Whitmore Lake Improvement Project
Proposed Budget 2017 - 2021

Lake Treatment Costs (includes permit fee, mailings & postings)

First year	$	**82,325**
Second year	$	**84,795**
Third year	$	**87,339**
Fourth Year	$	**89,959**
Fifth Year	$	**92,658**
Total - Plan Implementation	***$***	***437,076***

PA 185 Project Development Costs	**Hours**	**Average Hourly Rate**		
Special assessment and project documents and approvals	50	$75	$	**3,750**
Public Notice prep	10	$75	$	**750**
Public Notice publication			$	**1,200**
Printing and Mailing			$	**500**
BPW meetings			$	**350**
Total - Project Development Costs			***$***	***6,550***

Project Management Costs	**Hours**	**Average Hourly Rate**		
Lake Management Specialist	550	$110	$	**60,500**
Contract Administration/Project Management	75	$75	$	**5,625**
Administer Special Assessment Roll	150	$75	$	**11,250**
Total - Project Management Costs			***$***	***77,375***

Contingencies	$	**52,100**
Total Project Cost	$	**573,101**
Carryover Balance	$	**120,000**
Total assessment amount/5 years	$	**453,101**

Aquest Corporation

FIELD NOTES

Lake: **Whitmore Lake, Washtenaw and Livingston Counties, MI**

Date of Observation: **21 May 2017**

Activity: **LakeScan™ Category 700 Pre Treatment Review**

Key Points

~ **Weedy broad leaf pondweed was conspicuous everywhere and has become a moderate nuisance in portions of the lake. It obstructed boating in only a few areas of the lake. Most of the nuisance growth was in water depths greater than 5' or more than 300' from shore. Mechanical harvesting is the only permissible management strategy for this species in these areas of the lake.**

~ **Ebrid milfoil was also conspicuous in many parts of the lake ranging from near-shore areas along the northern shore to deep areas near the drop off zone on the east side of the lake. Percent occurrence appears to be less than what has been observed at this time of the year in previous years. It was not observed at nuisance levels; however, it is expected that it will reach nuisance levels in the next several weeks and was particularly dense near AROS 85 to 90. Ebrid milfoil in Whitmore Lake often grows below the water surface and does not form the canopies at the water surface which is a normal growth pattern.**

~ **Curly leaf pondweed was much more conspicuous than it has been in recent years. It was dominant or co-dominant with milfoil growth in TmtZ's 11.* areas.**

~ **Starry stonewort was present, but was not growing actively. It appears that it will not interfere with fish spawning in the lake this year. However, it is expected to grow to nuisance levels later in the summer.**

~ **Waterlilies were only beginning to appear in the lake and this is considered to be later than normal.**

Narrative

The day was overcast with a steady wind near 12 mph. The water clarity was good for Whitmore Lake. There were no signs of algae blooms. The water temperature near the water surface was in the low 60's°F.

It appears that weedy broad leaf pondweed will become the dominant nuisance in Whitmore Lake in 2017. Curly leaf pondweed and milfoil were co-dominant in some of the nearshore areas and treatment with selective herbicide combinations will be necessary to amelieortate nuisance conditions. Mechanical harvesting is expected to provide at least temporary relief from nuisance pondweed conditions.

Management Prescriptives

No herbicide treatment is recommended until the week of June 5th. Treatment areas are delineated on the accompanying map. Mechanical harvesting is recommended for the water ski course and other areas where weedy broadleaf production is found. The ebrid milfoil in Whitmore lake is not expected to be stimulated by the harvesting operations.

Figure 1. Whitmore Lake AROS/TmtZ Map, 2017. The green areas 11.* require milfoil treatment. The blue areas 12.* required broad spectrum treatment for pondweeds, curly leaf pondweed, and milfoil.

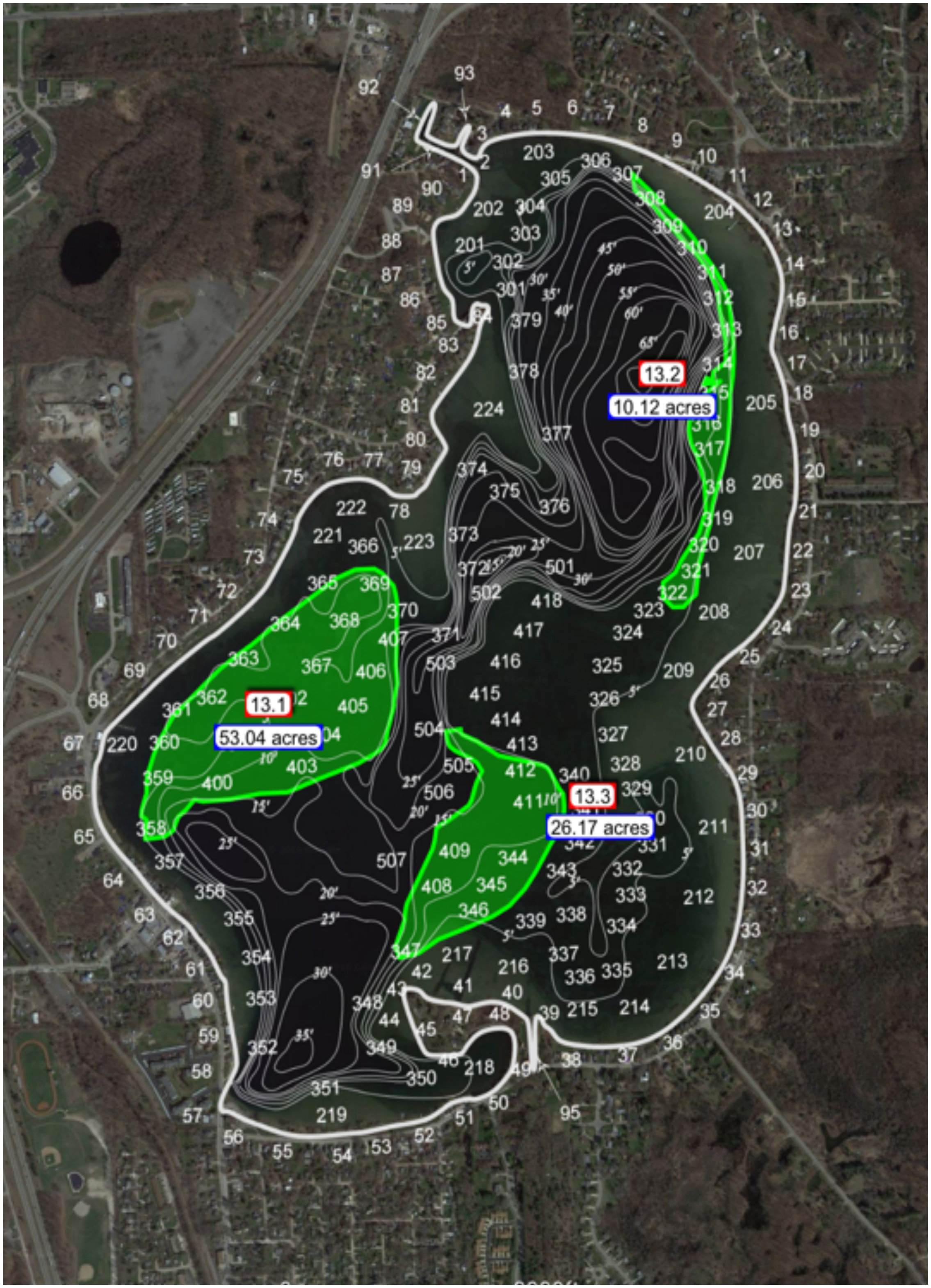
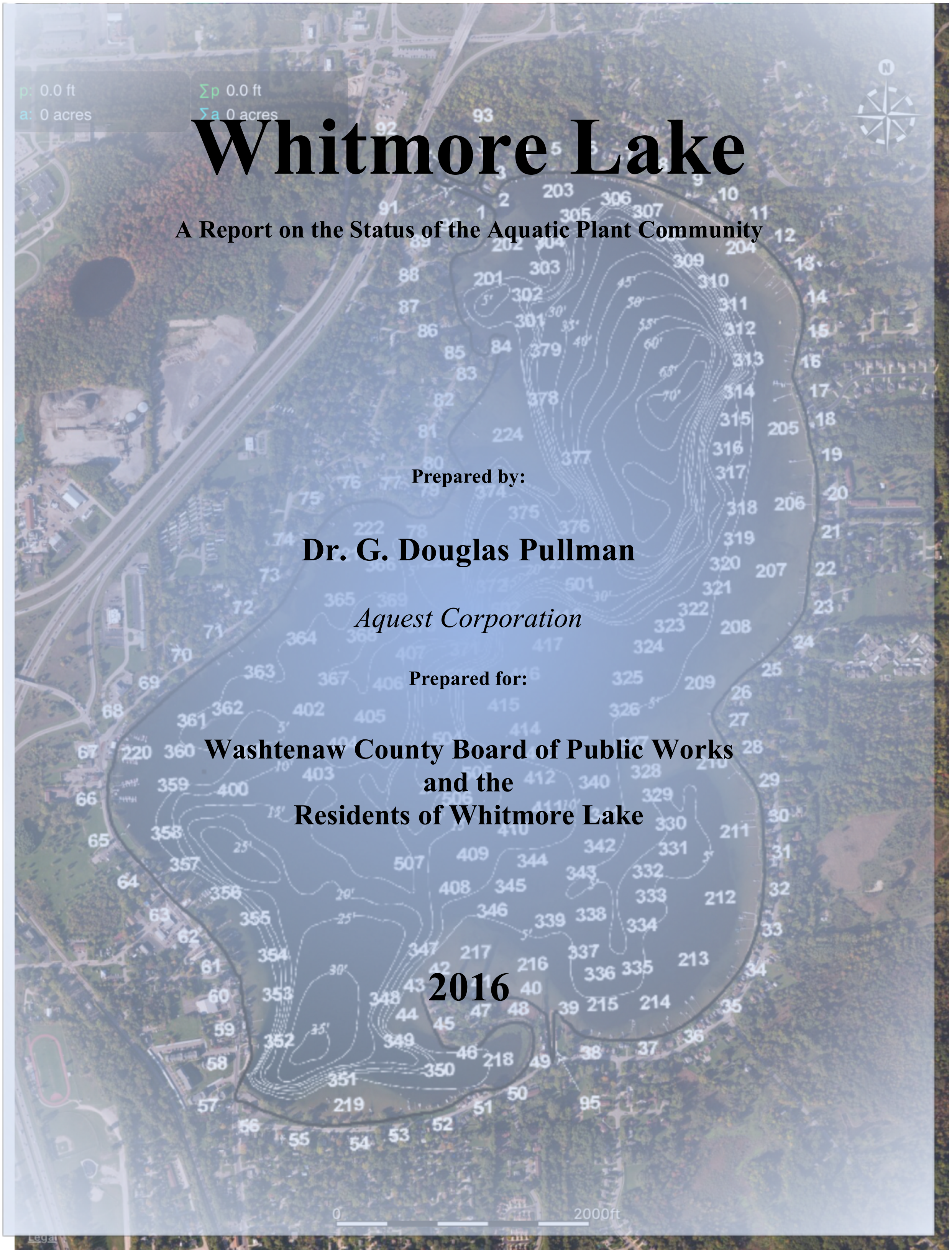


