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Aquest Corporation

A Summary of Findings from LakeScan™
Guided Surveys and Analysis of:

Lobdell Lake

Genesee and Livingston Counties

2022 LAKE CONDITION AND MANAGEMENT EVALUATION

Submitted by:

Dr. G. Douglas Pullman, President

Aquest Corporation

LakeScan™

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Introduction

Preface: Lakes are complicated systems. There is no simple way to consider all of the interacting systems within a lake and the impact of watersheds and invasive species invasions on these precious resources. LakeScan™ is a comprehensive system of analysis that is necessary to properly consider conditions in a lake and make reasonable, scientific and empirically based recommendations for management and improvement of lake ecosystems. This report is only the "tip of the iceberg". All recommendations are based on an extremely comprehensive data set.

Background: LakeScan™ provides an analysis of lake conditions, management impacts and management recommendations based on data and observations collected over multiple lake surveys executed during the course of the plant growing season. This report is focused on the large plant or macrophyte part of the lake ecosystem. Each aquatic vegetation survey includes a comprehensive mapping of aquatic vegetation present in the lake where observations are assigned to fixed points (AROS). A LakeScan™ analysis takes the data collected during these surveys and calculates a series of metrics representative of the health of the lake ecosystem, as well as the nuisance threat presented by invasive and weedy species. In addition to providing a snapshot of lake health, these metrics allow for a comparison of lake conditions on a year-to-year basis as well as a comparison with other lakes. Survey data and the maps generated from it are used to provide treatment and intervention recommendations, when necessary. Recommendations are made keeping in mind that they should always result in improvements and ensure no further degradation of the lake ecosystem.

This report is based on the recently introduced LakeScan™ 5.0 analysis for aquatic vegetation communities. Readers of previous reports report will notice that this is very different from earlier reports but these changes were needed to reflect a multitude of scientific advances and changes in our understanding of aquatic ecosystems that have occurred during the past five to seven years. Some metrics have been changed and some have been suspended. The appendix of this document provides the justifications for these changes. The reader will also note that this report also provides significantly more focus on the management of aquatic vegetation communities. Some of the findings presented herein will be transformative for the management of these critical communities.

Data Collection Methods: A typical LakeScan™ aquatic vegetation commumity analysis involves collecting data over two vegetation surveys. These surveys are based on a system where the lake is first divided into biological tiers (Table 1 and Figure 1) and then further subdivided into Aquatic Resource Observation Sites (AROS; Figure 2). Emergent or wetland plants dominate Tier 2 and data collected from this tier is sometimes included in species lists, but these data are not included in the calculation of major metrics. For each survey, field personnel record the density, distribution, and position in the water column of each aquatic plant species in each aquatic resource observation site AROS, as well as noting the presence and severity of observed nuisance conditions. Aquatic plant community species composition typically change rather dramatically over the course of a year, so the surveys are split into early and late-season observations. Early-season surveys are scheduled with the goal of taking place within 10 days of

early-summer treatments to best observe treatment-targeted and non-targeted vegetation. However, this scheduling is subject to weather and times of increased boat activity.

Table 1 - Biological Tier Descriptions

Tier	Description
2	Emergent Wetland
3	Near Shore
4	Off Shore
5	Off Shore, Drop-Off
6	Canals
7	Around Islands and Sandbars
9	Off Shore Island Drop-Off

At a Glance: The primary goal of aquatic plant management in Lobdell Lake, Genesee and Livingston Counties, MI, is to preserve, protect, and if possible, improve the biodiversity of the flora and fauna of the lake. This primary goal is consistent with providing excellent conditions for all forms of recreation including fishing. Key findings are as follows:

- The combined species biodiversity and structural diversity scoring for Lobdell Lake met management goals, suggesting adequate ecosystem health and habitat for fish. The LakeScan vegetation quality metric index scoring improved relative to 2020. Ecological and recreational nuisance conditions were highly variable but similar to those observed in the two previous years. PNL levels are evaluated after lake treatment and the results suggest the current treatment regimen may effectively eliminate nuisance conditions.
- The herbicide applications made to the lake in 2022 were considered to have met expectations. A second treatment focused on a small number of AROS that were not treated by the June herbicide application but where nuisance levels of ebrid watermilfoil began to develop in August. An even smaller number of AROS required late-season treatment that had been treated earlier in the summer.
- Every year is different in Lobdell Lake and both ecological and recreational nuisance conditions can vary widely from year to year. Effective and targeted management has succeeded in maintaining consistently and reasonable lake health as demonstrated by LakeScan™ data. An exhaustive range of management strategies are considered in late May each year the best possible strategies are applied to the lake to achieve the most desirable management outcome.
- Lobdell Lake has been a subject leader in national lake management since the early 1990's. Many of the novel strategies that have been applied to the lake are now used throughout the US. A new strategy to improve the management of canals is being considered for Lobdell Lake in 2023. The management team will continue to advocate for State approvals for products that may improve the time for nuisance vegetation to drop from the water column.

The following sections describe the lake and watershed characteristics, field water quality measurements, results of the aquatic vegetation surveys and aquatic vegetation management activities and recommendations. Some of these sections are essentially unchanged from year

to year, such as lake location and size data. Readers may wish to skip to Section 700, plant community data reviews since these data have been updated in this report. It is also important to note that the observation sites in the lake, AROS, have been relabeled in 2023.

Category 100 – Lake and Watershed Characteristics

This section provides an overview of physical and geopolitical characteristics of the lake and its watershed, as well as illustrations of tier layouts (Figure 1) and AROS (Figure 2) used for vegetation surveys. A summary of watershed land-use composition is included in Figure 3.

Location

County: Genesee and Livingston
Township: Argentine and Deerfield
Township/Range/Section(s): T5N, R5E Sections: 25, 35, & 36
GPS Coordinates: 42.787230, -83.822344

Morphometry

Total Area: 545 acres
Shoreline Length: 15,764 feet
Maximum Depth: 72 feet
Average Depth: 7 feet
Percent Total Plant Productive Area: ~80% (depending on year and water clarity)

Watershed Factors

Tributaries: Bennett Lake Channel (Ore Creek), several storm drains
Outlet type: Adjustable weir
Other Features: Several wetland complexes

Administrative Management

Management Authority: Argentine and Livingston Twps.
Years in LakeScan™ Program: 1990 to present
First Year of Monitoring Program: 1988

Figure 1: Aquatic Resource Observation Sites (AROS). Updated 2022 to include geo-referenced center points or way points for each AROS..

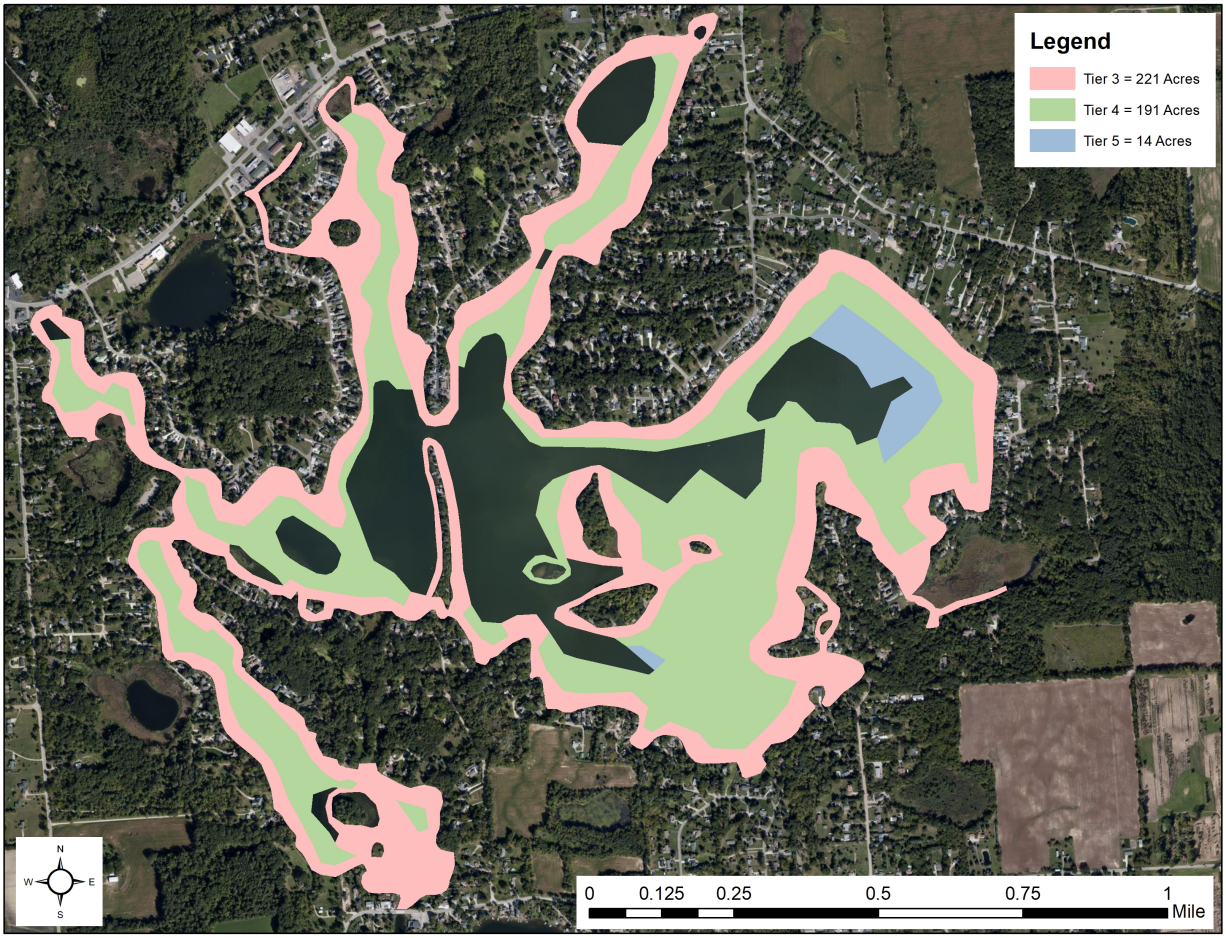

Figure 2. Map of biological tiers where each tier will host a unique plant community that is determined by distance from shoreline structure, water depth, and wind and wave energy. Each AROS is assigned to a tier and the numbering of the AROS reflects the individual AROS tier assignment.

Table 2. AROS number and acres assigned to observation sites in Lobdell Lake.

Total Lake Acres = 545			TOTAL AROS Acres = 485	
AROS AND TIER CHARACTERISTICS	Total	%	Acres	%
Lake	292		485	
Tier 3	142	49%	183	38%
Tier 4	92	32%	223	46%
Tier 5	5	2%	10	2%
Tier 6	12	4%	8	2%
Tier 7	40	14%	59	12%
Tier 8	1	0%	1	0%

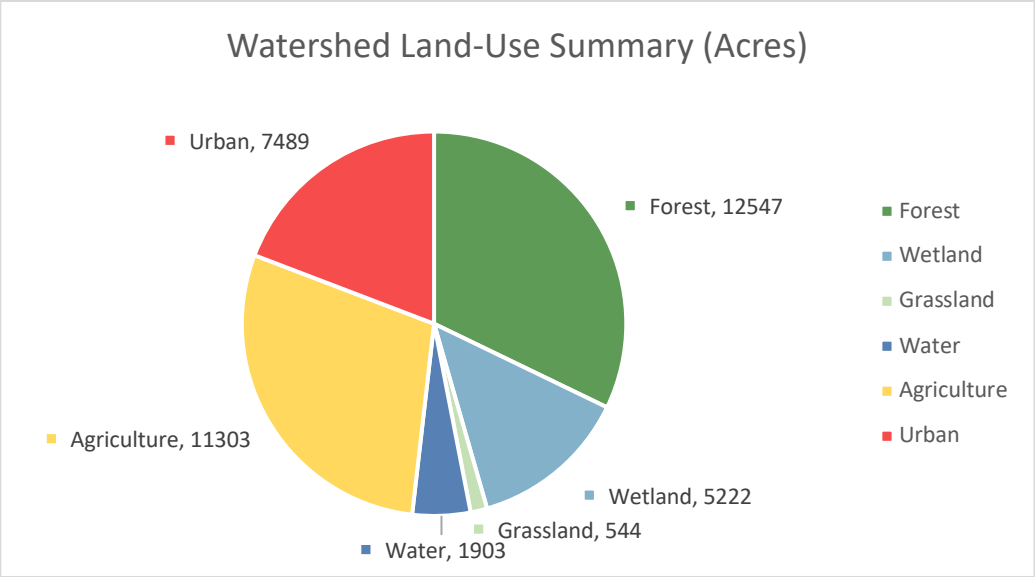

Figure 3. Lake watershed land-use composition (acres), according to the Michigan Glacial Lakes Partnership Conservation Planner, available online at: http://midwestglaciallakes.org/resources/conservationplanner/.

Category 200 – Water Quality

Over 80% of the total area of Lobdell Lake is rooted or large plant (macrophyte) productive. It is difficult or even misleading to base the quality of lakes where such a large percentage of the lake area is occupied by rooted vascular aquatic plants and weeds on measures such as traditional trophic state indices. These measures are focused on nutrient concentrations and related impacts on water clarity and chlorophyll *a*, in the water column where plankton community dynamics are not as tightly coupled to bottom dwelling and rooted plant communities. The water clarity, water column nutrient concentrations, and algae productivity in lakes like Lobdell Lake are driven and modified by expansive plant communities during the growing season. Hence, the production of plankton algae is more a reflection of the influence of these dense plant communities than other factors such as watershed nutrient loading.

Secchi depth, dissolved oxygen and temperature data are collected at the deepest point in the lake during each vegetation survey. Secchi disk transparency is the depth at which a Secchi disk (a flat white or black and white platter, approximately 20 centimeters in diameter) suspended into a lake disappears from the investigator's sight. In general, the greater depth at which the Secchi disk can be viewed, the lower the productivity of the water body. Secchi depth readings of greater than 15 feet can be indicative of low productivity or oligotrophic conditions.[1] It is important to note that established populations of zebra mussels in a lake can significantly increase water clarity, thus resulting in greater Secchi disk readings. Historically, Secchi disk transparency has varied considerably during the growing season in Lobdell Lake. Water clarity was highest during the time that starry stonewort totally dominated the submersed flora from 2008 to 2017 but has returned to historical levels in recent years. The Secchi disk transparency level seems to hover around 9 to 10 ft. It would appear that planktonic algae production as reflected in water transparency is sufficient to support a vibrant fishery and faunal community in Lobdell Lake.

