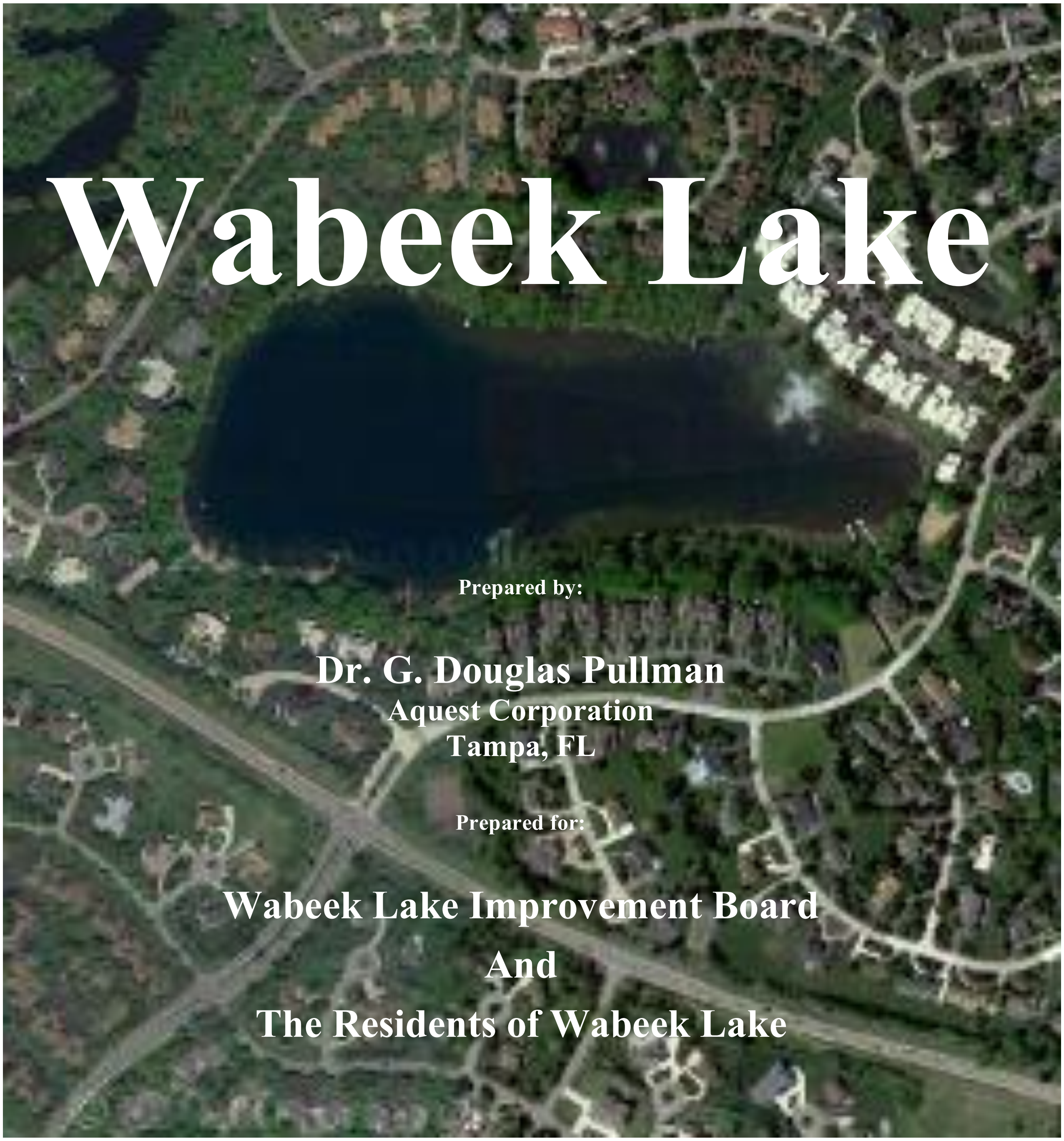


Wabeek Lake

Prepared by:

Dr. G. Douglas Pullman
Aquest Corporation
Tampa, FL

Prepared for:

Wabeek Lake Improvement Board
And
The Residents of Wabeek Lake

2013/2014

LakeScan

Wabeek Lake

A Report on Lake Conditions and Management Recommendations

Prepared by:

Dr. G. Douglas Pullman
Aquest Corporation
Tampa, FL

Prepared for:

The Wabeek Lake Improvement Board

2013/2014

PREFACE

The findings and conclusions in this report are all based on the LakeScan™ data acquisition and analysis tools. The method is essentially a collection of data collection methods algorithms that are used to consider a wide range of lake characteristics and ecosystem functions. These generate the empirical data necessary to construct an historical record of conditions and trends that can be used for year to year comparisons or lake to lake comparisons. These data are critical for the guidance of a lake management programs and are tied to the goals of the Lake Management Plan. LakeScan™ is the only system of lake analysis that can be used to measure progress toward meeting lake management goals (or lack of progress) and to provide the empirical data necessary to establish the objectives for future and continue program elements. Every year, the method is enhanced and improved according to a reasonably conceived schedule of development. The 2013 revisions improve the range and reliability of some of the index algorithms and allow for more meaningful comparisons of early and late season or pretreatment and post-treatment vegetation surveys.

Cost and management effort algorithms are in development and may be completed before the end of the summer of 2014. Some lakes will see these data and report updates and these clients will be notified when these changes take place. The DropBox link that is provided will not change this year. Reporting updates will be made to the same file so that no other link is necessary to access the edited file.

LakeScan™ data acquisition and analysis tools provide data that is needed to make the management process more cost effective and efficient. Decisions can be based on "real" numbers rather that visual assessments made on a boat or subjective comparisons of maps. The methodology does not suffer from the variability that is created by the use of different rakes in different kinds of plant beds. It is always interesting to compare the empirical data to subjective analysis because all too often, "impressions" are not consistent with the data anlysis. The intellectual property in these reports is protected and will be aggressively defended. Those who may be considering the theft of this property are forewarned. Those who offer LakeScan™ analysis as a part of lake monitoring and management guidance programs are licensed and have received special training.

These tools and this report is most importantly, provided for the consideration and enjoyment of the many lake leaders that I have the privilege to know and to work with as we strive to improve their individual lakes. I regard many of these people as friends and it is my sincere desire that they will enjoy and profit from the review of this report. Comments and suggestions are not only appreciated, but are encouraged.

-GDP, 2014

Wabeek Lake

2013/2014 Annual Report

Executive Summary

MONITORING OVSERVATIONS, 2013

Key Findings

- ~ **The Wabeek Lake aquatic plant community is dominated by weedy and invasive species. These plants serve to destabilize the ecosystem and impair the fishery.**
- ~ **High levels of biological and structureal diversity (many different plants and animals) are necessary to stabilize the lake ecosystem and minimize the occurrence and total impact of nuisance plant and animal blooms. A goal of the management program shall be to increase the plant community biodiversity value to 60.**
- ~ **The richness and diversity of the biology in Wabeek Lake is lower than levels measured in nearby lakes, but is considered to be very good for a lake of this size. The current management program appears to be helping to improve conditions in Wabeek Lake for recreation and stabilization of the ecosystem.**
- ~ **Key metric values were the highest in areas that have received the most aggressive management attention. It appears that the management program is either imposing few negative impacts or is contributing to the improvement of conditions in the aggressively monitored areas of the lake.**

Narrative

Wabeek Lake is considered to be in very good condition by all LakeScan™ lake quality measures and considered within the context of it's size. Species richness (species number) is considered to be lower than most lakes, but consistent with lakes that are shallow and uniform, like Wabeek Lake. Plant community species biodiversity and morpho diversity are all considered to be very good and better than expected because the species that are present in Wabeek Lake are found in most of the AROS's.

All lakes are different. Wabeek Lake is a highly plant productive compared to most inland Michigan Lakes and comments in this report are framed within the context of lakes that are inherently plant productive. The bottom soils of the lake are rich and capable of supporting a broad range of aquatic plants. The high potential for plant production demands that the lake management program be designed to promote the growth of species that do not interfere with recreation and that support critical ecosystem functions.

Ebrid milfoil is the name applied to the various Eurasian watermilfoil hybrids that are found throughout the upper Midwest. Ebrid milfoil emerges in the early summer in Wabeek Lake and can create nuisance conditions. The management program and competition with starry stonewort has helped to reduce the relative dominance of ebrid watermilfoil in Wabeek Lake. With continued effective management and careful monitoring, it is believed that the dominance of these weeds will not increase and that they will not be a conspicuous nuisance for most of the summer.

Starry stonewort is the most aggressive large submersed aquatic plant that has ever been observed in Michigan inland lakes. It seems to easily extirpate all other plant species and can form dense, impenetrable mounds of vegetation that impeded all forms of recreation. The impact on critical ecosystem functions can probably not be underestimated. This plant is expected be very conspicuous in 2014 and will have a dramatic impact on ecosystem fundamentals. It has reached a level in Wabeek Lake where it will boom and crash. These events cannot be predicted so the starry stonewort must be closely monitored and the management program must be flexible to address conditions as they develop.

Blue green algae can be harmful. Occasional blooms of these noxious algae have been observed in Wabeek Lake, but they have not reached an actionable level. They are being closely monitored and should the reach a certain level, action shall be taken.

LakeScan™ Plant and Weed Data at a Glance

Table ES 1.1 Year to year comparisons of critical LakeScan™ metrics and other data. The historical average is the mean of the values derived from data collected during the years that Wabeek Lake has been part of the LakeScan™ program. The Historical metric range provides the lowest and the highest values from the years that Wabeek Lake has been part of the LakeScan™ monitoring and analysis program.

Year To Year Comparison

	Species Richness	Morpho-types	Mean C	Whole Lake BioD	BioD T2+	MorphoD	Lake Biovol ft3/acre ft	Weediness
Wabeek Lake 2013	13	9	4.5	54	40	33	82	8.3
Historical Average	11	8	2.7	51	38	31	56	8.8
Historical Metric Range	8 to 13	6 to 9	2.0 to 3.0	47 to 54	34 to 40	26 to 33	22 to 76	8.3 to 9.1

Table ES 1.2 Lake to lake comparisons of critical LakeScan™ metrics and other data. Selected Wabeek Lake LakeScan™ metrics and other important data are compared to the average or mean metric values found in 16 Michigan lakes during 2013. The Historical Trend values are derived from the regression slope (or a line) value for individual metric data for each of the 22 lakes considered in this analysis. However, data is only reported for lakes where there is more than 3 years of data. A "+" symbol indicates that the data is trending positively over the years of analysis. The "-" symbol indicates that the data is trending negatively or toward lesser values during the years of analysis. If there was essentially no change in a metric value over the years of analysis, the "0" value is used to denote "no change".

Lake To Lake Comparisons and Trend Analysis

	Species Richness	Morpho-types	Mean C	Whole Lake BioD	BioD T2+	MorphoD	Lake Biovol ft3/acre ft	Weediness
Metric Values								
Wabeek Lake	13	9	4.5	54	40	33	82	8.3
2013 All Lake Average	18	12	5.0	60	53	45	67	5.2
2013 All Lake Range	7 to 30	6 to 20	4.0 to 5.5	37 to 75	28 to 73	28 to 67	19 to 146	0.0 to 8.3
Historical Trend Analysis								
Wabeek Lake	+	+	-	+	+	+	+	-
2013 All Lake Trend Analysis	+	+	-	+	+	+	-	+
2013 Trend Analysis	11 0 5	11 0 5	5 0 11	12 0 4	11 0 5	11 0 5	8 0 8	11 0 5
	Pos / Neutral / Neg	Pos / Neutral / Neg	Pos / Neutral / Neg	Pos / Neutral / Neg	Pos / Neutral / Neg	Pos / Neutral / Neg	Pos / Neutral / Neg	Pos / Neutral / Neg

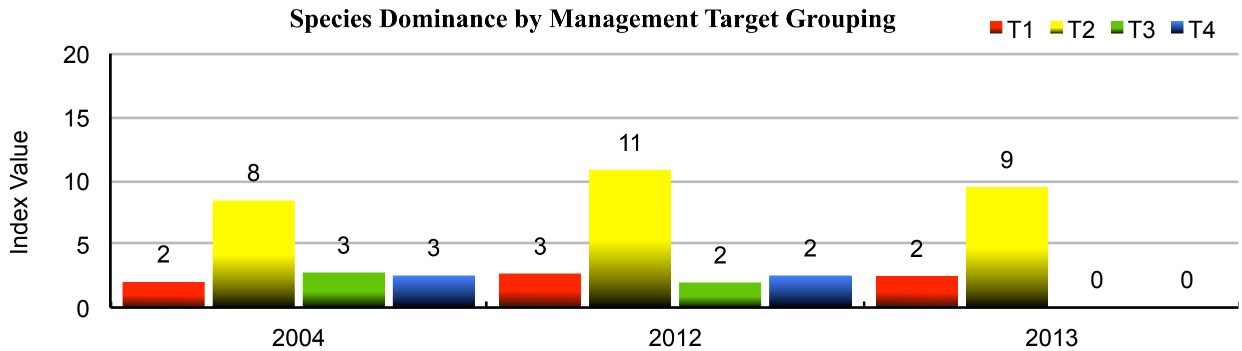


Figure ES 1.1 The quality of the Wabeek Lake plant and weed community considered from the perspective of plant species dominance. T1 species are usually exotic and highly invasive species that are aggressively targeted for control throughout most of the lake. T2 species are targeted for control in many, but not all parts of the lake. They are moderately weedy and are usually considered a significant nuisance in recreational use areas of the lake. T3 species are not usually targeted for complete control. They are typically suppressed for only a part of the growing season near boat docks and developed shorelines. T4 species are the most desirable of the aquatic plants and they are only targeted for control in MZL 4 areas where it is required that all plant growth be removed, such as beach areas.

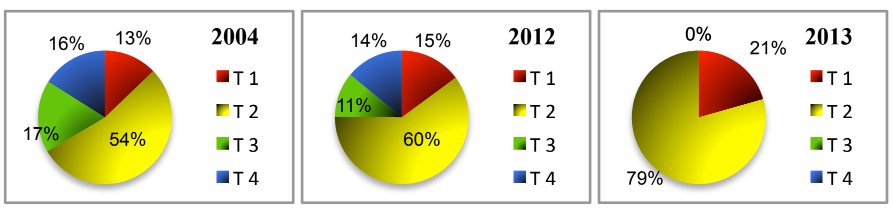


Figure ES 1.2 The quality of the Wabeek Lake plant and weed community considered from the perspective of plant species dominance. This is simply a different representation of the data presented in Figure ES 1.1. The percentages presented are the relative percent of the sum of the dominance values. These are helpful to track trends from year to year.

MANAGEMENT AND MONITORING PRESCRIPTIVES

2014 Plant Community Management Objectives

~ **The LakeScan™ BioD40© metric value should be 60 or more and this shall be a primary management objective in 2014. There should be a concurrent increase in the species richness with a goal of 14 species.**

~ **It is proposed that a new combination of systemic herbicides be applied to a small are of the lake where ebrid milfoil dominates the AROS. This systemic herbicide mixture will help to determine if the ebrid milfoil in Wabeek Lake is reproducing from seed in the late summer.**

Narrative

OVERVIEW:

The primary goal of the Wabeek Lake Management plan is to preserve, protect, and if possible, improve the biodiversity of the flora and fauna of the lake. Emphasis is placed on the large plant community since it is possible to modify and suppress parts of the community in a way that is consistent with attaining stated management goals and relieving nuisance conditions. Currently, species richness in Wabeek Lake is lower than most lakes, but the biodiversity of the lake is very good. The presence of nuisance levels of ebrid milfoil and starry stonewort in Wabeek Lake are a threat to attainment of the goals of the management plan because they could all contribute to the decline in biodiversity and the stability of the lake ecosystem. The prudent selection of management agents for the past several years has seemingly improved conditions in the lake. Extreme care must be taken to avoid the suppression one nuisance, to only create another plant nuisance.

PRIMARY MONITORING OBJECTIVES:

LakeScan™ plant community monitoring and analysis is currently the only available means or method to evaluate the effectiveness of the management program and to provide a measure of success and progress toward meeting management goals outlined in this document. Intensive plant surveys will be conducted in June and August of 2014. Other surveys may be conducted during other times of the year but these are usually used to evaluate the outcomes of the management program and monitor the potential collapse of ebrid milfoil or any other weedy species in the lake. Special effort shall be placed on monitoring the spread and dynamics of starry stonewort.

PRIMARY MANGEMENT OBJECTIVES:

Aggressive and selective control efforts shall focus on the suppression of ebrid milfoil and starry stonewort throughout the lake.

Ebrid milfoil should be suppressed in any area of the lake where it is found. The use of species specific aquatic herbicides is normally recommended to prevent the spread of the his plant to more AROS's.

TREATMENT 1: MAY/JUNE

T1 species, Ebrid milfoil and curly leaf pondweed shall be treated with species-specific herbicides in MZL 1 and 3 areas in early June, as permitted by the MI DEQ. MZL 0 areas shall not be treated unless T1 species show signs of totally dominating that part of the lake.

TREATMENT 2: JULY

Ebrid milfoil and starry stonewort can grow to nuisance levels in Wabeek Lake in July. A second herbicide treatment may be necessary to maintain acceptable recreation conditions after the Fourth of July.

TOUCH-UP TREATMENTS: ANYTIME

Starry stonewort production is unpredictable. It will be suppressed when it begins to show signs that it will from surface mats, or in areas in the lake where it threatens the production of desirable species. Treatments may occur just prior the Fourth of July Holiday, but this is merely spectulation.

Filamentous algae can bloom anytime and without warning. These are the "harry-like" algae that range from bright green to nearly black. The can grow to nuisance levels in a matter of days. Residents of the lake are encouraged to contact their lake leaders if they see rapidly expanding filamentous algae blooms on the bottom of the lake. It is sometimes possible to treat these blooms and prevent unsightly conditions from covering vast areas of the lake. This is one part of lake monitoring where residents of the lake can play an important role in preserving positive conditions on the lake.

Blue green algae are suspended algae that form surface scums or hazes that resemble oil slicks. They can become so dense that it forms surface scums that resemble spilled, green, latex paint. They smell bad and can synthesize compounds that are extremely toxic. Human exposure to intense of blooms of blue green algae can sicken individuals and in very rare instances, result in death. Blue greens are present in Wabeek Lake, but they have not been observed to reach actionable levels. Should actionable levels be observed, treatments will be implemented in the lake. The algaecides that are used for these kinds of lake treatment do not result in the imposition of any special water use restrictions.

Primary Goal of the Wabeek Lake Management Plan

The Primary Goal of the Wabeek Lake Management Program

The primary goal of Wabeek Lake Management Plan is to modify conditions within the lake to enhance species and habitat diversity and thereby stabilize the ecosystem by promoting the production of conservative species and inhibiting the production of those plants that are weedy or more opportunistic. The attainment of this goal is expected to foster conditions that will make Wabeek Lake more resilient to the rapid proliferation and domination of the aquatic ecosystem by invasive nuisance species. Success will also enhance recreational opportunities, including the fishery and the cultural utility of the resource. Any applied management strategy will focus on mitigating against the effects of cultural disturbance and be applied in a manner to minimize further disturbance of the ecosystem.

Proximal Management Goals

Nuisance Plant Production Management: The primary goal of the vegetation management plan is to mitigate against cultural and natural disturbances by modifying the quality of the Wabeek Lake flora through the prescriptive use of selective plant management agents and strategies. The submersed flora of Wabeek Lake is characterized by plant species that are generally considered to be both desirable and undesirable. For example, Eurasian watermilfoil or hybrid milfoil have been considered to be a serious nuisance in the lake for more than a decade. Selective plant management agents have been used to successfully suppress the production of opportunistic and invasive species, like milfoil, that are prone to form monocultures and suppress the production of preferred, conservative plant species. The density and distribution of all plant species in Wabeek Lake is being closely monitored to determine the best strategy for a given season or year. Various degrees of management effort have been assigned to different areas (AROS's) in the lake according to location, State permit conditions, and ecological importance. The management strategies that are used to achieve proximal management goals fall into 4 categories that are referred to as Management Levels or MZL's. These are described in the LakeScan™ Instructions manual.

Water Quality Management: Water quality management is typically focused on matters related to lake fertility (plant nutrients such a phosphorus) as they impact the production of suspended algae (phytoplankton) and the fishery. Nutrient limitation projects are typically aimed at reducing the production of all algae. However, these management strategies can also result in shifting the dominance of algae species in a lake from desirable algae, that support a vibrant food chain, to less desirable algae species that have far less value. The proliferation and production of zebra mussel also plays a significant role as a determinant of water transparency, plant nutrient dynamics, and ultimately, fisheries production. In most lakes the spread of zebra mussels is accompanied by tremendous increases in water clarity and a shift to undesirable algae that are not consumed by the zebra mussel. These algae are referred to as blue green algae or cyanobacteria, and some of these are capable of producing toxic substances, and they are not consumed by critical organisims in food chains that support fisheries. The water clarity in Wabeek Lake varies considerably from year to year and even month to month. Casual observations suggest that the suspended algae that dominate the phytoplankton in Wabeek Lake are the more desirable species, but Wabeek Lake is probably capable of supporting undesirable phytoplankton species. Technologies are being developed to manage plankton populations in such a manner that desirable algae species dominate the lake and that the production of undesirable species be minimized. This type of management is not currently being applied to Wabeek Lake; however, as technologies emerge that can provide a predictable outcome, these strategies may be applied to Wabeek Lake.

The plant nutrient concentrations in the sediments of Wabeek Lake are obviously capable of supporting luxuriant rooted plant production. Anecdotal observations also suggest that the water column nutrient concentrations are capable of supporting enough algae production to support a reasonably productive fishery. Blue green algae blooms can dominate the plankton community and disrupt the fishery food chain since these algae are not palatable to most aquatic organisms. They can also be a public health concern and blooms of these algae. Efforts should be made to limit unnecessary nutrient loading to the lake to prevent "excessive" algae blooms but it is important to remember that these efforts can also contribute to a shift in plankton species communities to highly undesirable blue green algae. Nutrient loading alterations should always be accompanied by adequate monitoring to make certain that the fishery continues to be supported. Water quality conditions should be maintained or altered to favor the greatest degree of phytoplankton species diversity and if possible, restrict the production of harmful, blue green algae blooms.

Other Considerations: The Wabeek Lake fishery is an important resource for Wabeek Lake residents. The vegetation and water quality management programs are intended to benefit all forms of recreation including fisheries production and angling opportunities by improving the quality of the flora and mitigating against conditions that may lead to the proliferation of blue green algae. Swimming, non-motorized boating, and sailing represent other key resource uses. The primary goal of the Wabeek Lake Management Plan is consistent with the maintenance of conditions that will enhance opportunities for the pursuit of these recreational activities.

Wabeek Lake

Genesee County, Michigan

Analysis of Key Parameters, Metric, Indices, and Conditions

Using the LakeScan™ Method

2013

Table of Contents

Section 1: Physical, Geopolitical, and Administrative Data

1.0 Physical and Geopolitical Characteristics

1.1 Location

State:	Michigan
County:	Oakland
Township:	Bloomfield Hills
Township/Range:	T2N, R10E
Section:	Sec. 18
Geo Location:	
Elevation:	

1.2 Basic Morphometry

Total Area (Acres):	25
Shoreline Length (Feet):	
Littoral Zone Depth (Feet):	10
Littoral Zone Area (Acres):	17
Maximum Depth (Feet):	24
Mean Depth Feet):	8
Littoral Zone Volume (Acre Feet):	147
Total Lake Volume (Acre Feet):	211
Hydraylic Residence Time:	

1.3 Watershed Factors

Tributaries:	Wetland Drainage from Development
	Several Storm Drains
Outlet Type:	Adjustable Weir at North End of Lake
Diffuse Connections:	Expansive Shoreline Wetland Complexes
Diffuse Connection Length (Feet):	
Developed Shoreline Length (Feet):	
Percent Commercial Shoreline (%):	
Percent Residential Shoreline (%):	
Percent Community Shoreline (%):	

1.4 Monitoring and Data Analysis

Total Aquatic Resource Observation Sites (AROS):	**51**
Total Total Tier 1 AROS	0
Total Total Tier 2 AROS	0
Total Total Tier 3 AROS	21
Total Total Tier 4 AROS	16
Total Total Tier 5 AROS	14
Total Total Tier 6 AROS	0
Total AROS/Acres:	2.04
Total MZL AROS:	**51**
Total Management Zone AROS:	**46**
% Managed MLZ's	90%
Total MLZ 0 AROS:	5
Total MLZ 1 AROS:	16
Total MLZ 2 AROS:	0
Total MLZ 3 AROS:	30
Total MLZ 4 AROS:	0
Total Management Zone Acres:	**21**
MLZ Acres as % of Total Acreage:	83%
MLZ Acres as % of Littoral Zone:	125%
Total MLZ 0 Acres:	1
Total MLZ 1 Acres:	7
Total MLZ 2 Acres:	
Total MLZ 3 Acres:	14
Total MLZ 4 Acres:	

1.5 Management History and Authorities

Management Authority:	Wabeek Lake Improvement Board
Contact:	Mr. August Hofbauer
Address:	c/o Bloomfield Township 4200 Telegraph Road Bloomfield Hills, MI 48302
Telephone:	Home 248 851 0052
Email:	hofbauer2@yahoo.com
Web Page:	
Lake Management Guidance Consultant:	Aquest Corporation
Contact:	Dr. G. Douglas Pullman
Address:	1195 Shipwatch Circle Tampa, FL 33602
Telephone:	810-516-6830
Email:	aquest@mac.com
Web Page:	
Program Contractors:	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:	aquaweed
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:	1
First Year of Monitoring Program:	2011

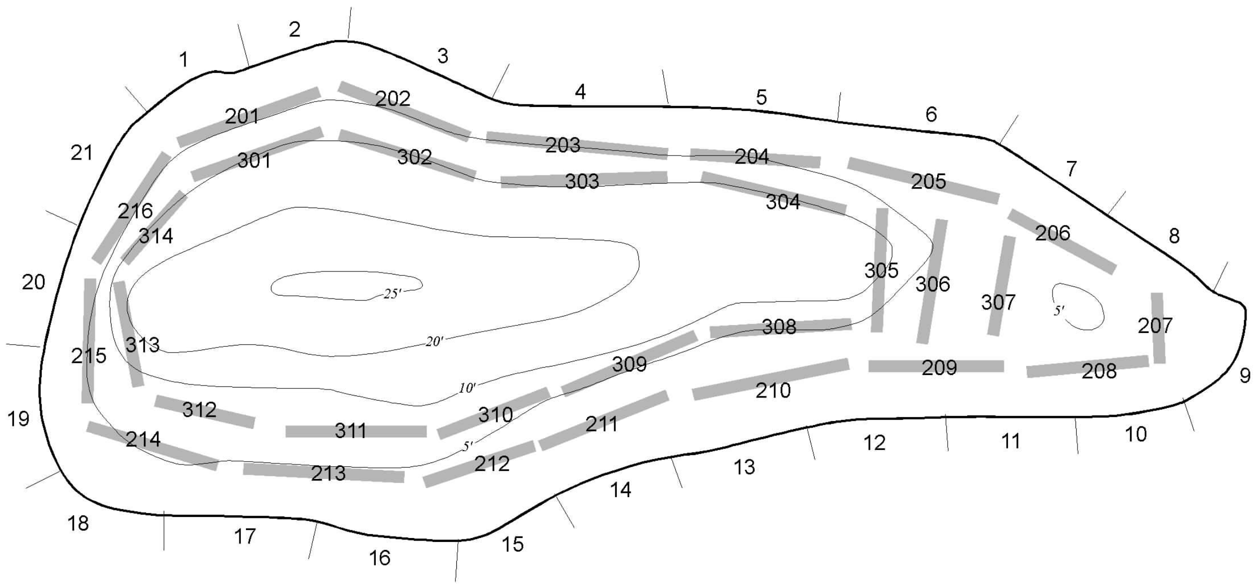


Figure 1.1. A map depicting the location of all Aquatic Resource Observation Sites (AROS's) that were used to make observations in Wabeek Lake.