Figure 1. Whitmore Lake AROS/TmtZ Map, 2017. The green areas 13.* are recommended harvesting areas for the management of weedy broadleaf pondweeds.

Whitmore Lake

A Report on the Status of the Aquatic Plant Community



Prepared by:

Dr. G. Douglas Pullman

Aquest Corporation

Prepared for:

Washtenaw County Board of Public Works
and the
Residents of Whitmore Lake

2016

Whitmore Lake

A Report on Lake Conditions and
Management Recommendations

Prepared by:

Dr. G. Douglas Pullman
Aquest Corporation

Prepared for:

Whitmore Lake Management Authorities and the Residents of Whitmore Lake

2016

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 custom 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™ Category 700 provides an analysis of large plant and weed conditions in the lake. Category 500 deals with phytoplankton communities. And, Category 200 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 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, 2016

Whitmore Lake

Washtenaw and Livingston Counties, Michigan

Analysis of Key Parameters, Metric, Indices, and Conditions

Using the LakeScan™ Method

2016

Statements of Management Goal and Program Objectives

The Primary Goal of the LakeScan™ Lake Management Programs

The primary goal of any lake management program should be to protect, preserve, and when possible, improve the stability of the lake ecosystem. This is accomplished when conditions are modified within the lake to enhance species and habitat diversity and thereby stabilize the ecosystem by promoting the production of conservative species. Success will help to inhibit the production of those plants that are weedy or more opportunistic and will make any lake more resilient to the rapid proliferation and domination of the aquatic ecosystem by invasive nuisance species. Success will also enhance recreational opportunities, including the fishery and the cultural utility of the resource. Any applied management strategy will focus on mitigating against the effects of cultural disturbance and be applied in a manner to minimize further disturbance of the ecosystem.

Proximal Management Objectives

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

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

Table of Contents

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

Section 100/122.300 Aquatic Resource Observation Sites and Zones

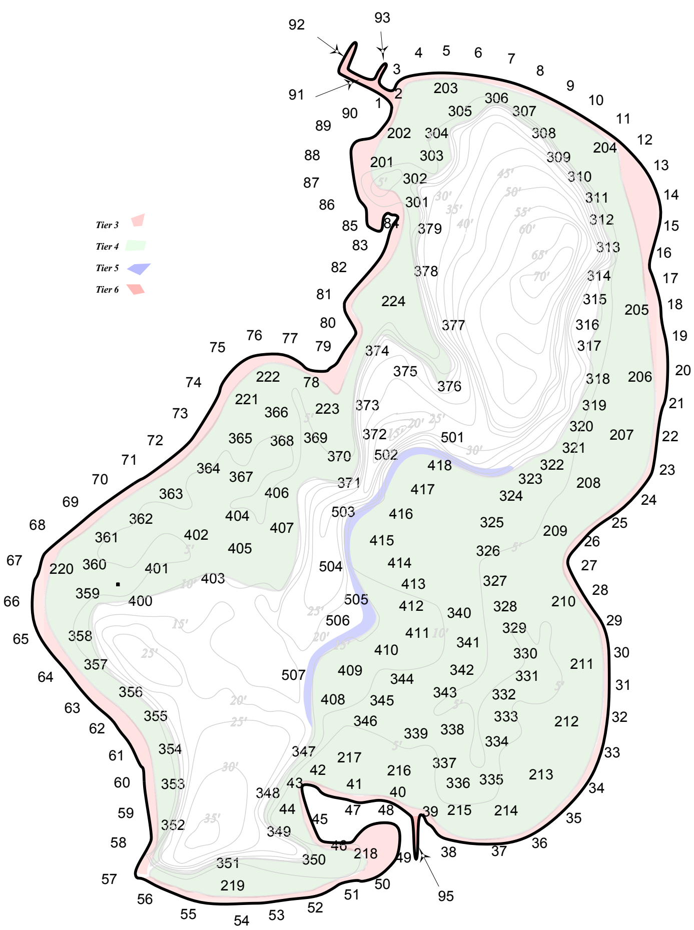


Figure 100.122.320 A map depicting the location of all Aquatic Resource Observation Sites (AROS's) that were used to make observations in Whitmore Lake.

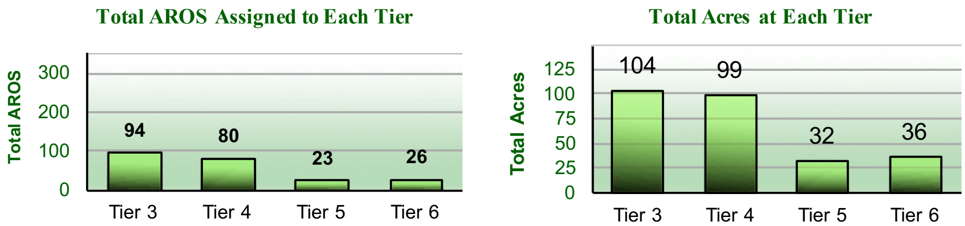


Figure 100/122.320 The total number of AROS and AROS acres at each Tier.

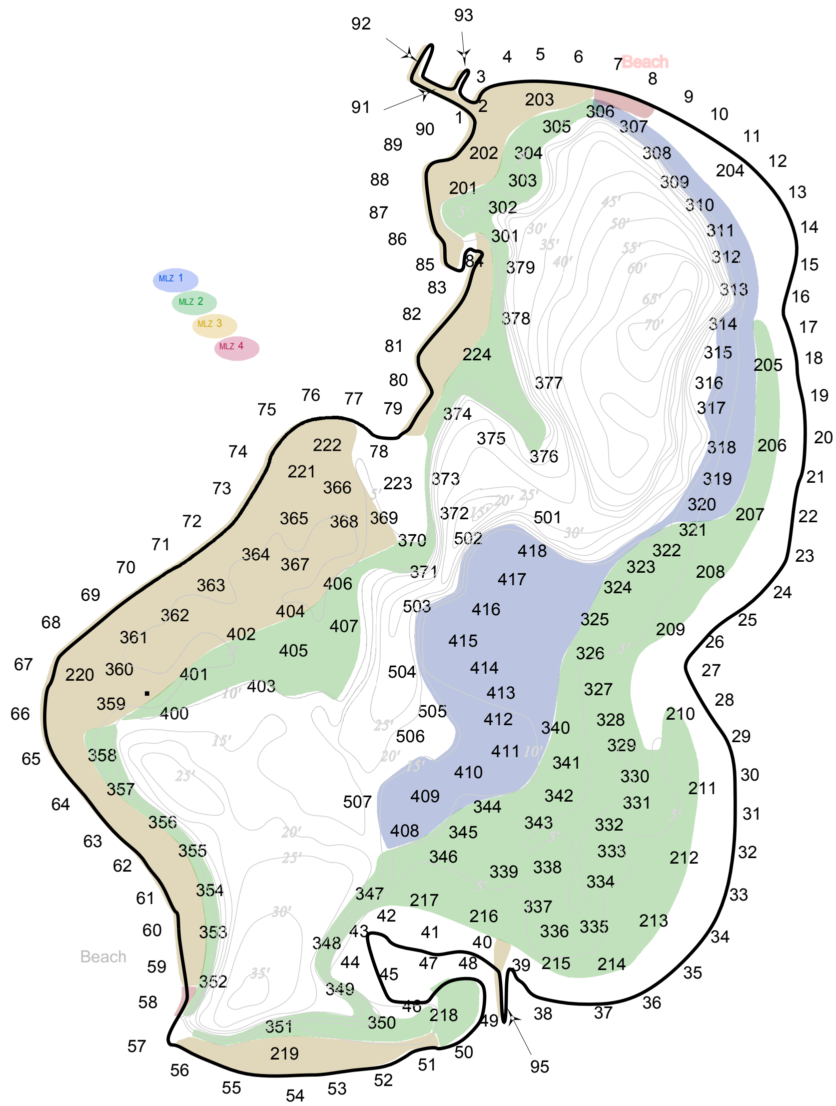


Figure 100/122.350 A map depicting the location of all Aquatic Resource Observation Sites (AROS's) that were used to make observations in Whitmore Lake according to MZL assignment.

