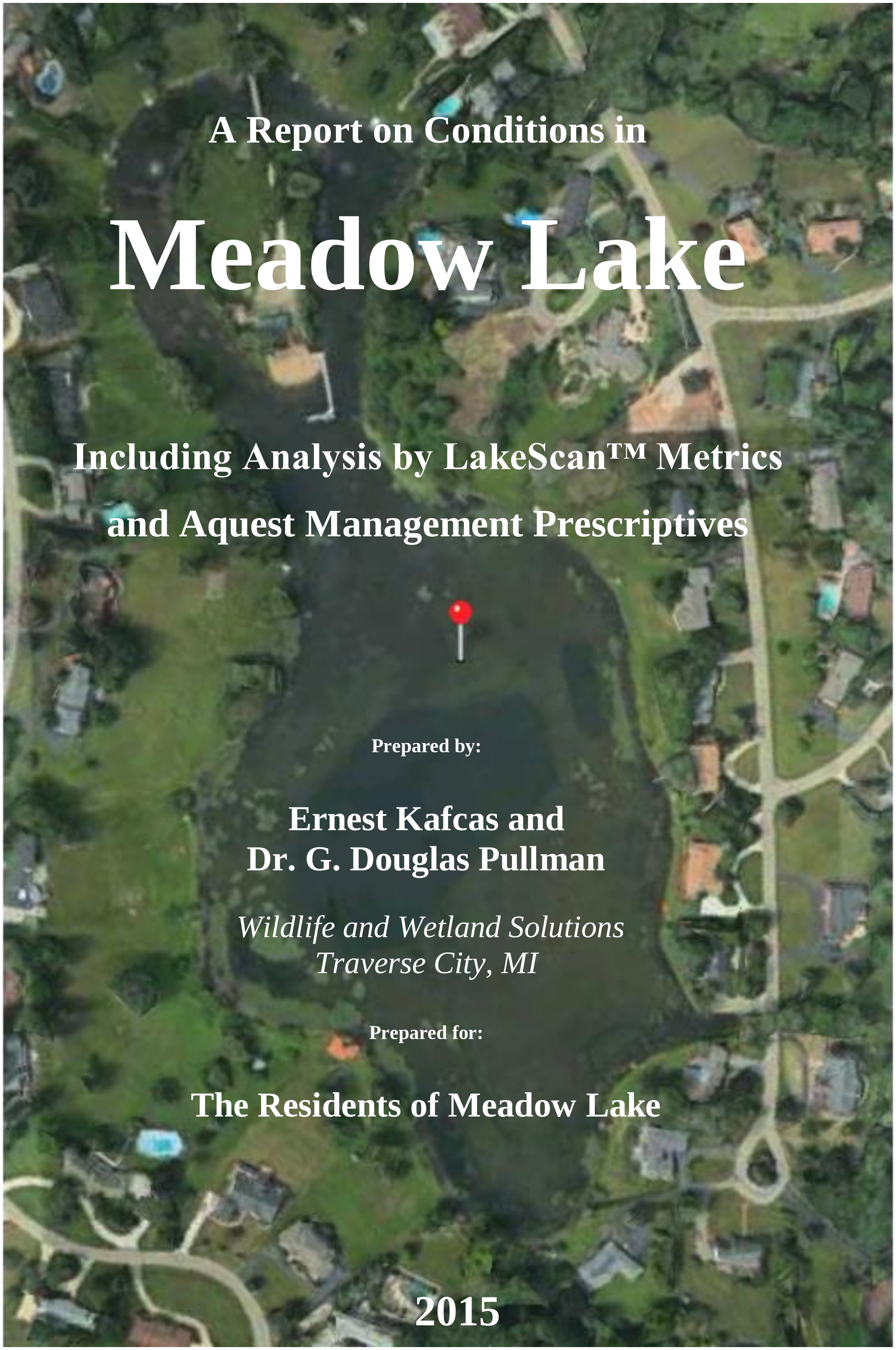

A Report on Conditions in

Meadow Lake

Including Analysis by LakeScan™ Metrics and Aquest Management Prescriptives

Prepared by:

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Dr. G. Douglas Pullman

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Traverse City, MI

Prepared for:

The Residents of Meadow Lake

2015

Meadow Lake

A Report on Lake Conditions and Management Recommendations

Prepared by:

Dr. G. Douglas Pullman
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St. Petersburg, FL

Prepared for:

The Residents of Meadow Lake

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

Meadow 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, and

Create and maintain reasonable conditions for recreational opportunities.

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 usually 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

~ 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 objectives are associated with the things that "are done" each year to manipulate conditions in a lake to create outcomes that are consistent with the management goals. Management Intervention Strategies and Technologies (**MIST**'s) are selected that will do the best job of improving lake conditions that will help to achieve properly conceived management goals. LakeScan™ places the focus on what the lake should be and not what is done or applied to a lake.

OVERVIEW AND MAJOR FINDINGS

Meadow Lake is in poor condition according to most LakeScan™ metric data. These data suggest that the lake may be inherently unstable and prone to present different levels and types of nuisance conditions each year. Starry stonewort has completely dominated the system and if allowed to continue dominate the flora at this, it could lead to some very undesirable consequences. Heavy starry stonewort infestations are known to collapse and precipitate toxic cyanobacteria blooms (blue green algae). If it can be effectively managed in this lake, other plants should begin to become more dominant and stabilize the ecosystem.

LakeScan™ Selected Monitoring and Key Metrics

Meadow Lake is considered to be in poor condition by all LakeScan™ Category 700 lake quality measures, especially when considered within the context of what might be expected from a lake of this type.

Category 200: Water Quality Monitoring and Management:

No interventions recommended at this time. The system is dominated by starry stonewort.

Category 400: Plankton Community Monitoring and Management

The impact of starry stonewort certainly extends to a strong influence on plankton communities. No monitoring or management is recommended at this time. However, should the starry stonewort collapse, there is high likelihood that cyanobacteria could bloom. If this occurs, it would be recommended that the plankton community be sampled and analyzed for the taxa present and for the presence of toxins.

Category 700: Plant Community Evaluation

LakeScan™ Section 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. Plant community surveys may also occur at other times of the year and the VS numbers applied to these are described in the LakeScan handbook.

Starry stonewort is an extreme nuisance in Meadow Lake and it is presumed that it will be present at extreme nuisance levels in early June, 2016, based on the mild winter. There are still no prophylactic treatment MIST available for starry stonewort. Therefore, MIST shall be applied to the lake when it begins to show signs that it may enter a "bloom" phase. There is currently no way to accurately predict the total production of the timing of peak growth in starry stonewort populations. It will take several years to suppress starry stonewort to a level where a reasonable plant community can become reestablished in the lake. This may require up to 4 treatments per season.

Table 700.000.1 Summary tables of critical LakeScan™ metrics and other aquatic plant community quality data. Historical data is presented if there are more than two years of record. The historical average is the mean of the values derived from data collected during the years that Meadow Lake has been part of the LakeScan™ program. The Historical metric range provides the lowest and the highest values from the years that Meadow 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
Meadow Lake	6	7	3.2	7	5	25	214	6.2
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								
Meadow 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

Category 700/000.014 Plant Community Species and Morphotype Richness

Species and Morphotype Richness *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 = 6** **Goal = 10**	The species richness in Meadow Lake in 2015 was 6 and is considered to be low. 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 lower than desirable, but respectable given the dominance of starry stonewort. It appears that the complete dominance of the system by starry stonewort and possible mismanagement of the system is responsible for such low numbers.
Spatial Data **Tiers, MZL and Lake to Lake**	Starry stonewort has overwhelmed every part of this lake system and extirpated most other macrophytes growth. The species richness in Meadow Lake was lower than any of the 25 other lakes considered in this report. It may be unrealistic to expect a small lake to support as many species as a larger lake, but it should be capable of the support of 10 species.
Seasonal Data and Historical Data	One other, commonly weedy plant species known as naiad did appear in the late summer flora. This is the first year of LakeScan™ Analysis so there are not data to do a thorough historical analysis.
Comments	The species and morphotypes richness in Meadow Lake is alarming low. A target level of 10 has been established for this lake and is one less than a neighboring lake of similar size. This lake must be contentiously managed to improve conditions and provide stability to the lake ecosystem.

Category 700/000.040 Plant Community Species Quality

Plant Community Quality	*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 = 3.2** **Goal = 4.0**	Given the overwhelming predominance of starry stonewort it is not surprising that the species quality of the Meadow Lake benthic flora would be very low. The 2015 distribution weighted "C" value for Meadow Lake was considered to be much lower than the target value of 4.0, This target will not likely be attained until a species targeted starry stonewort control is implemented in this lake.
Spatial Data **Tiers, MZL and Lake to Lake**	Starry stonewort dominance served to obliterate any difference in weighted C values between Tiers.
Seasonal Data and Historical Data	The weighted mean "C" value of the submersed flora of Meadow Lake improved in the late summer as naiad became more predominant. The weighted "T" or target weed management value for the lake was heavily weighted by starry stonewort. First year of LakeScan™ analysis. Historical data not yet available.
Comments	Starry stonewort production must be suppressed to achieve any improvement in this important metric value.

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

LakeScan™ BioD 60©	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.
Annual Data **2015 = 7** **Goal = 20**	The biological diversity of the Meadow Lake plant community is extremely low. The overwhelming predominance of starry stonewort make it nearly impossible to predict what might be possible in this lake since little is known about how hospitable the substrates might be for desirable plant growth.
Spatial Data **Tiers, MZL and Lake to Lake**	The weedy growth of starry stonewort is so uniform in the lake that there is virtually no difference in the BioD 60™ recorded for each Tier. The BioD 60© of the Meadow Lake submersed plant community was lower than any of the 25 lakes considered in this report. It is unlikely that this lake will ever support a plant community similar to some of the larger lakes in this analysis; however, the value should be much closer to values found in a nearby lake.
Seasonal Data and Historical Data	Very little difference between early and late season floras. First year of LakeScan™ analysis. Historical data not yet available.
Comments	The bottom type and character of the hydro soils will determine how well the lake can support a biologically diverse plant community. The presence of high levels of starry stonewort biomass has a tremendous impact on soil types and will to a large degree determine what might be expected from a renovated plant community.

Category 700 /000.084: LakeScan™ Weediness 10© Index Values

LakeScan™ Weediness 10©	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 = 6.2** **Goal = 5.0**	The inherent nature and predominance of starry stonewort is responsible for the extreme weediness index value recorded for this year. Proper plant community rehabilitation MIST will help to improve this metric value. However, it will be very difficult to meet stated goals.
Spatial Data **Tiers, MZL and Lake to Lake**	Uniform starry stonewort growth across all tiers have resulted in little variance in the weediness values recorded for each tier. The 2015 weediness value for Meadow Lake was the higher than any recorded in the 25 lakes included in the lake-to-lake comparisons provided in this report.
Seasonal Data and Historical Data	Meadow Lake was uniformly weedy in the early summer and late summer. First year of LakeScan™ analysis. Historical data not yet available.
Comments	Weediness will not decline unless a very precisely targeted starry stonewort program is implemented.

Category 750 /000.000: LakeScan™ Plant Management Review

This section is still under development and only partially presented in this report.

Comments

Meadow Lake is in critical condition. It has become completely overwhelmed by starry stonewort and this exotic, invasive species has extirpated nearly all other macrophytes growth in the lake. This has resulted in highly unstable conditions in the lake. The flora and fauna of this lake are highly degraded, as a result. Starry stonewort is an opportunistic aquatic plant and one of the inherent properties and characteristics of plants such as these is that they have a predisposition to not only bloom – but also to crash. Starry stonewort populations are very predisposed to "crash" events and these have been commonly observed in Michigan inland lakes. These events generally result in the elimination of all bottom dwelling macrophytes and blooms of potentially toxic cyanobacteria. Consequently, it is as important to manage the potential sudden decline of starry stonewort as it is to protect the lake from starry stonewort bloom events.

