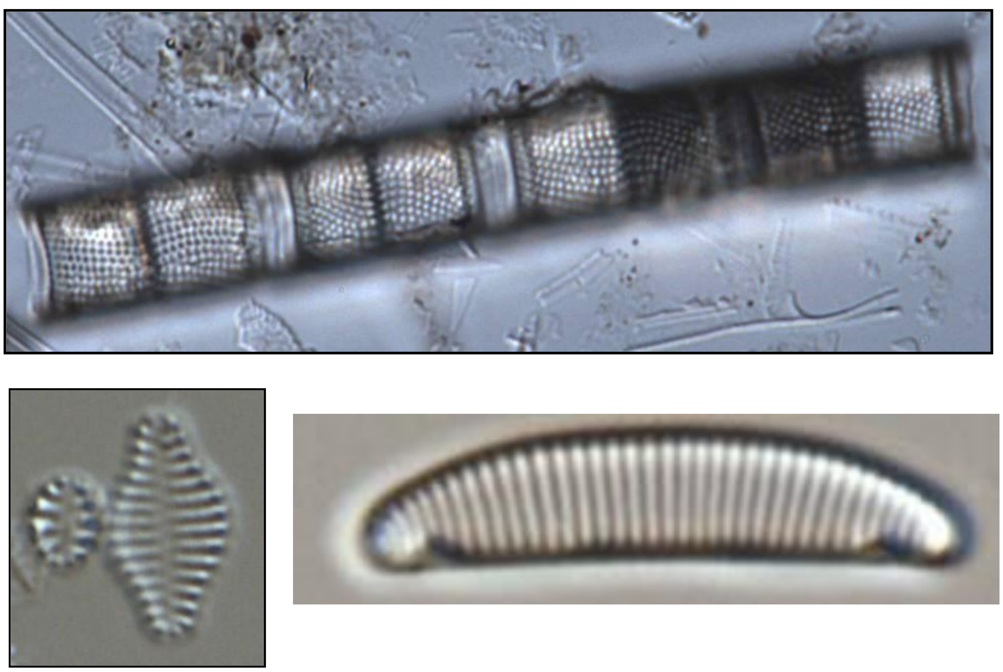


Figure 1. Photomicrographs of the diatoms commonly found in the Big Doctor Lake sediment core. The top diatom, *Aulacoseira am*bigua (A), is found in the open water environments, the bottom left diatoms are part of the benthic *Fragilaria* (B), while the bottom left diatom (*Eunotia incisa*) is found in lower pH environments. Benthic *Fragilaria* are commonly found at- tached to substrates such as aquatic plants.

By determining changes in the diatom community it is possible to determine water quality changes that have occurred in the lake. The diatom community provides information about changes in nutrient concentrations, water clarity, and pH conditions as well as alterations in the aquatic plant (macrophyte) community.

On 29 August 2012 a sediment core were taken from near the deep area (N45.74348° W92.39800°) of Big Doctor Lake using a gravity corer. Samples from the top of the core (0-1 cm) and a section (35-37 cm) deeper in the core were kept for analysis. It is assumed that the upper sample represents present conditions while the deeper sample is indicative of wa- ter quality conditions at least 100 years ago.

Results

In order to determine if the bottom sample of the core was deposited at least 130 years ago the sample was analyzed for the radionuclides lead-210 (^{210}Pb), radium-226 (^{226}Ra), and cesium-137 (^{137}Cs). Lead-210 and ^{226}Ra are naturally occurring radionuclides while ^{137}Cs is a byproduct of atmospheric nuclear testing that was conducted by the USA and USSR from 1954-1963. Lead-210 has a half life of 22.26 years which means it can be detected after deposition for about 130-150 years. Radium-226 is used to measure background concentrations of ^{210}Pb since values of ^{210}Pb and ^{226}Ra are similar when the lead isotope is around 130 years old.