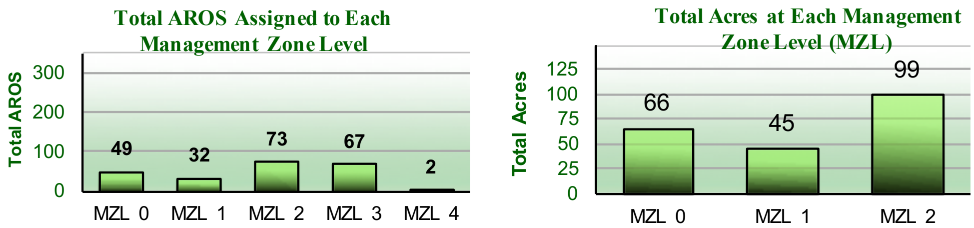


Figure 100/122.350 The total number of AROS and AROS acres at each Management Zone (MZL).

AQUEST TIP

Disturbed Aquatic Ecosystems

Characteristics

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

Common Disturbances

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

Category 700: Large Plant Communities in Whitmore 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 roll in determining the distribution of various aquatic macrophytes. Different plant species respond differently to wind and wave exposure and the total energy derived from this kind of physical disturbance which can include boat props and wakes. Sediment bulk density, sediment nutrient and naturally occurring phytotoxin concentrations are also key determinants of macrophyte species density, distribution and the percent occurrence of various species in the AROS in a lake. These factors, combined with competition and interactions with other plant species and animals are primary determinants of what plants will be present or absent in the AROS in a lake. Shoreline development is another key factor in determining what plant species can and will dominate a lake although the mechanisms involved in these kinds of disturbance are not known. Plant species that are able to tolerate a wide range of natural conditions and man-made disturbance are referred to as opportunistic species. Those species that are relatively intolerant of the same variables are considered to be conservative species. Opportunistic species are usually weedy. The same plants assigned C values of less than 4 are common weeds.

Submersed aquatic plant production in Whitmore Lake is considered to be low to moderate compared to other Michigan inland lakes. There are, considerable areas in Tiers 3 and 4 where bottom soils appear to be sandy and infertile. There are other, minor areas that are characterized by loose organic substances that are also inhospitable to plant growth because they can lead to the production of phytotoxins. This sediment is dominant in the canals. Since aquatic plants and weeds derive plant nutrients from the sediments through their roots, rather than from the water column as do the algae, inhospitable or infertile sediments seriously inhibit aquatic plant growth in some areas in a lake.

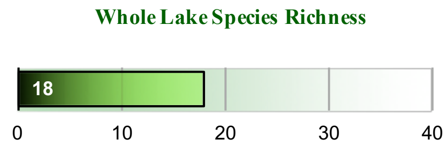
Ebrid milfoil (Eurasian watermilfoil and Eurasian watermilfoil and starry stonewort are currently believed to be the only species (or species genotypes) that could completely dominant the submersed flora in Whitmore Lake and extirpate desirable plant species. It is believed that a mid 2000's fluridone treatment has functionally eradicated herbicide sensitive Eurasian or ebrid milfoil in the lake. Ebrid milfoil has not returned to the nuisance levels observed prior to the treatment; however, it is beginning to spread. The dominance of Ebrid milfoil in early 2016 was alarming, but it has not yet reached a critical nuisance level. Ebrid milfoil has been observed to "boom and crash" in Whitmore Lake making it virtually impossible to determine when it might once again reach nuisance levels. However, it is expected that ebrid milfoil will present as a significant nuisance at some point in the near future. The ebrid milfoil found in Whitmore Lake in recent years has been unusually herbicide. Herbicide resistance is expected to increase as protective biofilms that form on plant surfaces seem to having a greater impact each year. The biofilm, microorganism communities that are thriving on the Whitmore Lake ebrid milfoil has conferred a significant degree of resistance to <u>all</u> herbicides. The phenomenon is equally present on non-target species so it appears that it is still possible to manage T1 species selectively and protect the diversity of the bottom dwelling plant community.

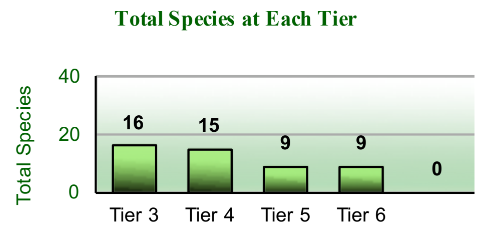
Starry stonewort emerged as a primary dominant species in 2007 to 2010; however, it was never present at levels that would interfere with swimming or boating. Unfortunately, it has been observed to cover fish spawning beds and seriously restrict the reproductive success of pan fish species. Studies have shown that algaecides can be applied to these areas to "open" the spawning sites for fish. This may be necessary in the future to protect the viability of the Whitmore Lake fishery. Pre treatment surveys are necessary to determine if treatment of spawning areas is necessary to protect the fishery.

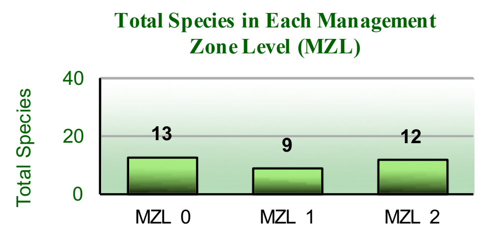
The dominant pondweed in Whitmore Lake appears to be a "hybrid type" that can be more weedy than most genotypes. Nuisance pondweed production has been constant in the water skiing area since monitoring was begun in 2004. The production of these pondweeds must be closely monitored. MDEQ permitting seriously restricts the ability to preserve the use of the skie course.

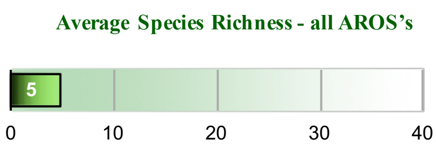
Category 710: 2016 Lake-Wide Plant Community LakeScan™ Analysis

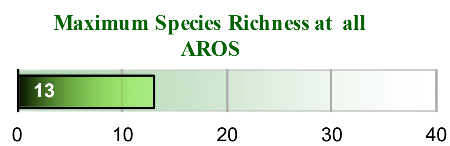
710/122.010 Plant Community Species Richness

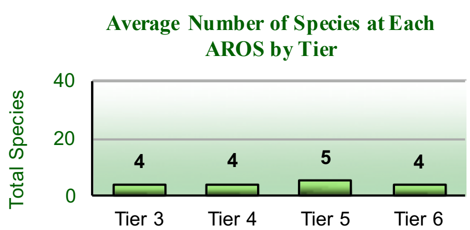


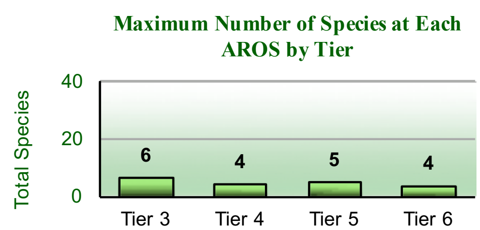


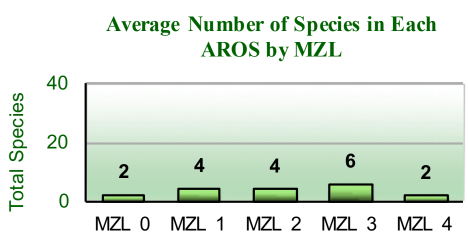












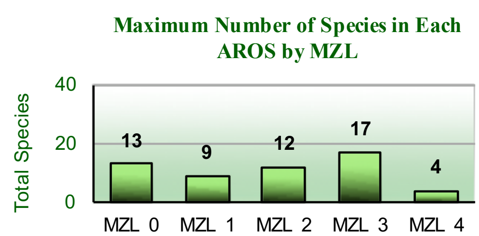


Figure 710/123,4.014 Total species richness or total species present in the lake and the average and maximum number of plant species found at any AROS in the lake during the most recent survey year. These data are also presented by Tier and MZL.

