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Technical Memorandum

Date: January 30th, 2026

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Project: Martha Lake Evaluation, Wright County SWCD

Subject: Summary Memo

Introduction

Moore was contracted by the Wright County Soil and Water Conservation District (Wright SWCD) to evaluate lakes within the North Fork Crow Watershed. The purpose of the evaluation is to document recent trends with overall lake health by examining a combination of the water quality, lake sediment, plant community, and fish populations. The focus of this effort is to set a baseline data set with information collected and determine if potential lake management activities are warranted. This memo focuses on review of Lake Martha.

Existing Conditions Lake Martha

Lake Martha is approximately 94 acres and is located west of Hanover in Wright County, Minnesota. It has a mean depth of 7.9 ft. and a maximum depth of 22 feet. The total littoral area within Lake Martha is 72 acres, which is 77 percent of the basin. Lake Martha is on the fringe of what would be considered a shallow lake. The Minnesota Pollution Control Agency (MPCA) generally uses the parameters of a basin having a maximum depth of 15 feet or less, or having a littoral zone that covers over 80% of the lake as the factors to define a shallow lake. Martha is just on the outside of these conditions with a maximum depth of 22 feet and a littoral zone that is 76% of the basin. With these conditions, Lake Martha is likely to exhibit some characteristics typically associated with shallow lakes. The watershed is approximately 1.96 km^2 (0.77 mi^2) Table 1 details the land use within the Lake Martha Watershed. Figure 1 displays the lake bathymetry and immediate watershed.

Table 1: Summary of Watershed Land Use for Lake Martha.

Land Category	Area km^2 (mi^2)
Water	0.51 (0.20)
Developed	0.23 (0.09)
Forest	0.34 (0.13)
Grassland	0.02 (0.01)
Pasture	0.25 (0.10)
Agriculture	0.61 (0.24)
Total	1.96 (0.77)

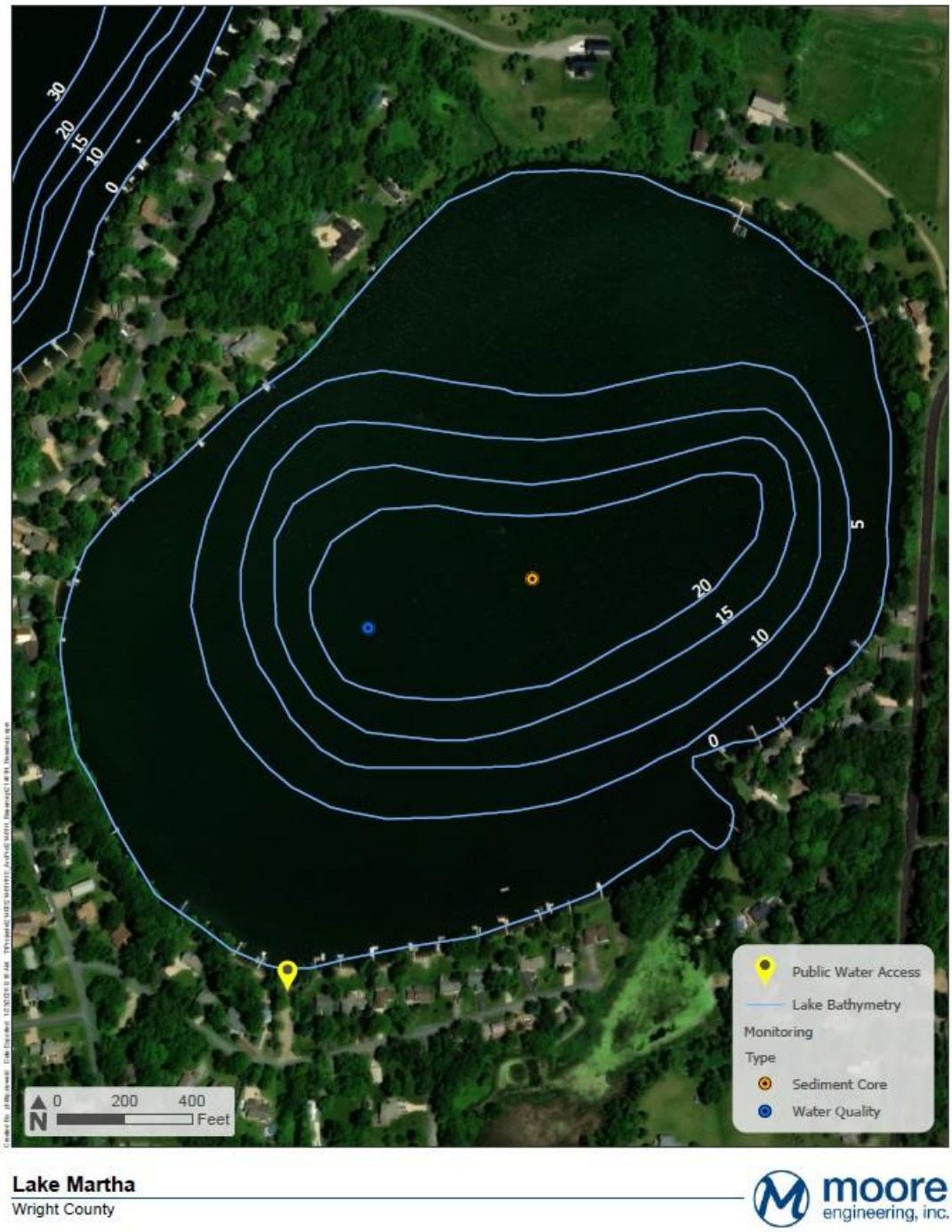

Figure 1: Map of Lake Martha with bathymetry and sampling locations.

Water Quality Summary

Staff from the Wright SWCD collected water quality samples throughout the growing season of 2024 and 2025. Ten sampling events were conducted bi-weekly from late May through late September each year. Samples were analyzed for multiple water quality parameters including chlorophyll-α, nitrites plus nitrates (N+N), total phosphorus (TP), ortho-phosphorus (OP), and total Kjeldahl nitrogen (TKN). Chlorophyll-α was only collected at the surface while both surface and bottom samples were collected

for the other water quality parameters. Secchi depth was also collected at the surface, and a profile of field parameters including temperature, dissolved oxygen, pH, and conductivity was collected at one meter intervals during each water quality sampling event. A summary of water quality parameters from each field season is presented in Table 2.

Table 2: Summary of Water Quality Parameters Mean Values Collected by Wright SWCD

WQ Parameter	2024	2025
Chlorophyll-α	60.66 (µg/L)	60.95 (µg/L)
Surface N+N	86.1 (µg/L)	< 0.03 (mg/L)
Bottom N+N	< 0.03 (mg/L)	< 0.03 (µg/L)
Surface TKN	1.27 (mg/L)	1.26 (mg/L)
Bottom TKN	1.78 (mg/L)	3.25 (mg/L)
Surface OP	6.0 (µg/L)	5.4 (µg/L)
Bottom OP	23.0 (µg/L)	7.9 (µg/L)
Surface TP	61.7 (µg/L)	64.4 (µg/L)
Bottom TP	169 (µg/L)	306.8 (µg/L)
Secchi Disk	1.6 (m)	1.24 (m)

The lakes in Wright County within the North Fork Crow watershed are located within the North Central Hardwood Forests ecoregion. The nutrient standard for Class 2b warmwater lakes within this ecoregion is 40 ug/L of total phosphorus. Lake Martha is above this water quality standard with the most recent two-year average TP concentration of 63 µg/L, and therefore is considered impaired for aquatic life and recreation due to excess total nutrients. A cursory review of the water quality results on the MPCA surface water data access portal reveals during the 10-year average of all summer samples for TP is 61 µg/L which aligns with the values for Lake Martha collected by staff in the last two years. Based on all water quality samples in Lake Martha, the Trophic State Index (TSI), or a lake's overall nutrient richness, is 60, which falls between mesotrophic and green eutrophic on the scale.

Lake Cores and Internal Load Estimates

Wright SWCD staff also collected ten temperature and dissolved oxygen profiles of Lake Martha in both 2024 and 2025 to determine the timing of lake stratification throughout the growing season and subsequent lake turnover. Lake stratification occurs when the lake waters separate into two distinct layers, with warmer waters over the top of colder temperature waters. When a lake stratifies, it is typical for dissolved oxygen levels to drop and create anoxic conditions below the thermocline. For this evaluation, anoxia was defined as less than 2.0 mg/L. During the peak of the summer the depth of anoxia was 3.5 meters and down to six meters when the lake is mixed.

Dissolved oxygen profiles can be used to create an Anoxic Factor for the lake. The Anoxic Factor (AF, expressed as days per year per season) can be used to quantify anoxia in stratified lakes. The AF is measured in the stratified season and uses the lake surface areas as (A_0). The equation was developed by Nurnberg (1995) and is calculated as follows: AF = (duration of anoxia x anoxic sediment area)/A_0

The number of anoxic days in 2024 was determined to be 18.8 days and 17.7 days in 2025. The importance of understanding anoxia is that stratified lakes can export phosphorus from lake sediments

under anoxic conditions. AF is used with the sediment phosphorus release rate to calculate an internal phosphorus load produce by lake sediments.

