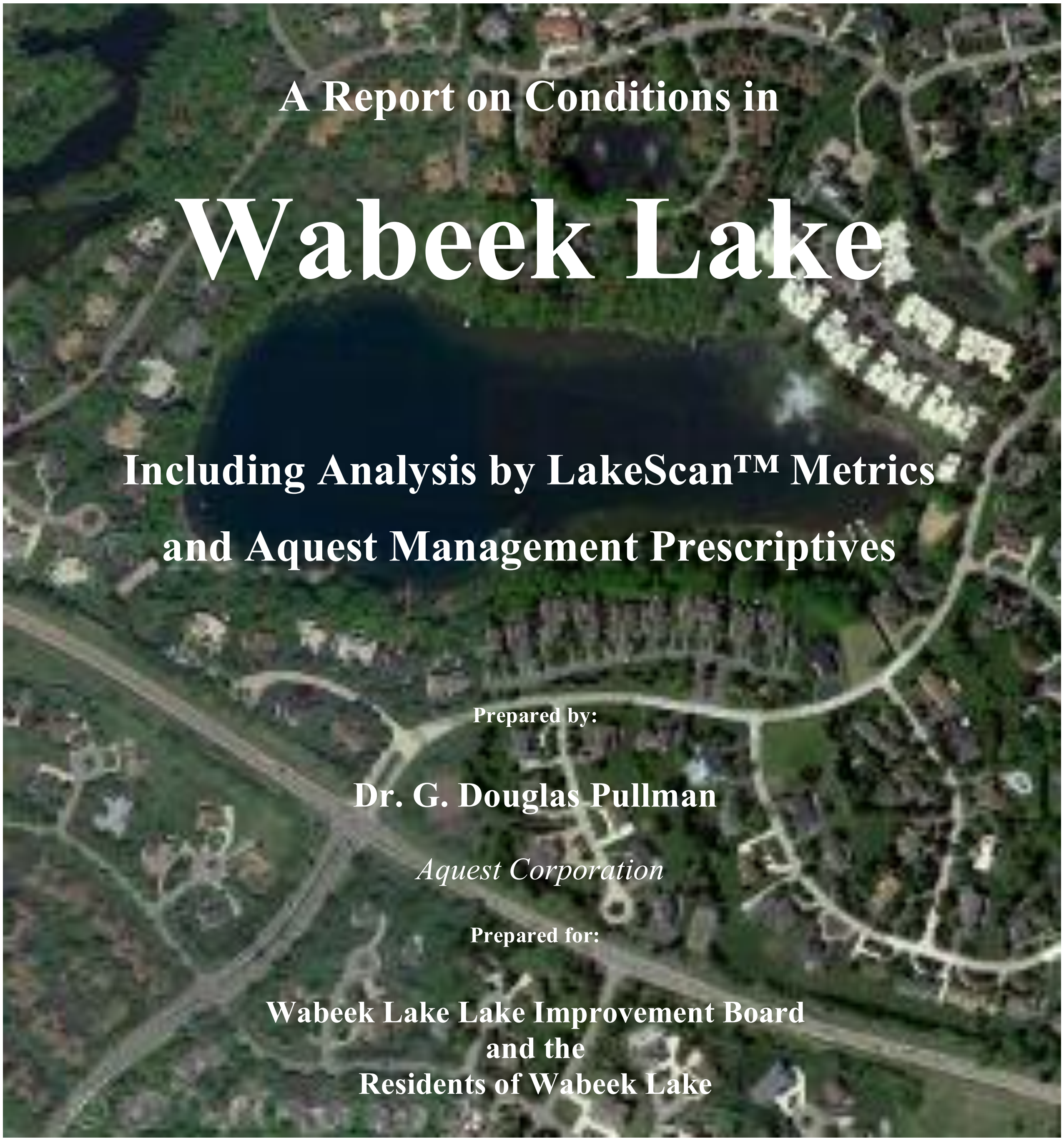

A Report on Conditions in

Wabeek Lake

Including Analysis by LakeScan™ Metrics and Aquest Management Prescriptives

Prepared by:

Dr. G. Douglas Pullman

Aquest Corporation

Prepared for:

**Wabeek Lake Lake Improvement Board
and the
Residents of Wabeek Lake**

2015

LakeScan™

Aquest Corporation

Wabeek Lake

A Report on Lake Conditions and Management Recommendations

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St. Petersburg, FL

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2015

PREFACE

The findings, conclusions, and prescriptives in this report are derived on a thorough analysis of lake conditions that are based on the LakeScan™ data acquisition and analysis tools. LakeScan™ is a system of component parts that include data collection methods and analysis algorithms that are used to consider and evaluate a wide range of lake characteristics and critical ecosystem functions. These generate the empirical data necessary to properly assess current lake conditions, consider lake conditions at different times during the growing season and to construct an historical record of conditions and trends that can be used for year-to-year comparisons. These data also permit meaningful lake-to-lake comparisons. 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.

There are numerous LakeScan™ sections and each section deals with a different part of the lake ecosystem. For example, LakeScan™ section 7 provides an analysis of large plant and weed conditions in the lake. Section 5 deals with phytoplankton communities. And, Section 2 deals with water quality metrics and concerns. Unlike many lake reports, this report will not provide an extensive analysis of water quality or phytoplankton data and then base weed control recommendations on scant data that relates to the plant community. If management objectives call for interventions and management of plant and weed communities, data will be presented that relate to that critical part of the lake ecosystem. Likewise, if there is an issue with phytoplankton or water quality, the recommendations in this report will be based on the empirical data that are produced by the LakeScan™ system. Since lakes are publicly held and shared resources, it is absolutely critical that these data be produced to prove that monies and resources are spent responsibly and based on solid and meaningful lake analysis. 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.

LakeScan™ is constantly being enhanced and improved - like software that is improved by the introduction succeeding versions. As this occurs, individual lake reports may be updated throughout the year. The DropBox link that is provided will not change during the course of the year. Reporting updates will be made to the same file so that no other link is necessary to access the edited file.

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.

-GDP, 2015

Wabeek Lake

2015 Annual Report

Executive Summary

Background and Overview:

MANAGEMENT GOAL

~ LakeScan™ guided management programs goal and target focused. LakeScan™ goals describe how a lake is supposed to look and function. Specifically, goals focus on lake attributes and desirable conditions. A properly conceived lake management goal will:

Stabilize ecosystems,

Protect the public health,

Preserve or improve lake and water quality and aesthetic attributes,

Create and maintain reasonable conditions for recreational opportunities, and

Preserve or improve lake shore property values.

Stabile aquatic ecosystems are supported and characterized by high levels of biological diversity and diverse and relatively undisturbed critical ecosystem habitats. They are believed to be more resilient to invasion by exotic organisms, and less likely to bloom with nuisance conditions and potentially toxin producing cyanobacteria. Stabile lakes generally are characterized by excellent water quality and clarity. They also support vibrant fisheries and are suitable for most forms of recreation. LakeScan™ data provides empirical data necessary to evaluate progress toward meeting the lake management goal.

MANAGEMENT OBJECTIVES

~ Management objectives are the things that "are done" each year to manipulate conditions in a lake to create outcomes that are consistent with the management goals. When conditions are found in a lake that might be inconsistent with any of the LakeScan™ management goals, interventions are prescribed that are intended to preserve, protect, or improve the aquatic ecosystem. These interventions are implemented as part of annual management objectives which are dynamic and may be subject to change in any given year, depending upon progress being made to meet LakeScan™ Category Management Goals Management Intervention Strategies and Technologies (MIST's) are selected that will do the best job of ameliorating conditions that prevent the attainment and sustainability of properly conceived management goals. LakeScan™ places the focus on what the lake should be and not what is applied to a lake.

OVERVIEW AND MAJOR FINDINGS

~ Wabeek Lake is in fair condition according to most LakeScan™ metric data. It appears to be a relatively unstable ecosystem but this is a characteristic of most lakes of this size. Conditions in the lake vary widely from year to year. A very aggressive weed management program was instituted in 2005 and has successfully produced acceptable outcomes. However, the program objectives have had to be adjusted each year to match the unique challenges that emerge each year. The dominant nuisance species have also changed from year to year from ebrid milfoil, to starry stonewort.

LakeScan™ Selected Monitoring and Key Metrics

LakeScan™ monitoring was begun on Wabeek Lake in 2005. Wabeek Lake is considered to be in only fair condition by all LakeScan™ lake quality measures when compared to other, larger lakes. However, when the size of the lake is considered, the metric values derived from the lake would indicate that the lake is in good condition – "for a lake of this size".

Category 200: Water Quality Monitoring and Management:

No interventions recommended at this time; however, participation in the State of Michigan water quality monitoring program, CLMP, is recommended.

Category 700: Plant Community Evaluation

LakeScan™ Category 7 surveys were conducted at different times during the plant-growing season. A shorthand method is used to describe when a plant community survey has been conducted. VS 3.0 surveys were conducted in the early summer at the peak of floristic diversity. VS 5.0 surveys were conducted in the late summer when the late summer floristic diversity was the greatest. All data is presented for all of the Tier areas and MZL areas in the lake. TmtZ area data is found in Section 750 (when available).

Table 700.000.1 Summary tables of critical LakeScan™ metrics and other aquatic plant community quality 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. Lake to lake comparison data was compiled from 25 Michigan inland lakes in 2015.

Lake To Lake Comparisons and Trend Analysis

Metric Values	Species Richness	Morpho-types	Mean C	Whole Lake BioD	BioD T2+	MorphoD	Lake Biovol ft3/acre ft	Weediness
Wabeek Lake	10	7	4.2	16	9	44	426	5.4
2015 All Lake Average	17	12	4.7	41	29	76	206	4.6
2015 All Lake Range	11 to 27	8 to 19	3.0 to 6.3	18 to 80	12 to 69	43 to 98	25 to 542	3.2 to 5.6
Historical Trend Analysis								
Wabeek Lake	+	-	+	+	+	+	+	+
2015 All Lake Trend Analysis	+	-	+	+	+	+	+	+
2015 Trend Analysis	14 1 5	8 1 11	12 1 7	12 1 7	11 1 8	10 1 9	14 1 5	14 1 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

Historical Averages

Total Years = 10

	Species Richness	Morpho-types	Mean C	Whole Lake BioD	BioD T2+	MorphoD	Lake Biovol ft3/acre ft	Weediness
Wabeek Lake 2015	10	7	4.2	16	9	44	426	5.4
Historical Average	10	8	3.4	16	10	44	215	5.1
Historical Metric Range	8 to 13	6 to 10	2.3 to 4.2	10 to 24	8 to 14	26 to 61	92 to 426	3.7 to 6.1

2 3 4 5 6 7 9 9

Annual Data Comparisons

	Species Richness	Morpho-types	Mean C	Whole Lake BioD	BioD T2+	MorphoD	Lake Biovol ft3/acre ft	Weediness
2011	8	6	2.7	10	8	26	322	6.1
2012	10	8	2.9	14	10	43	164	6.0
2013	12	10	3.3	20	12	61	315	5.9
2014	13	8	3.9	24	14	50	197	5.4
2015	10	7	4.2	16	9	44	426	5.4

Category 700/000.014 Plant Community Species Richness

Species and Morphotype Richness	
2015 Species Richness = 10 *Goal = 12* *2015 Morpho Richness = 7* *Goal - 10*	*Total number of species that are present in the lake is referred to as species richness. The total number of distinct plant morphotypes is referred to as the morphotype richness. Higher values are better.*
Annual Data **2015**	The species richness in Wabeek Lake is only fair. It was 2 species less than the target value in 2015 and this may have been related to the severity of the previous winter. The variety of plant morphotypes (leaf shape and plant form) is also considered to be important as a primary structural component of critical habitat. There were only 7 different morphotypes found in the lake in 2015 which was considered to be disappointing.
Spatial Data **Tiers, MZL and Lake to Lake**	The species and morphotype richness was much greater in the nearshore areas in 2015, (Tier 3 and MZL 3). However, values in the nears shore and other parts of the lake were nearly are still considered to be acceptable for a lake this size. These data emphasize the importance of nearshore plant communities and support the role that these areas play as critical lake habitat. The species richness in Wabeek Lake was among the lowest recoded among the 25 lakes considered in this report. They are considered to be acceptable for a lake of this size.
Seasonal Data and Historical Data	The species and morphotypes richness was equal in the early than the late summer in nearly all tiers and MZL's. Slightly more than half of the total number of species observed were only present during either the early or late summer surveys. These metrics are being monitored because as the data set is expanded, they may prove to be predictors of lake stability. The species and morphotype richness in 2015 was among the lowest recorded.
Comments	The species and morphotypes richness is considered to be fair for a lake of this size but has declined in the past year. This is a matter of considerable concern.

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Category 700/000.040 Plant Community Species Quality

Plant Community Quality	
2015 "C" Value = 4.2 *Goal = 4.5* *2015 Mean "T" = 2.0* *Goal = 2.5*	*Each plant species has been assigned a "C" value that ranges from 1 to 9. Lower weighted man values suggest that the plant community is too weedy. Each species is also assigned a "T" value ranging from 1 to 4. Weeds that are nearly always targeted for management are T1. A rare or endangered species that is never weedy would be a T4 species. Higher values are better.*
Annual Data **2015**	Given the predominance of ebrid milfoil and with the recent introduction of starry stonewort, it may have been expected that the species quality of the Wabeek Lake benthic flora would not necessarily meet target values. Ebrid milfoil was successfully suppressed throughout most of the summer so the quality of the lake was improved.. The target value will not likely be attained until ebrid milfoil and starry stonewort control is more effective.
Spatial Data **Tiers, MZL and Lake to Lake**	The quality of the plant community was higher in the near shore Tier 3 and MZL's. This emphasized the importance of these near shore communities. The mean weighted "C" value for 2015 was in Wabeek Lake was substantially lower than the average for the 25 lakes included in this analysis. The mean T value varied little from area to area.
Seasonal Data and Historical Data	The weighted mean "C" value of the submersed flora of Wabeek Lake has increased during past five years. The weighted "T" or target weed management value for the lake has generally increased during the same time period, but was lower in 2015. Desirable pondweed production is responsible for the increase in these metric values..
Comments	The quality of the Wabeek Lake plant community is good for a lake of this size and is consistent with reasonable expectations. It is hoped that recent improvements in these metrics will indicate that the lake is becoming more stable.

Category 700/000.074: Plant Community Biological Diversity, BioD 60©

<table>
<tr><td colspan="2">LakeScan™ BioD 60©

2015 BioD Value = 22
Goal = 40

2015 BioD T2+ Value = 28
Goal = 35

Plant community diversity is a key lake quality metric because it varies with lake quality and is probably related to ecosystem stability. Plant communities are much more than how many species are present. This metric is a combination of species richness and the occurrence of all species in all AROS. Higher values are better.</td></tr>
<tr><td>Annual Data

2015</td><td>The biological diversity of the Wabeek Lake plant community is very low. This is because the lake is small and the total species richness is low. A goal of 40 is typical for all lakes, but may be unrealistic for Wabeek Lake.</td></tr>
<tr><td>Spatial Data

Tiers, MZL and Lake to Lake</td><td>The near shore (Tier 3 and MZL 3) areas of the lake supported greater biodiversity than the deeper areas of the lake. This emphasizes the importance of the near shore area for the stabilization of the entire ecosystem.

The BioD 60© of the Wabeek Lake submersed plant community was considerably lower than the average of the 25 lakes considered in this report (41). However, the value does not seem unreasonable given the size of the lake.</td></tr>
<tr><td>Seasonal Data and Historical Data</td><td>BioD values have generally trended upward in Wabeek Lake until 2015. The 2015 value is still lower than the historical mean, but near the average and is considered to be adequate for this lake.</td></tr>
<tr><td>Comments</td><td>The management program appears to be having a positive impact on Wabeek Lake BioD and the stability of the ecosystem. MIST need to be carefully selected for this lake to maintain reasonable stability and minimize impact on the more desirable plants in the flora.</td></tr>
</table>

Category 700 /000.084: LakeScan Weediness 10© Index Values

LakeScan™ Weediness 10© *2015 Weediness Value = 4.1* *Goal = 5.0*	The weediness index is the most subjective of the LakeScan™ metrics. It is like a biodiversity index but field species data is weighted by the density and distribution of each species in the AROS. Each species is assigned an "I" value or potential invasiveness value. This factor is also combined with height, density, and distribution data to provide an additional weighting factor to the index. This index provides a very good estimate of perceived weed conditions and appears to be a good metric representation of aquatic plant communities. LOWER values are better.
Annual Data **2015**	The 2015 weediness index value for Wabeek Lake is 5.4 and is slightly off of the goal of 5.0. The predominance of ebrid milfoil and starry stonewort consistently cause the lake to be weedy and result in higher than desired weediness index values.
Spatial Data **Tiers, MZL and Lake to Lake**	Weediness index values vary only slightly from Tier to Tier and MZL to MZL. Weedy conditions are similar throughout the lake. Wabeek Lake was more weedy than most of the other lakes that are reviewed in this analysis. The mean, 2015 weediness index value was 4.6.
Seasonal Data and Historical Data	Wabeek Lake was weedier in the late summer than early summer in 2015. This can be attributed to a late season bloom of starry stonewort. Historically, weediness has been greater in the early summer than late summer; however, weediness seems to correspond with the bloom of starry stonewort. Starry stonewort bloomed later in 2015 than it had in previous years.
Comments	Weediness tends to increase or decrease with the bloom or decline of starry stonewort in Wabeek Lake.

Category 710: Plant Community Management and Outcome Analysis

Overview:

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. Early summer and late summer surveys are required to evaluate the quality of the distinct plant early and late summer plant communities.

Water milfoil has dominated the flora, to varying degrees, for decades. It is highly likely that the milfoil genotype in Wabeek Lake is a hybrid (ebrid) and that the dominant genotype may vary from year to year. However, weedy broad leaf pondweeds and curly leaf pondweed have also dominated the flora in some years. Prescriptive, species targeted management is absolutely critical to protect the Wabeek Lake ecosystem from further degradation by invasive plant species.

Starry stonewort has also been a dominant plant in the lake and has completely dominated the flora in some years. It may be the greatest challenge to maintaining the biodiversity and the stability of the Wabeek Lake ecosystem. It blooms unpredictably at different times of the year and can outcompete and extirpate all other plant species in the lake. It is also the chief control of the water quality and clarity in the lake.

Each year, treatment objectives are established only after lakes conditions have been reviewed near the Memorial Day holiday. Various herbicide combinations have been applied to Wabeek Lake and are adjusted to meet the challenges of that year.

A variety of herbicide combinations have been applied to Wabeek Lake in recent years. Historically the lake is usually treated with a contact herbicide combination in June for curly leaf pondweed and milfoil control. Starry stonewort controls have been applied later in the growing season. A systemic herbicide combination was applied in 2015 for milfoil control and milfoil was suppressed throughout the year. It is not known how great a nuisance milfoil may become in 2016, but it is hoped that the prescribed herbicide combos will provide some residual benefits into that year.

Prescriptives, 2016.

The winter of 2015/2016 has been unusually mild. Milfoil and curly leaf pondweed are capable of significant growth when conditions are similar to those observed this winter. It is expected that both species will be present at nuisance level in early summer, 2016. Aggressive management will be required around the circumference of the lake. A second treatment may be necessary to suppress the milfoil that may bloom from seed in August.

Starry stonewort continues to be highly unpredictable. It may or may not grow to nuisance levels in the lake in 2016, but the timing of such blooms is impossible to predict.

Treatment plans will be formulated following an early season, pre-treatment survey, and will be based on actual conditions that are observed during that survey. Management objectives shall be established and MIST shall be employed to protect the diversity of organisms and complexity of habitats in Wabeek Lake. These efforts will also support a vibrant fishery and recreational enjoyment of the resource.

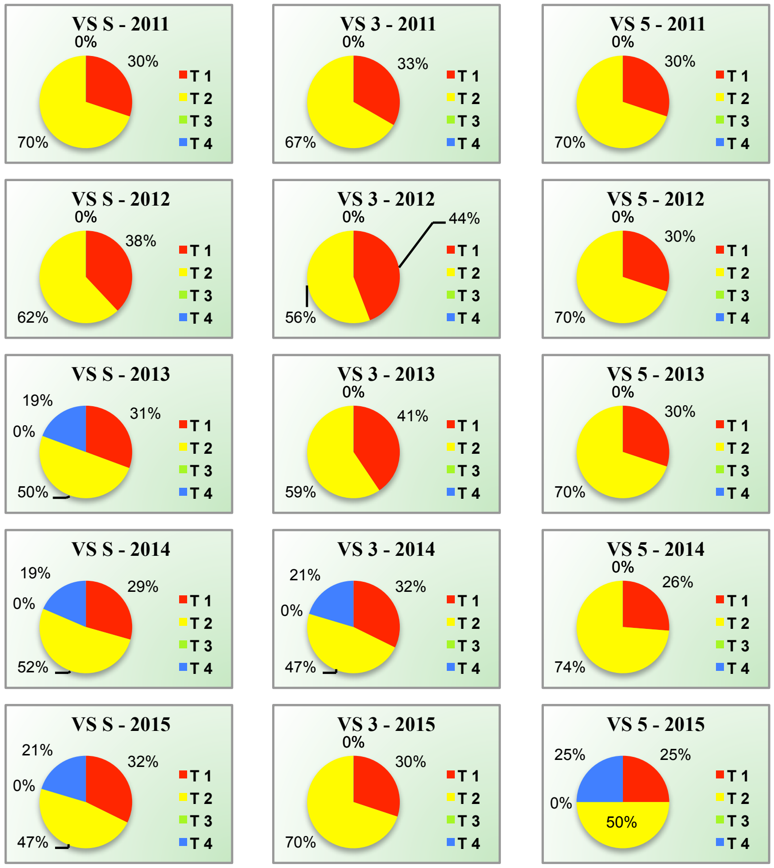


Figure 750/123.264 The relative dominance of T1 of weedy, management targeted plants and more desirable plant species (T 2 to T 4) averaged over the whole growing season (VS S), in the early summer (VS 3.0) and late summer (VS 5.0) in Wabeek Lake since 2011. Note that the VS 3, 2015 survey was done after curly leaf pondweed was removed from the water column. This figure is a testameant to the effectiveness of the 2015 early season treatment.

Wabeek Lake

Oakland County, Michigan

Analysis of Key Parameters, Metric, Indices, and Conditions

Using the LakeScan™ Method

2015

Statements of Management Goal and Program Objectives

The Primary Goal of the LakeScan™ Lake Management Programs

The primary goal of any lake management program should be to protect, preserve, and when possible, improve the stability of the lake ecosystem. This is accomplished when conditions are modified within the lake to enhance species and habitat diversity and thereby stabilize the ecosystem by promoting the production of conservative species. Success will help to inhibit the production of those plants that are weedy or more opportunistic and will make any 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 Objectives

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 submersed macrophyte flora through the prescriptive use of selective plant management agents and strategies. The submersed flora of nearly all inland lakes is characterized by plant species that are generally considered to be both desirable and undesirable. For example, ebrid milfoil (the various genotypes of Eurasian watermilfoil and hybrid milfoils) have been considered to be a serious nuisance in many Michigan inland lakes for several decades. Selective plant management agents have been used to successfully suppress the production of opportunistic and invasive species, like ebrid milfoil, that are prone to form monocultures and suppress the production of preferred, conservative plant species. Sometimes the near shore areas of the lake are so choked with a wide variety of species that broad-spectrum plant control strategies are needed to allow shoreline residents access to the main body of the lake. Typically, some plants are killed by such MIST applications while the growth of other species may only be arrested or suppressed and thereby maintained at below-nuisance levels. Nuisance conditions are usually related to the density and distribution patterns of the species that are growing within each AROS. The density and distribution of all plant species in all lake AROS must be closely monitored to determine the best strategy for a given season or year.

