Black Otter Lake

Outagamie County, Wisconsin

Aquatic Plant Management Plan Update

January, 2018

Sponsored by: Black Otter Lake District

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SUMMARY

Black Otter Lake, located in the Village of Hortonville, Wisconsin. At 75 acres and with a maximum depth of 10 feet, Black Otter Lake is like hundreds of small, local impoundments across Wisconsin. In these resources, large watersheds couple with shallow water levels and allow for dense aquatic plant growth which often impairs recreational use.

To address aquatic plant management, a review of current aquatic plant conditions and management techniques is necessary to be sure that the lake is being managed in the best way possible for the resource and its users. To that end, this report outlines past management, the current conditions, and a review of best management actions moving forward.

Aquatic plants were surveyed on June 15, 2017 using a point-intercept method. The most common species observed were Curly-leaf Pondweed, Common Waterweed, and Coontail.

Overall, aquatic plant populations encompassed 18 species with two of the species being exotic to Wisconsin (Eurasian Water Milfoil and Curly-leaf Pondweed) and four common nuisance species when observed in shallow water (Elodea, Coontail, White Water Crowfoot, and Sago pondweed).

Historically, management for Eurasian Water Milfoil and Curly-leaf Pondweed has shown mixed results and long-term control or eradication may not be possible. Seasonal exotic species control has been effective but other species have filled the empty space and grown to nuisance levels.

Management recommendations should target heavy growth areas of these native and non-native plant beds to allow for navigation, recreational use, and an overall healthier lake:

- Continue using the Black Otter Lake District aquatic plant harvester to create open areas and navigation channels according to an adaptive lake use map
- Track harvest data to guide future harvest and reduce accidental fish removal
- Utilize DASH to target mainly exotic species
- Perform annual aquatic plant surveys to track changes
- Review the Aquatic Plant Management Plan again in five years

Introduction

Description of Study Area

Black Otter Lake is located within the Village of Hortonville in the southwest corner of Outagamie County, Wisconsin (N44.33498° W88.63844°) (Figure 1). The shallow, 75-acre impoundment was created following the construction of a dam on Black Otter Creek in 1848 (Figure 2). The dam was constructed to provide hydraulic power to the local sawmill. Two tributary streams and nine storm water culverts fill the lake from a 10,043-acre watershed that drains through Black Otter Creek directly into the Wolf River.

The lake receives substantial recreational use relative to its size as Black Otter Lake is the only named lake in Outagamie County. The lake has two public boat launches, a county park and a village park along its shores.

The Lake has a maximum depth of 10' and an average depth of 5.3'. Black Otter Lake has been classified as eutrophic based on summer chlorophyll levels, total phosphorus, and by the trophic state index (TSI).

City, Resident, and User Input

The main steward for the resources is the Black Otter Lake District (BOLD). The Village of Hortonville used the Public Inland Lake Protection and Rehabilitation Act of 1974 to form the Black Otter Lake Rehabilitation District and it was later renamed the Black Otter Lake District in 1976. Since that time the Village and BOLD have guided much of the management of the resource.

Past studies showed high phosphorus levels, low dissolved oxygen levels, dense macrophyte growth and excessive sediment accumulation as the main threats to the lake.

Recent Management

Recent management of Black Otter Lake has focused on aquatic plant survey, aquatic plant control, habitat improvement, encouragement of best management practices within the watershed, and operation of an aeration system (Table 1). Volunteers have also monitored the water quality since 1986.

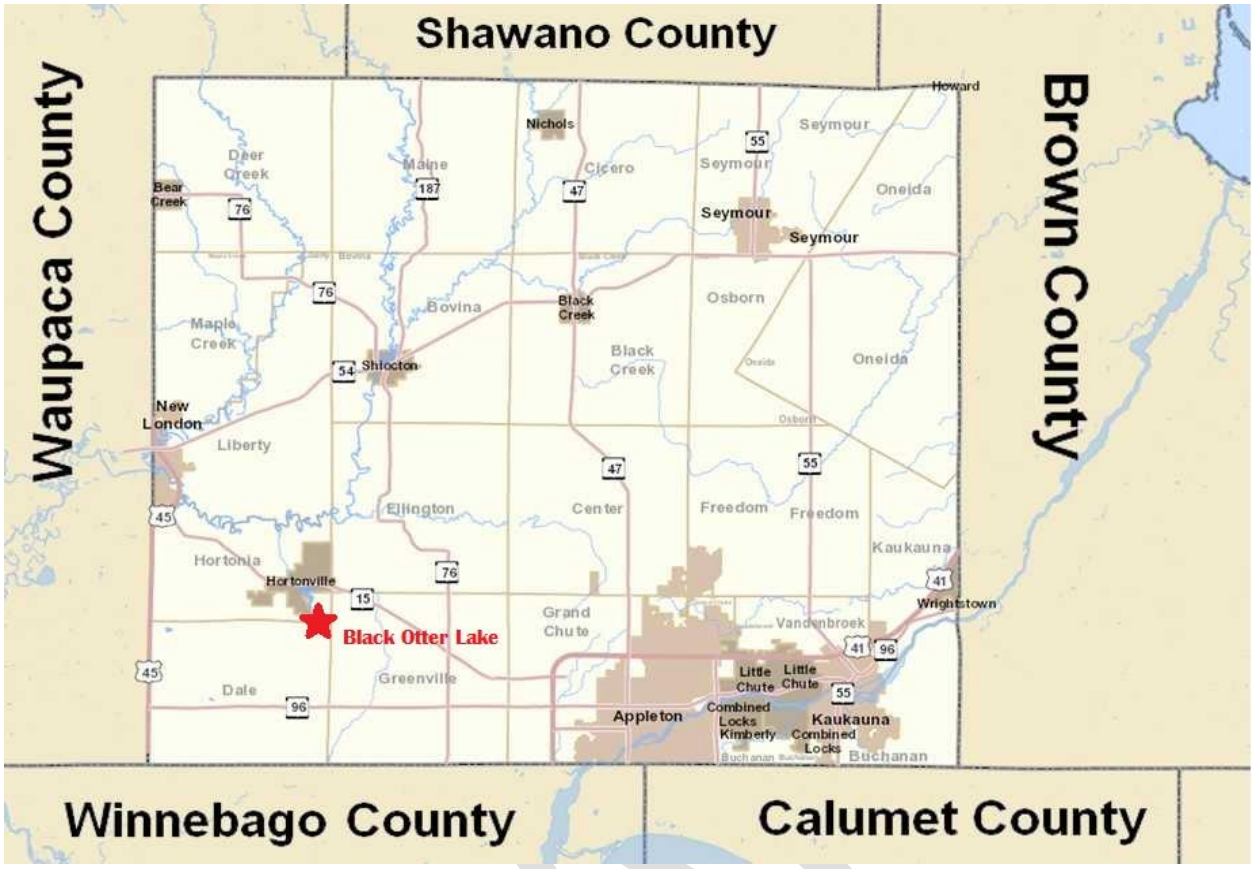


Figure 1. Location Map. Black Otter Lake, Outagamie County, WI.

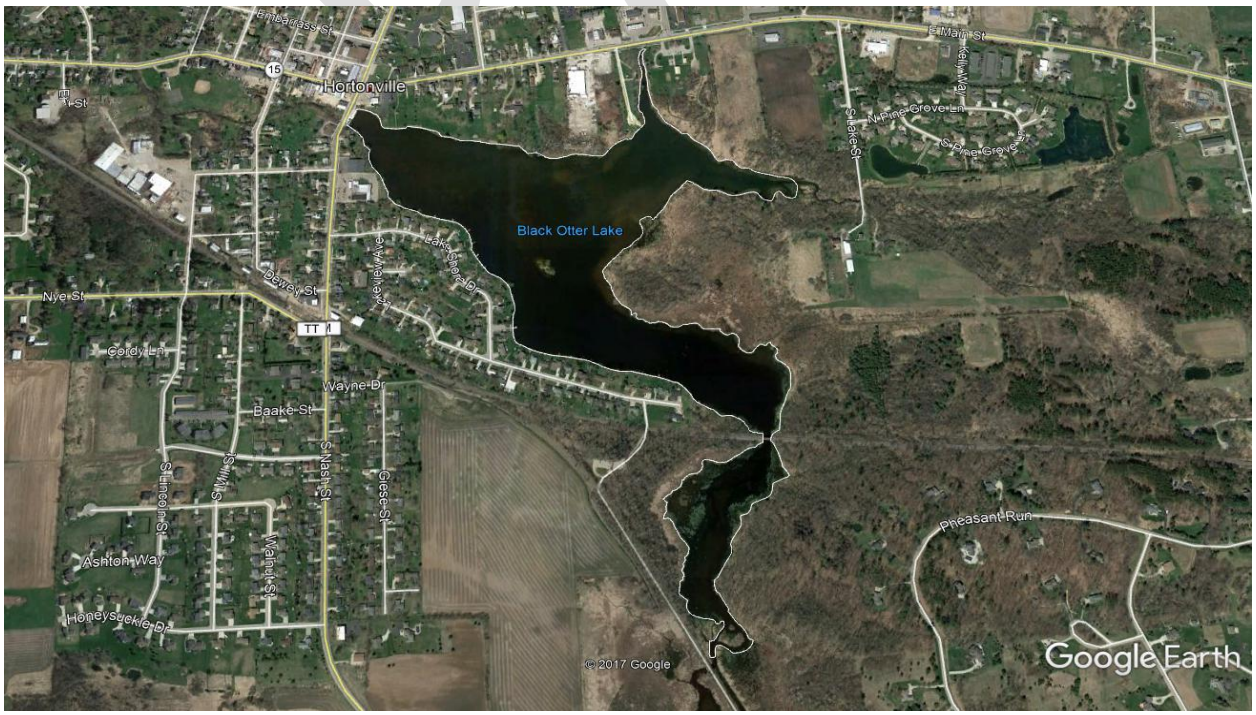


Figure 2. Location Map 2. Black Otter Lake, Outagamie County, WI.

Table 1. Historic Management, Black Otter Lake, Outagamie County, WI.

