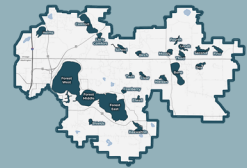




MEMORANDUM

Comfort Lake-Forest Lake Watershed District

Date: January 16, 2024
To: CLFLWD Board of Managers
From: Mike Kinney, District Administrator
Subject: 2023 Blue Water Science Reports



District Wide

Background/Discussion:

The purpose of this agenda item is for the Board to consider accepting Blue Water Science's 2023 survey reports. These reports were originally included in the December 20th regular board meeting packet.

Since that meeting, the District has received the final reports for Forest Lake flowering rush management and for the Forest Lake point intercept survey. Both have been attached below. Steve McComas of Blue Water Science will be attending the board meeting and he will present some of his findings from these reports.

Recommended Action:

Manager _____ moves to accept Blue Water Science's 2023 Survey Reports. Seconded by Manager _____.

Attached: (distributed at the December 20th, 2023, regular board meeting and included on the January 25th board packet webpage):

1. Moody Lake Curly-leaf Pondweed Delineation and Assessment Surveys
2. Bone Lake AIS Search
3. Bone Lake Curly-leaf Pondweed and Eurasian Watermilfoil Management and Point Intercept Surveys
4. Shields Lake Curly-leaf Pondweed Delineation and Assessment Surveys
5. Forest Lake Curly-leaf Pondweed and Eurasian Watermilfoil Delineation, Treatment, and Assessment Surveys
6. Forest Lake Flowering Rush Delineation, Treatment, and Assessment Surveys
7. Forest Lake Aquatic Plant Point Intercept Survey
8. Comfort Lake Curly-leaf Pondweed and Eurasian Watermilfoil Management and Point Intercept Surveys



Bed of Curlyleaf Pondweed, Moody Lake, Chisago County, Minnesota, June 1, 2023

Curlyleaf Pondweed Delineation and Assessment Surveys for Moody Lake, Chisago County, Minnesota, 2023

Curlyleaf Pondweed Delineation: April 25, 2023

Curlyleaf Treatment: No Treatment in 2023

Curlyleaf Pondweed Assessment: June 1, 2023

Prepared for:
Comfort Lake/Forest Lake
Watershed District
Forest Lake, Minnesota



Prepared by:
Steve McComas
Jo Stuckert
Connor McComas
Blue Water Science

November 30, 2023

Curlyleaf Pondweed Delineation and Assessment Surveys for Moody Lake, Chisago County, Minnesota, 2023

Summary

Curlyleaf Pondweed Delineation: Moody Lake (MnDNR ID #13-0023) is a 45 acre lake located in Chisago County, Minnesota. Water clarity has a summer average of 4.2 feet in 2022 (source: CLFLWD). A full point intercept survey were conducted on April 25, 2023 by Blue Water Science. Data from the point intercept survey was used to determine areas for curlyleaf pondweed treatment and to look for Eurasian watermilfoil. Results of the curlyleaf delineation found curlyleaf pondweed was found in a few sample sites but at mostly low projected growth (Figure 1). No treatment for curlyleaf pondweed was conducted in 2023.

Curlyleaf Pondweed Assessment: A point intercept survey was used for the curlyleaf pondweed assessment and was conducted on June 1, 2023 by Blue Water Science (Figure 1). Results of the curlyleaf pondweed assessment found curlyleaf pondweed in Moody Lake had expanded slightly and was growing at light to heavy densities. Heaviest curlyleaf growth was on the west side of the lake. Also, in June, Moody Lake had a low diversity of submerged aquatic plants, with chara, coontail, elodea, and flatstem pondweed the only other submerged aquatic plant species observed.

Moody Lake Curlyleaf Pondweed Delineation
April 25, 2023

Moody Lake Curlyleaf Pondweed
June 1, 2023

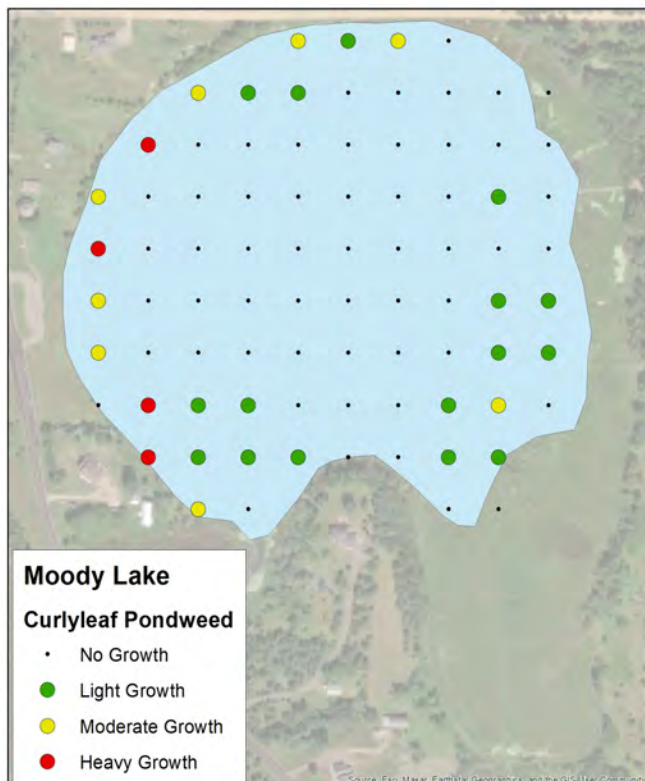
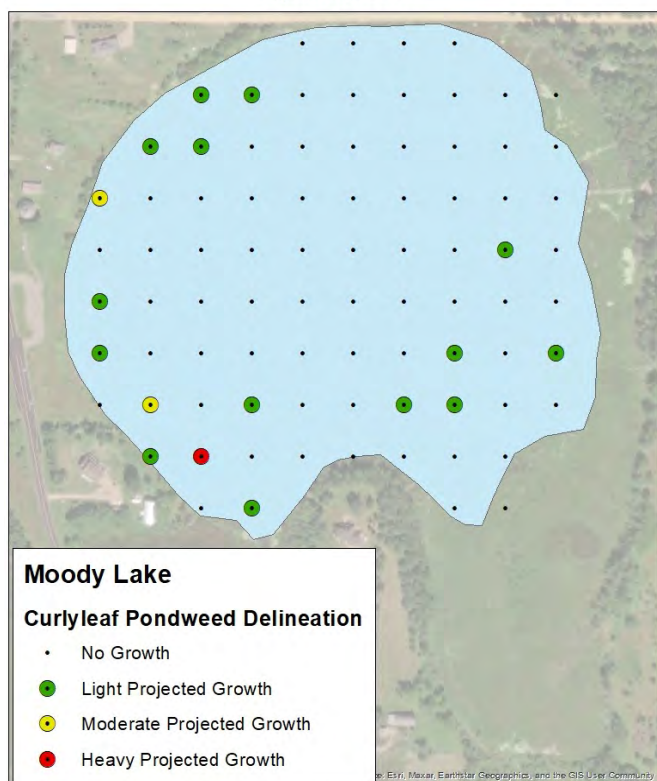


Figure 1. [left] Curlyleaf pondweed treatment areas Moody Lake that were delineated on April 25, 2023.

[right] Curlyleaf pondweed coverage for Moody Lake on June 1, 2023.

Key: green dots = light growth, yellow dots = moderate growth, red dots = heavy growth, and black dots = sample site without plants.

Curlyleaf Pondweed Delineation and Assessment Surveys for Moody Lake, Chisago County, Minnesota, 2023

Moody Lake, Chisago County (ID: 13-0023)

Size: 45 acres (MnDNR)

Littoral area: 22 acres (MnDNR)

Maximum depth: 48 ft (MnDNR)

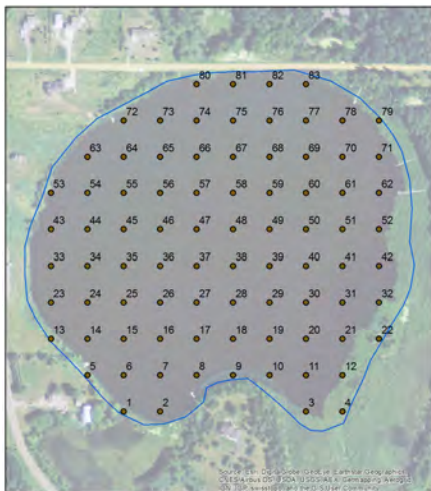
Introduction

A curlyleaf pondweed delineation was conducted on April 25, 2023 on 45 acre Moody Lake, Chisago County. The objective of the delineation was to check the distribution and abundance of curlyleaf pondweed. A curlyleaf pondweed assessment was conducted on June 1, 2023 again to check the distribution and abundance of curlyleaf pondweed and Eurasian watermilfoil and to characterize all native plants.

Methods

Curlyleaf Pondweed Delineation: At the time of the spring CLP delineations, only a fraction of the peak curlyleaf biomass is present. For spot treatments, the areas to be treated should be delineated prior to curlyleaf developing peak biomass. Curlyleaf stem counts on a rake sampler were used to identify areas that had a potential to produce dense curlyleaf. After a short sweep of about 1-foot (30 cm), 4 curlyleaf stems or more per rake sample generally indicated some CLP plants had developed runners and would likely produce heavy growth in the next few weeks. Alternatively, sites where 3 stems or less were collected per rake sample were not predicted to produce dense growth at the peak growing period. These areas were not treated. This delineation method was used for spot lake treatments in Gleason Lake and has worked for other lakes as well (McComas et al, 2015*).

Point Intercept Surveys and the Curlyleaf Pondweed Assessment: Two point intercept surveys were conducted by Blue Water Science on April 25



and June 1, 2023. Grid spacing was 50 meters. The plant species were recorded and the density of each species was assigned. Densities were based on the coverage on the teeth of the rake. Density ratings were from 1 to 3 with 1 being sparse and 3 being a nuisance. Based on these sample sites, plant distribution maps were constructed.

Figure 2. Point intercept site map for Moody Lake.

*McComas, S.R., Y.E. Christianson, and U. Singh. 2015. Effects of curlyleaf pondweed control on water quality and coontail abundance in Gleason Lake, Minnesota. *Lake and Reservoir Management*. 31:109-114.

Results for the CLP Delineation: April 21, 2022

A point intercept survey was conducted to delineate CLP on April 21, 2022 (Figure 3). Results from the survey found that CLP stem densities at most of the sites were not predicted to produce heavy growth of CLP abundance in June therefore no areas were delineated for treatment. No treatment occurred in 2022. Coontail and elodea was the only other submerged plant species observed (Tables 1 and 2).

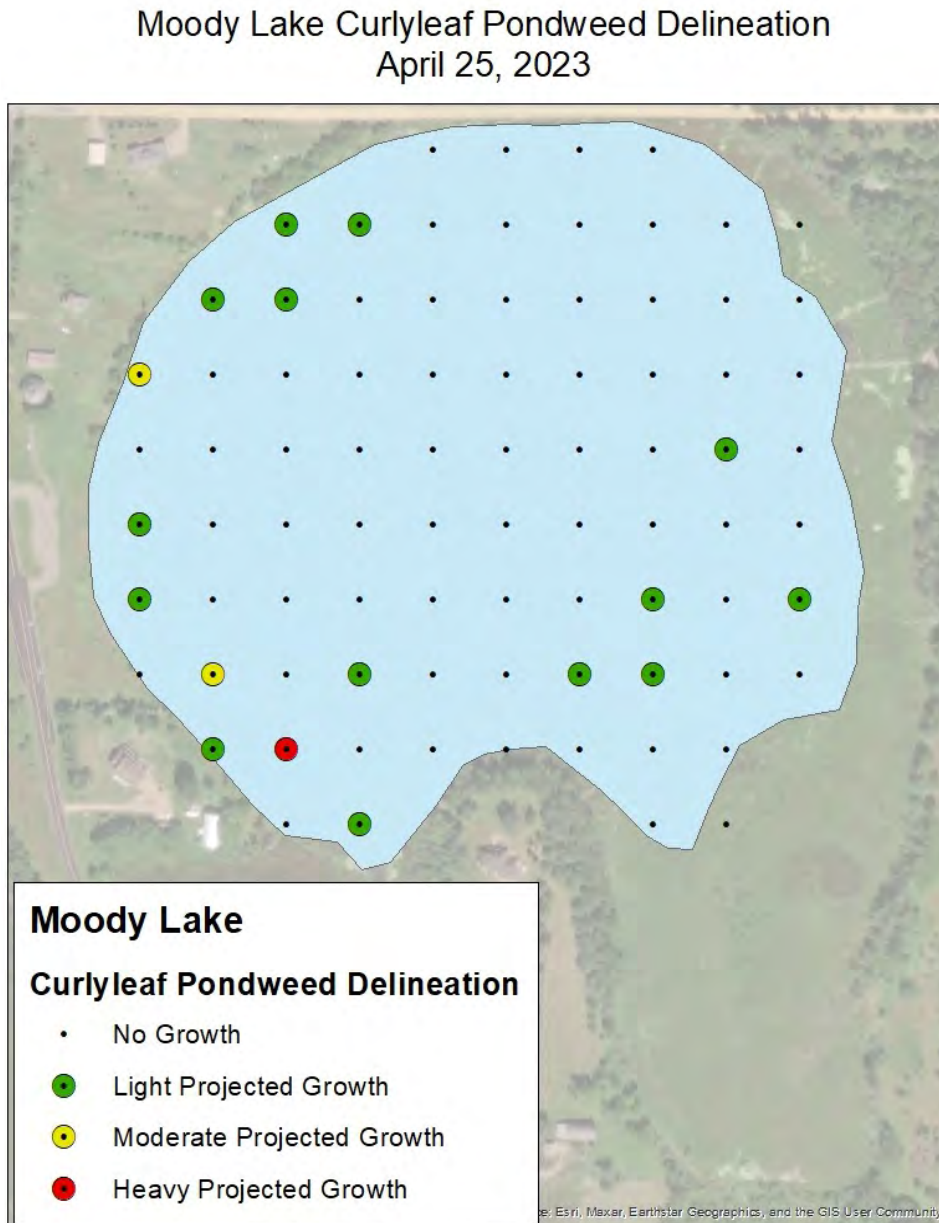


Figure 3. Curlyleaf pondweed from the point intercept survey conducted on April 25, 2023.
Key: Green dots = light growth, red dots = heavy growth, and black dot = sample site, no plants.

Table 1. Moody Lake aquatic plant occurrences and densities for the April 25, 2023 point intercept survey based on 83 sites. Density ratings are 1-3 with 1 being low and 3 being most dense.

| | All Stations (n=83) | | |
|--|---------------------|---------|---------|
| | Occur | % Occur | Density |
| Coontail (<i>Ceratophyllum demersum</i>) | 33 | 40 | 1.2 |
| Chara (<i>Chara sp</i>) | 3 | 4 | 1.3 |
| Elodea (<i>Elodea canadensis</i>) | 34 | 41 | 1.2 |
| Curlyleaf pondweed - stems (<i>Potamogeton crispus</i>) | 17 | 20 | 1.7 |

Table 2. Aquatic plant occurrence and stem density for the point intercept sample points in Moody Lake, April 25, 2023.

| Site | Depth (ft) | Chara | Coontail | CLP Stems | Elodea |
|------------------|------------|-------|----------|-----------|--------|
| 1 | 4 | | 1 | | |
| 2 | 4 | | 1 | 1 | |
| 3 | 3 | | 1 | | 1 |
| 5 | 4 | | 1 | 2 | 1 |
| 6 | 4 | | | 4 | |
| 7 | 6 | | 1 | | 2 |
| 8 | 6 | | 1 | | 2 |
| 9 | 3 | | 1 | | |
| 10 | 4 | | | | 1 |
| 11 | 4 | | | | 1 |
| 12 | 3 | | 1 | | 1 |
| 13 | 3 | | 1 | | 1 |
| 14 | 6 | | 1 | 3 | 1 |
| 15 | 8 | | 1 | | |
| 16 | 9 | | | 1 | |
| 17 | 7 | | 1 | | 2 |
| 18 | 7 | | | | 1 |
| 19 | 6 | 2 | 1 | 1 | 1 |
| 20 | 6 | | | 1 | 1 |
| 21 | 4 | | | | 1 |
| 22 | 5 | | 2 | | |
| 23 | 5 | | 1 | 2 | |
| 24 | 7 | | 1 | | 1 |
| 25 | 23 | | | | |
| 27 | 22 | | | | |
| 28 | 12 | | | | |
| 29 | 8 | | | | |
| 30 | 7 | 1 | 1 | 1 | |
| 31 | 6 | | | | 2 |
| 32 | 5 | | 2 | 1 | 1 |
| 33 | 6 | | 1 | 1 | 1 |
| 34 | 17 | | | | |
| 35 | 27 | | | | |
| 39 | 15 | | | | |
| 40 | 8 | | | | 1 |
| 41 | 6 | 1 | | | 1 |
| 42 | 5 | | 2 | | |
| 43 | 5 | | 1 | | 1 |
| 44 | 13 | | | | |
| 50 | 10 | | | | |
| 51 | 6 | | | 2 | 2 |
| 52 | 5 | | 1 | | 1 |
| 53 | 4 | | | | 1 |
| 54 | 7 | | | | 2 |
| 60 | 11 | | | | |
| 61 | 7 | | | | 1 |
| 62 | 5 | | | | 1 |
| 63 | 5 | | | | 2 |
| 64 | 7 | | | | 1 |
| 70 | 6 | | | | 2 |
| 71 | 3 | | | | 1 |
| 72 | 5 | | | | 1 |
| 73 | 6 | | | | 1 |
| 74 | 6 | | | | 2 |
| 75 | 8 | | | | |
| 76 | 10 | | | | |
| 77 | 13 | | | | |
| 78 | 6 | | | | 1 |
| 80 | 4 | | | | |
| 81 | 4 | | | | |
| 82 | 5 | | | | 1 |
| 83 | 6 | | | | 1 |
| Average | | 1.3 | 1.2 | 1.7 | 1.2 |
| Occur (83 sites) | | 3 | 33 | 17 | 34 |
| % occurrence | | 4 | 40 | 20 | 41 |

Results for the June 1, 2023 Point Intercept Survey and CLP Assessment

Results of the June 1, 2023 assessment using a point intercept survey found there were 5 submerged plant species, chara, coontail, curlyleaf pondweed, elodea, and flatstem pondweed with coontail being the dominant plant (Tables 3 and 4). No CLP treatment occurred in 2023 and CLP distribution increased from 17 sites to 28 sites. The heaviest CLP growth was on the west side of Moody Lake (Table 3 and Figure 4). Results from the assessment found native plants growing out to a depth of 11 feet (Table 4).

Table 3. Moody Lake aquatic plant occurrences and densities for the June 1, 2023 survey based on 83 sites. Density ratings are 1-3 with 1 being low and 3 being most dense.

| | All Stations (n=83) | | |
|--|---------------------|---------|---------|
| | Occur | % Occur | Density |
| Cattails (<i>Typha sp</i>) | 2 | 2 | 1.0 |
| White waterlily (<i>Nymphaea ordata</i>) | 3 | 4 | 1.0 |
| Coontail (<i>Ceratophyllum demersum</i>) | 48 | 58 | 1.7 |
| Chara (<i>Chara sp</i>) | 7 | 8 | 1.1 |
| Elodea (<i>Elodea canadensis</i>) | 36 | 43 | 1.3 |
| Curlyleaf pondweed (<i>Potamogeton crispus</i>) | 28 | 34 | 1.6 |
| Flatstem pondweed (<i>P. zosteriformis</i>) | 1 | 1 | 1.0 |

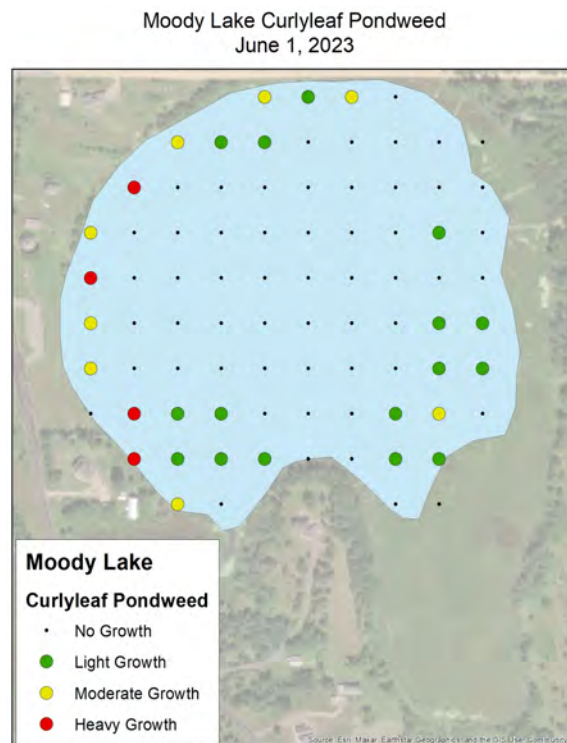


Figure 4. Curlyleaf pondweed coverage for Moody Lake on June 1, 2023. Key: black dots = no growth, green dot = light growth, yellow dots = moderate growth, and red dots = heavy growth.

Aquatic Plant Conditions

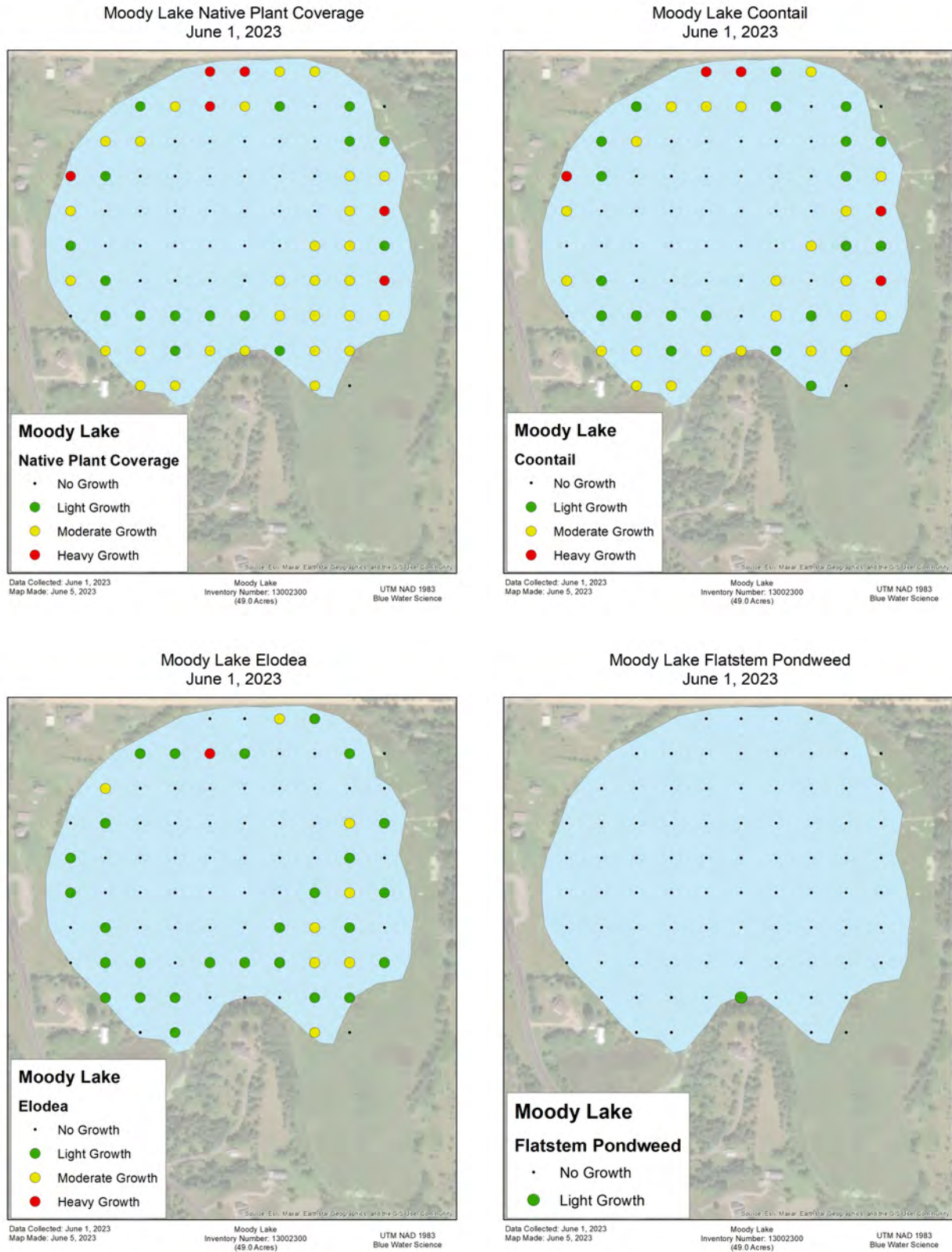
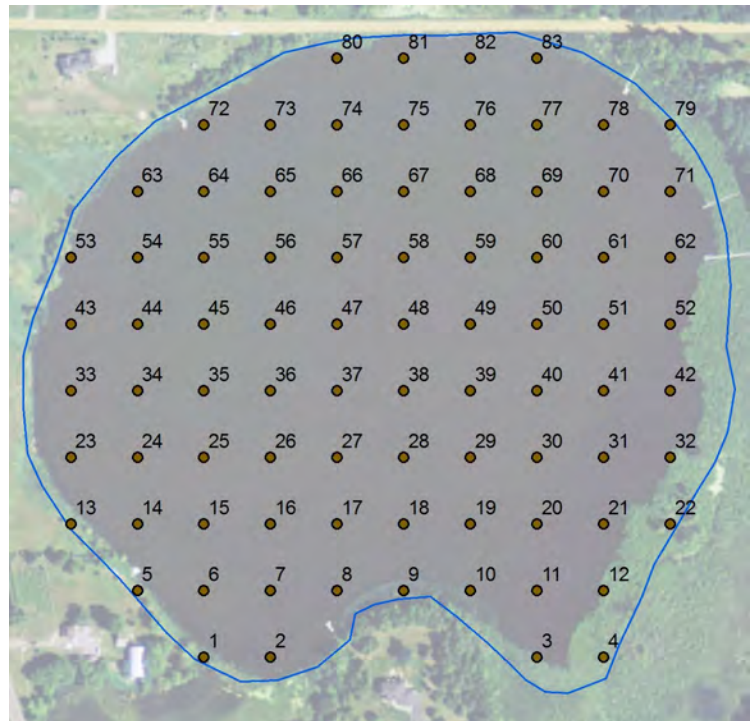


Figure 5. Aquatic plant conditions on June 1, 2023.

Table 4. Aquatic plant occurrence and density for the point intercept sample points in Moody Lake, June 1, 2023.

| Site | Depth (ft) | Cat-tails | White lily | Chara | Coon-tail | CLP | Elodea | Flat-stem | Fila algae |
|------|------------|-----------|------------|-------|-----------|-----|--------|-----------|------------|
| 1 | 1 | 1 | 1 | | 2 | 2 | | | 1 |
| 2 | 2 | | 1 | | 2 | | 1 | | 1 |
| 3 | 2 | | | | 1 | | 2 | | |
| 4 | 0 | | | | | | | | |
| 5 | 3 | | | | 2 | 3 | 1 | | |
| 6 | 5 | | | | 2 | 1 | 1 | | |
| 7 | 5 | | | | 1 | 1 | 1 | | |
| 8 | 5 | | | | 2 | 1 | | | |
| 9 | 3 | | | | 2 | | | 1 | |
| 10 | 3 | | | | 1 | | | | |
| 11 | | | | 1 | 2 | 1 | 1 | | |
| 12 | 1 | | | | 2 | 1 | 1 | | 2 |
| 13 | 0 | | | | | | | | |
| 14 | 5 | | | | 1 | 3 | 1 | | |
| 15 | 7 | | | | 1 | 1 | 1 | | |
| 16 | 8 | | | | 1 | 1 | | | |
| 17 | 6 | | | | 1 | | 1 | | |
| 18 | 6 | | | | | | 1 | | |
| 19 | 6 | | | 2 | 2 | | 1 | | |
| 20 | 5 | | | | 1 | 1 | 2 | | |
| 21 | 5 | | | | 2 | 2 | 2 | | |
| 22 | 4 | | | | 2 | | 1 | | |
| 23 | 4 | | | | 2 | 2 | | | |
| 24 | 8 | | | 1 | 1 | | 1 | | |
| 25 | 22 | | | | | | | | |
| 26 | 27 | | | | | | | | |
| 27 | 22 | | | | | | | | |
| 28 | 13 | | | | | | | | |
| 29 | 7 | | | | 2 | | 1 | | |
| 30 | 6 | | | | | | 2 | | 1 |
| 31 | 5 | | | | 2 | 1 | 1 | | |
| 32 | 3 | | | | 3 | 1 | | | 2 |
| 33 | 5 | | | | | 2 | 1 | | |
| 34 | 16 | | | | | | | | |
| 38 | 23 | | | | | | | | |
| 39 | 17 | | | | | | | | |
| 40 | 7 | | | 1 | 2 | | 1 | | |
| 41 | 6 | | | 1 | 1 | 1 | 2 | | |
| 42 | 4 | | | 1 | 1 | 1 | 1 | | 1 |
| 43 | 5 | | | | 2 | 3 | 1 | | |
| 44 | 17 | | | | | | | | |
| 45 | 26 | | | | | | | | |
| 50 | 11 | | | | | | | | |
| 51 | 6 | | | | 2 | | 1 | | |
| 52 | 4 | | | | 3 | | | | 1 |
| 53 | 3 | | 1 | | 3 | 2 | | | |
| 54 | 6 | | | 1 | 1 | | 1 | | |
| 55 | 18 | | | | | | | | |
| 60 | 12 | | | | | | | | |
| 61 | 6 | | | | 1 | 1 | 2 | | |
| 62 | 4 | | | | 2 | | 1 | | |
| 63 | 6 | | | | 1 | 3 | 2 | | |
| 64 | 7 | | | | 2 | | | | |
| 65 | 9 | | | | | | | | |
| 66 | 9 | | | | | | | | |
| 67 | 14 | | | | | | | | |
| 68 | 26 | | | | | | | | |
| 69 | 18 | | | | | | | | |

| Site | Depth (ft) | Cat-tails | White lily | Chara | Coon-tail | CLP | Elodea | Flat-stem | Fila algae |
|------------------|------------|-----------|------------|-------|-----------|-----|--------|-----------|------------|
| 70 | 5 | | | | 1 | | | | |
| 71 | 3 | | | | 1 | | | | |
| 72 | 5 | | | | 1 | 2 | 1 | | |
| 73 | 6 | | | | 2 | 1 | 1 | | |
| 74 | 6 | | | | 2 | 1 | 3 | | |
| 75 | 7 | | | | 2 | | 1 | | |
| 76 | 10 | | | | 1 | | | | |
| 77 | 9 | | | | | | | | |
| 78 | 5 | | | | 1 | | 1 | | |
| 79 | 1 | 1 | | | | | | | |
| 80 | 4 | | | | 3 | 2 | | | |
| 81 | 3 | | | | 3 | 1 | | | |
| 82 | 5 | | | | 1 | 2 | 2 | | |
| 83 | 4 | | | | 2 | | 1 | | |
| Average | | 1.0 | 1.0 | 1.1 | 1.7 | 1.6 | 1.3 | 1.0 | 1.3 |
| Occur (83 sites) | | 2 | 3 | 7 | 48 | 28 | 36 | 1 | 7 |
| % occur | | 2 | 4 | 8 | 58 | 34 | 43 | 1 | 8 |





Bone Lake, October 2023

Aquatic Invasive Species Search in Bone Lake, Washington County, Minnesota

Zebra Mussel Found: July 20, 2023
Second Search Date: October 12, 2023

Prepared for:
Comfort Lake Forest Lake
Watershed District



Prepared by:
Steve McComas,
Jo Stuckert,
Connor McComas
Blue Water Science,
St. Paul, MN

December 4, 2023

Aquatic Invasive Species Search in Bone Lake, Washington County, Minnesota

July 20, 2023 Zebra Mussel Discovery: A single zebra mussel was first observed at the public access in Bone Lake and the public access area was treated with Earthtec copper sulfate in 2019. AIS searches at the public water access continued from 2020 through 2023. On July 20, 2023, a single zebra mussel attached to a naiad plant was found by Blue Water Science on the east side of Bone Lake.

During a July 20, 2023 full lake point intercept survey, samples of naiads from 3 sites were placed in a bag and were brought back to the lab for identification. A single zebra mussel was found attached to the naiads. The 5 mm zebra mussel was likely from this year and indicates a reproducing population is probably established in Bone Lake.

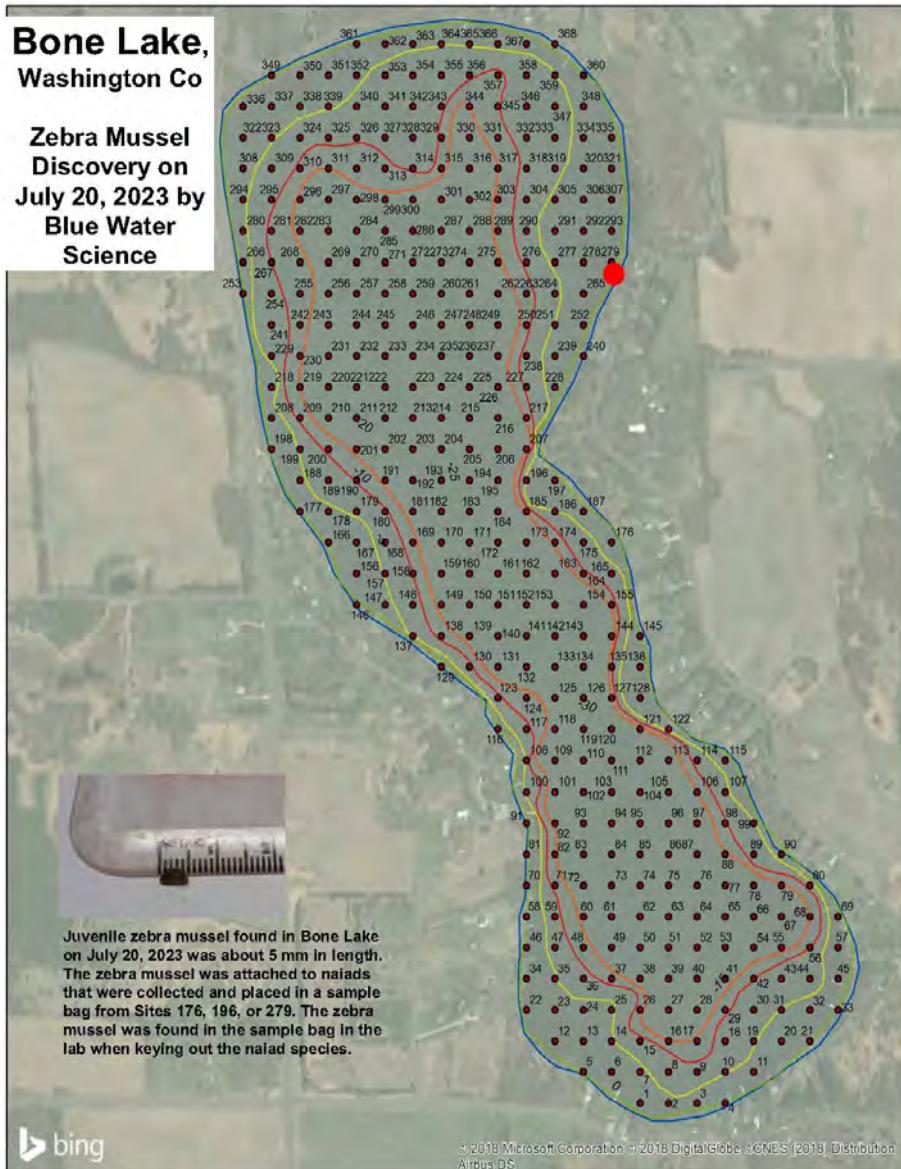


Figure 1. Location of the zebra mussel on July 20, 2023.

Summary of the 2023 search: Two searchers from Blue Water Science surveyed the boat access and surrounding areas in Bone Lake on October 12, 2023 searching for occurrences of invasive species, primarily zebra mussels or starry stonewort.

No starry stonewort and no additional zebra mussels were observed on the October 12, 2023. Representative photos and observations shown below.

Table 1. Site data for the two aquatic invasive species searches on October 12, 2023.

| | Number of Searchers | Starry Stonewort (SSW) | Zebra Mussels (ZM) | Bottom Conditions |
|---------------------------------------|---------------------|------------------------|--------------------|--|
| October 12, 2023 | | | | |
| 1. Public Access and surrounding area | 2 | No SSW found | No ZM observed | Sandy, rocks rare, some branches. Moderate plant growth. |
| 2. Inlet area | | No SSW found | No ZM observed | Sandy, rocks rare, some branches. Moderate plant growth. |
| 3. NW shore area | 2 | No SSW found | No ZM observed | Sandy, rocks rare, some branches. Moderate plant growth. |

Photos from the July 20, 2023 Point Intercept Survey and October 12, 2023 AIS Search



Figure 2. A single zebra mussel was found during the July 20, 2023 point intercept survey (top photos). Plants were still actively growing in Bone Lake in October but no zebra mussels were found (bottom pictures).

Starry Stonewort Information Sheet

INVASIVE

Starry stonewort
Nitellopsis obtusa

KEYS TO ID

- Long, smooth branchlets are attached in whorls of 5 - 8
- Small, star-shaped bulbils form on clear threads at base of plant and may be found above or below the sediment surface
- Small, orange spheres called antheridia may be visible, these are male reproductive structures
- Typical branchlets are long; can be up to twelve inches
- Can form dense mats in water




LOOKS SIMILAR TO

- Native *Chara* (native)
- Native *Nitella* (native)
- Sago pondweed (native)
- Water stargrass (native)

WHERE TO LOOK

- In shallow, still water and near access

CURRENTLY FOUND

Actual size of bulbils
Below: orange antheridia



Figure 3a. [left] Starry stonewort identification page from the University of Minnesota Aquatic Invasive Species Research Center (MAISRC).

NATIVE

Muskgrasses
Chara spp.

KEYS TO ID

- Stems are typically rough and crunchy
- Thin branchlets form whorls around thin stems
- May produce bulbils, but not star-shaped
- May have musky odor




LOOKS SIMILAR TO

- Starry stonewort (invasive)
- Native *Nitella* (native)
- Sago pondweed (native)
- Water stargrass (native)
- Minnesota has nine *Chara* species

WHERE TO LOOK

- Fully submerged
- Along lake bottoms forming patches called meadows

CURRENTLY FOUND

Rough stems; whorled branchlets

Starry stonewort looks a lot like some growth forms of chara and nitella (Figure 3). Starry stonewort was not observed in Bone Lake in 2023.

Initial searches for Starry Stonewort focus on public access points as a priority, nearly all new SSW infestations are found at boat launch locations.

Figure 3b. Chara identification page from the MAISRC.

Rapid Response Plan for Starry Stonewort

Starry stonewort was not found in Bone Lake on the October 12, 2023 search. However a single zebra mussel was found on July 20, 2023. A rapid response plan for starry stonewort, shown in Table 2, has a number of preventative steps as well as actions to be considered after a potential new AIS sighting.

Table 2. Tasks and assignments for an early detection and rapid response program for Bone Lake, Minnesota.

| | Bone Lake Association | CLFLWD | Washington County | MnDNR | Others | Treatment Contractor | BWS |
|--|-----------------------|-------------|-------------------|-------|--------|----------------------|-------------|
| 1. Early Detection | | | | | | | |
| 1.1. Create website information. | X | | | | | | |
| 1.2. Designate contact person. | X | | | | | | |
| 1.3. Conduct training session for volunteer searchers. | Late summer | Late summer | | | | | Late summer |
| 1.4. Conduct monthly targeted searches (late summer). | X | | | | | | X |
| 1.5. Press release if SSW is found. | X | | | X | | | |
| 2. Rapid Response Assessment | | | | | | | |
| 2.1. Conduct an initial exploratory search after the first report of a starry stonewort observation. | | | | X | | | X |
| 2.2. Organize and train lake resident searchers for a full search effort. | X | | | | | | X |
| 2.3. Conduct an expanded targeted search with diving (if needed). | X | X | | X | | | X |
| 3. Rapid Response Action | | | | | | | |
| 3.1. Meet to determine treatment options. | X | | X | X | X | X | X |
| 3.2. Close public access, if necessary. | X | | X | X | X | | |
| 3.3. Treat area with copper sulfate. | | | | | | X | |
| 3.4. Evaluate treatment. | | | | X | | | X |
| 3.5. Report all findings and results. | X | | | X | | | X |



White Water Lilies in Bone Lake, July 20, 2023

Curlyleaf Pondweed and Eurasian Watermilfoil Management and Point Intercept Survey for Bone Lake, Washington County, Minnesota, 2023

| | Delineation | Treatment | Assessment |
|-----|--------------------|------------------|-------------------|
| CLP | May 1, 2023 | No treatment | June 2, 2023 |
| EWM | June 2, 2023 | No treatment | July 20, 2023 |

Meander Surveys: May 1 and June 2, 2023
Point Intercept Survey: July 20, 2023

Prepared for:
Comfort Lake/Forest Lake
Watershed District
Forest Lake, Minnesota



December 4, 2023

Prepared by:
Steve McComas
Jo Stuckert
Connor McComas
Blue Water Science

Curlyleaf Pondweed and Eurasian Watermilfoil Management and Point Intercept Survey for Bone Lake, Washington County, Minnesota, 2023

Summary

Curlyleaf Pondweed Delineation and Assessment: Bone Lake (MnDNR ID #82-0054) is a 221 acre lake located in Washington County, Minnesota. On May 1, 2023 the curlyleaf pondweed (CLP) delineation survey sampled 117 sites. Curlyleaf pondweed growth was light and sparse and was found at 5 sample sites (Figure 1). No CLP treatment is necessary at this time.

No treatment of curlyleaf pondweed was conducted in 2023.

A CLP assessment was conducted on June 2, 2023, during the peak growth of CLP. Curlyleaf was sampled at 10 sites at light to moderate growth conditions on June 2, 2023 (Figure 1). One area in the southwest corner of the lake had one site of moderate CLP growth.

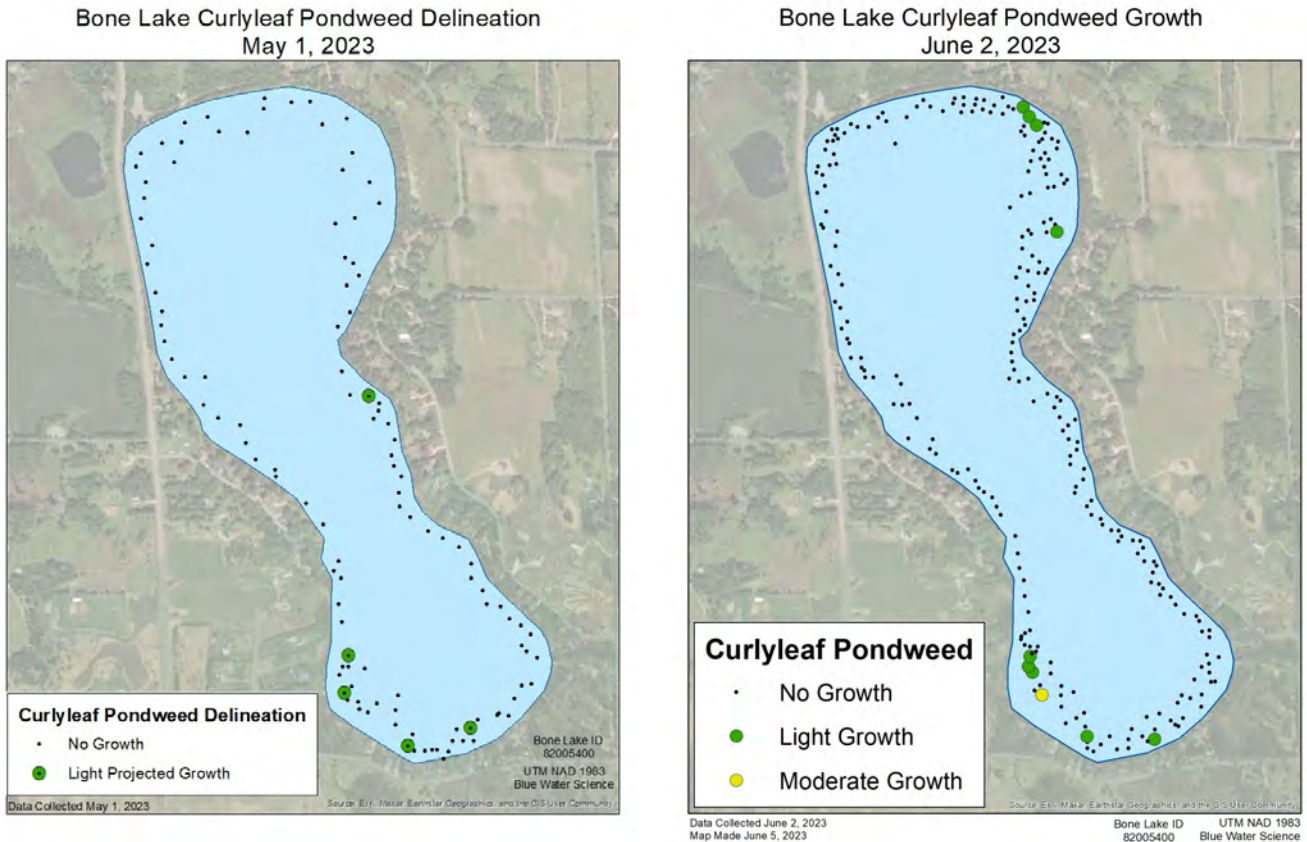


Figure 1. [left] CLP was found at 5 out of 117 sample sites in Bone Lake on May 1, 2023. [right] CLP was found at 10 out of 261 sample sites on June 2, 2023. Key: green = light growth potential and yellow = moderate growth potential.

Eurasian Watermilfoil Delineation and Assessment: Eurasian watermilfoil (EWM) was verified in Bone Lake in 2006. On May 1, 2023 the Eurasian watermilfoil (EWM) delineation survey sampled 117 sites. Eurasian watermilfoil growth was light and sparse and was found at 6 sample sites (Figure 2).

No treatment was conducted in 2023.

An assessment combined with a point intercept survey was conducted on July 20, 2023. Eurasian watermilfoil was sampled at 3 sites out of 163 sample locations out to 9 feet (depth of plant growth). EWM density was mostly light in 2023 (Figure 2).

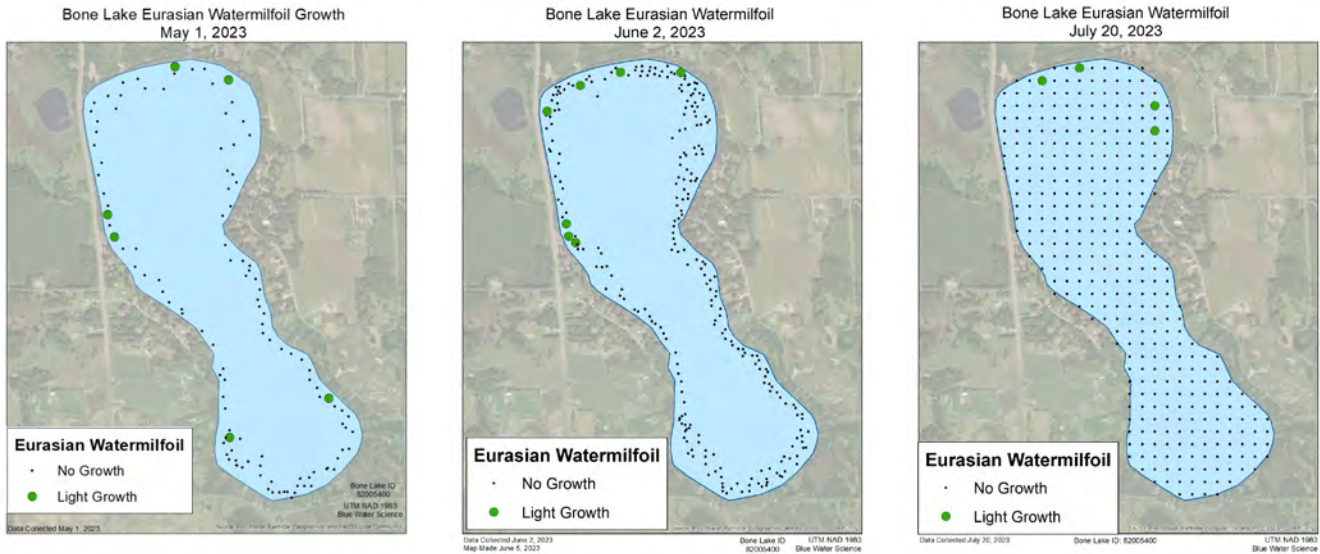


Figure 2. [left] EWM coverage for Bone Lake on May 1, 2023. [middle] EWM coverage for Bone Lake on June 2, 2023. [right] EWM coverage on for Bone Lake on July 20, 2023.

Summary of CLP and EWM Bone Lake Treatments: CLP has been treated in 5 out of the last 10 years. EWM has been treated in 3 out of the last 10 years. However, no CLP or EWM was treated in 2023 (Figure 3).

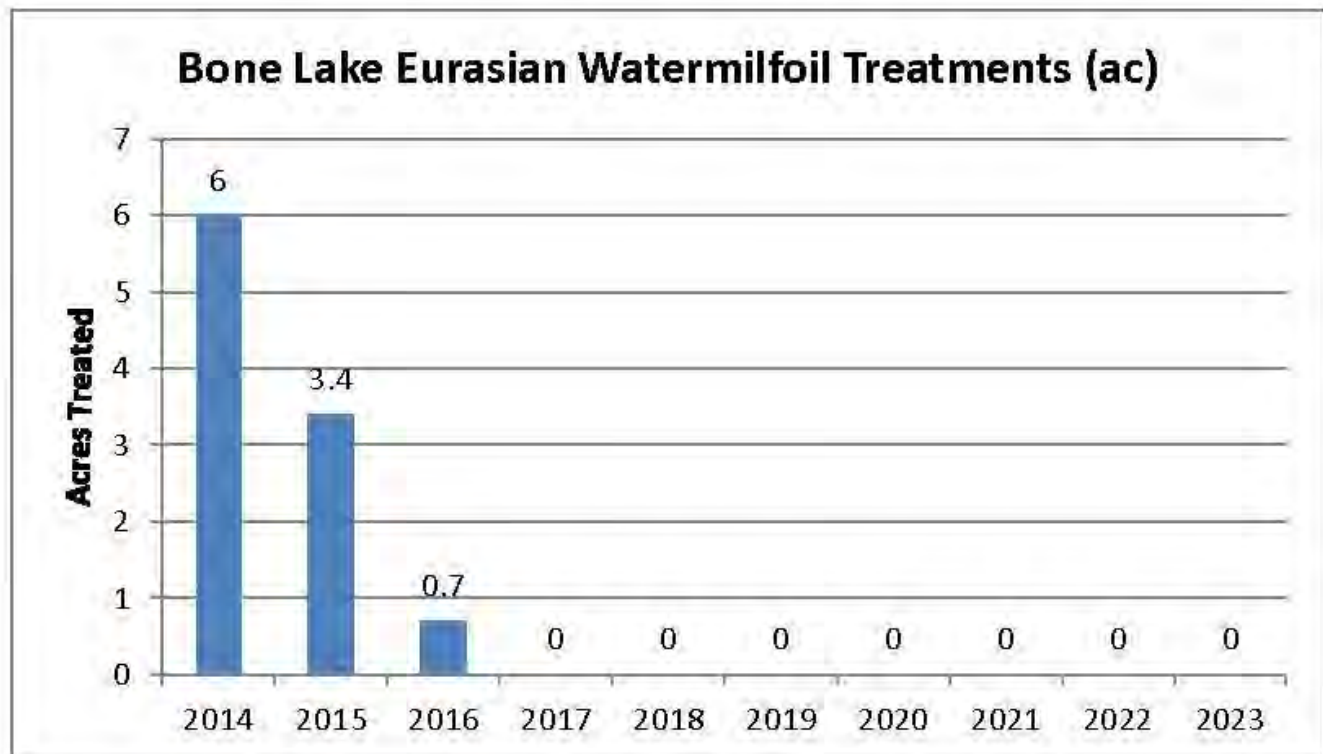
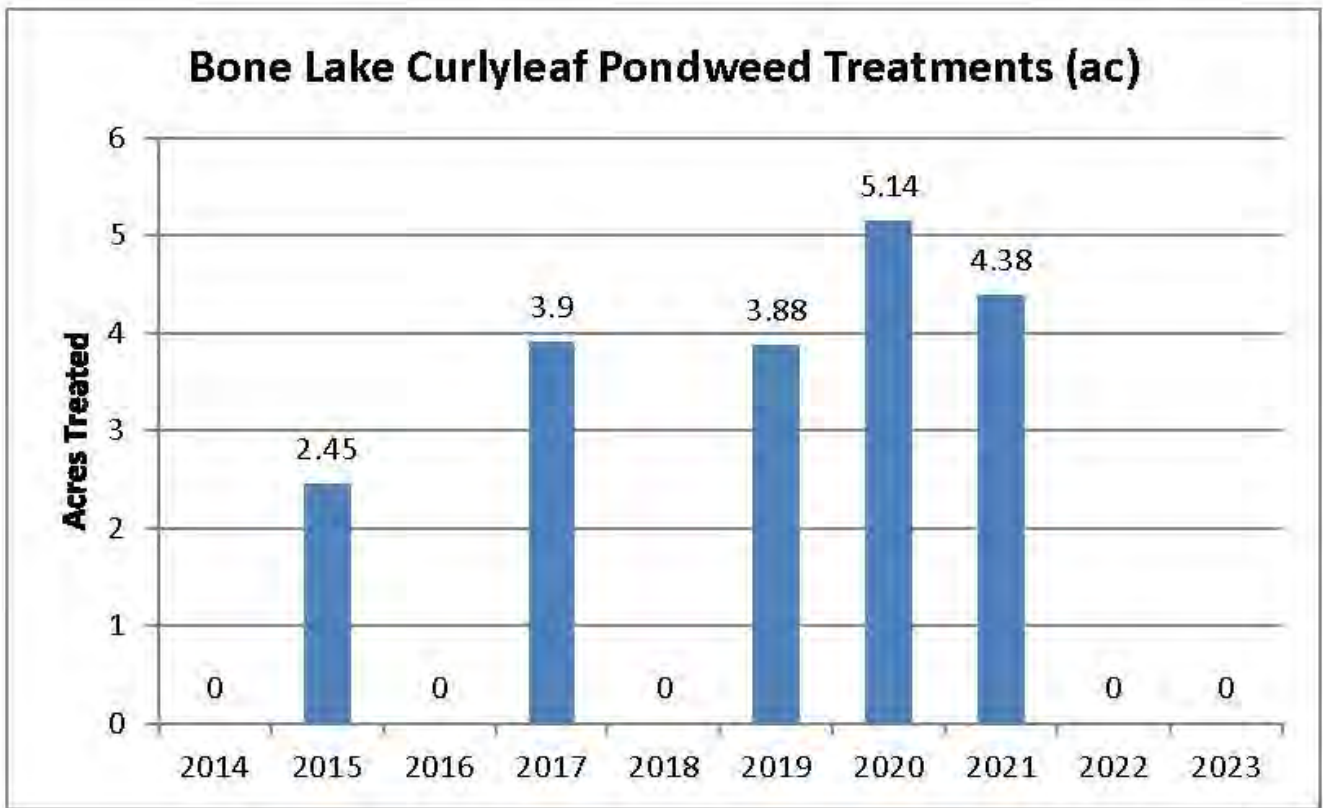


Figure 3. Summary of CLP and EWM treatment acreage for 2014-2023.

