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BARR

Memorandum

To: Valley Branch Watershed District (VBWD) Board of Managers
From: Meg Rattei, Senior Biologist
Subject: June 2016 Point-Intercept Plant Surveys at Long Lake, Lake DeMontreville, Lake Olson, Lake Jane, and Lake Elmo
Date: November 4, 2016
Project: 23/820405.06
c: John Hanson, Susannah Torseth, Ray Roemmich, Melissa Imse

This memorandum summarizes methods and results of the June 2016 point-intercept plant surveys at Long Lake, Lake DeMontreville, Lake Olson, Lake Jane, and Lake Elmo. Tables and figures follow the discussion. Brief discussions of lake impairment, water quality, and the lakes' fisheries are also included.

Requested Manager Actions

1. Post this memorandum to the District's website and inform the following individuals that it has been posted:
    A. Brian Buchmayer of Friends of Long Lake and the VBWD Lake Citizen Advisory Committee
    B. Justin Bloyer of the Lake Jane Association and City of Lake Elmo council member
    C. LeeAnn Leitch of the Lake Jane Association
    D. Roger Johnson of the Lake DeMontreville/Olson Association and the VBWD Citizen Advisory Committee
    E. Wendy Griffin of the Lake Elmo Association
    F. Jeff Berg of the Lake Elmo Association and the VBWD Citizen Advisory Committee
    G. Dale Dorschner of the Lake Elmo Association
    H. Keegan Lund, Kylie Cattoor, Chip Welling, Donna Perleberg of the Minnesota Department of Natural Resources (MNDNR) and any other MNDNR staff who make a request
2. Authorize technical support for Friends of Long Lake in 2017 to assist the organization with implementation of the Long Lake MNDNR-approved Lake Vegetation Management Plan. Technical support will include permitting, plant surveys, treatment design, and reporting.
3. Direct Barr to request a meeting with MNDNR to discuss the impacts of Eurasian watermilfoil (EWM) on native plant species in Lake DeMontreville, Lake Olson, and Lake Jane and ask for suggestions on stabilizing the native plant communities in these lakes. The meeting could include discussion of large-scale herbicide treatments to attain long-term EWM reductions and limit native plant displacement. The expansion of EWM in Lake Elmo and Lake Jane and suggestions for thwarting it could also be addressed.

Lake Impairment Standards

Until recently, lake impairment was determined using Minnesota Pollution Control Agency (MPCA) water quality or fish tissue standards published in Minnesota rules 7050. The MPCA would determine a lake impaired for water quality or fish consumption under the following conditions:

- **Water quality:** Average summer total phosphorus, chlorophyll *a*, or Secchi disc values fail to meet impairment standards
- **Fish consumption:** Fish tissues contain concentrations of dioxin, mercury, perfluorooctane sulfonate (PFOS), and/or polychlorinated biphenyls (PCBS) higher than impairment standards

The MNDNR has recently developed two new biological tools to assist the MPCA with determining lake impairment: (1) the Fish Index of Biotic Integrity (IBI) and (2) a Lake Plant Eutrophication IBI. The Fish IBI has been used by the MNDNR since 2015 to assess whether lake waters are impaired for fish (i.e., do not support a lake's fish population). The MNDNR has applied the Fish IBI to recent fish survey data from Lake DeMontreville and Lake Elmo. Because the Fish IBI only applies to lakes with at least 100 acres in surface area, these are the only two VBWD lakes assessed with this tool.[1]

The Lake Plant Eutrophication IBI is used to measure the response of a lake plant community to eutrophication (excessive nutrients). Although it is not currently used to determine lake impairment, the MPCA intends to use this IBI to identify impaired lakes in the future.[2] The Lake Plant Eutrophication IBI includes two metrics to assess the viability of aquatic life. The first metric is taxa richness—the estimated number of taxa (species) in a lake. The second metric is floristic quality index (FQI). This metric distinguishes the quality of the plant community, which is a reflection of the quantity of nutrients in the lake. Because the Lake Plant Eutrophication IBI will be used by the MPCA in the future, Barr used it to assess Long Lake, Lake DeMontreville, Lake Olson, Lake Jane, and Lake Elmo to determine whether plant communities were impaired. Taxa richness and FQI scores for the lakes were determined and then compared with MNDNR impairment thresholds: a minimum of 12 taxa (species) and an FQI score of at least 18.6.

[1] Bacigalupi, Jacquelyn. 2015. Fish-Based IBI Development for Minnesota Lakes & Use in the Watershed Assessment Process. October 15, 2015.
[2] Minnesota Department of Natural Resources. 2016. Lake Plant Eutrophication IBI, June 23, 2016: *An Assessment of Aquatic Plant Community Response to Anthropogenic Eutrophication.*

2016 Sample Methods

Matt Berg of Endangered Resource Services, LLC, conducted point-intercept plant surveys in five VBWD lakes on June 26 and June 27, 2016. He located equally spaced preset points in the field with a global positioning system (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

Endangered Resource Services used a rake (pictured above) to collect plants for the plant surveys. Rake fullness is a measure of plant density.

Results

Long Lake

Long Lake has been treated with herbicide almost annually since 2011 to reduce EWM. In May 2016, 3.78 acres of EWM were observed and treated with the maximum allowable dose of 2,4-D (4 mg/L, Figure 1). Research indicates a 2,4-D concentration of 0.5 mg/L sustained for 3 days is lethal to EWM.[3] The average 2,4-D concentration measured 3 days after the treatment of Long Lake was 0.2 mg/L; nevertheless, the June plant survey showed that the treatment reduced the area of EWM by more than an order of magnitude—from 3.78 acres to 0.33 acres (Figure 2 and Table 3).

The five herbicide treatments completed from 2011 to 2016 have reduced the EWM area in Long Lake by more than two orders of magnitude—from 52 acres prior to the 2011 treatment to 0.33 acres after the 2016 treatment. The treatments have also dramatically decreased the percentage of growth area occupied by EWM: from 97 percent to less than 1 percent (Table 3).

The Long Lake native plant community has also improved substantially with treatment:

- Sample points with native submersed vegetation increased from 14 percent in 2010 to 54 percent in 2016.
- The number of submersed plant species increased from seven in 2010 to 11 in 2016.

[3] Green, W.R. and Westerdahl, H.E. 1990. Response of Eurasian Watermilfoil to 2,4-D Concentrations and Exposure Times. *Journal of Aquatic Plant Management*. 28:27-32.

- The average number of native submersed taxa per sample point increase from 0.46 in 2010 to 0.97 in 2016.

In addition, diversity nearly doubled between 2010 and 2016 (Table 6). This is reflected by Simpson Diversity Index values; these values indicate that with treatment of the EWM, the probability that two individual plants randomly selected from Long Lake will belong to different species has increased from 40 to 78 percent.

In June, EWM in Long Lake consisted of a bed, observed near the inlet and pictured above; and a single plant, pictured below, found in 23 feet of water.

The 2016 Long Lake plant community meets the criteria of the MNDNR Lake Plant Eutrophication IBI and, hence, is not impaired. A total of 19 plant species were observed in Long Lake in 2016, 58 percent more than the impairment threshold of 12 species. The 2016 FQI score of 21.8 was 17 percent more than the impairment threshold of 18.6 (Table 7).

Curly-leaf pondweed (CLP), an invasive species, is present in Long Lake but not problematic. In 2016, CLP was found in 10 percent of samples taken from the plant-growth area of the lake (Table 8). Two other invasive species, reed canary grass and hybrid cattail, were also observed, but neither is problematic (Table 8).

The MNDNR has not completed any fish surveys of Long Lake since 1999, and no surveys were completed by the VBWD prior to aquatic plant treatments. The VBWD has not received reports that the aquatic plant treatments have affected the fishery.

Long Lake has excellent water quality and is not impaired, as indicated by average summer total phosphorus and chlorophyll *a* concentrations and Secchi disc transparency levels recorded from 2011 through 2015:

- **Average total phosphorus range:** 14 to 30 µg/L (impairment standard ≤40 µg/L)
- **Average chlorophyll *a* range:** 3.5 to 11.1 µg/L (impairment standard ≤14 µg/L)
- **Average Secchi disc transparency range:** 2.2 to 3.1 meters (impairment standard ≥1.4 meters[4])

[4] Metropolitan Council Environmental Services (MCES) Environmental Information Management Systems (EIMS). Retrieved from https://eims.metc.state.mn.us/ on October 12, 2016

Lake DeMontreville

Low-density EWM was first observed in the northern portion of Lake DeMontreville in June 2007. EWM extent and density remained relatively low for 5 years; however, between June 2012 and June 2013, EWM extent increased by an order of magnitude—from 5.4 to 51 acres. Since that time, the following treatment efforts have been made.

- **2014:** In May 2014, EWM extent reached 53 acres. The Lake DeMontreville/Olson Association treated 4.3 acres with 2,4-D in early June, initially reducing the EWM extent to 27 acres. However, the EWM was burned (not killed) by the treatment, and the plant extent more than doubled during the remainder of the growing season.

- **2015:** The EWM extent was 58 acres when the Lake DeMontreville/Olson Association treated 14.3 acres with 2,4-D in May. Though the treatment initially reduced the EWM extent to 21 acres, herbicide residue samples collected indicated the dose was not lethal and Barr expected that EWM would likely rebound. By the end of the growing season EWM had nearly doubled, reaching 38 acres by May 2016 (Table 9).

- **2016:** The Lake DeMontreville/Olson Association treated 14.3 acres with 2,4-D. The treatment reduced the EWM from 38 acres in May to 19 acres in June and provided seasonal relief, but was not lethal. The VBWD contractor observed that deep water EWM plants in the eastern basin (4- to 6-foot plants in 15 feet of water) survived herbicide treatment more successfully in 2016 than in previous years. In the western/northwestern basin, EWM plants observed in June were limited to young sprouts, 1- to 2-feet tall near shore among the white waterlilies. An August inspection by MNDNR documented the presence of EWM in all treated areas (Figure 5).

The Lake DeMontreville plant community meets the criteria of the MNDNR Lake Plant Eutrophication IBI and is not impaired. A total of 23 plant species were observed by the VBWD contractor in Lake DeMontreville in 2016, which is nearly double the impairment threshold of 12 species. The 2016 FQI score of 24.6 was 32 percent higher than the impairment threshold of 18.6 (Table 13).

While the Lake DeMontreville plant community is very healthy, a number of noteworthy changes have been observed between 2012 and 2016.

- The percentage of sampling points with native submersed vegetation increased from 94 percent in 2012 to 97 percent in 2016 (Table 10).
- The number of native submersed species per sample point increased from 2.21 to 2.49 (Table 10).
- The total number of species decreased from 27 to 23 (Table 13).
- The total number of submersed species decreased from 16 to 14 (Table 10).
- Diversity, as represented by Simpson's Diversity Index, declined from 0.89 to 0.86 (Table 12).

- The quality of the plant community, as represented by FQI, decreased from 26.4 to 24.6 (Table 13).
- Significant frequency changes were observed for a number of native species (Table 14).

The results of Chi-squared analyses of 2012 and 2016 data suggest that the frequency of some plant species increased significantly during that period (Table 14):

- *Ceratophyllum demersum* (coontail)—from 38 percent in 2012 to 70 percent in 2016
- *Elodea canadensis* (common waterweed)—from 8 to 68 percent
- *Chara sp.* (muskgrasses)—from 6 to 30 percent
- *Najas guadalupensis* (southern naiad)—from 0 to 18 percent
- *Vallisneria americana* (wild celery)—from 4 to 14 percent

According to the analyses, some plant species also decreased significantly between 2012 and 2016 (Table 14):

- *Potamogeton pusillus* (small pondweed)—from 41 percent in 2012 to 5 percent in 2016
- *Potamogeton zosteriformis* (flat-stem pondweed)—from 50 to 12 percent
- *Potamogeton robbinsii* (fern pondweed)—from 12 to 4 percent
- *Myriophyllum sibiricum* (northern watermilfoil)—from 5 percent to 0
- *Potamogeton amplifolius* (large-leaf pondweed)—from 4 percent to 0

Frequency changes between 2015 and 2016, as measured by Chi-squared analyses, were relatively similar to the long-term changes between 2012 and 2016. Three native species had statistically significant increases in frequency—*Elodea canadensis*, *Chara sp.*, and *Najas guadalupensis*. Four native species had statistically significant decreases in frequency—*Potamogeton zosteriformis, Potamogeton pusillus, Potamogeton robbinsii,* and *Potamogeton amplifolius* (Table 14). Although the reasons for the frequency changes are unknown, higher water levels in 2016 may have contributed.

In June 2016, *Elodea canadensis*, pictured above, had replaced the EWM affected by the May 2016 treatment in the western/ northwestern basin of Lake DeMontreville.

Between 2015 and 2016, changes in species richness, diversity, and quality were also relatively similar to changes observed between 2012 and 2016. Species richness (i.e., the number of species) declined from 28 in 2015 to 23 in 2016 (Table 13). Diversity, as measured by the Simpson Diversity Index, declined from 0.90 to 0.86 (Table 12). The quality of the plant community, measured by FQI, declined from 28.6 to 24.6 (Table 13). Although the reasons for these changes are unknown, the higher water levels in 2016 may have contributed.

From 2012 through 2016, EWM extent and density have fluctuated widely. Initially, EWM increased rapidly—from 5.4 acres in 2012 to 51 acres in 2013; this expansion of EWM displaced native species. Seasonal nuisance-relief herbicide treatments, started in 2014, resulted in short-term reductions in EWM extent and provided opportunities for native species to recolonize. However, annual regrowth of EWM again displaced native species. This annual cycle of rapid declines in EWM after herbicide treatment followed by rapid regrowth may have destabilized the native plant community, resulting in significant frequency changes for several native species. Long-term reduction of EWM via large-scale treatments is recommended to end the cyclical increases and decreases in EWM and stabilize the native plant community. A stable plant community protects fishery habitat.

Curly-leaf pondweed (CLP), an invasive species, is present in Lake DeMontreville, but not problematic. In 2016, CLP was found in 2 percent of the plant-growth area sampled (Table 14). Two other invasive species, reed canary grass and purple loosestrife, were also observed but are not problematic (Table 14).

The MNDNR completed two fish surveys in Lake DeMontreville in 2011 and computed Fish IBI scores of 39 and 28 from those results. These scores are close to the shallow lakes impairment threshold of 36 (scores below 36 indicate fish impairment). The MNDNR is currently using these scores for information only and will wait until the next fish survey in 2019 to decide whether Lake DeMontreville is impaired for fish. In the interim, stabilizing the lake's plant community to protect fishery habitat will be important.[5] Although the MNDNR did not complete fish surveys after herbicide treatment for EWM, the VBWD has not received any reports that the treatments have affected the fishery.

