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Meadow Lake
Lake Management Report

July 2018

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Lake Description

Meadow Lake is a 19-acre lake located in Bloomfield Township, Oakland County, Michigan (T 2N, R 10E, S 31). The lake has approximately 17.5 acres of littoral zone that can support aquatic plants. Meadow Lake is located within the River Rouge watershed. The lake is fed mainly from drains that course through a bio-swale before entering the lake. The lake drains to the Franklin Branch, flows to the River Rouge, and ultimately ends up the Detroit River.

The shoreline mostly developed with mostly year-round homes. This is a non-motorized lake, so watercraft are restricted to wind, electric, or man-powered. The lake is used for aesthetics, swimming, fishing, and boating.

Concerns for Meadow Lake

A representative from Meadow Lake contacted LakePro and expressed various concerns for the lake. The first concern was lack of information and documentation about the condition of the lake and current lake management practices.

The lake was overgrown with aquatic vegetation and herbicide treatments had not produced significant improvements. Also, the lake had not been tested to determine the water quality or any indicators of pollution.

Prior Management Practices

The lake was treated in the past by a commercial applicator. Treatments included a variety of algicides and herbicides to control the invasive and nuisance aquatic plants. The treatment acreage was normally around 17.5 acres.

Management Goals for Meadow Lake

Based on the problems facing the lake, LakePro set out to accomplish four objectives at Meadow Lake.

1. Conduct a lake vegetation survey, including depth sounding;
2. Use the survey to recommend any changes to the herbicide program;
3. Test the lake water;
4. Use the results of the analysis to document the lake condition and any areas of concern;

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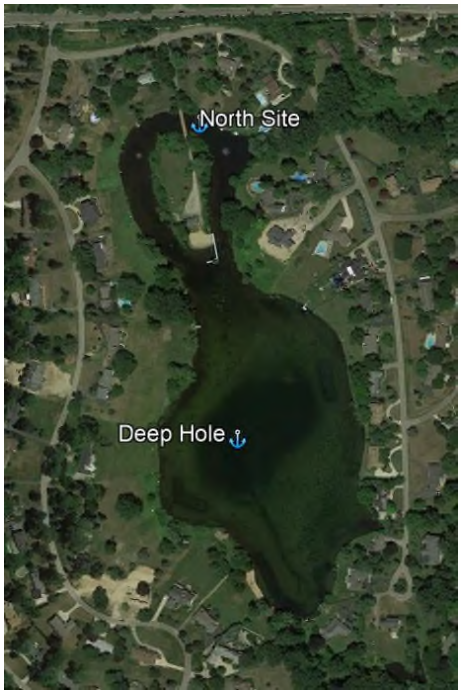
Water Quality Analysis

Introduction

The goals of this testing protocol were to test various water quality parameters of the lake, compare results to target values, and identify any potential risks to the health of Meadow Lake. Water samples were pulled from two locations and tested for 13 parameters. Tests were conducted one time on July 17th, 2018. Tests were conducted with a Hanna Multiparameter Water Quality Meter or LaMotte SMART2 Colorimeter.



Sampling Locations

The following aerial photograph shows the locations of the sampling sites.

Results

Parameter	North Canal	Deep Hole	Target Range	Status
Temperature	81.4 ˚F	82.9 ˚F	Less Than 75 ˚F	High
Dissolved Oxygen	6.4 mg/L	5.8 mg/L	4.0 – 12.0 mg/L	Healthy
Total Phosphorus	120 ppb	70 ppb	0 – 100 ppb	Slightly High
Phosphate	60 ppb	40 ppb	0 – 100 ppb	Healthy
Nitrate	792 ppb	616 ppb	0 – 1,000 ppb	Healthy
Chlorophyll	10.8 ppb	8.5 ppb	0 – 7.2 ppb	Slightly High
Transparency	--	9.4 feet	More than 6.5 feet	Healthy
pH	7.2 S.U.	7.4 S.U.	7.0 – 9.0 S.U.	Healthy
Total Dissolved Solids	439 ppm	332 ppm	0 – 1,000 ppm	Healthy
Conductivity	878 µS	664 µS	0 – 1,500 µS	Healthy
Alkalinity	113 ppm	129 ppm	100 – 250 ppm	Healthy
Hardness	157 ppm	160 ppm	100 – 250 ppm	Healthy
Salinity	430 ppm	320 ppm	0 – 500 ppm	Healthy

Discussion

Meadow Lake's water quality was healthy at the time of these tests. Most results were within the target ranges, with the exceptions of temperature, total phosphorus, and chlorophyll. Water temperatures are dependent upon the weather, so seasonal peaks are expected. Abundant nutrient concentrations feed the growth of aquatic plants, sometimes to nuisance levels.