In addition to temperature and dissolved oxygen profiles, three sediment cores were collected to determine the amount of phosphorus being released under anoxic conditions. Two samples were used for lab-based phosphorus release rate observation, and the third core was collected to measure the total phosphorus fractions within the sediment to gauge the nutrient availability. Cores were collected at the deepest point in the lake, approximately 7.5 m in Lake Martha during conditions when the lake was stratified in July 2024. Sediment cores were analyzed by the University of Wisconsin-Stout Laboratory. The two cores analyzed for anoxic release were incubated at a constant temperature in light-controlled conditions for eight days to create anoxic conditions. It was determined the phosphorus release rate of Lake Martha was 7.84 mg/m^2/d in 2024. This release rate was on the lower end of those observed from the nine lakes (seven in Wright County along with two in Meeker County) tested during summer 2024. A release rate of this level falls near the median of measured release rates compared to a dataset of Minnesota and Wisconsin Lakes and would be considered within the lower end of range of rates observed in eutrophic lakes. The release rate calculated from this evaluation will serve as a baseline for future assessments.

The laboratory analysis for Lake Martha of the phosphorus fractionations found that both the Iron Bound and Loosely Bound components are very high (See Attachment 1). These two fractions comprise portions of total phosphorus that are biologically available when exported from sediments. Martha had the highest Iron Bound component compared to the nine lakes examined in 2024, which was one of the highest Iron Bound fractions ever tested by the lab. For the Loosely Bound component Martha was toward the upper end of the range of the nine lakes examined in 2024, and fell outside the upper quartile of the subset of similar Minnesota and Wisconsin lakes. Overall, the high total phosphorus release rates and the sizeable components of the available phosphorus fractions in the sediments indicate that the internal load is a significant contributor to overall lake phosphorus balance.

2024 Lake Response Modeling

A Lake Response Model was used to evaluate the components of the nutrient load within Lake Martha. For this evaluation, Moore obtained a spreadsheet model from the MPCA to use as the Lake Response Model. Martha Lake was not evaluated in 2014 so this model will be considered the baseline for future studies. Inputs to the model include watershed/land use, precipitation and evaporation, observed total phosphorus (TP) concentrations, inflows, and internal phosphorus release rate and time of release. For the 2025 modeling effort on Lake Martha, the following inputs were used:

- Land use areas were calculated using PTM App for the watershed and runoff concentrations were assigned from the model based on the land use type.
- Watershed runoff was selected based on the watershed values assigned in the model
- Internal Load was calculated using the measured internal release rate from the analysis completed by UW Stout Laboratory and the calculated Anoxic Factor
- Septic Load were assumed to be very low based on Wright SWCD information stating that lake residents are over 95% connected to the wastewater system in St. Michael.
- Atmospheric Load was determined by the model inputs

The MPCA tool has nine possible lake model equations that can be selected within the model tool. Based on direction from the MPCA, the first model to evaluate is equation 8, which is the Canfield-Bachmann equation for natural lakes and the typical starting point for modeling. When utilizing this

equation for Lake Martha, the model greatly underpredicted the observed total phosphorus concentration. As a result, the use of an alternate model equation was considered

The model equation that was selected for Lake Martha is Equation 9, which is the Canfield-Bachmann equation for Reservoirs + Lakes. This equation has a higher settling coefficient compared to the natural lakes equation and is used for basins with shorter residence times. Lake Martha has a residence time of 22 weeks (a little over five months) with is on the lower end of the scale for natural lakes. Even though Martha is a natural basin and not a reservoir, it appears that the particle and nutrient settling dynamics of this lake more closely align with this equation.

Results from this model indicate that the predicted TP in Lake Martha is 65.5 µg/L, while the mean observed TP in Lake Martha from 2024-2025 is 63.0 µg/L. Table 3 summarized the inputs and results from the 2025 Lake Response Model. The watershed runoff was the highest contributor to TP load in Lake Martha, and the internal load was the second highest contributor. Agriculture is the largest land use within the Lake Martha watershed which is driving the high watershed runoff load. These lake model results indicate that a mixture of watershed improvements along with internal load management would be beneficial to work towards improving the water quality of Lake Martha.

Table 3: Summary of the 2024/2025 Lake Response Model for Lake Martha.

2025 Model	
Drainage /Watershed	223 ac-ft/yr
	147 lb/yr
Septic	1 ac-ft/yr
	22 lb /yr
Atmosphere	0 ac-ft/yr
	59 lb/yr
Internal	18 days
	7.84 mg/m2/day
	119 lbs
Model Total	224 ac-ft/yr
	347 lb/yr
Predicted TP	65.5 ug/L
Observed TP	63.0 ug/L

*Septic numbers are arbitrary based on correspondence with the SWCD

Aquatic Vegetation

The vegetation community of Lake Martha was surveyed by Blue Water Science in 2025 after 10 acres of curlyleaf pondweed (CLP) were treated. Approximately 16 acres of light growth area was treated as well as 2 acres of heavy growth. A meandering survey was completed on May 29, 2025, to investigate the abundance and distribution of CLP, determine possible future treatment areas, and evaluate potential phosphorus loading from CLP dieback. In addition to the spring meander survey, a point-intercept survey was conducted on August 28, 2025, to assess the aquatic vegetation community across the entire lake.

A total of 90 sites were sampled in the littoral area of Lake Martha during the meander survey. It was determined that CLP was growing most frequently in 4-7 feet and was found at 25/90 (28%) of sample

sites. At the time of the survey, the CLP was dead or dying. CLP was sporadic across the littoral area of the whole lake with no dense stands in the lake (See Attachment 2 – Report Page 4). It was determined from research conducted by McComas that approximately 36 pounds of phosphorus is released into Lake Martha from CLP dieback.

A total of six submerged aquatic plants were identified during the point-intercept survey with star duckweed being the dominate native plant. It was determined that very few aquatic plants grew in more than seven feet of water. The estimated aquatic plant coverage in Lake Martha was estimated at 8.7 acres (9%) of lake area. Martha lake is determined to have poor clarity in the future since the plant coverage does not exceed the 40% coverage criterium for good water clarity.

BioBase maps were used to supplement the point-intercept survey results. This method uses data collected from sonar to interpolate and estimate data points in between discrete sample sites used in the point-intercept survey. BioBase produces maps for the percent of the water column occupied by plant matter, bathymetric data, and bottom hardness. This data is combined with results from the point-intercept to provide a complete view of the aquatic plant community and can help assess change over time. BioBase maps confirmed the meander survey and point-intercept survey results showing sporadic aquatic vegetation distribution across Lake Martha.

Fish Community

Lake Martha was sampled via boat electrofishing to calculate the catch per unit effort (CPUE) and estimate population size and biomass of Common Carp. No carp were captured or observed during the electrofishing surveys on Lake Martha. Sportfish populations such as Largemouth Bass, Bluegill, Northern Pike, and Black Crappie seemed to be in good health and in a balanced state. Although no carp were observed in Lake Martha, they may still be present but in low abundance with minimal impact.

Conclusions and Recommendations

The review of the water quality, lake sediment, plant community, and carp populations for Lake Martha reveal that the lake has moderate water quality and is experiencing conditions in the range of mesotrophic to eutrophic. These surveys and Lake Response Model will serve as baseline data for future studies. The data shows that the lake has water quality that has an average that is above the water quality standard of 40 µg/L. There have been some early season samples for TP that are in the 35-40 µg/L range which suggests that improvements in TP loading to the lake could help to push that lake back towards the water quality target.

Moore's review of the data suggests that both watershed runoff and internal load are issues to be addressed when considering water quality improvements for the lake. Implementing watershed based projects is often dependent on finding a landowner partner where a practice can be design and constructed, unless a public land location can be identified (where County or municipal land can be used for the practice). Internal load management strategies can be undertaken based on funding availability and in some cases can lead to direct improvements that can be seen shortly after implementation.

Internal Load Management

Based on the measured internal phosphorus anoxic release rates and the proportion of Iron Bound and Loosely Bound phosphorus in the lake sediments, Lake Martha is a good candidate for internal load management through alum dosing. Before an alum treatment could be applied, additional investigation

of the lake sediments would be needed to complete the actual dosing calculations. However, using the analysis completed for Spring Lake in Meeker County as part of the 2024 investigation, the alum treatment would typically target depth of 15 feet and greater. For Lake Martha this is approximately 23.4 acres. For Spring Lake the area targeted for alum dosing was 47 acres, and the total cost was estimated to be ~$238,000. This would be for two lake treatments in back to back years where approximately half of the calculated dose would be applied each time. This equates to a cost of approximately $5,000 per acre. Martha Lake has a smaller area of the lake that is 15 ft compared to Spring. Using the cost from Spring Lake, an alum treatment for Martha would be expected to range from $100,000 to $150,000 to treat ~23 acres of the lake, which would depend on the specific dose that would be calculated from the follow-up analysis on the lake sediments.

Aquatic Vegetation Management

Based on the surveys completed by Bluewater Science, CLP is present at approximately 25% of the littoral zone, or approximately 18 acres. Of the 18 acres, only 2 acres were designated heavy growth and 16 acres was light growth. The CLP meander survey was completed after a treatment was conducted. Treatment seemed successful as there was no living CLP found during the survey. Future treatment in Lake Martha, following a similar program that appears to be effective based on the 2025 plant survey, should help keep the CLP population to light growth across the lake. It was also estimated that the CLP contributed 36 pounds of TP to Lake Marth from dieback which is not included in the Lake Response Model.