Date	Management Description
1848	Dam was installed and Lake was formed
1956	Black Otter Creek Watershed Dredging Project
1960's	First Recorded Fish Kills
1976	Black Otter Lake District is Formed
1977	Aqua Tech Inc. Performs Feasibility Study
1982	55 acres within Black Otter Lake are dredged
	Lake Study and Management Plan is Completed
	Aeration System Installed
1989	2 In-lake locations and 2 Upstream Locations are Dredged
1989-1991	5 Sediment basins are Constructed and Black Otter Creek is Re-routed
1990's	Mechanical Harvest is used to reduce plant Growth
1992	Lake Study and Management Plan is Completed
2002	Lake Study and Management Plan is Completed
2003	Comprehensive Lake Management Study Completed
	Exotic Species Herbicide Treatment
2004	Exotic Species Herbicide Treatment
	Aquatic Plant Restoration Program
2005	Exotic Species Herbicide Treatment
2006	Exotic Species Herbicide Treatment
2007	Exotic Species Herbicide Treatment
2008	Lake Study and Management Plan is Completed
	Exotic Species Herbicide Treatment
	Point Intercept Plant Survey Completed
2008-2009	Winter Drawdown
2009	Aquatic Plant Restoration Program
	Point Intercept Plant Survey Completed
2010	Aquatic Plant Restoration Program
	Osprey/Eagle Nesting Platform Installed
	Clean Boats Clean Waters Program Initiated
	Exotic Species Herbicide Treatment
	Point Intercept Plant Survey Completed
2011	Exotic Species Herbicide Treatment
	Point Intercept Plant Survey Completed
2012	Exotic Species Herbicide Treatment
	Strom Water Action Plan Completed.
	Point Intercept Plant Survey Completed
2013	Exotic Species Herbicide Treatment
	Point Intercept Plant Survey Completed
2015	Drawdown for Dam Repairs
2016	Aquatic Plant Harvester Program
2017	Diver Assisted Suction Harvesting
	Aquatic Plant Harvester Program

Aquatic plant surveys were completed 2008 – 2013 and have been a part of multiple management actions by BOLD. For the past 3 years a mechanical aquatic plant harvester has been used to control exotic and nuisance aquatic plant growth. The harvest operation was used to provide boat lanes, fishing access, and openings near popular shore areas. In addition, individual riparian owners can request nuisance plant relief that can be harvested up to two times per summer depending on plant growth. Harvest operations are permitted annually by the Wisconsin Department of Natural Resources (DNR) and according to an approved harvesting map (Figure 3) is submitted. Black Otter Lake District maintains detailed records such as harvesting dates, harvesting areas and total plants harvested (Table 2) which is provided to the DNR at the end of each harvesting season.

Multiple management actions have been used to control Eurasian water milfoil (*Myriophyllum spicatum*) and curly-leaf pondweed (*Potomogeton crispus*), both classified as exotic species to the state of Wisconsin. Herbicide treatments have been used from 2003-2008 and from 2010-2013 to control these exotic species that have historically dominated the lake. Diver Assisted Suction Harvester (DASH) was used in the summer of 2017 to help manage the densest and most problematic areas of the lake.

In the winter of 2008-2009 a drawdown of the lake was used to help control nuisance plant growth of both native and exotic species. The drawdown was also used to help with the desiccation and compaction of the lakes sediments. The Lake District also stocked thousands of game fish and minnows following the drawdown. In 2015 the lake was drawn down again as repairs were needed on the dam.

The Black Otter Lake District has used multiple habitat management techniques to improve habitat for both fish and wildlife around the lake. An aquatic plant restoration program took place in 2004 with additional plantings taking place in the summers of 2009 and 2010. The Wisconsin DNR implemented a tree-fall program along the shoreline dropping over 60 trees into the lake. In 2010 an osprey/eagle nesting platform was installed on the southeast end of the lake and a clean boats clean water program was initiated in the spring.

To alleviate winterkill, the BOLD also operates an aerator in the downstream area of the lake during ice over conditions.

Previous management also included dredging of sediment in 55 acres of the lake (1982), construction of five sediment basins to reduce sedimentation within the lake (1989) and the re-routing of Black Otter Creek through a wetland upstream of the lake (1989-91).

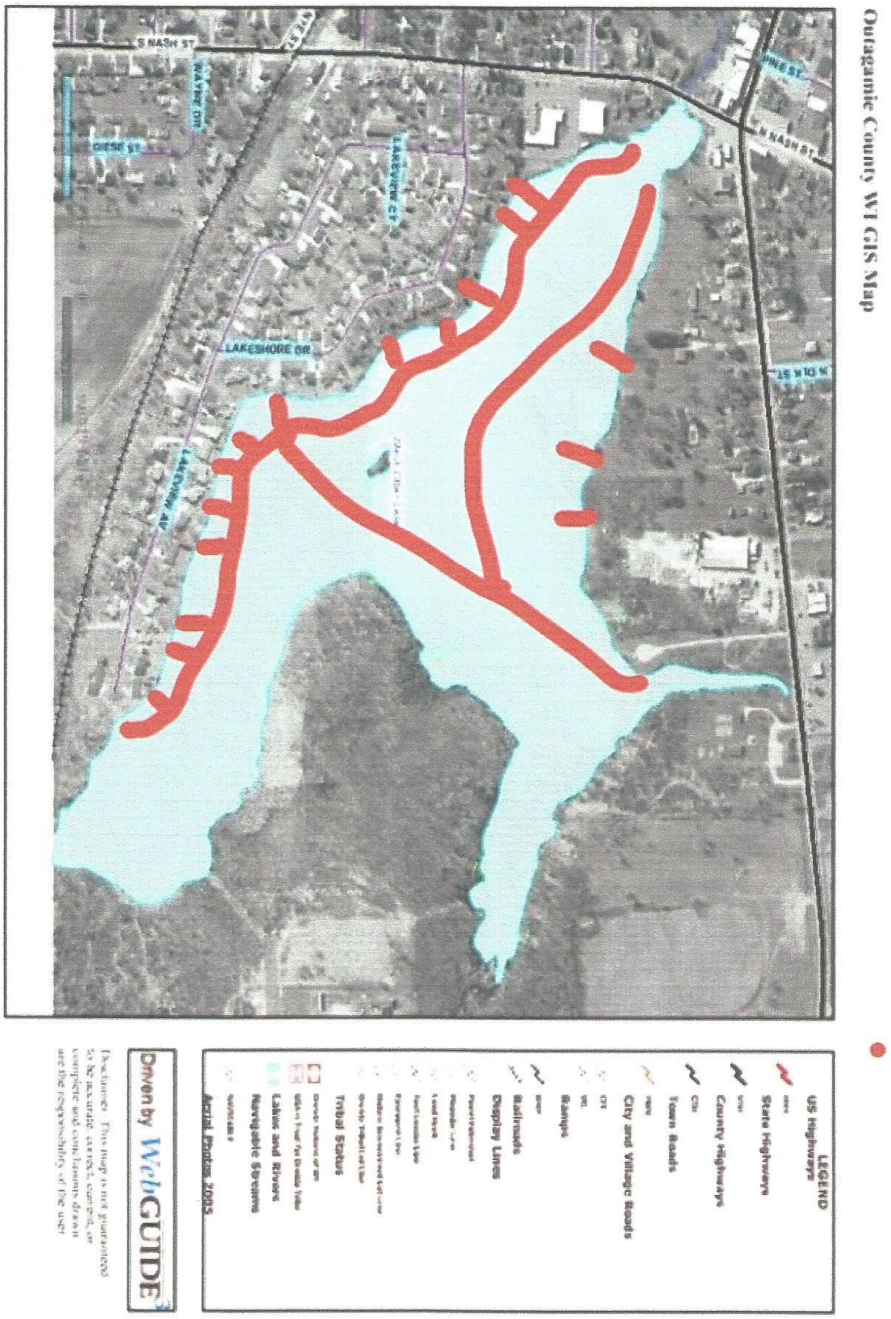


Figure 3. Aquatic Plant Harvesting Map. Black Otter Lake, Outagamie County, WI.

Table 2. 2016-2017 Mechanical Aquatic Plant Harvest Data, Black Otter Lake, Outagamie County, WI.

Date	Loads
7/20/2016	5
7/22/2016	3
7/23/2016	2
7/24/2016	1
7/25/2016	2
7/25/2016	2
7/26/2016	2
7/27/2016	2
7/28/2016	2
8/2/2016	1
8/4/2016	1
8/8/2016	1
8/9/2016	1
Total	25
Cubic Yards	176

Date	Loads
6/29/2017	2
7/2/2017	1
7/13/2017	2
7/27/2017	1
7/28/2017	1.25
8/10/2017	4
8/15/2017	1
8/16/2017	2
8/18/2017	2
8/22/2017	4
8/24/2017	3
8/25/2017	1
8/29/2017	2.5
Total	26.75
Cubic Yards	214

Methods

Aquatic Plant Survey

A Point-Intercept aquatic plant survey was conducted on June 15, 2017. The sample point grid was laid out by the DNR and points were sampled with rake throws at each sample site (Figure 4). Each sample site was located in the field using a Delorme Earthmate PN-60 handheld GPS unit.

Data collected at each sampled point included depth, substrate, total rake fullness, species and density (on a 0 to 3 scale, Figure 5). Data collected during the aquatic plant survey was used to determine species composition, percent frequency, species distribution, and relative abundances. Unknown species were collected and preserved in water for laboratory identification when necessary.

Data were then entered into DNR furnished Excel spreadsheets for data analysis and use in Geographical Information System (GIS) programming.