Lakes are dynamic and ever-changing ecosystems. It is well known that lakes cannot be restored. This is a fact reported in nearly introductory limnology text books. Therefore, it is important to align the expectations of the residents of Meadow Lake with what is possible to protect the lake – and public health. The issues in this lake will take years to correct and it would be unrealistic to expect that conditions will improve significantly in the coming years. Meadow Lake will continue to be weedy for several years before conditions can be significantly improved in the lake. This will require that the residents of this lake be patient until the lake can be stabilized. The lake will be weedy for as many as 5 years as the program is adapted to increase the stability of this ecosystem.

Recommended MIST for 2016

The objective of the 2016 program will be to suppress the production of starry stonewort to such a degree that other macrophytes species may regain a "foot hold" as part of the lake flora. Sago pondweed and naiad are already present in the lake. These species are extremely opportunistic and tolerate extremely adverse conditions. They can also be very weedy. They are very likely to be the first species to become "reestablished in the lake". They are also likely to be present as weeds for several years – but they will help to stabilize the lake ecosystem. As the lake becomes increasingly stable, other more desirable and less weedy species should find space and opportunity to grow in Meadow Lake.

2016 Prescriptives

Starry stonewort can be suppressed with only one or two applications of species targeted and selective algaecide combinations during the course of the summer. However, it is recognized the applicator of record has not been able to meet this threshold. Consequently, it is recommended that copper based algaecides be applied to the lake when starry stonewort begins to actively grow in Meadow Lake. Furthermore, these mixtures should be applied in a manner and as often so that the starry stonewort is essentially kept to a height of 6".

It is expected that sago pondweed and naiad will begin to flourish in the lake and will probably be present at weedy levels in 2016. This is an unfortunate outcome of treatment, but necessary to improve the stability of the plant ecosystem. These weeds will be addressed in 2017 if the expected outcomes from the 2016 are achieved.

Meadow 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 be 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 be 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, Geopolitical, Geomorphology, and Geographic Data

Section 100.01 GPA: Physical and Geopolitical Characteristics

Category 100

Physical and Geopolitical Characteristics

100/100.120 Location

State:	Michigan
County:	Oakland
Township:	Bloomfield
Township/Range:	T.2N, R.10E
Section:	Sec. 31
Geo Location:	42 32'25.05N 83 18'47.96W
Elevation:	820 ft.

100/120.210 Basic Morphometry

Total Area (Acres):	18
Shoreline Length (Feet):	5280
Littoral Zone Depth (Feet):	
Littoral Zone Area (Acres):	10
Maximum Depth (Feet):	21
Mean Depth Feet):	4
Littoral Zone Volume (Acre Feet):	
Total Lake Volume (Acre Feet):	85
Hydraylic Residence Time:	variable

100/110.110 Watershed Factors

Tributaries:	Franklin Creek
Outlet Type:	Overflow Structure south side
Diffuse Connections:	
Diffuse Connection Length (Feet):	
Developed Shoreline Length (Feet):	5280
Percent Commercial Shoreline (%):	0%
Percent Residential Shoreline (%):	100%
Percent Community Shoreline (%):	20%

Section 100.05 GPA: 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:	**53**		**18**	
	#	**%**	**acre**	**%**
Total Total Tier 1 AROS	0		0	
Total Total Tier 2 AROS	0		0	
Total Total Tier 3 AROS	32	60%	11	60%
Total Total Tier 4 AROS	17	32%	6	32%
Total Total Tier 5 AROS	4	8%	1	8%
Total Total Tier 6 AROS	0	0%	0	0%

Total AROS Acres:	0.34	Acre/AROS
Total AROS Area and Whole Lake Area:	100%	Of Total Lake Acres

AROS MANAGEMENT ZONE LEVEL (MZL) ASSIGNMENTS	AROS Numbers		AROS Acres	
Total MZL AROS (including MZL 0):	**53**		**18**	
Total Managed MZL AROS (MZL 1 to 4):	**53**		**18**	
	#	**%**	**acre**	**%**
Total MLZ 0 AROS:	0	0%	0	0%
Total MLZ 1 AROS:	53	100%	18	100%
Total MLZ 2 AROS:	0	0%	0	0%
Total MLZ 3 AROS:	0	0%	0	0%
Total MLZ 4 AROS:	0	0%	0	0%

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

Section 100.08 GPA: Program Administration

Category 1000

Management History and Authorities

Management Authority:	
Contact:	
Address:	
Telephone:	
Email:	
Web Page:	
Year SAD Established:	
Total SAD Units:	
Lake Management Guidance Consultant:	Wildlife and Wetland Solutions
Contact:	Ernie Kafcas
Address:	4371 N Long Lake Rd Traverse City, MI 49684
Telephone:	231-943-0762
Email:	enkafcas@gmail.com
Web Page:	www.wildlifewetlands.com
Herbicide Application Consultant:	AquaWeed Control
Contact:	
Address:	
Telephone:	
Email:	
Web Page:	

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 Meadow Lake. Tier 3 is the blue area near shore, Tier 4 is green, and the blue area in the middle of the lake is Tier 5.

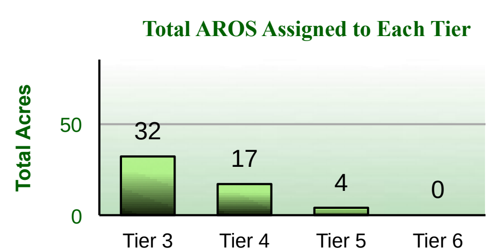


Figure 100/122.320 The total number of AROS and total number of AROS at each Tier.

Figure 100/122.350 a A map depicting the location of all Aquatic Resource Observation Sites (AROS's) and tiers that were used to make observations in Meadow Lake. The entier lake has been designated at MZL 1 area.

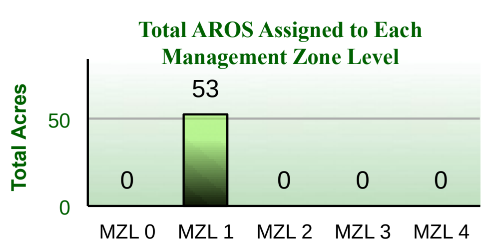
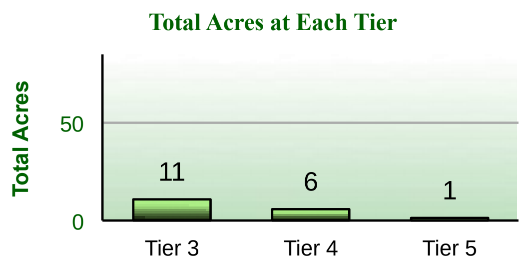


Figure 100/122.350 b Plant species management level assignments (MLZ) by AROS.



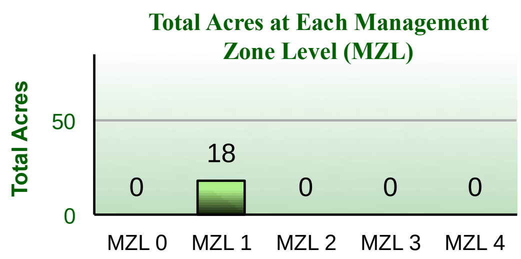


Figure 100/122.350 c The sum total acre area of the AROS assigned to each Tier and each Management Zone Level (MLZ).

LAKESCAN™ 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 impairments of water quality observed during any of the LakeScan™ . Meadow Lake plant surveys. The residents of Meadow Lake may benefit by participation in the Michigan Clean Lakes Monitoring Program (CLMP) if they are not already participants. Starry stonewort is the primary factor in the determination of water clarity in this lake.

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) and increased loading 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 is 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 impairments of water quality observed during any of the LakeScan™ surveys that might have been related to culturally elevated plant nutrient concentrations. Starry stonewort is currently the primary controlling factor and determinant of plant nutrient dynamics in this lake.

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. Meadow Lake is dominated by a moderately diverse benthic habitat. But, water depth, wind, and ice appear to be the primary factors that regulate plant (primary production) in the lake. For these reasons it is unwise to consider a measure of pelagial lake quality as relevant lake quality measure. Carlson index values are the standard water quality measure used to describe pelagial lake conditions. It is calculated from Secchi disk measurements and water column total phosphorus concentrations. Most lakes in Michigan reflect measures that are common to a lake where benthic (rooted and sediment associated) plants and animals dominate primary and secondary production. The reader is advised to refrain from making comparisons to any lakes where benthic communities do not dominant production in the lake.

There were no obvious impairments of water quality observed during any of the LakeScan™ surveys that might have been related to culturally elevated water column plant nutrient concentrations. Water quality is determined by starry stonewort production and dynamics in this lake.

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 130 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 Meadow Lake are encouraged to remove all organic debris (leaves, aquatic plant fragments, etc.) that may collect or accumulate in the vicinity of swimming areas.

310/020.110 Aufwuchs Communities and Plant Biofilms

The microbial community complexes that grow on the surfaces of plant appear to play a critical role in the presentation of herbicide tolerance in a wide variety of submersed aquatic plant species. Aquest is a principal investigator in 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 Meadow 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 play a key role in the development of specific vegetation management plan objectives.

Category 400: The Phytoplankton Community

What is Phytoplankton? The phytoplankton are primarily represented by a broad range of essentially free-floating or suspended organisms, algae, microorganisms and cyanobacteria (blue green algae) that inhabit the pelagial or open water parts of lake. These communities often determine how opaque or clear that water might be. They also impart color to the water when certain organisms are present at adequate densities. They are also critical as the basis for fisheries production. Most lakes support a large number of different plankton species that possess very different qualities and attributes. 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 community composition include the impact of competition, temperature, and the especially the impact of grazing and filter feeding organisms such as zebra mussels and zooplankton. It is generally believed that lakes that are dominated by algae species are in a better condition than those that are dominated by cyanobacteria (blue green algae). This is because the blue green algae can become a visual and odor nuisance and because some of the blue green algae are capable of generating toxic substances that can have an impact on livestock, pets, and even human health. Blue green algae can taint water supplies with off-odors and taste. They can also produce substances that are toxic and some of these substances have been determined to be carcinogenic. Furthermore, there is increasing evidence that blue green algae dominance may be less supportive of fisheries because of impacts on the food chains that support vibrant fisheries.

Plankton community sampling and appropriate analysis is recommended for all lakes but it can be expensive to conduct a sampling and analysis program that is truly representative of such a dynamic and rapidly changing community. Aquest and a wide range of collaborators are currently investigating rapid and more efficient methods for the analysis and management of the quality of plankton populations. 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 State of Michigan severely restricts the use of algaecides that would help to suppress harmful algae and promote the growth of desirable species. Although the selective control and suppression of nuisance and PTOX phytoplankton is by far the preferred means to gain control over problem phytoplankton blooms, there are several other MIST available to help to create better plankton communities. These include various ways of pre-empting or disrupting the successional season progression of plankton community dominance from desirable species to undesirable and often PTOX community dominated systems.

Water clarity was generally good in Meadow Lake in 2015. No serious bloom conditions were reported; however, continued observations may reveal a time when it may be appropriate to begin phytoplankton community monitoring. It may also become necessary to monitor the impact of starry stonewort production on plankton communities, since it has been found to dominate the flora in Meadow Lake. Anecdotal observations seem to indicate that this weedy species has a profound impact on plankton production and may have an impact on total fisheries production.