Temperature and Dissolved Oxygen

Dissolved oxygen is vital for a healthy aquatic ecosystem. The water temperature determines the maximum amount of oxygen that can be in the water. Colder water can hold more dissolved oxygen, so we prefer water temperatures to be as cool as possible. The water **temperatures** were above the target range. With higher water temperatures, there was concern about less dissolved oxygen in the water. Despite warm water temperatures, the **dissolved oxygen** was still sufficient for a healthy aquatic ecosystem and fishery.

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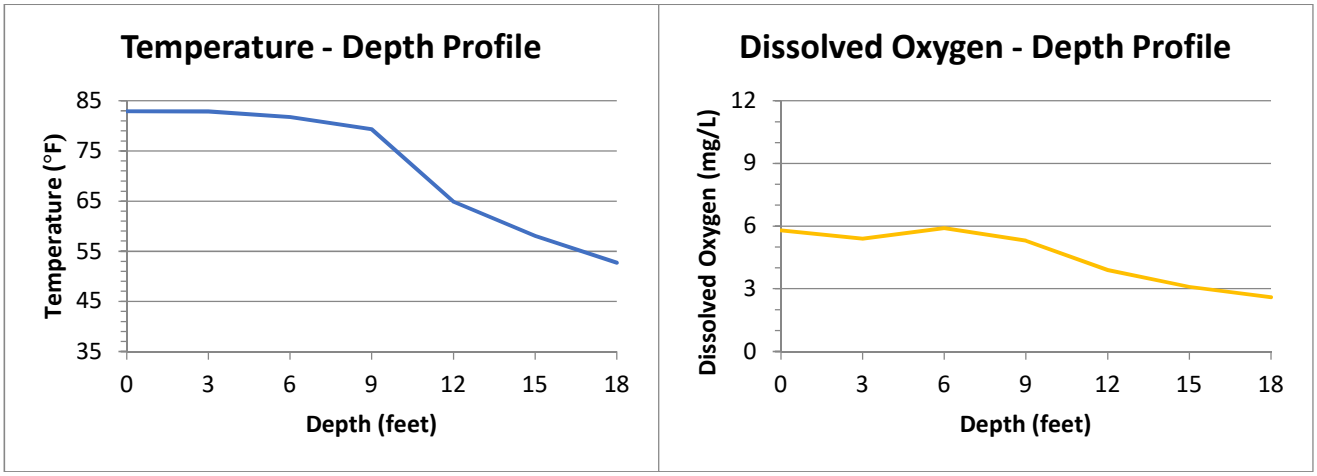
We also measured temperature and dissolved oxygen at different depths to create a depth profile. This data shows how the parameters changed with depth and whether or not a thermocline was present in the lake. The graph below shows the data we collected in 2018. During this test, there was a thermocline present near 10 feet.



The dissolved oxygen decreased from top to bottom of the lake. In the deepest water, the oxygen concentration dipped below the target levels. The lack of oxygen in cold water will limit the fishery to warm water species, such as bass and panfish. A thorough fish study would provide more information about the fish species, numbers, and sizes in the lake.

Nutrients, Plant Production, and Transparency

Nutrients in the water are the fuel for plant growth. So, the nutrient concentrations reveal the potential for nuisance plant growth. Phosphorus is one nutrient necessary for aquatic plant growth, so it is important that this nutrient remains low in the lake. The **phosphorus** was elevated in the open water but still within the target range. The active form, **phosphate**, was much lower and comfortably within the target range. Nitrate is another major nutrient for aquatic plant growth. At the time of these tests, the **nitrate** concentration was within the target range.

