A LakeScan™ Monitoring and Management Guidance Program for:

Wabeek Lake

Oakland County, MI

PART 1: METHODS, MANAGEMENT GOALS, AND PRESCRIPTIVE OBJECTIVES

Submitted by:

Dr. G. Douglas Pullman

Aquest Corporation

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 valuable 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 aquatic ecosystems. Persons who are already familiar with the LakeScan™ method may wish to skip to Part 2 since Part 1, the methods and approach sections, are primarily "boilerplate" and do not change from year to year. It is also important to remember that this report is only the "tip of the iceberg". All recommendations are based on the comprehensive record of data that are included in the LakeScan™ annual review document, Part 3. That report contains several hundred histograms and tables and will help the reader to understand the conditions and metrics found in different areas of the lake, at different times, and also provide a comprehensive year to year analysis of all metrics at different lake areas. The LakeScan™ Annual Review is available under separate cover.

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PART 1

BACKGROUND

(Understanding the Project)

Goals, Objectives, Methods, Definitions, and Rationale

Introduction

How to Read This Report: Lakes are complex, and a wide range of data and analysis are necessary to create an effective lake management plan. Responsible lake management requires in-depth analysis of critical ecosystem functions and proper consideration of appropriate lake systems. Good data supports the selection and application of effective and relevant lake management efforts. Furthermore, this information absolutely required to prove that program administrators are acting responsibly and assure the public, stakeholders, and regulatory personnel understand that the program is providing benefits to the lake ecosystem and stakeholders. Every LakeScan™ lake is considered from many perspectives; however, many people are satisfied to read only a review of some selected data rather than taking the time to examine the voluminous data that are generated by LakeScan™ that are used to develop prescriptive lake management plans. Consequently, LakeScan™ reports are now divided into three separate documents – a two-part executive summary and a comprehensive data document. Most people will benefit from reading one or both parts of the executive summary and may wish to go no further. These data may be especially helpful to persons who may be considering the purchase of real estate on a lake.

LakeScan™ project goals and objectives do not change dramatically from year to year. The first part, PART 1. of this executive summary provides an outline of these goals and the rationale for the following data review. Yes, it is mostly boiler plate. Persons who are familiar with this lake and have already studied LakeScan™ reports and are already familiar with the maps, goals, objectives and administration of the program may wish to skip to PART 2. PART 2 provides a summary of the conditions observed during the most recent year and make relevant reference to historical data that is cataloged for each lake. It also provides trend analsysis for most measures of lake heath that help to understand the impacts that management has had on the lake system. PART 3. Includes category reviews and a comprehensive and detailed data set. These data are all available separately in an effort to provide reports that are meaningful for the broadest range of readers.

Part 1: Geopolitical, GIS, Goals and Objectives of the Program and Administrative Information.

Part 2: An executive summary of conditions from the most current year of LakeScan™ Analysis and selected references to year to year data.

Part 3: Compiled LakeScan™ observations, metrics, and data analysis.

Lakes are usually a publicly held resources and thousands or tens of thousands of dollars are expended to improve lake conditions on each lake. Property values hinge on lake quality. Program administrators must ensure that lake management programs are rational, effective and that the data generated to support decisions is relevant and directly address obvious impairments. Failure to provide adequate information to stakeholders and government regulators increases the level of legal and political liability that is assumed by program administrators and can cause a program to fail. LakeScan™ is currently the only monitoring and management guidance system available that can provide relevant monitoring and reasonable assessments of lake condition with appropriate area and historical reference.

WABEEK LAKE EXECUTIVE SUMMARY, PART 1

The Project Goal: This Wabeek Lake Management Plan is goal driven. The primary goal of this plan is to preserve, protect, and if possible – improve the Wabeek Lake aquatic ecosystem. This can only be accomplished when critical habitat is protected and when biological diversity and ecosystem stability are enhanced. Lakes that are managed with this goal are best suited for all forms of recreation, fishery production and exhibit superior aesthetic qualities. This goal is the basis for a sustainable management approach that can provide long-term benefits and cost savings for lake communities. Failure to attain this goal can lead to a cascade of conditions and events that make the lake less desirable and infinitely more difficult to manage. Some may believe that the only "good aquatic plant is a dead aquatic plant". However, current technology demands that "bad" aquatic plant growth be controlled and managed, but that "good" aquatic plant growth be supported to avert the development of much more undesirable lake conditions.

The Goal

Because "Without a Defined Target – Lake management will certainly miss the point!"

Job 1: Establish Meaningful, Attainable, Reasonable, and Sustainable Goals, That Can Satisfy Most People Who Enjoy and Use Lakes

The LakeScan™ Standard Goal:

To Preserve, Protect, and if Possible – Improve Aquatic Ecosystem Biological Diversity and System Stability.

"Just killing a nuisance" will certainly backfire – there will always be yet another nuisance and badly directed lake management plans worsen conditions. The consequences of killing nuisance organisms without the proper focus on ecosystem health can lead to degraded aquatic ecosystems and undesirable lake conditions and attributes.

LakeScan™ Goals and Measurement

Simply stated, no one knows if you've attained or made progress toward meeting lake management goals unless there are some meaningful measurements of intervention outcomes and long-term monitoring of critical metrics. Meaningful observations take time. The evaluations, comments and recommendations included in this report are not based on a "quick spin around the lake". Observations are compiled in the field with well-defined methods and tools. Subsequent analysis and recommendations are based on specific measures that have been selected to address specific problems and measure success in meeting lake management goals. They are not based on the application of important, but irrelevant analysis of the wrong part of a complex ecosystem. For example, water quality data are not used to inform decisions about weed management and plant community data is not used as the sole source to recommend improvements of lake water quality. Essentially, the LakeScan™ method provides the most appropriate empirical data that is needed to make reasonable management decisions and to evaluate the effectiveness of the overall program. Lake associations, special assessment districts, and any of the various governmental units that provide the administrative

support to any lake management program must have these kinds of data to ensure that their management program is being administered in a responsible and transparent way. The management of publically held resources that is funded by special tax assessments must be based on relevant data and professional guidance or it will fail responsibly satisfy the public trust and to meet the expectations of stakeholders. Failure to provide these data represent a significant political and fiduciary liability.

Elements of the Wabeek Lake Protection and Improvement Project.

The Selection of Appropriate Metrics for the Wabeek Lake Monitoring and Management Guidance Project. All lakes are complex and are the sum of several independent but interactive systems. External factors influence these different systems in very different ways. There are a wide range of LakeScan™ monitoring and management guidance methods that can be used to address nearly every one of the subsystems in lake ecosystems. It is helpful if the reader recognizes that lake ecosystems are very much like the human or animal body and the parallels between human and veterinary medicine and lake ecosystem management are can be very helpful. Imagine a person with a brain disorder who is seeking a brain scan but receives a colonoscopy instead. Brain scans and colonoscopies are both extremely important, but it is critical that testing is done in a relevant and responsible manner to preserve the health of the patient and address problems with the "impaired system". This is also true of lakes where it is critical to consider appropriate data to formulate sustainable and effective management and protection projects. Too often valid, but inappropriate testing is applied to a lake as a means or basis for the development of management project plans. This is a waste of resources and can misinform lake residents and other stakeholders involved in the lake management process. The Wabeek Lake monitoring and management guidance project is focused on large plant and weed community. No obvious water quality impairments were observed, and this might be expected from a lake of this size and location in the State. The terms "eutrophic, mesotrophic, or oligotrophic" were developed to describe the conditions of the open water systems in lakes and are not applicable as a reasonable assessment of the condition or impairments to the plant community. Fortunately, LakeScan™ Category 700 metrics and methods can be used to evaluate the condition of the plant community system and make reasonable and numbers-based evaluations of the impacts of the management interventions that are applied to the lake.

LakeScan™
Monitoring for Effective Aquatic Resource Management

LakeScan™ management plans are based on "real and relevant numbers". These are critical for effective lake management planning and assessment.

LakeScan™ studies are system based and focus on the individual problems and challenges in each lake. For example, water quality data does not qualify as a basis for weed control. LakeScan™ is the only available system that can provide kind of comprehensive and meaningful data that can serve as a basis for targeted, effective and efficient lake management.

LakeScan™ helps to focus attention on management outcomes (biodiversity, ecosystem stability, low weediness, etc.) and can help to establish realistic user group expectations.

LakeScan™ can help to protect program administrators from legal liabilities associated with management plan development and fiduciary responsibilities. It provides the proof that lake management monies are being managed wisely and demonstrate that administrative bodies are acting responsibly. Everyone wants to be assured that the best technology is being used for each individual lake and that programs are guided by professionals.

LakeScan™ saves money. LakeScan™, goal focused management programs provide a coherent and inclusive approach to resource management. This reduces wasted or misguided efforts that can unnecessarily increase costs.

Aquest recognizes that every lake is different and develops individual management prescriptives each year, for each lake. The monitoring data and management guidance provided in this report are based on real numbers and relevant measurements. Each lake is different, and these data are needed to properly create the management plan, establish annual yearly management objectives and to evaluate the short and long-term impacts of the applied elements of the lake management project for each individual lake. Management guidance and recommendations are not only based on the quality and character of the lake ecosystem, but are also framed in the context of regulatory, lake use, and budget considerations. Wabeek Lake is a multi-use lake and this is an important consideration. A goal focused lake management project where diversity and stability are targeted can provide benefits to lake users from anglers to jet skiers, protect the public health and support property values.

What is the Category 700 Analysis of the Plant Community (System)?

LakeScan™ is comprised of various component parts or "Categories" that can be used to analyze everything in a lake from microbes to wildlife. The LakeScan™ method uses 8 different measures of the plant community to determine the condition of this critical part of the lake ecosystem. These measures or metrics are used to characterize the plant community in the entire lake, but they are also calculated for distinct or individual areas in the lake. For example, each metric is calculated for the distinct biological tiers or the distinct plant communities that are present and depend on the distance from the shore. LakeScan™ also identifies different management zones or areas in the lake where different management objectives are applied. And finally, the metrics are calculated for treatment zones and these data area critical to evaluate the impact and consequences of applied management objectives. Each metric can also be applied to different groupings of plant species when they differ in quality or impact on the lake ecosystem. For example; plant community biodiversity is calculated "with weed species" or "without weed species". Research has also revealed that different plant species are found in different lake ecosystems. Ranking scales have been used to describe these different plant qualities and a thorough analysis of these quality differences is also a part of the LakeScan™ system.