The plant community does have issues both with the presence of CLP and the lack of native species and overall plant coverage. Water clarity seems to be limiting the extent and density of plant growth in the lake. It is likely that other native species beyond those found during the most recent surveys could be present in the lake seed bed or within the overall watershed. Improving the water quality concentration along with lake clarity should improve aquatic plant growth. If an alum treatment was applied to the lake, that would immediately improve water clarity for that growing season. This could lead to increased plant growth that first year after alum application. The increased plant growth would help to consume nutrient inputs, reducing the amount of phosphorus available for algal uptake and helping to maintain improved water clarity. There may also be some contractors who could add native plant species to the basin in year 1 or year 2 after the alum treatment to help encourage native plant growth.

Fish Community Management

The study completed by WSB indicated that no carp were sampled during the field efforts in Lake Martha and that game fish appear to be doing well. Although no carp were sampled, surveys should continue every couple of years to monitor if the population increases. As a result, fish community management is not a priority for this lake.

Attachments

1. Excerpts from UW Stout Laboratory Report for Sediment Core Analysis (2024)
2. Aquatic Vegetation Report from Blue Water Science (2025)

Attachment 1

Excerpts from the UW Stout Laboratory Analysis of Sediment Cores

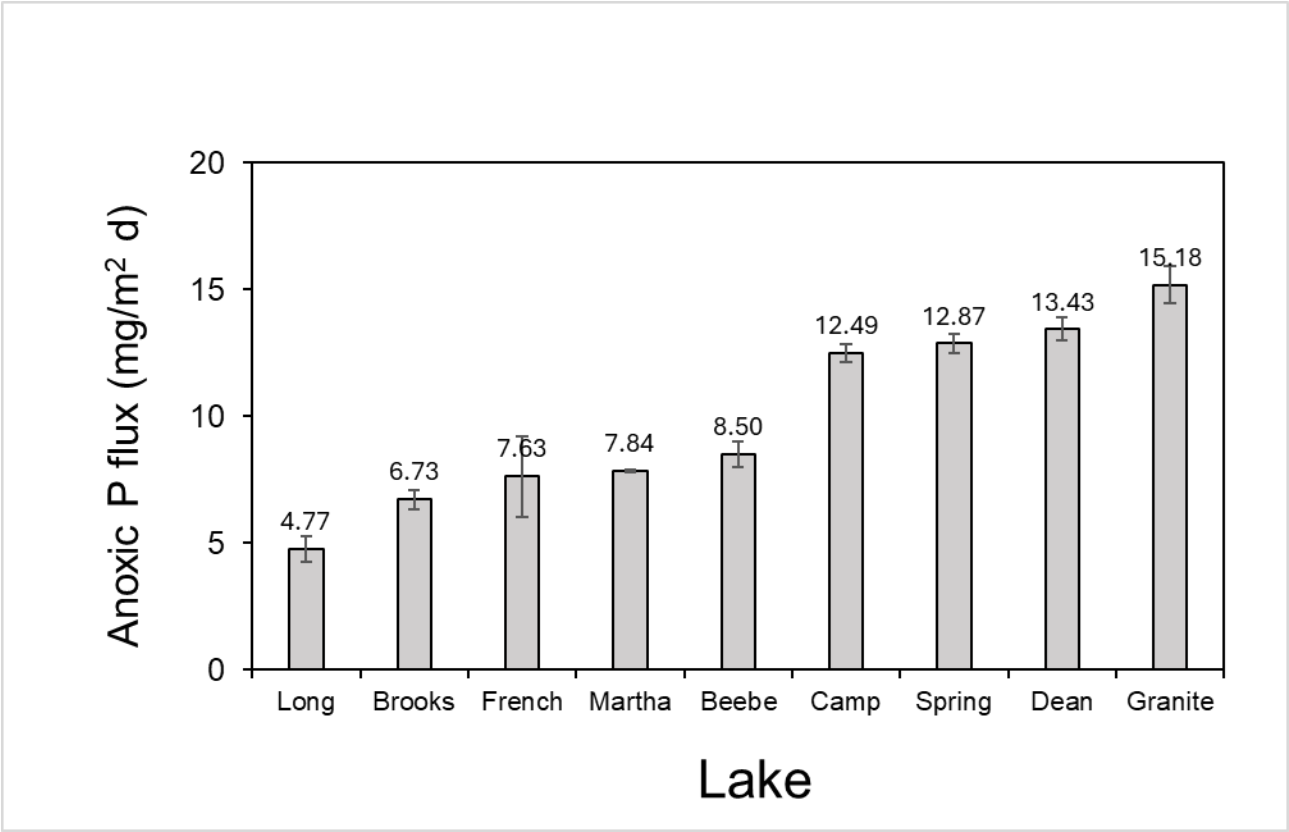

Figure 4. A comparison of mean (n = 2) anoxic phosphorus (P) flux for various lakes in Wright County MN. Mean fluxes are immediately above the bars. Vertical lines denote 1 standard error.

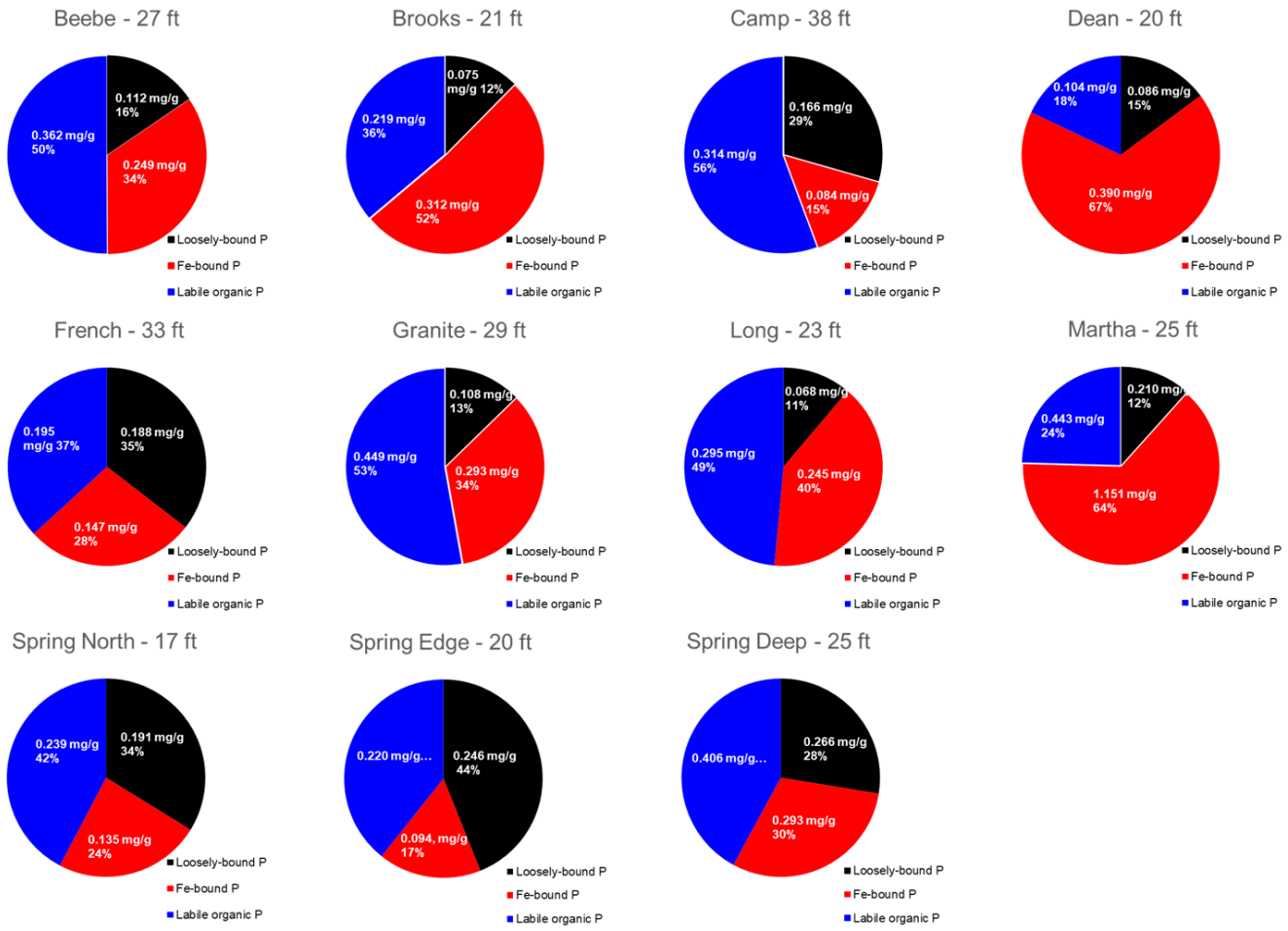

Figure 8. Pie charts showing the percent composition of mobile phosphorus in the upper 5-cm sediment layer for various lakes in Wright County MN.