No ^{137}Cs was detected in the sample (Table 1), indicating that the bottom sample was depos- ited before 1954. The ^{210}Pb concentration was lower than the concentration of ^{226}Ra indicating that the bottom sample was deposited more than 130 years ago. The radiochemical analysis suggests that the bottom sample is sufficiently old enough to use the diatom community to estimate water quality conditions prior to any significant anthropogenic disturbance in the watershed.

Table 1. Amount of ^{210}Pb, ^{226}Ra, and ^{137}Cs found in the bottom core sample. Units are pCi g^{-1}.

	Lead-210	Radium-226	Cesium-137
Bottom	0.1088	0.6232	0.0

In Big Doctor Lake the presettlement diatom community was dominated by diatoms of the group *Eunotia* (Figure 2). These diatoms are typically found in pH environments that are slightly acidic and often are dominant in northern WI wetlands. In the top sample these diatoms were much less common. Instead taxa that are more common at higher pH values. The community was dominated by Aulacoseira ambigua (Figure 1a), *Achnanthidium minutissima*, and the group benthic *Fragilaria* (Figure 2). The latter two diatoms are typically found attached to macrophytes.

The diatom community indicates that the present day pH level is higher than the historical level. This may be the result of increased sediment and nutrients input to the lake. A study in Northcentral WI found that a consequence of shoreland development was increased delivery higher pH sediment materials which resulted in an increase in the lake’s pH. This seems