LakeScan™ data can be used to compare observations of conditions that are surveyed at different times of the year. They are also used to compare conditions found in the same lake in different years. For example, early and late season plant communities can be very different, and the amount of difference may be significant. Everyone knows that each individual lake can be very different from other lakes, but LakeScan™ data can also be used to compare one lake to another and place these comparisons in reasonable context. The result is that nearly 100 different metric values are calculated for each lake. All of these are considered and reviewed and used to formulate the most appropriate plant community management plan for individual lakes. LakeScan™ is unique because it provides the data necessary to make certain that any management interventions result in no further degradation of the lake ecosystem. A typical LakeScan™ report is over 100 pages, but is presented in an easy to understand, graphical format. Histograms (bar graphs) are used to provide a quick understanding of lake conditions. Readers are encouraged to read the entire annual LakeScan™ report for this and other lakes. The following (Part 2) is a very small part of the analysis used to evaluate the Wabeek Lake plant community but does provide a general overview of conditions.

Category 700 LakeScan™ Metrics

Species Richness
(total species present)
Species Percent Occurrence
Predominant Leaf Type
Morphotype Richness
(total morphotypes present)
Biodiversity
Biodiversity of Preferred Species
Morphological Diversity
BioVolume
Weediness of Lake
Perceived Nuisance Levels

Category 700 LakeScan™ Qualifiers

Species Density
Species Distribution
Species Coefficient of Conservatism
Species Assigned Control Target Level

Category 700 LakeScan™ Time and Event

Seasonal Events
Survey Events VS1 to VS6
Treatment Events
Sum Season Surveys and Treatments
Year to Year

Category 700 LakeScan™ Areas

Biological Tier Areas
Usually vary with depth and distance from shore
Management Zones
Where different management objectives are established
Treatment Zones
Areas where different herbicides, herbicide combinations, mechanical controls, physical controls or biological controls are applied

Lake Management Actions and Objectives

"Whatever is done to a lake must be based on clear understanding of the goals and solid and empirical data that is relevant to the problems that have been identified through good monitoring."

Management Planning Benefits

~ Harvesting, Herbicides, Algaecides, Biological Manipulations, Physical and Mechanical Interventions – These are a few of the current lake management tools available to managed lakes. LakeScan™ can help and inform in the selection of the best tool for a given problem.

~ Only LakeScan™ provides the kind of seasonal and yearly data that can truly evaluate the outcome and consequences of Lake Management Program Actions.

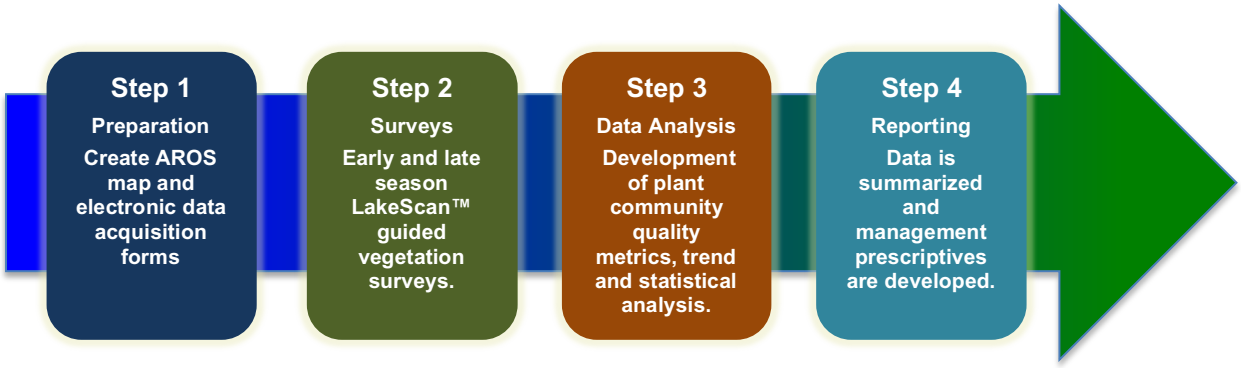
~ Respected LakeScan™ scientists insure access to the latest and best technologies. This approach is critical in the fight against invasive species impacts, toxic bluegreen algae blooms, and issues related to herbicide and harvesting resistance.

METHODS

The LakeScan™ / Aquest Approach

Category 700 Submersed Aquatic Plant Community Monitoring and Analysis

Aquest will employ a four-step approach to understand Wabeek Lake and provide management guidance.



Step 1: Preparation

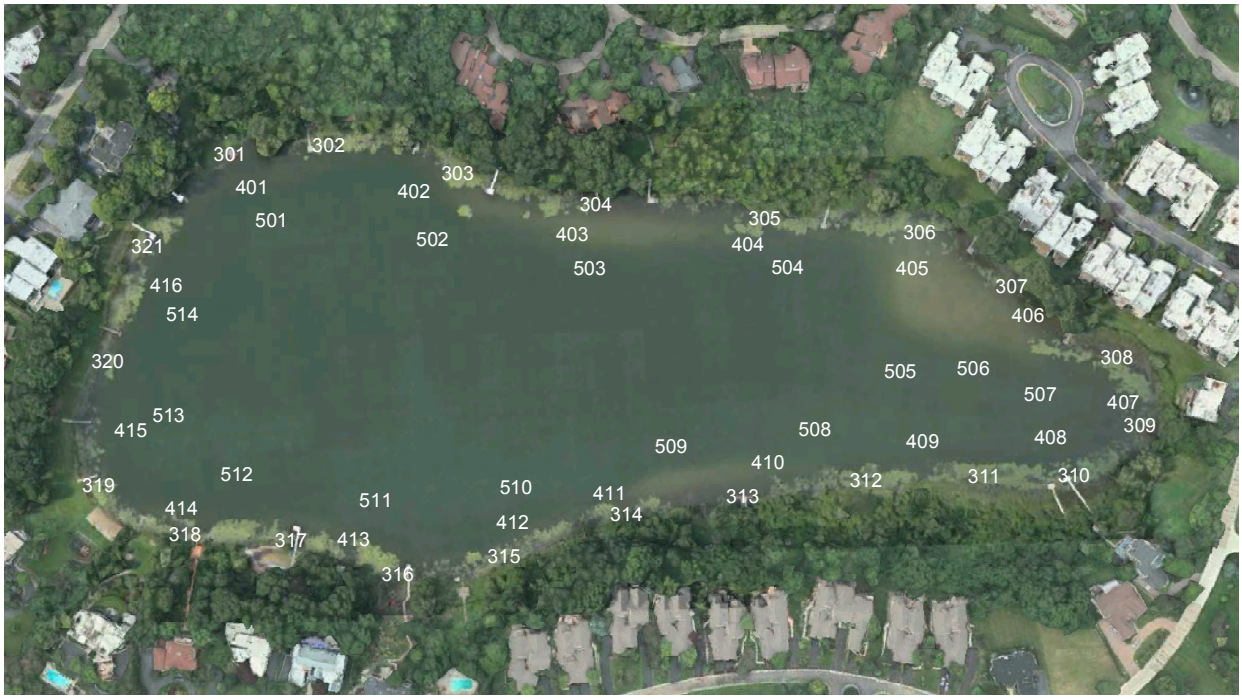
LakeScan™ guided vegetation surveys are based on a system where the lake is divided into observation sites. Each of the Wabeek Lake aquatic resource observation sites is georeferenced and placed on a map that serves to guide field personnel as they record critical information at each one of these places in the lake. AROS are not randomly scattered, but are purposefully placed to identify distinct biological zones and habitats in the lake. The information collected at each site can be weighted to reflect the size, volume, or relative importance of different areas in a lake. The LakeScan™ guided submersed aquatic vegetation survey is comprehensive.

Step 2: The LakeScan™ Cat 700 Aquatic Vegetation Survey

Field personnel record the density, distribution, and relative position of each aquatic plant species in the water column at each AROS. The perceived nuisance level of each AROS is also recorded, and offending plant species are identified. Certain plant species are only present in either the early or late summer. Consequently, two surveys are usually conducted each season to obtain a more complete analysis of the vegetation in the lake. Assessments are made from a boat by visual observations, rake (frodis) toss and plant retrieval, advanced hydroacoustics (sonar), and using an under-water video camera. Each one of these devices and methods seems to reveal a different "picture" and consequently, they are combined to provide proper assessment of the plant community. Data are recorded on a tablet computer and are sent to the "cloud" immediately at the end of the survey.

AROS

An AROS (Aquatic Resource Observation Site) is merely a point location in a lake, pond, reservoir, or running water resource. These points are assigned a number and are often georeferenced. Various observations can be made at each point site. Areas are often assigned to each AROS, but these might vary with how data is considered at each of the AROS.



Wabeek Lake LakeScan™ AROS (Aquatic Resource Observation Site) map. Observation data is collected from each AROS. The colored areas represent distinct biological tiers where distinct biological communities are found.

Step 3: LakeScan™ Data Collection and Compilation

AROS Tiers

Aquatic resources support a variety of distinct habitats that vary according to depth distance from the shore. AROS are grouped in distinct tiers labeled from 1 to 8.