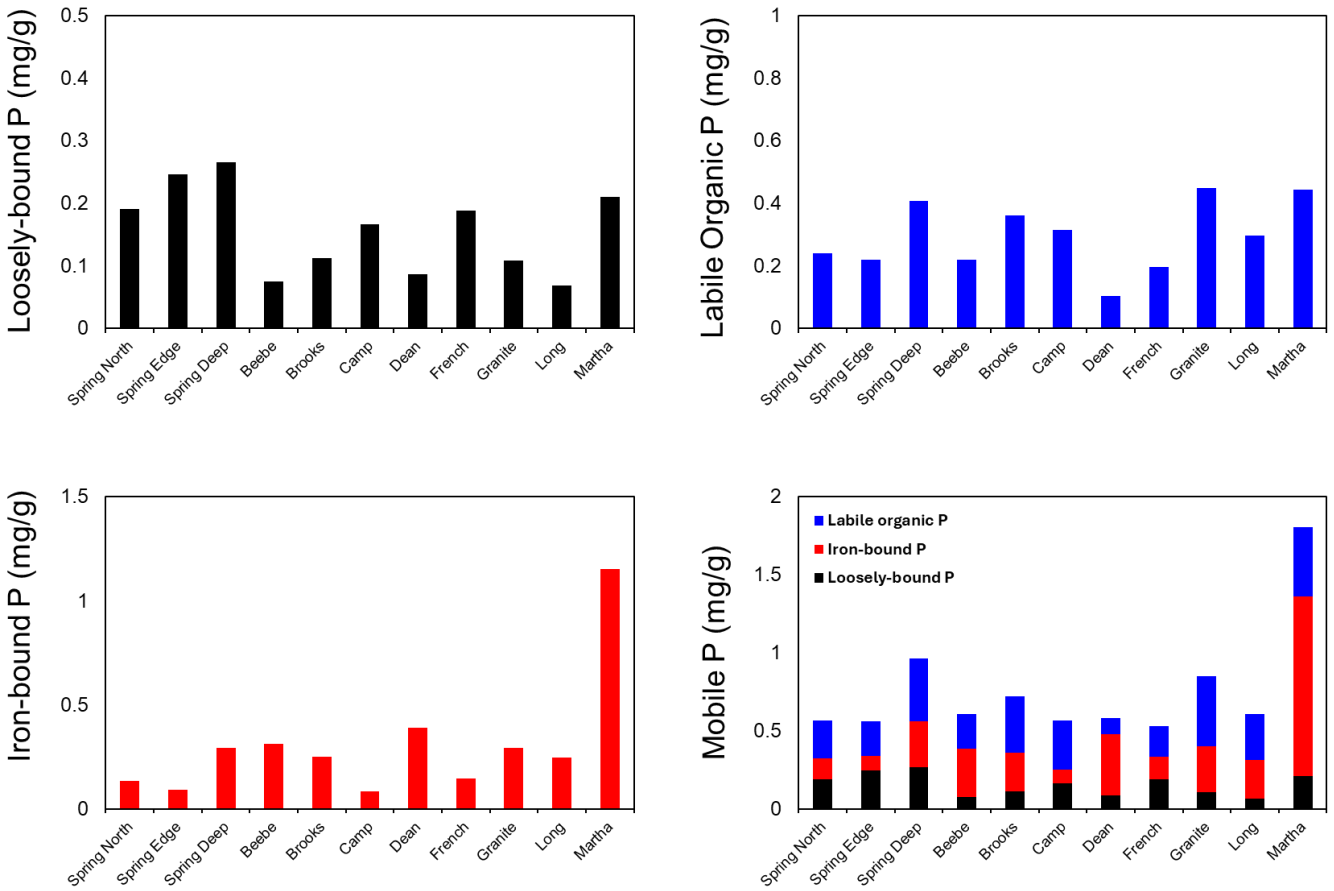

Figure 9. Variations in the concentration of loosely-bound phosphorus (P), iron-bound P, labile organic P, and mobile P in the upper 5-cm sediment layer for various lakes in Wright County MN.

Attachment 2

Blue Water Science Aquatic Vegetation Survey Report

Water Celery in Lake Martha, August 28, 2025

Meander and Point Intercept Surveys for Lake Martha, Wright County, Minnesota, 2025

Curlyleaf Pondweed Delineation: May 29, 2025
Point Intercept Survey: August 28, 2025

Prepared for:
Wright Soil and Water Conservation District

Prepared by:
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November 20, 2025

Meander and Point Intercept Surveys for Lake Martha, Wright County, Minnesota, 2025

MnDNR ID: 86000900
Size: 94 acres
Littoral area: 72 acres
Shore length: 1.47 miles
Mean depth: 7.9 feet
Maximum depth: 22 feet

Overview

Lake Martha is located within Wright County. A meander survey in 2025 was used to characterize the status of curlyleaf pondweed. Curlyleaf pondweed was sampled at 25 sites out of 90 sites on the May 29, 2025 delineation survey but all the samples were of dead curlyleaf plants. On August 28, 2025 a point intercept survey was conducted and sites were sampled with 50 meter spacing. A total of 6 submerged aquatic plant species were observed. Neither curlyleaf pondweed nor Eurasian watermilfoil were observed in the August survey. Aquatic plants grew out to a depth of 7 feet and covered an estimated 9% of the lake area. Star duckweed was the dominant native aquatic plant.

Methods

Curlyleaf Pondweed and Eurasian Watermilfoil Meander Survey:

Blue Water Science staff conducted a search for curlyleaf pondweed (CLP) using a GPS meander survey technique. A zigzag path was followed around the nearshore area of Lake Martha to assess the distribution and abundance of CLP, determine possible areas of future CLP treatment, and evaluate potential phosphorus loading from CLP dieback.

For the meander survey, 90 sites were sampled around Lake Martha. 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 nuisance. Based on these sample sites, a plant distribution map was constructed.

Point Intercept Survey Methods: An aquatic plant survey of Lake Martha using point intercept sampling method was conducted by Blue Water Science on August 28, 2025. A map and sampling grid were prepared by Blue Water Science and a consisted of a total of 151 points that were distributed throughout the lake. Points were spaced 50 meters apart. Each point represented about 0.6 acres (Figure 1). At each sample point, plants were sampled with a rake sampler. In water less than 15 feet, a fixed-head rake sampler on a telescoping pole was used. In water deeper than 15 feet, a double-ended rake sampler on a rope was tossed into the lake to sample plants. A plant density rating was assigned to each plant species on a scale from 1 to 3 (Figure 2). A density of a "1" indicated sparse growth and a "3" rating indicated heavy plant growth (Figure 2).