All three nutrient parameters were higher in the North Canal, with phosphorus going above the target range. This shallow area has a greater ratio of shoreline to water volume. It also has more sediment to water volume. Both of these ratios lead to more stagnation, higher inputs from runoff, and less opportunity for mixing or dilution. In most waterbodies, the shallow areas experience greater aquatic plant growth because of these factors. It is important that you fertilize and use the land responsibly to prevent additional nutrient s from entering the lake.

We also measured chlorophyll concentrations because it is the most direct indicator of plant production. The **chlorophyll** concentrations were above the target range and indicative of a productive lake. At the time of these tests, the lake was filled with aquatic plants, especially algae.

One effect of plant growth on the lake is the reduction of water clarity. Algae suspended in the water column decreases water clarity. This year, we measured the **transparency** at depth of 9.4 feet. This was very good for a productive lake.

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Trophic State Indices

In order to better understand the relationship between nutrients, plant production, and transparency, limnologists use Trophic State Indices (TSI) to score each category and examine the relationship between them. In general, lower scores indicate a less productive lake. In 2018, the TSIs for Meadow Lake were:

Category	Water Quality Parameter	Trophic State Index	Classifciation
Nutrients	Total Phosphorus	69	Eutrophic
Plant Production	Chlorophyll	52	Eutrophic
Clarity	Transparency	45	Mesotrophic

The TSI for total phosphorus classified the lake as eutrophic, or very productive, based on the availability of nutrients to sustain plant growth. The TSI for chlorophyll was lower than the nutrient index. This shows that the plants were not at the levels predicted by the nutrient concentrations. Finally, the TSI for transparency showed the clarity was better than predicted by the plant production. One explanation for the differences could be the plant management treatments that suppressed the plant growth.

Water Chemistry Parameters

It is important to monitor the basic water chemistry of the lake. Shifts in these parameters can indicate major changes to the lake that may need to be further investigated.

The **pH**, **total dissolved solids**, and **conductivity** of the lake were measured within the target ranges. This showed that the water chemistry of the lake was at a natural state and there were no immediate concerns for the water quality. With no historical data, we were unable to compare these results to look for any significant changes. Continuing to test in the future will provide insight to how the lake changed on a long term scale.

Alkalinity measures the concentration of one salt, Calcium Carbonate, which is beneficial to the aquatic ecosystem. The carbonate ions are able to accept protons from acids, making it a natural buffer. This means that as acidic substances enter the lake, the carbonate is able to buffer against severe changes in pH that could pose a threat to the ecosystem. The **alkalinity** was at a very healthy level for the time of year.

Hardness measures positive ions that generally compliment carbonates, such as calcium and magnesium. For this reason, hardness typically follows alkalinity. The **hardness** was very healthy for the time of year.

The lake was tested for total salinity. There should be salts present in the water naturally, but elevevated levels can indicate pollution from within the watershed and may pose a risk to the ecosystem. The **salinity** was in the middle of the target range at the time of this test.

Summary & Recommendations

Overall, the water quality of Meadow Lake was healthy at the time of this test. The results confirmed and quantified several characteristics of the lake. The data gives a baseline to improve the lake management methods. Continuing to test in the future will help determine the impacts of the lake management and monitor for any significant changes to the water quality.

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The nutrient concentrations were similar to those we see in other small, developed lakes. The total phosphorus was slightly elevated in the open water and high in the canal. This is common for a lake with a large ratio of watershed area to lake volume. The concentrations of available phosphate and nitrate were within the target ranges, but still sufficient to support abundant plant biomass, which was present in Meadow Lake at the time of the tests.

Improving the nutrient concentrations requires two approaches: prevention and remediation. It is first important to address the nutrients entering the lake from outside sources. This includes natural inputs, such as plant materials falling or sliding into the lake (e.g. fall leaf drop). Another natural source is soil erosion, which brings nutrients to the water. People and development introduce new sources, such as storm drains, lawn fertilizers, and septic systems. Each of these sources should be addressed to reduce their potential to deliver nutrients to the lake. A natural shoreline with abundant native plants is one way to help slow, stop, and absorb nutrients at the shoreline before they enter the lake.

Nutrient remediation involves removing the nutrients already in the lake. There are various methods to accomplish this, including chemical treatment, biological augmentation, or physical control, such as dredging. Each method has its own risks, benefits, and associated costs. These remediation methods are an investment, because removing nutrients will lead to lesser plant growth, which will save you money over time on the herbicide treatments. However, remediation should always take place along with prevention, otherwise you're cleaning up the spill but not stopping the leak.