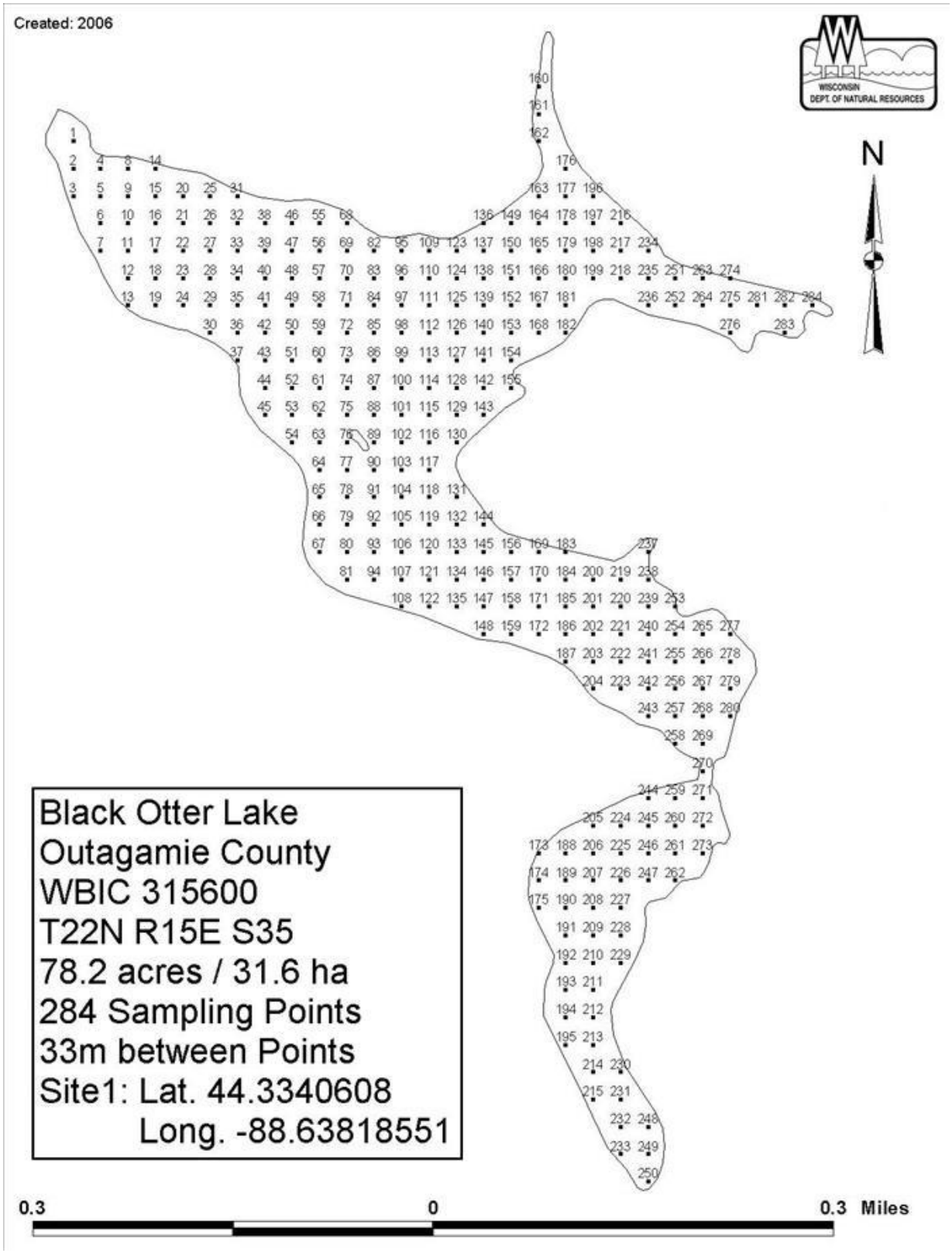


Figure 4. DNR Sample Points, Black Otter Lake, Outagamie County, WI.

Rating	Coverage	Description
1		A few plants on rake head
2		Rake head is about ½ full Can easily see top of rake head
3		Overflowing Cannot see top of rake head

Figure 5. Rake Fullness Guide. (Courtesy Wisconsin DNR)

Results and Discussion

The most abundant plants encountered for Black Otter Lake were (in order of percent observed): Curly-leaf Pondweed (73.66%), Elodea (*Elodea canadensis*) (47.77%), Coontail (*Ceratophyllum demersum*) (47.32%), Eurasian Water Milfoil (39.73%), Small Duckweed (*Lemna minor*) (35.71%), Watermeal (*Wolffia* spp.) (39.71%), White Water Crowfoot (*Ranunculus aquatilis*) (21.43%), and Sago Pondweed (*Stuckenia pectinata*) (13.39%). Of these, Curly-leaf Pondweed and Eurasian Water Milfoil are exotic species (not native to Wisconsin). (Table 3 and Figures 6 & 7). Together CLP and EWM encompass nearly 100% of the lake (Figure 8).

220 potential points were sampled for plant growth. Growth was noted at all 220 sites (Table 4).

Note: 284 sample points were mapped in the survey, however 64 points were non-navigable, with most of the non-navigable sites located on the south end of the lake.

CLP and EWM observed their highest percent and relative frequency since 2009 (Table 5). Percent frequency looks at the number of sites that individual species was found versus the number of total sites sampled, while relative frequency takes the abundance of a species in relation to all other species sampled. Multiple factors can influence plant growth from year to year. Time of year the survey was completed and herbicide management, especially for exotic species, can greatly influence plant growth. It is important to note the past surveys were completed after treatments for CLP and/or EWM was performed.

Elodea (common waterweed) and coontail were the two most common native plant species observed in the survey. Coontail was found at 47.32% of surveyed sites (Figure 9) and Elodea was observed at 47.77% (Figure 10). Historically, coontail has dominated Black Otter Lake and filled the open space created when CLP and EWM was treated. Due to Black Otter Lake's depth and available nutrients, coontail often grows to nuisance levels by mid-summer. Past plant surveys have all observed coontail at high frequencies with 2008 showing the highest percent frequency at 95.2% (Figure 11). Elodea was found at a 0.9% percent frequency in 2008 (Figure 12), however since 2008, Elodea has increased in frequency reaching highs of 88.51% and 89.94% in 2011 and 2012.

White Water Crowfoot was observed at a percent frequency of 21.43% (Figure 13). 2017 was the first survey White Water Crowfoot was observed in Black Otter Lake.

Table 3. Species Present, June 15, 2017, Black Otter Lake, Outagamie County, WI.

Species (Sites Observed)	Common Name
Ceratophyllum demersum (106)	Coontail
Chara sp. (2),	Muskgrasses
Elodea canadensis (107),	Common Waterweed
Heteranthera dubia (2),	Water Star-grass
Lemna minor (80),	Small Duckweed
Lemna trisulca (6),	Forked Duckweed
Myriophyllum spicatum (89)	Eurasian Water Milfoil
Nuphar variegata (2),	Spatterdock
Nymphaea odorata (4),	White Water Lily
Potamogeton crispus	Curly-leaf Pondweed
Potamogeton natans (3),	Floating-leaf Pondweed
Potamogeton pusillus (7),	Small Pondweed
Ranunculus aquatilis (48),	White Water Crowfoot
Schoenoplectus tabernaemontani (9),	Softstem Bulrush
Stuckenia pectinata (30),	Sago Po ndweed
Typha sp. (12),	Cattail
Sagatarius spp. (3)	Arrowhead
Wolffia columbiana (80),	Common Watermeal
Filamentous Algae (19)	Algae

Table 4. Point-Intercept Survey Statistics, June 15, 2017, Black Otter Lake, Outagamie County, WI.

SUMMARY STATS:	
Total number of sites visited	220
Total number of sites with vegetation	224
Total number of sites shallower than maximum depth of plants	220
Frequency of occurrence at sites shallower than maximum depth of plants	101.82
Simpson Diversity Index	0.86
Maximum depth of plants (ft)**	10.00
Number of sites sampled using rake on Rope (R)	0
Number of sites sampled using rake on Pole (P)	220
Average number of all species per site (shallower than max depth)	2.78
Average number of all species per site (veg. sites only)	2.75
Average number of native species per site (shallower than max depth)	1.62
Average number of native species per site (veg. sites only)	2.21
Species Richness	13
Species Richness (including visuals)	18

Table 5. Comparison of aquatic plant surveys conducted from 2008-2017 on Black Otter Lake, Outagamie County, WI.

	2008		2009		2010		2011		2012		2013		2017	
Species - Common Name	**Percent Frequency**	**Relative Frequency**	**Percent Frequency**	**Relative Frequency**	**Percent Frequency**	**Relative Frequency**	**Percent Frequency**	**Relative Frequency**	**Percent Frequency**	**Relative Frequency**	**Percent Frequency**	**Relative Frequency**	**Percent Frequency**	**Relative Frequency**
Curly-leaf Pondweed	6.5	2.5	69.53	22.3	1.59	0.8	2.03	1.2	0.59	0.2	0.46	0.2	73.66	22.8
Common Waterweed	0.9	0.3	19.74	6.3	44.22	21.9	88.51	54.1	89.94	34.9	54.17	20.2	47.77	14.8
Coontail	95.2	36.6	47.64	15.3	58.17	28.9	32.43	19.8	56.8	22	83.8	31.3	47.32	14.6
Euarasian Water Milfoil	16.5	6.4	5.15	1.7	visual	-	-	-	-	-	visual	-	39.73	12.3
Watermeal	38.3	14.7	-	-	-	-	4.73	2.9	23.67	9.2	30.56	11.4	35.71	11
Small Duckweed	32.2	12.4	3.43	1.1	27.89	13.8	3.38	2.1	24.85	9.6	23.61	8.8	35.71	11
White-water Crowfoot	-	-	-	-	-	-	-	-	-	-	-	-	21.43	6.6
Sago Pondweed	10	3.8	39.91	12.8	3.59	1.8	21.62	13.2	2.37	0.9	25.93	9.7	13.39	4.1
Filamentous Algae	49.6	19.1	14.59	4.7	17.93	8.9	4.05	2.5	55.03	21.3	39.35	14.7	8.48	2.6
Small Pondweed	-	-	36.48	11.7	0.4	0.2	2.03	1.2	0.59	0.2	-	-	3.13	1
Forked Duckweed	-	-	0.43	0.1	-	-	-	-	-	-	-	-	2.68	0.8
Floating-leaf Pondweed	5.2	2	4.29	1.4	2.79	1.4	-	-	-	-	-	-	1.34	0.4
Water Stargrass	2.6	1	9.01	2.9	23.11	11.5	2.03	1.2	visual	-	2.31	0.9	0.89	0.3
Muskgrass	0.9	0.3	11.59	3.7	16.73	8.3	-	-	-	-	1.85	0.7	0.89	0.3
Cattails	-	-	7.73	2.5	1.59	0.8	visual	-	visual	-	visual	-	visual	-
White Water Lily	visual	-	5.15	1.7	visual	-	visual	-	visual	-	visual	-	visual	-
Spatterdock	visual	-	visual	-	0.4	0.2	visual	-	visual	-	visual	-	visual	-
Softstem Bulrush	-	-	0.43	0.1	0.8	0.4	visual	-	visual	-	visual	-	visual	-
Common Arrowhead	-	-	0.86	0.3	visual	-	-	-	-	-	-	-	visual	-
Common Bladderwort	-	-	-	-	-	-	0.68	0.4	1.78	0.7	5.56	2.1	-	-
Bushy Pondweed	1.3	0.5	25.32	8.1	1.2	0.6	1.35	0.8	-	-	0.46	0.2	-	-
Stonewort	-	-	-	-	0.4	0.2	0.068	0.4	1.78	0.7	-	-	-	-
Northern Water Milfoil	0.9	0.3	8.58	2.8	-	-	-	-	0.59	0.2	-	-	-	-