Management objectives are rarely the same for different parts a lake. It is reasonable to expect that different MIST applications will be more appropriate for some areas of a lake and not for others. Decisions are based on LakeScan™ findings, predominant lake uses, shoreline development, and the ecological values associated with different areas in a lake. Consequently, management objectives are not uniform in lakes, but will vary from area to area. Best management practices and the preferred MIST programs prescribed for these areas must also be considered within the context of state permit conditions, cultural influences and economic considerations. Five distinct management objectives are assigned to lake areas and AROS aggregations where different the best MIST applications might tailored to meet the specific objectives for each designated lake area. These areas are referred to as Management Zone Levels (MZL - 1, MZL - 2, MZL - 3, MZL - 4 and MZL – 0 or no management). The objectives for each of the MZL areas or AROS aggregations provide guidance for the selection of the best MIST practices for a given area in a lake. It is critical to remember that MZL designations only provide guidance according to predetermined guideline objectives for these different areas in a lake. Treatment zones (TmtZ) are those areas in a lake where an actual MIST is applied. It may applied to an entire MZL or only a portion of these areas. Treatment zones (TmtZ) should not be confused with areal management zone levels (MZL).

Table of Contents

Category 100: Administrative, Geopolitcal, Geomorphology, and Geographic Data

Section 100.01 Physical and Geopolitical Characteristics

›gory 100

Physical and Geopolitical Characteristics

100/100.120 Location

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

100/120.210 Basic Morphometry

Total Area (Acres):	25
Shoreline Length (Feet):	
Littoral Zone Depth (Feet):	10
Littoral Zone Area (Acres):	16.5595
Maximum Depth (Feet):	24
Mean Depth Feet):	8
Littoral Zone Volume (Acre Feet):	147
Total Lake Volume (Acre Feet):	211
Hydraylic Residence Time:	

100/110.110 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 (%):	

Section 100.05 Aquatic Resource Observation Sites and Zones

Category 100

Physical and Geopolitical Characteristics

100/100.200 Monitoring and Data Analysis

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

AROS TIER ASSIGNMENTS	AROS Numbers		AROS Acres	
Total Tier AROS:	**51**		**17**	
	#	**%**	**acre**	**%**
Total Total Tier 1 AROS	0		0	
Total Total Tier 2 AROS	0		0	
Total Total Tier 3 AROS	21	41%	6	36%
Total Total Tier 4 AROS	16	31%	5	30%
Total Total Tier 5 AROS	14	27%	6	34%
Total Total Tier 6 AROS	0	0%	0	0%

Total AROS Acres:	0.33	Acre/AROS
Total AROS Area and Whole Lake Area:	67%	Of Total Lake Acres

AROS MANAGEMENT ZONE LEVEL (MZL) ASSIGNMENTS	AROS Numbers		AROS Acres	
Total MZL AROS (including MZL 0):	**51**		**17**	
Total Managed MZL AROS (MZL 1 to 4):	**46**		**15**	
	#	**%**	**acre**	**%**
Total MLZ 0 AROS:	5	10%	1	9%
Total MLZ 1 AROS:	16	31%	7	40%
Total MLZ 2 AROS:	0	0%	0	0%
Total MLZ 3 AROS:	30	59%	9	51%
Total MLZ 4 AROS:	0	0%	0	0%

% Total Managed MZL AROS:	91%	Of Total AROS Acres
% Total Managed MZL AROS Acres in Whole Lake:	61%	Of Total Lake Acres

Section 100.08 Program Administration

Category 1000

Management History and Authorities

Management Authority:	Wabeek Lake Improvement Board
Contact:	Mr. Jay Shah
Address:	c/o Bloomfield Township 4200 Telegraph Road Bloomfield Hills, MI 48302
Telephone:	
Email:	
Web Page:	
Year SAD Established:	
Total SAD Units:	
Lake Management Guidance Consultant:	Aquest Corporation
Contact:	Dr. G. Douglas Pullman
Address:	540 Trinity Lane N, 4103 St. Petersburg, FL 33716
Telephone:	810-516-6830
Email:	aquest@mac.com
Web Page:	
Herbicide Application Consultant:	
Contact:	Aqua-Weed Control, Inc.
Address:	Mr. Dick Pinagel 414 Hadley St. Holly, MI 48442
Telephone:	248-634-8388
Email:	dick@aquaweed.com
Web Page:	

Management History	
Years of Professional Management Guidance:	Since 2003
Lake Management Consultant:	Aquest Corporation, (since 2003)
Herbicide Application Contractor:	Aqua-Weed Control, Inc. (since 2007)
Years of LakeScan Analysis:	1
First Year of Monitoring Program:	2005

Section 100/122.300 Aquatic Resource Observation Sites and Zones

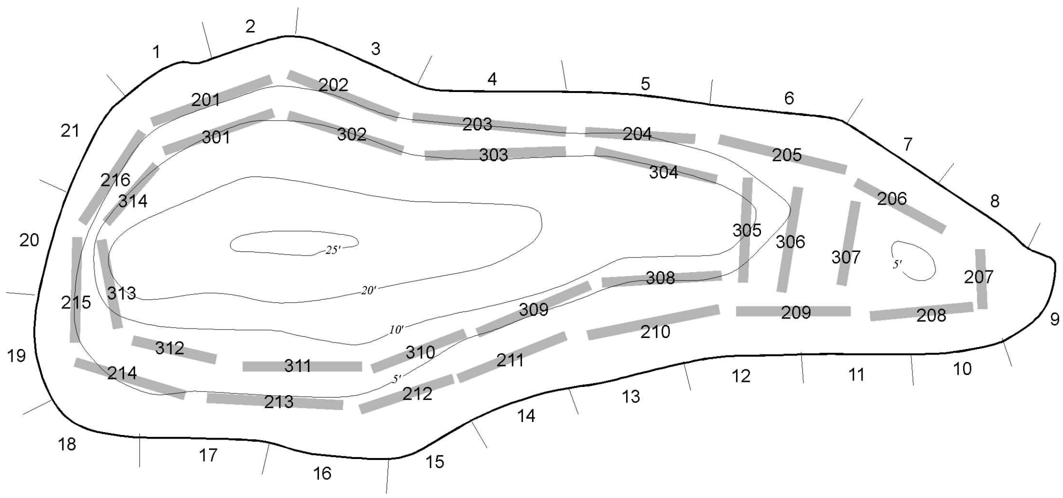


Figure 100.122.320 A map depicting the location of all Aquatic Resource Observation Sites (AROS's) that were used to make observations in Wabeek Lake.

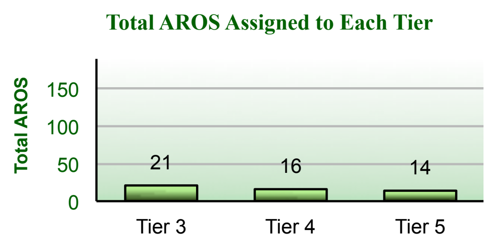


Figure 100/122.320 The total number of AROS and total number of AROS at each Tier.

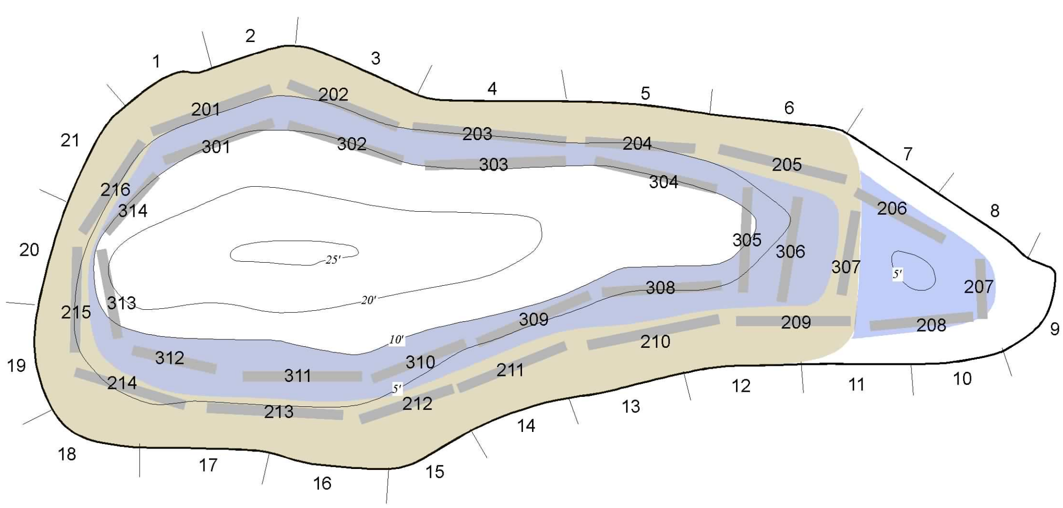


Figure 100/122.350 A map depicting the location of all Aquatic Resource Observation Sites (AROS's) that were used to make observations in Wabeek Lake according to MZL assignment. Tan = MZL 3 and Blue = MZL 1.

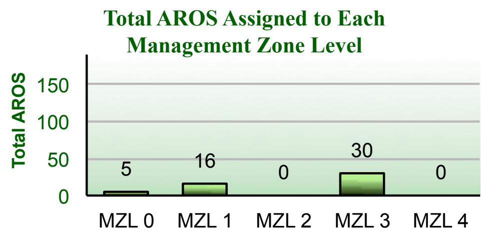
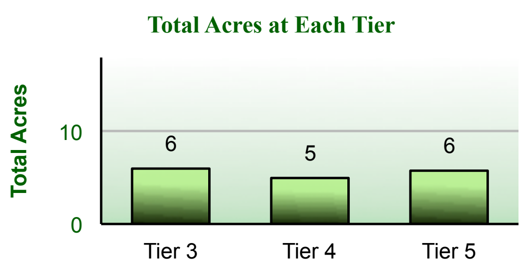


Figure 100/122.350 Plant species management level assignments (MLZ) by AROS.



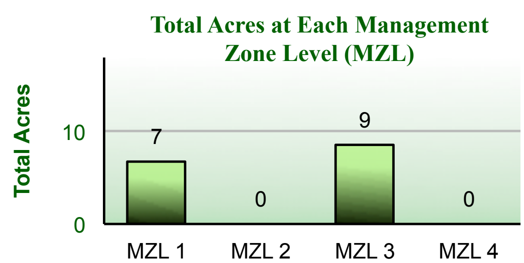


Figure 100/122.350 c The sum total acre area of the AROS assigned to each Tier and each Management Zone Level (MLZ).

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.

Category 200: Water Chemistry and Quality. Particulates and Pollutants

Organic and Inorganic Dissolved and Suspended Substances

210/020.110 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.

There were no obvious and serious impairments of water quality observed during any of the LakeScan™ Category 700 surveys.

210/020.140 Alkalinity, pH, and Free Carbon Dioxide

Recent data not reported. These data can be critical in lakes that are afflicted with frequent or persistent cyanobacteria blooms.

210/020.150 Plant Nutrient Concentrations

Phosphorus is a very important plant nutrient. It is often in limited supply in aquatic ecosystems. The total amount of primary production (plants and algae) and secondary production (bugs and fish) that can be produced in a lake is strongly correlated to the amount of available phosphorus within and inland lake. Watershed and shoreline development can result in increasing the amount of phosphorus that enters a lake (loading) which can ultimately result in undesirable consequences. Total phosphorus concentrations in lake water have been strongly correlated with pollution and the presence of serious nuisance algae blooms.

The spread and proliferation of starry stonewort and zebra mussel are known to focus nutrient resources in the bottom of a 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. In some cases, phosphorus levels could drop to a level where plant production will limit fish production should the lake be overcome with starry stonewort.

There were no obvious and serious impairments of water quality observed during any of the LakeScan™ Category 700 surveys that might have been related to culturally elevated plant nutrient concentrations.

210/020.211 Water quality indices

The Carlson water quality index has become widely accepted index or measure of pelagial water (open water) quality. Unfortunately, it is too often misused or inappropriately considered as an over-all summary measure of the quality of a lake. Wabeek Lake is dominated by a broad and diverse benthic habitat and it is unwise to consider a measure of pelagial lake quality as relevant lake quality measure.

There were no obvious impairments of water quality observed during any of the LakeScan™ Category surveys that might have been related to culturally elevated water column plant nutrient concentrations.

Category 300: Microbial and Bacteriological Communities

310/020.120 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 various neighborhood swimming areas.

310/020.110 Awfuchs 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 a wide range of studies that 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.

It is highly likely that herbicide tolerant aufwuchs communities or biofilms have the ability to seriously compromise the outcome of the herbicide application program. These considerations already play a key role in the development of specific vegetation management plan objectives since herbicide resistance has been a persistent problem in Wabeek Lake.

Category 400: 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 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. 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 fish and water supplies with off-odors and taste. They can also produce substances that are toxic in water supplies and some of these substances have also been determined to be carcinogenic. Furthermore, there is increasing evidence that blue green algae dominance may be less supportive of fisheries because of various 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 and developed. 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.

The cyanobacteria are extremely sensitive to a variety of EPA registered algaecides. Laboratory, challenge studies have shown that the cyanobacteria are four to twenty times more susceptible to algaecides than are other algae. Currently, MI DEQ rules prevent the use of low rates of algaecides over an entire water body as a means of achieving selective suppression of cyanobacteria.

WHO GUIDELINES FOR SAFE PRACTICE IN MANAGING RECREATIONAL WATERS*

Guidance level or How guidance situation level derived

Health risks	Typical actions
Relatively low probability of adverse health effects**	
20,000 cyanobacterial cells/ml or10 mg chlorophyll-a/litre with cyanobacteria dominance	
~ Short-term adverse health outcomes, e.g., skin irritations, gastrointestinal illness	~ Post on-site risk advisory signs ~ Inform relevant authorities
Moderate probability of adverse health effects ***	
100,000 cyanobacterial cells/ml or50 mg chlorophyll-a/litre with cyanobacteria dominance	
~ Potential for long-term illness with some cyanobacterial species ~ Short-term adverse health outcomes, e.g., skin irritations, gastrointestinal illness	~ Watch for scums or conditions conducive to scums ~ Discourage swimming and further investigate hazard ~ Post on-site risk advisory signs ~ Inform relevant authorities
High probability of adverse health effects ****	
Cyanobacterial scum formation in areas where whole-body contact and/or risk of ingestion/aspiration occur	
~ Potential for acute poisoning ~ Potential for long-term illness with some cyanobacterial species ~ Short-term adverse health outcomes, e.g., skin irritations, gastrointestinal illness	~ Immediate action to control contact with scums; possible prohibition of swimming and other water contact activities ~ Public health follow-up investigation ~ Inform public and relevant authorities

* From WHO (World Healt Organization) Guidelines, 1999.
** From human bathing epidemiological study
*** From provisional drinking-water guideline value for microcystin-LRc and data concerning other cyanotoxins
**** Inference from oral animal lethal poisonings Actual human illness case histories

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 water.

Continued

Blue Green Algae Part 2: Why Do Blue Greens Become a Problem:

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

1. **TP and TN**

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

2. **Free Carbon Dioxide**

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

3. **Biotic Factors**

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

Category 700: Large Plant Communities or Macrophytes – a primer

It has been well established that aquatic macrophyte production in a lake is strongly correlated with the quality of lake sediments rather than nutrient concentrations found in the lake water, as is the case with phytoplankton. It is not appropriate to apply terms such as oligotrophic, mesotrophic, eutrotrophic, and hypereutrophic; as they were originally conceived, to lakes where primary production is dominated by macrophytes. In fact, these classifications can be very misleading and the reader is advised to avoid distractions that occur as a result of the perpetuation of the myth that lake-wide macrophyte production can be reduced through nutrient loading abatements or sequestration by harvesting. It is simply not possible to diminish or constrain total aquatic macrophyte production on a long-term or sustainable basis with any currently available technologies, nor would this ever be desirable. Aquatic macrophytes to play a key role in the creation of critical habitats and in the stabilization of aquatic ecosystems. Conditions become unacceptable to people when certain nuisance macrophyte species dominate a lake and reduce the production of desirable species that are not generally considered to be a nuisance. Of the nearly 40 different species that are observed throughout Michigan inland lakes each year, only three species are consistently found to create nuisance conditions or problems. Aquatic weed problems are rarely the result of too much plant growth, but rather the bloom of just a small number of offending species. Most of the nuisance aquatic plant species are referred to and may be listed as "invasive". Many of these are not be endemic to a lake or are known to be "exotic" having been introduced to a lake from another continent. Selective and competitive pressures on certain plant species may result in the emergence of invasive genotypes of plant species that would normally not grow to nuisance levels, but this is not wide-spread. It is also important that the reader be cognizant that lakes are dynamic and ever-changing systems that adapt to conditions and disturbances imposed by people and weather. Conditions change, plant communities change, and predicting the future of macrophyte communities can be like predicting the weather in Michigan.

Plant species are assigned a "target" number in every LakeScan™ lake. T1 is the value assigned to the most weedy and invasive species such as Eurasian watermilfoil and starry stonewort. T2 is assigned to a large group of species that are not generally found to grow at nuisance levels throughout an entire lake, but may grow to nuisance levels in some discrete areas where use might dictate that some suppressive intervention be implemented. T3 species are usually fairly inconspicuous and will rarely be targeted for any form of control. They are; however, reasonably resilient and can recover reasonably well from either intentional plant management activities or natural disturbance or calamity. T4 species are rare and endangered and should be protected by reducing competition with aggressive and invasive species and from the exposure to the consequences of man-made disturbance.

Aquatic macrophyte species are not randomly distributed around lakes. The physical and biogeochemical characteristics of the sediments play a critical roll in determining the distribution of various aquatic macrophytes. Different plant species respond differently to wind and wave exposure and the total energy derived from this kind of physical disturbance which can include boat props and wakes. Sediment bulk density, sediment nutrient and naturally occurring phytotoxin concentrations are also key determinants of macrophyte species density, distribution and the percent occurrence of various species in the AROS in a lake. These factors, combined with competition and interactions with other plant species and animals are primary determinants of what plants will be present or absent in the AROS in a lake. Shoreline development is another key factor in determining what plant species can and will dominate a lake although the mechanisms involved in these kinds of disturbance are not known. Plant species that are able to tolerate a wide range of natural conditions and man-made disturbance are referred to as opportunistic species. Those species that are relatively intolerant of the same variables are considered to be conservative species. Opportunistic species are usually weedy. The same plants assigned C values of less than 4 are common weeds.

Cat 710: 2015 Lake-Wide Plant Community LakeScan™ Analysis

710/121.014 Species Richness (Total Species) (Annual)

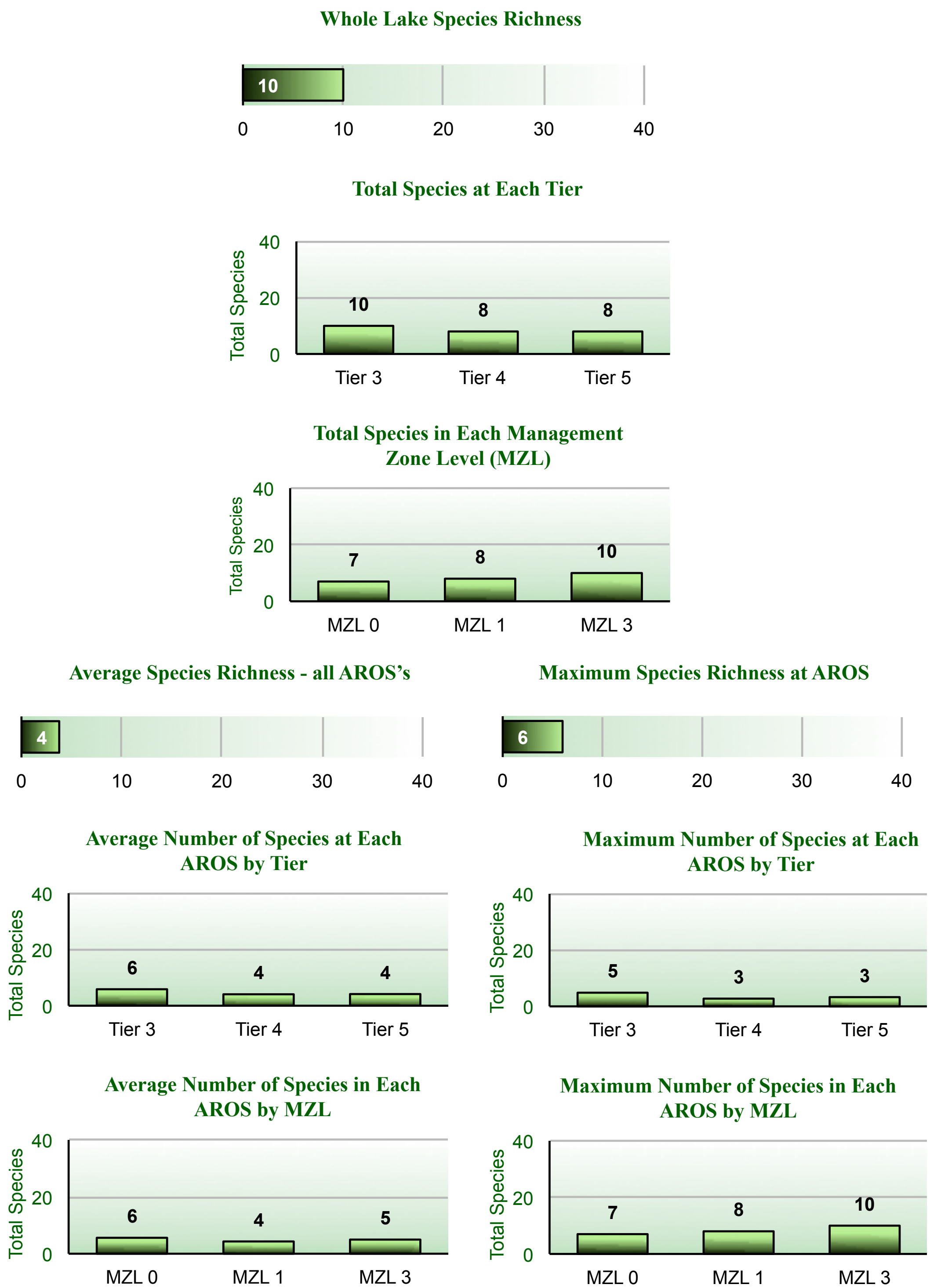


Figure 710/123,4.014 Total species richness or total species present in the lake and the average and maximum number of plant species found at any AROS in the lake during the most recent survey year. These data are also presented by Tier and MZL.

710/121.017 LakeScan™ Plant Community Quality (Annual)

710/121.017 Morphotypes

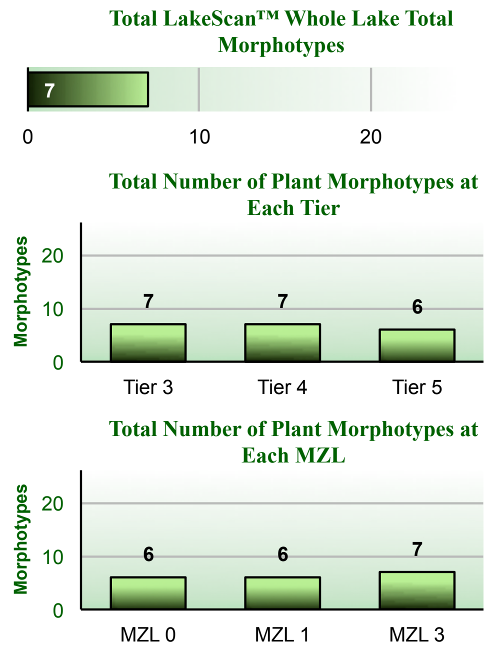
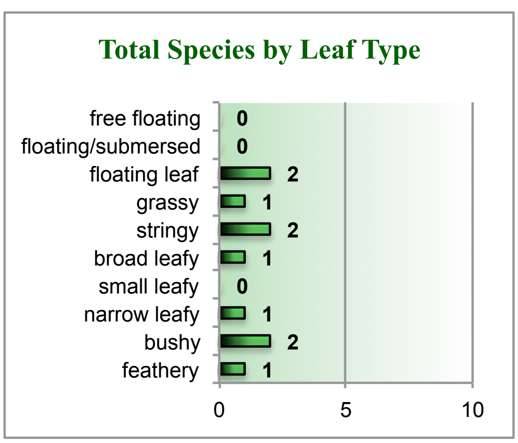


Figure 710/123,4.017 Plant morphology is an important measure of the structural complexity of any ecosystem. It could be said that fish don't care what names we given to submersed macrophytes – they care about structure. LakeScan™ recognizes 26 distinct plant morphotypes among common submersed macrophyte species.