Tier 3	**Near shore**
Tier 4	**Just off shore but distinct from Tier 3**
Tier 5	**The "drop off" zone where depth descends quickly to the bottom of the lake.**
Tier 6	**Narrow channels where there is little flow and the area is similar from shore to shore.**
Tier 7	**Submerged "off shore islands".**
Tier 8	**Flowing water where plants lay over because of consistent flow.**

Aquest will utilize LakeScan™ metrics and analysis tools to develop a complete and comprehensive – numbers-based analysis of lake conditions. These values and metrics will be used to characterize the special characteristics of the different vegetation tiers (i.e. near-shore, off-shore, drop offs, submerged islands) and in areas of the lake where different management objectives might be applied according to perceived need, shoreline development, and regulations. The AROS in treatment zones can be aggregated to provide appropriate analysis of the impacts of management interventions applied to each area. The perceived nuisance level of each AROS is also recorded, and these can be used to understand variations in nuisance conditions from early to late season and from year to year. Responsible lake management demands much more than a mere summary of the percent occurrence of plants scattered around a lake and maps that depict the location of those plants at a single date or point in time. Management projects that are based on these scant data are conducted more like an aimless game of "Whack a Mole". Established goals, realistic and relevant data collection, numerical analysis, and the expert interpretation of those data are necessary to develop proper lake management plans. Lake associations, special assessment districts, townships, towns, and counties must have these kinds of data to demonstrate due diligence and the appropriate stewardship of assessed dollars.

Why is Monitoring So Important?

Accountability, Liability, Compliance, and Cost

Most lakes are public resources being shared by multiple individuals and stakeholder groups. Unlike a individually owned, private pond, commonly held aquatic resources require competent, relevant, and independent management guidance. An independent lake management consultant is necessary for numerous reasons. 1. Monitoring by a professional and independent lake management consultant provides access to the broadest range of lake management technologies. The aquatic resource will be managed better where there is no conflict of interest. 2. Monitoring is necessary to reduce the public perception issues and the legal and fiduciary liabilities that are assumed by those who are paid and who volunteer to oversee lake management programs. 3. Regulators are too often perceived as "the enemy". However, regulators are frequently required to prove that the management programs that they permit do no harm to the environment. When these data do not exist, there is little any regulator can do to justify what some may perceive to be controversial management actions. Changes in permitting requirements on a Federal level will certainly demand compliance with more rigorous monitoring programs as a conditions of permit issuance. 4. An independent lake management consultant brings a perspective that is not encumbered by conflicts of interest. Proper monitoring, by a lake management consultant that is not tied to an application company or management contractor can reduce cost by being free to detect failed management outcomes and ensuring that only the most necessary management objectives are applied each year.

Performance

LakeScan™ licensed independent lake management consultants are not directly affiliated with any company or corporation that manufactures or applies any of the herbicides, mechanical devices, or systems that are used to management aquatic nuisance conditions. An independent consultant can provide unbiased guidance to design the best lake improvement projects that provide the greatest benefits to the lake ecosystem and for those that use and appreciate these valuable aquatic resources.

Administration Responsibility and Liabilities

Many states provide statutory authority to establish various governmental mechanisms for the governance and administration of programs intended to protect and potentially improve lakes and other water resources. Surprisingly, these programs were often conducted without any formal measurement of success or ancillary consequences. Large sums of public monies can be spent with no reasonable measure of the "health of the ecosystem". Most everyone in America is very aware of how people on both sides of the political spectrum are unified in their desire and demand for greater accountability from the public official who oversee and administer a broad range of programs. Project outcomes are as important in aquatic ecosystem management as are health outcomes in human and veterinary science. Imagine how ridiculous it would be to visit your physician with a persistent abdominal problem and he or she responds with only a prescription and does not perform a thorough examination or even ask pertinent questions. Sadly, this has been the state of water resource management for decades. When sampling is done, it is often focused on improper or irrelevant measures. All too often traditional water quality measures are provided as "substantiating data" to support weed control programs even if these data are as relevant as a brain scan may be to gastrointestinal illness. Occasionally the percent occurrence of plant species is presented with some relative measure of density. But, these data cannot provide a meaningful measure of lake health. People have the right to neglect their personal health - as unwise as that might be. But those who administer publically funded programs have a responsibility to those who are assessed and that everything is being done to ensure that project outcomes are being adequately and reasonably assessed. Failure to provide professional guidance for the management of a publically held resource significantly increases the legal and fiscal liability of the public and private officials that administer lake improvement programs.

Regulatory Requirements

Recent changes in aquatic herbicide application permitting systems acknowledge the critical need for professional, third party assessment of aquatic ecosystems and management outcomes. Regulators are exposed to the same labilities as lake improvement program administrators (even volunteers) when they appropriate funds for programs where there is no oversight or reasonable measure of success. There are new federal mandates (NPDES) that are now being applied to lake management programs throughout the U.S. that require that monitoring be a part of any management program. It will no longer be possible to base most lake management programs program on simplistic anecdotal comments about lake condition. Most lakes will be required to provide some cursory measures of success and responsible program management. It has been said that the LakeScan™ program should be applied to every lake; but the program is still in development and not ready to roll out to all but a select group of lakes. Fortunately, Wabeek Lake is one of those lake and administrators, stakeholders, volunteers, lake association members, and even regulators can all be assured that everything is being done to satisfy the most stringent regulatory legal requirements associated with an effective lake management program.

Fiscal Responsibility

Not only does monitoring measure responsible program management, but it can also be used to ensure that a lake is managed in an ecologically responsible manner. This can save money. Often, monitoring "pays for itself" with the cost savings that occur because of judicious monitoring and data analysis. A properly managed lake becomes more stable and stability helps to reduce the cost of management. It's certainly a lot more than "go out and kill the weeds". Residents of Wabeek Lake should be proud that they have also been distinguish as one of the first LakeScan Lakes in America and already can meet the requirements of the regulatory community. Furthermore, the data provided in these reports are a testament to the generally effective management program that has been founded on empirical and reliable data.

Step 4: Records and Reporting

Empirical data is critical to create effective lake management plans. Imagine an office visit where the physician simply looked at your throat, eyes, and in your ears and proclaimed that you needed surgery. No blood sample, no blood pressure monitoring, no data from x-ray images, no comparisons to prior health data – that simply doesn't make any sense. Too often lake management programs are similarly based on simplistic observations, scant data, and simplistic maps that cannot be reviewed in historical or regional perspectives. A quick observational tour of a lake can help to resolve some specific and immediate problems and questions but cannot be used to evaluate the impacts of long-term, year-after-year, management plans. Maps can be used to illustrate a "point" but cannot generate the kind of numerical rigor that is necessary for administrative bodies and government units to demonstrate that they are doing their "due diligence". Sometimes a listing of species present and relative proportions of species at a few randomly selected sites along randomly placed transects in a lake are used to evaluate lakes in a similar manner to the way that some studies are done in terrestrial ecology. However, these methods do not apply to aquatic ecosystems because they fail to recognize how aquatic plants grow in aquatic ecosystems where critical habitats can change quickly on a relatively small spatial scale. LakeScan™ metrics can be used to effectively meet these challenges because they can be applied to unique areas of the lake, such as critical nearshore areas or areas of the lake where the depth drops off steeply. The diversity of plant communities is believed to a key determinant of ecosystem stability. But, realistic planning and evaluation cannot be reasonably accomplished without empirical data that is based on rigorous sampling and analysis and that is tailored to the specific characteristics of aquatic ecosystems. These data are presented in LakeScan™ reports and can be used to determine if lake management goals are being approached and if the objectives of the program are helping to meet those goals.

AROS MZL

Different areas of a lake require different management objectives. A "varied approach is required to protect ecosystem stability and to satisfy State and Federal regulations.

MZL 1	**Highly targeted and selective plant management. Only the most invasive species will be managed in these areas.**
MZL 2	**Highly targeted management but some non-target impacts are acceptable if the impact is short-lived and there is rapid recovery of non-target plants.**
MZL 3	**Limited broad-spectrum plant control. Some species may not drop from the water column, even though they show signs of injury.**
MZL 4	**No "holds barred" management of swimming areas and around boat moorings.**

The reader is referred to Part 2 of the LakeScan Executive Summary to view an over view of the critical metrics that have been used to establish yearly management objectives.

Category 100

Physical and Geopolitical Characteristics

100/100.120 Location

State:	Michigan
County:	Oakland
Township:	Bloomfield Hills
Township/Range:	T2N, R10E
Section:	Sec. 18
Geo Location:	
Elevation (feet above sea level):	

100/120.210 Basic Morphometry

Total Area (Acres):	27.89
Shoreline Length (Feet):	
Littoral Zone Depth (Feet):	10
Littoral Zone Area (Acres):	16.5595
Maximum Depth (Feet):	24
Mean Depth Feet):	8.425626
Littoral Zone Volume (Acre Feet):	146.7625
Total Lake Volume (Acre Feet):	210.6407
Hydraylic Residence Time:	

100/110.110 Watershed Factors

Tributaries:	Residential Development and wetland shores Several Drains, Lower Long and Turtle Drains
Outlet Type:	Adjustable Weir at North End of Lake to Rouge River.
Diffuse Connections:	Expansive Shoreline Wetland Complexes
Undeveloped and Diffuse Shore Length (Feet):	
Commercial and Communal Shore Length (Feet):	
Developed Shoreline Length (Feet):	
Undeveloped and Diffuse Shoreline (%):	
Percent Commercial or Communal Shoreline (%):	
Percent Developed Shoreline (%):	

Category 100

Physical and Geopolitical Characteristics

100/100.200 Monitoring and Data Analysis

Aquatic Resource Observation Sites (AROS) **Tier and MZL Assignments:**

AROS TIER ASSIGNMENTS	**AROS Numbers**		**AROS Acres**	
Total Tier AROS:	**51**		**14**	
	#	**%**	**acre**	**%**
Total Tier 3 AROS	21	41%	5.1	36%
Total Tier 4 AROS	16	31%	7.1	50%
Total Tier 5 AROS	14	27%	2.0	14%
Total Tier 6 AROS				
Total Tier 7 AROS				
Total Tier 8 AROS				

Total AROS Acres:	0.28	Acre/AROS
Total AROS Area and Whole Lake Area:	51%	Of Total Lake Acres

AROS MANAGEMENT ZONE LEVEL (MZL) ASSIGNMENTS	**AROS Numbers**		**AROS Acres**	
Total MZL AROS (including MZL 0):	**51**		**14**	
Total Managed MZL AROS (MZL 1 to 4):	**51**		**14**	
	#	**%**	**acre**	**%**
Total MLZ 0 AROS:				
Total MLZ 1 AROS:	16	31%	3.0	21%
Total MLZ 2 AROS:				
Total MLZ 3 AROS:	35	69%	11.1	79%
Total MLZ 4 AROS:				

