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Memorandum

To: Valley Branch Watershed District Board of Managers
From: Meg Rattei, Senior Biologist
Subject: VBWD June 2014 Point-Intercept Macrophyte Surveys
Date: October 3, 2014
Project: 23/82-0405
c: John Hanson, Ray Marshall, Ray Roemmich, Melissa Imse

This memorandum summarizes methods and results of the June 2014 point-intercept plant surveys at Long Lake, Lake DeMontreville, Lake Olson, Lake Jane, Eagle Point Lake, Lake Elmo, Horseshoe Lake, Lake Edith, Lake McDonald, and Sunfish Lake.

Requested Manager Actions

1. Authorize the release of this memorandum and data to the following:
    - A. Maynard Kelsey of McDonald Lake
    - B. Brian Buchmayer of Friends of Long Lake
    - C. Roger Johnson of the VBWD Citizen Advisory Committee and Lake DeMontreville/Olson Association
    - D. Jeff Berg of the VBWD Citizen Advisory Committee and Lake Elmo area resident
    - E. Wendy Griffin, a Lake Elmo area resident
    - F. Dale Dorschner, a Lake Elmo area resident
    - G. Keegan Lund of Minnesota Department of Natural Resources (MnDNR) (permit reporting requirements for Long Lake herbicide treatment)
    - H. Wally Nelson, council member, City of Lake Elmo
    - I. Dean Zuleger, administrator, City of Lake Elmo
2. Approve Lake Vegetation Management Plans for Lake DeMontreville and Lake Olson and submit to the Minnesota Department of Natural Resources after the plans are signed by the VBWD President and Lake DeMontreville/Olson Association President.

3. Authorize technical support to prepare lake vegetation management plans (LVMPs) for Silver Lake, Lake Jane, and Lake Elmo

4. Authorize technical support to Friends of Long Lake, Lake DeMontreville/Olson Association, and the City of Lake Elmo for herbicide treatment of Eurasian watermilfoil (EWM) in Long Lake, Lake DeMontreville, Lake Olson, Lake Jane, and Lake Elmo during 2015. Authorize technical support to Silver Lake Improvement Association for management of EWM and/or curly-leaf pondweed (CLP) in 2015. Technical support would include:

    a. Two point-intercept plant surveys in each lake, one in spring before treatment and one in June after treatment. Both are permit requirements.

    b. Permitting.

    c. Treatment design.

    d. Reporting required by MnDNR in the treatment permit.

5. VBWD organize a special VBWD EWM management committee to inform stakeholders of EWM management options and discuss roles and responsibilities. Committee members could include representatives of the lake associations of lakes currently infested with EWM (Silver Lake, Long Lake, Lake DeMontreville, Lake Olson, Lake Jane, Lake Elmo), at least one VBWD Board member, the District Engineer and other appropriate Barr staff, and representatives from each of the cities (Lake Elmo, Pine Springs, Mahtomedi, North St. Paul, and Maplewood).

2014 Sample Methods

Matt Berg of Endangered Resource Services, LLC conducted the point-intercept plant surveys from June 25 through June 28 and on June 30, 2014. He located equally spaced preset points in the field with GPS and took measurements at each point. His measurements included the following:

1. Individual species present
2. Overall density of plants, as measured by rake method
3. Density of individual species, as measured by rake method
4. Water depth
5. Dominant sediment type

Results

The results of the 2014 aquatic plant surveys of 10 VBWD lakes are summarized in Table 1. The following data are presented:

- **Number of species**—the number of different plant species that were either collected on the rake or observed in the lake (e.g., water lilies or cattail beds not collected on the rake but observed). This number includes both invasive species and native species.

- **Number of native species**—the number of native plant species that were either collected on the rake or observed in the lake.

- **Number of native species collected on rake—** only native plants collected on the rake were used for this statistic.

- **Number of invasive species—**the number of invasive plant species that were either collected on the rake or observed in the lake.

Endangered Resource Services used a rake (pictured above) to collect plants for the plant surveys. Rake fullness is a measure of plant density. On average, VBWD Lakes had a rake fullness of 2.15 in 2014, indicating the rake head was generally between one third and two thirds full of plants.

- **Maximum depth of plant growth**—the maximum depth that plants were found in the lake.

- **Frequency of occurrence—**the frequency with which plants were found in water shallower than the maximum depth of plant growth.

- **Average rake fullness—**the density of plant growth, as measured by rake fullness on a scale of 1 to 4, where:

  1 = less than 1/3 of the rake head full of plants.

  2 = from 1/3 to 2/3 of the rake head full of plants.

  3 = plants fill more than 2/3 of the rake head.

  4 = rake head is full, with plants overtopping the rake head.

- **Simpson Diversity Index Value**—index used to measure plant diversity, which assesses the overall health of the lake's plant communities. The index, with scores ranging from 0 to 1, considers both the number of species present and the evenness of species distribution. The scores represent the probability that two individual plants randomly selected from the lake will belong to different species. A high score indicates a more diverse plant community—a higher probability that two randomly selected plants will represent different species.

- **C value—**scale of values used to measure the average tolerance of the plant community to degraded conditions. Plant species are assigned C values on a scale of 0 to 10, with increasing values indicating plants are less tolerant of degraded conditions and, hence, are of better quality. An average of the C values for individual species within a lake's plant community indicates the average tolerance of the community to degraded conditions.

- **Floristic Quality Index (FQI) value—**FQI was used to assess the quality of the plant communities in VBWD lakes. FQI considers both the quality of the individual native species found in the lake (C value) and the number of native species collected on the rake. Although Minnesota has not kept a record of FQI values, recorded Wisconsin FQI values range from 3 (degraded plant communities) to 49 (diverse native plant communities). The median FQI for Wisconsin is 22.

Table 2 summarizes invasive species data from the 10 VBWD lakes surveyed in 2014. The table shows the frequency of occurrence of species collected on the rake and species that were observed but not collected on the rake.

A discussion of survey results for the 10 individual lakes follows Table 2. Figures summarizing the frequency of occurrence of individual plant species found in the lakes from 2012 through 2014 are presented. The figures provide an overview of changes in plant frequency and indicate whether the changes are significant; significant changes are denoted with asterisks. The number of asterisks denotes the level confidence that the change is not due to chance. One asterisk indicates a 95 percent confidence, two asterisks indicate a 99 percent confidence, and three asterisks indicate a 99.9 percent confidence.

VBWD managed two invasive species in 2014—hand-harvesting purple loosestrife at Lake Jane and hand-harvesting yellow iris and purple loosestrife at Lake DeMontreville. In addition, VBWD provided technical assistance for herbicide management of EWM at Long Lake, Lake DeMontreville, and Lake Olson. A discussion of these management efforts is included in the discussions of these lakes.

Table 1 2014 Valley Branch Watershed District Lake Plant Survey Summary Statistics

Lake	Number of Species	Number of Native Species	Number of Native Species Collected on Rake*	Number of Invasive Species	Maximum Depth of Plant Growth (feet)	Frequency of Occurrence (%)	Average Rake Fullness	Simpson Diversity Index Value	C Value	FQI Value
Jane	36	31	28	5	18.5	100	2.75	0.92	6.4	32.0
Elmo	31	27	17	4	21.0	95	2.59	0.88	4.9	20.4
Sunfish	30	27	23	3	12.5	65	1.68	0.90	5.6	24.5
Olson	26	22	19	4	20.5	91	1.67	0.90	6.3	28.0
DeMontreville	25	21	19	4	22.0	92	1.95	0.90	6.0	26.8
McDonald	23	20	18	3	12.5	79	1.92	0.80	5.1	19.0
Eagle Point	20	17	15	3	8.5	100	3.34	0.85	5.5	22.6
Edith	20	17	13	3	10.5	90	1.73	0.88	5.3	19.8
Horseshoe	14	10	5	4	13.0	65	2.42	0.76	3.7	9.0
Long	14	10	10	4	24.0	43	1.40	0.83	5.5	17.4
Average	**24**	**20**	**17**	**4**	**16.3**	**82**	**2.15**	**0.86**	**5.4**	**22.0**

Table 2 2014 Valley Branch Watershed District Invasive Species Summary: Frequency of Occurrence at Sites Shallower than Maximum Depth of Plant Growth (Percent or Observed)

Lake	**Myriophyllum spicatum** (Eurasian watermilfoil)	**Potamogeton crispus** (curly-leaf pondweed)	**Phalaris arundinacea** (reed canary grass)	**Lythrum salicaria** (purple loosestrife)	**Typha angustifolia** (narrowleaf cattail)	**Typha glauca** (hybrid cattail)
Horseshoe	40	7	6	--	8	--
Elmo	34	Observed*	3	--	16	--
Olson	28	3	Observed*	--	Observed*	--
DeMontreville	19	10	1	--	--	1
Jane	19	8	Observed*	Observed*	--	Observed*
Long	10	11	Observed*	--	--	Observed*
Eagle Point	--	54	Observed*	--	30	--
Sunfish	--	6	9	--	Observed*	--
Edith	--	4	1	--	--	1
McDonald	--	2	15	--	2	--

*Observed in the lake but not collected on the rake.

Lake DeMontreville—On June 10, 2014, Barr completed hand harvesting of two invasive species from an area near the Lake DeMontreville boat launch. Barr removed a total of 30 yellow iris and 4 purple loosestrife plants.

Purple loosestrife (above left) and yellow iris (above right) were removed from Lake DeMontreville by hand harvesting on June 10, 2014.

In 2014, Barr provided technical assistance to help the Lake DeMontreville/Olson Association manage EWM, which had increased in frequency from 4 percent in 2012 to 33 percent in 2013. The results of a pre-treatment aquatic plant survey completed by Endangered Resource Services, LLC on May 24, 2014, indicated EWM frequency was 34 percent. Barr initially designed an herbicide treatment plan that involved treating a larger area and adding sufficient herbicide to effectively manage the EWM in the lake. However, budget constraints prevented the Lake DeMontreville/Olson Association from implementing this plan and a smaller area that fell within their budget was selected for treatment. On June 6, 4.3 acres were treated with 2,4-D (Figure 1). The treatment dose was 4 parts per million. A post-treatment aquatic plant survey completed by Endangered Resource Services, LLC on June 28 indicated the treatment reduced EWM frequency to 19 percent (Figure 2). The decline from 34 percent to 19 percent is a statistically significant decline. However, the Lake DeMontreville/Olson Association indicated that the EWM reduction was temporary. Plant levels rebounded to pre-treatment levels by late August, resulting in the worst EWM growth observed to date. Apparently, the treatment killed EWM plants but not the root crowns, which were able to grow new plants.

The Lake DeMontreville treatment results were consistent with current EWM research. A whole-lake 2,4-D concentration of about 0.3 ppm must be attained and sustained for about 3 days to kill the EWM root crowns and attain lasting EWM control. In Lake DeMontreville, Barr estimated that the whole lake 2,4-D concentration after mixing would be 0.04 ppm based upon lake volume and the gallons of herbicide applied. This low concentration killed the plants, but left viable root crowns that enabled EWM to rebound to pre-treatment levels.

A decline in curly-leaf pondweed (CLP) was observed in Lake DeMontreville in 2013 and, again, in 2014 (Figure 2). Both declines are attributed to thick snow cover and late ice-out that created unfavorable growth conditions for CLP during the winter months. The decline from a 49 percent frequency in 2012 to a 42 percent frequency in 2013 is not statistically significant. However, the decline from 42 percent in 2013 to 10 percent in 2014 is considered statistically significant (Figure 2).