710/121.017 Leaf Types



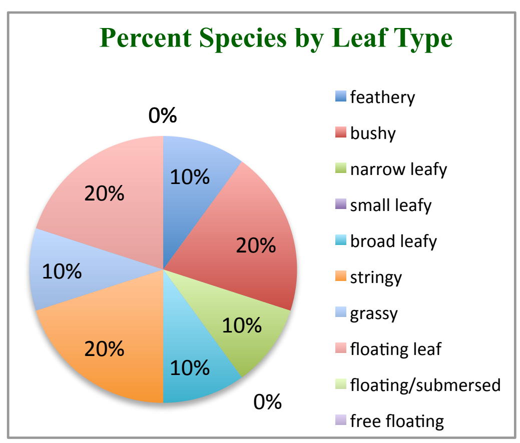


Figure 710/121.017 The total number (histogram) and percentage of plant species leaf morphotype (pie chart) found in the lake for the entire summer or growing season.

Table 710/121.040 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 #	Abbrev. Name	Common Name	Scientific Name	*t* Value	*i* Value	*c* Value	Leaf Type
1	2	EWMx	Eurasian Milfoil Hybrid	*Myriophyllum spicatum x sibiricum*	1	8	2	feathery
2	60	CHARA	Chara (many)	*Chara sp.*	4	3	40	bushy
3	65	StSt	Starry Stonewort	*Nitellopsis obtusa (Desv.) J.Groves*	1	9	45	bushy
4	75	CLP	Curly Leaf Pondweed	*Potamogeton crispus L.*	1	9	50	narrow leafy
5	109	HPW	Hybrid Pondweed	*Potamogeton Hybrid*	2	5	69	broad leafy
6	115	Stuk	Sago (3)	*Stuckenia sp.*	2	6	75	stringy
7	117	TLP	Thin Leaf Pondweed (7)	*Potamogeton sp.*	4	5	76	stringy
8	125	VAL	Wild Celery	*Vallisneria americana Michaux*	2	7	80	grassy
9	150	WL	Waterlily (2)	*Nymphaea sp.*	2	5	100	floating leaf
10	153	SPAD	Spadderdock (3)	*Nuphar sp.*	2	5	101	floating leaf

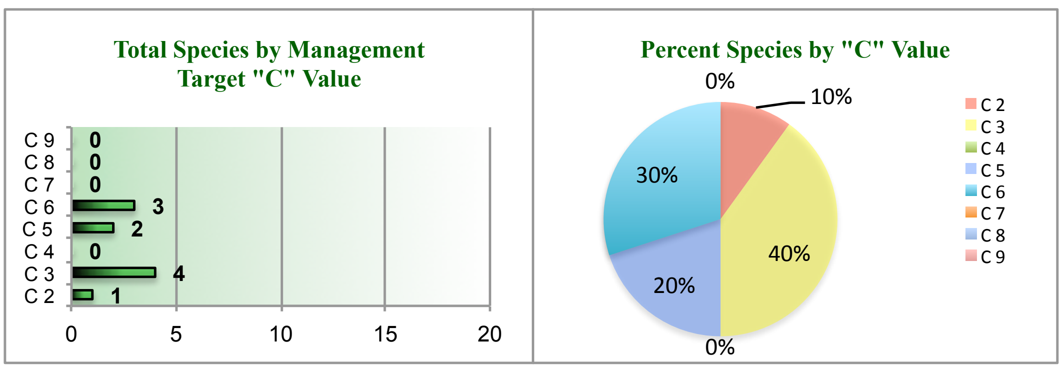
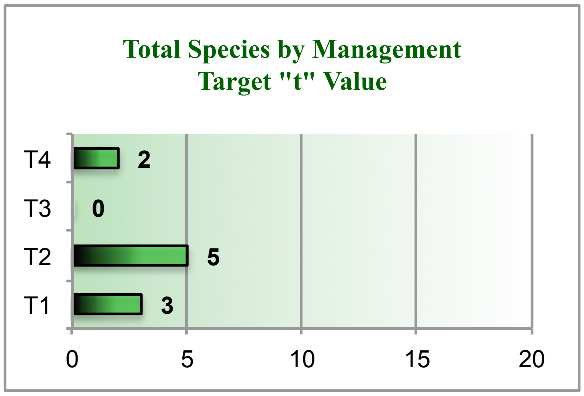


Figure 710/121.041 The total number (histogram) and percentage (pie chart) of plant species by “C” value found in the lake for the entire summer or growing season. Plants that are assigned lower C values are more tolerant of ecosystem and man-made disturbances and system alterations. Weedy specises usually are assigned lower C values. Conversely, rare and endangered species are assigned higher C values.



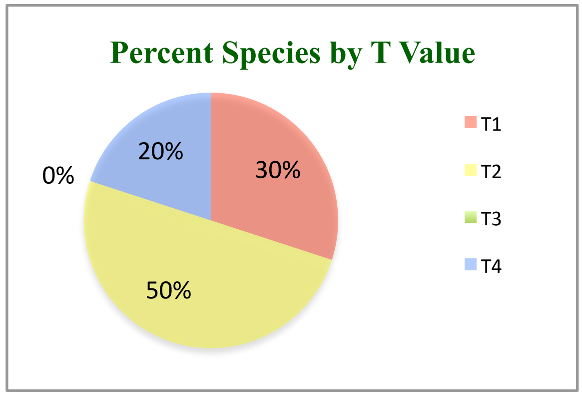


Figure 710/121.042 The total number (histogram) and percentage (pie chart) of plant species by "T" value found in the lake for the entire summer or growing season. The T 1 species are usually very weedy and targeted for control. These include nuisance watermilfoil genotypes, curly leaf pondweed, and starry stonewort.

Table 710/121.014 A list of species found since LakeScan™ monitoring was begun and during the course of the summer growing season.

PLANT NAME, CODES, AND SELECTED ATTRIBUTES

"T" VALUE	CODE #	SHORT NAME	COMMON NAME	SCIENTIFIC NAME	MORPHOTYPE
1	2	EWMx	Eurasian Watermilfoil Hybrid	*Myriophyllum spicatum x sibiricum*	feathery
1	65	StSt	Starry Stonewort	*Nitellopsis obtusa (Desv.) J.Groves*	bushy
1	75	CLP	Curly Leaf Pondweed	*Potamogeton crispus L.*	narrow leafy
2	4	GWM	Green/Variable Watermilfoil	*Myriophyllum verticillatum L. or Myriophyllum heterophyllum Michaux*	feathery
2	33	CNTL	Coontail	*Ceratophyllum sp.*	bushy
2	42	ELD	Elodea	*Elodea sp.*	bushy
2	50	NAID	Naiad	*Najas sp.*	bushy
2	77	WSG	Water Star Grass	*Zosterella dubia (Jacq.) Small*	narrow leafy
2	90	Rich	Richardsons Pondweed	*Potamogeton richardsonii (Benn.) Tydb.*	small leafy
2	109	HPW	Hybrid Pondweed	*Potamogeton Hybrid*	broad leafy
2	110	WBLP	Weedy Broad Leaf Pondweed	*Potamogeton amplifolius Hybrid*	broad leafy
2	115	Stuk	Sago Pondweed	*Stuckenia sp.*	stringy
2	125	VAL	Wild Celery	*Vallisneria americana Michaux*	grassy
2	150	WL	Waterlily	*Nymphaea sp.*	floating leaf
2	153	SPAD	Spadderdock	*Nuphar sp.*	floating leaf
3	3	NWM	Northern Watermilfoil	*Myriophyllum sibiricum Kom.*	feathery
3	25	BLAD	Common Bladderwort	*Utricularia vulgaris L.*	feathery
3	120	ZAN	Horned Pondweed	*Zannichellia palustris L.*	stringy
3	155	WSh	Water Shield	*Brasenia schreberi J.F. Gmel.*	floating leaf
3	165	FLP	Floating Leaf Pondweed	*Potamogeton sp.*	floating leaf pondweed
3	180	DUCK	Common Duckweed	*Lemna sp.*	floating
4	15	WMG	Water Marigold	*Bidens Beckii Torr. ex Spreng.*	bushy
4	27	MiniB	Mini-Bladderwort	*Utricularia sp.*	feathery
4	60	CHARA	Chara	*Chara sp.*	bushy
4	117	TLP	Thin Leaf Pondweed	*Potamogeton sp.*	stringy

710/121.040 Plant Species Coefficients and Assigned Qualities

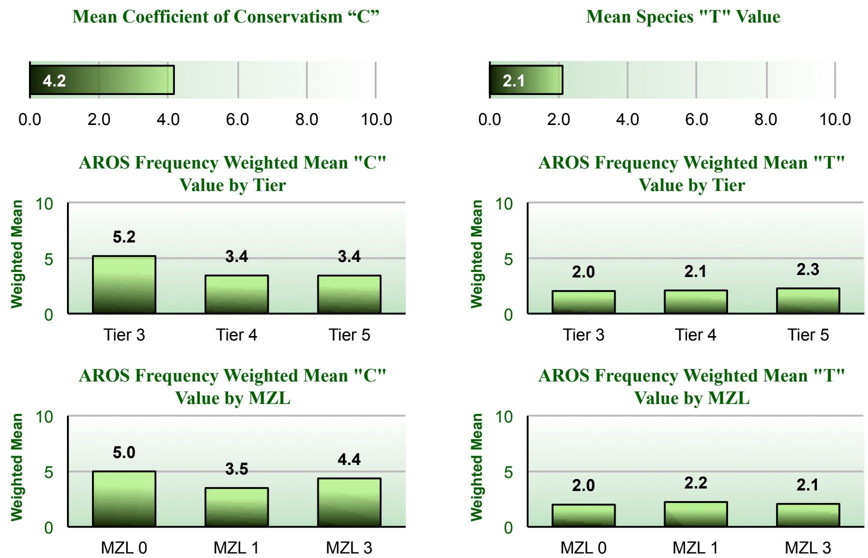


Figure 710/121.042 Mean weighted plant species coefficient of conservatism for the whole lake and by sorted Tier and MZL as measured at all lake AROS.

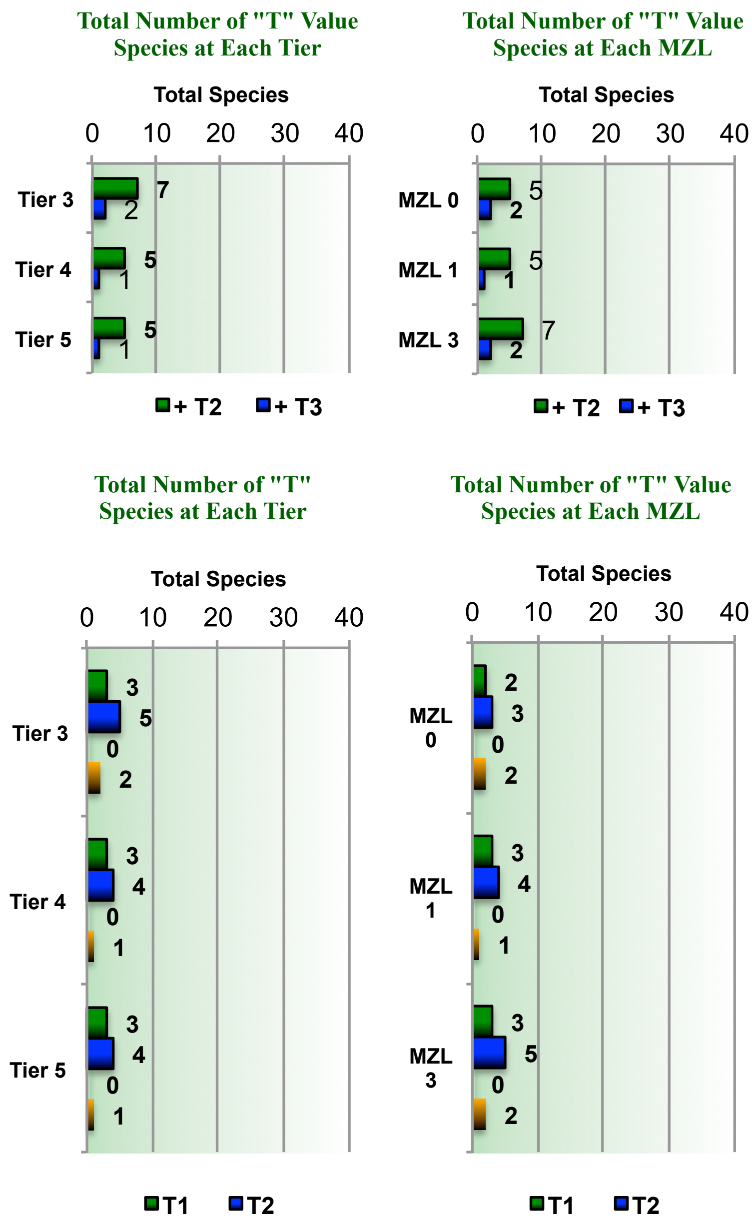


Figure 710.13,41.042 The total number of species assigned to the 4 management target priority values at each Tier and MZL. The upper part of this figure represents all of the species t values summed for T2, T3, and T4 (T2+) and T3 and T4 (T3+).

710/121.0x0 Plant Community Species Occurrence, and Dominance (Annual)

Table 710.121.0x0 A list of species found during the course of the summer growing season, abbreviated name, common name, scientific name, the percent occurrence of each species in the lake AROS, the species dominance values, and estimated biovolume of each plant species in the AROS areas in the lake.

PLANT NAME, CODES, AND SELECTED ATTRIBUTES								
	Code #	Abbrev. Name	Common Name	Scientific Name	*t* Value	*i* Value	*c* Value	Leaf Type
1	2	EWMx	Eurasian Milfoil Hybrid	*Myriophyllum spicatum x sibiricum*	1	8	2	feathery
2	60	CHARA	Chara (many)	*Chara sp.*	4	3	40	bushy
3	65	StSt	Starry Stonewort	*Nitellopsis obtusa (Desv.) J.Groves*	1	9	45	bushy
4	75	CLP	Curly Leaf Pondweed	*Potamogeton crispus L.*	1	9	50	narrow leafy
5	109	HPW	Hybrid Pondweed	*Potamogeton Hybrid*	2	5	69	broad leafy
6	115	Stuk	Sago (3)	*Stuckenia sp.*	2	6	75	stringy
7	117	TLP	Thin Leaf Pondweed (7)	*Potamogeton sp.*	4	5	76	stringy
8	125	VAL	Wild Celery	*Vallisneria americana Michaux*	2	7	80	grassy
9	150	WL	Waterlily (2)	*Nymphaea sp.*	2	5	100	floating leaf
10	153	SPAD	Spadderdock (3)	*Nuphar sp.*	2	5	101	floating leaf

710/121.014 LakeScan™ BioD60© Biodiversity Indices (Annual)

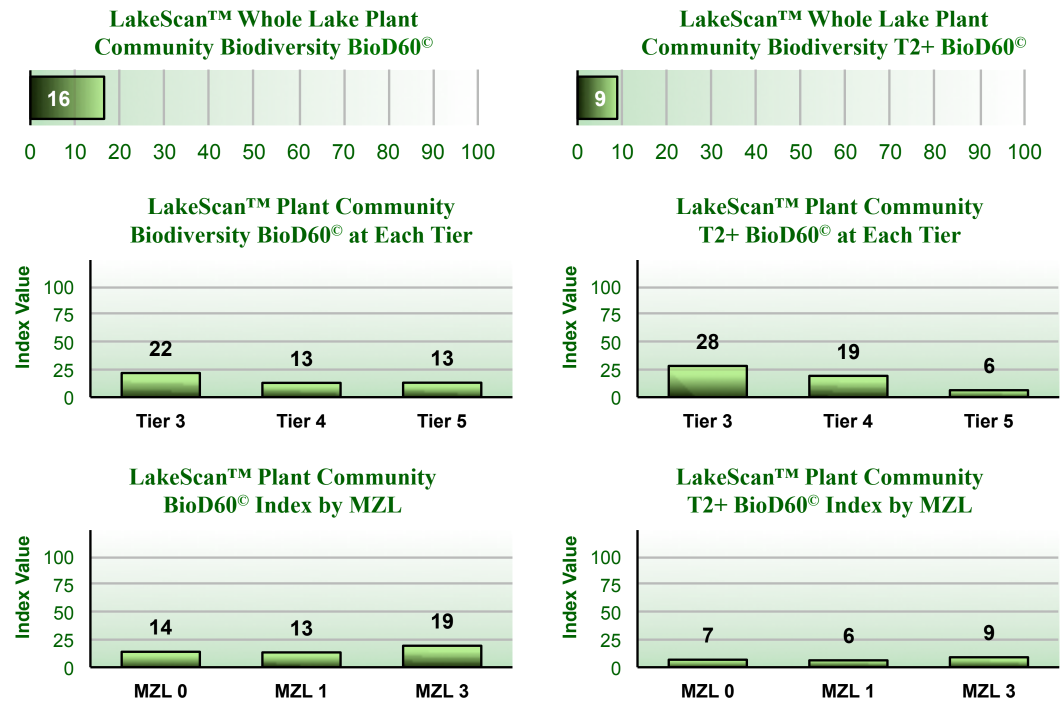


Figure 710/121.014a The LakeScan™ BioD 60© and LakeScan™ BioD 60© T2+ biodiversity index is a proportional index that assumes the greatest number of species that might be present during any survey will not be greater than or equal to 50. The fundamental algorithm is based on the Euler's equation where the greatest variance in value is found in the middle range of all possible values. The assumption is that at some point biodiversity is so low, or so high, that there is little difference in values. Index values greater than 50 are considered to be good. The T2+ index value is calculated for all species except T1 species that are targeted for elimination from the flora.

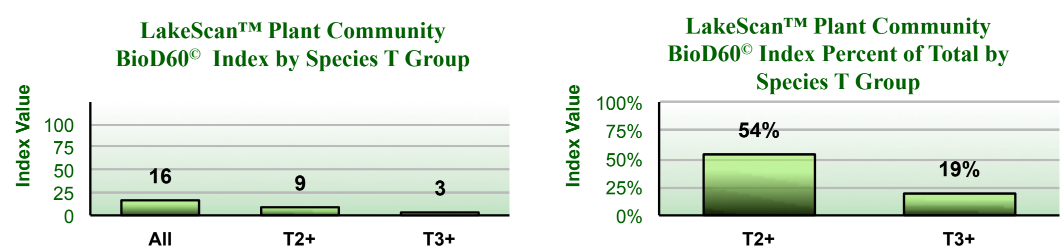


Figure 710/121.014a The goal of any aquatic plant community management plan should be to protect or enhance the biological diversity of the over-all plant community. T1 species are typically invasive and will extirpate or "crowd" out more conservative or desirable species. Consequently, the objective of any planned management interventions is to suppress or decrease the dominance of T1 species and this should increase the dominance of more desirable T2, T3, and T4 plant species. These data are presented to illustrate the relative BioD60© of the entire plant community and a plant community without T1 species – T2+ or the index value for only the most desirable of plant species, T3 and T4.

710/121.017 LakeScan™ MorphoD 26© Biodiversity Indices (Annual)

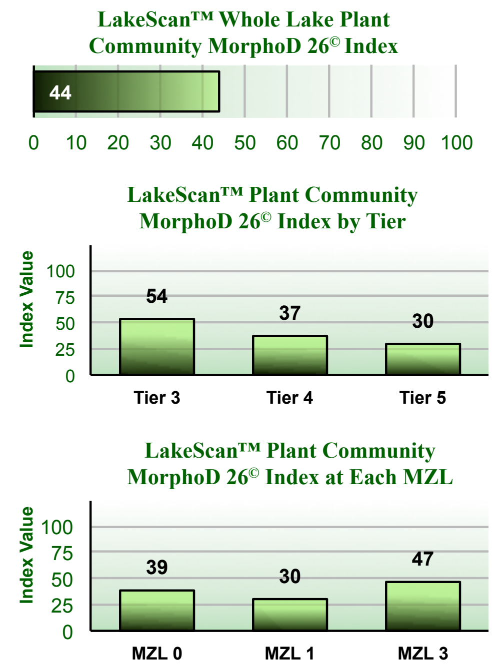


Figure 710/121.017 The LakeScan™ MorphoD 26© biodiversity index is a proportional index that assumes the greatest number of plant morphotypes, that might be present during any survey, will not be greater than or equal to 26. Again, index values greater than 50 are considered to be good.

710/121.024 LakeScan™ BioV© Indices (Annual)

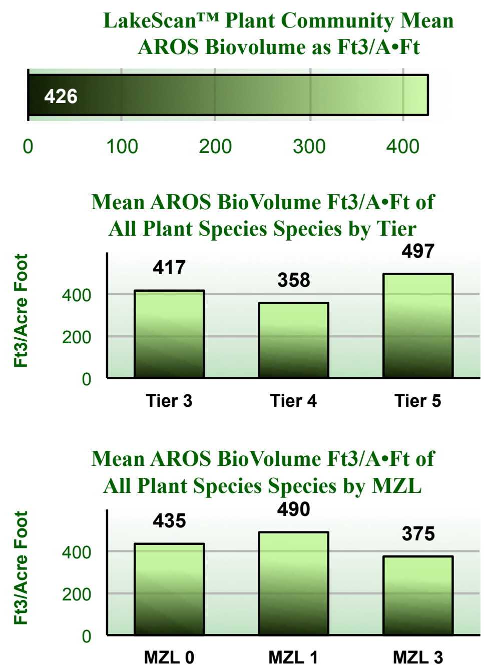


Figure 710/121.024 The LakeScan™ BioV© Biovolume index is based on the mean volume of various species per foot stem length and the density of stems per unit area. A compensatory factor is included for species that branch near the top of the plant or form surface canopies. These figures are based on the total estimated BioV found in each area divided by the acres encompassed by the data collection zone (Lake, Tier, or MZL).

710/121.018 LakeScan™ Weediness© Indices (Annual)

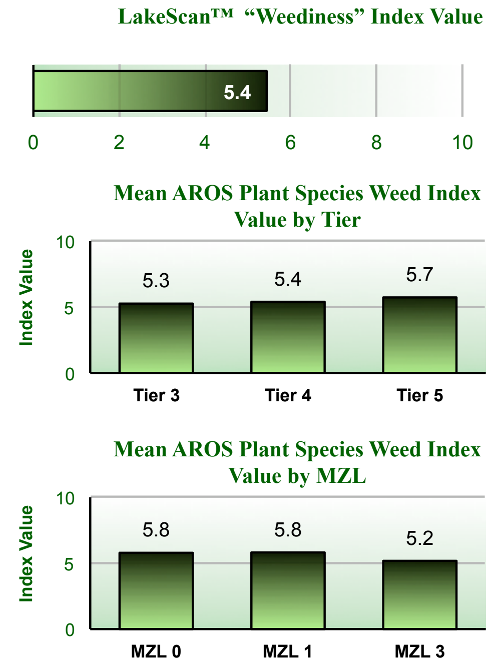


Figure 710/121.018 The LakeScan™ Weedines© index is fundamentally a diversity index (similar algorithm) however values are weighted according to the assigned "i" value, coupled with the density and distribution of various species at each AROS.

Cat 710: LakeScan™ Plant Community Survey Event Data

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.

710/123.014 Species Richness (Events)

Species Richness in the whole lake and at all MZL's at different sampling events during the course of the growing season. VS A is the total number of species found in the lake during the entire growing season.