Lake DeMontreville has excellent water quality and is not impaired, as demonstrated by average summer total phosphorus and chlorophyll *a* concentrations and Secchi disc transparency levels recorded from 2012 through 2015:

- **Average total phosphorus range:** 14 to 26 µg/L (shallow lakes impairment standard $\leq$60 µg/L)
- **Average chlorophyll *a* range:** 3.9 to 8.3 µg/L (shallow lakes impairment standard $\leq$20 µg/L)
- **Average Secchi disc transparency:** 2.7 to 3.6 meters (shallow lakes impairment standard $\geq$1.0 meters[6])

[5] Bacigalupi, Jacquelyn, MDNR, Email to Meg Rattei on July 11, 2016.
[6] Metropolitan Council Environmental Services (MCES) Environmental Information Management Systems (EIMS). Retrieved from https://eims.metc.state.mn.us/ on October 12, 2016

Lake Olson

EWM, first observed in Lake Olson in 2012, doubled in extent between June of 2013 and 2014 (from 2 acres to 4 acres). Although herbicide was applied to 4.7 acres in early June of 2014, EWM extent increased further (24 acres by late June of 2014 and 32 acres by May of 2015). Herbicide treatment of 7 acres in May of 2015 reduced EWM extent to 28 acres, partially mitigating the previous increase. Nonetheless, EWM extent in June of 2015 was 17 percent greater than in June of 2014.

The 7-acre herbicide treatment area in 2015 was only 22 percent of the total EWM area (32 acres). Herbicide residue samples collected after the treatment indicated the dose was not lethal and by May of 2016, EWM extent had increased to 53 acres (Table 15).

The Lake DeMontreville/Olson Association treated 6.85 acres with 2,4-D in May of 2016. The treatment provided seasonal relief, reducing EWM extent to 18 acres in June (Table 15), but was not lethal. The EWM observed after the treatment was burned, slimy, and reduced, but the majority of the plants (not necessarily the stems) survived the treatment and commonly had 4 to 6 inches of new growth. An August inspection by MNDNR documented the presence of EWM in all treated areas (Figure 8).

EWM observed in Lake Olson in June 2016, pictured above, was burned but survived the herbicide treatment.

The Lake Olson plant community meets the criteria of the MNDNR Lake Plant Eutrophication IBI and is not impaired. A total of 27 plant species were observed in 2016, which is more than double the impairment threshold of 12 species. The 2016 FQI score of 27.1 was 46 percent higher than the impairment threshold of 18.6 (Table 19).

While the Lake Olson plant community is very healthy, a number of noteworthy changes have been observed between 2012 and 2016.

- The percentage of sampling points with native submersed vegetation increased from 75 percent in 2012 to 94 percent in 2016 (Table 16).
- The number of native submersed species per sample point increased from 2.03 to 2.29 (Table 16).
- The number of species increased from 24 to 27 (Table 19).
- The number of submersed species increased from 16 to 17 (Table 16).
- The quality of the plant community as represented by FQI increased from 25.6 to 27.1 (Table 19).
- The diversity, as represented by Simpson's Diversity Index, declined from 0.92 to 0.85 (Table 18).
- Significant frequency changes were observed for a number of native species (Table 20).

The results of Chi-squared analyses of 2012 and 2016 data show significant frequency increases for the following plant species during that period (Table 20):

- *Ceratophyllum demersum* (coontail)—from 27 percent in 2012 to 50 percent in 2016
- *Elodea canadensis* (common waterweed)—from 11 to 67 percent
- *Chara sp.* (muskgrasses)—from 25 to 53 percent
- *Najas guadalupensis* (southern naiad)—from 0 to 4 percent.

According to the analyses, some plant species also decreased significantly between 2012 and 2016 (Table 20):

- *Potamogeton pusillus* (small pondweed)—from 30 percent in 2012 to 3 percent in 2016
- *Potamogeton illinoensis* (Illinois pondweed)—from 23 to 8 percent
- *Potamogeton zosteriformis* (flat-stem pondweed)—from 19 to 6 percent
- *Heteranthera dubia* (water star-grass)—from 16 to 4 percent
- *Potamogeton amplifolius* (large-leaf pondweed)—from 10 percent to 0
- *Myriophyllum sibiricum* (northern watermilfoil)—from 12 percent to 0

Frequency changes between 2015 and 2016 were relatively similar to the long-term changes observed between 2012 and 2016. Chi-squared analyses of frequency changes between 2015 and 2016 show statistically significant increases in frequency for three native species (*Ceratophyllum demersum*, *Chara sp*., and *Elodea Canadensis*) and statistically significant decreases for two native species (*Potamogeton zosteriformis and Potamogeton robbinsii*) (Table 20). Although the reasons for the frequency changes are unknown, higher water levels in 2016 may have contributed.

Changes in plant diversity, percentage of points sampled with native vegetation, and average number of native submersed species between 2015 and 2016 were relatively similar to the long-term changes observed between 2012 and 2016. Diversity, as measured by the Simpson Diversity Index, declined from 0.90 in 2015 to 0.85 in 2016 (Table 18). The percentage of points sampled with native vegetation increased from 79 to 94 percent. The average number of native submersed species increased from 1.87 to 2.29.

During the period from 2012 to 2016, EWM extent and density have fluctuated widely. Initially, EWM extent increased rapidly—from 3.6 acres in 2013 to 24.0 acres in 2014. Since 2014, annual small-scale herbicide treatments have provided seasonal nuisance relief from the EWM infestation; however, the plant has consistently rebounded. The expansion of EWM between 2012 and 2014 displaced native species. Seasonal nuisance-relief herbicide treatments resulted in short-term reductions of EWM and provided opportunities for native species to recolonize. However, annual EWM regrowth has, again, displaced

native species. Long-term reduction of EWM via large-scale treatments is recommended to end the cyclical increases and decreases in EWM and stabilize the native plant community.

Curly-leaf pondweed (CLP), an invasive species, is present in Lake Olson but not problematic. In 2016 it was found in only 1 percent of sampled plant-growth areas (Table 20). Two other invasive species were also observed in Lake Olson: reed canary grass and narrow-leaved cattail; however, neither is problematic (Table 20).

The most recent MNDNR fish survey of Lake Olson was completed in 2011. The VBWD has not completed any fish surveys and has not received reports that aquatic plant treatments have affected the fishery.

Lake Olson has excellent water quality and is not impaired, as demonstrated by average summer total phosphorus and chlorophyll *a* concentrations and Secchi disc transparency levels recorded from 2012 through 2015:

- **Average total phosphorus range:** 15 to 23 µg/L (shallow lakes impairment standard ≤60 µg/L)
- **Average chlorophyll *a* range:** 3.8 to 11.3 µg/L (shallow lakes impairment standard ≤20 µg/L)
- **Average Secchi disc transparency range:** 2.4 to 3.6 meters (shallow lakes impairment standard ≥1.0 meters[7])

Lake Jane

In June of 2012, a few scattered EWM plants (about 0.1 acres in extent) were first observed by the VBWD contractor in Lake Jane near the east shore. From 2012 through 2016, EWM increased rapidly (2 acres in 2013, 24 acres in 2014, 44 acres in 2015, and 69 acres in 2016). EWM currently infests 52 percent of the lake's plant-growth area.

After its introduction into Lake Jane, EWM has rapidly expanded its extent from 0.1 acres in 2012 to 69 acres in 2016. Pictured above is canopied EWM on the west side of Lake Jane.

In May of 2015, the Lake Jane Association treated 7.9 acres of the lake with 2,4-D. The permitted treatment area was only 18 percent of the 44 infested acres. While treatment reduced EWM extent to 31 acres, it only partially mitigated the growth that had occurred between June of 2014 and May of 2015. Hence, the June 2015 infested area was still 29 percent greater than the June 2014 area. Herbicide residue samples collected 3 days after the treatment indicated the treatment dose was less than 20 percent of the lethal dose for EWM, suggesting the plant

[7] Metropolitan Council Environmental Services (MCES) Environmental Information Management Systems (EIMS). Retrieved from https://eims.metc.state.mn.us/ on October 12, 2016

would likely rebound. As expected, EWM more than doubled in extent between June 2015 and June 2016 (increasing from 31 to 69 acres).

The rapid expansion of EWM in Lake Jane between 2012 and 2016 occurred at the expense of displaced native species. Although a small-scale herbicide treatment in 2015 provided seasonal nuisance relief and opportunities for native species to recolonize, rapid regrowth and further expansion of EWM after treatment has again displaced native species. Chi-squared analyses of 2012 and 2016 data indicate displacement by EWM has significantly decreased the frequency of the following species (Table 26):

- *Ceratophyllum demersum* (coontail)—from 33 percent in 2012 to 14 percent in 2016
- *Myriophyllum sibiricum* (northern watermilfoil)—from 22 to 3 percent
- *Potamogeton amplifolius* (large-leaf pondweed)—from 21 to 7 percent
- *Potamogeton zosteriformis* (flat-stem pondweed)—from 16 to 5 percent
- *Ranunculus aquatilis* (white water crowfoot)—from 15 to 1 percent
- *Potamogeton pusillus* (small pondweed)—from 8 to 1 percent
- *Heteranthera dubia* (water star-grass) — from 7 percent to 0

Long-term reduction of EWM via large-scale treatments is recommended to end displacement and decline of native species. Long-term reduction of EWM would stabilize the plant community and protect the diverse assemblage of native species.

Not all changes in native species frequency were negative. Chi-squared analyses of 2012 and 2016 data showed significant increases in frequency for two plants (Table 26):

- *Najas guadalupensis* (southern naiad)—from 6 to 37 percent
- *Potamogeton nodosus* (long-leaf pondweed)—from 0 to 9 percent

Noteworthy changes during 2015 and 2016 include the following:

- The number of species increased from 30 to 35 (Table 25) and the number of submerged species increased from 21 to 22 (Table 22).
- The average number of native species per sample point increased from 2.33 to 2.37 (Table 22).
- Diversity, as represented by Simpson's Diversity Index, decreased from 0.92 to 0.90 (Table 24).
- *Elodea canadensis* (common waterweed) significantly increased in frequency from 30 percent in 2015 to 46 percent in 2016 (Table 26).
- *Najas guadalupensis* (southern naiad) significantly increased in frequency from 17 percent in 2015 to 37 percent in 2016 (Table 26).
- *Lemna trisulca* (forked duckweed) significantly decreased in frequency from 7 percent in 2015 to 0 in 2016 (Table 26).

The Lake Jane plant community meets the criteria of the MNDNR Lake Plant Eutrophication IBI and is not impaired. A total of 35 plant species were observed in Lake Jane in 2016, which is nearly triple the impairment threshold of 12 species. The 2016 FQI score of 30.8 was 66 percent higher than the impairment threshold of 18.6 (Table 25).

CLP was present in 2016, but not problematic; the plant was observed in 18 percent of plant-growth areas sampled (Table 26). Three additional invasive species were observed: reed canary grass, purple loosestrife, and narrow-leaved cattail. However, none were problematic (Table 26).

The most recent MNDNR fish survey of Lake Jane was completed in 2013. The VBWD has not completed any fish surveys or received any reports that the 2015 aquatic plant treatment affected the fishery.

Lake Jane is listed as impaired for fish consumption because tissue from the lake's fish contains mercury concentrations that exceed the impairment standard. For this reason, the following fish consumption guidelines have been issued for the general population:

- Bluegill sunfish, all sizes—limit to 1 meal per week
- Bullhead, all sizes—limit to 1 meal per week
- Northern pike, shorter than 21 inches—limit to 1 meal per week
- Northern pike, 21 inches or longer—limit to 1 meal per month

The following fish consumption guidelines have been issued for pregnant women, women who may become pregnant, and children under age 15:

- Bluegill sunfish, all sizes—limit to 1 meal per week
- Bullhead, all sizes—limit to 1 meal per month
- Northern pike, shorter than 25 inches—limit to 1 meal per month
- Northern pike, 25 inches and longer—do not eat

Lake Jane has excellent water quality and is not impaired, as indicated by average summer total phosphorus and total chlorophyll *a* concentrations and Secchi disk transparency levels measured from 2012 through 2015:

- **Average total phosphorus range:** 13 to 17 µg/L (impairment standard $\leq$40 µg/L)
- **Average chlorophyll *a* range:** 2.5 to 2.9 µg/L (impairment standard $\leq$14 µg/L)
- **Average Secchi disc transparency range:** 4.2 to 5.3 meters (impairment standard $\geq$1.4 meters[8])

[8] Metropolitan Council Environmental Services (MCES) Environmental Information Management Systems (EIMS). Retrieved from https://eims.metc.state.mn.us/ on October 12, 2016

Lake Elmo

Problematic levels of EWM were observed by the VBWD contractor in Lake Elmo from 2012 through 2016. In 2016, as in previous years, EWM was the dominant plant in the north and south bays. EWM increased from 51 acres in 2014, to 68 acres in 2015, to 80 acres in 2016 (Table 27).

In 2016, dense canopied beds of EWM, pictured above, were prevalent in Lake Elmo.

The Lake Elmo Association has completed two small-scale EWM removal projects. During September 24 and 25, 2015, a dive team removed EWM from a small area (less than an acre) by hand. In July of 2016, about 10 acres of EWM at the north end of the lake were removed by mechanical harvesting, using a machine to pull the plants up by their roots.

The Lake Elmo plant community meets the criteria of the MNDNR Lake Plant Eutrophication IBI and is not impaired. A total of 29 plant species were observed by the VBWD contractor in Lake Elmo in 2016, more than double the impairment threshold of 12 species. The 2016 FQI score of 26.5 was 42 percent higher than the impairment threshold of 18.6 (Table 31).

Species frequency in the Lake Elmo plant community has remained relatively stable from 2012 through 2016. According to a Chi-squared analyses of 2012 and 2016 data, the only plant species with a significant change in frequency was *Schoenoplectus tabernaemontani* (softstem bulrush), decreasing from 5 percent in 2012 to 0 in June of 2016. Although not collected on the rake in June of 2016, softstem bulrush was observed in the lake by the VBWD contractor. A July plant survey completed by the Lake Elmo Association identified softstem bulrush frequency at 3 percent, not significantly different than the 2012 frequency of 5 percent.

A Chi-squared analyses of 2015 and 2016 data indicate no significant change in frequency of plant species, further verifying the stability of the Lake Elmo plant community. In addition, the number of plant species, number of submerged plant species, and FQI values were the same in June 2015 and June 2016.

CLP was present in 2016, but not problematic; the plant was observed in 1 percent of plant-growth areas sampled (Table 32). Two other invasive species were also observed: reed canary grass and hybrid cattail. However, neither were problematic (Table 32).

The MNDNR completed a fisheries survey of Lake Elmo in 2014 and used the survey results to compute a Fish IBI score of 53, which indicates the fishery is not impaired. The lake impairment threshold is 45; scores below this threshold suggest impairment.