All other water quality parameters were within the target ranges, showing the water quality was very good. As you continue to test in the future, trends will indicate how the lake changed over time. For now, you should take pride in Meadow Lake as a valuable water resource and continue your efforts in improving it.

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Aquatic Vegetation Survey

Introduction

The lake vegetation survey was undertaken to document the aquatic plant species, their abundances, and distributions. The survey was conducted according to the MDEQ's "Procedures for Aquatic Vegetation Surveys". During the survey, we also ran our BioBase system to record the trip around the lake. The BioBase system provides visual representations of the plant biomass, water depths, and bottom composition. The results of the survey can be used to help plan and improve the aquatic plant management program.

Methods

We split the lake into 20 distinct "sites" that are approximately 200 feet wide. In each site, we noted the plant species by their assigned numbers and the densities by the letters A (found), B (sparse), C (common), or D (dense).

Methods

The following is the survey summary table and survey map with notes.

Meadow Lake				**Oakland County**							**7/17/2018**
Standard Aquatic Vegetation Summary Sheet						SURVEY BY:	Peter Filpansick, LakePro, Inc.				
		Total number of AVAS's for each Density Category					Calculations				Sum of Previous Four Columns	Total Number of AVAS's	Quotient of Column 9 divided by Column 10
		A	B	C	D		Category A x 1	Category B x10	Category C x 40	Category D x 80			
Code No	Plant Name	1	2	3	4		5	6	7	8	9	10	11
1	Eurasian milfoil	2	2	2	1		2	20	80	80	182	20	9.1
3	Chara	2	1	3	14		2	10	120	1120	1252	20	62.6
4	Thin-leaf pondweed	1	4	1	0		1	40	40	0	81	20	4.1
19	M. heterophyllum	1	3	0	0		1	30	0	0	31	20	1.6
27	Sago pondweed	2	5	3	4		2	50	120	320	492	20	24.6
33	Duckweed	1	0	0	0		1	0	0	0	1	20	0.1

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Meadow Lake
7/17/2018

AVAS + Bio Base
Peter Fitzpatrick

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Discussion

The lake was dominated by aquatic plants at the time of this survey. Navigation with an outboard motor was difficult. Most of the plant growth was a combination of macroalgae, including native Chara and invasive Starry Stonewort. Below, we discuss the different aspects of the plant community.

Biodiversity

The lake showed low biodiveristy among plants. During the survey, we noted only six plant species, two of which were dominant in the lake. Biodiversity refers to the range of different species in an ecosystem. A wider range of species provides many benefits and services. A greater variety of plant species is able to support a wider range of other organisms, such as macroinvertebrates, fish, and waterfowl. Also, a wider range of species generally indicates healthy competition between species, so the lake is not dominated by one or two plants. In general, we look for at least ten different aquatic species and no dominance.

Invasive Species

One reason for the low biodiversity was the presence of invasive species. Starry stonewort, which was included under "3 – Chara" on the table above, was the invasive species that dominated most of the lake. Eurasian Milfoil was another invasive species that was abundant in the lake.

Invasive species ususally have an advantage that allows them to outcompete native species. This may be their physical structure, temperature tolerances, sunlight requirements, or method of reproduction. Over time, the invasive plants use their advantages to dominate the lake bottom, reducing and eliminating native plant species. This leads to a reduction in biodiversity and ecological services.

Nuisance Native Plants

Native plants are not always benign; they can grow to nuisance levels that inhibit recreation or degrade the aesthetics of the waterbody. At the time of this survey, Sago Pondweed was growing to nuisance levels, especially at the south end of the lake. This stringy plant impeded navigation and was visible on the surface of the water.