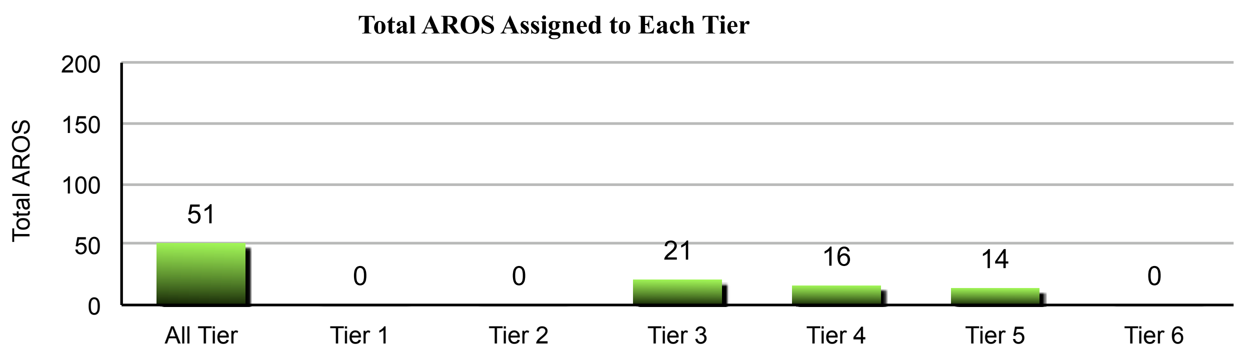


Figure 1.1.2 The total number of AROS and total number of AROS at each Tier.

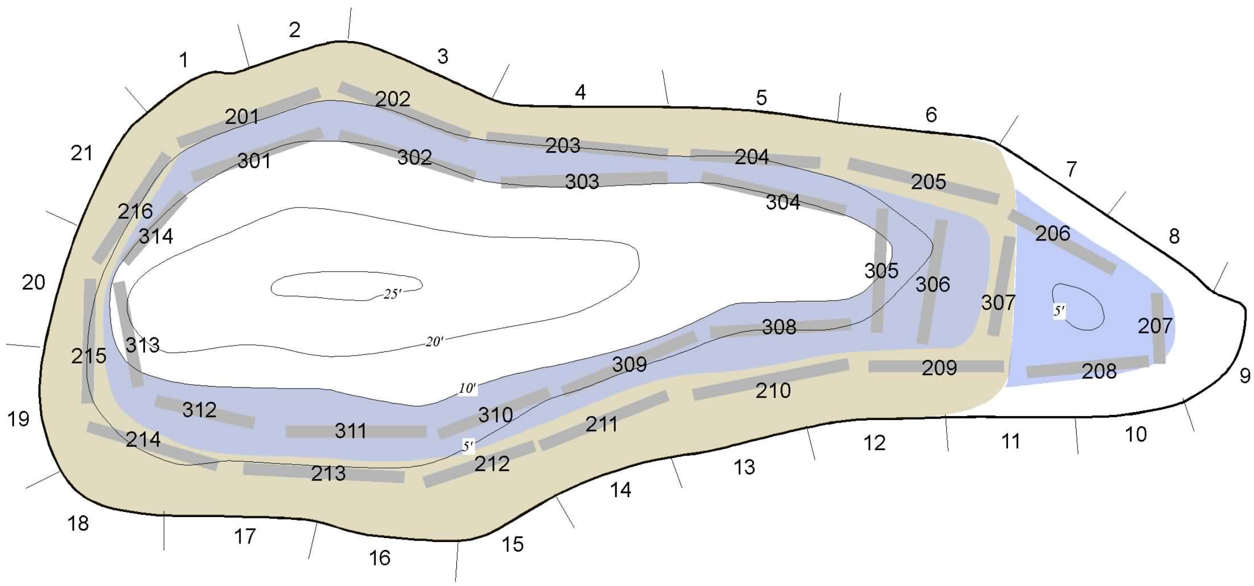


Figure 1.2 Plant species management level assignments (MLZ) by AROS.

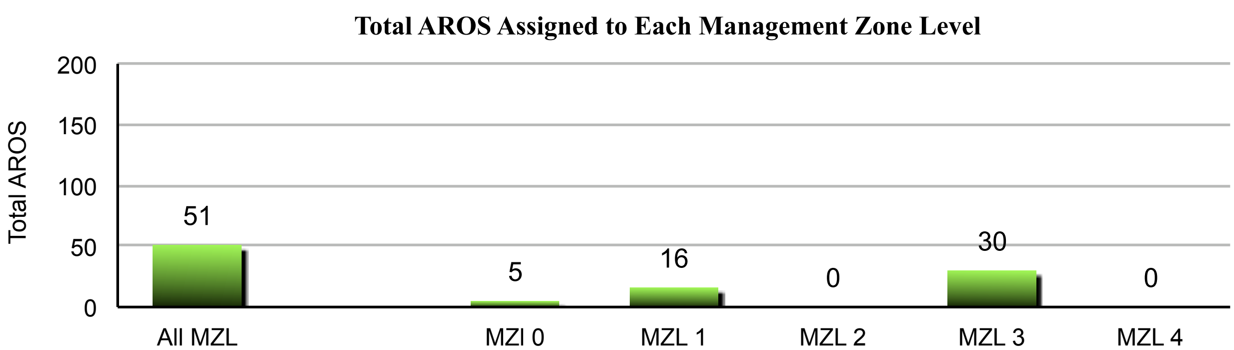


Figure 1.2.2 The total number of AROS and total number of AROS at each MLZ.

AQUEST TIP

Disturbed Aquatic Ecosystems

Characteristics

- Noxious Plants and Algae
- Compromised recreational and utilitarian values
- Loss of aesthetic value
- Rapidly changing conditions, such as blooms of algae, plant monocultures, fish kills.

Common Disturbances

- Lake shore development,
- Watershed development,
- Pollution inputs (plant nutrients and sediments),
- Introduction of exotic organisms,
- Boating in shallow areas,
- Random, non-ecologically based management practices.

Section 2: Water Quality

(Organic and Inorganic Dissolved and Suspended Substances).

A2.1.0 Water Clarity

There are several measures that are used to evaluate water clarity. Turbidity, light measurements, and the Secchi Disk Transparency value are the commonly used methods. Zebra mussel and starry stonewort invasions are primary factors in determining the clarity of the lakes that they inhabit. The water clarity in Wabeek Lake is highly variable and ranges from good to poor. Water clarity is determined by the status and condition of the rooted plant community, charoid algae, and mosses. The relationship between the bottom dwelling plants and suspended algae is complex.

A2.3.0 Alkalinity, pH, and Free Carbon Dioxide

Recent data not reported.

A2.4.0 Plant Nutrient Concentrations

Phosphorus is a very important plant nutrient. It is often in limited supply in aquatic ecosystems and the amount of primary production (plants and algae) and secondary production (bugs and fish) that can be produced in a lake is strongly tied to the amount of available phosphorus. However, residential, commercial, and agricultural shoreline and watershed development can result in increasing the amount of phosphorus that enters a lake (loading) to a level that can result in undesirable consequences. Total phosphorus concentrations in lake water have been strongly correlated with pollution and the presence of serious nuisance algae blooms. It is important to remember that algae blooms can be caused by numerous factors. Often the problem is not that there is too much algae, but the problem is caused by the proliferation of the "wrong kind" of algae. Available nitrogen, micronutrients, and carbon dioxide are some of the plant nutrients that can play a huge role in determining what algae might bloom and become a nuisance.

It was well established during the 1980's that rooted and bottom dwelling plants acquire essential nutrients from the lake sediments where concentrations are orders of magnitude higher than those found in the water column. Nutrient reduction and watershed modifications that are designed to limit phosphorous concentrations in lakes may have a positive impact on algae production, but are inappropriate as a means of weed control. In fact, if the water is made more clear by limiting the phosphorus availability to phytoplankton and algae, this could precipitate even more weed growth because the weedy rooted plants are able to gain more light exposure and because they depend on the normally more than adequate phosphorus reserves that are found in most lake sediments.

The spread and proliferation of starry stonewort and zebra mussel is known to focus nutrient resources in the bottom of the lake or benthic community and may be a key factor in the regulation of total phosphorus concentrations and other nutrient resources in lakes where it is found. Phosphorus levels could drop to a level where plant production will limit fish production in lakes that are overrun by these species.

Section 3: Microbial and Bacteriological Communities

A 3.1.0 E. Coli and Swimming Area Sanitation

E. coli testing is used to identify resources that are at risk from contamination from water or dissolved substances that may have been derived from sanitary sewage. Beaches are often closed for full body contact when E. coli levels exceed threshold levels. There are nearly 30 different strains of E. coli that range from the forms that are toxic to humans and that have been found in meat to those that are essentially harmless to humans. It is now clear that naturally occurring E. coli populations live and thrive in lake sediments. Concentrations of these bacteria can contaminate water samples taken by public health agencies and can result in the unnecessary closure of swimming beaches. Monitoring methods are being developed to determine what the risk might be from public health agency sample contamination. Furthermore, beach sand management strategies area also being developed to manage beach sand microbial communities to avoid sample contamination by naturally occurring and harmless E. coli. Studies suggest that the risk of sample contamination from sand dwelling (and harmless forms of E. coli) is reduced if organic matter and plant debris are removed from the vicinity of the beach. Residents of Wabeek Lake are encouraged to remove all organic debris (leaves, aquatic plant fragments, etc.) that may collect or accumulate in the swimming areas.

A 3.3.0 Aufwuchs Communities and Plant Biofilms

The microbial community complexes that grow on the surfaces of plant appear to play a critical role in the presentation of herbicide tolerance in a wide variety of submersed aquatic plant species. Aquest is a principal investigator in studies performed at the University of Michigan – Flint that will describe these species and suggest new ways to manage these communities and improve the efficacy of aquatic plant management programs. Anecdotal evidence from these studies will be used to devise a way to treat a serious nuisance conditions that are present in Wabeek Lake. A treatment program was devised that recognized the influence and impact of aufwuchs communities on the efficacy herbicide treatments. Future work and study will help to improve these treatment strategies, lower cost, and improve response times.

Section 5: The Phytoplankton Community

The phytoplankton are primarily represented by a broad range of essentially free-floating suspended organisms, algae, and cyanobacteria (blue green algae). The phytoplankton community is very dynamic and the dominant species at any given time can change rapidly from week to week or even day to day. Some of the factors that regulate these communities include the impact of competition, temperature, and the especially the impact of grazing and filter feeding organisms such as zebra mussels and zooplankton. Most lakes support and large number of different plankton species. It is generally believed that lakes that are dominated by algae species are in a better condition than those that are dominated by cyanobacteria (blue green algae). This is because the blue green algae can become a visual and odor nuisance and because some of the blue green algae are capable of generating toxic substances that can have an impact on livestock, pets, and even human health. Blue green algae can taint water supplies with off-odors and taste. They can also produce substances that are toxic in water supplies and some of these substances have been determined to be carcinogenic. Furthermore, there is increasing evidence that blue green algae dominance may be less supportive of fisheries because of impacts on the food chains that support vibrant fisheries.

Plankton community sampling is recommended for all lakes. Rapid and more efficient methods for the analysis of the quality of plankton populations are currently being investigated as part of a collaboration between researches at Aquest, the University of Michigan – Flint, and Clemson University. Unfortunately progress has been slow as these studies are focused on the use of relatively new analytical devices that are known as flow cytometry. Lake communities that have played a critical role in the development of these methods and technologies will be among the first lake communities to enjoy the benefits associated with these new methods when they finally become available.

Nuisance phytoplankton blooms are not currently a common occurrence on Wabeek Lake. However, should bloom conditions develop in the future, it is recommended that and phytoplankton monitoring and management program be instituted.

Blue Green Algae Part 1: Why All the Concern?

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 the zebra mussels has been closely associated with blooms of blue green algae according to MSU researchers.

Blue green algae really a form of bacteria known as the 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 (cyanobacteria) can be toxic or carcinogenic. They are known to have negative impacts on aquatic ecosystems can potentially poison and sicken pets, livestock, and wildlife. Blue green algae and 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. Studies are in progress to determine how serious the potential risks are to lake users and those exposed to blue green algae tainted water by other means.

An invasive, exotic blue green alga has recently been found in Michigan. Cylindro is also capable of producing phytotoxins and has been implicated in some public health incidents in Florida. Work groups in Indiana and Wisconsin have not reported similar incidents in their respective states. Unfortunately cylindro blooms are not obvious and the water must be sampled and analyzed to detect their presence.

It is estimated that approximately one half of obvious blue green algae blooms contain phytotoxins. Water resource managers and users are urged to not panic, but remain pre-cautious. Until studies are completed, 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. Because the blue green algae toxins can enter the human body through the lungs as aerosols it is suggested that water where there are obvious blue green algae blooms not be used for irrigation of areas where persons may be exposed to the irrigation water. Blue green algae blooms are usually temporal events and may disappear as rapidly as they appear, so it is important to closely monitor lakes that contain occasional or persistent blue green algae blooms.

Fortunately, blue green algae can be easily controlled by a variety of methods. There is increasing evidence that the blue green algae can be targeted specifically with certain algaecides. These strategies could help lake managers to selectively manage and improve suspended algae communities. The MI DEQ does not permit these treatments, so lake users are advised to use caution when entering blue green tainted

Section 8: Large Plant Communities in Wabeek Lake

Submersed plant production in Wabeek Lake is considered to high compared to other Michigan inland lakes. Species richness lower than most of the lakes included in this analysis but is still considered to be good for this lake with this management history. The exotic and invasive plant species, Ebrid milfoil and starry stonewort were the dominant weed species in the lake in 2013.

A Commentary on Conditions Related to the Plant Community in 2012

8.1 Plant Species Richness

It can be said that all things are relative. Wabeek Lake is by far the smallest lake considered in this analysis and it is not expected to have the species richness or diversity of lakes that are larger and have much greater diversity in physical habitat types. However, when the lake is considered for it's size, most metrics must be considered to be very good.

The total number of species present in the lake (species richness) in 2013 was 13 which is only 5 species fewer than the average of the lakes considered in this study. This is considered to be an excellent value for a lake of this size. Species richness has increased since 2011 and this is considered to be an good trend. Starry stonewort is by far the most common plants species in the lake and was found at every AROS in the lake. Milfoil and curly leaf pondweed were found at nuisance levels in the lake and have been found in between a quarter and one half of all AROS's in during the past 2 years. Both species were effectively suppressed as a result of the management program. The occurrence of desirable native Michigan pondweeds has not increased since 2011 and has declined slightly. This is a disturbing trend because this is considered to be a very desirable species, but it is able to grow at nuisance levels in some lakes. It will be closely monitored, and protected to as great a degree as possible.

Starry stonewort is by far, the most conspicuous plant in the lake. For a variety of reasons, it is believed that starry stonewort will bloom AND crash in Wabeek Lake as a normal part of it's life cycle in this lake. Unfortunately, it is difficult to predict when the blooms and crashes will occure and have maximum affect the lake, but crashes are expected to occur should the temperatures in the lake remain fairly constant for an extended period of time. Sometimes, starry stonewort crashes are associated with bad odors as the plant decomposes. Careful monitoring will be required to understand the production of this plant in Wabeek Lake, with emphasis on the management of bloom and crash phenomena. It is certain that starry stonewort will be a significant nuisance in the lake for some part, if not all, of 2014.

Tier 3 is closer to the shore and was occupied by a greater number of species than Tiers 4 and 5. Tier 5 is the drop off area of the lake and is not expected to support a large number of species because of the inherent instability of the slopes in this zone. Starry stonewort was the only specie to occupy this Tier in 2013. This "arrangement" of species richness typical for most SE Michigan lakes. The active management zones MZL 3 was inhabited by more plant species than MZL zones 1 and this is because most of MZL 3 is in the Tier 3. There were significantly fewer species in the "no management" zone, MZL 0. One of the management objectives for Wabeek Lake is to increase the species richness and biodiversity in the MZL 0 area. Should this area continue to be dominated by milfoil and starry stonewort, it may be necessary to adjust the MZL level of that area to diminish the dominance of invasive and weedy species.

V1 survey data was collected in June and V2 data was collected in late August. The total number of species found in MZL 0 and MZL 1 was less in August than in June; however, the number of species in MZL 3 actually was greater in the later part of the summer. This is due in part to the appearace of 2 late season aquatic plant species that were not present in the surveys conducted in the early summer.

8.2 Plant Species Morphotypes

Large aquatic plants create structure in aquatic ecosystems. It is believed that aquatic animals discriminate between the plant shape and texture (morphology) of plant communities for refuge, grazing, and reproduction. The plant morphotype is probably much more important to an aquatic animal than the name that we use to identify a plant. Nine distinct plant morphotypes were found in Wabeek Lake in 2013 which is considered to be excellent given that there are so few species in this lake. There was a greater number of plant morphotypes observed in Tier 3 than Tier 4, but this is expected considering that Tier 3 is the nearshore area of the lake. There number of plant morphotypes was three times greater in MZL 3 than in either MZL 0 or MZL 1. The most active management zone is also the zone that has the greatest species and morphotype richness. Over all, the morphotypes richness of the lake must be considered to be excellent considering the size of the lake

8.3 Plant Species Quality

The average coefficient of conservatism or "C" value for Michigan Lakes is 5 and ranges narrowly from 4 to 6. The mean "C" value for plant species found in Wabeek Lake in 2013 was 4.5 and is lower than the optimum for this lake but the value has been trending positively. One of the goals of the management plan is to reduce the importance and dominance of plants that have C ratings less than 4 and all plants given a management target rating of T1. It is abundantly clear that starry stonewort has had a negative impact on both species richness and biodiversity and this is because the plants that are better able to coexist with starry stonewort are generally assigned lower C and T values. Starry stonewort is expected to reach an equilibrium in the submersed plant community that will also be a result of active management. As this occurs, it is an increase in the plant species quality of the Wabeek Lake flora is expected.

8.5 Plant Community Species Diversity

The 2013 LakeScan™ BioD 40© biodiversity value for the entire lake was 54 and this is considered to be very good for a lake this size and with such low relative species richness. It is also greater than the average value for the 3 years included in this analysis. It was only 6 points lower than the average of the lakes included in this analysis, but is still considered to be very good considering the lake size. The LakeScan™ BioD 40© value for Tier 3 was 62 and is considered to be excellent. This demonstrates that the plants that are present in Wabeek Lake are able to inhabit most areas of the lake except Tier 5. The LakeScan™ BioD 40© value for MZL 3 was also 54 and suggests that the management program is helping to support the plant biodiversity of the lake.

8.6 Plant Community Morphological Diversity

The morphological diversity of Wabeek Lake is also considered to be very good even though it is lower than the average value for all of the lakes included in the 2013 analysis. It must be considered to be very good because of the size of the lake and the limited number of plants species present in the submersed flora. Furthermore, this suggests that there are an adequate number of plant species morphotypes, scattered throughout the lake, to support a vibrant fishery.

8.7 The Plant Biovolume

The LakeScan BioVol index is currently under development. The index presented in the report is based on the mean AROS biovolume of all species in each AROS. Values for the average AROS in some lakes range as high as 90 Ft3 per Acre Foot. The BioVol per AROS acre foot value for 2013 was extremely high, and seems to be related to the dominance of starry stonewort and milfoil.

8.8 Plant Species Dominance

The LakeScan™ Dom 100© plant dominance index is like a diversity index in that it factors in the spread or percent occurrence of individual plant species at the AROS's in the lake and is not merely based on the total number of plant species that may be present in a lake at a given time. The LakeScan™ Dom 100© plant dominance index also provides factors and weighting for the density and distribution estimates made for plant species growing in each AROS. The dominance values fo the exotic and weedy plant species, ebrid milfoil and starry stonewort was greater than 75 in 2013. One of the objectives of the management program is to reduce the dominance values of these 2 species. Dominance monitoring will be a critical part of the management plan during 2014.

8.9 Weediness Index

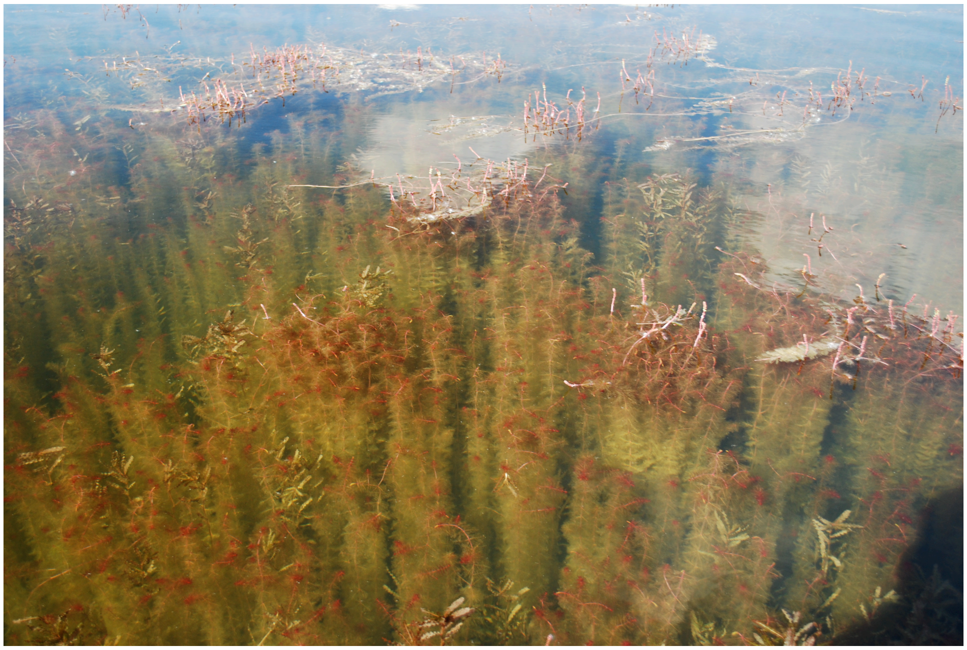
The weediness index value for Wabeek Lake was the highest of all of the lakes considered as a part of this analysis. The "i" values for many of the plant species found in Wabeek Lake are high and the density and distribution values recorded for most of the dominant species was also very high. The domination of the lake by starry stonewort is the primary reason that the weediness value in the lake is so high.

The submersed, large-plant flora of Wabeek Lake is considered to be good to very good by nearly every measure. However, considering the size of the lake and the relatively low diversity of habitats in the lake, it is believed that these values are considered to be excellent. It is hoped that values will increase significantly as the starry stonewort management program is improved.

Plant and Algae Photos

Pic 1. Hybrid weedy pondweed is becoming a serious problem in some Michigan Lakes. These plants can become a significant nuisance and may need to be reclassified as a T1 species in some circumstances. Broader spectrum plant controls are required to manage this weed and it is difficult to maintain good plant species biodiversity when these agents must be used. Currently, these plants are not a concern in Wabeek Lake.

Pic 2. A filamentous algae known by many names, including spyro, pond snot, and pond slime can grow to nuisance levels when water temperatures are relatively low. These blooms are unsightly but they are not potentially toxic. The blooms can; however, extirpate or crowd out desirable plants. If the blooms cover a large enough area, they can negatively impact plant community biodiversity. Fortunately, the blooms can be easily and inexpensively controlled.



Pic 3. Hybrid watermilfoil is a persistent problem in Wabeek Lake. It is easily controlled; however, there are some very herbicide resistant populations of the water milfoil genotypes in Michigan. The milfoil population is closely monitored in Wabeek Lake with particular attention given to the possibility of emerging herbicide resistance.

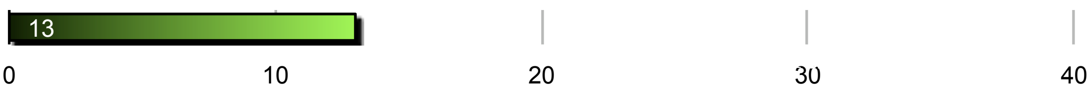
Pic 4. A dense stand of starry stonewort in a lake near Wabeek Lake.

Pic 5. A dense stand of wild celery (upper photo) and wild celery flowers (in lower photo). Wild celery is a significant nuisance in the late summer months in many Michigan inland lakes. It is virtually impossible to control. There are some scattered patches of this plant in Wabeek Lake; however, they have not become a serious nuisance. Monitoring will focus on the status of this particular plant.

Section ALR 8: Lake-Wide Plant Community LakeScan™ Analysis

ALR 8.1 Whole Lake Species Richness (Total Species)

Total Plant Species Present (Species Richness)



Average Number of Plant Species Found at AROS's

Maximum Number of Plant Species Found at Any AROS

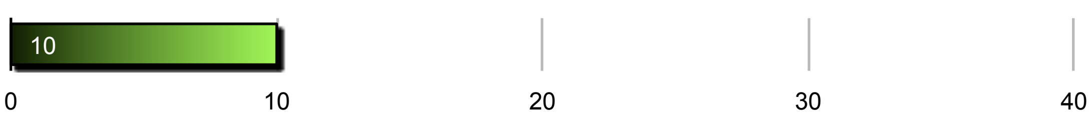
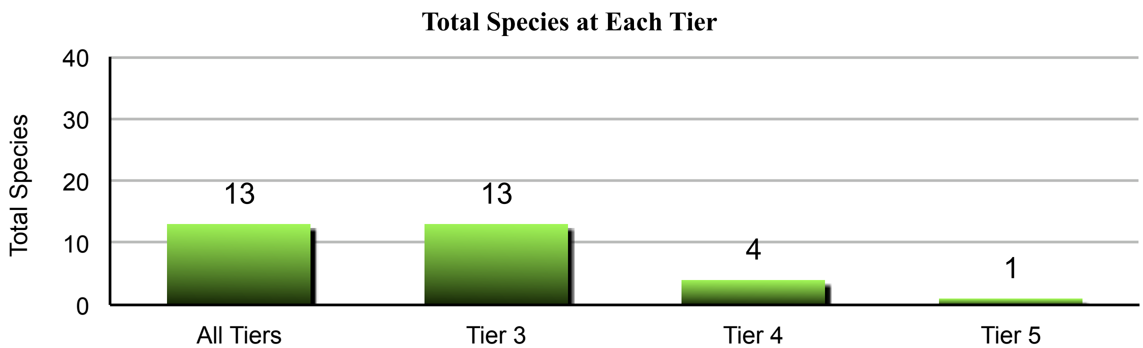
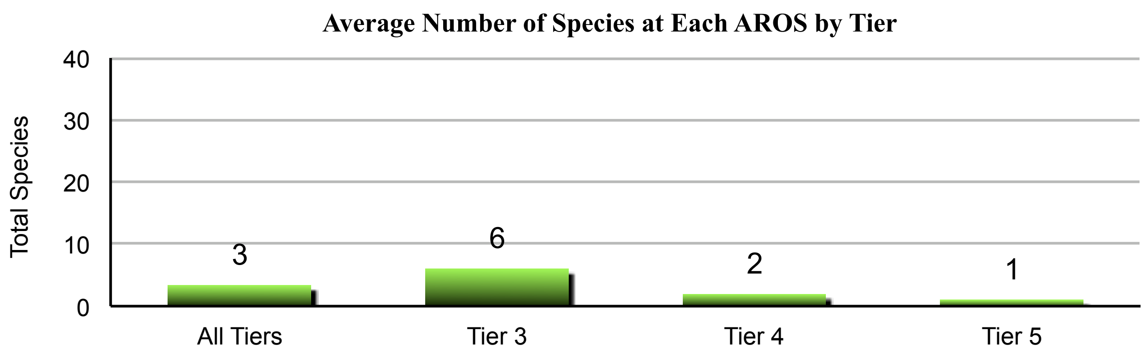


Figure ALR 8.2.0 Total species richness or total species present in the lake and the average and maximum number of plant species found at any AROS in the lake during the most recent survey year.

BAD GOOD

ALR 8.1 Total Species by Tier





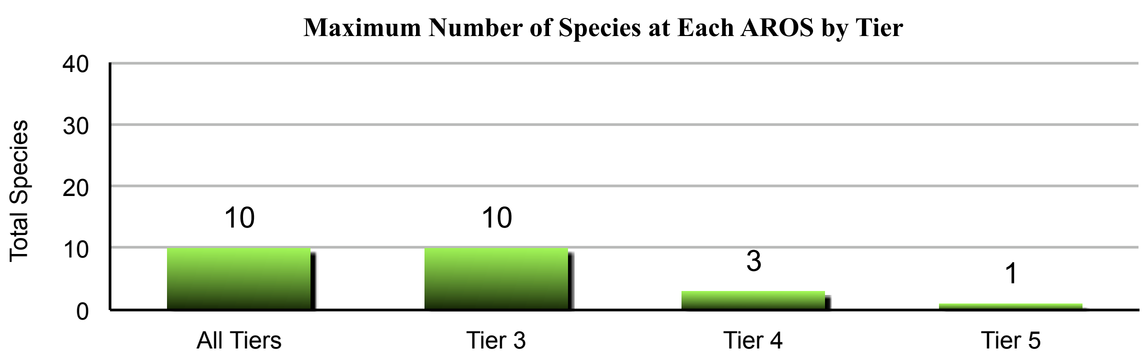


Figure ALR 8.2.1 Total species richness or total species present at each Tier in the lake and the average and maximum number of plant species found at any AROS, within Tier groupings, in the lake during the most recent survey year.