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.

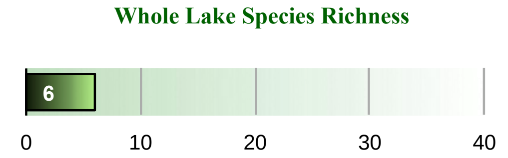
Category 700: Large Plant Communities in Meadow Lake (Annual Review)

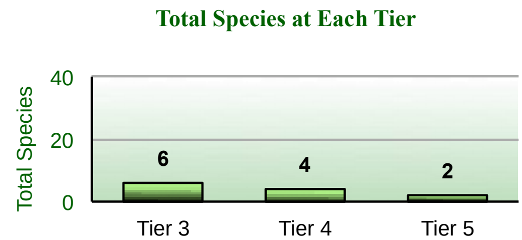
It has been well established that aquatic macrophyte production in a lake is strongly correlated with the quality of lake sediments rather than nutrient concentrations found in the lake water, as is the case with phytoplankton. It is not appropriate to apply terms such as oligotrophic, mesotrophic, eutrotrophic, 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. Macrophyte 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 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.

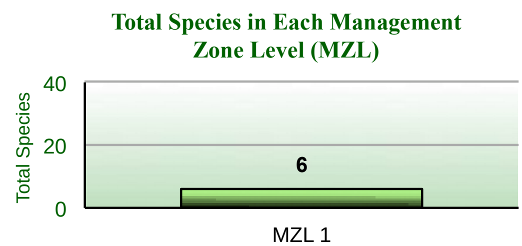
Aquatic macrophyte species are not randomly distributed around lakes. The physical and biogeochemical characteristics of the sediments play a critical role in determining the distribution of various aquatic macrophytes. Different plant species respond differently to wind and wave exposure and the total 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 and assigned lower C values. Conservative species are assigned higher C values greater than 4.

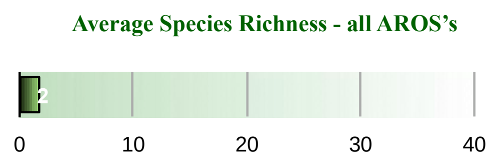
Cat 710: 2015 Lake-Wide Plant Community LakeScan™ Analysis

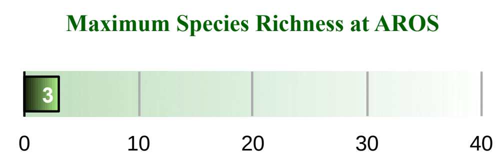
710/121.014 ALR: Species Richness (Total Species) (Annual)

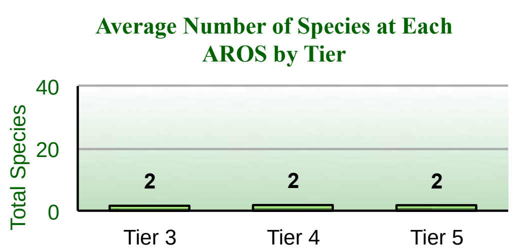


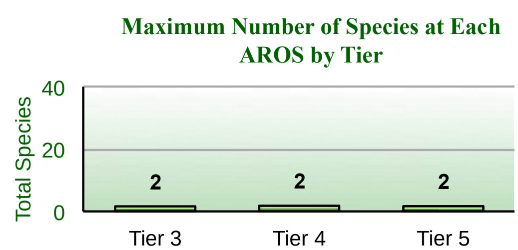


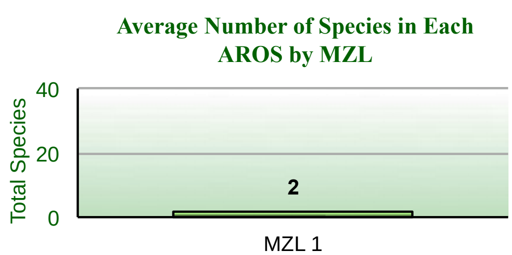












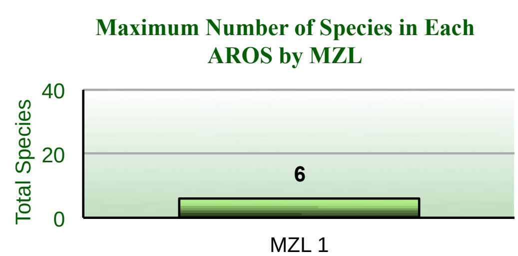


Figure 710/123,4.014 Total species richness or total species present in the lake and the average and maximum number of plant species found at any AROS in the lake during the most recent survey year. These data are also presented by Tier and MZL.

710/121.017 Morphotypes

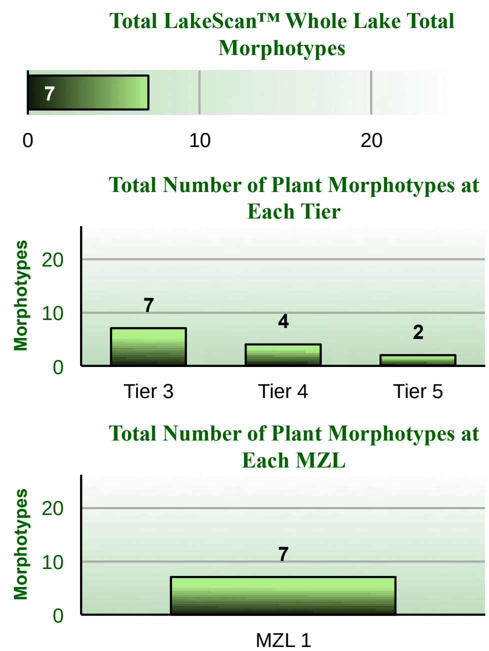


Figure 710/123,4.017 Plant morphology is an important measure of the structural complexity of any ecosystem. It could be said that fish don't care what names we given to submersed macrophytes – they care about structure. LakeScan™ recognizes 26 distinct plant morphotypes among common submersed macrophyte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

710/121.017 Leaf Types

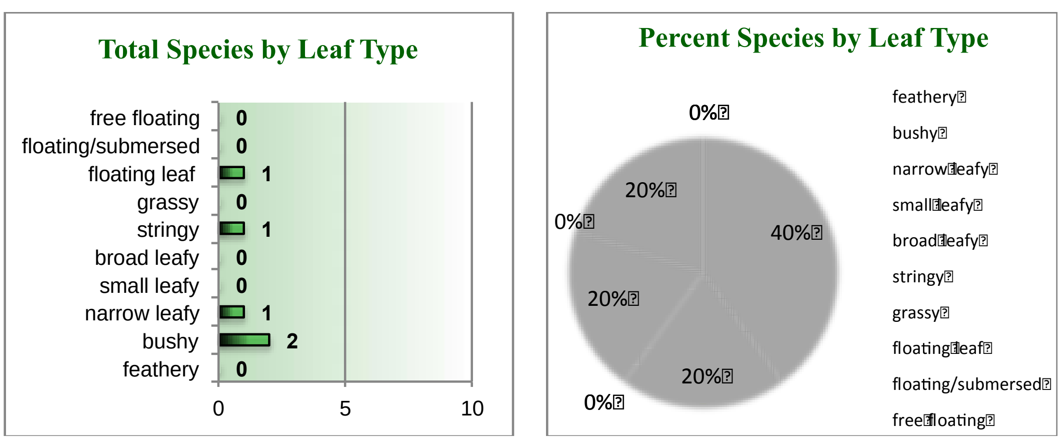


Figure 710/121.017 The total number (histogram) and percentage of plant species leaf morphotype (pie chart) found in the lake for the entire summer or growing season.

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	50	NAID	Naiad (3)	*Najas sp.*	2	7	35	bushy
2	65	StSt	Starry Stonewort	*Nitellopsis obtusa (Desv.) J.Groves*	1	9	45	bushy
3	75	CLP	Curly Leaf Pondweed	*Potamogeton crispus L.*	1	9	50	narrow leafy
4	115	Stuk	Sago (3)	*Stuckenia sp.*	2	6	75	stringy
5	150	WL	Waterlily (2)	*Nymphaea sp.*	2	5	100	floating leaf
6	180	DUCK	Common Duckweed (8)	*Lemna sp.*	3	6	120	floating

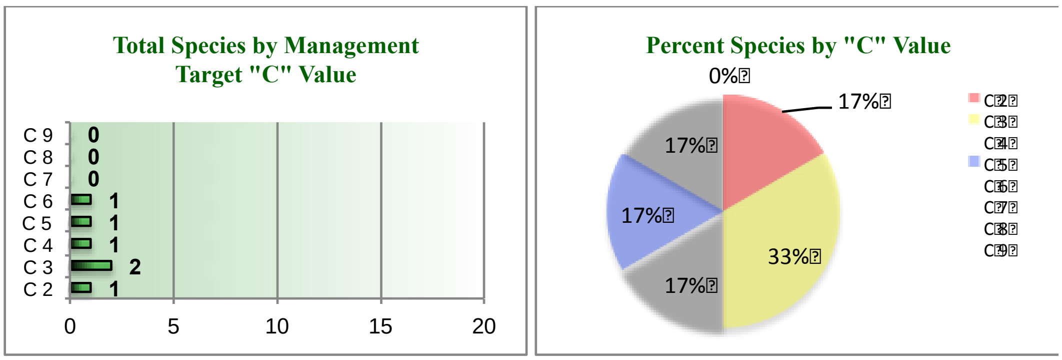


Figure 710/121.041 The total number (histogram) and percentage (pie chart) of plant species by "C" value found in the lake for the entire summer or growing season. Plants that are assigned lower C values are more tolerant of ecosystem and man-made disturbances and system alterations. Weedy species usually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

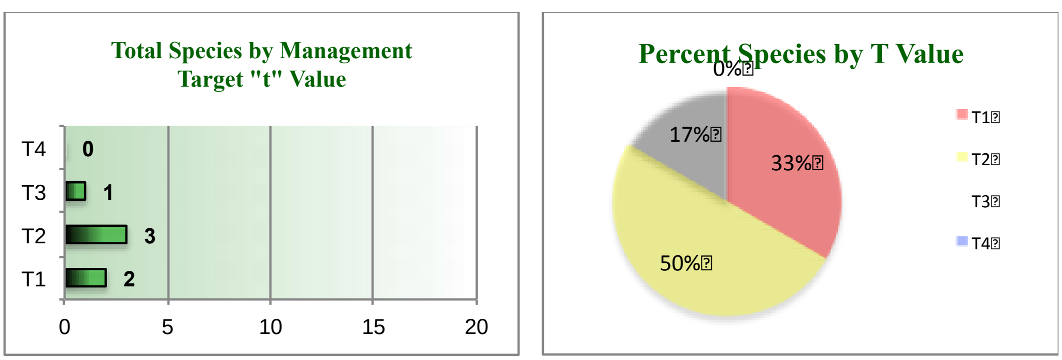


Figure 710/121.042 The total number (histogram) and percentage (pie chart) of plant species by "T" value found in the lake for the entire summer or growing season. The T 1 species are usually very weedy and targeted for control. These include nuisance watermilfoil genotypes, curly leaf pondweed, and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

Table 711/121.014 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	65	StSt	Starry Stonewort	*Nitellopsis obtusa (Desv.) J.Groves*	bushy
1	75	CLP	Curly Leaf Pondweed	*Potamogeton crispus L.*	narrow leafy
2	115	Stuk	Sago Pondweed	*Stuckenia sp.*	stringy
2	150	WL	Waterlily	*Nymphaea sp.*	floating leaf
3	180	DUCK	Common Duckweed	*Lemna sp.*	floating
3	180	DUCK	Common Duckweed	*Lemna sp.*	floating

710/121.040 Plant Species Coefficients and Assigned Qualities

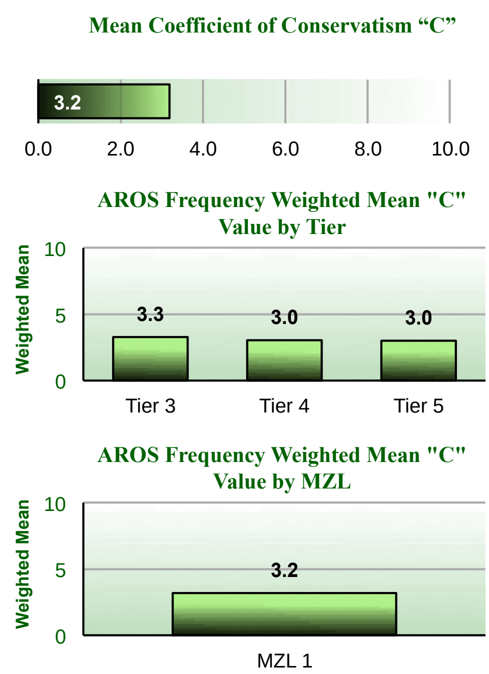


Figure 710/121.042 Mean weighted plant species coefficient of conservatism for the whole lake and by sorted Tier and MZL as measured at all lake AROS.