Curlyleaf and Milfoil Treatments from 2015-2023: A summary of CLP and EWM treatments from 2015 through 2023 is shown in Figure 4. Curlyleaf pondweed growth has fluctuated over the years. No treatment was conducted in 2022 and 2023. EWM treatment areas have decreased since 2014 with no treatment occurring 2017 through 2023 in Bone Lake.

A hotspot map of sites of CLP and EWM that show moderate and heavy growth for 2015 through 2023 is shown in Figure 4. CLP and EWM have typically grown to a water depth of 6 feet or less.

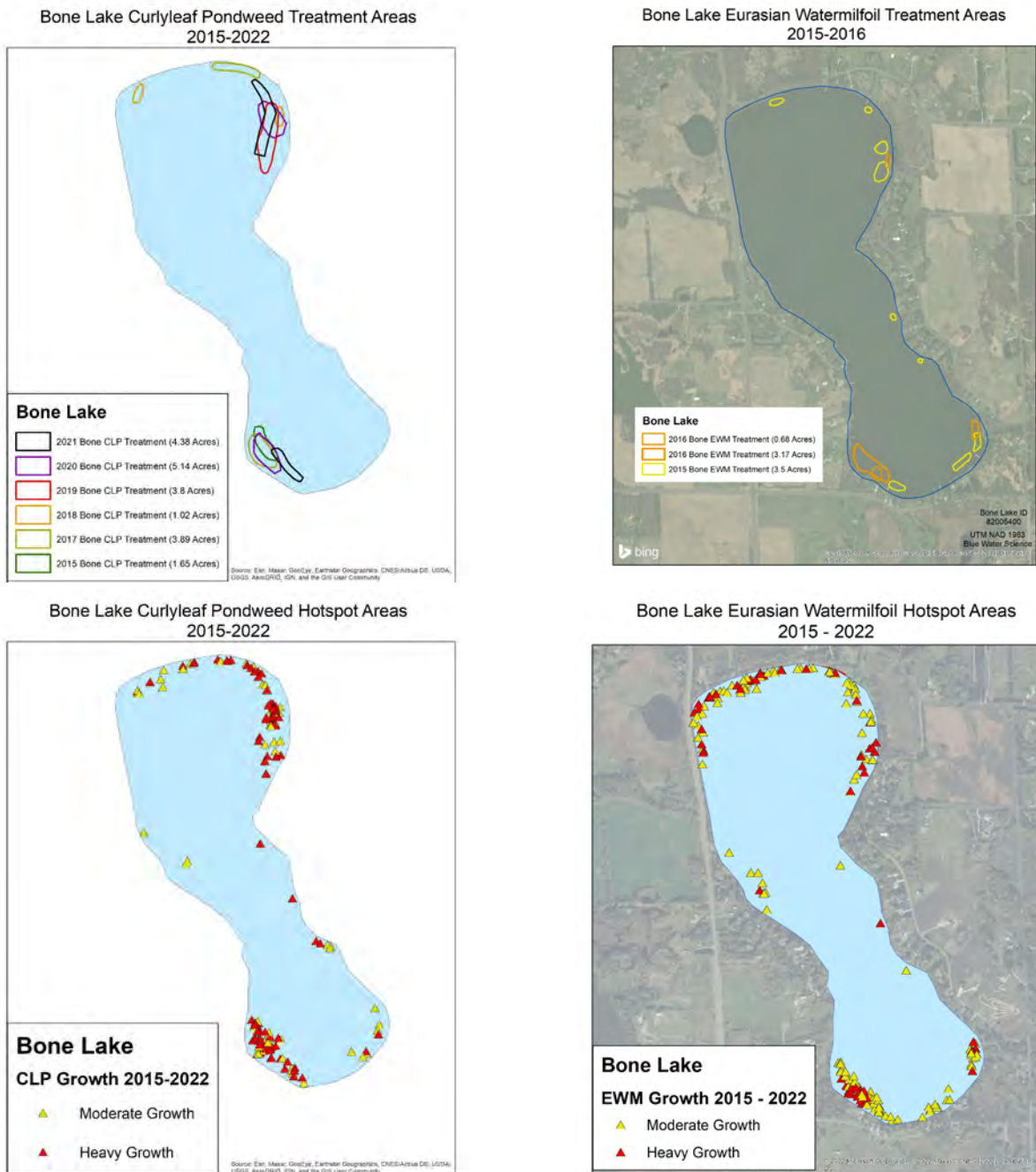


Figure 4. [top-left] Bone Lake CLP treatment map 2015-2022. [top-right] Bone Lake EWM treatment map 2015-2016. [bottom-left] Hotspot map of CLP growth over the years of 2015-2022 placed on a single map. [right] Hotspot map of EWM growth over the years of 2015-2022 placed on a single map. Key: yellow = moderate growth, and red = heavy growth.

Aquatic Plant Point Intercept Survey: On July 20, 2023 an aquatic plant point intercept survey using 50 m spacing between sites was conducted on Bone Lake. During the survey non-native species including curlyleaf pondweed, Eurasian watermilfoil, starry stonewort, and zebra mussels as well as characterized all aquatic plants. Eight submerged aquatic plant species and 2 water lily species were sampled on July 20, 2023 in Bone Lake.

In July, the most abundant native aquatic plant species were naiads (found at 43% of the sites out to 9 feet) followed by coontail (found at 35% of the sites)(Table 1). Eurasian watermilfoil was found at 3 out of 163 sites (2%). Plants were found at 163 sites and grew out to 9 feet of water depth. Aquatic plants covered about 67 acres or 30% of the lake area.

Table 1. The percent occurrence of aquatic plants for Bone Lake. Percent occurrence is calculated based on the number of times a plant species occurs at a sampling station divided into the total number of stations for the survey. For example, if coontail was found in 25 out of 50 stations, its percent occurrence would be 50%.

| | July 20, 2023 % Occur (0-9 feet, 163 sites) |
|--|---|
| Spatterdock (<i>Nuphar variegatum</i>) | 6 |
| White water lily (<i>Nymphaea odorata</i>) | 19 |
| Coontail (<i>Ceratophyllum demersum</i>) | 35 |
| Chara (<i>Chara spp</i>) | 1 |
| Northern watermilfoil (<i>Myriophyllum sibiricum</i>) | 2 |
| Eurasian watermilfoil (<i>Myriophyllum spicatum</i>) | 2 |
| Naiads (<i>Najas flexilis</i>) | 43 |
| Stringy pondweed (<i>Potamogeton sp</i>) | 16 |
| Sago pondweed (<i>Stuckenia pectinata</i>) | 1 |
| Water celery (<i>Vallisneria americana</i>) | 1 |
| Number of submerged aquatic plant species | 8 |

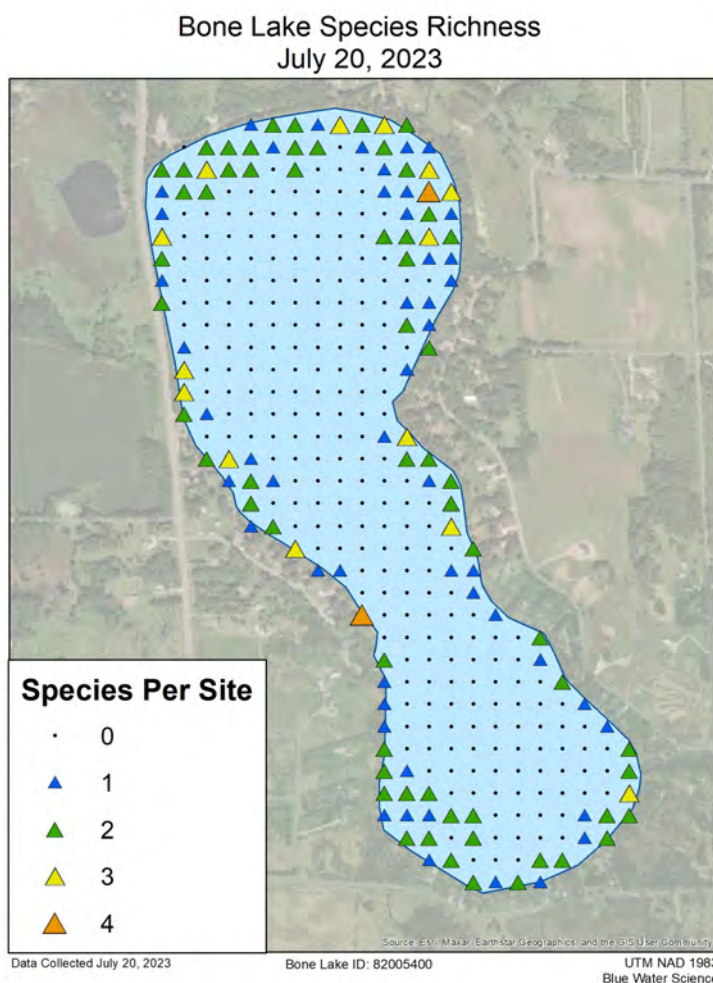


Figure 5. Species richness coverage on July 20, 2023.

Curlyleaf Pondweed and Eurasian Watermilfoil Management and Point Intercept Survey for Bone Lake, Washington County, Minnesota, 2023

Bone Lake, Washington County (ID: 82-0054)

Size: 221 acres (MnDNR) Littoral area: 124 acres (MnDNR)

Maximum depth: 30 ft (MnDNR)

Introduction

Curlyleaf pondweed (CLP) and Eurasian watermilfoil (EWM) are non-native species and both are present in Bone Lake. Curlyleaf pondweed and Eurasian watermilfoil delineations and assessments were conducted in Bone Lake in 2023. The objectives of the delineations were to locate areas of nuisance invasive species and recommend areas for potential treatments. The purpose of the assessments were to determine if any nuisance growth of CLP or EWM were missed during the delineations. In addition, an aquatic plant point intercept survey was conducted on July 20, 2023 to characterize the entire plant community.

Methods

Curlyleaf Pondweed Delineation Method: At the time of the spring curlyleaf delineation on May 1 only a fraction of the peak curlyleaf biomass is present compared to what could be present in June, at its peak. For spot treatments, the areas to be treated are delineated prior to curlyleaf developing peak biomass. The CLP delineation survey is conducted using a meandering path around the nearshore area of the entire lake. Curlyleaf is sampled using a fixed 14 tine rakehead on a pole. Curlyleaf stem counts on a rake sampler were used to identify areas that had a potential to produce curlyleaf growth at its June peak. After a short sweep of about 1-foot (which samples about 0.1 m²), if one or two stems (10-20 stems/m²) were collected on the rake sweep, it was predicted that this area would produce only future light growth at its peak and was not delineated for treatment. Alternatively, sites where 3 stems (30 stems/m²) were collected per rake sample future potential growth was considered to be moderate. However if 4 curlyleaf stems (40 stems/m²) or more per rake sample generally indicated some plants had developed runners and would likely produce heavy growth in the next few weeks and this site would be marked for potential treatment. This survey method used for determining curlyleaf pondweed spot herbicide treatments was similar to the methodology published in a peer reviewed journal (McComas et al, 2015)*.

*McComas, S.R., Y.E. Christianson, and U. Singh. 2015. Effects of curlyleaf pondweed control on water quality and coontail abundance in Gleason Lake, Minnesota. *Lake and Reservoir Management*, 31:109–114.
<https://doi.org/10.1080/10402381.2015.1014583>

Curlyleaf Assessment and Eurasian Watermilfoil Delineation and Assessment Sampling: An EWM initial delineation along with a CLP assessment were conducted on June 2 and 261 sites were sampled. On July 20 an EWM assessment was conducted and the entire perimeter of the lake was checked for CLP and EWM. A point intercept survey was also conducted at this time.

Point Intercept Survey: An aquatic plant survey of Bone Lake using a point intercept sampling method was conducted by Blue Water Science on July 20, 2023. A map and sampling grid were prepared by Blue Water Science and a consisted of a total of 368 points that were distributed throughout the lake (Figure 6). Points were spaced 50 meters apart. Each point represented about 0.6 acres. At each sample point, plants were sampled with a rake sampler. A plant density rating was assigned to each plant species on a scale from 1 to 3 (Figure 7). A density of a “1” indicated sparse growth with one or two stems present on the rake sampler. A 3 rating indicated matting surface plant growth.

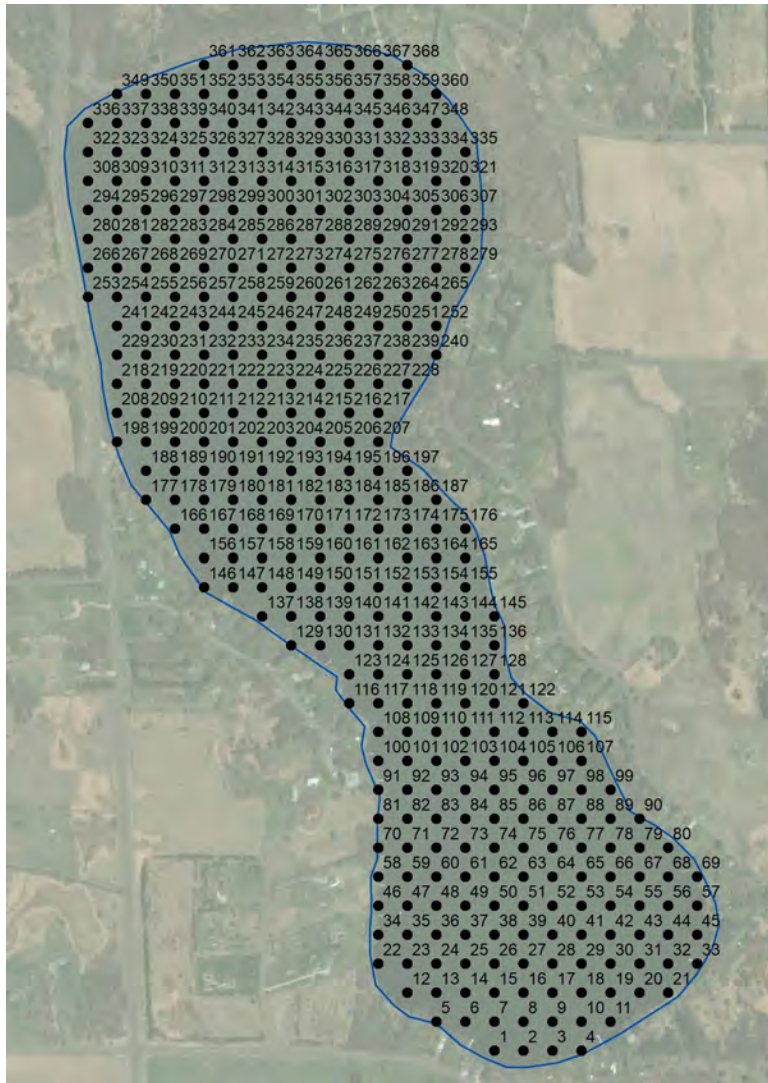


Figure 6. Point locations for the aquatic plant surveys.

Chart of Aquatic Plant Density Ratings



Figure 7. Aquatic plant density ratings from 1 to 3.

Curlyleaf Pondweed Delineation on May 1, 2023

A CLP delineation conducted on May 1, 2023 and found CLP was present at 5 sample sites out to a total of 117 sampled sites. No CLP treatment was not recommend in 2023 (Figure 8).

Bone Lake Curlyleaf Pondweed Delineation
May 1, 2023

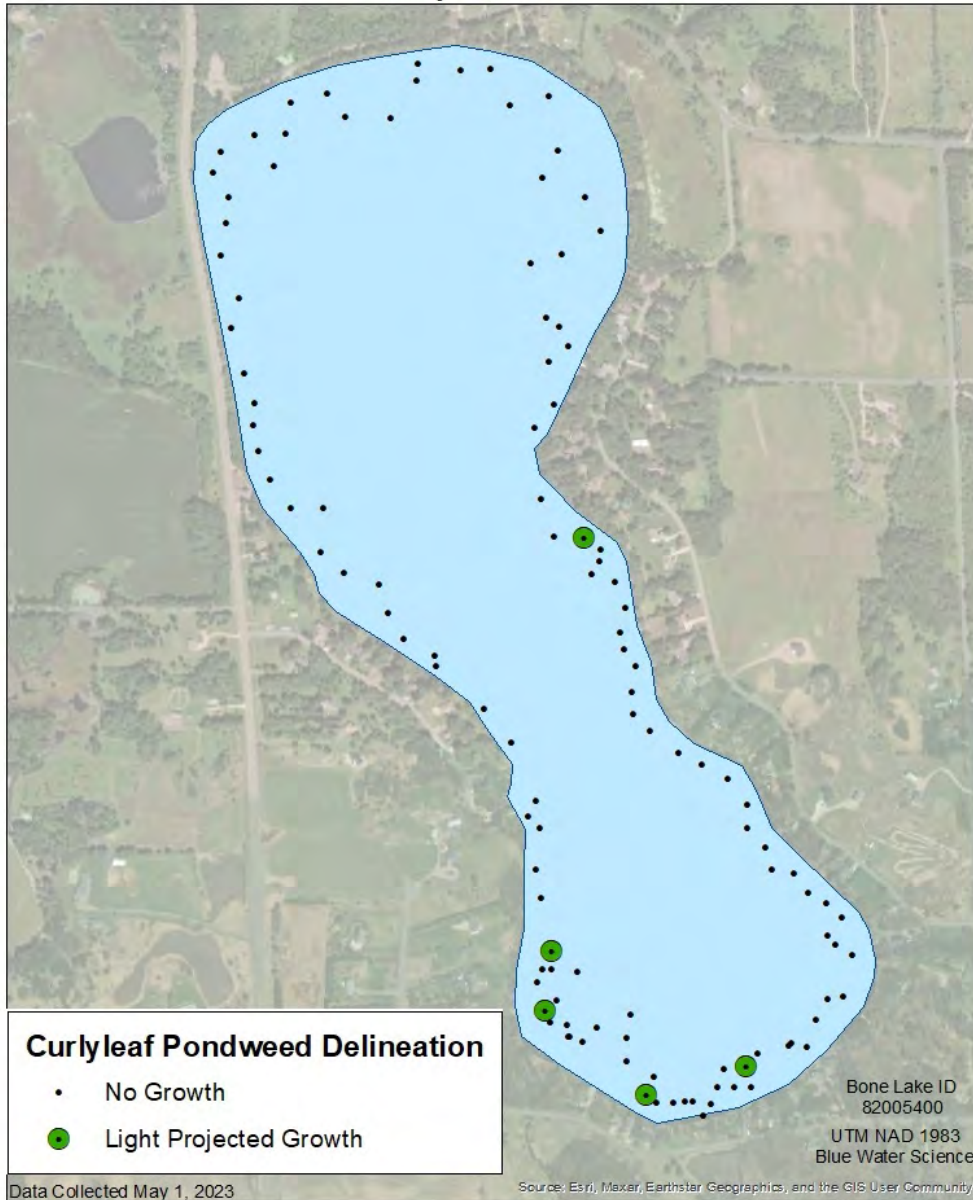


Figure 8. Curlyleaf coverage for Bone Lake on May 1, 2023. Key: black dot = no growth and green dots = light growth.

Curlyleaf Pondweed Assessment on June 2, 2023

An assessment was conducted on June 2, 2023 and found CLP was present at 10 sites out of the 261 sample sites (Figure 9). Curlyleaf growth had increased slightly since May 1, 2023. Moderate growth of CLP was found at 1 site in the lower southwest corner of Bone Lake.

Bone Lake Curlyleaf Pondweed Growth
June 2, 2023

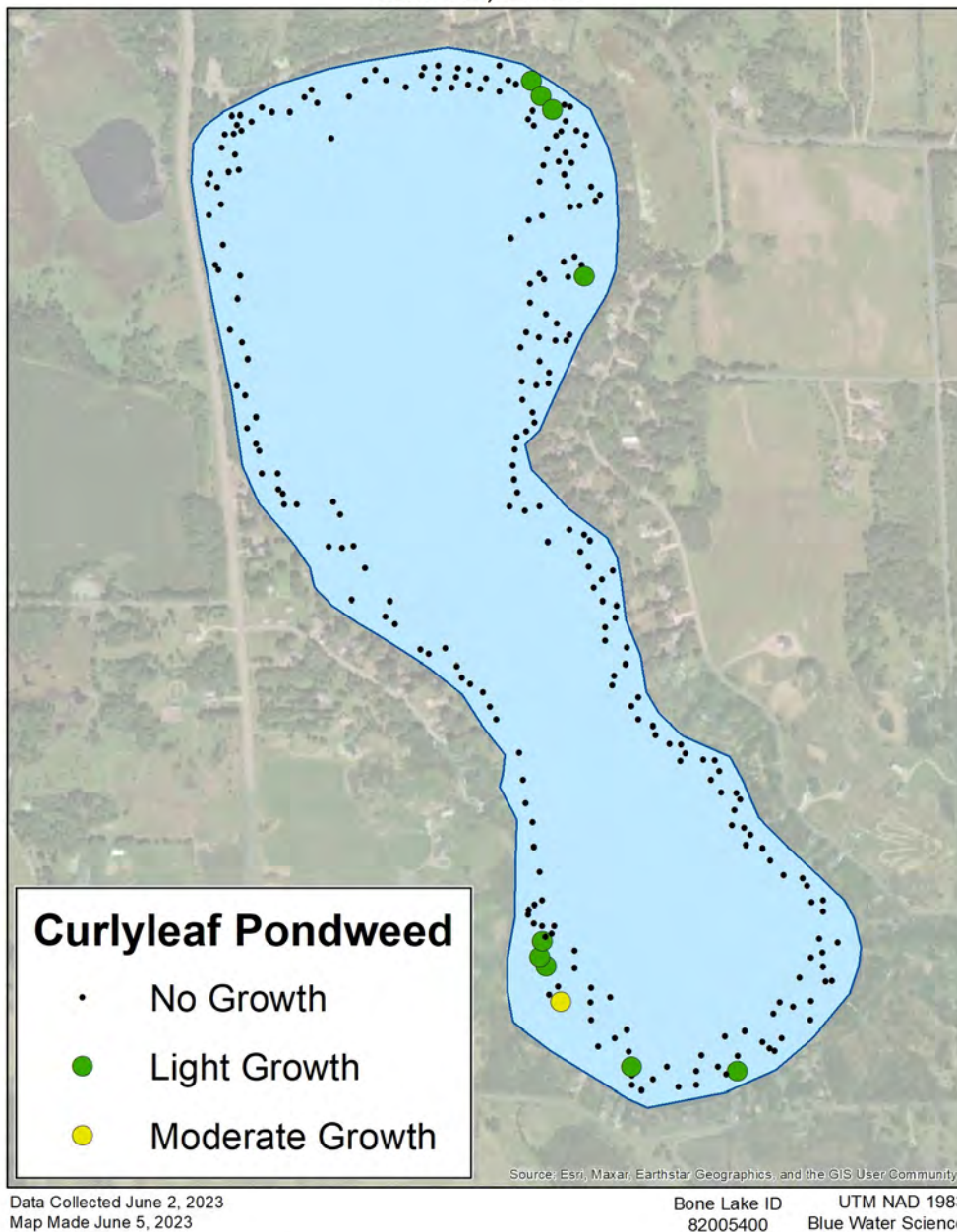


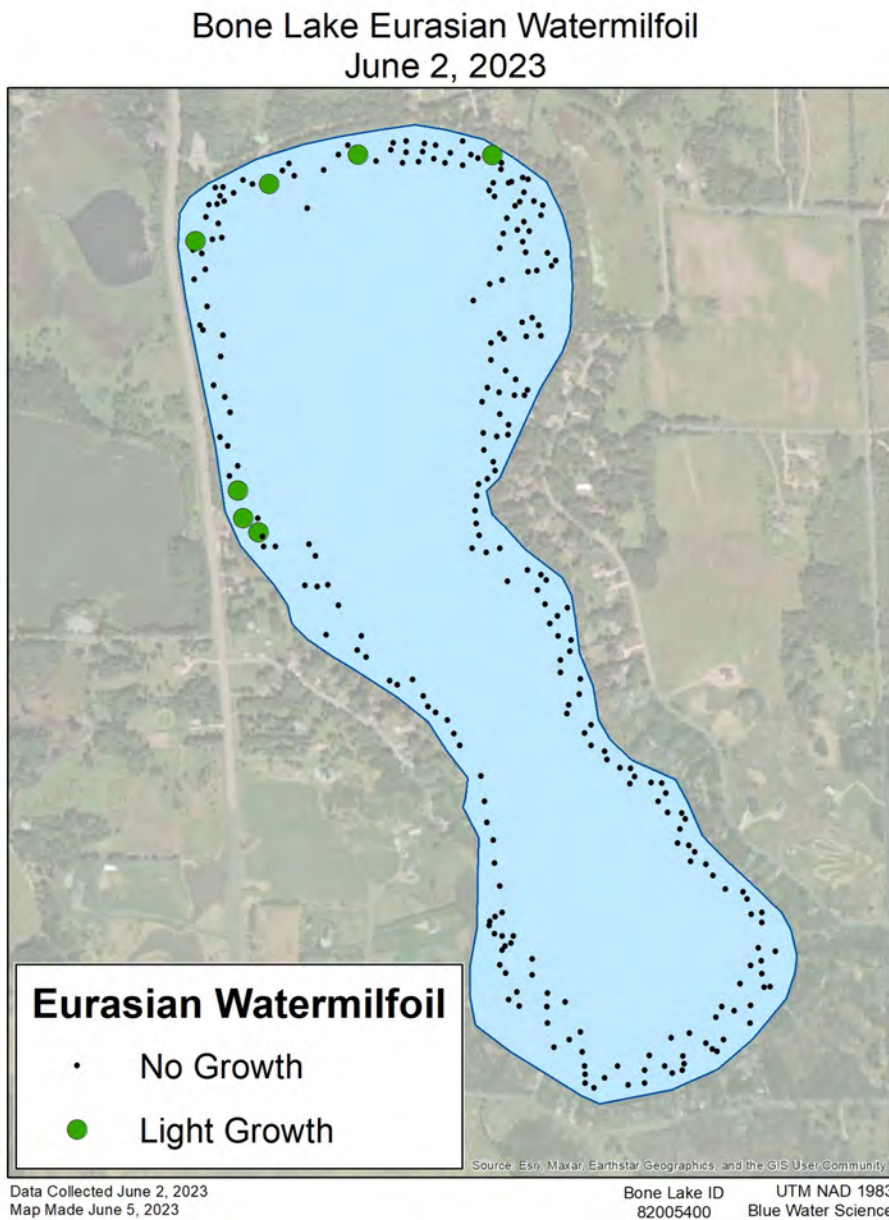
Figure 9. Curlyleaf growth in Bone Lake on June 2, 2023.

Key: black dot = no curlyleaf growth, green dot = light growth, and yellow dot = moderate growth.

Eurasian Watermilfoil Delineation on June 2, 2023

An EWM delineation was conducted on June 2, 2023. Eurasian watermilfoil was sampled at 7 sites out of 261 sites sampled and all sites had light growth (Figure 10).

No treatment areas were delineated for 2023.



**Figure 10. Eurasian watermilfoil coverage for Bone Lake on June 2, 2023.
Key: black dot = no growth and green dots = light growth.**

Point Intercept Survey Conducted on July 20, 2023

Bone Lake Point Intercept Survey Statistics: A summary of plant statistics from the point intercept survey is shown in Tables 2 and 3 and Figure 11. A total of 177 points were sampled. A total of 163 points were sampled in the depths out to 9 feet which was the maximum depth of plant growth. (Table 3). The mean number of native plant species identified at each sample point was 1.0 species per point (Table 2).

Table 2. MnDNR Template Statistics

| | |
|---------------------------------------|----------|
| Total # Points Sampled | 177 |
| Depth Range of Rooted Veg | 1-9 feet |
| Maximum Depth of Growth (95%) in feet | 8 |
| # Points in Max Depth Range | 163 |
| # Points in Littoral Zone (0-15 feet) | 176 |
| % Points w/ Submersed Native Taxa | 63 |
| Mean Submersed Native Taxa/Point | 1.0 |
| # Submersed Native Taxa | 8 |
| # Submersed Invasive Taxa | 1 |
| Max Depth of EWM in feet | 4 |
| % Frequency of EWM | 2 |
| Mode Rake Abundance of EWM | 1 |
| Max Depth of CLP in feet | 0 |
| % Frequency of CLP | 0 |
| Mode Rake Abundance of CLP | NA |

Table 3. Aquatic plants sampled by depth.

| Depth (feet) | Number of Points Sampled | Percent of Sampling Points with Submersed Species Observed |
|--------------|--------------------------|--|
| 1 | 6 | 0% |
| 2 | 31 | 77% |
| 3 | 38 | 87% |
| 4 | 18 | 100% |
| 5 | 21 | 62% |
| 6 | 14 | 71% |
| 7 | 7 | 57% |
| 8 | 15 | 47% |
| 9 | 13 | 8% |
| 10 | 9 | 0% |
| 11 | 2 | 0% |
| 12 | 0 | 0% |
| 13 | 0 | 0% |
| 14 | 2 | 0% |
| 15 | 0 | 0% |
| 16 | 0 | 0% |
| 17 | 0 | 0% |
| 18 | 0 | 0% |
| 19 | 1 | 0% |
| 20 | 0 | 0% |
| All sites | 177 | |

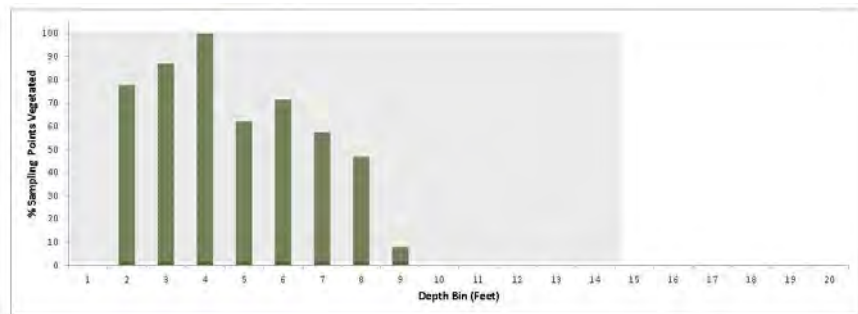


Figure 11. Depth of plant colonization (in feet).

Aquatic Plant Occurrence and Density

The most common plant in the point intercept plant survey was the native naiad followed by coontail (Table 4). A total of 8 submerged species were observed. Native plant coverage is shown in Figure 12 and covered approximately 30% of the lake bottom.

Table 4. The percent occurrence and density of aquatic plants for Bone Lake. Percent occurrence is calculated based on the number of times a plant species occurs at a sampling station divided into the total number of stations for the survey. For example, if coontail was found in 25 out of 50 stations, its percent occurrence would be 50%. Density is a rating scale from 1 to 3 with 3 being the densest.

| | July 20, 2023 | |
|--|------------------------|---------|
| | % Occur (163 sites) | Density |
| Spatterdock (<i>Nuphar variegatum</i>) | 6 | 1.8 |
| White water lily (<i>Nymphaea odorata</i>) | 19 | 1.9 |
| Coontail (<i>Ceratophyllum demersum</i>) | 35 | 1.3 |
| Chara (<i>Chara spp</i>) | 1 | 1.5 |
| Northern watermilfoil (<i>Myriophyllum sibiricum</i>) | 2 | 1.0 |
| Eurasian watermilfoil (<i>Myriophyllum spicatum</i>) | 2 | 1.0 |
| Naiads (<i>Najas flexilis</i>) | 43 | 1.5 |
| Stringy pondweed (<i>Potamogeton sp</i>) | 16 | 1.1 |
| Sago pondweed (<i>Stuckenia pectinata</i>) | 1 | 1.0 |
| Water celery (<i>Vallisneria americana</i>) | 1 | 1.0 |
| Number of submerged aquatic plant species | 8 | |

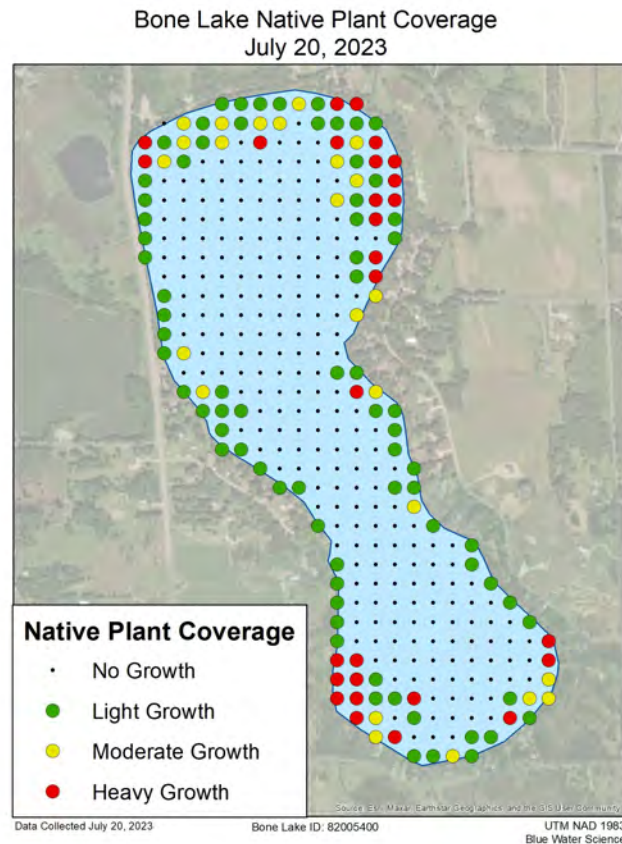


Figure 12. Native plant coverage on July 20, 2023. Key: green = light growth, yellow = moderate growth, and red = heavy growth.

Aquatic Plant Maps

The most abundant native plant on the July 20, 2023 point intercept plant survey for Bone Lake was naiads, found at 70 out of 163 sites sampled out to 9 feet (43%)(Figure 13). The other submerged plant species observed were also found to be growing at light to moderate conditions (Figure 13).

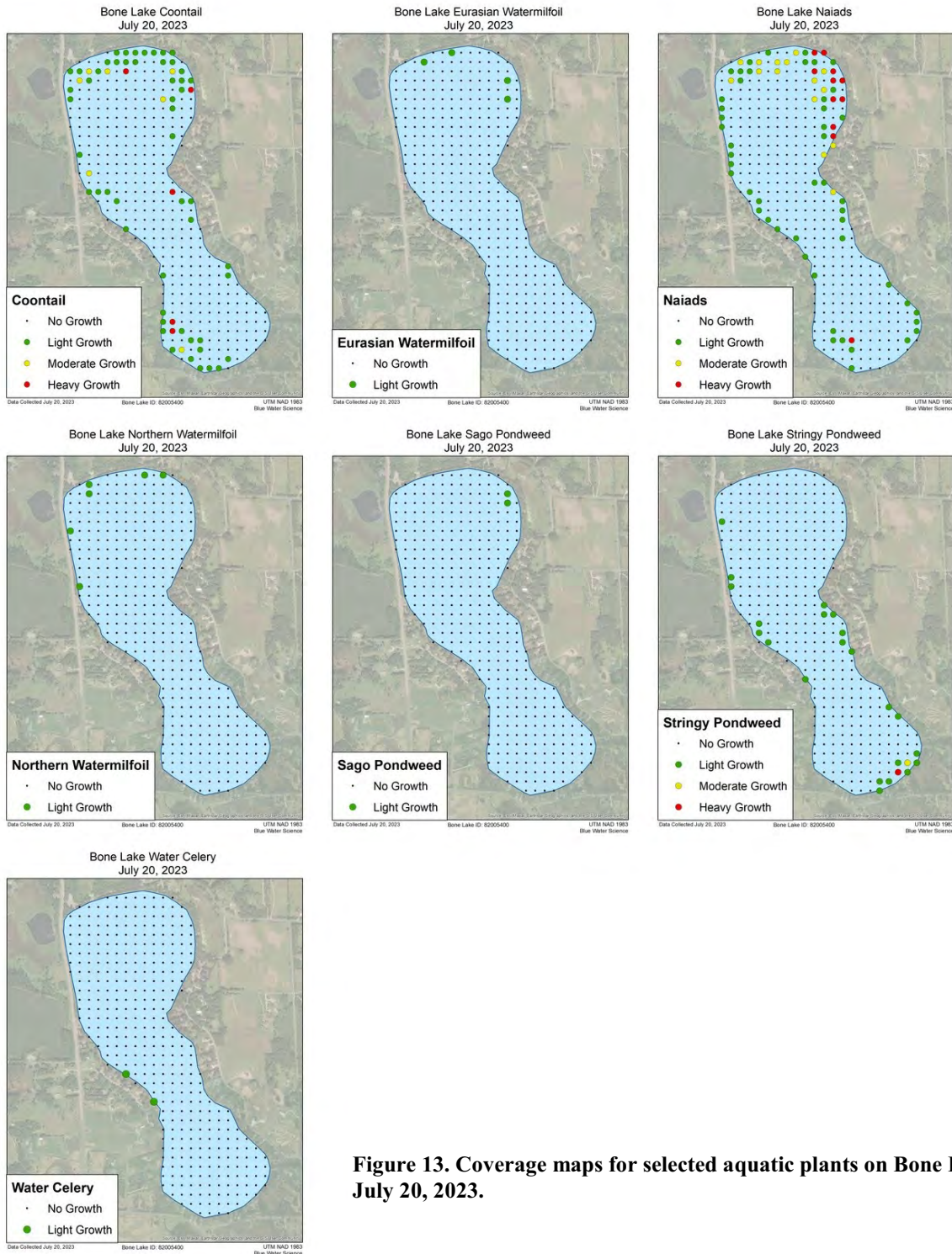


Figure 13. Coverage maps for selected aquatic plants on Bone Lake on July 20, 2023.

A summary of plant density and occurrence at each sample site is shown in Table 5.

Table 5. Individual site data for August 2, 2018. Numbers indicate plant density.

| Site | Depth (ft) | Spatterdock | White lilies | Chara | Coontail | EWM | Naiads | NWM | Sago | Stringy | Water celery | No Plants |
|------|------------|-------------|--------------|-------|----------|-----|--------|-----|------|---------|--------------|-----------|
| 1 | 3 | | | | 1 | | 1 | | | | | |
| 2 | 3 | | | | 1 | | | | | | | |
| 3 | 3 | 2 | | | 1 | | | | | | | |
| 4 | 2 | | | | | | | | | 1 | | |
| 5 | 1 | | 2 | | | | | | | | | |
| 6 | 2 | | 3 | | 1 | | | | | | | |
| 7 | 5 | | | | | | | | | | | 1 |
| 8 | 10 | | | | | | | | | | | 1 |
| 9 | 9 | | | | | | | | | | | 1 |
| 10 | 3 | | | | 1 | | | | | 1 | | |
| 11 | 2 | 1 | | | | | | | | 1 | | |
| 12 | 2 | | 3 | | 1 | | | | | | | |
| 13 | 3 | | 2 | | 2 | | | | | | | |
| 14 | 2 | | | | | | | | | | | 1 |
| 15 | 5 | | | | 1 | | 1 | | | | | |
| 18 | 9 | | | | | | | | | | | 1 |
| 19 | 5 | | | | | | | | | | | 1 |
| 20 | 3 | | | | | | | | | 3 | | |
| 21 | 2 | | 1 | | | | | | | 1 | | |
| 22 | 1 | | 3 | | | | | | | | | |
| 23 | 3 | | 3 | | | | | | | | | |
| 24 | 4 | | | | | | 1 | | | | | |
| 25 | 5 | | | | 1 | | 1 | | | | | |
| 26 | 7 | | | | 1 | | 3 | | | | | |
| 30 | 8 | | | | | | | | | | | 1 |
| 31 | 6 | | | | | | | | | 1 | | |
| 32 | 3 | | | | | | 1 | | | 2 | | |
| 33 | 2 | | 2 | | | | | | | 1 | | |
| 34 | 2 | | 3 | | 1 | | | | | | | |
| 35 | 4 | | 2 | | 3 | | | | | | | |
| 36 | 5 | | | | 1 | | 1 | | | | | |
| 37 | 9 | | | | | | | | | | | 1 |
| 42 | 14 | | | | | | | | | | | 1 |
| 43 | 11 | | | | | | | | | | | 1 |
| 44 | 5 | | | | | | | | | | | 1 |
| 45 | 3 | | 2 | | | | 1 | | | 1 | | |
| 46 | 2 | | 3 | | 1 | | | | | | | |
| 47 | 6 | | | | 3 | | | | | | | |
| 56 | 6 | | | | | | | | | | | 1 |
| 57 | 2 | | 3 | | | | 1 | | | | | |
| 58 | 1 | | 1 | | 1 | | | | | | | |
| 59 | 8 | | | | | | | | | | | 1 |
| 68 | 9 | | | | | | | | | | | 1 |
| 69 | 3 | | 3 | | | | 1 | | | | | |
| 70 | 2 | 1 | | | | | | | | | | |
| 71 | 10 | | | | | | | | | | | 1 |
| 79 | 11 | | | | | | | | | | | 1 |
| 80 | 4 | | | | | | 1 | | | | | |
| 81 | 1 | 1 | | | | | | | | | | |
| 89 | 9 | | | | | | | | | | | 1 |
| 90 | 3 | | | | | | | | | 1 | | |
| 91 | 2 | | 1 | | | | | | | | | |
| 98 | 9 | | | | | | | | | | | 1 |
| 99 | 3 | | | | | | 1 | | | 1 | | |
| 100 | 5 | | | | 1 | | 1 | | | | | |
| 107 | 5 | | | | 1 | | | | | | | |
| 108 | 7 | | | | | | | | | | | 1 |
| 114 | 6 | | | | | | | | | | | 1 |

Table 5. Individual site data for August 2, 2018. Numbers indicate plant density.

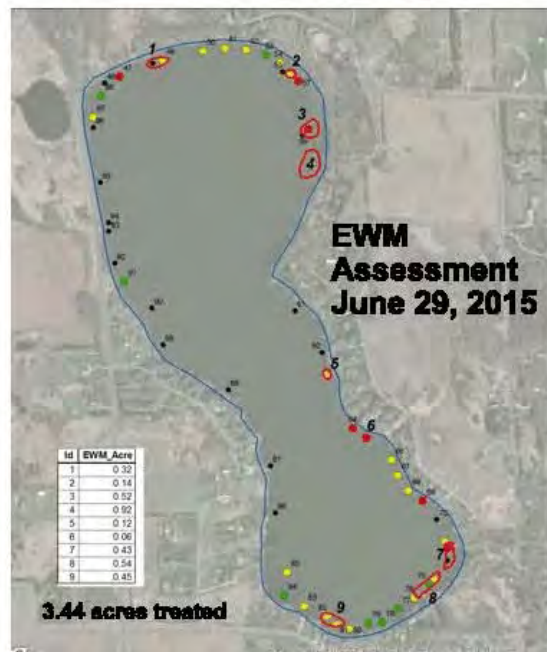
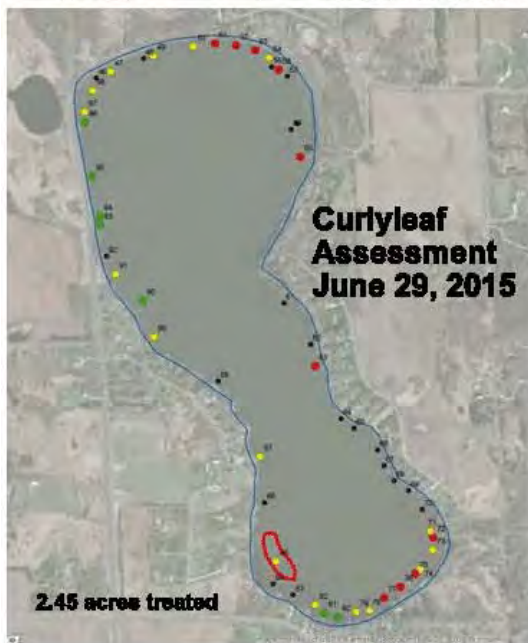
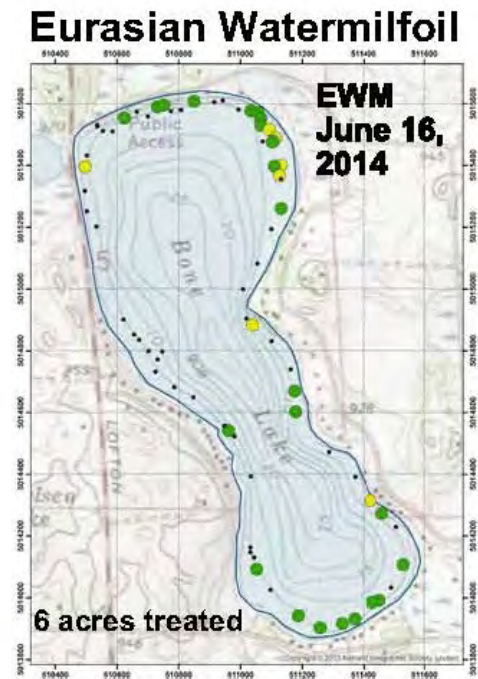
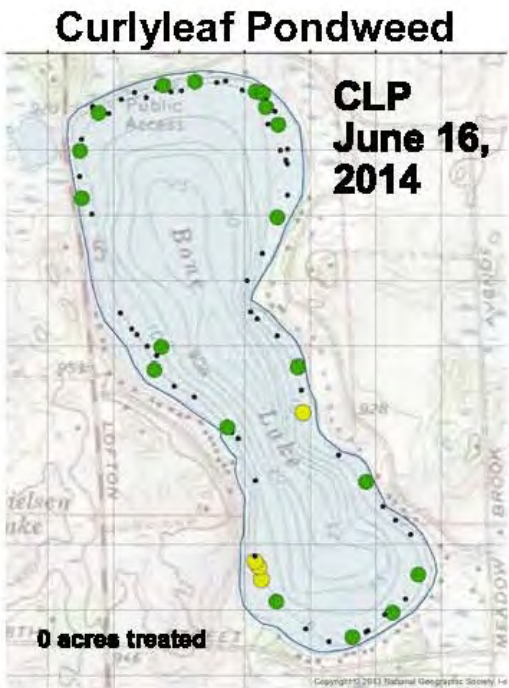
| Site | Depth (ft) | Spatterdock | White lilies | Chara | Coontail | EWM | Naiads | NWM | Sago | Stringy | Water celery | No Plants |
|------|------------|-------------|--------------|-------|----------|-----|--------|-----|------|---------|--------------|-----------|
| 115 | 3 | | 1 | | 1 | | | | | | | |
| 116 | 3 | | 1 | | | | 1 | | | 1 | 1 | |
| 121 | 19 | | | | | | | | | | | 1 |
| 122 | 5 | | 1 | | | | | | | | | |
| 123 | 5 | | | | | | | | | | | 1 |
| 127 | 10 | | | | | | | | | | | 1 |
| 128 | 2 | | | 2 | | | | | | | | |
| 129 | 1 | | 1 | | | | | | | | | |
| 130 | 3 | | | | | | 1 | | | | | |
| 135 | 3 | | | | | | 1 | | | | | |
| 136 | 2 | | 1 | | | | | | | | | |
| 137 | 3 | | | | 1 | | 1 | | | | 1 | |
| 138 | 6 | | | | | | | | | | | 1 |
| 144 | 7 | | | | | | | | | | | 1 |
| 145 | 2 | | 1 | | | | | | | 1 | | |
| 146 | 2 | | 1 | | | | | | | | | |
| 147 | 3 | | | | | | 1 | | | 1 | | |
| 148 | 7 | | | | | | | | | | | 1 |
| 155 | 6 | | | | 1 | | 1 | | | 1 | | |
| 156 | 2 | | | | | | 1 | | | 1 | | |
| 157 | 5 | | | | | | | | | | | 1 |
| 158 | 9 | | | | | | | | | | | 1 |
| 164 | 10 | | | | | | | | | | | 1 |
| 165 | 5 | | | | | | 1 | | | 1 | | |
| 166 | 1 | | 1 | | | | | | | | | |
| 167 | 2 | | | | | | 1 | | | 1 | | |
| 168 | 4 | | | | 1 | | | | | | | |
| 169 | 9 | | | | | | | | | | | 1 |
| 175 | 6 | | | | 1 | | | | | | | |
| 176 | 3 | | | | 1 | | 1 | | | | | |
| 177 | 2 | | 1 | | 1 | | | | | | | |
| 178 | 4 | 2 | | | 1 | | 1 | | | | | |
| 179 | 6 | | | | 1 | | | | | | | |
| 180 | 9 | | | | | | | | | | | 1 |
| 186 | 5 | | | | 3 | | | | | 1 | | |
| 187 | 3 | | | | | | 2 | | | 1 | | |
| 188 | 5 | | | | | | | | | | | 1 |
| 189 | 6 | | | | | | | | | | | 1 |
| 196 | 2 | | | | | | 1 | | | | | |
| 197 | 2 | | | 1 | | | 1 | | | 1 | | |
| 198 | 3 | | 1 | | | | 1 | | | | | |
| 199 | 6 | | | | 2 | | | | | | | |
| 200 | 9 | | | | | | | | | | | 1 |
| 208 | 3 | | | | | | 1 | 1 | | 1 | | |
| 209 | 9 | | | | | | | | | | | 1 |
| 218 | 4 | | | | 1 | | 1 | | | 1 | | |
| 227 | 14 | | | | | | | | | | | 1 |
| 228 | 5 | | | | | | 2 | | | | | |
| 229 | 5 | | | | | | 1 | | | | | |
| 239 | 5 | | | | | | | | | | | 1 |
| 240 | 2 | 2 | | | | | 2 | | | | | |
| 241 | 8 | | | | | | | | | | | 1 |
| 251 | 6 | | | | 1 | | 1 | | | | | |
| 252 | 3 | | | | | | 3 | | | | | |
| 253 | 2 | | 1 | | | | 1 | | | | | |
| 254 | 8 | | | | | | | | | | | 1 |
| 264 | 5 | | | | | | 1 | | | | | |
| 265 | 2 | | | | | | 3 | | | | | |
| 266 | 2 | | | | | | 1 | | | | | |
| 267 | 8 | | | | | | | | | | | 1 |
| 276 | 8 | | | | | | | | | | | 1 |
| 277 | 3 | | | | | | | | | | | 1 |
| 278 | 3 | | | | | | | | | | | 1 |

Table 5. Individual site data for August 2, 2018. Numbers indicate plant density.