ALR 8.1 Total Species by Management Zone Level (MZL)

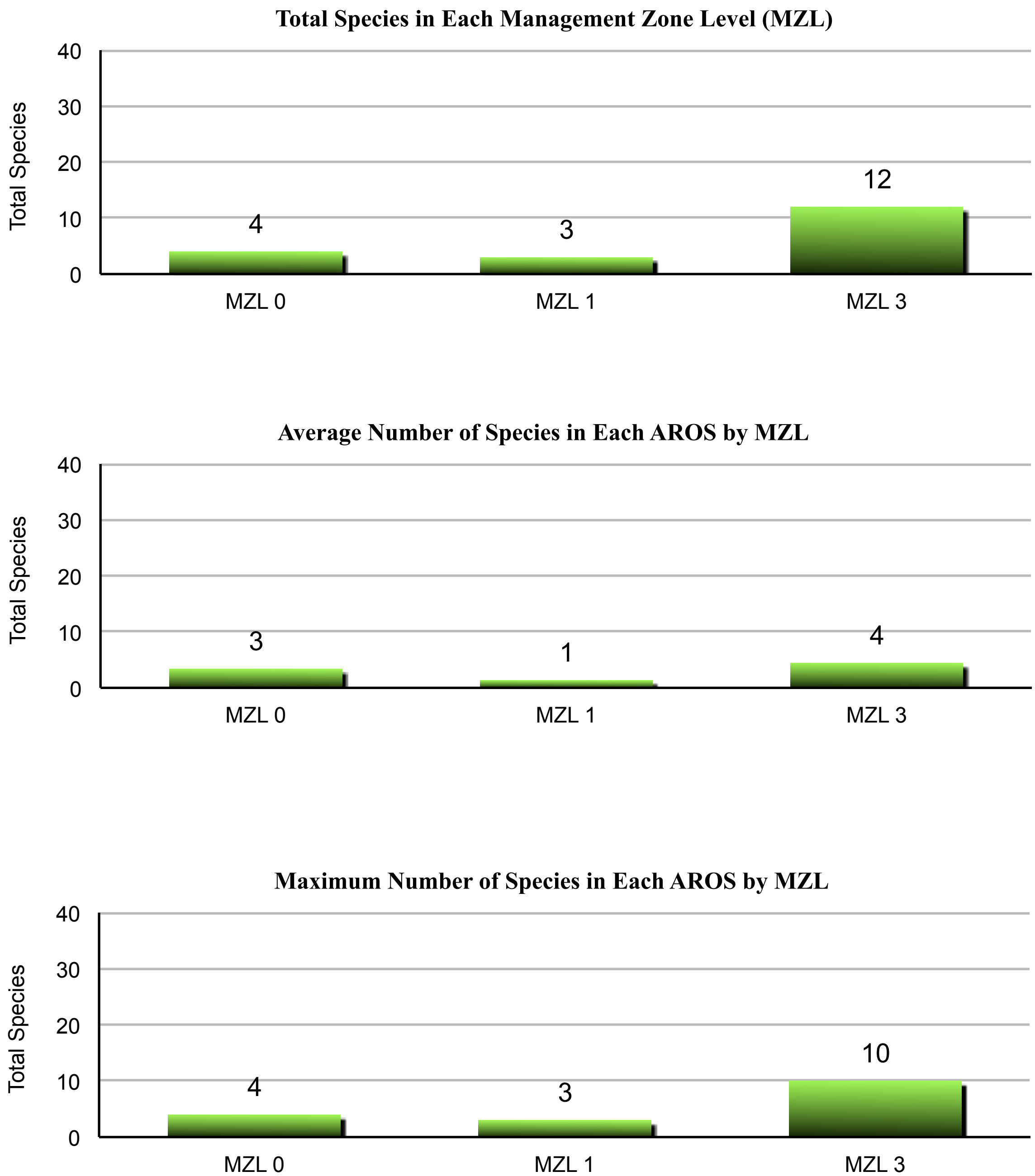


Figure ALR 8.2.1 Total species richness or total species present at each MZL in the lake and the average and maximum number of plant species found at any AROS, within MZL groupings, in the lake during the most recent survey year.

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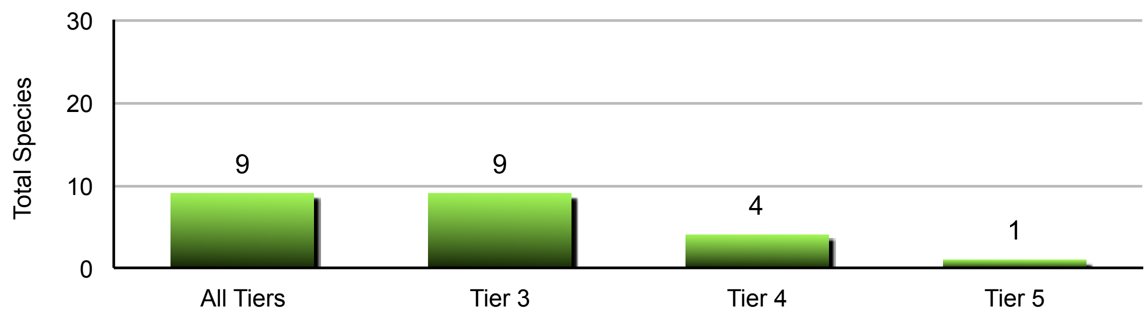
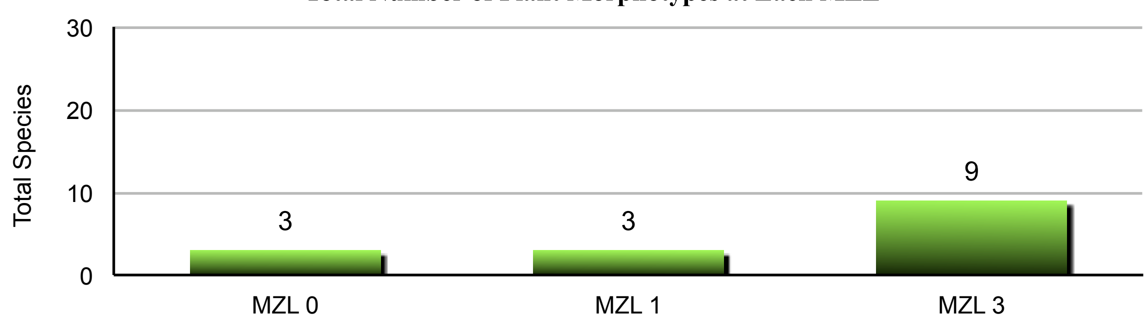
ALR 8.2 LakeScan™ Morphotype Richness

Total LakeScan™ Whole Lake Total Morphotypes

Total Number of Plant Morphotypes at Each Tier



Total Number of Plant Morphotypes at Each MZL



Figures ALR 8.2.1-3 Plant morphology is an important measure of the structural complexity of any ecosystem. It could be said that fish don't care what names we given to submersed macrophytes – they care about structure. LakeScan™ recognizes 26 distinct plant morphotypes among common submersed macrophyte species.

ALR 8.3 LakeScan™ Species Qualities

Table ASR 8.3.1 A list of species found during the course of the summer growing season, abbreviated name, common name, scientific name, t value, i value, c value, and morphotype classification.

PLANT NAME, CODES, AND SELECTED ATTRIBUTES								
	CODE #	SHORT NAME	COMMON NAME	SCIENTIFIC NAME	***t*** VALUE	***i*** VALUE	***c*** VALUE	MORPHOTYPE
1	2	EWMx	Eurasian Watermilfoil Hybrid	*Myriophyllum spicatum x sibiricum*	1	8	3	feathery
2	50	NAID	Naiad	*Najas sp.*	2	7	4	bushy
3	60	CHARA	Chara	*Chara sp.*	4	3	6	bushy
4	65	StSt	Starry Stonewort	*Nitellopsis obtusa (Desv.) J.Groves*	1	9	3	bushy
5	75	CLP	Curly Leaf Pondweed	*Potamogeton crispus L.*	1	9	2	narrow leafy
6	100	VP	Variable Pondweed	*Potamogeton graminius L.*	3	5	7	broad leafy
7	109	HPW	Hybrid Pondweed	*Potamogeton Hybrid*	2	5	5	broad leafy
8	115	Stuk	Sago Pondweed	*Stuckenia sp.*	2	6	3	stringy
9	117	TLP	Thin Leaf Pondweed	*Potamogeton sp.*	4	5	5	stringy
10	125	VAL	Wild Celery	*Vallisneria americana Michaux*	2	7	3	grassy
11	150	WL	Waterlily	*Nymphaea sp.*	2	5	6	floating leaf
12	153	SPAD	Spadderdock	*Nuphar sp.*	2	5	6	floating leaf
13	180	DUCK	Common Duckweed	*Lemna sp.*	3	6	5	floating

Table ASR 8.3. 2 The plants found during the entire growing season and the management target assignment given to each species.

Plant Management Target			
Species Short Name	**Management Target Value**		
EWMx	T1		Primary Target
StSt	T1		Primary Target
CLP	T1		Primary Target
NAID	T2		Secondary Target
HPW	T2		Secondary Target
Stuk	T2		Secondary Target
VAL	T2		Secondary Target
WL	T2		Secondary Target
SPAD	T2		Secondary Target
VP	T3		Tertiary Target
DUCK	T3		Tertiary Target
CHARA	T4		Non Target
TLP	T4		Non Target

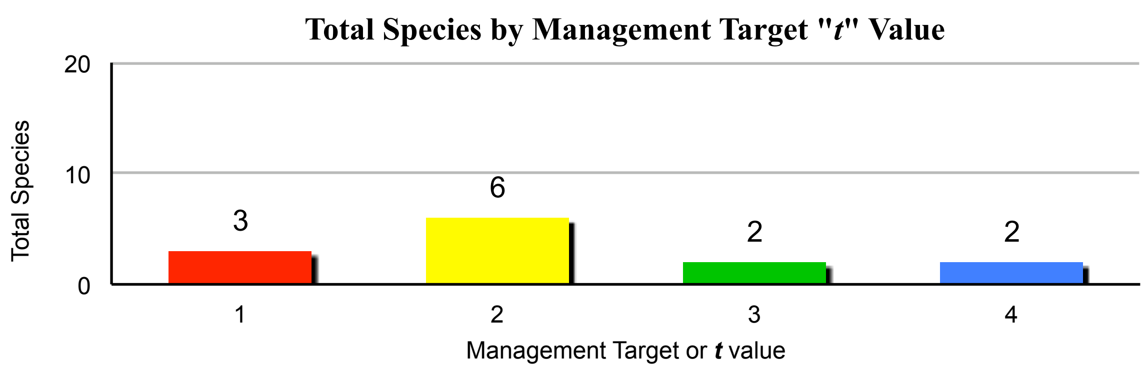
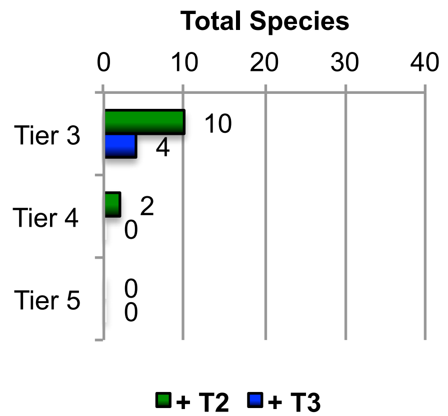
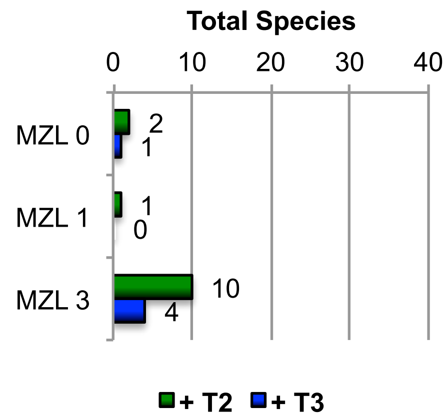


Figure ALR 8.3.1 The total number of plant species assigned to each of the four management target levels for plants found during the entire growing season or summer.

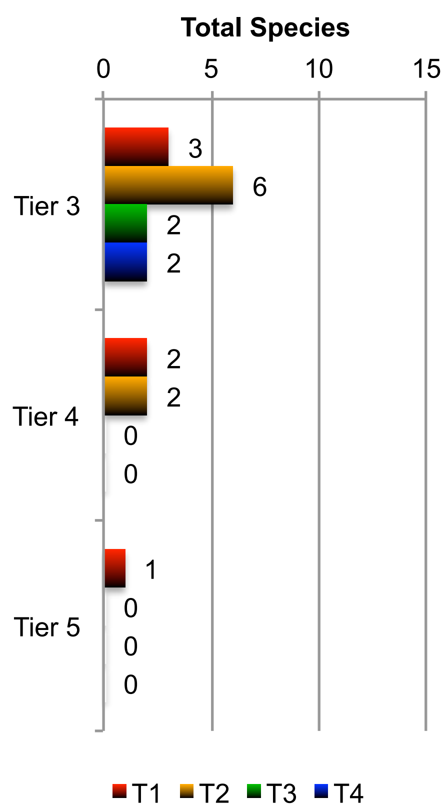
Total Number of "T" Value Species at Each Tier



Total Number of "T" Value Species at Each MZL



Total Number of "T" Species at Each Tier



Total Number of "T" Species at Each MZL

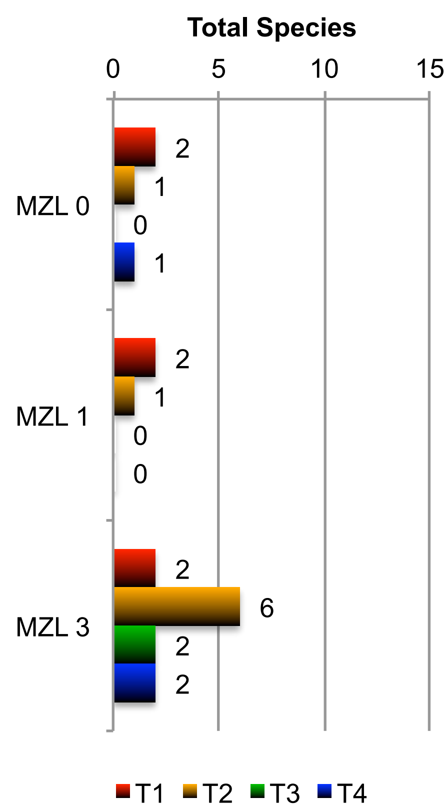


Figure ALR 8.3.2.a-d The total number of plant species assigned to each of the four management target levels for plants found during the entire growing season or summer sorted according to Tier and MZL.

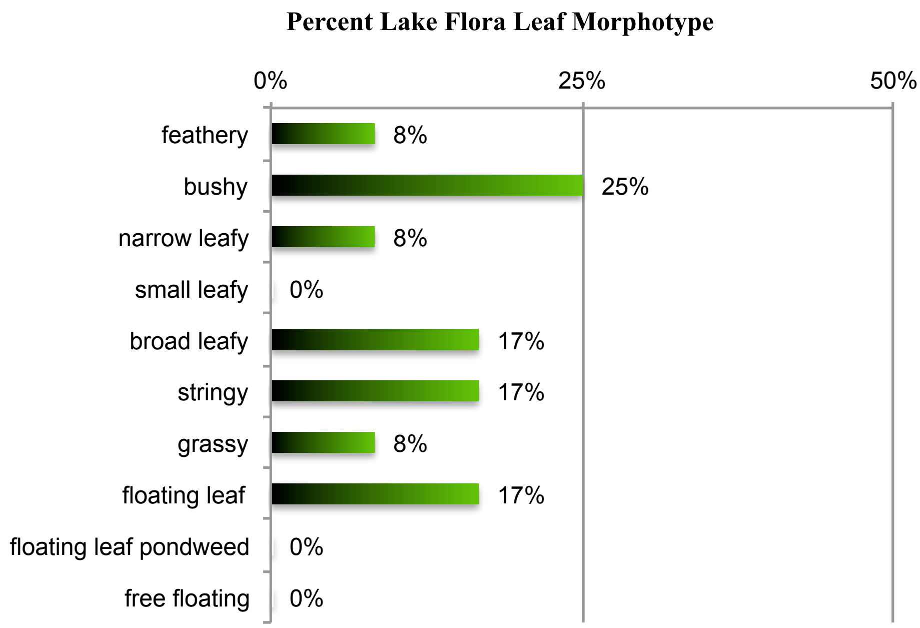


Figure ALR 8.3.3 The total percentage of plant species leaf morphotype found in the lake for the entire summer or growing season.

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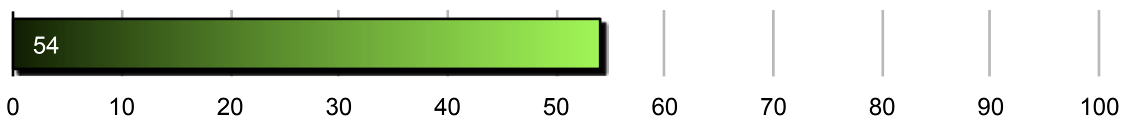
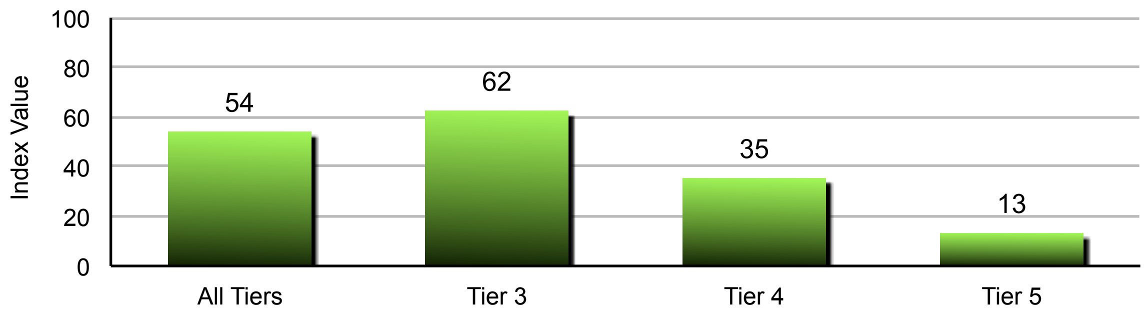
ALR 8.5 LakeScan™ BioD40© Biodiversity Indices

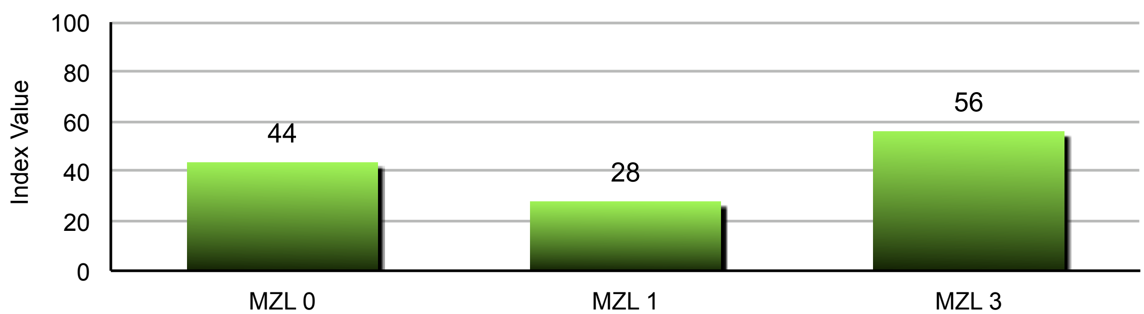
LakeScan™ Whole Lake Plant Community Biodiversity 40 Index



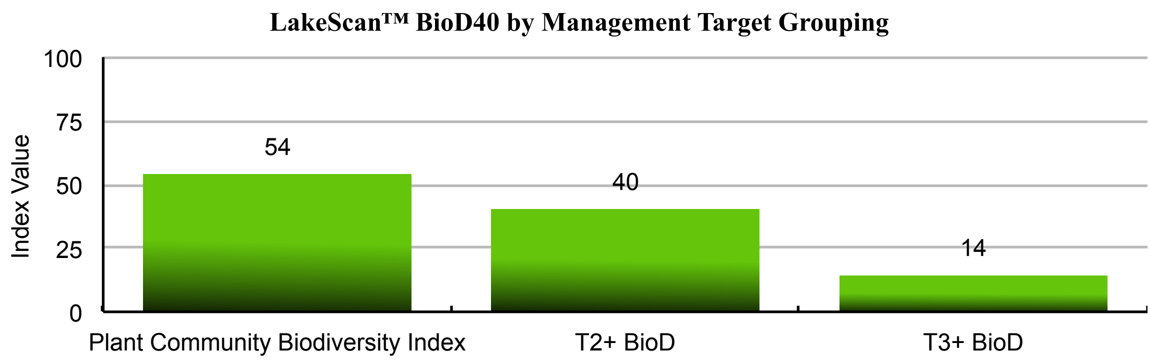
LakeScan™ Plant Community Biodiversity 40 Index at Each Tier



LakeScan™ Plant Community Biodiversity 40 Index by MZL

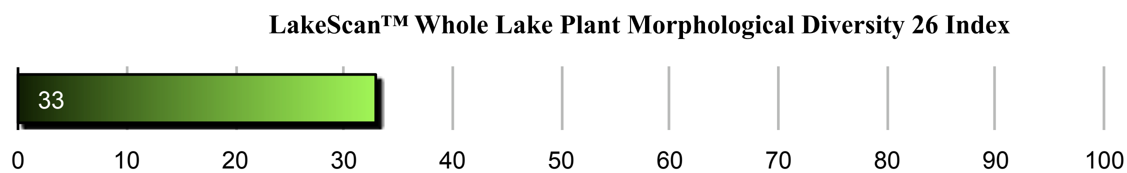


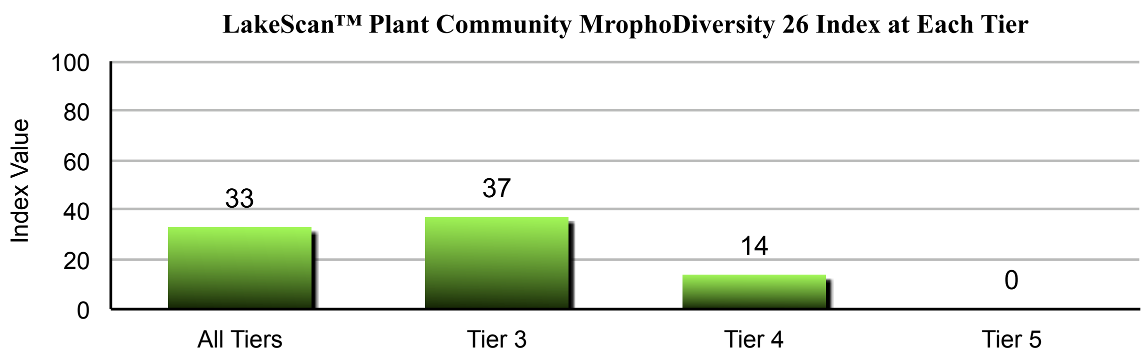
Figures ALR 8.5.1-3 The LakeScan™ BioD 40© biodiversity index is a proportional index that assumes the greatest number of species that might be present during any survey will not be greater than or equal to 40. Index values greater than 50 are considered to be good.

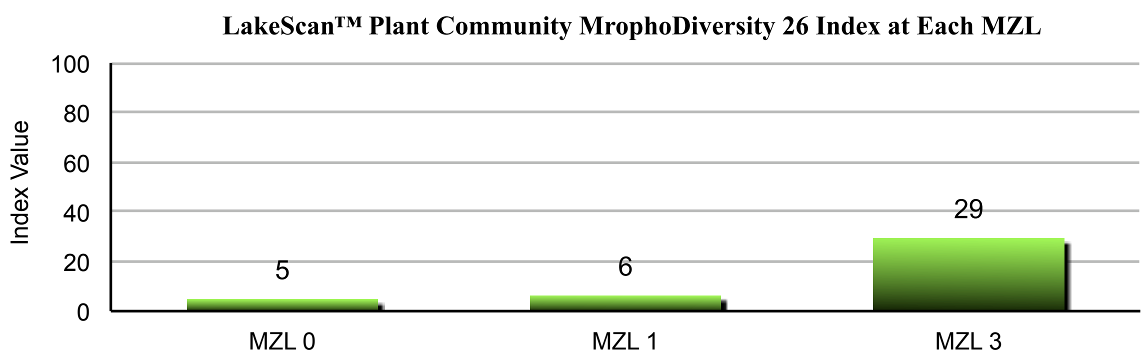


Figures ALR 8.5.4 The LakeScan™ BioD 40© biodiversity index is a proportional index that assumes the greatest number of species that might be present during any survey will not be greater than or equal to 40. Index values greater than 50 are considered to be good. Here, the plant species are grouped according to management target "T" value. Weedy species are typically assigned to the T1 group. This figure illustrates the biodiversity of the species that are considered to be desirable. In some respects, this may be the most important than the whole lake biodiversity measure because the results approximate what is being sought as a goal for the management of the lake.

ALR 8.6 LakeScan™ MorphoD26© Biodiversity Indices

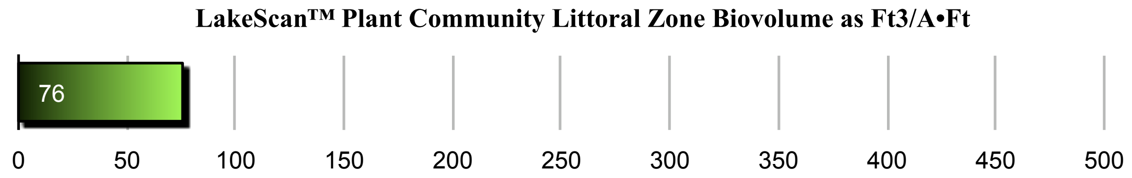


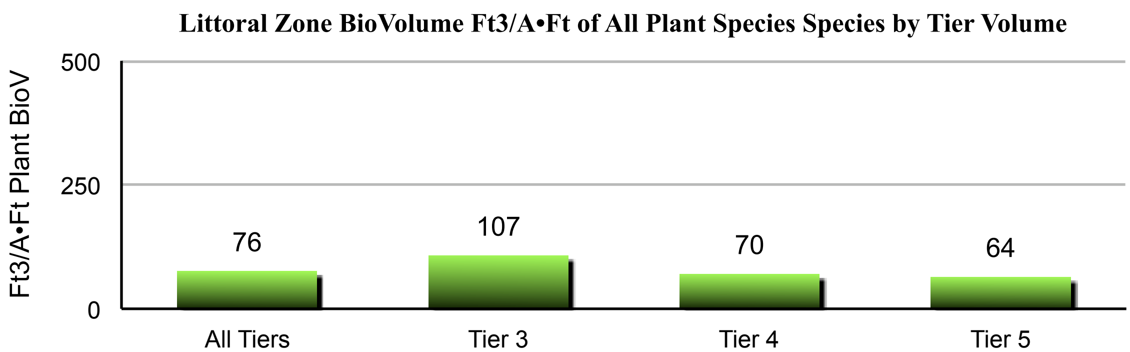


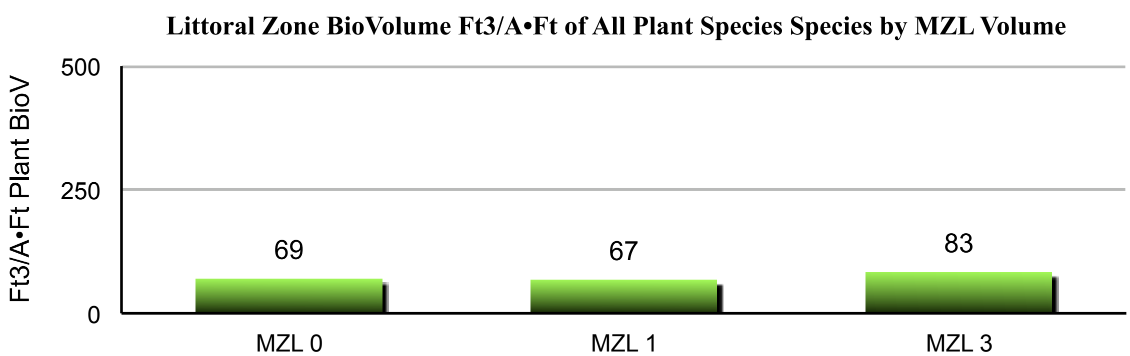


Figures ALR 8.6.1-3 The LakeScan™ MorphoD 40© biodiversity index is a proportional index that assumes the greatest number of plant morphotypes, that might be present during any survey, will not be greater than or equal to 26. Again, index values greater than 50 are considered to be good.