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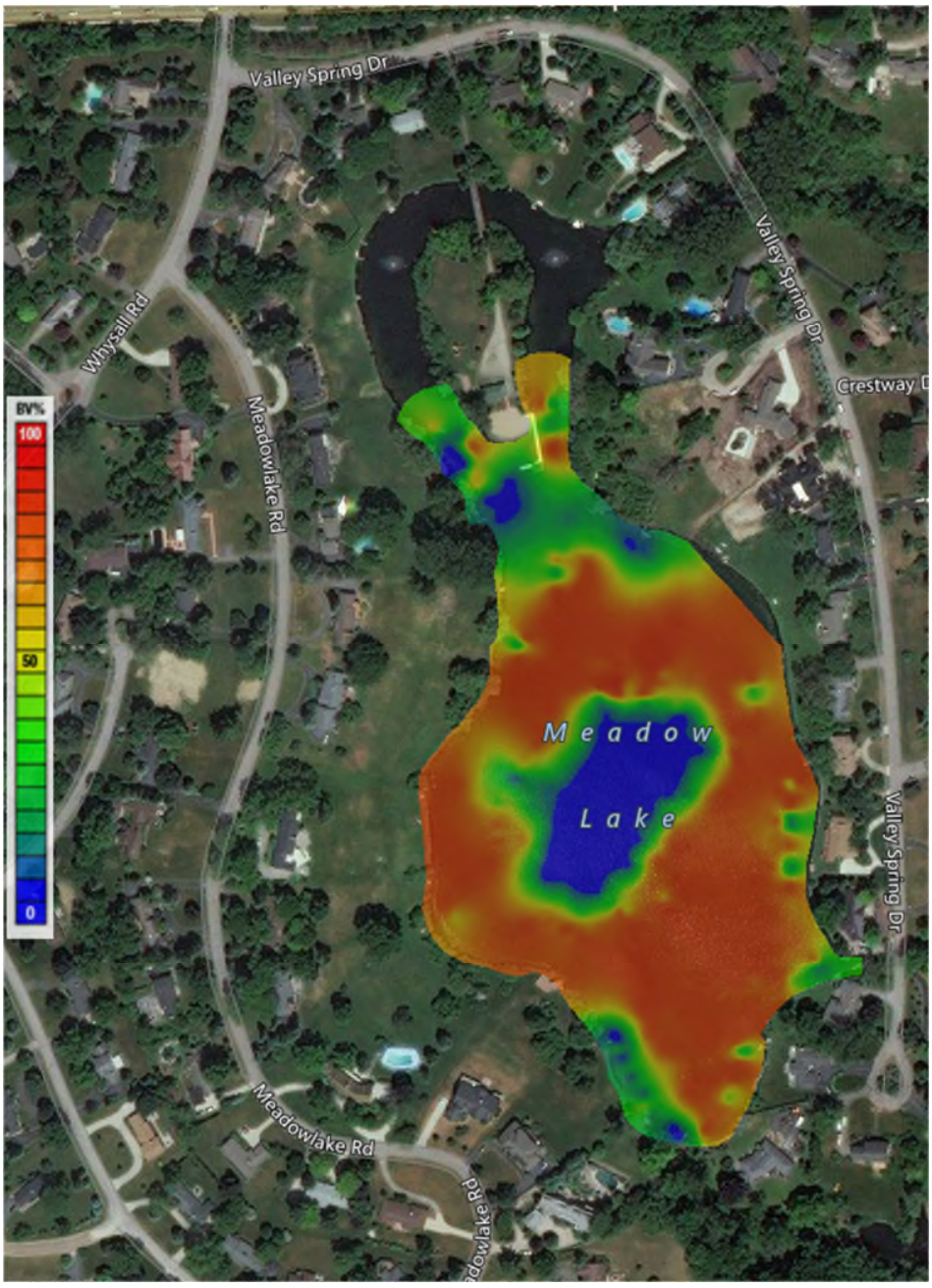
BioBase Maps

During the survey, we used our sonar chartplotter to record the trip then create maps with our BioBase software. The following maps are the result of this mapping.

Plant Biomass



This map visualizes the plant biomass with red indicating the most dense growth. The large red doughnut shows the dense growth of Starry Stonewort, Eurasian Milfoil, and Sago Pondweed. We could not record usable data in the north canal because of the shallow depth.