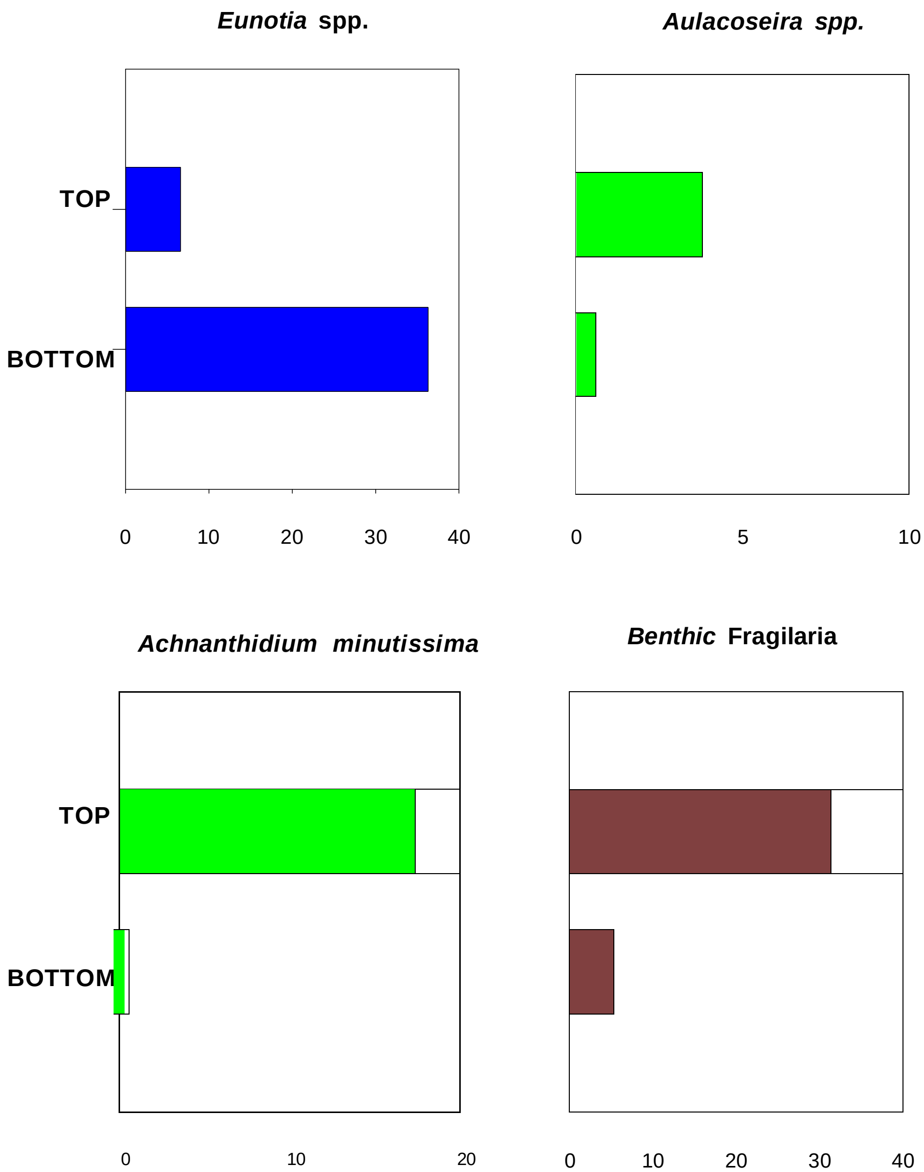

Eunotia spp.
Aulacoseira spp.
TOP
BOTTOM
0 10 20 30 40
0 5 10
Achnanthidium minutissima
Benthic Fragilaria
TOP
BOTTOM
0 10 20
0 10 20 30 40

Figure 2. Changes in the abundance of important diatoms found at the top and bottom of the Big Doctor Lake sediment core. The dominant diatoms at the bottom of the core were *Eunotica* which are typically found in lower pH environments. At the top of the core the diatoms that grow attached to aquatic plants are more common. This indicates an increase in growth of submerged aquatic vegetation. *Aulacoseira* are found floating the open water and probably indicate higher nutrient levels.

to have occurred in Big Doctor Lake. The increase in benthic *Fragilaria* and *A. minutissima* indicate there are more submerged aquatic plants (SAV) at the present time.

In northern WI, many lakes with shoreline development have experienced an increase in SAV. Dr. Susan Borman recently conducted a study in lakes in the northwestern part of WI where she compared the SAV community in the 1930s with the present day community. She found that lakes with cottages have more plants and the species have shifted to those that are larger and grow closer to the lake's surface. This same thing has occurred in southern and central WI but often these lakes have higher phosphorus loading rates and planktonic diatoms become more important. The change in the plant community appears to have happened in Big Doctor Lake as the top sample has more diatoms that typically are associated with aquatic plants.

Diatom assemblages historically have been used as indicators of nutrient changes in a qualitative way. In recent years, ecologically relevant statistical methods have been developed to infer environmental conditions from diatom assemblages. These methods are based on multivariate ordination and weighted averaging regression and calibration. Ecological preferences of diatom species are determined by relating modern limnological variables to surface sediment diatom assemblages. The species-environment relationships are then used to infer environmental conditions from fossil diatom assemblages found in the sediment core.

Such a model was applied to the diatom community in the core from Big Doctor Lake. The model estimates a summer phosphorus concentration of about 25 µg L^{-1} which is much lower than has been measured in the last few years. The concentration measured in 2012 was generally between 80-90 µg L^{-1}. The model significantly under estimates the present day phosphorus levels so the model estimates of historical phosphorus concentrations of 13-15 µ g L^{-1} are suspect. Judging from the change in the diatom community I would speculate that pre- sent day phosphorus levels are higher than historical ones but I do not know how much higher they are.

In the bottom sample there were a large number of sponge spicules and phytoliths but not many in the top sample. This is further indication that the lake has higher phosphorus levels at the present time compared with pre-settlement condtions. Sponges are usually found in relatively good water clarity conditions and phytoliths are an indication of abundant emergent aquatic plants.

In summary, the bottom sample of the sediment core was deposited at least 130 years ago which means that it can be used to estimate background conditions. The core indicates that there has been an increase the pH level in the lake and at the present time the aquatic plant community is greater than it was historically. Although the modeling indicates summer phosphorus levels have increased from 13 to 25 µg L^{-1} this is suspect since the present day concentration is underestimated. It is likely that phosphorus levels have increased but it is difficult to know what the historical levels were.