A sufficient supply of dissolved oxygen (DO) in lake water is necessary for most forms of desirable aquatic life. Colder waters contain more dissolved oxygen than warmer waters. Oxygen depletion can occur in deeper, unmixed bottom waters during warmer summer months in highly productive lakes. Increased algal growth associated with additional nutrients in the lake can lead to severe decreases in DO in lake bottom waters. This decrease in oxygen is due, in part, to dead algae and other organic matter, such as rooted plant material broken away from shoreline areas and leaves, grass and other plant debris washed in from shoreline lawns and storm drains settling to the bottom of the lake and decaying. This decay process is performed by organisms that consume oxygen and by chemical reactions in the sediment. The DO impacts are most often observed in bottom waters during periods of temperature stratification in warmer summer months and, to a lesser degree, under winter ice cover conditions.

Dissolved oxygen levels and temperature were measured using a YSI ProODO dissolved oxygen meter, calibrated prior to use. Michigan water quality standards for surface waters designated for warm water fish and aquatic life call for a DO of at least 5 mg/L.[2] Oxygen concentrations in 2022 were consistent with expectations given the basin morphometry of Lobdell Lake and are considered to be within reasonable bounds, and within the range of desirable conditions for fish and aquatic life.

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[1] US Geological Survey. 2012. "Water Quality Characteristics of Michigan's Inland Lakes, 2001-10." Scientific Investigations Report 2011–5233. Available online at: https://pubs.usgs.gov/sir/2011/5233/.

[2] Michigan Department of Environmental Quality. 2006. "Part 4-Water Quality Standards." Water Bureau, Water Resources Protection. Available online at: http://dmbinternet.state.mi.us/DMB/ORRDocs/AdminCode/302_10280_AdminCode.pdf.

Total Phosphorus concentrations were measured in the early and late summer between 1992 and 1997. Concentrations varied from year to year and sample to sample based on the status of rooted plant production at the time of sampling. The highest average total phosphorus concentration was 36 ppb in 1992 and concentrations trended steadily downward to 26 ppb in 1997. These concentrations ranged within reasonable limits and would place the lake in the mesotrophic range if this were a lake where bottom dwelling plant production did not dominate the lake ecology. Levels were consistent with expectations for the support of a good fishery. Water sampling for nutrient concentrations was suspended after 1997 since the cost could no longer be justified given the value of these measurements in a bottom dwelling plant dominated system.

The State of Michigan offers a water quality sampling program through it's clean lakes initiative and organized by the Michigan Lakes and Streams Association. It is strongly suggested that the lake association participate in this program. The data collected as a part of this program can be presented in these annual reports.

Category 300 – Bacterio-Plankton and Microbial Communities

Lakes can be contaminated with various pathogenic bacteria and viruses. Recent developments in eDNA sampling and molecular analysis will make it much easier to detect the presence of potentially harmful microbes, but these methods have yet to be adapted common lake monitoring practice. E. coli is used as an indicator of possible harmful microbe pollution because is generally present in water that could be contaminated with genuine human pathogens that can be found in septage. There are well over 100 strains of E. coli but only a small few are actually harmful humans, but they still serve as an excellent indicator organism because sampling is easy and analysis can be done at a very low cost. Studies conducted at the University of Michigan, Flint revealed that a strain of E. coli commonly inhabits the surface of submersed plants in Lobdell Lake and other nearby lakes. The strain appears to be a normal part of the microbial flora found on typical submersed plants and there is not indication of any public health concern. However, this plant associated E. coli can contaminate samples taken to monitor for potential septic leakage and have precipitated beach closures where the possibility of any septage pollution is virtually impossible. Fortunately, the residents around Lobdell Lake are served by a sanitary sewer collection system and the potential for septic pollution of the lake is low. If there were a reasonable concern for septage contamination of the lake it would not be prudent to use generally accepted means for water sampling because of the very high likelihood that samples would be contaminated by the plant-based E. coli strains and yield false positive results. Any bacteriological sampling in Lobdell Lake would need to be specialized and focused on concentrated influent streams given the extensive nature of the submersed plant communities in Lobdell Lake.

Category 400 – Plankton (Algae and Cyanobacteria)

Unusually high levels of plankton growth and poor water clarity was found in many upper midwestern and Great Lakes region lakes in 2007 and prompted water sampling for algae community composition because of a concern for the potential production of toxin producing cyanobacteria (blue green algae). A sample composited from samples taken around the lake did not reveal the presence of any potentially toxin-forming algae.

Cyanotoxins were found to be concentrated near a road drain outlet near AROS 87 in 2018. Further investigation and consultations with nationally recognized experts in cyanobacteria toxicology suggested that the recent excavation and clearing of road-side drains opened areas to the production of road salt-tolerant toxigenic cyanobacteria. An area near a drain outlet exhibited obvious cyanobacteria bloom conditions where the drain water entered the lake. As the vegetation in the affected drains has

recovered and matured, the production of toxigenic cyanobacteria has become infrequent and is for the most part, no longer contaminating the lake.

Category 700 – Aquatic Vegetation

This section details findings from the two vegetation surveys that were conducted on the lake during the course of the summer. Early and late season floral communities can be quite different, and these differences are important (See Table 2). The second seasonal survey also help to determine the value and efficacy of applied management interventions. This section also includes observations and LakeScan™ analysis metrics that help to describe "lake health" and to provide an empirical evaluation of management strategies and practices applied to the lake.

Species Richness (total species present)

Lobdell Lake has historically been host to more species numbers than most lakes in the region. More species is considered "good". High species richness can be attributed to a diversity of habitats that range from canals to vast areas ranging to 9' deep and the presence of "drop off zones" where depths increase dramatically in short distances.

Table 3. Submersed and floating/floating leaved aquatic plant species listed by the percent occurrence in all AROS and observed during two LakeScan™ surveys. The VS 3 survey was conducted in June and the VS 5 survey was conducted in August.

	2019 VS 3	2019 VS 5	2020 VS 3	2020 VS 5	2021 VS 3	2021 VS 5	2022 VS 3	2022 VS 5	2023 VS 3	2023 VS 5	2024 VS 3	2024 VS 5
EWMx	64%	22%	61%	42%	35%	30%	45%	45%	46%	44%	32%	30%
VarM		1%	3%	2%	0%	1%		5%		5%		1%
GreM	7%											
BLAD	1%	4%	2%	3%	1%	4%	0%	8%	0%	8%		4%
CNTL	3%	3%	1%		1%	9%	3%	15%	3%	15%	4%	9%
ELD						4%	1%	2%	1%	2%	9%	4%
NAID	0%	5%			1%	12%	2%	55%	4%	24%	1%	12%
CHARA	20%	43%	19%	25%	29%	73%	34%	4%	39%	4%	80%	73%
StSt	32%	66%	35%	34%	66%	71%	48%	37%	58%	37%	80%	71%
Moss								3%		3%		
CLP	36%	10%	60%	24%	9%	6%	29%	8%	29%	7%	4%	6%
FSP		4%	5%		2%	20%	8%	15%	8%	16%	13%	20%
WSG		17%					1%	23%	2%	23%		
ROB								3%		3%		
Rich		2%			0%	3%	3%	2%	3%	2%	17%	3%
AMER		18%			6%		31%	28%	32%	28%		
MHPW	38%	62%	41%	28%	63%	4%	52%	57%	44%	21%		4%
BHPW	1%	0%	0%			19%	8%				45%	19%
Stuk	21%	5%	20%	21%		7%	32%	32%	33%	32%	5%	7%
TLP		15%	11%	3%	25%	7%	25%	5%	26%	5%		7%
ZAN			8%	6%								
VAL		53%	1%	1%	9%	51%	10%	52%	11%	53%	32%	51%
WL	15%	44%	33%	27%	35%	44%	35%	36%	33%	35%	25%	44%
WLh							3%		2%			
SPAD	11%	9%	23%	13%	19%	19%	17%	11%	17%	10%	22%	19%
WSh	2%	2%	1%	2%	5%		2%		2%		1%	
FLP						6%						6%
TLFP											7%	
DUCK	0%	2%				2%	1%	1%	1%	1%		2%

Table 4. Total number of species observed during VS3 (June) and VS5 (August) surveys in Lobdell Lake and number of species that are observed during both early and late growing-season surveys.

Year	2019	2020	2021	2022	2023	2024
Species Total Observed During Surveys	22	17	22	25	24	22
Total Species Observed During Both Surveys	14	14	15	19	19	14
Species Observed Exclusively During the VS3 Survey	1	3	2	3	2	2
Species Observed Exclusively During the VS5 Survey	7	0	5	3	3	6
Percent Species Observed Both Suveys	64%	82%	68%	76%	79%	64%

Roughly, 20% to 30% of the total number of species observed in Lobdell Lake are only present during early and late season surveys and are not typically observed during both survey events. These data are consistent with observations made in other inland lakes in the Great Lakes region demonstrate how critical it is to conduct a minimum of two surveys each year.

Critical Lake Health Metrics

Table 4. Critical, LakeScan™ lake health metric values.

Target Values	Metric		2019	2020	2021	2022	2023	2024
	Species Richness #	VS 3	16	21	19	18	17	20
Typical Target Value	*16*	VS 5	13	11	10	11	15	14
	Average Species Number per AROS	VS 3	2	3	3	4	4	3
Typical Target Value	*4*	VS 5	3	2	3	4	4	3
	Mean Density/Distribution at AROS	VS 3	53	50	42	44	44	56
Typical Target Value	*30 to 50*	VS 5	50	67	53	47	46	53
	BioD 60©	VS 3	58	62	59	61	61	64
Typical Target Value	*50*	VS 5	59	57	57	59	60	60
	Morpho Richness	VS 3	12	11	11	14	13	12
Typical Target Value	*13*	VS 5	13	10	15	14	14	15
	Average Morphotype Number per AROS	VS 3	3	3	4	3	3	3
Typical Target Value	*3*	VS 5	3	4	3	3	3	3
	MorphoD 26©	VS 3	65	65	66	66	64	67
Typical Target Value	*60*	VS 5	88	87	89	88	88	90

Various metrics have been used to describe the relative health, quality, resilience and stability of submersed aquatic plant communities, located in Tiers 3 to 8, by LakeScan™, governmental agencies, and academic communities for decades. The rudimentary beginnings of LakeScan™ were adopted by the State of Michigan to evaluate the impacts and outcomes of aquatic herbicide treatments in inland lakes in the early 1990's. Various metrics were considered at that time and it was finally decided that species richness and the cumulative cover of each species would be used to measure the effects of aquatic herbicide apparition or conditions in lakes where no management interventions may have been applied. Later, LakeScan™ innovated ways to consider the macrophyte community as a whole to make it easier to compare conditions from different areas in a lake, differences that might appear during the course of the growing season, to make meaningful year-to-year comparisons, and lake-to-lake condition comparisons. A formal discussion of the process is located in the appendix of this document. After considerable review of the literature and review of metrics used to evaluate conditions from hundreds of inland lake vegetation surveys LakeScan™ 5.0 presents a compendium calculation based on critical characteristic data. Most importantly, unlike some conventional evenness metrics that were originally used to evaluate the succession of terrestrial old-field and that are often considered for the evaluation of lake health, the new metric seems to provide metric data that is inherently more consistent with reasonable perceptions of lake condition.

Species Richness is considered to be very good in Lobdell Lake when compared to that found in most Michigan inland lakes. A target value of 16 seems to be appropriate but needs further study and data review. However, even after such review, the species richness of Lobdell Lake will likely still be considered to be very good.

The Average Number of Species per AROS is another useful metric. Lakes, such as Lobdell Lake, encompass a wide range of habitats, such as canals, abysal plains, steep depth or drop-off zones, areas around island or submersed, off-shore shallows or submerges islands that inherently support the growth and production of various species that are better adapted to growth in different situations. This metric is species epithet agnostic because of the preferential habitation of different habitats by different species and thereby does not suffer from the difficulty found in resolving obvious lake characteristics with an overall evenness index that would penalize lakes that encompass different habitats that will favor specific species. More data is needed to arrive at better target level estimations, but experienced surveyors would agree that 4 species at any AROS is a good target number. For example, ebriid watermilfoil or starry stonewort has been observed to extirpate all other species and may result in a single species found in afflicted AROS's. An effective invasive species management program has seemingly resulted in good average numbers of species at the AROS in Lobdell Lake.

Mean Density/Distribution metrics were originally developed to calculate the how individual species come to dominate the vegetation community. Density is linked to the percentage cover of the bottom of the lake by a particular species observed in an AROS. Distribution is used to characterize the pattern of habitation of a particular species observed in the AROS. Distribution

can be used to assess "edge effect" which is a critical metric used to assess the value of critical fishery habitats. These two values are weighted (see appendix) and then simply averaged in this document. They are treated separately for the purpose of the development of a new LakeScan™ habitat assessment metric that is still being reviewed and may be revealed in future reports. The vegetation density/distribution levels observed in most Lobdell Lake AROS probably exceed a level that is best for the support of aquatic animal communities, but there is considerable edge available at the edge of the littoral zone and this may compensate for high levels of density and distribution located within individual AROS.

The BioD 60© metric is presented to approximates the biological diversity of aquatic plant species in a biological Tier, portion of a lake, or an entire lake. It may be the most important metric for area-to-area, time-to-time, and lake-to-lake comparisons. It is currently based on the average of log transformed species richness, average number of species at an AROS, and the mean density/distribution (sic. cumulative occurrence) per AROS observation data. These data are calculated by Tier and then adjusted for the ratio of AROS and acres assigned to each of these tiers. This metric not only recognizes various important metrics that are covered in the scientific literature but also seems to do a very good job of describing conditions that appear to be inherently obvious to the experienced observer/vegetation community surveyor. The BioD 60© metric values observed in Lobdell Lake have consistently exceeded target values for decades. This is a primary reason that Lobdell Lake has been used extensively for research and product evaluations by industry, universities, and State and Federal agencies, currently and in past decades.