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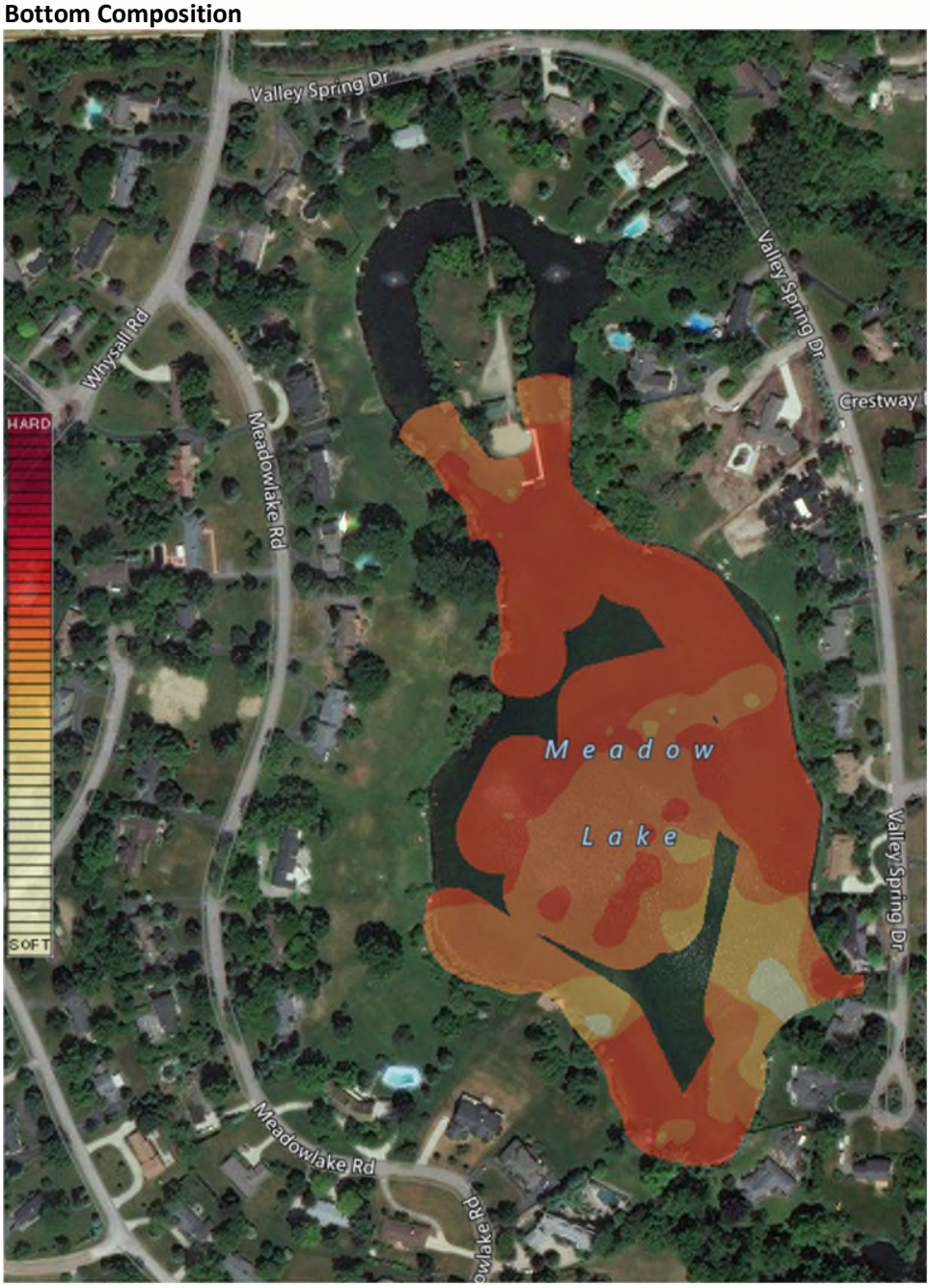
Bottom Composition



This map shows the relative bottom hardness with red indicating a harder bottom. Areas without color did not record usable data due to shallow depth or plant growth too dense to differentiate the lake bottom.