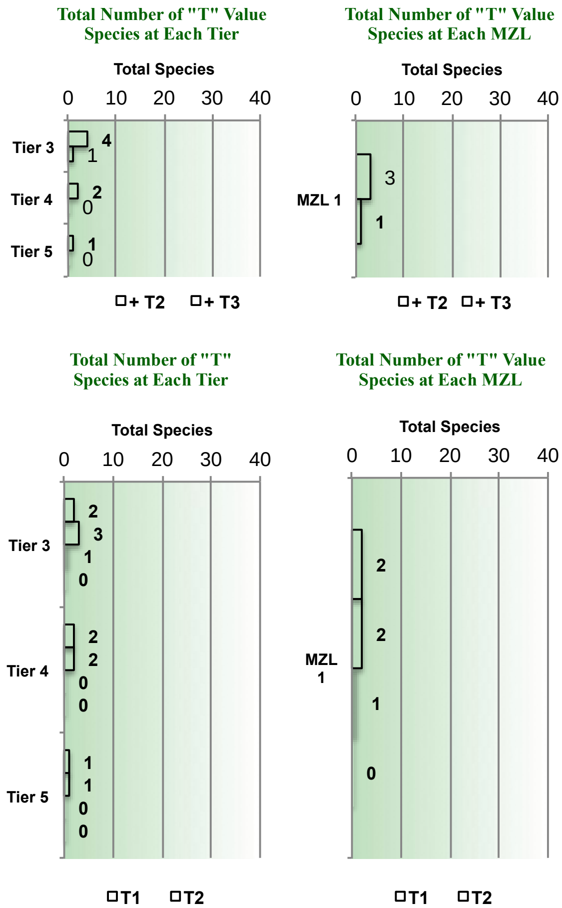


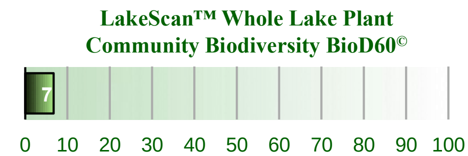
Figure 710.13,41.042 The total number of species assigned to the 4 management target priority values at each Tier and MZL. The upper part of this figure represents all of the species t values summed for T2, T3, and T4 (T2+) and T3 and T4 (T3+).

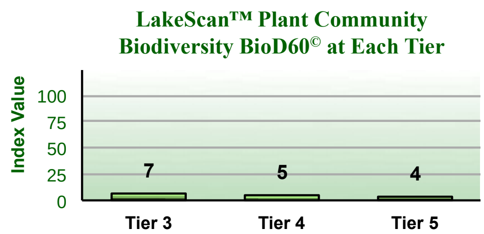
710/121.0x0 Plant Community Species Occurrence, and Dominance (Annual)

Table 710.121.0x0 A list of species found in Meadow Lake, abbreviated name, common name, and scientific name since LakeScan™ monitoring was begun and 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 during the past summer.

PLANT NAME, CODES, AND SELECTED ATTRIBUTES								
	Code #	Abbrev. Name	Common Name	Scientific Name	*t* Value	*i* Value	*c* Value	Leaf Type
1	50	NAID	Naiad (3)	*Najas sp.*	2	7	35	bushy
2	65	StSt	Starry Stonewort	*Nitellopsis obtusa (Desv.) J.Groves*	1	9	45	bushy
3	75	CLP	Curly Leaf Pondweed	*Potamogeton crispus L.*	1	9	50	narrow leafy
4	115	Stuk	Sago (3)	*Stuckenia sp.*	2	6	75	stringy
5	150	WL	Waterlily (2)	*Nymphaea sp.*	2	5	100	floating leaf
6	180	DUCK	Common Duckweed (8)	*Lemna sp.*	3	6	120	floating

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





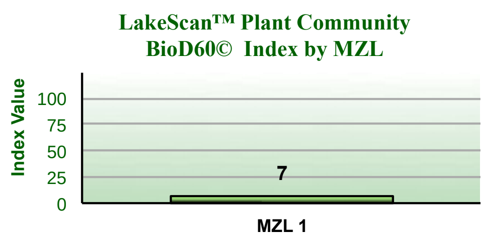


Figure 710/121.014a The LakeScan™ BioD 60© biodiversity index is a proportional index that assumes the greatest number of species that might be present during any survey will not be greater than or equal to 50. The fundamental algorithm is based on the Euler's equation where the greatest variance in 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 40 are considered to be good.

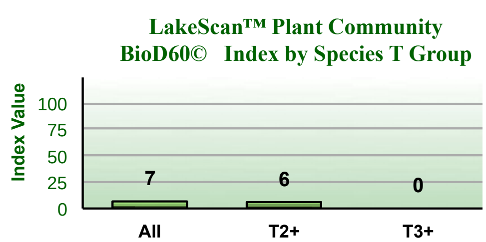


Figure 710/121.014a The goal of any aquatic plant community management plan should be to protect or enhance the biological diversity of the over-all plant community. T1 species are typically invasive and will extirpate or "crowd" out more conservative or desirable species. Consequently, the objective 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 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, T3 and T4.

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

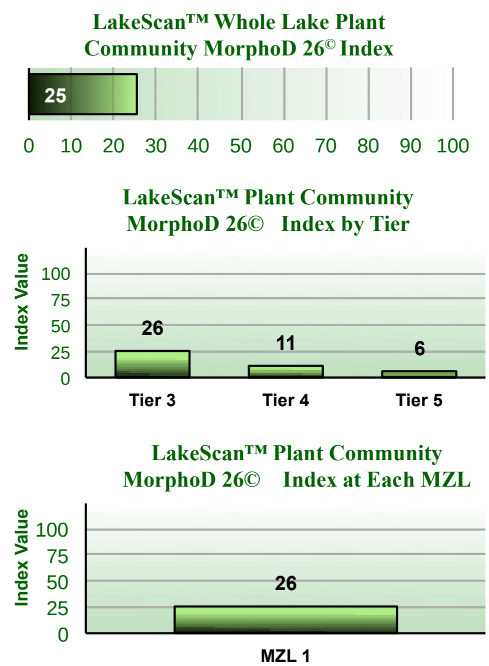


Figure 710/121.017 The LakeScan™ MorphoD 26© biodiversity index is a proportional index that assumes the greatest number of plant morphotypes, that might be present during any survey, will not be greater than or equal to 26. Again, index values greater than 50 are considered to be good.

710/121.024 LakeScan™ BioV© Indices (Annual)

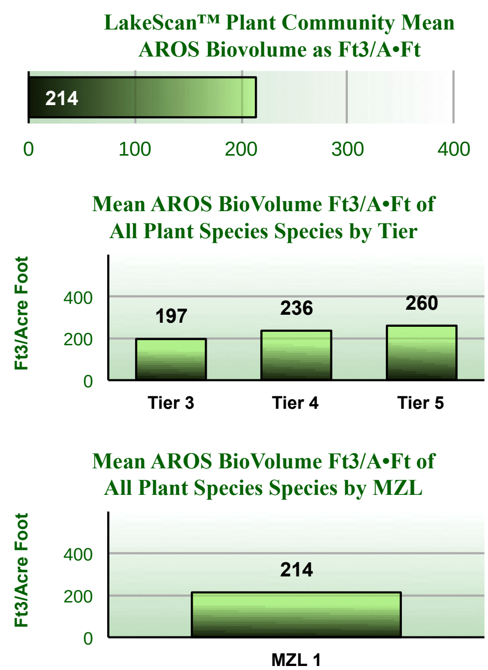


Figure 710/121.024 The LakeScan™ BioV© Biovolume index is based on the mean volume of various species per foot stem length and the density of stems per unit area. A compensatory factor is included for species that branch near the top of the plant or form surface canopies. These figures are based on the 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)

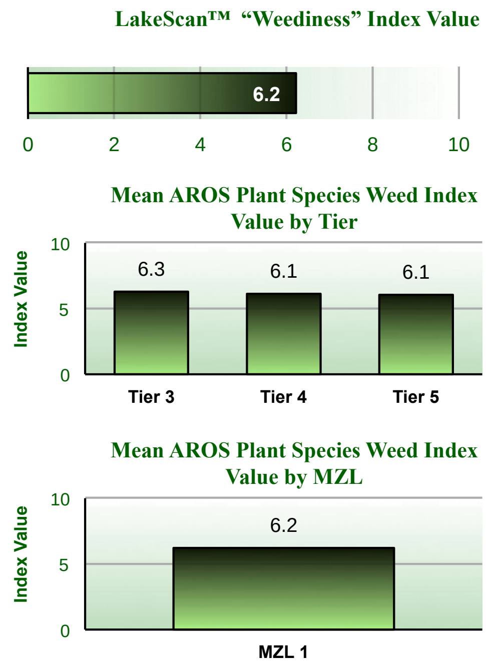


Figure 710/121.018 The LakeScan™ Weedines© index is fundamentally a diversity index (similar algorithm) however values are weighted according to the assigned "i" value, coupled with the density and distribution of various species at each AROS.

Cat 710: LakeScan™ Plant Community Survey Event Data

Comment:

Michigan lakes support distinct early summer and late season floras that are comprised of "early and "late" season plant species. VS 3.0 surveys are typically conducted in late May or June when plant growth is most likely to be growing at exponential rates. VS 5.0 surveys are conducted from mid-August to September when the late summer plant community has been fully established. Data from VS 5.0 is only a partial reflection of the direct impact of the applied management program because of the emergence of various "late season" species after typical MIST objectives have been applied to the lake. It is important to remember that some of the differences that are observed from the early to late summer are merely a reflection of the changes that normally occur in lakes as successional changes occur and 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 plant community survey events that were conducted during the course of the growing season. VS 3.0 data is from an early growing season survey and VS 5.0 is data from a late season event. VS A is the data compiled during the entire growing season. See LakeScan™ handbook for a more complete description of VS and Survey Dates.

Table 710/103.014 A list of species present during the most recent year of record and the occurrence of each species at early and late summer sampling events. These data are based on the presence or absence of each species at the all lake AROS.

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		
Naiad (3)		P	L	
Starry Stonewort	P	P	E/L	4%
Curly Leaf Pondweed	P	P	E/L	0%
Sago (3)	P	P	E/L	9%
Waterlily (2)		P	L	
Common Duckweed (8)		P	L	

Table 710/103.010 The total number of species in Meadow Lake that were present during an early season, late season and at both early and late season survey events during the most recent year of record.