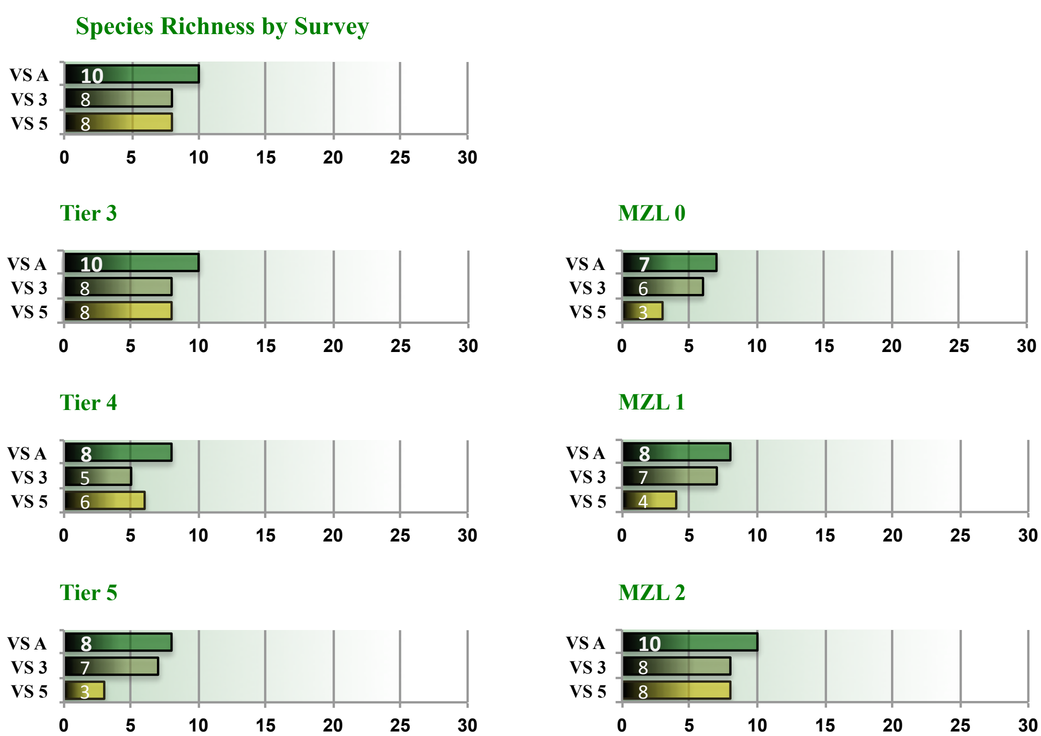


Figure 710/143.014 The species richness of the entire lake during the entire summer (VS A) and at distinct survey events that occurred in the early summer (VS 3) and late summer (VS 5) survey events for the whole lake and at all Tiers and MZL's (except MZL 4 where there was only 1 AROS).

Early Late Season Species Occurrence	
Total Species	10
Early/Late Season	6
Early Season Only	2
Late Season Only	2

Species Common Name	Seasonal Occurrence Present = P		VS Occurrence E = Early L = Late E/L = Both	Percent Change in AROS Occurrence
	VS 3	VS 5		
Eurasian Milfoil Hybrid	P	P	E/L	-45%
Chara (many)	P	P	E/L	-57%
Starry Stonewort		P	L	
Curly Leaf Pondweed	P		E	
Hybrid Pondweed	P	P	E/L	-25%
Sago (3)	P		E	
Thin Leaf Pondweed (7)		P	L	
Wild Celery	P	P	E/L	10%
Waterlily (2)	P	P	E/L	8%
Spadderdock (3)	P	P	E/L	-4%

Figure 710/143.014b The species richness of the entire lake during the entire summer (VS A) and at distinct survey events that occurred in the early summer (VS 3) and late summer (VS 5) survey events for the whole lake and the seasonality of the species present during each survey event.

710/143.017 Plant Community Quality (Event)

Morphotypes:
The sum total of distinct plant morphotypes observed during the entire growing season in the lake and at all Tiers and most MZL's, contrasted with data compiled for specific survey events that occurred during the same growing season.

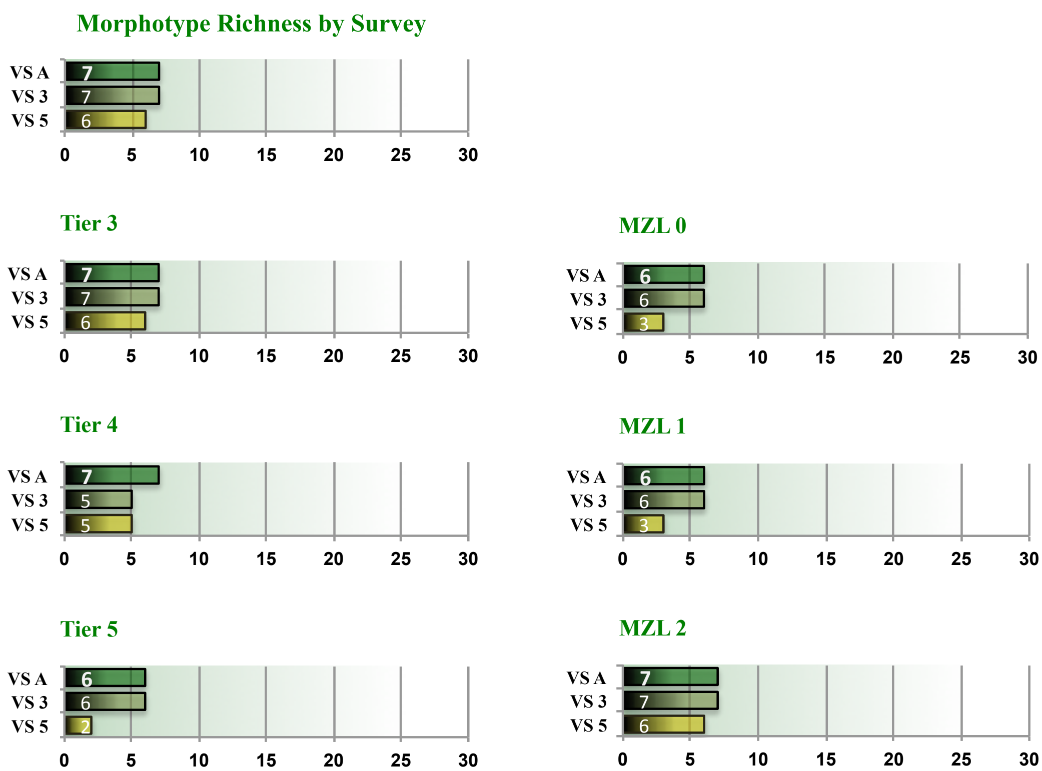


Figure 710/143.017 The total number of distinct plant morphotypes in the lake during the entire summer (VS A) and at specific early summer (VS 3) and late summer (VS 5) survey events for the whole lake and at all Tiers and most MZL's (MZL 4 is not included because it has only 1 AROS).

710/143.074 Plant Community Diversity and Structural Complexity

The LakeScan™ BioD 60© index value calculated for the entire growing season in the lake and at select Tiers and MZL's, contrasted with data compiled for specific survey events that occurred during the same growing season.

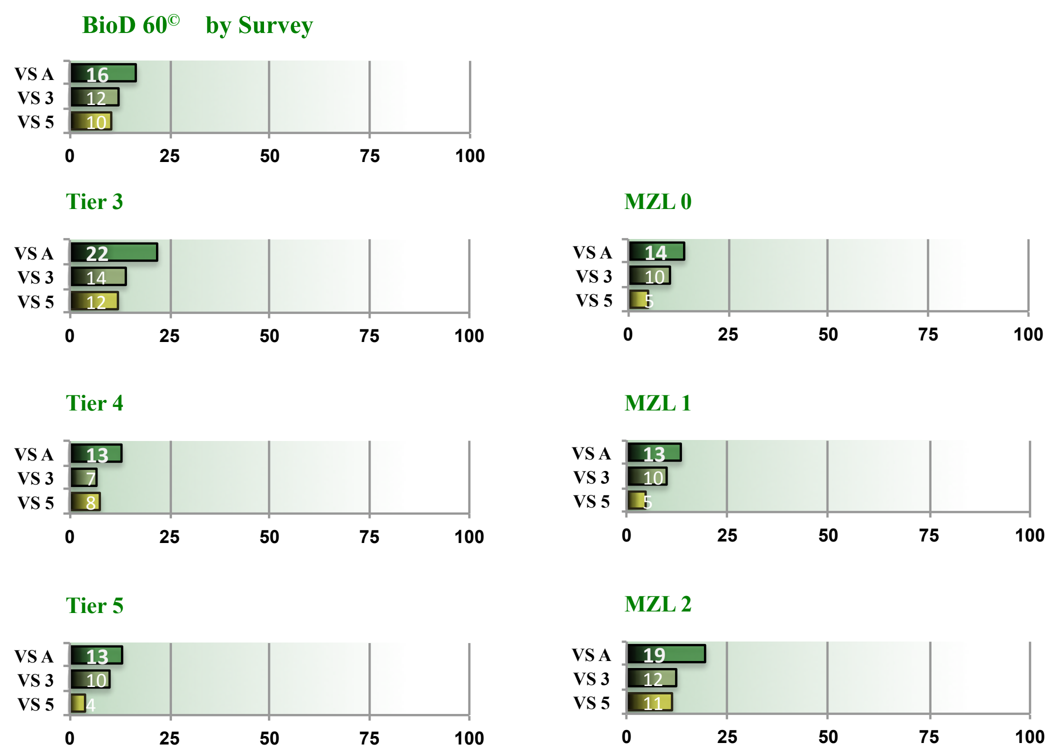


Figure 710/143.074a The LakeScan™ BioD 60© index value based upon all plant species observed in the entire lake during the entire summer (VS A) and at specific survey events that occurred in the early summer (VS 3) and late summer (V5) in the entire lake and at specific Tiers and MZL's (value cannot be calculated for a single AROS, i.e. MZL 4).

***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 50© index and this may be one of the most useful metrics when considering the impact and success of the applied management program.

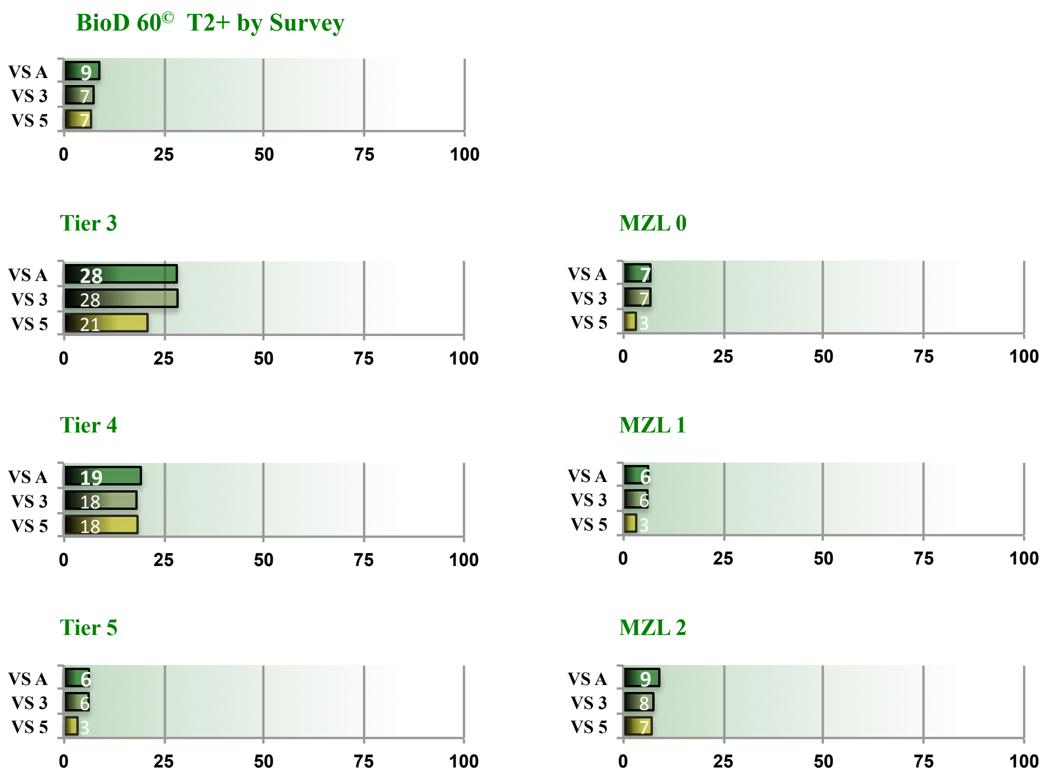


Figure 710/143.074b The LakeScan™ BioD 60© index value for all plant species of target rating T2 or greater calculated for the entire lake during the entire summer (VS A) and at distinct survey events that occurred in the early summer (VS 3) and late summer (VS 5) survey events in the entire lake, all Tiers and at specific MZL's.

710/143.075 Plant Community Diversity and Structural Complexity

The LakeScan™ MorphoD 26© index value calculated for the entire growing season in the lake and at select Tiers and MZL's, contrasted with data compiled for specific survey events that occurred during the same growing season.

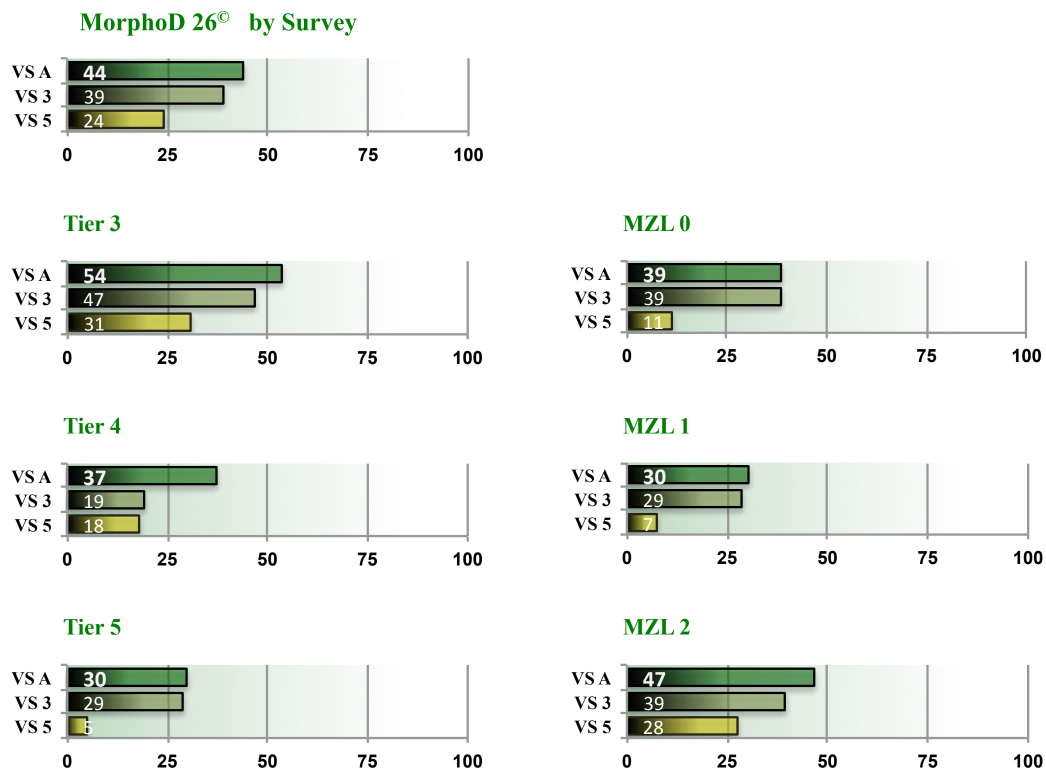


Figure 710/143.075 The LakeScan™ MorphoD 26© index value for all plant species of target rating T2 or greater calculated for the entire lake during the entire summer (VS A) and at distinct survey events that occurred in the early summer (VS 3) and late summer (VS 5) survey events in the entire lake, all Tiers and at specific MZL's.

710/143.084 Weediness Index (Event)

The LakeScan™ Weediness 10© index value for the whole lake for all species observed in the lake during the entire summer and for the lake and select Tiers and MZL's as determined from observations made at specific sampling events.

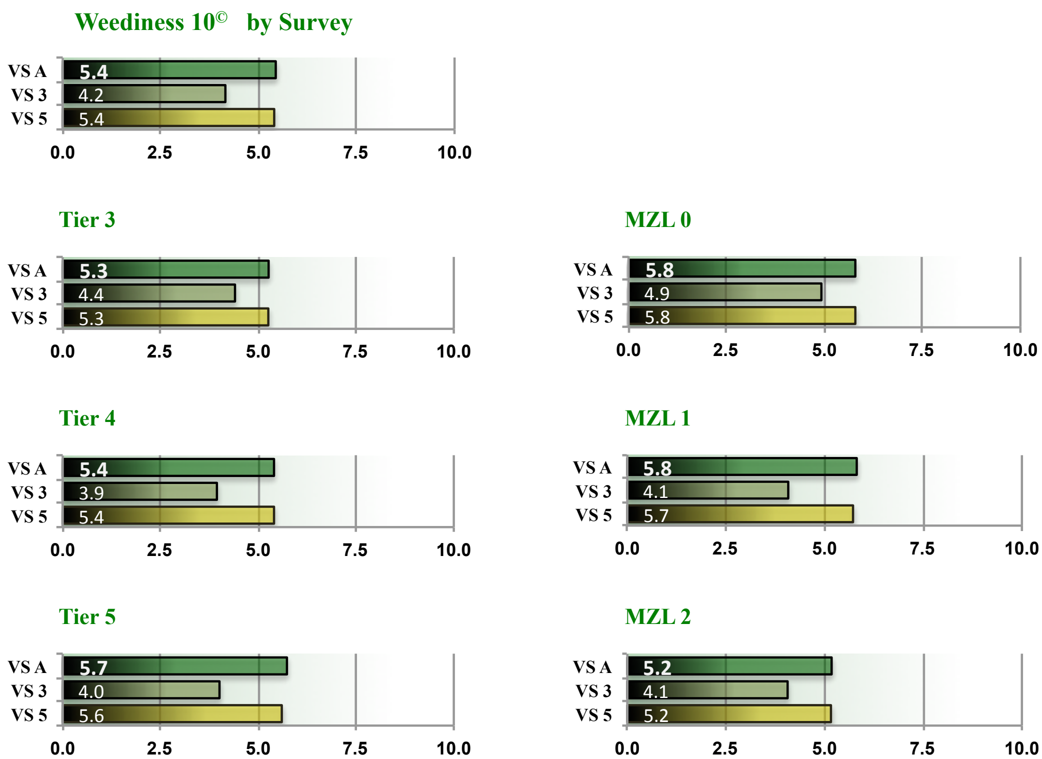


Figure 710/143.084 The LakeScan™ Weediness 10© index value of plant species calculated for the entire lake during the entire summer (VS) and at early summer (V1), mid summer (V2) and late summer (V3) survey events for the whole lake and selected Tiers and MZL's.

Cat 710: LakeScan™ Metric and Index Year to Year Comparisons

711/121.014 Species Richness (Total Species) Historical Record

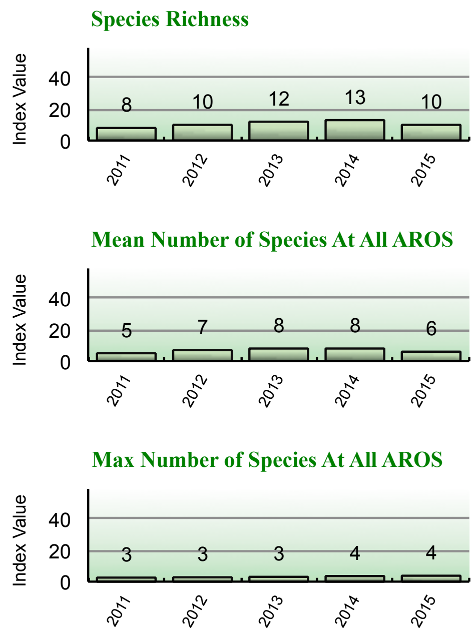


Figure 711/121.014 The total species richness found in the years of record and the mean and the maximum number of species found at the lake AROS's.

Species Richness

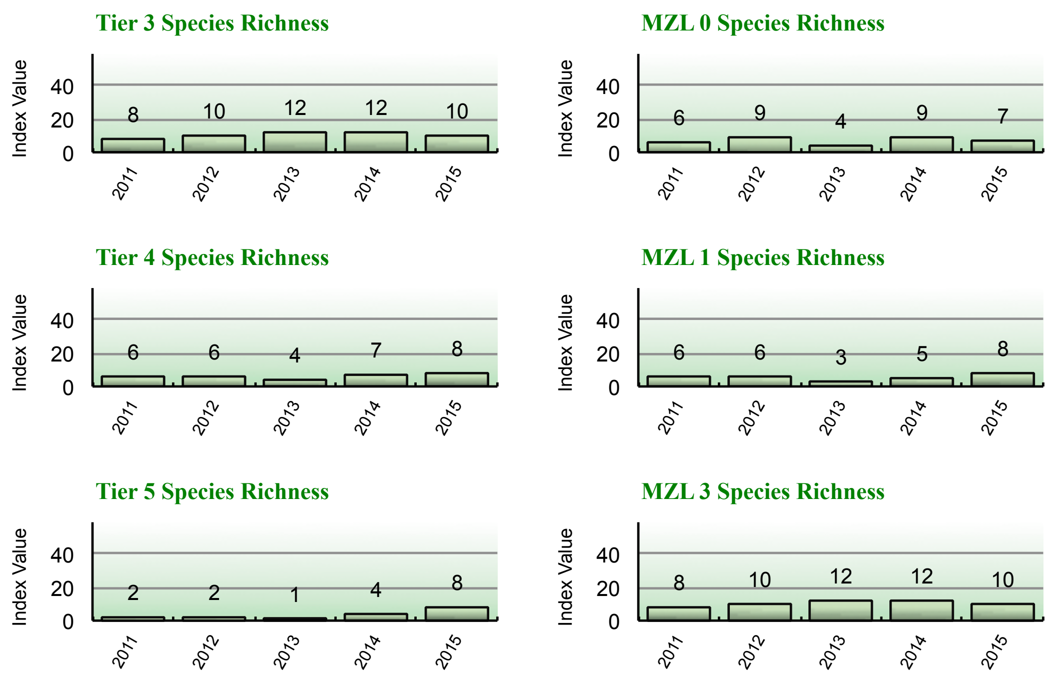


Figure 711/121.014 The total species richness found in the years of record at AROS in each tier and at each management zone (MZL).

711/121.041 A Historical Record of Plant Species Quality.

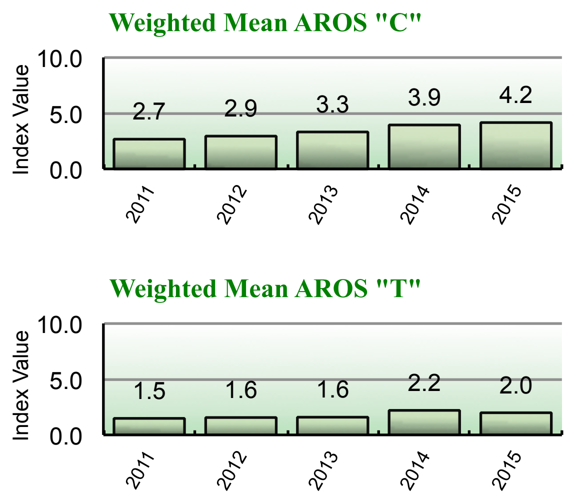


Figure 711/121.041 Historical record of plant community species quality. The upper figure is the AROS occurrence frequency weighted, mean species C value grouping from all of the AROS for each year of record. The middle figure is the mean weighted AROS average species T value from all of the AROS and averaged by year. The bottom figure is likewise, a weighted weediness

711/121.054 A Historical Record of Occurrence and Dominance.

Table 711/121.054 a The percent species occurrence of plant species present at the AROS's in the lake during the years of LakeScan™ analysis.

SPECIES OCCURRENCE										
Species Short Name	Percent of AROS's Where Species Was Observed									
	2005	2006	2007	2008	2010	2011	2012	2013	2014	2015
EWMx	57%	57%	2%	49%	45%	49%	45%	63%	59%	98%
NWM									10%	
GWM					18%					
WMG									18%	
BLAD			67%							
MiniB		2%								
CNTL		14%	18%			20%	16%		2%	
ELD	84%	14%	18%							
NAID	18%	2%	25%	76%				4%		
CHARA		12%	20%		39%			16%	100%	100%
StSt					59%	100%	100%	100%	96%	82%
CLP		12%	4%	8%	22%		14%	22%	6%	29%
WSG	47%	14%		16%					2%	
Rich					4%					
HPW	37%			14%	25%	41%	25%	24%	33%	31%
WBLP	2%	12%	14%	49%						
Stuk	18%	14%		22%	25%		24%	33%	18%	51%
TLP								6%		2%
ZAN							20%			
VAL					31%	20%	16%	8%	27%	16%
WL					43%	47%	47%	41%	39%	61%
SPAD	29%				6%	6%	10%	14%	10%	12%
WSh						2%				
FLP	18%	59%	12%	37%						
DUCK								4%		

Table 711/121.054 b The percent species occurrence of plant species present at the AROS's in the lake in 2015 and comparisons to mean historical data during the years of LakeScan™ analysis.