The native plants in Lake DeMontreville remained stable in 2014 except for a significant reduction in filamentous algae, a positive change for the lake. Filamentous algae increased significantly from 6 percent in 2012 to 33 percent in 2013, then decreased significantly to 14 percent in 2014 (Figure 2).

Figure 1 Lake DeMontreville June 2014 Herbicide Treatment Areas

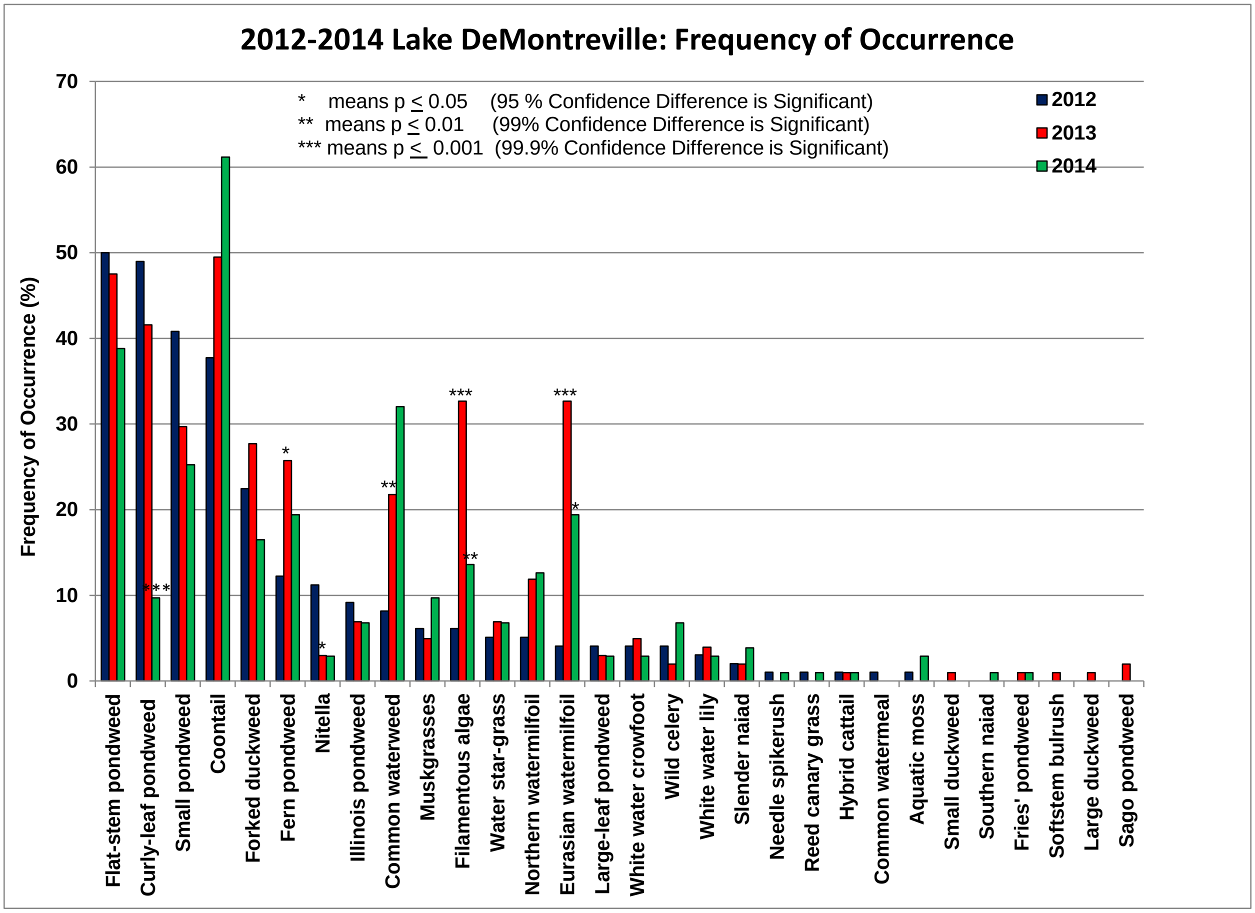

Figure 2 2012–2014 Lake DeMontreville Frequency of Occurrence (Frequency of Occurrence at Sites Shallower than the Maximum Depth of Plants)

Note: * indicates a significant change in frequency of occurrence between years.

The frequency of occurrence for coontail and wild celery, two native plants, increased noticeably during 2014, but not at statistically significant levels. Coontail has increased from 38 percent in 2012, to 50 percent in 2013, to 61 percent in 2014 (Figure 2). Coontail in the western bays of Lake DeMontreville was often canopied in 2014 (i.e., reached the surface) at water depths of 8 feet or greater.

In the western bays of Lake DeMontreville, coontail (pictured above) was often canopied at water depths of 8 feet or greater.

Wild celery also increased in 2014, going from a 2 percent frequency of occurrence in June of 2013 to 6 percent in June of 2014 (Figure 2). While not statistically significant, this increase was noticeable to residents. One reported that "wild celery really went wild in late July and early August when its pig-tail curly stems shot to the surface. It was ugly and it was likely a lot more than 6 percent." Although residents did not like this change, wild celery is a native plant considered valuable to the lake ecosystem. Wild celery is a premiere source of food for waterfowl, marsh birds, shore birds, and muskrats. Wild celery also provides shade, shelter, and feeding opportunities for fish. In early September, wild celery plants became dislodged from the bottom and clumps of wild celery plants, complete with roots, were observed floating in the lake. The reason for the dislodging of the wild celery plants is unknown.

Eagle Point Lake—Eagle Point Lake experienced problematic growths of CLP from 2012 through 2014. In 2014, the overall density of CLP was significantly reduced, but the distribution was not (Figure 3). The reduction in density is presumably due to the thick snow cover and late ice-out during 2014. The frequency of occurrence for small pondweed, coontail, and common waterweed increased at statistically significant levels (Figure 3); density also increased (Figure 4) during 2014. These plants seem to be suppressing CLP growth. The reduction in CLP density is a positive change for the lake.

Reed canary grass, which is an invasive species, was abundant along the lakeshore and in surrounding wetland areas.

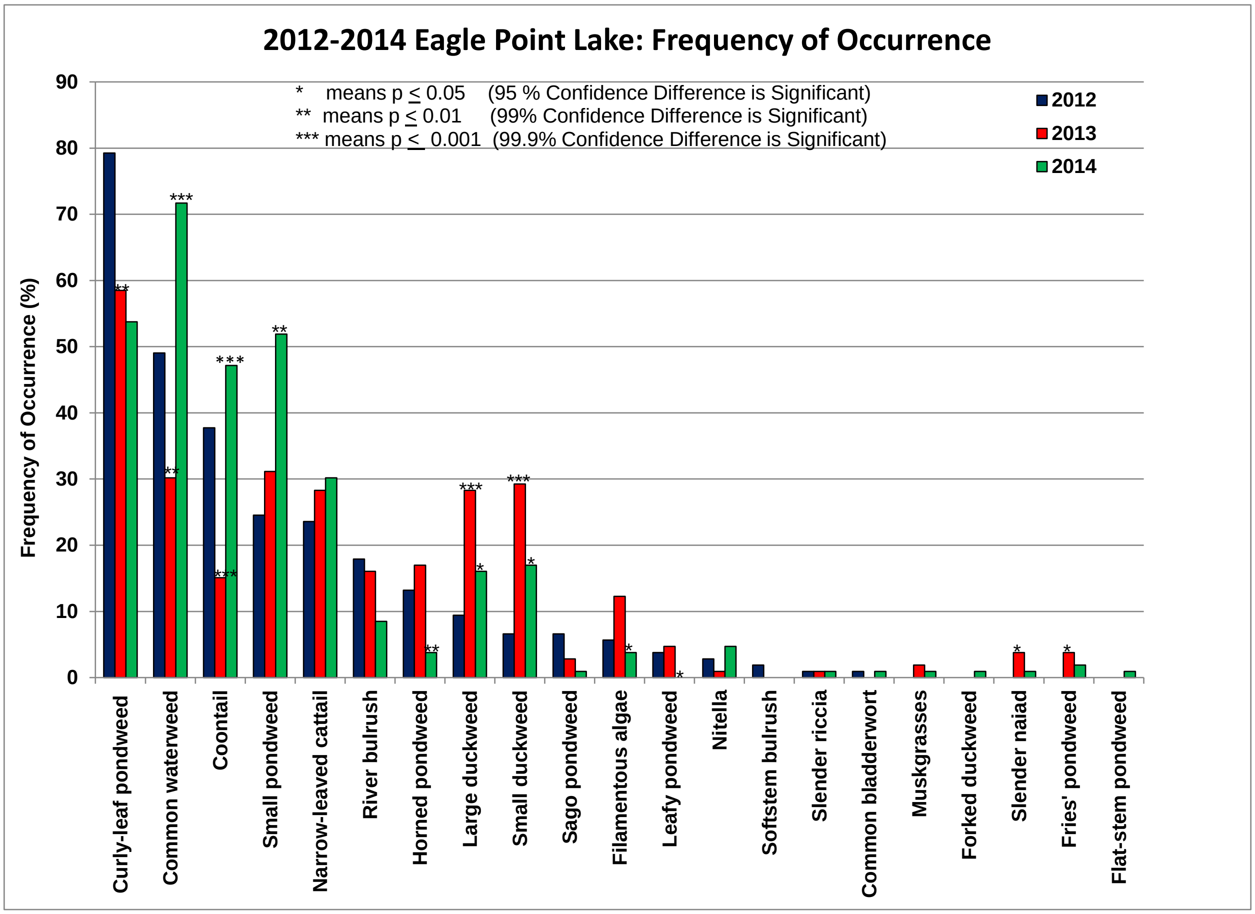

Figure 3 2012–2014 Eagle Point Lake Frequency of Occurrence (Frequency of Occurrence at Sites Shallower than the Maximum Depth of Plants)

Note: * indicates a significant change in frequency of occurrence between years.