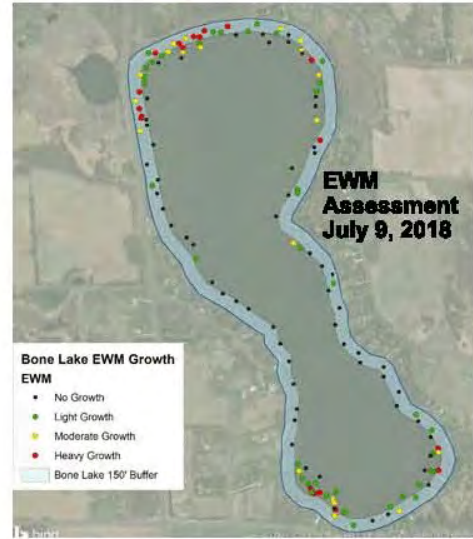
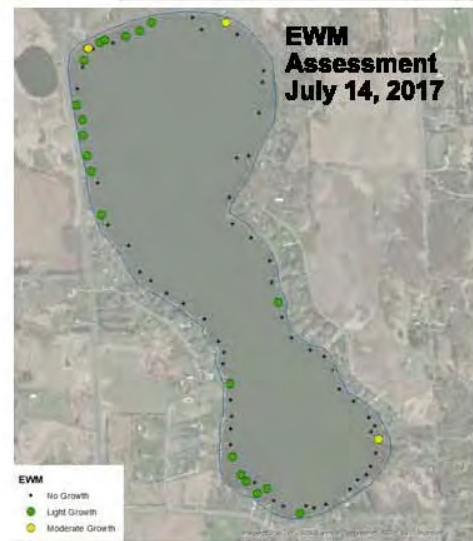
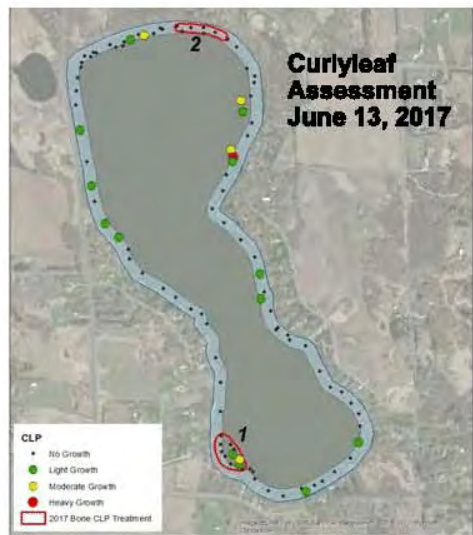
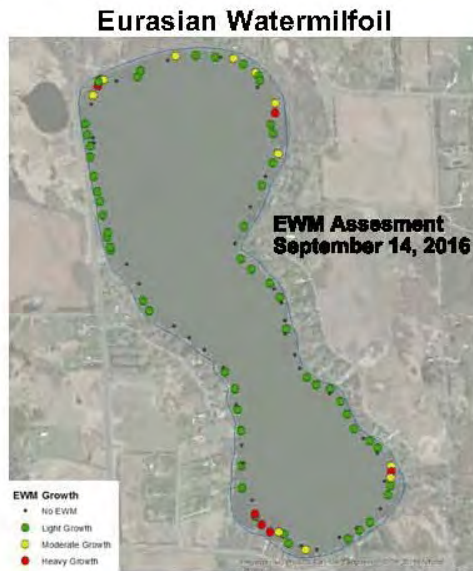
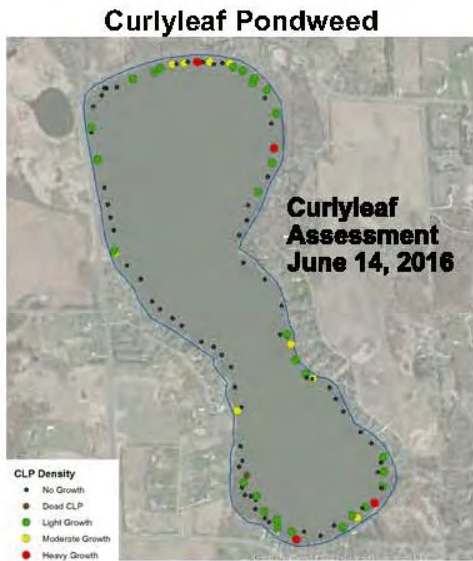
| Site | Depth (ft) | Spatterdock | White lilies | Chara | Coontail | EWM | Naiads | NWM | Sago | Stringy | Water celery | No Plants |
|---------------|------------|-------------|--------------|-------|----------|-----|--------|-----|------|---------|--------------|-----------|
| 279 | 2 | | | | | | 1 | | | | | |
| 280 | 3 | | | | | | 1 | 1 | | | | |
| 290 | 10 | | | | | | | | | | | 1 |
| 291 | 3 | | | | 1 | | 1 | | | | | |
| 292 | 2 | | 3 | | | | | | | | | |
| 293 | 2 | 1 | | | | | | | | | | |
| 294 | 3 | | | | 1 | | 1 | | | 1 | | |
| 295 | 8 | | | | | | | | | | | 1 |
| 304 | 8 | | | | 2 | | 2 | | | | | |
| 305 | 4 | | | | 1 | | 1 | | | | | |
| 306 | 3 | 3 | | | | 1 | 3 | | | | | |
| 307 | 3 | | 3 | | | | 3 | | | | | |
| 308 | 4 | | | | 1 | | | | | | | |
| 309 | 8 | | | | | | | | | | | 1 |
| 318 | 10 | | | | | | | | | | | 1 |
| 319 | 5 | | | | | | 2 | | | | | |
| 320 | 4 | | | | 1 | | 1 | | | | | |
| 321 | 4 | | | | 3 | | | | | | | |
| 322 | 3 | 3 | | | | | | | | | | |
| 323 | 6 | | | | 2 | | 2 | | | | | |
| 324 | 8 | | | | 1 | | 1 | | | | | |
| 325 | 10 | | | | | | | | | | | 1 |
| 332 | 8 | | | | | | 2 | | | | | |
| 333 | 7 | | | | 1 | | | | | | | |
| 334 | 3 | | | | 1 | 1 | 3 | | 1 | | | |
| 335 | 3 | | 2 | | 1 | | 3 | | | | | |
| 336 | 3 | | 3 | | 1 | | | | | | | |
| 337 | 4 | | | | 1 | | 1 | | | | | |
| 338 | 5 | | | | 2 | | 1 | 1 | | | | |
| 339 | 6 | | | | 1 | | 1 | | | | | |
| 340 | 8 | | | | 2 | | 2 | | | | | |
| 341 | 9 | | | | | | | | | | | 1 |
| 342 | 8 | | | | 3 | | 2 | | | | | |
| 345 | 10 | | | | | | | | | | | 1 |
| 346 | 8 | | | | | | 3 | | | | | |
| 347 | 5 | | | | 2 | | 2 | | | | | |
| 348 | 4 | | | | 1 | | 3 | | 1 | | | |
| 350 | 2 | | | | | | 2 | 1 | | | | |
| 351 | 3 | | | | | 1 | 1 | | | | | |
| 352 | 4 | | | | 1 | | 2 | | | | | |
| 353 | 6 | | | | 1 | | | | | | | |
| 354 | 7 | | | | 1 | | 2 | | | | | |
| 355 | 8 | | | | 1 | | 2 | | | | | |
| 356 | 10 | | | | | | | | | | | 1 |
| 357 | 9 | | | | | | 1 | | | | | |
| 358 | 7 | | | | 1 | | 1 | | | | | |
| 359 | 4 | | | | 1 | | | | | | | |
| 360 | 2 | | | | | | 1 | | | | | |
| 361 | 3 | | 1 | | | | | | | | | |
| 362 | 3 | | | | 1 | | 1 | | | | | |
| 363 | 4 | | | | 1 | 1 | | | | | | |
| 364 | 4 | | | | 1 | | | | | | | |
| 365 | 4 | | | | 1 | | 2 | 1 | | | | |
| 366 | 4 | | | | 1 | | 1 | | | | | |
| 367 | 3 | | | | 1 | | 3 | 1 | | | | |
| 368 | 2 | | | | 1 | | 3 | | | | | |
| Average | | 1.8 | 1.9 | 1.5 | 1.3 | 1.0 | 1.5 | 1.0 | 1.0 | 1.1 | 1.0 | |
| Occur to 9 ft | 163 | 9 | 31 | 2 | 57 | 3 | 70 | 4 | 2 | 24 | 2 | 51 |
| % Occur | | 6 | 19 | 1 | 35 | 2 | 43 | 2 | 1 | 15 | 1 | |

APPENDIX

Curlyleaf Pondweed and Eurasian Watermilfoil Assessments from 2014 - 2022

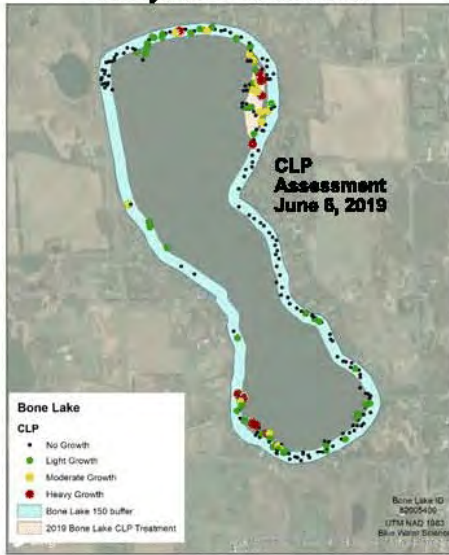


CLP and EWM maps for 2014 through 2022 (continued on the next 2 pages).



CLP and EWM maps for 2014 through 2022.

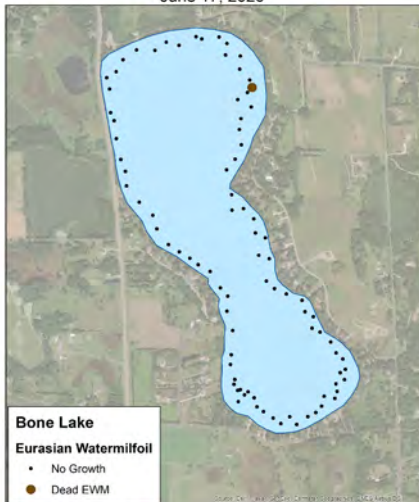
Curlyleaf Pondweed



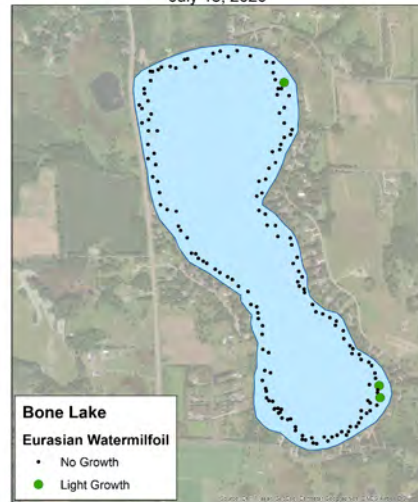
Eurasian Watermilfoil



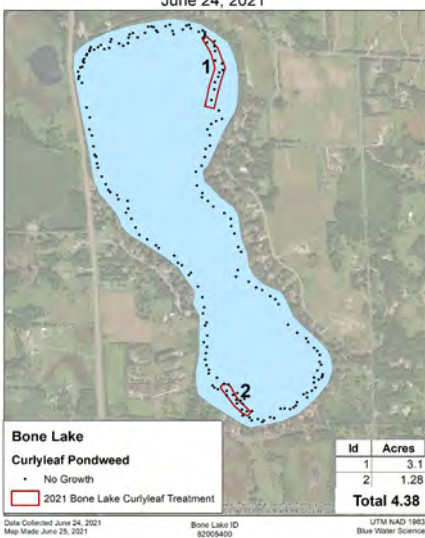
Bone Lake Eurasian Watermilfoil June 17, 2020



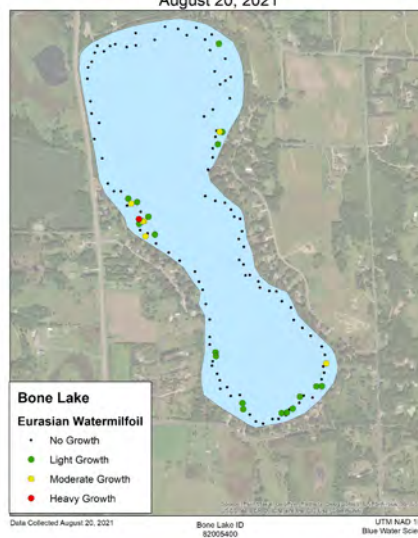
Bone Lake Eurasian Watermilfoil July 15, 2020



Bone Lake Curlyleaf Pondweed Assessment June 24, 2021



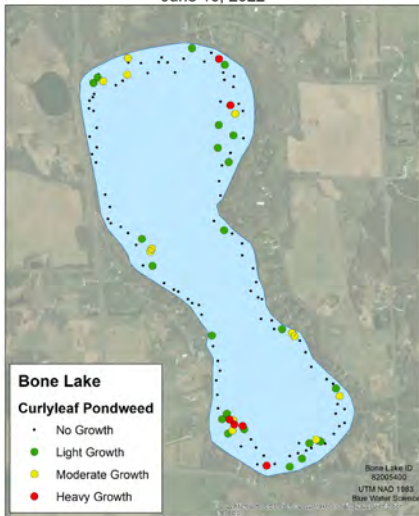
Bone Lake Eurasian Watermilfoil August 20, 2021



CLP and EWM maps for 2014 through 2022.

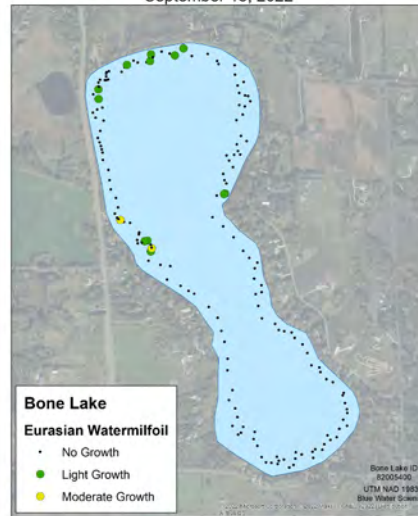
Curlyleaf Pondweed

Bone Lake Curlyleaf Pondweed Growth
June 10, 2022



Eurasian Watermilfoil

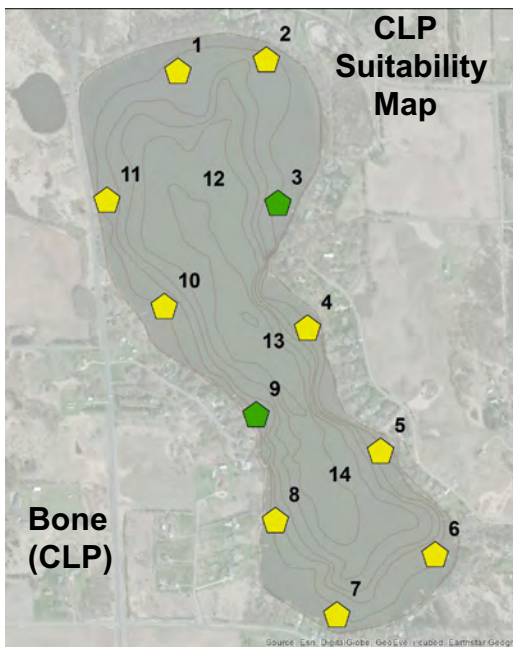
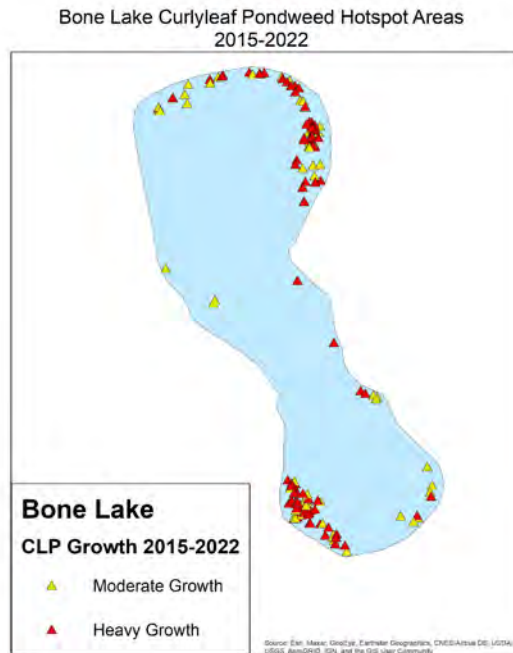
Bone Lake Eurasian Watermilfoil Growth
September 15, 2022



CLP and EWM maps for 2014 through 2022.

Curlyleaf Pondweed from 2015 - 2022

A summary of CLP treatments from 2015 through 2022 is shown below. CLP growth has been variable for the last couple of years. Lake ice, snow cover, and even cloudy days can limit curlyleaf growth. A hotspot map of sites of CLP moderate and heavy growth for 2015 through 2022 is shown in Figure 8. In the last 5 years CLP growth has been most evident in the northern and southern ends of Bone Lake where growing conditions are conducive to heavy plant growth. CLP has typically grown to a water depth of 6 feet or less.



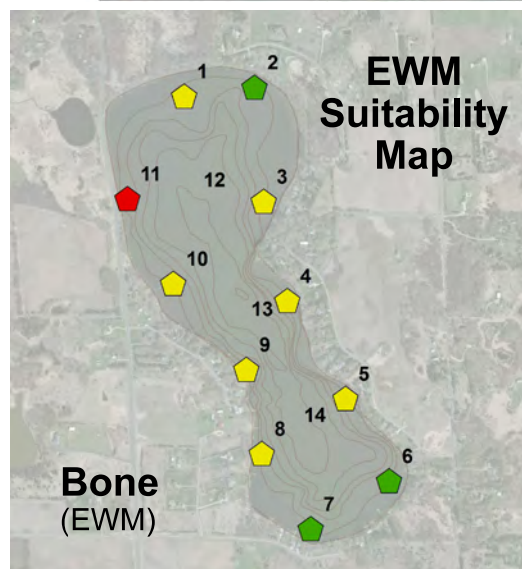
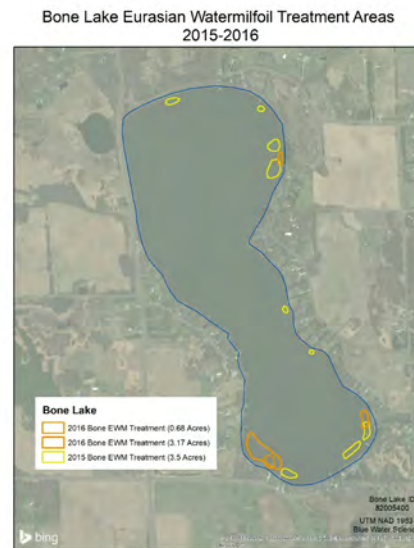
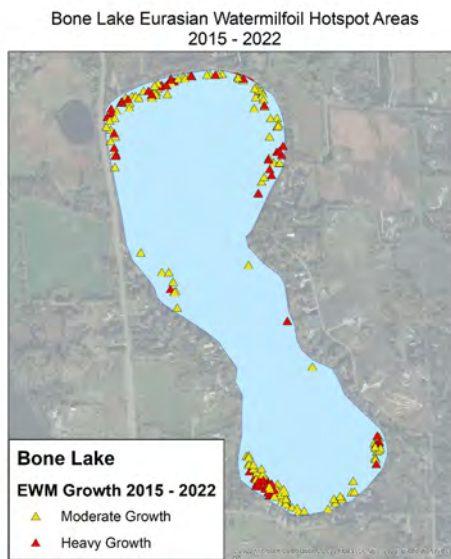
[top-left] Bone Lake CLP hotspot map 2015-2022. [top-right] Treatment map of CLP growth over the years of 2015-2022 placed on a single map. [bottom-left] Curlyleaf pondweed potential growth based on lake sediment analyses for Bone Lake. Key for Potential Growth: green = light growth, yellow = moderate growth, red = heavy growth (shown with octagons).

Eurasian Watermilfoil from 2015 - 2022

EWM has been in Bone Lake since 2006. Although control of EWM has been ongoing since 2006, EWM continued to expand around the lake. A map showing the occurrence of moderate to heavy growth of EWM in Bone Lake from 2015 through 2022 is shown below. Some nearshore areas in the north and south ends of Bone Lake support consistently significant growth. These “hotspot” areas are shown below.

Heavy milfoil growth has been correlated with high sediment nitrogen conditions and from a soils survey conducted in 2014, Bone Lake has at least 1 area with high lake sediment nitrogen conditions. The potential for long term milfoil growth, based on lake sediment sampling, predicts mostly moderate growth with the potential for annual heavy growth limited to the northwest side of Bone Lake.

For Bone Lake, it is estimated the plants have the potential to grow down to at least 7 feet of water depth based on low Secchi transparencies, restricting milfoil growth to nearshore areas. Results of the sediment survey indicate growth would be primarily light on a long term basis.



[top-left] Hotspot map of EWM growth over the years of 2015 to 2022 placed on a single map.

[top-right] Treatment map of EWM growth over the years of 2015-2022 placed on a single map.

[bottom-left] Suitability map for EWM growth in Bone Lake.

Key: green = light growth, yellow = moderate growth, and red = heavy growth.



Shields Lake, Washington County, Minnesota, June 1, 2023

Curlyleaf Pondweed Delineation and Assessment Surveys for Shields Lake, Washington County, Minnesota, 2023

Curlyleaf Delineation (point intercept): April 25, 2023

Curlyleaf Treatment: May 22, 2023 (3.07 ac)

Curlyleaf Assessment (point intercept): June 1, 2023

Prepared for:
Comfort Lake/Forest Lake
Watershed District
Forest Lake, Minnesota



Prepared by:
Steve McComas
Jo Stuckert
Connor McComas
Blue Water Science

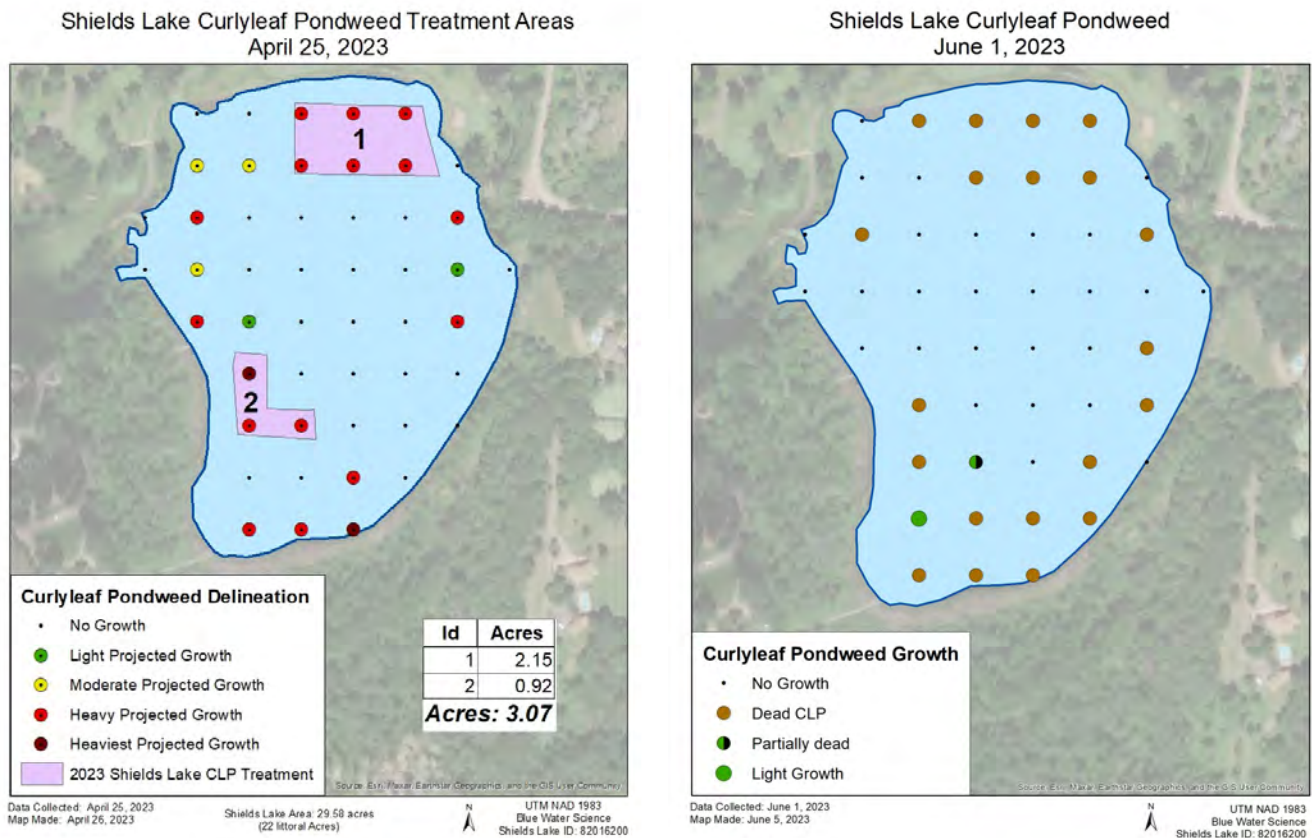
December 1, 2023

Curlyleaf Pondweed Delineation and Assessment Surveys for Shields Lake, Washington County, Minnesota, 2023

Summary

Curlyleaf Pondweed Delineation: Shields Lake (MnDNR ID #82-016200) is a 30 acre lake located in Washington County, Minnesota. Water clarity has a summer average of 6.5 feet in 2022 (source: Comfort Lake/Forest Lake Watershed District). A curlyleaf pondweed point intercept survey was conducted on April 25, 2023 by Blue Water Science. Results of the curlyleaf delineation survey found curlyleaf pondweed was widespread in water depths to 10 feet of Shields Lake (Figure 1). A treatment area of 3.07 acres was delineated and was treated on May 22, 2023 using Aquathol K at 1.25 ppm (3.2 gallons/acre). A lakewide concentration of the active ingredient was 59 ppb. Curlyleaf pondweed and coontail were the only aquatic plant species found on April 25, 2023.

Curlyleaf Pondweed Assessment: A point intercept survey was used for the curlyleaf pondweed assessment and was conducted on June 1, 2023 by Blue Water Science (Figure 1). Results of the curlyleaf pondweed assessment found viable curlyleaf in two sites in Shields Lake. Coontail and elodea were the only other submerged plant was found in Shields Lake on June 1, 2023.



Curlyleaf Pondweed Delineation and Assessment Surveys for Shields Lake, Washington County, Minnesota, 2023

Shields Lake, Washington County (ID: 82-016200)

Size: 29.6 acres (MnDNR)

Littoral area: 22 acres (MnDNR)

Maximum depth: 27 ft (MnDNR)

Introduction

A curlyleaf pondweed delineation using a point intercept survey was conducted on April 25, 2023 on 30 acre Shields Lake, Washington County. The objective of the delineation was to check the distribution and abundance of curlyleaf pondweed. About a month after a CLP treatment, a second point intercept was conducted on June 1, 2023 to assess the status of CLP and to check the distribution and abundance of all aquatic plants.

Methods

Curlyleaf Pondweed Delineation: At the time of the spring CLP delineations, only a fraction of the peak curlyleaf biomass is present. For spot treatments, the areas to be treated should be delineated prior to curlyleaf developing peak biomass. Curlyleaf stem counts on a rake sampler were used to identify areas that had a potential to produce dense curlyleaf. After a short sweep of about 1-foot (30 cm), 4 curlyleaf stems or more per rake sample generally indicated some CLP plants had developed runners and would likely produce heavy growth in the next few weeks. Alternatively, sites where 3 stems or less were collected per rake sample were not predicted to produce dense growth at the peak growing period. These areas were not treated. This delineation method was used for spot lake treatments in Gleason Lake and has worked for other lakes as well (McComas et al, 2015*).

An endothall herbicide application at 3.2 gallons/acre was conducted by Lake Management, Inc and a total of 3.07 acres were treated in May, 2023. A lakewide concentration of the active ingredient was estimated at 59 ppb.

Point Intercept Surveys and the Curlyleaf Pondweed Assessment: Two point intercept surveys were conducted by Blue Water Science on April 25 and June 1, 2023. Grid spacing was 50 meters. The plant species were recorded and the density of each species was assigned. Densities were based on the coverage on the teeth of the rake. Density ratings were from 1 to 3 with 1 being sparse and 3 being a nuisance. Based on these sample sites, plant distribution maps were constructed.

*McComas, S.R., Y.E. Christianson, and U. Singh. 2015. Effects of curlyleaf pondweed control on water quality and coontail abundance in Gleason Lake, Minnesota. *Lake and Reservoir Management*. 31:109-114.

Results for the CLP Delineation on April 25, 2023

A point intercept survey was conducted to delineate curlyleaf pondweed in 2023 on April 25, 2023 (Figure 1). Results from the survey determined areas of significant curlyleaf pondweed growth were delineated (Figure 2) based on CLP stem densities that were predicted to produce heavy growth at peak CLP abundance in June (Figure 2). Two areas totaling 3.07 acres were delineated for treatment. No other submerged aquatic plant species observed (Tables 1, 2, and 3).

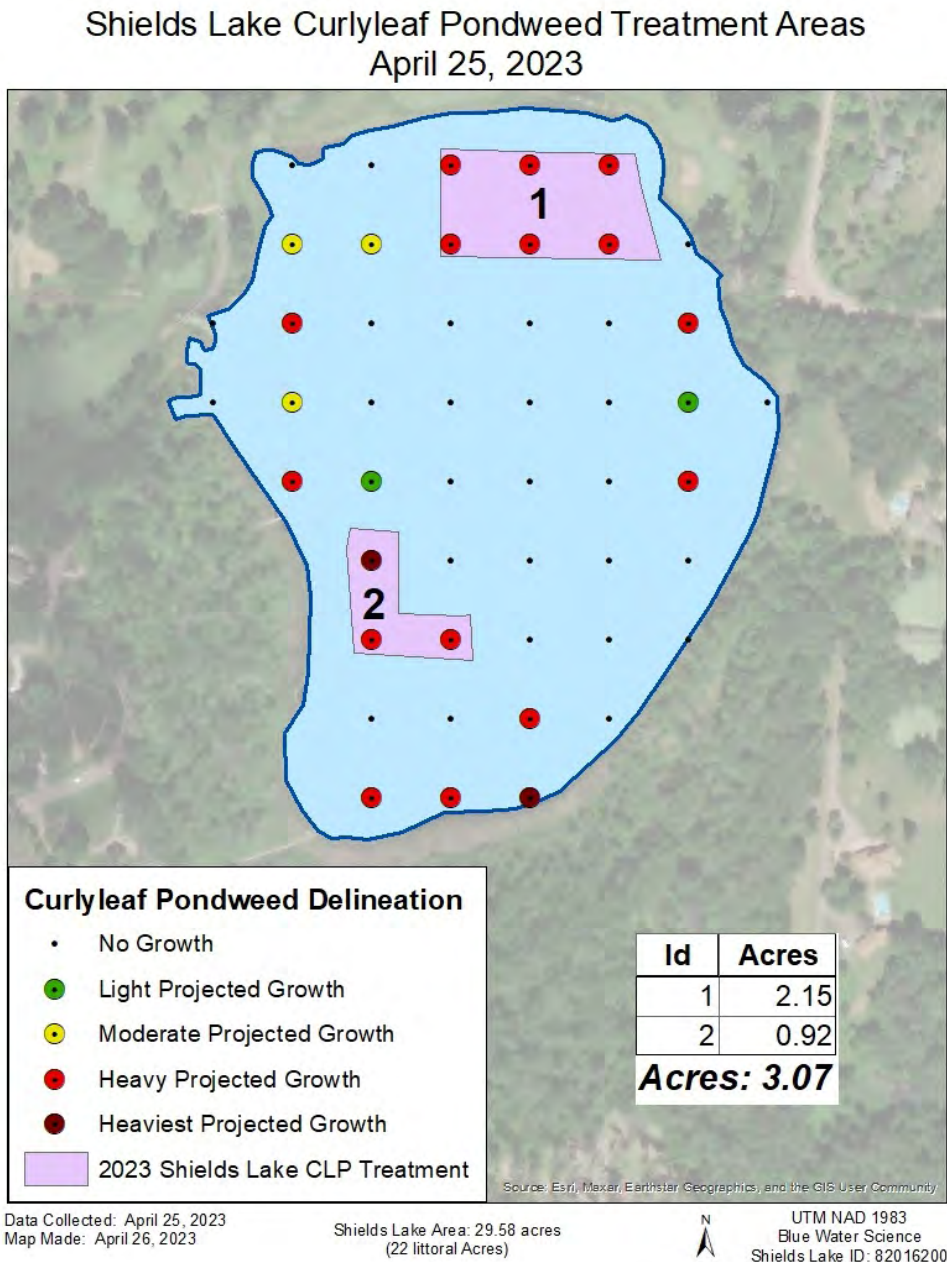


Figure 2. Curlyleaf pondweed potential treatment areas Shields Lake that were delineated on April 25, 2023.

Point Intercept Survey on April 25, 2023: Results of the point intercept survey conducted on April 25, 2023 found there was significant curlyleaf pondweed growth at many of the sample sites in the nearshore area (Table 1). Based on results from the point intercept surveys, two areas representing 3.07 acres were delineated that had the characteristic stem densities that were predicted to produce heavy growth at peak CLP abundance in June (Figure 2).

Table 1. Curlyleaf pondweed occurrences and stem densities for the April 25, 2023 point intercept survey based on 49 sites.

| | All Stations (n=49) | | |
|--|---------------------|---------|---------|
| | Occur | % Occur | Density |
| Coontail (<i>Ceratophyllum demersum</i>) | 16 | 33 | 1.1 |
| Curlyleaf pondweed - stems (<i>Potamogeton crispus</i>) | 22 | 45 | 6.7 |

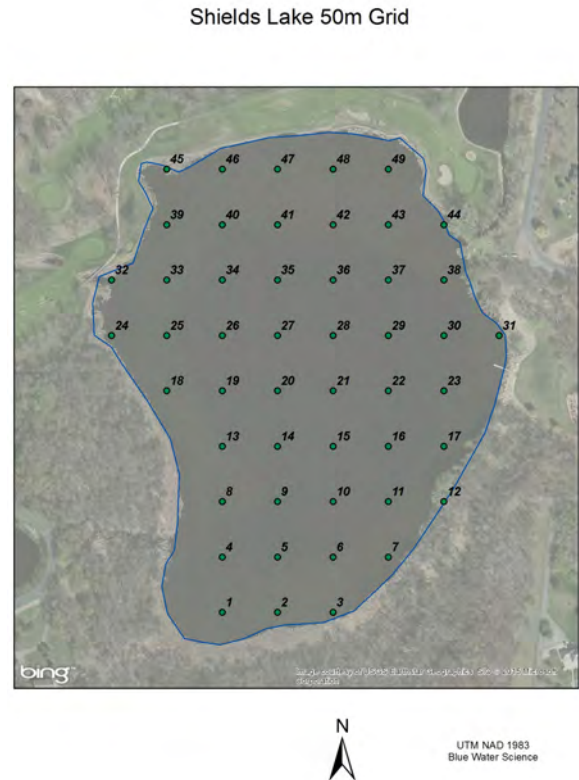


Figure 3. Curlyleaf pondweed rake density on April 25, 2023.

Point Intercept Survey on April 25, 2023 Plant Data for the Delineation: Low plant diversity was found in Shields Lake in the April 25, 2023 point intercept survey with curlyleaf pondweed and coontail being the only aquatic plant species observed (Table 2).

Table 2. Aquatic plant occurrence and stem density for the point intercept sample points in Shields Lake, April 25, 2023.

| Site | Depth (ft) | Coontail | CLP_stems |
|-----------------------|------------|----------|-----------|
| 1 | 5 | | 7 |
| 2 | 5 | | 5 |
| 3 | 4 | 1 | 17 |
| 4 | 10 | | |
| 5 | 10 | | |
| 6 | 7 | | 6 |
| 7 | 5 | 1 | |
| 8 | 5 | | 7 |
| 9 | 9 | | 5 |
| 10 | 13 | | |
| 11 | 10 | | |
| 12 | 3 | 1 | |
| 13 | 6 | | 13 |
| 14 | 13 | | |
| 15 | 18 | | |
| 16 | 17 | | |
| 17 | 6 | 1 | |
| 18 | 5 | | 7 |
| 19 | 10 | | 1 |
| 22 | 20 | | |
| 23 | 8 | | 8 |
| 24 | 3 | 1 | |
| 25 | 8 | 1 | 3 |
| 26 | 13 | | |
| 30 | 10 | | 2 |
| 31 | 5 | 1 | |
| 32 | 3 | 2 | |
| 33 | 6 | | 11 |
| 34 | 13 | | |
| 35 | 15 | | |
| 36 | 18 | | |
| 37 | 12 | | |
| 38 | 5 | | 4 |
| 39 | 4 | 1 | 3 |
| 40 | 5 | 1 | 3 |
| 41 | 7 | | 10 |
| 42 | 7 | | 11 |
| 43 | 5 | 1 | 5 |
| 44 | 3 | 1 | |
| 45 | 3 | | |
| 46 | 4 | 2 | |
| 47 | 5 | 1 | 7 |
| 48 | 5 | 1 | 9 |
| 49 | 4 | 1 | 4 |
| Average | | 1.1 | 6.7 |
| Occurrence (49 sites) | | 16 | 22 |
| % occurrence | | 33 | 45 |



Results of the June 1, 2023 Point Intercept Survey and CLP Assessment

Results of the June 1, 2023 assessment using a point intercept survey found three native submerged plant species, including curlyleaf pondweed, coontail, and elodea (Table 2). The curlyleaf pondweed was observed in the lake both living and dead (Table 3 and Figure 4). Results from the assessment found native plants growing out to a depth of 6 feet (Table 4)(Figure 5).

Table 3. Shields Lake aquatic plant occurrences and densities for the June 1, 2023 survey based on 49 sites. Density ratings are 1-3 with 1 being low and 3 being most dense.

| | All Stations (n=49) | | |
|--|---------------------|---------|---------|
| | Occur | % Occur | Density |
| Coontail (<i>Ceratophyllum demersum</i>) | 21 | 43 | 1.6 |
| Elodea (<i>Elodea canadensis</i>) | 1 | 2 | 1.0 |
| Curlyleaf pondweed (<i>Potamogeton crispus</i>) | 2 | 4 | 1.0 |

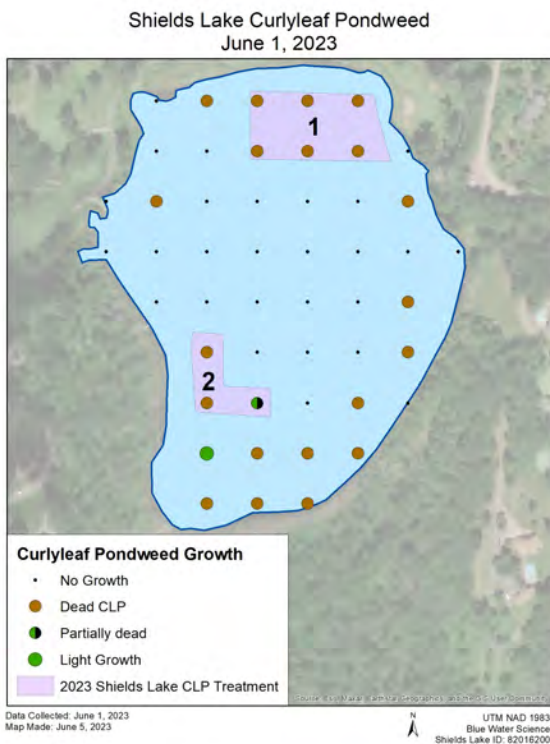


Figure 4. Curlyleaf pondweed coverage for Shields Lake on June 1, 2023. Key: black dots = no growth, green dot = light growth, and brown dots = dead curlyleaf pondweed.

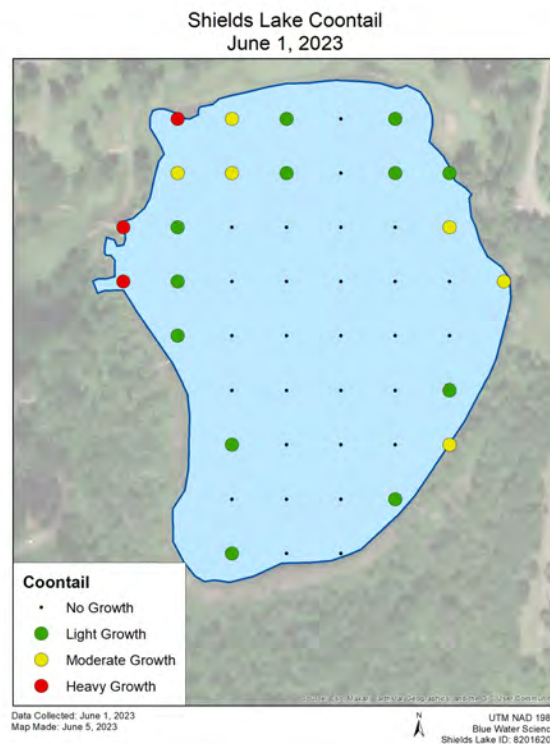


Figure 5. Coontail coverage for Shields Lake on June 1, 2023. Key: black dot = no growth, green dots = light growth, yellow dots = moderate growth, and red dot = heavy growth.

Point Intercept Survey (June 1, 2023) Plant Data for the Assessment

Low plant diversity was found in Shields Lake with a total of 3 submerged aquatic plant species (Table 4).

Table 4. Aquatic plant occurrence and density for the point intercept sample points in Shields Lake, June 1, 2023.

| Site | Depth (ft) | Coontail | CLP | CLP-dead | Elodea | FA |
|------------------|------------|----------|-----|----------|--------|-----|
| 1 | 5 | 1 | | 1 | | 2 |
| 2 | 3 | | | 2 | | 1 |
| 3 | 3 | | | 1 | | 1 |
| 4 | 9 | | 1 | | | |
| 5 | 7 | | | 1 | | |
| 6 | 5 | | | 1 | | 1 |
| 7 | 4 | 1 | | 1 | | |
| 8 | 5 | 1 | | 1 | | 1 |
| 9 | 9 | | 1 | 1 | | |
| 10 | 12 | | | | | |
| 11 | 8 | | | 1 | | |
| 12 | 3 | 2 | | | 1 | 2 |
| 13 | 6 | | | 2 | | |
| 14 | 13 | | | | | |
| 16 | 14 | | | | | |
| 17 | 4 | 1 | | 1 | | 1 |
| 18 | 4 | 1 | | | | 2 |
| 19 | 12 | | | | | |
| 22 | 17 | | | | | |
| 23 | 7 | | | 1 | | |
| 24 | 2.5 | 3 | | | | 3 |
| 25 | 6 | 1 | | | | |
| 26 | 12 | | | | | |
| 29 | 20 | | | | | |
| 30 | 10 | | | | | |
| 31 | 2 | 2 | | | | 1 |
| 32 | 2 | 3 | | | | 3 |
| 33 | 5 | 1 | | 1 | | 2 |
| 34 | 11 | | | | | |
| 35 | 15 | | | | | |
| 36 | 16 | | | | | |
| 37 | 12 | | | | | |
| 38 | 5 | 2 | | 1 | | 1 |
| 39 | 4 | 2 | | | | 1 |
| 40 | 5 | 2 | | | | |
| 41 | 6 | 1 | | 2 | | |
| 42 | 6 | | | 1 | | |
| 43 | 4.5 | 1 | | 1 | | 1 |
| 44 | 2 | 1 | | | | 1 |
| 45 | 3 | 3 | | | | 2 |
| 46 | 4 | 2 | | 1 | | 2 |
| 47 | 4 | 1 | | 1 | | 1 |
| 48 | 4 | | | 1 | | |
| 49 | 3 | 1 | | 1 | | 1 |
| Average | | 1.6 | 1.0 | 1.1 | 1.0 | 1.5 |
| Occur (49 sites) | | 21 | 2 | 21 | 1 | 20 |
| % occurrence | | 43 | 4 | 43 | 2 | 41 |



Aquatic plant conditions on June 1, 2023



Figure 6. Aquatic plant growth on June 1, 2023.



Curlyleaf Pondweed on a Sample Rake Pole, Forest Lake on June 13, 2023

Curlyleaf Pondweed and Eurasian Watermilfoil Delineation, Treatment, and Assessment for Forest Lake, Washington County, 2023

| | Delineation | Treatment | Assessment |
|-----|-------------------------|------------------------------|--------------------|
| CLP | May 9, 2023 | May 22, 2023 (61.55 acres) | June 13, 2023 |
| EWM | June 13, August 8, 2023 | August 18, 2023 (8.41 acres) | September 20, 2023 |

Prepared for:
**Comfort Lake-Forest Lake
 Watershed District
 Forest Lake, Minnesota**



Prepared by:
**Steve McComas
 Blue Water Science
 St. Paul, MN 55116**

December 27, 2023

Curlyleaf Pondweed and Eurasian Watermilfoil Delineation, Treatment, and Assessment for Forest Lake, Washington County, 2023

Summary

Curlyleaf Pondweed (CLP) Delineation, Treatment, and Assessment: Forest Lake (MnDNR ID#82-015900) is a 2,271 acre lake in Washington County, Minnesota. Early season curlyleaf pondweed distribution and abundance were evaluated May 9, 2023.

In the delineation survey, heaviest potential curlyleaf growth was found in the Second Lake and potential early summer heavy growth was estimated at 61.55 acres for all 3 basins (Figure 1). A total of 61.55 acres of curlyleaf areas were treated on May 22, 2023.

A post treatment curlyleaf assessment was conducted on June 13, 2023. The June curlyleaf assessment found excellent control in the treated areas although there was some new curlyleaf pondweed sprouting in 3rd lake (Figure 1).

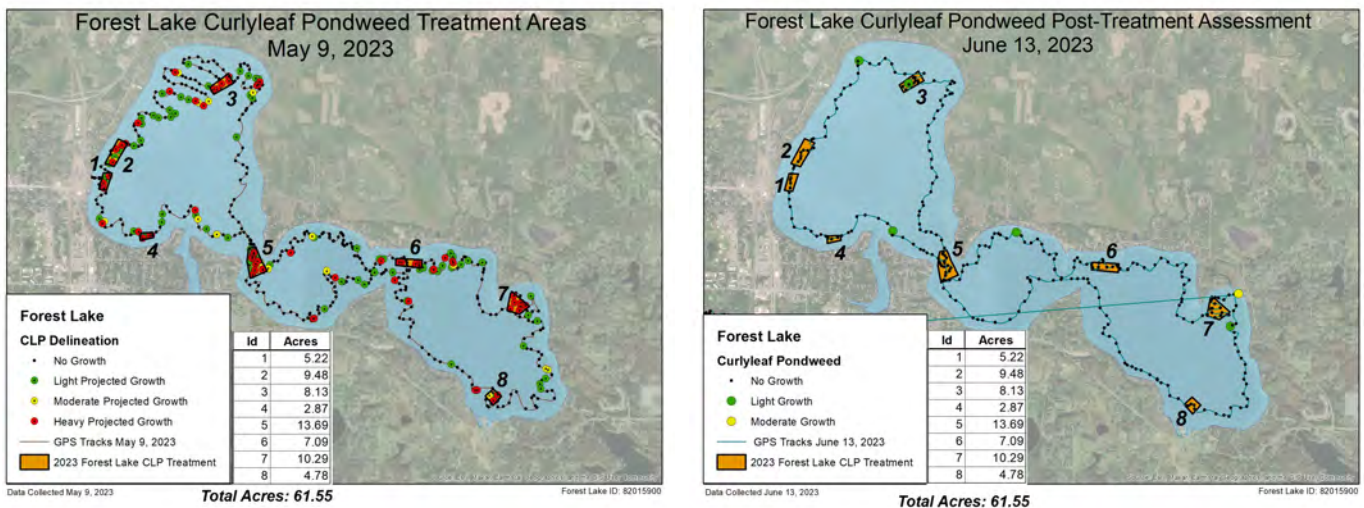


Figure 1. [left] DELINEATION: Map of curlyleaf pondweed distribution from the May 9, 2023 survey. Approximately 61.55 acres were delineated for CLP treatment.

[right] ASSESSMENT: Map of curlyleaf pondweed assessment sites for June 13, 2023.

Key: green dots = light growth, yellow dots = moderate growth, red dots = heavy growth, and black dots = no curlyleaf growth. Orange shaded areas indicates treatment areas.

Eurasian Watermilfoil (EWM) Delineation, Treatment, and Assessment: EWM distribution and abundance were evaluated June 13, 2023. EWM growth was light and based on that delineation, no treatment was recommended at that time (Figure 2).

Later in the summer, another EWM delineation was conducted on August 8, 2023 and a few EWM locations were found that could be treated. Based on this delineation, a treatment area of 8.41 acres was constructed.

Treatment of 8.41 acres occurred on August 18, 2023 using ProcellaCor herbicide.

On September 20, 2023, after the EWM treatment, an EWM assessment found good control in the treated areas. Only a few scattered plants were observed outside of the treatment polygons. Northern watermilfoil was abundant in much of Forest Lake in water depths of 3 to 6 feet.

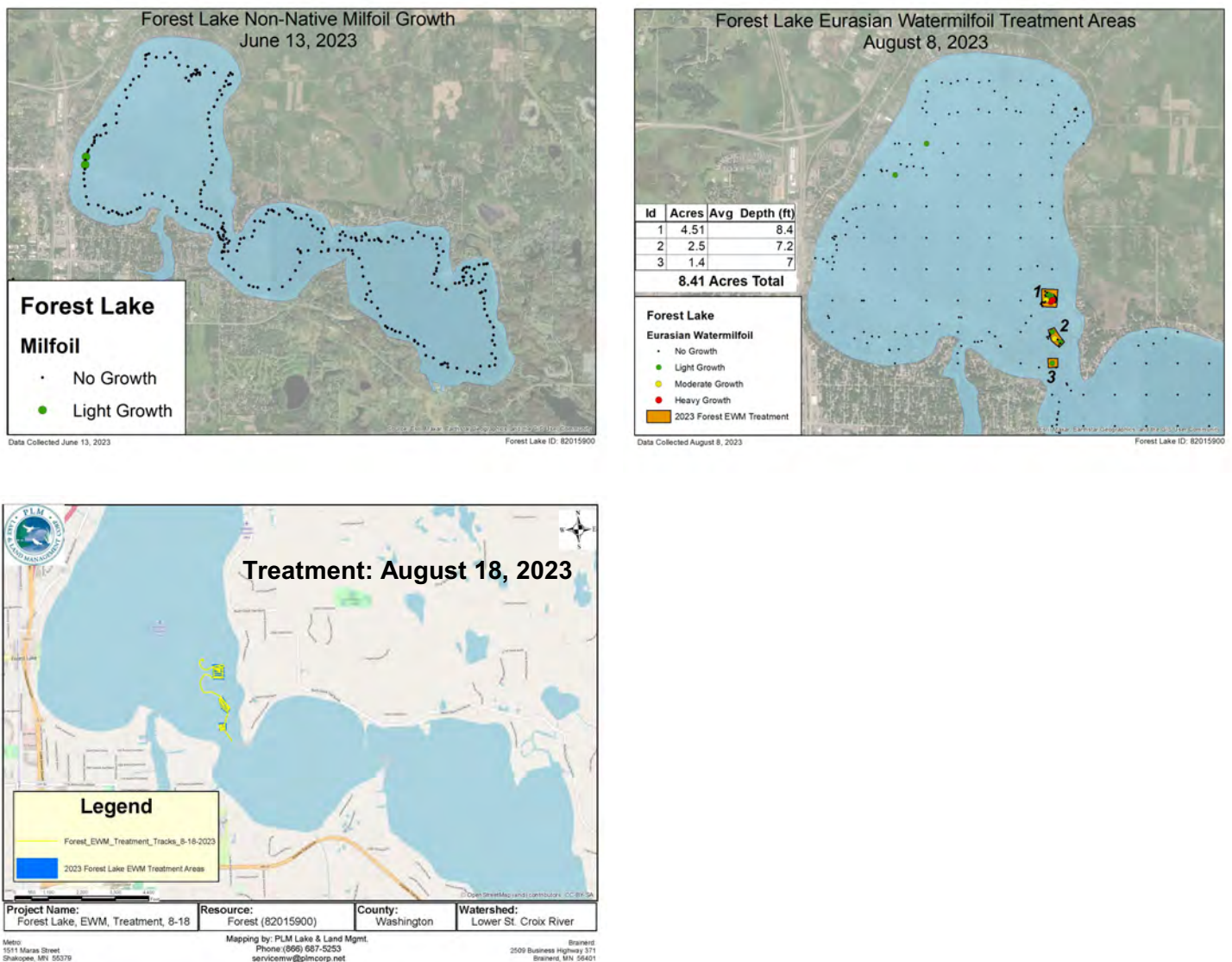


Figure 2. [top-left] DELINEATION: Map of EWM distribution from the June 13, 2023 survey. [top-right] Proposed treatment map, based on the August 8, 2023 EWM delineation. [bottom-left] Treatment map on August 18, 2023.