% Total Managed MZL AROS:	100%	Of Total AROS Acres
% Total Managed MZL AROS Acres in Whole Lake:	51%	Of Total Lake Acres

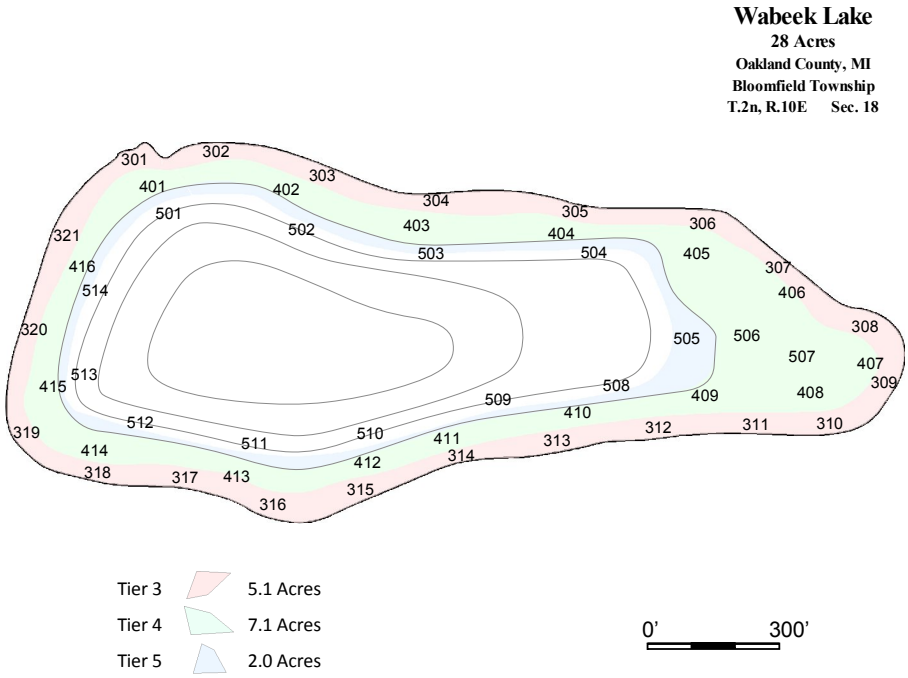
Category 1000

Management History and Authorities

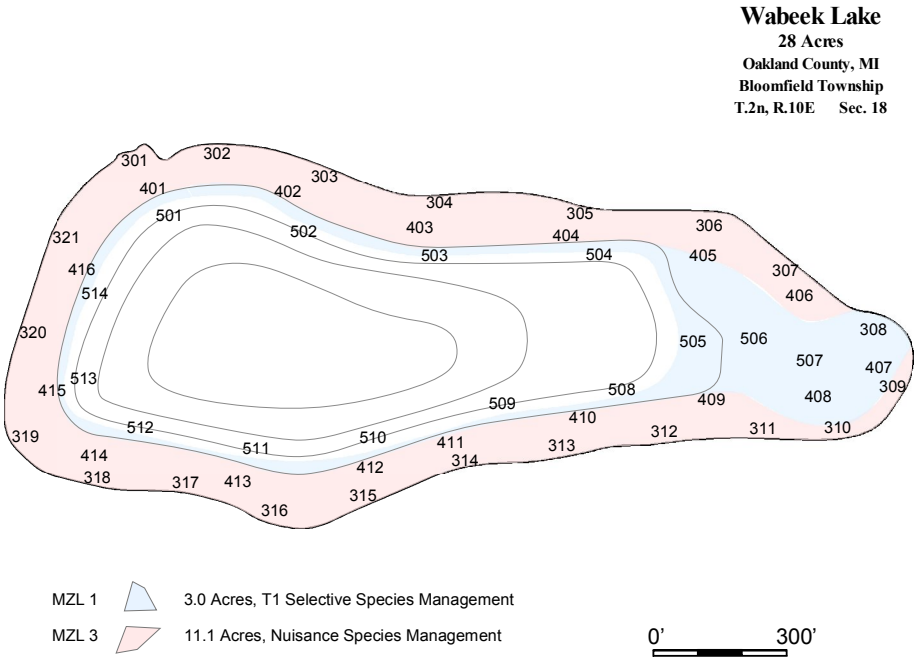
Management Authority:	Wabeek Lake Improvement Board
Contact:	Mr. Jay Shah
Address:	c/o Bloomfield Township
	4200 Telegraph Road
	Bloomfield Hills, MI 48302
Telephone:	
Email:	
Web Page:	
Year SAD Established:	
Total SAD Units:	
Lake Management Guidance Consultant:	Aquest Corporation
Contact:	Dr. G. Douglas Pullman
Address:	12030 Stone Brook Cove
	Alpharetta, GA 30009
Telephone:	810-516-6830
Email:	aquest@mac.com
Web Page:	
Herbicide Application Contractor:	Aqua-Weed Control, Inc.
Contact:	Mr. Dick Pinagel
Address:	414 Hadley St.
	Holly, MI 48442
Telephone:	248-634-8388
Email:	dick@aquaweed.com
Web Page:	
Mechanical Harvesting Contractor:	
Contact:	
Address:	
Telephone:	
Email:	
Web Page:	

Management History

Years of Professional Management Guidance:	Since 2003
Lake Management Consultant:	Aquest Corporation, (since 2003)
Herbicide Application Contractor:	Aqua-Weed Control, Inc. (since 2007)
Years of LakeScan Analysis:	
First Year of Monitoring Program:	



Wabeek Lake Biological Tier Map



Wabeek Lake Management Zone Priority Level

A Summary of Findings from a LakeScan™
Survey and Analysis of:

Wabeek Lake

Oakland County, MI

PART 2: DATA AND ANALYSIS EXECUTIVE SUMMARY

Submitted by:

Dr. G. Douglas Pullman

Aquest Corporation

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 valuable 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 aquatic ecosystems. Persons who are already familiar with the LakeScan™ method may wish to skip to Part 2 since the methods and approach sections are primarily "boilerplate". This report is only the "tip of the iceberg". All recommendations are based on the comprehensive record of data that are included in the Wabeek Lake, LakeScan™ annual review document. That report is available under separate cover.

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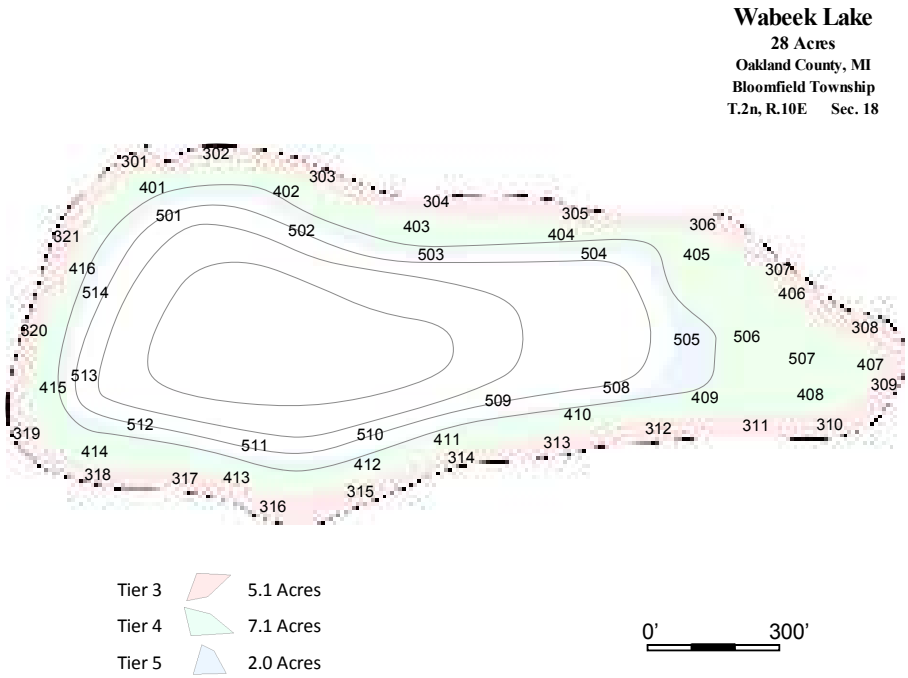


Wabeek Lake LakeScan™ AROS (Aquatic Resource Observation Site) map. Observation data is collected from each AROS. The colored areas represent distinct biological tiers where distinct biological communities are found.

Category 700: LakeScan™ Analysis Highlights – the 2017 Plant Community.

Background: LakeScan™ is a comprehensive lake analysis system that is designed to consider all of the physical, chemical, and biological systems that contribute to lake condition. These various systems function in a similar way that the vascular, skeletal, nervous, and digestive systems in organisms or humans. Water quality is often the focus of lake assessments; however, such an assessment Wabeek Lake is not relevant since the the submersed plant is the dominant sub-system. Category 700 is far more relevant because it is aimed at plant and weed communities. Wabeek Lake is currently one of nearly three dozen Michigan inland lakes where LakeScan™ is used to monitor aquatic plant community conditions (Category 700) and evaluate the results of the aquatic vegetation management program.

The LakeScan™ method uses nine different measures of the plant community to determine the condition of this critical part of the lake ecosystem. These measures or metrics were applied to the whole lake and to individual or distinct areas of the lake including biological tiers, management zones, or treatment zones (where applicable). These data were also used to consider groupings of plant species that differ in quality, invasiveness, and impact on ecosystem stability. For example; plant community biodiversity is calculated “with weed species” and “without weed species”. These data were also used to compare conditions that were surveyed at different times of the year – early and late summer and all of these data can also be compared in year-to-year or lake-to-lake analysis. This analysis is used to formulate the most appropriate management plan for the submersed plant community and to make certain that any management interventions result in improvements and ensure no further degradation of the lake ecosystem. These data are also necessary to satisfy some of the regulatory conditions imposed by States and Federal agencies. A typical LakeScan™ report is over 100 pages, but is presented in an easy to understand, graphical format. Readers are encouraged to read the

entire annual LakeScan™ report for this and other lakes. However, some readers are interested in a summary version of the report and this executive summary has been developed for those readers and stakeholders. It provides only a glimpse of the comprehensive the analysis that is used to evaluate the Wabeek Lake plant community and inform management decisions but does present many key findings.