Early Late Season Species Occurrence	
Total Species	6
Early/Late Season	3
Early Season Only	0
Late Season Only	3

Species Richness by Sampling Event

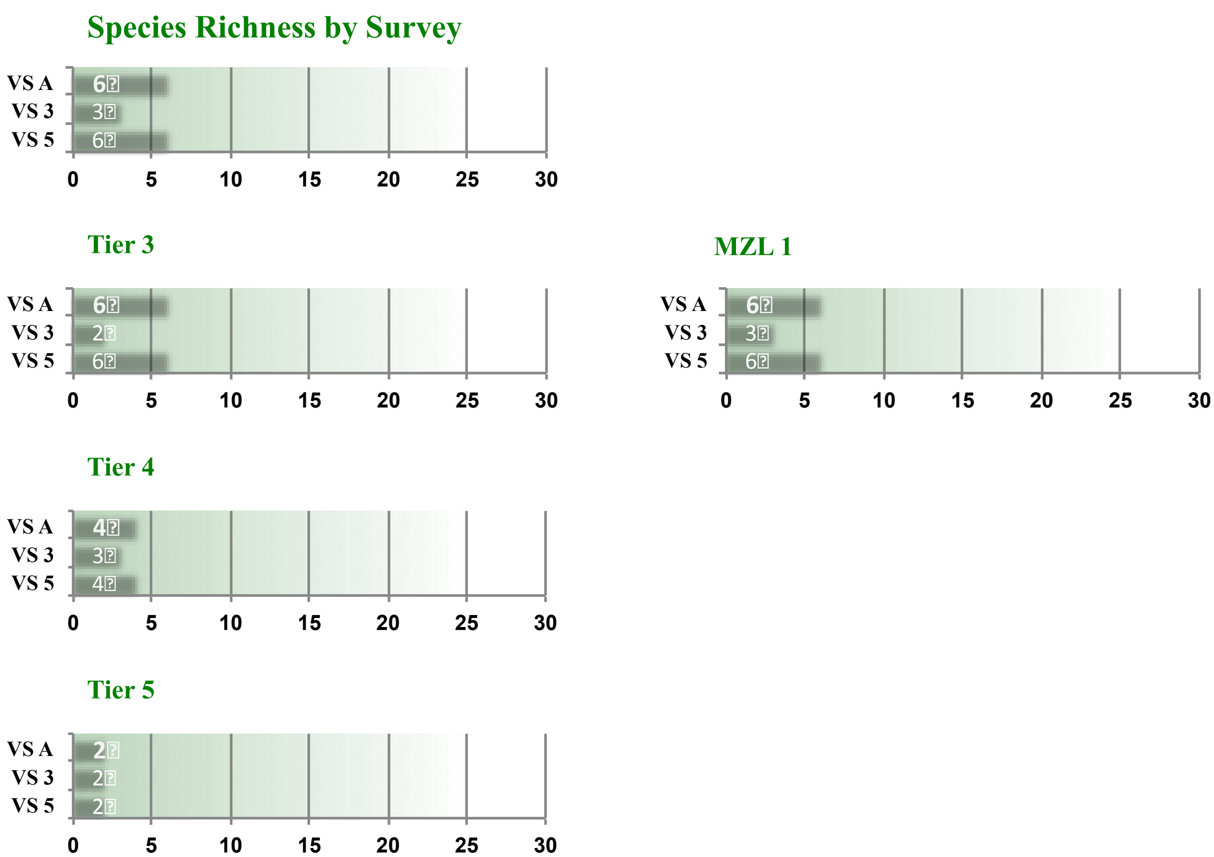
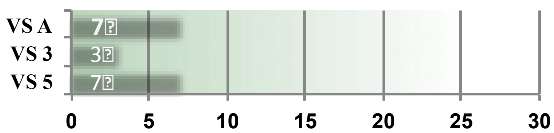


Figure 710/143.014 The species richness of the entire lake during the entire summer (VS A) and at distinct survey events that occurred in the early summer (VS 3) and late summer (VS 5) survey events for the whole lake and at all Tiers and MZL's.

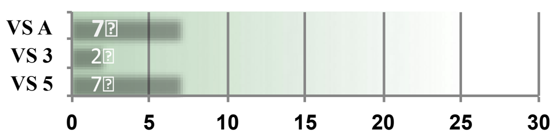
710/143.017 Plant Community Quality (Event)

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.

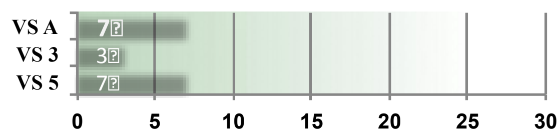
Morphotype Richness by Survey



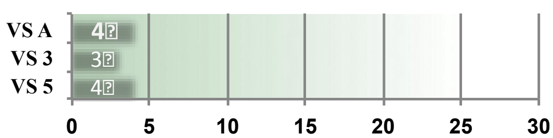
Tier 3



MZL 1



Tier 4



Tier 5

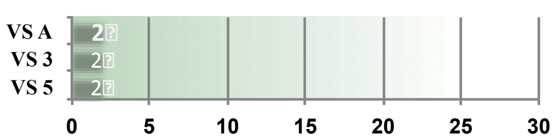


Figure 710/143.017 The total number of distinct plant morphotypes in the lake during the entire summer (VS A) and at specific early summer (VS 3) and late summer (VS 5) survey events for the whole lake and at all Tiers and most MZL's.

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.

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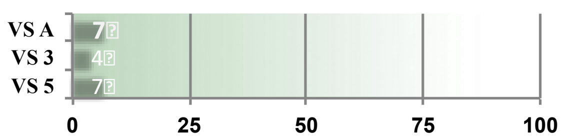
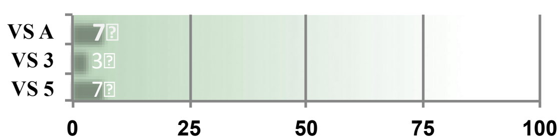
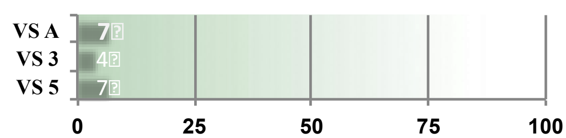
BioD 60© by Survey



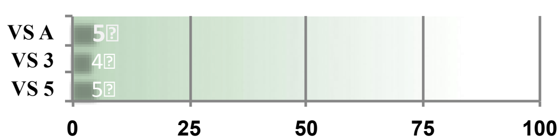
Tier 3



MZL 1



Tier 4



Tier 5

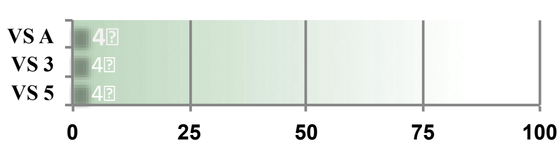
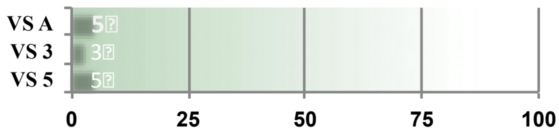


Figure 710/143.074a The LakeScan™ BioD 60© index value based upon all plant species observed in the entire lake during the entire summer (VS A) and at specific survey events that occurred in the early summer (VS 3) and late summer (V5) in the entire lake and at specific Tiers and MZL's.

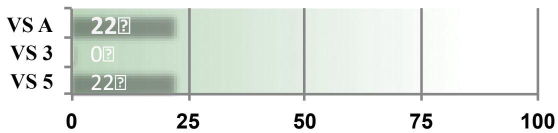
Comment:

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

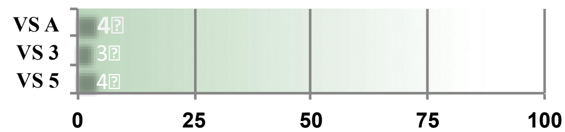
BioD 60© T2+ by Survey



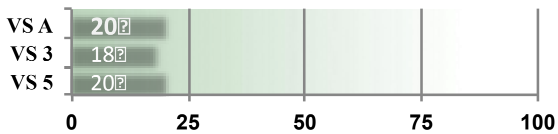
Tier 3



MZL 1



Tier 4



Tier 5

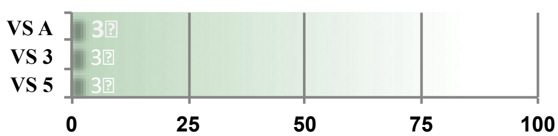
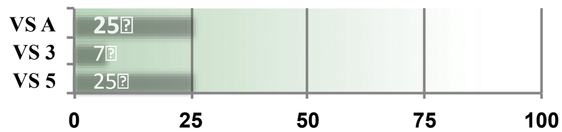


Figure 710/143.074b The LakeScan™ BioD 60© index value for all plant species of target rating T2 or greater calculated for the entire lake during the entire summer (VS A) and at distinct survey events that occurred in the early summer (VS 3) and late summer (VS 5) survey events in the entire lake, all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

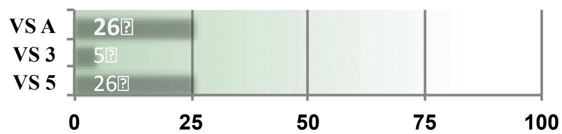
710/143.075 Plant Community Diversity and Structural Complexity

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.

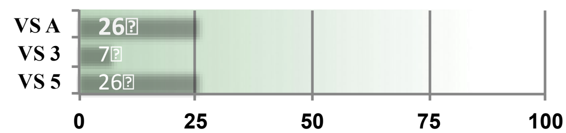
MorphoD 26© by Survey



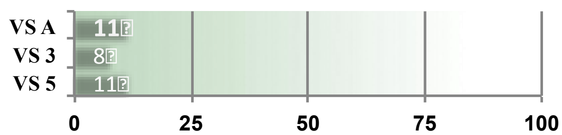
Tier 3



MZL 1



Tier 4



Tier 5

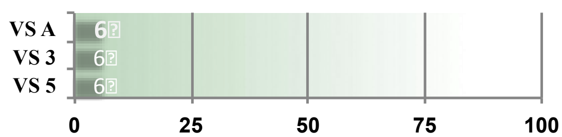
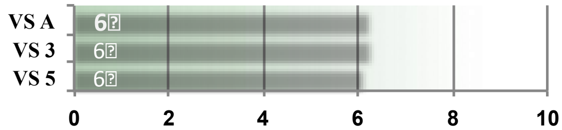


Figure 710/143.075 The LakeScan™ MorphoD 26© index value for all plant species of target rating T2 or greater calculated for the entire lake during the entire summer (VS A) and at distinct survey events that occurred in the early summer (VS 3) and late summer (VS 5) survey events in the entire lake,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

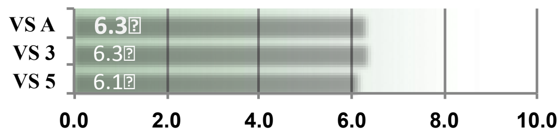
710/143.084 Weediness Index (Event)

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.