Lake Elmo is listed as impaired for fish consumption because tissue from the lake's fish contains mercury and perfluorooctane sulfonate (PFOS) concentrations that exceed the impairment standards. For this reason, the following fish consumption guidelines have been issued for the general population:

- Bluegill sunfish, all sizes—1 meal per month
- Bullhead, all sizes—1 meal per week
- Crappie, all sizes—1 meal per month
- Largemouth bass, all sizes—1 meal per month
- Northern pike, all sizes—1 meal per month
- Walleye, all sizes—1 meal per week
- Yellow perch—1 meal per month
- Carp and white sucker—no restrictions

The following fish consumption guidelines have been issued for pregnant women, women who may become pregnant, and children under age 15:

- Bluegill sunfish, all sizes—limit to 1 meal per month
- Bullhead, all sizes—limit to 1 meal per week
- Carp, all sizes—limit to 1 meal per week
- Crappie, all sizes—limit to 1 meal per month
- Largemouth bass—limit to 1 meal per month
- Northern pike—limit to 1 meal per month
- Walleye—limit to 1 meal per week
- Yellow perch—limit to 1 meal per month
- White sucker—no restrictions

Lake Elmo has excellent water quality and is not impaired, as indicated by summer total phosphorus and chlorophyll *a* concentrations and Secchi disc transparency levels recorded from 2012 through 2015:

- **Average total phosphorus range:** 15 to 20 µg/L (impairment standard $\leq$40 µg/L)
- **Average chlorophyll *a* range:** 1.8 to 2.3 µg/L (impairment standard $\leq$14 µg/L)
- **Average Secchi disc transparency range:** 4.7 to 5.7 meters (impairment standard $\geq$1.4 meters).

Summary

The MNDNR developed a Lake Plant Eutrophication IBI to measure the response of a lake plant community to eutrophication (excessive nutrients). The MPCA will use this IBI to identify lakes that are impaired (i.e., not supporting aquatic life due to stress from excessive nutrients). In 2016, Long Lake, Lake DeMontreville, Lake Olson, Lake Jane, and Lake Elmo met the criteria of the MNDNR Lake Plant Eutrophication IBI and are not impaired.

Although Long Lake, Lake DeMontreville, Lake Olson, and Lake Elmo are infested with EWM, the degree of infestation and impacts vary. A multi-year management program in Long Lake has reduced EWM from 52 acres to less than 1 acre. During the EWM reduction period, the native plant community responded positively, with increases in the number of submerged plant species, the percent of sample points with native submerged vegetation, and plant diversity.

Rapid expansion of EWM in Lake DeMontreville, Lake Olson, and Lake Jane since 2012 has displaced native plant species and caused significant reductions in the frequency of several native species. Efforts to attain seasonal relief from the infestation in Lake DeMontreville and Lake Olson from 2014 through 2016 and in Lake Jane during 2015 did not thwart EWM expansion. Rapid regrowth after treatment may have destabilized the plant community and contributed to significant changes in native plant frequency. If this hypothesis is true, long-term reduction of EWM via large-scale treatments is recommended to: (1) end displacement of native species and the resulting significant declines in the frequency of those species, (2) stabilize the plant community, and (3) protect the diverse assemblage of native species in the lakes.

Lake Elmo has been infested with EWM for a longer period than the other four lakes. EWM fluctuations have been observed from 2012 through 2016, including annual increases in total area during the past 2 years. Despite these fluctuations, the Lake Elmo plant community has remained relatively stable during the 2012 through 2016 monitoring period.

Although some additional invasive species are present in the five VBWD lakes, none are problematic. CLP and reed canary grass are found in all five lakes. Purple loosestrife is found in Lake DeMontreville and Lake Jane. Narrow-leaved cattail is found in Lake Olson and Lake Jane, while hybrid cattail is found in Lake Elmo, Lake DeMontreville, and Long Lake.

The MNDR has raised concerns that aquatic plant treatments might affect the fishery. Neither the MNDNR nor VBWD have completed fish surveys in Long Lake, Lake DeMontreville, Lake Olson, or Lake Jane following aquatic plant treatments to reduce EWM. The VBWD has not received any reports that the aquatic plant treatments have affected the fishery in any way.

From 1997 through 2012, the MNDNR developed Fish IBI tools to assess whether lakes support healthy fish populations. The MNDNR has used the Fish IBI since 2015 to characterize lakes as impaired (not

supporting aquatic life), or not impaired (supporting aquatic life). The Fish IBI only applies to lakes that have at least 100 acres of surface area (in the VBWD, only Lake DeMontreville and Lake Elmo).

The MNDNR completed two fish surveys in Lake DeMontreville in 2011 and computed Fish IBI scores of 39 and 28 from those results. These scores are close to the shallow lakes impairment threshold of 36 (scores below 36 indicate fish impairment). The MNDNR is currently using these scores for information only and will wait until the next fish survey in 2019 to decide whether Lake DeMontreville is impaired for fish. In the interim, stabilizing the lake's plant community to protect fishery habitat will be important.

A fisheries survey of Lake Elmo was completed by the MNDNR in 2014 and used to compute a Fish IBI score of 53. This score is above the lake impairment threshold of 45, indicating that the Lake Elmo fishery is not impaired.

Both Lake Elmo and Lake Jane have restrictions on fish consumption because tissue from fish in those lakes has failed to meet MPCA standards (mercury standards for Lake Jane and both mercury and PFO standards for Lake Elmo).

Long Lake, Lake DeMontreville, Lake Olson, Lake Jane, and Lake Elmo have excellent water quality and are not impaired. Summer average total phosphorus and chlorophyll *a* concentrations and Secchi disc transparencies from 2011 through 2015 for Long Lake and 2012 through 2015 for all other lakes met the MPCA lake water quality standards.

Description of Tables

- **Table 1** summarizes the results of the 2016 aquatic plant surveys of five VBWD lakes. 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 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.
    - **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 = more than 2/3 of the rake head full of plants.
        - 4 = rake head is full, with plants overtopping.
    - **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 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. The C values were provided by the MNDNR.

  - **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 three (degraded plant communities) to 49 (diverse native plant communities). The median FQI for Wisconsin is 22.

- **Table 2** summarizes invasive species data from the five VBWD lakes surveyed in 2016. The table shows the frequency of occurrence for species collected on the rake and includes species that were observed but not collected on the rake.

- **Tables 3, 9, 15, 21, and 27** summarize Eurasian watermilfoil (EWM) extent during the period of record for Long Lake, Lake DeMontreville, Lake Olson, Lake Jane, and Lake Elmo. EWM extent is shown as acres of EWM in the lake and as a percent of the plant-growth area.

- **Tables 4, 10, 16, 22, and 28** show several plant survey statistics for the period of record for the entire depth range sampled in Long Lake, Lake DeMontreville, Lake Olson, Lake Jane, and Lake Elmo.

- **Tables 5, 11, 17, 23, and 29** show several plant survey statistics for the period of record for the 0–15 foot depth range in Long Lake, Lake DeMontreville, Lake Olson, Lake Jane, and Lake Elmo.

- **Tables 6, 12, 18, 24, and 30** show Simpson Diversity Index values for the period of record in Long Lake, Lake DeMontreville, Lake Olson, Lake Jane, and Lake Elmo.

- **Tables 7, 13, 19, 25, and 31** show MNDNR Lake Eutrophication Plant IBI values for the period of record in Long Lake, Lake DeMontreville, Lake Olson, Lake Jane, and Lake Elmo.

- **Tables 8, 14, 20, 26, and 32** show species frequency for the period of record in Long Lake, Lake DeMontreville, Lake Olson, Lake Jane, and Lake Elmo.

Table 1 2016 Valley Branch Watershed District: Lake Plant Survey Summary Statistics (June 2016)

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	35	30	24	5	25.0	97	2.60	0.90	5.9	30.8
Elmo	29	25	16	4	24.0	99	2.87	0.89	5.3	26.9
Olson	27	23	18	4	18.5	94	2.14	0.85	5.7	27.1
DeMontreville	23	19	18	4	19.5	97	2.05	0.86	5.6	24.6
Long	19	15	12	4	23.5	49	2.18	0.78	5.3	21.8

Filamentous algae, aquatic moss, and liverworts were not included in number of species.

Table 2 2016 Valley Branch Watershed District: June 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* (narrow-leaved cattail)	*Typha glauca* (hybrid cattail)
Jane	41	18	1	Observed*	Observed*	
Elmo	43	1	1			1
Olson	19	1	Observed*		Observed*	
DeMontreville	16	2	Observed*	Observed*		1
Long	1	10	Observed*			Observed*

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

Table 3 Long Lake acres of EWM, acres of Plant Growth, and percentage of Plant-Growth Area with EWM

Sample Date	EWM Extent: Acres of EWM	Acres of Plant Growth	Percentage of Plant-Growth Area with EWM
6/15/2010	52.31	53.71	97.39%
8/1/2011	4.89	22.67	21.56%
4/29/2012	2.44	31.47	7.74%
6/18/2012	7.24	21.06	34.39%
5/16/2013 (Partial Survey)	14.28	--	--
6/24/2013	7.88	50.43	15.62%
5/24/2014	9.75	39.94	24.41%
6/25/2014	4.77	47.68	10.00%
5/9/2015	5.5	52.81	10.41%
6/22/2015	0.40	54.72	0.73%
5/1/2016	3.78	50.34	7.51%
6/27/2016	0.33	51.94	0.64%

Table 4 Summary of Point-Intercept Survey Results (Entire Depth Range) for Long Lake, Washington County, MN (DOW 82.011800)

Year	Month	Day	Max Depth Sampled	Max Depth of Submerged Plant Growth	Vegetated Depth Range Sampled (ft)*	Number of Points Sampled in Vegetated Depth Range	Number of Points Sampled with Native Submersed Vegetation	Percentage of Points Sampled with Native Submersed Vegetation	Percentage of Points Sampled with Submersed Vegetation	Average Number of Native Submersed Taxa per Sample Point	Submersed Species Richness (number of submerged species)
2010	June	15	34.8	26.9	1.0–26.9	144	13	9	92	0.46	7
2011	August	1	39.0	15.5	3.5–15.5	62	15	24	50	0.32	8
2012	June	18	35.0	11.5	0.5–11.5	58	28	48	76	0.92	8
2013	June	24	40.5	27.5	4.0–27.5	133	31	23	56	0.59	7
2014	June	25	40.0	24.0	4.0–24.0	127	41	32	43	0.49	8
2015	June	22	35.5	27.0	0.5–27.0	144	67	47	49	0.69	11
2016	June	27	35.5	23.5	0.5–23.5	134	61	54	49	0.97	11

*Depth range may be greater than or less than 0 to 15 feet.

To determine the denominator for the necessary calculations, we usually use the number of points in the range from the shallowest depth sampled to the maximum depth of colonization for submersed plants.

Aquatic moss, filamentous algae, and liverworts are not included in submersed vegetation.

Table 5 Summary of Point-Intercept Survey Results (0–15 Foot Depth Range) for Long Lake, Washington County, MN (DOW 82.011800)

Year	Month	Day	Max Depth Sampled within 0–15 Feet (ft)	Max Depth of Submerged Plant Growth within 0–15 Feet (ft)	Vegetated Depth Range Sampled within 0–15 Feet (ft)	Number of Points Sampled in Vegetated Depth Range within 0–15 Feet	Number of Points Sampled with Native Submersed Vegetation within 0–15 Feet	Percentage of Points Sampled with Native Submersed Vegetation within 0–15 Feet	Percentage of Points Sampled with Submersed Vegetation within 0–15 Feet	Average Number of Native Submersed Taxa per Sample Point within 0–15 Feet	Submersed Species Richness (number of submersed species within 0–15 feet)
2010	June	15	15	14.8	1.0–14.8	90	13	14	99	0.51	7
2011	August	1	15	15.0	3.5–15.0	57	14	25	53	0.50	8
2012	June	18	15	11.5	0.5–11.5	58	28	48	76	0.92	8
2013	June	24	15	15.0	4.0–15.0	54	30	56	70	0.72	7
2014	June	25	15	14.5	4.0–14.5	54	33	61	72	1.00	8
2015	June	22	15	15.0	0.5–15.0	86	50	57	60	0.92	11
2016	June	27	15	15.0	0.5–15.0	85	59	69	72	1.25	11

Aquatic moss, filamentous algae, and liverworts are not included in submersed vegetation.

Table 6 Simpson Diversity Index Values for Long Lake, Washington County, MN (DOW 82.011800)

Year	Month	Day	Diversity
2010	June	15	0.40
2011	August	1	0.80
2012	June	18	0.85
2013	June	24	0.81
2014	June	25	0.83
2015	June	22	0.77
2016	June	27	0.78

Table 7 MNDNR Plant IBI: Long Lake, Washington County, MN (DOW 82.011800)

Year	Month	Day	MNDNR Species Richness Plant IBI Criterion*	Long Lake Species Richness**	Percent Difference between MNDNR Criterion and Long Lake Species Richness	MNDNR Floristic Quality Index (FQI) Plant IBI Criterion*	Long Lake FQI***	Percent Difference between MNDNR Criterion and Long Lake FQI	Does Long Lake Meet MNDNR Plant IBI Criteria?
2010	June	15	≥12	16	33	≥18.6	21.3	15	Yes
2011	August	1	≥12	14	17	≥18.6	18.9	2	Yes
2012	June	18	≥12	15	25	≥18.6	18.9	2	Yes
2013	June	24	≥12	14	17	≥18.6	17.6	-5	No
2014	June	25	≥12	14	17	≥18.6	17.0	-9	No
2015	June	22	≥12	18	50	≥18.6	20.0	8	Yes
2016	June	27	≥12	19	58	≥18.6	21.8	17	Yes

*Criteria for North Central Hardwoods—2B Deeper Water Lakes (≥ 15' Max Depth)

**Filamentous algae, aquatic moss, and liverworts not included in species richness

***Filamentous algae, aquatic moss, liverworts, reed canary grass, and cattails not included in FQI

Table 8 Percent Frequencies of Occurrence in Vegetated Depth Range of Plants in Long Lake, Washington County, MN (DOW 82.011800)