Morpho Richness is offered to recognize that plant morphotype (growth habit and leaf and stem structure) are probably more ecologically important than the specific names we apply to individual species. Basically, what a plant "looks like" is more important than what it is named to aquatic animals, algae, microbes, and competing plant species. This is also an estimate of "structural complexity" that is very important to fisheries biologists. Relative to other lakes, the Lobdell Lake Morpho Richness is very good and this seems to be consistent with the reputation that the lake has for supporting a vibrant fishery.

The Average Morphotype Number at Each AROS is similar to the average number of named species observed at each AROS. Again, Lobdell Lake seems to exceed typical values found in other Michigan inland lakes.

The LakeScan™ HabVal© index is based on alternate interpretations of Density/Distribution values, coupled with the height of the species within the water column at each AROS, and plant morphotype metrics to calculate the intrinsic habitat value within a lake or areal subunit of a lake. The index value would be very "time specific" given how rapidly some plant species can grow and thereby contribute to very different values from week to week and even from day to day depending on the species present. This metric is still in development and is therefore, not presented in this document, but it is hoped to be provided in future years.

Table 5 below demonstrates how the current management program is providing very species targeted management outcomes. Nearly all species in Lobdell Lake cohabit AROS where primary weed targets (ebriid watermilfoil, curly leaf pondweed, and starry stonewort) are found and yet they persist after being exposed to herbicide treatments used to suppress invasive species growth. The table seems to suggest that species specific treatment may be necessary to support the non-invasive plant species found in the lake.

Anthropogenic Influences and Impact on Plant Community Dynamics. Shoreline development, lake history and watershed runoff have significant impacts on water quality and more subtle impacts on aquatic plant community dynamics. Aquatic plants can derive most of the necessary nutrients to fuel growth from the sediments and do not necessarily have to depend on water column nutrient concentrations as do suspended algae. In fact, lake that may be considered to be oligotrophic with clear water may support a prodigious amount of nuisance rooted vegetation. It is still important that Lobdell Lake improvement advocates remember that the lake is a reservoir and that the water covers nutrient rich sediments. Shoreline development of the lake is intense and recent studies suggest that this type of development may stress some species that are more development intolerant.

The plant community management program is another form of anthropogenic impact on plant community dynamics. Herbicides are used because they can provide selective control of invasive species growth and protect less aggressive but beneficial plant species. There is a wide range of species in Lobdell Lake and the beneficial species appear to have tolerated the herbicide treatments and have possibly flourished as a consequence of judicious management and suppression of aggressive invasive species.

Table 5. The percent of the total AROS occurrence of all species in Lobdell Lake that are in areas where invasive species are targeted with species selective aquatic herbicide treatments.

	2019 VS 3	2019 VS 5	2020 VS 3	2020 VS 5	2021 VS 3	2021 VS 5	2022 VS 3	2022 VS 5	2023 VS 3	2023 VS 5	2024 VS 3	2024 VS 5
EWMx	80%	77%	69%	81%	66%	82%	53%	59%	57%	65%	72%	84%
VarM		25%	70%	100%	0%	100%		87%		87%		33%
GreM	95%											
BLAD	100%	73%	71%	89%	50%	92%	0%	50%	100%	67%		92%
CNTL	80%	63%	100%		50%	88%	38%	73%	22%	80%	54%	72%
ELD						64%	50%	57%	50%	86%	74%	64%
NAID	100%	67%			100%	68%	0%	47%	0%	51%	50%	68%
CHARA	79%	78%	75%	63%	67%	67%	49%	50%	50%	58%	75%	79%
StSt	72%	70%	66%	76%	59%	69%	57%	59%	57%	62%	75%	80%
Moss								75%		75%		
CLP	88%	97%	69%	107%	73%	82%	58%	83%	60%	95%	17%	88%
FSP		100%	93%		80%	74%	59%	53%	64%	70%	82%	82%
WSG		90%					133%	62%	100%	74%		
ROB								63%		88%		
Rich		83%			100%	67%	89%	67%	67%	100%	76%	100%
AMER		89%			82%		53%	44%	55%	58%		
MHPW	83%	77%	62%	88%	67%	0%	52%	52%	69%	163%		33%
BHPW	100%	100%	0%			53%	17%				76%	71%
Stuk	75%	88%	67%	83%		84%	54%	44%	59%	66%	56%	84%
TLP		86%	64%	100%	73%	86%	46%	27%	59%	47%		100%
ZAN			48%	94%								
VAL		78%	33%	100%	78%	75%	57%	53%	55%	61%	89%	91%
WL	87%	88%	64%	60%	77%	85%	77%	70%	74%	77%	84%	88%
WLh							63%		29%			
SPAD	94%	76%	57%	51%	75%	76%	63%	45%	70%	63%	83%	80%
WSh	83%	100%	0%	29%	64%		71%		57%		50%	
FLP						59%						82%
TLFP											85%	
DUCK	100%	83%				100%	100%	100%	33%	50%		80%

Impairments and Nuisance Conditions

Most of the plant species found in Lobdell Lake are desirable and perform important stabilizing functions. The most notorious of invasive species in northern lakes, ebrid watermilfoil, curly leaf pondweed, and starry stonewort are not native to Michigan but they have inhabited Lobdell Lake for decades. They have and continue to be the focus of intense management efforts. However, there are other North American species or genotypic variants of plants in Lobdell that create serious nuisance problems.

Aquatic plants are not immune to the power of natural selection and evolution. It appears that certain plants that have here-to-fore, have not generally been considered to be a nuisance threat or ecologically

invasive, have hybridized or generated biotypes or genotypes that can rival the nuisance levels created by some of the most notorious invasive species such as watermilfoil and curly leaf pondweed in temperate inland lakes. Data from Lobdell Lake show that certain pondweeds in the lake have possibly hybridized but seem to appear at nuisance levels that rival ebrid watermilfoil in this lake. There are also naiad (*Najas sp*.) species that are variously considered non-native to Michigan and that have exhibited considerable nuisance potentials in Lobdell Lake and other regional inland lakes. Field identification is difficult requiring magnification and since other naiad species co-mingle with invasive form, the entire genus has been grouped for field survey purposes. Nuisance conditions are no longer the sole province of exotic invasive species, such as ebrid watermilfoil, curly leaf pondweed, and starry stonewort.

Table 6, below is a testimony to the effectiveness of the management program. The surveys are conducted AFTER the lake has been treated and these show that there are few AROS where nuisance conditions are detected during either the early or late survey season surveys. Although it is observed at low nuisance levels, it is still not surprising that ebriid watermilfoil is consistently present at nuisance levels in some AROS.

Table 6. The total number of AROS where nuisance conditions were observed, by species, during early VS3 and late VS5 season vegetation surveys. Surveys are conducted after management interventions have been executed so nuisance levels are expected to be lower than those observed prior to the management interventions.

	Total Years	2019 VS 3	2019 VS 5	2020 VS 3	2020 VS 5	2021 VS 3	2021 VS 5	2022 VS 3	2022 VS 5	2023 VS 3	2023 VS 5	2024 VS 3	2024 VS 5
EWMx	6	52		183	181		2	1	1	1	1	9	2
GreM	1	2											
BLAD	1			2									
CNTL	1			1									
StSt	2							1	4	1	4		
CLP	4	29		156	156			3		3			
FSP	2								2		2		
WSG	2								3		3		
AMER	2							4	5	4	5		
MHPW	4		2	20	20			4	3	6	4		
BHPW	2							2				4	
Stuk	4	1		25	25			5	3	5	3		
TLP	2							1		1			
VAL	5		2				39		5		5		39
WL	4						1		4		4		1

Table 7. The total percentage of AROS where individual species were found in the lake that were also observed at some nuisance level in some AROS, during early VS3 and late VS5 season vegetation surveys.

	Mean	2019 VS 3	2019 VS 5	2020 VS 3	2020 VS 5	2021 VS 3	2021 VS 5	2022 VS 3	2022 VS 5	2023 VS 3	2023 VS 5	2024 VS 3	2024 VS 5
StSt	53%	32%	66%	35%	34%	66%	71%	48%	37%	58%	37%	80%	71%
EWMx	41%	64%	22%	61%	42%	35%	30%	45%	45%	46%	44%	32%	30%
MHPW	38%	38%	62%	41%	28%	63%	4%	52%	57%	44%	21%		4%
WL	34%	15%	44%	33%	27%	35%	44%	35%	36%	33%	35%	25%	44%
VAL	30%		53%	1%	1%	9%	51%	10%	52%	11%	53%	32%	51%
AMER	24%		18%			6%		31%	28%	32%	28%		
Stuk	19%	21%	5%	20%	21%		7%	32%	32%	33%	32%	5%	7%
CLP	19%	36%	10%	60%	24%	9%	6%	29%	8%	29%	7%	4%	6%
WSG	13%		17%					1%	23%	2%	23%		
BHPW	13%	1%	0%	0%			19%	8%				45%	19%
TLP	13%		15%	11%	3%	25%	7%	25%	5%	26%	5%		7%
FSP	11%		4%	5%		2%	20%	8%	15%	8%	16%	13%	20%
GreM	7%	7%											
CNTL	6%	3%	3%	1%		1%	9%	3%	15%	3%	15%	4%	9%
BLAD	3%	1%	4%	2%	3%	1%	4%	0%	8%	0%	8%		4%

When all observed nuisance species since 2019 are ranked according to total AROS occurrence in the entire lake, it is interested to note that stary stonewort is more dominant than all other species, but it is not really targeted for control outside of the Bennett Lake channel. It is present in much of the lake, but does not constitute a major nuisance in most of the lake. This is in stark contrast to the way it dominated the lake flora soon after it was identified in the lake in 2006.

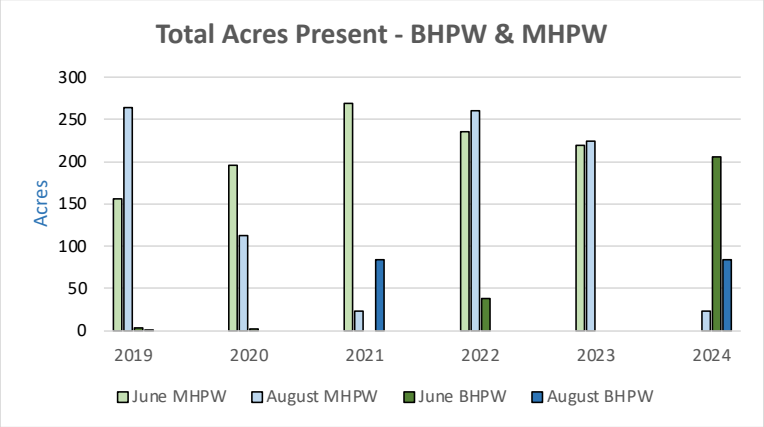
Perhaps it is more disturbing that even though only a very few AROS supported nuisance level production, pondweeds (other than curly leaf pondweed) appear on the nuisance species list. This is particularly disturbing in that they at are present at a level and where they rival the exotic species found in the lake. Obviously, the exotic species are targeted for management, so the levels of pondweed nuisance are consistent with the levels associated with herbicide targeted weeds. But pondweeds were rarely or never found at nuisance levels in previous decades and they seem to be trending toward more nuisance growth. Nuisance growth was addressed in the nearshore areas of the eastern most part of the lake in 2024.

It is also disturbing that wild celery was found at such high nuisance levels in 2024. Nuisance wild celery was targeted specifically as part of the 2024 management program with only modest success. Wild celery management is discussed later in this report as a part of special evaluation discussions.

Some pondweed species can be difficult to identify because they are so similar. Many of the more similar pondweed species have been lumped into broader categories to accommodate differeing abiities and opinions regarding plant identification that are common among persons who survey lake vegetation. Species “lumping” is critical to provide meaningful comparisons between lakes and survey times that are conducted by different field personel. Recent molecular studies (see appendix) reveal and confirm historical observations that there is potentially a considerable degree of hybridization occuring between a large number of pondweed species. It is only logical to surmise that pondweed hybrids might emerge that are more invasive simce they must compete with highly aggressive and invasive exotic species such as ebrid watermilfoil. The relative abundance of broad leaf and medium

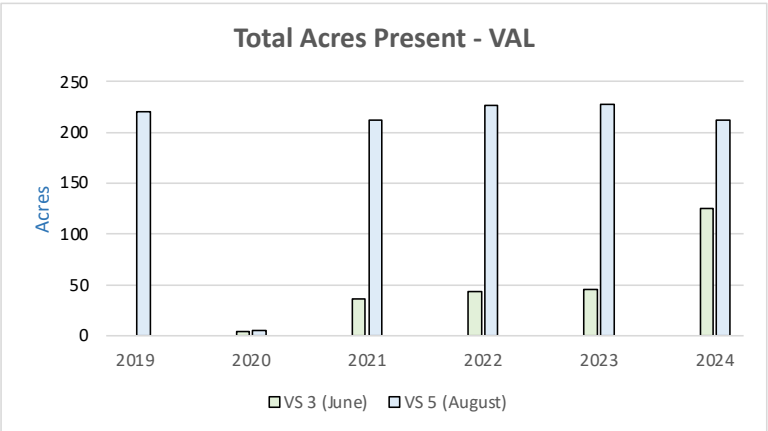
leaf pondweeds varies from year to year in Lobdell Lake. It is clear from Figure xx that the AROS occurence of this species category (MHPW and BHPW) is high and is higher than records from several decades ago. This is a matter of concern and will be addressed in the coming years.

Figure 4. *The total acres inhabited by broadleaf and medium leaf pondweeds during surveys conducted in June and August 2024. The pondweeds are presumed to be hybrids when they appear in Lobdell Lake at near or actual nuisance levels.*



Wild Celery (Vallisneria sp.) has presented as a significant nuisance in Lobdell Lake only occasionally over the past three decades. It has increased in AROS occurrence in recent years and has subsequently grown to serious nuisance levels. It is nearly impossible to selectively manage since it is highly tolerant of most EPA registered aquatic herbicides. This is discussed in the management section of this report which is used to describe some of the 2024 alternate treatment evaluations. It is important to note that it was present at a highly troubling nuisance level in 2024 and it is possible that this may be a characteristic of growth in the coming years. The Lobdell Lake management team is aggressively pursuing remedies for this problem.