Water Smartweed			1.72	0.6	-	-	-	-	-	-	-	-	-	-

	2008	2009	2010	2011	2012	2013	2016
Simpson Diversity Index	0.79	0.88	0.82	0.65	0.77	0.81	0.86
Coefficient of Conservatism	5.2	4.9	5	4.9	5.1	5.2	6.27
Floristic Quality Index	17.9	20.1	19.4	18.4	19.9	17.2	20.8

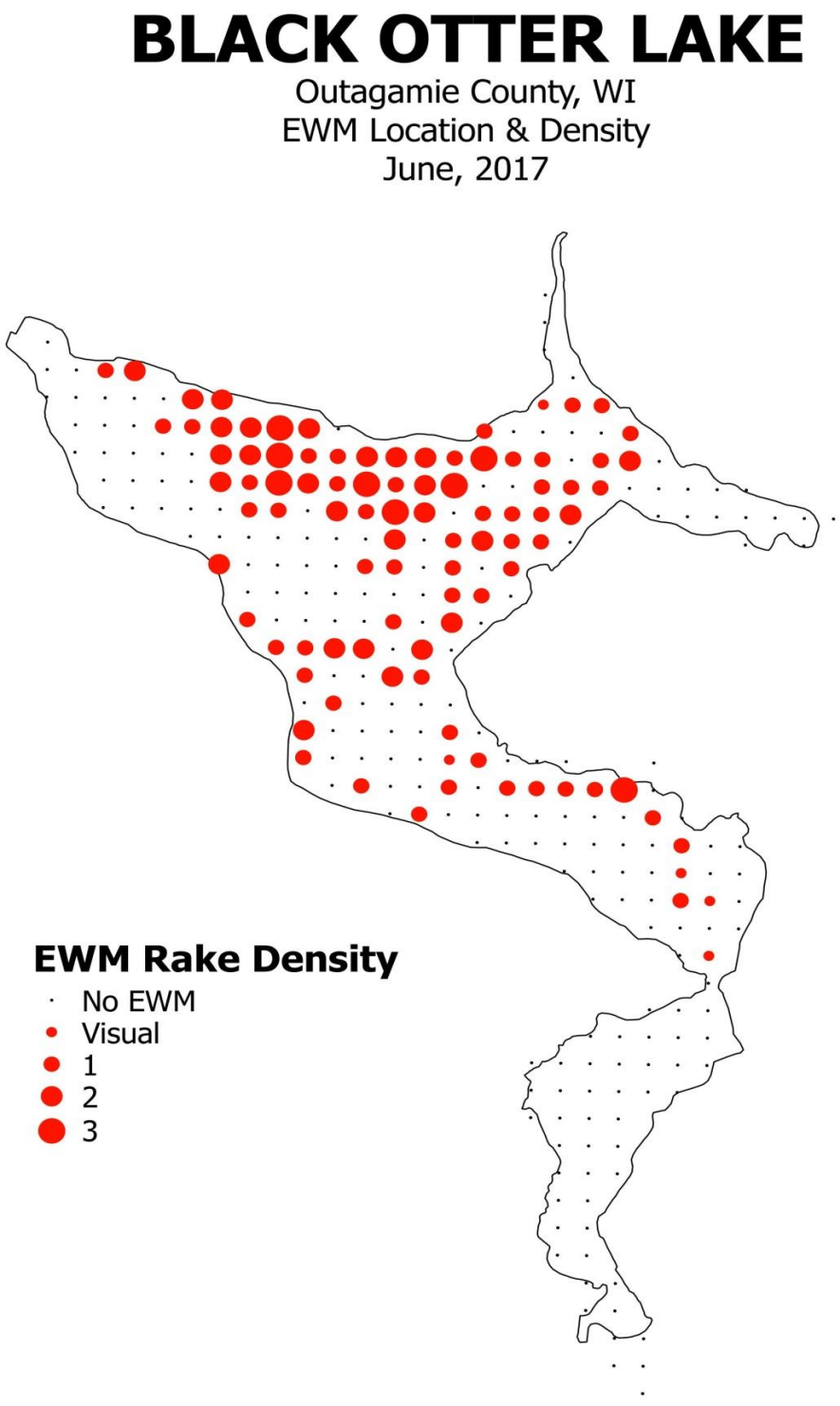


Figure 6. Eurasian Water Milfoil Rake Density Map, Black Otter Lake, June 2017

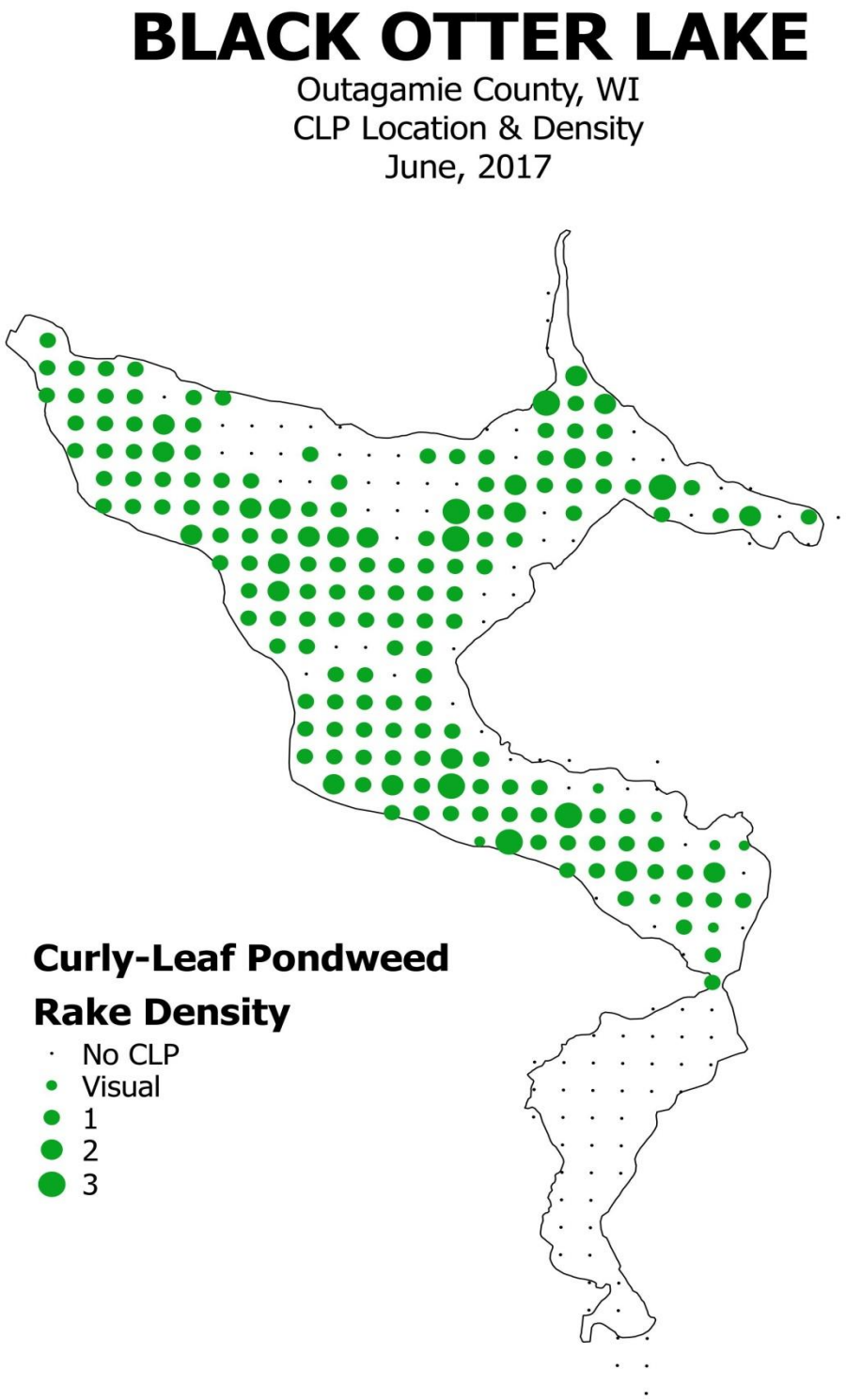


Figure 7. Curly Leaf Pondweed Rake Density Map, Black Otter Lake, June 2017

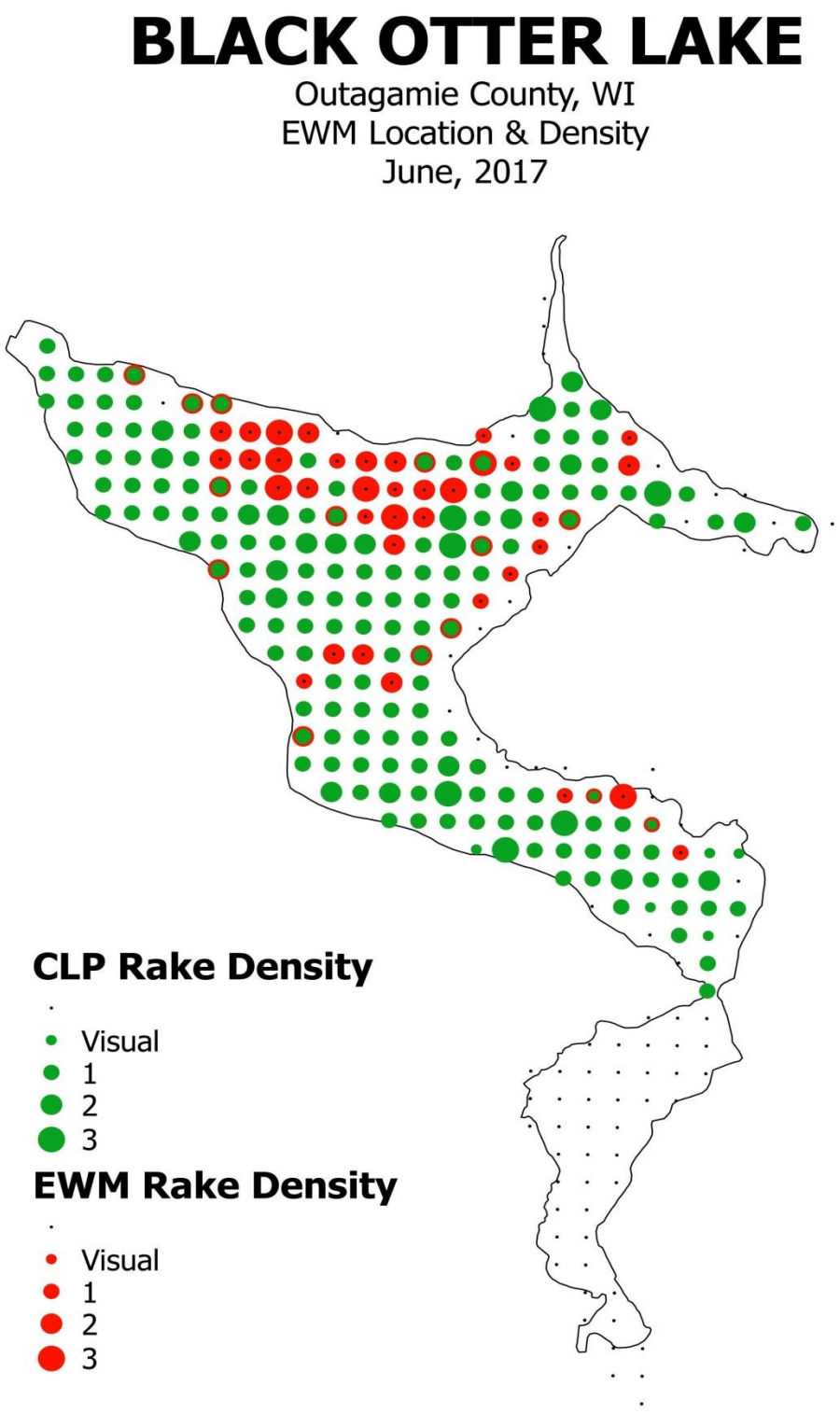


Figure 8. Aquatic Invasive Species Rake Density, Black Otter Lake, June 2017

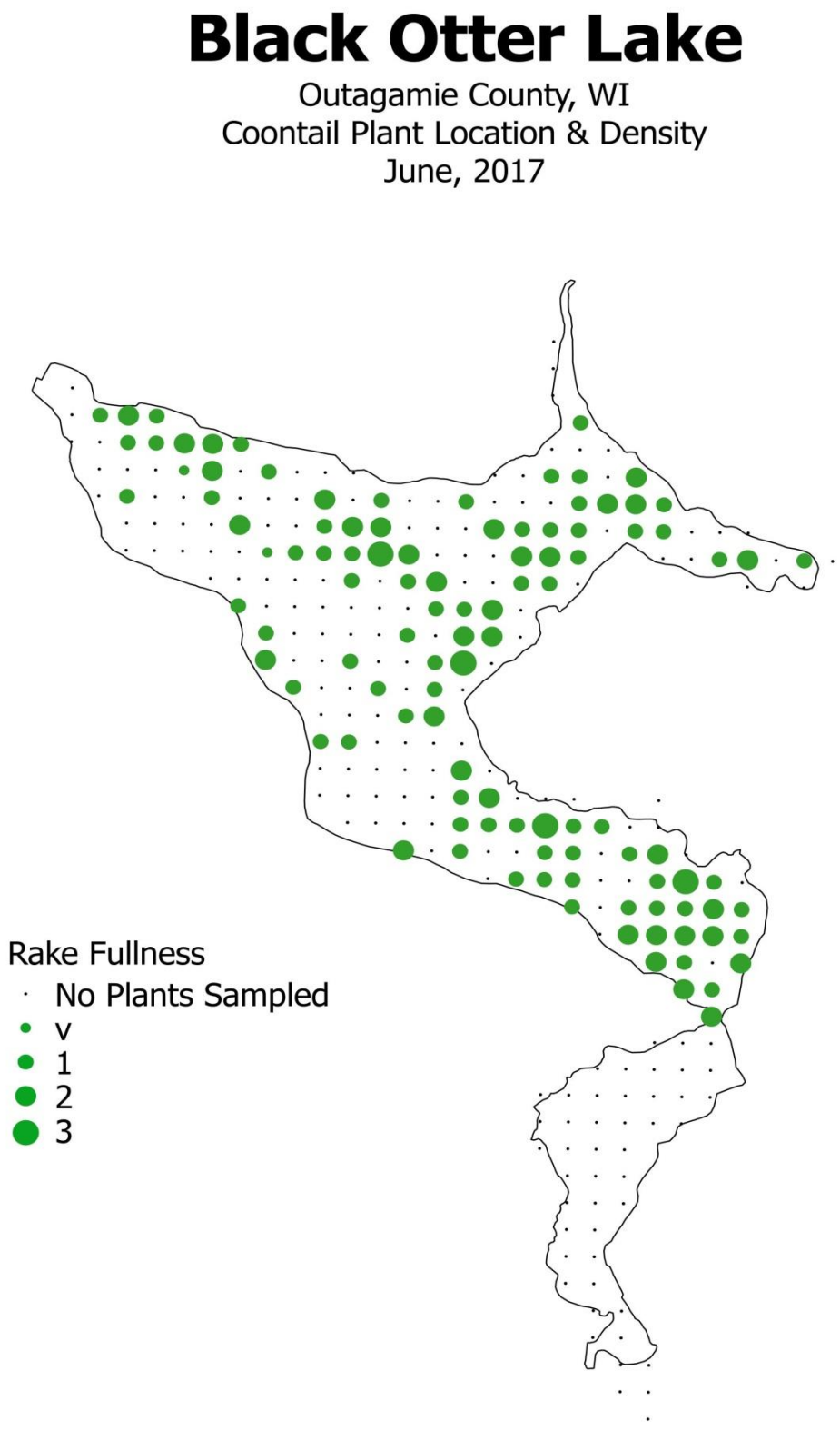


Figure 9. Coontail Rake Density, Black Otter Lake, June 2017

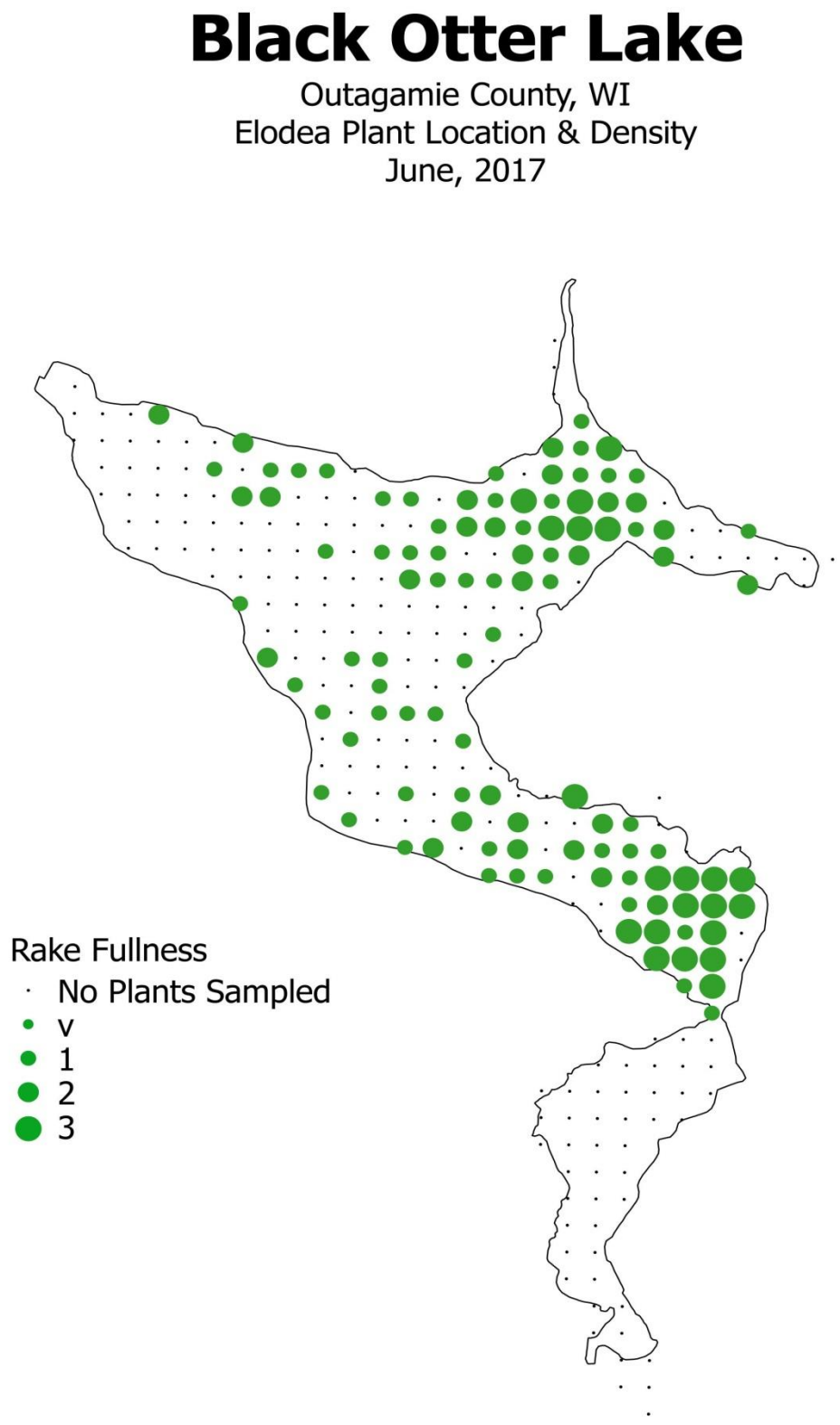


Figure 10. Elodea Rake Density, Black Otter Lake, June 2017

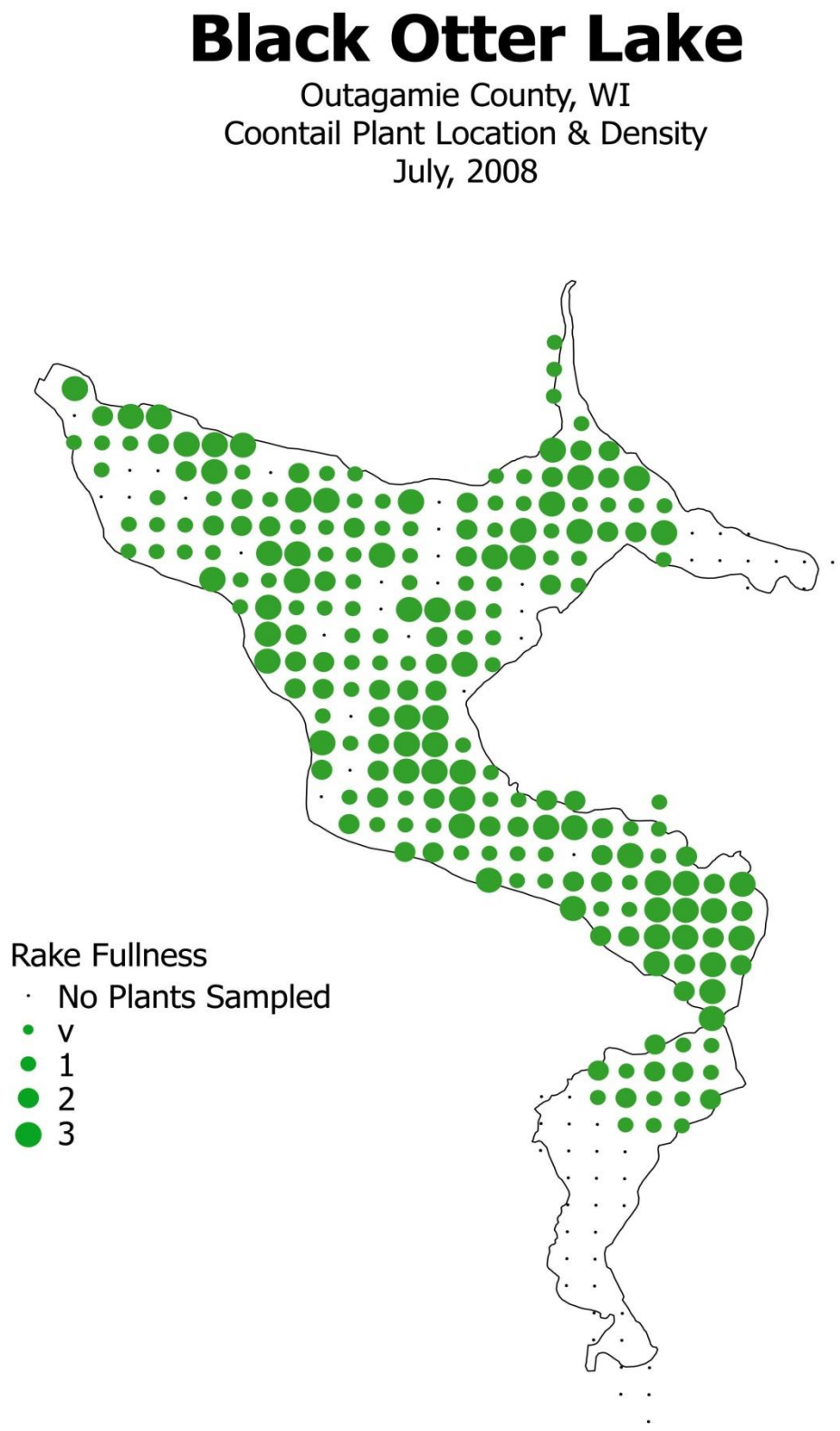


Figure 11. Coontail Rake Density, Black Otter Lake, July 2008

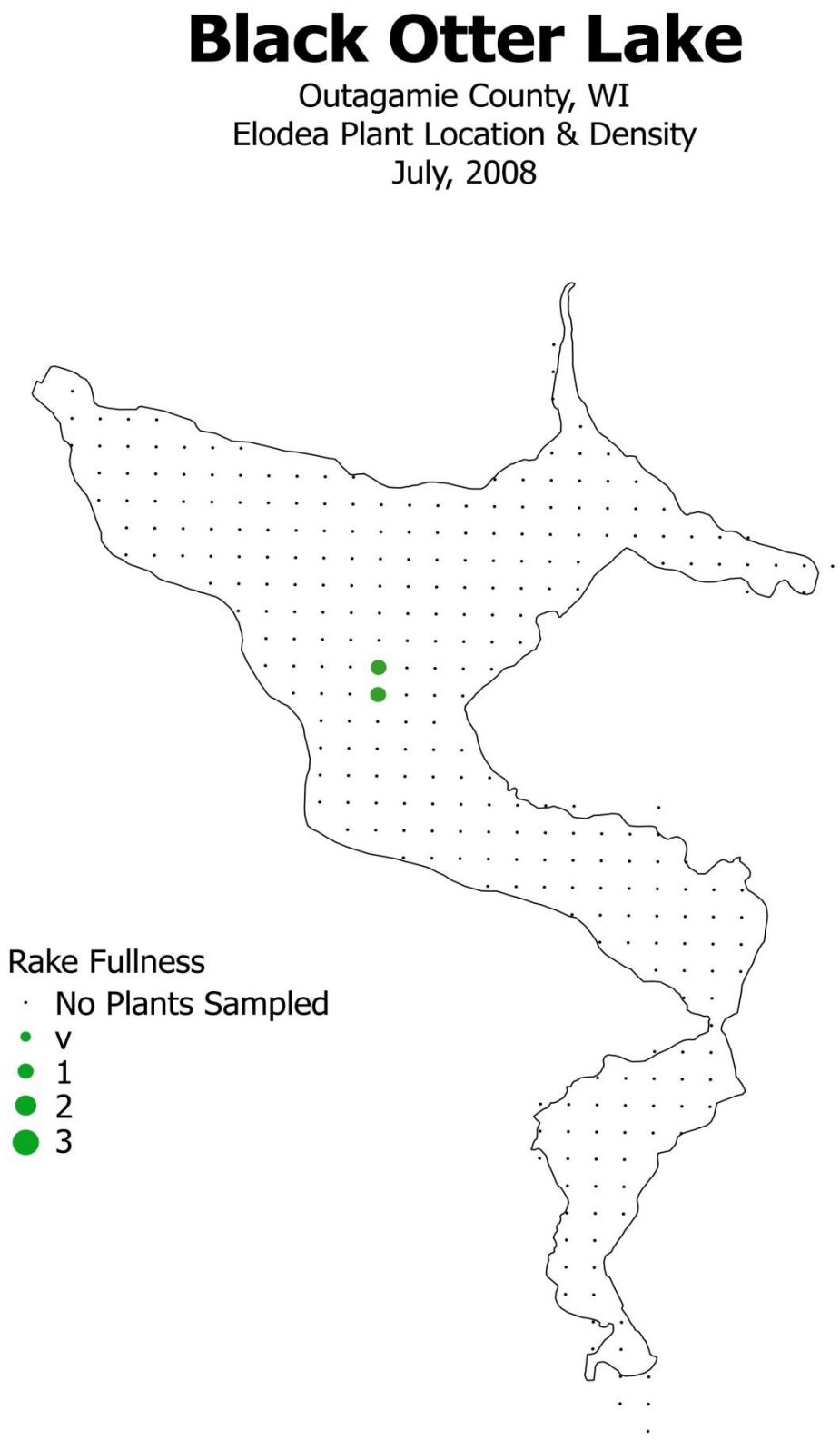


Figure 12. Elodea Rake Density, Black Otter Lake, July 2008

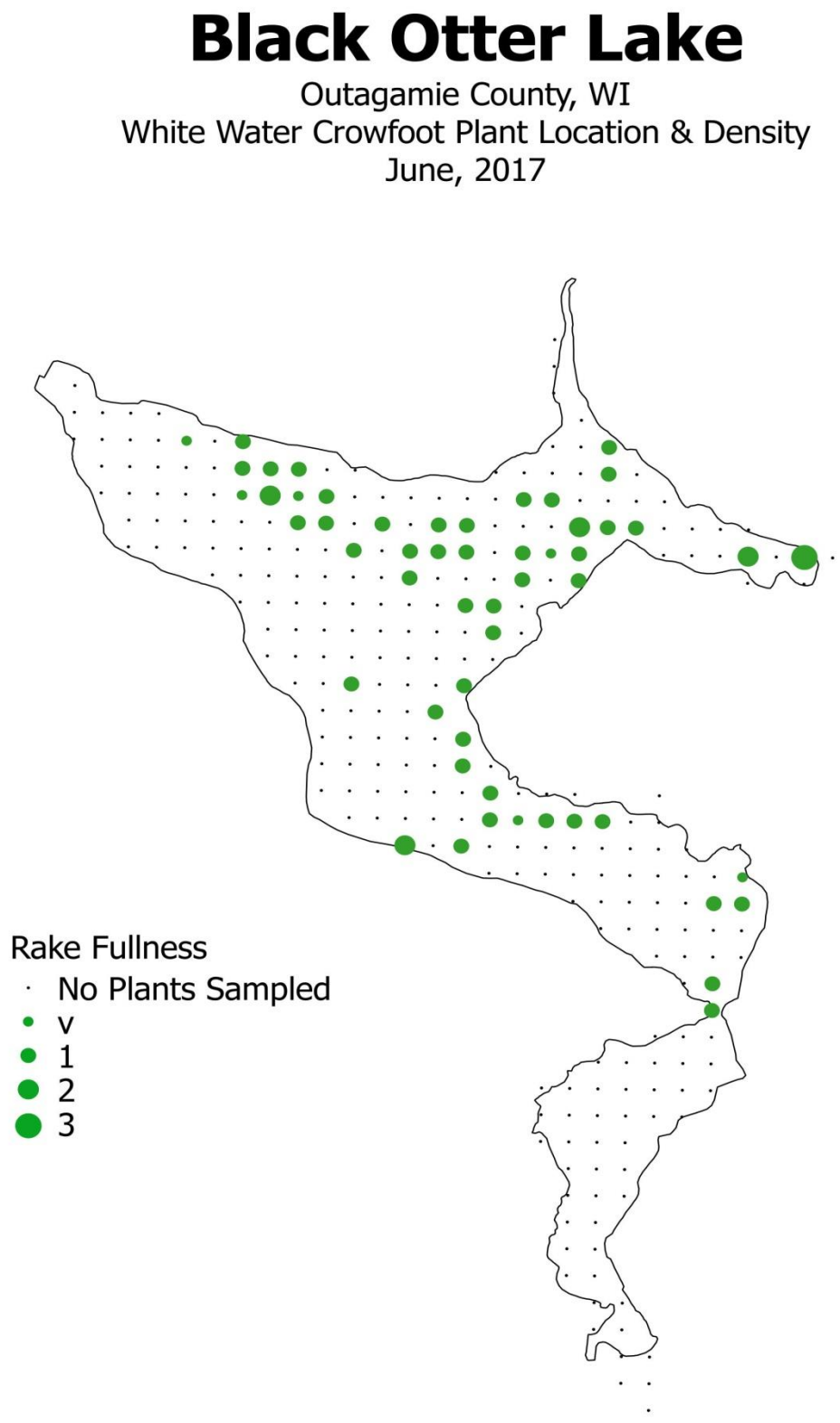


Figure 13. White Water Crowfoot Rake Density, Black Otter Lake, June 2017

The Importance of Aquatic Plants

Aquatic plants serve an important purpose in the aquatic environment. They play an instrumental role in maintaining ecological balance in ponds, lakes, wetlands, rivers, and streams. Native aquatic plants have many values. They serve as important buffers against nutrient loading and toxic chemicals, they act as filters that capture runoff-borne sediments, they stabilize lakebed sediments, they protect shorelines from erosion, and they provide critical fish and wildlife habitat. Therefore, it is essential that the native aquatic plant community be protected where at all practical.

The following is a list of common native aquatic plants that were found in Black Otter Lake. Ecological values and a description are given for each plant. Plant information was gathered from Borman et al. (1997), Eggers and Reed (1997), Fasset (1940), Fink (1994), Nichols and Vennie (1991), and Whitley et al. (1999). Images obtained from Schmidt and Kannenberg, 1998, Borman et al., 1997, and Texas A&M, 2017.

Submersed Plants (Plants that tend to grow with their leaves under water.)