Year	Month	Day	*Myriophyllum sibiricum*	*Myriophyllum spicatum*	*Ceratophyllum demersum*	*Ranunculus aquatilis*	*Utricularia vulgaris*	*Elodea canadensis*	*Heteranthera dubia*	*Potamogeton crispus*	*Potamogeton pusillus*	*Potamogeton sp.*	*Potamogeton nodosus*	*Stuckenia pectinata*	*Najas flexilis*	*Nitella spp.*	*Chara spp.*	*Lemna minor*	*Lemna trisulca*	*Spirodela polyrhiza*	*Wolffia columbiana*	Filamentous Algae	Aquatic Moss	*Bolboschoenus fluviatilis*	*Eleocharis acicularis*	*Phalaris arundinacea*	*Schoenoplectus acutus*	*Sparganium eurycarpum*	*Typha glauca*	*Typha sp.*	*Salix spp.*
			Submersed	Submersed	Submersed	Submersed	Submersed	Submersed	Submersed	Submersed	Submersed	Submersed	Submersed	Submersed	Submersed	Submersed	Submersed	Free-float	Free-float	Free-float	Free-float	Algae	Mosses	Emergent	Emergent	Emergent	Emergent	Emergent	Emergent	Emergent	Upland
			Dicot	**Dicot**	**Dicot**	**Dicot**	**Dicot**	Monocot	Monocot	Monocot	Monocot	Monocot	Monocot	Monocot	Monocot			Monocot	Monocot	Monocot	Monocot			Monocot	Monocot	Monocot	Monocot	Monocot	Monocot	Monocot	**Eudicot**
			Native	**Non-Native**	Native	Native	Native	Native	Native	**Non-Native**	Native	Native	Native	Native	Native	Native	Native	Native	Native	Native	Native	Native	Native	Native	Native	Native	Native	Native	Hybrid		**Non-Native**
2010	06	15	1	92					8	6		P			2			2	2	1					P	1	2	P		1	1
2011	08	1		29	5		P		2	2	2				16		8	P	11			15	3	P	5	P	2				
2012	06	18		29	9				21	41	5				26	2	17	2	5			16		2	2	2	2		2		
2013	06	24		19	5				3	25	5				7		11	2	1			20		1	1	P	1		P		
2014	06	25		10	10			2	2	11	14				1		20		2			17		1	2	P	1		P		
2015	06	22		1	6			26	1	6	8		P	P	1	1	26	1			1	25		P	1	P	P		P		
2016	06	27		1	10	3		31	2	10	4		1		1	1	29	1	1	P		37		P	1	P	P		P		

*P = Present—Observed but not collected on the sampling rake

Table 9 Lake DeMontreville acres of EWM, acres of Plant Growth, and percentage of Plant-Growth Area with EWM

Sample Date	EWM Extent: acres of EWM	Acres of Plant Growth	Percentage of Plant-Growth Area with EWM
6/18/2012	5.39	137.07	3.93%
6/24/2013	50.88	144.45	35.22%
5/24/2014	53.08	143.93	36.88%
6/28/2014	26.75	146.94	18.20%
5/10/2015	58.01	149.40	38.83%
6/21/2015	20.60	157.29	13.10%
5/1/2016	38.28	156.25	24.50%
6/26/2016	19.04	147.06	12.95%

Table 10 Summary of Point-Intercept Survey Results (Entire Depth Range) for Lake DeMontreville, Washington County, MN (DOW 82.010100)

Year	Month	Day	Max Depth Sampled (ft)	Max Depth of Submerged Plant Growth (ft)	Vegetated Depth Range Sampled (ft)	Number of Points Sampled in Vegetated Depth Range	Number of Points Sampled with Native Submersed Vegetation	Percentage of Points Sampled with Native Submersed Vegetation	Percentage of Points Sampled with Submersed Vegetation	Average Number of Native Submersed Taxa per Sample Point	Submersed Species Richness (number of submerged species)
2012	June	18	28.5	18.5	0.5–18.5	98	90	91.84	94.90	2.00	16
2013	June	24	31.0	21.0	1.5–21.0	101	90	89.11	90.10	2.23	18
2014	June	28	30.0	22.0	1.0–22.0	103	92	89.32	92.23	2.34	18
2015	June	21	28.5	26.5	0.5–26.6	109	99	90.83	92.66	2.36	18
2016	June	26	28.5	19.5	1.0–19.5	101	97	96.04	96.04	2.49	15

* May be greater than or less than 0 to 15 feet

To determine the denominator for the necessary calculations, we usually use the number of points in the range from the shallowest depth sampled to the maximum depth of colonization by submersed plants.

Aquatic moss, filamentous algae, and liverworts are not included in submersed vegetation.

Table 11 Summary of Point-Intercept Survey Results (0–15 Foot Depth Range) for Lake DeMontreville, Washington County, MN (DOW 82.010100)

Year	Month	Day	Max Depth Sampled within 0–15 Feet (ft)	Max Depth of Submerged Plant Growth within 0–15 Feet (ft)	Vegetated Depth Range Sampled within 0–15 Feet (ft)	Number of Points Sampled in Vegetated Depth Range within 0–15 Feet	Number of Points Sampled with Native Submersed Vegetation within 0–15 Feet	Percentage of Points Sampled with Native Submersed Vegetation within 0–15 Feet	Percentage of Points Sampled with Submersed Vegetation within 0–15 Feet	Average Number of Native Submersed Taxa per Sample Point within 0–15 Feet	Submersed Species Richness (number of submersed species within 0–15 feet)
2012	June	18	15	15	0.5–15.0	72	66	91.67	94.44	2.21	16
2013	June	24	15	15	1.5–15.0	72	69	95.83	95.83	2.46	17
2014	June	28	15	15	1.0–15.0	74	70	94.59	95.95	2.47	17
2015	June	21	15	15	0.5–15.0	89	87	97.75	97.75	2.69	18
2016	June	26	15	15	1.0–15.0	87	84	96.55	96.55	2.49	14

Aquatic moss, filamentous algae, and liverworts are not included in submersed vegetation.

Table 12 Simpson Diversity Index Values for Lake DeMontreville, Washington County, MN (DOW 82.010100)

Year	Month	Day	Diversity
2012	June	18	0.89
2013	June	24	0.90
2014	June	28	0.90
2015	June	21	0.90
2016	June	26	0.86

Table 13 MNDNR Plant IBI: Lake DeMontreville, Washington County, MN (DOW 82.010100)

Year	Month	Day	MNDNR Species Richness Plant IBI Criterion*	Lake DeMontreville Species Richness**	Percent Difference between MNDNR Criterion and Lake DeMontreville Species Richness	MNDNR Floristic Quality Index (FQI) Plant IBI Criterion*	Lake DeMontreville FQI***	Percent Difference between MNDNR Criterion and Lake DeMontreville FQI	Does Lake DeMontreville Meet MNDNR Plant IBI Criteria?
2012	June	18	≥12	27	125	≥18.6	26.4	42	Yes
2013	June	24	≥12	31	158	≥18.6	27.6	48	Yes
2014	June	28	≥12	25	108	≥18.6	27.9	50	Yes
2015	June	21	≥12	28	133	≥18.6	28.6	54	Yes
2016	June	26	≥12	23	92	≥18.6	24.6	32	Yes

*Criteria for North Central Hardwoods—2B Deeper Water Lakes (≥ 15' Max Depth)

**Filamentous algae, aquatic moss, and liverworts not included in species richness

***Filamentous algae, aquatic moss, liverworts, purple loosestrife, reed canary grass, water smartweed, iris, and cattails not included in FQI

Table 14 Percent Frequencies of Occurrence in Vegetated Depth Range of Plants in Lake DeMontreville, Washington County, MN (DOW 82.010100)

Year	Month	Day	*Ceratophyllum demersum*	*Myriophyllum spicatum*	*Myriophyllum sibericum*	*Ranunculus aquatilis*	*Elodea canadensis*	*Heteranthera dubia*	*Isoetes echinospora*	*Potamogeton amplifolius*	*Potamogeton crispus*	*Potamogeton friesii*	*Potamogeton illinoensis*	*Potamogeton pusillus*	*Potamogeton robbinsii*	*Potamogeton zosteriformis*	*Stuckenia pectinata*	*Najas flexilis*	*Najas s guadalupensis*	*Vallisneria americana*	*Chara sp.*	*Nitella sp.*	*Lemna minor*	*Lemna trisulca*	*Spirodela polyrhiza*	*Wolffia columbiana*	*Nymphaea odorata*	*Polygonum amphibium*	Filamentous Algae	Aquatic moss	*Eleocharis acicularis*	*Eleocharis palustris*	*Lythrum salicaria*	*Iris Pseudacorus*	*Phalaris arundinacea*	*Schoenoplectus acutus*	*Schoenoplectus tabernaemontani*	*Typha angustifolia*	*Typha latifolia*	*Typha glauca*
			Submersed	Submersed	Submersed	Submersed	Submersed	Submersed	Submersed	Submersed	Submersed	Submersed	Submersed	Submersed	Submersed	Submersed	Submersed	Submersed	Submersed	Submersed	Submersed	Submersed	Free-float	Free-float	Free-float	Free-float	Float-leaf	Float-leaf	Algae	Mosses	Emergent	Emergent	Emergent	Emergent	Emergent	Emergent	Emergent	Emergent	Emergent	Emergent
			Dicot	**Dicot**	**Dicot**	**Dicot**	Monocot	Monocot		Monocot	Monocot	Monocot	Monocot	Monocot	Monocot	Monocot	Monocot	Monocot	Monocot	Monocot			Monocot	Monocot	Monocot	Monocot	**Dicot**	**Dicot**			Monocot	Monocot		Monocot	Monocot	Monocot	Monocot	Monocot	Monocot	Monocot
			Native	**Non-Native**	Native	Native	Native	Native	Native	Native	**Non-Native**	Native	Native	Native	Native	Native	Native	Native	Native	Native	Native	Native	Native	Native	Native	Native	Native	Native	Native	Native	Native	Native	**Non-Native**	**Non-Native**	**Non-Native**	Native	Native	**Non-Native**	Native	**Non-Native**
			Ceratophyllum demersum	*Myriophyllum spicatum*	*Myriophyllum sibericum*	*Ranunculus aquatilis*	*Elodea canadensis*	*Heteranthera dubia*	*Isoetes echinospora*	*Potamogeton amplifolius*	*Potamogeton crispus*	*Potamogeton friesii*	*Potamogeton illinoensis*	*Potamogeton pusillus*	*Potamogeton robbinsii*	*Potamogeton zosteriformis*	*Stuckenia pectinata*	*Najas flexilis*	*Najas s guadalupensis*	*Vallisneria americana*	*Chara sp.*	*Nitella sp.*	*Lemna minor*	*Lemna trisulca*	*Spirodela polyrhiza*	*Wolffia columbiana*	*Nymphaea odorata*	*Polygonum amphibium*	Filamentous Algae	Aquatic moss	*Eleocharis acicularis*	*Eleocharis palustris*	*Lythrum salicaria*	*Iris Pseudacorus*	*Phalaris arundinacea*	*Schoenoplectus acutus*	*Schoenoplectus tabernaemontani*	*Typha angustifolia*	*Typha latifolia*	*Typha glauca*
2012	06	18	38	4	5	4	8	5		4	49		9	41	12	50		2		4	6	11		22		1	3		6	1	1	P	P		1		P	P	P	1
2013	06	24	50	33	12	5	22	7		3	42	1	7	30	26	48	2	2		2	5	3	1	28	1		4	P	33			P		P	P			P	P	1
2014	06	28	61	19	13	3	32	7		3	10	1	7	25	19	39		4	1	7	10	3		17			3	P	14	3	1	P			1					1
2015	06	21	61	17	1	5	30	2	1	6	31		6	18	17	45		6	8	12	13	6		15			3	P	27	6	2	P		P	P	P	P			1
2016	06	26	70	16		3	68	4			2		6	5	4	12		4	18	14	30	11		14			5	1	39	1			P		P	P	P			1

*P = Present—Observed but not collected on the sampling rake

Table 15 Lake Olson acres of EWM, acres of Plant Growth, and percentage of Plant-Growth Area with EWM

Sample Date	EWM Extent: Acres of EWM	Acres of Plant Growth	Percentage of Plant-Growth Area with EWM
6/18/2012	2.17	88.03	2.46%
6/24/2013	3.55	89.01	3.99%
5/24/2014	22.96	87.11	26.36%
6/28/2014	23.96	89.02	26.92%
5/9/2015	31.77	89.26	35.59%
6/21/2015	28.13	87.02	32.33%
5/1/2016	53.49	89.26	59.93%
6/26/2016	17.56	89.26	19.67%

Table 16 Summary of Point-Intercept Survey Results (Entire Depth Range) for Lake Olson, Washington County, MN (DOW 82.010300)

Year	Month	Day	Max Depth Sampled (ft)	Max Depth of Submerged Plant Growth (ft)	Vegetated Depth Range Sampled (ft)	Number of Points Sampled in Vegetated Depth Range	Number of Points Sampled with Native Submersed Vegetation	Percentage of Points Sampled with Native Submersed Vegetation	Percentage of Points Sampled with Submersed Vegetation	Average Number of Native Submersed Taxa per Sample Point	Submersed Species Richness (number of submerged species)
2012	June	18	19.0	19.0	1.0–19.0	120	90	75	79	2.03	16
2013	June	24	21.0	21.0	0.5–21.0	120	90	75	85	1.78	16
2014	June	28	20.5	20.0	1.5–20.0	119	108	91	91	2.22	18
2015	June	21	19.0	18.5	0.5–18.5	119	94	79	82	1.87	19
2016	June	26	18.5	18.5	0.5–18.5	120	113	94	94	2.29	17

To determine the denominator for the necessary calculations, we usually use the number of points in the range from the shallowest depth sampled to the maximum depth of colonization by submersed plants.

Aquatic moss, filamentous algae, and liverworts are not included in submersed vegetation.

Table 17 Summary of Point-Intercept Survey Results (0–15 Foot Depth Range) for Lake Olson, Washington County, MN (DOW 82.010300)

Year	Month	Day	Max Depth Sampled within 0–15 Feet (ft)	Max Depth of Submerged Plant Growth within 0–15 Feet (ft)	Vegetated Depth Range Sampled within 0–15 Feet (ft)	Number of Points Sampled in Vegetated Depth Range within 0–15 Feet	Number of Points Sampled with Native Submersed Vegetation within 0–15 Feet	Percentage of Points Sampled with Native Submersed Vegetation within 0–15 Feet	Percentage of Points Sampled with Submersed Vegetation within 0–15 feet	Average Number of Native Submersed Taxa per Sample Point within 0–15 Feet	Submersed Species Richness (number of submerged species within 0–15 feet)
2012	June	18	15	14.5	1.0–14.5	73	69	95	95	2.82	16
2013	June	24	15	15.0	0.5–15.0	74	66	90	90	2.44	16
2014	June	28	15	15.0	1.5–15.0	75	72	96	96	2.36	18
2015	June	21	15	15.0	0.5–15.0	87	80	92	92	2.36	19
2016	June	26	15	15.0	0.5–15.0	94	91	97	97	2.49	17

To determine the denominator for the necessary calculations, we usually use the number of points in the range from the shallowest depth sampled to the maximum depth of colonization by submersed plants.