710/132,142.017 Morphotypes

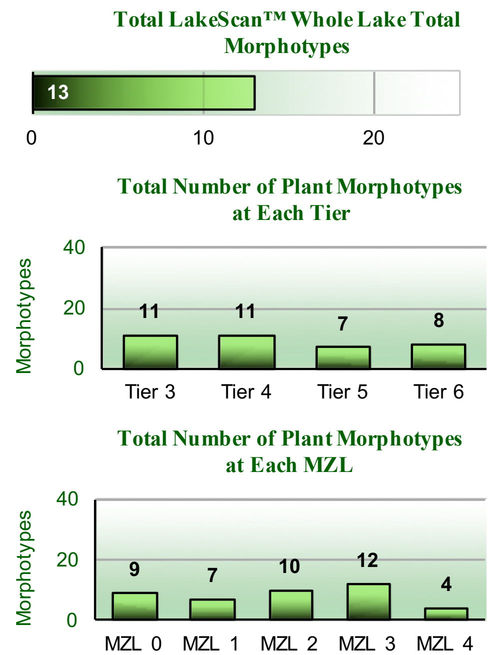
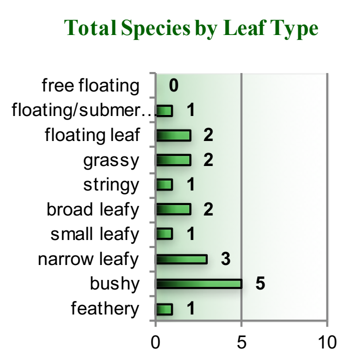


Figure 710/132,142.017 Plant morphology is an important measure of the structural complexity of any ecosystem. It could be said that fish don't care what names we given to submersed macrophytes – they care about structure. LakeScan™ recognizes 26 distinct plant morphotypes among common submersed macrophyte species.

710/121.017 Leaf Types



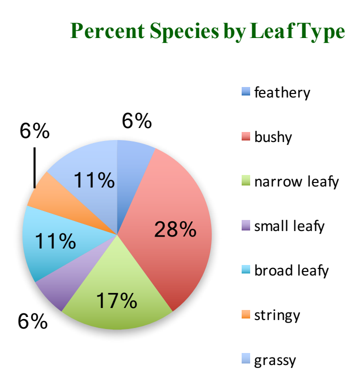


Figure 710/122.017 The total number (histogram) and percentage of plant species leaf morphotype (pie chart) found in the lake for the entire summer or growing season.

Table 710/121.014 A list of species found by LakeScan™ monitoring during the course of the summer growing season listed by "t" or nuisance target value. Plants with different "t" values are segregated by color.

2016 PLANT NAMES, CODES, AND SELECTED ATTRIBUTES				
"T" Value	Code #	Abrev.	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	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.*
3	3	NWM	Northern Watermilfoil	*Myriophyllum sibiricum Kom.*
3	25	BLAD	Common Bladderwort	*Utricularia vulgaris L.*

710/121.020 LakeScan™ BioV© Indices (Annual)

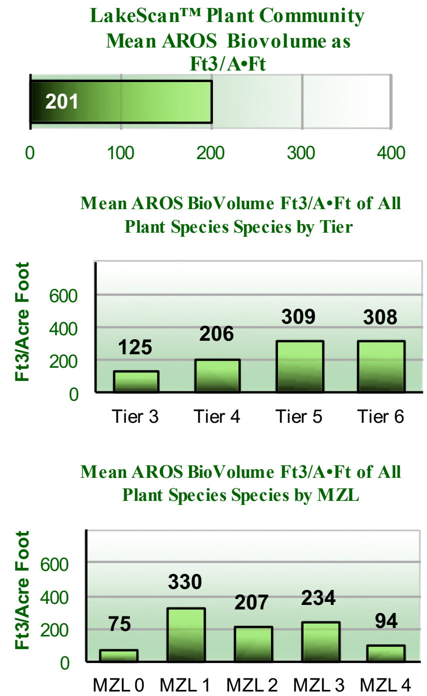


Figure 710/121.024 The LakeScan™ BioV© Biovolume index is based on the mean volume of various species per foot stem length and the density of stems per unit area. A compensatory factor is included for species that branch near the top of the plant or form surface canopies. These figures are based on the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

Table 710/122.040 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.

2016 PLANT NAMES, CODES, AND SELECTED ATTRIBUTES								
		Abbrev.			*t*	*i*	*c*	
	Code #	Name	Common Name	Scientific Name	Value	Value	Value	Leaf Type
1	2	EWMx	Eurasian Milfoil Hybrid	*Myriophyllum spicatum x sibiricum*	1	8	3	feathery
2	33	CNTL	Coontail (2)	*Ceratophyllum sp.*	2	7	3	bushy
3	42	ELD	Elodea (2)	*Elodea sp.*	2	6	3	bushy
4	50	NAID	Naiad (3)	*Najas sp.*	2	7	4	bushy
5	60	CHARA	Chara (many)	*Chara sp.*	4	3	6	bushy
6	65	StSt	Starry Stonewort	*Nitellopsis obtusa (Desv.) J.Groves*	1	9	3	bushy
7	75	CLP	Curly Leaf Pondweed	*Potamogeton crispus L.*	1	9	2	narrow leafy
8	76	FSP	Flat Stem Pondweed	*Potamogeton zosteriformis Fern.*	2	5	6	narrow leafy
9	80	ROB	Robbins Pondweed	*Potamogeton robbinsii Oakes*	3	2	8	narrow leafy
10	90	Rich	Richardsons Pondweed	*Potamogeton richardsonii (Benn.) Tydb.*	2	5	5	small leafy
11	109	HPW	Hybrid Pondweed	*Potamogeton Hybrid*	2	5	5	broad leafy
12	110	WBLP	Weedy Broad Leaf	*Potamogeton amplifolius Hybrid*	2	6	4	broad leafy
13	115	Stuk	Sago (3)	*Stuckenia sp.*	2	6	3	stringy
14	125	VAL	Wild Celery	*Vallisneria americana Michaux*	2	7	3	grassy
15	126	SAG	Sagittaria (4)	*Sagittaria sp.*	4	3	7	grassy
16	150	WL	Waterlily (2)	*Nymphaea sp.*	2	5	6	floating leaf
17	153	SPAD	Spadderdock (3)	*Nuphar sp.*	2	5	6	floating leaf
18	166	TLFP	Thin and Floating Leaf (6)	*Potamogeton sp.*	3	0	5	floating leaf pondweed

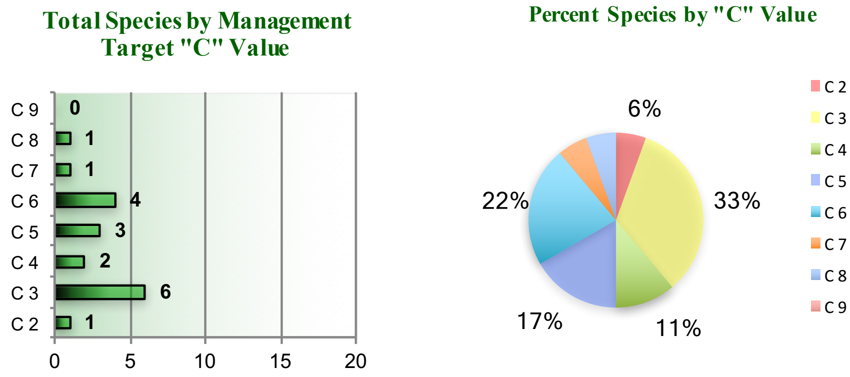


Figure 710/122.041 The total number (histogram) and percentage (pie chart) of plant species by "C" value found in the lake for the entire summer or growing season. Plants that are assigned lower C values are more tolerant of ecosystem and man-made disturbances and system alterations. Weedy species usually are assigned lower C values. Conversely, rare and endangered species are assigned higher C values.

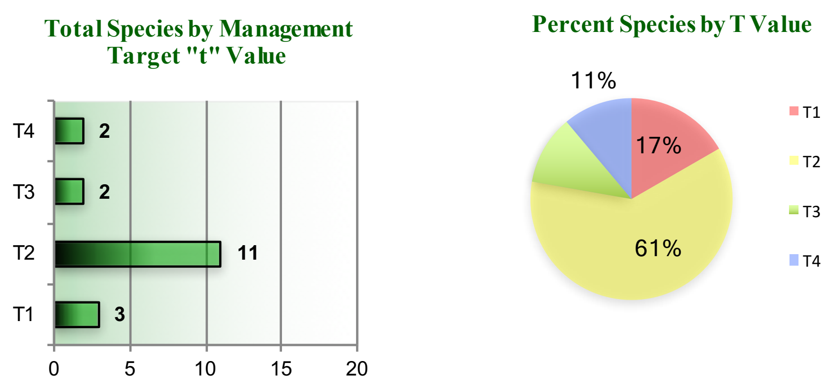


Figure 710/121.042 The total number (histogram) and percentage (pie chart) of plant species by "T" value found in the lake for the entire summer or growing season. The T 1 species are usually very weedy and targeted for control. These include nuisance watermilfoil genotypes, curly leaf pondweed, and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