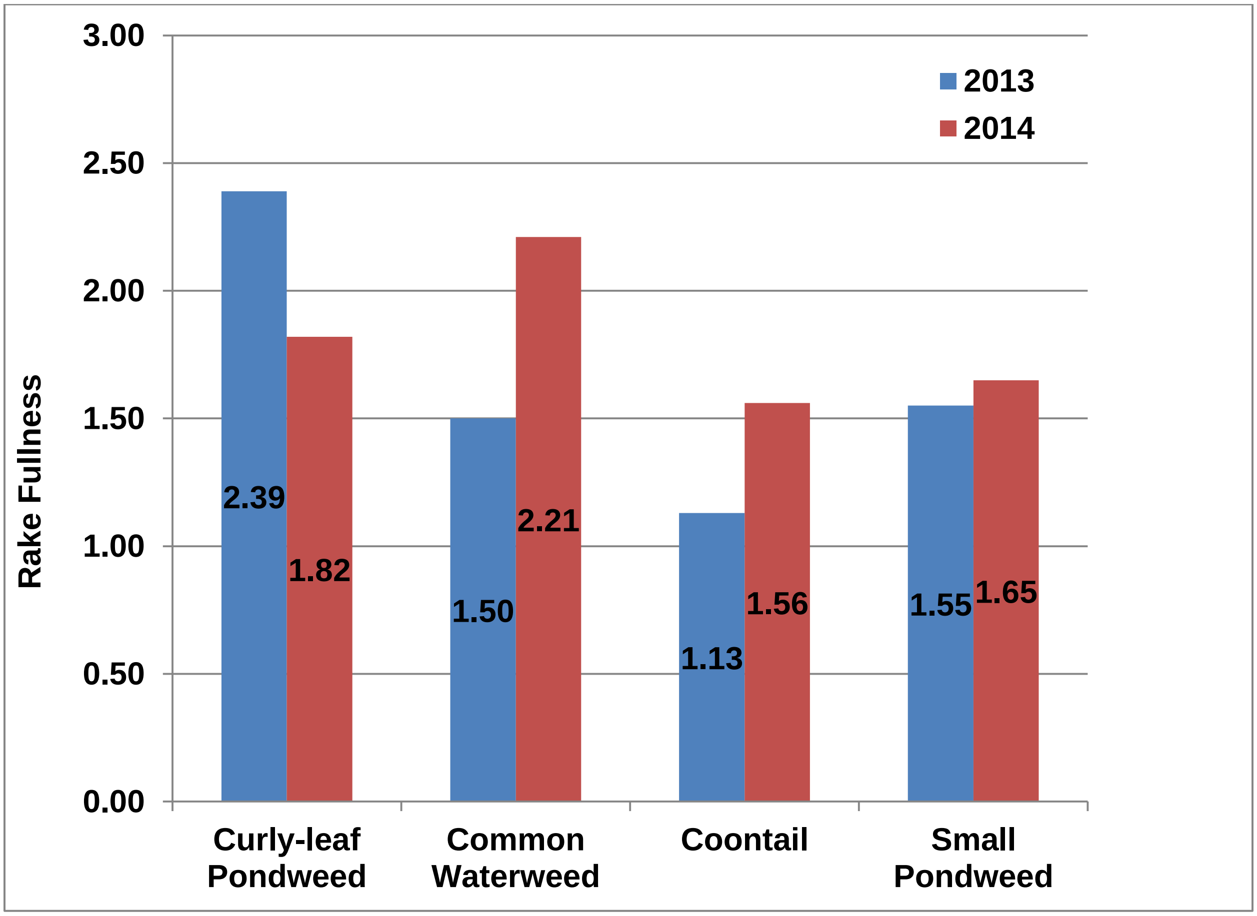

Figure 4 **2013–2014 Changes in Eagle Point Lake Plant Density (Rake Fullness): Curly-Leaf Pondweed, Small Pondweed, Coontail, and Common Waterweed**

The native plant community was generally stable during 2014, although horned pondweed, large and small duckweed, and leafy pondweed declined significantly. The occurrence of filamentous algae also declined, which is a positive change for the lake (Figure 3).

Horseshoe Lake—In Horseshoe Lake, EWM frequency increased significantly: from 10 percent in 2013 to 40 percent in 2014 (Figure 5). This makes EWM frequency in Horseshoe Lake higher than any other VBWD lake (Table 2). Both EWM distribution and density increased, from a rake fullness of 1.4 in 2013 to 2.4 in 2014.

EWM in Horseshoe Lake, pictured above, increased in both distribution and density in 2014.

EWM displaced native species, resulting in decreased frequencies for these plants. With the exception of common waterweed, the decreases were not statistically significant (Figure 5).

Although CLP increased in frequency from 4 percent in 2013 to 7 percent in 2014 (Figure 5), the increase is not statistically significant and was not accompanied by an increase in density. Widely scattered and represented by just a handful of plants, CLP was not a problem in 2014.

In 2014, the number of plant species in Horseshoe Lake was less than all VBWD lakes except Long Lake. The other eight VBWD lakes had from 20 to 36 plant species, compared with 14 species in both Horseshoe Lake and Long Lake. In 2013, Horseshoe Lake's plant community was below average in quality as measured by a C value of 4.3 (average value is 5) and an FQI value of 12 (Wisconsin median value is 22). These values declined in 2014 (C value of 3.7 and FQI value of 9), indicating that the quality of the Horseshoe Lake plant community declined. The increased distribution and density of EWM in 2014 is the presumed cause of the decline in plant community quality.

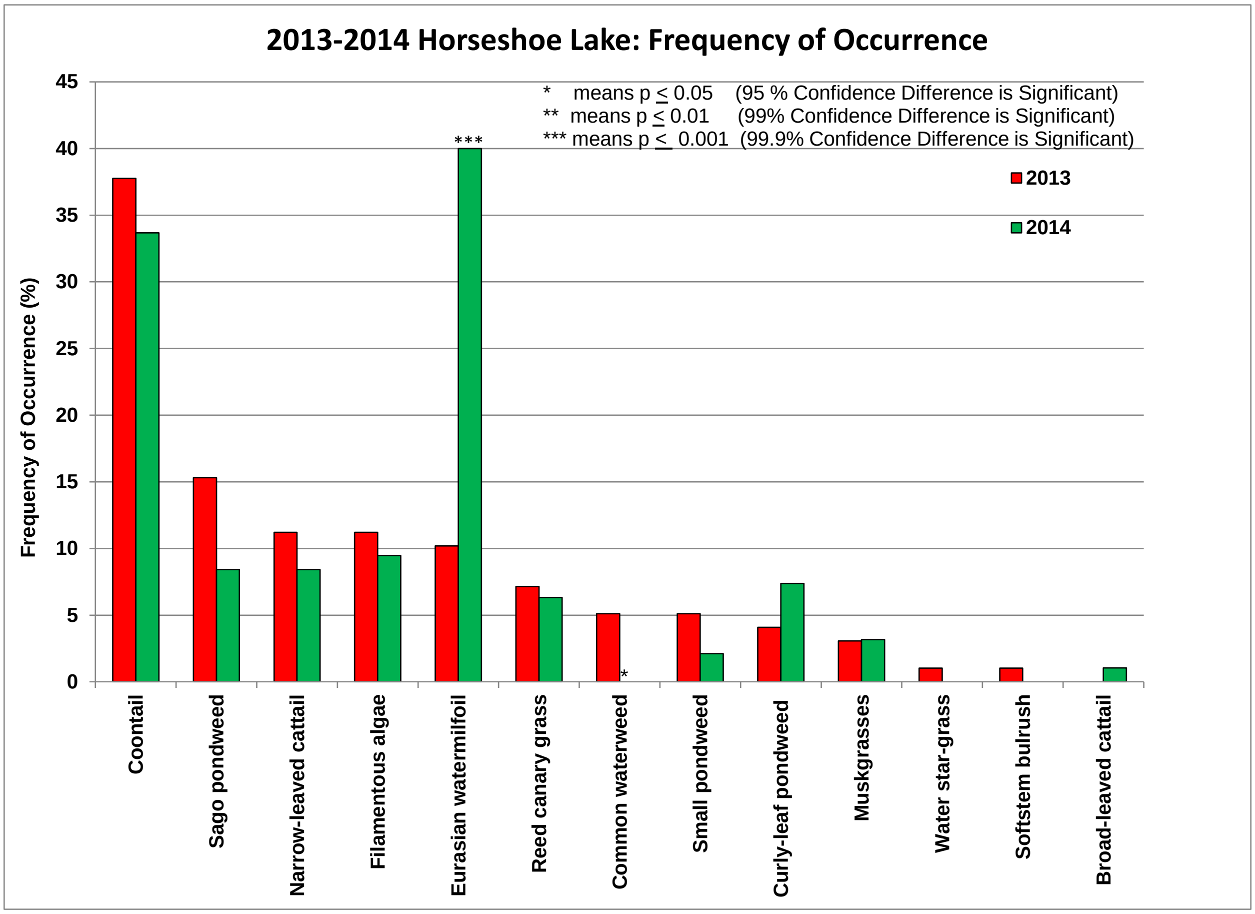

Figure 5 2013–2014 Horseshoe Lake Frequency of Occurrence (Frequency of Occurrence at Sites Shallower than the Maximum Depth of Plants)

Note: * indicates a significant change in frequency of occurrence between years

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Lake Edith—Lake Edith has a poor growing substrate for plants; the lake bottom consists of marly clay and thin muck over sand. This poor substrate protects the lake from problematic growth of invasive species. Hence, even though CLP is present in the lake, the poor habitat limits its growth and will likely prevent CLP from becoming problematic. CLP was found at a frequency of 4 percent and at a low density (i.e., 1) in both 2013 and 2014.

The native plant community remained relatively stable during 2014. However, significant changes were observed for three species. Northern watermilfoil significantly increased while horned pondweed and large duckweed significantly decreased. Rapid increases and decreases in frequency are common for northern watermilfoil. The decrease in horned pondweed is attributed to scouring by high water in the stream inlet from Metcalf Marsh during 2014. The decrease in large duckweed is likely due to the very late ice-out/spring.

Lake Elmo—EWM was problematic in 2014, despite a decline in frequency. EWM frequency has declined from 44 percent in 2012, to 34 percent in 2014; however, the declines were not statistically significant (Figure 7). EWM was again dominant in the north and south bays, but more scattered along the deep drop-offs on the east and west shorelines. EWM and all plants, in general, were behind last year's growth due to the late ice-out/spring.

Curly-leaf pondweed was observed in the lake, but was not collected on the rake during the 2014 plant survey. It was uncommon in 2014 and, hence, not problematic.

The native plant community was relatively stable, but there was a significant increase in the frequency of coontail—from 26 percent in 2013 to 43 percent in 2014 (Figure 7). The frequency of hybrid cattail increased significantly in 2014, while the frequency of narrow-leaved cattail decreased significantly.