SPECIES OCCURRENCE						
Total Years of Record **10**		Years Species Present	Percent Years Present	Mean Occurence at AROS's	Minimum Occurence at AROS's	Maximum Occurence at AROS's
2015						
EWMx	98%	10	100%	52%	2%	98%
NWM		1	10%	10%	10%	10%
GWM		1	10%	18%	18%	18%
WMG		1	10%	18%	18%	18%
BLAD		1	10%	67%	67%	67%
MiniB		1	10%	2%	2%	2%
CNTL		5	50%	14%	2%	20%
ELD		3	30%	39%	14%	84%
NAID		5	50%	25%	2%	76%
CHARA	100%	6	60%	48%	12%	100%
StSt	82%	6	60%	90%	59%	100%
CLP	29%	8	80%	14%	4%	29%
WSG		4	40%	20%	2%	47%
Rich		1	10%	4%	4%	4%
HPW	31%	8	80%	29%	14%	41%
WBLP		4	40%	19%	2%	49%
Stuk	51%	8	80%	25%	14%	51%
TLP	2%	2	20%	4%	2%	6%
ZAN		1	10%	20%	20%	20%
VAL	16%	6	60%	20%	8%	31%
WL	61%	6	60%	46%	39%	61%
SPAD	12%	7	70%	12%	6%	29%
WSh		1	10%	2%	2%	2%
FLP		4	40%	31%	12%	59%
DUCK		1	10%	4%	4%	4%

Table 711/121.064 a The LakeScan™ Dom 100© plant species dominance factor for all of plant species present at the AROS's in the lake during the history of LakeScan™ analysis.

SPECIES DOMINANCE										
Species Short Name	LakeScan™ Dom 100© Index Value									
	2005	2006	2007	2008	2010	2011	2012	2013	2014	2015
EWMx	36.7	55.8	6.6	36.3	35.0	31.4	30.4	37.7	31.1	41.6
NWM									14.6	
GWM					22.2					
WMG									11.3	
BLAD			61.4							
MiniB		6.6								
CNTL		14.7	25.9			11.3	9.6		2.5	
ELD	64.9	22.3	27.6							
NAID	16.9	2.7	33.3	60.1				7.2		
CHARA		11.8	27.5		30.7			15.8	58.9	54.2
StSt					45.0	81.5	79.8	77.3	57.4	47.0
CLP		11.8	7.0	8.9	19.0		11.0	10.6	9.0	16.3
WSG	27.7	12.8		19.4					3.2	
Rich					5.6					
HPW	28.3			9.9	21.1	19.9	16.7	18.3	20.3	19.6
WBLP	4.8	11.8	19.1	31.0						
Stuk	15.1	13.5		19.2	25.2		19.5	19.5	12.7	27.1
TLP								7.2		3.5
ZAN							17.2			
VAL					30.0	12.1	9.6	8.6	0.0	13.3
WL					35.5	38.9	35.4	32.6	0.0	37.0
SPAD	27.0				10.5	11.9	14.0	14.9	13.0	13.4
WSh						7.0				
FLP	15.3	35.2	17.9	29.0						
DUCK								7.3		

Table 711/121.064 b   The LakeScan™ Dom 100© plant species dominance factor for all of plant species present at the AROS's in the lake during the summer of 2015 compared to historical averages from the years of record.

SPECIES DOMINANCE						
Total Years of Record	10	Total Years When Species Present	Percent Years Present	Mean Dominance at AROS's	Minimum Dominance at AROS's	Maximum Dominance at AROS's
2015		25	%	Value	Value	Value
EWMx	42	10	100%	34	7	56
NWM		1	10%	15	15	15
GWM		1	10%	22	22	22
WMG		1	10%	11	11	11
BLAD		1	10%	61	61	61
MiniB		1	10%	7	7	7
CNTL		5	50%	13	3	26
ELD		3	30%	38	22	65
NAID		5	50%	24	3	60
CHARA	54	6	60%	33	12	59
StSt	47	6	60%	65	45	82
CLP	16	8	80%	12	7	19
WSG		4	40%	16	3	28
Rich		1	10%	6	6	6
HPW	20	8	80%	19	10	28
WBLP		4	40%	17	5	31
Stuk	27	8	80%	19	13	27
TLP	4	2	20%	5	4	7
ZAN		1	10%	17	17	17
VAL	13	6	60%	12	0	30
WL	37	6	60%	30	0	39
SPAD	13	7	70%	15	10	27
WSh		1	10%	7	7	7
FLP		4	40%	24	15	35
DUCK		1	10%	7	7	7

711/121.074 An Historical Record of Plant Community Species Diversity.

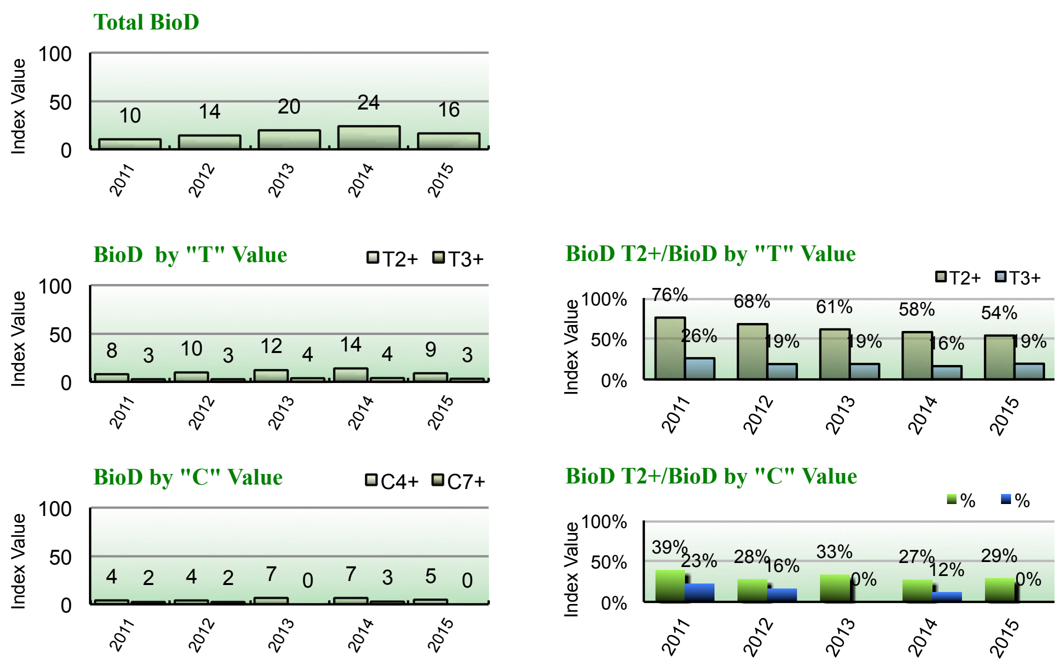


Figure 711/121.074 Total LakeScan™ BioD 60© Plant Community Diversity and the diversity of plants grouped according to management target "t" value and coefficient of conservatism "C" value and percent T2+ and T3+ plant community biodiversity of total biodiversity for both cummulative "t" values and "C" values. Higher is better in every figure.

LakeScan BioD 60©

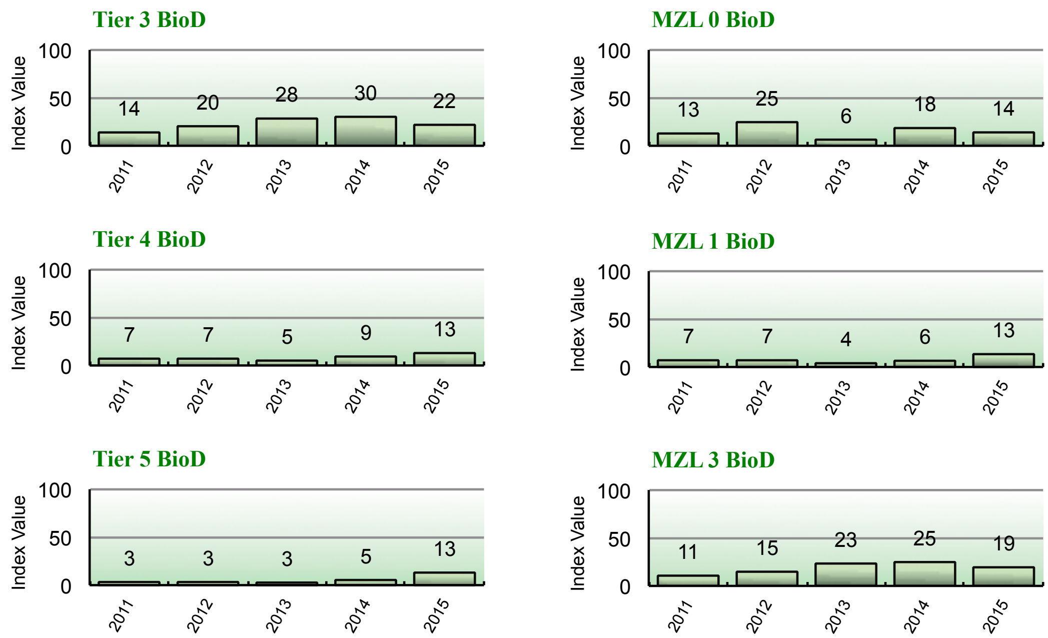


Figure 711/121.074 The LakeScan™ BioD 60© Plant Community Diversity at various tiers and management zones (MZL) determined from survey compiled each year for the entire growing season.

711/121.077 An Historical Record of Plant Community Morpho-Diversity.

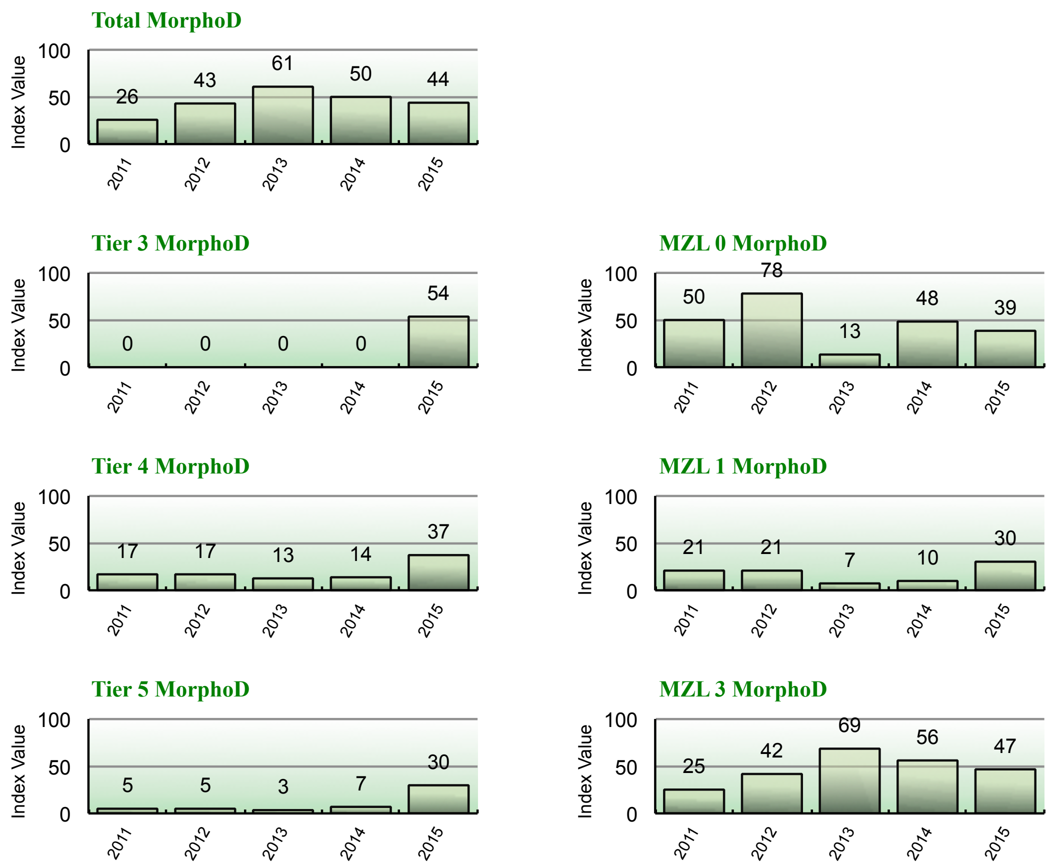


Figure 711/121.075 Total LakeScan™ MorphoD 26© plant community morphological diversity and the morpho-diversity of plants grouped at the AROS in each tier and at each MZL. Data compiled for the entire growing season from each year of record.

711/121.020 Historical Record of Plant Community Biovolume.

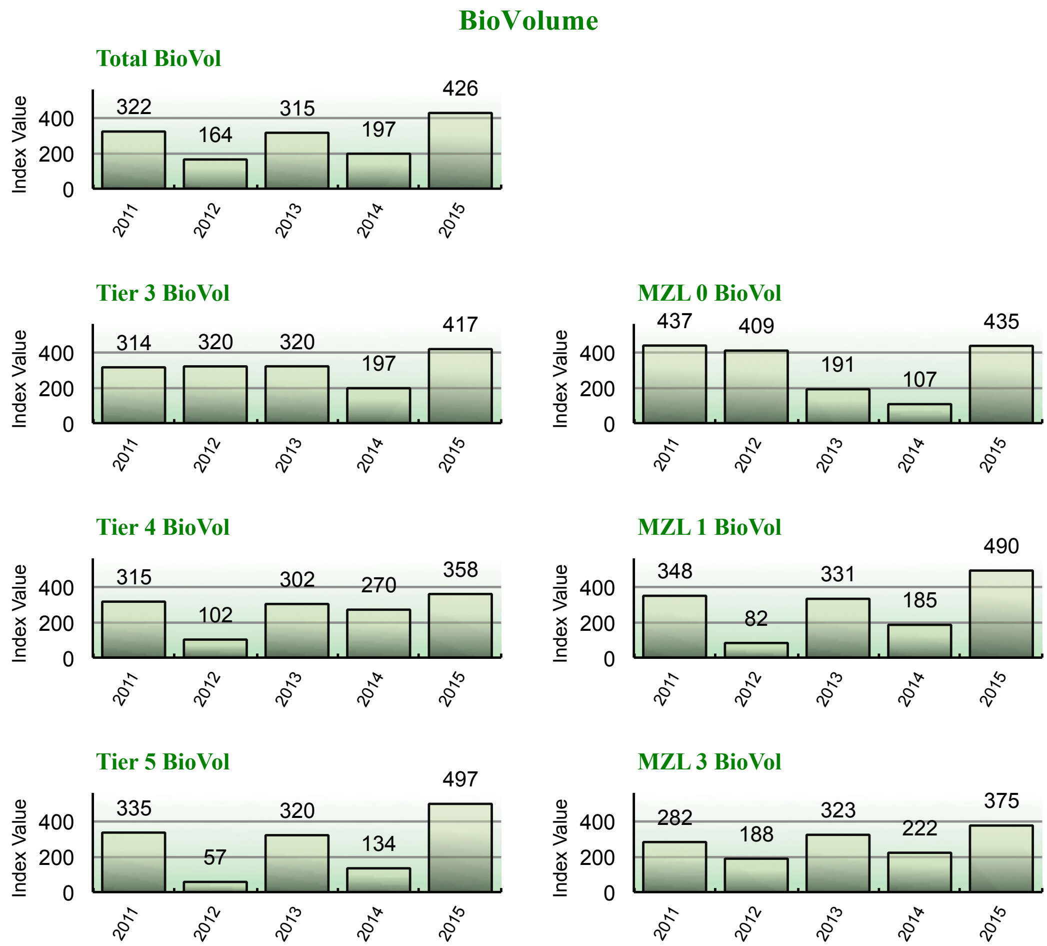


Figure 711/121.024 The LakeScan™ BioV plant community average AROS biovolume the lake and in each tier and management zone (MZL). Data was compiled for the entire growing season for each year.

Table 711/121.024 a The sum LakeScan™ BioVol© factor for all of plant species present at the AROS's in the lake during the history of LakeScan™ analysis.

BIOVOLUME AS MEAN AROS PLANT FT3/ACRE FOOT										
Species Short Name	Mean Plant Species BioVol Ft³ per Acre Ft.									
	2005	2006	2007	2008	2010	2011	2012	2013	2014	2015
EWMx	16	21	23	14	22	25	33	19	30	32
NWM									0	
GWM					62					
WMG									0	
BLAD			21							
MiniB		2								
CNTL		29	4			0	0		0	
ELD	7	7	2							
NAID	11	0	18	10				51		
CHARA		27	12		4			8	0	17
StSt					9	59	23	50	0	42
CLP		18	0	0	2		9	0	3	5
WSG	1	15		4					0	
Rich					0					
HPW	13			0	2	2	4	13	4	4
WBLP	3	13	25	4						
Stuk	14	8		8	6		12	3	3	24
TLP								17		0
ZAN							31			
VAL					21	0	0	4	2	5
WL					7	19	19	23	19	14
SPAD	15				7	19	19	19	19	16
WSh						19				
FLP	2	6	19	3						
DUCK								4		

Table 711/121.024 b The sum LakeScan™ BioVol© factor for all of plant species present at the AROS's in the lake during the summer of 2015 compared to average historical data from all the years of LakeScan™ analysis.

BIOVOLUME AS MEAN AROS PLANT FT3/ACRE FOOT						
Total Years of Record	10	Total Years When Species Present	Percent Years Present	Mean BioVol at AROS's	Minimum BioVol at AROS's	Maximum BioVol at AROS's
2015		25	%	Value	Value	Value
EWMx	32	10	100%	37	1	349
NWM		1	10%	7	0	15
GWM		1	10%	18	0	62
WMG		1	10%	7	0	15
BLAD		1	10%	45	0	151
MiniB		1	10%	6	0	27
CNTL		5	50%	12	0	40
ELD		3	30%	37	0	206
NAID		5	50%	30	0	187
CHARA	17	6	60%	38	0	288
StSt	42	6	60%	83	0	854
CLP	5	8	80%	13	0	75
WSG		4	40%	17	0	77
Rich		1	10%	13	0	90
HPW	4	8	80%	20	0	109
WBLP		4	40%	22	0	110
Stuk	24	8	80%	22	1	115
TLP	0	2	20%	14	0	117
ZAN		1	10%	25	0	120
VAL	5	6	60%	17	0	125
WL	14	6	60%	37	0	215
SPAD	16	7	70%	23	1	153
WSh		1	10%	23	0	155
FLP		4	40%	31	0	165
DUCK		1	10%	24	0	180

711/121.084 Historical Record of Plant Community Weediness.

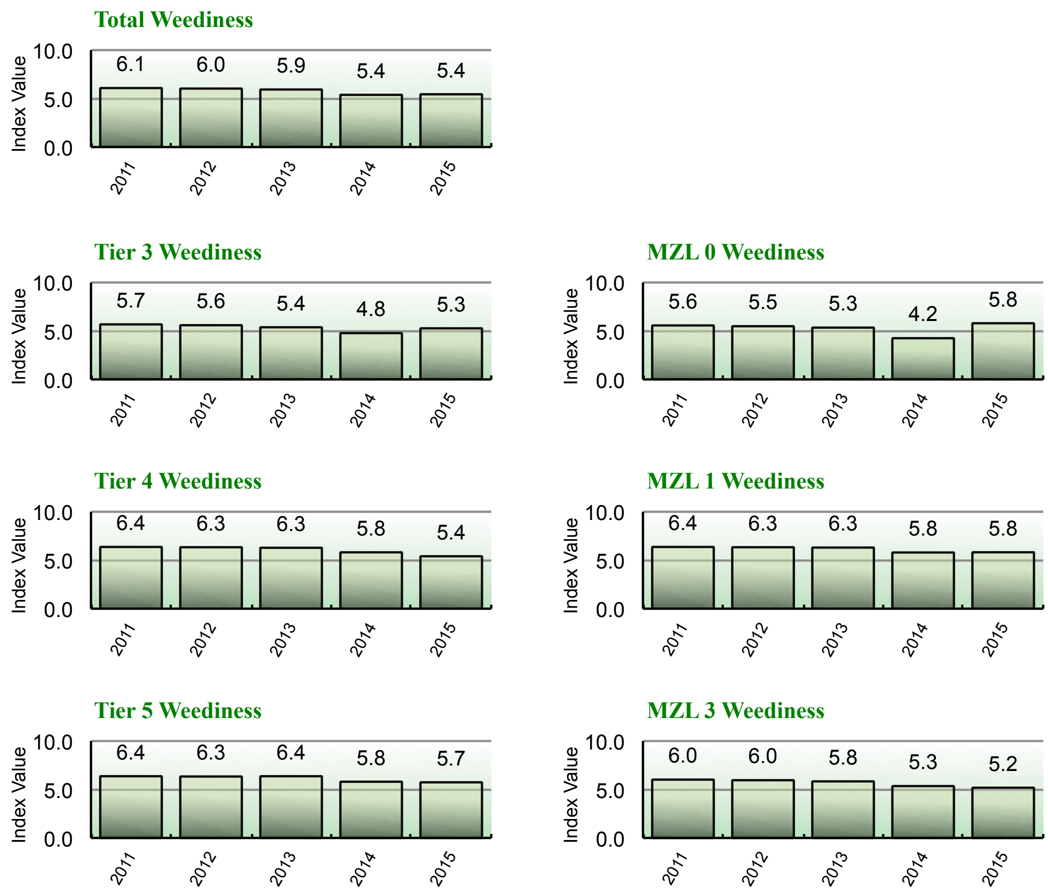


Figure 711/121.084 Total LakeScan™ Weediness 10© and the weediness of the plant community at the AROS in each tier and at each MZL.

Cat 711: A Historical Record of Plant Community Survey Event Data.

711/143.014 A Historical Record of Species Richness.

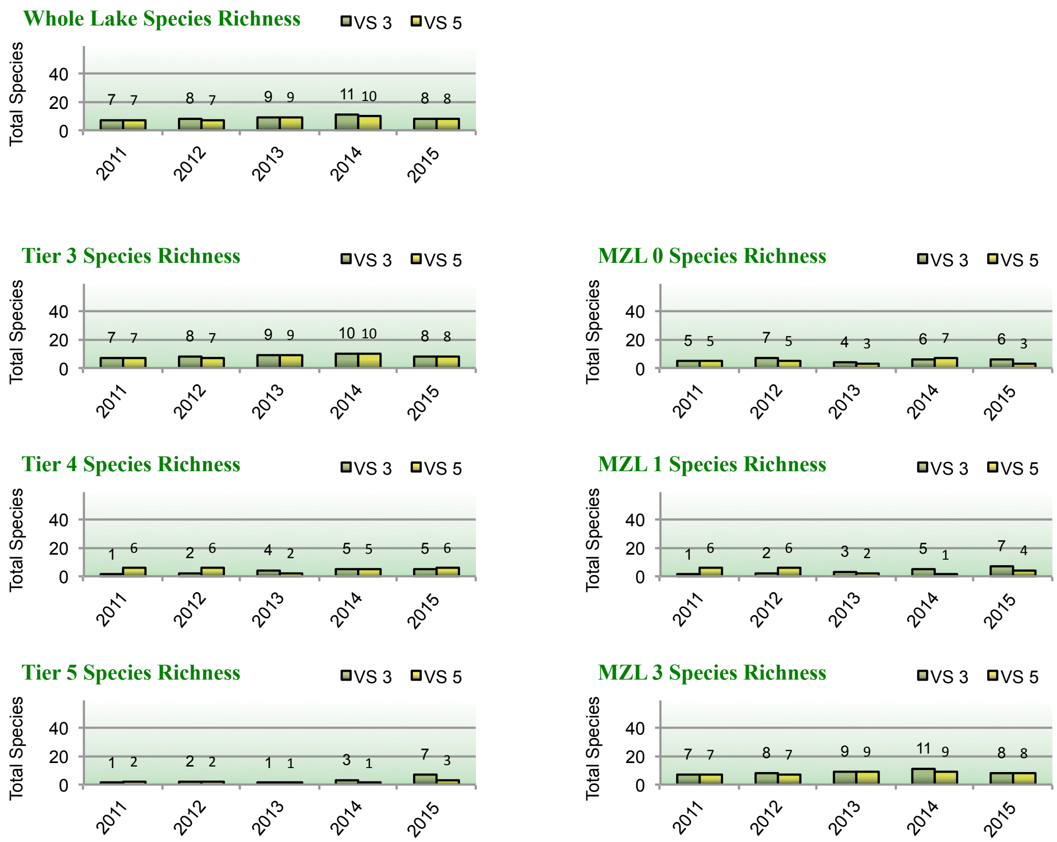


Figure 711/143.014 Total species richness or species present the lake AROS at selected Tiers and MZL's during vegetation community surveys conducted at different times of the year.