Figure 5. *The total acres inhabited by wild celery (Vallisneria sp.) during surveys conducted in June and August 2024. The pondweeds are presumed to be hybrids when they appear in Lobdell Lake at near or actual nuisance levels.*



Lake Condition Summary

By all provided and considered metrics, the submersed vegetation community of Lobdell Lake continues to be in very good condition. Favorable analytics may be at least in part, attributed to the judicious suppression of invasive aquatic plant species through the use of selective herbicide applications.

As research continues to reveal more about the genetic composition of species and hybrid species, the focus of the management program must continue to be adaptable to emerging problems and issues. Ebrid water milfoil continues to be a constant threat to the biodiversity of the Lobdell Lake ecosystem, but the management program has also been able to keep up with and maintain this threat at acceptable levels. Extensive efforts were made in 2024 to evaluate technologies that might enhance the nuiance species maintenance program. 2024 Milfoil management is covered in more detail in the special section on management.

Curly leaf pondweed is another exotic invasive aquatic species and recurrent pest in Lobdell Lake. It is easy to manage and is generally managed effectively and concurrently with nusance ebrid water milfoil. It is an early season species and rarely ever grows to nuisance levels after spring or early summers. It is an issue that needs to be addressed annually but is not a key concern because acceptable levels of growth are easy to maintain.

Sarry stonewort, like ebriid watermilfoil and curly leaf pondweed, is an exotic and potentially invasive species in Michigan. At one time it was a serious nuisance, but nuisance growth has regressed to a near non-nuisance level in the past several years. It has occasionally grown to nuisance levels in the Bennett Lake channel and has been a management target there, but is not a primary threat at the current time. Recent advances in our understanding of the prevalence of pondweed hybridization is shedding light on the emergence of pondweed invasive habits. This is another threat that must be considered and addressed as part of the management program. Nuisance hybrid pondweeds could become a primary management focus in the future for Lobdell Lake.
Finally, studies have also revealed that there are more than 2 species of wild celery in North America. Seventeen individual species have now been described, and it is thought that there are more to be identified. There are species that are endemic to North America and exotic species found in lakes throughout the US. Some species have been intentionally translocated from one region of North America to other areas and these transplants appear to have the ability to become quite invasive and threaten the biodiversity of infested lakes.

Category 750 – Lake Management

There are several species that typically become a nuisance in Michigan's inland lakes including ebrid watermilfoil, starry stonewort, and curly leaf pondweed. Other species are emerging at nuisance levels in many Michigan inland lakes, including Lobdell Lake. Among these emerging nuisance threats are are wild celery and naiad, both which may or may not be native to Michigan inland lakes. Others such as variable milfoil and hybrid pondweeds are also growing to increasing nuisance levels and it is suspected that the invasive forms are genetic variants that may or may not have emerged in Michigan but seem to be spreading. (See Appendix B). However, ebrid water milfoil and curly leaf pondweed are still the principal targets of management action on Lobdell Lake and are targeted for very selective control to prevent them from becoming an aesthetic or recreational nuisance and to protect desirable plants that are part of lake floras. Curly leaf pondweed is susceptible to nearly all of the same management agents that are used to maintain acceptable ebriid watermilfoil production levels. Because both species are managed concurrently in Lobdell Lake and curly leaf pondweed is generally "inactive in the summer" the

next section will focus on the recurrent management needs to maintain acceptable ebriid watermilfoil levels to protect the ecosystem and facilitate reasonable recreational expectations.

Ebrid Watermilfoil

Table 8. Management data and information that describes the milfoil maintenance efforts and interventions used in Lobdell Lake.

	2019 VS 3	2019 VS 5	2020 VS 3	2020 VS 5	2021 VS 3	2021 VS 5	2022 VS 3	2022 VS 5	2023 VS 3	2023 VS 5	2024 VS 3	2024 VS 5
Total Acres Present	274	102	273	196	148	113	210	200	201	198	140	113
Percent Acres Treated	80%	77%	69%	81%	66%	82%	53%	59%	57%	65%	72%	84%
Total Treatments (Events)	2	2	2	2	2	2	3	3	2	2	4	4
Total TmtZ	2	2	2	2	4	3	2	2	2	2	2	2
Total Acres Treated	142	142	246	246	194	194	125	125	147	147	373	373
Total Acres Retreated	0	0	33	33	0	0	43	43	112	112	125	125

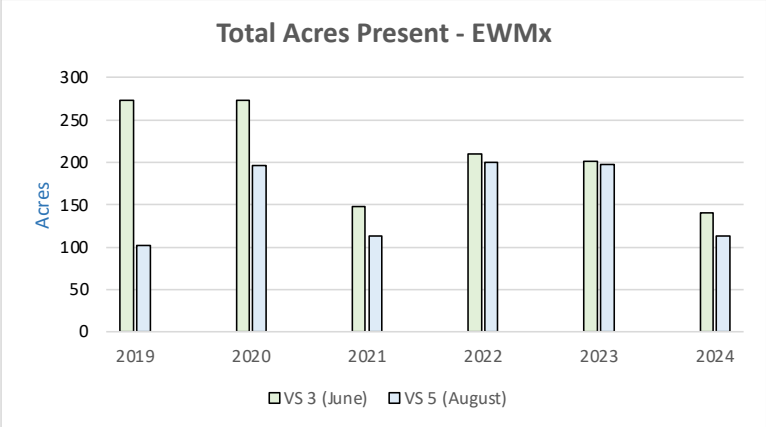


Figure 6. Total acres cover of ebriid watermilfoil in Lobdell Lake.

The total number of acres inhabited by ebrid watermilfoil has declined over the past six years. However, ebrid watermilfoil is still a very significant nuisance and represents a serious ecosystem impairment in Lobdell Lake. It is not clear why the cumulative cover of ebrid watermilfoil has declined because there are many reasons why this may be occurring.

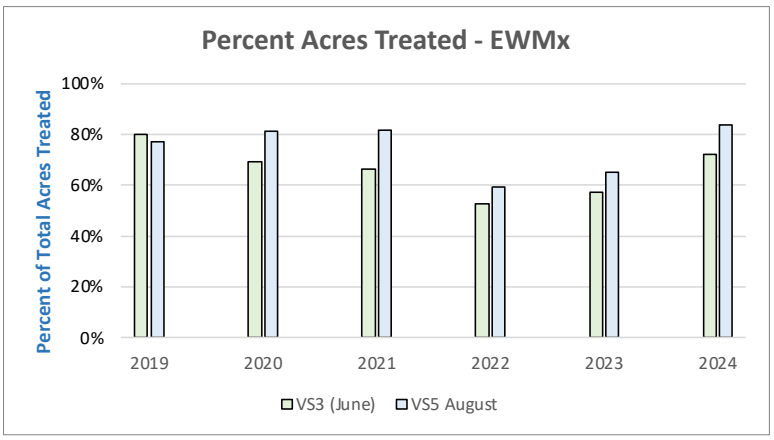


Figure 7. The percentage of the total acres cover of ebriid watermilfoil that are treated with species selective aquatic herbicides in Lobdell Lake since 2019.

Ebrid watermilfoil appears to be constantly evolving through genetic changes and the development of different hybrids. The nuisance levels that were commonly observed in Michigan inland lakes in the the early 1980's were far, far greater than anything observed in recent years. It is commonly believed that invasive non-endemic or exotic species eventually regress as a nuisance. For example, this has generally been the case with starry stonewort in Lobdell Lake where it is found throughout nearly the entire lake, but nuisance levels are constrained to only one area where conditions are ideal for nuisance level growth. Ebrid watermilfoil nuisance levels have declined over time; however, they have not retreated to an acceptable level and annual maintenance is required to protect the lake ecosystem and recreational values. Currently, approximately 80% total area covered by ebrid watermilfoil is under treatment. Even though ebrid water milfoil has a reputation as being a major problem for lakes, field observations show that the plant can coexist with other species without extirpating the competing species. Just because ebrid water milfoil is present in an AROS doesn't mean that it has to be managed.

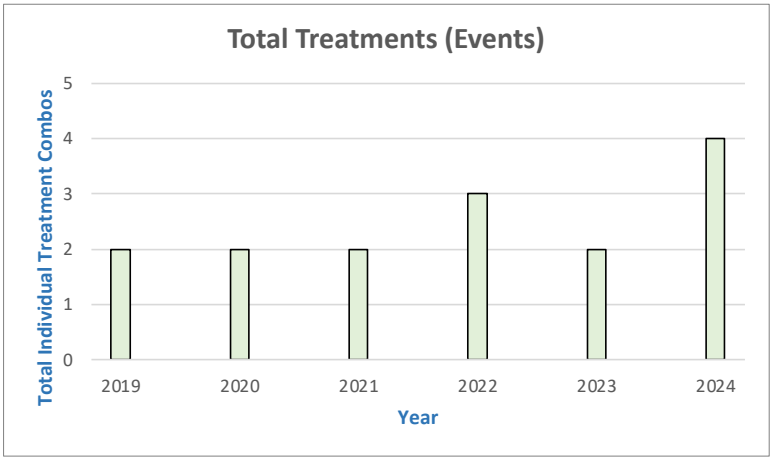


Figure 8. The total number of treatment events executed during the summer growing season that were focused on the maintenance of ebrid watermilfoil at an acceptable, non-nuisance level.

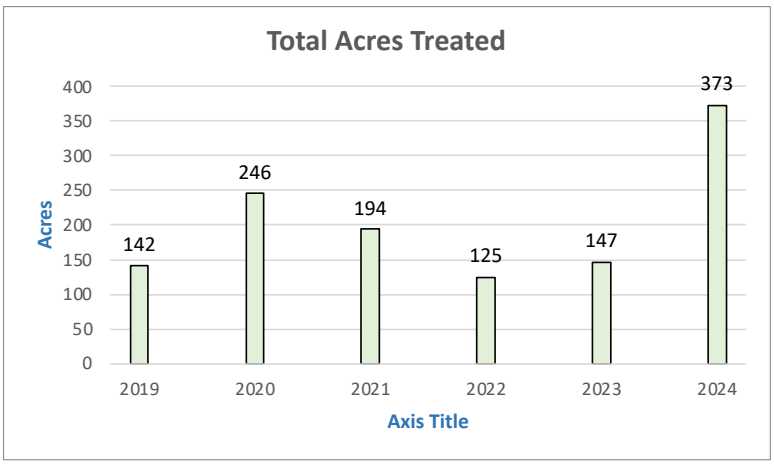


Figure 9. *The total number of treatment acres where species specific agents were applied for the maintenance of ebrid watermilfoil at an acceptable, non-nuisance level.*

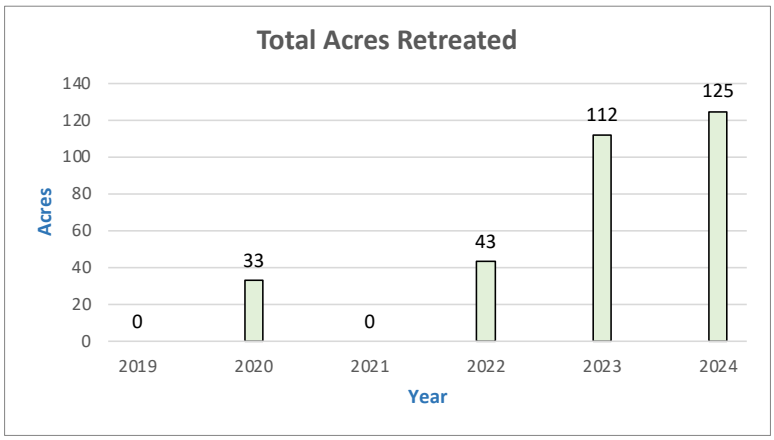


Figure 10. *The total number of treatment acres where species specific agents were applied for the maintenance of ebrid watermilfoil that had to be retreated to maintain an acceptable, non-nuisance level.*

One of the objectives of the vegetation community maintenance plan in Lobdell Lake is to execute as few interventions as possible. This is a way to save money, maintain good conditions for recreation over extended periods of time and to avoid imposition of use restrictions during the peak lake use season.

The winters prior to the 2023 ad 2024 summers were extremely mild. Ebrid watermilfoil presented nuisance conditions prior to the important Memorial Day holiday and interventions were executed in late May. Early treatments such as these are notorious for not providing season–long benefits. Approximately one half of all acres treated early in the season had to be retreated before the Labor Day holiday to maintain suitable conditions for recreation. It is best to wait until early June to apply aquatic herbicides to Lobdell Lake, but occasionally nuisance conditions become so severe that pressures demand that the treatments be done before optimal conditions are achieve. This has a significant impact on use restrictions and budgets.

Species Selective Herbicide Application Interventions

An extraordinarily high number of treatment approaches and agent combos characterize the 2024 management season. A number of innovative treatment approaches were adopted by the management team to improve the benefits of each treatment in terms of time and efficacy. The following table outline the treatment approaches, agents, and characteristics of the submersed plant communities surveyed both early and late season.

Table 9. *LakeScan™ metrics and lake characteristics at the TmtZ applied to Lobdell Lake in 2024 as observed during a June vegetation community survey.*

YEAR	2024	Total	Ave Sp	D/D	Total	Total	
VS	3	Species	per AROS	per AROS	AROS	Acres	BioD 60
TmtZ	11	14	3.9	0.8	103	156	58.72
TmtZ	12	12	3.7	0.7	10	61	40.81
TmtZ	21	12	4.5	1.1	61	125	58.65
TmtZ	22	0			29	0	
TmtZ	31	0			17	25	
TmtZ	32	9	4.4	0.4	28	24	47.61
TmtZ	33	9	4.2	0.3	26	23	44.86
TmtZ	34	9	3.5	0.9	22	29	48.47
TmtZ	35	12	4.1	0.8	9	4	41.95
TmtZ	41	9	4.6	1.0	7	4	44.44
TmtZ	42	0			3	0	
TmtZ	51	0			8	14	

Table 10. *LakeScan™ metrics and lake characteristics at the TmtZ applied to Lobdell Lake in 2024 as observed during an August vegetation community survey.*

YEAR	2024	Total	Ave Sp	D/D	Total	Total	
VS	5	Species	per AROS	per AROS	AROS	Acres	BioD 60
TmtZ	11	20	5.5	1.3	103	156	40.06
TmtZ	12	8	3.6	0.9	10	61	26.40
TmtZ	21	19	4.3	1.0	61	125	36.04
TmtZ	22	0			29	0	
TmtZ	31	0			17	25	
TmtZ	32	13	6.3	0.6	28	24	32.49
TmtZ	33	11	4.4	0.5	26	23	25.94
TmtZ	34	13	3.3	0.8	22	29	29.19
TmtZ	35	8	4.0	1.0	9	4	28.02
TmtZ	41	8	5.0	1.2	7	4	31.58
TmtZ	42	0			3	0	
TmtZ	51	0			8	14	

The LakeScan™ BioD 60© value dropped significantly in the two primary or large area herbicide application treatment zones (TmtZ 11 & 21) from the early to the late season survey dates. The average number of species observed at each of the TmtZ was higher in the late season survey, but the overall density/distribution level was apparently diminished by the treatment intervention. This is not necessarily a bad thing and it must be noted that the initial review of a new metric that is related to habitat value would show that conditions may have improved from the early to late season surveys even though the BioD 60© levels declined. The total species richness of the TmtZ also improved from early to late season surveys. In essence, the density of the vegetation was diminished, but the richness of the flora was enhanced.