Summary of CLP and EWM Treatments from 2009-2023: Historically two non-native submerged aquatic plants were treated with herbicides and again in 2023 both curlyleaf pondweed and Eurasian watermilfoil were treated (Table 1 and Figure 3). Curlyleaf pondweed treatments have ranged from 16 to 169 acres from 2009 through 2023 with variability from year to year.

Eurasian watermilfoil was discovered in Forest Lake in 2015 and 30 acres were treated in the first year. From 2016 through 2023, EWM treatments have ranged from 5.86 acres to 53.83 acres (Table 1 and Figure 3). Eurasian watermilfoil has been confined mostly to the first lake but there is some growth in the second lake at the end of 2023. The greatest number of acres treated were in 2020 (Figure 3).

Table 1. Acres of non-native plants treated from 2009 through 2023.

| | CLP (acres) | EWM (acres) |
|------|----------------|----------------|
| 2009 | 98 | |
| 2010 | 155 | |
| 2011 | 168 | |
| 2012 | 155 | |
| 2013 | 60 | |
| 2014 | 101 | |
| 2015 | 88 | 30 |
| 2016 | 114 | 13.9 |
| 2017 | 169 | 33.35 |
| 2018 | 16.59 | 40.74 |
| 2019 | 99.11 | 49.34 |
| 2020 | 59.29 | 53.83 |
| 2021 | 120.33 | 5.86 |
| 2022 | 103.96 | 22.3 |
| 2023 | 61.55 | 8.41 |

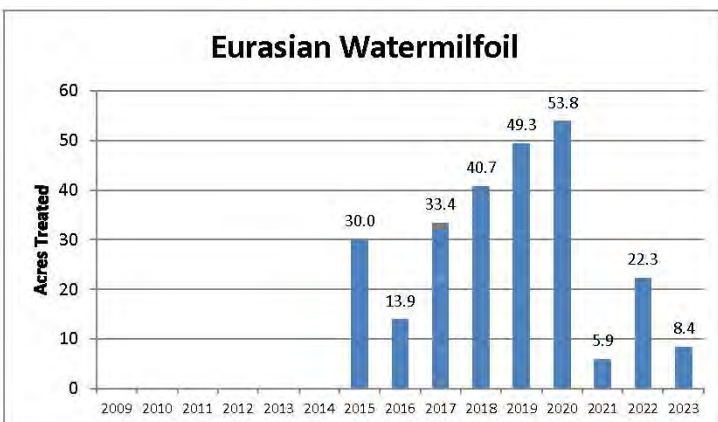
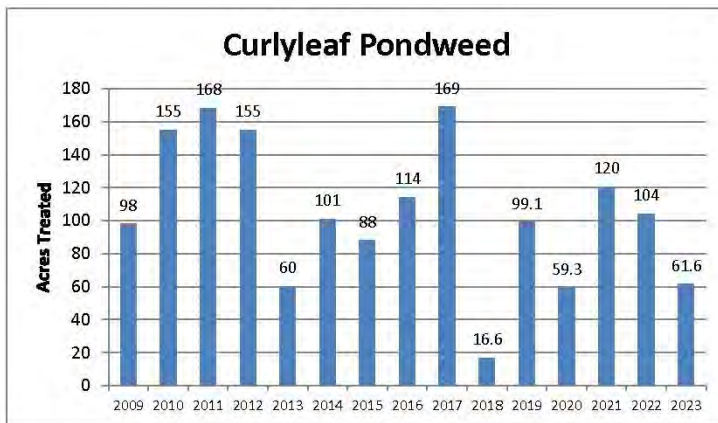


Figure 3. [top] Curlyleaf pondweed treated from 2009-2023. [bottom] Eurasian watermilfoil treated from 2015-2023. Eurasian watermilfoil was first found in Forest Lake in 2015.

A hotspot map of curlyleaf pondweed treatment areas over the last 10 years is shown in Figure 4. There appears to be about 100 acres of persistent curlyleaf in the 3 basins. The actual acreage of curlyleaf treated varies from year to year based on climatic factors. A hotspot map of EWM areas that have been treated from 2015 to 2023 is shown in Figure 4. EWM is found primarily in the 1st lake.

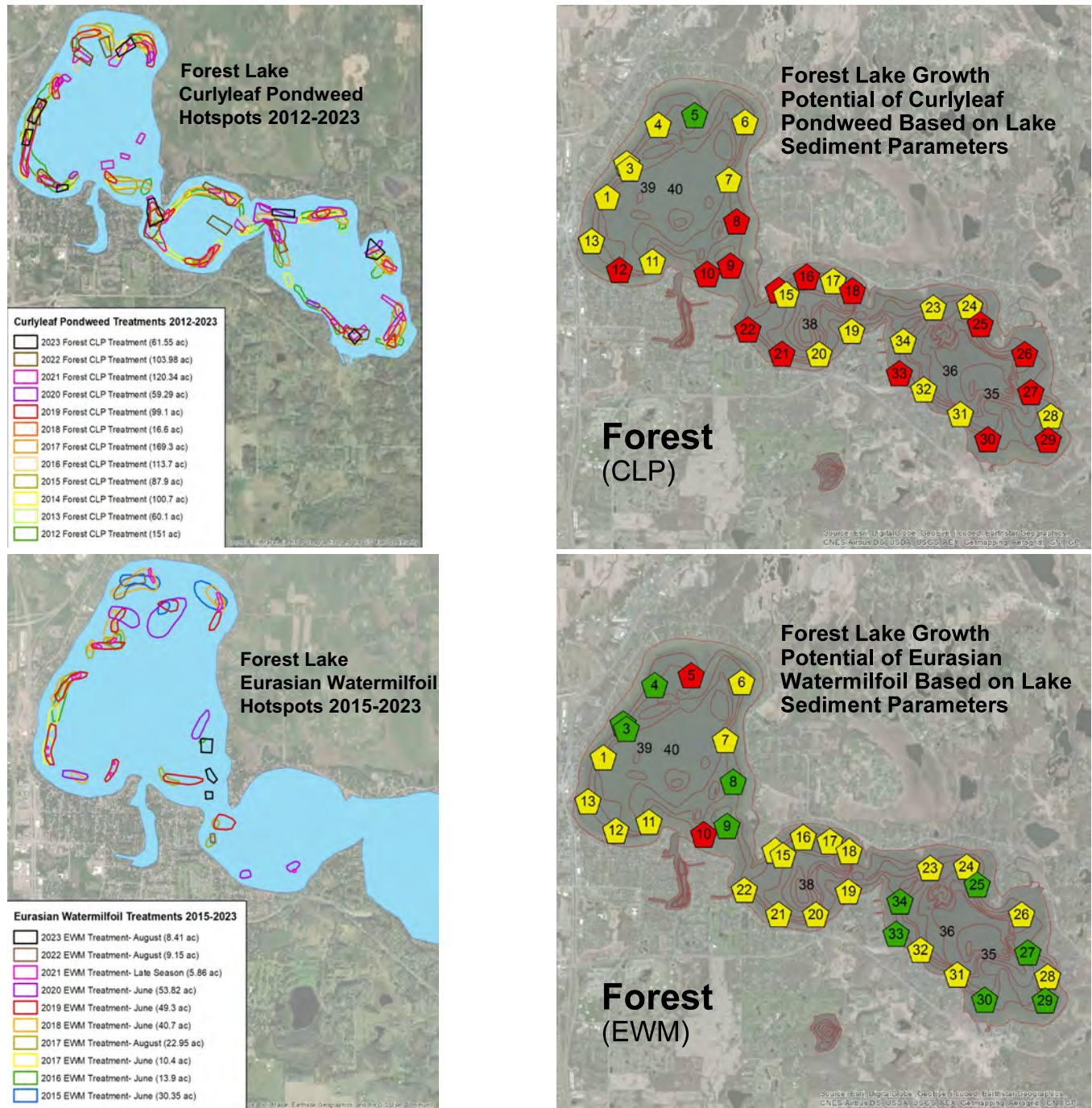


Figure 4. [top-left] Map of historical treatment of curlyleaf pondweed in Forest Lake, 2012-2023. [top-right] Curlyleaf potential growth based on lake sediment analyses for Forest Lake. Key: green = light growth, yellow = moderate growth, and red = heavy growth. [bottom-left] Map of historical treatment of Eurasian watermilfoil in Forest Lake, 2015-2023. [bottom-right] Eurasian watermilfoil potential growth based on lake sediment analyses for Forest Lake. Key: green = light growth, yellow = moderate growth, and red = heavy growth.

ADDITIONAL INFORMATION

Curlyleaf Pondweed and Eurasian Watermilfoil Delineation, Treatment, and Assessment for Forest Lake, Washington County, 2023

Size: 2,271 acres
Littoral area: 1,531 acres
Maximum depth: 37 feet

Overview

Forest Lake is located within Washington County. A meandering survey in 2023 was used to characterize the status of curlyleaf pondweed. A total of 520 sites were sampled. Curlyleaf pondweed was sampled at 153 sites out of 520 sites on the May 9, 2023 delineation survey. Eight areas of projected heavy growth totaling about 61.55 acres were delineated for treatment.

An initial curlyleaf pondweed delineation was conducted on May 9, 2023. A total of 61.55 acres of curlyleaf pondweed were treated on May 22, 2023. A follow-up curlyleaf pondweed assessment was conducted on June 13, 2023 to characterize the status of CLP at its peak growing period. Eurasian watermilfoil distribution and abundance were delineated on June 13 and August 8, 2023 and 8.41 acres were treated in 2023. An EWM assessment for all treatment areas occurred on September 20, 2023. EWM was sparse.



Figure 5. After treatment, curlyleaf pondweed growth was light to moderate on June 13, 2023 and was sampled at 6 sample sites.

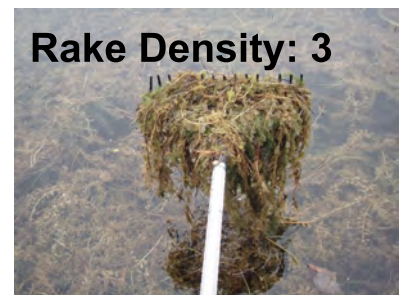
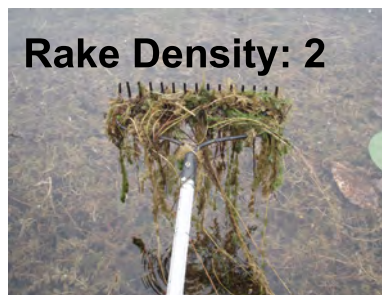
Methods

Curlyleaf Pondweed: At the time of the spring CLP delineations, only a fraction of the peak curlyleaf biomass is present. For spot treatments, the areas to be treated should be delineated prior to curlyleaf developing peak biomass. Curlyleaf stem counts on a rake sampler were used to identify areas that had a potential to produce dense curlyleaf. After a short sweep of about 1-foot (30 cm), 4 curlyleaf stems or more per rake sample generally indicated some CLP plants had developed runners and would likely produce heavy growth in the next few weeks. Alternatively, sites where 3 stems or less were collected per rake sample were not predicted to produce dense growth at the peak growing period. These areas were not treated. This delineation method was used for spot lake treatments in Gleason Lake and has worked for other lakes as well (McComas et al, 2015*).

Eurasian Watermilfoil: A Eurasian watermilfoil delineation was conducted by Blue Water Science on June 13 (284 sample sites) and August 8 (99 sample sites). The delineation involved surveying the entire lake nearshore area, observing milfoil growth, and sampling aquatic plants with rakes. Areas to be treated were selected based on the growth status of milfoil in mid June, the known previous occurrence of EWM and the importance for navigation and/or recreation in the area.

A herbicide application was conducted in 2023 on 8.41 acres for EWM control. A follow-up EWM assessment was conducted by Steve McComas, Blue Water Science, on September 20, 2023 to evaluate the EWM growth. EWM density ratings used in the June delineation and August assessment are shown in the chart below.

Chart of Density Ratings for Plant Growth



Aquatic plant density ratings from 1 to 3.

*McComas, S.R., Y.E. Christianson, and U. Singh. 2015. Effects of curlyleaf pondweed control on water quality and coontail abundance in Gleason Lake, Minnesota. *Lake and Reservoir Management*. 31:109-114.

Curlyleaf Pondweed Delineation on May 9, 2023

In the delineation survey, heaviest potential curlyleaf growth was found in many locations around the full lake, summer heavy growth was estimated at 61.55 acres for all 3 basins (Figure 6). A total of 61.55 acres of curlyleaf areas were treated on May 22, 2023.

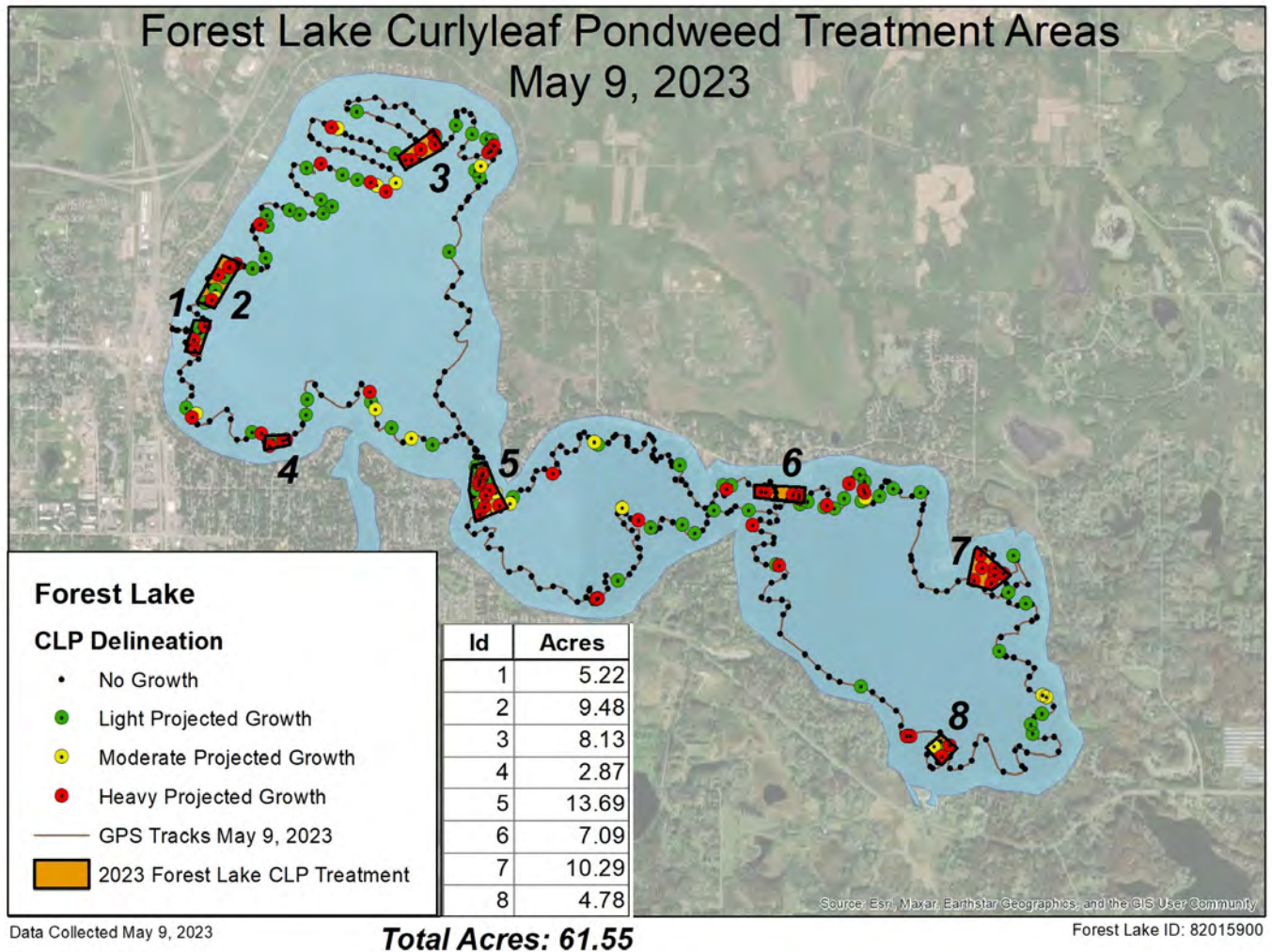


Figure 6. DELINEATION: Map of curlyleaf pondweed distribution from the May 9, 2023 survey. Approximately 61.55 acres were delineated for CLP treatment.

Curlyleaf Pondweed Assessment on June 13, 2023

A total of 61.55 acres of curlyleaf areas were treated on May 22, 2023. A post treatment curlyleaf assessment was conducted on June 13, 2023. The June curlyleaf assessment found excellent control in the treated areas although there was some new curlyleaf pondweed sprouting in a few locations in each lake (Figure 7).

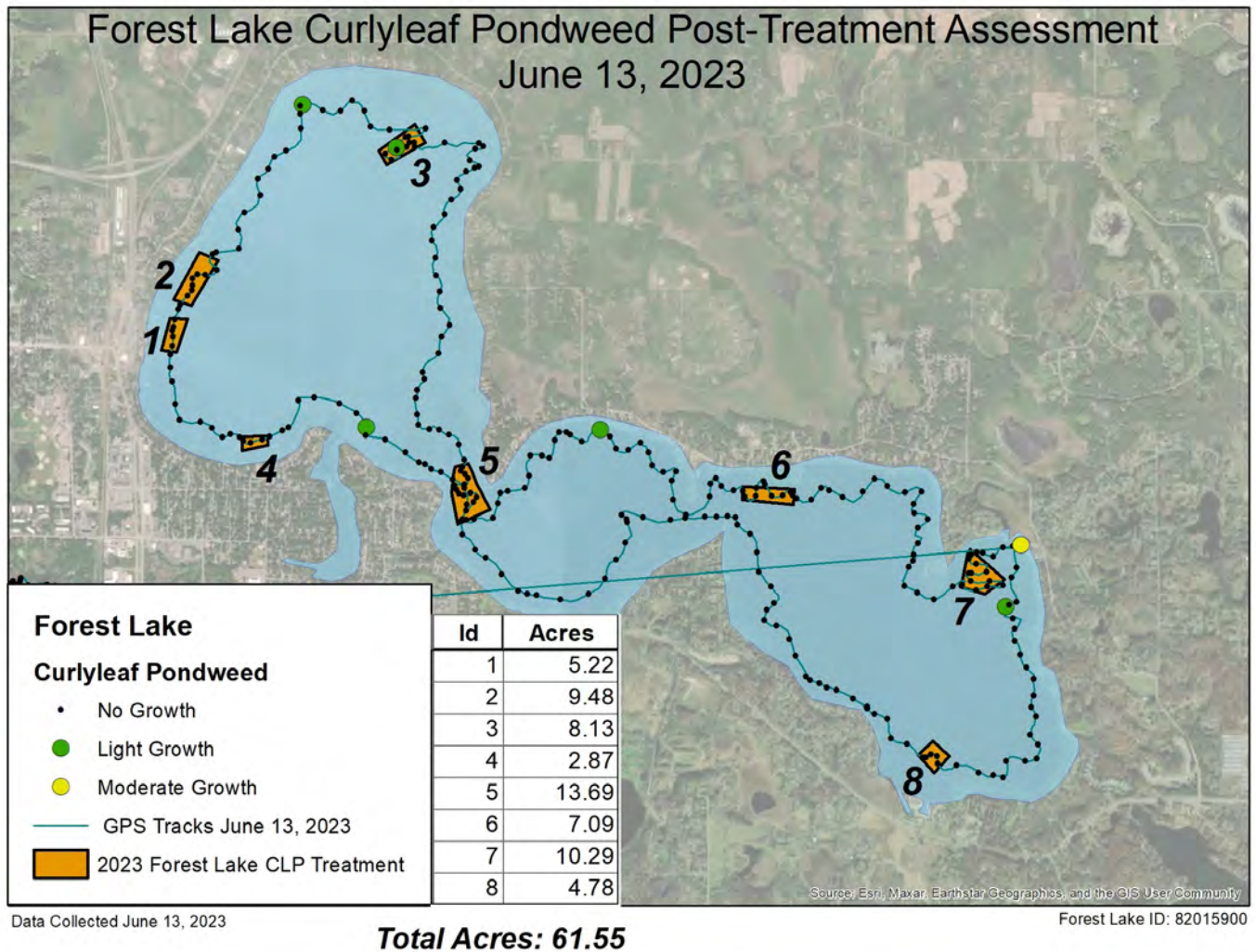


Figure 7. ASSESSMENT: Map of curlyleaf pondweed assessment sites for June 13, 2023. Key: green dots = light growth, yellow dots = moderate growth, red dots = heavy growth, black dots = no curlyleaf growth, and brown dots = dead curlyleaf.

Compilation of Curlyleaf Treatment Areas from 2012 through 2023

Curlyleaf pondweed growth patterns are somewhat established in Forest Lake. All treatment areas from 2012 through 2023 are compiled in Figure 8. These “hotspot” areas represent about 100 acres of curlyleaf growth. The curlyleaf growth pattern varies from year to year. Some years there will be more than 100 acres and other years there will be less than 100 acres to treat (Table 2). Variables to growth include previous treatments, snow cover, ice off, sunny days, and water temperatures.

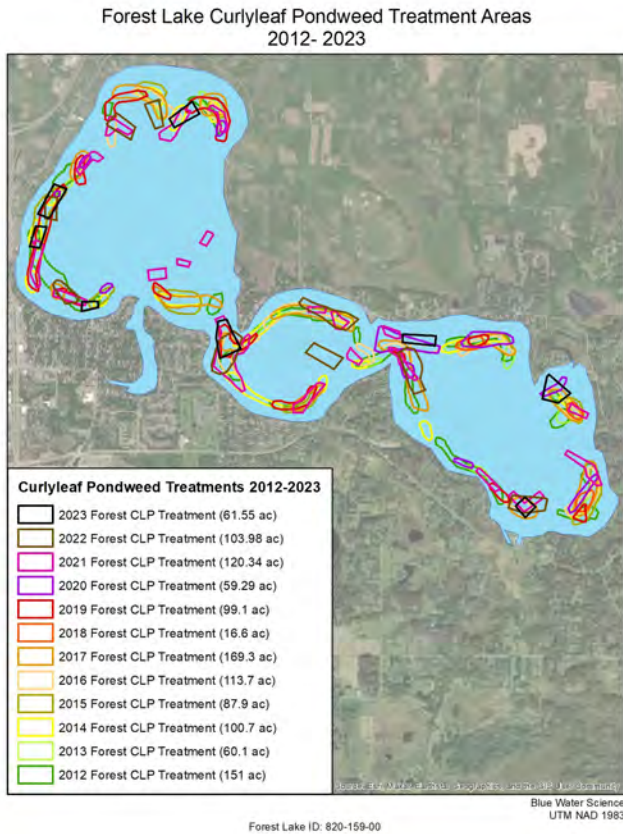


Figure 8. Map of historical treatment of curlyleaf pondweed in Forest Lake, 2012-2023, with hotspot areas shaded black.

Table 2. Acres of non-native plants treated from 2009 through 2023.

| | CLP (acres) | EWM (acres) |
|------|-------------|-------------|
| 2009 | 98 | |
| 2010 | 155 | |
| 2011 | 168 | |
| 2012 | 155 | |
| 2013 | 60 | |
| 2014 | 101 | |
| 2015 | 88 | 30 |
| 2016 | 114 | 13.9 |
| 2017 | 169 | 33.35 |
| 2018 | 16.59 | 40.74 |
| 2019 | 99.11 | 49.34 |
| 2020 | 59.29 | 53.83 |
| 2021 | 120.33 | 5.86 |
| 2022 | 103.96 | 22.3 |
| 2023 | 61.55 | 8.41 |

Eurasian Watermilfoil Delineation on June 13, 2023

EWM distribution and abundance were evaluated June 13, 2023. EWM growth was light and based on that delineation, no treatment was recommended at that time (Figure 9).

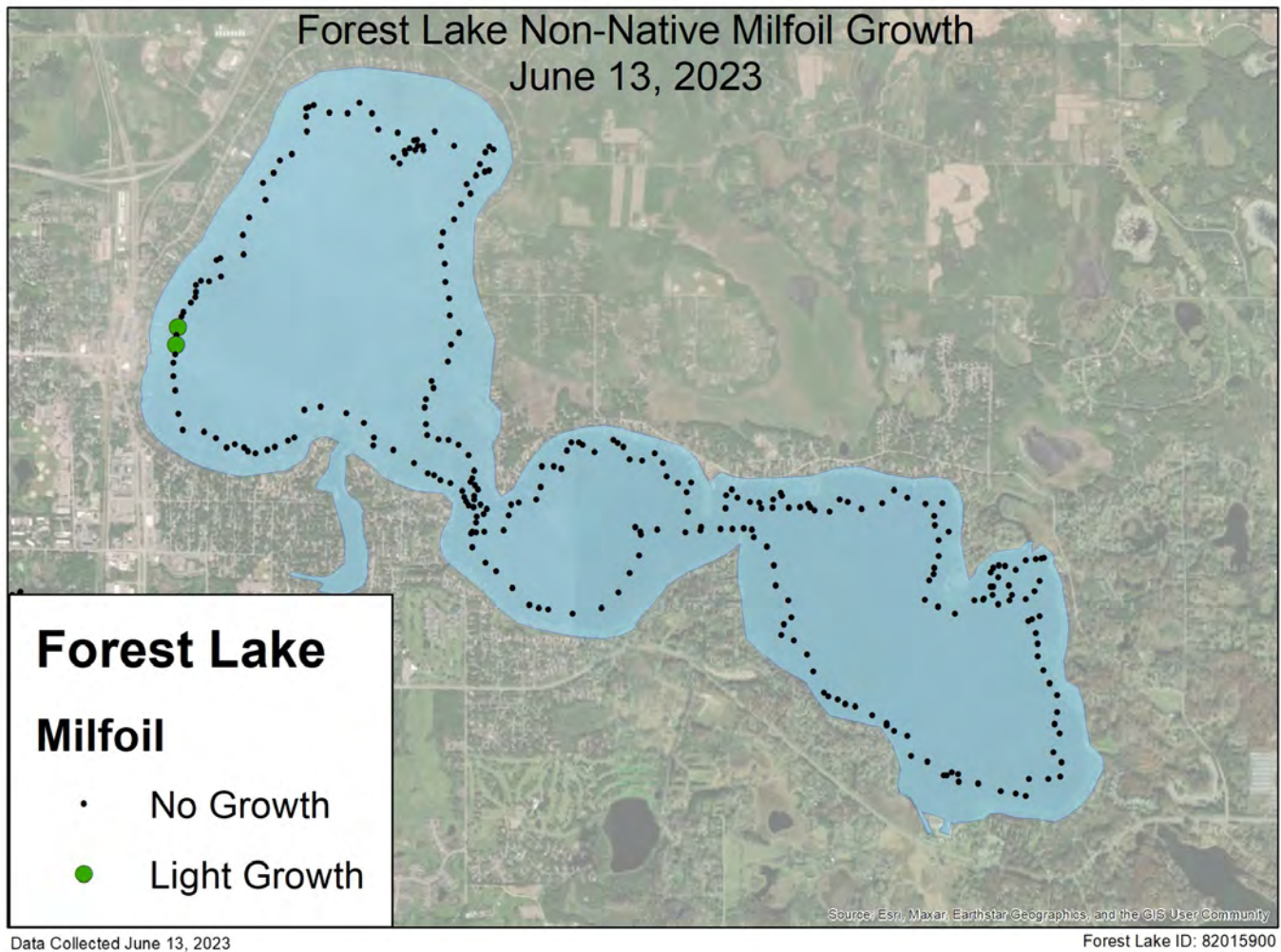


Figure 9. DELINEATION: Map of EWM distribution from the June 13, 2023 survey, no areas were delineated for EWM treatment.

Eurasian Watermilfoil Delineation on August 8, 2023

A second EWM delineation was conducted on August 8, 2023. Based on this delineation, three treatment area of 8.41 acres were delineated. Treatment of EWM was conducted on 8.41 acres on August 18, 2023.

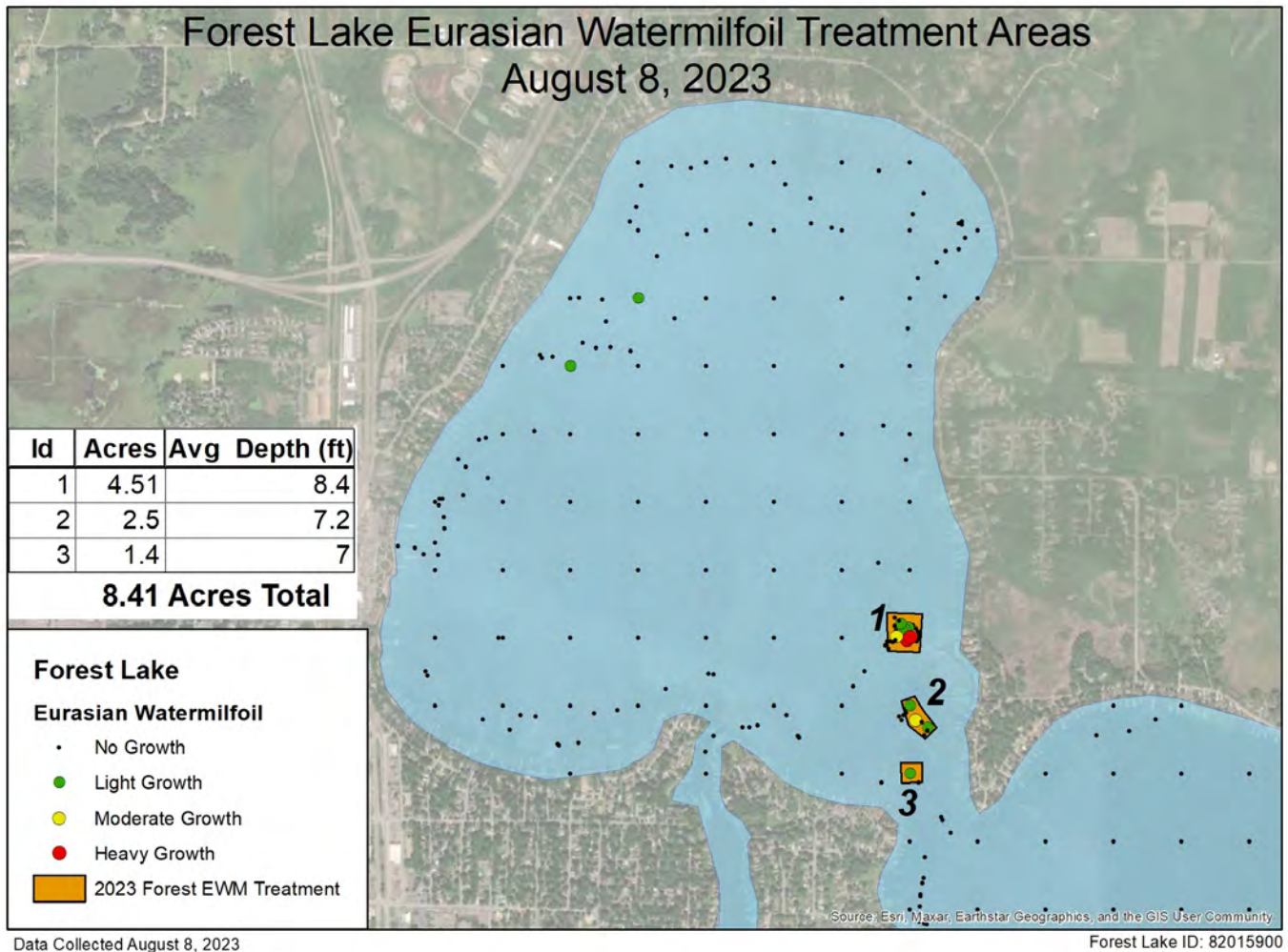
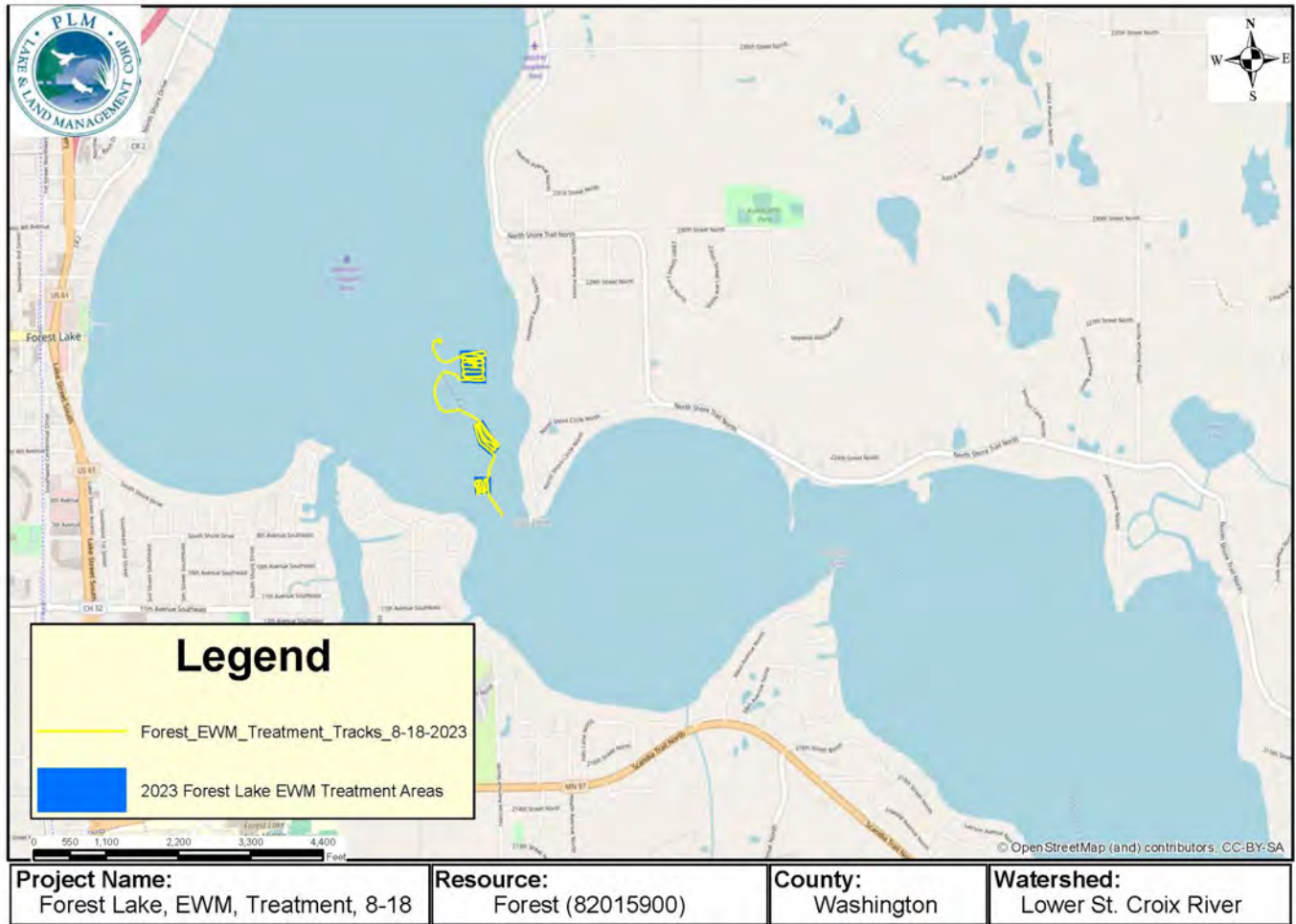


Figure 10. DELINEATION: Map of EWM distribution from the August 8, 2023 survey, 8.41 acres were delineated for EWM treatment.

Eurasian Watermilfoil Treatment 2023

A total of 8.41 acres were treated in 2023 using ProcellaCOR at 5.97 ounces per acre-foot (total of 417 units) and Tribune at 1.25 gallons per acre (total of 10.5 gallons)(Figure 11).



Metro:
1511 Maras Street
Shakopee, MN 55379

Mapping by: PLM Lake & Land Mgmt.
Phone:(866) 687-5253
servicemw@plmcorp.net

Brainerd:
2509 Business Highway 371
Brainerd, MN 56401

Figure 11. EWM treatment areas in 2023.

Eurasian Watermilfoil Assessment on September 20, 2023

After the EWM treatment on August 18, 2023, an EWM assessment on September 20, 2023 was conducted using a combination of visual inspections and rake sampling. No EWM growth was observed in the treated areas or any other sites in Forest Lake. Survey sites at the public accesses is shown in Figure 12.

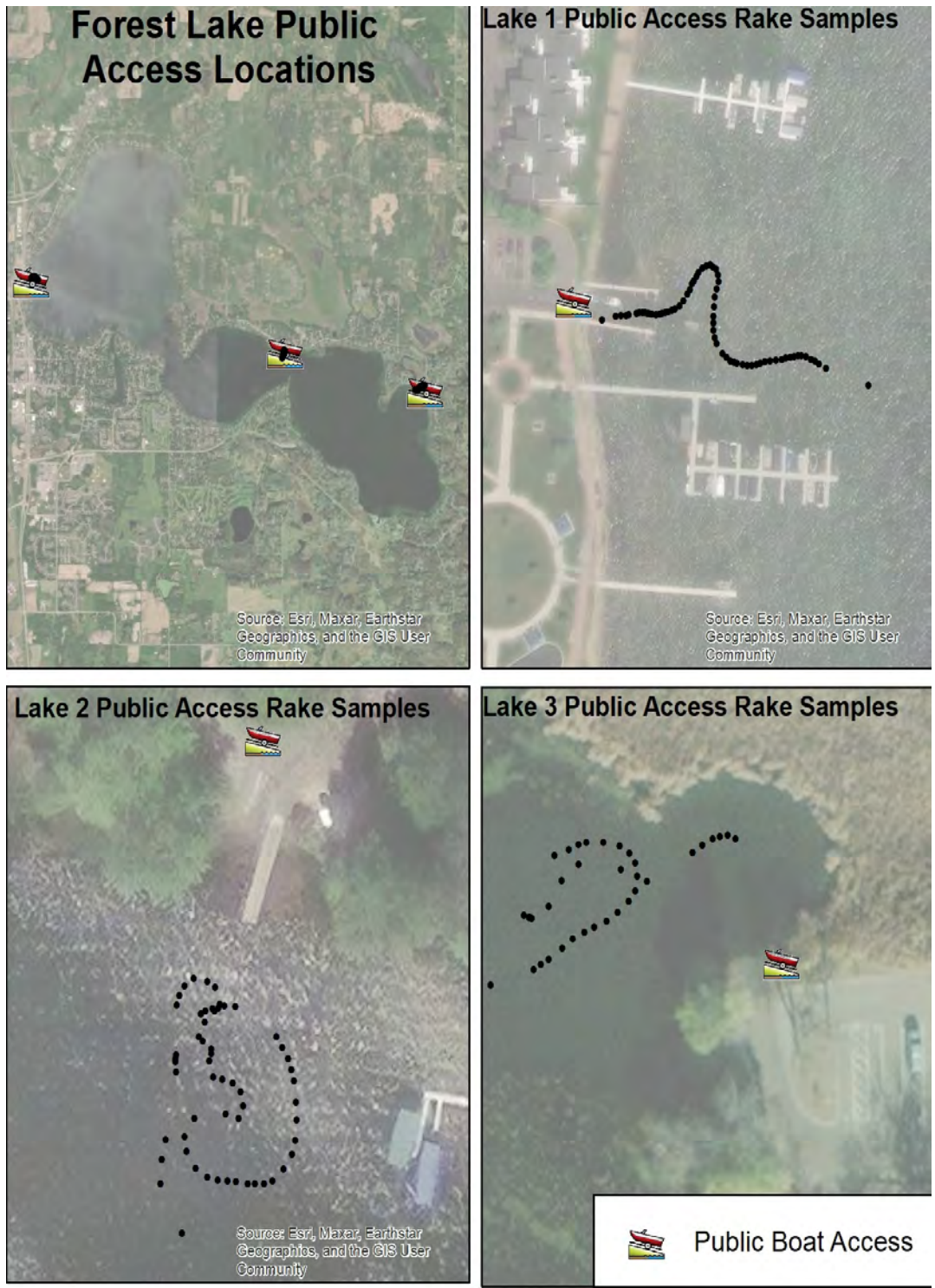


Figure 12. ASSESSMENT: Map of some of the EWM survey sites on September 20, 2023.

Eurasian Watermilfoil Treatments from 2015-2023

Eurasian watermilfoil was first observed in Forest Lake in 2015. EWM treatments have occurred in 2015 through 2023. All areas that have been treated are shown in Figure 13. EWM growth is primarily in the first lake however some EWM has been found into second lake in previous years at the end of 2023.

Forest Lake Eurasian Watermilfoil Treatment Areas 2015-2023

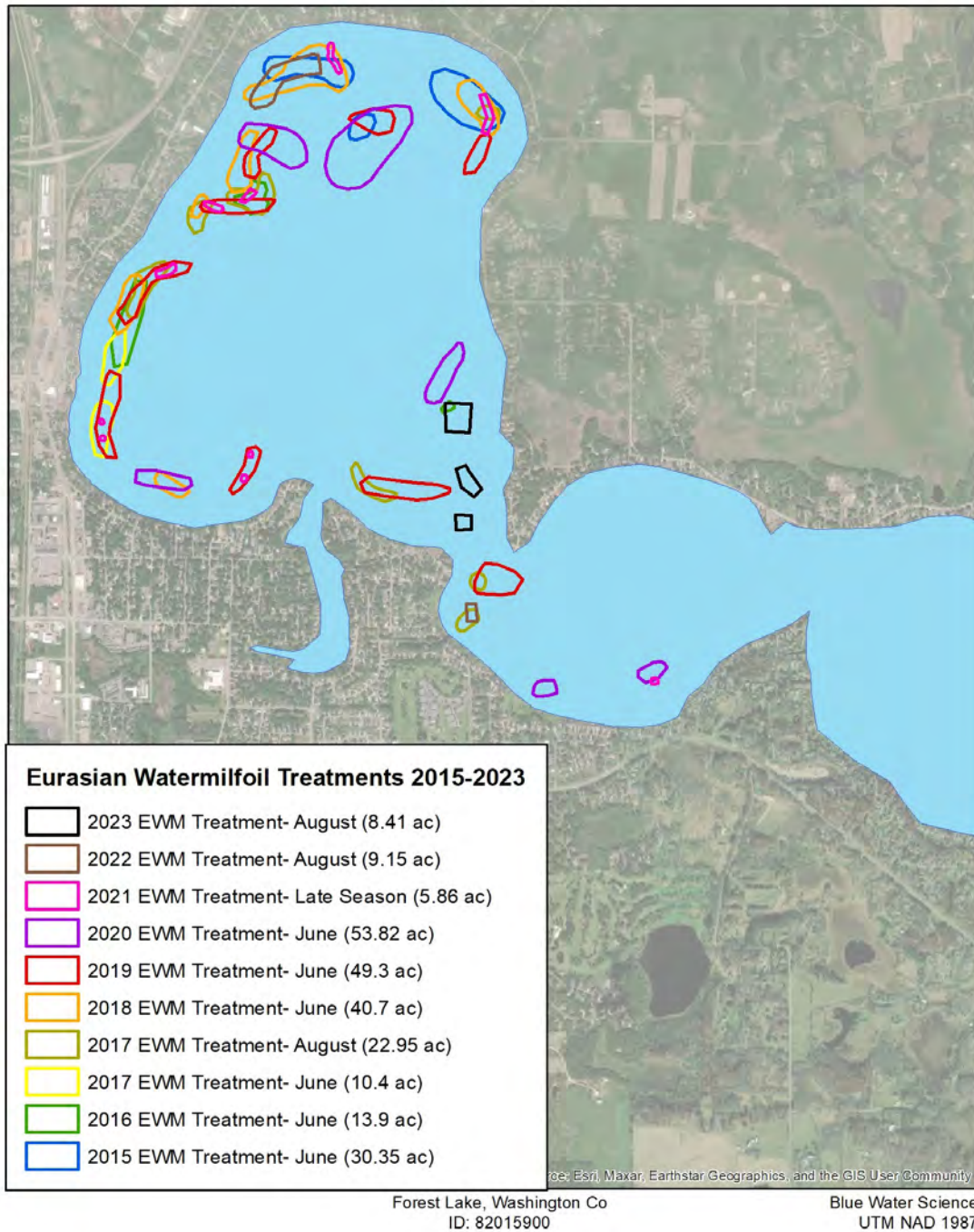


Figure 13. Map of Eurasian watermilfoil treatment areas in Forest Lake, 2015-2023.

What's Next for 2024?

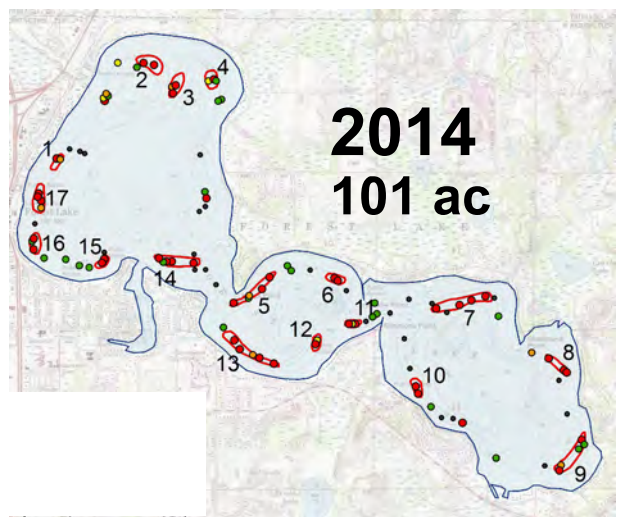
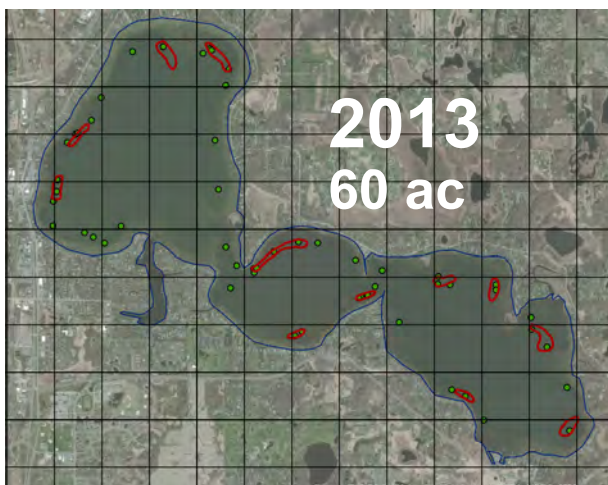
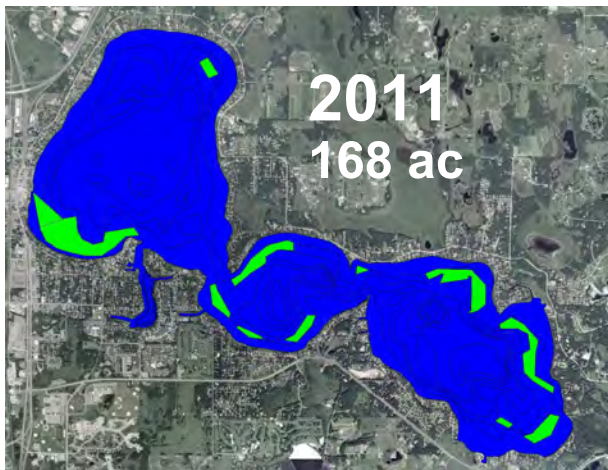
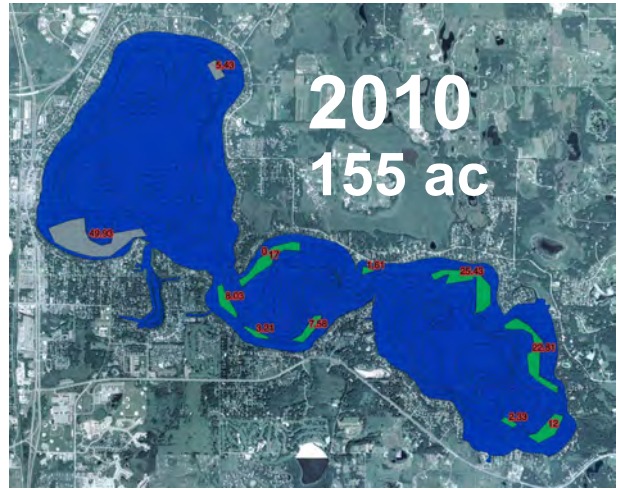
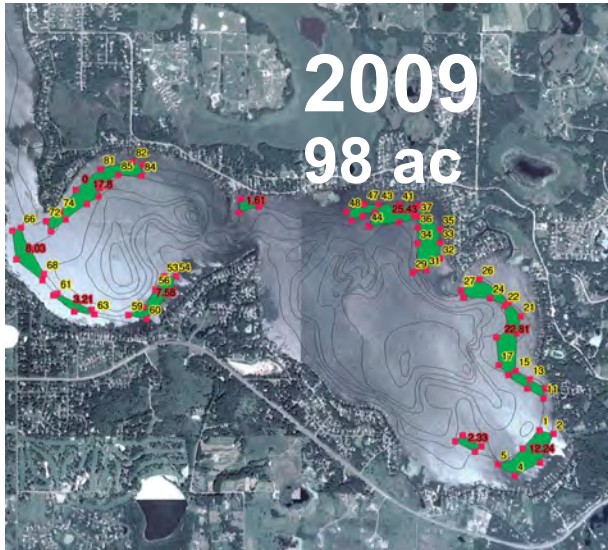
Curlyleaf Pondweed: Treating heavy growth of curlyleaf pondweed based on early season curlyleaf distribution is a challenge. Curlyleaf in late April or early May has just started to go into a rapid growth phase. However, not all early season curlyleaf growth will result in heavy curlyleaf growth in June. It appears there are factors that limit curlyleaf growth and significant variables are associated with sediment conditions. The question is how to best delineate areas to treat what could be heavy growth in June but not overtreat areas where growth wouldn't be a nuisance for the season. Currently, for Forest Lake, the method has been to use past treatment history combined with early season scouting and then a recheck after treatment to evaluate treatment effectiveness and see if curlyleaf areas were missed. Using this technique, most of the potential heavy growth of curlyleaf pondweed was controlled in 2023.

For 2024, it is proposed to delineate CLP later in April or early May to capture late sprouting CLP. Also the herbicide diquat could be considered for CLP treatments as well.