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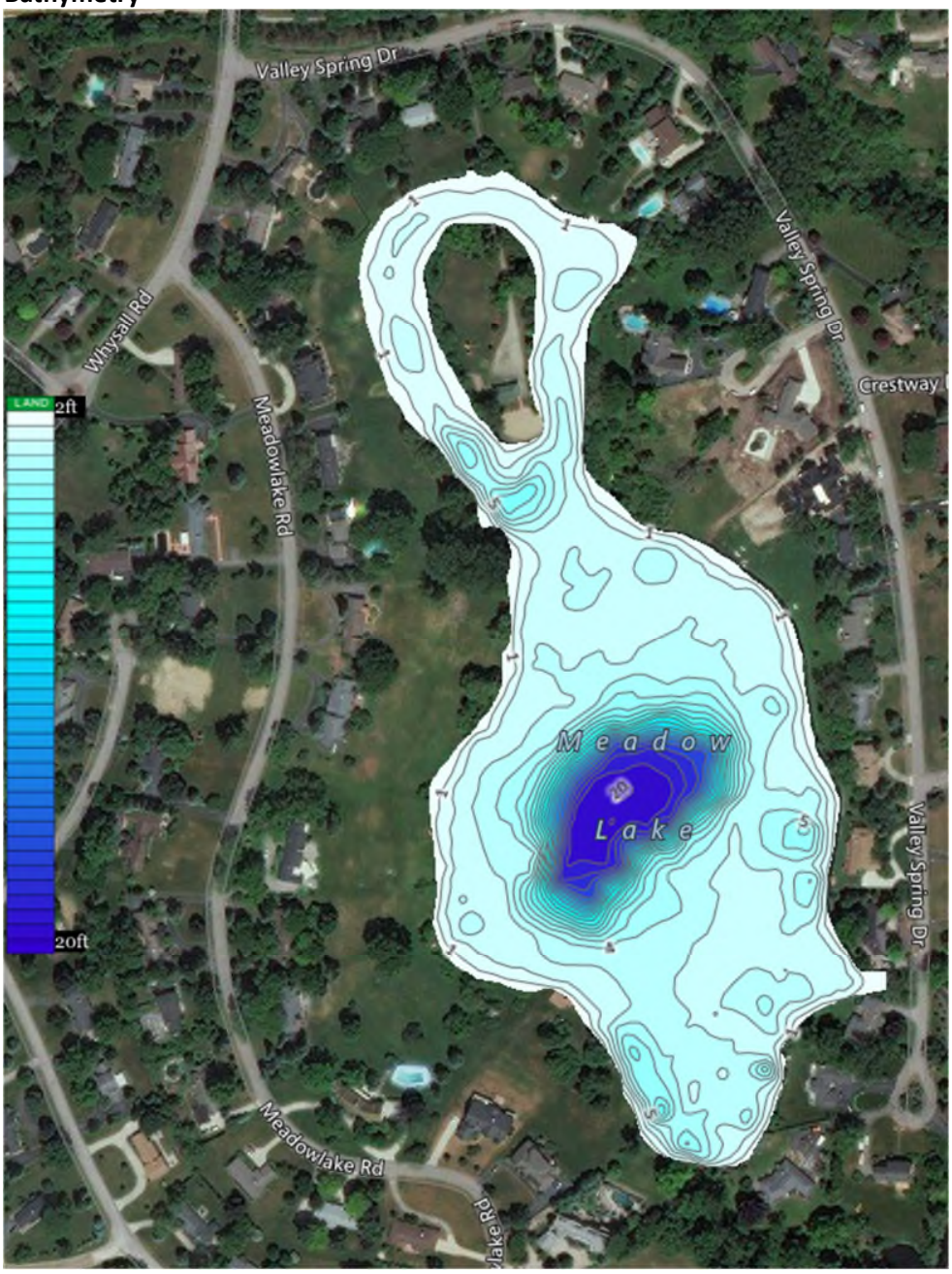
Bathymetry



This map shows the depths in the lake at the time of the survey. This map may be used to update your herbicide permit map and treatment areas.

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Integrated Plant Management Recommendation

Based on the results of the Water Quality Analysis and the Vegetation Surveys, we recommend an integrated approach to managing the lake and the plants within it. No single practice will solve all of challenges facing the lake. Instead, it will take a combination of tools to improve the lake responsibly.

Lake Vegetation Surveys

This report established a baseline for the plant community. It will be a long journey to restore the plant community to a more natural condition. Additional vegetation surveys are important to document changes in the plant community, such as further spread of invasive plants or successful control by an herbicide program.

Herbicide Treatments

The primary problem in the lake is the growth of invasive and nuisance species. Currently, the lake is treated with herbicides to suppress and control the aquatic plants. Herbicides are selective for the target plants, provide reliable results, and reduce the possibility of spreading the plant through fragmentation.