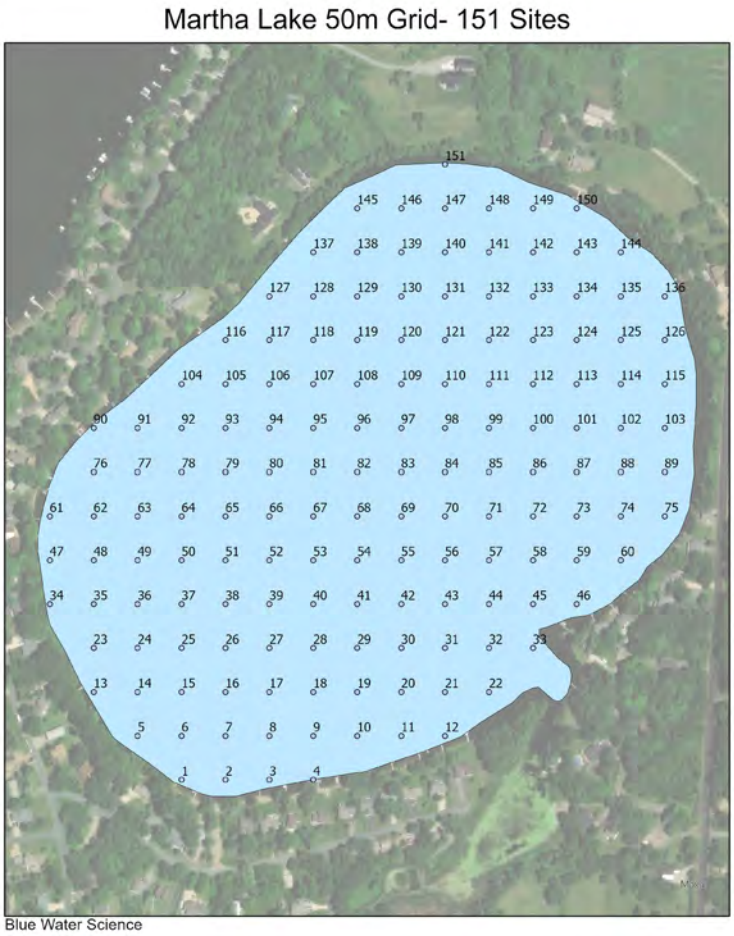


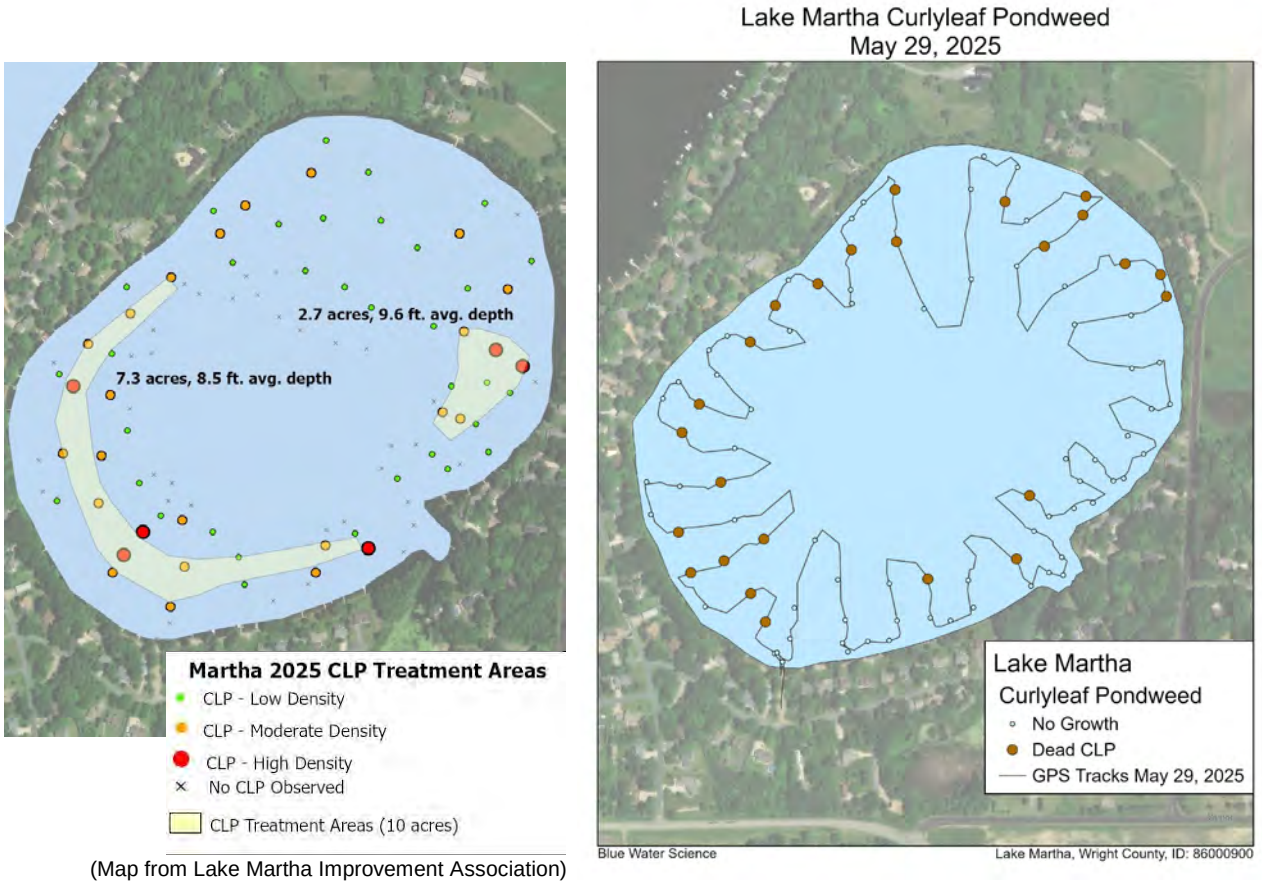
Figure 1. Point intercept site map for Lake Martha.

Figure 2. Aquatic plant density ratings from 1 to 3.

Figure 3. Two different rake samplers used during the Lake Martha surveys.
[left] Fixed head sampler.
[right] Double headed throw rake.

Results of the Meander Survey

May 29, 2025: Curlyleaf Pondweed Meander Survey Results: In spring, 10 acres of CLP were treated in Lake Martha. On May 29, 2025 a curlyleaf pondweed survey sampled 90 sites and at 25 sites curlyleaf pondweed was dead or dying (Figure 4). Curlyleaf pondweed was found most frequently in 4-7 feet of water in Lake Martha.



(Map from Lake Martha Improvement Association)

Figure 4. Lake Martha curlyleaf pondweed maps. (left) CLP delineation and treatment map. (right) Curlyleaf survey on May 29, 2025. On May 29, 2025, all the CLP was non-viable.

May 29, 2025: Curlyleaf Pondweed Nutrient Inputs into Lake Martha:

When curlyleaf pondweed dies back in late June or July, the nutrients in the plant tissue that are released from decomposition may be available for algal growth. Research by McComas (unpublished) analyzed curlyleaf plant tissue phosphorus that was correlated with light, moderate, or heavy growth in pounds of TP per acre. Areas of light, moderate, and heavy CLP growth were delineated (Figure 5) and the phosphorus loading from CLP dieback was estimated (Table 1 and Figure 6).

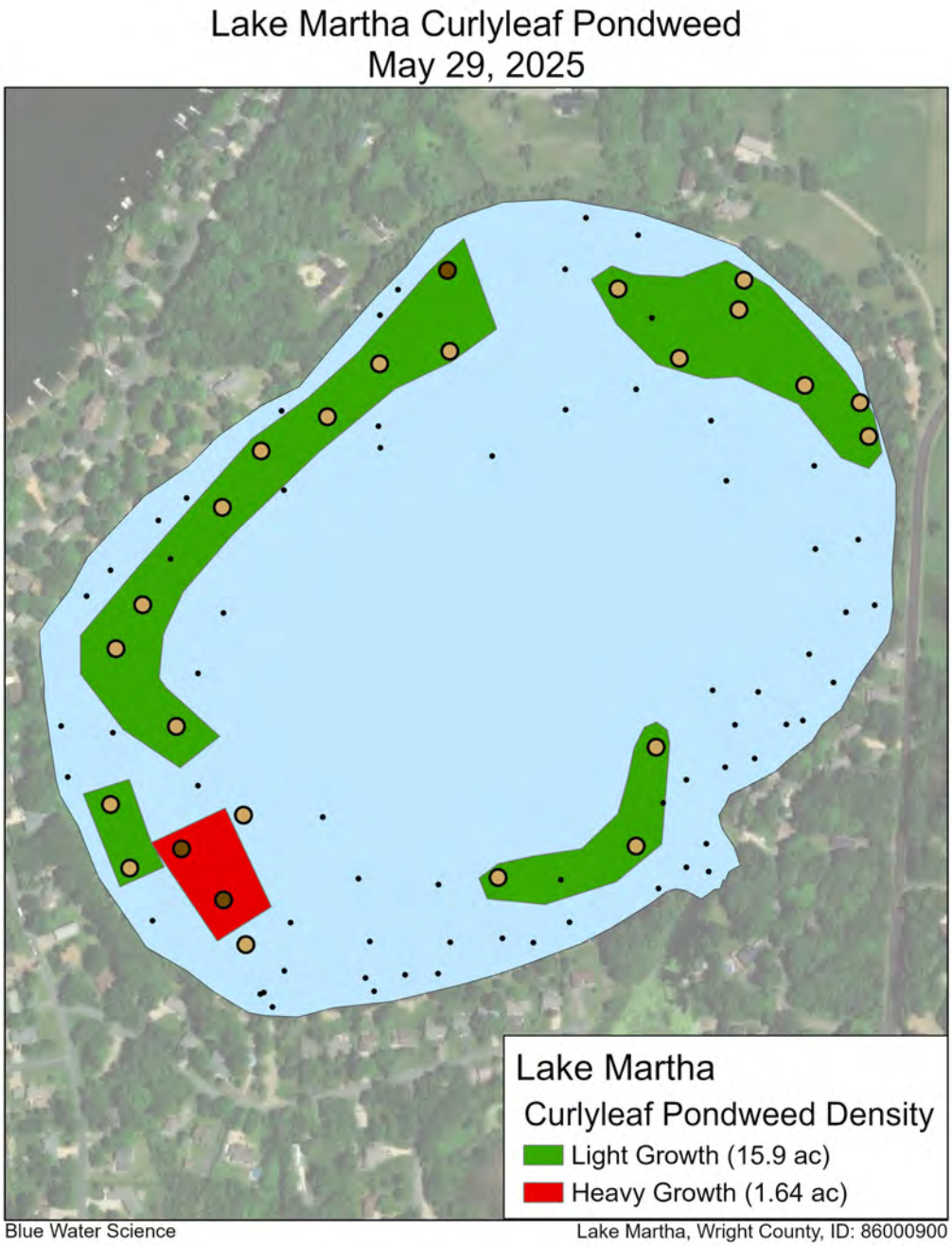


Figure 5. Curlyleaf pondweed density on May 29, 2025 (estimated from dead CLP remnants).

Table 1. Phosphorus loading from curlyleaf pondweed dieback is based on growth conditions of light, moderate and heavy on May 29, 2025. The estimated phosphorus loading from CLP dieback of 36 pounds or 0.4 pounds/lake acre was moderate.