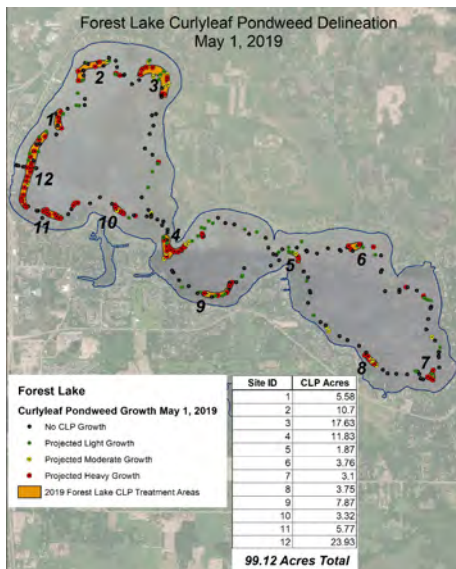
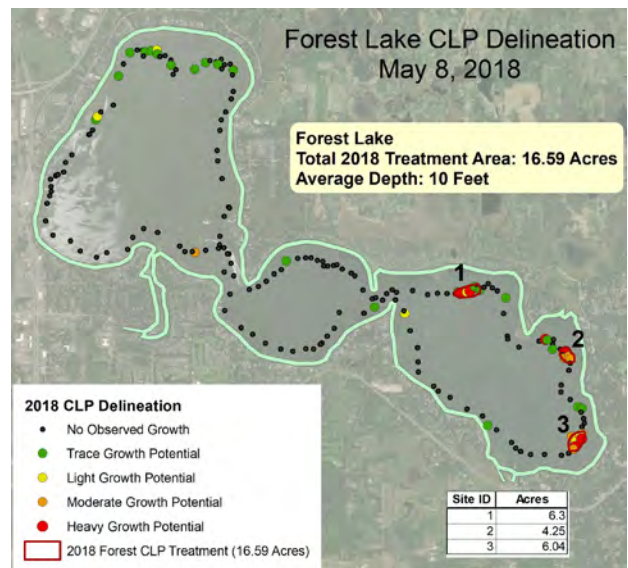
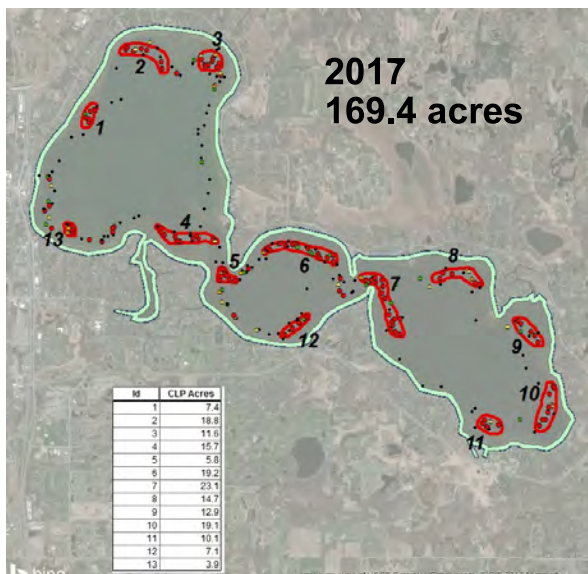
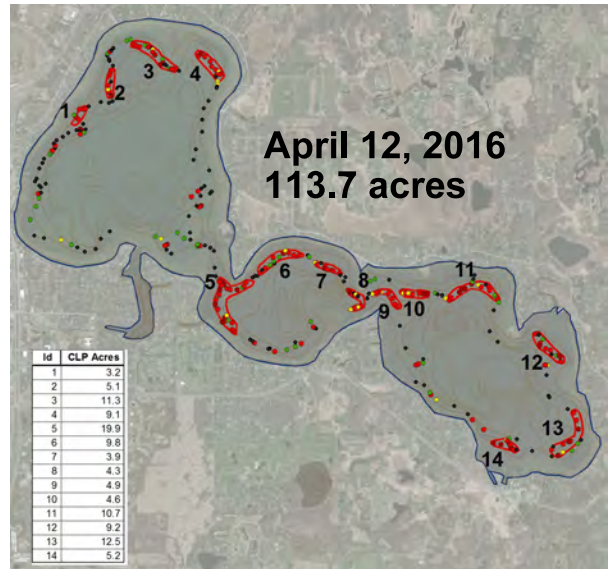
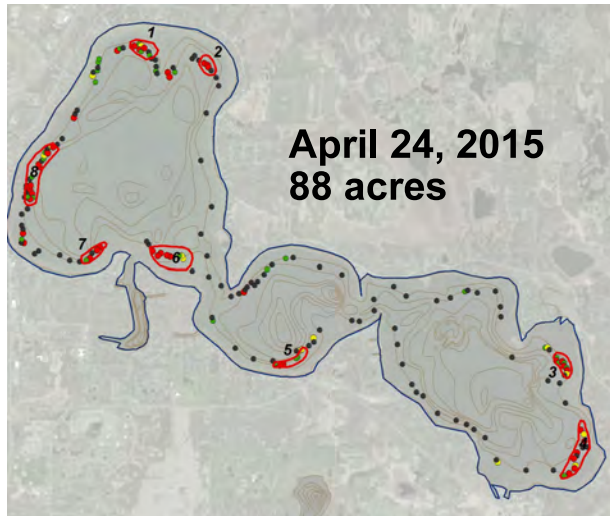
Eurasian Watermilfoil: Two passes with a liquid 2,4-D herbicide for EWM control prevented the occurrence of heavy EWM growth in 2016. The first pass treated half the area and the second pass treated the other half of the area. The same basic approach for EWM control was used in 2017 through 2019. In 2020 through 2023, a combination of 2 herbicides (diquat and ProcellaCPR) were applied and control was very good. This treatment approach could be considered by 2024, if treatment is needed.

APPENDIX

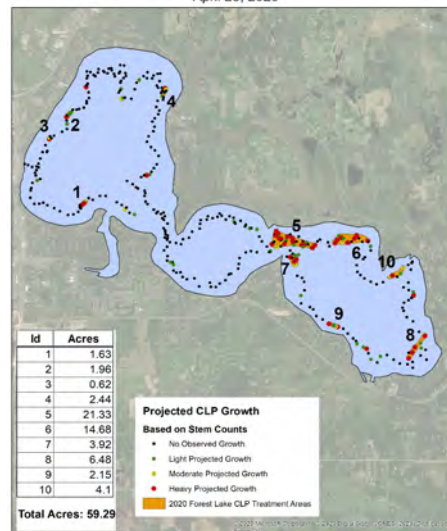
Forest Lake Curlyleaf Treatment Areas for 2009-2023



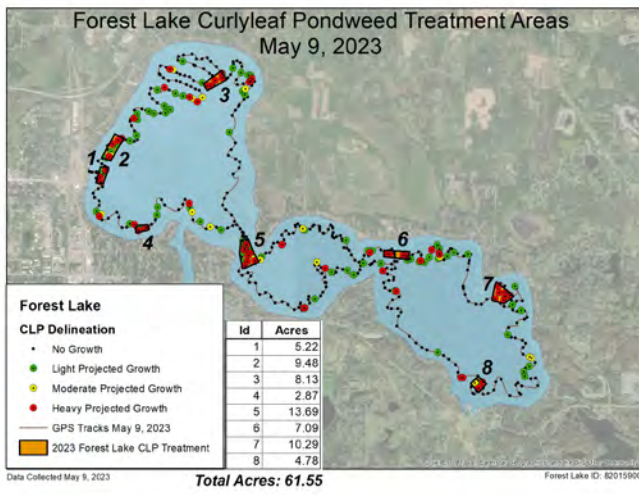
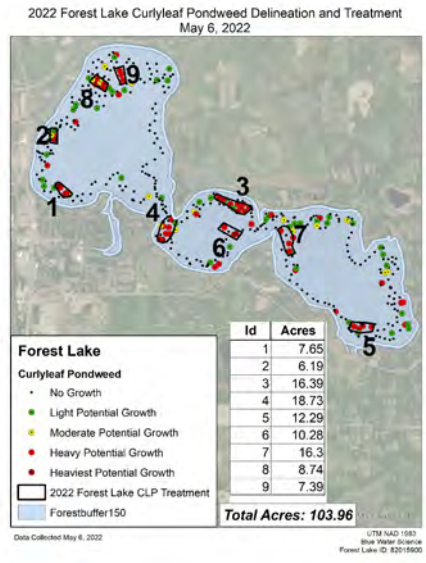
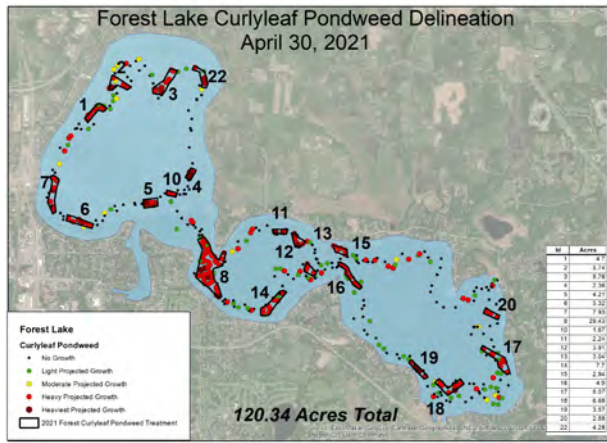
Curlyleaf treatment areas in 2009 through 2014.



Forest Lake Curlyleaf Pondweed Delineation and Treatment Areas
April 23, 2020

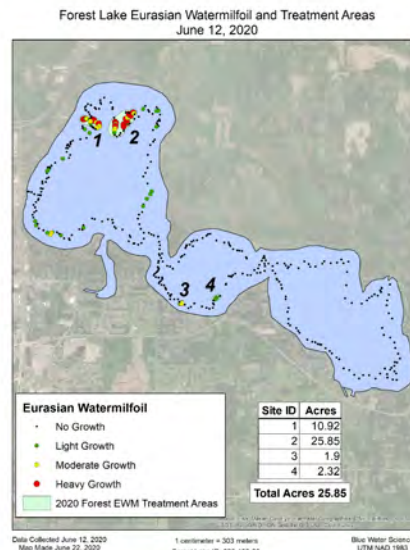
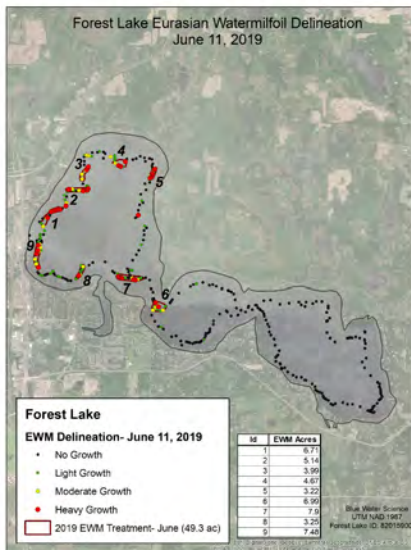
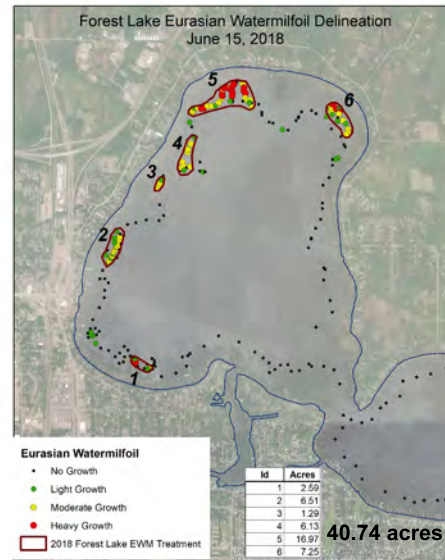
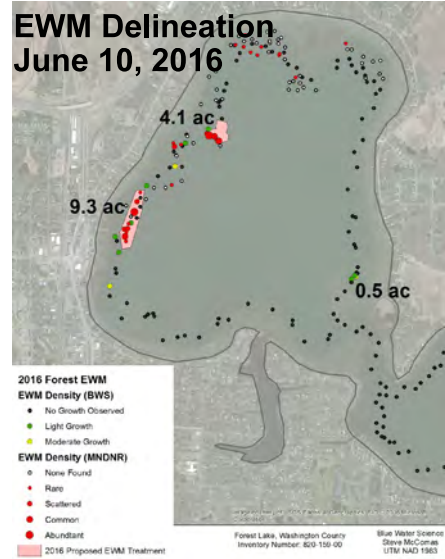


Curlyleaf treatment areas in 2015 through 2020.



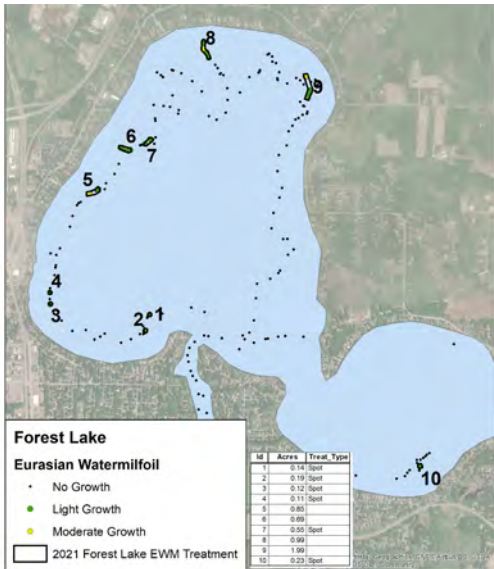
Curlyleaf treatment areas in 2021 through 2023.

Forest Lake EWM Treatment Areas for 2015-2023

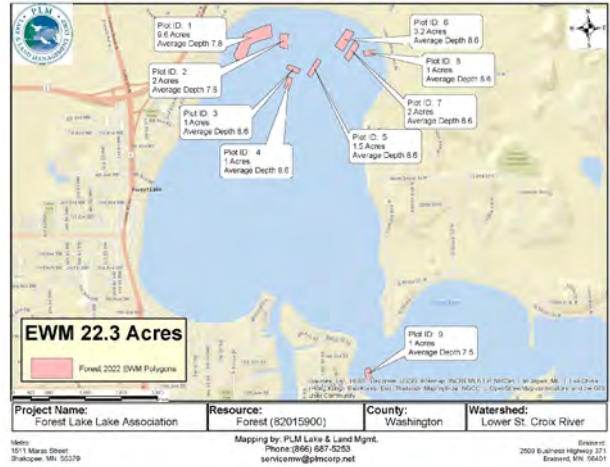


Eurasian watermilfoil treatment areas in 2015 through 2020.

2021



2022



2023



Eurasian watermilfoil treatment areas in 2021 through 2023.



Flowering Rush Flowerhead, Forest Lake, September 20, 2023

Flowering Rush Delineation, Treatment, and Assessment for Forest Lake, Washington County, Minnesota, 2023

Pre-Treatment Delineation: July 11, 2023

*Treatment: **July 26, 2023***

*Treatment: **August 15, 2023***

*Shoreline Treatment (test): **August 29, 2023***

Post Treatment Assessment: September 20, 2023

*Shoreline Treatment (entire shoreline): **September 27, 2023***

*Treatment - off shore: **October 10, 2023***

Prepared for:
Washington County and
Comfort Lake - Forest Lake
Watershed District



Prepared by:
Steve McComas
Blue Water Science

January 19, 2024

Flowering Rush Delineation, Treatment, and Assessment For Forest Lake, Washington County, Minnesota, 2023

Summary

Several flowering rush treatments occurred in 2023. On July 11, 2023, a flowering rush delineation found 84 sites of flowering rush covering about 0.24 acres. A diquat and Cide-kick application on July 26, 2023 was for spot treatment of small individual patches as well as for patches that were grouped closely together. A spot treatment with diquat and Cide-kick occurred on August 15, 2023 on 4.5 acres and another spot treatment with diquat on 1.0 acre occurred on August 29, 2023.

A flowering rush assessment and new delineation survey were conducted on September 20, 2023 and new flowering rush sprouting was found at 160 sites with an estimated area of flowering rush coverage of 0.78 acres. Treatment using diquat was conducted on September 27, 2023 on 1.34 acres and a treatment using diquat and Cide-kick was conducted on October 10, 2023 on 4.5 acres.

In Forest Lake, the total area of flowering rush has decreased from 7.8 acres in 2014 to 0.78 acres in September of 2023 indicating the flowering rush control program is reducing the distribution and density of flowering rush (Figure 1). Although the estimated total area of flowering rush was around 0.78 acres in September of 2023, flowering rush regrowth is expected in 2024. Continuing to control areas of flowering rush should reduce abundant regrowth but it appears eradication will be a challenge.

The steps for controlling flowering rush in the next few years include the following three methods.

1. Treat large continuous patches of flowering rush with diquat and spot treat small patches.
2. Treating small patches should occur 2 or 3 times/season.
3. Continue to remove flowerheads before seeds are produced which should help reduce new sites of flowering rush colonization.

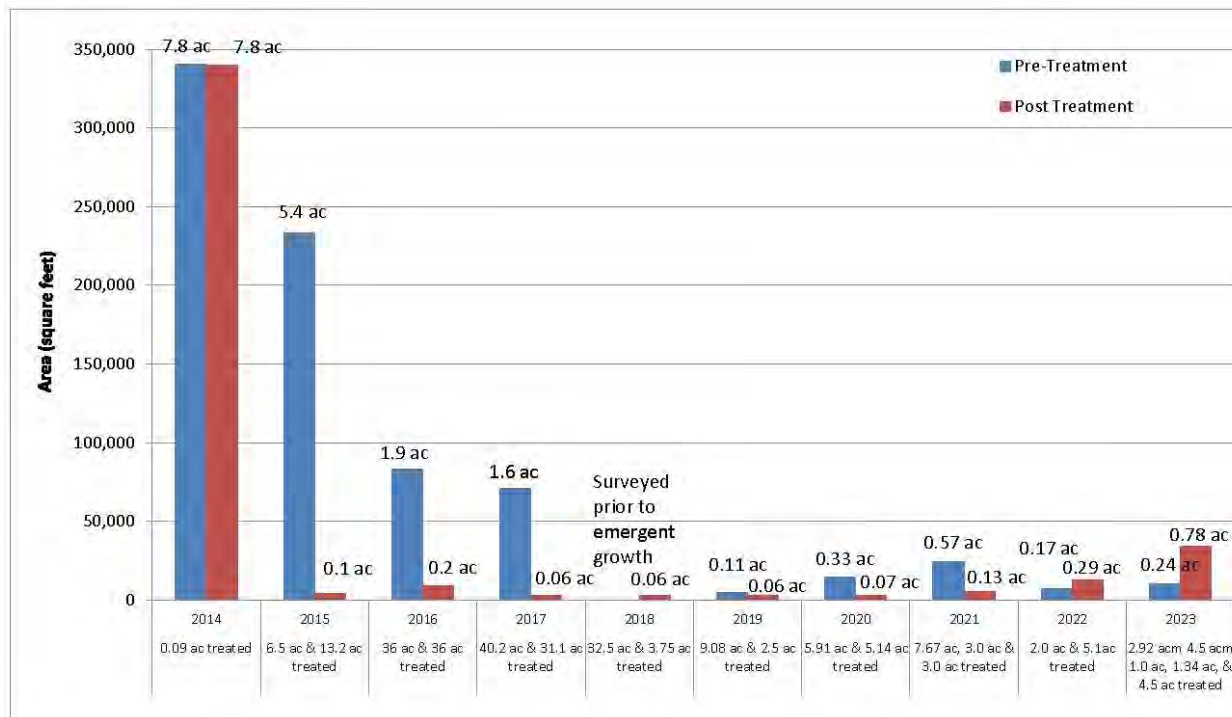
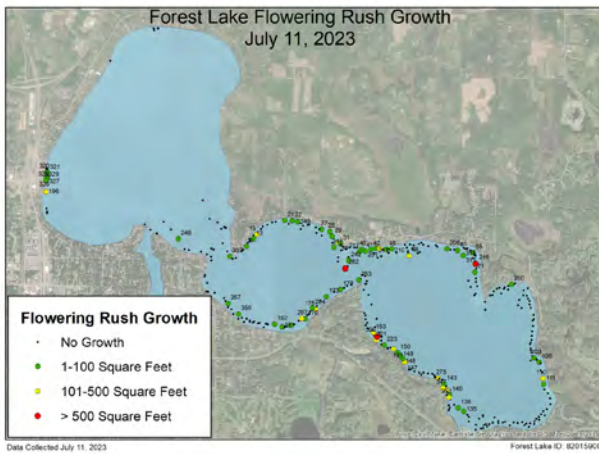


Figure 1. Flowering rush areas from 2014 through 2023 for pre-treatment and post treatment conditions.

Flowering Rush Delineation and Treatments in 2023



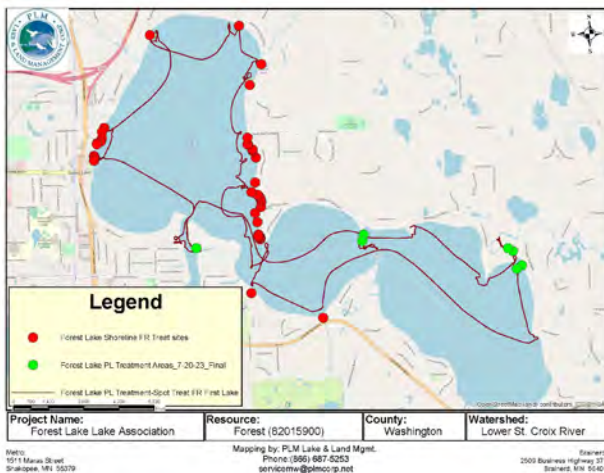
July 11: Delineation



July 26: Treatment - 2.92 ac
(Diquat and Cide-kick)



August 15: Treatment - 4.5 ac
(Diquat and Cide-kick)



August 29: Treatment - 1.0 ac
(Diquat)



September 20: Delineation



September 27: Treatment - 1.34 ac (Diquat)



October 10: Treatment - 4.50 ac (Diquat and Cide-kick)

Overview of Flowering Rush Delineations, Treatments, and Assessments for Forest Lake, in 2023

Project Approach: Flowering rush (*Butomus umbellatus*) is an invasive species and is actively expanding in the United States. It has spread from a limited area around the Great Lakes and the St. Lawrence river to sporadic appearances in the northern U.S. and southern Canada. Populations in the eastern U.S. produce seeds. Only one Minnesota population (Forest Lake, Washington County) produces viable seeds. Otherwise, flowering rush reproduces by vegetative spread from its rootstock in the form of rhizome buds. Both seeds and rhizome buds are dispersed by water current.

A management and control program for flowering rush in Forest Lake was initiated in 2014 and has continued through 2023.

For the delineation and assessment of Forest Lake flowering rush, 2 observers in a boat traveled the entire lake nearshore area and searched for emergent flowering rush stems. A record of the occurrence of all flowering rush sites since 2014 has been recorded by GPS and was placed on the lake map of the Lowrance HDS7 sonar unit. During the survey, a flowering rush occurrence was either associated with a previous point or was assigned a new GPS point if it had not previously been observed at that location. For each flowering rush observation site, an estimated square footage of emergent growth was recorded.

July 11, 2023 - Delineation

- A total of 84 flowering rush sites were observed.
- Over 300 patches of flowering rush were observed.
- A total area of flowering rush was estimated at 10,470 square feet (0.24 acres)
- At least 20 sites had flowers present.

July 26, August 15, August 29 - Flowering Rush Treatments

September 20, 2023

- A total of 160 flowering rush sites were observed.
- Over 1,000 patches of flowering rush were observed.
- A total area of flowering rush was estimated at 33,895 square feet (0.78 acres)
- At least 20 sites had flowers present.

September 27 and October 10 - Flowering Rush Treatments

Table 1. Summary of delineations and herbicide treatments for flowering rush.

| | Delineations | | Treatment | | |
|--------------|----------------------|------------|-----------|----------|-------------|
| | Flowering Rush Sites | Total Area | Diquat* | | Cide-kick** |
| | | | (acres) | (gal/ac) | (gal/ac) |
| July 11 | 84 | 0.24 ac | | | |
| July 26 | | | 2.92 | 2.0 | 0.137 |
| August 15 | | | 4.5 | 1.0 | 0.44 |
| August 29 | | | 1.0 | 1.0 | |
| September 20 | 160 | 0.78 ac | | | |
| September 27 | | | 1.34 | 0.7 | |
| October 10 | | | 4.50 | 0.56 | 0.11 |

*Diquat - brand name was Tribune

**Cide-kick: an adjuvant that breaks down the waxy cuticle on a leaf surface to allow more effective herbicide uptake

Review of Flowering Rush Treatments and Results for 2014-2023

A summary of flowering rush treatments and results over the previous 10 years are shown in Table 2. Flowering rush has decreased from 7.8 acres in 2014 to 0.78 acres in September of 2023 roughly, a decrease of about 90% from 2014. Regrowth has occurred at a number of persistent areas located in 2nd and 3rd lakes since 2014.

At the end September of 2023, there were a total of 160 flowering rush sites identified before the October treatment. Often a flowering rush site is only 10 stems or less. Although large beds of flowering rush of over 1,000 square feet occur, they are rarely found after the second treatment.

Although a total of 459 flowering rush sites have been identified over the last 10 years, only 20% of the sites had flowering rush growth in the July 11, 2023 delineation survey.

It appears flowering rush does not sprout every year at every site, however, it apparently continues to produce new growth at new sites as the summer progresses. Therefore a delineation in July will not delineate all the flowering rush for the summer. New growth will occur in August and September.

Although new flowering rush sites are found annually, the number of new flowering rush sites per year has averaged 36 sites per year for 2017-2023. The number of new sites found annually have decreased since flowering rush flowerheads have been removed from 2017-2023. Prior to flower and seedhead removal, new flowering rush sites averaged 52 new sites per year in 2015 and 2016.

Table 2. Summary of flowering rush sites and areas for 2014-2023.

| | All Known Flowering Rush Sites at Start of the Year | New Sites | Total Known Flowering Rush Sites | Flowering Rush Sites with Plants | | Flowering Rush (acres) | | Average Size of Flowering Rush Patch (square feet) | | Percent of All Previously Recorded Sites with Flowering Rush | | Acres of Flowering Rush Treated per Application | Total Acres Treated |
|------|---|-----------|----------------------------------|----------------------------------|------|------------------------|-------|--|------|--|------|---|---------------------|
| | | | | start | end | start | end | start | end | start | end | | |
| 2014 | -- | -- | 142 | -- | 142 | 7.8 | 7.8 | -- | 2393 | -- | 100% | 0.9 ac | 0.9 |
| 2015 | 142 | 72 | 214 | 107 | 120 | 5.4 | 0.1 | 2198 | 36 | 75% | 56% | 13.2 ac (2 times) | 26.4 |
| 2016 | 214 | 32 | 246 | 182 | 81 | 1.9 | 0.2 | 455 | 107 | 87% | 33% | 36 ac (2 times) | 72.0 |
| 2017 | 246 | 4 | 250 | 159 | 15 | 1.6 | 0.06 | 438 | 174 | 65% | 1% | 40.2 ac and 30.1 ac | 70.3 |
| 2018 | 250 | ND | 250 | ND | 108 | ND | 0.06 | ND | 24 | ND | 43% | 32.5 ac and 3.8 ac | 36.3 |
| 2019 | 250 | 37 | 287 | 83 | 76 | 0.11 | 0.06 | 58 | 34 | 33% | 27% | 9.1 ac and 2.5 ac | 11.6 |
| 2020 | 287 | 24 | 311 | 145 | 53 | 0.33 | 0.07 | 100 | 53 | 47% | 17% | 5.91 ac and 5.14 ac | 11.1 |
| 2021 | 311 | 62 | 373 | 75 | 65 | 0.57 | 0.13 | 329 | 88 | 20% | 17% | 7.67 ac, 3.0 ac, 3.0 ac | 13.7 |
| 2022 | 373 | 36 | 409 | 35 | 25 | 0.17 | 0.29 | 206 | 530 | 9% | 3% | 2.0 ac, 5.1 ac | 7.1 |
| 2023 | 409 | 50 | 459 | 84 | 160* | 0.24 | 0.78* | 132 | 297* | 20% | 35% | 8.4 ac, 5.8 ac | 14.26 |

*160 flowering rush sites and average from September 27, 2023, prior to the last October 10, 2023 treatment.

Flowering Rush Response to Treatments from 2014-2023

Summary of flowering rush areas before and after treatments for 2014 through 2023 are shown in Tables 3 and 4.

Table 3. Summary of flowering rush treatments and resulting flowering rush remaining at the end of the summer from 2014-2023.

| | Initial Flowering Rush Area (acres) | TREATMENTS | | | | | | End of Season | | |
|------|-------------------------------------|--------------------------------|--------------------------------|--------------------------------|--------------------------------|--------------------------------|---------------------|-----------------------------|----------------------|---|
| | | 1 st Treatment (ac) | 2 nd Treatment (ac) | 3 rd Treatment (ac) | 4 th Treatment (ac) | 5 th Treatment (ac) | Total Acres Treated | Flowering Rush Area (acres) | Flowering Rush Sites | Flowering Rush Average Individual Size (sf) |
| 2014 | 7.8 | 0.09 | -- | | | | 0.09 | 7.8* | 142 | 2,392 |
| 2015 | 5.4 | 6.5 | 13.2 | | | | 19.7 | 0.1 | 120 | 37 |
| 2016 | 1.9 | 36 | 36 | | | | 72 | 0.2 | 81 | 113 |
| 2017 | 1.6 | 40.2 | 31.1 | | | | 71.3 | 0.06** | 15 | 177** |
| 2018 | no emergent FR | 32.5 | 3.75 | | | | 36.25 | 0.06 | 108 | 25 |
| 2019 | 0.11 | 9.08 | 2.5 | | | | 11.58 | 0.06 | 76 | 37 |
| 2020 | 0.33 | 5.91 | 5.14 | | | | 11.05 | 0.07 | 53 | 60 |
| 2021 | 0.57 | 7.67 | 3.0 | 3.0 | | | 13.67 | 0.13 | 65 | 87 |
| 2022 | 0.17 | 2.0 | 5.1 | | | | 7.1 | 0.29 | 25 | 530 |
| 2023 | 0.24 | 2.92 | 4.5 | 1.0 | 1.34 | 4.50 | 14.26 | 0.78 | 160 | 297 |

*Treatment was a trial on a small area to test herbicide effectiveness.

**One flowering rush bed in 3rd lake was 2,000 sf (0.05 ac) which accounted for much of the FR acreage in 2017.

Table 4. Summary of flowering rush sites and areas for 2014 through 2023.

| Total Sites | 1 st Lake | | 2 nd Lake | | 3 rd Lake | | Total | |
|--|-----------------------------|-----------|-----------------------------|-----------|-----------------------------|---|--|------------------------------|
| | Number of sites with plants | Area (sf) | Number of sites with plants | Area (sf) | Number of sites with plants | Area (sf) | Number of sites with plants | Area (sf) |
| July 22, 2014 (Delineation) | 0 | 0 | 34 | 3,750 | -- | 336,990 (estimated based on Oct 8 survey) | 34+ (not including 3 rd lake) | 340,740 (estimated) (7.8 ac) |
| 2 nd Lake was treated with diquat on 0.09 ac on September 9, 2014 | | | | | | | | |
| October 8, 2014 (Assessment) | 0 | 0 | 26 | 3,135 | 116 | 336,990 | 142 | 340,125 (7.8 ac) |
| July 17, 2015 (Delineation) | 0 | 0 | 22 | 2,360 | 85 | 230,939 | 107 | 233,299 (5.4 ac) |
| 2 nd and 3 rd Lakes were treated by cutting in July and August; 3 rd Lake treated with diquat twice in August, 2015 (13.2 ac) | | | | | | | | |
| September 28, 2015 (Assessment) | 11 | 170 | 20 | 237 | 88 | 4,004 | 120 | 4,411 (0.1 ac) |
| (new sites compared to 2014) | (11) | -- | (13) | -- | (25) | -- | (49) | -- |
| July 14 and 15, 2016 (Delineation) | 4 | 100 | 46 | 33,000 | 132 | 50,000 | 182 | 83,189 (1.9 ac) |
| 2 nd and 3 rd Lakes were treated with diquat twice in August, 2016 (36 ac) | | | | | | | | |
| September 21, 2016 (Assessment) | 0 | 0 | 21 | 305 | 60 | 8,818 | 81 | 9,183 (0.2 ac) |
| (new sites compared to 2015) | (0) | -- | (0) | -- | (3) | -- | (3) | -- |
| August 1, 2017 (Delineation) | 4 | 170 | 37 | 1,735 | 118 | 69,190 | 159 | 71,095 (1.6 ac) |
| 2 nd and 3 rd Lakes were treated with diquat twice, once in August (40.2) and once in September, 2017 (30.1 ac) | | | | | | | | |
| October 23, 2017 (Assessment) | 1 | 20 | 4 | 150 | 10 | 2,485 | 15 | 2,655 (0.06 ac) |
| (new sites compared to 2016) | (1) | -- | (1) | -- | (5) | -- | (7) | -- |
| July 5, 2018 (Pre-treatment survey) | no emergent plants observed | -- | no emergent plants observed | -- | no emergent plants observed | -- | no emergent plants observed | -- |
| 12 areas, delineated in 2017 totaling 32.5 acres were treated with diquat on July 13, 2018. | | | | | | | | |
| July 25, 2018 (Survey) | 0 | 0 | 73 | 2,540 | 54 | 1,280 | 127 | 3,820 (0.09 ac) |
| Spot treatment of 125 patches totaling 3.75 acres on August 21, 2018. | | | | | | | | |
| September 19, 2018 (Post treatment assessment) | 0 | 0 | 54 | 1,160 | 54 | 1,566 | 108 | 2,726 (0.06 ac) |
| July 9, 2019 (Pre-treatment survey) | 4 | | 34 | | 43 | | 83 (13 new) | 4,990 (0.11 ac) |
| 9.1 acres plus spot treatments on July 31, 2019 | | | | | | | | |
| August 12, 2019 (Survey) | 11 | | 26 | | | | 105 (17 new) | 18,505 (0.42 ac) |
| Spot treatment of 105 patches totaling 2.5 acres on August 30, 2019. | | | | | | | | |
| September 30, 2019 (Post treatment assessment) | 1 | | 21 | | 54 | | 76 (7 new) | 2,790 (0.06 ac) |
| (new sites compared to 2018) | (5) | -- | (22) | -- | (10) | -- | (37) | -- |
| July 21, 2020 (Pre-treatment survey) | 7 | | 44 | | 94 | | 145 (21 new) | 14,562 (0.33 ac) |
| 5.91 acres plus spot treatments on August 6, 2020. | | | | | | | | |
| August 26, 2020 (Survey) | 5 | | 43 | | 83 | | 131 (0 new) | 26,330 (0.60 ac) |
| 5.14 ac spot treatments on September 2, 2020 | | | | | | | | |
| October 12, 2020 (Post treatment assessment) | 0 | | 7 | | 46 | | 53 (3 new) | 3,200 (0.07 ac) |
| (new sites compared to 2019) | (3) | -- | (10) | -- | (11) | -- | (24) | -- |
| 7.67 acres plus spot treatments on July 26, 2021. | | | | | | | | |

Table 4. Summary of flowering rush sites and areas for 2014 through 2023.

| Total Sites | 1 st Lake | | 2 nd Lake | | 3 rd Lake | | Total | |
|---|-----------------------------|-----------|-----------------------------|-----------|-----------------------------|-----------|-----------------------------|---------------------|
| | Number of sites with plants | Area (sf) | Number of sites with plants | Area (sf) | Number of sites with plants | Area (sf) | Number of sites with plants | Area (sf) |
| July 27, 2021 (Pre-treatment survey) | 4 | 1,640 | 20 | 1,295 | 53 | 2,190 | 75 (14 new) | 24,695 (0.57 ac) |
| 3.0 acres of spot treatments on August 13, 2021. | | | | | | | | |
| September 9, 2021 (Survey) | 26 | 1,923 | 26 | 4,540 | 51 | 14,169 | 98 (46 new) | 19,082 (0.44 ac) |
| 3.0 ac of spot treatments on September 13, 2021. | | | | | | | | |
| October 18, 2021 (Post treatment assessment) | 11 | 825 | 19 | 1,490 | 35 | 3,415 | 65 (2 new) | 5,695 (0.13 ac) |
| (new sites compared to 2020) | (18) | -- | (29 less) | -- | (84 less) | -- | (62) | -- |
| July 12, 2022 (Pre-treatment survey) | 3 | 240 | 8 | 920 | 24 | 6,065 | 35 (4 new) | 7,225 (0.17 ac) |
| 0.17 acres of spot treatments on July 29, 2022. | | | | | | | | |
| August 9, 2022 (Survey) | | | | | | | 157 (32 new) | 24,868 (0.57 ac) |
| 0.57 ac of spot treatments September, 2022. | | | | | | | | |
| October 18, 2022 (Post treatment assessment) | | | | | | | 25 (0 new) | 12,720 (0.29 ac) |
| (new sites compared to 2021) | | | | | | | (36) | -- |
| July 11, 2023 (Pre-treatment survey) | | | | | | | 84 | 10,470 (0.24 ac) |
| 2.92 ac of spot treatments on July 26, 2023. | | | | | | | | |
| 4.5 ac of spot treatments on August 15, 2023. | | | | | | | | |
| 1.0 ac of spot treatments on August 29, 2023. | | | | | | | | |
| September 20, 2023 (Post treatment assessment) | | | | | | | 160 | 33,895 (0.78 ac) |
| 1.34 ac of spot treatments on September 27, 2023. | | | | | | | | |
| 4.50 ac of spot treatments on October 10, 2023. | | | | | | | | |
| (new sites compared to 2022) | | | | | | | (50) | -- |

Flowering Rush Status After Final Treatments from 2014-2023

At the middle of October 2023, the area of flowering rush was about 90% less compared to 2014. The number of sites, usually less than 88 square feet per site, also declined slightly compared to 2014. Maps of flowering rush assessments for 2014-2023 are shown in Figure 2.

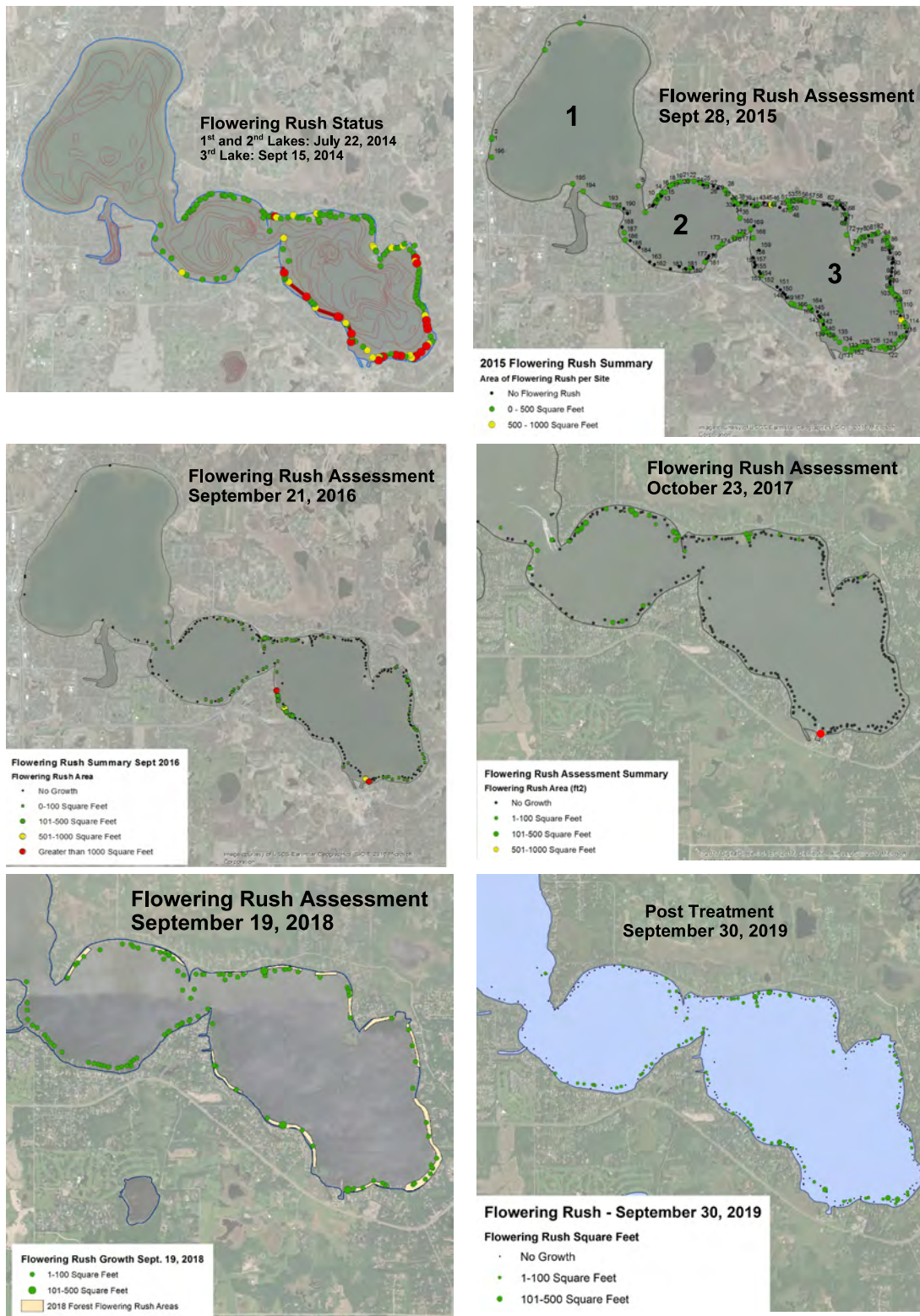


Figure 2. Estimated flowering rush coverage. [top-left] Sept 2014: 340,125 square feet (sf)(only 0.09 acres were treated). [top-right] Sept 2015: 4,411 sf. [middle-left] Sept 2016: 9,183 sf. [middle-right] October 2017: 2,655 sf. [bottom-left] Sept 2018: 2,726 sf. [bottom-right] Sept 2019: 2,790 sf.

Flowering Rush Status After Final Treatments from 2014-2023 (Concluded)

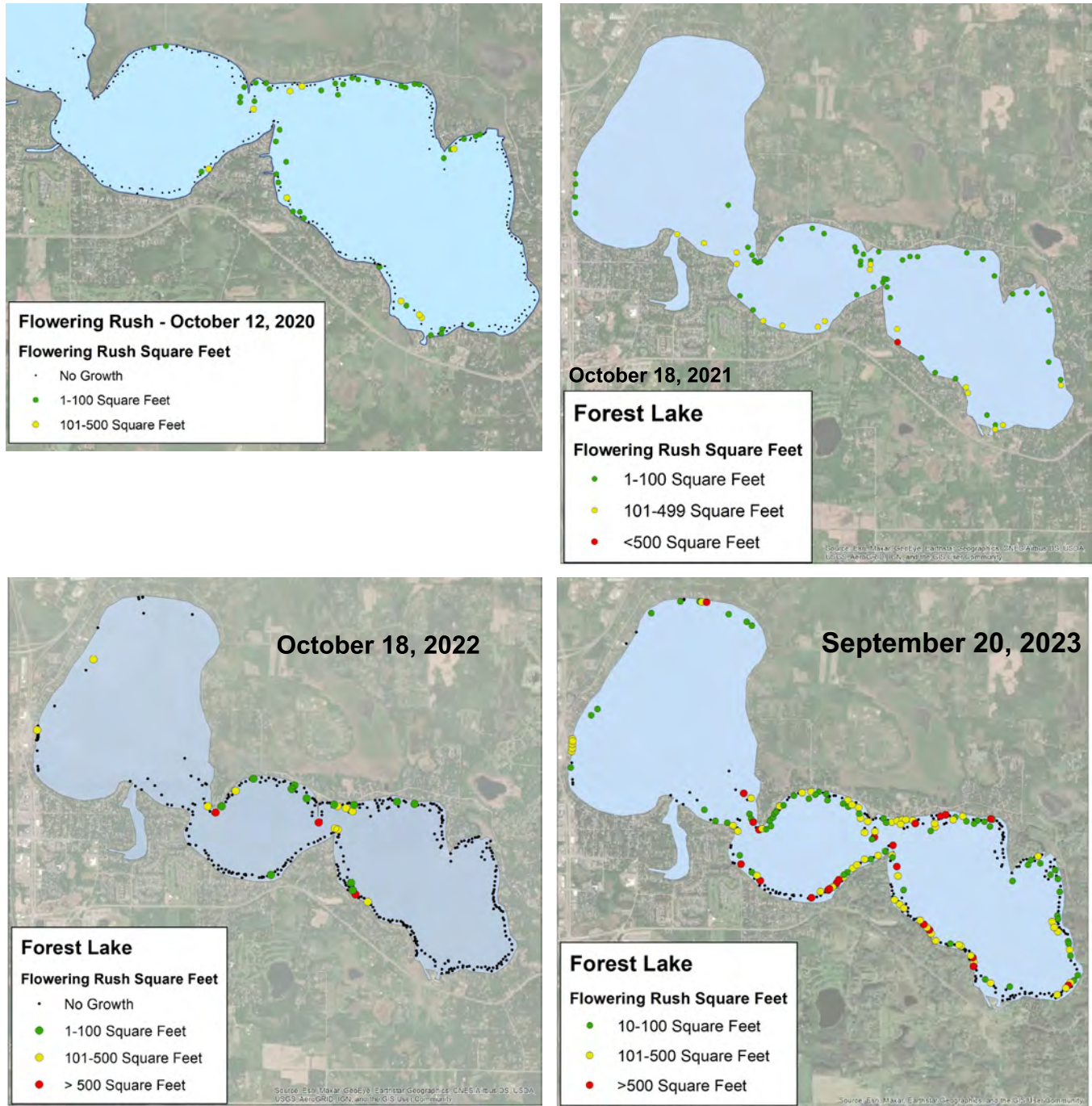


Figure 2 concluded. Estimated flowering rush coverage. [top-left] October 2020, 3,200 square feet (sf). [top-right] October 2021, 5,695 sf. [bottom-left] October 2022, 12,720 sf. [bottom-right] September 2023, 33,895 sf.

Table 5. Surveys and treatments in 2014 through 2023.

2014 - Year 1

Delineation of 1st and 2nd Lakes: July 22, 2014

Delineation of 3rd Lake: September 15, 2014

Herbicide Treatment in 2nd Lake: September 9, 2014 (0.09 ac)

Assessment of 2nd Lake: September 28, 2014

2015 - Year 2

Delineation of 1st, 2nd, and 3rd Lakes: July 17, 2015

Cutting in 2nd and 3rd Lakes: July and August, 2015

Herbicide Treatments in 3rd Lake: August 4 (6.5 ac) and 26 (13.2 ac), 2015

Assessment of 1st, 2nd, and 3rd Lakes: September 28, 2015

2016 - Year 3

Delineation of 1st, 2nd, and 3rd Lakes: July 14 and 15, 2016

Herbicide Treatments in 3rd Lake: August 3 (36 ac) and 31 (36 ac), 2016

Assessment of 1st, 2nd, and 3rd Lakes: September 21, 2016

2017 - Year 4

Delineation of 1st, 2nd, and 3rd Lakes: August 1, 2017

Herbicide Treatments in 2nd and 3rd Lake: August 14 (40.2 ac) and September 27 (31.1 ac), 2017

Assessment of 1st, 2nd, and 3rd Lakes: October 23, 2017

2018 - Year 5

Pre-treatment point intercept survey: July 5, 2018

Treatment: July 13, 2018 (32.5 ac)

Point Intercept Survey Combined with a Meandering Survey: July 25, 2018

Spot Treatments in 2nd and 3rd Lake: August 21, 2018 (3.75 ac)

Post Treatment Assessment: September 19, 2018

2019 - Year 6

Delineation of 1st, 2nd, and 3rd Lakes: July 9, 2019

Spot Herbicide Treatments in 2nd and 3rd Lake: July 31, 2019 (9.08 ac)

Assessment of 1st, 2nd, and 3rd Lakes: August 12, 2019

Spot Herbicide Treatments in 2nd and 3rd Lake: August 30, 2019 (2.5 ac)

Assessment of 1st, 2nd, and 3rd Lakes: September 30, 2019

2020 - Year 7

Delineation of 1st, 2nd, and 3rd Lakes: July 21, 2020

Spot Herbicide Treatments in 2nd and 3rd Lake: August 2, 2020 (5.91 ac)

Assessment of 1st, 2nd, and 3rd Lakes: August 26, 2020

Spot Herbicide Treatments in 2nd and 3rd Lake: September 2, 2020 (5.14 ac)

Assessment of 1st, 2nd, and 3rd Lakes: October 12, 2020

2021 - Year 8

Delineation of 1st, 2nd, and 3rd Lakes: Based on areas of heavy growth from 2020

Spot Herbicide Treatments: July 26, 2021 (7.67 ac)

Assessment and Delineation of 1st, 2nd, and 3rd Lakes: July 27, 2021

Spot Herbicide Treatments in 2nd and 3rd Lake: August 13, 2021 (3.0 ac)

Assessment of 1st, 2nd, and 3rd Lakes:

September 9, 2021

Spot Herbicide Treatments in 2nd and 3rd Lake: September 13, 2021 (3.0 ac)

Assessment of 1st, 2nd, and 3rd Lakes:

October 18, 2021

2022 - Year 9

Delineation of 1st, 2nd, and 3rd Lakes: July 12, 2022

Spot Herbicide Treatments: July 29, 2022

Assessment and Delineation of 1st, 2nd, and 3rd Lakes: August 9, 2022

Spot Herbicide Treatments in 2nd and 3rd Lake: September 19, 2022

Assessment of 1st, 2nd, and 3rd Lakes:

October 18, 2022

2023 - Year 10

Delineation of 1st, 2nd, and 3rd Lakes: July 11, 2023

Spot Herbicide Treatments: July 26, August 15, and August 29, 2023

Assessment and Delineation of 1st, 2nd, and 3rd Lakes: September 20, 2023

Spot Herbicide Treatments in 2nd and 3rd Lake: September 27 and October 10, 2023



The 3 basins in Forest Lake.