Elodea (*Elodea canadensis*) or **common waterweed** is made up of slender stems with small, lance-shaped leaves that attach directly to the stem. Leaves are found in whorls of two or three and are more crowded toward the stem tip. The branching stems of elodea provide valuable cover for fish and are home for many insects that fish feed upon. Elodea also provides food for muskrats and waterfowl.

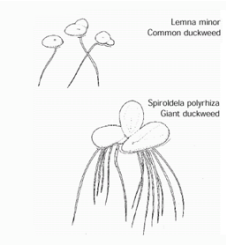
Coontail *(Ceratophyllum demersum)* produces whorls of narrow, toothed leaves on a long trailing stem that often resembles the tail of a raccoon. The leaves tend to be more crowded toward the tip. Coontail blankets the bottom, which helps to stabilize bottom sediments. Tolerant to nutrient rich environments, coontail filters a high amount of phosphorus out of the water column. Coontail provides a home for invertebrates and juvenile fish. Seeds are consumed by waterfowl, but are not of high preference.

White water Crowfoot *(Ranunculus aquatilis)* leaves are finely cut into thread-like divisions and attach directly to the stem or have a very short leaf stalk. Leaves emerge along the stem in an alternate arrangement. Small white flowers are produced early is the season. The flower gives way to fruit and becomes a choice spot for dabbling ducks. Stems and leaves of water crowfoot provide valuable invertebrate habitat.

Sago Pondweed *(Potamogeton pectinatus)* leaves are very thin and resemble pine needles, ending in a sharp point. Each branch may be forked several times into a spreading, fan-like, arrangement. Sago is considered one of the top food producers for waterfowl. Both the fruit and tubers are heavily grazed and are considered critical for a variety of migratory waterfowl. Sago also provides shelter for juvenile fish and invertebrates.

Floating Leaf Plants (Plants that may or may not be rooted in the bottom sediment and have leaves that float at the water's surface.)

Small Duckweed (*Lemna minor*) has round to oval-shaped leaf bodies called fronds that float individually or in groups on the water surface. Each frond has three faint nerves, one root and no stems. Small duckweed is a nutritious food source that can provided up to 90% of the dietary needs for a variety of ducks and geese. It is also consumed by muskrats, beaver, and fish. Rafts of duckweed offer shade and cover for fish and invertebrates.



Common Watermeal (*Wolffia* spp.) is composed of pale green, asymmetrical globes with no roots, stems, or true leaves. Watermeal has the distinction of being one of the world's smallest flowering plant, however the flowers can only be seen under magnification and are seldom found. Watermeal is a good food source for a variety of ducks including mallards and scaup. It is also eaten by muskrat and some fish.