ALR 8.7 LakeScan™ BioV© Indices

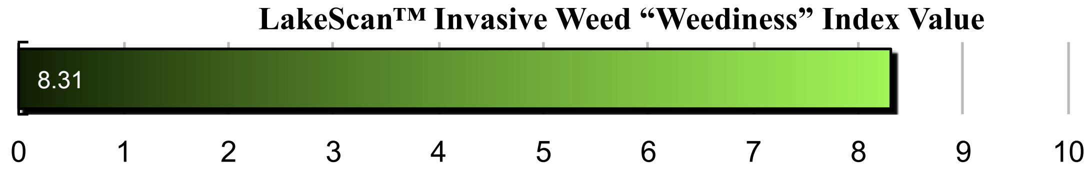


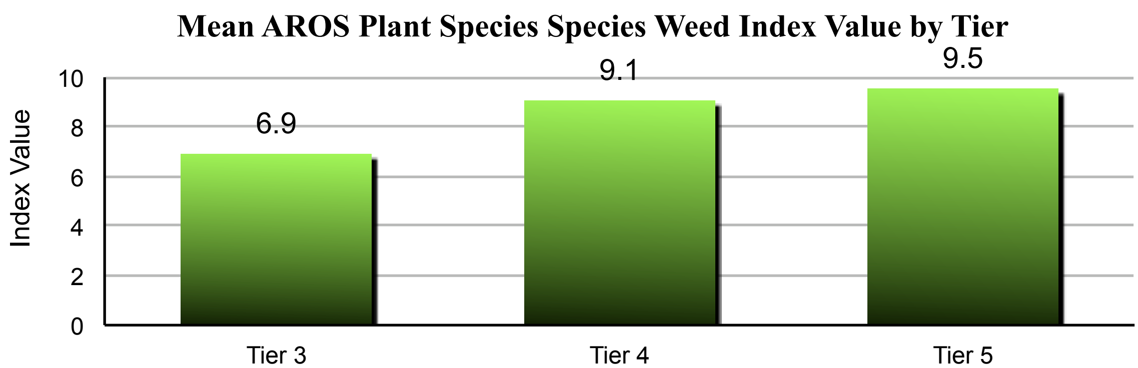


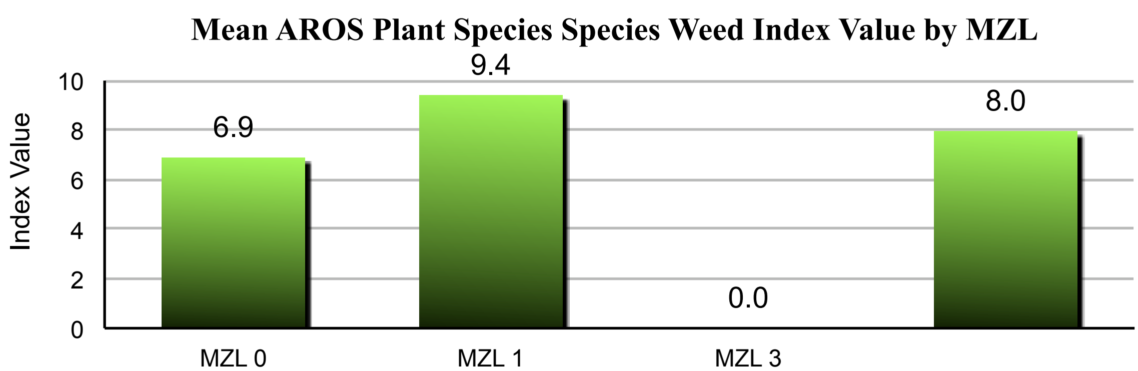


Figures ALR 8.7.1-3 The LakeScan™ BioV© Biovolume index is based on the mean volume of various species per foot stem length and the density of stems per unit area. A compensatory factor is included for species that branch near the top of the plant or form surface canopies. These figures are based on the total estimated BioV found in each area divided by the acres encompassed by the data collection zone (Lake, Tier, or MZL).

ALR 8.8 LakeScan™ Weediness Indices







Figures ALR 8.8.1-3 The LakeScan™ Weedines© index is fundamentally a diversity index (similar algorithm) however values are weighted according to the assigned "i" value, coupled with the density and distribution of various species at each AROS.

AER 8: LakeScan™ Plant Community Survey Event Comparisons

Comment:
V1 surveys were conducted in June and V2 surveys were conducted in August. Data is only a partial reflection of the direct impact of the applied management program. Michigan lakes support an early summer and late season flora that is comprised of "early and "late" season species. Consequently, some of the differences that are observed from the early to late summer are merely a function of the changes that normally occur in lakes as early season plant species are replaced by late season plant species.

AER 8.1 Species Richness in the whole lake and at all MZL's during an early growing season vegetation survey (V1) and a later, late growing season vegetation survey event (V2).

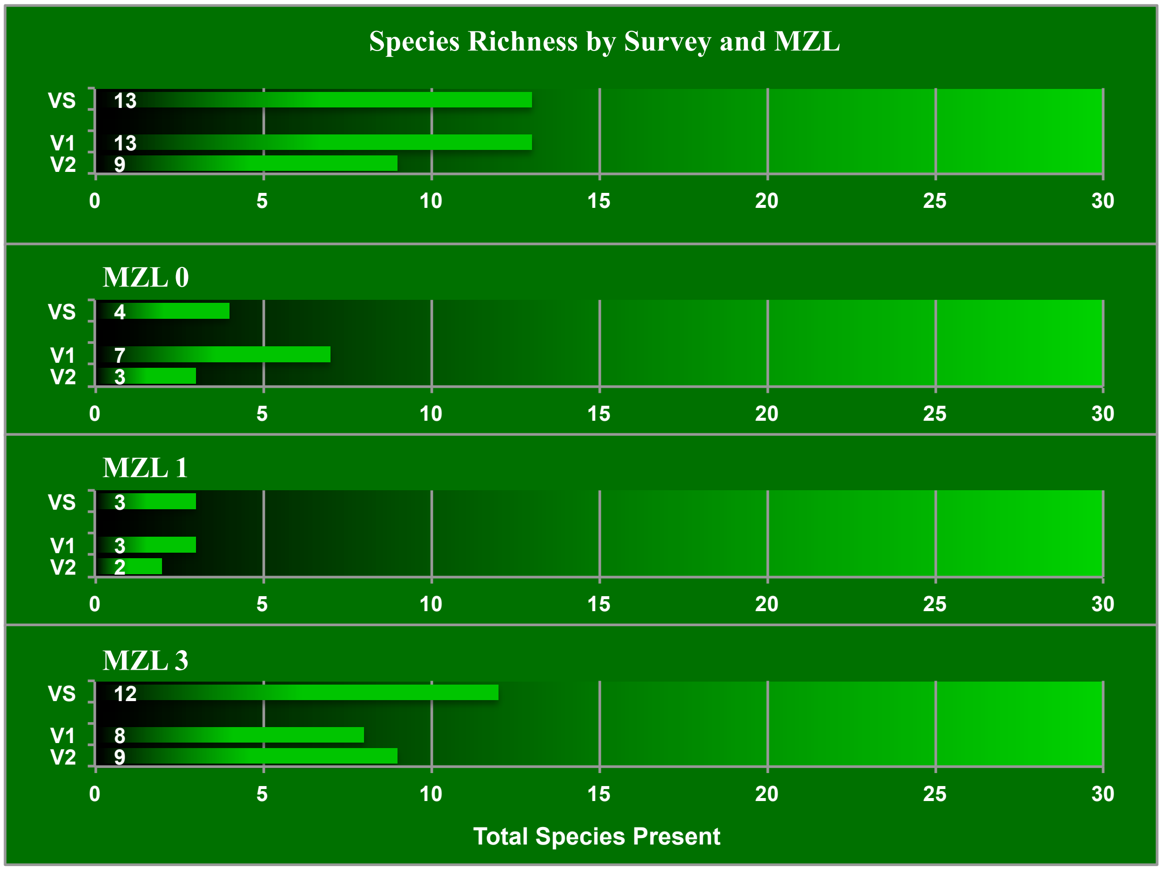


Figure AER 8.1.1.1 The species richness for the whole lake, MZL 0 (no management), MZL 2, and MZL 4 during and at early summer (V1) and late summer (V2) survey events.

AER 8.2 The total number of distinct plant morphotypes observed in the whole lake at all MZL's when summed for the entire summer (VS) and at an early growing season vegetation survey (V1) and a later, late growing season vegetation survey event (V2).

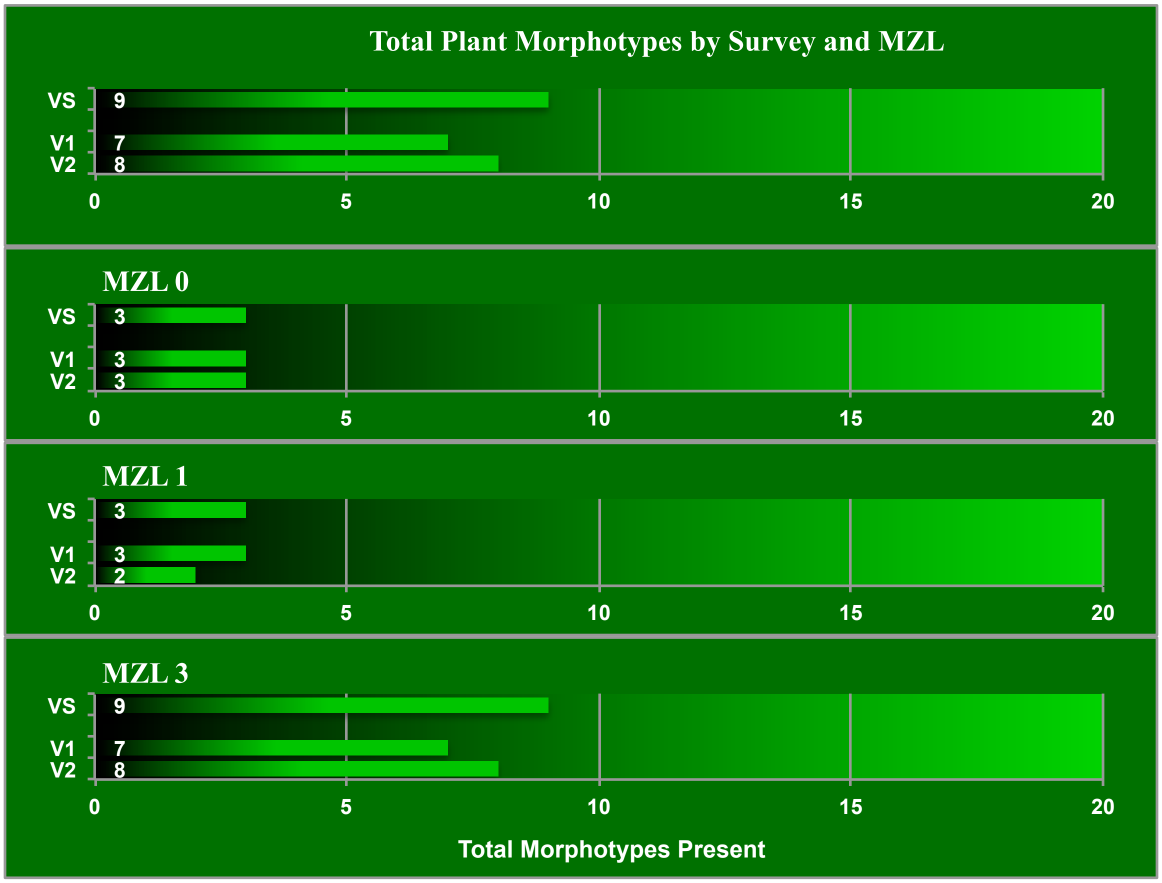


Figure AER 8.2.1.1 The total number of distinct plant morphotypes in the whole lake, MZL 0 (no management zone), MZL 2, and MZL 4 during the entire summer (VS) and at early summer (V1) and late summer (V2) survey events.

AER 8.5 The LakeScan™ BioD 40© index value in the whole lake and several MZL's for the entire summer (VS) and at an early growing season vegetation survey (V1) and a later, late growing season vegetation survey event (V2).

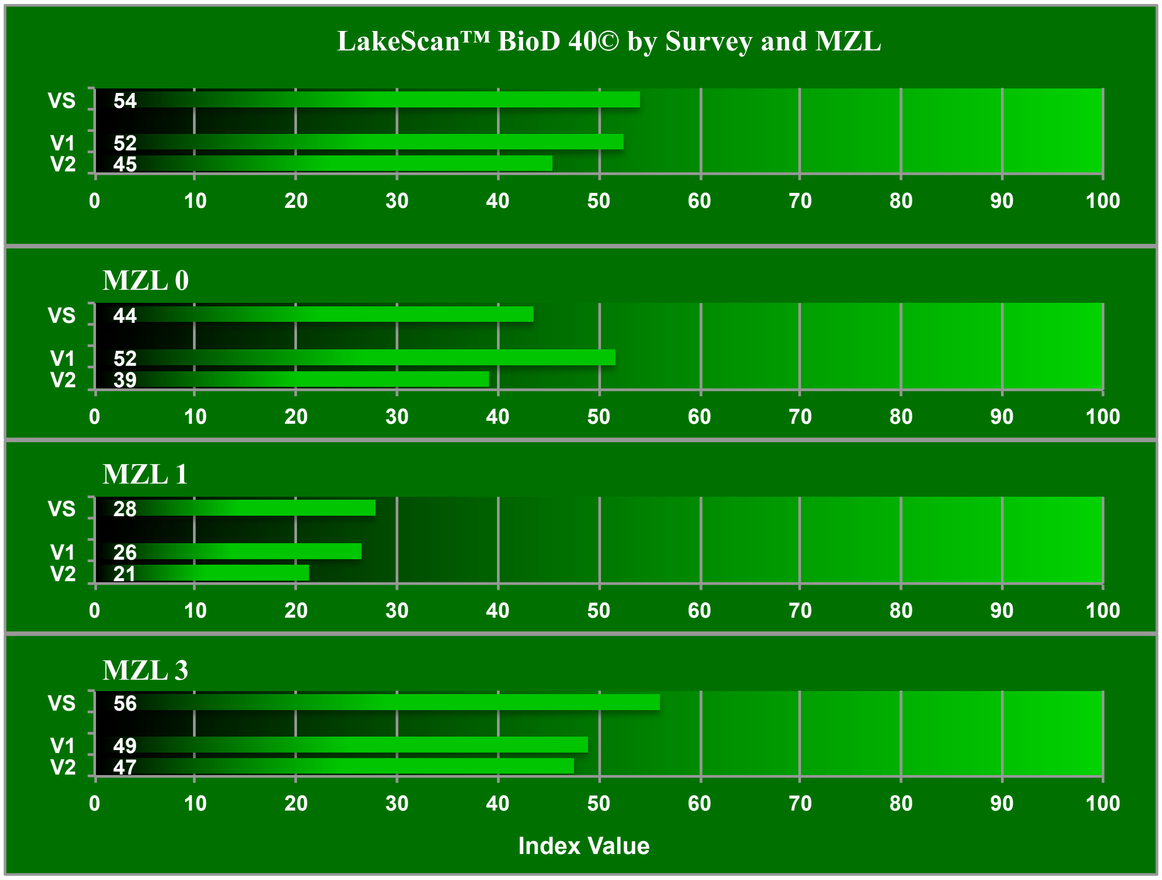


Figure AER 8.5.1.1 The LakeScan™ BioD 40© index value calculated for the whole lake, MZL 0 (no management zone), MZL 2 (semi-selective plant management), and MZL 4 (non-selective plant management) during the entire summer (VS) and at early summer (V1) and late summer (V2) survey events.

AER 8.5.2 The LakeScan™ BioD 40© index value for all plant species except the primary target species categorized as T1 (T2 species or greater) in the whole lake when summed for the entire summer (VS) and at an early growing season vegetation survey (V1) and a later, late growing season vegetation survey event (V2).

Comment:
One of the chief objectives of the lake management plan is to reduce the abundance and impact of the most invasive plants species in the lake. These species are categorized as "target 1" species and are assigned a corresponding "T" value of T1. Since the goal of the program is to reduce these species to the lowest possible level, it is reasonable to consider the plant community biodiversity of the lake in terms of plant species ranked T2 or greater. This is referred to as the LakeScan ™ T2+ BioD 40© index and this may be one of the most useful metrics when considering the impact and success of the applied management program.

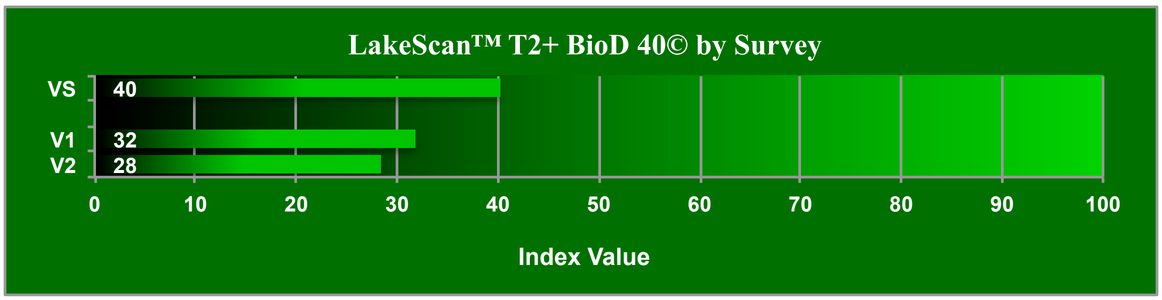


Figure AER 8.5.2.1 The LakeScan™ BioD 40© index value of plant species of target rating T2 or greater calculated for the entire lake during the entire summer (VS) and at early summer (V1) and late summer (V2) survey events.

AER 8.9 The LakeScan™ Weediness 10© index value for the whole lake and at the management zones summed for the entire summer (VS) and at an early growing season vegetation survey (V1) and a later, late growing season vegetation survey event (V2).

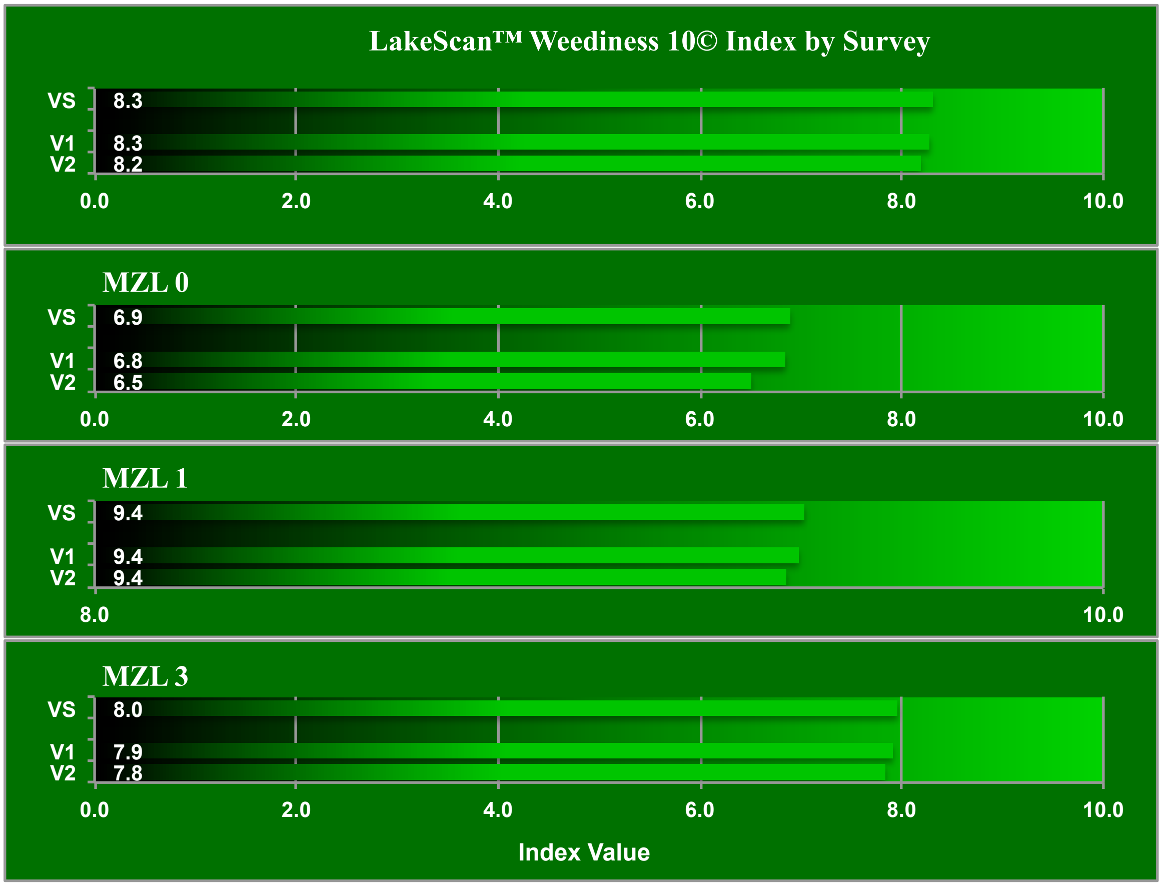


Figure AER 8.9.1 The LakeScan™ Weediness 10© index value of plant species calculated for the whole lake and at MZL 0 (no management zone), MZL 2 (semi-selective plant management zone), and MZL 4 (non-selective plant management zone for the entire summer (VS) and for 2 sampling events, early summer (V1) and late summer (V2).

HLR 8: LakeScan™ Metric and Index Year to Year Comparisons

Trend Analysis

Most major metrics have been trending in a negative way since 2004. However, metrics have trended in both positive and negative directions from year to year. Most Metrics were higher during the first five years of analysis and trended negatively in the last five years. Values from 2014 are much better than those determined in the pervious 3 years.

Table HLR 8.0.1 Trend analysis for LakeScan™ metric data compiled since 2011.

Species Richness	Morpho-types	Mean C	BioD in Lake and at MZL's Lake	MZL 0	MZL 1	MZL 3	BioD T2+	MorphoD	Lake Biovol ft3/acre ft	Weediness
+	+	-	+	-	-	+	+	+	+	-

Table HLR 8.1.1 & 2 The percent occurrence of plant species present at the AROS's during the years of LakeScan™ analysis and year to year statistics compared to 2013 data.

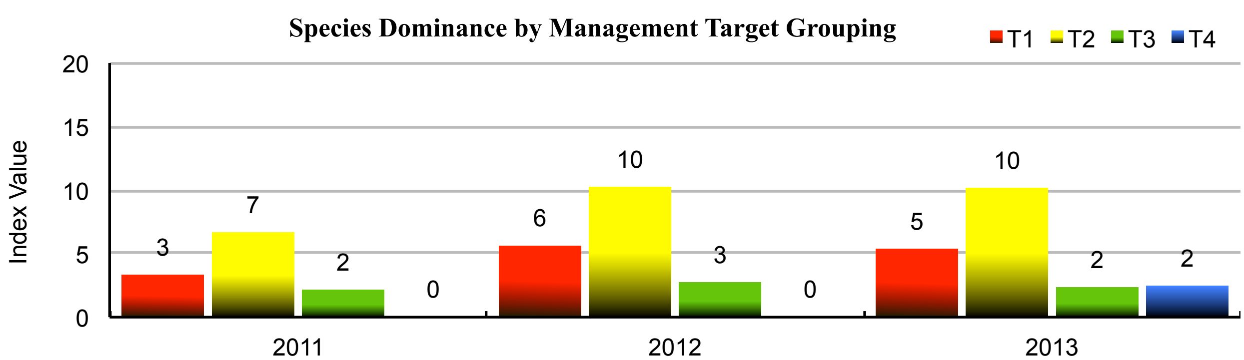
SPECIES OCCURRENCE			
Species Short Name	Percent of AROS's Where Species Was Observed		
	2011	2012	2013
EWMx	49%	45%	63%
CNTL	20%	16%	
NAID			4%
CHARA			16%
StSt	100%	100%	100%
CLP		14%	22%
VP	41%	24%	20%
HPW		8%	8%
Stuk		24%	33%
TLP			6%
ZAN		20%	
VAL	20%	16%	8%
WL	47%	47%	41%
SPAD	6%	10%	14%
WSh	2%		
DUCK			4%

SPECIES OCCURRENCE						
3	**2013**	Years Species Present	Percent Years Present	Mean Occurence at AROS's	Minimum Occurence at AROS's	Maximum Occurence at AROS's
Total Years		3				
EWMx	63%	3	100%	52%	45%	63%
CNTL		2	67%	18%	16%	20%
NAID	4%	1	33%	4%	4%	4%
CHARA	16%	1	33%	16%	16%	16%
StSt	100%	3	100%	100%	100%	100%
CLP	22%	2	67%	18%	14%	22%
VP	20%	3	100%	28%	20%	41%
HPW	8%	2	67%	8%	8%	8%
Stuk	33%	2	67%	28%	24%	33%
TLP	6%	1	33%	6%	6%	6%
ZAN		1	33%	20%	20%	20%
VAL	8%	3	100%	14%	8%	20%
WL	41%	3	100%	45%	41%	47%
SPAD	14%	3	100%	10%	6%	14%
WSh		1	33%	2%	2%	2%
DUCK	4%	1	33%	4%	4%	4%

Table HLR 8.1.3 & 4 The dominance of plant species present at the AROS's during the years of LakeScan™ analysis and year to year statistics compared to 2013 data.

SPECIES DOMINANCE			
Species Short Name	LakeScan™ Dom 100© Index Value		
	2011	2012	2013
EWMx	71.5	72.5	79.9
CNTL	32.8	29.7	
NAID			21.9
CHARA			52.0
StSt	100.2	100.2	99.0
CLP		29.4	1.0
VP	52.8	48.7	56.1
HPW		33.7	27.4
Stuk		57.6	56.6
TLP			30.7
ZAN		56.9	
VAL	21.9	24.8	30.7
WL	82.4	82.0	79.1
SPAD	34.5	45.3	52.0
WSh	9.8		
DUCK			18.6

SPECIES DOMINANCE						
2013		Total Years When Species Present	Percent Years Present	Mean Dominance at AROS's	Minimum Dominance at AROS's	Maximum Dominance at AROS's
	Value	3	%	Value	Value	Value
EWMx	80	3	100%	75	71	80
CNTL		2	67%	31	30	33
NAID	22	1	33%	22	22	22
CHARA	52	1	33%	52	52	52
StSt	99	3	100%	100	99	100
CLP	1	2	67%	15	1	29
VP	56	3	100%	53	49	56
HPW	27	2	67%	31	27	34
Stuk	57	2	67%	57	57	58
TLP	31	1	33%	31	31	31
ZAN		1	33%	57	57	57
VAL	31	3	100%	26	22	31
WL	79	3	100%	81	79	82
SPAD	52	3	100%	44	35	52
WSh		1	33%	10	10	10
DUCK	19	1	33%	19	19	19



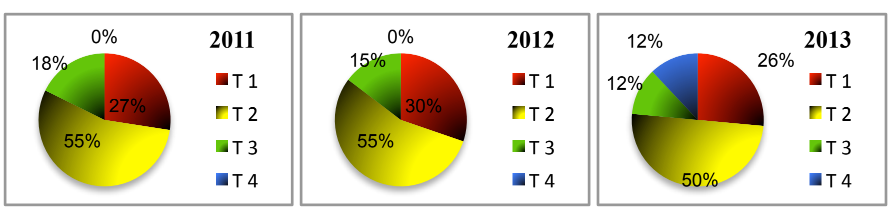


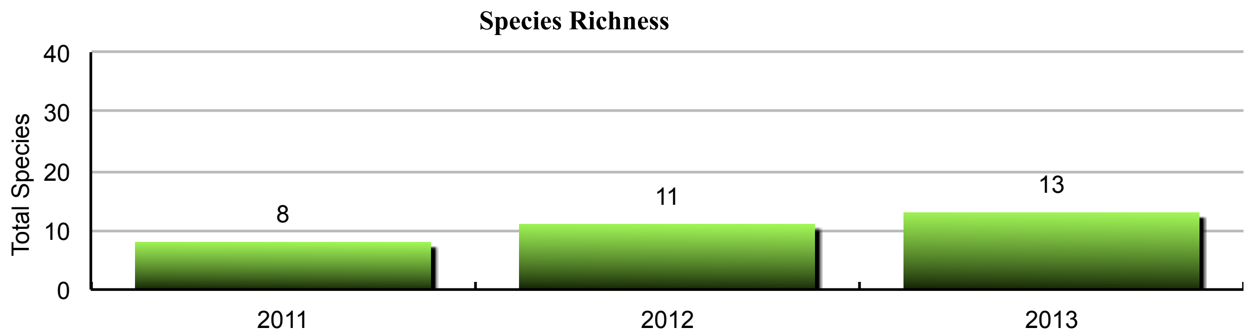
Figure HLR 8.1.1 & 2 The dominance of plant species grouped according to management target emphasis ("T" value) present at the AROS's in Wabeek Lake.