BIG DOCTOR LAKE Burnett County

Top (0-2 cm)

TAXA	COUNT TOTAL Number	Prop.
Achnanthidium altergracillima (Lange-Bertalot) Round et Bukhtiyarova	2	0.004
Achnanthidium minutissimum (Kützing) Czarnecki	87	0.174
Achnanthidium rivulare Potapova et Ponader	2	0.004
Aulacoseira ambigua (Grunow in Van Heurck) Simonsen	13	0.026
Aulacoseira distans (Ehrenberg) Simonsen	1	0.002
Aulacoseira italica (Ehrenberg) Simonsen	5	0.010
Aulacoseira spp.	2	0.004
Brachysira microcephala (Kützing) Compère	5	0.010
Brachysira serians (Brébisson) Round et Mann	1	0.002
Brachysira spp.	1	0.002
Cavinula pseudoscutiformis (Hustedt in Schmidt et al.) Mann et Stickle in Round, Crawford and Mann	1	0.002
Cocconeis placentula Ehrenberg	9	0.018
Cocconeis spp.	6	0.012
Cymbella mesiana Cholnoky	2	0.004
Cymbella naviculiformis Auerswald ex Heiberg	1	0.002
Cymbella spp.	2	0.004
Discostella stelligera (Cleve et Grunow in Cleve) Houk et Klee	1	0.002
Encyonema minutum (Hilse in Rabenhorst) Mann in Round, Crawford and Mann	5	0.010
Eunotia bilunaris (Ehrenberg) Souza in Souza and Moreira-Filho	1	0.002
Eunotia circumborealis Lange-Bertalot et Nörpel in Lange-Bertalot	6	0.012
Eunotia incisa Smith ex Gregory	13	0.026
Eunotia minor (Kützing) Grunow in Van Heurck	4	0.008
Eunotia parallela Ehrenberg	2	0.004
Eunotia serra Ehrenberg	1	0.002
Eunotia spp.	6	0.012
Fragilaria radians (Kützing) Williams et Round	9	0.018
Fragilaria sepes Ehrenberg	1	0.002
Fragilaria tenera (Smith) Lange-Bertalot	4	0.008
Gomphonema anjae Lange-Bertalot & Reidhardt	1	0.002
Gomphonema exilissimum (Grunow in Van Heurck) Lange-Bertalot et Reichardt in Lange-Bertalot and Metzeltin	3	0.006
Gomphonema parvulum (Kützing) Kützing	2	0.004
Gomphonema parvulum fo. saprophilum Lange-Bertalot et Reichardt in Lange-Bertalot	1	0.002
Gomphonema spp.	3	0.006
Hantzschia amphioxys (Ehrenberg) Grunow in Cleve and Grunow	1	0.002

BIG DOCTOR LAKE Burnett County

Top (0-2 cm)