	Estimated acres of curlyleaf	Estimated pounds of phosphorus per acre from curlyleaf	Phosphorus loading from curlyleaf dieback (pounds)
Light growth	15.9	1.5	24
Moderate growth	0	0	0
Heavy growth	1.64	7.0	12
TOTAL			36 pounds

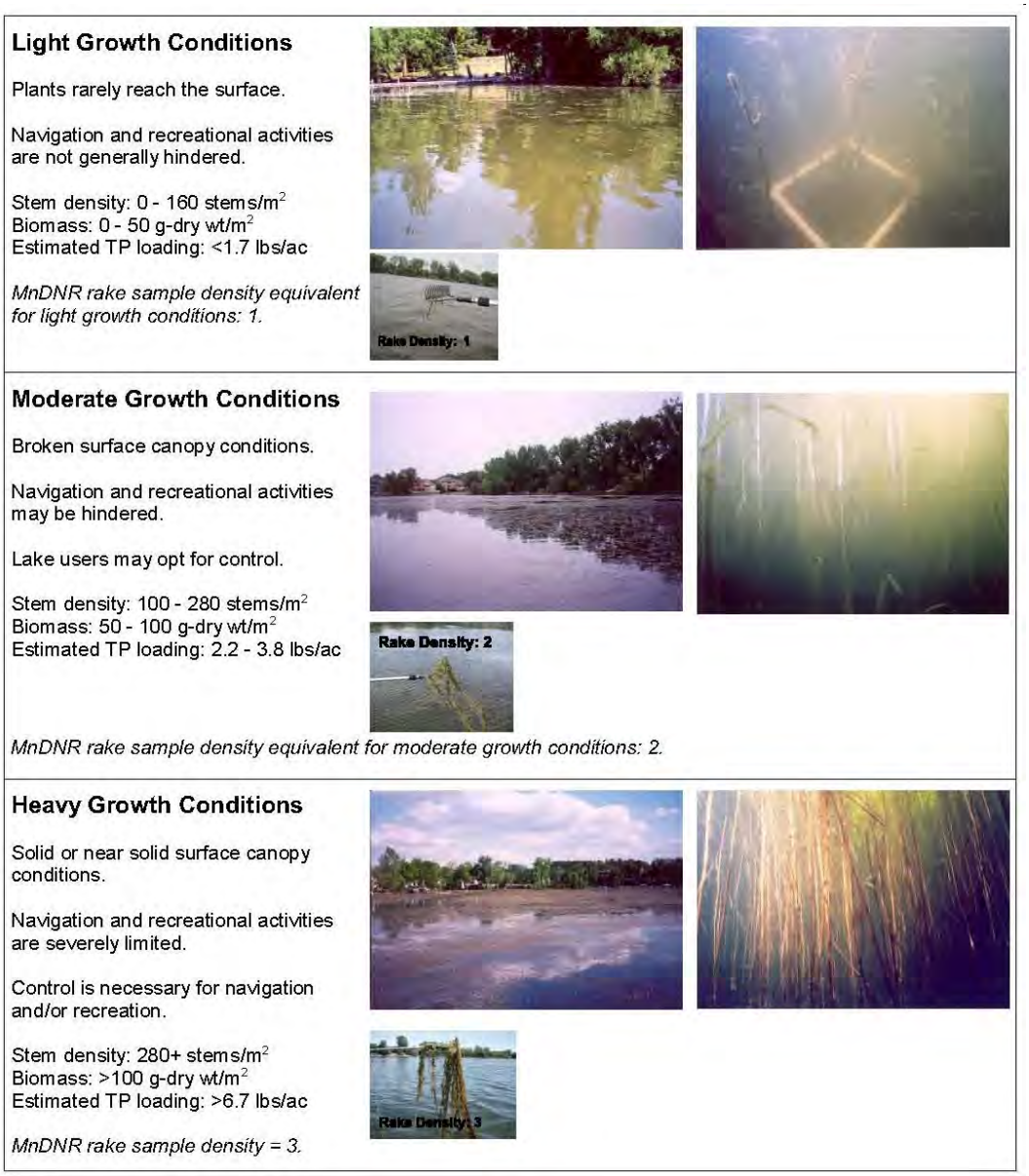


Figure 6. Estimated pounds of phosphorus per acre resulting from curlyleaf pondweed dieback. Pounds of phosphorus per acre were based on curlyleaf tissue analyses conducted at the University of Minnesota Crop Research Analytical Laboratory. Plant stem densities associated with light, moderate, or heavy growth conditions were determined with scuba diving by counting stems within a 0.1 m^2 quadrat. (Source: McComas, unpublished).

August 28, 2025: Results of the Point Intercept Survey

The submerged aquatic plants were rare in Lake Martha for the August 28, 2025 point intercept plant survey. A total of 6 submerged aquatic plants were found. Star duckweed was the dominant native plant in Lake Martha (Table 2).

A summary of plant occurrence and density for individual species is shown in Table 2.

Table 2. Lake Martha aquatic plant occurrences and densities for the August 28, 2025 survey based on 30 sites in the plant growth zone, out to 12 feet of water depth for Lake Martha. Density ratings are 1-3 with 1 being low and 3 being most dense.

	All Stations (n=30)		
	Occurrence	% Occur	Density
Submergents			
Coontail (*Ceratophyllum demersum*)	3	10	1.0
Chara (*Chara spp*)	5	17	1.0
Elodea (*Elodea canadensis*)	1	3	2.0
Star duckweed (*Lemna trisulca*)	11	37	1.0
Nitella (*Nitella spp*)	1	3	2.0
Sago (*Stuckenia pectinata*)	1	3	1.0
Number of submerged species	6		

Figure 7. Star duckweed was the most common plant in Lake Martha in August.

August 28, 2025: Aquatic Plant Maps for Lake Martha

The number of aquatic plant species found at a sample point is referred to as species richness. The species richness in Lake Martha for each sample site is shown in Figure 8. The number of plant species at a sample point ranged from 0 to 2 with an average of 0.2 species per sample point. This is a low species richness. Additional aquatic plant maps for individual plant species showing abundance and distribution are shown on the next page. Overall, aquatic plant growth in Lake Martha is mostly light.