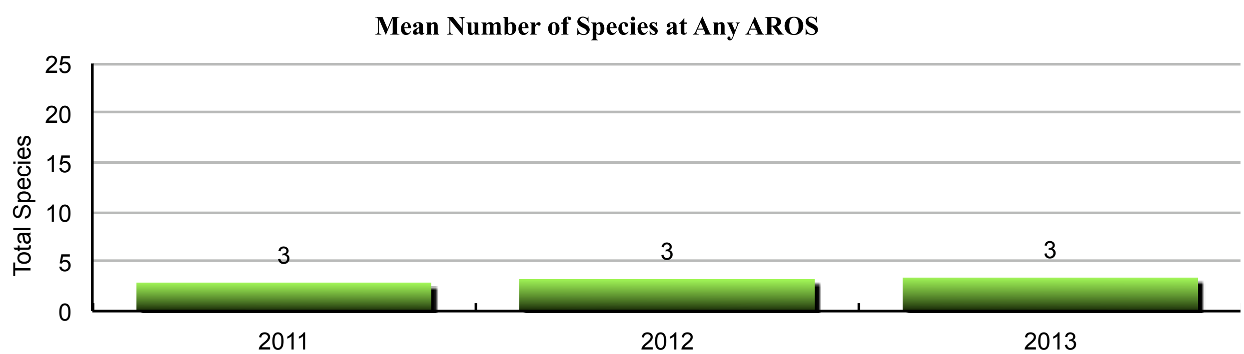
Table HLR 8.1.3 & 4 The biovolume of plant species present at the AROS's in Wabeek Lake during the years of LakeScan™ analysis and year to year statistics compared to 2013 data.

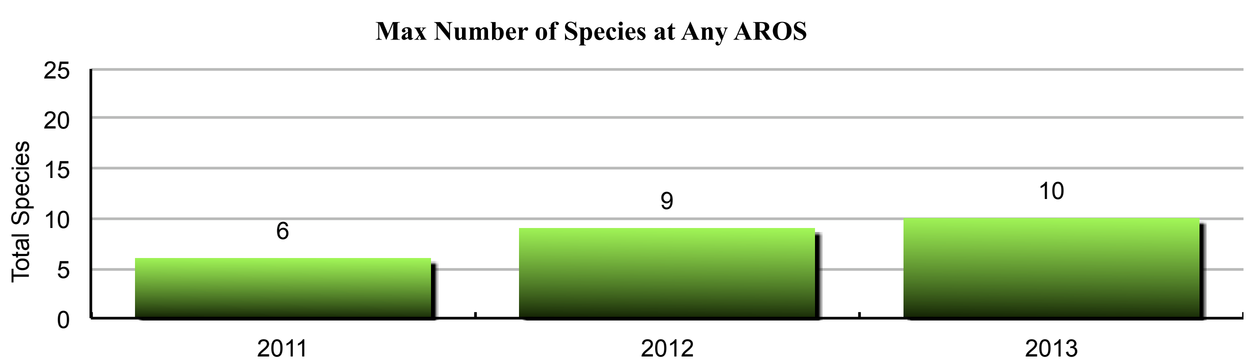
MEAN FT3/ACRE FOOT PLANT BIOVOLUME			
Species Short Name	Mean AROS BioVol Ft^3 per Acre Ft.		
	2011	2012	2013
EWMx	9.87	15.05	0.14
CNTL	0.07	0.08	
NAID			0.01
CHARA			0.01
StSt	64.10	15.89	0.75
CLP		4.07	0.00
VP	1.82	2.31	0.02
HPW		6.92	0.00
Stuk		10.26	0.01
TLP			0.01
ZAN		19.01	
VAL	0.20	0.15	0.00
WL	5.44	4.96	0.04
SPAD	5.44	5.44	0.01
WSh	5.44		
DUCK			0.00

MEAN FT3/ACRE FOOT PLANT BIOVOLUME						
	2013	Total Years When Species Present	Percent Years Present	Mean BioVol at AROS's	Minimum BioVol at AROS's	Maximum BioVol at AROS's
	Value	4	%	Value	Value	Value
EWMx	10	3	100%	40	0	80
CNTL		2	67%	18	0	33
NAID	0	1	33%	16	0	50
CHARA	0	1	33%	33	0	60
StSt	1	3	100%	61	1	100
CLP	0	2	67%	14	0	75
VP	0	3	100%	35	0	100
HPW	0	2	67%	26	0	109
Stuk	0	2	67%	40	0	115
TLP	0	1	33%	28	0	117
ZAN		1	33%	42	0	120
VAL	0	3	100%	23	0	125
WL	0	3	100%	53	0	150
SPAD	0	3	100%	35	0	153
WSh		1	33%	24	0	155
DUCK	0	1	33%	29	0	180

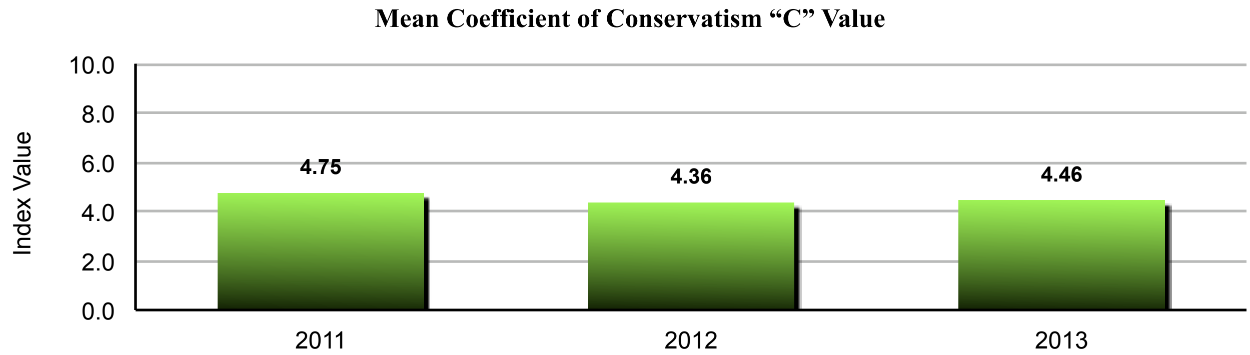
HLR 8.1 A Historical Record of Species Richness.

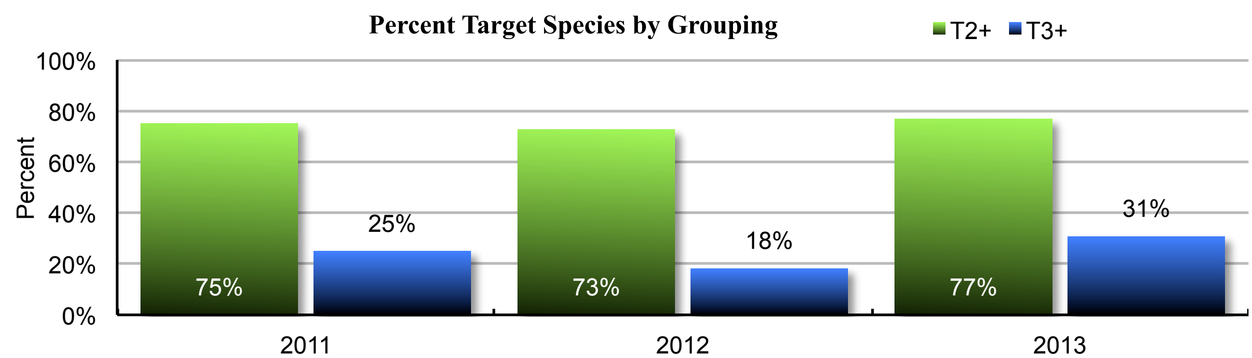


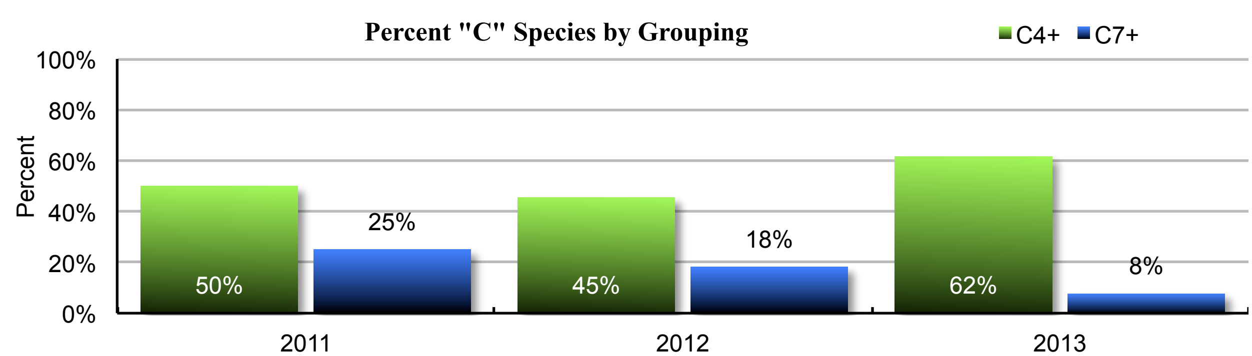




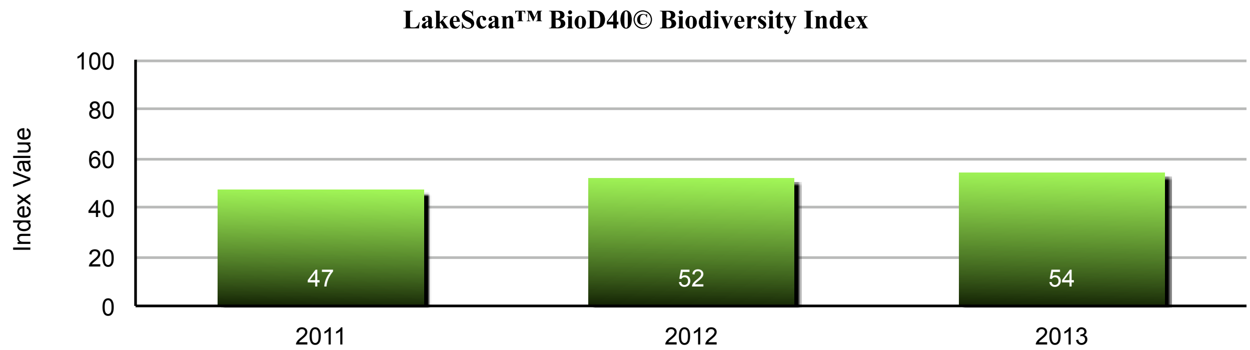
HL 8.3 A Historical Record of Plant Species Quality

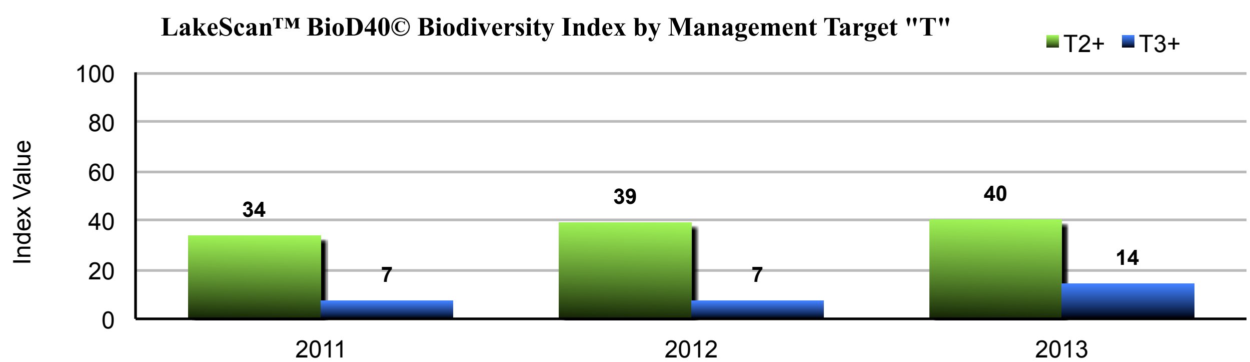


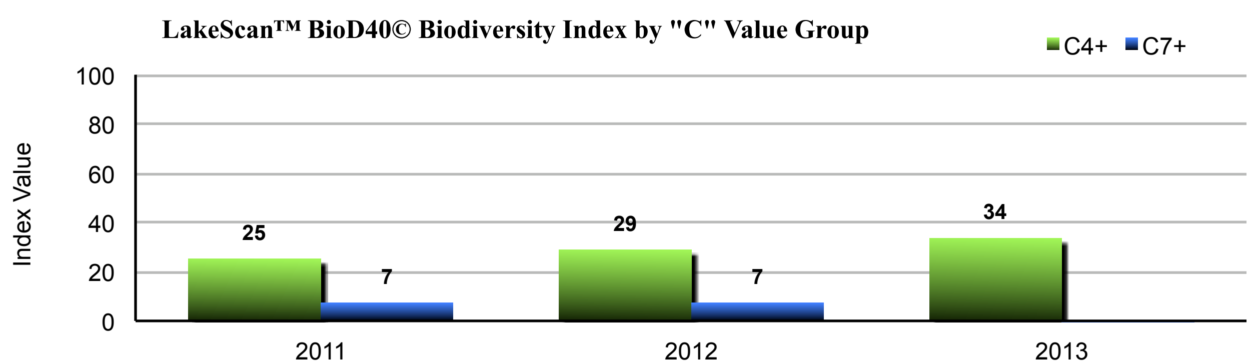




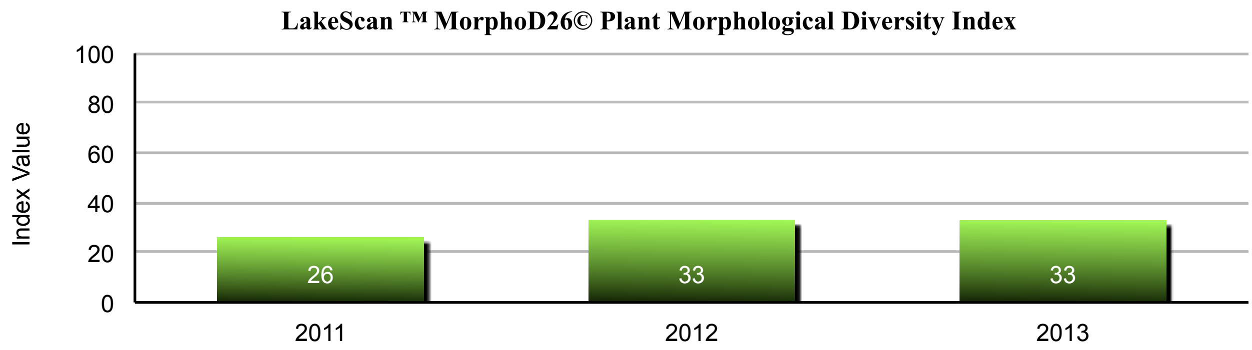
HLR 8.5 A Historical Record of Plant Community Species Diversity.



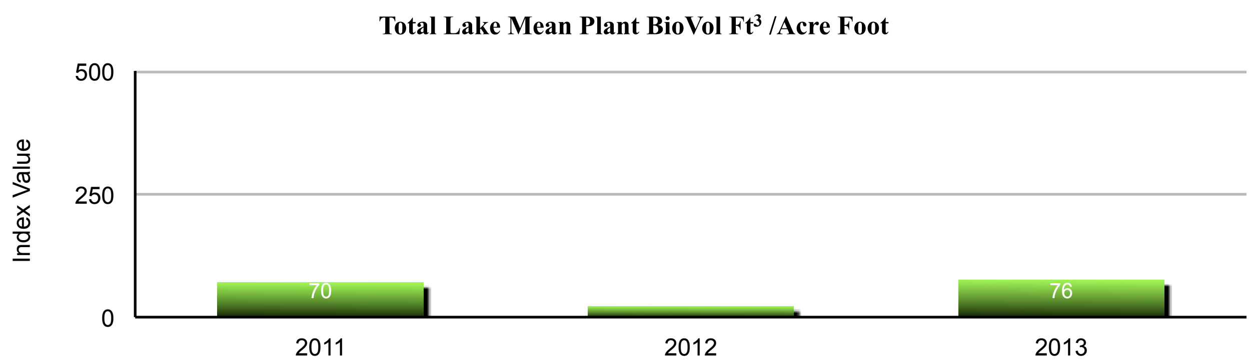




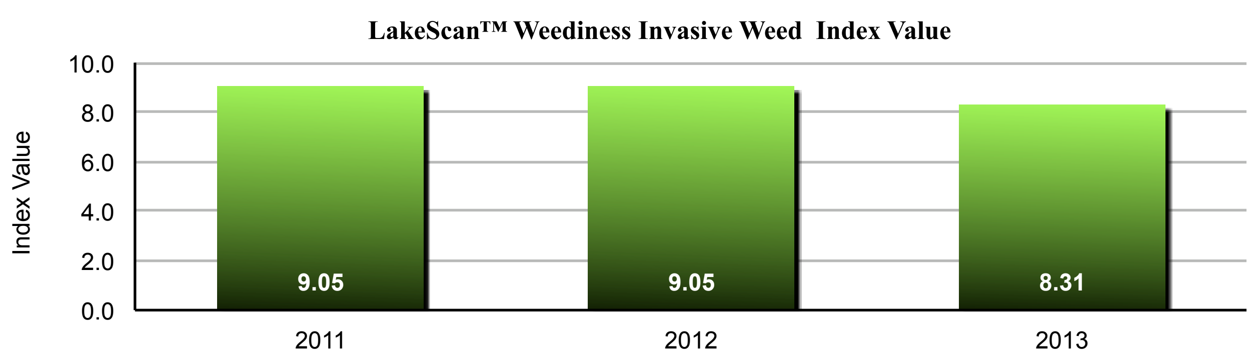
HLR 8.6 A Historical Record of Plant Community Morphological Diversity.



HLR 8.8 A Historical Record of Plant Community Biovolume.



HLR 8.9 A Historical Record of Plant Community Weediness.



ALC 1.0 The Physical Characteristics of 22 Michigan Lakes

Table CL 1.1.1 Lake area, mean depth, littoral zone area, and % littoral zone area statistics.

			Lake Area (Acres)		Mean Depth (Feet)		Littoral Zone Area (Acres)		Percent Littoral Zone (%)	
		Mean	361		8		288		1	
		Median	247		8		214		1	
		Max	1100		14		1100		1	
		Min	25		4		17		0	
#	Lake Name	Abrev.	(Acres)	(Rank)	(Feet)	(Rank)	(Acres)	(Rank)	(%)	(Rank)
1	Barnes	BAR	147	19	5	20	92	19	63%	18
2	Bass	BAS	524	6	7	12	371	6	71%	13
3	Big	BIG	215	15	6	15	209	13	97%	6
4	Cedar	CED	1100	1	8	10	1100	1	100%	2
5	Indianwood	IND	86	21	5	17.5	86	20	100%	2
6	Joslin	JOS	187	17	5	19	185	15	99%	4
7	Kent	KNT	800	2	8	11	688	2	86%	9
8	Lapeer	LAP	350	9	5	17.5	215	11	61%	19
9	Lobdell	LOB	545	5	4	21	545	3	100%	2
10	Long	LON	493	8	10	5	192	14	39%	22
11	Lower Straits	LOW	235	13	4	22	230	9	98%	5
12	North	NOR	227	14	10	6	176	16	78%	11
13	Ogemaw	OGE	565	4	8	8	399	5	71%	14
14	Pleasant	PLN	103	20	11	3	55	21	53%	21
15	Pleiness	PLS	202	16	10	4	114	17	56%	20
16	Shinanguag	SHN	238	12	6	16	219	10	92%	7
17	Stony	STN	498	7	7	13	366	7	73%	12
18	Tamarack	TAM	323	10	7	14	297	8	92%	8
19	Tipsico	TIP	256	11	10	7	214	12	84%	10
20	Wabeek	WAB	25	22	8	9	17	22	66%	16
21	Whitmore	WHT	677	3	14	1	472	4	70%	15
22	Williams	WIL	155	18	12	2	102	18	66%	17

Table CL 1.1.2 Total AROS, AROS per acre, Percent AROS Assigned to Each Tier

	Total AROS (#)	AROS Per Acre (Ratio)	Percent Tier 3 AROS	Percent Tier 4 AROS	Percent Tier 5 AROS	Percent Tier 6 AROS
Mean	**216**	**0.68**	**53%**	**32%**	**11%**	**0%**
Median	**233**	**0.54**	**55%**	**32%**	**10%**	**0%**
Max	**345**	**2.04**	**76%**	**55%**	**36%**	**9%**
Min	**51**	**0.14**	**0%**	**16%**	**0%**	**0%**

#	Lake Name	Abrev.	(#)	(Rank)	(Ratio)	(Rank)	%	(Rank)	%	(Rank)	%	(Rank)	%	(Rank)
1	**Barnes**	**BAR**	157	19	0.14	22	53%	13	41%	4	6%	14	0%	12
2	**Bass**	**BAS**	295	4	0.27	18	43%	18	44%	2	13%	8	0%	12
3	**Big**	**BIG**	157	19	0.21	20	57%	11	26%	18	18%	6	0%	12
4	**Cedar**	**CED**	295	4	0.27	18	68%	4	22%	20	9%	12	0%	12
5	**Indianwood**	**IND**	235	12	0.22	19	66%	5	32%	10	1%	19	0%	12
6	**Joslin**	**JOS**	295	4	1.58	3	39%	20	35%	9	27%	3	0%	12
7	**Kent**	**KNT**	238	11	0.33	15	65%	7	32%	11	3%	17	0%	12
8	**Lapeer**	**LAP**	295	4	0.21	21	72%	3	28%	16	0%	21	0%	12
9	**Lobdell**	**LOB**	260	9	0.53	12	63%	8	35%	7	2%	18	0%	12
9	**Long**	**LON**	230	13	0.50	13	0%	22	30%	13	10%	11	0%	12
11	**Lower Straits**	**LOW**	290	7	0.56	11	66%	6	30%	14	5%	15	0%	12
13	**North**	**NOR**	245	10	0.65	7	48%	14	39%	5	12%	9	0%	12
14	**Ogemaw**	**OGE**	131	22	0.61	9	73%	2	20%	21	6%	13	0%	12
15	**Pleasant**	**PLN**	147	20	0.92	5	58%	10	29%	15	13%	7	0%	12
16	**Pleiness**	**PLS**	345	1	0.90	6	54%	12	42%	3	4%	16	0%	12
17	**Shinanguag**	**SHN**	95	23	1.21	4	61%	9	16%	22	23%	4	0%	12
19	**Stony**	**STN**	181	16	0.44	14	76%	1	24%	19	0%	21	0%	12
20	**Tamarack**	**TAM**	289	8	0.59	10	45%	16	55%	1	0%	21	0%	12
21	**Tipsico**	**TIP**	218	14	0.62	8	37%	21	26%	17	36%	1	0%	12
22	**Wabeek**	**WAB**	138	21	2.04	1	41%	19	31%	12	27%	2	0%	12
23	**Whitmore**	**WHT**	159	17	0.32	16	44%	17	37%	6	11%	10	9%	1
24	**Williams**	**WIL**	51	24	1.89	2	47%	15	35%	9	18%	5	0%	12

Table CL 1.1.3 Total management zones (MLZ) and percent AROS assigned to each MZL.

			Total MZL AROS		Percent MZL 0 AROS		Percent MZL 1 AROS		Percent MZL 2 AROS		Percent MZL 3 AROS		Percent MZL 4 AROS	
		Mean	218		13%		15%		22%		50%		87%	
		Median	233		4%		11%		22%		53%		96%	
		Max	345		81%		43%		47%		72%		100%	
		Min	51		0%		0%		0%		0%		19%	
#	Lake Name	Abrev.	(#)	(Rank)	(%)	(Rank)	(%)	(Rank)	(%)	(Rank)	(%)	(Rank)	(%)	(Rank)
1	Barnes	BAR	157	17	3%	14	10%	13	38%	3	49%	15	97%	9
2	Bass	BAS	295	4	5%	10	6%	17	37%	4	52%	14	95%	13
3	Big	BIG	235	11	2%	16	43%	2	10%	18	45%	16	98%	7
4	Cedar	CED	295	4	11%	6	0%	20	17%	15	72%	2	89%	17
5	Indianwood	IND	238	10	0%	21	29%	5	0%	21	71%	3	100%	3
6	Joslin	JOS	295	4	4%	11	7%	14	47%	1	42%	17	96%	12
7	Kent	KNT	260	8	70%	2	0%	20	26%	10	0%	22	30%	21
8	Lapeer	LAP	230	12	15%	5	0%	20	14%	17	71%	4	85%	18
9	Lobdell	LOB	290	6	0%	21	10%	12	28%	9	63%	6	100%	3
9	Long	LON	245	9	2%	15	40%	3	0%	21	58%	9	98%	8
11	Lower Straits	LOW	131	20	6%	8	15%	9	22%	12	55%	10	94%	15
13	North	NOR	147	18	3%	12	20%	6	22%	11	54%	11	97%	11
14	Ogemaw	OGE	345	1	1%	18	6%	16	29%	8	64%	5	99%	5
15	Pleasant	PLN	95	21	0%	21	12%	10	37%	5	52%	13	100%	3
16	Pleiness	PLS	181	15	5%	9	43%	1	0%	21	52%	12	95%	14
17	Shinanguag	SHN	289	7	3%	13	20%	7	17%	14	60%	7	97%	10
19	Stony	STN	218	13	81%	1	0%	20	15%	16	0%	22	19%	22
20	Tamarack	TAM	138	19	34%	3	0%	20	35%	6	30%	20	66%	20
21	Tipsico	TIP	159	16	0%	21	19%	8	40%	2	41%	18	100%	3
22	Wabeek	WAB	51	22	10%	7	31%	4	0%	21	59%	8	90%	16
23	Whitmore	WHT	216	14	23%	4	12%	11	34%	7	31%	19	77%	19
24	Williams	WIL	295	4	2%	17	6%	15	19%	13	72%	1	98%	6

ALC 8.1, 8.7, & 8.8: Comparisons of Michigan LakeScan™ Large Plant Indices

Table ALC 8.1.1 Submersed plants observed in 22 Michigan Lakes in 2013.

PLANT NAME, CODES, AND SELECTED ATTRIBUTES								
	CODE #	SHORT NAME	COMMON NAME	SCIENTIFIC NAME	"C" VALUE	"I" VALUE	"T" VALUE	MORPHOTYPE
1	2	EWMx	Eurasian Watermilfoil Hybrid	*Myriophyllum spicatum x sibiricum*	3	8	1	feathery
2	3	NWM	Northern Watermilfoil	*Myriophyllum sibiricum Kom.*	7	3	3	feathery
3	4	GWM	Green/Variable Watermilfoil	*Myriophyllum verticillatum L. or Myriophyllu*	7	6	2	feathery
4	15	WMG	Water Marigold	*Bidens Beckii Torr. ex Spreng.*	8	2	4	bushy
5	22	WWCF	White Water Crowsfoot	*Ranunculus sp.*	8	4	3	feathery
6	25	BLAD	Common Bladderwort	*Utricularia vulgaris L.*	7	4	3	feathery
7	27	MiniB	Mini-Bladderwort	*Utricularia sp.*	9	4	4	feathery
8	33	CNTL	Coontail	*Ceratophyllum sp.*	3	7	2	bushy
9	42	ELD	Elodea	*Elodea sp.*	3	6	2	bushy
10	50	NAID	Naiad	*Najas sp.*	4	7	2	bushy
11	60	CHARA	Chara	*Chara sp.*	6	3	4	bushy
12	63	NitT	Tufted Nitella	*Nitella sp.*	6	3	4	bushy
13	65	StSt	Starry Stonewort	*Nitellopsis obtusa (Desv.) J.Groves*	3	9	1	bushy
14	70	Moss	Water Moss	*Drepanocladus sp. or Fontinalis sp.*	6	5	4	bushy
15	75	CLP	Curly Leaf Pondweed	*Potamogeton crispus L.*	2	9	1	narrow leafy
16	76	FSP	Flat Stem Pondweed	*Potamogeton zosteriformis Fern.*	6	5	2	narrow leafy
17	77	WSG	Water Star Grass	*Zosterella dubia (Jacq.) Small*	6	5	2	narrow leafy
18	80	ROB	Robbins Pondweed	*Potamogeton robbinsii Oakes*	8	2	3	narrow leafy
19	90	Rich	Richardsons Pondweed	*Potamogeton richardsonii (Benn.) Tydb.*	5	5	2	small leafy
20	93	AMER	American Pondweed	*Potamogeton nodosus Poiret*	7	5	3	broad leafy
21	94	MLF	Medium Leaf Pondweed	*Potamogeton alpinus Balb.*	8	2	3	broad leafy
22	100	VP	Variable Pondweed	*Potamogeton graminius L.*	7	5	3	broad leafy
23	102	WSP	White Stem Pondweed	*Potamogeton praelongus Wulfen*	8	5	3	broad leafy
24	109	HPW	Hybrid Pondweed	*Potamogeton Hybrid*	5	5	2	broad leafy
25	110	WBLP	Weedy Broad Leaf Pondweed	*Potamogeton amplifolius Hybrid*	4	6	2	broad leafy
26	115	Stuk	Sago Pondweed	*Stuckenia sp.*	3	6	2	stringy
27	117	TLP	Thin Leaf Pondweed	*Potamogeton sp.*	5	5	4	stringy
28	120	ZAN	Horned Pondweed	*Zannichellia palustris L.*	7	5	3	stringy
29	125	VAL	Wild Celery	*Vallisneria americana Michaux*	3	7	2	grassy
30	126	SAG	Sagittaria	*Sagittaria sp.*	7	0	4	grassy
31	127	SPRG	Sparganium	*Sparganium sp.*	8	2	4	grassy
32	135	SPIK	Spikerush	*Eleocharis sp.*	5	3	4	grassy
33	140	TEN	M Tenellum	*Myriophyllum tenellum Bigel*	7	1	4	grassy
34	150	WL	Waterlily	*Nymphaea sp.*	6	5	2	floating leaf
35	153	SPAD	Spadderdock	*Nuphar sp.*	6	5	2	floating leaf
36	155	WSh	Water Shield	*Brasenia schreberi J.F. Gmel.*	7	5	3	floating leaf
37	157	NELh	Lotus Hybrid	*Nelumbo sp..*	8	5	2	floating leaf
38	165	FLP	Floating Leaf Pondweed	*Potamogeton sp.*	7	6	3	floating leaf pondweed
39	166	TLFP	Thin and Floating Leaf Pondweed	*Potamogeton sp.*	5	0	3	floating leaf pondweed
40	167	SMTW	Smartweed	*Polygonum sp.*	5	4	3	floating leaf
41	179	WOLF	Watermeal	*Wolffia sp.*	5	6	3	floating
42	180	DUCK	Common Duckweed	*Lemna sp.*	5	6	3	floating
43	185	SPIR	Giant Duckweed	*"Spirodela polyrrhiza (L.) Schleiden*	5	6	3	floating
44	186	TRIS	Star Duckweed	*Lemna trisulca L*	6	4	3	floating

Table ALC 8.1.2 The listing of species and the percent occurrence of these species at AROS's in 22 Michigan Lakes in 2013.