711/143.017 Historical Record of Species Attributes.

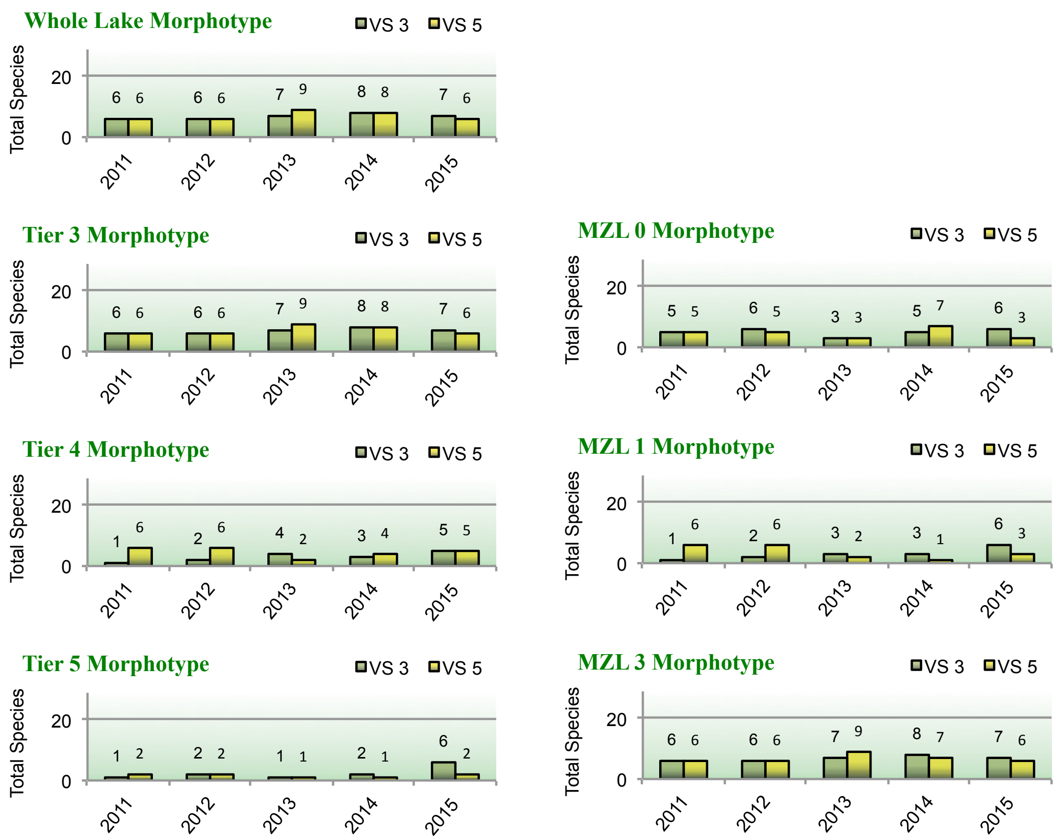


Figure 711/143.017 Total morphotye richness or present the lake AROS at selected Tiers and MZL's at different survey times in each year for selected years of record.

711/143.074 Historical Record of Biodiversity.

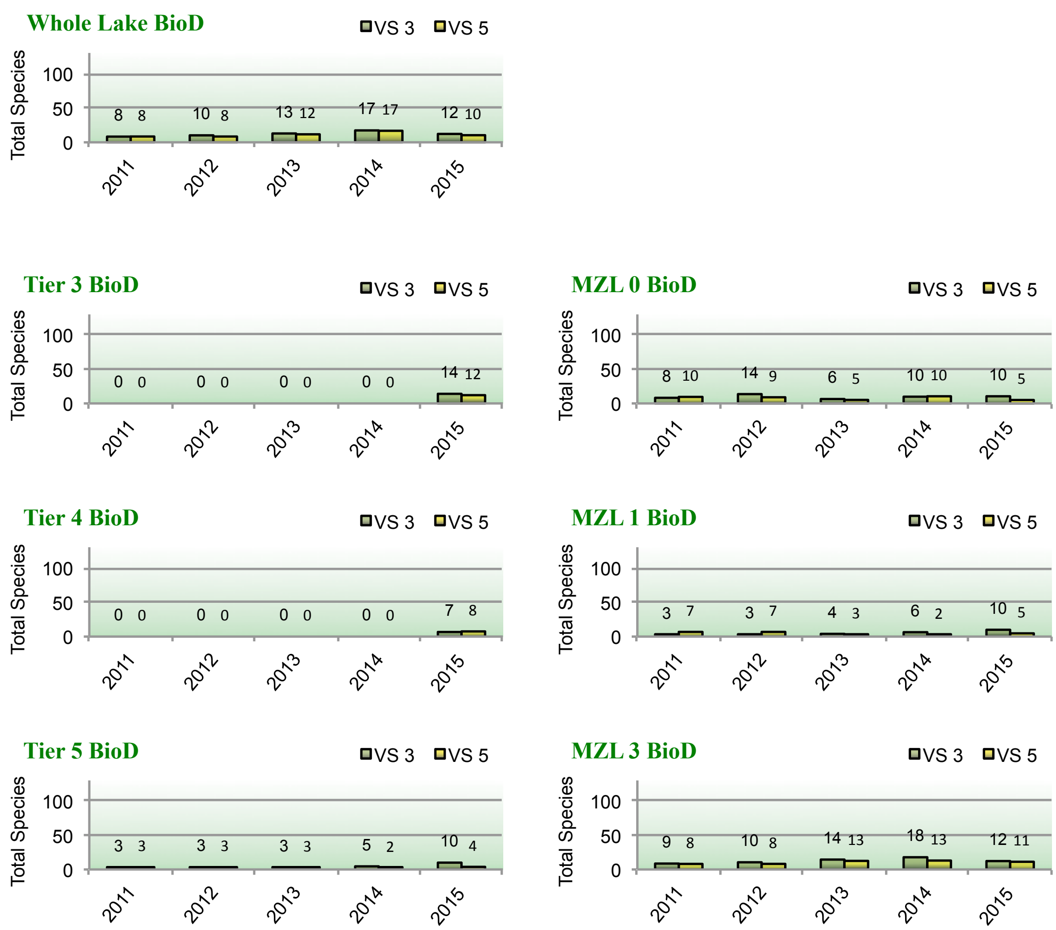


Figure 711/143.074b Total LakeScan BioD 60© plant community biodiversity at the AROS in the lake and at selected Tiers and MZL's at different survey times in each year.

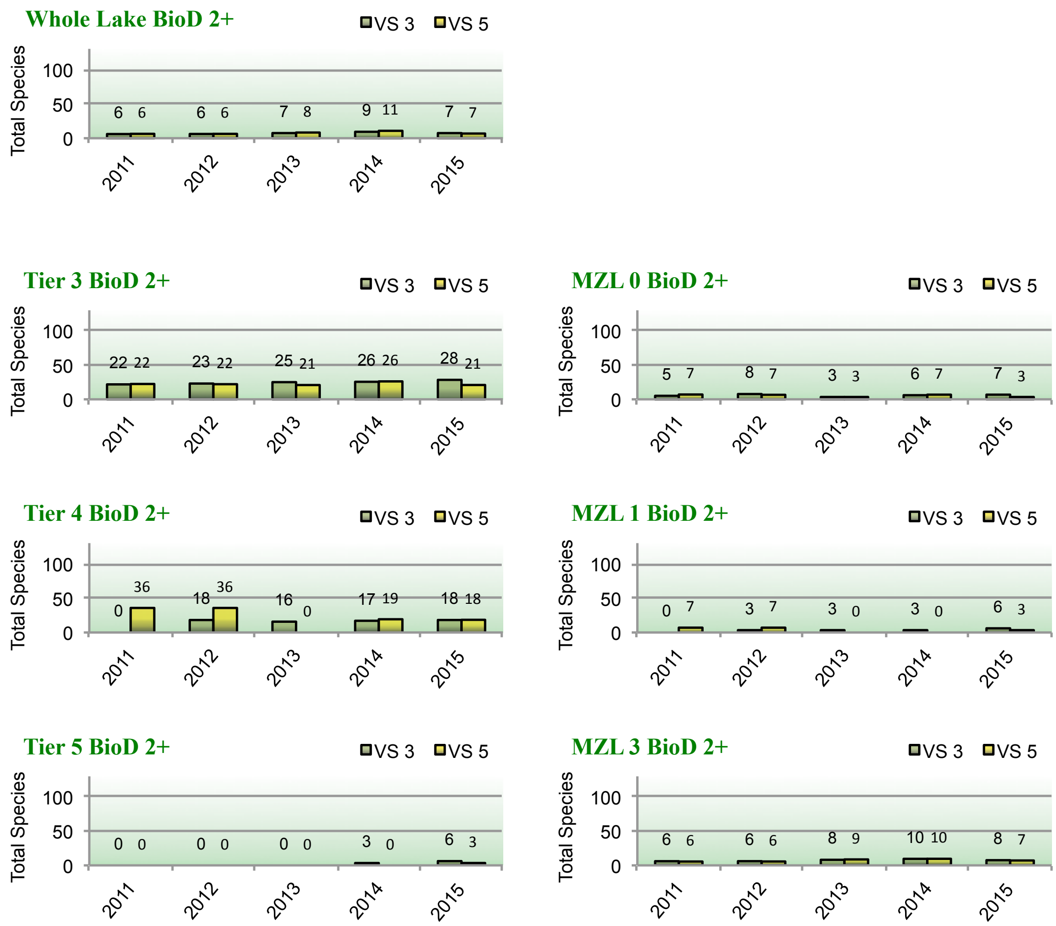


Figure 711/143.074 Total LakeScan BioD 60© T2+ plant community biodiversity for T species 2 through 4 at the AROS in the lake and at selected Tiers and MZL's at different survey times in each year.

711/143.077 Historical Record of Morphodiversity.

Figure 711/143.074b Total LakeScan MorphoD 26© plant community biodiversity at the AROS in the lake and at selected Tiers and MZL's at different survey times in each year for selected years of record.

711/143.084 Historical Record of Community Weediness.

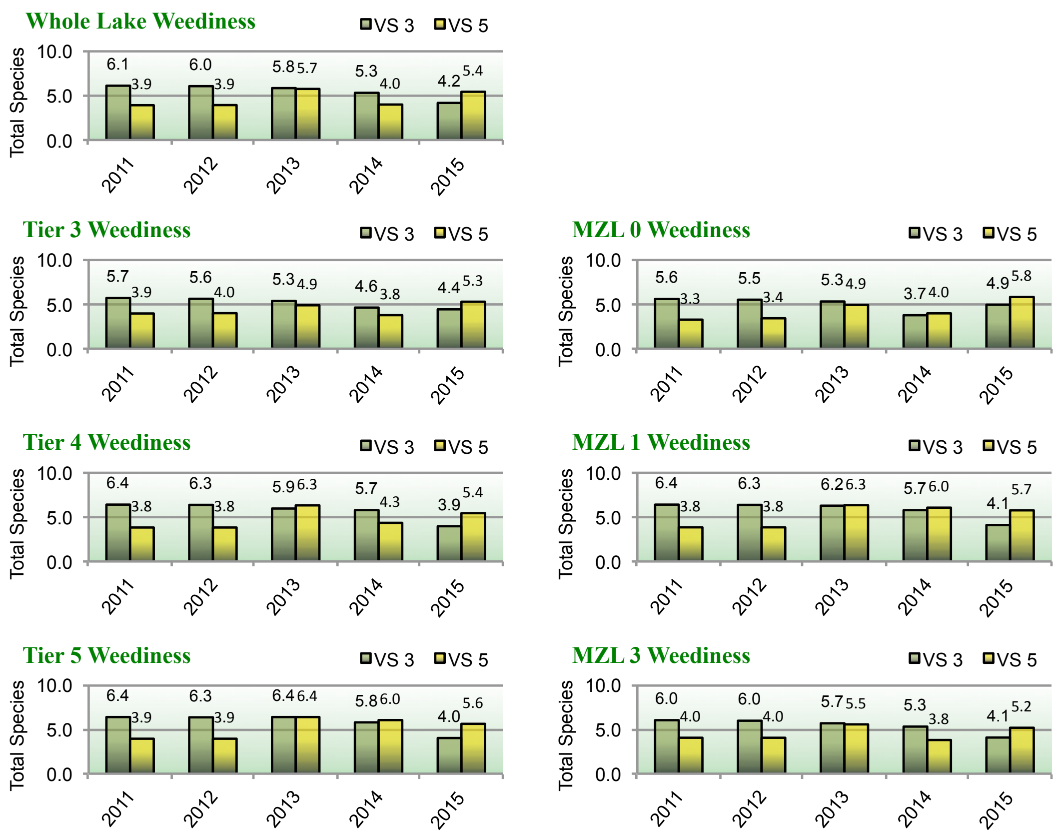


Figure 711.143.084 Total LakeScan™ Weediness Index© plant at the AROS in the lake and at selected Tiers and MZL's at different survey times in selected years of record.

Cat 710 2015 Lake-to-Lake Plant Community LakeScan™ Analysis

710/111.014 Species Richness (Total Species) (Annual)

Table 710.111.014 A compilation of species found during LakeScan™ vegetation surveys conducted during the course of the summer growing season in 25 Michigan inland lakes in 2015. Nuisance plant target priority values "t", the inherent relative invasiveness of each species, and the coefficient of conservatism that has been assigned to each speces are also listed along with the "leaf type" of each species.

PLANT NAME, CODES, AND SELECTED ATTRIBUTES

	CODE #	SHORT NAME	COMMON NAME	SCIENTIFIC NAME	"t" Value	"I" Value	"c" Value	Leaf Type
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 Myriophyllum hete*	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	51	SpNAD	Spiny Naiad	*Najas marina L.*	4	7	2	bushy
12	60	CHARA	Chara	*Chara sp.*	6	3	4	bushy
13	62	Nitella	Nitella	*Nitella sp.*	6	3	4	bushy
14	63	NitT	Tufted Nitella	*Nitella sp.*	6	3	4	bushy
15	65	StSt	Starry Stonewort	*Nitellopsis obtusa (Desv.) J.Groves*	3	9	1	bushy
16	70	Moss	Water Moss	*Drepanocladus sp. or Fontinalis sp.*	6	5	4	bushy
17	71	JMoss	Java Moss	*0*	6	5	4	bushy
18	75	CLP	Curly Leaf Pondweed	*Potamogeton crispus L.*	2	9	1	narrow leafy
19	76	FSP	Flat Stem Pondweed	*Potamogeton zosteriformis Fern.*	6	5	2	narrow leafy
20	77	WSG	Water Star Grass	*Zosterella dubia (Jacq.) Small*	6	5	2	narrow leafy
21	80	ROB	Robbins Pondweed	*Potamogeton robbinsii Oakes*	8	2	3	narrow leafy
22	90	Rich	Richardsons Pondweed	*Potamogeton richardsonii (Benn.) Tydb.*	5	5	2	small leafy
23	93	AMER	American Pondweed	*Potamogeton nodosus Poiret*	7	5	3	broad leafy
24	94	MLF	Medium Leaf Pondweed	*Potamogeton alpinus Balb.*	8	2	3	broad leafy
25	109	HPW	Hybrid Pondweed	*Potamogeton Hybrid*	5	5	2	broad leafy
26	110	WBLP	Weedy Broad Leaf Pondweed	*Potamogeton amplifolius Hybrid*	4	6	2	broad leafy
27	115	Stuk	Sago Pondweed	*Stuckenia sp.*	3	6	2	stringy
28	117	TLP	Thin Leaf Pondweed	*Potamogeton sp.*	5	5	4	stringy
29	120	ZAN	Horned Pondweed	*Zannichellia palustris L.*	7	5	3	stringy
30	125	VAL	Wild Celery	*Vallisneria americana Michaux*	3	7	2	grassy
31	126	SAG	Sagittaria	*Sagittaria sp.*	7	3	4	grassy
32	127	SPRG	Sparganium	*Sparganium sp.*	8	2	4	grassy
33	130	FR	Flowering Rush	*Butomus umbellatus L.*	4	2	4	grassy
34	133	Wrice	Wild Rice	*Zizania sp.*	8	1	4	grassy
35	135	SPIK	Spikerush	*Eleocharis sp.*	5	3	4	grassy
36	138	BLRsh	Bull Rush	*Scirpus subterminalis Torrey*	7	1	4	grassy
37	150	WL	Waterlily	*Nymphaea sp.*	6	5	2	floating leaf
38	153	SPAD	Spadderdock	*Nuphar sp.*	6	5	2	floating leaf
39	155	WSh	Water Shield	*Brasenia schreberi J.F. Gmel.*	7	5	3	floating leaf
40	157	NELh	0	*Nelumbo sp..*	8	5	2	floating leaf
41	165	FLP	Floating Leaf Pondweed	*Potamogeton sp.*	7	6	3	floating leaf pondweed
42	166	TLFP	Thin and Floating Leaf Pondweed	*Potamogeton sp.*	5	0	3	floating leaf pondweed
43	167	SMTW	Smartweed	*Polygonum sp.*	5	4	3	floating leaf
44	180	DUCK	Common Duckweed	*Lemna sp.*	5	6	3	floating
45	186	TRIS	Star Duckweed	*Lemna trisulca L*	6	4	3	floating

Table 710/111.054 The percent occurrence of the plant species at AROS in 25 Michigan inland lakes during LakeScan™ vegetation surveys conducted in 2015.

SPECIES OCCURRENCE

Species Short Name	Percent of AROS's Where Species Was Observed																								
	BAR	BAS	BIG	CED	CRC	FIS	GUL	HIL	IND	JOS	KNT	LOB	LON	LOW	NOR	PLN	PLS	SHN	STN	TAM	TIP	UPR	WHT	WAB	WIL
EWMx	73%	20%	52%	8%	39%	83%	4%	86%	96%	8%	79%	42%	27%	69%	56%	68%	82%	44%	82%	96%	75%	68%	48%	98%	44%
NWM													37%						9%						
GWM				26%	22%		38%		67%	12%		12%		2%											
WMG													14%												
WWCF		2%											4%						2%			3%			
BLAD		6%	0%	66%			14%	38%	99%	73%		11%	1%	13%	3%						5%	1%			5%
MiniB	2%		6%						5%	1%											4%				
CNTL		1%	8%		17%	63%	1%	59%	2%		80%	27%	25%		4%	18%	9%	72%	56%	22%	21%	4%	1%		4%
ELD	1%		1%		11%	4%	3%				29%	4%	42%						3%	49%	3%	11%	2%		
NAID	38%	5%	26%	29%	3%	90%	11%	4%		69%	52%	28%		6%	32%	59%	76%	43%	40%	5%	26%	16%	9%		9%
SpNAD							1%																		
CHARA	97%	33%	66%	99%	78%	30%	24%	3%	93%	70%	40%	26%	8%	84%	85%	69%	83%	60%	57%	96%	90%	86%	72%	100%	36%
Nitella					1%												1%		1%						
NitT	27%						4%		38%																
StSt	4%		85%		11%		1%	51%	64%	29%	88%	67%	3%	73%	76%			18%	49%		90%	8%	24%	82%	32%
Moss	1%															12%					1%				2%
JMoss	6%																								
CLP	48%	11%	57%		42%	73%	3%		19%	2%	7%	6%	5%	6%	60%	18%	18%	30%	10%	88%	38%	4%	11%	29%	12%
FSP		1%	1%	0%	7%	20%	3%	32%			15%	8%	36%		13%	26%	13%	15%	11%			5%	4%		
WSG	2%	3%	1%	0%		50%	0%				48%	20%	34%		1%			18%	4%	17%		6%	2%		
ROB													0%										19%		
CrJ																					1%				
Rich				27%			1%		4%				23%				2%					1%			
AMER		1%		0%							61%	24%					1%		84%			5%			
MLF													0%												
HPW	61%		79%	54%	22%	67%	17%	1%	35%	81%		19%	55%	68%	54%	56%	61%	14%		3%	48%	60%	61%	31%	14%
WBLP	64%		3%	18%		59%	1%			6%		9%	44%	2%	48%		4%	28%		10%	8%		38%		
Stuk	19%			7%	5%	9%	21%		17%	26%	35%	23%	1%	13%	32%		46%	6%	56%	21%		58%	41%	51%	36%
TLP					11%		0%	3%			19%		7%	1%				48%				2%		2%	
ZAN	6%						1%		10%				1%							1%	8%	2%			
VAL		20%	14%	19%	56%		11%	70%	5%	22%	7%	32%	42%	4%	44%	84%	71%		65%		28%	67%	47%	16%	19%
SAG							4%	24%					1%								3%		4%		
SPRG								1%														0%			
FR																					3%	15%			
Wrice							1%																		
SPIK										3%															
BLRsh						14%																			
WL	46%	10%	46%	36%	33%	37%	5%	64%	69%	22%	65%	36%	22%	63%	30%	46%	41%	55%	26%	31%	27%	41%	24%	61%	20%
SPAD	29%	7%	2%	12%			3%	9%	19%	20%		10%	16%	13%	21%	11%	9%			1%	18%	7%	3%	12%	6%
WSh	3%		4%			16%				19%		1%	0%		28%	4%	29%				28%	0%			1%
NELh											4%														
FLP										3%															
TLFP				5%			1%			6%												4%	1%		
SMTW	6%											1%													
DUCK	3%								8%													2%			
TRIS													0%												

Table 710/111.064 The individual dominance of the plant species at AROS in 25 Michigan inland lakes during LakeScan™ vegetation surveys conducted in 2015.