710/121.040 Plant Community Quality

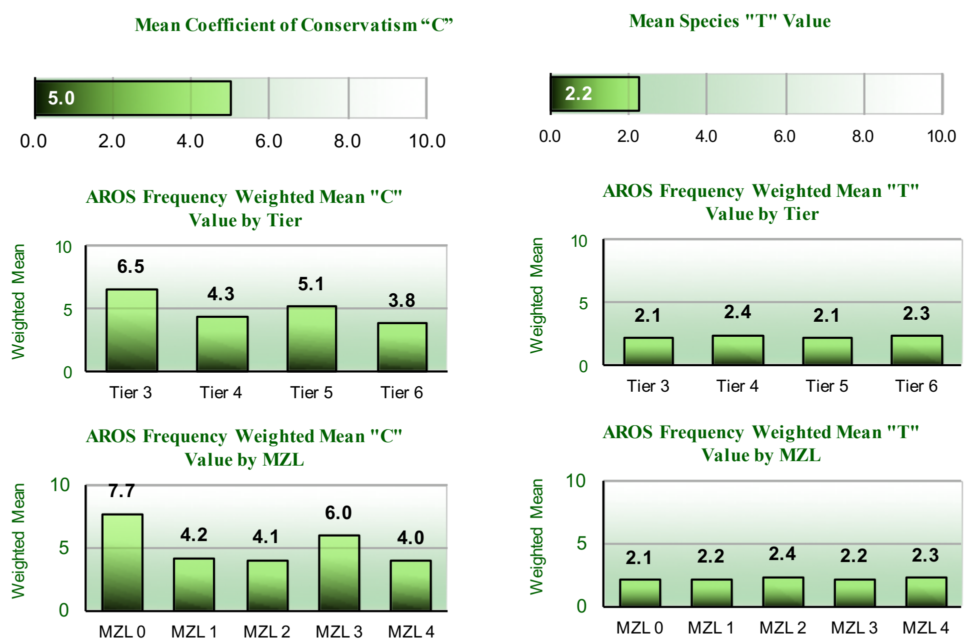


Figure 710/132,142.042 Mean weighted plant species coefficient of conservatism for the whole lake and by sorted Tier and MZL as measured at all lake AROS.

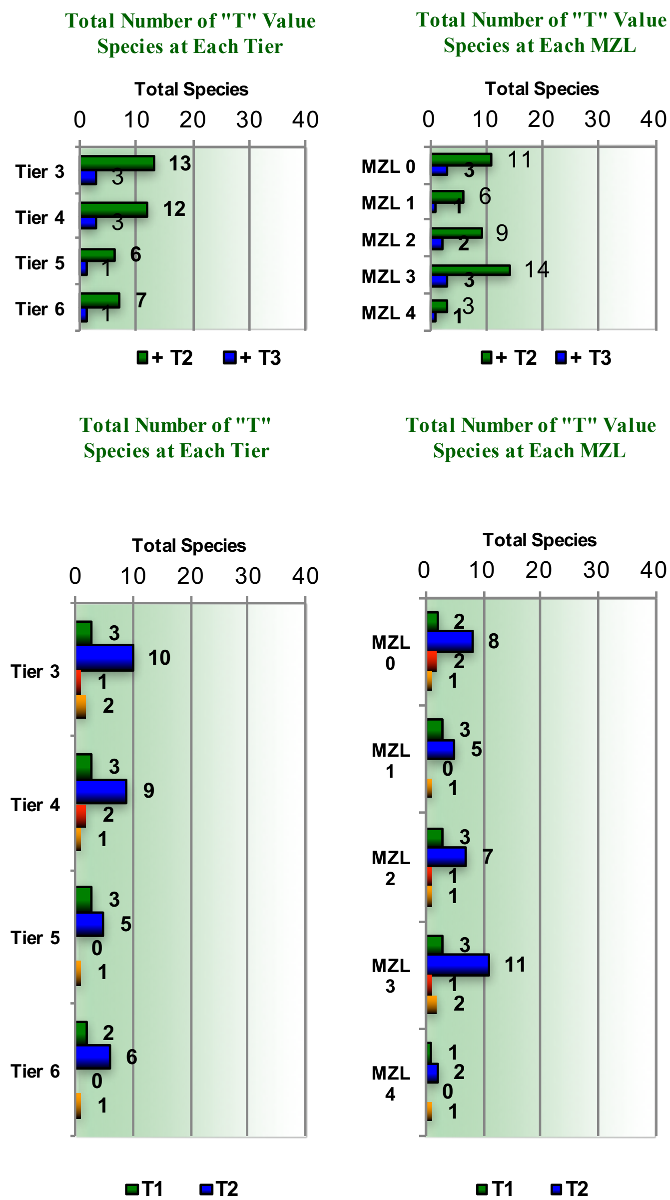


Figure 710.132,142.041,2 The total number of species assigned to the 4 management target priority values at each Tier and MZL. The upper part of this figure represents all of the species T values summed for T2, T3, and T4 (T2+) and T3 and T4 (T3+).

710/132.050 Plant Community Occurrence

Table 710/132.057 A list of species ranked according to the percent occurrence of each species for the entire year.

SPECIES LIST ACCORDING TO PERCENT OCCURRENCE RANK, 2016					
	Code #	Abbrev. Name	Common Name	Scientific Name	% Occurrence
1	60	CHARA	Chara (many)	*Chara sp.*	80%
2	109	HPW	Hybrid Pondweed	*Potamogeton Hybrid*	76%
3	110	WBLP	Weedy Broad Leaf	*Potamogeton amplifolius Hybrid*	68%
4	2	EWMx	Eurasian Milfoil Hybrid	*Myriophyllum spicatum x sibiricum*	42%
5	125	VAL	Wild Celery	*Vallisneria americana Michaux*	40%
6	150	WL	Waterlily (2)	*Nymphaea sp.*	25%
7	75	CLP	Curly Leaf Pondweed	*Potamogeton crispus L.*	23%
8	115	Stuk	Sago (3)	*Stuckenia sp.*	18%
9	76	FSP	Flat Stem Pondweed	*Potamogeton zosteriformis Fern.*	13%
10	80	ROB	Robbins Pondweed	*Potamogeton robbinsii Oakes*	11%
11	65	StSt	Starry Stonewort	*Nitellopsis obtusa (Desv.) J.Groves*	9%
12	42	ELD	Elodea (2)	*Elodea sp.*	8%
13	153	SPAD	Spadderdock (3)	*Nuphar sp.*	4%
14	126	SAG	Sagittaria (4)	*Sagittaria sp.*	1%
15	33	CNTL	Coontail (2)	*Ceratophyllum sp.*	1%
16	166	TLFP	Thin and Floating Leaf (6)	*Potamogeton sp.*	0%
17	90	Rich	Richardsons Pondweed	*Potamogeton richardsonii (Benn.) Tydb.*	0%
18	50	NAID	Naiad (3)	*Najas sp.*	0%

710/132.060 Plant Community Dominance

Table 710/122.067 A list of species ranked according to the LakeScan™ dominance factor assigned to each species for the entire year.

SPECIES LIST BY TO LAKESCAN™ DOMINANCE RANK, 2016					
	Code #	Abbrev. Name	Common Name	Scientific Name	DOM FACTOR
1	60	CHARA	Chara (many)	*Chara sp.*	1
2	109	HPW	Hybrid Pondweed	*Potamogeton Hybrid*	2
3	110	WBLP	Weedy Broad Leaf	*Potamogeton amplifolius Hybrid*	3
4	2	EWMx	Eurasian Milfoil Hybrid	*Myriophyllum spicatum x sibiricum*	4
5	125	VAL	Wild Celery	*Vallisneria americana Michaux*	5
6	150	WL	Waterlily (2)	*Nymphaea sp.*	6
7	75	CLP	Curly Leaf Pondweed	*Potamogeton crispus L.*	7
8	115	Stuk	Sago (3)	*Stuckenia sp.*	8
9	80	ROB	Robbins Pondweed	*Potamogeton robbinsii Oakes*	10
10	65	StSt	Starry Stonewort	*Nitellopsis obtusa (Desv.) J.Groves*	11
11	76	FSP	Flat Stem Pondweed	*Potamogeton zosteriformis Fern.*	9
12	42	ELD	Elodea (2)	*Elodea sp.*	12
13	153	SPAD	Spadderdock (3)	*Nuphar sp.*	13
14	126	SAG	Sagittaria (4)	*Sagittaria sp.*	14
15	166	TLFP	Thin and Floating Leaf (6)	*Potamogeton sp.*	16
16	50	NAID	Naiad (3)	*Najas sp.*	18
17	90	Rich	Richardsons Pondweed	*Potamogeton richardsonii (Benn.) Tydb.*	17
18	33	CNTL	Coontail (2)	*Ceratophyllum sp.*	15

Table 710.121.2,5,6,9 A list of species found during the course of the summer growing season, abbreviated name, common name, scientific name, the percent occurrence, dominance value, species biovolume, and perceived nuisance level designation of each species in the lake.