Category 700 LakeScan™ analysis include target values for each metric to provide an estimate of scale and specific direction to any management objectives based on the LakeScan™ analysis. Target metric values are determined and derived from observations and analysis made from a very wide range of lakes that differ in size, shape, shoreline development, and chemistry. Some of these lakes are virtually filled with plants because of basin morphometry and sediment fertility and structure. These lakes can support very high metric values and support a stabile ecosystem if they are properly managed. Other lakes support very little rooted plant and bottom dwelling vegetation and metric values tend to trend lower. These considerations are used to establish realistic target metric values for Wabeek Lake.

Wabeek Lake is the smallest of all that lakes that have been analyzed by LakeScan™ methods. It is moderately plant productive when compared to most other Michigan inland lakes. Sediment fertility and organic content is high. These enriched sediments can both promote and limit growth in the system as a result of microbial activity in the lake. Plant growth is extremely variable in Wabeek Lake and year-to-year data suggest a considerable degree of ecosystem instability.

The typical and notoriously invasive, exotic species that are found in most Michigan inland lakes have also become established in Wabeek Lake. Ebrid watermilfoil is one of these species but nuisance production can vary widely from year to year. Starry stonewort is another dominant weed in the lake, but it was not conspicuously present in 2017 despite the fact that it totally dominated the flora in previous years.

The lake has failed to meet nearly all LakeScan™ plant community metric target because of the ecologically catastrophic decline of starry stonewort during the winter of 2017. Consequently, Wabeek Lake was not as weedy or impaired by high perceived nuisance levels as might be considered normal in such a plant productive lake system. Only a single AROS supported any obvious plant growth in June 2017. However, ebrid watermilfoil and several other species mounted a tepid recovery during the course of the summer. Ebrid watermilfoil was found at nuisance levels in approximately 4 AROS acres in the late summer and was treated to protect the recovery of more desirable species.

Starry stonewort was first observed to inhabit Wabeek Lake in 2010. It totally dominated the submersed flora and regulated all ecosystem functions up until June 2017. Starry stonewort is capable of producing high levels of biovolume during the course of an extended growing season. It is also known to bloom and crash, as do many other aquatic weed species. When it crashes, high levels of biomass can produce elevated concentrations of decomposition byproducts that are very toxic to other plants species. Such an event rendered Wabeek Lake nearly devoid of all plant production in June 2017. There is no other reasonable explanation for the wholesale decline of submersed plant growth in Wabeek Lake. Water lilies are essentially immune to the impacts associated with catastrophic starry stonewort declines. They were the dominant aquatic plant in the system in 2017.

Year-to-year trends for LakeScan™ metric values varied wildly in the lake since monitoring began. It is important to note that unusual weather conditions were observed in the winter of 2017 and most LakeScan™ metrics declined in most lakes in Michigan as a consequence of “unusual weather”. Close monitoring is necessary to evaluate impacts of weather and invasive species on ecosystem stability (lake health) and will help to make best management decisions. This will also help to make better predictions regarding the nuisance potentials of species found in the lake.

The quality of plant species community found in Wabeek Lake was poor in 2017 following the catastrophic decline of starry stonewort since low quality ebrid milfoil mounted the more rapid recovery. However, there is considerable variability of plant quality as a result of aggressive blooms of either ebrid watermilfoil or starry stonewort. The relative dominance of Target 1 species (T1) has exceeded 50% during some surveys conducted during the past five years. These high levels of undesirable species exceeded the levels observed in any of the other LakeScan™ lakes.

The biodiversity of the near-shore Tier 3 and just off-shore Tier 4 plant communities was virtually the same. This is a reflection of the relatively uniform depth and sediment types that are found in these zones in Wabeek Lake. Deeper, off-shore areas (Tier 5) did not support any plant production in 2017.

A Graphic Review of Selected LakeScan™ Metrics Used to Evaluate Lake Conditions in Wabeek Lake

2017 LakeScan™ Metric Targets and Trends

Table ESP2-1.0 Selected LakeScan™ metric values and target values, 2017. Metric target values are based on values collected from a wide range of Michigan inland lakes and may not be totally appropriate for lakes like Wabeek Lake. However, as the LakeScan™ database continues to grow, it may be possible to establish more realistic target values based on lake groupings. Pink backgrounds are used to highlight metric target values that have not been met or exceeded target values and highlight trends in annual data that are not positive. Blue backgrounds are used to highlight metric values that have exceeded expectations and highlight metric values that trend positively from year to year. Pink is "not good" and blue "is good".

LakeScan™ Metrics and Targets

	Wabeek Lake		
	2017 Values	Target Values	Trend Analysis
Species Richness	10	16	0
Morphotype	8	12	-
Mean Weighted C	4.2	5	-
Whole Lake BioD	14	40	+
Whole Lake BioD T2+	9	25	+
MorphoD	33	70	-
BioVol	88	88	-
Weediness	4.2	5.0	-
Mean Perceived Nuisance	1	50	-

2017 and Historical LakeScan™ Metric Data

Table ESP2-2.1 Wabeek Lake LakeScan™ data for the current year and historical comparisons. Historical values are averaged over all of the years of LakeScan™ monitoring. Target values are selected subjectively and may change as the LakeScan™ database expands and different kinds of lakes can be grouped into meaningful assemblages. Metric values where the header is blue, and the footer is pink depict metrics where greater values are better. Lower values are better for the last two metrics, Weediness and PNL Index where the header is pink, and the footer is blue. Blue highlighted trend values are considered good but red highlighted values are bad.

Total Years = 12

	Species Richness	Morpho-types	Weighted Mean C	Whole Lake BioD	Whole Lake BioD T2+	MorphoD	Lake Biovol ft3/acre ft	Weediness	PNL Index
Wabeek Lake 2017	10	8	4.2	14	9	41	105	4.2	13
Target Values	16	12	5.0	40	25	70	105	5.0	50
Historical Average	10	8	4.9	17	10	45	212	4.9	11
12 Year Trend Analysis	+	+	+	+	+	+	+	+	+
Historical Metric Range	8 to 13	6 to 10	3.7 to 6.1	10 to 28	8 to 13	26 to 63	92 to 413	3.7 to 6.1	to 30

Table ESP2-2.2 Historical perspectives on selected LakeScan™ metric data collected during the previous years. Mean metric values represent a sum of all relevant data or a mean value derived from observations collected at several vegetation community surveys that were conducted throughout each summer/growing season. Metric values where the header is blue, and the footer is pink depict metrics where greater values are better. Lower values are better for the last two metrics, Weediness and PNL Index where the header is pink, and the footer is blue.

	Species Richness	Morpho-types	Weighted Mean C	Whole Lake BioD	BioD T2+	MorphoD	Lake Biovol ft3/acre ft	Weediness	PNL Index
2013	12	10	5.9	20	10	55	312	5.9	
2014	13	8	5.4	24	12	50	224	5.4	
2015	10	7	5.4	16	8	47	413	5.4	30
2016	13	9	3.8	28	13	63	293	3.8	2
2017	10	8	4.2	14	9	41	105	4.2	13

Figure ESP2-1.1 Species richness is the total number of species that are present during a LakeScan™ survey. Each of the species are assigned different target values, T-1, T-2, T-3, T-4. These target values are related to the probability that that species would be targeted for control or management in the lake. T-1 species are usually very weedy and create the greatest nuisance conditions and are therefore most likely to be targeted for control by a variety of means. T-2 species are occasional nuisance species and may be targeted for control in some circumstances. T-3 species are not targeted for control but may sustain some collateral damage if near other species that are targeted for control of suppression. T-4 species are protected from impact from any management activity.

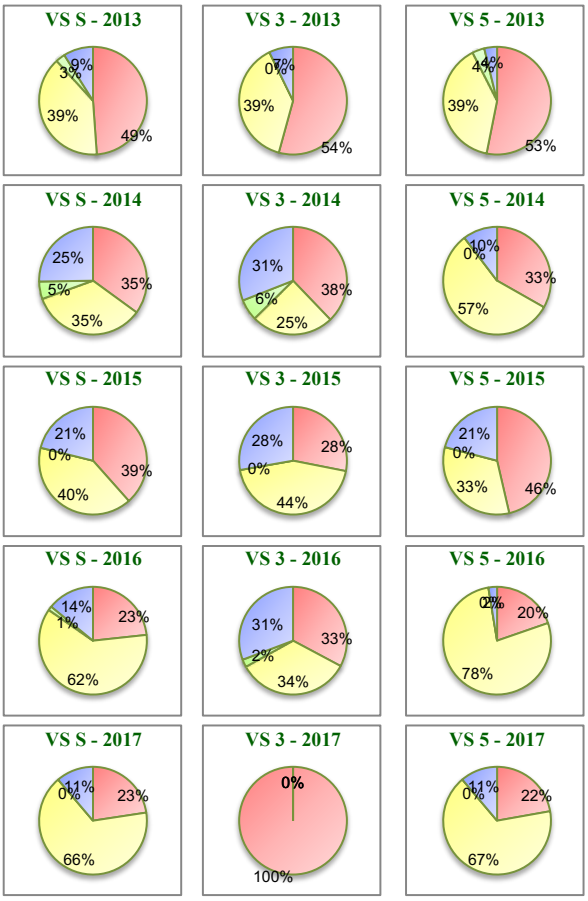


Table ESP2-2.3 A listing of submersed aquatic plants found in Wabeek Lake in 2017 and various LakeScan™ species qualifiers. The "T" value refers to species that may be targeted for management or suppression. 1 = highly likely and 4 = highly unlikely. Species highlighted in red are common weed species and are commonly targeted for control. The "i" value or invasive potential scale ranges from 1 to 10 where 1 is highly invasive and 10 is not invasive. The "C" value is an index of conservation that ranges from 1 to 10. Species assigned lower C values are more tolerant of ecological disturbance. Typically, species characterized by low C values are considered to be weedy and undesirable.