TAXA	COUNT TOTAL Number	Prop.
Navicula joubaudii Germain	4	0.008
Navicula leptostriata Jørgensen	4	0.008
Navicula minima Grunow in Van Heurck	2	0.004
Navicula spp.	7	0.014
Navicula subminuscula Manguin	7	0.014
Navicula utermoehlii Hustedt in A. Schmidt	4	0.008
Neidium bisulcatum (Lagerstedt) Cleve	2	0.004
Neidium spp.	2	0.004
Nitzschia dissipata var. media (Hantzsch) Grunow in Van Heurck	2	0.004
Nitzschia palea var. debilis (Kützing) Grunow in Cleve and Grunow	1	0.002
Nitzschia spp.	7	0.014
Nupela fennica (Hustedt) Lange-Bertalot in Krammer and Lange-Bertalot	2	0.004
Nupela impexiformis (Lange-Bertalot in Lange-Bertalot and Krammer) Lange -Bertalot	5	0.010
Nupela sp. 1 ?	6	0.012
Nupela vitiosa (Schimanski) Siver et Hamilton	10	0.020
Nupela wellneri (Lange-Bertalot in Lange-Bertalot and Krammer) Lange- Bertalot in U. Rumrich, Lange-Bertalot and M. Rumrich	2	0.004
Pinnularia rupestris Hantzsch in Rabenhorst	1	0.002
Pinnularia spp.	7	0.014
Psammothidium subatomoides (Hustedt in Schmidt) Bukhtiyarova et Round	2	0.004
Pseudostaurosira brevistriata (Grunow in Van Heurck) Williams et Round	63	0.126
Punctastriata mimetica Morales	2	0.004
Sellaphora disjuncta (Hustedt) Mann	2	0.004
Sellaphora laevissima (Kützing) Mann	2	0.004
Sellaphora pupula (Kützing) Meresckowsky	2	0.004
Sellaphora rectangularis (Gregory) Lange-Bertalot et Metzeltin	1	0.002
Sellaphora seminulum (Grunow) Mann	9	0.018
Sellaphora sp. 1 ?	1	0.002
Stauroforma exiguiformis (Lange-Bertalot) Flower, Jones et Round	2	0.004
Stauroneis anceps fo. gracilis Rabenhorst	1	0.002
Stauroneis spp.	2	0.004
Staurosira construens var. venter (Ehrenberg) Hamilton in Hamilton, Poulin, Charles and Angell	38	0.076
Staurosirella pinnata (Ehrenberg) Williams et Round	52	0.104
Synedra delicatissima var. angustissima Grunow in Van Heurck	5	0.010
Synedra minuscula Grunow in Van Heurck	4	0.008
Synedra rumpens Kützing	4	0.008
Synedra spp.	2	0.004

Tabellaria flocculosa (strain III) sensu Koppen (Roth) Kützing	7	0.014
Tabellaria flocculosa var. linearis Koppen	1	0.002
Tabellaria spp.	2	0.004
Tabellaria ventricosa Kützing	1	0.002
Tryblionella scalaris (Ehrenberg) Siver et Hamilton	1	0.002
unknown pennate	15	0.030
TOTAL	500	1.000

BIG DOCTOR LAKE

Burnett County

Bottom (35-37 cm)

lots of diatoms fragments; sponge spicules and phytoliths

TAXA	COUNT TOTAL Number	Prop.
Achnanthidium altergracillima (Lange-Bertalot) Round et Bukhtiyarova	1	0.002
Achnanthidium minutissimum (Kützing) Czarnecki	3	0.006
Aulacoseira italica (Ehrenberg) Simonsen	2	0.004
Aulacoseira nygaardii (Camburn in Camburn and Kingston) Camburn et Charles	1	0.002
Cymbella mesiana Cholnoky	2	0.004
Cymbella spp.	3	0.006
Encyonema minutum (Hilse in Rabenhorst) Mann in Round, Crawford and Mann	7	0.014
Encyonema silesiacum (Bleisch in Rabenhorst) Mann in Round, Crawford and Mann	4	0.008
Encyonopsis sp. 1 ?	11	0.021
Eunotia bilunaris (Ehrenberg) Souza in Souza and Moreira-Filho	1	0.002
Eunotia carolina Patrick	38	0.074
Eunotia circumborealis Lange-Bertalot et Nörpel in Lange-Bertalot	1	0.002
Eunotia faba (Ehrenberg) Grunow in Van Heurck	3	0.006
Eunotia flexuosa (Brébisson ex Kutzing) Kützing	24	0.047
Eunotia formica Ehrenberg	7	0.014
Eunotia hexaglyphis Ehrenberg	4	0.008
Eunotia implicata Nörpel, Alles et Lange-Bertalot in Alles, Nörpel and Lange-Bertalot	2	0.004
Eunotia incisa Smith ex Gregory	79	0.154
Eunotia intermedia (Krasske ex Hustedt) Nörpel et Lange-Bertalot in Lange-Bertalot	6	0.012
Eunotia parallela Ehrenberg	1	0.002
Eunotia praerupta Ehrenberg	6	0.012
Eunotia rhomboidea Hustedt	3	0.006
Eunotia spp.	11	0.021
Fragilaria famelica (Kützing) Lange-Bertalot	1	0.002
Fragilaria vaucheriae (Kützing) Petersen	2	0.004
Gomphonema acuminatum Ehrenberg	7	0.014
Gomphonema auritum Braun & Kutzing	1	0.002
Gomphonema exilissimum (Grunow in Van Heurck) Lange-Bertalot et Reichardt in Lange-Bertalot and Metzeltin	3	0.006
Gomphonema gracile Ehrenberg	11	0.021
Gomphonema hebridense Gregory	1	0.002
Gomphonema maclaughlinii Reichardt	4	0.008
Gomphonema minutum (Agardh) Agardh	16	0.031
Gomphonema minutum fo. curtum (Hustedt) Lange-Bertalot et Reichardt in Krammer and Lange-Bertalot	7	0.014