2016 PLANT NAME, CODES, AND SELECTED METRICS								
	Code #	Abbrev. Name	Common Name	Scientific Name	% Occurrence	Dom Value	BioVolume Ft3/A•Ft	PNL SPECIES
1	2	EWMx	Eurasian Milfoil Hybrid	*Myriophyllum spicatum x sibiricum*	42%	26	14	YES
2	33	CNTL	Coontail (2)	*Ceratophyllum sp.*	1%	2	0	
3	42	ELD	Elodea (2)	*Elodea sp.*	8%	8	18	
4	50	NAID	Naiad (3)	*Najas sp.*	0%	2	18	
5	60	CHARA	Chara (many)	*Chara sp.*	80%	47	6	
6	65	StSt	Starry Stonewort	*Nitellopsis obtusa (Desv.) J.Groves*	9%	12	7	
7	75	CLP	Curly Leaf Pondweed	*Potamogeton crispus L.*	23%	18	13	
8	76	FSP	Flat Stem Pondweed	*Potamogeton zosteriformis Fern.*	13%	10	4	
9	80	ROB	Robbins Pondweed	*Potamogeton robbinsii Oakes*	11%	12	3	
10	90	Rich	Richardsons Pondweed	*Potamogeton richardsonii (Benn.) Tydb.*	0%	2	5	
11	109	HPW	Hybrid Pondweed	*Potamogeton Hybrid*	76%	39	10	YES
12	110	WBLP	Weedy Broad Leaf	*Potamogeton amplifolius Hybrid*	68%	39	13	YES
13	115	Stuk	Sago (3)	*Stuckenia sp.*	18%	16	4	
14	125	VAL	Wild Celery	*Vallisneria americana Michaux*	40%	24	8	
15	126	SAG	Sagittaria (4)	*Sagittaria sp.*	1%	5	18	
16	150	WL	Waterlily (2)	*Nymphaea sp.*	25%	21	4	YES
17	153	SPAD	Spadderdock (3)	*Nuphar sp.*	4%	7	5	
18	166	TLFP	Thin and Floating Leaf (6)	*Potamogeton sp.*	0%	4	10	

710/122.070 LakeScan™ BioD60© Biodiversity Indices (Annual)

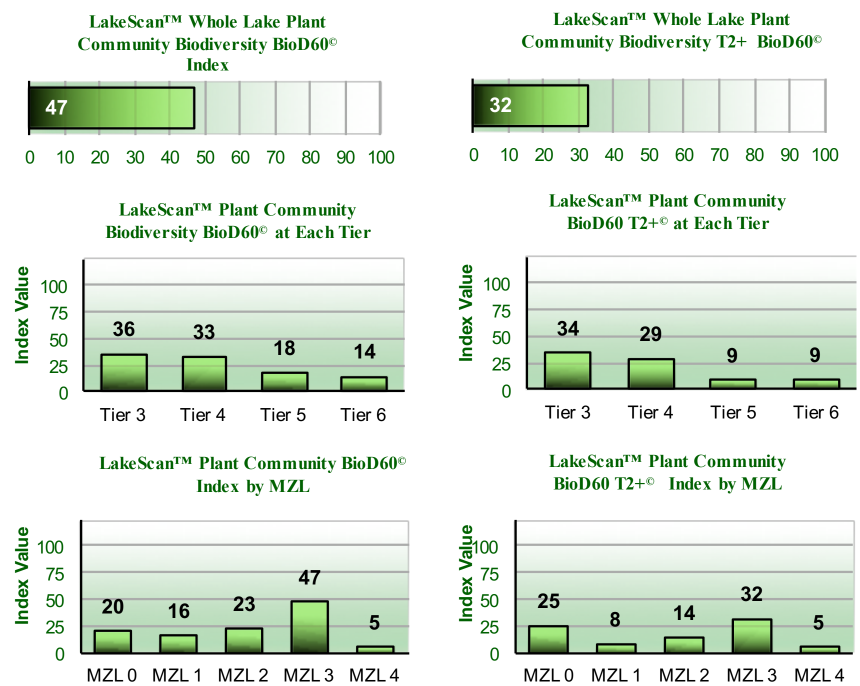


Figure 710/122.074a The LakeScan™ BioD 60© biodiversity index is a proportional index that assumes the greatest number of species that might be present during any survey will not be greater than or equal to 60. The fundamental algorithm is based on the Euler's equation where the greatest variance in 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 is little difference in values. Index values greater than 40 are considered to be good. The left-most column of figures are index values based all of the species present during the year of record, including T1 species such as nuisance milfoil, starry stonewort, etc. The right-most column of figures is derived from data where the T1 species ARE NOT included in the analysis. The biodiveristy of the lake, sans T1 species, may be considered to be a target biodiversity index value. An index value of 35 or greater is currently considered to be good.

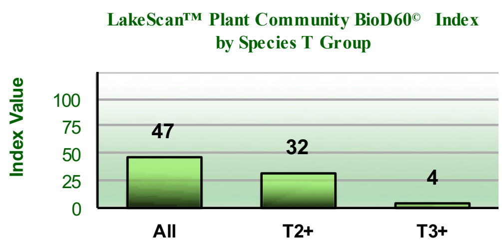


Figure 710/122.074a The goal of any aquatic plant community management plan should be to protect or enhance the biological diversity of the over-all plant community. T1 species are typically invasive and will extirpate or "crowd" out more conservative or desirable species. Consequently, the objective 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.

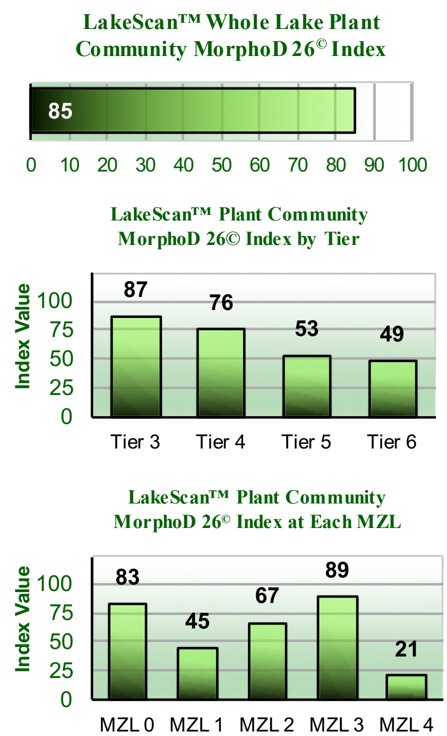


Figure 710/132,142.077 The LakeScan™ MorphoD 26© biodiversity index is a proportional index that assumes the greatest number of plant morphotypes, that might be present during any survey, will not be greater than or equal to 26. Index values greater than 50 are considered to be good.

710/121.080 LakeScan™ Weediness© Indices (Annual)

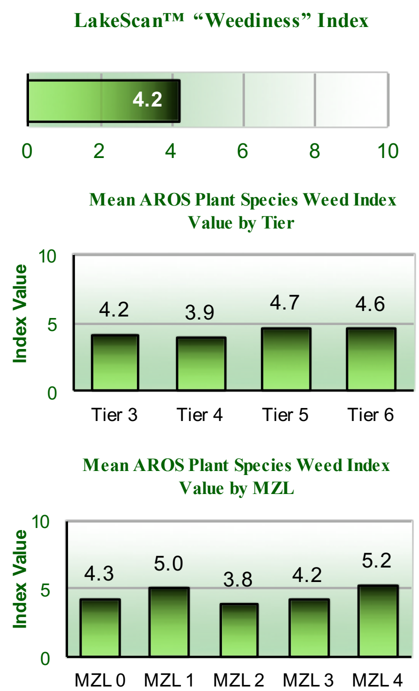


Figure 710/132,142.084 The LakeScan™ Weedines© index is fundamentally a diversity index (similar algorithm) however values are weighted according to the assigned "i" value, coupled with the density and distribution of various species at each AROS.

710/132.090 LakeScan™ Perceived Nuisance Level© Indices (Annual)

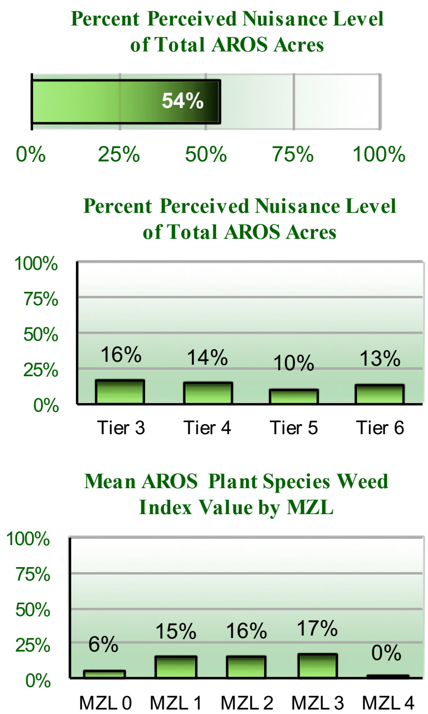


Figure 710/132,142.094 The LakeScan™ Perceived Nuisance Level index. These figures represent the percentage of the total AROS acres where PNL index values were 1, 2, or 3. Data is also presented by Tier and MZL.

Table 710/122.097 A list of species ranked according to the LakeScan™ Perceived Nuisance Level factor factor assigned to each species for the entire year.

SPECIES LIST BY TO LAKESCAN™ PERCEIVED NUISANCE LEVEL RANK, 2016					
	Code #	Abbrev. Name	Common Name	Scientific Name	PNL FACTOR
1	109	HPW	Hybrid Pondweed	*Potamogeton Hybrid*	38
2	2	EWMx	Eurasian Milfoil Hybrid	*Myriophyllum spicatum x sibiricum*	23
3	110	WBLP	Weedy Broad Leaf	*Potamogeton amplifolius Hybrid*	23
4	125	VAL	Wild Celery	*Vallisneria americana Michaux*	3
5	33	CNTL	Coontail (2)	*Ceratophyllum sp.*	
6	42	ELD	Elodea (2)	*Elodea sp.*	
7	50	NAID	Naiad (3)	*Najas sp.*	
8	60	CHARA	Chara (many)	*Chara sp.*	
9	65	StSt	Starry Stonewort	*Nitellopsis obtusa (Desv.) J.Groves*	
10	75	CLP	Curly Leaf Pondweed	*Potamogeton crispus L.*	
11	76	FSP	Flat Stem Pondweed	*Potamogeton zosteriformis Fern.*	
12	80	ROB	Robbins Pondweed	*Potamogeton robbinsii Oakes*	
13	90	Rich	Richardsons Pondweed	*Potamogeton richardsonii (Benn.) Tydb.*	
14	115	Stuk	Sago (3)	*Stuckenia sp.*	
15	126	SAG	Sagittaria (4)	*Sagittaria sp.*	
16	150	WL	Waterlily (2)	*Nymphaea sp.*	
17	153	SPAD	Spadderdock (3)	*Nuphar sp.*	
18	166	TLFP	Thin and Floating Leaf (6)	*Potamogeton sp.*	

Category 710: LakeScan™ Plant Community Survey Event Data

Comment:

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

710/133.010 LakeScan™ Plant Community Species Richness

710/124.014 Species Richness (Events)

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

Table 710/1244.014 The species present during the VS 3 and VS 5 (early and late season) surveys, when they were present, and the percent change in species occurrence during the course of the season.