SPECIES OCCURRENCE																						
Species Short Name	Percent of AROS'S Where Species Was Observed																					
	BAR	BAS	BIG	CED	IND	JOS	KNT	LAP	LOB	LON	LOW	NOR	OGE	PLS	PLN	SHN	STN	TAM	TIP	WAB	WHT	WIL
EWMx	93%	37%	92%	9%	95%	1%	88%	81%	68%	53%	71%	32%	93%	59%	55%	64%	89%	95%	92%	63%	40%	36%
NWM	1%		2%							23%			28%				9%					1%
GWM		1%		17%	46%	1%			14%	1%			4%									8%
WMG										1%												
WWCF							7%			27%				1%								
BLAD	5%	2%	4%	40%	64%	39%		0%	28%	1%		3%	37%	1%			4%		3%		1%	2%
MiniB	2%				22%									1%					6%			
CNTL	4%		8%			1%	78%	45%	12%	58%		3%	5%	12%	4%	37%	77%	6%	53%			6%
ELD	1%		0%	5%			12%			58%		3%	23%				32%	7%			10%	0%
NAID			24%	18%		35%	42%	13%	13%	39%		8%	11%	8%	2%	15%	45%	14%	64%	4%	27%	2%
CHARA	100%	45%	91%	97%	100%	35%	49%	45%	83%	83%	62%	93%	94%	59%	62%	100%	59%	99%	100%	16%	100%	56%
NitT	41%				32%								1%									
StSt			60%		8%	18%	68%		97%		58%	79%	2%				53%		75%	100%	35%	47%
Moss	1%												39%									
CLP	78%	14%	45%		62%		64%	69%	60%	1%	2%	2%	57%	24%	22%	35%	39%	57%	45%	22%	11%	12%
FSP	1%					9%	30%		2%	66%		5%	7%	24%	3%	34%	3%				34%	
WSG	2%						45%	0%	8%	21%			31%			2%	15%					
ROB										1%							1%				7%	
Rich			0%	14%					0%	44%			2%								2%	
AMER	1%				0%		80%	7%	1%				2%		1%		92%					
MLF						8%																
VP	25%		9%	28%	7%	33%			18%			63%						1%	6%	20%	40%	1%
WSP		6%		3%					6%	25%		13%	4%	18%					1%		42%	
HPW	48%		52%	60%	16%	30%		1%	21%	96%	30%	25%	85%	60%	53%	3%			36%	8%	8%	9%
WBLP	48%		41%	2%		1%			23%	56%		30%	17%	22%		39%		1%	21%		12%	
Stuk	26%	0%	24%	10%	2%	14%	20%	33%	20%	1%	26%	1%	45%	64%			67%	35%	6%	33%	32%	41%
TLP	2%		15%	2%	25%		70%	28%		30%			1%	4%				1%	14%	6%	5%	
ZAN				0%					2%					2%								
VAL		10%		7%			4%		43%	67%		71%	70%	31%	52%		36%	2%	68%	8%	49%	14%
SAG					0%					4%		8%		5%							2%	
SPRG									1%													
SPIK										0%			1%									
TEN										2%												
WL	48%	6%	49%	22%	51%	10%	60%	49%	61%	36%	46%	37%	51%	30%	37%	60%	34%	49%	29%	41%	17%	19%
SPAD	33%	4%	9%	9%	2%	11%			24%	25%		22%	30%	10%	16%			5%	18%	14%	2%	6%
WSh	4%		9%	1%		10%			2%	8%		27%	3%	30%	8%				31%			
NELh							5%															
FLP				0%																		
TLFP	1%			0%	0%	6%				2%			0%	2%	1%							
SMTW	1%												1%									
WOLF							1%															
DUCK	2%								1%	1%		3%								4%		
SPIR									1%													
TRIS										1%												

Table ALC 8.1.2 Plant species observed in Michigan Lakes in 2013 and the percentage of AROS where they were observed compared to lake data collected in 2013.

SPECIES OCCURRENCE						
LAKE =	**WAB**	Total Lakes Where Species Present	Percent Lakes Present	Mean Presence at AROS	Minimum Presence at AROS	Maximum Presence at AROS
Total Lakes In Analysis =		22				
EWMx	63%	22	100%	64%	1%	95%
NWM		6	27%	11%	1%	28%
GWM		8	36%	12%	1%	46%
WMG		1	5%	1%	1%	1%
WWCF		3	14%	11%	1%	27%
BLAD		16	73%	15%	0%	64%
MiniB		4	18%	8%	1%	22%
CNTL		16	73%	26%	1%	78%
ELD		11	50%	14%	0%	58%
NAID	4%	18	82%	21%	2%	64%
CHARA	16%	22	100%	74%	16%	100%
NitT		3	14%	25%	1%	41%
StSt	100%	13	59%	54%	2%	100%
Moss		2	9%	20%	1%	39%
CLP	22%	20	91%	36%	1%	78%
FSP		12	55%	18%	1%	66%
WSG		8	36%	16%	0%	45%
ROB		3	14%	3%	1%	7%
Rich		6	27%	10%	0%	44%
AMER		8	36%	23%	0%	92%
MLF		1	5%	8%	8%	8%
VP	20%	12	55%	21%	1%	63%
WSP		9	41%	13%	1%	42%
HPW	8%	18	82%	36%	1%	96%
WBLP		13	59%	24%	1%	56%
Stuk	33%	20	91%	25%	0%	67%
TLP	6%	13	59%	16%	1%	70%
ZAN		3	14%	1%	0%	2%
VAL	8%	15	68%	36%	2%	71%
SAG		5	23%	4%	0%	8%
SPRG		1	5%	1%	1%	1%
SPIK		2	9%	1%	0%	1%
TEN		1	5%	2%	2%	2%
WL	41%	22	100%	38%	6%	61%
SPAD	14%	17	77%	14%	2%	33%
WSh		11	50%	12%	1%	31%
NELh		1	5%	5%	5%	5%
FLP		1	5%	0%	0%	0%
TLFP		8	36%	2%	0%	6%
SMTW		2	9%	1%	1%	1%
WOLF		1	5%	1%	1%	1%
DUCK	4%	5	23%	2%	1%	4%
SPIR		1	5%	1%	1%	1%
TRIS		1	5%	1%	1%	1%

Table ALC 8.8.1 The listing of the LakeScan™ dominance/density factors for plant species in the AROS's in 22 Michigan Lakes in 2013.

SPECIES DOMINANCE																						
Species Short Name	MEAN SPECIES DOMINANCE VALUE AT ALL AROS'S																					
	BAR	BAS	BIG	CED	IND	JOS	KNT	LAP	LOB	LON	LOW	NOR	OGE	PLS	PLN	SHN	STN	TAM	TIP	WAB	WHT	WIL
EWMx	88	72	88	40	83	2	93	87	83	79	87	61	93	79	83	80	87	95	95	80	71	68
NWM	1		3							57			63				36					1
GWM		1		53	71	1			49	1			11									36
WMG										1												
WWCF							11			66				1								
BLAD	9	0	11	61	75	59		1	57	1		1	68	1			1		14		1	1
MiniB	6				58									1					35			
CNTL	24		25			20	88	72	44	71		14	13	50	1	77	86	21	62			1
ELD	1		1	36			51			79		17	60				72	37			45	1
NAID			62	59		72	77	48	37	71		44	47	38	8	55	68	49	74	22	67	7
CHARA	100	69	96	88	99	77	79	19	93	79	79	96	97	77	64	93	83	100	99	52	92	73
NitT	75				69								1									
StSt			88		41	59	89		98		87	92	18				79		91	99	75	82
Moss	1												79									
CLP	85	28	72		79		83	77	84	22	4	1	80	61	53	75	66	56	65	1	45	24
FSP	1					1	58		1	76		18	31	56	13	32	23				68	
WSG	1						75	22	28	58			67			25	52					
ROB										6							1				33	
Rich			1	47					1	73			1								11	
AMER	1				1		85	35	1				8		1		94					
MLF						40																
VP	51		33	68	24	56			46			73						19	27	56	65	6
WSP		20		2					28	54		53	13	57					1		72	
HPW	75		78	70	42	57		1	59	89	52	54	89	82	77	20			73	27	17	23
WBLP	79		73	27		12			60	80		65	57	59		76		1	59		46	
Stuk	55	1	42	38	0	40	61	67	54	8	60	1	67	84			79	65	19	57	67	70
TLP	18		50	3	60		81	53		67			10	23				9	48	31	20	
ZAN				1					1					6								
VAL		46		27			33		76	85		86	88	64	84		72	8	80	31	74	51
SAG					1					20		28		17							11	
SPRG									1													
SPIK										1			1									
TEN										1												
WL	77	35	79	62	73	47	82	75	83	68	78	76	80	70	72	83	53	80	68	79	58	57
SPAD	68	23	35	44	17	48			61	60		63	68	47	58			29	54	52	13	34
WSh	22		37	1		44			12	41		68	25	69	43				67			
NELh							35															
FLP				1																		
TLFP	1			1	1	29				1			1	5	1							
SMTW	1												1									
WOLF							1															
DUCK	1								1	1		2								19		
SPIR									1													
TRIS										1												

Table ALC 8.8.2 Plant species dominance factor values

SPECIES DOMINANCE					
LAKE =	**WAB**	Total Lakes Where Species Present	Mean Dominance Value at AROS	Minimum Dominance Value at AROS	Maximum Dominance Value at AROS
Total Lakes In Analysis =		22			
EWMx	80	22	77	2	95
NWM		6	27	1	63
GWM		8	28	1	71
WMG		1	1	1	1
WWCF		3	26	1	66
BLAD		16	23	0	75
MiniB		4	25	1	58
CNTL		16	42	1	88
ELD		11	36	1	79
NAID	22	18	50	7	77
CHARA	52	22	82	19	100
NitT		3	48	1	75
StSt	99	13	77	18	99
Moss		2	40	1	79
CLP	1	20	53	1	85
FSP		12	32	1	76
WSG		8	41	1	75
ROB		3	13	1	33
Rich		6	22	1	73
AMER		8	28	1	94
MLF		1	40	40	40
VP	56	12	44	6	73
WSP		9	34	1	72
HPW	27	18	55	1	89
WBLP		13	51	1	80
Stuk	57	20	47	0	84
TLP	31	13	36	0	81
ZAN		3	3	1	6
VAL	31	15	60	8	88
SAG		5	15	1	28
SPRG		1	1	1	1
SPIK		2	1	1	1
TEN		1	1	1	1
WL	79	22	70	35	83
SPAD	52	17	46	13	68
WSh		11	39	1	69
NELh		1	35	35	35
FLP		1	1	1	1
TLFP		8	5	1	29
SMTW		2	1	1	1
WOLF		1	1	1	1
DUCK	19	5	5	1	19
SPIR		1	1	1	1
TRIS		1	1	1	1

Note: The Dom Factor chart correlates tightly with the T assignment of the plant species listed in this analysis. It is a matter of great concern to note that the hybrid weedy pondweeds exhibit Dom values that are much higher than might be expected for "typical" native Michigan pondweeds.

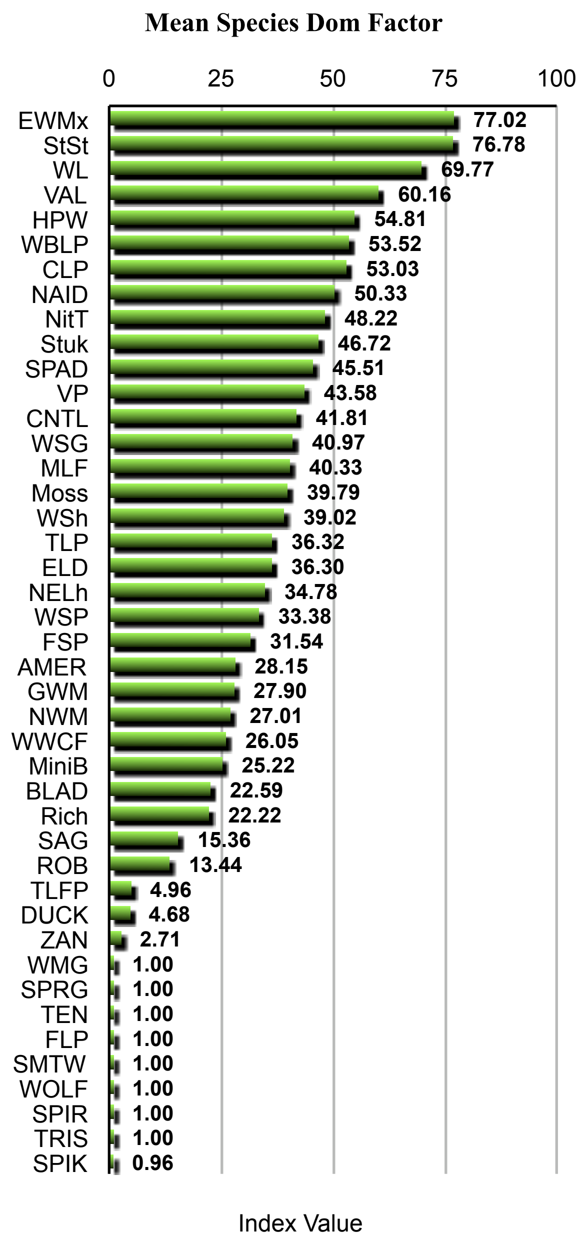
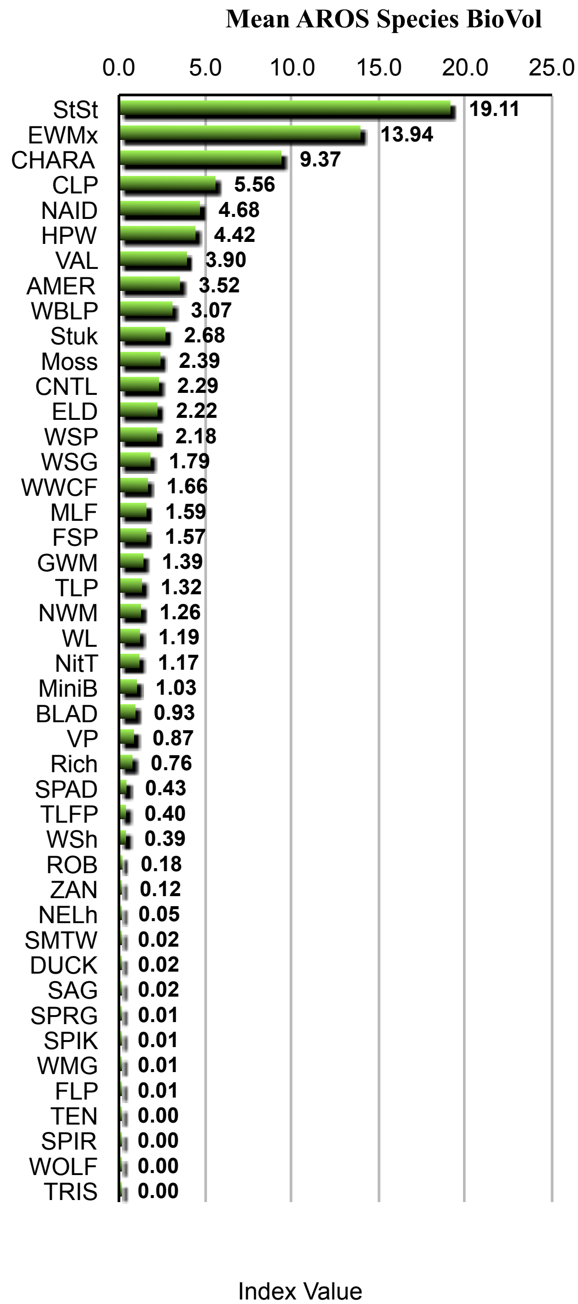


Table ALC 8.7.1 The LakeScan™ BioVol biovolume of individual species at the AROS's in 22 Michigan Lakes in 2013.

MEAN PLANT SPECIES FT^3 PER ACRE FOOT BIOVOLUME AT ALL LAKE AROS'S																						
Species Short Name	PLANT SPECIES FT3 PER ACRE FOOT BIOVOLUME																					
	BAR	BAS	BIG	CED	IND	JOS	KNT	LAP	LOB	LON	LOW	NOR	OGE	PLS	PLN	SHN	STN	TAM	TIP	WAB	WHT	WIL
EWMx	13.74	17.52	9.33	1.16	11.33	0.40	29.28	15.34	9.87	16.72	17.63	7.95	21.56	9.90	20.25	2.59	13.15	39.51	24.48	10.23	9.21	5.54
NWM	0.26		0.67							1.78			2.03				2.54					0.25
GWM		0.12		5.95	2.42	0.36			1.54	0.00			0.12									0.60
WMG										0.01												
WWCF							0.00			4.98				0.00								
BLAD	0.08	0.22	0.10	0.18	8.25	2.24		0.00	1.73	0.04		0.00	1.44	0.48			0.00		0.16		0.00	0.01
MiniB	0.09				3.77									0.05					0.22			
CNTL	0.63		0.54			0.01	10.33	3.40	1.35	1.40		0.37	0.33	2.99	0.00	2.58	8.90	0.18	3.57			0.01
ELD	0.00		0.00	0.80			3.55			7.39		0.82	2.61				5.30	0.58			3.33	0.02
NAID			16.47	1.92		24.80	11.32	2.38	1.48	3.57		7.82	0.96	0.46	0.46	0.82	4.61	1.00	3.59	0.84	1.63	0.07
CHARA	8.01	2.20	25.28	4.09	16.21	6.11	2.19	0.19	30.71	2.19	1.91	11.10	8.34	2.97	1.23	3.71	4.99	60.61	7.33	0.71	4.13	1.93
NitT	2.03				1.28								0.20									
StSt			9.09		0.80	18.56	34.23		60.73		3.05	15.87	0.86				22.46		18.38	57.00	1.66	5.70
Moss	0.03												4.75									
CLP	11.38	0.46	8.50		11.48		28.10	4.57	16.20	0.00	0.10	0.02	7.47	1.97	3.34	7.03	5.12	1.16	0.65	0.02	3.19	0.36
FSP	0.01					0.00	1.94		0.04	5.45		0.58	0.40	4.62	0.11	0.17	0.16				5.37	
WSG	0.04						6.77	0.11	0.50	1.99			3.19			0.04	1.71					
ROB										0.02							0.14				0.39	
Rich			0.00	0.27					0.06	4.14			0.01								0.10	
AMER	0.04				0.10		8.34	0.69	0.12				0.20		0.21		18.46					
MLF						1.59																
VP	1.33		0.28	1.49	0.25	1.84			1.05			1.36						0.00	0.47	1.33	0.93	0.07
WSP		0.43		0.00					0.64	2.23		2.24	0.10	7.42					0.04		6.54	
HPW	4.36		8.44	2.35	0.15	1.13		0.08	3.37	11.64	0.42	1.56	6.66	18.00	14.27	0.06			6.49	0.27	0.06	0.23
WBLP	6.05		5.84	0.03		0.01			3.10	7.36		7.04	1.91	3.76		3.30		0.00	1.34		0.15	
Stuk	1.49	0.01	0.37	0.60	0.08	0.85	3.64	3.91	2.09	0.28	0.89	0.00	2.55	14.08			5.65	3.13	0.06	0.42	5.35	8.21
TLP	0.13		1.52	0.01	1.60		4.76	1.13		5.32			0.00	0.25				0.00	2.00	0.39	0.08	
ZAN				0.01					0.18					0.19								
VAL		3.59		0.02			0.79		4.15	6.28		8.33	9.70	1.56	11.37		2.79	0.05	4.74	0.15	4.37	0.60
SAG					0.00					0.02		0.02		0.01							0.02	
SPRG									0.01													
SPIK										0.00			0.03									
TEN										0.00												
WL	1.20	0.09	2.08	0.12	4.76	0.73	0.50	0.95	1.43	0.38	0.73	0.68	1.33	1.86	1.65	1.30	0.28	0.76	0.61	3.25	0.16	1.32
SPAD	0.77	0.05	0.36	0.04	0.21	0.82			0.43	0.31		0.41	0.78	0.52	0.78			0.07	0.35	0.90	0.02	0.46
WSh	0.01		0.38	0.00		0.65			0.09	0.10		0.51	0.10	1.55	0.36				0.59			
NELh							0.05															
FLP				0.01																		
TLFP	0.03			0.00	0.04	2.99				0.00			0.02	0.11	0.00							
SMTW	0.01												0.03									
WOLF							0.00															
DUCK	0.01								0.00	0.00		0.01								0.05		
SPIR									0.00													
TRIS										0.00												

Table ALC 8.7.1 The LakeScan™ BioVol biovolume of individual species per acre foot in 2013 and compared to lake data collected the same year.

MEAN PLANT SPECIES FT^3 PER ACRE FOOT BIOVOLUME AT ALL LAKE AROS'S					
LAKE =	WAB	Total Lakes Where Species Present	Mean AROS BioVol per Acre•Ft	Minimum AROS BioVol per Acre•Ft	Maximum AROS BioVol per Acre•Ft
Total Lakes In Analysis =		22			
EWMx	10.23	22	13.94	0.40	39.51
NWM		6	1.26	0.25	2.54
GWM		8	1.39	0.00	5.95
WMG		1	0.01	0.01	0.01
WWCF		3	1.66	0.00	4.98
BLAD		16	0.93	0.00	8.25
MiniB		4	1.03	0.05	3.77
CNTL		16	2.29	0.00	10.33
ELD		11	2.22	0.00	7.39
NAID	0.84	18	4.68	0.07	24.80
CHARA	0.71	22	9.37	0.19	60.61
NitT		3	1.17	0.20	2.03
StSt	57.00	13	19.11	0.80	60.73
Moss		2	2.39	0.03	4.75
CLP	0.02	20	5.56	0.00	28.10
FSP		12	1.57	0.00	5.45
WSG		8	1.79	0.04	6.77
ROB		3	0.18	0.02	0.39
Rich		6	0.76	0.00	4.14
AMER		8	3.52	0.04	18.46
MLF		1	1.59	1.59	1.59
VP	1.33	12	0.87	0.00	1.84
WSP		9	2.18	0.00	7.42
HPW	0.27	18	4.42	0.06	18.00
WBLP		13	3.07	0.00	7.36
Stuk	0.42	20	2.68	0.00	14.08
TLP	0.39	13	1.32	0.00	5.32
ZAN		3	0.12	0.01	0.19
VAL	0.15	15	3.90	0.02	11.37
SAG		5	0.02	0.00	0.02
SPRG		1	0.01	0.01	0.01
SPIK		2	0.01	0.00	0.03
TEN		1	0.00	0.00	0.00
WL	3.25	22	1.19	0.09	4.76
SPAD	0.90	17	0.43	0.02	0.90
WSh		11	0.39	0.00	1.55
NELh		1	0.05	0.05	0.05
FLP		1	0.01	0.01	0.01
TLFP		8	0.40	0.00	2.99
SMTW		2	0.02	0.01	0.03
WOLF		1	0.00	0.00	0.00
DUCK	0.05	5	0.02	0.00	0.05
SPIR		1	0.00	0.00	0.00
TRIS		1	0.00	0.00	0.00



ALC 8.1 Species Richness (Total Number of Species)

Commentary: Species Richness
Species richness remained very good in most lakes where any number greater than 15 is considered to be good. The average number of species found in each lake in 2013 was 18 and 15 of the 22 lakes were populated by 15 or more species. Two of the lakes had 30 species while no lake had fewer than 7 species. These data suggest that the lakes support reasonable to very good species richness.

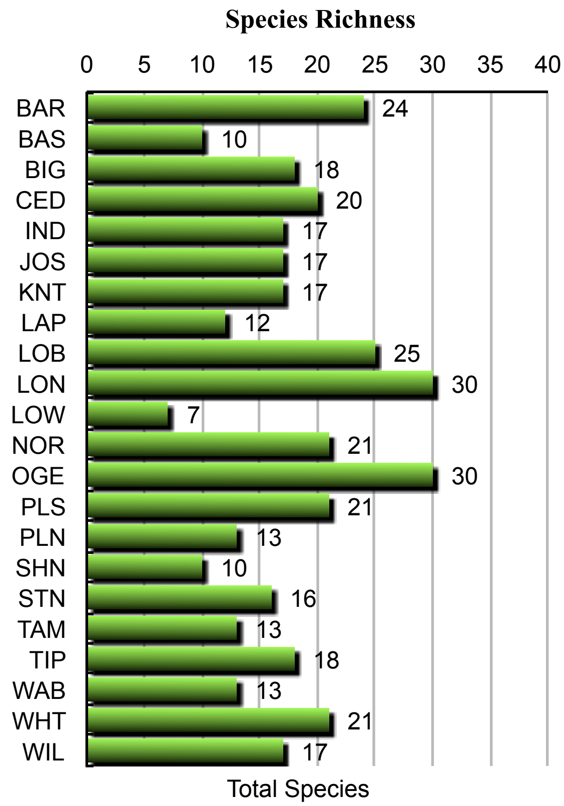


Figure ALC 8.1.2 Total number of large plant species (macrophytes) in each lake.

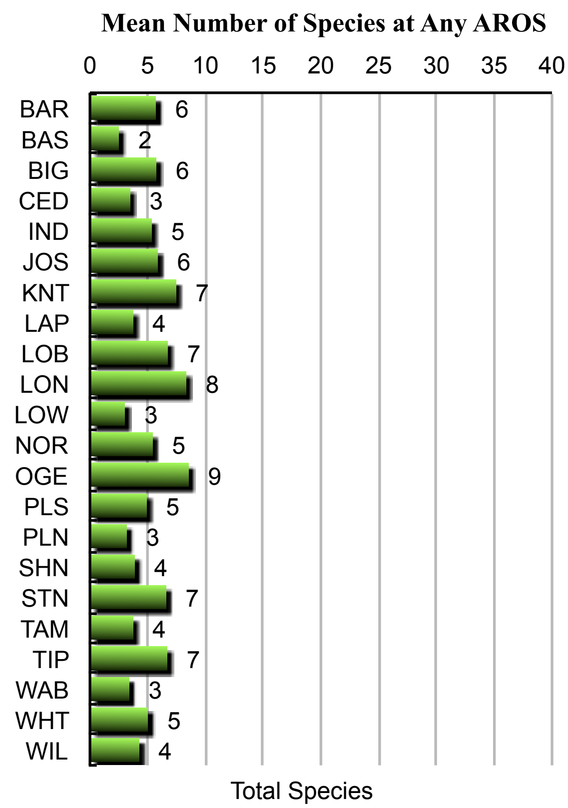


Figure ALC 8.1.3 Average Number of large plant species in AROS's at each lake.