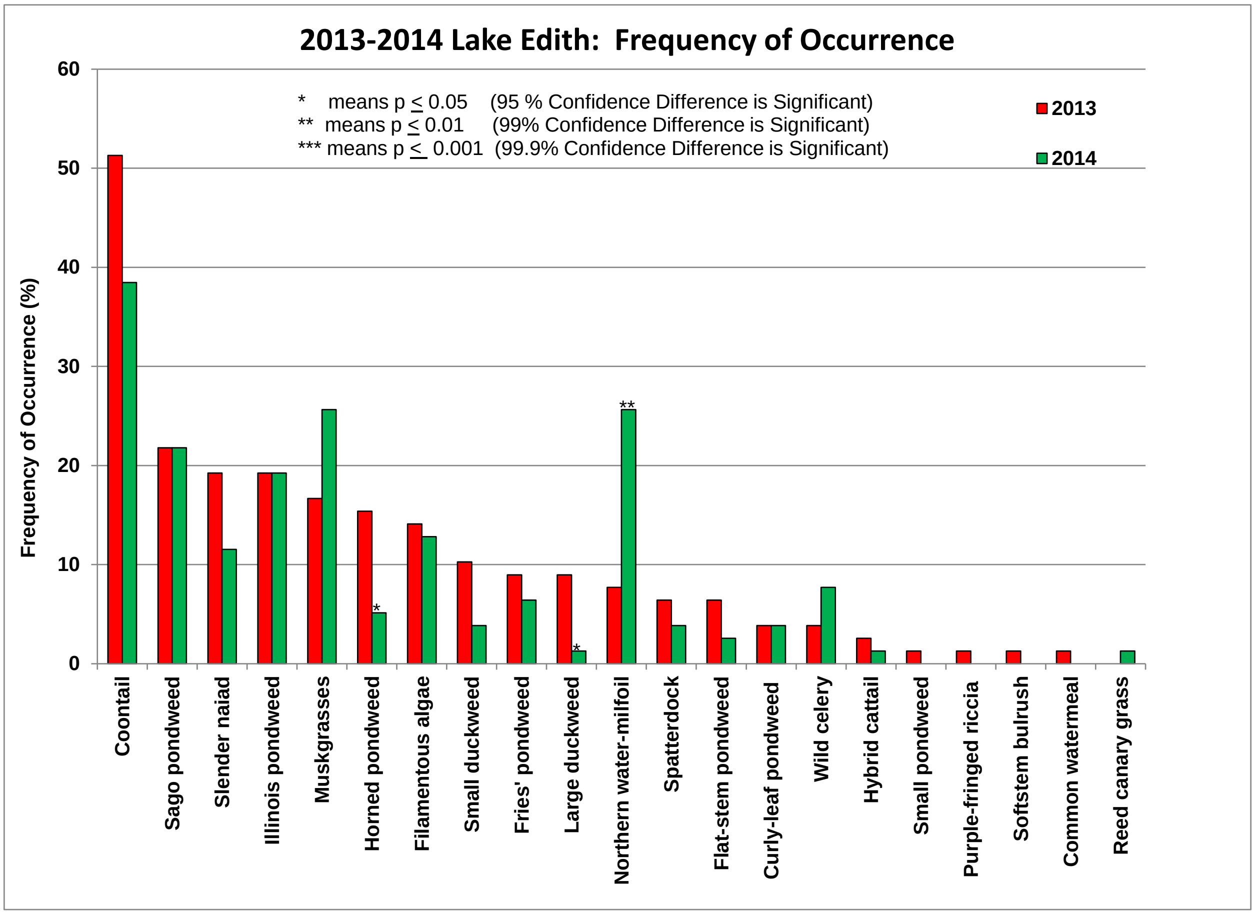

Figure 6 2013–2014 Lake Edith Frequency of Occurrence (Frequency of Occurrence at Sites Shallower than the Maximum Depth of Plants)

Note: * indicates a significant change in frequency of occurrence between years.

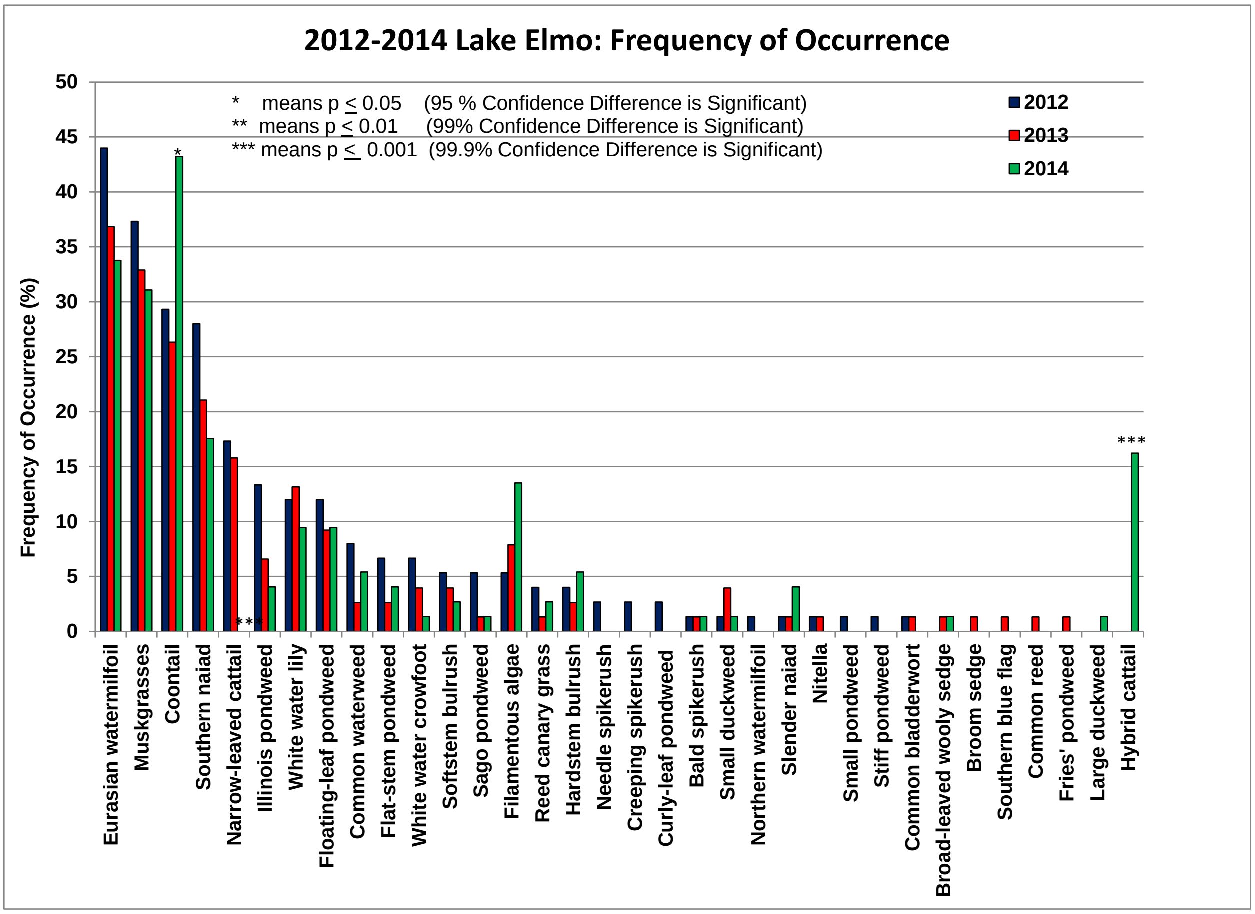

Figure 7 2012–2014 Lake Elmo Frequency of Occurrence (Frequency of Occurrence at Sites Shallower than the Maximum Depth of Plants)

Note: * indicates a significant change in frequency of occurrence between years.

Lake Jane—Barr completed hand harvesting of purple loosestrife in 2014 because plants were observed at the Lake Jane boat landing in 2012 and 2013. On June 10, 2014, Barr removed 30 to 40 purple loosestrife plants near the boat landing. Although purple loosestrife was not observed near the boat landing during the June 27, 2014, plant survey, it was scattered among the cattails and other emergent plants on the south and western shorelines.

Top photo: Purple loosestrife plants near the Lake Jane boat landing were removed by hand harvesting in 2014.

Bottom photo: In 2014, EWM in Lake Jane formed dense monotypic beds.

EWM frequency in Lake Jane has steadily increased since 2012, when it was first observed in the lake. The 2012 EWM infestation consisted of a few scattered plants on the east side of the lake and was not collected on the rake during the 2012 survey. EWM increased to a frequency of 2 percent in 2013 and then to 19 percent in 2014 (Figure 8)—expanding throughout the lake, especially along the east side.

The significant increase in EWM distribution was accompanied by a significant increase in density, from a rake fullness of 1.0 in 2013 to 1.9 in 2014. Dense monotypic beds of EWM were seen (i.e., EWM was the sole species).

CLP density is low and frequency (8%) has decreased by about half since 2012, which is not considered statistically significant (Figure 8). In 2014, as in 2013, most CLP plants in Lake Jane were found on the south shoreline, mixed with lilies and watershield.

In 2014, as in 2013, reed canary grass was scattered throughout the lake's shoreline.

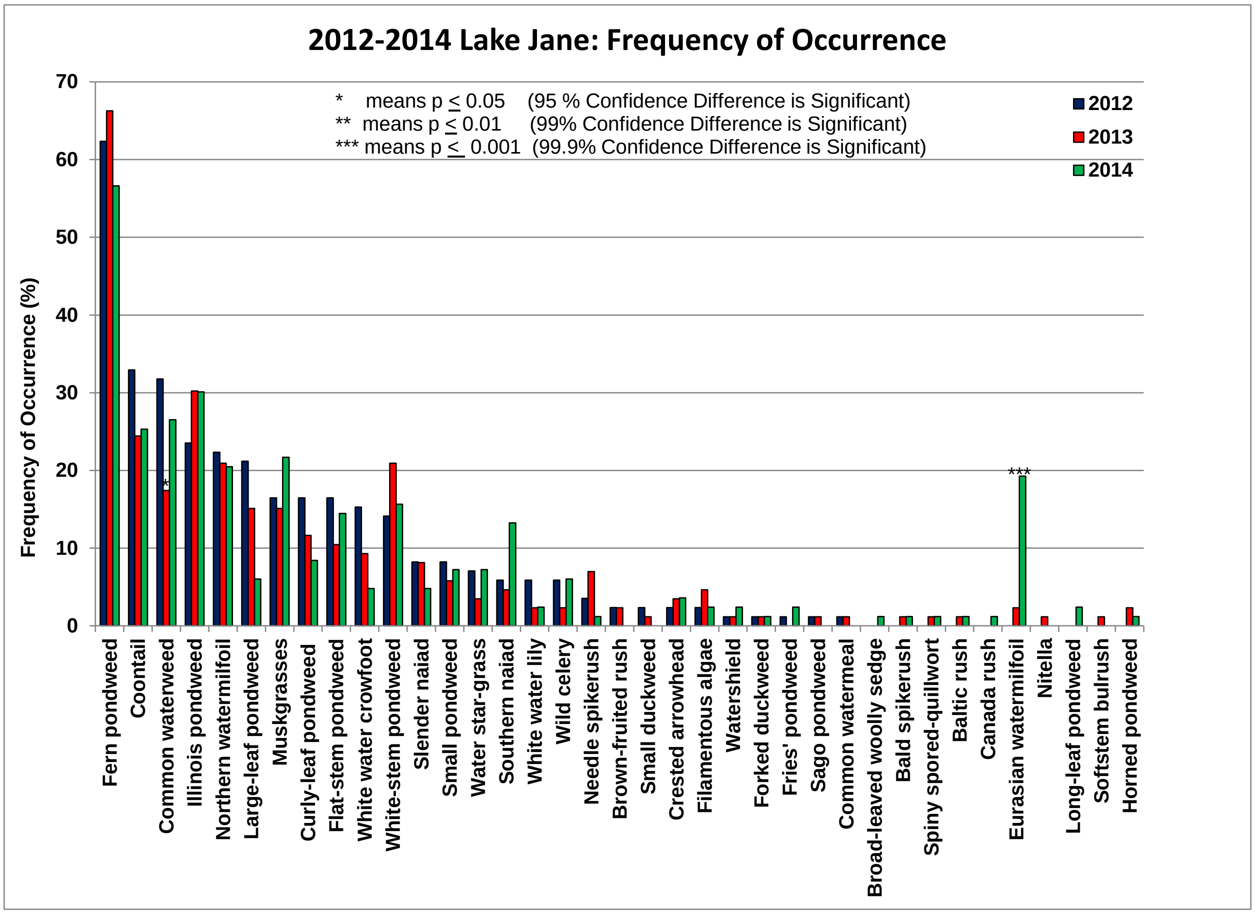

Figure 8 2012–2014 Lake Jane Frequency of Occurrence (Frequency of Occurrence at Sites Shallower than the Maximum Depth of Plants)

Note: * indicates a significant change in frequency of occurrence between years

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As measured by number of species and quality, Lake Jane has an above-average plant community. The community was generally stable in 2014, except for a significant increase in southern naiad. The expansion of southern naiad appears to be correlated with EWM expansion in the lake. Southern naiad often increases in lakes with EWM because it can overwinter and crowd into gaps/understory created by EWM. The significant increase in southern naiad is considered good for the lake because this native plant provides food for both waterfowl and fish and provides shelter for fish.