Table 11. An overview of herbicide treatments, based on AROS, made to maintain reasonable vegetation community conditions to support critical ecosystem functions and recreation.

Histroical Analysis of AROS Treated

Perecnt AROS Never Treated During Record Years	1%
Percent AROS Treated Each Record Year	60%
AROS Treated Less Than One Half or Years in Record	97%
AROS Treated More Than One Half or Years in Record	3%
Percent of AROS Treated Multiple Times in Most Years	14%

The littoral zone (plant productive area) in Lobdell Lake is very large relative to many other lakes. Shallow areas and bays characterize much of the lake and these are ideal areas for the support of submersed vegetation. The areas that required treatment each year in the lake will vary considerable from AROS to AROS. These data emphasize the importance of early season condition reviews to identify the constantly changing landscape for treatment and target the areas that truly need mitigation interventions to maintain acceptable levels and the quality of vegetation communities. These data also suggest that there may be ways to modify and adapt the treatment strategies to provide longer-lasting impact for the maintenance of good conditions in certain AROS.

Table 12. Nuisance plant species management/maintenance specifications recorded during select including cost of treatments..

	1994	2014	2015	2016	2017	2019	2020	2021	2022	2023	2024
Total AROS Treated:	151	151	39	169	47	184	290	127	127	151	175
1 Time:	85	85	39	127	0	78	192	127	121	85	68
2 Times:	66	66	0	29	47	93	47	0	6	66	75
3 Times:	0	0	0	13	0	13	51	0	0	0	32
Total Lake Acres Treated											
TmtZ < 5 acres	0	0	0	2	0	0	5	0	24	17	19
TmtZ > 5 acres	0	311	220	226	444	371	87	147	37	132	283
Cost of Treatment	$81,099	$113,725	$75,900	$55,932	$108,780	$137,235	$65,597	$51,710	$21,072	$41,889	$145,655
Application Contractor:	151	151	39	169	47	184	290	127	127	151	175

The cost of herbicide treatment during 2024 was much greater than most years of record in Lobdell lake. The total cost of treatment typically hovers around $55k to $70k per year, but costs in 2024 were nearly

double that typical cost. Part of the increased cost was focused on the evaluation of new treatment options that are hoped to decrease the overall cost of vegetation management each year. However, the overwhelming portion of the increased cost can be attributed to the retreatment of previously treated areas to maintain acceptable conditions until the Labor Day holiday. Mild winters have forced earlier treatment scenarios very near or before Memorial Day.

TREATMENT EVENTS 10 AND 20, 23 MAY AND 03 JUNE, 2024

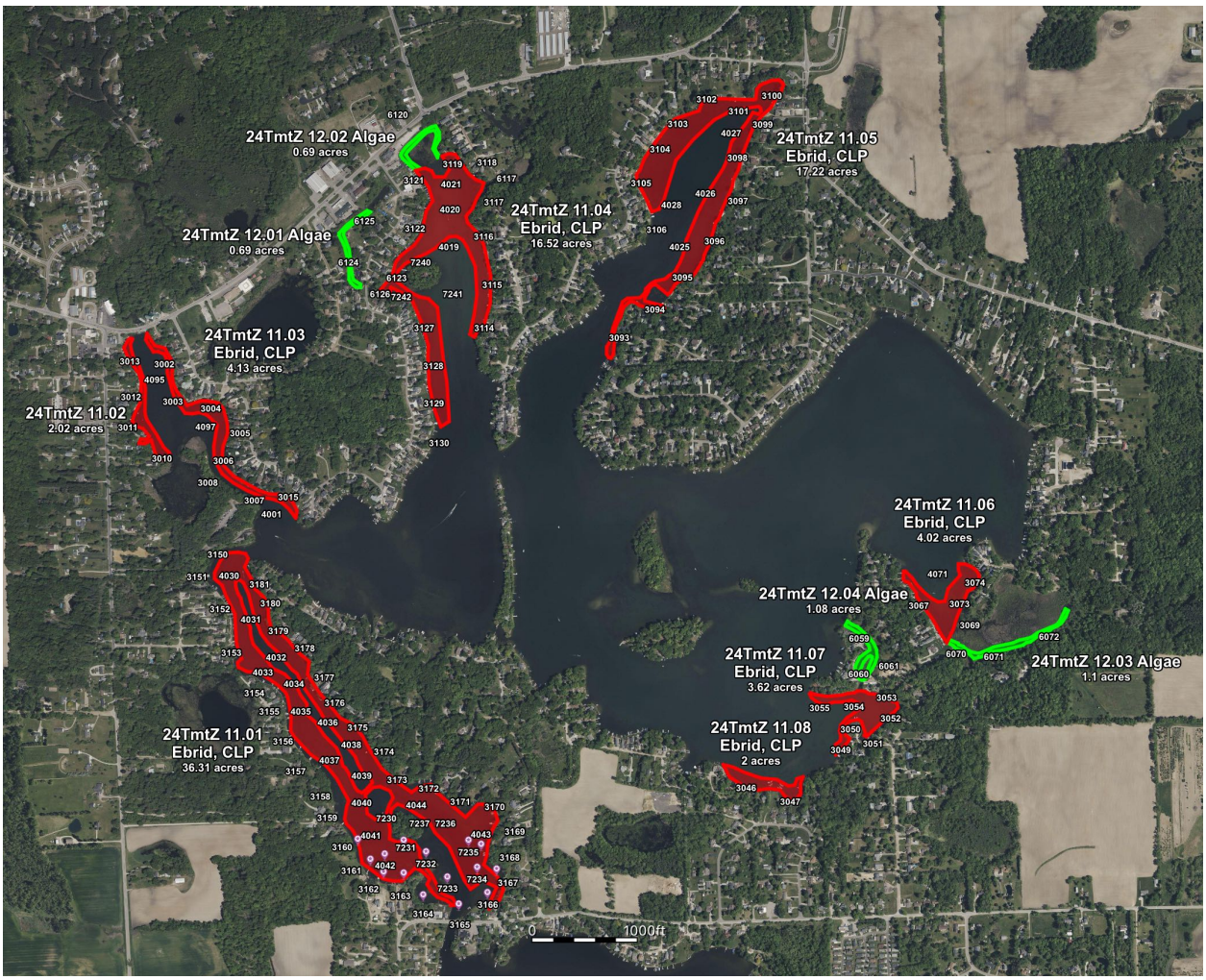


Figure 11. The first species selective herbicide application of 2024, Tmt 10, and the individual TmtZ (treatment zones). Treatment date: 05/23/24.

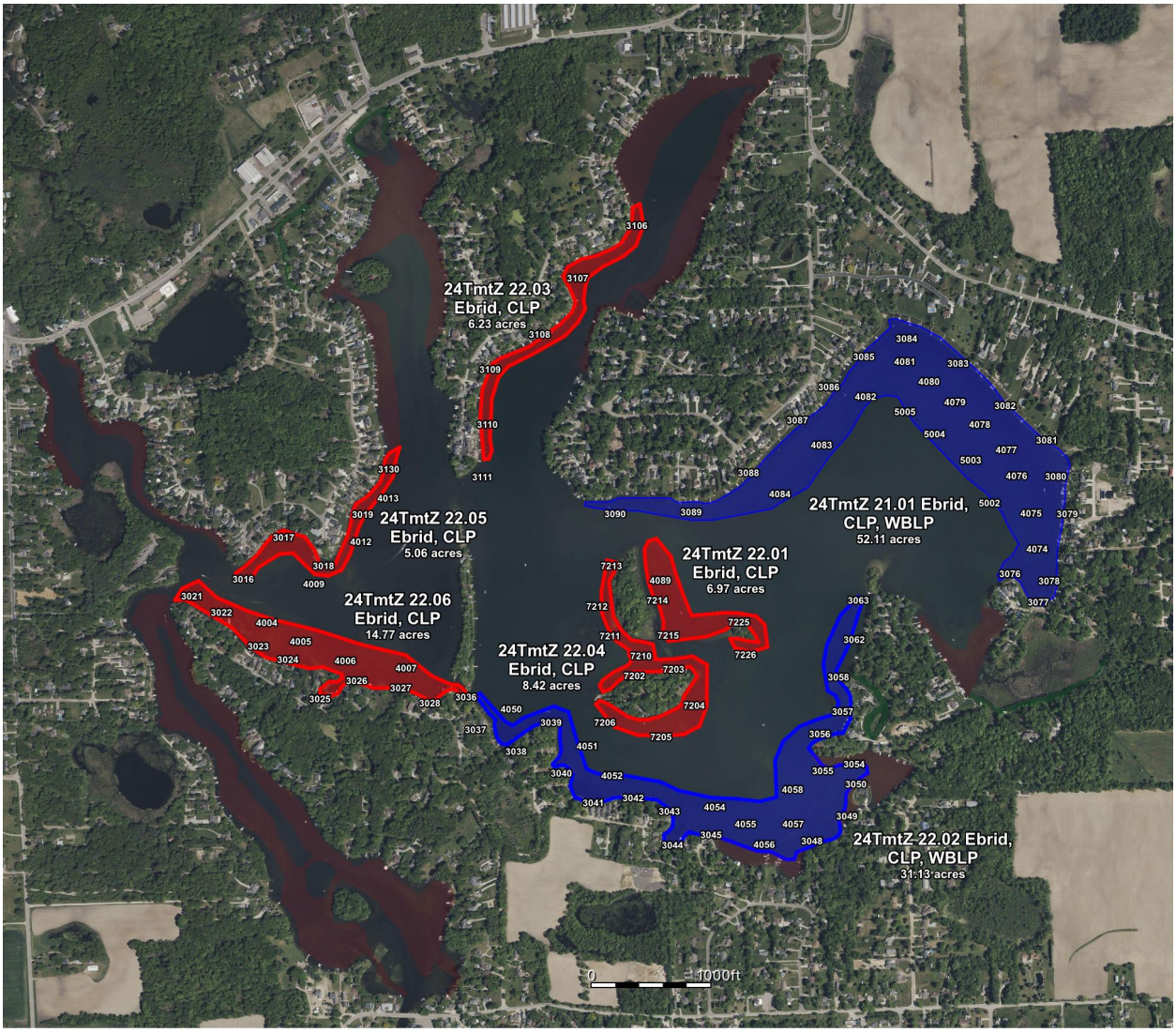


Figure 12. The second species selective herbicide application of 2024, Tmt 20, and the individual TmtZ (treatment zones). The TmtZ that were targeted in the Tmt 10, or first treatment are shown in a dark red. Treatment date: 06/03/24.

Table 13. The agents and agent combinations used to suppress nuisance conditions and maintain acceptable vegetation community condition in Lobdell Lake, 2024. TmtZ 11 and 21 were large area treatments where the focus was the suppression of invasive ebrid watermilfoil, and to a lesser degree, curly leaf pondweed.

TmtZ	Cost Per Acre	Total Acres	Total Cost of Application
11	$390	160	$62,330
	< 5 Acres	10	
	> 5 Acres	150	

Control Agent and Combo	Control Agent Unit Dose per Acre	Unit Volume Or Weight
Diquat Dibromide (L)	1.00	160
Endothall Salt (L)	1.00	160
Copper Chelate +Adjv (L)	1.00	160
Carfentrazone (F/WP)	0.13	20

TmtZ	Cost Per Acre	Total Acres	Total Cost of Application
12	$120	17	$2,008
	< 5 Acres	9	
	> 5 Acres	8	

Control Agent and Combo	Control Agent Unit Dose per Acre	Unit Volume Or Weight
Copper Chelate +Adjv (L)	1.00	160
Endothall Amine (L)	0.25	40

TmtZ	Cost Per Acre	Total Acres	Total Cost of Application
21	$295	125	$36,990
	< 5 Acres	0	
	> 5 Acres	125	

Control Agent and Combo	Control Agent Unit Dose per Acre	Unit Volume Or Weight
Diquat Dibromide (L)	1.00	125
Endothall Salt (L)	1.00	125
Carfentrazone (F/WP)	0.13	16

TmtZ 11 AROS were treated prior to Memorial Day and many of those areas had to be retreated before the end of the summer since the treatment did not provide good long-term control of ebrid watermilfoil beyond the middle of July. The TmtZ 21 AROS prevented the reemergence of nuisance ebrid watermilfoil for many more weeks than the TmtZ 11 AROS although some AROS still required retreatment prior to the Labor Day holiday.