2017 PLANT NAME, CODES, AND SELECTED ATTRIBUTES

	CODE #	REFERENCE NAME	TOTAL PHENO-TYPES	COMMON NAME	SCIENTIFIC NAME	T VALUE	i VALUE	c VALUE	MORPH #	LEAF AND STRUCTURAL MORPHOTYPE DESCRIPTION
1	2	EWMx	MANY	Eurasian Watermilfoil & Hybrids	*Myriophyllum spicatum x M. sibiricum*	1	8	3	3	*feathery*
2	33	CNTL	2	Coontail	*Ceratophyllum sp.*	2	7	3	3	*bushy*
3	50	NAID	3	Naiad	*Najas sp.*	2	7	4	4	*bushy*
4	75	CLP	1	Curly Leaf Pondweed	*Potamogeton crispus L.*	1	9	2	2	*narrow leafy*
5	77	WSG	1	Water Star Grass	*Zosterella dubia (Jacq.) Small*	2	5	6	6	*narrow leafy*
6	109	HPW	MANY	Hybrid Pondweed	*Potamogeton Hybrid*	2	5	5	5	*broad leafy*
7	117	TLP	7	Thin Leaf Pondweed	*Potamogeton sp.*	4	5	5	5	*stringy*
8	125	VAL	1	Wild Celery	*Vallisneria americana Michaux*	2	7	3	3	*grassy*
9	150	WL	2	Waterlily	*Nymphaea sp.*	2	5	6	6	*floating leaf*
10	153	SPAD	3	Spadderdock	*Nuphar sp.*	2	5	6	6	*floating leaf*

Table ESP2-2.3 A listing of submersed aquatic plants found in Wabeek Lake in 2017 and historical context. Several LakeScan™ metrics are included in this table for each species. The species are arranged in each of the metric categories according to the highest to lowest respective values. Only a few species are designated each year as perceived nuisances, so the species listed in that category are usually far fewer than the total found in the lake.

2017 PLANT SPECIES SELECTED METRICS AND BY RANK

	REFERENCE NAME	COMMON NAME	PRESENT IN 2017	TOTAL YEARS PRESENT IN LAKE	SPECIES OCCURRENCE RANKING		SPECIES DOMINANCE RANKING		RELATIVE BIOVOLUME RANKING		SPECIES PERCEIVED NUISANCE LEVEL FACTOR RANKING	
			√	#	SPECIES	PERCENT	SPECIES	VALUE	SPECIES	VALUE	SPECIES	VALUE
1	EWMx	Eurasian Watermilfoil & Hybrids	√	12	EWMx	45%	WL	54	SPAD	37	EWMx	48
2	CNTL	Coontail	√	1	WL	43%	EWMx	43	EWMx	36		
3	NAID	Naiad	√	1	HPW	37%	HPW	35	WL	33		
4	CLP	Curly Leaf Pondweed	√	1	TLP	24%	TLP	24	NAID	31		
5	WSG	Water Star Grass	√	5	VAL	8%	VAL	13	CNTL	25		
6	HPW	Hybrid Pondweed	√	4	WSG	8%	SPAD	12	TLP	19		
7	TLP	Thin Leaf Pondweed	√	9	CLP	6%	CNTL	12	WSG	18		
8	VAL	Wild Celery	√	4	CNTL	6%	WSG	11	HPW	14		
9	WL	Waterlily	√	7	SPAD	4%	NAID	7	VAL	14		
10	SPAD	Spadderdock	√	9	NAID	2%	CLP	6	CLP	0		

ANTICIPATED ISSUES	ANSWERS
OVERALL LAKE CONDITION *Most LakeScan™ metric value did not meet expectations or target values in 2017. This is a logical outcome from the catastrophic collapse of starry stonewort biomass during the winter of 2017.*	*Plant community conditions in Wabeek Lake are as unpredictable as is the Michigan weather. Monitoring is required to provide evidence that management interventions are necessary to protect the lake from threat posed by several individual species. The effort to reduce nuisance growth of variable milfoil has been very effective. Monitoring prevented the needless application of aquatic herbicides in June 2017.*
Ebrid watermilfoil *is a perennial, if not predictable nuisance in Wabeek Lake. It has totally dominated the lake flora and been a primary determinant of ecosystem function until it ceded this dominant role to starry stonewort in 2010. A starry stonewort declined event in 2017 prevented ebrid milfoil from growing until late July. It was treated in the late summer. Despite treatment with systemic agents it is still expected to return at nuiance levels in 2018. Management action will be required to prevent the loss of any of the desirable species that inhabit the lake.*	*Careful monitoring is required to determine the relative dominance of ebrid milfoil, particularly in context of the emergence of less weedy genotypes. Invasive species growth is inherently unpredictable and annual management objectives must be based on the conditions that are presented in the early summer of each year. Ebrid milfoil has the potential to become the dominant nuisance in 2018.*
Starry stonewort *is an alga that looks like a higher plant. It is more aggressive than any other aquatic plant in Michigan and can outcompete all the species currently found in Wabeek Lake. It was first observed in Wabeek Lake in 2010 and rapidly dominated the system and became a primary controller of ecosystem functions in the lake. Starry stonewort was not obviously present in the lake in 2017 after a catastrophic decline of the plant during the winter of 2017.*	*Careful monitoring and management are required to prevent the loss of plant community biodiversity and degradation of recreation values in systems that have become infested with starry stonewort. The rapid and unpredictable growth of this plant cannot be understated, and careful monitoring is necessary. It is likely that starry stonewort will recover in the future, but it is not known if it is capable of dominating the lake as it has in previous years.*
Water lily *production is highly variable in all Michigan Lakes since production is regulated by a wide range of herbivores and microbial diseases. The total area covered can easily vary by 70% from year to year, depending upon these biological factors. Sometimes, production does reach recreational nuisance levels.*	*Careful monitoring of native plant production is always required to determine if there are biotypes that may be capable of creating serious nuisance conditions in Wabeek Lake. Some, but limited water lily control is allowed by the MDEQ. There are significant regulatory restrictions on the use of the only known control agents for waterlilies. Recent management efforts have been successful in spite of certain regulatory obstacles.*
Native pondweed *production has not generally been considered to have reached nuisance levels in most of the Wabeek Lake AROS in recent years. The appearance and growth of weedy hybrid pondweeds is of particular concern. There will be areas where the ecosystem may benefit from targeted control. Effective management of these plant species can be difficult.*	*As with all native submersed vegetation, careful monitoring is required to determine if there are biotypes that may be capable of creating serious nuisance conditions in Wabeek Lake. Should nuisance native plant production occur, management action may be necessary. Unfortunately, selective pondweed management is very difficult, and outcomes can be unpredictable. Caution is always required for native plant control.*

Category 750: LakeScan™ Management Program, 2017

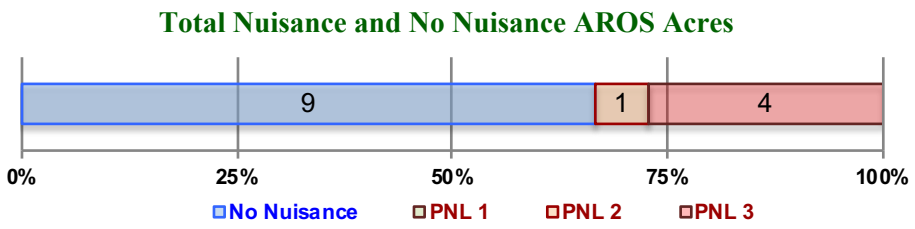
Perceived Nuisance Index, "PNL" Index and Invasive or Nuisance Species.

Background: There are several species that typically become a nuisance in Michigan's inland lakes. These species are usually 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. The species that are nearly always targeted for control are referred to as T1 species in LakeScan™ parlance.

Wabeek Lake 2017: Only ten different plant species were observed in Wabeek Lake in 2017 and this is equal to the lowest level ever recorded for this lake. Unequivocal nuisance level aquatic plant conditions were observed in only 6% of lake observation sites (AROS) in August/September as a result of ebrid milfoil recovery. These areas supported plant patches that were considered to be a threat to the biodiversity of the submersed aquatic plant community and were subjected to species selective control.

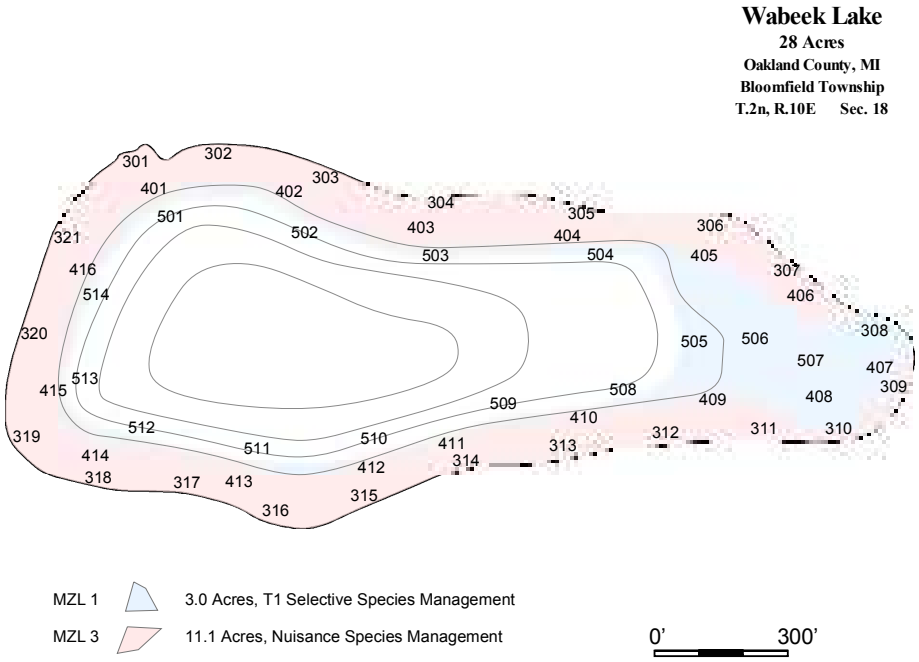
Table ESP2-3.1 The perceived nuisance level (PNL) is determined at each AROS during the LakeScan™ surveys. The AROS acre is the area of each lake Tier (see Tier Map above) divided by the number of AROS that lie inside that tier. The maximum PNL values that are found at each AROS during the seasonal LakeScan™ surveys is used for this analysis. The total number of AROS acres is summed for each of the four PNL levels and the "no nuisance" AROS (PNL 0). The first column is the percentage of the total AROS acres of AROS that are assigned each PNL value.