Exotic Species

The invasive exotic plants identified in Black Otter Lake are Eurasian Water Milfoil and Curly-Leaf Pondweed. The following descriptions are given to promote awareness of these plants.

Eurasian Water Milfoil (*Myriophyllum spicatum*) produces long spaghetti-like stems that often grow up to the water's surface. Leaves are feather-like and resemble bones on a fish. 3-5 leaves are arranged in whorls around the stem, and each leaf contains 12-21 pairs of leaflets. At mid-summer small reddish flower spikes may emerge above the water's surface. Perhaps the most distinguishing characteristic though, is the plant's ability to form dense, impenetrable beds that inhibit boating, swimming, fishing, and hunting.

Eurasian Water Milfoil is native to Europe, Asia and Northern Africa. Of the eight milfoil (*Myriophyllum*) species found in Wisconsin, Eurasian Water Milfoil is the only exotic. The plant was first introduced into U.S. waters in 1940. By 1960, it had reached Wisconsin's lakes. Since then, its expansion has been exponential (Brakken, 2000).

Eurasian Water Milfoil begins growing earlier than native plants, giving it a competitive advantage. The dense surface mats formed by the plant block sunlight and have been found to displace nearly all native submergent plants. Over 200 studies link declines in native plants with increases in EWM (Madsen, 2001). The resultant loss of plant diversity degrades fishery habitat (Pullman, 1993), and reduces foraging opportunities for waterfowl and aquatic mammals. Eurasian Water Milfoil has been found to reduce predatory success of fish such as largemouth bass (Engel, 1985), and spawning success for trout (*Salmonidae spp.*) (Newroth, 1985).

The continued spread of EWM can produce significant economic consequences. In the Truckee River Watershed below Lake Tahoe, located in western Nevada and northeastern California, economic damages caused by EWM to the recreation industry have been projected at $30 to $45 million annually (Eiswerth et al., 2003). In Tennessee Valley Authority Reservoirs, EWM was found to depress real estate values, stop recreational activities, clog municipal and industrial water intakes and increase mosquito breeding (Smith, 1971).