Long Lake—The Friends of Long Lake treated a 22-acre area of the lake with 2,4-D on May 29, 2014, to control EWM. The treatment areas are shown in Figure 9 as green polygons. Approximately 36 percent of the lake surface area was treated with a dose of 1.10 parts per million (ppm).

After application, the herbicide typically mixes with untreated waters as waves and lake currents move the herbicide and untreated waters around the lake. The concentration of herbicide in the treatment area typically diminishes as the lake mixes, with untreated waters diluting the herbicide. Eventually, the herbicide is mixed throughout the lake and a homogeneous concentration is attained. After mixing, Barr estimated that the herbicide concentration would be 0.3 parts per million based upon the lake volume and gallons of herbicide applied (Figure 9). This is the optimum 2,4-D whole-lake concentration for controlling EWM while protecting native species (personal communication, John Skogerboe 2012).

To determine whether the treatment areas in Long Lake attained and sustained the target 2,4-D concentration of 0.3 ppm for at least 3 or 4 days after treatment, Friends of Long Lake collected herbicide residue samples from three treatment locations 2 and 4 days after treatment. Sample locations are shown in Figure 10 and monitoring results are presented in Table 3. Stations 1 and 3 are located in shallow areas at the north and south ends of the lake, respectively. Station 2, located in a shallow mid-lake area near the lake's deep hole and surrounded by deeper waters, is very vulnerable to mixing and dilution. This mixing reduced the 2,4-D concentration to 0.2 ppm 2 and 4 days after treatment. Stations 1 and 3 were able to sustain a 2,4-D concentration above the 0.3 ppm target, with concentrations from 0.5 to 0.6 ppm observed 2 and 4 days after treatment.

An herbicide residue sample collected 30 days after treatment showed that the herbicide had degraded into carbon dioxide and water, as expected, and was nearly gone from the lake.

Figure 9 Long Lake 2014 Herbicide Treatment Areas

	UTM NAD83 Zone 15N (meters)	
Herbicide Residue Monitoring Location	Easting	Northing
1	503005.41	4987222.23
2	503257.04	4986706.38
3	503185.14	4986499.46

Figure 10 2014 Long Lake Herbicide Residue Monitoring Locations

Table 3 2014 Long Lake 2,4-D Residue Data Summary

Date Sampled	Days After Treatment	2,4-D (ppm)			
		Station 1	Station 2	Station 3	Average All Locations
5/31/2014	2	0.464	0.165	0.576	0.401
6/2/2014	4	0.565	0.227	0.491	0.427
6/30/2014	30	0.013	Not Measured	Not Measured	0.013

From 2010 through 2014, VBWD has annually provided technical assistance to help the Friends of Long Lake manage EWM. Data collected by VBWD indicate herbicide treatments in 2011, 2013, and 2014 have reduced EWM frequency from 92 percent to 10 percent (Figure 11). The effectiveness of the Long Lake herbicide treatment is further verified by comparing the reduction in EWM frequency within Long Lake with increases in EWM frequency within two untreated VBWD lakes:

- From 2012 through 2014, EWM frequency in Lake Jane, an untreated lake, increased from 0 to 19 percent (Figure 8). Over the same period, herbicide treatment reduced EWM frequency in Long Lake from 29 percent to 10 percent (Figure 11).

- From 2013 through 2014, EWM frequency in Horseshoe Lake increased from 10 percent to 40 percent (Figure 5). Over the same period, herbicide treatment reduced EWM frequency in Long Lake from 26 percent to 10 percent (Figure 11).

On June 25 of 2014, EWM was observed at 13 locations (Figure 12) in Long Lake. Although some individual plants/root crowns had survived the 2014 herbicide treatment, almost all EWM plants found in June were small sprouts less than 1 foot in length (see photo at right) growing from vegetation fragments in relatively deep water (i.e., 11 to 20 feet). The lake level at the time of the survey was 942.10 feet, which is 54 inches above the outlet. The lake level was high and the lake was turbid due to a major rainstorm on June 19 in which more than 4 inches of rainfall occurred. The turbidity of the lake at the time of the sampling suggested the survival of the EWM sprouts was questionable due to light limitation in the deep waters. The majority of locations with EWM growth were in the southwest area of the lake, relatively near the lake's inlet.

Almost all EWM plants found in June of 2014 were small sprouts, less than 1 foot in length.

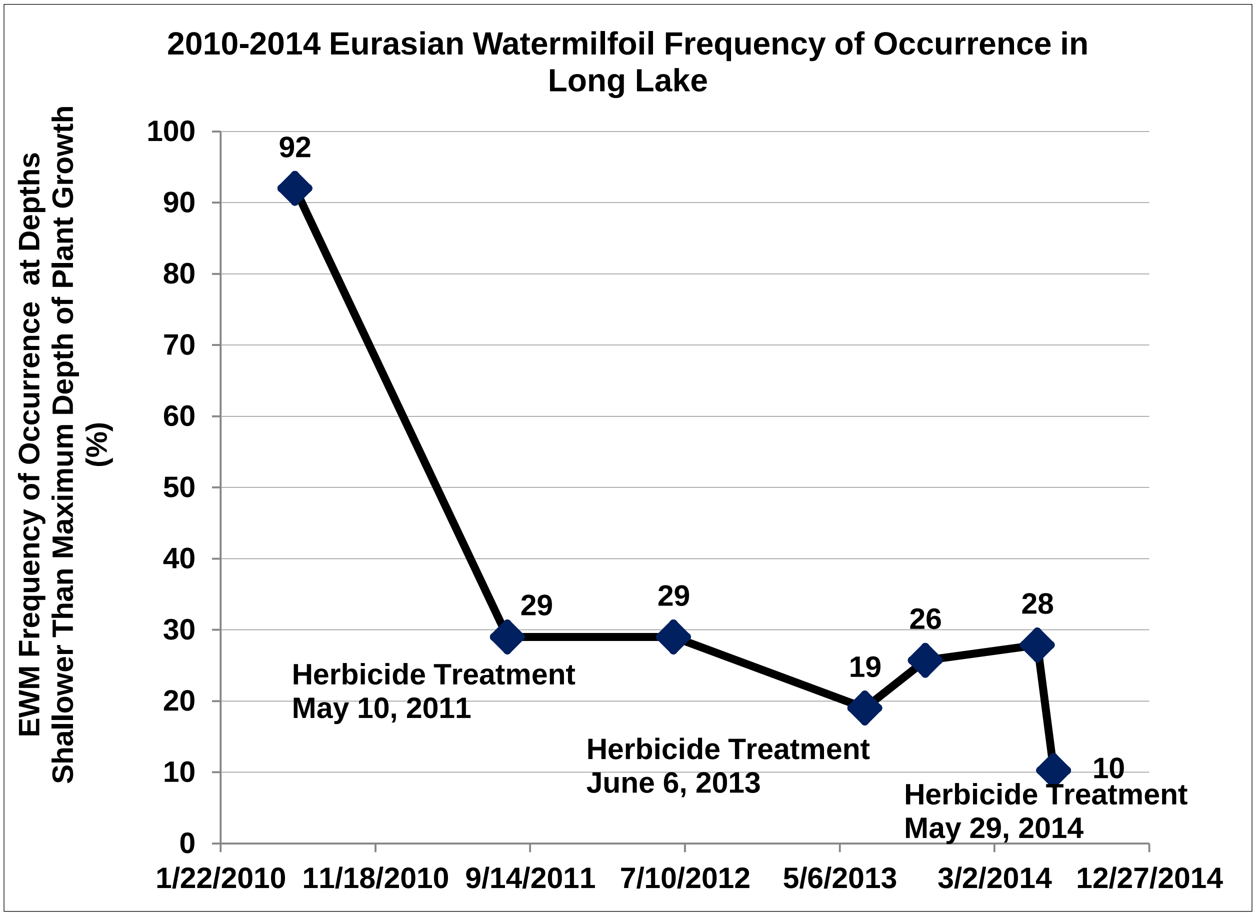

Figure 11 **2010–2014 Eurasian Watermilfoil Frequency of Occurrence in Long Lake**

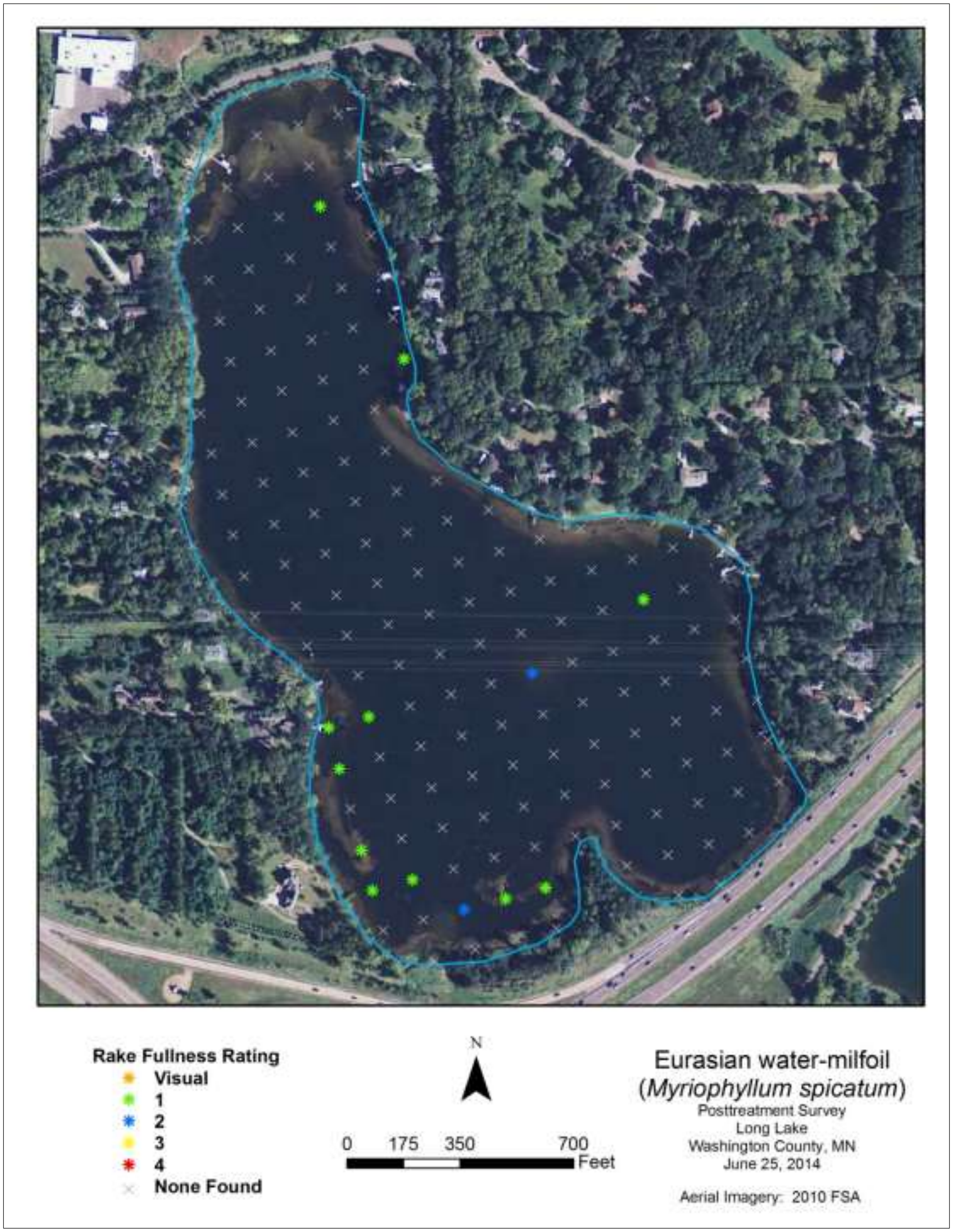

Figure 12 Long Lake Post-Treatment EWM Locations (June 25, 2014)

After the reduction in EWM during 2011, CLP frequency increased rapidly in Long Lake, as the plant took over areas previously occupied by EWM. However, since its 2012 peak of 41 percent, CLP frequency has subsequently declined by 30 percent. Decreases to 25 percent in 2013 and 11 percent in 2014 are attributed to the thick snow cover and late ice-out. The increase in CLP during 2012 and decreases during 2013 and 2014 were statistically significant (Figure 13).