% Total AROS Acres	PNL Level	Perceived Nuisance Level Description	Total AROS Acres
66%	PNL 0	*"No Nuisance"*	9
0%	PNL 1	*"Ecological Nuisance"*	0
6%	PNL 2	*"Equivocal Nuisance"*	1
27%	PNL 3	*"Obvious Nuisance"*	4



Wabeek Lake Management Zones (MZL):

MZL's are areas where different management objectives are used that are consistent with the over-all program goal. These objectives range from highly species selective management intervention strategies and technologies (MIST) to fairly broad-spectrum controls that might be considered desirable in a swimming area or marinas. The selection and designation of the areas is based on the ecological significance of the area and State regulatory policy. MZL 4 areas are the most aggressively managed areas in lakes where strategies are non-selective and may be applied frequently throughout the growing season. Again, these areas include swimming areas and marinas. MZL 3 areas are also aggressively managed but the focus is generally to prevent the weediest species from growing at nuisance levels near homes and commercial developments. Lake access is the critical focus in MZL 3 areas and selectivity is a subordinate priority. Only T1 (Target 1) species, such as milfoil, curly leaf pondweed, and starry stonewort are targeted in MZL 2 areas, but there may be some temporary impacts on desirable plants. Only the most highly selective management agents are applied to MZL 1 and the objectives in these areas are to focus on only a single species or two.

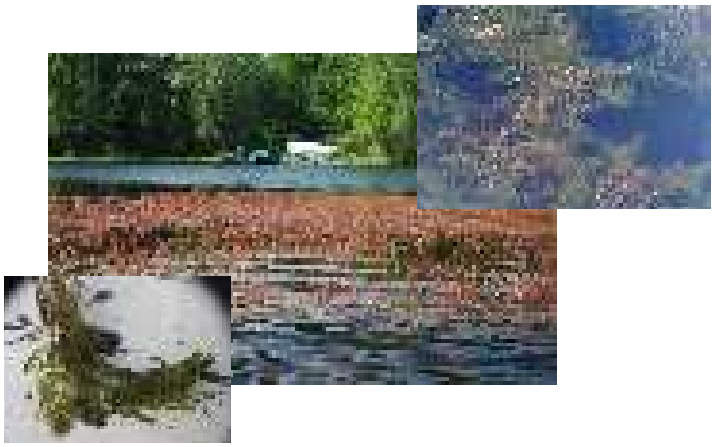


Management Interventions Strategies and Technologies (MIST)

Ebrid watermilfoil growth is expected to reach nuisance levels after the Memorial Day Holiday in some Wabeek Lake AROS in 2018. It is also possible that starry stonewort could return at nuisance levels. The lake is surveyed by one or more members of the lake resident community and the Cedar Lake Monitoring and Management Advisor (Aquest) in May or early June (depending on weather) and specific targets are established during that survey. Species selective herbicide combinations are applied to the lake to target invasive species and encourage the development of a biologically diverse, desirable, native plant community. Varying areas of the lake are treated each year and the total number of acres vary according to conditions. Small areas do not respond well to chemical treatment, so it is typical that larger areas are targeted for control to enhance the efficacy of treatments and preclude the “trap” of numerous, recurring treatments.

Comments on Individual Plant Species and Management

Eurasian Watermilfoil and Hybrids (Ebrids):



Background: Anecdotal evidence suggests that hybrid milfoil has been found in Michigan inland lakes for decades (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 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.

Wabeek Lake 2017: Ebrid watermilfoil was a huge problem in Wabeek Lake prior to the invasion of starry stonewort in 2010. It is characteristically very weedy wherever it is found; however, nuisance level production of Ebrid milfoil was not observed in June as a result of the catastrophic decline of starry stonewort. It was conspicuous in nearly five AROS acres by late summer 2017 and it was treated with species selective herbicide agents. It is very likely that this plant will return at extreme nuisance levels in early 2018.

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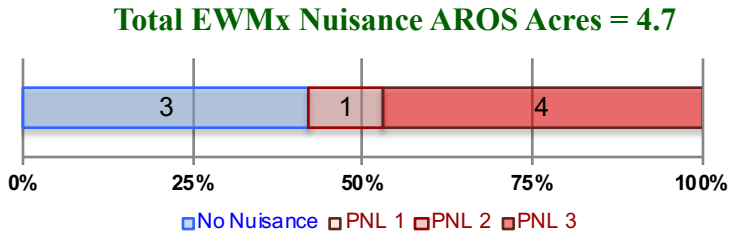


Figure 704. Ebrid milfoil (Eurasian water milfoil + Eurasian and northern watermilfoil hybrids = Ebrid) Perceived Nuisance Levels. These include recreational and aesthetic nuisances, ecological nuisances, and non-nuisance rankings assigned to each AROS and the sum of acres for each PNL designation for data collected throughout the entire summer. Nuisance acres are represented by pinks and reds. PNL-2 = "Equivocal Recreational Nuisance" is pink and PNL-3 = "Unequivocal Nuisance" (everyone would agree that conditions are bad) is represented by the red bars. PNL 1 = "Ecological Nuisance Only" are represented in blue. The green bars represent AROS acres where ebrid milfoil was not detected.

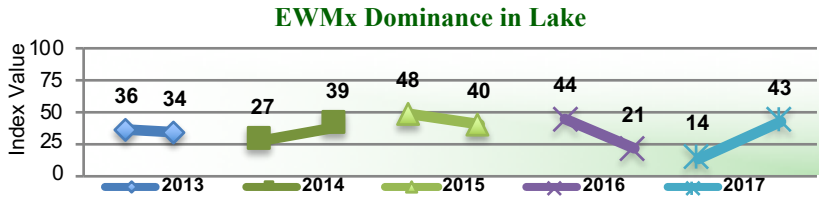
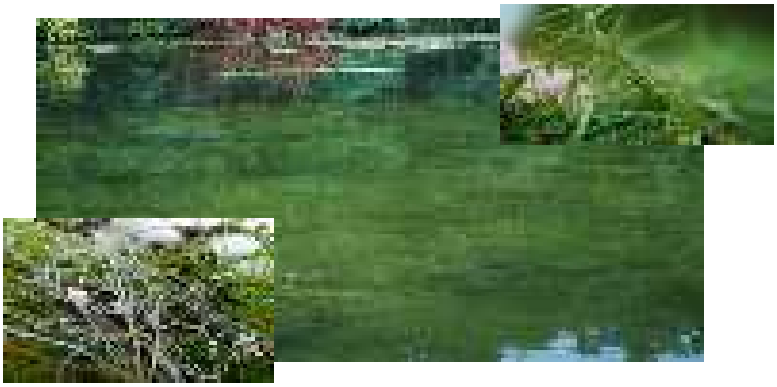


Figure 705. Ebrid milfoil (Eurasian water milfoil + Eurasian and northern watermilfoil hybrids = Ebrid) dominance recorded in the AROS of Wabeek Lake. AROS are assigned to all of the plant productive and potentially plant productive parts of the lake.

Prescriptives: Even though Ebrid milfoil production did not reach typical nuisance levels in Wabeek Lake in 2017, it can still grow to significant nuisance levels and is an ever-present threat to the biological diversity and stability of the ecosystem. Species selective herbicides are often used to successfully suppress the nuisance production ebrid milfoil and support the production of a more desirable flora.

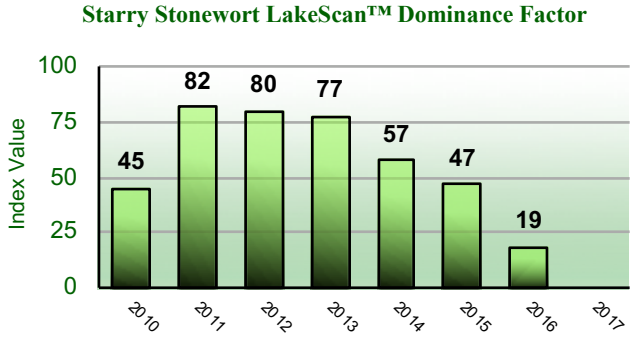
Milfoil community genetics are dynamic – not static, and careful monitoring is needed to adapt to the expected changes in the dominance of distinct milfoil genotypes. It is plausible that milfoil dominance will not be significant in Wabeek Lake in 2018, but this cannot be guaranteed. Should MIST applications be warranted, it is important to note that some of the milfoil genotypes may be more herbicide resistant than others and treatment strategies must be adjusted to remain effective.

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 Lobdell Lake, Genesee County, MI. Since then, it has been discovered in lakes all over Michigan. The most important characteristic of this species is that it is predictably unpredictable. It is truly an opportunistic species and 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. Some years it 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.