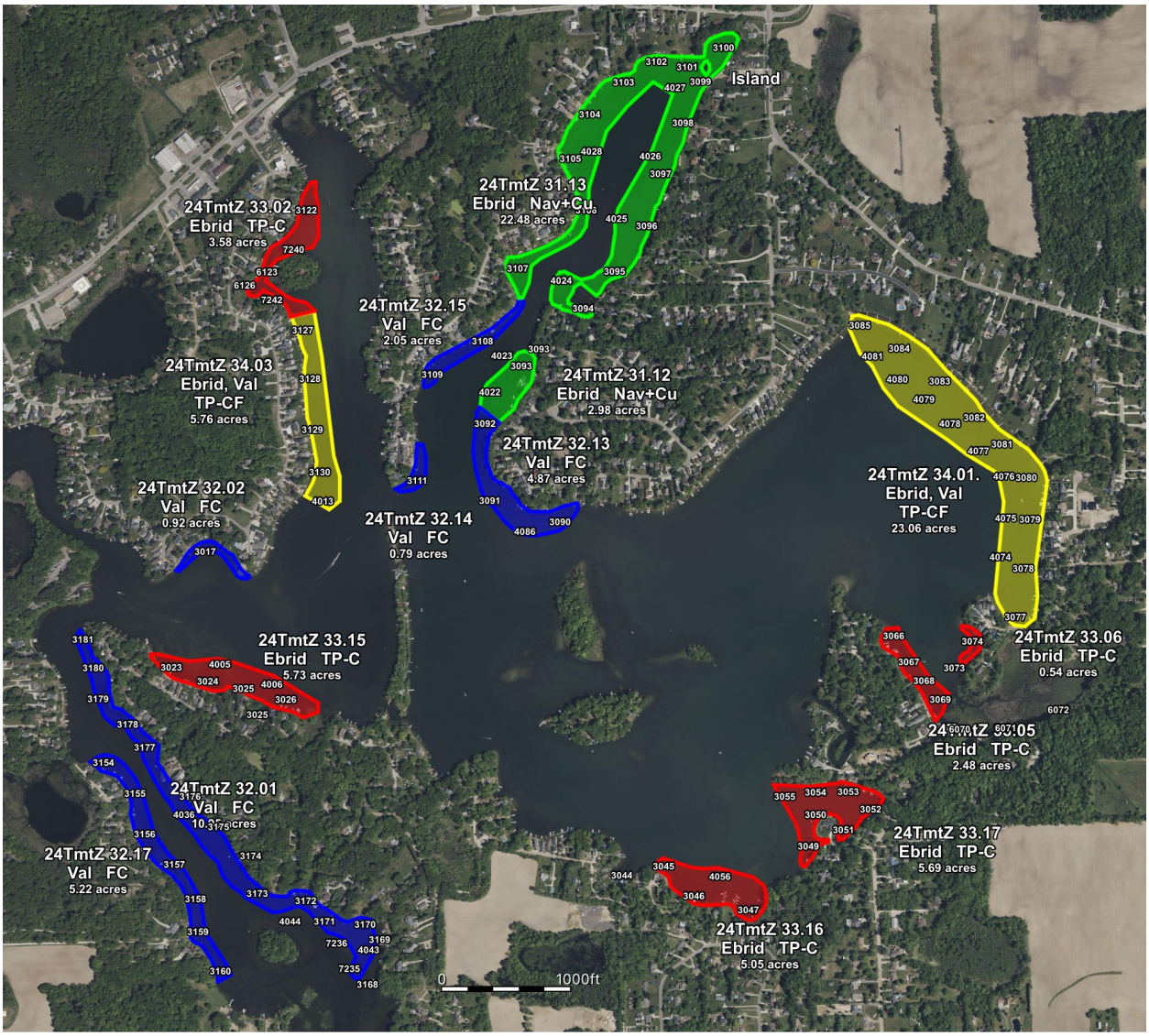


Figure 13. The third species selective herbicide application of 2024, Tmt 30, and the individual TmtZ (treatment zones). Most of the TmtZ were included as part of various evaluations. Treatment date: 09/05/24.

Table 14. The agents and agent combinations used during a third treatment event to suppress nuisance conditions and maintain acceptable vegetation community condition in Lobdell Lake, 2024. These AROS were selected to evaluate novel means to apply different combinations of agents to potentially extend the time of sufficient effect of treatment and to potentially reduce costs.

TmtZ	Cost Per Acre	Total Acres	Total Cost of Application
31	$600	25	$15,276
	< 5 Acres	3	
	> 5 Acres	22	

Control Agent and Combo	Control Agent Unit Dose per Acre	Unit Volume Or Weight
Triclopyr Amine (G)	120.00	3,055.2
Copper Chelate +Adjv (L)	1.00	25.5

TmtZ	Cost Per Acre	Total Acres	Total Cost of Application
32	$283	24	$6,758
	< 5 Acres	8	
	> 5 Acres	16	

Control Agent and Combo	Control Agent Unit Dose per Acre	Unit Volume Or Weight
Carfentrazone	0.40	9.6
Flumioxazin	1.00	23.9

TmtZ	Cost Per Acre	Total Acres	Total Cost of Application
33	$390	23	$8,997
	< 5 Acres	7	
	> 5 Acres	16	

Control Agent and Combo	Control Agent Unit Dose per Acre	Unit Volume Or Weight
Diquat Dibromide (L)	1.00	23.1
Endothall Salt (L)	1.00	23.1
Copper Chelate +Adjv (L)	1.00	23.1
Carfentrazone (F/WP)	0.13	3.0

TmtZ	Cost Per Acre	Total Acres	Total Cost of Application
34	$420	29	$12,096
	< 5 Acres	0	
	> 5 Acres	29	

Control Agent and Combo	Control Agent Unit Dose per Acre	Unit Volume Or Weight
Diquat Dibromide (L)	1.00	28.8
Endothall Salt (L)	1.00	28.8
Copper Chelate +Adjv (L)	1.00	28.8
Carfentrazone (F/WP)	0.13	3.7
Flumioxazin	1.00	28.8

TmtZ	Cost Per Acre	Total Acres	Total Cost of Application
35	$300	4	$1,200
	< 5 Acres	0	
	> 5 Acres	4	

Control Agent and Combo	Control Agent Unit Dose per Acre	Unit Volume Or Weight
Copper Chelate +Adjv (L)	0.25	1.0
Endothall Amine (L)	0.25	1.0
Phoslock	100.00	400.0

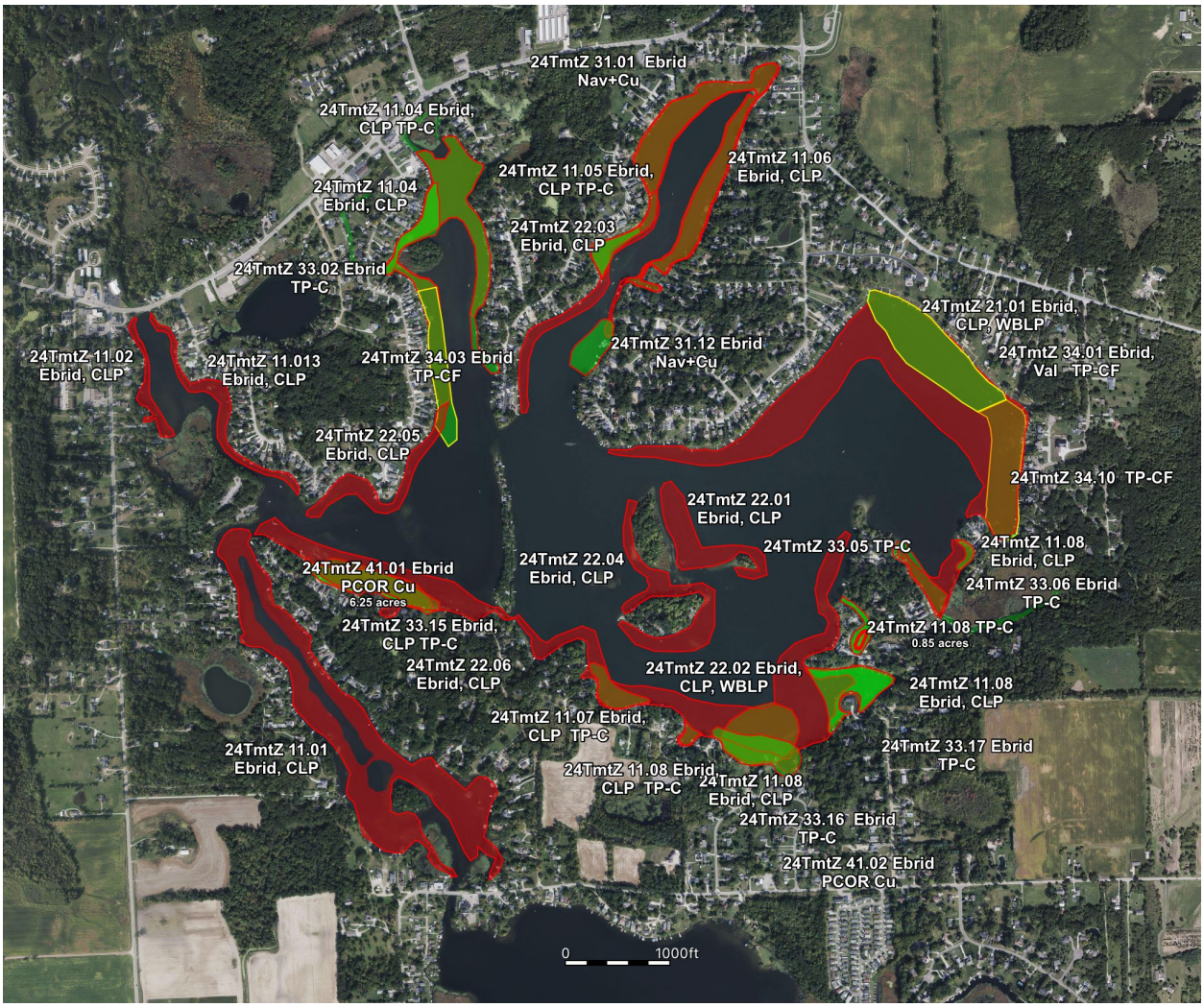


Figure 14. The agents and agent combinations used during a third treatment event to suppress nuisance conditions and maintain acceptable vegetation community condition in Lobdell Lake, 2024. These AROS were selected to evaluate novel means to apply different combinations of agents to potentially extend the time of sufficient effect of treatment and to potentially reduce costs.

Triclopyr Evaluation. A granular herbicide known by the generic name of triclopyr was applied to TmtZ 31 for the management of nuisance ebrid watermilfoil. This evaluation was supported in part by the manufacturer of triclopyr, Nufarm, and the aquatic herbicide distributor, Nutrien. Triclopyr is a highly species selective agent for the management of nuisance ebrid watermilfoil. Granular aquatic herbicides but it can be difficult to apply and agricultural spreaders do not provide the ability to inject the herbicide at precise depth. A new device was provided by Nutrien to apply the granular product at specific depth. It is based on a venturi and the technology is referred to as induction application. The combination of precise depth application and triclopyr granular herbicide was coupled to improve application efficiency, amd to enhance the activity and longevity of the desired effect. An antimicrobial agent, chelated copper was applied concurrently with the triclopyr granular to further enhance the activity of the selective herbicide. Ebrid watermilfoil exhibited pronounced symptoms of being exposed to the herbicide within

weeks of the application, but the true test will focus on how the sufficient effect might extend into 2025. Another new herbicide known as ProcellaCOR was applied in TmtZ 42 to test the relative efficacies of triclopyr and this new herbicide. Conditions in TmtZ 31 and 42 will be monitored in early 2025 and this assessment will be used to guide the management team in making the best treatment plans in the future.

Wild Celery Treatment Evaluation. Wild celery has only occasionally become a significant nuisance in Lobdell Lake over the past decades, but when it does grow to nuisance levels it creates a very significant impairment to recreation. It emerges at nuisance levels after the Fourth of July holiday when it becomes a serious impediment to boat traffic and an aesthetic nuisance later when it becomes flotsam that accumulates on leeward shorelines in August. There are no know ways to consistently, effectively and affordably manage nuisance wild celery production. Effective nuisance management is further complicated by findings that there are potentially multiple wild celery species, some being exotic, located throughout North America. The management team believes that they may have discovered a novel combination of treatment agents that when properly applied, may result in effective wild celery control. Plans were developed for a test area in TmtZ's 34. Unfortunately, the materials were mis-applied by the herbicide applicator and the test had to be scrubbed. However, there were some indications that the treatment strategy could be successful, if applied properly. It is hoped that the evaluation might be repeated in 2025, but it must be applied properly.

TREATMENT EVENTS 40 AND 50, 18 AND 24 SEPTEMBER 2024

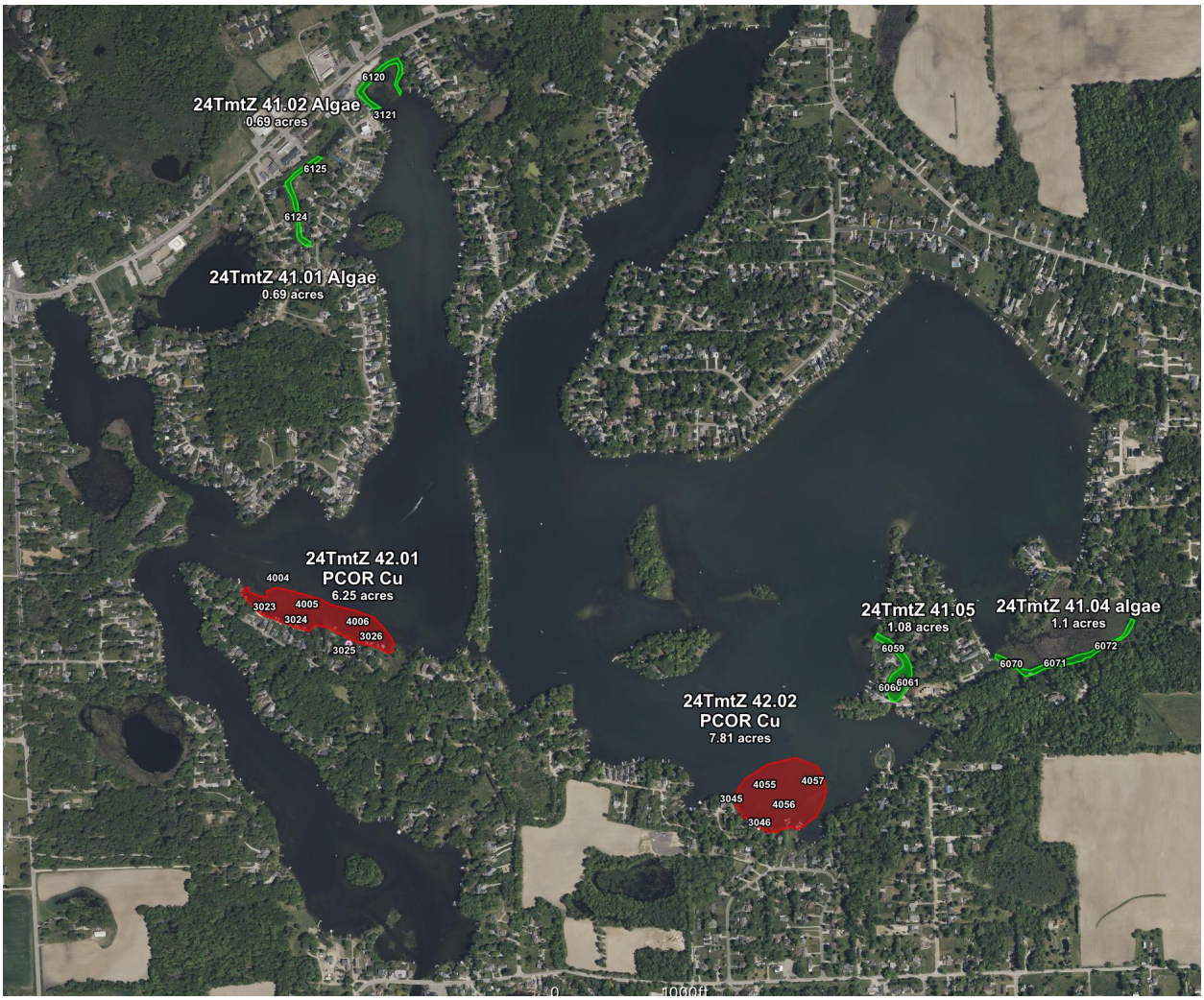


Figure 15. Treatment event 40 and the location of ProcellaCOR, amended with copper chelate applications for long-term ebrid watermilfoil control and canals (Tier 6) AROS treated with algaecides and a nutrient deactivant known as Phoslock.