The small size of the CLP plants collected in June of 2014 and the lack of turions (overwintering buds) on the plants provided further indication that growing conditions for CLP in 2014 were poor. At the time of the June 2014 survey, CLP plants were at the end of their growing cycle and the lower leaves had started to turn black.

As EWM frequency has declined, muskgrasses and small pondweed have been making a comeback in the lake. A significant increase was observed for both species during 2014, with frequencies either doubling or tripling those documented in 2013 (Figure 13). The other native plants were stable and, with the exception of slender naiad, did not change significantly. Slender naiad is a valuable native plant and its decline in 2014 was an unfavorable change for the lake. However, the significant decline in slender naiad frequency during 2014 appears to be due to a climate-related change rather than a long-term change. The apparent decline appears to be caused by a delay in germination due to the late growing season. Slender naiad reproduces only from seeds and typically germinates late. With the late growing season, it appears that slender naiad had not yet germinated at the time of the plant survey.

Plant diversity in Long Lake initially improved after the 2011 herbicide treatment greatly reduced EWM. Native plants were able to expand their coverage and the lake's plant diversity doubled. Since this initial improvement, the lake's plant diversity has remained stable. Diversity, measured by Simpson's Diversity Index on a scale of 0 to 1, estimates the probability that two individual plants randomly selected from the lake will belong to different species. Long Lake's diversity score in 2010 was 0.40 (i.e., if two plants were randomly selected from the lake there would be a 40% chance that they would represent different species). Diversity scores from 2011 through 2014 ranged from 0.80 to 0.85 (i.e., an 80 to 85 percent chance of selecting plants from two different species). The improved score indicates that treatment to control EWM has changed the lake's plant diversity from poor to good.

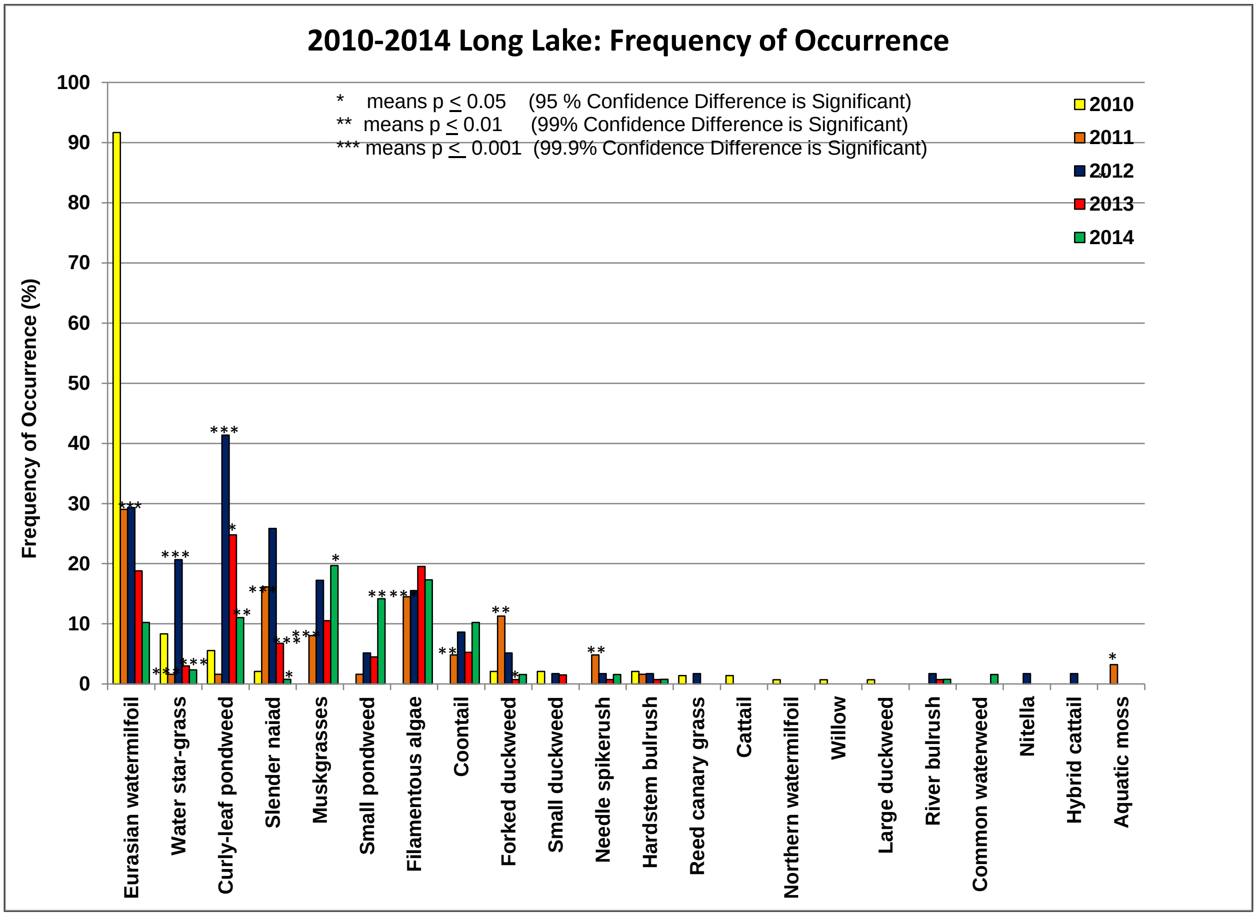

Figure 13 2010–2014 Long Lake Frequency of Occurrence (Frequency of Occurrence at Sites Shallower than the Maximum Depth of Plants)

Note: * indicates a significant change in frequency of occurrence between years.

The quality of the plant community, as measured by the Floristic Quality Index (FQI), has also improved since 2010. The reduction of EWM that has facilitated increased plant diversity has also improved the overall quality of the lake's plant community, as measured by the Floristic Quality Index (FQI),. FQI in Long Lake was 14.1 in 2010, 15.7 in 2011, 18.5 in 2012, 17.7 in 2013, and 17.4 in 2014. Although Minnesota has not kept a record of FQI values, FQI values recorded in Wisconsin have ranged from 3 (representing degraded plant communities) to 49 (representing diverse native plant communities). The median FQI for Wisconsin lakes is 22. Although Long Lake's FQI scores have improved since 2010, the current score is still below the Wisconsin average. This is not unexpected since the quality of the Long Lake plant community was very poor prior to the 2011 herbicide treatment. The 23 percent improvement in FQI score during the past 4 years is considered good progress toward improved quality of the plant community.

McDonald Lake—A major change occurred in the McDonald Lake plant community between the June 2013 and 2014 plant surveys. As shown in Table 4, plant frequency, density, diversity, and quality all declined during 2014. Plant frequency declined from 95 percent in 2013 to 79 percent in 2014. The average density, measured by rake fullness, declined from 3.12 in 2013 to 1.92 in 2014. Plant diversity, as measured by Simpson's Diversity Index, declined from 0.85 to 0.80. FQI values declined from 22.3 in 2013 to 19.0 in 2014.

Table 4 2013–2014 McDonald Lake Frequency, Density, Diversity, and Quality of Plant Community

Sample Date	Frequency of Occurrence (%)	Density (Average Rake Fullness)	Simpson Diversity Index Value	Plant Community Quality (FQI Value)
6/27/2013	95	3.12	0.85	22.3
6/26/2014	79	1.92	0.80	19.0

Despite overall decreases, significant increases were observed for two species in 2014: small duckweed and nitella. The nine decreasing species were: white water lily, common bladderwort, common waterweed, small pondweed, curly-leaf pondweed, watershield, small bladderwort, slender riccia, and spadderdock (Figure 14). The declines in curly-leaf pondweed and small pondweed are presumably in response to late ice-out/thick snow cover. Although the cause of the decreased frequency of the other seven species is unknown, the contractor who completed the 2013 and 2014 plant surveys provided the following hypothesis in his field notes during the 2014 survey:

"North Basin showed evidence of recent herbicide application. Most water lilies were dead or near dead. Coontail still present, but densities much reduced and remaining plants appeared near death/very brittle/may not survive. Central and southern basins had some burn, but did not appear to have been treated directly."

In 2013, water lilies and coontail caused the North Basin of McDonald Lake, pictured above, to be nearly non-navigable.

The description of the plant community in the North Basin of McDonald Lake during the 2014 survey sharply contrasts the 2013 description:

"Area is nearly non-navigable except a narrow channel around the border that boats appear to have kept open."

In 2014, the North Basin experienced greater changes in the plant community than the rest of the lake. Plant density in the North Basin declined from a rake fullness of 3.5 in 2013 to 1.9 in 2014, compared with a decline from 2.7 to 2.0 for the rest of the lake. Plant diversity in the North Basin declined from 0.82 in 2013 to 0.67 in 2014, compared with an increase from 0.85 to 0.87 for the rest of the lake. The average number of plant species per site (shallower than the maximum depth in which plants were found) in the North Basin declined from 2.8 in 2013 to 1.6 in 2014, compared with a decline of 1.9 to 1.4 for the rest of the lake. The data support the hypothesis that an herbicide treatment may have occurred in the North Basin of the lake.

In 2014, there was a significant reduction in plants in the North Basin of McDonald Lake, pictured above.

Because McDonald Lake is classified by the MnDNR as a natural environment lake, herbicide use is not allowed and any herbicide treatment of the lake would be illegal. As directed by the VBWD Board of Managers, Barr informed the MnDNR of the plant surveyor's observations.