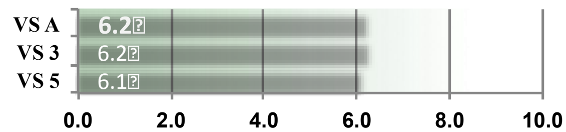
Weediness 10© by Survey



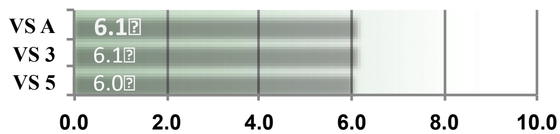
Tier 3



MZL 1



Tier 4



Tier 5

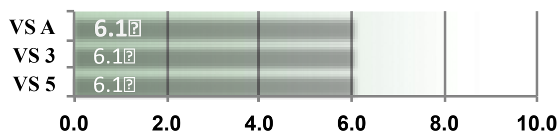


Figure 710/143.084 The LakeScan™ Weediness 10© index value of plant species calculated for the entire lake during the entire summer (VS) and at early summer (V1), mid summer (V2) and late summer (V3) survey events for the whole lake and selected Tiers and MZL's.

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

First Year of LakeScan™ Analysis – Historical Data is Not Available

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

LakeScan™ Dom 100© Index Value

Species Short Name	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 simmary 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.

SPECIES OCCURRENCE				
Meadow		All Lakes		
2015	Mean Occurence at AROS's	Mean Occurence at AROS's	Maximum Occurence at AROS's	Minimum Occurence at AROS's
EWMx		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	15.1%	30.6%	90.0%	3.3%
SpNAD		1.2%	1.2%	1.2%
CHARA		63.4%	100.0%	2.7%
Nitella		0.7%	0.9%	0.6%
NitT		22.7%	37.7%	3.7%
StSt	98.1%	44.9%	89.9%	0.7%
Moss		3.9%	11.6%	0.6%
JMoss		6.4%	6.4%	6.4%
CLP	5.7%	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		43.7%	81.1%	1.4%
WBLP		22.8%	64.3%	1.0%
Stuk	30.2%	26.2%	58.5%	0.8%
TLP		10.3%	47.6%	0.5%
ZAN		4.2%	9.7%	1.0%
VAL		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	9.4%	38.2%	69.1%	4.7%
SPAD		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	9.4%	4.2%	8.1%	1.9%
TRIS		0.4%	0.4%	0.4%

SPECIES DOMINANCE				
Meadow		All Lakes		
2015	Mean Dominance at AROS's	Mean Dominance at AROS's	Minimum Dominance at AROS's	Maximum Dominance at AROS's
EWMx		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	18	21	46	5
SpNAD		6	6	6
CHARA		40	68	4
Nitella		4	6	3
NitT		21	23	18
StSt	87	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		24	36	3
WBLP		16	32	4
Stuk	34	18	30	4
TLP		9	28	2
ZAN		7	11	4
VAL		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	18	25	38	8
SPAD		12	21	3
WSh		10	21	2
NELh		11	11	11
FLP		6	6	6
TLFP		6	8	4
SMTW		6	8	4
DUCK	15	7	9	5
TRIS		2	2	2

MEAN AROS PLANT FT3/ACRE FOOT BIOVOLUME				
Meadow		All Lakes		
2015	Mean BioVol at AROS's	Mean BioVol at AROS's	Minimum BioVol at AROS's	Maximum BioVol at AROS's
EWMx		34	432	1
NWM		3	5	0
GWM		17	41	6
WMG		4	4	4
WWCF		21	48	0
BLAD		8	32	0
MiniB		23	52	6
CNTL		8	19	0
ELD		19	41	0
NAID	7	18	39	0
SpNAD		6	6	6
CHARA		13	57	0
Nitella		13	23	3
NitT		13	22	5
StSt	53	24	72	2
Moss		19	55	0
JMoss		56	56	56
CLP	24	19	85	2
FSP		10	30	0
WSG		9	21	0
ROB		3	4	2
CrJ		2	2	2
Rich		6	16	0
AMER		22	44	0
MLF		12	12	12
HPW		10	29	0
WBLP		9	18	0
Stuk	15	14	34	1
TLP		12	26	0
ZAN		20	50	1
VAL		9	25	3
SAG		4	7	0
SPRG		0	1	0
FR		14	15	14
Wrice		0	0	0
SPIK		16	16	16
BLRsh		1	1	1
WL	16	14	100	1
SPAD		10	32	0
WSh		11	42	1
NELh		2	2	2
FLP		16	16	16
TLFP		9	19	1
SMTW		14	25	4
DUCK	3	7	8	3
TRIS		0	0	0

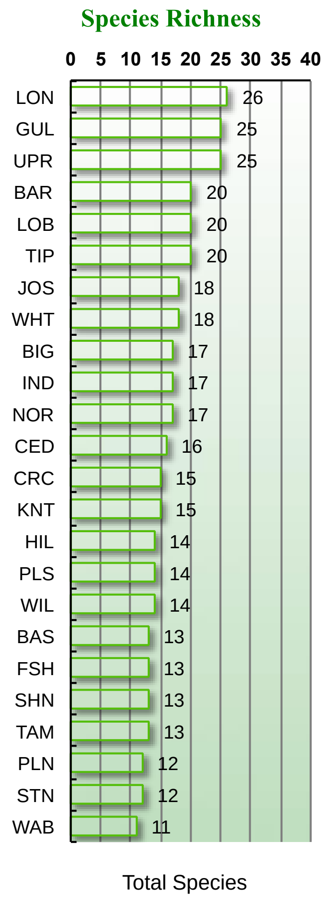


Figure 700/111.014 Total species richness or total species present in each lake during the most recent survey year.

710/111.044 LakeScan™ Plant Community Quality (Annual)

710/111.017 Morphotypes

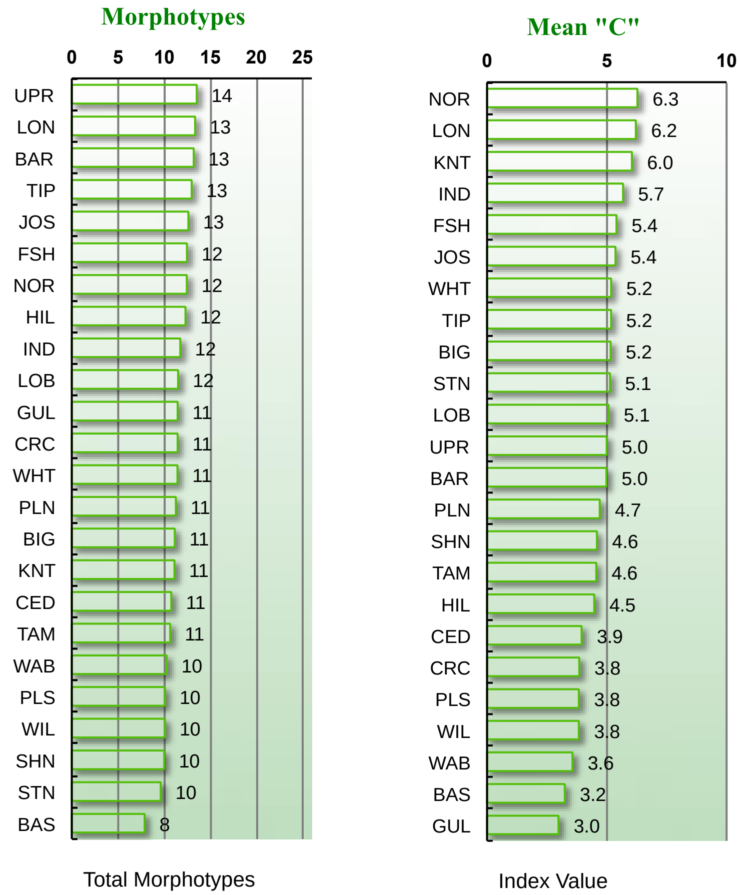


Figure 710/111.017 Plant morphology is an important measure of the structural complexity of any ecosystem. It could be said that fish don't care what names we give to submersed macrophytes – they care about structure. LakeScan™ recognizes 26 distinct plant morphotypes among common submersed macrophyte 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 in the 25 lake analysis including abbreviated name, common name and scientific name. The percent occurrence of each species in the 25 lakes, the mean species dominance values, and estimated biovolume of each plant species in the AROS areas in all of the lakes.

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
	157	NELh	Lotus Hybrid	*Nelumbo sp..*	4%	11	2
	165	FLP	Floating Leaf Pondweed	*Potamogeton sp.*	4%	6	16
	166	TLFP	Thin and Floating Leaf Pondweed	*Potamogeton sp.*	20%	6	9
	167	SMTW	Smartweed	*Polygonum sp.*	8%	6	14
	180	DUCK	Common Duckweed	*Lemna sp.*	12%	7	7
	186	TRIS	Star Duckweed	*Lemna trisulca L*	4%	2	0

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

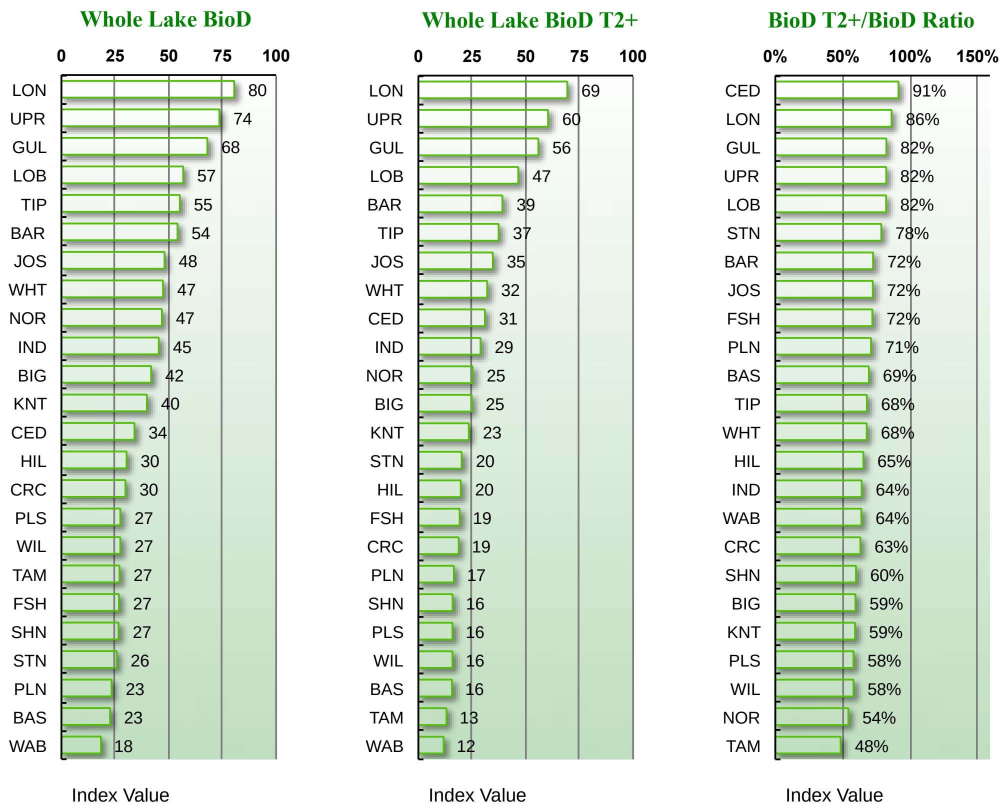


Figure 710/111.074 **ALC**: The LakeScan™ BioD 60© and BioD T2+ biodiversity index for each of the lakes analyzed in 2015. The right figure shows the ratio of the BioD T2+ index value over the total BioD. This is a relative estimate of the influence of undesirable plants, T1 species, on the over all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

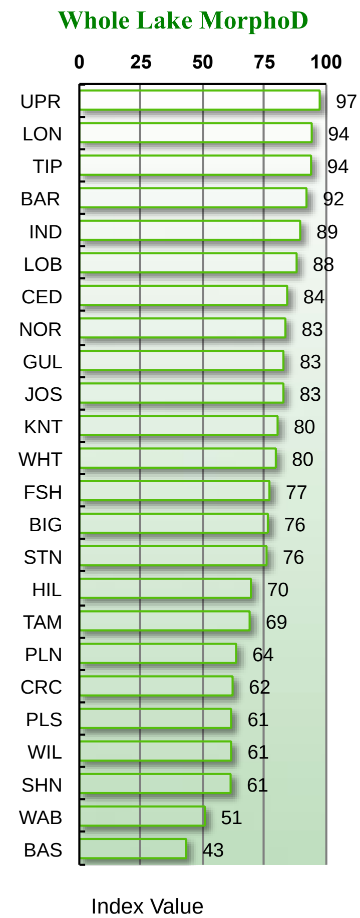


Figure 710/111.075 The LakeScan™ MorphoD 26© biodiversity index is a proportional index that assumes the greatest number of plant morphotypes, that might be present during any survey, will not be greater than or equal to 26. Again, index values greater than 50 are considered to be good.