BIG DOCTOR LAKE

Burnett County

Bottom (35-37 cm)

lots of diatoms fragments; sponge spicules and phytoliths

TAXA	COUNT TOTAL Number	Prop.
Gomphonema parvulius (Lange-Bertalot et Reichardt) Lange-Bertalot et Reichardt in Lange-Bertalot and Metzeltin	9	0.038
Gomphonema parvulum (Kützing) Kützing	2	0.008
Gomphonema sp. 1 Big Doctor	3	0.013
Gomphonema sp. 26 NAWQA EAM	1	0.004
Gomphonema spp.	10	0.042
Gomphonema truncatum Ehrenberg	3	0.013
Hantzschia amphioxys (Ehrenberg) Grunow in Cleve and Grunow	1	0.004
Navicula spp.	4	0.017
Navicula vulpina Kützing	21	0.088
Neidium ampliatum (Ehrenberg) Krammer in Krammer and Lange-Bertalot	1	0.004
Neidium spp.	13	0.054
Neidium temperei Reimer	3	0.013
Pinnularia maior (Kützing) Rabenhorst	2	0.008
Pinnularia microstauron (Ehrenberg) Cleve	2	0.008
Pinnularia pseudogibba Krammer	4	0.017
Pinnularia spp.	7	0.029
Pinnularia subgibba Krammer	3	0.013
Pinnularia viridiformis Krammer	6	0.025
Pinnularia viridis (Nitzsch) Ehrenberg	1	0.004
Sellaphora americana (Ehrenberg) Mann	2	0.008
Sellaphora laevissima (Kützing) Mann	5	0.021
Sellaphora pupula (Kützing) Meresckowsky	3	0.013
Sellaphora rectangularis (Gregory) Lange-Bertalot et Metzeltin	9	0.038
Sellaphora rugula (Hohn & Hellerman) Potapova & Ponader	1	0.004
Sellaphora spp.	3	0.013
Stauroneis anceps Ehrenberg	3	0.013
Stauroneis gracilior (rabenhorst) Reichardt	1	0.004
Stauroneis phoenicenteron (Nitzsch) Ehrenberg	5	0.021
Stauroneis spp.	10	0.042
Staurosira construens var. venter (Ehrenberg) Hamilton in Hamilton, Poulin, Charles and Angell	27	0.113
Synedra delicatissima Smith	2	0.008
Synedra rumpens Kützing	2	0.008
Synedra spp.	1	0.004
Synedra ulna var. danica (Kützing) Grunow in Van Heurck	1	0.004
Tabellaria flocculosa (strain III) sensu Koppen (Roth) Kützing	12	0.050

Tabellaria flocculosa var. linearis Koppen	9	0.038
Tabellaria spp.	6	0.025
Undetermined Pennate	41	0.172
TOTAL	239	1.000

Appendix G
References

Aquatic Ecosystem Restoration Foundation. *Aquatic Plant Management: Best Management Practices in Support of Fish and Wildlife Habitat.* 2005. http://www.aquatics.org/aquatic_bmp.pdf

Beckmann, Todd. *Aquatic invasives still a concern in Burnett County*. Burnett County Sentinel. May 28, 2008.