Table 15. Agents applied and acreage of canal treatments, Events 40 and 50. Treatment events 40 and the location of ProcellaCOR, amended with copper chelate applications for long-term ebrid watermilfoil control and canals (Tier 6) AROS treated with algaecides and a nutrient deactivant known as Phoslock.

TmtZ	Cost Per Acre	Total Acres	Total Cost of Application
41	$160	7	$1,120
	< 5 Acres	0	
	> 5 Acres	7	

Control Agent and Combo	Control Agent Unit Dose per Acre	Unit Volume Or Weight
Copper Chelate +Adjv (L)	1.00	7.0
Endothall Amine (L)	0.25	1.8
Phoslock	100.00	700.0

TmtZ	Cost Per Acre	Total Acres	Total Cost of Application
42	$600	3	$1,800
	< 5 Acres	0	
	> 5 Acres	3	

Control Agent and Combo	Control Agent Unit Dose per Acre	Unit Volume Or Weight
Copper Chelate +Adjv (L)	1.00	3.0
ProcellaCOR (L)	0.25	0.8

TmtZ	Cost Per Acre	Total Acres	Total Cost of Application
51	$160	8	$1,280
	< 5 Acres	0	
	> 5 Acres	8	

Control Agent and Combo	Control Agent Unit Dose per Acre	Unit Volume Or Weight
Copper Chelate +Adjv (L)	1.00	8.0
Endothall Amine (L)	0.25	2.0

Algae and Other Nuisance Management in Canals. There are a number of canals that project off the main body of Lobdell Lake. These canals are usually afflicted with serious and intense nuisance conditions. Filamentous Algae is often the most offensive of the plant growth found in these areas since it can resemble a green "sewage scum" that impedes boat traffic, suppresses desirable plant production, and is an extreme esthetic nuisance. Filamentous algae derive nutrition from the bottom of the canals where nutrient rich sediments fuel the emergence of dense mats of nuisance algae that later float to the water surface. Phoslock is not a herbicide but is an agent that locks up the key plant nutrient, phosphorus. It was applied to the canals in an effort to interrupt the transfer of this key nutrient to the filamentous algae mats as the form on the bottom of the canals. Where treatment events are normally limited to two or fewer in the main body of the Lobdell Lake, problems in canals are recurrent and 3 or 4 treatments may be required each summer to maintain somewhat acceptable conditions. The application of Phoslock (TmtZ 41) is expected to provide longer-term relief from nuisance filamentous

algae production and possibly improve treatment outcomes and the time of sufficient suppression of nuisance conditions. This approach shall continue in 2025 when it will be possible to gain a better understanding of the possible benefits of the novel treatment strategy. TmtZ 51 was used as a "control" where more traditional filamentous algae treatments were applied to compare to the outcomes observed in TmtZ 41 AROS.

ProcellaCOR (Florpyrauxifen-benzyl) is a relatively new, phenoxy-type herbicide that has proven to be very effective for the control of ebrid watermilfoil. It is very expensive and it is difficult to justify the increased cost where early season management demands a more varied approach that can concurrently control the growth of curly leaf pondweed. However, other phenoxy herbicides are enhanced when amended with anti-microbial agents such as the chelated coppers that were originally developed for the management of nuisance algae. ProcellaCOR was amended with a chelated copper with the intention that milfoil production would be reduced in the treatment zones in early 2025.

Figure 16. Treatment event 60 and the location of the highly invasive aquatic wetland plant, Phragmites. This area was treated to suppress the further invasion of the wetland area by this highly aggressive and damaging species.

The vegetation management program on Lobdell Lake is focused on Tiers 3 through 8; however, the highly aggressive and damaging invasive and exotic wetland plant species has invaded the Tier 2 area as depicted in the map above. Treatments occur in the late season when the targeted plant is translocating starch from the upper part of the plant, to the roots to stimulate the resurgence of growth in the spring. This area will continue to be monitored and treated in an effort to protect and improve conditions in this vital, Tier 2 wetland area.

2024 Treatment Evaluation Overview: As mentioned previously, one of the objectives of the vegetation community management program in Lobdell lake is to intervene as little as possible. This is done to avoid the imposition of water use restrictions and contain cost. Typically, a large-scale treatment is executed on the lake in early June to address issues related to weedy production of ebrid watermilfoil, curly leaf pondweed, and starry stonewort in limited areas. A second treatment event is often executed in August to enhance conditions in the end of the summer and before the Labor Day holiday. The second treatment of the year is generally very limited in scope and involves treatment of far fewer AROS that the June treatment. Warming weather has required two large scale treatments be made in June since nuisance conditions appear at different times in different parts of the lake. Five treatment events were executed in 2024. The first two covered large numbers of AROS but were needed to address nuisance conditions that developed at different times in different areas of the lake. Subsequent treatments were done to evaluate alternative treatment strategies that may provide longer-term relief from nuisance conditions, with particular emphasis on the difficulty in maintaining acceptable conditions for most of the season after any treatment that occurs prior to Memorial Day. These special evaluations are discussed in a separate section of this report.

2024 Vegetation Management Review and 2025 Projections

Despite issues related to the recent imposition of onerous permit restrictions on the application of algaecides in 2021, the nuisance vegetation management program has continued to be successful in most part. It is critical to note that nuisance milfoil species and genotypes, Eurasian watermilfoil (*M. spicatum*), Ebrid watermilfoil (Eurasian northern watermilfoil hybrids), and variable milfoil (*M. heterophyllum*) have become increasingly difficult to suppress each year since management began in the late 1980's. Combinations of control agents are now used instead of the single agent approaches that were used through the 1990's. The changes in watermilfoil sensitivity to herbicides has required that different combinations of agents be used to improve treatment outcomes, hasten the time that it takes for nuisance conditions to drop out of the water column, provide longer-term relief from nuisance conditions, and accomplish these goals at reasonable cost. A quick review of previous annual LakeScan™ reports will illustrate the use of more than a dozen different combination strategies to achieve better treatment outcomes. Nearly all of these strategies have provided adequate to excellent milfoil control; however, increasing regulatory restrictions on the use of some agents threatens to compromise treatment effects in the future. Aquest and K&A scientists continue to lead the industry in the development of better ways to alleviate nuisance milfoil conditions. Treatment evaluations were begun in 2024 to inform better ebrid watermilfoil management approaches, deal with emerging issues with nuisance wild celery control, and provide more consistent and persistent control of filamentous algae in the canals (Tier 6).

Control Agent and Application Development and Assessment, 2025

Continued Evaluation Monitoring in 2025 - Preseason Observations

1. Monitor the recovery of ebrid watermilfoil populations in 24TmtZ 11 and 12 to elucidate the risks and benefits associated with early treatment (May) vs June treatments. The relative nuisance levels in each of the TmtZ will be considered and used to develop treatment plans for 2025.
2. Monitor the recovery of ebrid watermilfoil in 24TmtZ 31, triclopyr treatment zones and 24TmtZ 51, florpyrauxifen-benzyl (ProcellaCOR) test sites. The goal of these applications was to deter the nuisance production in the TmtZ in the year after treatment. Attention shall be paid to how much ebrid watermilfoil returns to the TmtZ and what impact ebrid watermilfoil control has on the relative nuisance production of curly leaf pondweed.
3. Evaluate the relative nuisance abundance of filamentous algae in Tier 6 canals where the phosphorus deactivant, Phoslock was applied to reduce the rate of recurrence of algae nuisance conditions. It is expected that several applications will need to be made during algaecide applications made to the canals in 2025.

Wild Celery Management Program

It is proposed that the 2024 evaluation program be repeated in 2025 – BUT ONLY IF – there is cooperation from the herbicide applicator. Treatment method is absolutely critical to achieve the expected results. If the applicator is not able to fulfill obligations of the study, it is not recommended that the same thing be done in 2024.

Variable watermilfoil is present throughout much of Lobdell Lake where it is rarely noticed but is often a conspicuous nuisance in the Bennett Lake Channel, Millpond, and AROS in the vicinity of the public boat launch. This plant has been subjected to genetic testing to determine if it is a particularly pernicious genotype but study results have been equivocal. It remains notoriously hard to control. A test of a new herbicide was conducted in the Bennett Lake Channel in 2020 and 2021, but the treatment outcomes were impossible to interpret. The cost of this option has decreased in recent years and a new herbicide combination was used in 2024 and is likely to be used in 2025. Management decisions will be made during the early season plant community assessment.

Curly leaf pondweed is extremely susceptible to nearly all registered aquatic herbicides and can be easily and selectively suppressed by a wide variety of methods or agents. It responded well to the same combination of agents that is used to suppress nuisance ebrid watermilfoil production. It is expected that concurrent management of ebrid watermilfoil and curly leaf pondweed will mitigate nuisance conditions in the coming year.

Filamentous algae grow to unsightly nuisance levels in various Lobdell Lake canals (Tier 6). This growth originates on the bottom of the canals and then floats to the water surface where it is bleached by sun and is desiccated becoming a serious aesthetic nuisance. Water quality conditions below the floating mats are also degraded which compromises the quality of the critical habitat in these afflicted areas. A relatively new, phosphorus inactivator compound, Phoslock seems to show promise in interrupting the link between bottom sediment plant nutrient stores and noxious filamentous algae production. The application of this material may improve the critical habitat structure and aesthetic quality of the canals. It is believed that the impact of Phoslock application is additive over years of applications. The first application was made in September 2024, but the strategy will be continuously deployed in the coming years if the cost remains reasonable.

A multi-tiered application strategy using a combination of herbicide and algaecide agents will be used to simultaneously target ebrid watermilfoil and curly leaf pondweed where nuisance conditions emerge in 2023. Treatment will occur when weather conditions and sediment temperatures reach levels that will insure successful and long-lasting treatment outcomes. The actual prescriptive will not be developed until conditions are observed in the late Spring or early Summer.

Algaecides will be prescribed for the control of nuisance starry stonewort if it presents a nuisance in 2025. State algaecide restrictions do not extend to starry stonewort so it is reasonable to expect that effective treatment strategies can be used in 2025.

LakeScan™ monitoring has been critical to securing permit amendments to gain access to effective management agents because it can provide clear empirical evidence that conditions in the lake are improving as a consequence of effective management. There are only a small number of lakes in MI that have this advantage. Monitoring will continue to focus on the most important elements and criteria as they relate to the “health” of Lobdell Lake. These data will also be used to evaluate treatment outcomes and assure residents of the SAD that the goals of the management plan are being addressed and achieved.

References

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US Geological Survey. 2012. "Water Quality Characteristics of Michigan's Inland Lakes, 2001-10." Scientific Investigations Report 2011–5233. Available online at: https://pubs.usgs.gov/sir/2011/5233/.

Appendices

Table 10. A history of significant management and monitoring events for Lobdell Lake since 1988.

Year	Event Description
1988	Beginning of Lake Monitoring and Management Guidance Program.
1992	Fluridone (Sonar) aquatic herbicide strategy applied to lake at 8 ppb. Exceptional control was achieved at the prescribed application concentrations which are much greater than currently permitted.
1994	Mechanical harvesting first deployed to manage nuisance pondweeds and wild celery. Outcomes were considered to be fair. Herbicide combinations based on diquat dibromide are used to manage ebrid watermilfoil that had recovered following the previous fluridone treatment.
1999	Unusually dense watermilfoil challenges the management program. Various management options begin to be considered and variously applied to the lake. Fluridone applied to the lake in the late fall. Provides excellent results in east side of the lake in the following year. Failed to provide adequate control in the Ore Creek Channel (Bennett Lake Channel and Millpond) during the following year. Collaborative Michigan State University / US Army Corps study is completed concluding that fluridone is an expectable tool for ebrid watermilfoil management but fails to recognize that diquat-based herbicide combinations were use in the lake during the time of study.
2000	Charoid algae creates significant nuisance conditions in the Millpond
2002	Water quality data collected along the Ore Creek Channel I response to proposed upstream development and possible impacts on the lower lakes water quality.
2003	Aquest and University of CT researchers confirm that a hybrid Eurasian watermilfoil and northern water milfoil (Ebrid watermilfoil) inhabit Lobdell Lake.
2004	SEAS completes first LakeScan™ critical fisheries habitat study
2006	Starry stonewort is detected in Lobdell Lake at nuisance levels on February 6. This is the first detection of starry stonewort in any inland Michigan Lake.
2007	Novel strategy to use contact herbicides and chelated coppers developed by Aquest, University of Michigan, and Aquatic Services to address challenging water milfoil. Different management agents and combos are used each year to achieve good nuisance species control that are based on the 2007 research findings. Strategy developed by Aquest and Aquatic Services to effectively manage starry stonewort that has reached extreme nuisance levels. However, ebrid watermilfoil quickly replaces starry stonewort in nearshore treatment areas. Treatment strategies were adjusted. Lobdell Lake is part of a study of cyanobacteria dominance in Michigan inland lake. Cyanobacteria dominated the planktonic flora, but nuisance blooms were not present in the lake.
2010	A new strain of variable watermilfoil emerges as a conspicuous nuisance in the Ore Creek Channel. It does not respond well to treatment and may become a persistent nuisance.