Species Common Name	Seasonal Occurrence Present = P VS 3	VS 5	VS Occurrence E = Early L = Late E/L = Both	Percent Change in AROS Occurrence
Eurasian Milfoil Hybrid	P	P	E/L	3%
Coontail (2)		P	L	
Elodea (2)	P		E	
Naiad (3)		P	L	
Chara (many)	P	P	E/L	6%
Starry Stonewort	P		E	
Curly Leaf Pondweed	P		E	
Flat Stem Pondweed	P	P	E/L	-9%
Robbins Pondweed	P		E	
Richardsons Pondweed	P		E	
Hybrid Pondweed	P	P	E/L	11%
Weedy Broad Leaf	P	P	E/L	-21%
Sago (3)	P	P	E/L	-11%
Wild Celery	P	P	E/L	29%
Sagittaria (4)		P	L	
Waterlily (2)	P	P	E/L	3%
Spadderdock (3)	P	P	E/L	-1%
Thin and Floating Leaf (6)		P	L	

Table 710/124.014 Continued. Early and late season species tallys from the first section of the table.

Early Late Season Species Occurrence	
Total Species	18
Early/Late Season	0
Early Season Only	0
Late Season Only	0

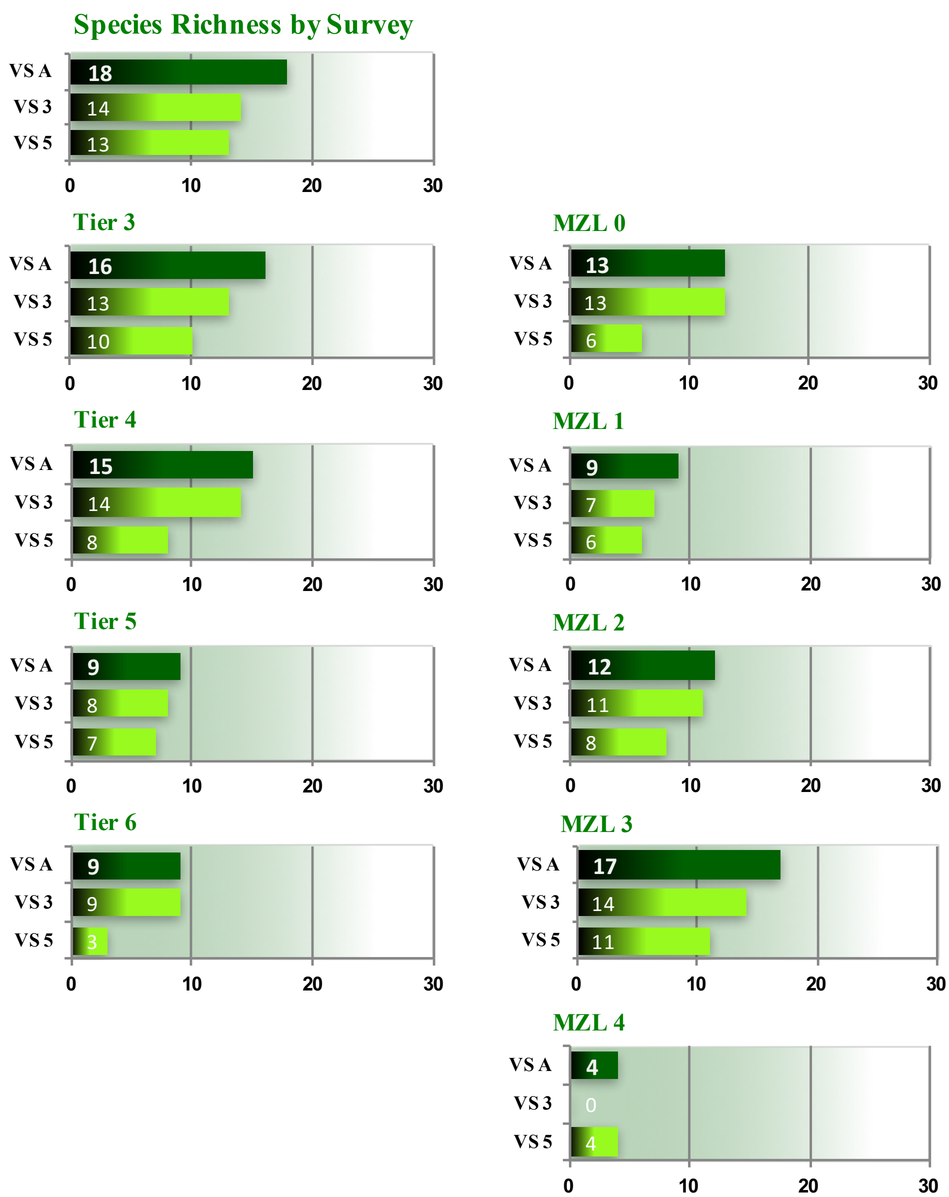


Figure 710/133,143.014 The species richness of the entire lake during the entire summer (VS A) and at distinct survey events that occurred in the early summer (VS 3) and late summer (VS 5) survey events for the whole lake and at all Tiers and MZL's (except MZL 4 where there was only 1 AROS). Any value greater than 16 is considered good.

710/123.040 Plant Community Quality (Event)

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

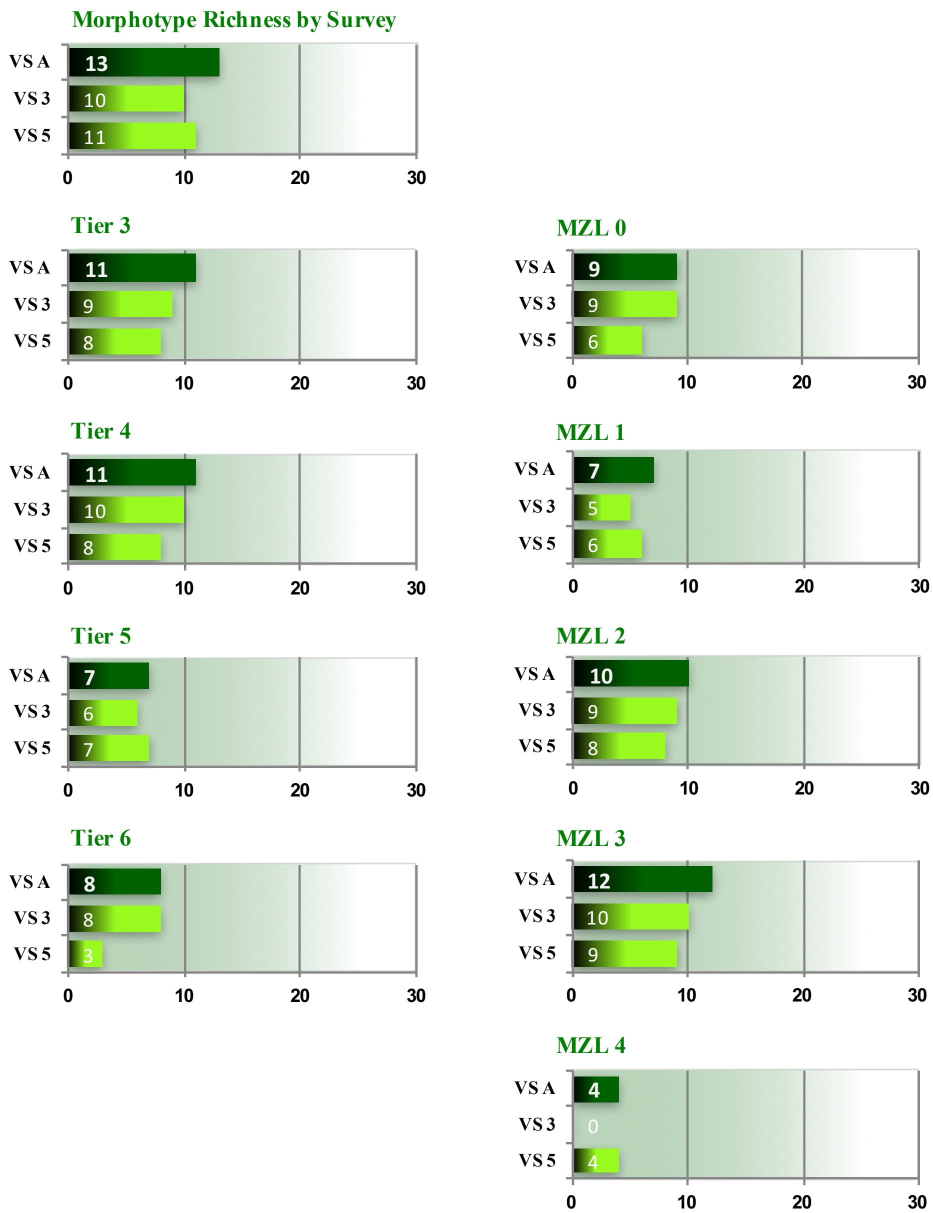


Figure 710/13,43,4.017 The total number of distinct plant morphotypes in the lake during the entire summer (VS A) and at specific early summer (VS 3) and late summer (VS 5) survey events for the whole lake and at all Tiers and most MZL's (MZL 4 is not included because it has only 1 AROS). Any index value greater than 12 is considered to be good.