710/111.024 LakeScan™ BioV© Indices (Annual)

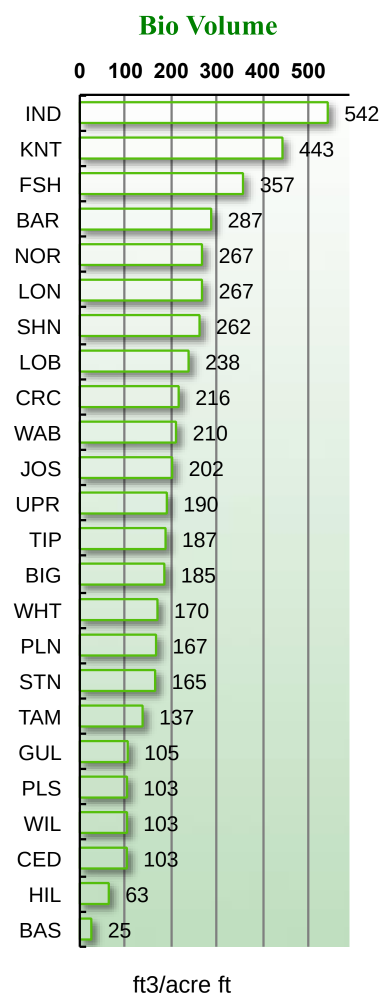


Figure 710/111.024 The LakeScan™ BioV© Biovolume index is based on the mean volume of various species per foot stem length and the density of stems per unit area. A compensatory factor is included for species that branch near the top of the plant or form surface canopies. These figures are based on the 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)

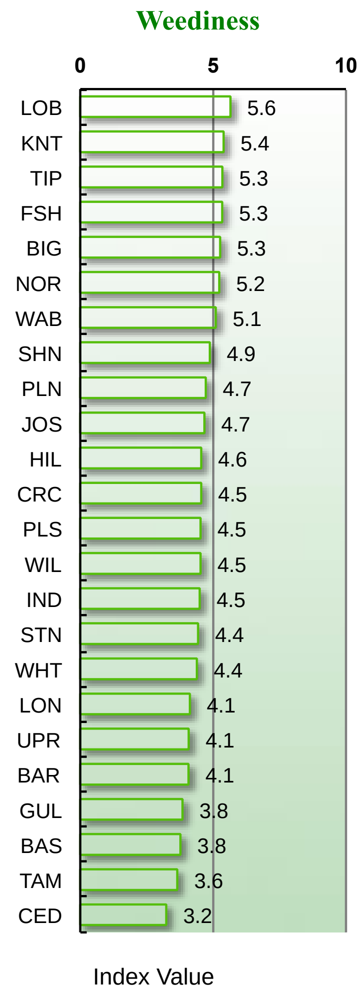


Figure 710/111.084 The LakeScan™ Weedines© index is fundamentally a diversity index (similar algorithm) however values are weighted according to the assigned "i" value, coupled with the density and distribution of various species at each AROS.

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)

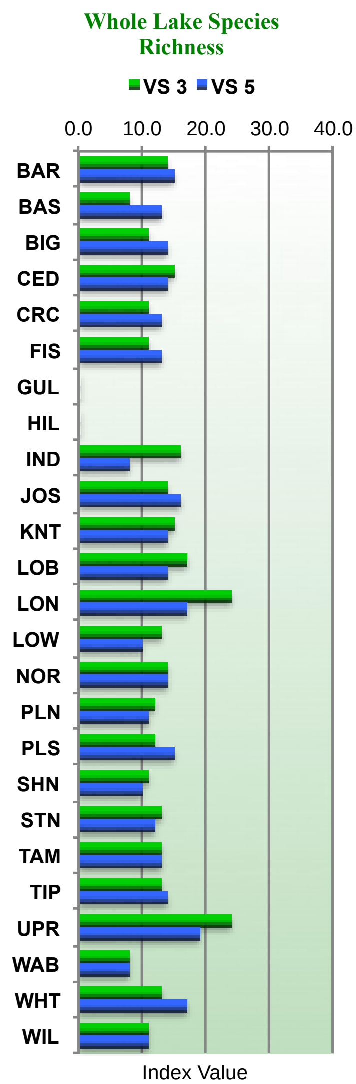


Figure 710/113.014 The species richness in all 25 lakes during the entire summer at distinct survey events that occurred in the early summer (VS 3) and late summer (VS 5) survey events for the whole lake and at all MZL's.

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.

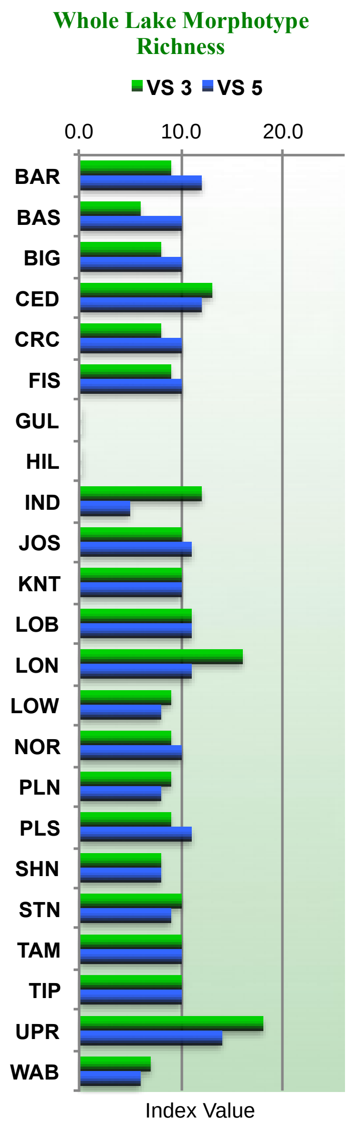


Figure 710/113.017 The total number of distinct plant morphotypes in all 25 lakes at specific early summer (VS 3) and late summer (VS 5) survey events for the whole lake and at all MZL's.

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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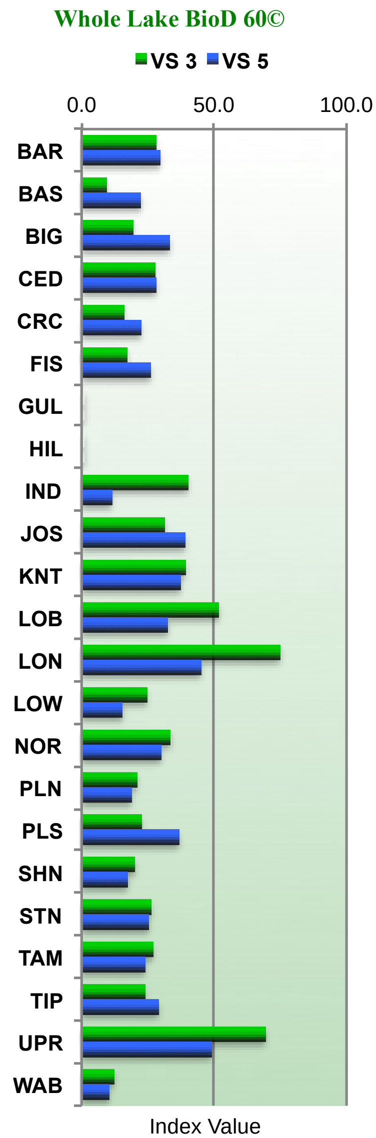

Figure 710/113.074 The LakeScan™ BioD 60© index value based upon all plant species observed in all of the lakes at specific survey events that occurred in the early summer (VS 3) and late summer (V5) in the entire lake and at specific MZL's.

***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.

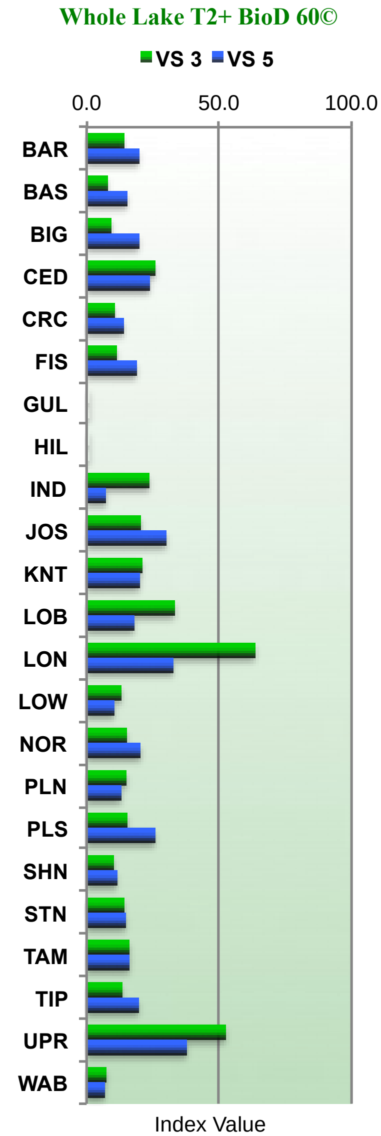

Figure 710/113.053 The LakeScan™ BioD 60© index value for all plant species of target rating T2 or greater calculated for all of the lakes at distinct survey events that occurred in the early summer (VS 3) and late summer (VS 5) survey events in the entire lake.

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.

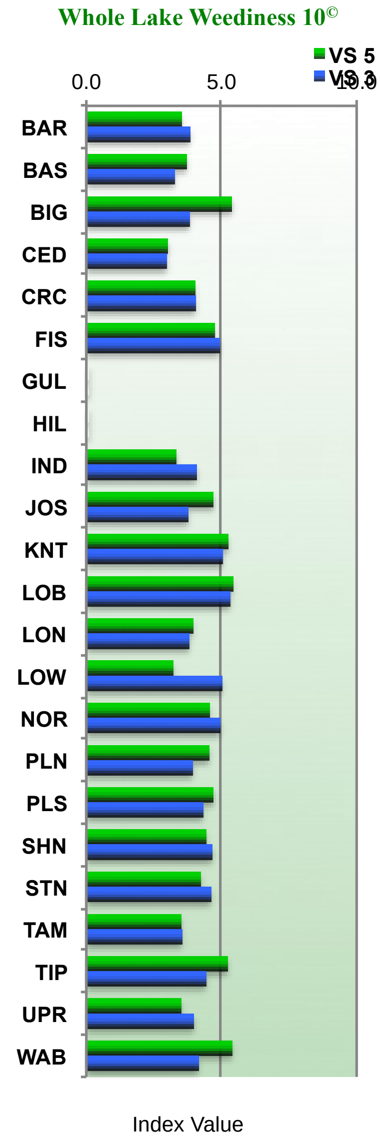

Figure 710/113.084 The LakeScan™ Weediness 10© index value of plant species calculated for all of the lakes at an early summer (VS 3) and late summer (VS 5) survey events for the whole lake.