Aquatic moss, filamentous algae, and liverworts are not included in submersed vegetation.

Table 18 Simpson Diversity Index Values for Lake Olson, Washington County, MN (DOW 82.010300)

Year	Month	Day	Diversity
2012	June	18	0.92
2013	June	24	0.91
2014	June	28	0.90
2015	June	21	0.90
2016	June	26	0.85

Table 19 MNDNR Plant IBI: Lake Olson, Washington County, MN (DOW 82.010300)

Year	Month	Day	MNDNR Species Richness Plant IBI Criterion*	Lake Olson Species Richness**	Percent Difference between MNDNR Criterion and Lake Olson Species Richness	MNDNR Floristic Quality Index (FQI) Plant IBI Criterion*	Lake Olson FQI***	Percent Difference between MNDNR Criterion and Lake Olson FQI	Does Lake Olson Meet MNDNR Plant IBI Criteria?
2012	June	18	≥12	24	100	≥18.6	25.6	38	Yes
2013	June	24	≥12	23	92	≥18.6	25.3	36	Yes
2014	June	28	≥12	26	117	≥18.6	27.1	46	Yes
2015	June	21	≥12	28	133	≥18.6	29.2	57	Yes
2016	June	26	≥12	27	125	≥18.6	27.1	46	Yes

*Criteria for North Central Hardwoods—2B Deeper Water Lakes (≥ 15' Max Depth)

**Filamentous algae, aquatic moss, and liverworts not included in species richness.

***Filamentous algae, aquatic moss, liverworts, reed canary grass, bluejoint reedgrass, water smartweed, iris, and cattails not included in FQI.

Table 20 Percent Frequencies of Occurrence in Vegetated Depth Range of Plants in Lake Olson, Washington County, MN (DOW 82.010300)

Year	Month	Day	*Ceratophyllum demersum*	*Myriophyllum spicatum*	*Myriophyllum sibericum*	*Ranunculus aquatilis*	*Elodea canadensis*		*Heteranthera dubia*	*Isoetes echinospora*	*Potamogeton amplifolius*	*Potamogeton crispus*	*Potamogeton illinoensis*	*Potamogeton nodosus*	*Potamogeton pusillus*	*Potamogeton robbinsii*	*Potamogeton zosteriformis*	*Najas flexilis*	*Najas guadalupensis*	*Stuckenia pectinata*	*Vallisneria americana*	Chara sp..	*Nitella sp*	*Lemna trisulca*	*Nymphaea odorata*	*Polygonum amphibium*	Filamentous algae	Aquatic moss	*Calamagrostis canadensis*	*Eleocharis acicularis*	*Eleocharis palustris*	*Iris virginica*	*Phalaris arundinacea*	*Sagittaria cristata*	Sagittaria graminea	Schoenoplectus Tabernaemontani	Typha angustifolia
			Submersed	Submersed	Submersed	Submersed	Submersed		Submersed	Submersed	Submersed	Submersed	Submersed	Submersed	Submersed	Submersed	Submersed	Submersed	Submersed	Submersed	Submersed	Submersed	Submersed	Submersed	Float-leaf	Float-leaf	Algae	Mosses	Emergent	Emergent	Emergent	Emergent	Emergent	Emergent	Emergent	Emergent	Emergent
			Dicot	**Dicot**	**Dicot**	**Dicot**	**Dicot**		Monocot		Monocot	Monocot	Monocot	Monocot	Monocot	Monocot	Monocot	Monocot	Monocot	Monocot	Monocot			Monocot	**Dicot**	**Dicot**			Monocot	Monocot	Monocot	**Monocot**	Monocot	Monocot	Monocot	Monocot
			Native	**Non-Native**	Native	Native	Native		Native	Native	Native	**Non-Native**	Native	Native	Native	Native	Native	Native	Native	Native	Native	Native	Native	Native	Native	Native	Native	Native	Native	Native	Native	**Non-Native**	Native	Native	Native	**Non-Native**
2012	06	18	27	3	12	4	11		16		10	28	23		30	10	19	3			2	25	12	15	1	P	7	18		4	1		1			1	P
2013	06	24	38	5	10	3	11		12		7	43	17		25	7	21	13		P		10	6	20	1		8	14		3	1		P			1	P
2014	06	28	57	28	8	2	23		24	1	1	3	13		22	10	17	11	2	P	3	25	4	19	1		19	13		1	1		P			P	P
2015	06	21	37	28	2	P	23		6		3	5	13	1	6	21	15	8	4	P	5	38	7	11	1		9	15		4	1	P	P	P		P	P
2016	06	26	50	19		3	67		4			1	8	P	3	8	6	8	4	1	6	53	9	8	1	P	23	13	P	5	P		P		2	P	P

*P = Present—Observed but not collected on the sampling rake

Table 21 Lake Jane acres of EWM, acres of Plant Growth, and percentage of Plant-Growth Area with EWM

Sample Date	EWM Extent: Acres of EWM	Acres of Plant Growth	Percentage of Plant-Growth Area with EWM
6/18/2012	0.10	118.54	0.08%
6/28/2013	1.68	121.82	1.38%
6/27/2014	24.08	112.61	21.38%
5/9/2015	44.16	125.08	35.31%
6/21/2015	31.01	126.77	24.46%
6/27/2016	68.71	131.23	52.36%

Table 22 Summary of Point-Intercept Survey Results (Entire Depth Range) for Lake Jane, Washington County, MN (DOW 82.010400)

Year	Month	Day	Max Depth Sampled (ft)	Max Depth of Submerged Plant Growth (ft)	Vegetated Depth Range Sampled (ft)	Number of Points Sampled in Vegetated Depth Range	Number of Points Sampled with Native Submersed Vegetation	Percentage of Points Sampled with Native Submersed Vegetation	Percentage of Points Sampled with Submersed Vegetation	Average Number of Native Submersed Taxa per Sample Point	Submersed Species Richness (number of submerged species)
2012	June	18	38.0	20.0	1.0–20.0	85	82	96	96	2.94	19
2013	June	28	40.5	22.5	0.5–22.5	86	82	95	95	2.60	21
2014	June	27	40.5	18.5	1.5–18.5	83	81	98	99	2.67	22
2015	June	21	39.0	23.0	0.5–23.0	90	85	94	96	2.33	21
2016	June	27	39.0	25.0	0.5–25.0	91	88	97	97	2.37	22

To determine the denominator for the necessary calculations, we usually use the number of points in the range from the shallowest depth sampled to the maximum depth of colonization by submersed plants.

Aquatic moss, filamentous algae, and liverworts are not included in submersed vegetation.

Table 23 Summary of Point-Intercept Survey Results (0–15 Foot Depth Range) for Lake Jane, Washington County, MN (DOW 82.010400)

Year	Month	Day	Max Depth Sampled within 0–15 feet (ft)	Max Depth of Submerged Plant Growth within 0–15 feet (ft)	Vegetated Depth Range Sampled within 0–15 Feet (ft)	Number of Points Sampled in Vegetated Depth Range within 0–15 Feet	Number of Points Sampled with Native Submersed Vegetation within 0–15 Feet	Percentage of Points Sampled with Native Submersed Vegetation within 0–15 Feet	Percentage of Points Sampled with Submersed Vegetation within 0–15 Feet	Average Number of Native Submersed Taxa per Sample Point within 0–15 Feet	Submersed Species Richness (number of submerged species within 0–15 feet)
2012	June	18	15	14.5	1.0–14.5	75	75	100	100	3.16	19
2013	June	24	15	15.0	0.5–14.5	76	75	99	99	2.84	21
2014	June	28	15	15.0	1.5–15.0	75	73	97	99	2.81	22
2015	June	21	15	15.0	0.5–15.0	80	79	99	100	2.53	20
2016	June	27	15	15.0	0.5–15.0	76	76	100	100	2.64	21

To determine the denominator for the necessary calculations, we usually use the number of points in the range from the shallowest depth sampled to the maximum depth of colonization by submersed plants.

Aquatic moss, filamentous algae, and liverworts are not included in submersed vegetation.

Table 24 Simpson Diversity Index Values for Lake Jane, Washington County, MN (DOW 82.010400)

Year	Month	Day	Diversity
2012	June	18	0.92
2013	June	28	0.91
2014	June	27	0.92
2015	June	21	0.92
2016	June	27	0.90

Table 25 MNDNR Plant IBI: Lake Jane, Washington County, MN (DOW 82.010400)

Year	Month	Day	MNDNR Species Richness Plant IBI Criterion*	Lake Jane Species Richness**	Percent Difference between MNDNR Criterion and Lake Jane Species Richness	MNDNR Floristic Quality Index (FQI) Plant IBI Criterion*	Lake Jane FQI***	Percent Difference between MNDNR Criterion and Lake Jane FQI	Does Lake Jane Meet MNDNR Plant IBI Criteria?
2012	June	18	≥12	34	183	≥18.6	31.6	70	Yes
2013	June	28	≥12	35	192	≥18.6	33.1	78	Yes
2014	June	27	≥12	36	200	≥18.6	32.3	74	Yes
2015	June	21	≥12	30	150	≥18.6	30.8	66	Yes
2016	June	27	≥12	35	192	≥18.6	30.8	66	Yes

* Criteria for North Central Hardwoods—2B Deeper Water Lakes (≥ 15' Max Depth)

** Filamentous algae, aquatic moss, and liverworts not included in species richness

*** Filamentous algae, aquatic moss, liverworts, reed canary grass, and cattails not included in FQI

Table 26 Percent Frequencies of Occurrence in Vegetated Depth Range of Plants in Lake Jane, Washington County, MN (DOW 82.010400)

Year	Month	Day	Submersed	Submersed	Submersed	Submersed	Submersed	Submersed	Submersed	Submersed	Submersed	Submersed	Submersed	Submersed	Submersed	Submersed	Submersed	Submersed	Submersed	Submersed	Submersed	Submersed	Submersed	Submersed	Submersed	Submersed	Submersed	Float-leaf	Float-leaf	Float-leaf	Free-float	Free-float	Free-float	Free-float	Mosses	Algae	Emergent	Emergent	Emergent	Emergent	Emergent	Emergent	Emergent	Emergent	Emergent	Emergent	Emergent	Emergent	Emergent	Emergent	Emergent
			Dicot	**Dicot**	**Dicot**	**Dicot**	**Dicot**	**Dicot**	Monocot	Monocot	Monocot	Monocot	Monocot	Monocot	Monocot	Monocot	Monocot	Monocot	Monocot	Monocot	Monocot	Monocot	Monocot	Monocot	Monocot	Monocot	Monocot	**Dicot**	**Dicot**	**Dicot**	Monocot	Monocot		Monocot			Monocot	Monocot	Monocot	Monocot	Monocot	Monocot	Monocot	Monocot	**Dicot**	Monocot	Monocot	Monocot	Monocot	Monocot	Monocot
			Native	Native	**Non-Native**	Native	Native	Native	Native	Native	**Non-Native**	Native	Native	Native	Native	Native	Native	Native	Native	Native	Native	Native	Native	Native	Native	Native	Native	Native	Native	Native	Native	Native	Native	Native	Native	Native	Native	Native	Native	Native	Native	Native	Native	Native	Native	Native	Native	Native	Native	Native	Native
			Ceratophyllum demersum	*Bidens beckii*	*Myriophyllum spicatum*	*Myriophyllum sibericum*	*Ranunculus aquatilus*	*Elodea canadensis*	*Heteranthera dubia*	*Potamogeton amplifolius*	*Potamogeton crispus*	*Potamogeton friesii*	*Potamogeton illinoensis*	*Potamogeton nodosus*	*Potamogeton pusillus*	*Potamogeton praelongus*	*Potamogeton robbinsii*	*Potamogeton zosteriformis*	*Stuckenia pectinata*	*Najas flexilis*	*Najas guadalupensis*	*Vallisneria americana*	*Zannichellia palustris*	*Isoetes echinospora*	Chara sp.	*Nitella sp*	*Brasenia schreberi*	*Nymphaea odorata*	*Polygonum amphibium*	*Lemna minor*	*Lemna trisulca*	*Riccia fluitans*	*Wolffia columbiana*	Aquatic moss	Filamentous algae	*Carex pellita*	*Eleocharis acicularis*	*Eleocharis erythropoda*	*Iris virginica*	*Juncus articus variation balticus*	*Juncus canadensis*	*Juncus effusus*	*Juncus pelocarpus*	*Juncus pilocarpus f. submersum*	*Lythrum salicaria*	*Phalaris arundinacea*	*Sagittaria cristata*	*Schoenplectus tabernaemontani*	*Typha angustifolia*	*Typha X glauca*
2012	06	18	33		P	22	15	32	7	21	16	1	24		8	14	62	16	1	8	6	6			16		1	6	P	2	1		1			2		4					P	2		P	P	2	P	P	P
2013	06	28	24		2	21	9	17	3	15	12		30		6	21	66	10	1	8	5	2	2	1	15	1	1	2		1	1	P	1		5		7	1		1				2	P	P	3	1	P	
2014	06	27	25		19	20	5	27	7	6	8	2	30	2	7	16	57	14	P	5	13	6	1	1	22		2	2			1			1	2	1	1	1		1	1	P			P	P	4	P		P
2015	06	21	23	1	23	9	2	30		7	11	2	19	7	7	14	53	12	2	4	17	4			17	2	1	3			7			1	16		3								P	P	3	P	P	
2016	06	27	14		41	3	1	46	P	7	18		18	9	1	9	54	5	1	2	37	5	2	1	18	3		5	P					1	10	1	5	1	P	P	P				P	1	1	P	P	

*P = Present—Observed but not collected on the sampling rake

Table 27 Lake Elmo acres of EWM, acres of Plant Growth, and percentage of Plant-Growth Area with EWM

Sample Date	EWM Extent: acres of EWM	Acres of Plant Growth	Percentage of Plant-Growth Area with EWM
6/18–19/2012	71.09	112.68	63.09
6/28/2013	52.69	109.61	48.07
6/27/2014	50.58	112.42	44.99
6/21/2015	67.52	113.53	59.47
4/30/2016	58.77	123.62	47.54%
6/27/2016	78.58	123.31	63.73%
7/29/2016*	80.15	126.60	63.31%

*July 29, 2016, data collected by the Lake Elmo Association

Table 28 Summary of Point-Intercept Survey Results (Entire Depth Range) for Lake Elmo, Washington County, MN (DOW 82.010600)

Year	Month	Day	Max Depth Sampled (ft)	Max Depth of Submerged Plant Growth (ft)	Vegetated Depth Range Sampled (ft)	Number of Points Sampled in Vegetated Depth Range	Number of Points Sampled with Native Submersed Vegetation	Percentage of Points Sampled with Native Submersed Vegetation	Percentage of Points Sampled with Submersed Vegetation	Average Number of Native Submersed Taxa per Sample Point	Submersed Species Richness (number of submerged species)
2012	June	18-19	133	19.5	0.5-19.5	75	60	80	85	1.55	21
2013	June	28	137	23.0	0.5-23.0	76	56	74	80	1.12	18
2014	June	27	135	21.0	1.0-21.0	74	57	77	81	1.22	15
2015	June	21	134	20.5	0.5-20.5	75	59	79	85	1.24	16
2016	June	27	134	24.0	0.5-24.0	79	67	85	91	1.70	16
2016	July	29	134	25.5	0.5-25.5	80	61	76	81	1.38	15

To determine the denominator for the necessary calculations, we usually use the number of points in the range from the shallowest depth sampled to the maximum depth of colonization by submersed plants.