We recommend adapting your herbicide program to include these three items:

Macroalgae Control

The predominant problem in the lake is macroalgae, including invasive Starry Stonewort. The herbicide program should include algicide treatments that include the maximum treatment area allowed by the MDEQ permit. Treatments should include a combination of chelated copper and endothal and be made as frequently as the permit allows. Successful treatment programs typically include six to eight treatments per summer to control the Starry Stonewort.

Eurasian Milfoil Control

Eurasian Milfoil is the other invasive plant in the lake. It is not as dominant as the Starry Stonewort but may spread as the macroalgae is controlled. So, we strongly recommend eradicating the Eurasian Milfoil with the use of systemic herbicides. Systemic herbicides control the entire plant, including the roots, providing long-term control. Using these products properly can lead to eradication of this invasive plant.

Pondweed Control

The Sago Pondweed can be suppressed to reduce the growth and improve the aesthetics of the lake. This plant can be controlled with a one-time treatment with a contact herbicide, such as Diquat Dibromide or Endothal. The use of these products should be coordinated with the treatments listed above to not conflict with treatment goals or permit restrictions.

Mechanical Harvesting

Eurasian Milfoil should not be harvested. Harvesting can create fragments that float away from the harvesting machines. Fragments of EWM can find soil, grow new roots, and start a new colony. For this reason, harvesting can spread the EWM and negate any other management efforts, so we strongly advise against harvesting the EWM.

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Mechanical harvesting can provide a tremendous benefit to the lake. By removing plant material, harvesting also removes the nutrients that are bound in the plants, reducing the overall nutrient load of the lake. Furthermore, after an herbicide treatment the EWM plants will go to the bottom and decompose. Other native plants will use this organic material to grow, so harvesting will help slow the accumulation of muck on the bottom of the lake.

Harvesting is also another option when the MDEQ restricts the use of herbicides. For example, the MDEQ permits usually restrict the treatment of Lily Pads with herbicides, but do not restrict the cutting of these plants with a harvester.

Water Quality Analysis

Continuing to test the water quality of the lake is important to monitor the lake for any changes. We normally test the water two times annually to ensure the management program is not causing any detrimental effects to the lake and to watch for progress from year to year.

Nutrient Mitigation

Another issue facing the lake is the high nutrient load, both in the water and in the sediment. There are several options for reducing or removing these nutrients. Reducing the nutrients and organic material will improve the water clarity and reduce any odors. Nutrient mitigation can also help slow the growth of algae and aquatic plants and improve depth by reducing the "muck" on the bottom.

Biological Augmentation

Adding beneficial bacteria to the lake helps consume excess nutrients and improve the water quality. These bacteria can be applied to the water or as pellets to the "muck". Once in the water, the microbes get to work by consuming organic material and nutrients. The bacteria consume nutrients that would otherwise fuel excess plant and algae growth. Probiotics are not a cure-all but will improve the aquatic ecosystem over time. Because biological augmentation utilizes living organisms, it is important to apply biological products on a regular basis and from one year to the next. This helps keep the populations elevated throughout the summer to provide the largest benefit.

Nutrient Inactivation

Phosphorus can be bound by applying a product to the water that binds the nutrient at the chemical level. PhosClear and PhosLock are examples of products that can be applied one time to the lake that bind the phosphorus and precipitate it to the lake bottom. These treatments are best conducted early in the spring, before plants have a chance to use them. There is a separate permit required for these treatments.

SeClear is an algicide that also includes a nutrient binding agent. Should you choose to adapt a more aggressive algicide program, including SeClear will help control algae and bind additional phosphorus, slowing the next wave of algae growth.

Dredging

Dredging is the most drastic solution for the lake condition. Dredging removes plants, their seeds, excess nutrients, and excess sediment. It also usually includes pumping the lake down, flushing the nutrient-rich water currently in the lake. Dredging includes many challenges, including the high cost, rigorous permitting, and difficult logistics.

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Summary

LakePro appreciates the opportunity to help assess your lake and improve the lake management. This report is meant to serve as a checkpoint to document the lake condition and help improve your management efforts. If you have any questions or concerns, please feel free to contact us to discuss this report or learn more about our recommendations.

Thank you for choosing LakePro,

Peter Filpansick
Director of Lake Management
Aquatic Biologist