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.

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. Two LakeScan™ plant community surveys were conducted each year since Meadow Lake started the program. It is strongly recommended that LakeScan™ surveys and analysis be continued on this lake to measure the vitality of the aquatic plant community and to detect any incursions by invasive species.

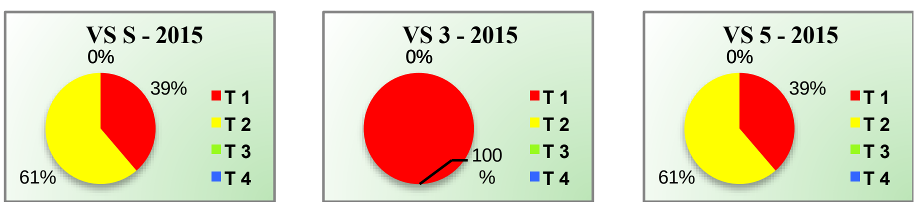

Figure 750/123.264 The relative dominance of T1 of weedy, management targeted plants and more desirable plant species (T 2 to T 4) averaged over the whole growing season (VS S), in the early summer (VS 3.0) and late summer (VS 5.0) in Meadow Lake in 2014 and 2015.

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	65	StSt	Starry Stonewort	*Nitellopsis obtusa (Desv.) J.Groves*	bushy
1	75	CLP	Curly Leaf Pondweed	*Potamogeton crispus L.*	narrow leafy
2	115	Stuk	Sago Pondweed	*Stuckenia sp.*	stringy
2	150	WL	Waterlily	*Nymphaea sp.*	floating leaf
3	180	DUCK	Common Duckweed	*Lemna sp.*	floating
3	180	DUCK	Common Duckweed	*Lemna sp.*	floating

751/401.264 Plant Community Management T1 Species Data

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

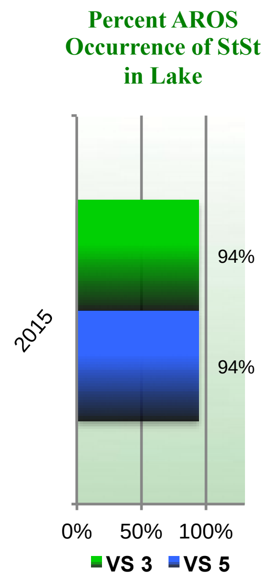

Figure 751/401.254 a The percent AROS occurrence of **ebrid watermlfoil (EWMx) and starry stonewort (StSt)** found during early summer (VS 3.0) and late summer (VS 5.0) survey events for the LakeScan™ years of record.

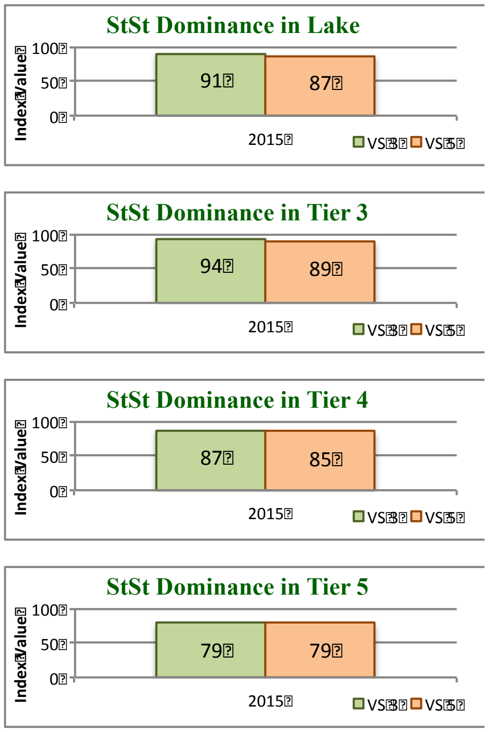

Figure 751/401.284 a The LakeScan™ Dom 100© of **starry stonewort (StSt)** found during early summer (VS 3.0) and late summer (VS 5.0) survey events for the LakeScan™ years of record.

Photos

Figure 700.00.1 Starry stonwort near the water surface. Notice the absence of any other plant species.

List of Figures

Definitions

LakeScan™ Quick Reference Guide

LakeScan™ Section 7 provides a comprehensive analysis of aquatic plant communities in lakes and wetlands. It uses analytical metrics that have been tested for over a decade to provide the data that is necessary to provide meaningful assessments of lake quality. These metrics can be applied to different areas of a lake to assess the impact of management programs or specific management strategies. Field data can be analyzed from any source; however, only LakeScan™ approved field data can provide a complete and most meaningful assessment. Field surveys can be conducted at anytime of the year. One of the greatest values of LakeScan™ that it standardizes the definitions and labels the things that we already do but have not had a standardized vocabulary to adequately describe aquatic ecosystems.

Standard and LakeScan™ Definitions

AROS: Aquatic Resource Assessment Site. Can be an area in the lake (polygon, circle, etc.) or a point intercept (GPS points).

MIST Management Intervention Strategy or Technology. This is what is "done". Herbicide application, harvesting operation, biological manipulation or introduction, etc.

AoC: Area of Concern: Sometimes an investigator wishes to focus on only an area within a lake such as an area that has been subjected to a treatment and another area that serves as a control area. LakeScan™ includes several ways to look at a lake from this perspective.

AoI: Area of Impact. An area where a MIST has been applied.

LakeScan™ Metrics

Species Richness: The total number of species found in a lake or a discrete area of a lake.

Species Occurrence: The percentage of AROS in a lake or a area of concern where a plant species or plant type (morphotypes or genotype) is found relative to all others in the total AROS in a lake or area.

BioD 60© Biodiversity: A measure of species richness combined with the occurrence of all species or genotypes at all of the AROS within a lake or area of concern.

Morpho Richness: Fish probably don't care what we name a plant. This is exactly like species richness, but rather than use species names, 26 different plant morphotypes area used to compute this metric.

MrophoD 26©: Fish probably don't care what we name a plant. This is exactly like the BioD 60© except that morphotypes are used for calculation rather than species name.

Dom 100© Dominance: This metric uses the occurrence of a specie, throughout all of the AROS in a lake or area of concern, combined with density and distribution estimates to provide a weighted estimate of the dominance of a single species or genotype.

BioV© Plant Biovolume: The biovolume of common plant species was painstakingly measured at standard lengths of different plant species. Canopy forming plants are proof that the biovolume of different plant species vary with depth. The BioV metric calculates the biovolume of each AROS based on the depth of the AROS and the way that each species distributes it biovolume, according to depth, in each AROS.

Weediness 10©: Weediness 10 should be viewed as the BioD© metric estimate, but where the individual specie or genotype data is weighted by the density and distribution data from each AROS and an index of weediness that has been assigned to each specie, group of species, or genotype. The index of weediness is essentially the inverse of a standard assessment of conservatism established in Wisconsin over a decade ago.

Plant Quality

"C" Value: This refers to a coefficient of conservatism that includes a "C" value assignement for each plant species. LakeScan™ C value assignments are very similar to those created in Wisconsin over a decade ago. The least conserved (weedy species) are assigned lower numbers. The scale runs from 1 to 9.

"T" Value: Certain plant species are so invasive and aggressive that they are nearly always targeted for control because failure to do so would result in degradation of the ecosystem.

T1: Species that are weed species are nearly always targeted for suppression.

T2: These species are common and are sometimes targeted for at least temporary suppression.

T 3: These species are rarely weedy, but they are not protected or endangered. They are rarely targeted for management suppression.

T 4: These species are very rare and protected. MIST applications are generally necessary to protect these species from extirpation by T1 species.

Plant Community Characteristics

Density: There are 4 levels of density that are assigned for each species, species group, or genotype in an AROS.

A (1): Found in AROS, but could only be easily be found in that AROS with precise GPS coordinates.

B (2): Found in the AROS and could be easillyt found again, but not common in the AROS.

C (3): Very common and usually a dominant species in the AROS.

D (4): Weedy and overwhelmingly dominating the AROS

Distribution: A fisheries biologist suggested that the distribution of plants in an AROS is important because "edge effect" is a critical habitat feature:

S (1): Spotty, single plants of a given species, distributed in the AROS

Sp (2): Scattered small patches of a single species (2 or 3 individuals per patch) distributed throughout the AROS

P (3): Large patches of a given species that are found throughout the AROS, but the pathes do not cover more than 50% of the AROS

Cp (4): The distribution of a single species covers more than 50% of the AROS.

Plant Community Survey Events

VS x.0: It is critical that the timing of sampling events is referenced by a standard system that helps to describe when a survey has been conducted and what the intended purpose of the survey might be. There are 6 labels that are used to describe when a Vegetation Survey has been conducted and these have been established according to the growth status of the plant community and do not strictly adhere to calendar dates. Typical early summer (peak growth and community diversity) surveys occur at VS 3.0 and would are conducted around late May to early June in the Great Lakes region. Similarly the typical late summer or season suveys (again, peak growth and late season plant species diversity) are labeled VS 5.0 and are typically conducted in August or early September in the Great Lakes region.

VS x.1: If a MIST evaluation is being conducted and for example, a VS 3.0 survey serves as a "pretreatment" survey, subsequent surveys that are intended to evaluate the outcome of the MIST application would be numbered as VS 3.1, VS 3.2, etc.

Areas of Concern

Tiers

Plants and critical habitat seem to aggregate according to depth and expsorue to energy such as wind and wave action. Sediments conditions can also strongly influence the distribution of aquatic plants and other organisms. It is often important to consider these different zones independently.

Tier 3: Tier nearest the shoreline. Influenced heavily by energy and shoreline characteristics and development.

Tier 4: An area where water is deeper and energy is not a great factor. Plant growth in these areas is often stable because it is not subjected to variance in water level and wind and wave action.

Tier 5: A distinct community found on “drop off” areas where there is a dramatic change in water depths with distance from shore.

Tier 6: Off shore submerged islands that support a unique flora.

MZL (Management Zone Level)

The objective of the management program will vary according to where a group of AROS is located in respect to shoreline development, lake uses, and proximity to critical shoreline habitats, such as wetlands. There are some areas in a lake where the management objective might be to only remove the most offensive weed species for the protection of desirable plants and critical habitat. Only the most species selective MIST’s are used in these areas. On the other end of the scale, swimming areas and marinas require that there be little plant growth to protect public safety and property. There are 4 MZL levels, MZL 1 – 4, that span this range of management objectives. MZL 0 is reserved for areas where no MIST may ever be applied due to a variety of constraints.

MZL 0: No management zone

MZL 1: Only the most species selective MIST’s will be considered

MZL 2: Areas where MIST’s will be relatively species specific, but where some non-target impacts can be tolerated.

MZL 3: Areas where all plant growth will be suppressed on a very temporary scale, such as near developed shorelines. It is expected that T 1 species will be removed, some species will be suppressed, and some species will be unaffected.

MZL 4: All plant growth will be targeted for removal (swimming areas, marinas). The objectives that are used to attain this level of control are generally unsustainable.

Areas of Impact

TmtZ: LakeScan has an established labeling system to designate areas and describe various MIST’s as they are applied to different areas in a lake. Generally, the first application of a MIST during a given growing season is labeled from 11 to 19, the second event would be labeled 21 to 29, and so on. The first MIST (i.e. herbicide combo, mechanical removal method, etc) would be labeled TmtZ 11. Another MIST applied during the first “lake treatment event” would be labeled TmtZ 12 and so on. The first MIST to be applied during a second, later in the season event, would be labeled 21. The next MIST to be applied at the second lake “treatment event” would be 22.

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 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 lake 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.