Aquatic moss, filamentous algae, and liverworts are not included in submersed vegetation.

July 29, 2016, data collected by the Lake Elmo Association.

Table 29 Summary of Point-Intercept Survey Results (0–15 Foot Depth Range) for Lake Elmo, Washington County, MN (DOW 82.010600)

Year	Month	Day	Max Depth Sampled within 0–15 Feet (ft)	Max Depth of Submerged Plant Growth within 0–15 Feet (ft)	Vegetated Depth Range Sampled within 0–15 Feet (ft)	Number of Points Sampled in Vegetated Depth Range within 0–15 Feet	Number of Points Sampled with Native Submersed Vegetation within 0–15 Feet	Percentage of Points Sampled with Native Submersed Vegetation within 0–15 Feet	Percentage of Points Sampled with Submersed Vegetation within 0–15 Feet	Average Number of Native Submersed Taxa per Sample Point within 0–15 Feet	Submersed Species Richness (number of submerged species within 0-15 feet)
2012	June	18-19	15	15.0	0.5–15.0	68	54	79	85	1.59	20
2013	June	28	15	15.0	0.5–14.5	66	48	73	79	1.12	17
2014	June	27	15	15.0	1.0–15.0	65	51	78	82	1.29	15
2015	June	21	15	15.0	0.5–15.0	67	52	79	85	1.30	16
2016	June	27	15	15.0	0.5–15.0	70	59	84	91	1.50	16
2016	July	29	15	15.0	0.5–15.0	67	52	78	84	1.51	15

To determine the denominator for the necessary calculations, we usually use the number of points in the range from the shallowest depth sampled to the maximum depth of colonization by submersed plants.

Aquatic moss, filamentous algae, and liverworts are not included in submersed vegetation.

July 29, 2016 data collected by the Lake Elmo Association.

Table 30 Simpson Diversity Index Values for Lake Elmo, Washington County, MN (DOW 82.010600)

Year	Month	Day	Diversity
2012	June	18–19	0.91
2013	June	28	0.89
2014	June	27	0.88
2015	June	21	0.88
2016	June	27	0.89
2016	July	29	0.88

July 29, 2016, data collected by the Lake Elmo Association

Table 31 MNDNR Plant IBI: Lake Elmo, Washington County, MN (DOW 82.010600)

Year	Month	Day	MNDNR Species Richness Plant IBI Criterion*	Lake Elmo Species Richness**	Percent Difference between MNDNR Criterion and Lake Elmo Species Richness	MNDNR Floristic Quality Index (FQI) Plant IBI Criterion*	Lake Elmo FQI***	Percent Difference between MNDNR Criterion and Lake Elmo FQI	Does Lake Elmo Meet MNDNR Plant IBI Criteria?
2012	June	18–19	≥12	35	192	≥18.6	31.1	67	Yes
2013	June	28	≥12	34	183	≥18.6	28.0	51	Yes
2014	June	27	≥12	31	158	≥18.6	25.4	37	Yes
2015	June	21	≥12	30	150	≥18.6	26.9	45	Yes
2016	June	27	≥12	30	150	≥18.6	26.9	45	Yes
2016	July	29	≥12	29	142	≥18.6	26.5	42	Yes

* Criteria for North Central Hardwoods—2B Deeper Water Lakes (≥ 15' Max Depth)

** Filamentous algae, aquatic moss, and liverworts not included in species richness

*** Filamentous algae, aquatic moss, liverworts, reed canary grass, and cattails not included in FQI

Table 32 Percent Frequencies of Occurrence in Vegetated Depth Range of Plants in Lake Elmo, Washington County, MN (DOW 82.010600)

Year	Month	Day	*Ceratophyllum demersum*	*Elodea canadensis*	*Myriophyllum spicatum*	*Myriophyllum sibericum*	*Ranunculus aquatilus*	*Utricularia vulgaris*	*Heteranthera dubia*	*Potamogeton amplifolius*	*Potamogeton crispus*	*Potamogeton foliosus*	*Potamogeton friesii*	*Potamogeton illinoensis*	*Potamogeton natans*	*Potamogeton praelongus*	*Potamogeton pusillus*	*Potamogeton richardsonii*	*Potamogeton strictifolius*	*Potamogeton zosteriformis*	*Najas flexilis*	*Najas guadalupensis*	*Stuckenia pectinata*	Chara sp..	*Nitella sp*	*Nymphaea odorata*	*Polygonum amphibium*	*Lemna minor*	*Lemna trisulca*	*Spirodela polyrhiza*	Filamentous algae	*Riccia fluitans*	*Ricciocarpus natans*	*Carex comosa*	*Carex pellita*	*Carex scoparia*	*Eleocharis acicularis*	*Eleocharis erythropoda*	*Eleocharis palustris*	*Equisetum fluviatile*	*Iris virginica*	*Phalaris arundinacea*	*Phragmites australis*	*Schoenplectus acutus*	*Schoenoplectus pungens*	*Schoenoplectus Tabernaemontani*	*Sparganium eurycarpum*	*Typha angustifolia*	*Typha glauca*
			Submersed	Submersed	Submersed	Submersed	Submersed	Submersed	Submersed	Submersed	Submersed	Submersed	Submersed	Submersed	Submersed	Submersed	Submersed	Submersed	Submersed	Submersed	Submersed	Submersed	Submersed	Submersed	Submersed	Submersed	Float-leaf	Float-leaf	Free-float	Free-float	Free-float	Algae	Liverwort	Liverwort	Emergent	Emergent	Emergent	Emergent	Emergent	Emergent	Emergent	Emergent	Emergent	Emergent	Emergent	Emergent	Emergent	Emergent	Emergent	Emergent
			Dicot	**Dicot**	**Dicot**	**Dicot**	**Dicot**	**Dicot**	Monocot	Monocot	Monocot	Monocot	Monocot	Monocot	Monocot	Monocot	Monocot	Monocot	Monocot	Monocot	Monocot	Monocot	Monocot			**Dicot**	**Dicot**	Monocot	Monocot	Monocot	Monocot			Monocot	Monocot	Monocot	Monocot	Monocot	Monocot		Monocot	Monocot	Monocot	Monocot	Monocot	Monocot	Monocot	Monocot	Monocot	Monocot
			Native	Native	**Non-Native**	Native	Native	Native	Native	Native	**Non-Native**	Native	Native	Native	Native	Native	Native	Native	Native	Native	Native	Native	Native	Native	Native	Native	Native	Native	Native	Native	Native	Native	Native	Native	Native	Native	Native	Native	Native	Native	Native	Native	Native	Native	Native	Native	Native	Native	Native
2012	06	18-19	29	8	44	1	7	1		P	3	P	P	13	12		1	P	1	7	1	28	5	37	1	12	P	1			5			P			3	1	3	P		4		4	P	5	P	17	
2013	06	28	26	3	37	P	4	1			P		1	7	9		P	P		3	1	21	1	33	1	13		4			8		P	P	1	1	P	P	1	1	1	3	P	4	P	16	
2014	06	27	43	5	34		1	P			P		P	4	9			P		4	4	18	1	31		9	P	1		1	14			P	1	P		1	P	P		3	P	5	P	3			16
2015	06	21	41	3	45	P	3	1	1	P	P			4	13		1			7		12	3	35		13	P	5		7	11	3					3	P	P	P	P	P	3	P	3		17	
2016	06	27	43	8	43		6	P	3	P	1			9	10		1			6	P	23	1	34		18	P	4	1	3	8		1					P	P		1	P	5	P	P		15	1
2016	07	29	40	8	39		3	P	3	P	P			11	10	P				4	1	28	3	29		11	P	3		1	3						1	P	P			P	5	P	3		1	15

*P = Present—Observed but not collected on the sampling rake

July 29, 2016, data collected by the Lake Elmo Association

Description of Figures

- **Figures 1, 3, and 6** show the 2016 herbicide treatment areas for Long Lake, Lake DeMontreville, and Lake Olson.
- **Figures 2, 4, 7, 9, and 10** show EWM extent in Long Lake, Lake DeMontreville, Lake Olson, Lake Jane, and Lake Elmo in June of 2016.
- **Figures 5 and 8** show locations of EWM observed in treated areas during August inspection by MNDNR.
- **Figure 11** shows EWM extent in Lake Elmo in July of 2016.

Figure 1 2016 Long Lake Eurasian Watermilfoil Treatment Areas

Figure 2 June 2016 Long Lake Eurasian Watermilfoil Extent

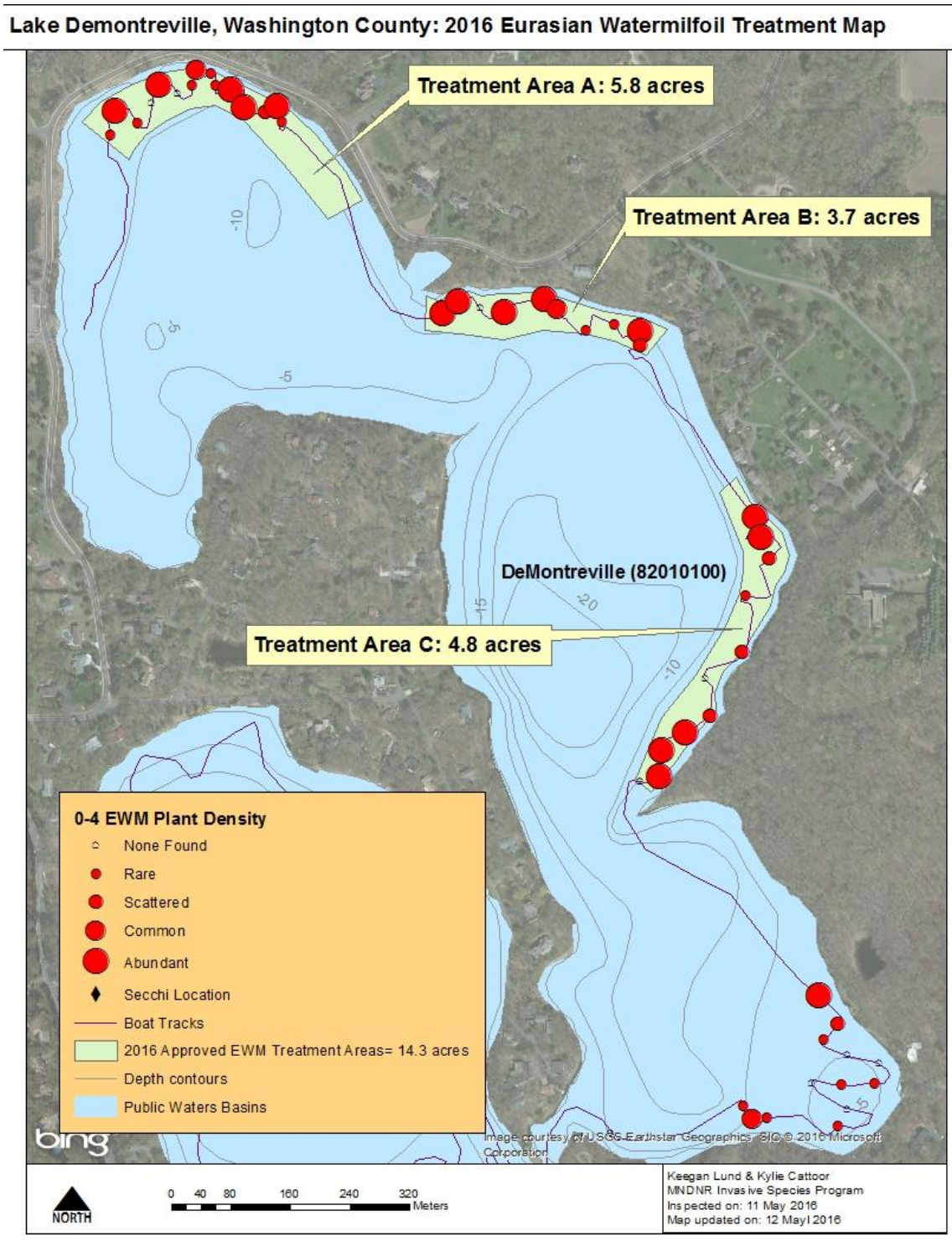

Figure 3 2016 Lake DeMontreville Eurasian Watermilfoil Treatment Areas (Map Prepared by Minnesota Department of Natural Resources)