APPENDIX

Individual flowering rush sites on July 11, 2023. Gray shading indicates largest groups of flowering rush patches.

| Site | FR (sq ft) | FR patches | FR on shore (out to edge of docks) | FR off shore | Site with Flowers | Notes |
|------|------------|------------|------------------------------------|--------------|-------------------|-------|
| 9 | 100 | | | 1 | | |
| 13 | 20 | 2 | | 1 | | |
| 15 | 200 | 8 | | 1 | | |
| 21 | 20 | | | 1 | | |
| 22 | 10 | | | 1 | | |
| 27 | 20 | 2 | | 1 | | |
| 28 | 10 | | | 1 | | |
| 29 | 40 | 3 | | 1 | | |
| 30 | 140 | 7 | 1 | | 1 | |
| 31 | 100 | 1 | 1 | | 1 | |
| 40 | 100 | | 1 | | | |
| 41 | 60 | | | 1 | | |
| 42 | 100 | 6 | | 1 | | |
| 45 | 100 | 2 | | 1 | | |
| 48 | 200 | | | 1 | | |
| 61 | 20 | 2 | | 1 | | |
| 65 | 300 | 20 | 1 | | | |
| 71 | 100 | | | 1 | | |
| 103 | 20 | | 1 | | 1 | |
| 106 | 10 | 1 | | 1 | | |
| 110 | 200 | 1 | | | | |
| 111 | 40 | 2 | 1 | | | |
| 135 | 50 | 5 | | 1 | | |
| 136 | 60 | 4 | | 1 | | |
| 140 | 60 | 4 | | 1 | | |
| 141 | 160 | 8 | 1 | 1 | | |
| 143 | 60 | 5 | | 1 | | |
| 147 | 150 | | 1 | | | |
| 148 | 100 | | | 1 | | |
| 149 | 100 | | 1 | | | |
| 150 | 50 | | 1 | | | |
| 151 | 300 | 2 | 1 | | | |
| 153 | 110 | 6 | 1 | | | |
| 172 | 60 | | 1 | | | |
| 173 | 100 | 2 | 1 | | | |
| 175 | 200 | | 1 | | 1 | |
| 178 | 100 | | 1 | | 1 | |
| 179 | 60 | 3 | | 1 | | |
| 181 | 80 | 6 | | 1 | | |
| 182 | 10 | | | 1 | | |
| 196 | 400 | | 1 | | | |
| 206 | 10 | 1 | | 1 | | |
| 210 | 100 | 2 | 1 | | | |
| 211 | 100 | 6 | 1 | 1 | | |
| 212 | 100 | 2 | | 1 | | |
| 221 | 300 | 30 | 1 | | 1 | |
| 223 | 100 | | 1 | | | |
| 241 | 10 | | | 1 | | |
| 242 | 100 | | | 1 | | |
| 246 | 1000 | 15 | | 1 | | |
| 248 | 30 | | | 1 | | |
| 249 | 100 | | 1 | | 1 | |
| 250 | 100 | | 1 | | | |
| 261 | 200 | 12 | | | | |

Individual flowering rush sites on July 11, 2023. Gray shading indicates largest groups of flowering rush patches.

| Site | FR (sq ft) | FR patches | FR on shore (out to edge of docks) | FR off shore | Site with Flowers | Notes |
|---------|------------|------------|------------------------------------|--------------|-------------------|----------------------|
| 262 | 800 | 20 | | 1 | | |
| 275 | 200 | 1 | 1 | | | |
| 284 | 100 | | | 1 | | |
| 291 | 120 | 6 | 1 | | | |
| 297 | 400 | 20 | | 1 | 1 | |
| 307 | 100 | | | 1 | | |
| 309 | 510 | 50 | 1 | 1 | | |
| 315 | 10 | 1 | | 1 | | |
| 320 | 100 | | 1 | | 1 | Continuous bed |
| 321 | 100 | | 1 | | 1 | Continuous bed |
| 322 | 100 | | 1 | | 1 | Continuous bed |
| 323 | 100 | | 1 | | 1 | Continuous bed |
| 324 | 100 | | 1 | | 1 | Continuous bed |
| 325 | 100 | | 1 | | 1 | Continuous bed |
| 326 | 100 | | 1 | | 1 | Continuous bed |
| 327 | 100 | | 1 | | 1 | Continuous bed |
| 328 | 100 | | 1 | | 1 | Continuous bed |
| 329 | 100 | | 1 | | 1 | Continuous bed |
| 347 | 150 | 10 | 1 | | | |
| 353 | 100 | | 1 | | 1 | |
| 356 | 100 | | 1 | | | |
| 357 | 10 | 1 | | 1 | | |
| 1N | 100 | | | | | Beginning of NWM bed |
| 2N | | | | | | End of NWM bed |
| 3N | 100 | 10 | | 1 | | |
| 4N | 200 | 6 | | 1 | | |
| 5N | | | | | | NWM 2 ac topping out |
| 6N | 200 | | 1 | | 1 | |
| 7N | | | | | | NWM 1 ac topping out |
| Average | 132.1 | 7.4 | | | | |
| Occur | 84 | 40 | 40 | 40 | 20 | |
| Total | 10570 | 295 | | | | |

Individual flowering rush sites on September 20, 2023.

| New Site | Existing Site | FR (sq ft) | FR patches | FR on shore | FR between docks | FR past docks | Site with Flowers | Sagittaria (sq ft) | Sagittaria present | Sagittaria patches | Wild rice (sf) | Wild rice present |
|----------|---------------|------------|------------|-------------|------------------|---------------|-------------------|--------------------|--------------------|--------------------|----------------|-------------------|
| | 2 | 200 | | | | 1 | 1 | | | | | |
| | 5 | 300 | | | | 1 | 1 | | | | | |
| | 6 | 600 | 50 | | | 1 | | | | | | |
| | 8 | 10 | | | | 1 | | | | | | |
| | 9 | 100 | | | | 1 | | | | | | |
| | 10 | 20 | | | | 1 | | | | | | |
| | 11 | 100 | 10 | | | | 1 | | | | | |
| | 14 | 400 | 20 | | | | 1 | | | | | |
| | 15 | 80 | 4 | | | | 1 | | | | | |
| | 18 | 60 | 5 | | | 1 | 1 | | | | | |
| | 20 | 150 | 10 | | | | 1 | | | | | |
| | 21 | 150 | 10 | | | | 1 | | | | | |
| | 22 | 100 | 5 | | | | 1 | | | | | |
| | 23 | 60 | 6 | | | | 1 | | | | | |
| | 27 | 200 | 1 | | | | 1 | | | | | |
| | 29 | 300 | 15 | | | 1 | 1 | | | | | |
| | 34 | 200 | 5 | | | | 1 | | | | | |
| | 35 | 2000 | 50 | | | | 1 | | | | | |
| | 39 | 100 | 10 | | | 1 | | | | | | |
| | 41 | 200 | 10 | | | | 1 | | | | | |
| | 42 | 400 | 20 | | | | 1 | | | | | |
| | 45 | 200 | 10 | | | | 1 | | | | | |
| | 48 | 200 | 1 | | | | 1 | | | | | |
| | 49 | 200 | 10 | | | | 1 | | | | | |
| | 54 | 600 | 15 | | | | 1 | | | | | |
| | 55 | 600 | | | | | 1 | | | | | |
| | 57 | 100 | | | | | 1 | | | | | |
| | 59 | 80 | 4 | | | | 1 | | | | | |
| | 61 | 80 | 4 | | | | 1 | | | | | |
| | 62 | 50 | 2 | | | | 1 | | | | | |
| | 73 | 20 | | | | | 1 | | | | | |
| | 86 | 60 | 3 | | | | 1 | | | | | |
| | 89 | 40 | 3 | | | 1 | 1 | | | | | |
| | 92 | 20 | 1 | | | 1 | | | | | | |
| | 98 | 20 | | | | | 1 | | | | | |
| | 99 | 60 | 4 | | | | 1 | | | | | |
| | 108 | 20 | | | | 1 | | | | | | |
| | 108 | 300 | 10 | | | 1 | 1 | | | | | |
| | 109 | 40 | | | | 1 | | | | | | |
| | 110 | 400 | | 1 | | | | | | | | |
| | 111 | 80 | 50 | | | 1 | | | | | | |
| | 115 | 100 | | | | 1 | | | | | | |
| | 116 | 100 | | | | 1 | | | | | | |
| | 117 | 200 | | | | 1 | | | | | | |
| | 118 | 800 | | | | 1 | | | | | | |
| | 120 | 300 | | | | 1 | 1 | | | | | |
| | 135 | 300 | 30 | | | | | | | | | |
| | 136 | 60 | 5 | | | | 1 | | | | | |
| | 141 | 200 | 10 | | | 1 | | | | | | |
| | 142 | 600 | 50 | | | 1 | 1 | 1 | | | | |
| | 143 | 400 | | | | 1 | | | | | | |
| | 146 | 200 | | | | 1 | | | | | | |
| | 147 | 500 | | | | 1 | 1 | | | | | |
| | 148 | 1000 | 50 | | | 1 | 1 | | | | | |
| | 149 | 500 | | | | 1 | 1 | | | | | |
| | 150 | 1000 | 50 | | | 1 | 1 | | | | | |
| | 151 | 400 | 20 | | | 1 | | | | | | |
| | 153 | 200 | 20 | | | | 1 | | | | | |
| | 159 | 500 | 15 | | | | 1 | | | | | |
| | 161 | 20 | 1 | | | | 1 | | | | | |
| | 164 | 400 | | | | 1 | | | | | | |
| | 170 | 200 | | | | 1 | 1 | | | | | |
| | 173 | 150 | 10 | | | | 1 | | | | | |
| | 174 | 20 | 2 | | | | 1 | | | | | |
| | 176 | 800 | 20 | | | | 1 | 1 | | | | |
| | 184 | 100 | 5 | | | | 1 | | | | | |
| | 185 | 600 | 30 | | | | 1 | | | | | |
| | 189 | 400 | 16 | | | | 1 | | | | | |
| | 190 | 150 | 10 | | | | 1 | | | | | |

Individual flowering rush sites on September 20, 2023.

| New Site | Existing Site | FR (sq ft) | FR patches | FR on shore | FR between docks | FR past docks | Site with Flowers | Sagittaria (sq ft) | Sagittaria present | Sagittaria patches | Wild rice (sf) | Wild rice present |
|----------|---------------|------------|------------|-------------|------------------|---------------|-------------------|--------------------|--------------------|--------------------|----------------|-------------------|
| | 191 | 100 | 6 | | | 1 | | | | | | |
| | 192 | 100 | | 1 | | | 1 | | | | | |
| | 198 | 100 | 8 | | | 1 | | | | | | |
| | 205 | 1000 | 10 | | | 1 | | | | | | |
| | 207 | 150 | 10 | | | 1 | | | | | | |
| | 211 | 200 | 10 | | | 1 | | | | | | |
| | 212 | 80 | 2 | | | 1 | | | | | | |
| | 214 | 60 | 3 | | | 1 | | | | | | |
| | 216 | 80 | 4 | | | 1 | | | | | | |
| | 226 | 300 | | | 1 | | | | | | | |
| | 240 | 200 | | | | 1 | | | | | | |
| | 241 | 400 | 2 | | | 1 | | | | | | |
| | 242 | 400 | 10 | | | 1 | | | | | | |
| | 248 | 100 | 4 | | | 1 | | | | | | |
| | 250 | 600 | 20 | | | 1 | | | | | | |
| | 250 | 200 | | | 1 | | | | | | | |
| | 256 | 50 | | | 1 | | 1 | | | | | |
| | 256 | 1000 | | | 1 | 1 | 1 | | | | | |
| | 260 | 200 | | | 1 | | | | | | | |
| | 261 | 300 | 15 | | | 1 | | | | | | |
| | 261 | 100 | | | | 1 | | | | | | |
| | 262 | 100 | 5 | | | 1 | | | | | | |
| | 263 | 400 | 20 | | 1 | | | | | | | |
| | 263 | 60 | | | | 1 | | | | | | |
| | 264 | 60 | 3 | | | 1 | | | | | | |
| | 269 | 600 | | | | 1 | | | | | | |
| | 272 | 200 | 5 | | | 1 | | | | | | |
| | 273 | 200 | 10 | | | 1 | | | | | | |
| | 283 | 400 | | | 1 | | 1 | | | | | |
| | 284 | 800 | | | 1 | | 1 | | | | | |
| | 286 | 100 | 5 | | | 1 | | | | | | |
| | 292 | 100 | | | 1 | | | | | | | |
| | 294 | 400 | 15 | | 1 | 1 | 1 | | | | | |
| | 295 | 200 | | | 1 | | | | | | | |
| | 297 | 600 | 20 | | | 1 | 1 | | | | | |
| | 299 | 600 | | | | 1 | 1 | | | | | |
| | 309 | 300 | 20 | | | 1 | 1 | | | | | |
| | 312 | 40 | 2 | | | 1 | | | | | | |
| | 313 | 600 | 30 | | | 1 | | | | | | |
| | 315 | 80 | 4 | | | 1 | | | | | | |
| | 317 | 20 | 3 | | | 1 | | | | | | |
| | 318 | 30 | 3 | | | 1 | | | | | | |
| | 332 | 100 | | | | 1 | | | | | | |
| | 333 | 10 | | | | 1 | | | | | | |
| | 341 | 400 | 12 | | | | | | | | | |
| | 345 | 600 | 20 | | 1 | | | | | | | |
| | 351 | 50 | 5 | | | | | | | | | |
| | 353 | 100 | | | 1 | 1 | | | | | | |
| 1 | | | | | | | | 1000 | | | | |
| 2 | | | | | | | | 1000 | | | | |
| 3 | | | | | | | | 100 | | | | |
| 4 | | | | | | | | 50 | | | | |
| 5 | | 100 | | 1 | | | | | | | | |
| 6 | | 50 | | 1 | | | | | | | | |
| 7 | | | | | | | | 100 | | 2 | | |
| 8 | | | | | | | | 20 | | | | |
| 9 | | | | | | | | 10 | | | | |
| 10 | | | | | | | | 20 | | | | |
| 11 | | 20 | | | 1 | | | | | | | |
| 12 | | | | | | | | 20 | | | | |
| 13 | | | | | | | | 20 | | | | |
| 14 | | | | | | | | 20 | | | | |
| 15 | | | | | | | | 20 | | | | |
| 16 | | | | | | | | 20 | | | | |
| 17 | | 10 | | | 1 | | | | | | | |
| 18 | | 20 | | | 1 | | | | | | | |
| 19 | | 20 | | | 1 | | | | | | | |
| 20 | | 20 | | | 1 | | | | | | | |
| 21 | | 500 | | 1 | | | 1 | | | | | |

Individual flowering rush sites on September 20, 2023.

| New Site | Existing Site | FR (sq ft) | FR patches | FR on shore | FR between docks | FR past docks | Site with Flowers | Sagittaria (sq ft) | Sagittaria present | Sagittaria patches | Wild rice (sf) | Wild rice present |
|------------|---------------|------------|------------|-------------|------------------|---------------|-------------------|--------------------|--------------------|--------------------|----------------|-------------------|
| 22 | | | | | | | | | | | | 1 |
| 23 | | | | | | | | | | | | 1 |
| 24 | | | | | | | | | | | 1000 | |
| 25 | | | | 1 | | | | | | | | |
| 26 | | 1000 | | 1 | | | | | | | | |
| 27 | | | | | | | | | | | | 1 |
| 28 | | | | | | | | 20 | 1 | | | |
| 29 | | | | | | | | 20 | 1 | | | |
| 30 | | | | | | | | | | | | 300 |
| 31 | | | | | | | | | | | | 3000 |
| 32 | | | | | | | | 600 | | | | |
| 33 | | | | | | | | | | | | 10 |
| 34 | | 15 | | 1 | | | | | | | | |
| 35 | | 60 | | 1 | | | | | | | | |
| 36 | | 10 | | 1 | | | | | | | | |
| 37 | | | | | | | | | 1 | | | |
| 38 | | | | | | | | | 1 | | | |
| 39 | | | | | | | | | 1 | | | |
| 40 | | | | | | | | | | | | |
| 41 | | | | | | | | 2500 | | | | |
| 42 | | | | | | | | 300 | | | | |
| 43 | | 100 | | | | 1 | | | | | | |
| 44 | | 1000 | 30 | | | 1 | | | | | | |
| 45 | | 20 | 2 | | 1 | | | | | | | |
| 46 | | 20 | | | | 1 | | | | | | |
| 47 | | 60 | 3 | | | 1 | | | | | | |
| 48 | | 200 | 1 | | 1 | 1 | | | | | | |
| 49 | | 50 | 5 | | | 1 | | | | | | |
| 50 | | 200 | | | | 1 | | | | | | |
| 51 | | 100 | 6 | | | 1 | | | | | | |
| 52 | | 40 | 2 | | | 1 | | | | | | |
| 53 | | 40 | 2 | | | 1 | | | | | | |
| 54 | | 20 | 1 | | | 1 | | | | | | |
| 55 | | 200 | 9 | | | 1 | | | | | | |
| 56 | | 200 | 10 | | | | | | | | | |
| 57 | | 1000 | 30 | | | 1 | | | | | | |
| 58 | | 60 | 20 | | | 1 | | | | | | |
| 59 | | 2000 | 100 | | | 1 | | | | | | |
| 60 | | 300 | 10 | | | 1 | | | | | | |
| 61 | | 150 | 6 | | | 1 | | | | | | |
| 63 | | 10 | | | | 1 | | | | | | |
| 64 | | 400 | 10 | | | 1 | 1 | | | | | |
| 65 | | 1000 | 30 | | | 1 | 1 | | | | | |
| 66 | | 150 | 6 | | | 1 | | | | | | |
| 67 | | 1000 | 20 | | 1 | 1 | | | | | | |
| 68 | | 300 | 20 | | | 1 | | | | | | |
| 69 | | 60 | 4 | | | 1 | | | | | | |
| 70 | | 1000 | | 1 | 1 | | | | 1 | | | |
| 71 | | 1000 | | 1 | 1 | | 1 | | | | | |
| 72 | | 1000 | | 1 | 1 | | 1 | | | | | |
| 73 | | 1000 | | 1 | 1 | | 1 | | | | | |
| 74 | | 1000 | | 1 | 1 | | 1 | | | | | |
| Average | | 296.7 | 13.3 | | | | | 324.4 | 1.0 | 2.0 | | |
| Occurrence | | 160 | 98 | 15 | 56 | 107 | 20 | 84 | 6 | 1 | 1 | 6 |
| Total | | 33895 | 1305 | | | | | 5840 | 6 | 2 | | |



Northern Watermilfoil in Forest Lake on August 8, 2023

Aquatic Plant Point Intercept Survey for Forest Lake, Washington County, 2023

Point Intercept Aquatic Plant Survey: August 8, 2023

Prepared for:
Comfort Lake/Forest
Lake Watershed District
Forest Lake, Minnesota



Prepared by:
Steve McComas
Jo Stuckert
Connor McComas
Blue Water Science
St. Paul, MN 55116

December 22, 2023

Aquatic Plant Point Intercept Survey for Forest Lake, Washington County, 2023

Summary

An aquatic plant point intercept survey (250 meter spacing between points) was conducted on August 8, 2023 on Forest Lake (2,271 ac) by Blue Water Science to characterize conditions of aquatic plants.

The coverage of native plants is shown in Figure 1 and plants grow out to a water depth of about 15 feet. Plants covered approximately 1,386 acres (61% of the lake). The dominant plant in the August point intercept survey was coontail followed by water celery. In the survey, curlyleaf pondweed was found at 3 sample sites and was found to be growing at a low density. Eurasian watermilfoil (EWM) was first observed in Forest Lake in 2015. EWM was found at 1 site in the point intercept survey. Growth of EWM was been found in the first lake (northern basin). About 8.41 acres of EWM were treated in 2023.

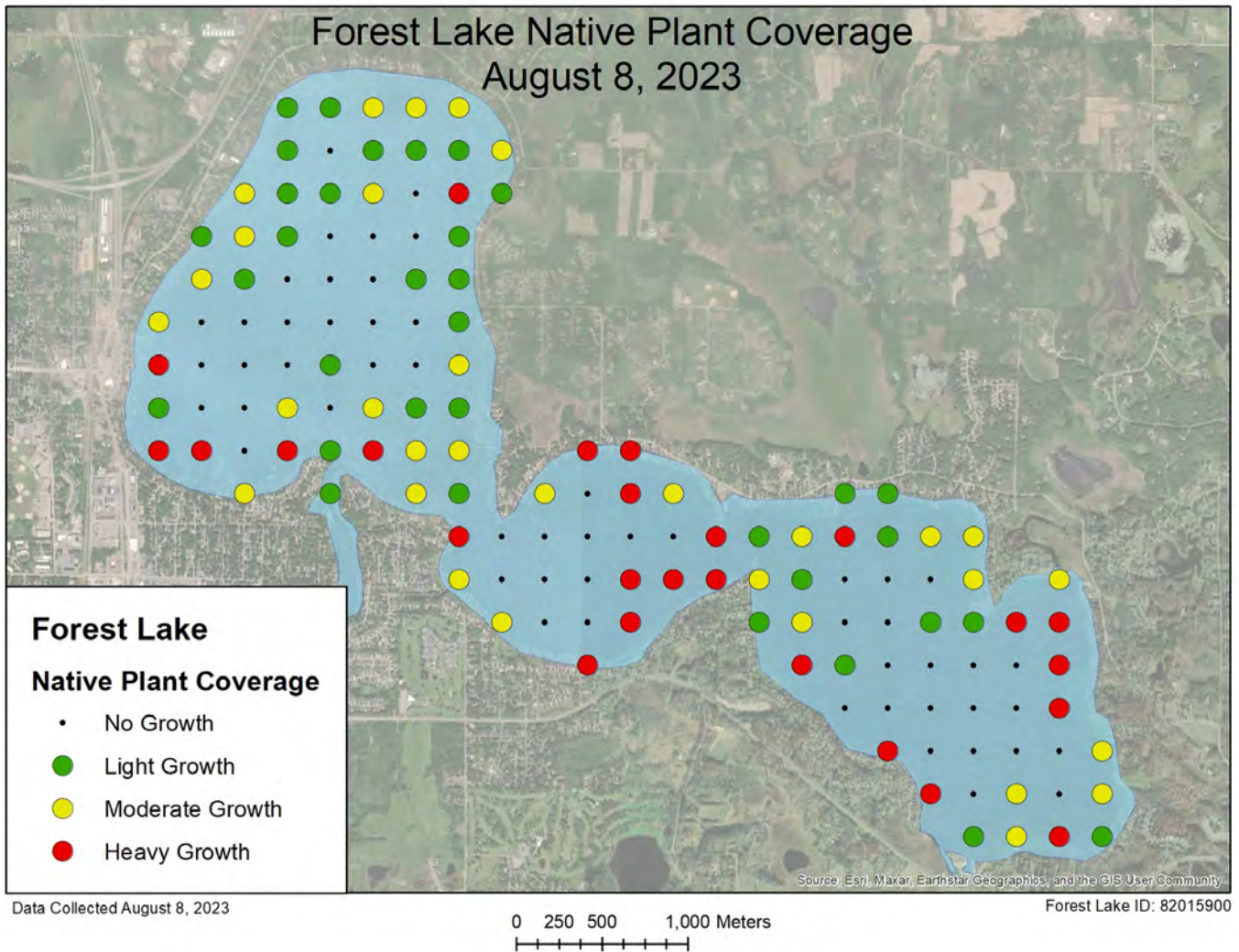


Figure 1. Native aquatic plant coverage of Forest Lake on August 8, 2023.

Key: Green shading = light growth, yellow shading = moderate growth, and red shading = heavy growth.

Forest Lake has a good diversity of aquatic plants, with 18 submerged species, 2 floatingleaf species, and 3 emergent species. Plant occurrence and relative densities are listed in Table 1. In 2023 the most common plant in the lake is coontail followed by water celery.

Table 1. Forest Lake aquatic plant occurrences and densities for the 2013, 2018, and 2023 surveys. Density ratings are 1-3 with 1 being low and 3 being most dense.

| | 2013 July 11-12 (n=97)(growth to 12 feet) | | 2018 August 15 (n=101)(growth to 15 feet) | | 2023 August 8 (102 sites)(growth to 15 feet) | |
|--|---|---------|---|---------|--|---------|
| | % Occurrence | Density | % Occurrence | Density | % Occurrence | Density |
| Flowering rush (<i>Butomus umbellatus</i>) | | | | | 1 | 1.0 |
| Bulrush (<i>Scirpus sp</i>) | 7 | 2.6 | 3 | 2.3 | 2 | 2.0 |
| Cattails (<i>Typha sp</i>) | 1 | 5.0 | | | 1 | 1.0 |
| Spatterdock (<i>Nuphar variegatum</i>) | 2 | 2.0 | | | 3 | 1.3 |
| White waterlily (<i>Nymphaea sp</i>) | 1 | 2.0 | 2 | 1.5 | 2 | 1.5 |
| Marsh marigold (<i>Bidens Beckii</i>) | 2 | 1.0 | 3 | 1.0 | | |
| Coontail (<i>Ceratophyllum demersum</i>) | 30 | 1.5 | 46 | 1.1 | 52 | 1.4 |
| Chara (<i>Chara sp</i>) | 38 | 2.1 | 28 | 1.3 | 17 | 1.4 |
| Elodea (<i>Elodea canadensis</i>) | 1 | 1.0 | 3 | 1.0 | 4 | 1.5 |
| Star duckweed (<i>Lemna trisulca</i>) | 4 | 1.3 | 2 | 1.0 | 2 | 1.0 |
| Northern watermilfoil (<i>Myriophyllum sibiricum</i>) | 21 | 1.2 | 17 | 1.1 | 36 | 1.7 |
| Eurasian watermilfoil (<i>M. spicatum</i>) | | | 10 | 1.0 | 5 | 1.4 |
| Naiads (<i>Najas flexilis</i>) | 18 | 1.6 | 23 | 1.2 | 21 | 1.1 |
| Nitella (<i>Nitella spp</i>) | | | 2 | 1.0 | | |
| Cabbage (<i>Potamogeton amplifolius</i>) | | | | | 2 | 1.0 |
| Curlyleaf pondweed (<i>Potamogeton crispus</i>) | 22 | 1.0 | 4 | 1.3 | 3 | 1.0 |
| Fries pondweed (<i>P. friesii</i>) | | | | | 1 | 1.0 |
| Variable pondweed (<i>P. gramineus</i>) | | | 1 | 1.0 | | |
| Illinois pondweed (<i>P. illinoensis</i>) | | | 6 | 1.3 | 6 | 1.0 |
| Whitestem pondweed (<i>P. praelongus</i>) | 6 | 1.0 | 2 | 1.0 | 8 | 1.0 |
| Claspingleaf pondweed (<i>P. Richardsonii</i>) | 10 | 1.4 | 11 | 1.0 | 4 | 1.0 |
| Stringy pondweed (<i>P. sp</i>) | 8 | 1.6 | | | 13 | 1.0 |
| Flatstem pondweed (<i>P. zosteriformis</i>) | 4 | 1.3 | | | 27 | 1.2 |
| Buttercup (<i>Ranunculus sp</i>) | 1 | 1.0 | | | | |
| Sago pondweed (<i>Stuckenia pectinata</i>) | 1 | 1.0 | 2 | 1.0 | 1 | 1.0 |
| Water celery (<i>Vallisneria americana</i>) | 21 | 1.3 | 41 | 1.8 | 42 | 1.8 |
| Horned pondweed (<i>Zannichellia palustris</i>) | 19 | 1.5 | | | | |
| Water stargrass (<i>Zosterella dubia</i>) | 4 | 1.0 | 22 | 1.5 | 37 | 1.3 |
| Number of submerged species | 17 | | 17 | | 18 | |

2023 Aquatic Plant Maps for Selected Species

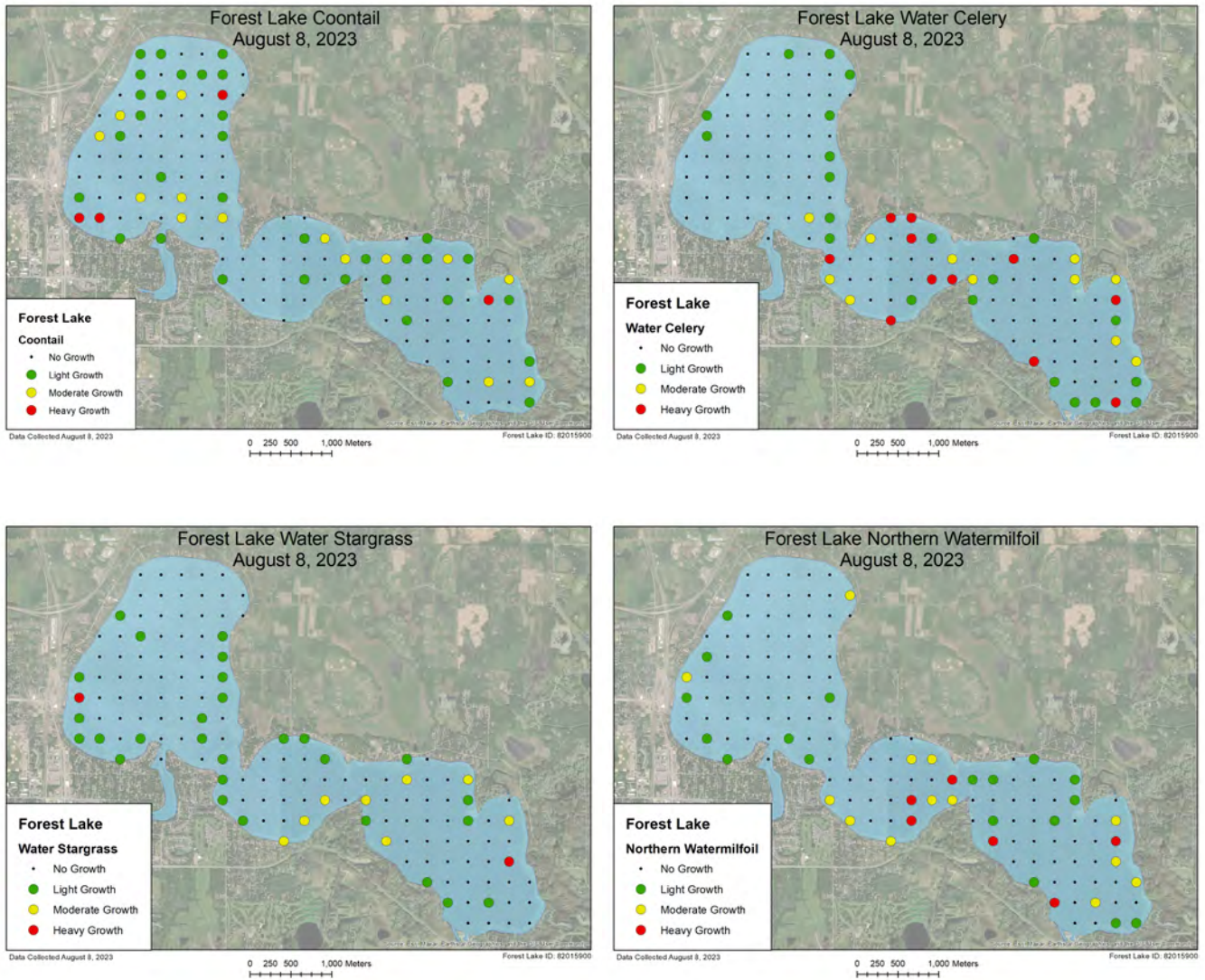


Figure 2. Coontail, water celery, water stargrass, and northern watermilfoil were the most common native submerged plants in 2023.

Aquatic Plant Point Intercept Survey for Forest Lake, Washington County, 2023

ID: 82015900

County: Washington

Area: 2270.94 acres

Littoral Area: 1,531 acres

Shore length: 15.71 miles

Maximum depth: 37 feet

Introduction

An aquatic plant point intercept survey was conducted on August 8, 2023 on Forest Lake. Results of this survey were also compared to a point intercept survey conducted by the MnDNR in 2009 and point intercept surveys conducted in 2013 and 2018 by Blue Water Science.



Figure 3. Contour map of Forest Lake (source: MnDNR).

Methods

A point intercept aquatic plant survey of Forest Lake was conducted by Blue Water Science on August 8, 2023, and 102 points were sampled out to 15 feet of water depth (Figure 4). The deepest depth of plant colonization in Forest Lake was out to 15 feet. Sample points were placed 250 meters apart on a grid that covered the lake. This is the same spacing used by the MnDNR in 2009 and by Blue Water Science in 2013 and 2018. Each sample point was equal to 15.4 acres of the lake area. At each sample point, a sampling rake was lowered into the water and a plant sample was taken. The plant species were recorded and the density of each species was assigned. Densities were based on the coverage on the teeth of the rake. Density ratings were from 1 to 3 with 1 being sparse and 3 being heavy growth. Based on these sample results, plant distribution maps were constructed.

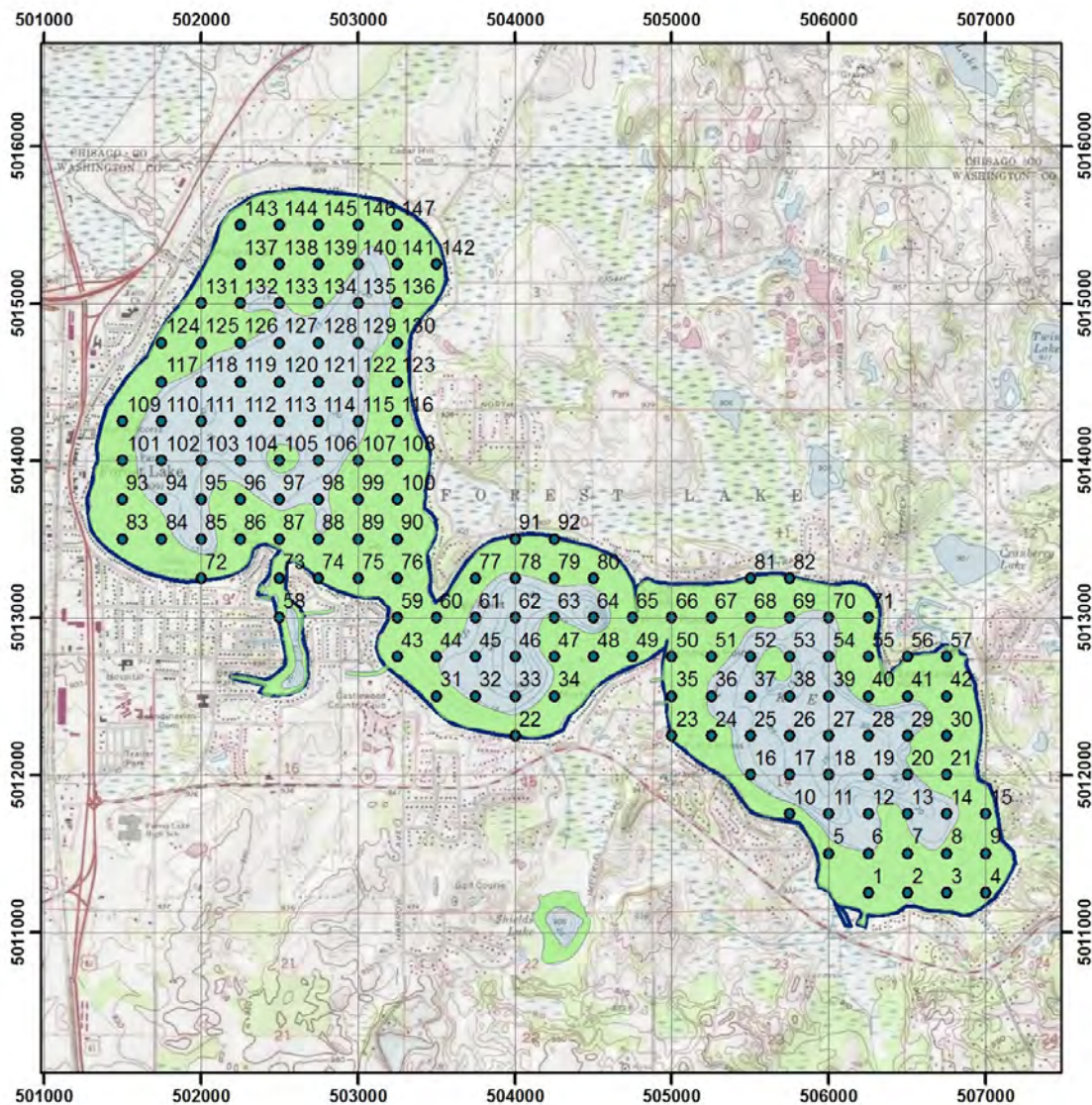


Figure 4. Sample location map for the aquatic plant surveys conducted on Forest Lake. Green shading represents the littoral zone of Forest Lake.

Forest Lake Point Intercept Survey Statistics

A summary of plant statistics from the August 8, 2023 point intercept survey is shown in Tables 2 and 3 and Figure 3. A total of 102 points were sampled in the growing zone, from 0 to 15 feet. Plants were common in depths up to 15 feet and no plants were observed growing deeper than 15 feet (Figure 5).

Table 2. Forest Lake plant survey statistics (using the MnDNR template).

| | |
|--|--------------------|
| Total # Points Sampled | 120 |
| Depth Range of Rooted Veg | 0.5-15 feet |
| Maximum Depth of Growth (95%) in feet | 11 |
| # Points in Max Depth Range | 87 |
| # Points in Littoral Zone (0-15 feet) | 102 |
| % Points w/ Submersed Native Taxa | 87 |
| Mean Submersed Native Taxa/Point | 2.7 |
| # Submersed Native Taxa | 16 |
| # Submersed Invasive Taxa | 2 |
| Max Depth of *MYS in feet | 12 |
| % Frequency of *MYS | 5 |
| Mode Rake Abundance of *MYS | 1 |
| Max Depth of *PC in feet | 10 |
| % Frequency of *PC | 3 |
| Mode Rake Abundance of *PC | 1 |

Table 3. Forest Lake aquatic plants sampled by depth.

| Depth (feet) | Number of Points Sampled | Percent of Sampling Points with Submersed Species Observed |
|--------------|--------------------------|--|
| 0 | 1 | 100% |
| 1 | 0 | 0% |
| 2 | 7 | 86% |
| 3 | 9 | 100% |
| 4 | 13 | 100% |
| 5 | 12 | 100% |
| 6 | 8 | 100% |
| 7 | 6 | 100% |
| 8 | 9 | 89% |
| 9 | 5 | 100% |
| 10 | 9 | 100% |
| 11 | 8 | 100% |
| 12 | 5 | 20% |
| 13 | 1 | 100% |
| 14 | 1 | 0% |
| 15 | 8 | 25% |
| 16 | 9 | 0% |
| 17 | 4 | 0% |
| 18 | 0 | 0% |
| 19 | 1 | 0% |
| 20 | 2 | 0% |
| All sites | 118 | |

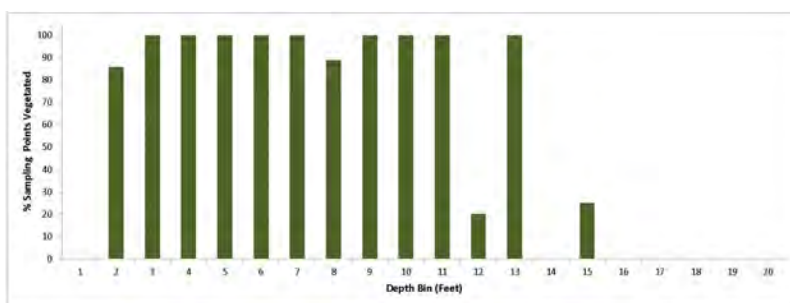


Figure 5. Depth of plant colonization (in feet).

Forest Lake has a good diversity of aquatic plants, with 18 submerged species (includes curlyleaf pondweed and Eurasian watermilfoil), 2 water lily species, and 3 emergent species. A summary of plant occurrence and relative densities is listed in Table 4. The most common plant in the lake was coontail followed by water celery. Northern watermilfoil and water stargrass were common. Aquatic plants covered about 1,386 acres or 61% of the 2,271 acre lake.

Table 4. Forest Lake aquatic plant occurrences and densities for the August 8, 2023 survey. Density ratings are 1-3 with 1 being low and 3 being most dense. Plants grew to a depth of 15 feet.

| | 2023 August 8 (102 sites) | | |
|--|---------------------------------|---------|---------|
| | Occur | % Occur | Density |
| Flowering rush (<i>Butomus umbellatus</i>) | 1 | 1 | 1.0 |
| Bulrush (<i>Scirpus</i> sp) | 2 | 2 | 2.0 |
| Cattails (<i>Typha</i> sp) | 1 | 1 | 1.0 |
| Spatterdock (<i>Nuphar variegatum</i>) | 3 | 3 | 1.3 |
| White waterlily (<i>Nymphaea</i> sp) | 2 | 2 | 1.5 |
| Coontail (<i>Ceratophyllum demersum</i>) | 53 | 52 | 1.4 |
| Chara (<i>Chara</i> sp) | 17 | 17 | 1.4 |
| Elodea (<i>Elodea canadensis</i>) | 4 | 4 | 1.5 |
| Star duckweed (<i>Lemna trisulca</i>) | 2 | 2 | 1.0 |
| Northern watermilfoil (<i>Myriophyllum sibiricum</i>) | 37 | 36 | 1.7 |
| Eurasian watermilfoil (<i>M. spicatum</i>) | 5 | 5 | 1.4 |
| Naiads (<i>Najas flexilis</i>) | 21 | 21 | 1.1 |
| Cabbage (<i>Potamogeton amplifolius</i>) | 2 | 2 | 1.0 |
| Curlyleaf pondweed (<i>Potamogeton crispus</i>) | 3 | 3 | 1.0 |
| Fries pondweed (<i>P. friesii</i>) | 1 | 1 | 1.0 |
| Illinois pondweed (<i>P. illinoensis</i>) | 6 | 6 | 1.0 |
| Whitestem pondweed (<i>P. praelongus</i>) | 8 | 8 | 1.0 |
| Claspingleaf pondweed (<i>P. Richardsonii</i>) | 4 | 4 | 1.0 |
| Stringy pondweed (<i>P. sp</i>) | 13 | 13 | 1.0 |
| Flatstem pondweed (<i>P. zosteriformis</i>) | 28 | 27 | 1.2 |
| Sago pondweed (<i>Stuckenia pectinata</i>) | 1 | 1 | 1.0 |
| Water celery (<i>Vallisneria americana</i>) | 43 | 42 | 1.8 |
| Water stargrass (<i>Zosterella dubia</i>) | 38 | 37 | 1.3 |
| Number of submerged species | | 18 | |

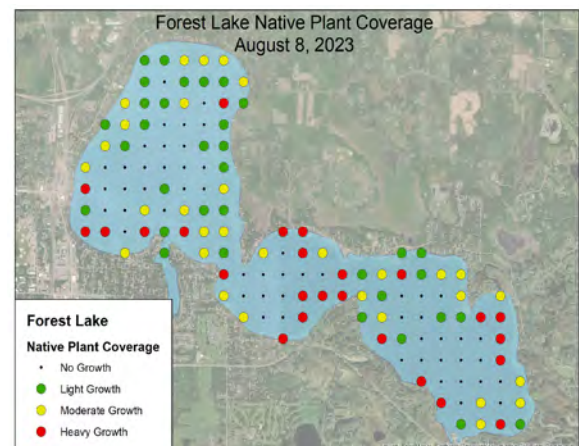
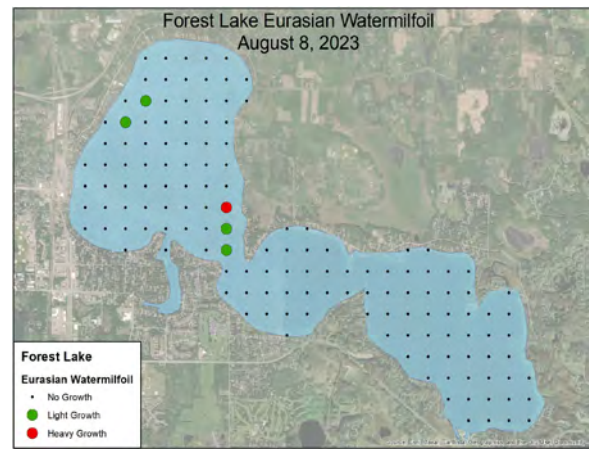
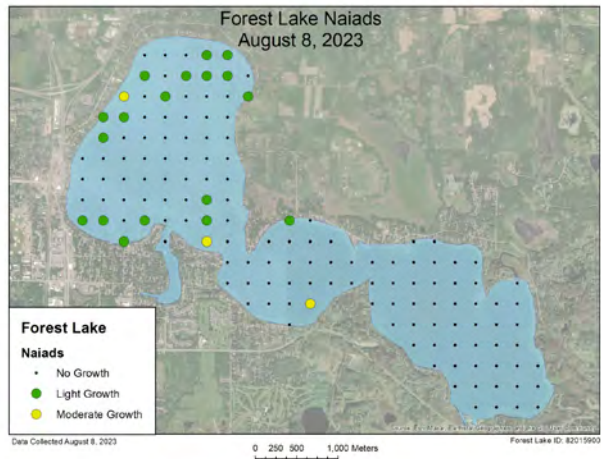
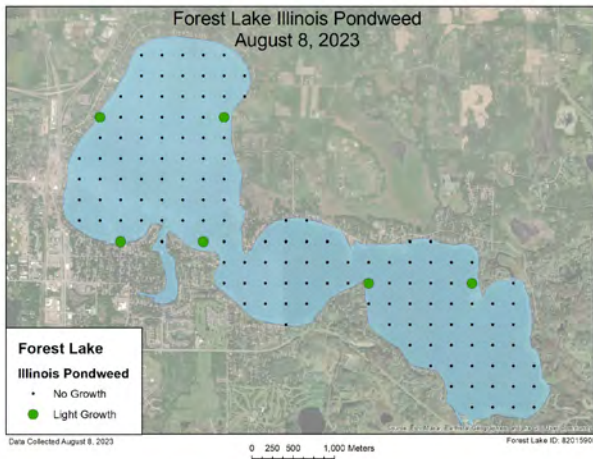
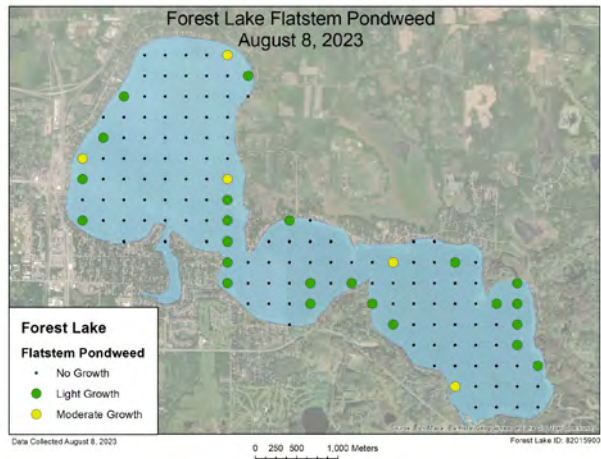
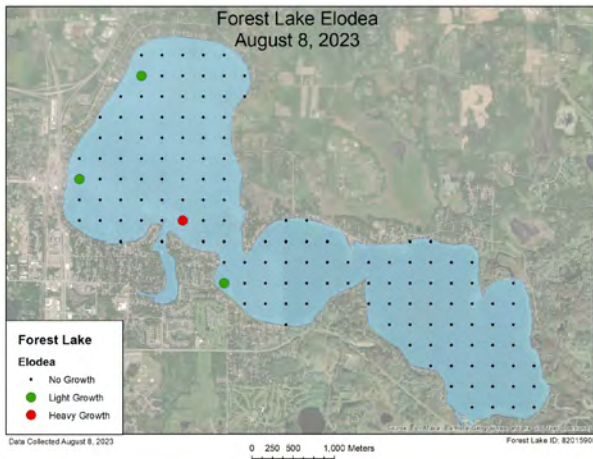
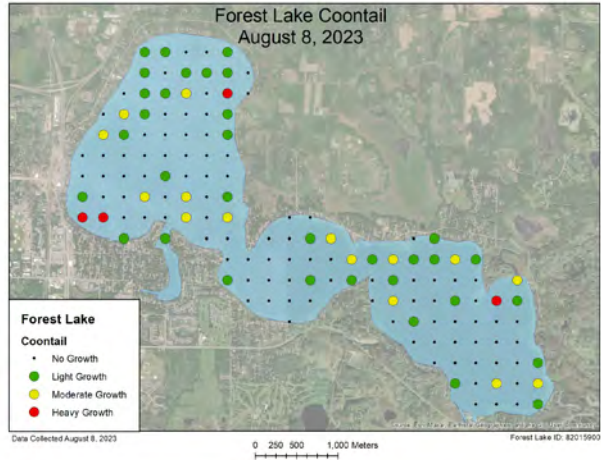
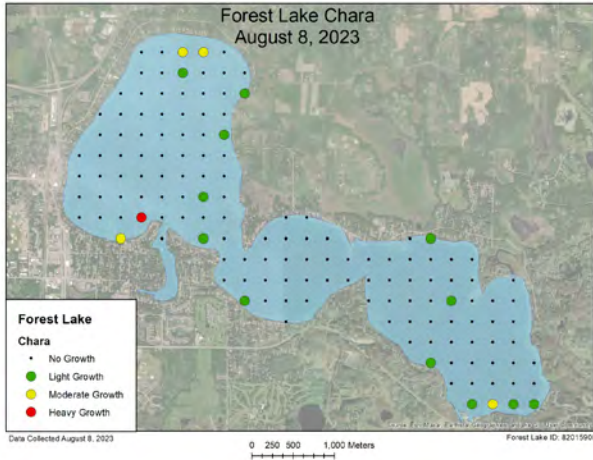
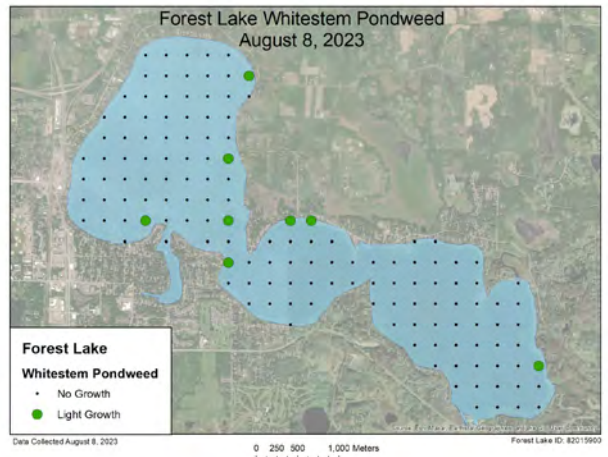
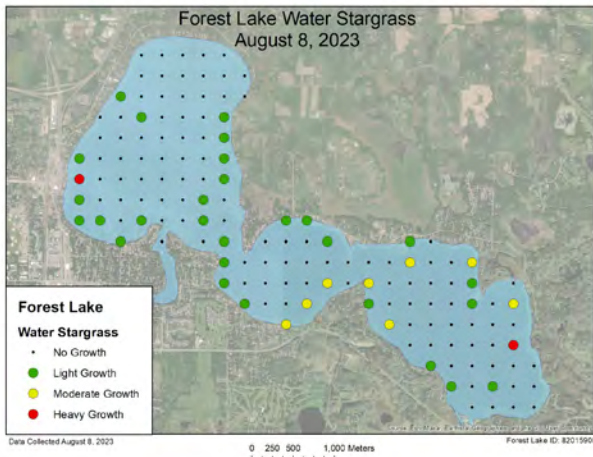
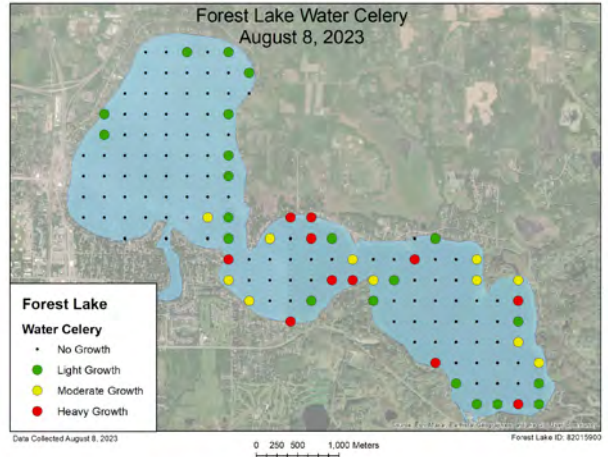
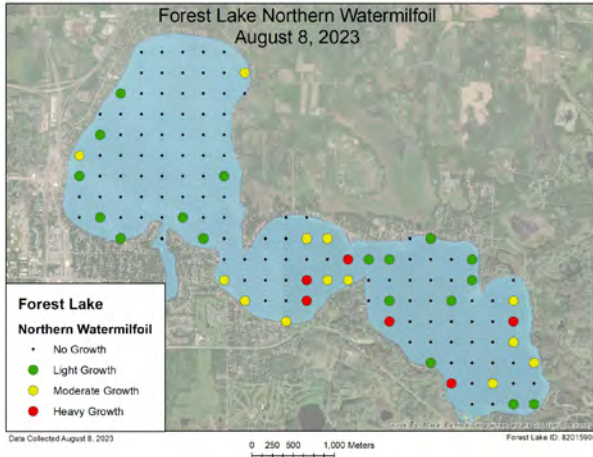


Figure 6. EWM (top) and native plants (bottom) density and distribution for the August 8, 2023 point-intercept survey. Key: green shading = light growth, yellow shading = moderate growth, and red shading = heavy growth.

Aquatic Plant Maps of Forest Lake from the August 8, 2023 Plant Survey





2009, 2013, 2018, and 2023 Point Intercept Surveys: Results of an aquatic plant point-intercept survey on June 22, 2009 by the MnDNR, along with point intercept surveys on July 11-12, 2013, on August 15, 2018, and on August 8, 2023 conducted by Blue Water Science are shown in Table 5.

A few changes may have occurred from 2009 to 2023. It appears coontail, naiads, water celery, and water stargrass increased in distribution from 2009 to 2023. On the other hand, it appears chara and horned pondweed may have decreased from 2009 to 2023. Several other species appear to have remained about the same.

Eurasian watermilfoil was first observed in Forest Lake in 2015 and has been treated since then in first and second lakes. Based on 2023 survey results, EWM does not appear to be rapidly spreading into third lake.

The aquatic plant community has changed over the last 15 years. Heavy growth seems to have increased for several plant species which may be due to lower lake levels and improved water clarity from filtering activities of zebra mussels.



Figure 7. Coontail has been the dominant plant in 2018 and 2023 point intercept surveys.

Table 5. Forest Lake aquatic plant occurrences for the 2013, 2018, and 2023 surveys.

| | 2009 June 22 (n=97) (MnDNR) | 2013 July 11-12 (n=97) (growth to 12 feet) (Blue Water Science) | 2018 August 15 (n=101) (growth to 15 feet) (Blue Water Science) | 2023 August 8 (102 sites) (growth to 15 ft) (Blue Water Science) |
|---|--|---|---|--|
| | % Occurrence | % Occurrence | % Occurrence | % Occurrence |
| Flowering rush (<i>Butomus umbellatus</i>) | | | | 1 |
| Bulrush (<i>Scirpus sp</i>) | present | 7 | 3 | 2 |
| Cattails (<i>Typha sp</i>) | | 1 | | 1 |
| Duckweed (<i>Lemna sp</i>) | 1 | | | |
| Spatterdock (<i>Nuphar variegatum</i>) | 2 | 2 | | 3 |
| White waterlily (<i>Nymphaea sp</i>) | 3 | 1 | 2 | 2 |
| Marsh marigold (<i>Bidens Beckii</i>) | 8 | 2 | 3 | |
| Coontail (<i>Ceratophyllum demersum</i>) | 13 | 30 | 46 | 52 |
| Hornwort (<i>Ceratophyllum sp</i>) | 4 | | | |
| Chara (<i>Chara sp</i>) | 36 | 38 | 28 | 17 |
| Elodea (<i>Elodea canadensis</i>) | 2 | 1 | 3 | 4 |
| Star duckweed (<i>Lemna trisulca</i>) | 3 | 4 | 2 | 2 |
| Northern watermilfoil (<i>Myriophyllum sibiricum</i>) | 27 | 21 | 17 | 36 |
| Eurasian watermilfoil (<i>M. spicatum</i>) | | | 10 | 5 |
| Naiads (<i>Najas flexilis</i>) | 5 | 18 | 23 | 21 |
| Nitella (<i>Nitella spp</i>) | 5 | | 2 | |
| Cabbage (<i>Potamogeton amplifolius</i>) | 4 | | | 2 |
| Curlyleaf pondweed (<i>Potamogeton crispus</i>) | 54 | 22 | 4 | 3 |
| Fries pondweed (<i>P. friesii</i>) | | | | 1 |
| Variable pondweed (<i>P. diversifolius</i>) | 2 | | | |
| Variable pondweed (<i>P. gramineus</i>) | | | 1 | |
| Illinois pondweed (<i>P. illinoensis</i>) | 5 | | 6 | 6 |
| Whitestem pondweed (<i>P. praelongus</i>) | 4 | 6 | 2 | 8 |
| Claspingleaf pondweed (<i>P. Richardsonii</i>) | 8 | 10 | 11 | 4 |
| Stringy pondweed (<i>P. sp</i>) | 2 | 8 | | 13 |
| Flatstem pondweed (<i>P. zosteriformis</i>) | 20 | 4 | | 27 |
| Buttercup (<i>Ranunculus sp</i>) | 4 | 1 | | |
| Sago pondweed (<i>Stuckenia pectinata</i>) | | 1 | 2 | 1 |
| Water celery (<i>Vallisneria americana</i>) | 17 | 21 | 41 | 42 |
| Horned pondweed (<i>Zannichellia palustris</i>) | 38 | 19 | | |
| Water stargrass (<i>Zosterella dubia</i>) (<i>Heteranthera dubia</i>) | 3 | 4 | 22 | 37 |
| Number of submerged species | 21 | 17 | 17 | 18 |

Flowering Rush: Flowering rush is a non-native aquatic plant with mostly emergent growth, but has a submerged form as well. Flowering rush is established in Forest Lake and is the only known lake that has viable flowering rush seeds. During the point intercept survey flowering rush showed up on one sample site location. The distribution of flowering rush on August 8, 2023 is shown in Figure 8.