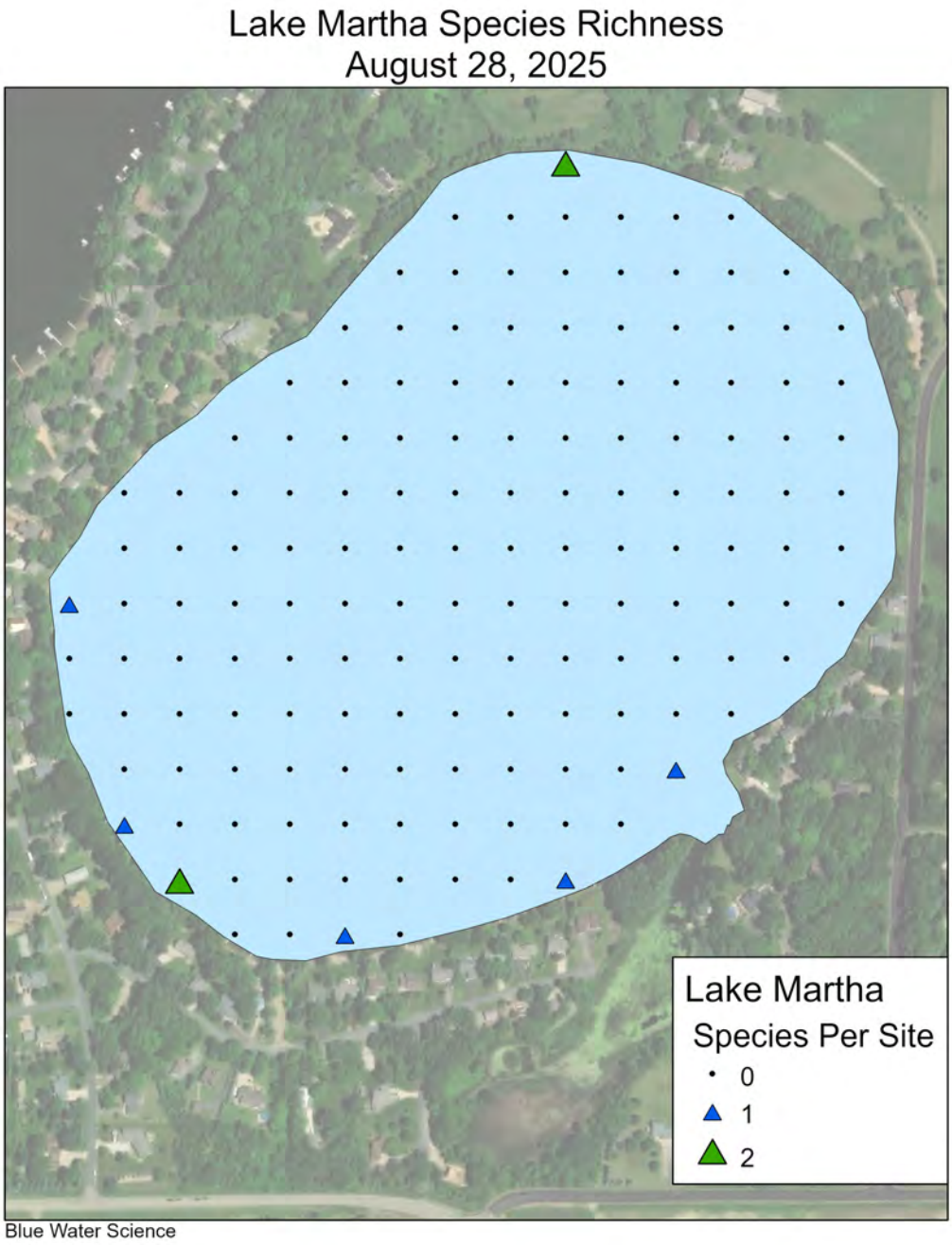
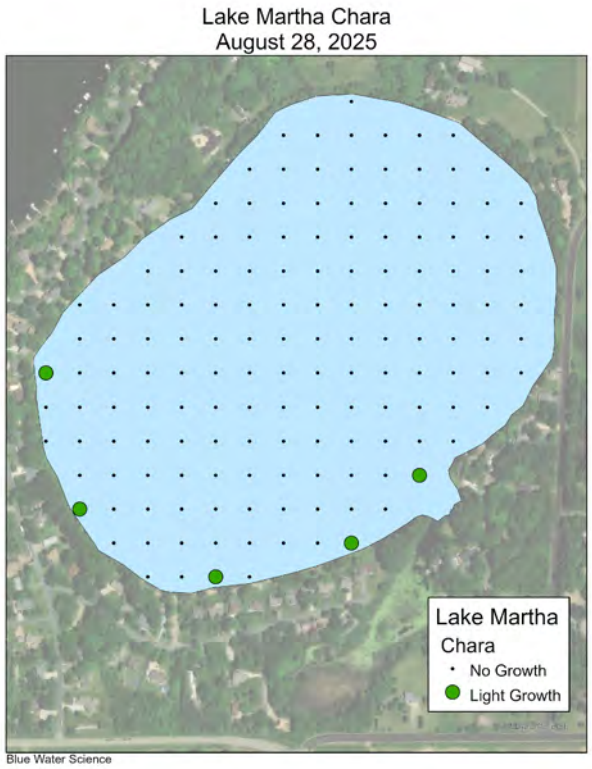
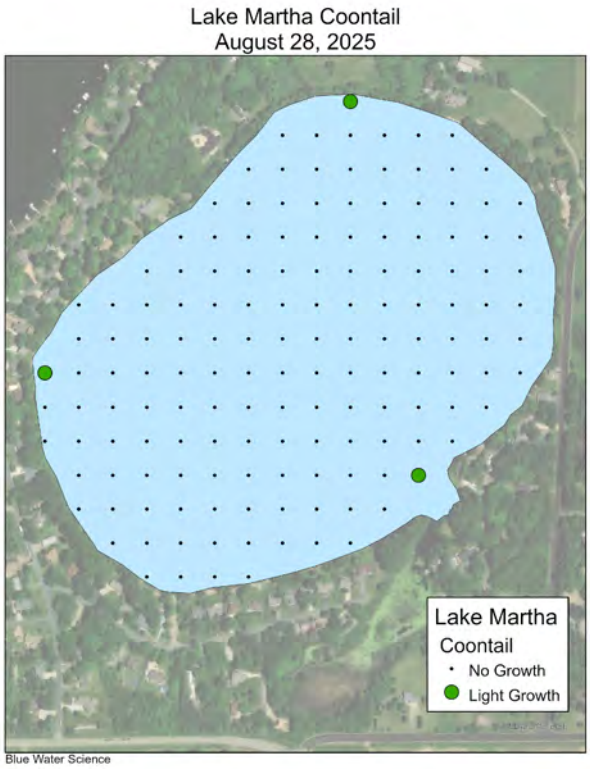
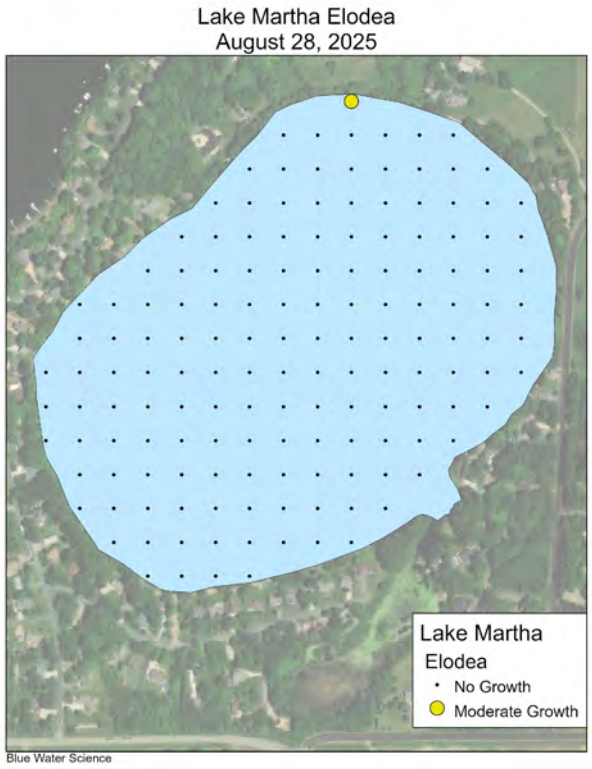


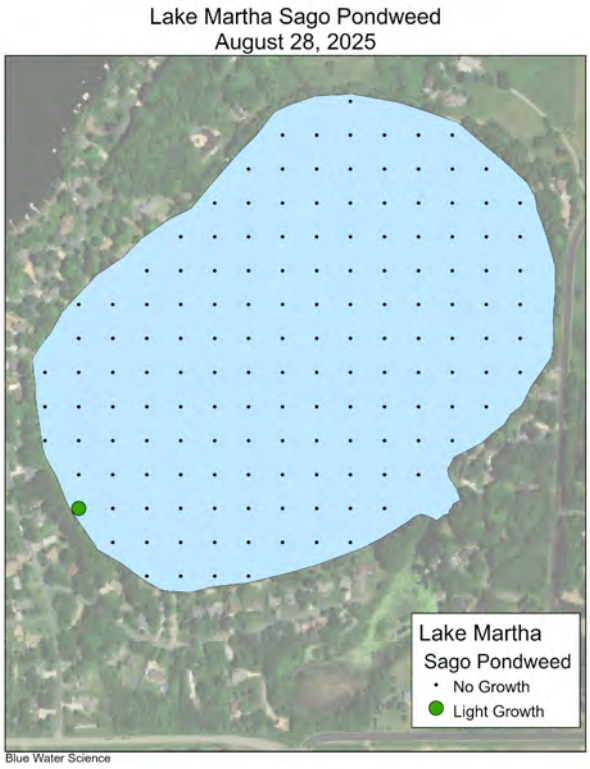
Figure 8. The number of aquatic plant species found at a sample point.

Aquatic Plant Abundance and Distribution









Lake Martha Aquatic Plant Point Intercept Statistics: A summary of plant statistics from the point intercept survey is shown in Tables 3 and 4 and Figure 9. Plants were observed in depths up to 7 feet and a total of 30 points were sampled in that depth zone (Table 3).

The aquatic plant coverage of Lake Martha was estimated at 8.7 acres or 9% of the lake area. Since plant coverage does not exceeds the 40% coverage criterium for good water clarity, Martha is predicted to have poor clarity in the future.

Table 3. Lake Martha aquatic plant statistics (using MnDNR format).

Total Number of Points Sampled	**56**
Depth Range of Rooted Vegetation	**1-6 feet**
Maximum Depth of Growth (95%) in feet	**6**
Number of Points in Maximum Depth Range	**14**
Number of Points in Littoral Zone (0-15 feet)	**56**
Percent of Points with Submersed Native Taxa	**13**
Mean Submersed Native Taxa/Point	**0.2**
Number of Submersed Native Taxa	**5**
Number of Submersed Invasive Taxa	**0**

Table 4. Aquatic plants sampled by depth.

Depth (feet)	Number of Sites Sampled at that Depth	Percent Occurrence of Plants at that Depth
0	0	0%
1	1	0%
2	0	0%
3	0	0%
4	6	33%
5	7	57%
6	7	14%
7	9	0%
8	6	0%
9	12	0%
10	8	0%
11	0	0%
12	0	0%
13	0	0%
14	0	0%
15	0	0%
16	0	0%
17	0	0%
18	0	0%
19	0	0%
20	0	0%
All sites	56	

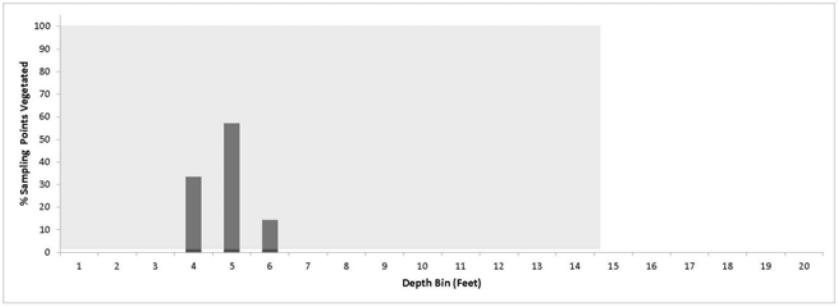


Figure 9. Depth of plant colonization (in feet).