SPECIES DOMINANCE																									
Species Short Name	LakeScan™ Dom 100© Index Value																								
	BAR	BAS	BIG	CED	CRC	FIS	GUL	HIL	IND	JOS	KNT	LOB	LON	LOW	NOR	PLN	PLS	SHN	STN	TAM	TIP	UPR	WHT	WAB	WIL
EWMx	32.7	21.1	27.6	10.7	25.6	44.7	7.6	39.9	37.3	13.6	35.6	29.3	15.9	38.0	26.9	34.4	39.2	28.2	38.8	42.1	36.7	35.6	29.8	41.6	33.0
NWM													19.5						7.2						
GWM				22.2	22.1		43.9		30.4	11.6		9.4		6.5											
WMG													13.6												
WWCF		5.3											6.8						3.6			5.7			
BLAD		8.7	1.7	33.6			19.7	24.1	37.0	34.9		8.6	3.1	15.2	6.6						5.4	4.2			7.6
MiniB	4.7		9.8						7.3	2.9											5.1				
CNTL		2.9	8.9		15.9	29.3	2.9	42.0	2.1		38.5	16.1	17.4		7.3	17.4	8.3	48.0	26.5	13.0	12.0	6.7	3.0		7.5
ELD	2.4		3.3		13.4	9.6	6.0				17.5	5.2	25.8						5.4	31.3	6.1	12.1	4.4		
NAID	22.1	8.0	17.7	24.7	5.2	46.3	17.5	5.1		45.5	27.3	17.8		8.5	20.2	39.8	33.7	27.6	24.2	5.7	16.5	14.4	9.6		14.2
SpNAD							6.0																		
CHARA	58.8	42.0	37.9	68.0	56.5	20.3	30.2	4.4	48.5	40.3	22.8	18.3	10.8	48.2	43.5	41.0	40.5	38.0	32.8	60.8	47.2	50.1	45.0	54.2	32.7
Nitella					2.8												2.7		6.1						
NitT	21.5						18.2		22.6																
StSt	7.3		51.8		20.1		3.4	46.6	35.0	20.9	45.9	53.1	6.5	42.0	40.1			21.1	32.2		48.0	10.4	20.6	47.0	26.4
Moss	1.7															12.0					3.4				5.1
JMoss	7.3																								
CLP	25.8	12.3	27.9		29.2	36.6	5.2		13.6	4.7	6.9	7.4	7.4	9.8	24.7	12.8	13.6	19.9	11.4	38.7	17.2	4.7	11.2	16.3	12.7
FSP		3.4	3.3	1.6	8.1	13.4	5.7	19.5			10.7	6.8	20.6		7.9	16.2	8.5	14.1	10.7			7.1	4.7		
WSG	4.2	5.8	2.8	1.2		23.3	2.4				22.8	12.8	23.3		1.7			14.8	5.5	11.9		5.7	2.0		
ROB													1.9										15.6		
CrJ																					2.5				
Rich				18.3			5.1		6.7				12.9				1.8					2.4			
AMER		2.9		1.6							31.1	16.3					3.9		39.3			7.1			
MLF													1.6												
HPW	34.7		36.5	28.4	20.0	31.0	19.5	2.5	18.5	35.8		13.3	29.1	31.5	24.4	28.9	29.3	12.6		10.3	27.1	28.3	32.8	19.6	20.7
WBLP	31.6		8.7	16.8		28.6	3.8			10.5		9.0	26.4	4.1	24.3		6.6	20.5		12.5	8.8		25.3		
Stuk	12.6			9.1	8.9	7.2	24.3		10.0	19.7	18.6	14.8	3.7	14.0	18.1		23.3	7.1	26.6	22.1		30.1	24.1	27.1	29.8
TLP					12.0		2.2	4.1			15.4		9.7	3.5				27.5				4.0		3.5	
ZAN	11.2						4.6		9.9				3.6							5.0	8.8	3.5			
VAL		23.9	13.7	18.7	36.4		17.5	45.0	8.3	15.5	8.7	21.2	26.9	8.2	23.5	47.5	35.4		32.3		20.0	34.1	27.1	13.3	23.0
SAG							9.8	15.7					2.9								5.5		6.2		
SPRG								2.8														1.8			
FR																					5.5	15.2			
Wrice							3.2																		
SPIK										6.2															
BLRsh						11.0																			
WL	26.2	15.6	29.3	27.8	26.1	17.9	8.5	32.6	32.2	17.0	31.9	22.0	19.9	38.0	23.0	29.7	27.6	31.3	17.1	24.0	19.2	32.3	20.2	37.0	22.3
SPAD	19.6	11.7	6.1	17.0			7.5	10.2	14.3	15.2		10.1	20.9	16.6	16.8	15.0	9.4			3.4	15.3	11.0	7.0	13.4	9.2
WSh	5.6		7.4			12.2				15.1		3.1	4.5		20.7	7.5	20.2				20.0	2.5			3.2
NELh											11.3														
FLP										5.7															
TLFP				8.2			4.3			7.6												6.9	4.2		
SMTW	7.7											3.9													
DUCK	7.5								8.8													5.1			
TRIS													1.6												

Table 710/011.024 The biovolume of plant species at AROS in 25 Michigan inland lakes during LakeScan™ vegetation surveys conducted in 2015. Units are ft^3 of plant biovolume per acre foot of water.

BIOVOLUME AS MEAN AROS PLANT FT3/ACRE FOOT																									
Species Short Name	Mean Plant Species BioVol Ft^3 per Acre Ft.																								
	BAR	BAS	BIG	CED	CRC	FIS	GUL	HIL	IND	JOS	KNT	LOB	LON	LOW	NOR	PLN	PLS	SHN	STN	TAM	TIP	UPR	WHT	WAB	WIL
EWMx	9	17	432	6	39	11	4	1	32	18	21	22	8	16	8	16	36	24	26	7	13	22	16	32	18
NWM													5						0						
GWM				8	41		12		22	6		15		11											
WMG													4												
WWCF		0											24						13			48			
BLAD		15	1	0			5	0	32	8		8	8	3	21						3	6			3
MiniB	52		6						40	6											13				
CNTL		11	10		8	3	1	4	0		16	14	6		19	7	4	14	6	1	3	16	0		11
ELD	38		15		41	20	11				24	20	12						7	13	0	21	27		
NAID	39	26	16	19	5	20	9	0		12	32	30		13	12	6	30	32	29	0	13	12	18		12
SpNAD							6																		
CHARA	15	11	7	13	15	2	11	0	57	7	8	10	4	14	9	7	41	21	8	9	6	10	7	17	12
Nitella					12												23		3						
NitT	22						5		12																
StSt	9		21		72		16	4	15	17	42	47	2	22	18			32	28		8	45	8	42	15
Moss	0															7					55				12
JMoss	56																								
CLP	25	5	13		85	15	4		65	15	13	23	16	20	9	7	12	20	29	6	2	11	20	5	11
FSP		30	15	1	7	0	5	2			12	10	16		2	6	7	19	19			20	1		
WSG	15	2	4	0		4	18				21	16	19		0			14	15	1		8	0		
ROB													4										2		
CrJ																					2				
Rich				5			16		9				5				0					3			
AMER		20		0							19	20					44		21			29			
MLF													12												
HPW	17		25	6	13	10	3	0	9	5		18	14	4	6	8	12	15		29	9	4	6	4	8
WBLP	13		10	8		3	0			18		15	16	0	9		7	15		11	1		13		
Stuk	14			11	24	1	6		20	11	20	21	34	10	7		22	11	19	5		11	7	24	7
TLP					14		1	0			18		13	25				11				26		0	
ZAN	33						9		50				20							12	1	15			
VAL		9	9	8	25		3	4	4	7	11	16	10	10	6	3	16		11		8	5	6	5	10
SAG							4	0					4								7		3		
SPRG								0														1			
FR																					15	14			
Wrice							0																		
SPIK										16															
BLRsh						1																			
WL	18	15	100	6	25	1	2	1	40	3	2	4	14	5	11	5	15	16	4	5	8	12	5	14	10
SPAD	17	14	5	5			2	0	32	3		5	16	6	10	6	22			5	7	11	4	16	10
WSh	42		3			1				3		5	17		11	8	17				8	13			10
NELh											2														
FLP										16															
TLFP				16			1			8												19	1		
SMTW	25											4													
DUCK	8								8													3			
TRIS													0												

Table 710.011.010 A summary of species percent occurrence at the lake AROS, individual species dominance and the plant biovolume of plant species at AROS in 25 Michigan inland lakes during LakeScan™ averaged from the surveys performed on each lake and compared to data from Wabeek Lake.

SPECIES OCCURRENCE				
	Wabeek	All Lakes		
	Mean Occurence at AROS's	Mean Occurence at AROS's	Maximum Occurence at AROS's	Minimum Occurence at AROS's
EWMx	98.0%	57.9%	98.0%	3.7%
NWM		22.9%	37.1%	8.7%
GWM		25.4%	67.4%	1.6%
WMG		13.9%	13.9%	13.9%
WWCF		2.7%	4.1%	1.8%
BLAD		24.0%	98.7%	0.4%
MiniB		3.8%	6.4%	1.4%
CNTL		24.8%	80.0%	1.0%
ELD		12.6%	49.0%	0.6%
NAID		30.6%	90.0%	3.3%
SpNAD		1.2%	1.2%	1.2%
CHARA	100.0%	63.4%	100.0%	2.7%
Nitella		0.7%	0.9%	0.6%
NitT		22.7%	37.7%	3.7%
StSt	82.4%	44.9%	89.9%	0.7%
Moss		3.9%	11.6%	0.6%
JMoss		6.4%	6.4%	6.4%
CLP	29.4%	26.0%	88.3%	2.1%
FSP		12.3%	35.5%	0.3%
WSG		13.8%	50.0%	0.3%
ROB		9.8%	19.3%	0.4%
CrJ		0.6%	0.6%	0.6%
Rich		9.7%	27.1%	0.9%
AMER		25.0%	83.9%	0.3%
MLF		0.4%	0.4%	0.4%
HPW	31.4%	43.7%	81.1%	1.4%
WBLP		22.8%	64.3%	1.0%
Stuk	51.0%	26.2%	58.5%	0.8%
TLP	2.0%	10.3%	47.6%	0.5%
ZAN		4.2%	9.7%	1.0%
VAL	15.7%	35.4%	84.2%	3.9%
SAG		7.3%	24.3%	0.8%
SPRG		0.9%	1.4%	0.5%
FR		9.1%	15.1%	3.1%
Wrice		1.0%	1.0%	1.0%
SPIK		2.8%	2.8%	2.8%
BLRsh		14.3%	14.3%	14.3%
WL	60.8%	38.2%	69.1%	4.7%
SPAD	11.8%	11.3%	28.7%	0.7%
WSh		11.0%	28.6%	0.4%
NELh		3.8%	3.8%	3.8%
FLP		3.5%	3.5%	3.5%
TLFP		3.4%	5.6%	1.0%
SMTW		3.2%	5.7%	0.7%
DUCK		4.2%	8.1%	1.9%
TRIS		0.4%	0.4%	0.4%

SPECIES DOMINANCE				
	Wabeek	All Lakes		
	Mean Dominance at AROS's	Mean Dominance at AROS's	Minimum Dominance at AROS's	Maximum Dominance at AROS's
EWMx	42	31	45	8
NWM		13	19	7
GWM		21	44	7
WMG		14	14	14
WWCF		5	7	4
BLAD		15	37	2
MiniB		6	10	3
CNTL		16	48	2
ELD		11	31	2
NAID		21	46	5
SpNAD		6	6	6
CHARA	54	40	68	4
Nitella		4	6	3
NitT		21	23	18
StSt	47	30	53	3
Moss		6	12	2
JMoss		7	7	7
CLP	16	16	39	5
FSP		10	21	2
WSG		9	23	1
ROB		9	16	2
CrJ		2	2	2
Rich		8	18	2
AMER		15	39	2
MLF		2	2	2
HPW	20	24	36	3
WBLP		16	32	4
Stuk	27	18	30	4
TLP	4	9	28	2
ZAN		7	11	4
VAL	13	24	48	8
SAG		8	16	3
SPRG		2	3	2
FR		10	15	5
Wrice		3	3	3
SPIK		6	6	6
BLRsh		11	11	11
WL	37	25	38	8
SPAD	13	12	21	3
WSh		10	21	2
NELh		11	11	11
FLP		6	6	6
TLFP		6	8	4
SMTW		6	8	4
DUCK		7	9	5
TRIS		2	2	2

SPECIES DOMINANCE				
	Wabeek	All Lakes		
	Mean Dominance at AROS's	Mean Dominance at AROS's	Minimum Dominance at AROS's	Maximum Dominance at AROS's
EWMx	42	31	45	8
NWM		13	19	7
GWM		21	44	7
WMG		14	14	14
WWCF		5	7	4
BLAD		15	37	2
MiniB		6	10	3
CNTL		16	48	2
ELD		11	31	2
NAID		21	46	5
SpNAD		6	6	6
CHARA	54	40	68	4
Nitella		4	6	3
NitT		21	23	18
StSt	47	30	53	3
Moss		6	12	2
JMoss		7	7	7
CLP	16	16	39	5
FSP		10	21	2
WSG		9	23	1
ROB		9	16	2
CrJ		2	2	2
Rich		8	18	2
AMER		15	39	2
MLF		2	2	2
HPW	20	24	36	3
WBLP		16	32	4
Stuk	27	18	30	4
TLP	4	9	28	2
ZAN		7	11	4
VAL	13	24	48	8
SAG		8	16	3
SPRG		2	3	2
FR		10	15	5
Wrice		3	3	3
SPIK		6	6	6
BLRsh		11	11	11
WL	37	25	38	8
SPAD	13	12	21	3
WSh		10	21	2
NELh		11	11	11
FLP		6	6	6
TLFP		6	8	4
SMTW		6	8	4
DUCK		7	9	5
TRIS		2	2	2

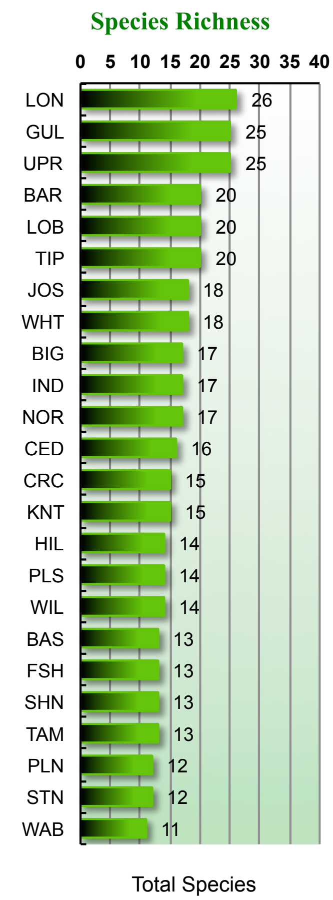
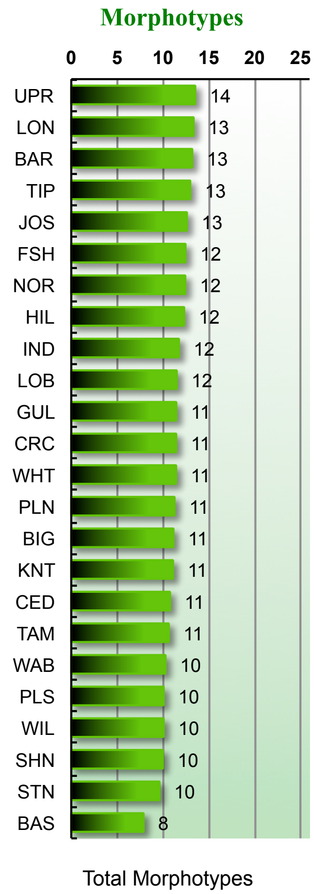


Figure 700/111.014 Total species richness or total species present in each lake during the most recent survey year.

710/111.044 LakeScan™ Plant Community Quality (Annual)

710/111.017 Morphotypes



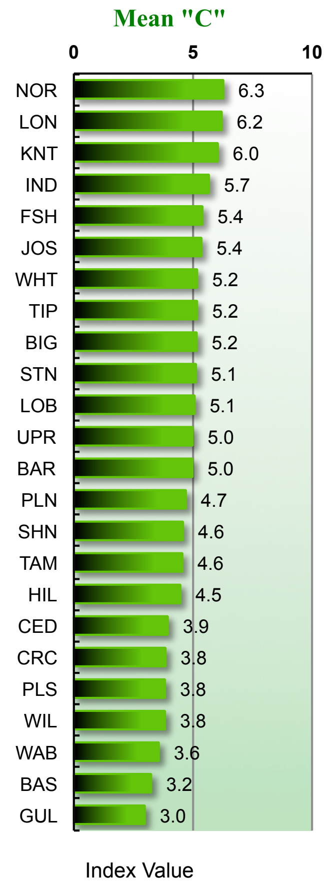


Figure 710/111.017 Plant morphology is an important measure of the structural complexity of any ecosystem. It could be said that fish don't care what names we give to submersed macrophytes – they care about structure. LakeScan™ recognizes 26 distinct plant morphotypes among common submersed macrophyte species. The left figure provides estimates of the total number of morphotypes that were observed in the 25 lakes in 2015. Plant quality is also an excellent measure of lake quality. Lakes that have higher "C" values are generally considered to be of higher quality and less disturbed than other lake systems. Data for the 25 lakes included in this analysis are presented in the right figure. These data suggest that "C" value is not necessarily and inversely correlated with perceived weediness.

Table 710/111..044

A list of species found during the course of the summer growing season, grouped according to “T” value. T1 species are nearly always weedy and are generally assigned a high priority for control. T2 species are occasionally targeted for control while T3 specie are rarely targeted for control but may be suppressed when they are present in dense stands of T1 species. These plant usuallly recover quickly from properly conceived MIST applcations. T4 species are often rare and every effort is usually expended to protect them from all anthropogenic activity.

PLANT NAME, CODES, AND SELECTED ATTRIBUTES

"T" VALUE	CODE #	SHORT NAME	COMMON NAME	SCIENTIFIC NAME
1	2	EWMx	Eurasian Watermilfoil Hybrid	*Myriophyllum spicatum x sibiricum*
1	65	StSt	Starry Stonewort	*Nitellopsis obtusa (Desv.) J.Groves*
1	75	CLP	Curly Leaf Pondweed	*Potamogeton crispus L.*
2	4	GWM	Green/Variable Watermilfoil	*Myriophyllum verticillatum L. or Myriophyllum heterophyllum Michaux*
2	33	CNTL	Coontail	*Ceratophyllum sp.*
2	42	ELD	Elodea	*Elodea sp.*
2	50	NAID	Naiad	*Najas sp.*
2	51	SpNAD	Spiny Naiad	*Najas marina L.*
2	76	FSP	Flat Stem Pondweed	*Potamogeton zosteriformis Fern.*
2	77	WSG	Water Star Grass	*Zosterella dubia (Jacq.) Small*
2	90	Rich	Richardsons Pondweed	*Potamogeton richardsonii (Benn.) Tydb.*
2	109	HPW	Hybrid Pondweed	*Potamogeton Hybrid*
2	110	WBLP	Weedy Broad Leaf Pondweed	*Potamogeton amplifolius Hybrid*
2	115	Stuk	Sago Pondweed	*Stuckenia sp.*
2	125	VAL	Wild Celery	*Vallisneria americana Michaux*
2	150	WL	Waterlily	*Nymphaea sp.*
2	153	SPAD	Spadderdock	*Nuphar sp.*
2	157	NELh	0	*Nelumbo sp..*
3	3	NWM	Northern Watermilfoil	*Myriophyllum sibiricum Kom.*
3	22	WWCF	White Water Crowsfoot	*Ranunculus sp.*
3	25	BLAD	Common Bladderwort	*Utricularia vulgaris L.*
3	80	ROB	Robbins Pondweed	*Potamogeton robbinsii Oakes*
3	84	CrJ	Creeping Jenny (sub)	*Lysimachia nummularia L.*
3	93	AMER	American Pondweed	*Potamogeton nodosus Poiret*
3	94	MLF	Medium Leaf Pondweed	*Potamogeton alpinus Balb.*
3	120	ZAN	Horned Pondweed	*Zannichellia palustris L.*
3	155	WSh	Water Shield	*Brasenia schreberi J.F. Gmel.*
3	165	FLP	Floating Leaf Pondweed	*Potamogeton sp.*
3	166	TLFP	Thin and Floating Leaf Pondweed	*Potamogeton sp.*
3	167	SMTW	Smartweed	*Polygonum sp.*
3	180	DUCK	Common Duckweed	*Lemna sp.*
4	15	WMG	Water Marigold	*Bidens Beckii Torr. ex Spreng.*
4	27	MiniB	Mini-Bladderwort	*Utricularia sp.*
4	60	FR	Flowering Rush	*Butomus umbellatus L.*
4	62	Wrice	Wild Rice	*Zizania sp.*
4	63	SPIK	Spikerush	*Eleocharis sp.*
4	70	BLRsh	Bull Rush	*Scirpus subterminalis Torrey*
4	71	WL	Waterlily	*Nymphaea sp.*
4	117	SPAD	Spadderdock	*Nuphar sp.*
4	126	WSh	Water Shield	*Brasenia schreberi J.F. Gmel.*
4	127	NELh	0	*Nelumbo sp..*
4	130	FLP	Floating Leaf Pondweed	*Potamogeton sp.*
4	133	TLFP	Thin and Floating Leaf Pondweed	*Potamogeton sp.*
4	135	SMTW	Smartweed	*Polygonum sp.*
4	138	DUCK	Common Duckweed	*Lemna sp.*
4	138	TRIS	Star Duckweed	*Lemna trisulca L*

710/111.004 Plant Community Species Occurrence, and Dominance (Annual)

Table 710/111.004 A list of species found during the course of the summer growing season, abbreviated name, common name, scientific name, the percent occurrence of each species in the lake AROS, the species dominance values, and estimated biovolume of each plant species in the AROS areas in the lake.

PLANT NAME, CODES, AND SELECTED METRICS							
	Code #	Abbrev. Name	Common Name	Scientific Name	Lake % Occurrence	Mean Dom Value	BioVolume Ft3/A•Ft
1	2	EWMx	Eurasian Watermilfoil Hybrid	*Myriophyllum spicatum x sibiricum*	100%	31	34
2	3	NWM	Northern Watermilfoil	*Myriophyllum sibiricum Kom.*	8%	13	3
3	4	GWM	Green/Variable Watermilfoil	*Myriophyllum verticillatum L. or Myriophyllum heterophyllum*	28%	21	17
4	15	WMG	Water Marigold	*Bidens Beckii Torr. ex Spreng.*	4%	14	4
5	22	WWCF	White Water Crowsfoot	*Ranunculus sp.*	16%	5	21
6	25	BLAD	Common Bladderwort	*Utricularia vulgaris L.*	56%	15	8
7	27	MiniB	Mini-Bladderwort	*Utricularia sp.*	20%	6	23
8	33	CNTL	Coontail	*Ceratophyllum sp.*	80%	16	8
9	42	ELD	Elodea	*Elodea sp.*	52%	11	19
10	50	NAID	Naiad	*Najas sp.*	88%	21	18
11	51	SpNAD	Spiny Naiad	*Najas marina L.*	4%	6	6
12	60	CHARA	Chara	*Chara sp.*	100%	40	13
13	62	Nitella	Nitella	*Nitella sp.*	12%	4	13
14	63	NitT	Tufted Nitella	*Nitella sp.*	12%	21	13
15	65	StSt	Starry Stonewort	*Nitellopsis obtusa (Desv.) J.Groves*	76%	30	24
16	70	Moss	Water Moss	*Drepanocladus sp. or Fontinalis sp.*	16%	6	19
17	71	JMoss	Java Moss	*0*	4%	7	56
18	75	CLP	Curly Leaf Pondweed	*Potamogeton crispus L.*	92%	16	19
19	76	FSP	Flat Stem Pondweed	*Potamogeton zosteriformis Fern.*	68%	10	10
20	77	WSG	Water Star Grass	*Zosterella dubia (Jacq.) Small*	60%	9	9
21	80	ROB	Robbins Pondweed	*Potamogeton robbinsii Oakes*	8%	9	3
22	84	CrJ	Creeping Jenny (sub)	*Lysimachia nummularia L.*	4%	2	2
23	90	Rich	Richardsons Pondweed	*Potamogeton richardsonii (Benn.) Tydb.*	24%	8	6
24	93	AMER	American Pondweed	*Potamogeton nodosus Poiret*	28%	15	22
25	94	MLF	Medium Leaf Pondweed	*Potamogeton alpinus Balb.*	4%	2	12
26	109	HPW	Hybrid Pondweed	*Potamogeton Hybrid*	88%	24	10
27	110	WBLP	Weedy Broad Leaf Pondweed	*Potamogeton amplifolius Hybrid*	60%	16	9
28	115	Stuk	Sago Pondweed	*Stuckenia sp.*	80%	18	14
29	117	TLP	Thin Leaf Pondweed	*Potamogeton sp.*	36%	9	12
30	120	ZAN	Horned Pondweed	*Zannichellia palustris L.*	28%	7	20
31	125	VAL	Wild Celery	*Vallisneria americana Michaux*	84%	24	9
32	126	SAG	Sagittaria	*Sagittaria sp.*	20%	8	4
33	127	SPRG	Sparganium	*Sparganium sp.*	8%	2	0
34	130	FR	Flowering Rush	*Butomus umbellatus L.*	8%	10	14
35	133	Wrice	Wild Rice	*Zizania sp.*	4%	3	0
36	135	SPIK	Spikerush	*Eleocharis sp.*	4%	6	16
37	138	BLRsh	Bull Rush	*Scirpus subterminalis Torrey*	4%	11	1
38	150	WL	Waterlily	*Nymphaea sp.*	100%	25	14
39	153	SPAD	Spadderdock	*Nuphar sp.*	80%	12	10
40	155	WSh	Water Shield	*Brasenia schreberi J.F. Gmel.*	48%	10	11
41	157	NELh	Lotus Hybrid	*Nelumbo sp..*	4%	11	2
42	165	FLP	Floating Leaf Pondweed	*Potamogeton sp.*	4%	6	16
43	166	TLFP	Thin and Floating Leaf Pondweed	*Potamogeton sp.*	20%	6	9
44	167	SMTW	Smartweed	*Polygonum sp.*	8%	6	14
45	180	DUCK	Common Duckweed	*Lemna sp.*	12%	7	7
46	186	TRIS	Star Duckweed	*Lemna trisulca L*	4%	2	0

710/111.174 LakeScan™ BioD60© Biodiversity Indices (Annual)

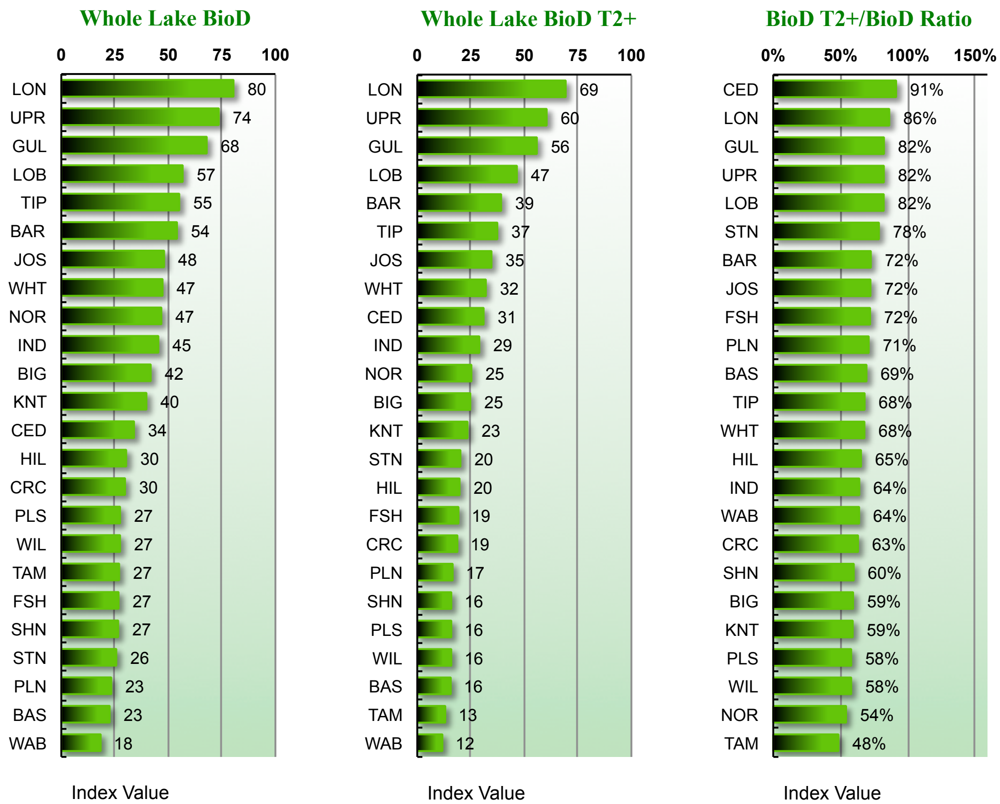


Figure 710/111.074 The LakeScan™ BioD 60© and BioD T2+ biodiversity index for each of the lakes analyzed in 2015. The right figure shows the ratio of the BioD T2+ index value over the total BioD. This is a relative estimate of the influence of undesirable plants, T1 species, on the over all biodiversity of the plant community.