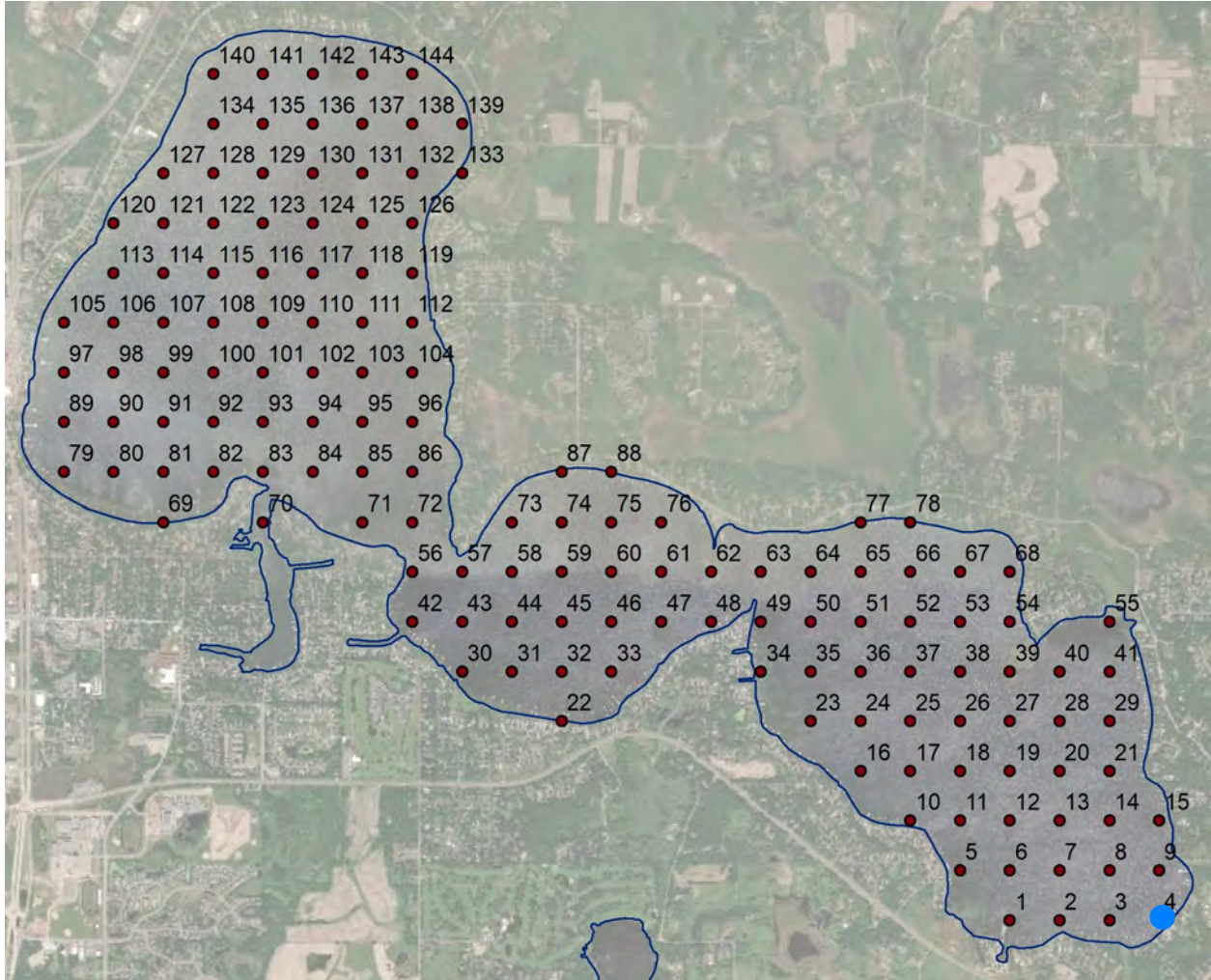


Figure 8. Location of flowering rush in Forest Lake sampled during the point intercept survey on August 8, 2023.

Zebra Mussels: Zebra mussels were first observed in Forest Lake in 2015. Because hard substrate needed for zebra mussel attachment is scarce in Forest Lake, zebra mussels will attach to aquatic plant surfaces. The occurrence of attached zebra mussels to aquatic plants was recorded during the point intercept survey. Zebra mussel distribution is shown in Figure 9. Zebra mussels are distributed throughout all three lakes basins. This map serves as a benchmark for future plant surveys to evaluate if zebra mussels are increasing or decreasing in Forest Lake.

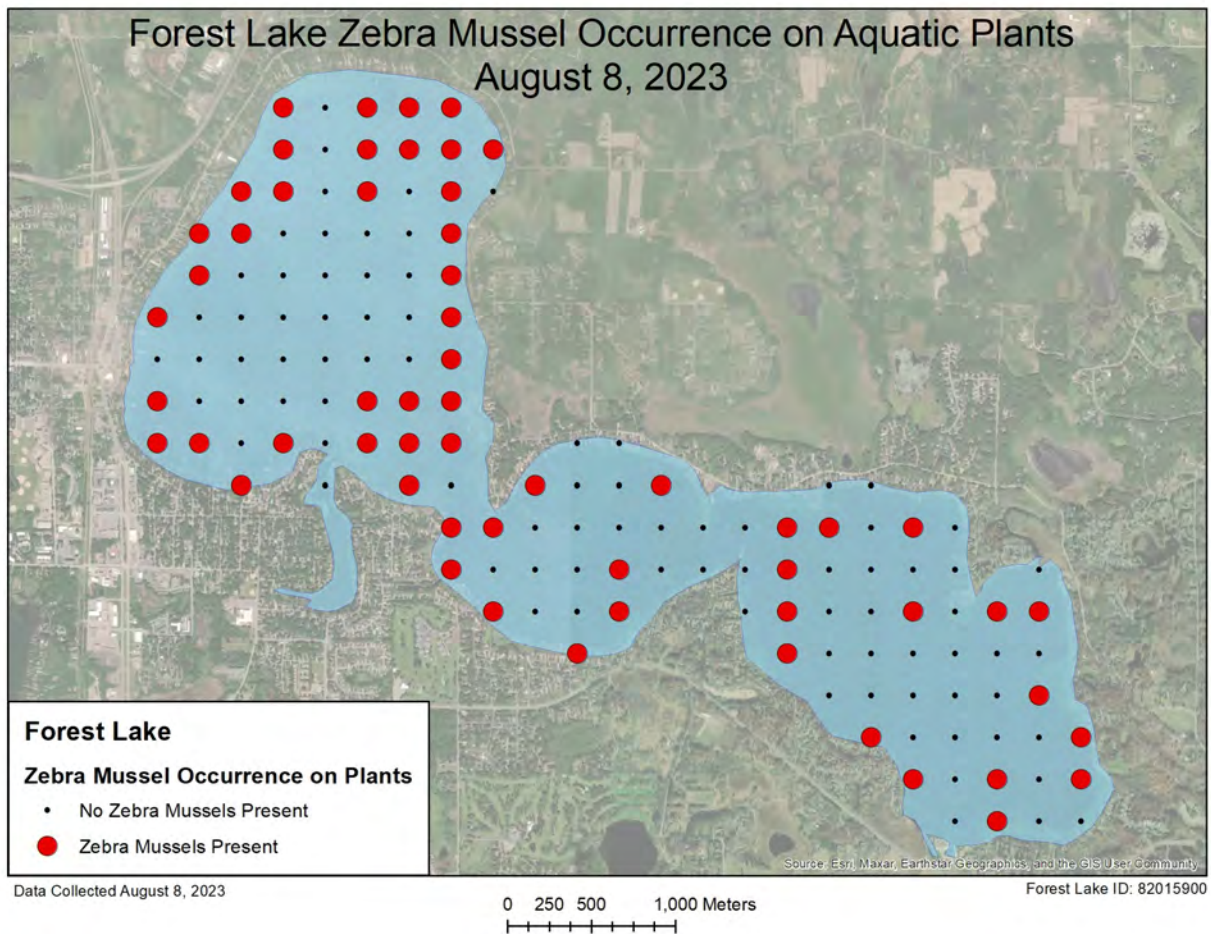


Figure 9. Location of zebra mussels on aquatic plants in Forest Lake sampled during the point intercept survey on August 8, 2023.

APPENDIX

Plant diversity was above average in Forest Lake with a total of 18 submerged aquatic plant species. Coontail was the most common plant followed by water celery.

Aquatic plant occurrence and density for individual sample points in Forest Lake, August 8, 2023.

| Site | Depth (ft) | Bul-rush | Cat-tails | Flower-ing rush | Spatter dock | White lilies | Cab-bage | Chara | Clasp-ingleaf | Coon-tail | CLP | Elodea | EWM | Flat-stem | Fries | Illinois | Naiad | NWM | Sago | Star-duck-weed | Stringy | Water celery | Water star-grass | White-stem | ZM on plants |
|------|------------|----------|-----------|-----------------|--------------|--------------|----------|-------|---------------|-----------|-----|--------|-----|-----------|-------|----------|-------|-----|------|----------------|---------|--------------|------------------|------------|--------------|
| 1 | 3 | | | | | | 1 | 1 | | | | | | | | | | | | | | 1 | | | |
| 2 | 3 | | | | | | | 2 | | | | | | | | | | | | | | 1 | | | 1 |
| 3 | 3 | | | | | | | 1 | | | | | | | | | | 1 | | | | 3 | | | |
| 4 | 2 | | | 1 | | | | 1 | | 1 | | | | | | | | | | | 1 | 1 | | | |
| 5 | 5 | | | | | | | | | 1 | | | | 2 | | | | | | | | 1 | 1 | | 1 |
| 6 | 12 | | | | | | | | | | | | | | | | | | | | | | | | |
| 7 | 8 | | | | | | | | | 2 | | | | | | | | | | | | 1 | | 1 | 1 |
| 8 | 12 | | | | | | | | | | | | | | | | | | | | | | | | |
| 9 | 7 | | | | | | | | | 2 | | | | | | | | | | | | 1 | | | 1 |
| 10 | 5 | | | | | | | 1 | | | | | | | | | | 1 | | | | 1 | 3 | 1 | 1 |
| 11 | 22 | | | | | | | | | | | | | | | | | | | | | | | | |
| 12 | 12 | | | | | | | | | | | | | | | | | | | | | | | | |
| 13 | 22 | | | | | | | | | | | | | | | | | | | | | | | | |
| 14 | 16 | | | | | | | | | | | | | | | | | | | | | | | | |
| 15 | 7 | | | | | | | | | 1 | | | | 1 | | | | | | | | | 2 | | 1 |
| 16 | 16 | | | | | | | | | | | | | | | | | | | | | | 2 | | 1 |
| 20 | 20 | | | | | | | | | | | | | | | | | | | | | | | | |
| 21 | 5 | | | | | | | | | | | | | 1 | | | | | | | | 2 | 3 | | 1 |
| 22 | 4 | | | | | | | | | | | | | 2 | | | | | | | | 1 | 2 | | 1 |
| 23 | 5 | | | | | | | | | | | | | 2 | | | | | | | | 3 | 2 | | 1 |
| 24 | 10 | | | | | | | | | 1 | 1 | | | 3 | | | | | | | | | 2 | | 1 |
| 28 | 19 | | | | | | | | | | | | | | | | | | | | | | | | |
| 29 | 8 | | | | | | | | | | | | | 1 | | | | | | | | | 1 | | |
| 30 | 5 | | | | | | | 1 | | | | | | | 1 | | | | | | | 2 | 1 | | 1 |
| 31 | 16 | | | | | | | | | | | | | | | | | | | | | | | | |
| 33 | 6 | | | | | | | | | | | | | 1 | | | 2 | 3 | | | | 1 | 2 | | 1 |
| 34 | 3 | 1 | | | 1 | | | | | | | | | 1 | | | | | | | | 1 | 1 | | |
| 35 | 9 | | | | | | | | | 2 | | | | | | | | | | | | | | | 1 |
| 38 | 10 | | | | | | | 1 | | 1 | | | | | | | | | | | | | | | 1 |
| 39 | 2 | | | | | | | | | | | | | | | | | | | | | | | 1 | |
| 40 | 8 | | | | | | | | | 3 | | | | 1 | | | | | | | | | | | 1 |
| 41 | 5 | | | | | | | | | 1 | | | | 1 | | | | | | | | 3 | 2 | | 1 |
| 42 | 4 | | | | | | | | | 1 | | 1 | | 1 | | | | | | | | 2 | 1 | | 1 |
| 43 | 14 | | | | | | | | | | | | | | | | | | | | | | | | |
| 46 | 6 | | | | | | | | | 1 | | | | 1 | | | | | | | | | | | 1 |
| 47 | 5 | | | | | | | | 1 | | | | | | | | | | | | 1 | 3 | 2 | | |
| 48 | 6 | | | | | | | | | 1 | | | | 1 | | | | | | | | 3 | | | |
| 49 | 4 | | | | | | | | | | | | | | | 1 | | | | | | 2 | 2 | | |
| 50 | 11 | | | | | | | | | 1 | | | | | | | | | | | | 1 | | | 1 |
| 51 | 20 | | | | | | | | | | | | | | | | | | | | | | | | |
| 52 | 17 | | | | | | | | | | | | | | | | | | | | | | | | |
| 53 | 15 | | | | | | | | | | | | | | | | | | | | | | | | |
| 54 | 2 | | | | | | | | | | | | | | | 1 | | 1 | | | | 2 | 1 | | |
| 55 | 2 | | | | 2 | 2 | | | | 2 | | | | 1 | | | | | | | | 2 | | | |
| 56 | 4 | | | | | | | | | | | | | 1 | | | | | | | | 3 | 1 | 1 | 1 |
| 57 | 8 | | | | | | | | | | | | | | | | | | | | | | | | |
| 58 | 16 | | | | | | | | | | | | | | | | | | | | | | | | |
| 60 | 12 | | | | | | | | | | | | | | | | | | | | | | | | |
| 61 | 15 | | | | | | | | | | | | | | | | | | | | | | | | |
| 61 | 17 | | | | | | | | | | | | | | | | | | | | | | | | |
| 62 | 6 | | | | | | | | | 2 | | | | | | | | | | | | | 2 | | |
| 63 | 11 | | | | | | | | | 1 | | | | | | | | | | | | 1 | | | |
| 64 | 8 | | | | | | | | | 2 | | | | 2 | | | | | | | | | | | 1 |
| 65 | 5 | | | | | | | | | 1 | | | | | | | | | | | | 3 | 2 | | 1 |
| 66 | 11 | | | | | | | | | 1 | | | | | | | | | | | | | | | |
| 67 | 11 | | | | | | | | | 2 | | | | 1 | | | | | | | | | | | 1 |
| 68 | 4 | | | | | | | | | 1 | | | | | | | | | | | | 2 | 2 | | |
| 69 | 3 | | | | | | | 2 | | 1 | | | | | | 1 | 1 | 1 | | | | | 1 | | 1 |
| 70 | 4 | | | | | | | | | 1 | | | | | | | | | | | | | | | |
| 71 | 3 | | | | | | | 1 | | | | | | | | 1 | 2 | 1 | | | | | | | 1 |
| 72 | 7 | | | | | | | | | | | | 1 | 1 | | | | | | | 1 | | 1 | | |
| 73 | 6 | | | | | | | | | | | | | | | | | | | | | 1 | 1 | | |
| 74 | 15 | | | | | | | | | | | | | | | | | | | | | 1 | 2 | | 1 |
| 75 | 8 | | | | | | | | | | | | | | | | | | | | | 3 | | | |
| 76 | 7 | | | | | | | | | 2 | | | | | | | | | | | | 1 | 1 | | 1 |
| 77 | 0.5 | 1 | | | 1 | | | | 1 | | | | | | | | | | | | | | 1 | | |
| 78 | 2 | | | | | | | 1 | | 1 | | | | | | | | | | | | 1 | | | |
| 79 | 10 | | | | | | | | | 3 | | | | 1 | | | 1 | | | | | | 1 | | 1 |
| 80 | 9 | | | | | | | | | 3 | | | | | | | 1 | 1 | | | | | 1 | | 1 |
| 81 | 15 | | | | | | | | | | | | | | | | | | | | | | | | |
| 82 | 3 | | | | | | | 3 | | | | | | | | | 1 | | | | | | 1 | 1 | 1 |

Aquatic plant occurrence and density for individual sample points in Forest Lake, August 8, 2023.

| Site | Depth (ft) | Bul-rush | Cat-tails | Flower-ing rush | Spatter-dock | White-lilies | Cab-bage | Chara | Clasp-ingleaf | Coon-tail | CLP | Elodea | EWM | Flat-stem | Fries | Illinois | Naiad | NWM | Sago | Star-duck-weed | Stringy | Water-celery | Water-star-grass | White-stem | ZM on plants | |
|--------------------------------|------------|----------|-----------|-----------------|--------------|--------------|----------|-------|---------------|-----------|-----|--------|-----|-----------|-------|----------|-------|-----|------|----------------|---------|--------------|------------------|------------|--------------|----|
| 83 | 2 | 3 | | | | 1 | | | | | | | | | | | | | | | | | | | | |
| 84 | 11 | | | | | | | | | 2 | | 3 | | | | | | 1 | | | | | | | | 1 |
| 85 | 5 | | | | | | | | | | | | | | | | 1 | | | | | 2 | 1 | | | 1 |
| 86 | 8 | | | | | | | | | 2 | | | 1 | 1 | | | | | | | | 1 | | | 1 | 1 |
| 87 | 4 | | | | | | | | | | | | | 1 | | | 1 | | | | | 3 | 1 | 1 | | 1 |
| 88 | 4 | | | | | | | | | | | | | | | | | | | | | 3 | 1 | 1 | | |
| 89 | 9 | | | | | | | | | 1 | | | | | | | | | | | | | 1 | | | 1 |
| 90 | 15 | | | | | | | | | | | | | | | | | | | | | | | | | |
| 92 | 10 | | | | | | | | | 2 | | | | | | | | | | | | | | | | |
| 93 | 17 | | | | | | | | | | | | | | | | | | | | | | | | | |
| 94 | 10 | | | | | | | | | 2 | | | | | | | | | | | | | | | | 1 |
| 95 | 4 | | | | | | | 1 | | | | | | | | | 1 | | | | | | | 1 | | 1 |
| 96 | 8 | | | | | | | | | 1 | | | 3 | 1 | | | | | 1 | | | | | | | 1 |
| 97 | 7 | | | | | | | | | | | 1 | | 1 | | | | | 1 | | | | | | | |
| 100 | 17 | | | | | | | | | | | | | 1 | | | | | | | | | 3 | | | |
| 101 | 15 | | | | | | | | | 1 | | | | | | | | | | | | | | | | |
| 102 | 16 | | | | | | | | | | | | | | | | | | | | | | | | | |
| 103 | 15 | | | | | | | | | | | | | | | | | | | | | | | | | |
| 104 | 6 | | | | | | | | | | | | | 2 | | | | | 1 | | | 1 | 1 | | | 1 |
| 105 | 5 | | | | | | | | | | | | | 2 | | | | | | | 1 | | 1 | | | 1 |
| 106 | 16 | | | | | | | | | | | | | | | | | | | | | | | | | |
| 112 | 6 | | | | | | | | | | | | | | | | | | | | | 1 | 1 | 1 | 1 | 1 |
| 113 | 8 | | | | | | | | 1 | 2 | | | | 1 | | | 1 | 1 | | | 1 | 1 | | | | 1 |
| 114 | 10 | | | | | | | | | 1 | | | | | | | | | | | | | | | | |
| 115 | 16 | | | | | | | | | | | | | | | | | | | | | | | | | |
| 118 | 15 | | | | | | | | | | | | | | | | | | | | 1 | | | | | |
| 119 | 5 | | | | | | | 1 | | 1 | | | | | | | | | | | | | 1 | | | 1 |
| 120 | 2 | | | | | | | | | | | | | | | 1 | 1 | | | | | 1 | | | | 1 |
| 121 | 11 | | | | | | | | | 2 | | | 1 | | | | 1 | | | | 1 | | | | | 1 |
| 122 | 11 | | | | | | | | | 1 | | | | | | | | | | | 1 | | 1 | | | 1 |
| 126 | 4 | | | | | | | | | 1 | | | | | | 1 | | | | | | 1 | 1 | | 1 | 1 |
| 127 | 4 | | | | | | | | | | | | | 1 | | | 2 | 1 | | | | | 1 | | | 1 |
| 128 | 12 | | | | | | | | | 1 | | | 1 | | | | | | | | | | | | | 1 |
| 129 | 10 | | | | | | | | | 1 | | | | | | | 1 | | | | | | | | | |
| 130 | 10 | | | | | | | | | 2 | | | | | | | | | | | | | | | | 1 |
| 131 | 16 | | | | | | | | | | | | | | | | | | | | | | | | | |
| 132 | 11 | | | | | | | | | 3 | | | | | | | | | | | | | | | | 1 |
| 133 | 3 | | | | | | | 1 | | | | | | | | | 1 | | | | | | | | | |
| 134 | 10 | | | | | | | | | 1 | | 1 | | | | | 1 | | | | | | | | | 1 |
| 135 | 16 | | | | | | | | | | | | | | | | | | | | | | | | | |
| 136 | 5 | | | | | | | 1 | | 1 | | | | | | | 1 | | | | | | | | | 1 |
| 137 | 13 | | | | | | | | | 1 | | | | | | | 1 | | | | 1 | | | | | 1 |
| 138 | 9 | | | | | | | | | 1 | 1 | | | | | | 1 | | | | 1 | | | | | 1 |
| 139 | 4 | | | | | | 1 | | | | | | | 1 | | | | | 2 | | | 1 | | 1 | | 1 |
| 140 | 7 | | | | | | | | 1 | 1 | 1 | | | | | | | | | | 1 | | | | | 1 |
| 141 | 9 | | | | | | | | | 1 | | | | | | | | | | | | | | | | |
| 142 | 4 | | | | | | | 2 | | | | | | | | | | | | | | | 1 | | | 1 |
| 143 | 3 | | | | | | | 2 | | | | | | | | | 1 | | | | | | | | | 1 |
| 144 | 6 | | | | | | | | | 1 | | | | | | | 1 | | | | | | | | | 1 |
| Average | | 2.0 | 1.0 | 1.0 | 1.3 | 1.5 | 1.0 | 1.4 | 1.0 | 1.4 | 1.0 | 1.5 | 1.4 | 1.2 | 1.0 | 1.0 | 1.1 | 1.7 | 1.0 | 1.0 | 1.0 | 1.8 | 1.3 | 1.0 | | |
| Occur out to 15 ft (102 sites) | | 2 | 1 | 1 | 3 | 2 | 2 | 17 | 4 | 53 | 3 | 4 | 5 | 28 | 1 | 6 | 21 | 37 | 1 | 2 | 13 | 43 | 38 | 8 | | 58 |
| % occur | | 2 | 1 | 1 | 3 | 2 | 2 | 17 | 4 | 52 | 3 | 4 | 5 | 27 | 1 | 6 | 21 | 36 | 1 | 2 | 13 | 42 | 37 | 8 | | |



Water Lilies were Common in Comfort Lake on August 8, 2023

Curlyleaf Pondweed and Eurasian Watermilfoil Management and Point Intercept Surveys for Comfort Lake, Chisago County, 2023

June 2, 2022: Whole Lake Fluridone Treatment

| | Delineation | Treatment | Assessment |
|-----|--------------------|------------------------------|---------------------------|
| CLP | April 24, 2023 | No Treatment | June 2, 2023 |
| EWM | April 24, 2023 | September 19, 2023 (2.77 ac) | June 2 and August 8, 2023 |

Meander Surveys: April 24 and August 8, 2023

Point Intercept Survey: June 2, 2023

Prepared for:
**Comfort Lake/Forest
 Lake Watershed District
 Forest Lake, Minnesota**



December 6, 2023

Prepared by:
**SteveMcComas
 Blue Water Science
 St. Paul, MN 55116**

Curlyleaf Pondweed and Eurasian Watermilfoil Management and Point Intercept Surveys for Comfort Lake, Chisago County, 2023

Summary

Surveys were conducted on 3 dates in Comfort Lake in 2023. On April 24, 2023 a meander survey was completed, on June 2, 2023 a meander survey was combined with a point intercept survey, and on August 8, 2023 a meander survey was conducted.

Curlyleaf Pondweed Delineation and Assessment Surveys: Curlyleaf pondweed delineation for distribution and abundance was conducted on April 24, 2023. A follow-up curlyleaf assessment was conducted on June 2, 2023.

In the delineation survey, curlyleaf was found in Comfort Lake at 4 sites (Figure 1) and a few native plants were sampled as well.

Curlyleaf pondweed was not treated in 2023.

A little over a month later, the June curlyleaf assessment included a point intercept survey combined with a meander survey. Curlyleaf was found at a total of 32 sites and growth was mostly light (Figure 1).

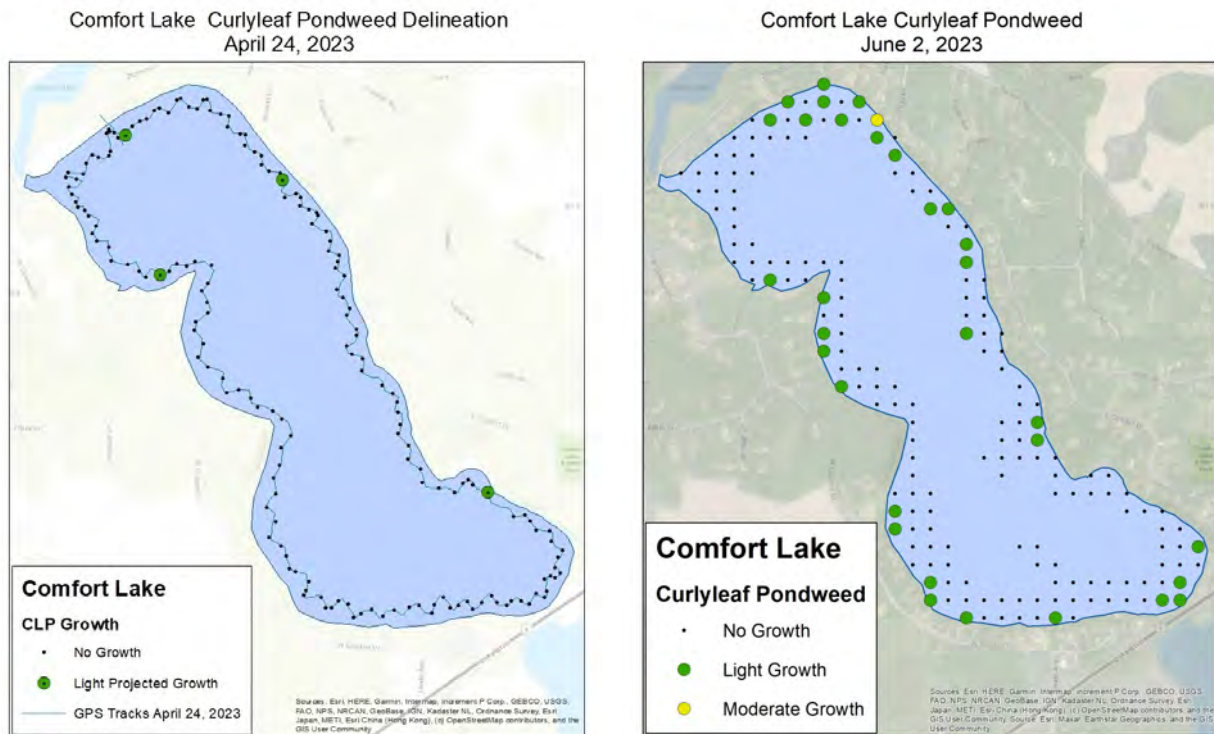


Figure 1. [left] DELINEATION: Map of curlyleaf pondweed distribution from the April 24, 2023 meander survey. Key: black dots = sample locations and green dot = light growth potential.

TREATMENT: No curlyleaf pondweed treatment occurred in 2023.

[right] ASSESSMENT: Map of curlyleaf pondweed assessment sites for June 2, 2023 included a point intercept combined with a meander survey. Key: black dots = no curlyleaf growth, green dots = light growth, and yellow dots = moderate growth.

Eurasian Watermilfoil Delineation, Treatment, and Assessment Surveys: A whole lake EWM treatment using Fluridone was conducted on June 22, 2022. Surveys in 2023 were intended to assess results from the 2022 whole lake treatment and delineate and assess 2023 EWM growth. An EWM delineation for distribution and abundance was conducted on April 24, 2023 and EWM was not observed at any of the sample sites. A point intercept survey combined with a meander survey was conducted on June 2, 2023. Eurasian watermilfoil was found at 3 meander sites and 1 point intercept site on June 2, 2023 (Figure 2). Another meander survey was conducted on August 8, 2023 and EWM was sampled at 21 sites. Based on the August findings, 2.77 acres of EWM were delineated for treatment.

A treatment of 2.77 acres of EWM was conducted on September 19, 2023 in 2 areas on Comfort Lake using ProcellaCOR (Figure 2).

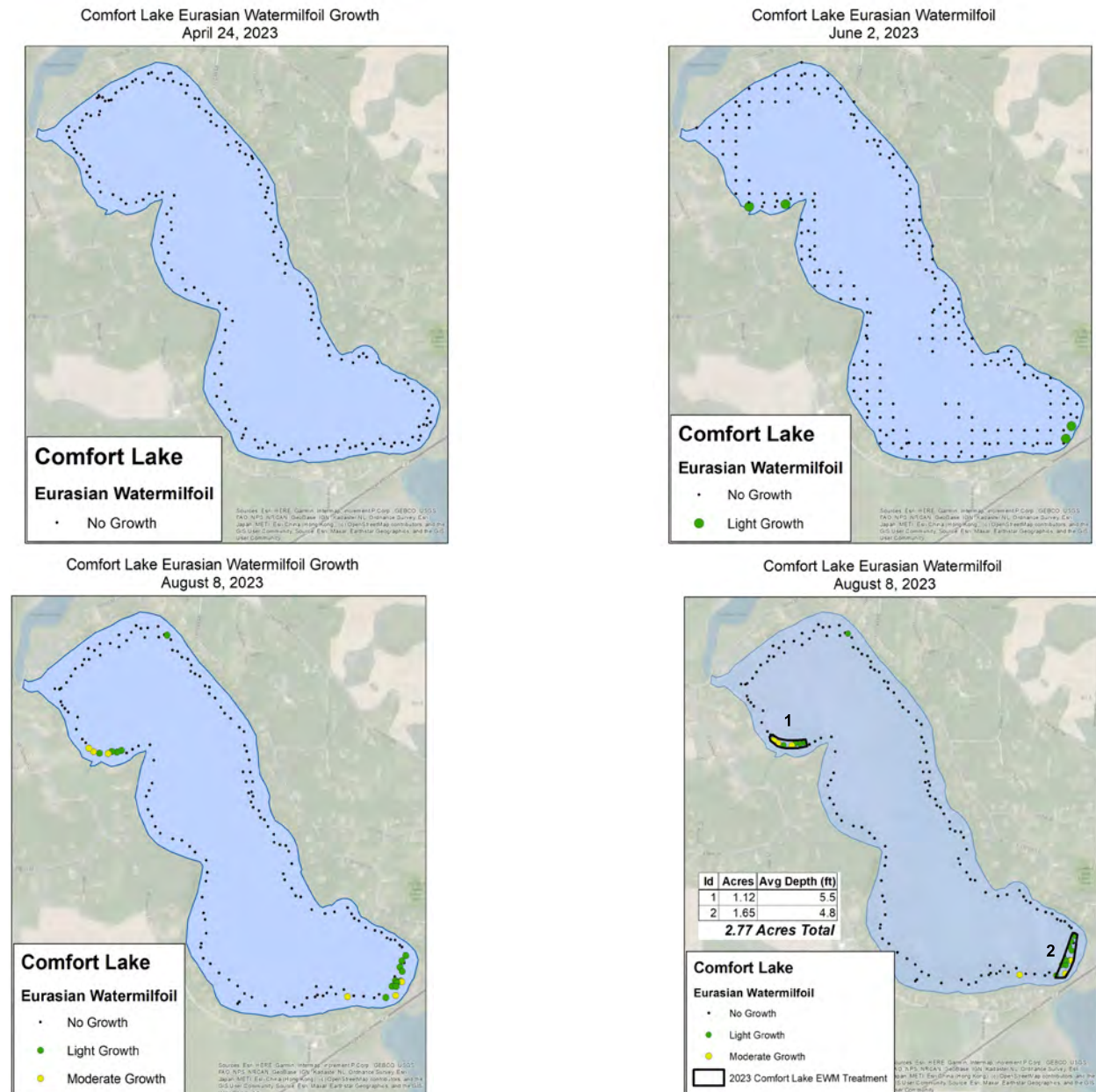


Figure 2. [top-left] DELINEATION: Map of EWM distribution from the April 24, 2023 survey. No EWM was sampled. **[top-right] ASSESSMENT:** Map of point intercept and meander survey for June 2, 2023. EWM was found at 4 sites and all light growth. **[bottom-left] DELINEATION/ASSESSMENT:** Map of a meander survey on August 8, 2023. EWM was found at 21 sites. **[bottom-right] TREATMENT:** Map of meander survey for August 8, 2023 showing the two treatment areas. EWM was treated on September 19, 2023.

Curlyleaf Pondweed and Eurasian Watermilfoil Treatments from 2014 Through 2023: A summary of CLP and EWM treatments from 2014-2023 is shown in Figure 3. Curlyleaf was only treated at 1 acre in 2015. Curlyleaf has been sparse in Comfort Lake since then. EWM was first observed in 2014 and it has spread around the lake in the last few years. A total of 7.5 acres was treated in 2016 and 3.2 acres were treated in 2017. Spot herbicide treatments were conducted from 2018 to 2021 in nearshore areas by the Comfort Lake Association. On June 22, 2022 a whole lake fluridone treatment of 218 acres was conducted and on September 19, 2023 two areas totaling 2.77 acres were treated.

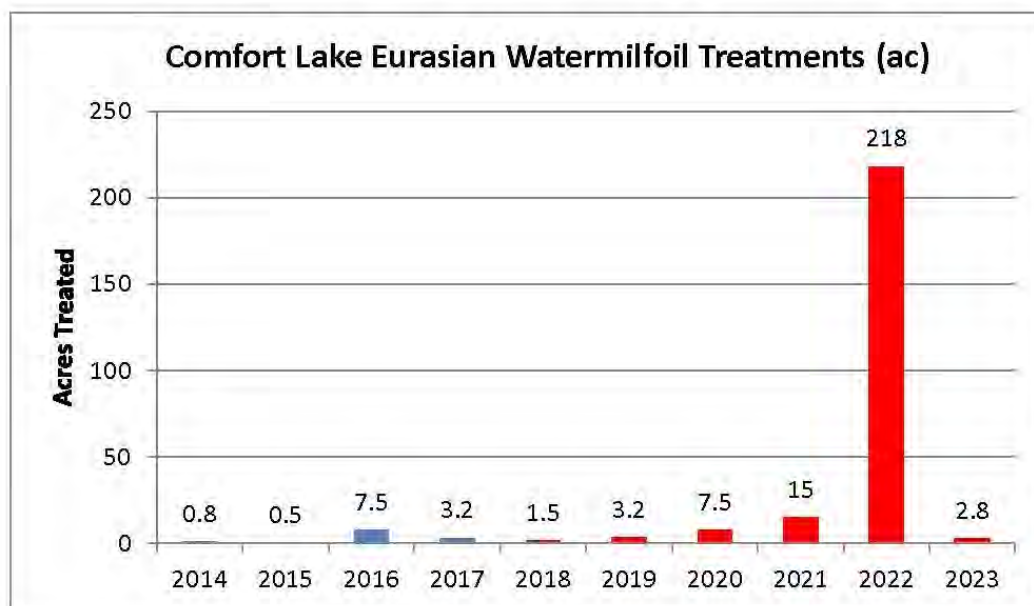
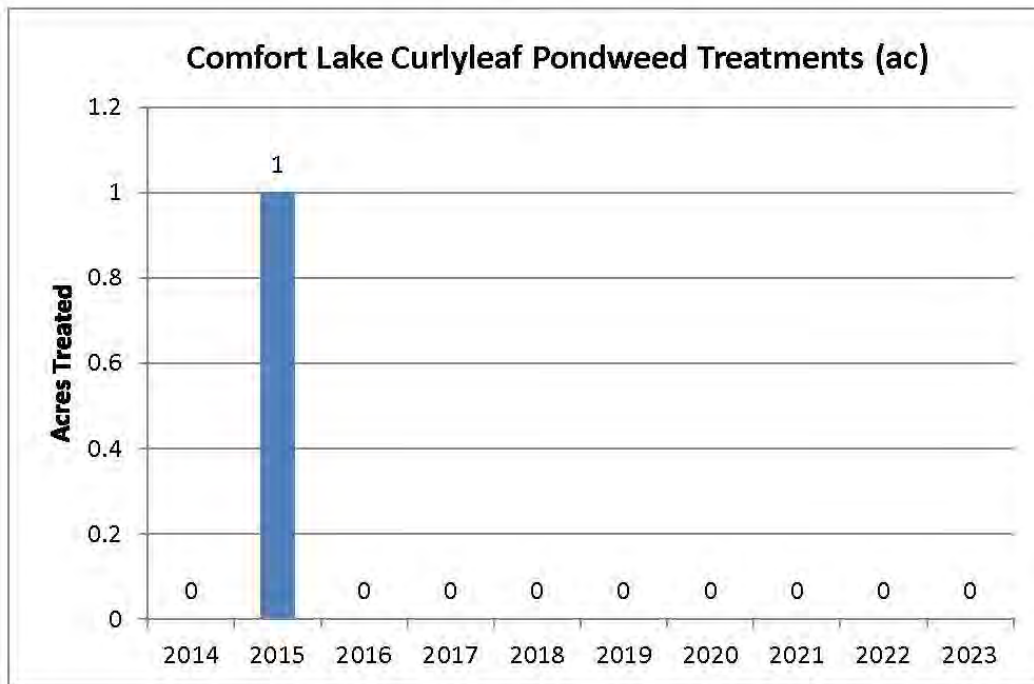


Figure 3. CLFLWD Sponsored Treatments with blue bars and Comfort Lake Association sponsored treatments with red bars: [top] Curlyleaf pondweed treated in 2014-2023. [bottom] Eurasian watermilfoil treated in 2014-2023 (2018 is estimated based on individual permits and 2019, 2020, and 2021 treatments were by the Comfort Lake Association). A full lake fluridone treatment was conducted in 2022. An EWM treatment of 2.77 acres occurred in 2023.

Comparison of Point Intercept Surveys in 2022 and 2023: Results of aquatic plant occurrence for the 2022 and 2023 point intercept surveys are shown in Table 1. A whole lake fluridone herbicide treatment was conducted on June 22, 2022. The results of the September 2022 point intercept survey which reflects the impact of the fluridone treatment showed a significant decrease in EWM. Several other aquatic plant species also decreased in occurrence in September of 2022 compared to the June 10, 2022 survey.

A point intercept survey conducted on June 2, 2023 showed a decrease in EWM compared to June 10, 2022. An increase in submerged aquatic plants was observed compared to the September 15, 2022 survey. Eurasian watermilfoil was found in 1 sample site on June 2, 2023 point intercept survey growing at light conditions. The fluridone treatment reduced EWM in 2022 and through June of 2023. Future surveys will track EWM occurrences.

Table 1. Comfort Lake aquatic plant occurrences for the two point intercept surveys in 2022 and one survey in 2023. All three surveys used the same sample grid based on 180 sample sites.

| | June 10, 2022 | Sept 15, 2022 | June 2, 2023 |
|--|---------------|---------------|--------------|
| Bulrush (<i>Typha sp</i>) | 2 | 1 | 2 |
| Spatterdock (<i>Nuphar advena</i>) | 25 | 51 | 6 |
| White lilies (<i>Nymphaea odorata</i>) | 35 | 19 | 28 |
| Cabbage (<i>Potamogeton amplifolius</i>) | 3 | 2 | 13 |
| Chara (<i>Chara sp</i>) | 18 | | 5 |
| Coontail (<i>Ceratophyllum demersum</i>) | 26 | 3 | 6 |
| Curlyleaf (<i>P. crispus</i>) | 26 | | 32 |
| Elodea (<i>Elodea canadensis</i>) | 16 | | |
| EWM (<i>Myriophyllum spicatum</i>) | 35 | | 1 |
| Flatstem (<i>P. zosteriformis</i>) | 9 | 1 | 7 |
| Illinois (<i>P. illinoensis</i>) | 2 | | |
| Naiad (<i>Najas sp</i>) | 7 | | |
| Narrowleaf (<i>P. sp</i>) | | | 1 |
| NWM (<i>M. sibiricum</i>) | 1 | | |
| Sago (<i>Stuckenia pectinata</i>) | | 2 | 7 |
| Stringy (<i>P. sp</i>) | 10 | | 29 |
| Water celery (<i>Vallisneria americana</i>) | 1 | | |
| Water stargrass (<i>Heteranthera dubia</i>) | | | 1 |
| Total number of species | 15 | 7 | 13 |



Figure 4. Eurasian watermilfoil on June 2, 2023.

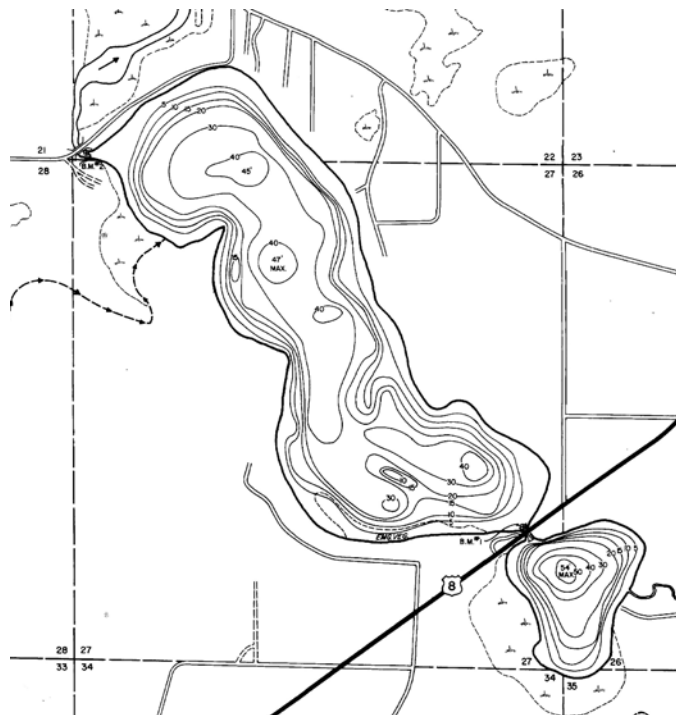
Curlyleaf Pondweed and Eurasian Watermilfoil Management and Point Intercept Surveys for Comfort Lake, Chisago County, 2023

Introduction and Methods

Comfort Lake has an area of 218 acres with a littoral area of 90 acres (MnDNR). The maximum depth of Comfort Lake is 37 feet. Curlyleaf pondweed (CLP) and Eurasian watermilfoil (EWM) have been managed in Comfort Lake since at least 2014. The objectives of the curlyleaf surveys were to delineate the acreage of curlyleaf pondweed to treat and then treat is necessary and then after treatment, assess the effectiveness of the treatment. The objectives of the Eurasian watermilfoil (EWM) surveys were to delineate the acreage of EWM to treat and then treat is necessary and then after treatment, assess the effectiveness of the treatment.

Curlyleaf Pondweed Delineation and Assessment Methods: An initial curlyleaf pondweed delineation was conducted on April 24, 2023. The entire perimeter of the lake was checked for curlyleaf pondweed. A total of 176 sites were sampled for aquatic plants. A follow-up curlyleaf pondweed assessment was conducted on June 2, 2023 to characterize the status of curlyleaf pondweed at it's peak growing period. The methodology that was used for the assessment included a point intercept survey combined with a meander survey. A total of 240 sites were sampled for aquatic plants.

Eurasian Watermilfoil Delineation and Assessment Methods: An initial EWM delineation was conducted on April 24, 2023 with a meander survey. The entire perimeter of the lake was checked for EWM. A total of 176 sites were sampled for aquatic plants.



An EWM assessment was conducted on June 2, 2023. In this survey a meander survey was combined with a point intercept survey. A total of 60 meander points were sampled along with 180 point intercept points for a total of 240 points.

An additional EWM assessment was conducted on August 8, 2023 with a meander survey. The entire perimeter of the lake was checked for EWM. A total of 150 sites were sampled for aquatic plants.

Figure 5. Contour map of Comfort Lake (source: MnDNR).

Point Intercept Survey Methods: A point intercept aquatic plant survey of Comfort Lake was conducted by Blue Water Science on June 2, 2023 and 180 points were sampled (Figure 6). The deepest depth of plant colonization in Comfort Lake was out to 8 feet on June 2, 2023. Sample points were placed 50 meters apart on a grid that covered the lake. Each sample point was equal to 0.62 acres. At each sample point, a sampling rake was lowered into the water and a plant sample was taken. The plant species were recorded and the density of each species was assigned. Densities were based on the coverage on the teeth of the rake. Density ratings were from 1 to 3 with 1 being sparse and 3 being a matted nuisance (Figure 7). Based on these sample sites, plant distribution maps were constructed.

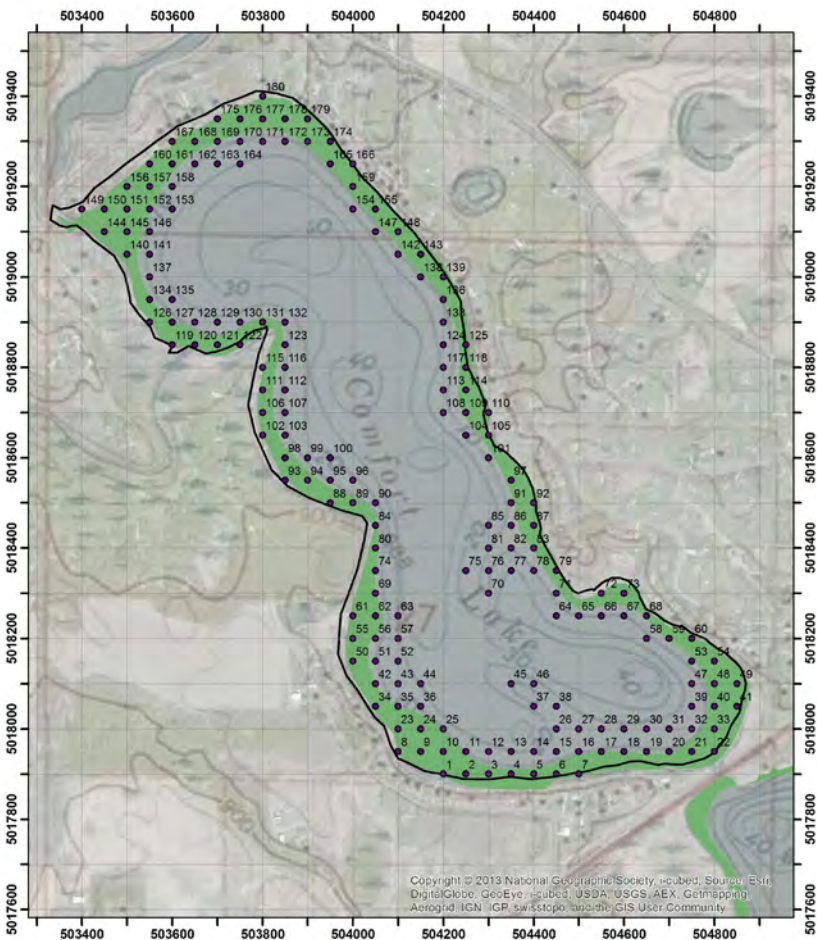


Figure 6. Sample location map for the aquatic plant surveys conducted on Comfort Lake. Green shading represents the littoral zone of Comfort Lake.

Chart of Aquatic Plant Density Ratings

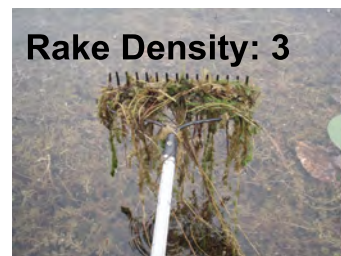
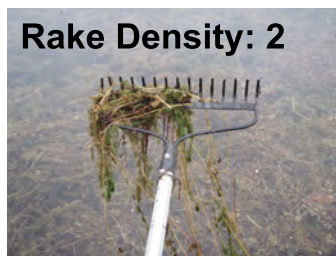
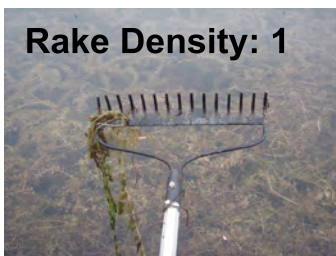


Figure 7. Aquatic plant density ratings from 1 to 3.

Curlyleaf Pondweed Results

April 24, 2023 Delineation and June 2, 2023 Assessment

A curlyleaf delineation was conducted using a meander rake sampling survey on April 24, 2023 and 176 sites were examined. Curlyleaf was found at 4 sites in Comfort Lake (Table 2 and Figure 8). No curlyleaf treatment occurred in 2023.

A curlyleaf assessment occurred on June 2, 2023 using both a meander survey and a point intercept survey. A total of 240 sites were sampled. Curlyleaf was found at 32 sample sites in the point intercept survey (180 sample sites total). Curlyleaf growth was mostly light (Figure 8 and Table 2).

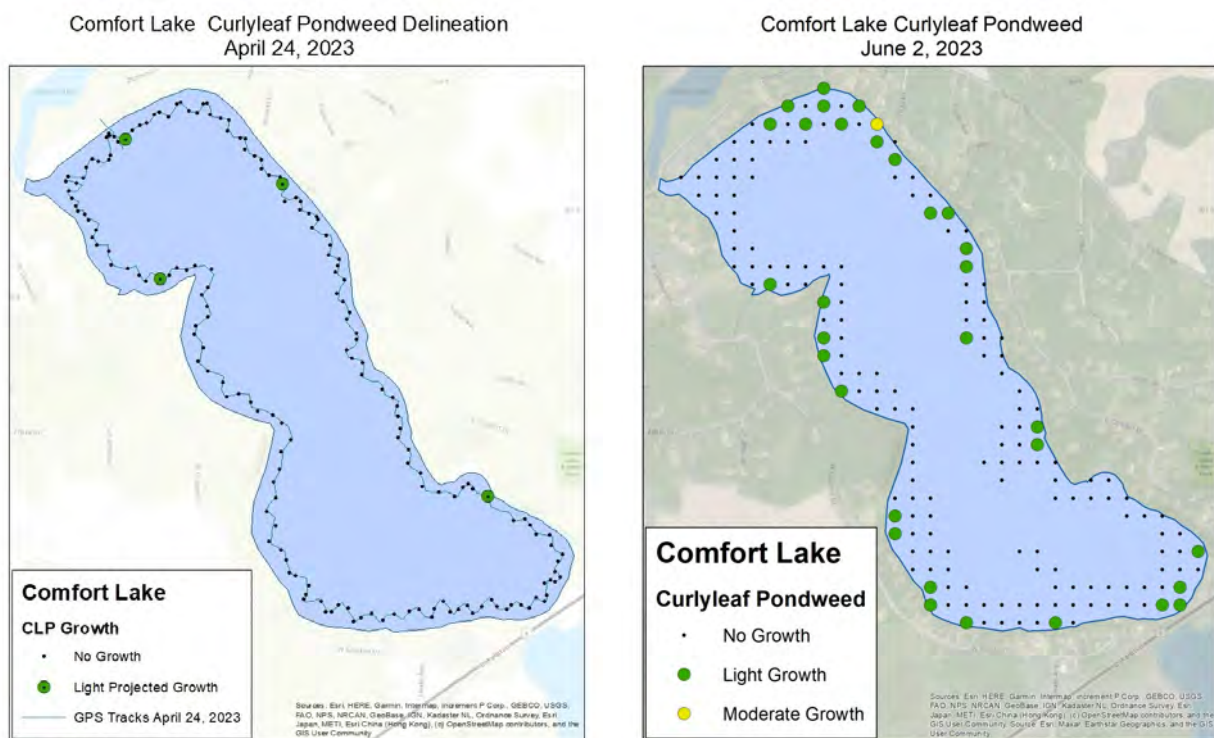


Figure 8. [left] DELINEATION: Map of curlyleaf pondweed distribution from the April 24, 2023 meander survey. Key: black dots = sample locations and green dot = light growth potential. **TREATMENT:** No curlyleaf pondweed treatment occurred in 2023. **[right] ASSESSMENT:** Map of curlyleaf pondweed assessment sites for June 2, 2023 included a point intercept combined with a meander survey. Key: black dots = no curlyleaf growth, green dots = light growth, and yellow dots = moderate growth.