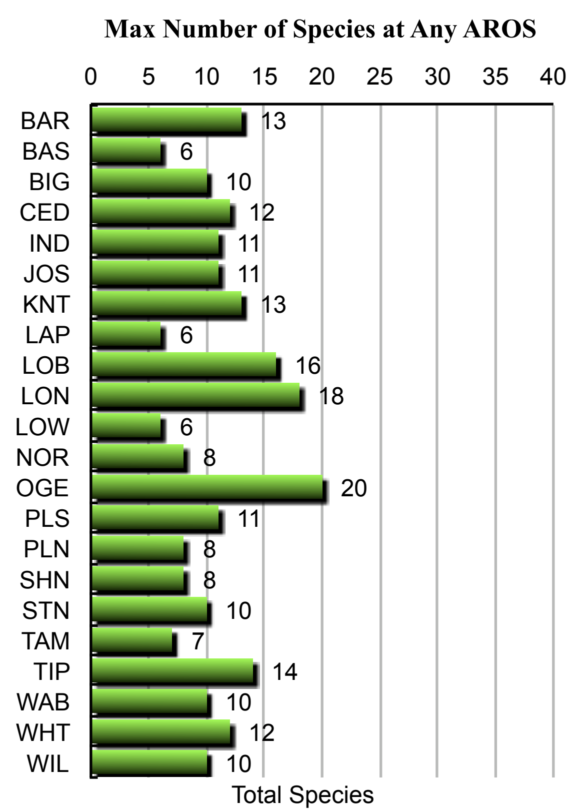


Figure ALC 8.1.3 Maximum Number of Large Plant Species at all AROS's.

ALC 8.2 Total Morphotypes

Commentary: Morphotypes

There are 26 different Morophotypes or distinct leaf and plant structures that have been identified in Michigan Lakes. These range from bushy and feathery plant shapes and forms to stringy and leafy plant forms that resemble cabbage. Any number of morphotypes greater than 10 is considered to be good.

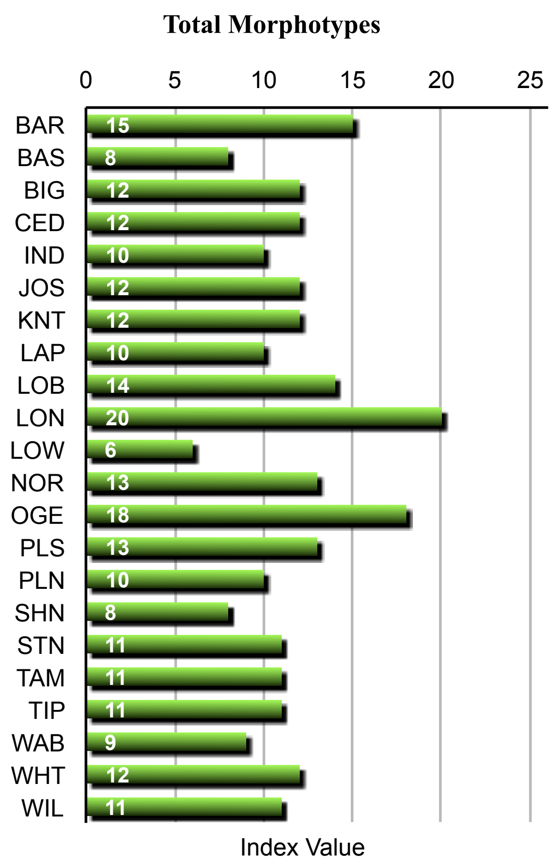


Figure 8.2.1 The number of distinct morphotypes found in Michigan Lakes.

ALC 8.3 Coefficient of Conservatism, "C" Values

Commentary: "C" Value.
This metric is "under construction". The scientific literature has presented some new and elegant ways to consider and analyze coefficients of conservatism. These advancements shall be included in future iterations of LakeScan™ analysis methods. A quick glance at these data suggest that lakes with the largest littoral zones, relative to the whole lake, seem to support plant communities of higher mean AROS C value. Historical data show that the mean C value is declining in most of the lakes. This is a troubling statistic because it suggests that disturbance tolerant or weedy species may be increasing in number relative to other more desirable species. The mean LakeScan™ Weediness10© index is a measure of the "diversity" of different species ranked according to the "*i*" or invasiveness index value and is roughly the inverse of the "C" value. This value seems to confirm the assertion that the "quality" of the flora of most of these lakes appears to be declining.

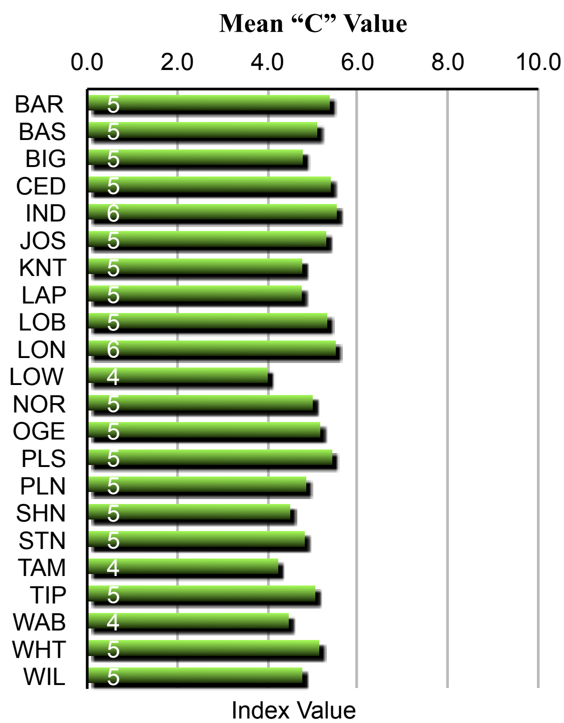


Figure ALC 8.3.1 Average "C" Value for all AROS's.

Commentary: Biodiversity
Interestingly, there is no obvious correlation between biodiversity and lake size. Even more interesting is the fact that casual observation of lake conditions does not seem to act as a good predictor of whole lake biodiversity. This underscores the importance of obtaining good empirical data for each lake. The biodiversity of most lakes is increasing and this is a very good thing. However, the kinds of species that are spreading throughout these lakes seem to be species of lower “c” values. The T1, primary target species, are not declining from year to year; however, they are being sufficiently suppressed to a non-nuisance level in the managed parts of nearly all of these lakes for most of the summer. The biodiversity of T2 and higher management value species (T2+) is increasing in all but one of the lakes that have a historical data base that can be used for trend analysis. The biodiversity of these species was greater in the late summer than the early summer, and this is also considered to be a positive trend. This means that the flora is shifting to species that are more tolerant of cultural disturbance, but these are not the T1 species that are the most notorious weeds such as watermilfoil, curly leaf pondweed, and starry stonewort.

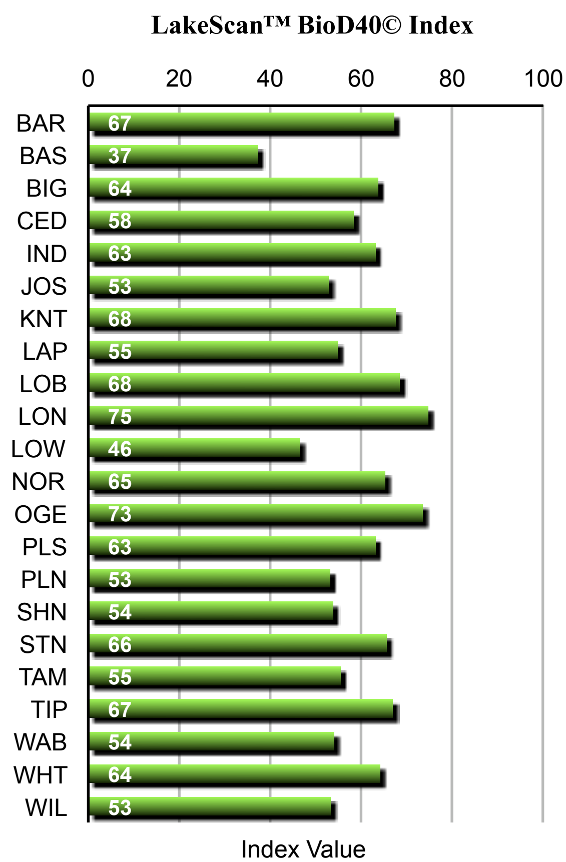


Figure ALC 8.5.1 LakeScan™ BioD 40© Large Submersed Aquatic Plant Community Biodiversity whole season index values for 22 lakes.

ALC 8.6 Plant Community Morphotype Diversity

Commentary: Morphodiversity
A fish could probably care less what names we apply to different aquatic plants. The shape and architecture of a plant is probably far more important than a name. The biochemistry of plant communities is probably a very important factor for aquatic animals as well, but we have no easy way to measure these factors, nor do we know what factors are the most important. Values equal to or greater than 40 seem to describe lakes that "look good" from this perspective. However, it is also very important to note that this factor does not seem to correlate with any other factors and that the value is not obvious from casual observations of the lakes in this analysis.

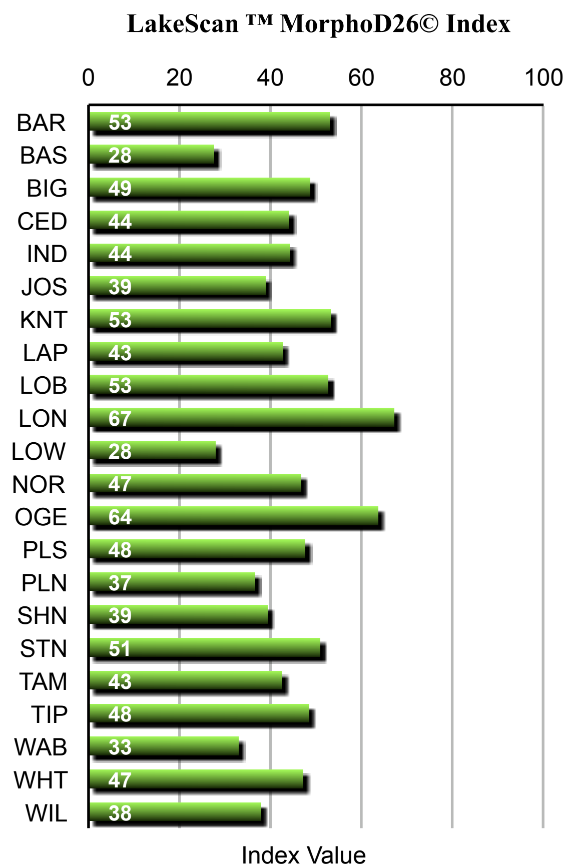


Figure ALC 8.6.1 LakeScan™ Morpho 26© Large Submersed Aquatic Plant Community Biodiversity.

ALC 8.7 Plant Community Species Biovolume

Commentary: LakeScan™ BioVol© Biovolume
The LakeScan™ BioVol© biovolume metrics were introduced in 2012. They are currently being evaluated and considered, but because they are so new, commentary shall be limited. Figure ALC 8.7.1 clearly seems to suggest that lakes that contain significant biovolumes of starry stonewort and similar species are those where average or mean plant community biovolume is higher in the AROS's in the lake.

Typically, the lakes with the highest mean AROS BioVol values are dominated by starry stonewort or chara (Figure ALC 8.7.2). These data suggest that the species present in an AROS are a chief determinant in the mean AROS biovolume in a lake.

Figure ALC 8.7.1 seems to illustrate that there is a weak, but positive correlation between lake sized and the biovolume per lake Acre Foot. Here, species composition does not seem to be nearly as an important factor as it is in mean AROS biovolume. This metric shall be subjected to further consideration and may be modified in coming reports.

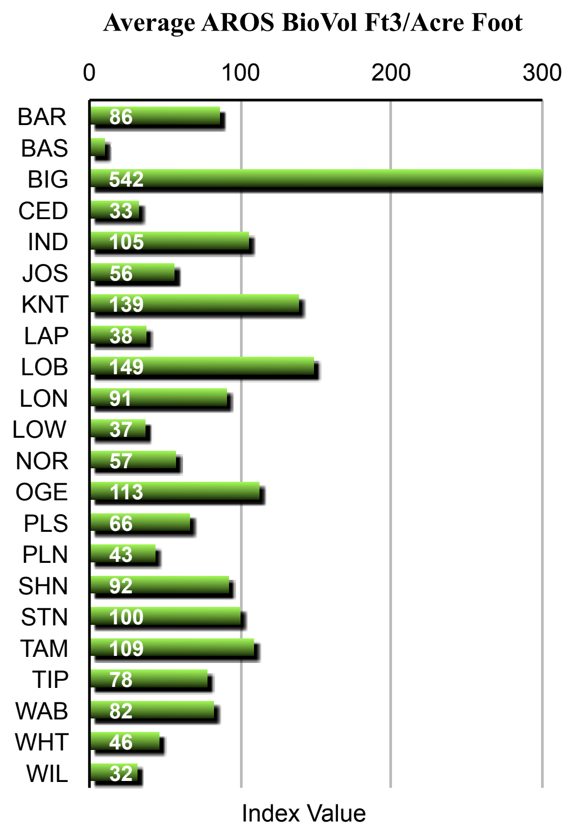


Figure ALC 8.7.1 LakeScan™ BioVol© Large Submersed Aquatic Plant Community average AROS index value. This is the average total predicted BioVol found at the AROS's of each lake included in this analysis.

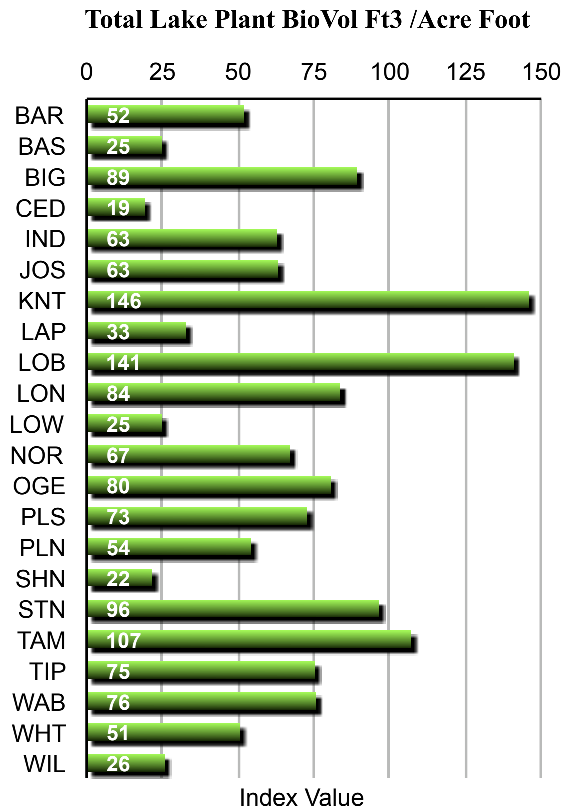


Figure ALC 8.7.2 LakeScan™ BioVol© Large Submersed Aquatic Plant Community average combined management zones index value. This is the sum total predicted BioVol found at the AROS's in all of the MZL's divided by the total calculated volume of all of the AROS's in all of the MZL's.

ALC 8.5 Plant Community LakeScan™ Weediness 10© Index

Commentary: Weediness Index Values
This index value seems to be a very good predictor of how lake users might perceive lake conditions. The higher values are without exception, associated with lakes that are generally considered to be weedy. In 2013, all of the lakes with the highest Weediness Index values were dominated by starry stonewort. The impact of this plant on Michigan lake ecosystems cannot be underestimated. Over time, it is critical that diversity indices and weediness indices are reconciled.

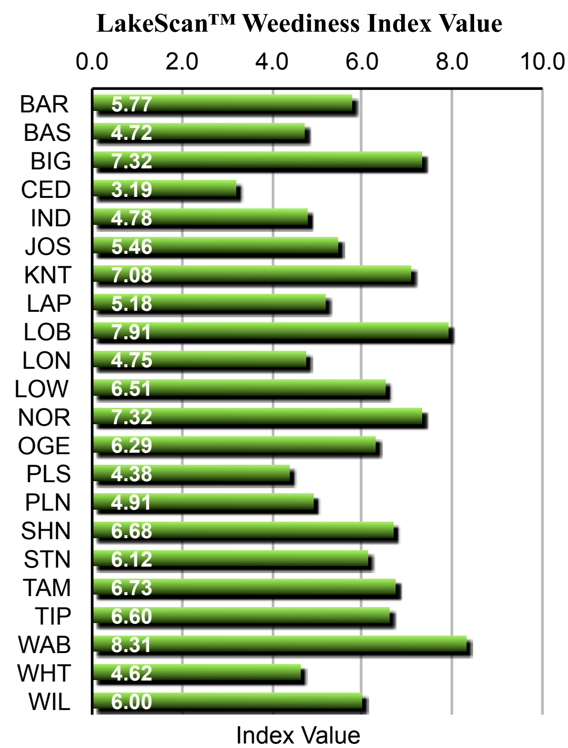
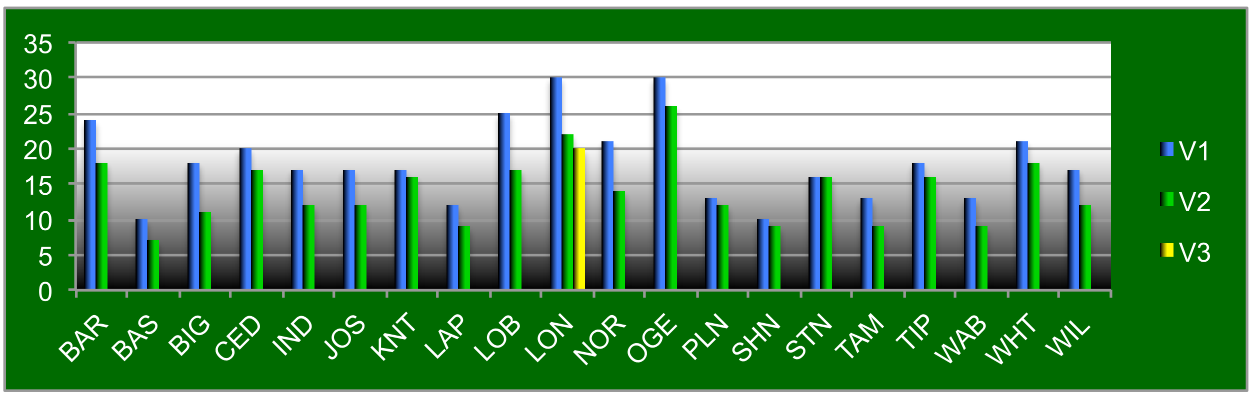


Figure ALC 8.8.1 LakeScan™ Weediness 10© Large Submersed Aquatic Plant Community Weediness Index Value.

ALC 8.0 Seasonal Plant Community Variation in LakeScan™ Metrics

Three surveys were conducted in Long Lake. One was completed at the time of an herbicide application evaluation, a second completed four weeks after the application, and a final survey was completed in late August.

ALC 8.1 Plant communities are dynamic and normally there are more species found in Michigan lakes in the early summer than the later part of the season. Many of the "early season" species flower, set seed, and then regress as the summer progresses. There are several "late season" species that do not become prominent until late July or early August, but the "early season" plant species typically out-number these plants. Targeted plant management activities are also intended to reduce species richness by eliminating, to the greatest possible degree, the dominance of T1 species such as nuisance milfoil, curly leaf pondweed, and starry stonewort. LakeScan™ analysis confirms these observations and it was found that the species richness was lower or the same in all of the lakes at the time of the late season surveys.



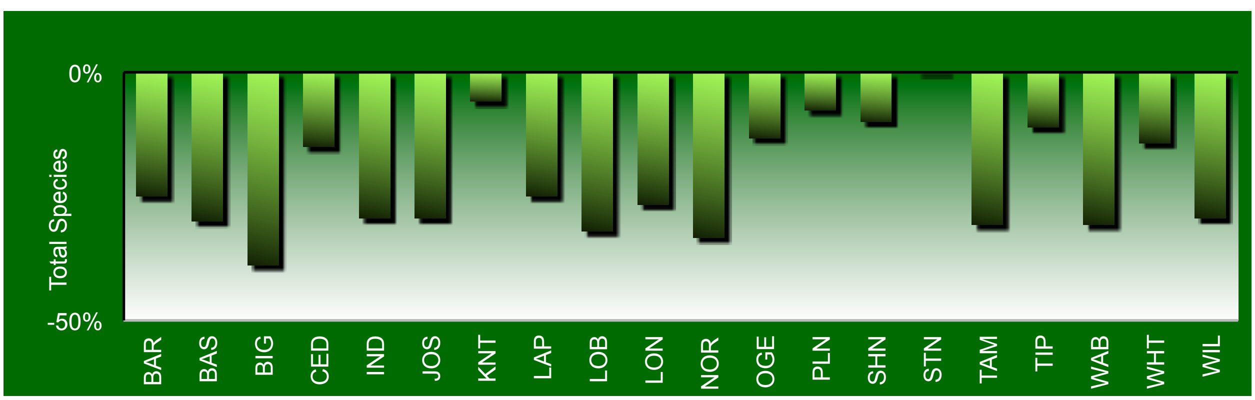
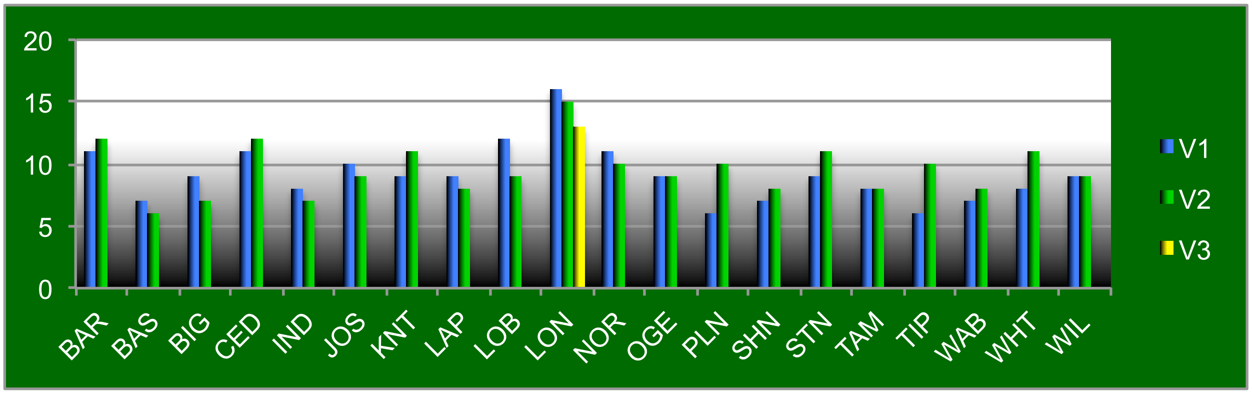


Figure ALC 8.1.1 Species richness during early and late season vegetation analysis. V1 – the first survey of the season, V2 – the second survey , etc.

ALC 8.3 Total Morpho Types: Interestingly, the diversity of different plant morphotypes increased by 4% during the course of the summer of 2013 in these 20 lakes. This is an important part of critical fisheries habitat and it is refreshing to see metric values increase during the course of the summer when refuge is particularly important for YoY fish. This might be attributed to the diversity of morphotypes of the plants that characterize late season plant communities in Michigan Lakes but could also be attributed to management effort. Some of the greatest increases in total species morphotypes were found in some of the more intensely managed lakes.



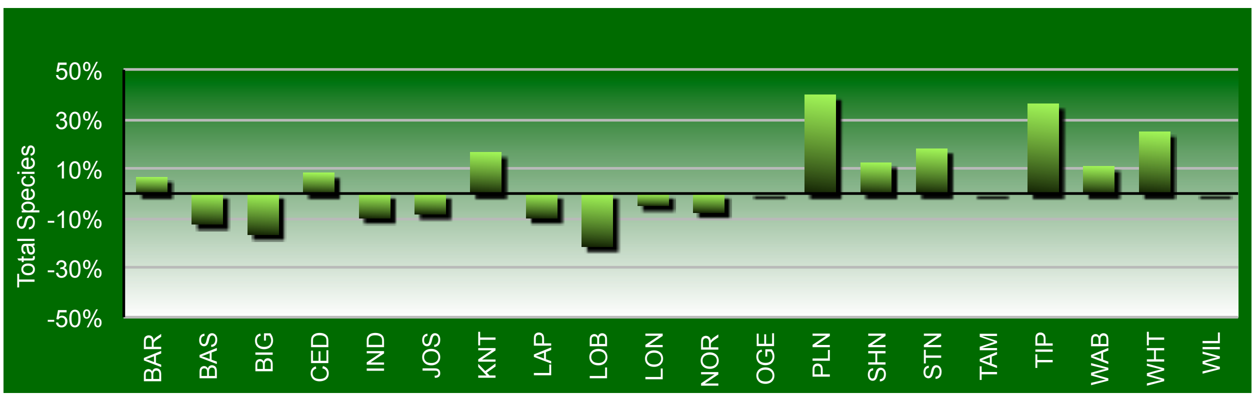
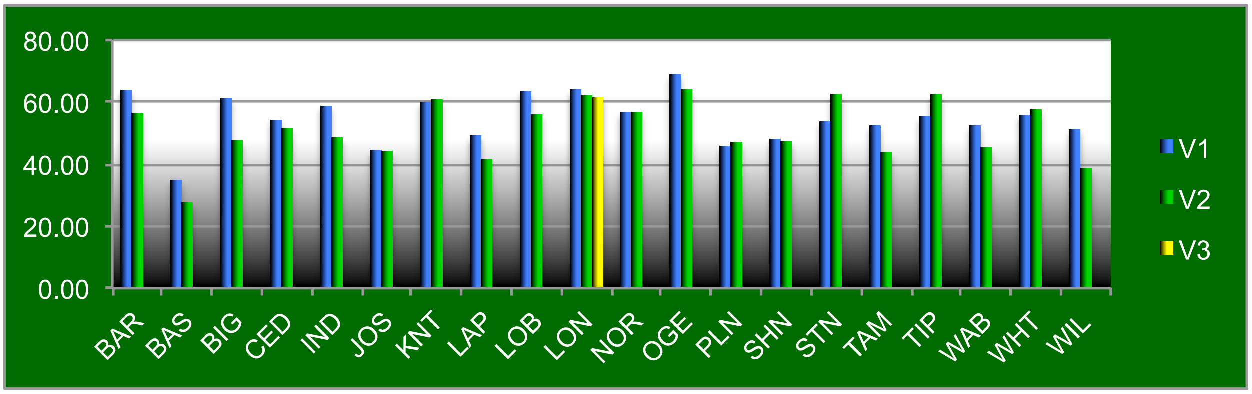


Figure ALC 8.3.1 Plant morphotypes found during early and late season vegetation analysis. V1 – the first survey of the season, V2 – the second survey , etc.

ALC 8.5 Biodiversity, Total BioD and T+2 BioD: The mean plant community biodiversity declined by 7% in these lakes during the summer of 2013. This is not unexpected and could be predicted from declining species richness analysis. Total Lakes that contained a higher percentage of T1 species and where they are actively suppressed saw significant levels of species richness decline and is expected and a desired impact of plant community management. Obviously, weedy species are targeted for suppression



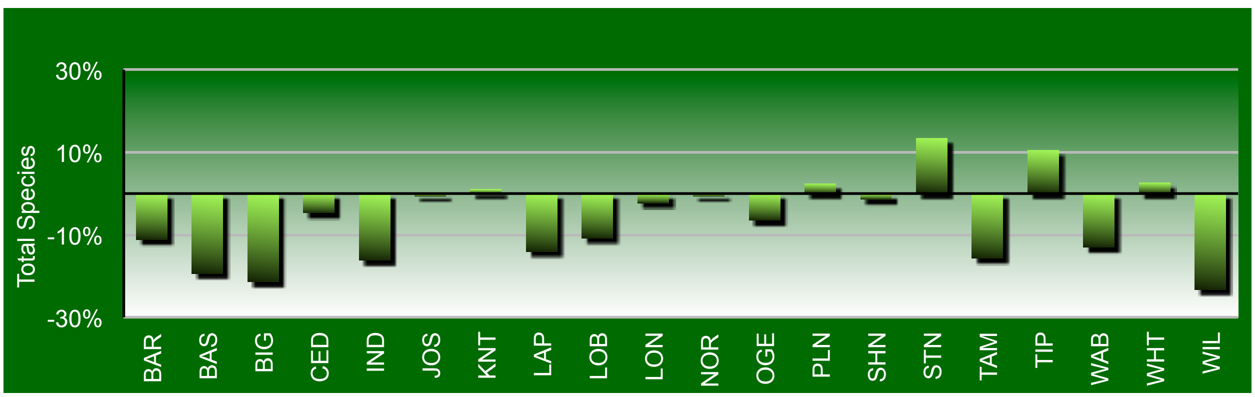
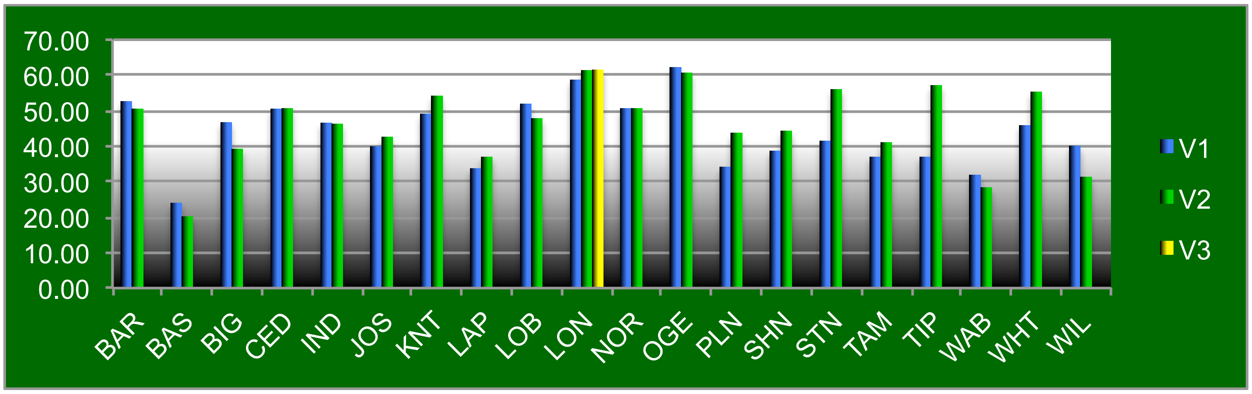


Figure ALC 8.5.1. Total Plant Community LakeScan ™BioD during early and late season vegetation analysis. V1 – the first survey of the season, V2 – the second survey , etc.