Comment:

The LakeScan™ BioD 60© 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 60. The fundamental algorithm is based on the Euler's equation where the greatest variance in value is found in the middle range of all possible values. The assumption is that at some point biodiversity is so low, or so high, that there should be little difference in values. In other words, a lake can only get "so bad" or "so good". Index values greater than 40 are considered to be good. The goal of any aquatic plant community management plan should be to protect or enhance the biological diversity of the over-all plant community. T1 species are typically invasive and will extirpate or "crowd" out more conservative or desirable species. Consequently, the objective of any planned management interventions is to suppress or decrease the dominance of T1 species and this should increase the dominance of more desirable T2, T3, and T4 plant species. These data are presented to illustrate the relative BioD50© of the entire plant community and a plant community without T1 species – T2+ or the index value for only the most desirable of plant species. The ratio for these two metric values is presented for the first time in 2015. These data shall be considered in the coming years to see if they correlate with perceived weedy conditions in lakes.

710/111.075 LakeScan™ MorphoD 26© Biodiversity Indices (Annual)

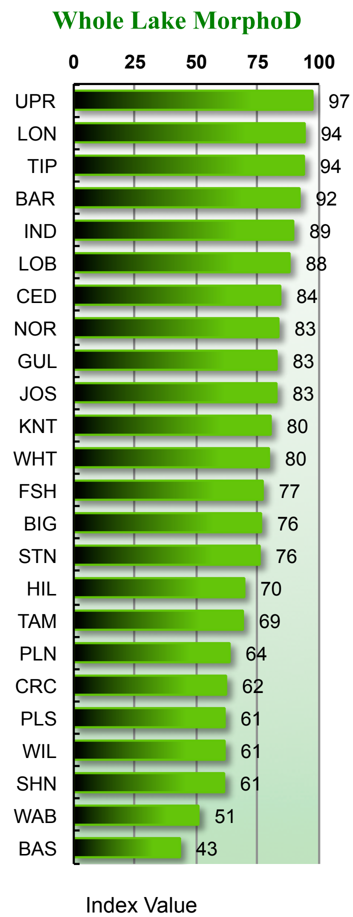


Figure 710/111.075 The LakeScan™ MorphoD 26© biodiversity index is a proportional index that assumes the greatest number of plant morphotypes, that might be present during any survey, will not be greater than or equal to 26. Again, index values greater than 50 are considered to be good.

710/111.024 LakeScan™ BioV© Indices (Annual)

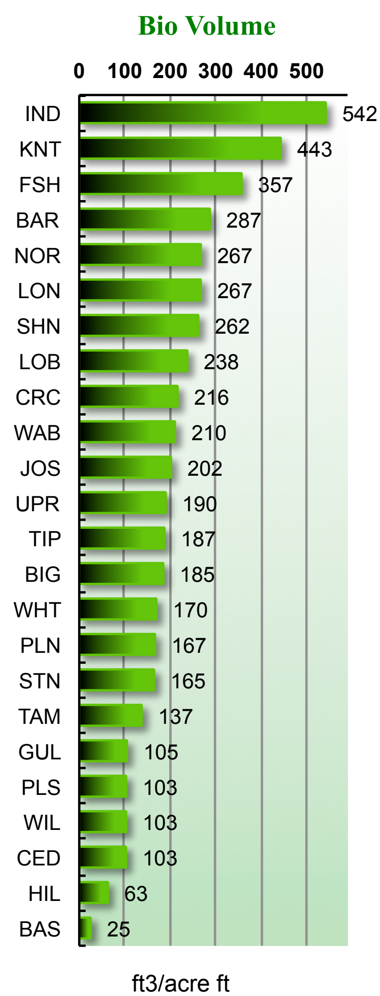


Figure 710/111.024 The LakeScan™ BioV© Biovolume index is based on the mean volume of various species per foot stem length and the density of stems per unit area. A compensatory factor is included for species that branch near the top of the plant or form surface canopies. These figures are based on the total estimated BioV found in each area divided by the acres encompassed by the data collection zone (Lake, Tier, or MZL).

710/111.084 LakeScan™ Weediness© Indices (Annual)

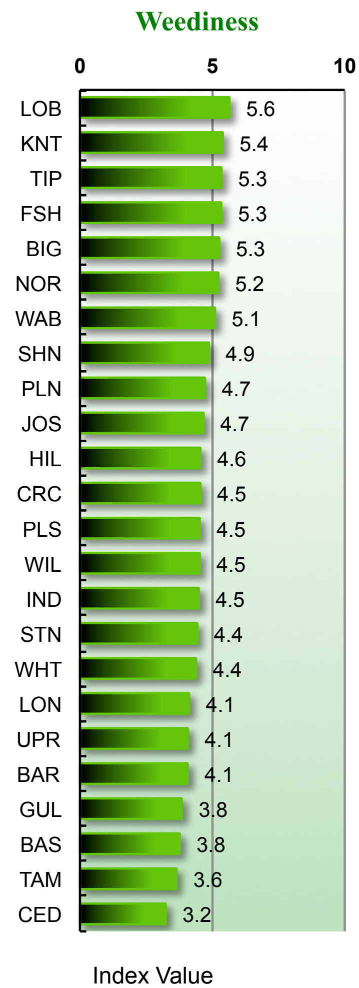


Figure 710/111.084 The LakeScan™ Weedines© index is fundamentally a diversity index (similar algorithm) however values are weighted according to the assigned "i" value, coupled with the density and distribution of various species at each AROS.

710/113 LakeScan™ Plant Community Survey Event Data

Comment:

VS 3.0 surveys were conducted in June and VS 5.0 surveys were conducted in August. Data are 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.

710/113.014 Species Richness (Events)

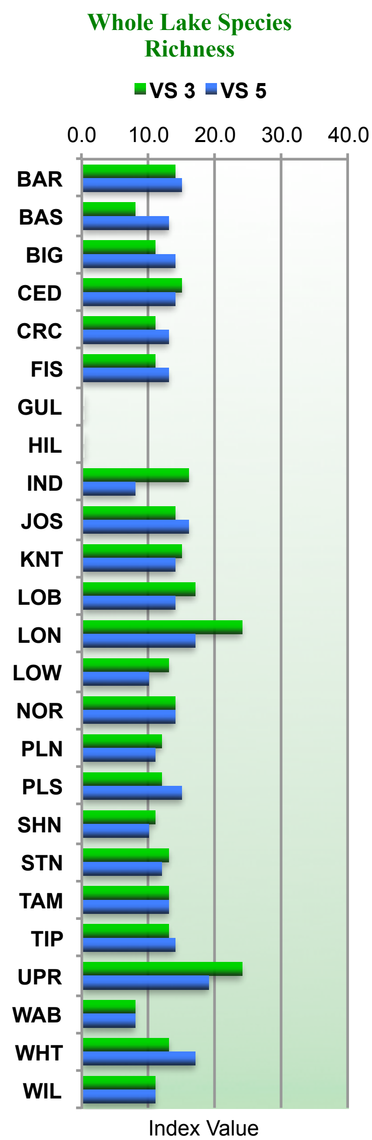


Figure 710/113.014 The species richness in all 25 lakes during the entire summer at distinct survey events that occurred in the early summer (VS 3) and late summer (VS 5) survey events for the whole lake and at all MZL's.

710/113.017 Plant Community Quality (Event)

Morphotypes:
The sum total of distinct plant morphotypes observed during the entire growing season in the lake and at all MZL's, contrasted with data compiled for specific survey events that occurred during the same growing season.

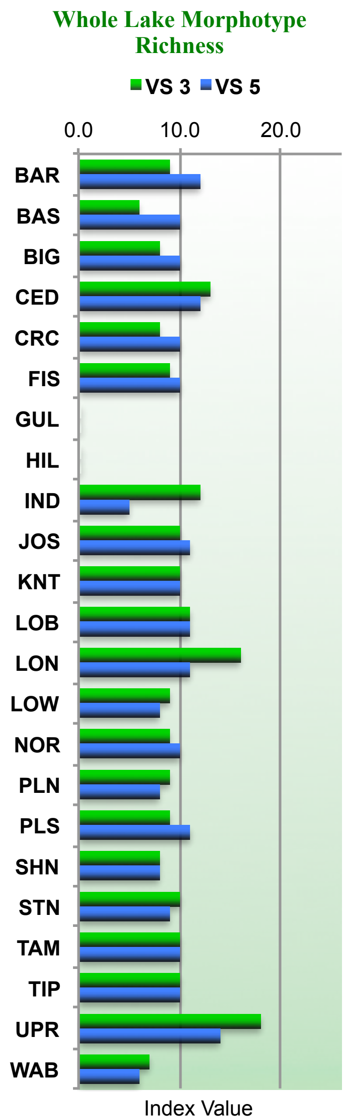


Figure 710/113.017 The total number of distinct plant morphotypes in all 25 lakes at specific early summer (VS 3) and late summer (VS 5) survey events for the whole lake and at all MZL's.

710/113.074 Plant Community Diversity and Structural Complexity

The LakeScan™ BioD 60© index in all lakes during early summer, VS 3, and late summer VS 5, vegetation surveys.

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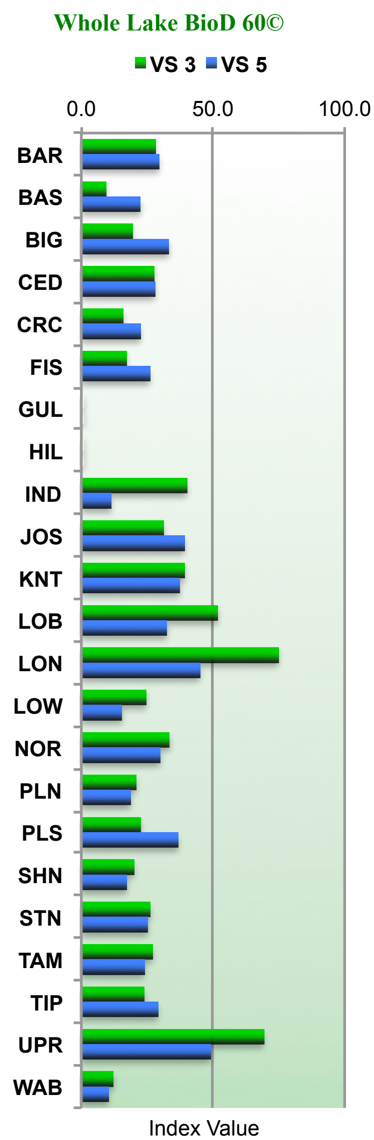

Figure 710/113.074 The LakeScan™ BioD 60© index value based upon all plant species observed in all of the lakes at specific survey events that occurred in the early summer (VS 3) and late summer (V5) in the entire lake and at specific MZL's.

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 50© index and this may be one of the most useful metrics when considering the impact and success of the applied management program.

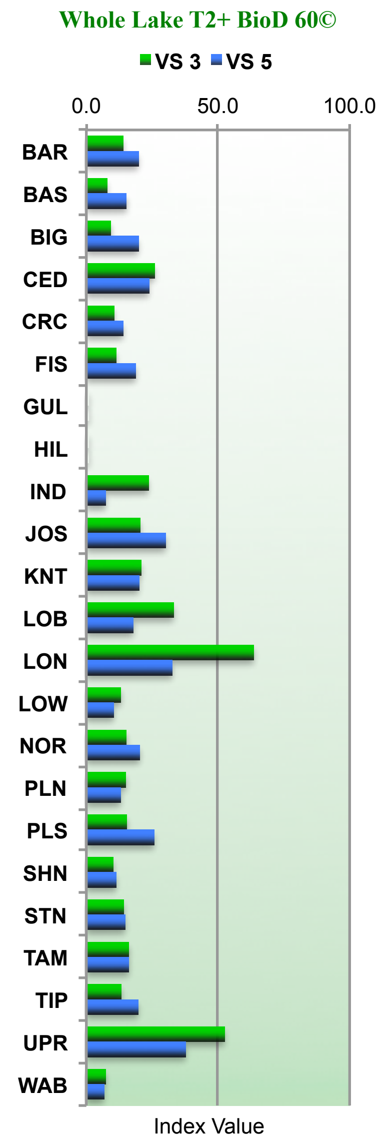

Figure 710/113.053 The LakeScan™ BioD 60© index value for all plant species of target rating T2 or greater calculated for all of the lakes at distinct survey events that occurred in the early summer (VS 3) and late summer (VS 5) survey events in the entire lake.

710/113.084 Weediness Index (Event)

The LakeScan™ Weediness 10© index value for the whole lake for all species observed in the lake during the entire summer and for the lake and all MZL's as determined from observations made at specific sampling events.

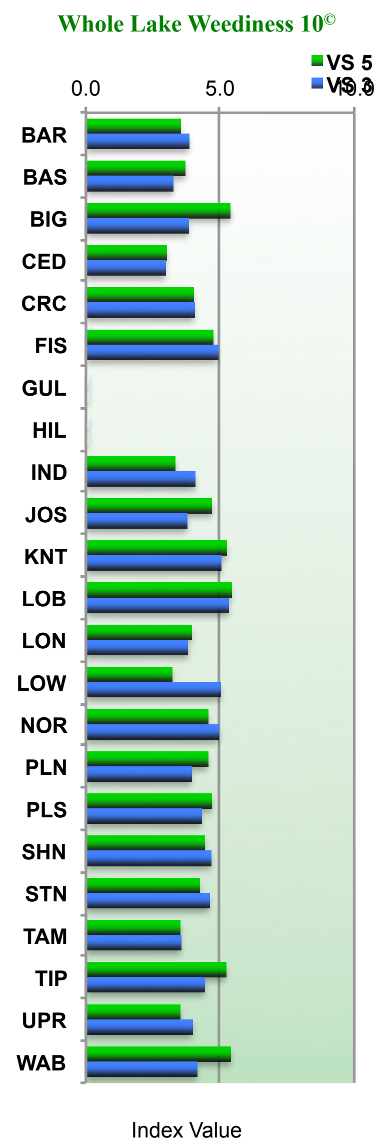

Figure 710/113.084 The LakeScan™ Weediness 10© index value of plant species calculated for all of the lakes at an early summer (VS 3) and late summer (VS 5) survey events for the whole lake.

Category 750 Macrophyte Management Program

This section is currently under development and is presented in part in 2015. Lake management objectives are usually established on an annual basis and the strategic elements of the plan (the things that we apply or do to the lake) are subject to change. For this reason, the treatment information is compiled at the end of the growing season so that the actual management strategies that were used in a given season are considered as a part of the LakeScan™ analysis. Pertinent data appears in other parts of the LakeScan™ report. For example, biometric data such as species richness and biodiversity collected at different surveys that are conducted during the course of the year are presented in both the annual data section and year-to-year comparison sections. Sometimes these data are presented in the management section if it is important from the perspective of the management discussion. As always comments and suggestions are encouraged as we seek to make the LakeScan™ report not just informative, but easy to navigate and understand.

750/122.214 Plants and Weeds

Table 750/122.214 A list of the species that have been present since the beginning of LakeScan™ monitoring including plant code number and respective "T" value assignments and plant leaf morphotype group assignment.

PLANT NAME, CODES, AND SELECTED ATTRIBUTES					
"T" VALUE	CODE #	SHORT NAME	COMMON NAME	SCIENTIFIC NAME	MORPHOTYPE
1	2	EWMx	Eurasian Watermilfoil Hybrid	*Myriophyllum spicatum x sibiricum*	feathery
1	65	StSt	Starry Stonewort	*Nitellopsis obtusa (Desv.) J.Groves*	bushy
1	75	CLP	Curly Leaf Pondweed	*Potamogeton crispus L.*	narrow leafy
2	4	GWM	Green/Variable Watermilfoil	*Myriophyllum verticillatum L. or Myriophyllum heterophyllum Michaux*	feathery
2	33	CNTL	Coontail	*Ceratophyllum sp.*	bushy
2	42	ELD	Elodea	*Elodea sp.*	bushy
2	50	NAID	Naiad	*Najas sp.*	bushy
2	77	WSG	Water Star Grass	*Zosterella dubia (Jacq.) Small*	narrow leafy
2	90	Rich	Richardsons Pondweed	*Potamogeton richardsonii (Benn.) Tydb.*	small leafy
2	109	HPW	Hybrid Pondweed	*Potamogeton Hybrid*	broad leafy
2	110	WBLP	Weedy Broad Leaf Pondweed	*Potamogeton amplifolius Hybrid*	broad leafy
2	115	Stuk	Sago Pondweed	*Stuckenia sp.*	stringy
2	125	VAL	Wild Celery	*Vallisneria americana Michaux*	grassy
2	150	WL	Waterlily	*Nymphaea sp.*	floating leaf
2	153	SPAD	Spadderdock	*Nuphar sp.*	floating leaf
3	3	NWM	Northern Watermilfoil	*Myriophyllum sibiricum Kom.*	feathery
3	25	BLAD	Common Bladderwort	*Utricularia vulgaris L.*	feathery
3	120	ZAN	Horned Pondweed	*Zannichellia palustris L.*	stringy
3	155	WSh	Water Shield	*Brasenia schreberi J.F. Gmel.*	floating leaf
3	165	FLP	Floating Leaf Pondweed	*Potamogeton sp.*	floating leaf pondweed
3	180	DUCK	Common Duckweed	*Lemna sp.*	floating
4	15	WMG	Water Marigold	*Bidens Beckii Torr. ex Spreng.*	bushy
4	27	MiniB	Mini-Bladderwort	*Utricularia sp.*	feathery
4	60	CHARA	Chara	*Chara sp.*	bushy
4	117	TLP	Thin Leaf Pondweed	*Potamogeton sp.*	stringy

751/401.264 Plant Community Management T1 Species Data

Historical LakeScan™ Dominance 100© at different seasonal survey events for select data records by TmtZ.

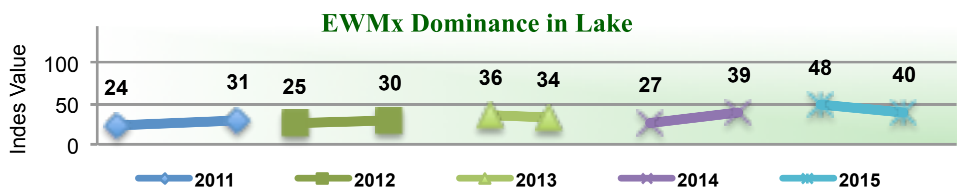

Figure 751/401.264a The LakeScan™ Dominance factor for **Ebrid** (Eurasian or hybrid watermilfoil and all sub-genotypes) found in the lake and selected Tiers for selected years of record.

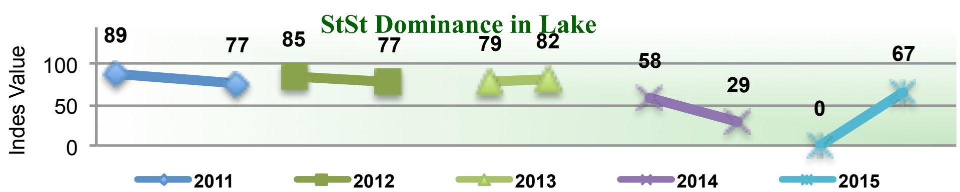

Figure 751/401.264b The LakeScan™ Dominance factor for **starry stonewort** found in the lake and selected Tiers for selected years of record.

Photos

Figure 700.00.1 Extremely dense ebrid water milfoil. It is expected to grow to extreme nuisance conditions next year.

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Figure 700.00.2 Extremely dense ebrid water milfoil and wild celery plant parts. The white “stems” are actually wild celery flowers. The grass-like leaves that are produced by wild celery have been nearly obscured by the dense milfoil growth.

List of Figures

Definitions

V1 Beginning of growing season. Usually May or early June,

V2 End of early season growth, upon evidence of management intervention outcomes, and early always before the Fourth of July, and

V3 Late Season/Summer.

Table G1.1 Definitions of MZL assignments in LakeScan™ lakes.

MZL- 1: Highly selective weed control targeted at a select group of very weedy plant species that are referred to as T-1 species (Target Level 1 species). T-1 species assignments may vary from lake to lake, but typically include Eurasian watermilfoil, Ebrid milfoil, curly leaf pondweed, starry stonewort and any other species that seriously threaten the biodiversity of the plant community, critical ecosystem functions and habitats, and the overall stability of the lake ecosystem.

MZL - 2: Selective plant control that targets the same weedy species or T-1 species that are managed in the ML-1 AROS's plus other species that are not consistently "weedy", but may be as serious a nuisance as T1 species in some lakes in some years. These T-2 species may include: Wild Celery, Coontail, Elodea, Weedy Pondweed Hybrids, water lilies, and Variable Milfoil. Lake monitoring data (species presence, density, distribution, and impact on lake use) is used to determine if a species should be labeled as a T-2 species in a given lake.

MZL - 3: Relatively non selective plant control in areas where most macrophyte growth would be generally considered to be a nuisance. ML - 3 areas are typically residentially or commercially developed near shore areas that are used for the location of docks, swimming areas, or irrigation intakes. Most plant growth is suppressed in ML - 3 areas through the judicious use of herbicides or herbicide combinations that are typically applied only one or two times during the active lake use season. Several algaecide applications may be made to ML - 3 areas during the course of a summer for filamentous algae control or bio-manipulative potentially toxic, blue green algae control. Mechanical harvesting or other relatively non-selective control strategies may also be deployed in ML - 3 zones or AROS's.

MZL - 4: This level of management effort is reserved for active swim beaches or marinas where virtually no plant growth is considered to be desirable at any time of the year. Herbicides and herbicide combos may be used repeatedly in ML - 4 areas during the course of the active lake use season. Algaecides are also applied repeatedly in these areas. Benthic barriers, weed rollers, and other mechanical/physical plant control strategies may also be used in ML-4 areas.

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 Stony) 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.