Table 2. Occurrences of curlyleaf pondweed for the April 24, 2023 and delineation using a meandering survey. EWM was not sampled on April 24, 2023.

| | Curlyleaf | EWM |
|------------------------|-----------|-----|
| April 24, 2023 | | |
| Occurrence (176 sites) | 4 | 0 |
| June 2, 2023 | | |
| Occurrence (240 sites) | 32 | 4 |

Eurasian Watermilfoil Results

April 24, 2023 Delineation: An EWM delineation was conducted using a meander rake sampling survey on April 24, 2023 and 176 sites were examined. EWM was not found in Comfort Lake on April 24, 2023 (Table 3).

June 2, 2023 Assessment: On June 2, 2023, an EWM assessment survey using both a meander survey combined with a point intercept survey found EWM at 4 sample sites out of the 240 sites (Figure 9 and Table 3).

August 8, 2023 Assessment: On August 8, 2023, an EWM assessment survey using a meander survey found EWM at 21 sample sites out of the 150 sites (Figure 9 and Table 3).

September 19, 2023 EWM Treatment: An EWM treatment on 2.77 acres was conducted on September 19, 2023 using ProcellaCOR herbicide.

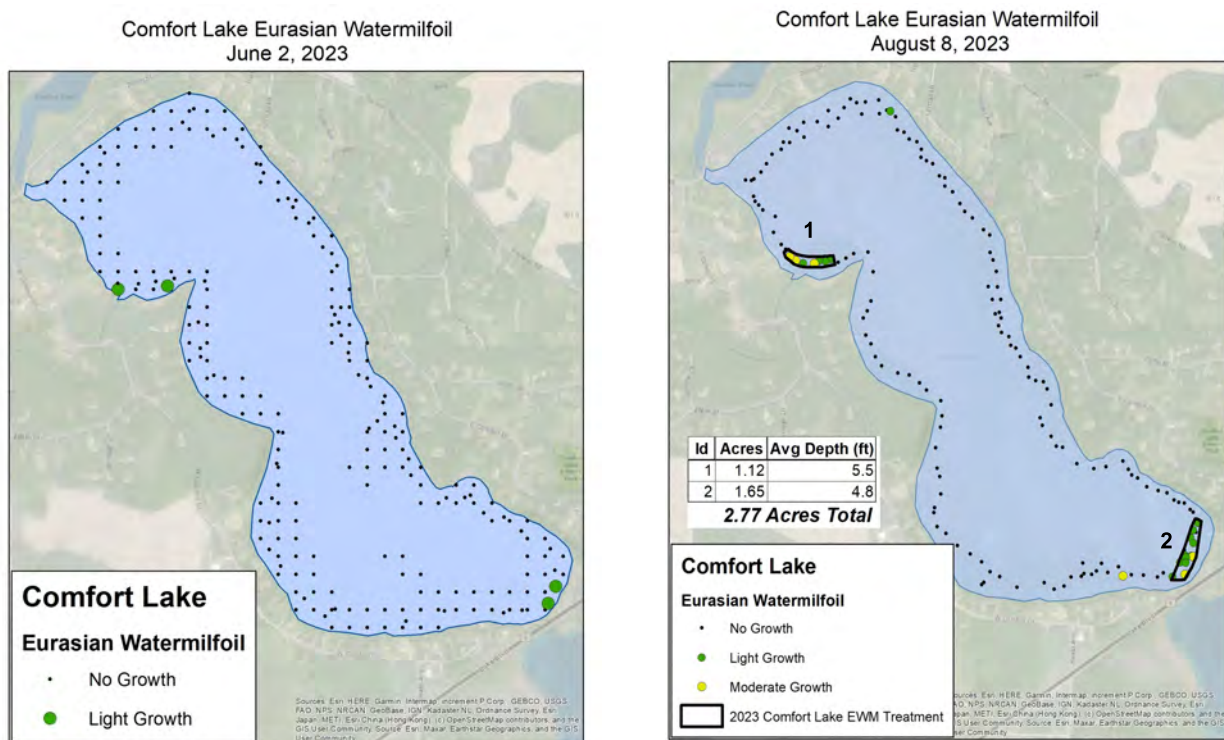


Figure 9. ASSESSMENT: Map of EWM distribution from the June 2, 2023 (left) survey. EWM was sampled at 4 sites. Map of EWM distribution from the August 8, 2023 (right) survey. EWM was sampled at 21 sites and 2 areas totaling 2.77 acres were treated on September 19, 2023.

Table 3. Eurasian watermilfoil occurrences from the EWM surveys.

| Survey | April 24, 2023 | June 2, 2023 | August 8, 2023 |
|-----------------|----------------|--------------|----------------|
| Meander | 0 | 3 | 21 |
| Point Intercept | 0 | 1 | 0 |
| Total Sites | 176 | 240 | 150 |

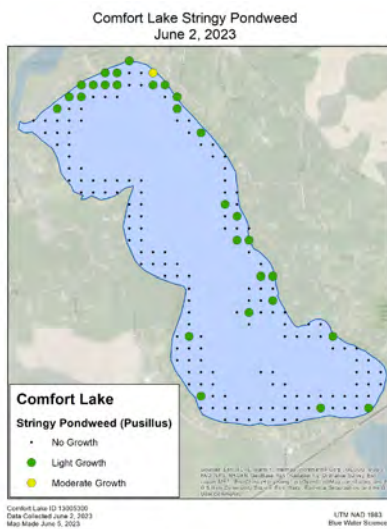
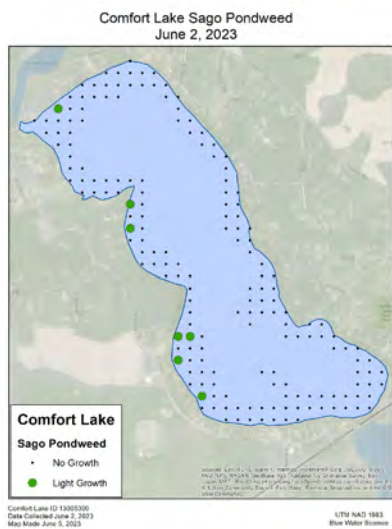
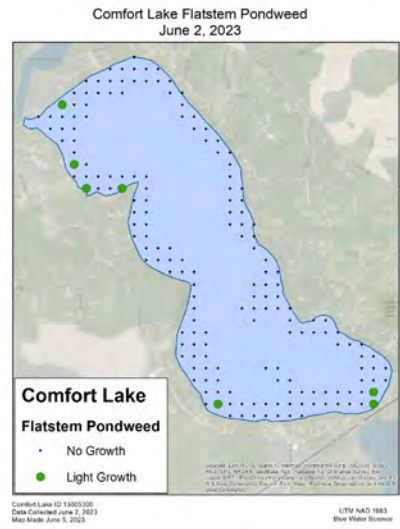
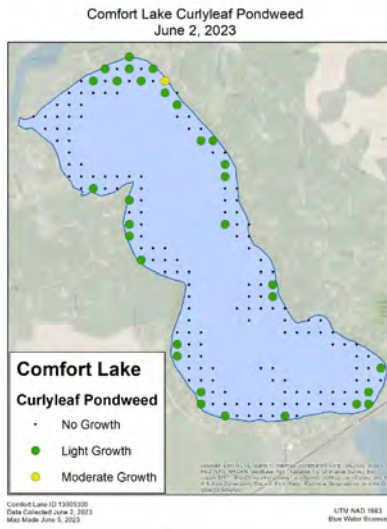
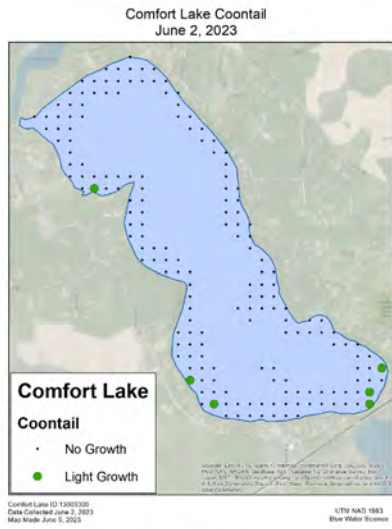
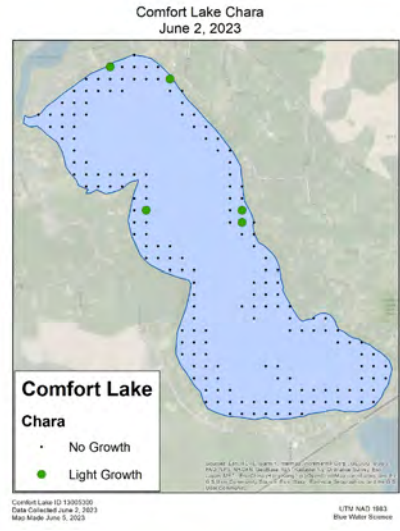
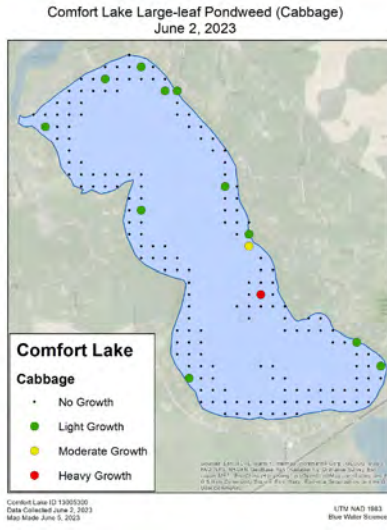
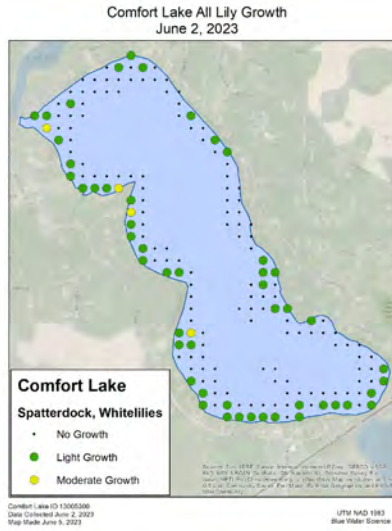
Point Intercept Survey of June 2, 2023

A whole lake fluridone herbicide treatment was conducted on June 22, 2022. The point intercept survey that was conducted on June 2, 2023 found 13 species of aquatic plants (Table 4). Eurasian watermilfoil was found at 1 sample site on June 2, 2023 growing at light conditions. The dominant plant in June was curlyleaf pondweed followed by a stringy pondweed (Table 4).

Table 4. Comfort Lake aquatic plant occurrences for the June 2, 2023 point intercept survey. Based on 180 sample sites.

| | June 2, 2023 |
|--|--------------|
| Bulrush (<i>Typha sp</i>) | 2 |
| Spatterdock (<i>Nuphar advena</i>) | 6 |
| White lilies (<i>Nymphaea odorata</i>) | 28 |
| Cabbage (<i>Potamogeton amplifolius</i>) | 13 |
| Chara (<i>Chara sp</i>) | 5 |
| Coontail (<i>Ceratophyllum demersum</i>) | 6 |
| Curlyleaf (<i>P. crispus</i>) | 32 |
| EWM (<i>Myriophyllum spicatum</i>) | 1 |
| Flatstem (<i>P. zosteriformis</i>) | 7 |
| Narrowleaf (<i>P. sp</i>) | 1 |
| Sago (<i>Stuckenia pectinata</i>) | 7 |
| Stringy (<i>P. sp</i>) | 29 |
| Water stargrass (<i>Heteranthera dubia</i>) | 1 |
| Total number of species | 13 |

Point Intercept Aquatic Plant Maps - June 2, 2023



Comparison of Point Intercept Surveys in 2022 and 2023

Results of aquatic plant occurrence for the 2022 and 2023 point intercept surveys are shown in Table 5. A whole lake fluridone herbicide treatment was conducted on June 22, 2022. The results of the September 2022 point intercept survey which reflects the impact of the fluridone treatment showed a significant decrease in EWM. Several other aquatic plant species also decreased in occurrence in September of 2022 compared to the June 10, 2022 survey.

A point intercept survey was conducted on June 2, 2023 showed a decrease in EWM compared to June 10, 2022. An increase in submerged aquatic plants was observed compared to the September 15, 2022 survey. Eurasian watermilfoil was found in 1 sample site on June 2, 2023 point intercept survey growing at light conditions. The fluridone treatment reduced EWM in 2022 and through June of 2023. Future surveys will track EWM occurrences.

Table 5. Comfort Lake aquatic plant occurrences for the two point intercept surveys in 2022 and one survey in 2023 based on 180 sample sites for each of the surveys.

| | June 10, 2022 | Sept 15, 2022 | June 2, 2023 |
|--|---------------|---------------|--------------|
| Bulrush (<i>Typha sp</i>) | 2 | 1 | 2 |
| Spatterdock (<i>Nuphar advena</i>) | 25 | 51 | 6 |
| White lilies (<i>Nymphaea odorata</i>) | 35 | 19 | 28 |
| Cabbage (<i>Potamogeton amplifolius</i>) | 3 | 2 | 13 |
| Chara (<i>Chara sp</i>) | 18 | | 5 |
| Coontail (<i>Ceratophyllum demersum</i>) | 26 | 3 | 6 |
| Curlyleaf (<i>P. crispus</i>) | 26 | | 32 |
| Elodea (<i>Elodea canadensis</i>) | 16 | | |
| EWM (<i>Myriophyllum spicatum</i>) | 35 | | 1 |
| Flatstem (<i>P. zosteriformis</i>) | 9 | 1 | 7 |
| Illinois (<i>P. illinoensis</i>) | 2 | | |
| Naiad (<i>Najas sp</i>) | 7 | | |
| Narrowleaf (<i>P. sp</i>) | | | 1 |
| NWM (<i>M. sibiricum</i>) | 1 | | |
| Sago (<i>Stuckenia pectinata</i>) | | 2 | 7 |
| Stringy (<i>P. sp</i>) | 10 | | 29 |
| Water celery (<i>Vallisneria americana</i>) | 1 | | |
| Water stargrass (<i>Heteranthera dubia</i>) | | | 1 |
| Total number of species | 15 | 7 | 13 |

Point Intercept Survey Statistics (using the MnDNR format)

| | June 10, 2022 | Sept 15, 2022 | June 2, 2023 |
|---------------------------------------|---------------|---------------|--------------|
| Total # Points Sampled | 155 | 116 | 149 |
| Depth Range of Rooted Veg | 1-9 feet | 1-5 feet | 1-8 feet |
| Maximum Depth of Growth (95%) in feet | 7 | 5 | 6 |
| # Points in Max Depth Range | 99 | 92 | 108 |
| # Points in Littoral Zone (0-15 feet) | 135 | 114 | 141 |
| % Points w/ Submersed Native Taxa | 42 | 7 | 36 |
| Mean Submersed Native Taxa/Point | 0.7 | 0.1 | 0.5 |
| # Submersed Native Taxa | 11 | 4 | 9 |
| # Submersed Invasive Taxa | 2 | 0 | 2 |
| Max Depth of EWM in feet | 7 | 0 | 3 |
| % Frequency of EWM | 26 | 0 | 1 |
| Mode Rake Abundance of EWM | 1 | 0 | 1 |
| Max Depth of CLP in feet | 9 | 0 | 8 |
| % Frequency of CLP | 19 | 0 | 23 |
| Mode Rake Abundance of CLP | 1 | 0 | 1 |

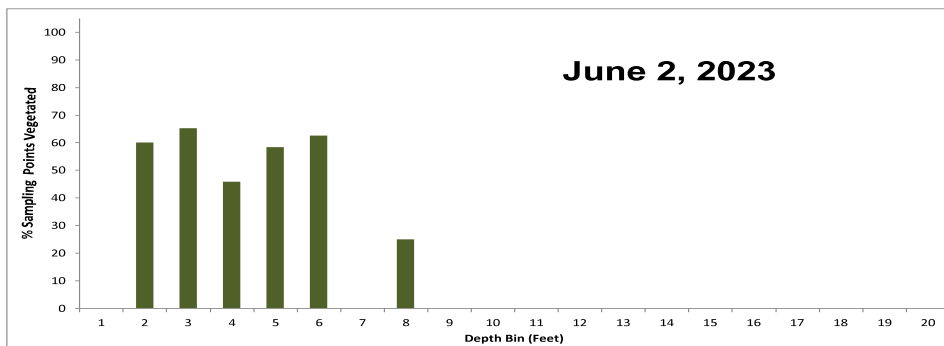
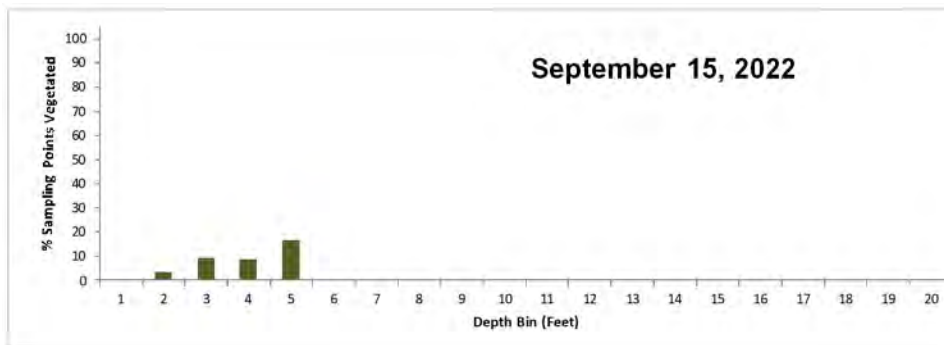
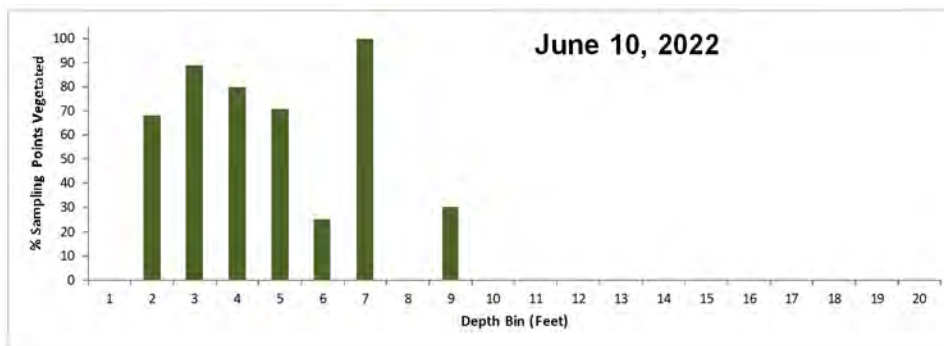


Figure 10. Number of vegetated sites by depth.

Milfoil Hotspots and Growth Potential in Comfort Lake: Eurasian watermilfoil was first observed in Comfort Lake in 2014. Areas of moderate and heavy growth of EWM for 2015 through 2022 are shown on the hotspot map in Figure 11. In the last couple of years EWM has nearly ringed the lake with growth (Figure 11). However lake sediment nitrogen concentrations collected in 2014 found mostly low nitrogen, except for 1 location near the Comfort Lake inlet (Figure 11). High nitrogen is correlated with heavy milfoil growth. EWM is still in a heavy growth mode that is typical of new invasive species. EWM growth will likely be reduced in the future but is difficult to pin down a year.

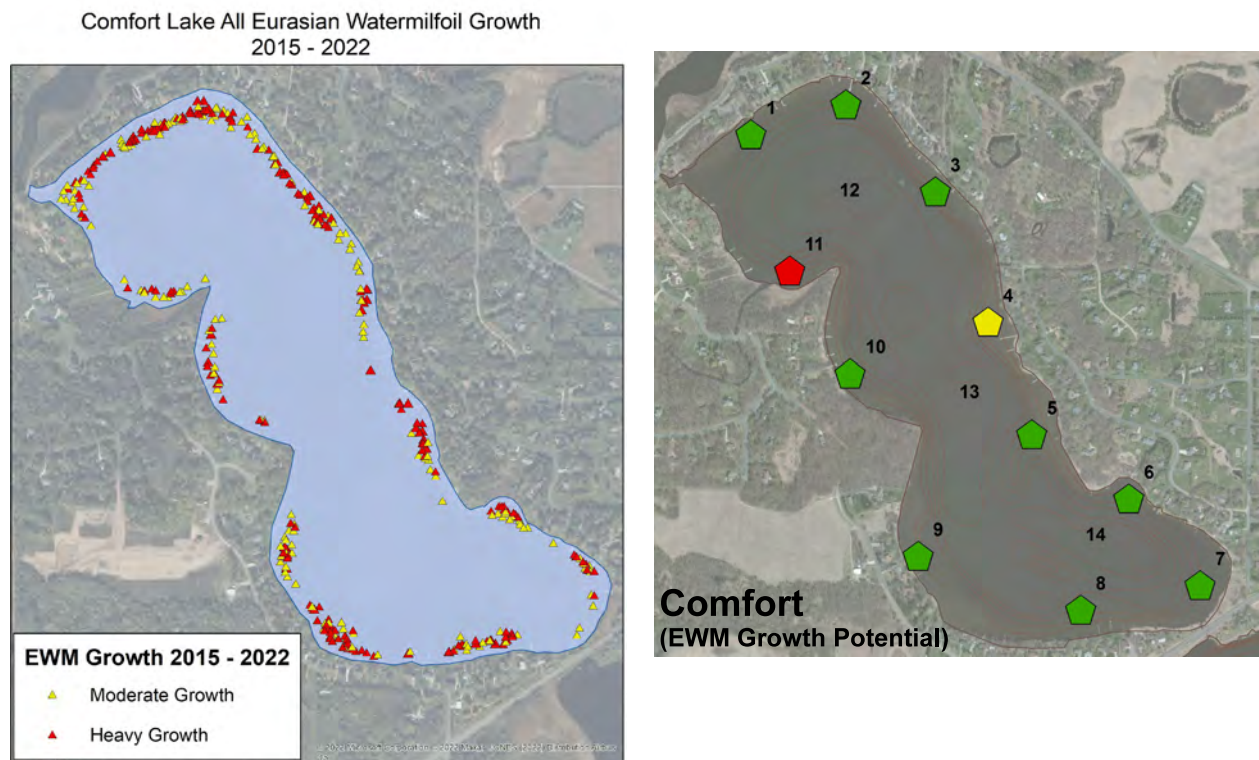


Figure 11. [left] EWM growth distribution and density for 2015-2022. [right] EWM potential growth based on lake sediment analyses for Comfort Lake. Key: green = light growth, yellow = moderate growth, and red = heavy growth.

APPENDIX

Point Intercept Individual Site Data for 2023

June 10, 2022

| Site | Depth (ft) | Bulrush | Spatter dock | White lilies | Cab-bage | Chara | Coon-tail | CLP | EWM | Flat-stem | Narrow leaf | Sago | Stringy | Water star-grass | No plants |
|------|------------|---------|--------------|--------------|----------|-------|-----------|-----|-----|-----------|-------------|------|---------|------------------|-----------|
| 1 | 3 | | | 1 | | | | 1 | | | | | | | |
| 2 | 2 | | 1 | | | | | | | | | | | | |
| 3 | 3 | | 1 | | | | | | | | | | | | |
| 4 | 3 | 1 | 1 | | | | | | | | | | | | |
| 5 | 3 | | | 1 | | | | | | | | | | | |
| 6 | 2 | | | | | | | 1 | | | | | | | |
| 7 | 3 | | | 1 | | | | | | | | | | | |
| 8 | 2 | | | 1 | | | | 1 | | | | | | | |
| 9 | 3 | | | | | | 1 | | | 1 | | | | | |
| 10 | 4 | | 1 | 1 | | | | | | | | | | | |
| 11 | 12 | | | | | | | | | | | | | | 1 |
| 12 | 14 | | | | | | | | | | | | | | 1 |
| 13 | 20 | | | | | | | | | | | | | | 1 |
| 14 | 15 | | | | | | | | | | | | | | 1 |
| 15 | 6 | | | | | | | | | | | | | | 1 |
| 16 | 4 | | | 1 | | | | | | | | | | | |
| 17 | 4 | | | | | | | | | | | | | | 1 |
| 18 | 3 | | | 1 | | | | | | | | | 1 | | |
| 19 | 3 | | | 1 | | | | | | | | | | | |
| 20 | 3 | | | 1 | | | | | | | | | | | |
| 21 | 6 | | | | | | | 1 | | | | | | | |
| 22 | 3 | | | 1 | | | 1 | 1 | | 1 | | | 1 | | |
| 23 | 3 | | | 1 | | | | 1 | | | | 1 | 1 | | |
| 24 | | | | | | | | | | | | | | | 1 |
| 25 | 10 | | | | | | | | | | | | | | 1 |
| 26 | 20 | | | | | | | | | | | | | | 1 |
| 27 | | | | | | | | | | | | | | | 1 |
| 28 | | | | | | | | | | | | | | | 1 |
| 29 | | | | | | | | | | | | | | | 1 |
| 30 | | | | | | | | | | | | | | | 1 |
| 31 | 19 | | | | | | | | | | | | | | 1 |
| 32 | 14 | | | | | | | | | | | | | | 1 |
| 33 | 3 | | | 1 | | | 1 | 1 | | 1 | | | | | |
| 34 | 3 | | | 1 | 1 | | 1 | | | | | | | | |
| 35 | 7 | | | | | | | | | | | | | | 1 |
| 36 | | | | | | | | | | | | | | | 1 |
| 37 | | | | | | | | | | | | | | | 1 |
| 38 | | | | | | | | | | | | | | | 1 |
| 39 | 15 | | | | | | | | | | | | | | 1 |
| 40 | 7 | | | | | | | | | | | | | | 1 |
| 41 | 3 | | 1 | 1 | | | | | | | | | | | |
| 42 | 5 | | | | | | | | | | | | | | 1 |
| 43 | 17 | | | | | | | | | | | | | | 1 |
| 44 | | | | | | | | | | | | | | | 1 |
| 45 | | | | | | | | | | | | | | | 1 |
| 46 | | | | | | | | | | | | | | | 1 |
| 47 | 14 | | | | | | | | | | | | | | 1 |
| 48 | 9 | | | | | | | | | | | | | | 1 |
| 49 | 3 | | | 1 | 1 | | 1 | 1 | | | | | | | |
| 50 | 3 | | | | | | | 1 | | | | 1 | | | |
| 51 | 14 | | | | | | | | | | | | | | 1 |
| 52 | | | | | | | | | | | | | | | 1 |
| 53 | 17 | | | | | | | | | | | | | | 1 |
| 54 | 4 | | | | | | | | | | | | | | 1 |
| 55 | 3 | | | 1 | | | | 1 | | | | | | | |
| 56 | 3 | | | 1 | | | | | | | | | | | |
| 57 | | | | | | | | | | | | | | | 1 |
| 58 | 16 | | | | | | | | | | | | | | 1 |
| 59 | 9 | | | | | | | | | | | | | | 1 |
| 60 | 3 | | | | 1 | | | | | | | | | | |
| 61 | 2 | | | 1 | | | | | | | | 1 | | | |
| 62 | 3 | | | 2 | | | | | | | | 1 | 1 | | |

June 10, 2022

| Site | Depth (ft) | Bulrush | Spatter dock | White lilies | Cabbage | Chara | Coon-tail | CLP | EWM | Flat-stem | Narrow leaf | Sago | Stringy | Water star-grass | No plants |
|------|------------|---------|--------------|--------------|---------|-------|-----------|-----|-----|-----------|-------------|------|---------|------------------|-----------|
| 63 | | | | | | | | | | | | | | | 1 |
| 64 | 15 | | | | | | | | | | | | | | 1 |
| 65 | 17 | | | | | | | | | | | | | | 1 |
| 66 | 10 | | | | | | | | | | | | | | 1 |
| 67 | 12 | | | | | | | | | | | | | | 1 |
| 68 | 4 | | | | | | | | | | | | 1 | | 1 |
| 69 | 5 | | | | | | | | | | | | | | 1 |
| 70 | | | | | | | | | | | | | | | 1 |
| 71 | 4 | | | | | | | | | | | | | | 1 |
| 72 | 3 | | | 1 | | | | | | | | | | | 1 |
| 73 | 2 | | | | | | | | | | | | | | 1 |
| 74 | 13 | | | | | | | | | | | | | | 1 |
| 75 | | | | | | | | | | | | | | | 1 |
| 76 | 6 | | | | | | | | | | | | 1 | | 1 |
| 77 | 13 | | | | | | | | | | | | | | 1 |
| 78 | 4 | | | 1 | | | | | | | | | | | 1 |
| 79 | 2 | | | 1 | | | | | | | | | | | 1 |
| 80 | 10 | | | | | | | | | | | | | | 1 |
| 81 | 8 | | | | | | | | | | | | | | 1 |
| 82 | 5 | | | | 3 | | | | | | | | | | 1 |
| 83 | 3 | | | | | | | 1 | | | | | 1 | | 1 |
| 84 | 4 | | | | | | | | | | | | | | 1 |
| 85 | 20 | | | | | | | | | | | | | | 1 |
| 86 | 5 | | | 1 | | | | | | | | | | | 1 |
| 87 | 3 | | | | | | | 1 | | | | | | | 1 |
| 88 | 3 | | | 1 | | | | | | | | | | | 1 |
| 89 | 4 | 1 | | 1 | | | | | | | | | | | 1 |
| 90 | | | | | | | | | | | | | | | 1 |
| 91 | 4 | | | 1 | | | | | | | | | 1 | | 1 |
| 92 | 2 | | | 1 | | | | | | | | | 1 | | 1 |
| 93 | 3 | | | 1 | | | | 1 | | | 1 | | | | 1 |
| 94 | 8 | | | | | | | | | | | | | | 1 |
| 95 | 11 | | | | | | | | | | | | | | 1 |
| 96 | | | | | | | | | | | | | | | 1 |
| 97 | 2 | | 1 | 1 | | | | | | | | | | | 1 |
| 98 | 4 | | | 1 | | | | | | | | | | | 1 |
| 99 | | | | | | | | | | | | | | | 1 |
| 100 | | | | | | | | | | | | | | | 1 |
| 101 | 4 | | | | 2 | | | | | | | | | | 1 |
| 102 | 2 | | | 1 | | | | 1 | | | | | | | 1 |
| 103 | 15 | | | | | | | | | | | | | | 1 |
| 104 | 4 | | | | | | | | | | | | 1 | | 1 |
| 105 | 3 | | | | 1 | | | | | | | | 1 | 1 | 1 |
| 106 | 3 | | | 1 | | | | 1 | | | | 1 | | | 1 |
| 107 | 12 | | | | | | | | | | | | | | 1 |
| 108 | 6 | | | | | | | 1 | | | | | | | 1 |
| 109 | 3 | | | | | 1 | | | | | | | | | 1 |
| 110 | 2 | | | | | | | | | | | | | | 1 |
| 111 | 3 | | | 2 | | | | | | | | | | | 1 |
| 112 | 4 | | | | 1 | 1 | | | | | | | | | 1 |
| 113 | 12 | | | | | | | | | | | | | | 1 |
| 114 | 2 | | | | | 1 | | | | | | | 1 | | 1 |
| 115 | 2 | | | 1 | | | | 1 | | | | 1 | | | 1 |
| 116 | | | | | | | | | | | | | | | 1 |
| 117 | 5 | | | | | | | | | | | | 1 | | 1 |
| 118 | 2 | | | | | | | | | | | | | | 1 |
| 119 | 3 | | 1 | 1 | | | | | 1 | 1 | | | | | 1 |
| 120 | 1 | | | 1 | | | 1 | 1 | | | | | | | 1 |
| 121 | 4 | | | 1 | | | | | | | | | | | 1 |
| 122 | 3 | | | 2 | | | | | | 1 | | | | | 1 |
| 123 | | | | | | | | | | | | | | | 1 |
| 124 | 5 | | | | 1 | | | | | | | | | | 1 |
| 125 | 3 | | | | | | | | | | | | | | 1 |
| 126 | 3 | | | 1 | | | | | | | | | | | 1 |
| 127 | | | | | | | | | | | | | | | 1 |
| 128 | 12 | | | | | | | | | | | | | | 1 |
| 129 | 11 | | | | | | | | | | | | | | 1 |
| 130 | 4 | | | | | | | | | | | | | | 1 |
| 131 | 7 | | | | | | | | | | | | | | 1 |

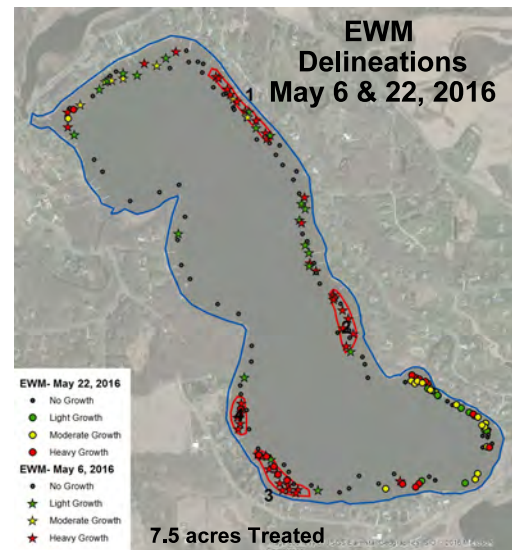
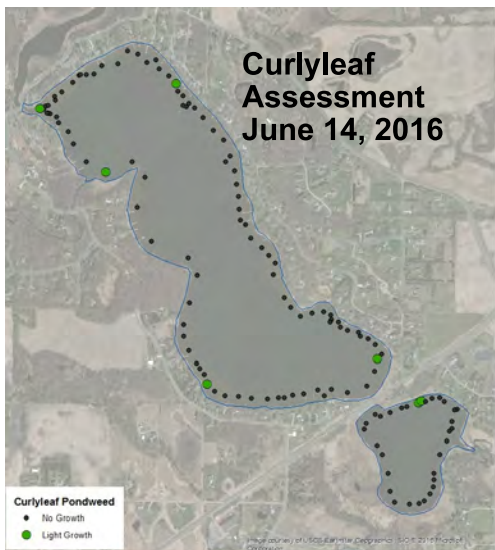
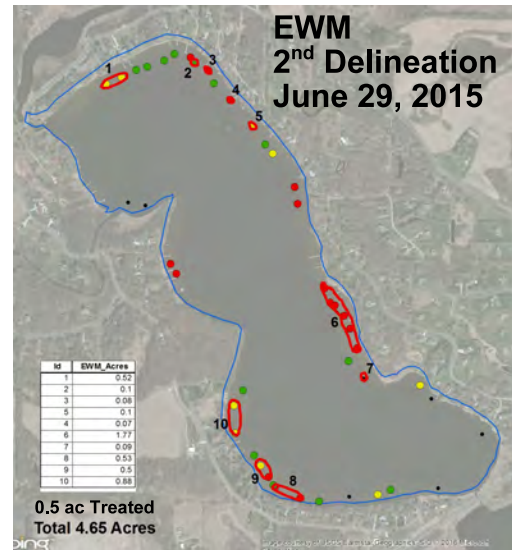
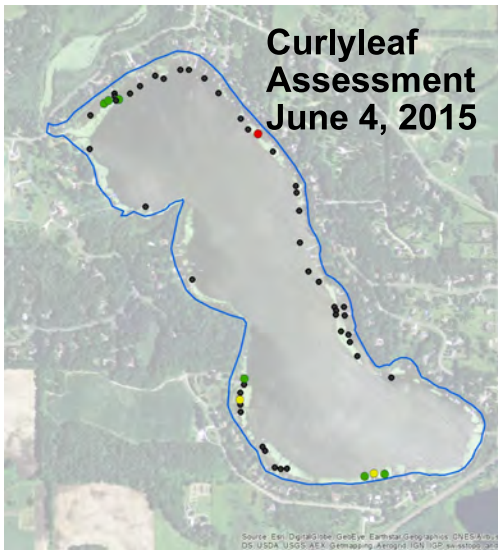
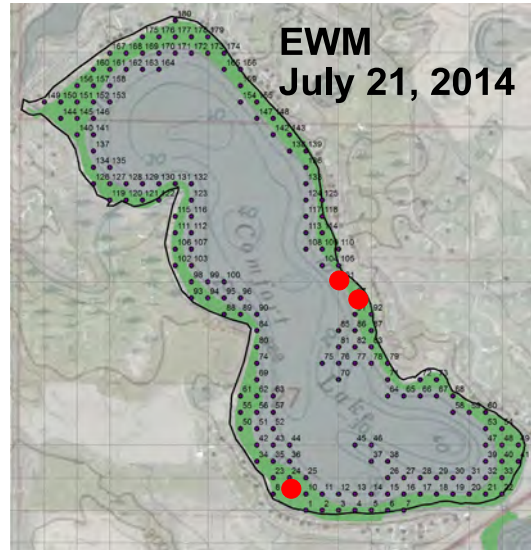
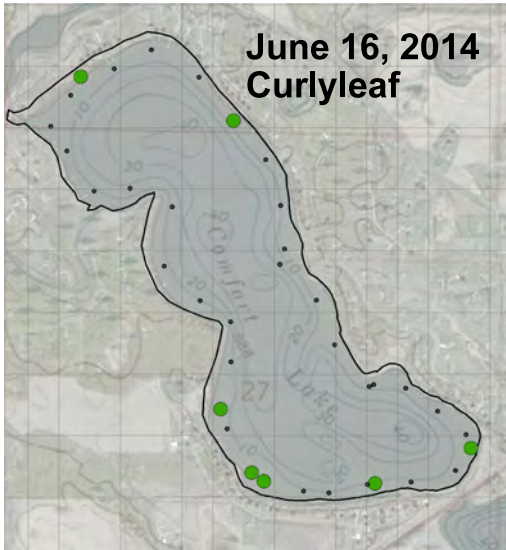
June 10, 2022

| Site | Depth (ft) | Bulrush | Spatter dock | White lilies | Cab-bage | Chara | Coon-tail | CLP | EWM | Flat-stem | Narrow leaf | Sago | Stringy | Water star-grass | No plants |
|-------------------|------------|---------|--------------|--------------|----------|-------|-----------|-----|-----|-----------|-------------|------|---------|------------------|-----------|
| 132 | | | | | | | | | | | | | | | 1 |
| 133 | 6 | | | | | | | 1 | | | | | | | |
| 134 | 4 | | | 1 | | | | | | 1 | | | | | |
| 135 | | | | | | | | | | | | | | | 1 |
| 136 | 5 | | | | | | | 1 | | | | | | | |
| 137 | 5 | | | | | | | | | | | | | | 1 |
| 138 | 4 | | | | | | | | | | | | | | 1 |
| 139 | 2 | | | 1 | | | | | | | | | | | |
| 140 | 4 | | 1 | 1 | | | | | | | | | | | |
| 141 | 15 | | | | | | | | | | | | | | 1 |
| 142 | 4 | | | | | | | 1 | | | | | | | |
| 143 | 2 | | 1 | 1 | | | | 1 | | | | | | | |
| 144 | 3 | | | 2 | 1 | | | | | | | | | | |
| 145 | 11 | | | | | | | | | | | | | | 1 |
| 146 | | | | | | | | | | | | | | | 1 |
| 147 | 6 | | | | | | | | | | | | | | 1 |
| 148 | 3 | | | | | | | | | | | | 1 | | |
| 149 | 3 | | 1 | 1 | | | | | | | | | | | |
| 150 | 2 | | | 1 | | | | | | | | | | | |
| 151 | 5 | | | | | | | | | | | | | | 1 |
| 152 | 15 | | | | | | | | | | | | | | 1 |
| 153 | | | | | | | | | | | | | | | 1 |
| 154 | 10 | | | | | | | | | | | | | | 1 |
| 155 | 3 | | | 1 | | | | | | | | | | | |
| 156 | 2 | | | | | | | | | 1 | | 1 | 1 | | |
| 157 | 6 | | | 1 | | | | | | | | | | | |
| 158 | | | | | | | | | | | | | | | 1 |
| 159 | 4 | | | | | | | 1 | | | | | 1 | | |
| 160 | 3 | | | | | | | | | | | | 1 | | |
| 161 | 5 | | | | | | | | | | | | 1 | | |
| 162 | | | | | | | | | | | | | | | 1 |
| 163 | | | | | | | | | | | | | | | 1 |
| 164 | | | | | | | | | | | | | | | 1 |
| 165 | 4 | | | | 1 | | | 1 | | | | | | | |
| 166 | 2 | | | | 1 | | | | | | | | 1 | | |
| 167 | 3 | | | | | | | | | | | | 1 | | |
| 168 | 4 | | | | | | | 1 | | | | | 1 | | |
| 169 | 5 | | | | 1 | | | | | | | | 1 | | |
| 170 | 6 | | | | | | | 1 | | | | | 1 | | |
| 171 | 8 | | | | | | | | | | | | | | 1 |
| 172 | 8 | | | | | | | 1 | | | | | | | |
| 173 | 5 | | | | | | | | | | | | 1 | | |
| 174 | 3 | | | | | 1 | | 2 | | | | | 1 | | |
| 175 | 3 | | | | | 1 | | 1 | | | | | 1 | | |
| 176 | 3 | | | 1 | | | | | | | | | 1 | | |
| 177 | 4 | | | | | | | 1 | | | | | | | |
| 178 | 3 | | | 1 | 1 | | | | | | | | | | |
| 179 | 2 | | | | | | | 1 | | | | | 2 | | |
| 180 | 2 | | 1 | | | | | 1 | | | | | 1 | | |
| Average | | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | |
| Occur (180 sites) | | 2 | 11 | 50 | 13 | 5 | 6 | 32 | 1 | 7 | 1 | 7 | 29 | 1 | 84 |
| % occur | | 1 | 6 | 28 | 7 | 3 | 3 | 18 | 1 | 4 | 1 | 4 | 16 | 1 | 47 |

CLP and EWM Delineation or Assessments

Curlyleaf Pondweed 2014-2023

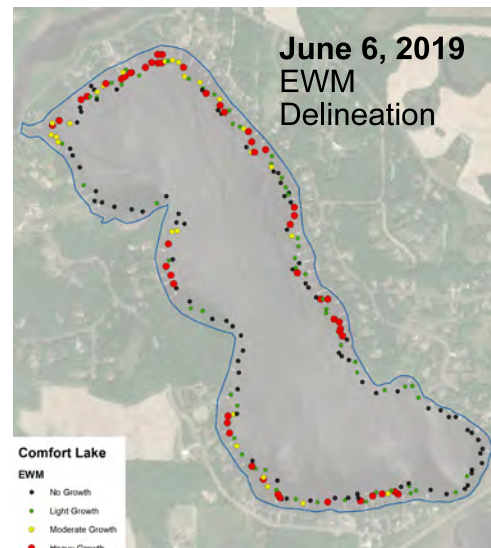
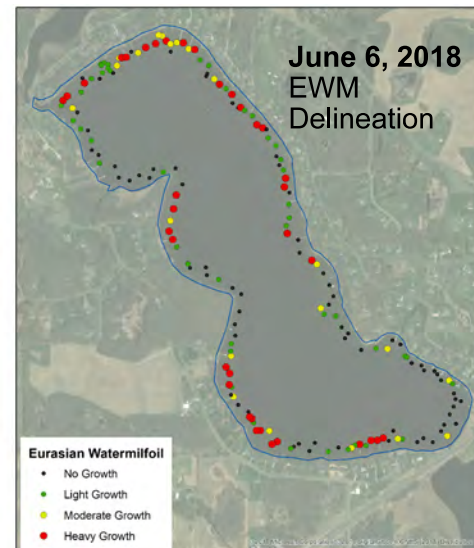
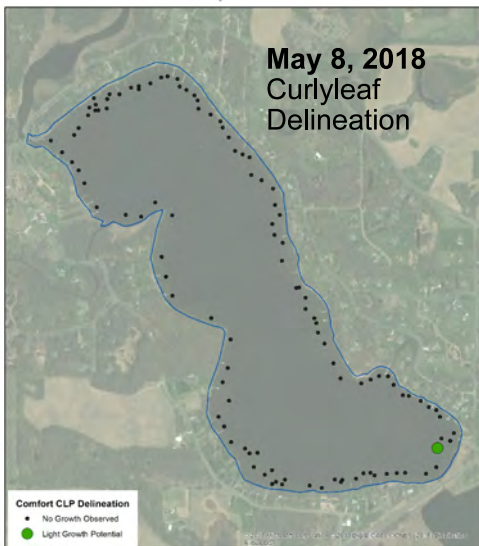
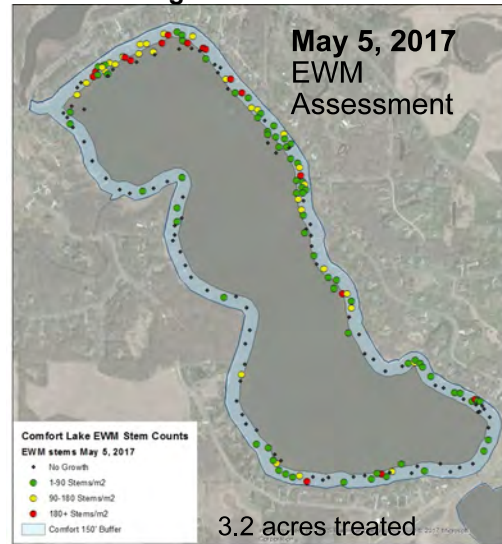
Eurasian Watermilfoil 2014-2023



Curlyleaf Pondweed 2014-2023

Eurasian Watermilfoil 2014-2023

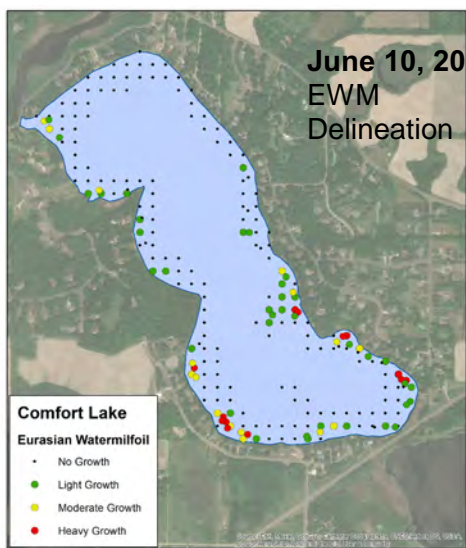
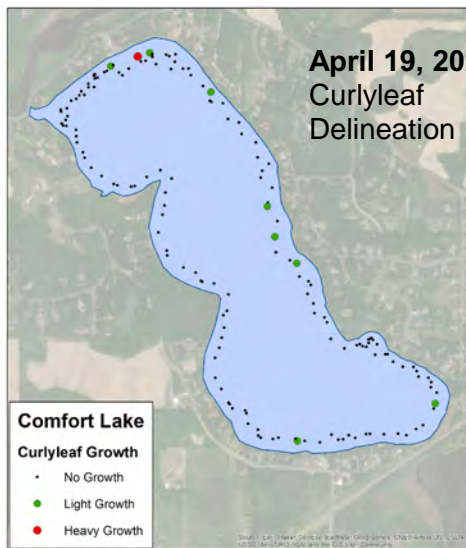
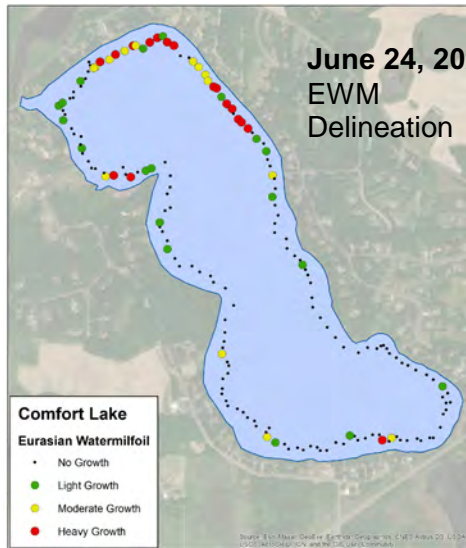
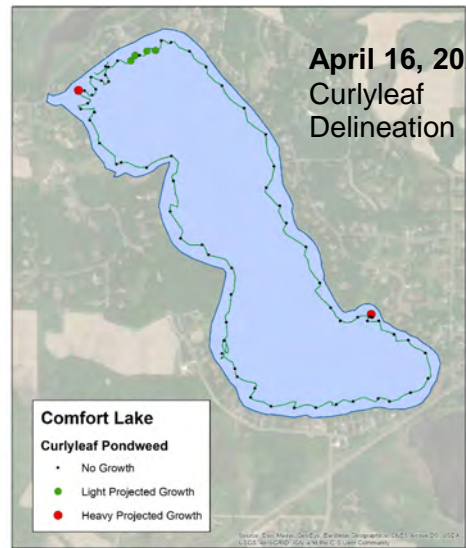
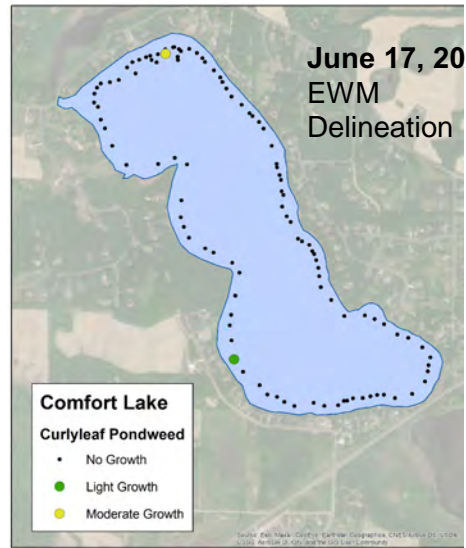
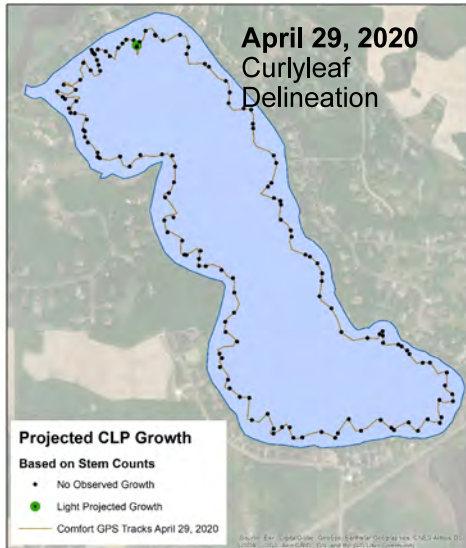
Curlyleaf pondweed and Eurasian watermilfoil maps for 2014 through 2023



Curlyleaf pondweed and Eurasian watermilfoil maps for 2014 through 2023.

Curlyleaf Pondweed 2014-2023

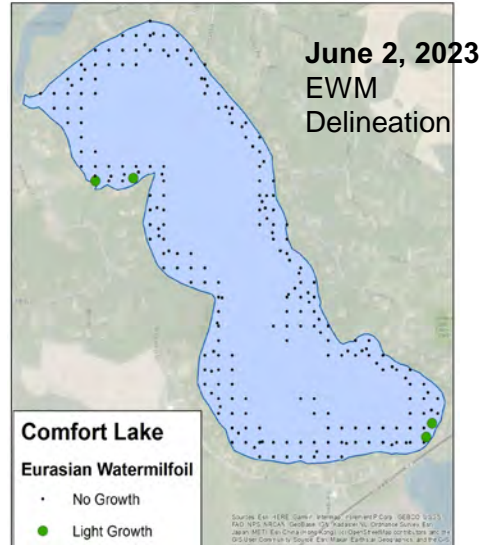
Eurasian Watermilfoil 2014-2023



Curlyleaf pondweed and Eurasian watermilfoil maps for 2014 through 2023.

Curlyleaf Pondweed 2014-2023

Eurasian Watermilfoil 2014-2023



Curlyleaf pondweed and Eurasian watermilfoil maps for 2014 through 2023.