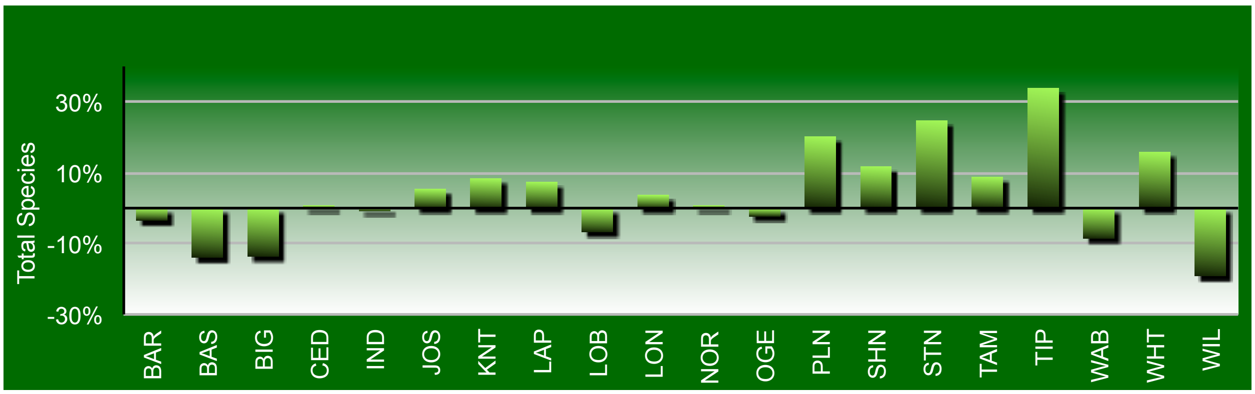
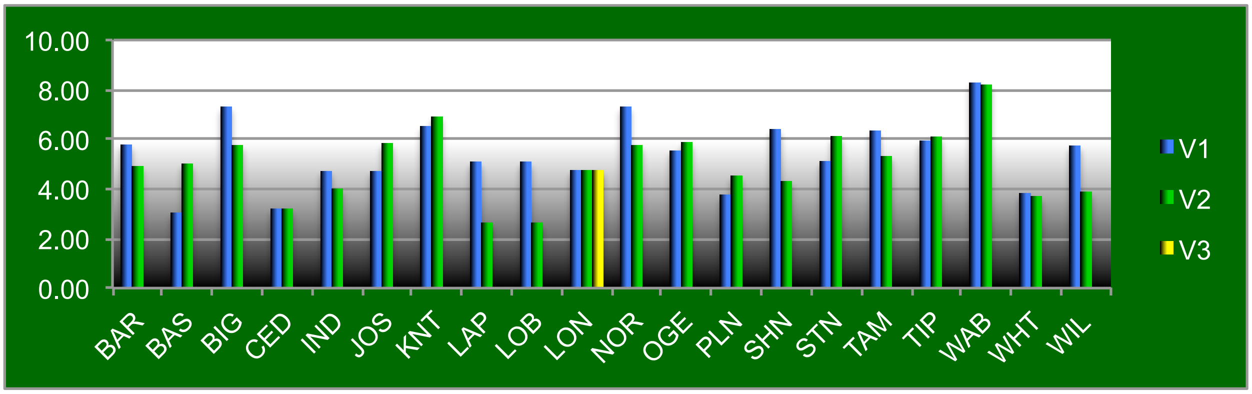


Figure ALC 8.5.1. Total T2+ Plant Community LakeScan ™BioD during early and late season vegetation analysis. V1 – the first survey of the season, V2 – the second survey , etc.

AEC 8.7 Seasonal Variation in LakeScan™ Weediness 10© values.



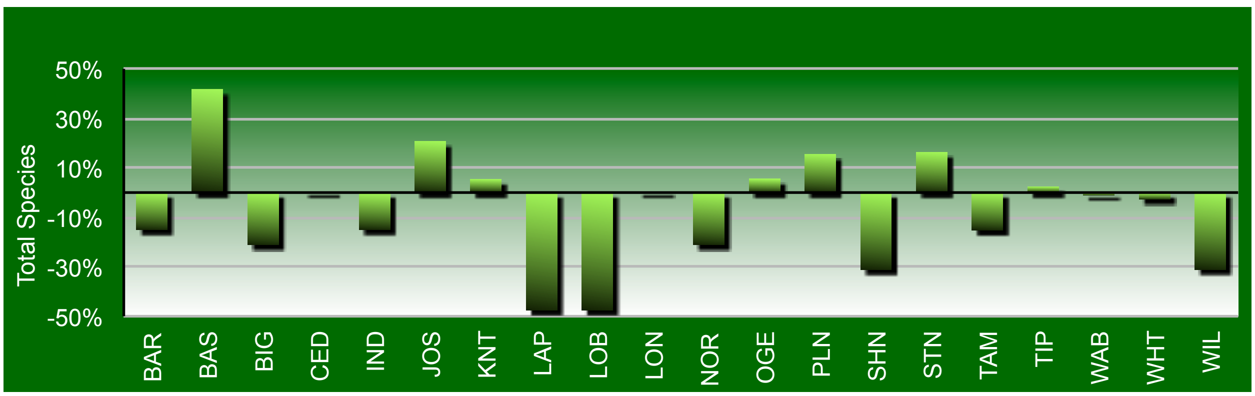


Figure AEC 8.7.1. The total and percent change in Weediness Values during the course of the summer.

HCL 8: Year to Year Comparison of Michigan LakeScan™ Large Plant Indices

Commentary: The same number and range of metrics have been calculated in all of the LakeScan™ lakes since 2011. However, all of these data are not reported here. The histograms (graphs) are stored in the original data set analysis sheets in the LakeScan™ office and can be provided on request.

Table HCL 8.1.0 The range, mean, standard deviation of the mean, minimum, and maximum values for critical statistics and metrics measured in lakes included in the LakeScan™ lake-to-lake comparison analysis.

2013	RANGE	MEDIAN	MEAN	STD DEV	MIN	MAX
TOTAL SPECIES AND AROS DATA						
% Vegetated AROS's	0 - 100	14	15	6	4	28
Total Number of Species	0 - 40	17	17	6	7	30
Maximum Number of Species at any AROS	0 - 40	10	10	4	6	20
Average Number of Species at all AROS's	0 - 40	5	5	2	2	9
	RANGE	MEDIAN	MEAN	STD DEV	MIN	MAX
LAKESCAN™ INDICES						
BioD 40© Biodiversity Index Value	0 - 100	61	59	9	37	75
MorphoD 26© Plant Morpho-Diversity Index Value	0 - 100	44	45	10	28	67
Total Morpho Types	0 - 26	11	12	3	6	20
Weediness 10© Weedy Index Value	0 - 10	5.5	5.1	2.2	0.0	8.3

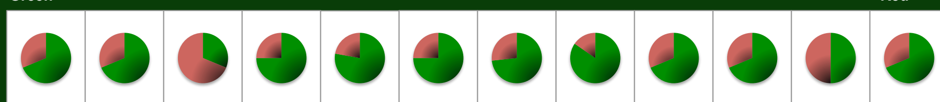
2012	RANGE	MEDIAN	MEAN	STD DEV	MIN	MAX
TOTAL SPECIES AND AROS DATA						
% Vegetated AROS's	0 - 100	13	14	5	6	29
Total Number of Species	0 - 40	16	17	6	8	32
Maximum Number of Species at any AROS	0 - 40	11	14	5	5	21
Average Number of Species at all AROS's	0 - 40	6	6	2	2	8
	RANGE	MEDIAN	MEAN	STD DEV	MIN	MAX
LAKESCAN™ INDICES						
BioD 40© Biodiversity Index Value	0 - 100	63	62	7	43	75
MorphoD 26© Plant Morpho-Diversity Index Value	0 - 100	50	47	8	33	63
Total Morpho Types	0 - 26	13	12	2	8	17
Weediness 10© Weedy Index Value	0 - 10	7	7	2	0	9

Commentary: A Comparison of Plant Community Data.
2012 was the second warmest year on record. The growing season was very long and seemed to impact many of the key metrics and analysis factors. However, these data show that if the entire growing season in each lake is considered, rather than a month or week or other lesser measure of time, conditions in the lakes in 2012 were not that different from 2011 or 2013. It is encouraging to see that the mean weediness factor for the lake considered in these analyses has declined significantly in 2013.

HCL 8.2 Trend Analysis: A slope has been calculated over several years for each of the lakes included in this year's analysis. These slopes vary from lake, but are presented here as positive, negative, or unchanged values. The Pie Charts are provided to provide a quick visual representation of the total number of lakes that trended positively and negatively during the time of analysis.

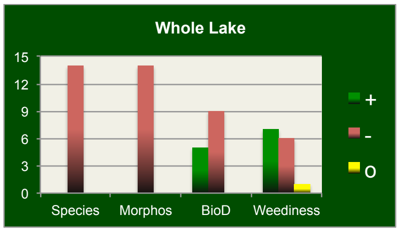
				LakeScan™ BioD 40©							
	Species Richness	Morphos	Mean C	Lake	MZL 0	MZL 1	MZL 2	MZL 3	BioD T2+	MorphoD	Lake Biovol	Weediness
Total Lakes	16	16	16	16	9	12	15	13	16	16	16	16
Total Positive Lakes	11	11	5	12	7	9	11	11	11	11	8	11
Total Negative Lakes	5	5	11	4	2	3	4	2	5	5	8	5
Total Lakes Unchanged	0	0	0	0	0	0	0	0	0	0	0	0

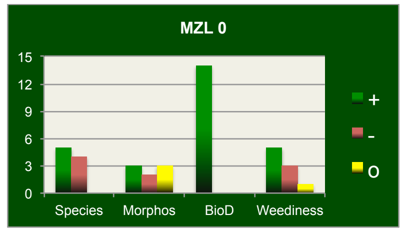
Green = "+" Red = "-"

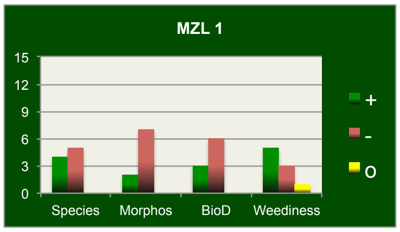


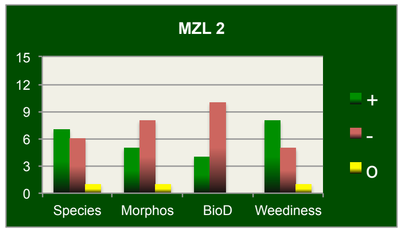
	Species Richness	Morphos	Mean C	Lake	MZL 0	MZL 1	MZL 2	MZL 3	BioD T2+	MorphoD	Lake Biovol	Weediness
Percent Positive	69%	69%	31%	75%	78%	75%	73%	85%	69%	69%	50%	69%
Percent Negative	31%	31%	69%	25%	22%	25%	27%	15%	31%	31%	50%	31%
Percent Unchanged	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%

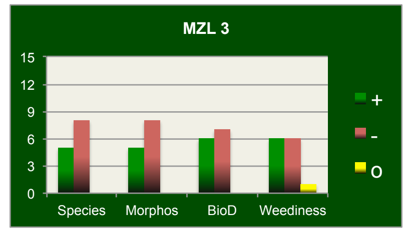
	Species Richness	Morphos	Mean C	Lake	MZL 0	MZL 1	MZL 2	MZL 3	BioD T2+	MorphoD	Lake Biovol	Weediness
BAR	-	-	-	-	+	+	+	+	-	-	-	+
BAS	-	+	+	-	+	+	+		-	+	+	+
BIG	+	+	-	+	-	+	-	-	+	+	+	+
CED	+	-	+	+	+		+	+	+	-	-	-
IND	+	+	+	+		+		+	+	+	+	-
JOS	-	-	-	+		-	-	-	-	-	-	-
KNT	+	-	-	+	+		+		+	+	+	+
LAP												
LOB	+	+	-	+		-	-	+	+	+	+	+
LON												
LOW	+	+	-	+	+	+	+	+	+	+	-	+
NOR												
OGE	+	+	+	+		+	+	+	+	+	+	+
PLS	+	+	-	-		+	+	+	+	-	+	-
PLN												
SHN												
STN	+	+	-	+	+		+		+	+	-	+
TAM	+	+	-	+	+		+	+	+	+	-	+
TIP	-	-	-	+		+	+	+	-	-	-	+
WAB												
WHT	+	+	+	+	-	-	-	+	+	+	+	-
WIL	-	+	-	-		+	+	+	-	+	-	+
0												







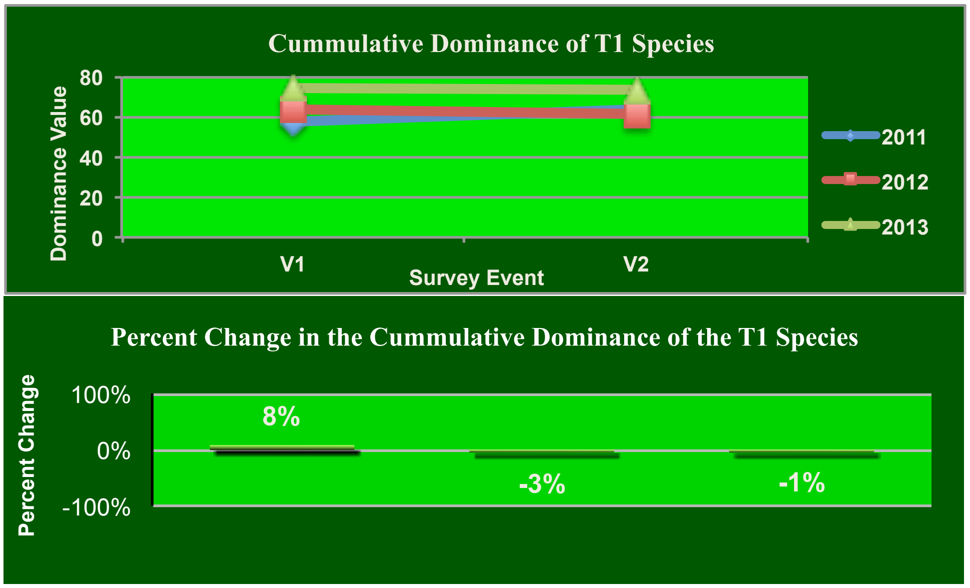




HCL 8.3 Trend Analysis: Early and late season plant communities vary because there are early and late season plant species. This author believed that all major metric decline from the early to late season floras. However, it is interesting to note that the LakeScan™ BioD and Weediness metrics do not decline in all lakes. In fact, the number of lakes that saw declines in metric values from the early to late season flora were only slightly greater of equal to the number of lakes that actually see an increase in metric values.

AM 1.5.0 Submersed Aquatic Plant Management

This section is currently under development. It will include a record of management elements and implementations. It will also include an historical analysis of previous management activities and comparisons to other lakes. Currently the dominance of certain species and T1 and T2+ species groups are presented.



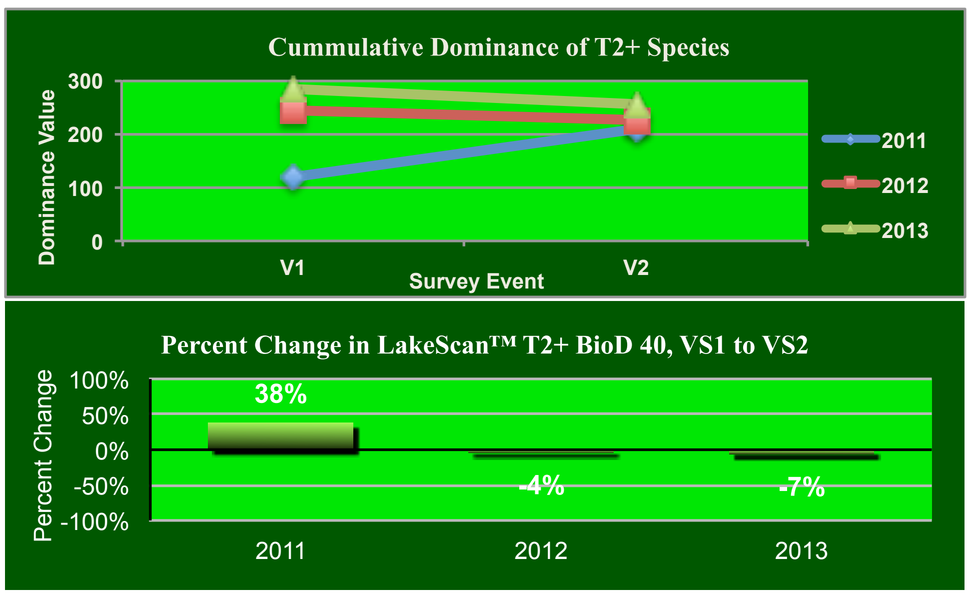


Figure AM 8.9.1 The dominance of the weedy, T1 group of species and the more desirable T2, T3, & T4 (T2+) species. V1 and VS1 represent the results derived from a June or early summer, pre-treatment survey. V2 and VS2 represent the results derived from an August or late summer, survey.

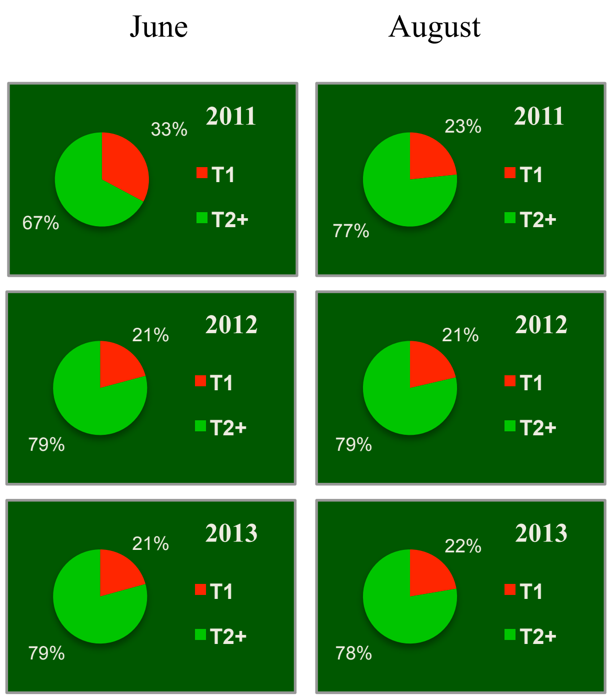
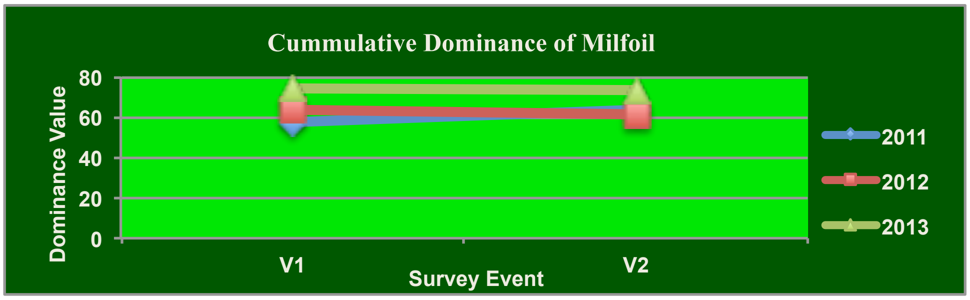


Figure AM 8.9.2 The relative dominance of the weedy, T1 group of species and the more desirable T2, T3, & T4 (T2+) species. The percentages represent the cumulative total of all of the dominance values at the first, early summer survey (before treatment) and the cumulative dominance values determined at the second sampling event (August).



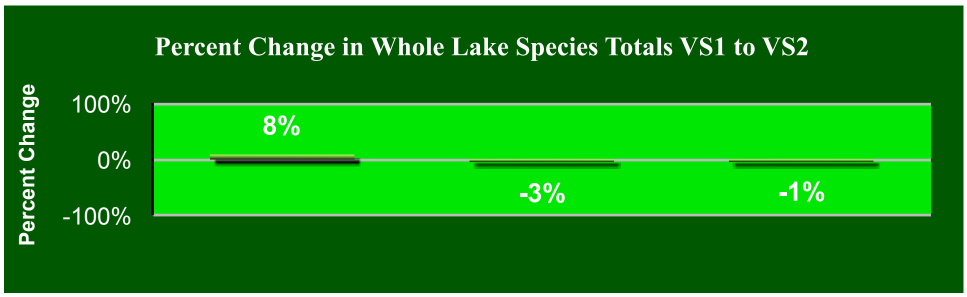


Figure AM 8.9.3 The dominance of the nuisance milfoil plants and the more desirable T2, T3, & T4 (T2+) species. V1 and VS1 represent the results derived from a June or early summer, pre-treatment survey. V2 and VS2 represent the results derived from an August or late summer, survey.

June August

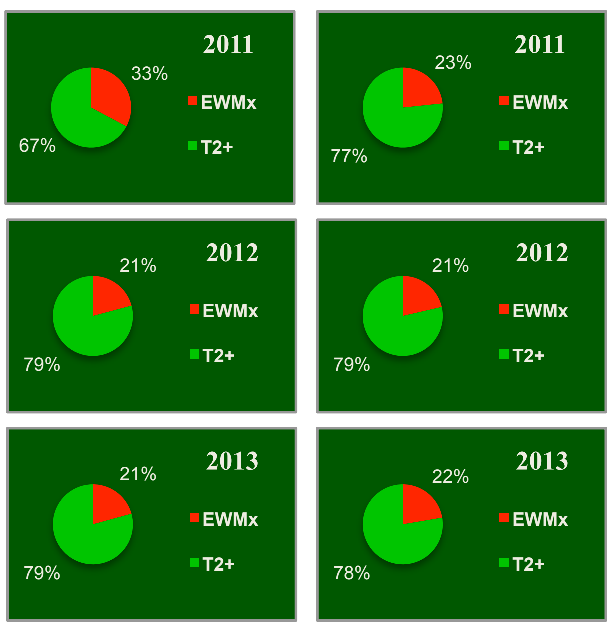


Figure AM 8.9.4 The relative dominance of nuisance milfoil and the more desirable T2, T3, & T4 (T2+) species. The percentages represent the cumulative total of all of the dominance values at the first, early summer survey (before treatment) and the cumulative dominance values determined at the second sampling event (August).

Aquest Tip:

Rationale for Managing Aquatic Vegetation

Lake leaders and managers cringe when they hear someone say that “the lake has never been this bad before”. Often the comment is made without accurate recollection of of recent lake conditions; however, there is truth in the statement when lakes are considered within the context of the past several decades. When aquatic vegetation cover and biomass become sufficiently high to disrupt the natural balance of a lake and interfere with recreation people begin to seek solutions to the problems. Aquatic weeds are usually referred to as being a nuisance or invasive. The list of nuisance and invasive plants has grown much longer in the past three decades as weedy species have invaded North America from other continents and other species have become more problematic as they respond to human activity and the introduction of foreign species. Excessive aquatic plant growth interferes with nearly all forms of recreation and causes many biological problems. For example, dense plant growth at the water surface impedes exchange of gases between the air and water, thereby contributing to nighttime dissolved oxygen depletion and large daily pH fluctuations. Dense invasive species growth can cause the desirable plants to decline and can destroy the quality of spawning habitats. Production of desirable sport fish (e.g., largemouth Whitmore) is maximized at intermediate levels of plant cover and biomass. Boaters and swimmer are usually satisfied with the conditions that support a good fishery. It is fortunate that there a number of things that can be done to improve or renovate aquatic plant communities to enhance recreation, improve fishery habitats, and make lakes more resilient to the invasion of new or emerging weeds.

The list of invasive plant species that create problems in Michigan lakes is expanding rapidly. Invasive species are often exotic, which are plants that do not naturally occur in the same geographical area but invade lakes after being introduced from other parts of the world. Invasive plants do not necessarily have to be exotic. Native species or hybrids can emerge as invasive plant genotypes that dominate parts of a lake in response to the selective pressures placed on aquatic vegetation communities as a result of human activity and invasion of other invasive species. Exotic and invasive plant genotypes typically form dense mono-specific (single species) plant beds that result in a loss of plant community diversity, habitat complexity, ecosystem stability, and resilience. Lake quality is seriously degraded unless unless interventions are applied and the offensive plant species are suppressed. It is not possible to reduce the total amount of aquatic plant biomass that is produced in a lake. And, it may not even be desirable to do that. Generally the problem is not really too much plant growth, but too much of the wrong kind of plant growth.

At moderate density levels, aquatic plants provide important benefits to the lake, including sediment stabilization, invertebrate habitat and cover for small fish. Thus, management of problem aquatic plant growth should be carried in such a way as to preserve desirable aquatic vegetation or preferred plant species. Most preferred species are characteristic of stable, undisturbed ecosystems and are not usually considered to be a nuisance. Effective aquatic plant management can preserve beneficial aquatic vegetation in a number of ways. Selective techniques control problem species with minimal effect on desirable ones. Desirable vegetation can also be preserved by limiting the application of control techniques to areas where they are needed. In general, areas in every lake should be set aside to support different types of plants. For example some of these areas may support plants that may interfere with boating, but create good “edge effect” for anglers. There are lower growing plant species that should be maintained in areas of the lake where boating is really important. Because invasive species fail to recognize the boundaries of the lake management plan proper vegetation management is a “whole lake proposition”. It is certain that a lakes in Michigan will never have “been so bad” unless responsible lake communities take action to mitigate against the consequences of ecosystem disturbance and target invasive species for suppressive management activity.

An Overview of the LakeScan™ Method, Metrics, and Analysis Tools

Aquatic Ecosystem Analysis Tools

LakeScan EcoAnalysis tools provide the only practical, comprehensive, and meaningful way to assess the quality of surface water resources. LakeScan™ is a system that provides the empirical data that is necessary to compare one lake to another or evaluate trends in a lake by comparing year to year data. It can also be used to more accurately assess the impacts and outcomes of management plans. These tools are critical to formulate appropriate and scientifically based lake management decisions and to assess the impact of changes to the resource, watershed, or changes that have been affected by management activities. They have been designed to meet or exceed the monitoring requirements of State or Federal governments and the new NPDES permitting system as it applies to the application of aquatic herbicides. LakeScan analysis tools are affordable and provide the essential record needed to know what you're getting into when enjoying surface water resources or developing plans to improve these critical habitats.

LakeScan is the ONLY available system that can provide the information that is critical to meet a wide range of aquatic resource management needs. These include:

~ Development of prescriptive management plans,
~ Evaluation of the outcomes of applied management programs,
~ Support the use of lake specific management tools,
~ Definitive measures of the impacts of invasive species,
~ Provide a mechanism for the comparison of conditions in different lakes,
~ Provide a mechanism for the comparison of lake conditions over time,
~ Delineation of the location and type of critical habitat characteristics,
~ Provide empirical evidence of efficacy for research and development efforts.

Note: This section has recently been deleted from the LakeScan™ Master Report Format because of the size of the file. Please refer to the LakeScan™ instruction manual found at:

https://www.dropbox.com/s/kx55o63yabtheqb/14%20LakeScan%20Metrics%20HandOut.docx

PLEASE REFER TO THE LAKESCAN™ HANDBOOK FOR DESCRIPTIONS AND DEFINITIONS