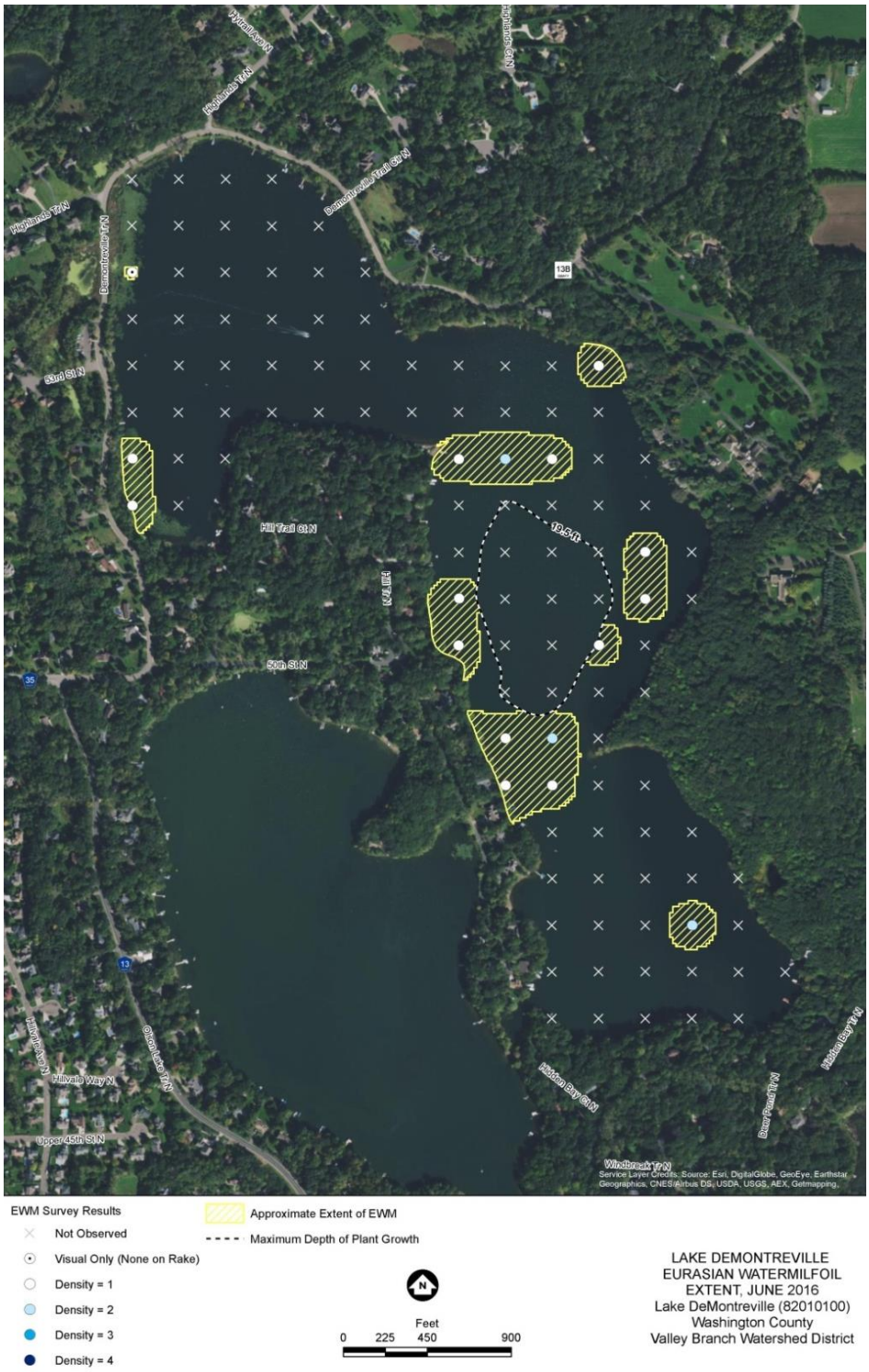

Figure 4 June 2016 Lake DeMontreville Eurasian Watermilfoil Extent

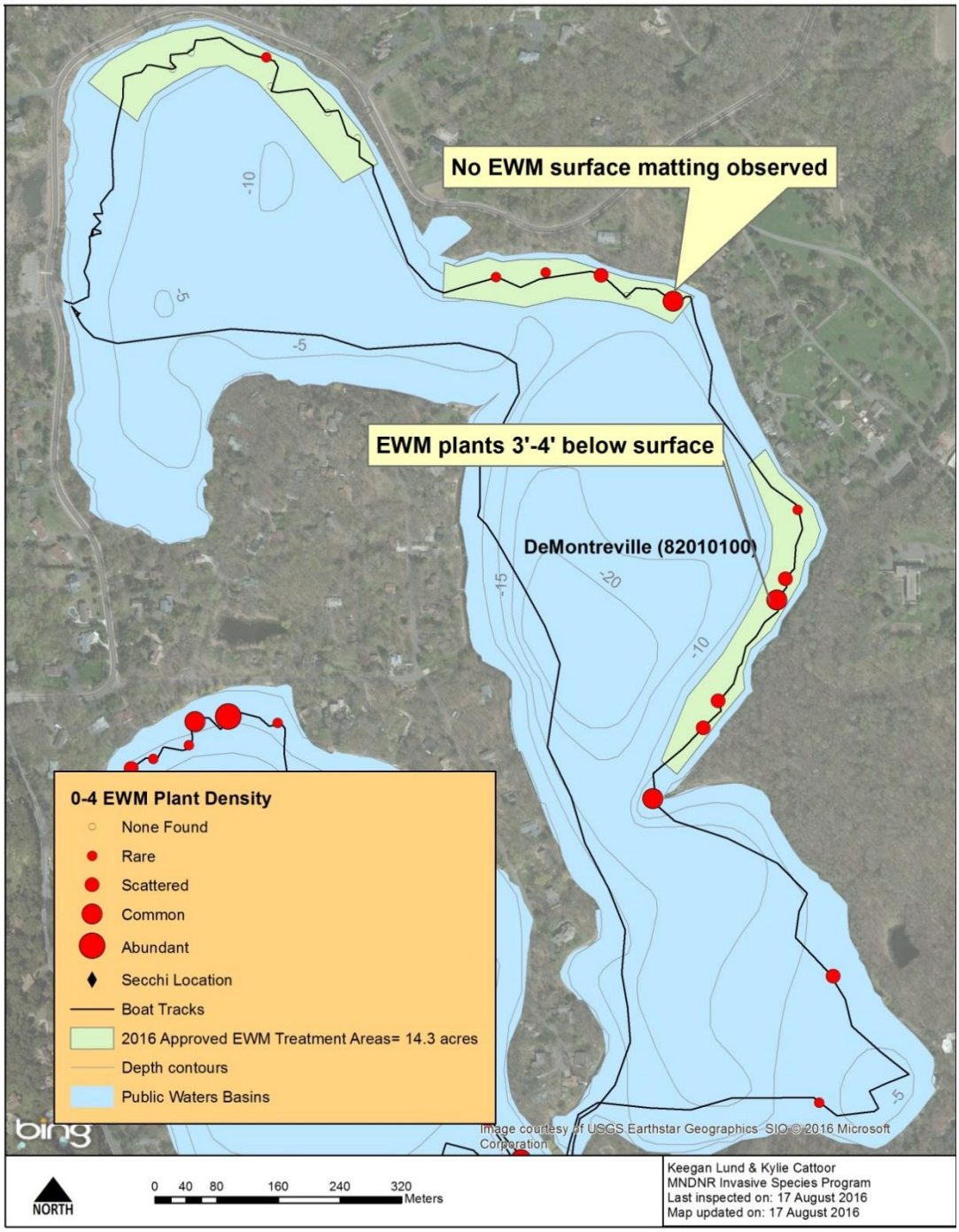

Figure 5 August 2016 MNDNR Inspection of Lake DeMontreville Treatment Areas for Eurasian Watermilfoil (Map Prepared by Minnesota Department of Natural Resources)

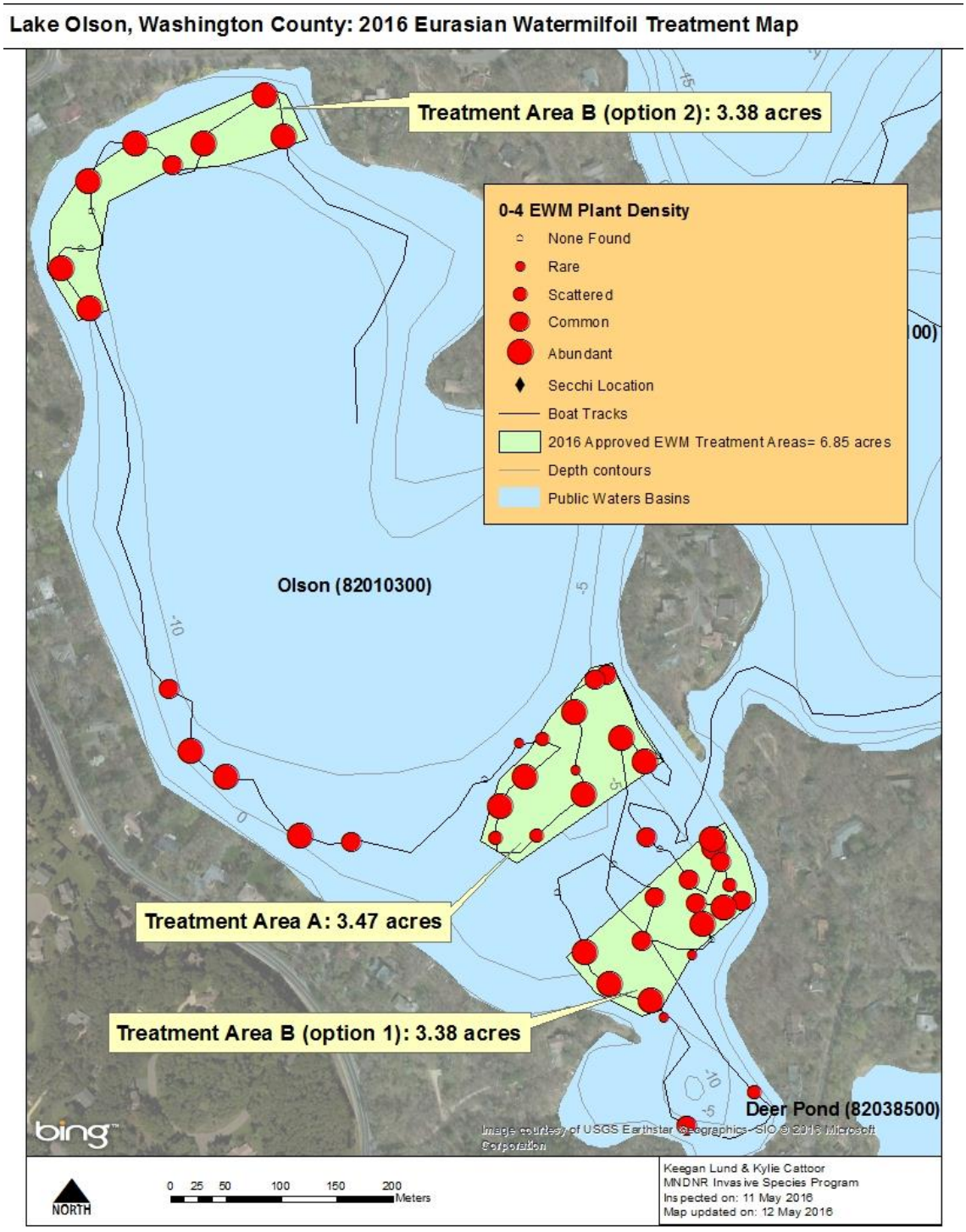

Figure 6 2016 Lake Olson Eurasian Watermilfoil Treatment Areas (Map Prepared by Minnesota Department of Natural Resources)