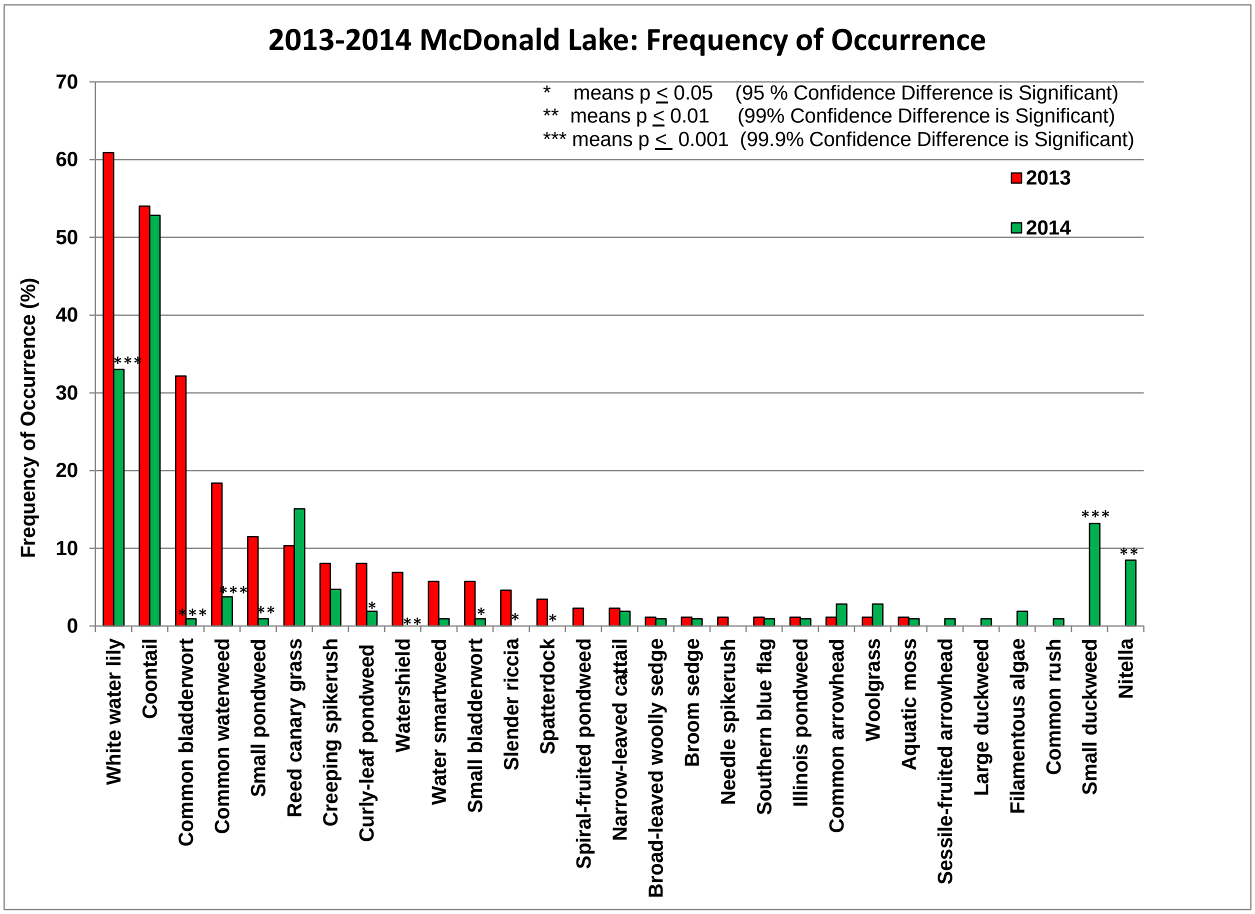

Figure 14 2013–2014 McDonald Lake Frequency of Occurrence (Frequency of Occurrence at Sites Shallower than the Maximum Depth of Plants)

Note: * indicates a significant change in frequency of occurrence between years.

Lake Olson—In 2014, VBWD provided technical assistance to help the Lake DeMontreville/Olson Association manage EWM, which had increased in frequency from 3 percent in 2012, to 5 percent in 2013, to 26 percent on May 24, 2014. Barr initially designed an herbicide treatment plan that involved treating a larger area and adding sufficient herbicide to effectively manage the EWM in the lake. Budget constraints prevented the Lake DeMontreville/Olson Association from implementing this plan and a smaller area that fell within their budget was selected for treatment. The Lake DeMontreville/Olson Association treated 4.7 acres with 2,4-D on June 6 (Figure 15). The 2,4-D treatment dose was 4 parts per million. After the herbicide mixed and was diluted by the lake's untreated waters, Barr estimated that the whole lake concentration would be 0.09 parts per million based upon lake volume and the gallons of herbicide applied. A whole lake 2,4-D concentration of about 0.3 ppm is generally needed to kill the EWM (including root crowns) and attain lasting EWM control. Lower concentrations, such as occurred in Lake Olson due to the small treatment area killed the plants, but not the root crowns, which were able to grow new plants.

A post-treatment aquatic plant survey completed by VBWD on June 28 indicated the treatment reduced the majority of the EWM biomass, but did not reduce the frequency with which EWM was found. EWM frequency increased after the treatment, from 26 percent on May 24 to 28 percent on June 28. However, most sites surveyed in June contained only a single EWM plant less than six inches long. One site had a substantial number of larger EWM plants, but the plants had been severely burned by the herbicide and their survival was questionable. A member of Lake DeMontreville/Olson Association reported dense EWM growth near the channel to Lake DeMontreville in late summer, but indicated EWM was not dense throughout the lake. Nonetheless, the significant increase in EWM frequency between June of 2013 (5 percent) and June of 2014 (28 percent) indicates continued management of EWM is necessary.

CLP was not problematic in Lake Olson in 2014. CLP frequency increased significantly from 28 percent in 2012 to 43 percent in 2013, and then declined significantly in 2014 to 3 percent. The decrease in 2014 is attributed to the thick snow cover/late ice-out (Figure 16).