Eurasian Water Milfoil has been found to reduce water quality in lakes by several means. Dense mats of EWM have been found to alter temperature and oxygen profiles – producing anoxic conditions in bottom water layers (Unmuth et al., 2000). These anoxic conditions can cause localized die-offs of mollusks and other invertebrates. Eurasian Water Milfoil has also been found to increase phosphorus concentration in lakes through accelerated internal nutrient cycling (Smith and Adams, 1986). Increased phosphorus concentrations released by dead and dying EWM have been linked to algae blooms and reduced water clarity.

Curly Leaf Pondweed (*Potamogeton crispus*) has oblong leaves that are 2-4 inches long and attach to a slightly flattened stem in an alternate pattern. The most distinguishing characteristics are the curled appearance of the leaves, and the serrated leaf edges. Curly-Leaf pondweed produces a seed-like turion, which resembles a miniature pinecone. This exotic pondweed is a cold-water specialist. Curly-Leaf pondweed can begin growing under the ice, giving it a competitive advantage over native plants, which are still lying dormant. By mid-summer when water temperatures reach the upper 70° F, it begins to die off.

Curly-Leaf pondweed has been found in the U.S. since at least 1910. A native of Europe, Asia, Africa and Australia, this plant is now found throughout much of U.S. (Baumann et al., 2000).

As with EWM, curly-leaf pondweeds aggressive early season growth allows it to out compete native species and grow to nuisance levels. Because the plant dies back during the peak of the growing season for other plants though, it is better able to coexist with native species than EWM. Perhaps the most significant problem associated with curly-leaf pondweed involves internal nutrient cycling. The die-off and decomposition of the plant, during the warmest time of year, leads to a sudden nutrient release in the water. This often leads to nuisance algae blooms and poor water quality.

Aquatic Plant Management Options

Historical management of EWM and other widespread aquatic plant populations has included mechanical, biological, and chemical means. It is important to consider each of these control measures before recommending any one for Black Otter Lake. After weighing the pros and cons of each option, the wisest course of action should be chosen, and control efforts continue to provide a recreationally and biologically viable resource. A review of the most pertinent methods follows; other methods are outlined in Table 6.