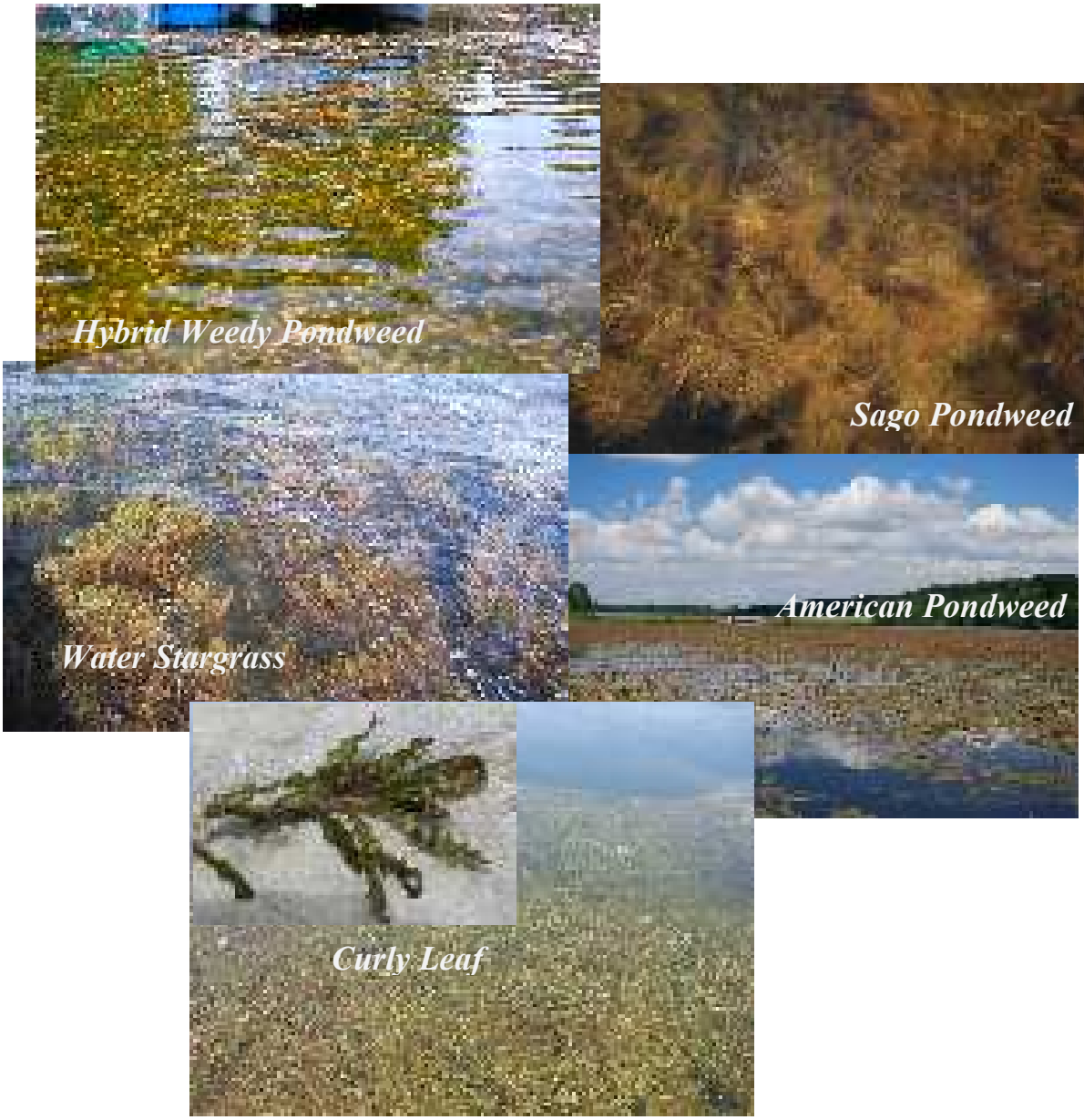
Wabeek Lake, 2017: Starry stonewort has totally dominated and controlled the Wabeek Lake ecosystem since it was first detected in the lake in 2010. It was not observed in Wabeek Lake in 2017 following a catastrophic decline event that occurred during the winter of 2017. It is likely to return as a dominant nuisance and ecosystem controlling factor at some time in the future, but it is not known when this might occur.



Pondweeds

Background: The pondweeds are possibly the most common plant found in Michigan inland lakes. They are a very large and diverse group of aquatic plants. All but one of the common Michigan Pondweeds are native or endemic. Curly leaf pondweed is the only exception and is native to Europe and Asia and is thought to have arrived in North America near the turn of the 20th century. It can become an extreme nuisance in the early spring but generally declines on its own prior to the important Fourth of July holiday. It seems to have been a more common nuisance in previous decades and has been less aggressive in recent years. However, it can still bloom near Memorial Day and become a terrible nuisance in some lakes – in some years.

The leaves of the native pondweeds range from thin stringy to broad and almost "cabbage-like". This kind of morphological diversity contributes to the structural diversity of the submersed flora of lakes they inhabit and is believed to be an important component of constitutes critical habitat. More often than not, pondweeds are thought to be desirable because of the support they provide for a wide range of aquatic animals, including fish. Many of the most common species are considered to be promiscuous and hybrids, resulting from a variety of species crosses, abound in Michigan inland lakes. Although the native pondweeds are generally considered to be desirable and rarely grow to nuisance levels, they have been observed to grow to increasingly nuisance levels during the past decade. American pondweed can grow to extreme nuisance levels in slow moving water. Sago pondweed has been observed at extreme nuisance levels in lakes where there has been excessive weed control pressure. There is a broad leaf pondweed/hybrid that forms a dense cover on the sediment in the late fall that over-winters and provides a strong competitive advantage to this biotype in the spring. The first reports that Richardson's pondweed could grow to nuisance levels came from western Michigan more than ten years ago; however, it has been observed to grow to nuisance level throughout Michigan in the past 5 years. And finally, hybrids of Illinois, variable, white-stem, and broad leaf pondweed are becoming an increasing nuisance. There is no definitive answer or reason why the native pondweeds are emerging as increasingly weedy and problematic plants in inland lakes. However, it is not difficult to imagine that the pondweeds have evolved to become more aggressive after 40 years of competition with aggressive ebrid milfoils, curly leaf pondweed, and starry stonewort - and steadily increasing cultural disturbance in Michigan. Today, pondweed production must be carefully monitored. Management action may be required when particular pondweed biotype becomes invasive and threatens the diversity of large plant communities.


Hybrid Weedy Pondweed
Sago Pondweed
Water Stargrass
American Pondweed
Curly Leaf

Wabeek Lake, 2017. Weedy hybrid pondweeds are common in Wabeek Lake but have not been considered to be present at serious nuisance levels since the lake was invaded by starry stonewort in 2010. Pondweed production, like all submersed aquatic plant growth was seriously and adversely impacted by the catastrophic decline of starry stonewort during the winter of 2017.

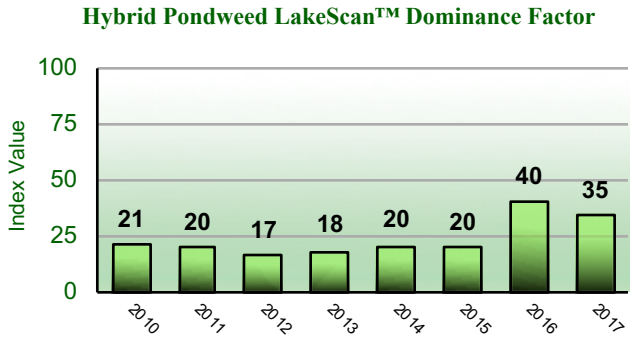


Figure 706. Hybrid pondweed and weedy broad leaf pondweed Perceived Nuisance Levels. These include recreational and aesthetic nuisances, ecological nuisances, and non-nuisance rankings assigned to each AROS and the sum of acres for each PNL designation for data collected throughout the entire summer. Nuisance acres are represented by pinks and reds. PNL-2 = "Equivocal Recreational Nuisance" is pink and PNL-3 = "Unequivocal Nuisance" (everyone would agree that conditions are bad) is represented by the red bars. PNL 1 = "Ecological Nuisance Only" are represented in blue. The green bars represent AROS acres where ebrid milfoil was not detected.

Prescriptives: Nuisance pondweed growth is very difficult to manage. However, it can become necessary to manage these native species when they interfere with reasonable navigation and compromise ecosystem stability. It is recommended that the production of various pondweeds be closely monitored before any specific management intervention strategy or technology (MIST) be considered for management. Most native pondweeds are much more resistant to herbicides than other plant species. Mechanical harvesting is generally recommended for nuisance pondweed management, despite the lack of selectivity. However, the shape and configuration of the Wabeek Lake would make mechanical harvesting cost prohibitive. There are contact herbicides that can be used to suppress nuisance native pondweeds, but the use of these agents needs to be precisely prescribed and executed or worse problems can emerge.

Appendix

AROS locations of ebrid watermilfoil in 2017 and prescribed treatment areas. The treatment area is slightly larger than the total acres where the ebrid watermilfoil is found to ensure effective treatment.

FIELD NOTES

Lake: **Wabeek Lake, Oakland County, MI**

Date of Observation: **13 August 2017**

Activity: **LakeScan™ Category 700 VS 5.0 Survey**

Key Points

~ **Starry stonewort had seemingly reached a biomass peak just at the beginning of the beneficial plant growing season. The result was a total collapse of the aquatic plant community. Starry stonewort was not conspicuously present during this survey. However, it was found at only 26% of all AROS in late 2016, so there is still potential that it could bloom again prior to ice on.**

~ **Ebrid milfoil was conspicuous in many parts of the lake and particularly in Tier 4. Percent occurrence appeared to be greater than normal which may be expected since it was observed in the absence of starry stonewort.**

~ **Waterlilies were generally not considered to be growing at nuisance levels, but were present at significant levels near the ends of several boat docks..**

Narrative

The day was clear and the wind was still. The water clarity was good for Wabeek Lake. The water temperature near the water surface was in the upper 70's°F.

Ebrid milfoil was the dominant nuisance in Wabeek Lake during the LakeScan™ VS 5.0 plant community survey. Pondweed production was good. It appears that the lake has generally recovered from the catastrophic decline of starry stonewort that had occurred during the winter of 2016/2017. Although the lake failed to meet target LakeScan™ metric values, the recovery of the lake can only be considered to be remarkable considering the condition of the plant community in early 2017. These data have interrupted a generally positive trend in the annual lake condition data, but are considered to be reasonable and acceptable considering weather conditions.