2015	Starry stonewort domination begins to recede. Sporadic population crashes become more common and density in the deep zones of the east side of the lake begin to decline. Ebrid watermilfoil populations begin to regain lost dominance as a result of diminished starry stonewort production. Study of thermal impacts on the effects of algaecides on starry stonewort is conducted on Lobdell Lake. Treatment strategies are improved as a consequence of this study.
2017	Lobdell Lake is included in a comprehensive study of starry stonewort control techniques conducted by Clemson University. Aquest finished collecting pertinent data but study was not completed.
2018	Cyanobacteria enter the lake through a drain on the north shore of the east side of the lake at levels of concern. Further investigation reveal that the event is a consequence runoff from salt laden and recently cleaned drains near the lake inlet. Starry stonewort nuisance levels have diminished to the point where this exotic species is no longer a primary management target in this lake except for the Ore Creek channel area.
2020	"Zombie Milfoil" treatment approach is initiated on Lobdell Lake. Treatment outcomes did not meet expectations, but study sets course for future investigations.
2024	Evaluations of novel ways to apply and utilize triclopyr and ProcellaCOR for long-term suppression of ebrid watermilfoil. Evaluation of a method to improve filamentous algae conditions enclosed canals, Tier 6. Evaluation of a potentially effective and affordable way to manage invasive wild celery.

Appendix A: Blue Green Algae

Blue green algae blooms are becoming increasingly common in Michigan. Blooms can appear as though green latex paint has been spilled on the water, or resemble an oil slick in enclosed bays or along leeward shores. Blue green algae blooms are usually temporal events and may disappear as rapidly as they appear. Blue green algae blooms are becoming more common for a variety of reasons; however, the spread and impact of zebra mussels has been closely associated with blooms of blue green algae.

Figure A1: Example blue green algae images from the 2021 LakeScan™ field crew.

Blue green algae are really a form of bacteria known as cyanobacteria. They are becoming an important issue for lake managers, riparian property owners and lake users because studies have revealed that substances made and released into the water by some of these nuisance algae can be toxic or carcinogenic. They are known to have negative impacts on aquatic

ecosystems and can potentially poison and sicken pets, livestock, and wildlife. Blue green algae can have both direct and indirect negative impacts on fisheries. Persons can be exposed to the phytotoxins by ingestion or dermal absorption (through the skin). They can also be exposed to toxins by inhalation of aerosols created by overhead irrigation, strong winds, and boating activity.

Approximately one half of blue green algae blooms contain phytotoxins, and this is determined through lab testing. It is recommended that persons not swim in waters where blue green algae blooms are conspicuously present. Specifically, persons should avoid contact with water where blooms appear as though green latex paint has been spilled on the water, or where the water in enclosed bays appears to be covered by an "oil slick". Pets should be prevented from drinking from tainted water. Since blue green algae toxins can enter the human body through the lungs as aerosols, it is suggested that water containing obvious blue green algae blooms not be used for irrigation in areas where persons may be exposed to it.

Blue green algae are not very good competitors with other, more desirable forms of algae. They typically bloom and become a nuisance when resources are limiting or when biotic conditions reach certain extremes. Some of the reasons that blue green algae can bloom and become noxious are listed below:

TP and TN: The total phosphorus (TP) concentration in a water resource is usually positively correlated with the production of suspended algae (but not rooted plants, i.e., seaweed). Very small amounts of phosphorus may result in large algae blooms. If the ratio of total nitrogen (TN) to total phosphorus is low (<20), suspended algae production may become nitrogen limited and noxious blue green algae may dominate a system because they are able to "fix" their own nitrogen from atmospheric sources. Other common and desirable algae are not able to do this.

Free Carbon Dioxide: All plants, including algae, use carbon dioxide in photosynthesis. Alkalinity, pH, temperature, and the availability of free carbon dioxide are all closely related and inter-regulated in what can be referred to as a lake water buffering system. Concentrations of these key water constituents will shift to keep pH relatively constant. Carbon dioxide is not very soluble (think about the bubbles of carbon dioxide that escape soda pop). The availability of this essential substance can be in short supply in lake water. Many blue green algae contain gas "bubbles" that allow them to float upward in the water column toward the water surface where they can access carbon dioxide from the atmosphere. Consequently, blue green algae that can float have a competitive advantage in lakes where carbon dioxide is in low supply in the water. This is also why blooms form near the surface of the water.

Biotic Factors: Zebra mussels and zooplankton (microscopic, free-floating animals) are filter feeding organisms that strain algae and other substances out of the lake water for food. Studies have shown that filter-feeding organisms often reject blue green algae and feed selectively on more desirable algae. Over time, and given enough filter feeding organisms, a lake will experience a net loss in "good" algae and a gain in "bad" blue green algae as the "good" algae are consumed and the "bad" algae are rejected back into the water column. This is one of the most disturbing factors associated with the invasion and proliferation of zebra mussel. Lakes that are full of zebra mussel may not support the production of "good" algae and experience a partial collapse of the system of "good" algae that are necessary to support the fishery.

Appendix B: Common Aquatic Invasive Species

Eurasian Watermilfoil and Hybrids (Ebrids):

Background: Anecdotal evidence suggests that hybrid milfoil has been found in Michigan inland lakes for a long time (since the late 1980's). University of Connecticut professor Dr. Don Les was the first to determine that there were indeed, Eurasian watermilfoil and northern watermilfoil hybrids in Michigan based on samples sent to his Connecticut lab by Dr. Douglas Pullman, Aquest Corp. in 2003. Experience has proven that it is usually not possible to determine whether the milfoil observed is either Eurasian or hybrid genotype. However, because they play such similar roles in lake ecology, they are simply "lumped together" and referred to collectively as ebrid milfoil. Ebrid milfoil is a very common nuisance in many Michigan inland lakes.

Management: Lake disturbance, such as weed control, unusual weather, and heavy lake use can destabilize the lake ecosystem and encourage the sudden nuisance bloom of weeds, like ebriid milfoil. Ebrid milfoil is an ever-present threat to the stability and biological diversity of the lake ecosystem. Species selective, systemic and contact herbicide combinations have been used to successfully suppress the nuisance production of ebrid milfoil and support the production of a more desirable flora. However, it is becoming much more resistant to all herbicidal treatment. This resistance can be easily overcome with the addition of microbiological system treatment agents. This can be accomplished with only a minor cost increase. Milfoil community genetics are dynamic, not static, and careful monitoring is needed to adapt to the expected changes in the dominance of distinct milfoil genotypes. Some of these genotypes may be more herbicide resistant than others and treatment strategies must be adjusted to remain effective in different parts of the lake. It is also important to remember that the first documented population of hybrid water milfoil was comingled with Eurasian watermilfoil on all of the genotypes present in that lake failed – equally - to respond to herbicide treatment.

Figure B1: Example Eurasian Watermilfoil and Hybrids images from the 2021 LakeScan™ field crew.

Starry Stonewort

Background: Starry stonewort invaded North American inland lakes after becoming established in the St. Lawrence Seaway/Great Lakes system. It has probably been present in Michigan's inland lakes since the late 1990's but was not positively identified until 2006 by Aquest Corporation in Lobdell Lake, Genesee County, MI. Since then, it has been discovered in lakes all over Michigan. It is truly an opportunistic species that will bloom AND crash and impose a very significant and deleterious impact on many ecosystem functions. Bloom and crash events are unpredictable and can happen at any time of the year. In some years starry stonewort can become a horrendous nuisance while it can be inconspicuous in others. It can comingle with other similar species and be very difficult to find when it is not blooming.

Management: Starry stonewort is capable of growing to extreme nuisance levels. It is easy to kill, but very difficult to treat. It grows so rapidly that mechanical methods of control are strongly discouraged. First, starry stonewort can regrow so rapidly after cutting that it can be nearly impossible to keep up with the nuisance production of this fast-growing plant. Mechanical controls can also help to disperse and spread starry stonewort throughout inland lakes when the plant is fragmented. It is even more disturbing that desirable plant species are more susceptible to mechanical control strategies than starry stonewort and mechanical controls can thereby select for the dominance of starry stonewort over a much more desirable flora. Starry stonewort is susceptible to most selective algaecides, but the dense mats of vegetation are very difficult to penetrate and provide reasonable biocide exposure. Consequently, multiple algaecide applications may be required to "whittle down" dense starry stonewort growth if the mats reach sufficient height.

Figure B2: Example starry stonewort images from the 2021 LakeScan™ field crew.

Curly-Leaf Pondweed

Background: Curly-leaf pondweed (CLP) is one of the world's most widespread aquatic plant species. Although it is found worldwide, CLP is native to only Eurasia. The earliest verifiable records of the plant are from Pennsylvania in the 1840s, and has been found in Michigan since 1910. Curly-leaf pondweed is currently found in inland lakes in at least 34 counties in Michigan, distributed both in the upper and lower peninsulas. [3] Scientific literature suggests that curly-leaf pondweed is an aggressively growing species that often expands to nuisance levels when native plants are damaged.

Unmitigated curly-leaf pondweed growth can result in the formation of recreational nuisances, ecological nuisances (by outcompeting native species and reducing light availability to other plants), and degraded fish spawning habitat. Curly-leaf pondweed is easily detectable in early spring as it will be one of the few plants readily growing and the first submersed plant to reach the surface. This gives it a competitive advantage and can grow 4 to 5 feet tall before other plants begin germinating from the bottom sediments. As water temperatures rise in late June and early July, curly-leaf pondweed stems begin to die, break down, and can be completely gone by mid-July.[4] It is sometime observed in the Fall when water begins to cool, but rarely is observed to grow to nuisance levels.

Management: Unlike other invasive species, CLP is easy to control, but it eradication is elusive or not practical. It is considered widespread in Michigan but, prevention of new populations in uninfected waters is the most economical management approach. Several herbicides have been shown to be effective and selective for the control of CLP, but it will decline naturally in late June or early July in the Great Lakes region. There may be little benefit in applying herbicides near the time of the Fourth of July holiday since the plant are already preparing for dormancy and are in natural decline by that time.

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[3] MDEQ. (2018). "State of Michigan's Status and Strategy for Curly-leafed Pondweed (*Potamogeton crispus L.*)." Accessed online: <https://www.michigan.gov/documents/invasives/egle-ais-potamogeton-crispus_708948_7.pdf>.

[4] Hart, Steven, M. Klepinger, H. Wandell, D. Garling, L. Wolfson. (2000). "Integrated Pest Management for Nuisance Exotics in Michigan Inland Lakes." Accessed online: <https://www.michigan.gov/documents/invasives/egle-great-lakes-aquatics-IPM-manual_708904_7.pdf>.

Bottom barriers have shown effectiveness at combating CLP in small areas, and mechanical harvesting of CLP can be effective if timed and managed correctly.[5] The environmental consequences of bottom barrier treatments have not been adequately assessed.

The most effective ways to control CLP is through chemical and physical means after developing an integrated pest management plan. Early infestations may best be controlled by manual removal, diver-assisted suction harvesting (DASH), or benthic barrier use during spring before turions are produced. Aquatic herbicides including endothall, diquat, and imazamox are the most effective for general applications. Aquatic herbicides including flumioxazin and imazamox are effective for specific types of application and in specific environments. Chemical treatments are a part of a long-term integrated management plan as the turions are viable for at least 5 years and only diquat, fluridone, and some hormone treatments have shown a reduction of turion development in the laboratory.[6]

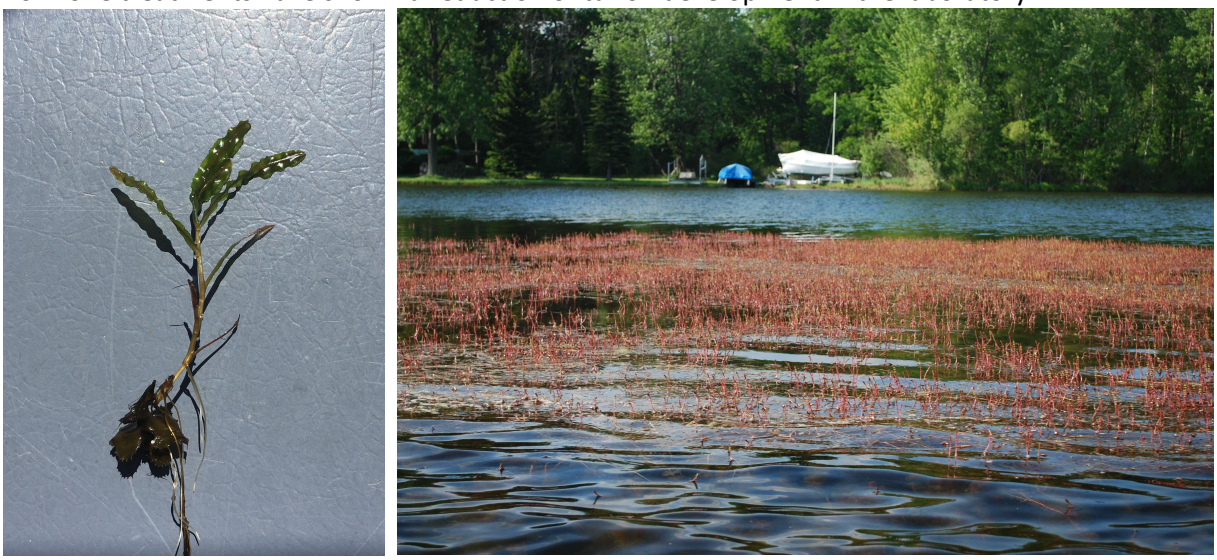

Figure A3: Example curly-leaf pondweed image from the 2021 LakeScan™ field crew and "topped out" curly leaf pondweed in a SE Michigan lake.

[5] MDEQ, 2018.
[6] MDEQ, 2018.