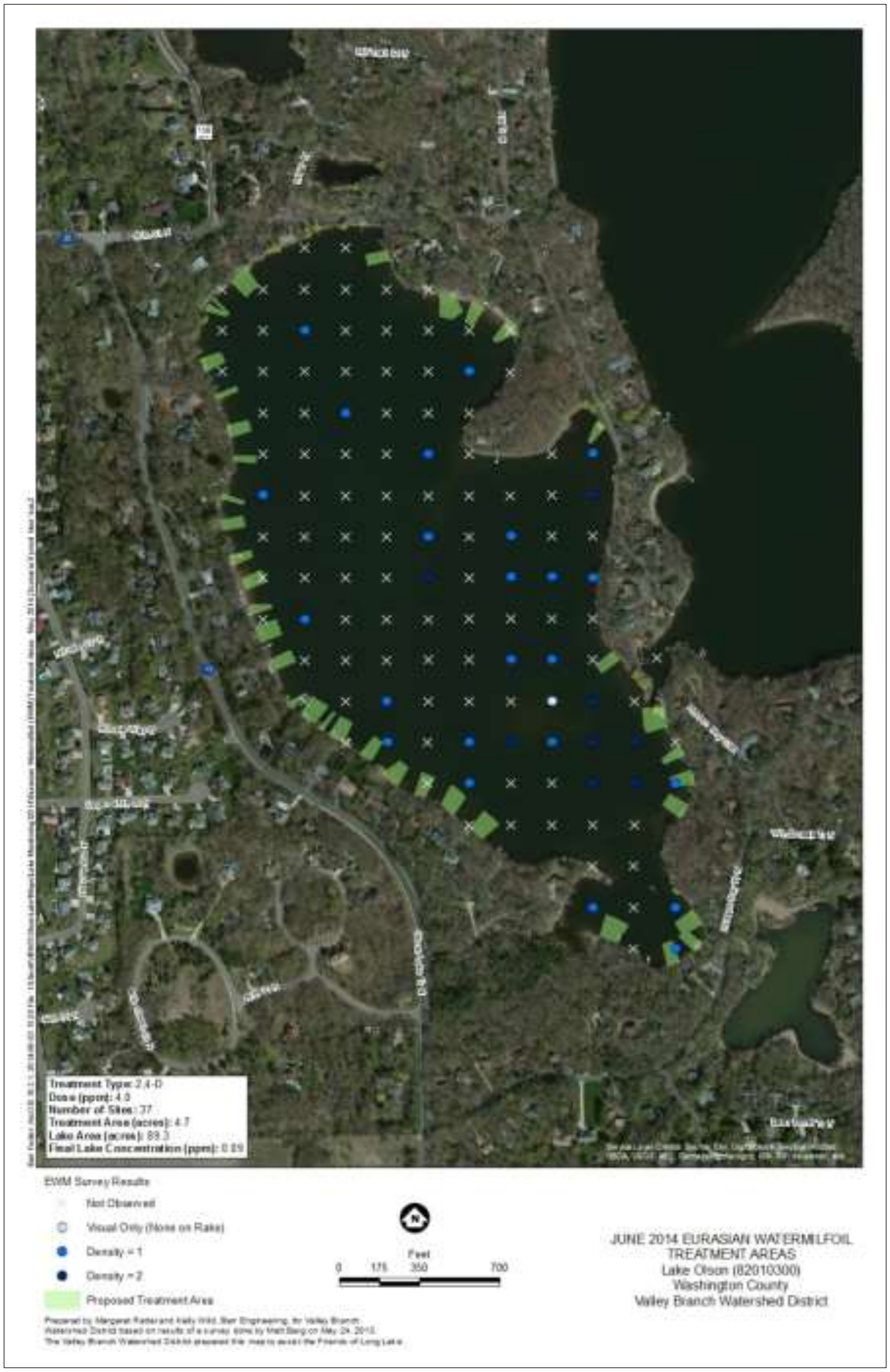

Figure 15 Lake Olson June 2014 Herbicide Treatment Areas

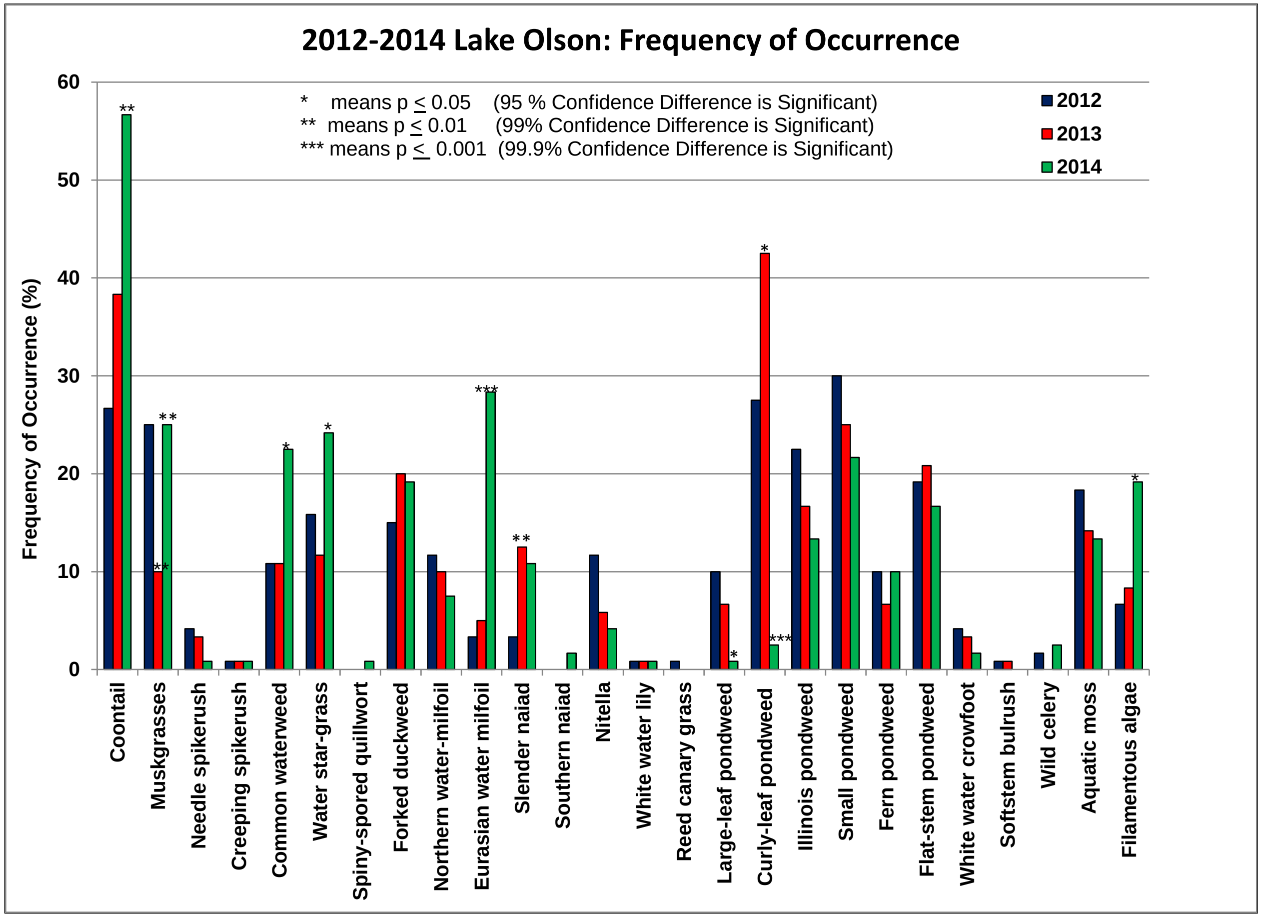

Figure 16 2012–2014 Lake Olson Frequency of Occurrence (Frequency of Occurrence at Sites Shallower than the Maximum Depth of Plants)

Note: * indicates a significant change in frequency of occurrence between years.

The native plants in Lake Olson were generally stable, although significant increases in coontail, muskgrasses, common waterweed, water stargrass, and filamentous algae were observed in 2014 (Figure 16). The increases are presumably in response to the significant decline in CLP, which provided opportunities for recolonization by native plants.

Sunfish Lake—Neither invasive nor native species were problematic in Sunfish Lake during 2014. In 2014, Sunfish Lake noted a plant community that was both high in quality and diverse. Of the 10 VBWD lakes surveyed in 2014, Sunfish Lake was tied with Lake Elmo for the second highest number of native species (27 species, Table 1) and was tied with Lake Olson and Lake DeMontreville for the second highest diversity score (0.90, Table 1). The lake's FQI was 24.5 (Table 1), which is higher than the median score for Wisconsin lakes (22).

The native plants were relatively stable in 2014, except for changes caused by the unusually late ice-out. The delay in ice-out in 2014 delayed the growth of several native species (pondweed, muskgrasses, and nitella) and presumably resulted in a significant decline in their frequency. Because the delay in plant growth from the unusually late ice-out in 2014 caused the decline in pondweed, muskgrasses, and nitella, this is considered a climate-related change rather than a long-term change.

Leafy pondweed increased significantly in 2014: from not present in 2013 to 5 percent frequency in 2014 (Figure 17). This is a positive change for the lake since leafy pondweed provides valuable food and habitat for waterfowl and fish. The fruit produced by leafy pondweed is an important food source for ducks and geese, particularly because it matures before many other aquatic fruits. The plant may be grazed by deer, muskrat, and beaver and provides cover for juvenile fish.

Summary

The majority of VBWD lakes noted a diverse and high quality plant community during 2014. Of the 10 VBWD lakes, Lake Jane noted the highest number of native species, the highest diversity score, and the highest FQI value. While Lake Jane noted an unusually high quality plant community, the plant communities in Lake Elmo, Sunfish Lake, Lake Olson, and Lake DeMontreville are also considered both diverse and of high quality. The Horseshoe Lake plant community was less diverse and of poorer quality than all other VBWD lakes. Rapidly expanding EWM in the lake is the apparent cause of the poor quality and diversity of the lake's plant community. Of the 10 VBWD lakes, the Long Lake plant community was second lowest in both diversity and quality, but has been improving as herbicide treatment has reduced the prevalence of EWM in the lake.

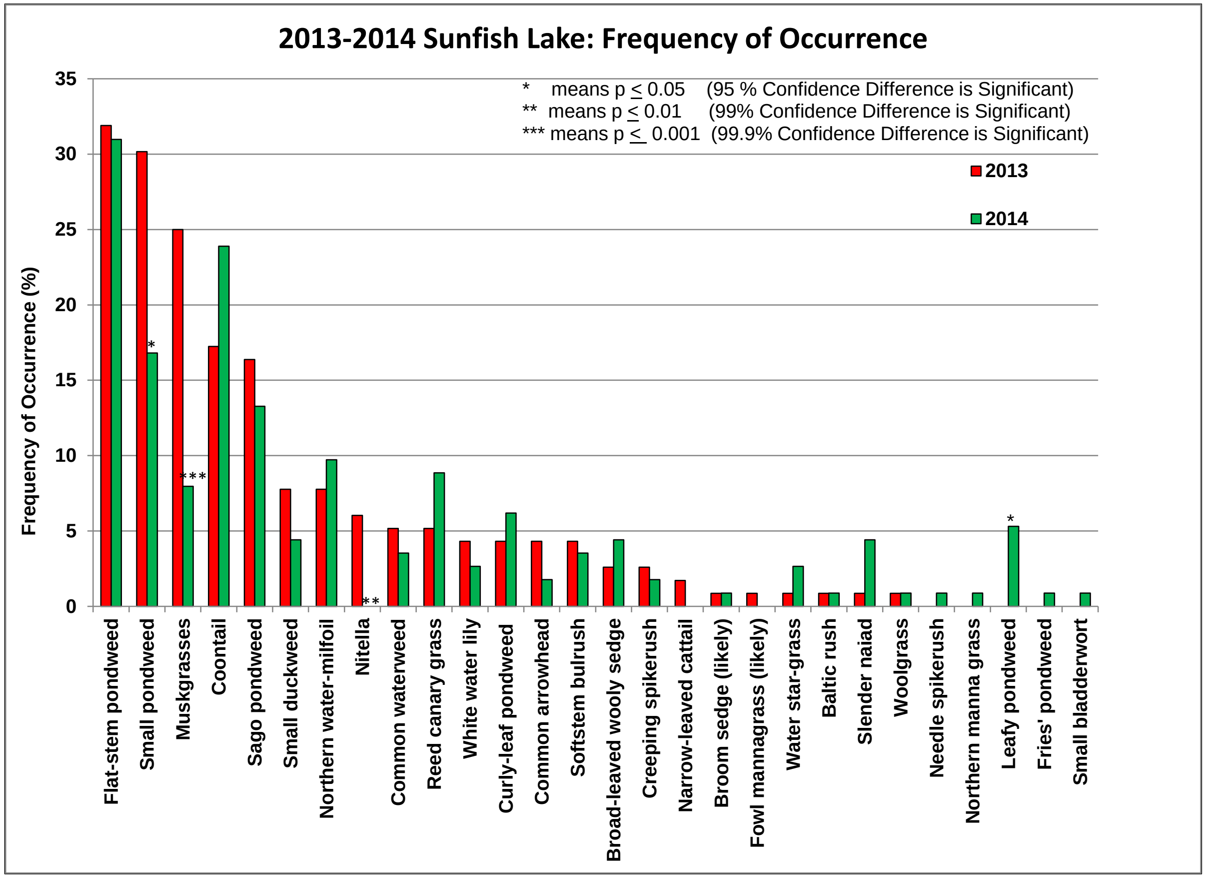

Figure 17 2013–2014 Sunfish Lake Frequency of Occurrence
(Frequency of Occurrence at Sites Shallower than the Maximum Depth of Plants)

Note: * indicates a significant change in frequency of occurrence between years.

Although aquatic invasive species are found in all 10 lakes, EWM is the only species that is problematic and EWM is only found in 6 of the 10 lakes. Herbicide treatment to manage EWM is recommended for the following lakes: Horseshoe Lake, Lake Elmo, Lake Olson, Lake DeMontreville, Lake Jane, and Long Lake. The Friends of Long Lake have been managing EWM since 2011 and the completion of herbicide treatments in 2011, 2013, and 2014 has reduced the frequency of EWM in the lake from 92 percent to 10 percent.

The Lake DeMontreville/Olson Association completed an herbicide treatment of a small area within Lake DeMontreville and Lake Olson in 2014. Barr initially designed an herbicide treatment plan that involved treating a larger area and adding sufficient herbicide to effectively manage the EWM in the lake. However, budget constraints prevented the Lake DeMontreville/Olson Association from implementing this plan, and a smaller area that fell within their budget was treated. Although the treatments reduced EWM mass in both lakes and EWM frequency in Lake DeMontreville (from 34 percent to 19 percent), the quantity of herbicide applied to the lakes was insufficient to attain EWM control and EWM increased in frequency in both lakes during the growing season.

To prepare for a more effective treatment in 2015, the Lake DeMontreville/Olson Association requested, and received, technical assistance from VBWD to prepare Lake Vegetation Management Plans (LVMPs) for Lake DeMontreville and Lake Olson. As directed by VBWD, Barr has completed Lake DeMontreville and Lake Olson LVMPs and will present them at a public meeting, organized by the Lake DeMontreville/Olson Association scheduled for October 20, 2014. Barr requests that the VBWD Managers approve the LVMPs at their October 9 Board meeting. Upon approval and signature by VBWD and the Lake DeMontreville/Olson Association, the LVMPs will be submitted to the MnDNR. Once approved by the MnDNR, the Lake DeMontreville/Olson Association will be eligible to receive treatment permits and grants for large scale herbicide treatments of the lakes. The large scale treatments are expected to effectively manage EWM in the lakes.

The VBWD has received requests to authorize Barr to complete LVMPs for Silver Lake, Lake Elmo, and Lake Jane. A MnDNR approved LVMP would make these lakes eligible to receive treatment permits and grants for large scale EWM treatments.

VBWD has received requests to authorize Barr to provide technical assistance for herbicide treatments to manage EWM in Long Lake, Lake DeMontreville, Lake Olson, Lake Jane, and Lake Elmo in 2015. VBWD has also received a request to authorize Barr to provide technical assistance to manage EWM and/or CLP in Silver Lake in 2015. Technical assistance includes permitting, completion of pre-treatment and post-treatment aquatic plant surveys, herbicide treatment design, and reporting required by MnDNR in the treatment permit.

Because the role of VBWD in providing technical assistance for the management of EWM in VBWD lakes appears to be quickly increasing, Barr suggests organizing a EWM committee to inform stakeholders of EWM management options and discuss roles and responsibilities for EWM management. Dissemination of EWM management options to the committee members would increase the efficiency of providing technical support to stakeholders. The committee would also help stakeholders determine their roles and responsibilities for EWM management and gain a better understanding of the management process. Committee members could include representatives of the lake associations of lakes currently infested with EWM (Silver Lake, Long Lake, Lake DeMontreville, Lake Olson, Lake Jane, Lake Elmo), at least one VBWD Board member, the District Engineer and other appropriate Barr staff, and representatives from each of the cities (Lake Elmo, Pine Springs, Mahtomedi, North St. Paul, and Maplewood).