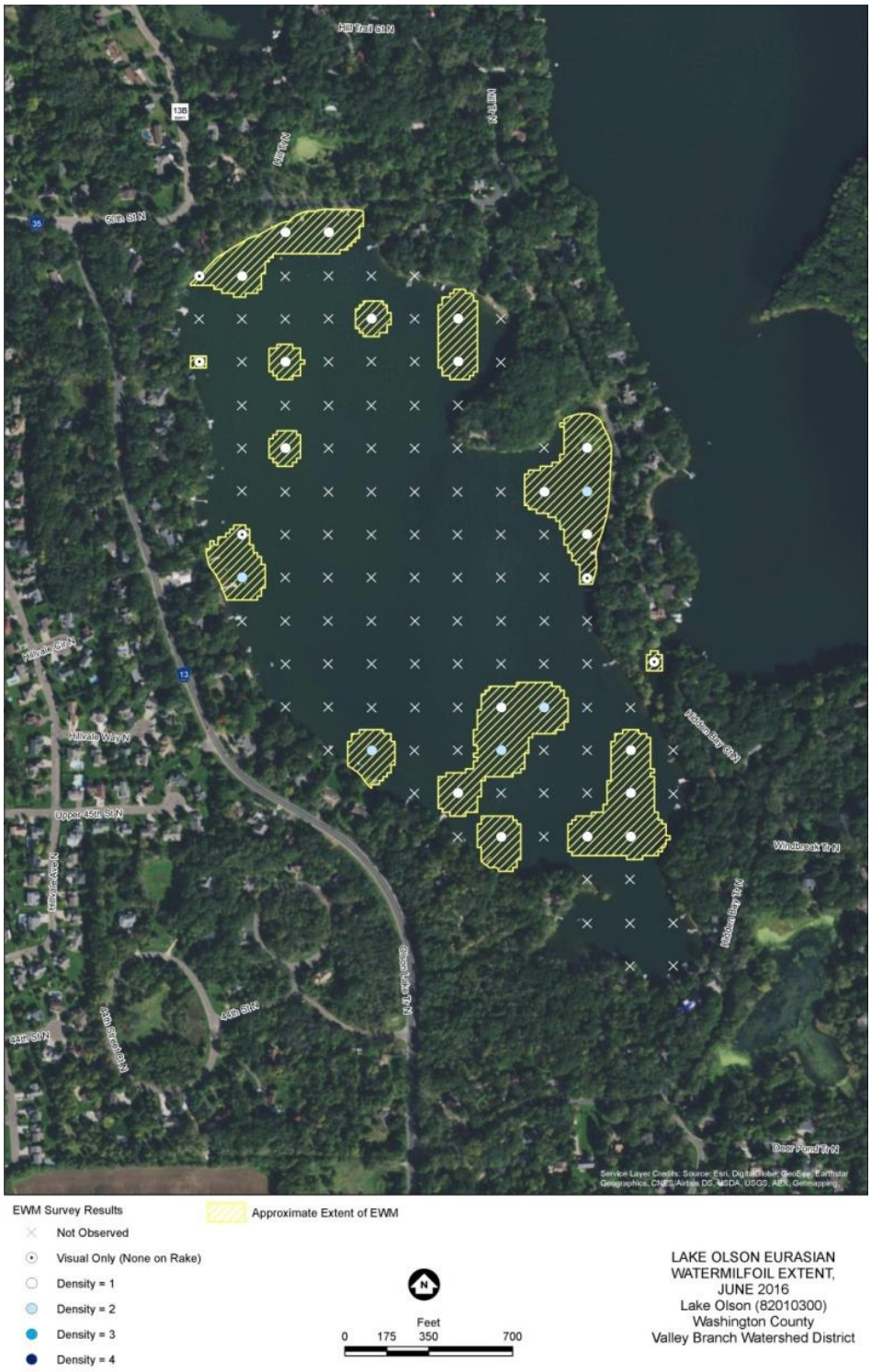

Figure 7 June 2016 Lake Olson Eurasian Watermilfoil Extent

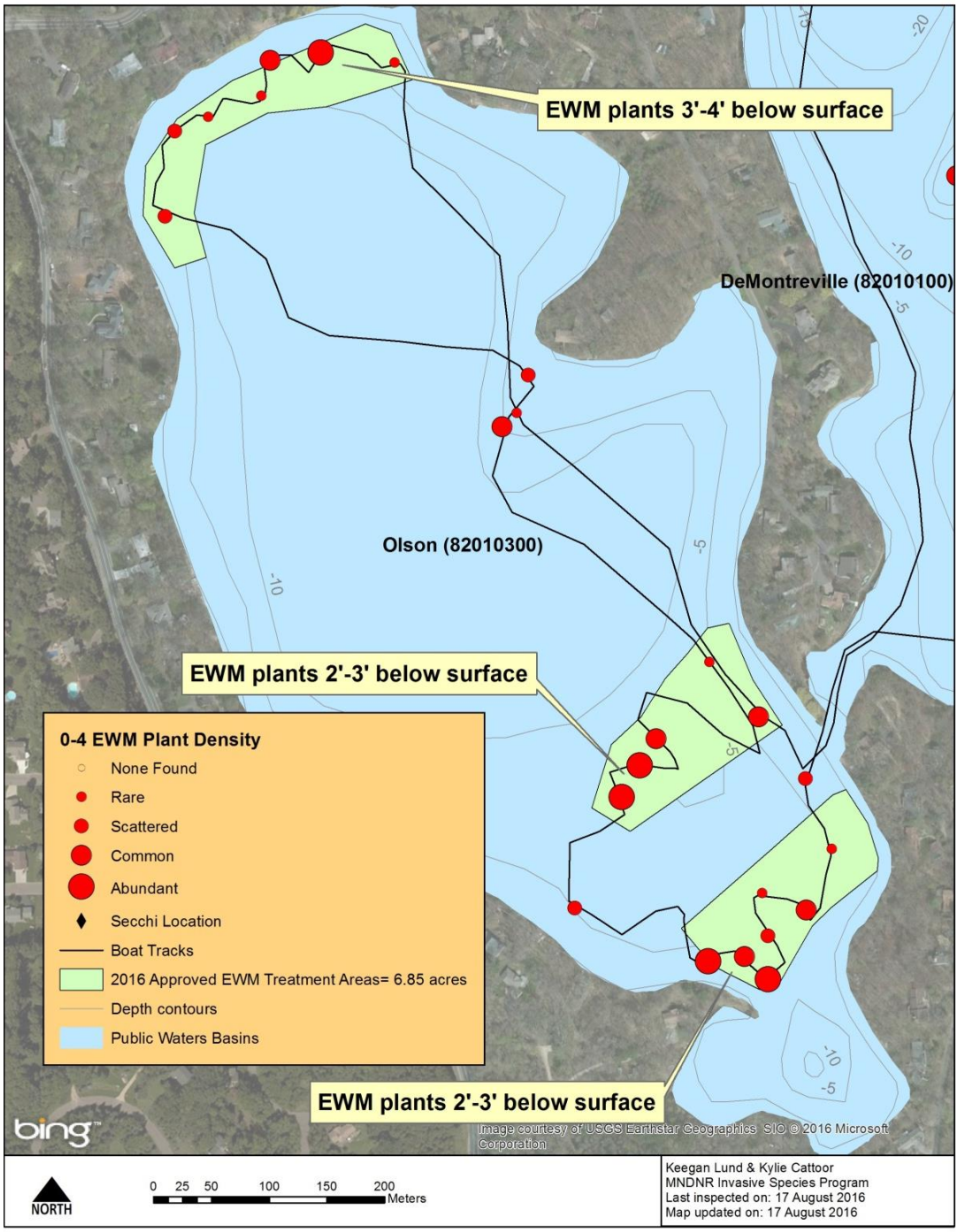

Figure 8 August 2016 MNDNR Inspection of Lake Olson Treatment Areas for Eurasian Watermilfoil (Map Prepared by Minnesota Department of Natural Resources)

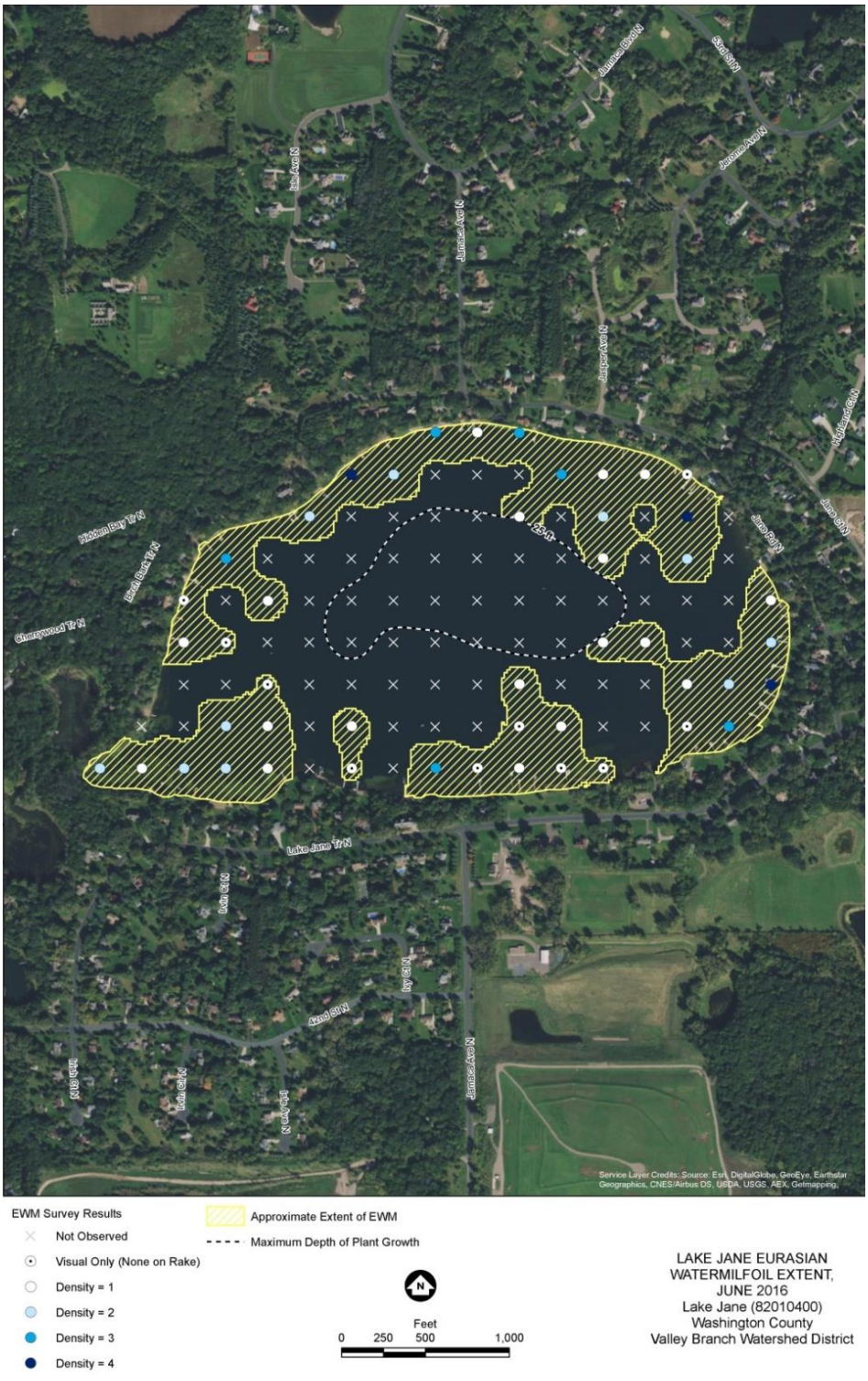

Figure 9 June 2016 Lake Jane Eurasian Watermilfoil Extent

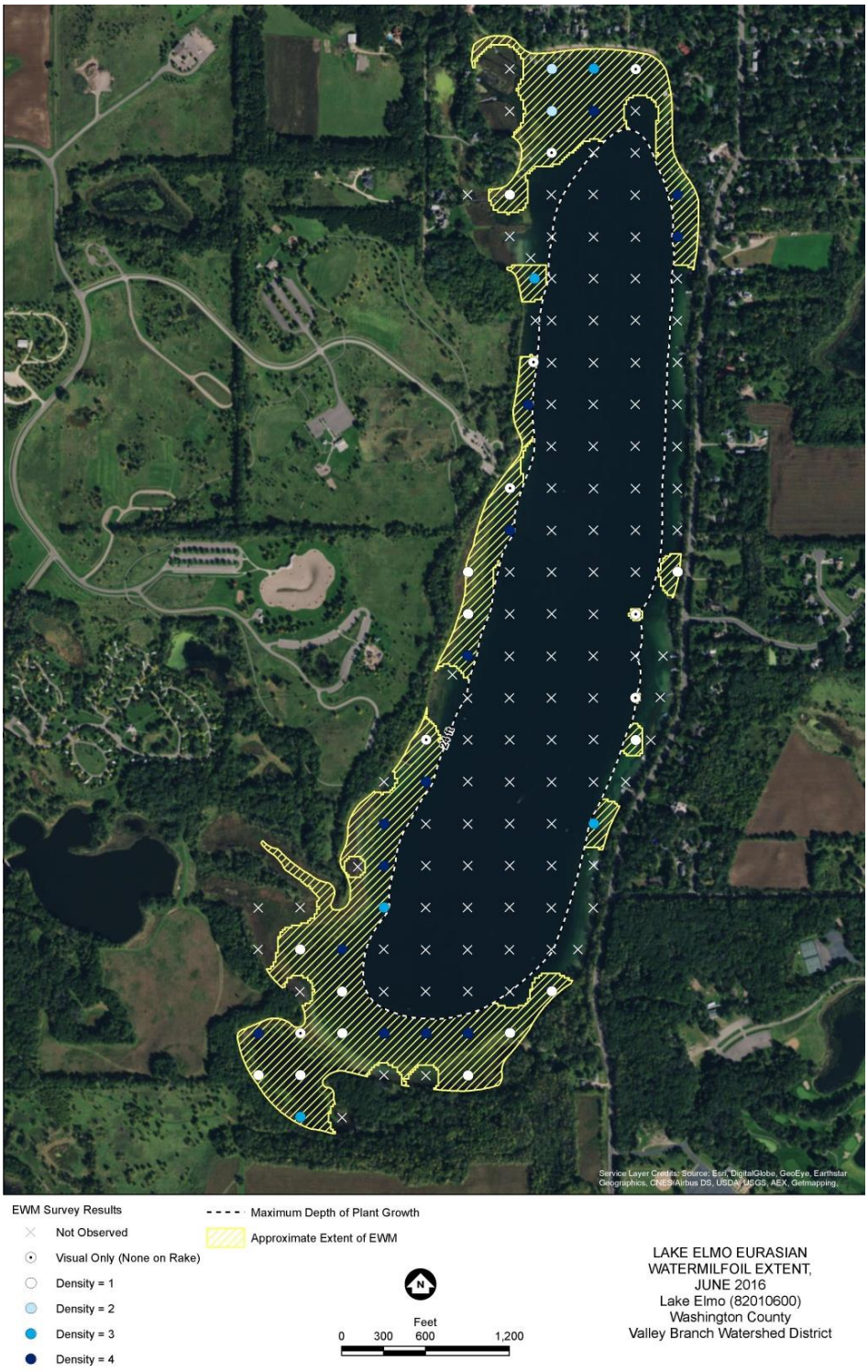

Figure 10 June 2016 Lake Elmo Eurasian Watermilfoil Extent

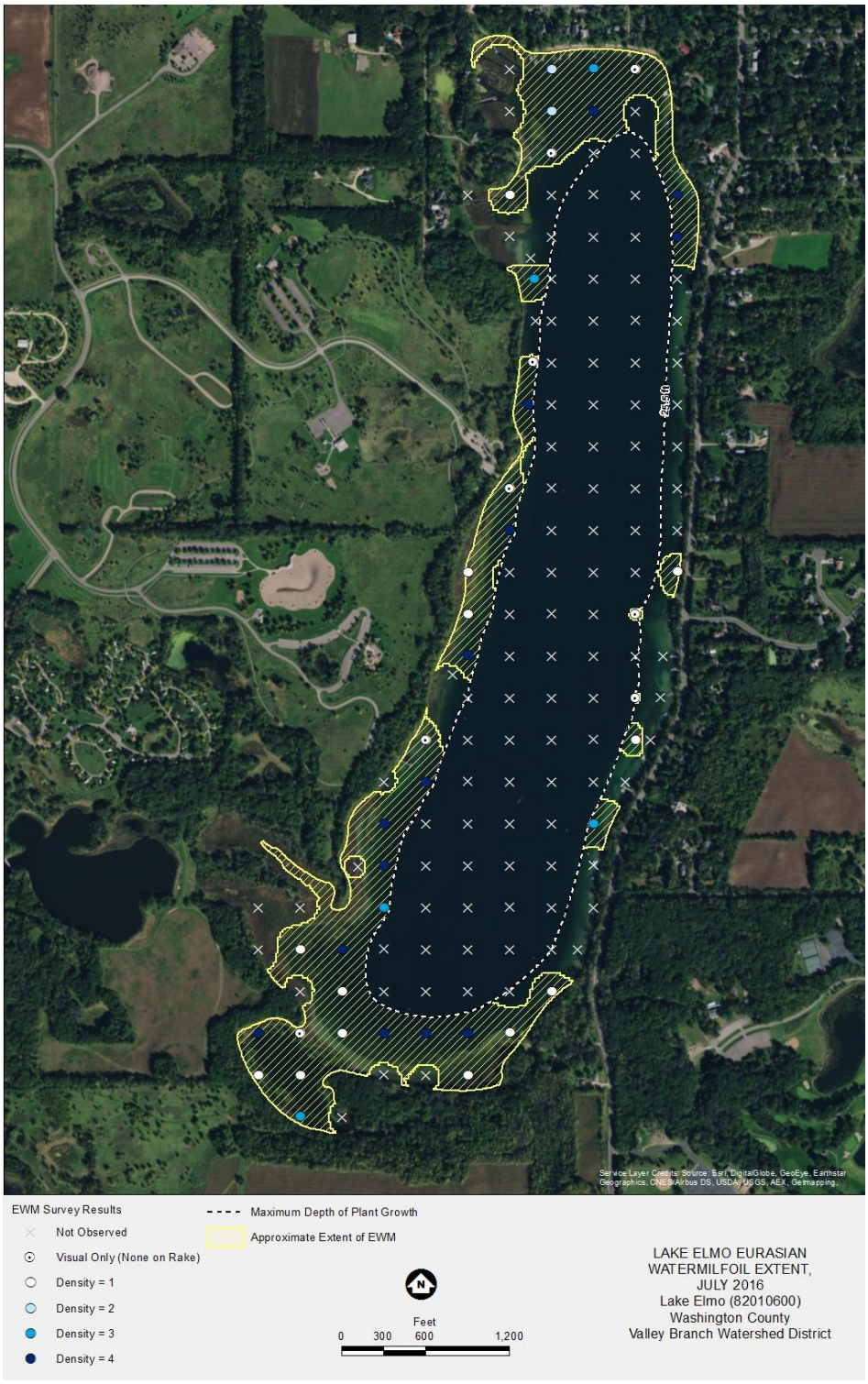

Figure 11 July 2016 Lake Elmo Eurasian Watermilfoil Extent