Berg, Matthew S., Endangered Resources Services, LLC. *Aquatic Macrophyte Surveys for Lipsett Lake, Burnett County, Wisconsin*. July 2007.

Borman, Susan, Robert Korth and Jo Tempte. *Through the Looking Glass*. University of Wisconsin-Extension. Stevens Point, Wisconsin. 1997.

Crow, Garrett E. and C. Barre Hellquist. *Aquatic and Wetland Plants of Northeastern North America*. The University of Wisconsin Press. Madison, Wisconsin. Volumes 1 and 2. 2000.

Garrison, Paul. Wisconsin Department of Natural Resources Lakes Biologist. *Results of Sediment Core Taken From Big Doctor Lake – August 29, 2012, Burnett County, Wisconsin.* August, 2012.

Harmony Environmental. *Aquatic Plant Management Plan. Big and Little Dummy Lakes, Burnett County, Wisconsin.* January 2009.

Harmony Environmental. *Aquatic Plant Management Plan. Burnett County, Wisconsin.* 2009.

Hraychuck, Ann. *Invasive Species Month*. Inter-County Leader. June 13, 2007.

Nichols, Stanley A. *Distribution and Habitat Descriptions of Wisconsin Lake Plants*. Wisconsin Geological and Natural History Survey. Bulletin 96. Madison Wisconsin.1999.

Nichols, Stanley A. *Floristic Quality Assessment of Wisconsin Lake Plant Communities with Example Applications.* Journal of Lake and Reservoir Management 15 (2): 133-141. 1999.

North American Lake Management Society. *Managing Lakes and Reservoirs.* 2001.

Roesler, Craig. Wisconsin Department of Natural Resources Lakes Biologist. Siren WWTP Effluent Flow Path Evaluation. *May 8, 2012.*

University of Wisconsin-Extension. *Phosphorus Levels in the Red Cedar River Basin: A Source of Concern*.

University of Wisconsin-Extension. *Citizen Lake Monitoring Manual*. Revised 2006.

University of Wisconsin-Extension. *Aquatic Plant Management in Wisconsin*. April 2006 Draft.

University of Wisconsin – Madison. Wisconsin State Herbarium. WISFLORA: Wisconsin Vascular Plant Species. www.botany.wisc.edu/wisflora/

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

Vilas County Land and Water Conservation Department. *Aquatic Invasive Species: A Guide for Proactive & Reactive Management.* 2006. http://wisconsinlakes.org/AboutLakes/PDFs/aisguidevc06.pdf

Wendell, Jameson. Wisconsin Department of Natural Resources, Fisheries Biologist. *Fish Species List for Big Doctor Lake*. August, 2012.

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

Wisconsin Department of Natural Resources. Eau Claire, WI. *Designation of Critical Habitat Areas. Bear Lake, Portage County.* March 2007.

Wisconsin Department of Natural Resources. *Fisheries Information Sheet Big Doctor Lake, Burnett County, 2008.*

Wisconsin Department of Natural Resources. *Fisheries in the Wisconsin Ceded Territory.* Last revised March 27, 2009.

Wisconsin Department of Natural Resources. *Natural Heritage Inventory County Data by Township: Burnett County*. Last revised December 2008.

Wisconsin Department of Natural Resources. Northern Region. *Aquatic Plant Management Strategy.* Summer 2007.

Wisconsin Department of Natural Resources. *Reports and Data: Burnett County*. June 2009. <http://www.dnr.state.wi.us/lakes/CLMN/reportsanddata/>

Wisconsin Department of Natural Resources. *The State of the St. Croix River Basin.* 2002.

Wisconsin Department of Natural Resources. *Walleye Bag Limits Revised on 255 Northern Lakes.* May 19, 2009.

Wisconsin Department of Natural Resources. *WISCLAND Digital Land Cover*. 1998.