Comparing Results of BioBase Mapping to Conventional Surveys for Lake Martha

Background: BioBase maps were used to supplement the aquatic plant point intercept survey results. BioBase uses data collected from the sonar to interpolate and estimate data points in between the discrete sample sites. BioBase produces maps for aquatic plant biovolume (percent of the water column occupied by plant matter), bathymetric data, and bottom hardness. Combining point intercept data with BioBase derived maps can provide a more complete view of the aquatic plant community and helps to assess change over time.

Methods: Hydroacoustic and GPS data were passively collected and logged on a Lowrance HDS sonar unit. The collected data was exported and uploaded to BioBase maps website. The georeferenced sonar log file data is then processed by BioBase maps and maps are automatically created using an interpolation (kriging) to create digital coverage maps showing bathymetry, aquatic plant abundance in the water column (biovolume: 0-100%), and bottom hardness.

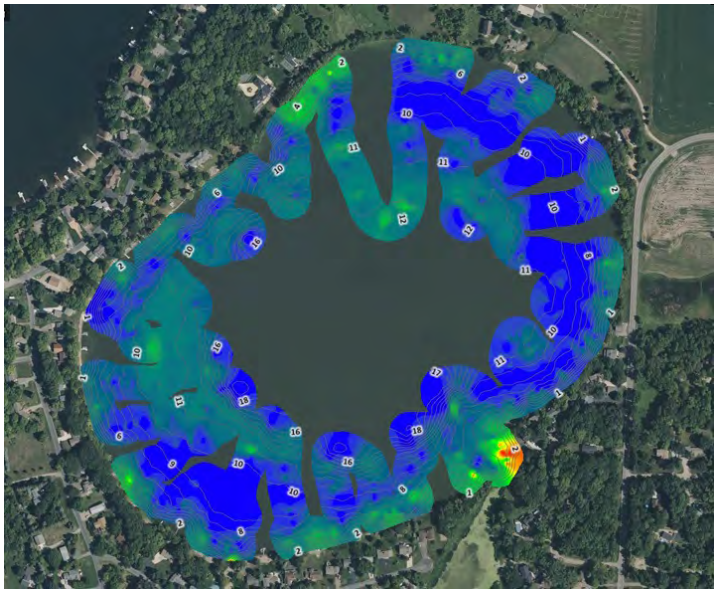
Results: During the course of the point intercept aquatic plant surveys on Lake Martha, BioBase aquatic plant biovolume maps were created to show the abundance of plant growth in the water column.

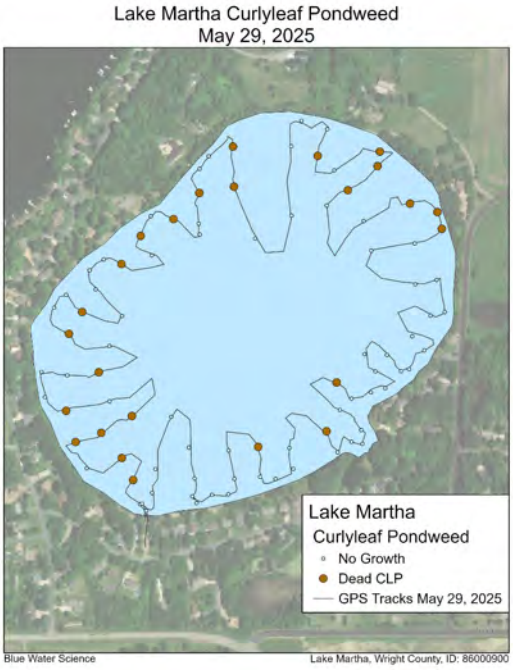
On May 29, 2025, curlyleaf was dying back and both the BioBase map and the PI map reflect those conditions.

On August 28, 2025, native plants had mostly light growth. Point intercept map for native plants is similar to what was found with BioBase mapping (Figure 10).

May

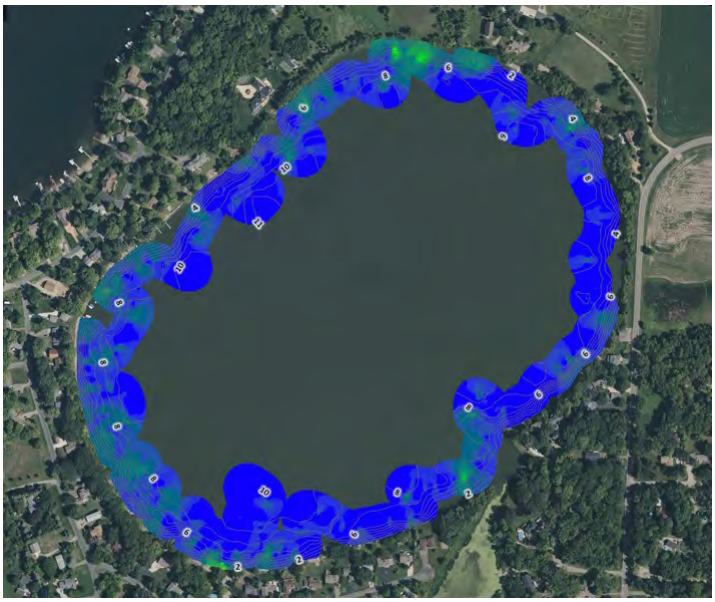
BioBase May 29, 2025





August

BioBase August 28, 2025



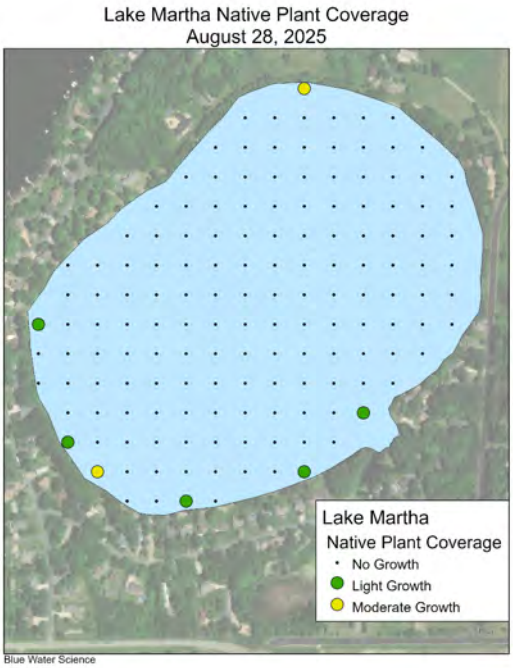
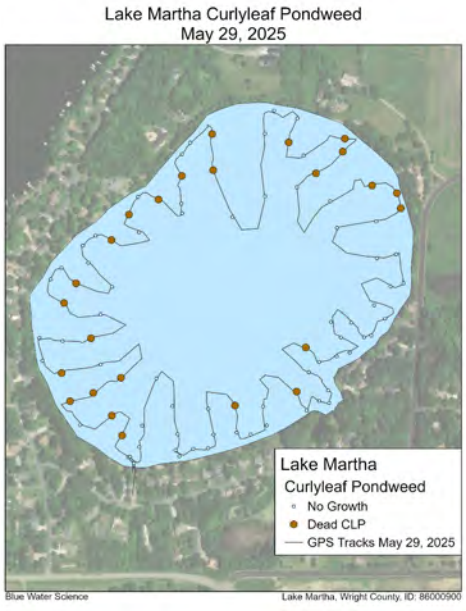


Figure 10. Lake Martha aquatic plant volume based on a BioBase map on May 29, 2025 with curlyleaf pondweed distribution (top), BioBase map on August 28, 2025 with native plant distribution (bottom).

BioBase key:	**Blue: no plants** **Green: low biovolume** **Yellow: moderate biovolume** **Red: high biovolume**

Aquatic Invasive Species Search: Dead curlyleaf pondweed was found at 25 sites in Lake Martha on May 29, 2025 during the meander survey. In the point intercept survey (30 sample sites out to 7 feet) curlyleaf pondweed was not sampled. The locations of curlyleaf pondweed is shown in Figure 11. Also on August 28, 2025, 80 rake samples were taken at the public access.

No starry stonewort or Eurasian watermilfoil were observed (Figure 11).



NO CURLLYLEAF PONDWEED WAS SAMPLED ON AUGUST 28, 2025

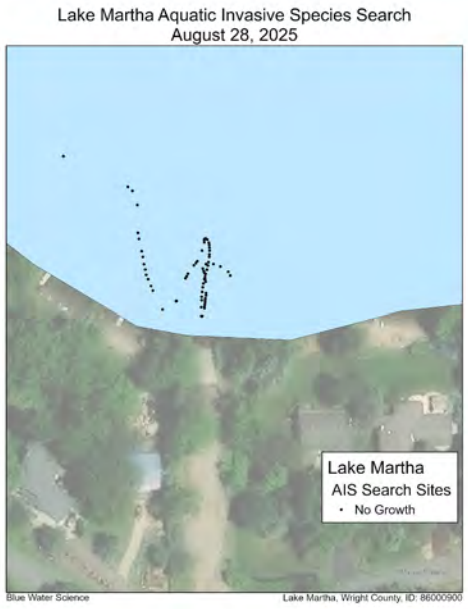


Figure 11. Sample sites for the littoral meander survey (top) and the sample sites from the point intercept survey (bottom) showing the sample sites were curlyleaf was sampled. No starry stonewort or Eurasian watermilfoil was observed at the public access (bottom right).