Hand pulling / DASH

Hand pulling of aquatic plants is useful when plants occur at localized, low frequencies. Care must be taken to remove the entire root mass along with the plant or it will regenerate. Given the current high occurrence and wide distribution of plants in Black Otter Lake, this method is impractical as a lake-wide control option, though it can be used for localized areas with other aquatic plant management options.

This is also a viable option for riparian property owners. Individuals can hand-pull aquatic plants in a 30-foot strip along their property extending out as far as necessary without a permit. If exotic plants are singled out for hand removal, there are no restrictions on the extent of hand-pulling. If individuals choose to hand pull, care should be taken to properly identify exotic species and completely remove any fragments of cut plants.

Mechanical harvesting

Mechanical control methods include hand cutters and boat-mounted mechanical weed harvesters (Nichols, 1974). These methods provide temporary nuisance relief and are rarely recommended as control methods for EWM or CLP, but given the wide distribution, shallow water depths, and high nutrient levels, mechanical harvest should be considered for reclaiming water use in areas overgrown with nuisance levels of aquatic plants. Since the Black Otter Lake District owns its own harvester, this method has merit for the future management of Black Otter Lake.

Milfoil weevils

There has been considerable research on biological vectors, such as insects, and their ability to affect a decline in EWM populations. Of these, the milfoil weevil (*Euhrychiopsis lecontei*) has received the most attention. Native milfoil weevil populations have been associated with declines in EWM in natural lakes in Vermont (Creed and Sheldon, 1995), New York (Johnson et al., 2000) and Wisconsin (Lilie, 2000). While numerous lakes have attempted stocking milfoil weevils in hopes of controlling milfoil in a more natural manner, this method has not proven successful in Wisconsin. A twelve-lake study called "The Wisconsin Milfoil Weevil Project" (Jester et al. 1999) conducted by the University of Wisconsin, Stevens Point in conjunction with the WDNR researched the efficacy of weevil stocking. This report concluded that milfoil weevil densities were not elevated, and that EWM was unaffected by weevil stocking in any of the study lakes. Also, given that EWM is only one of several nuisance species in Black Otter Lake, control of only EWM probably would not result in marked results on the overall plant population and should not be considered as a control option.

Herbicides

Herbicides have been the most widely used and often successful tool for controlling EWM/CLP and other nuisance aquatic plant growth. Historically in Black Otter Lake, large scale treatments for CLP using endothall at a rate of 1.5 ppm have proved successful at reducing biomass in each year but not for long term control or eradication. Herbicide treatments for EWM have used liquid 2, 4-D at a rate of 1.5 ppm and have been observed to get multiple seasons of control. After treatments in 2010 and 2011 no treatment of EWM was needed in 2012 and 2013. Previous treatments for CLP and EWM have decreased biomass to below 2 percent frequency (CLP values of 73.66 and 69.53 were observed in untreated years since 2008). Post treatment, Coontail and Elodea has historically occupied the areas that CLP and EWM occupied pre-treatment.

Herbicide treatments can be less effective in impoundment settings where continuous water flow is a problem. A study in 2013, following a CLP treatment, monitoring endothall concentrations and movement showed the concentration of the main lake remained at or above the target concentration for approximately five days. Concentrations measured south of the train trestle and near the east inlet dropped off quickly (Cason 2014). Most recently the BOLD has determined that they wanted to move away from annual herbicide use. There may be special situations in the future that may warrant the use of herbicides, but for now the BOLD would like to continue with other measures.

Considerations for Black Otter Lake

The Black Otter Lake District currently owns and operates its own harvester and it makes sense to continue to use it for nuisance aquatic plant relief. By creating open areas near shoreline recreational areas and navigation lanes in the lake, BOLD can make the best use of the harvester's time and cost. A recreational use map should be consulted and adapted as lake user groups needs change (Figure 14). The BOLD also wants to continue to target CLP and EWM concentrations with DASH and that effort should be guided by annual aquatic plant surveys.

Table 6. Comparison of Aquatic Plant Control Techniques for Black Otter Lake, Outagamie County, Wisconsin.

Method	Species Selective	Permit Required	Native Plantings also Required	Labor Intensive	Cost per Acre	Labor per Acre	Notes
Manual Cutting/Raking	No	Yes/No	No	Yes	$0	$0	Cost of rake only for small areas
Harvester	No	Yes	Maybe	Yes	$250	Included	Removal off site can be problematic
SCUBA Hand Pulling	Yes	No	No	Yes	$0	$?	Small scale applications only
Bottom Barrier	No	No	Yes	Yes	$1,740	$300	Must be removed annually
Dredging	No	Yes	Yes	Yes	Varies	Varies	Radical habitat alteration
Drawdown	Yes/No	Yes	Yes	No	Permit	$0	Affects lake wide habitat/wildlife
Milfoil Weevils	Yes	No	No	Yes	$500?	$250?	Not proven cost effective / only for EWM
Herbicide	Yes	Yes	Yes / No	No	$400	$100	CLP treatments have not worked long term
Native Plantings	Yes	No	n/a	Yes	$400	$200	Variable / Use with other methods

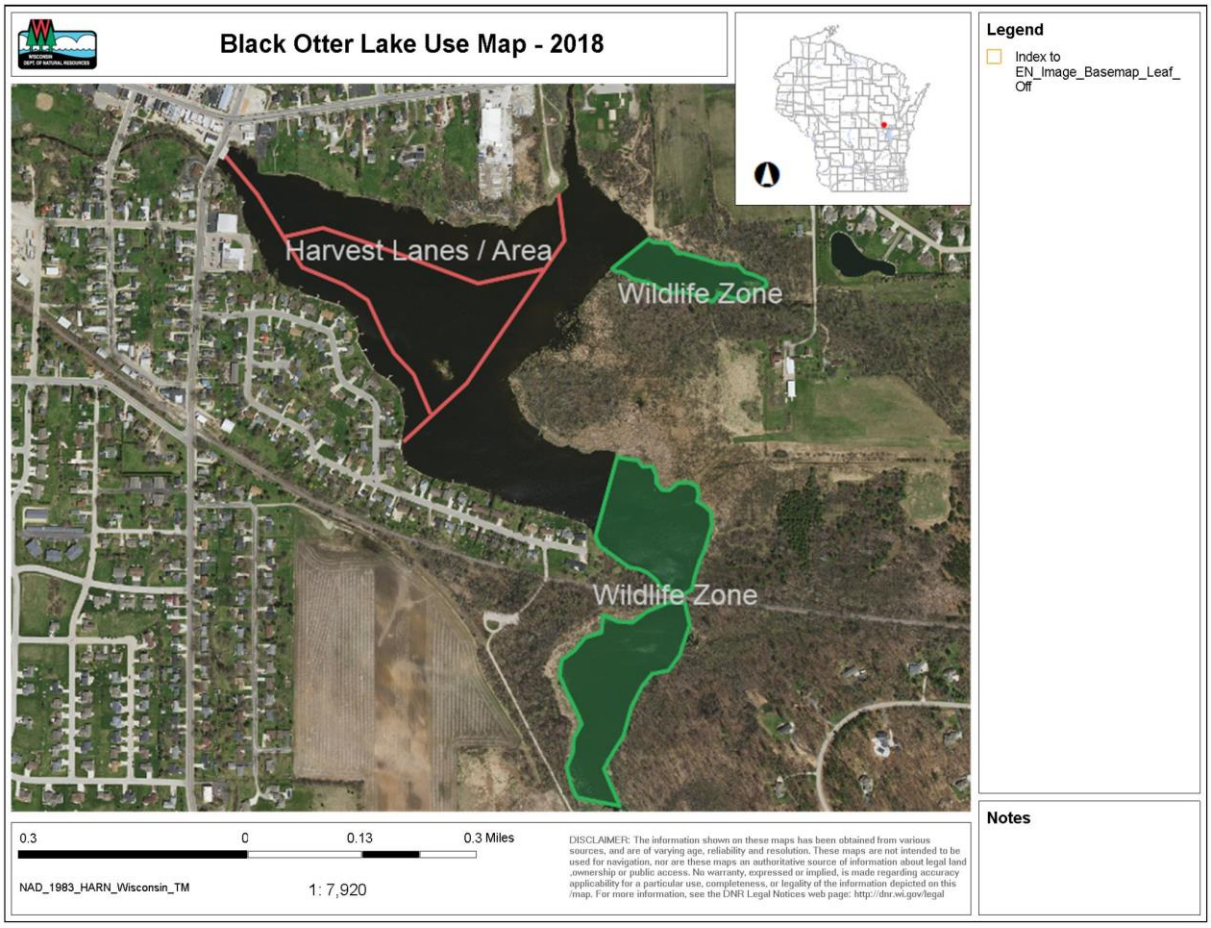


Figure 14. Black Otter Lake Use Map, Black Otter Lake, Outagamie County, WI

Conclusions and Recommendations

- Black Otter Lake District is the main steward for the Black Otter Lake resource and the district and the Village of Hortonville have a long history of managing the lake
- Black Otter Lake, like most of these relatively small community impoundments, has a large watershed, is relatively shallow, receives a lot of runoff, has excess nutrients and aquatic plants which limit recreational use and has caused fish-kills.
- In 2017 Eurasian Water Milfoil and Curly-Leaf Pondweed were observed at their highest frequency levels since point intercept aquatic plant surveys began in 2008 and occupied nearly 100% of the lake.
- Herbicide treatments have historically proved to be effective at reducing exotics but due to the shallowness of the lake, native species would then over take those areas and create recreational use problems.
- The Black Otter Lake District owns and maintains its own harvester and mechanical harvesting has been in use the past three years.
- The District also began using diver assisted suction harvest in 2017 to more effectively control exotic species
- Future management of the resource should include a mix of mechanical harvest (for open water areas and navigation) and diver assisted suction harvest (for exotic species control). Herbicide treatment may be considered for future special circumstances, but at this point is not recommended.
- The Black Otter Lake District should continue to perform annual aquatic plant surveys and review harvest data to track changes and provide data for future management of the resource.

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