710/13,43.074 Plant Community Diversity and Structural Complexity

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

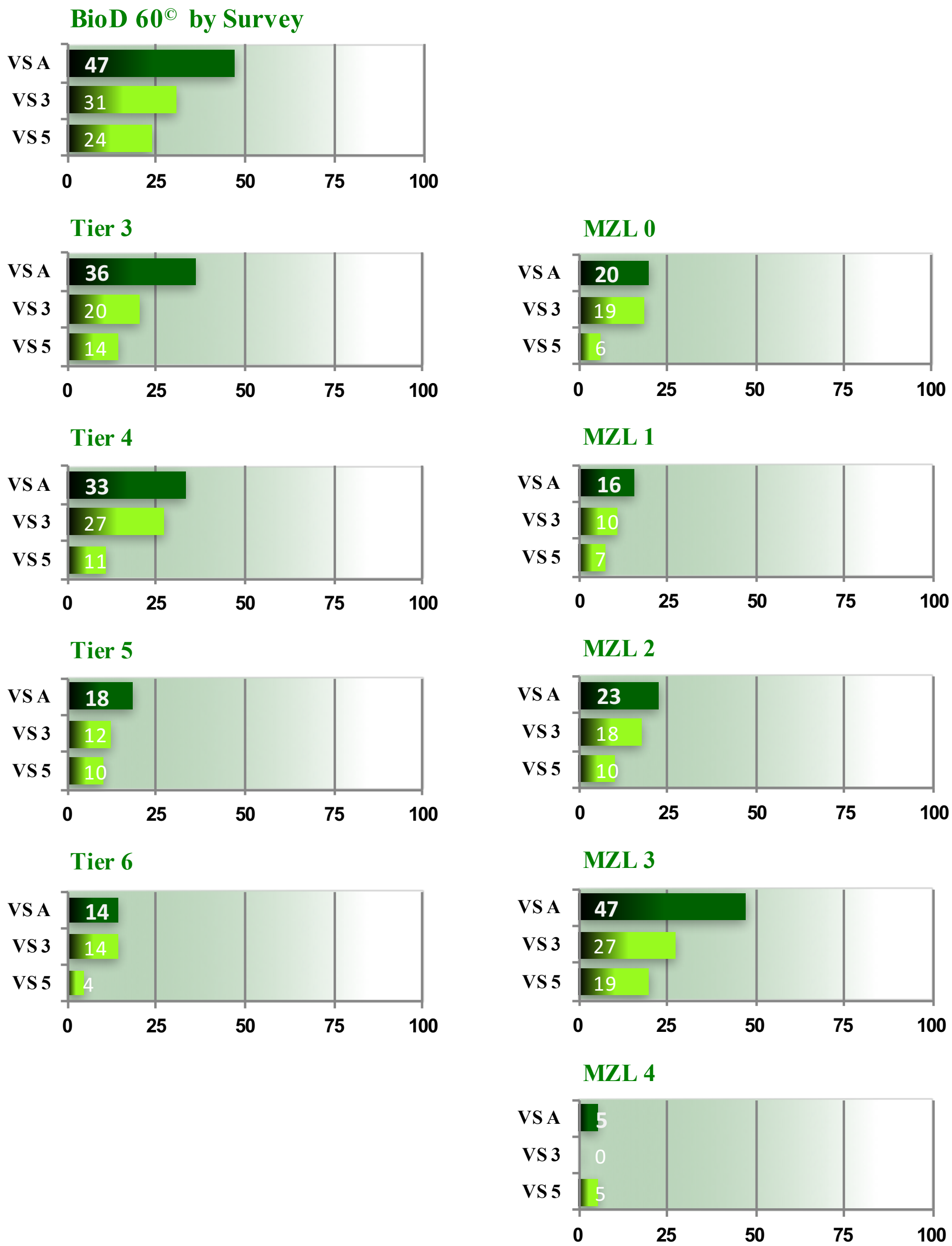


Figure 710/13,14,4.074a The LakeScan™ BioD 60© index value based upon all plant species observed in the entire lake during the entire summer (VS A) and at specific survey events that occurred in the early summer (VS 3) and late summer (V5) in the entire lake and at specific Tiers and MZL's (value cannot be calculated for a single AROS, such as MZL 4). Any index value greater than 40 is considered to be good.

***Comment**:*
One of the chief objectives of the lake management plan is to reduce the abundance and impact of the most invasive plants species in the lake. These species are categorized as "target 1" species and are assigned a corresponding "T" value of T1. Since the goal of the program is to reduce these species to the lowest possible level, it is reasonable to consider the plant community biodiversity of the lake in terms of plant species ranked T2 or greater. This is referred to as the LakeScan ™ T2+ BioD 50© index and this may be one of the most useful metrics when considering the impact and success of the applied management program.

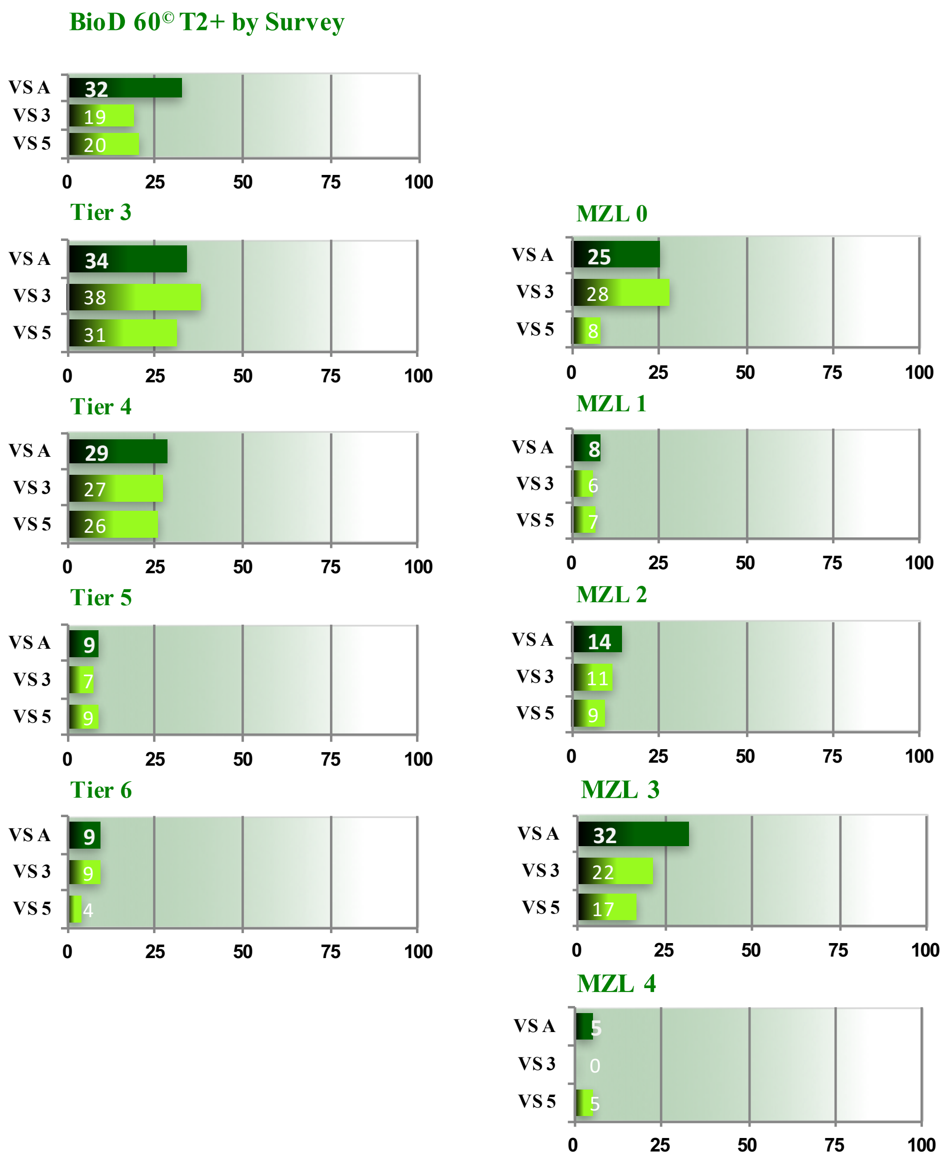


Figure 710/143.074b The LakeScan™ BioD 60© index value for all plant species of target rating T2 or greater calculated for the entire lake during the entire summer (VS A) and at distinct survey events that occurred in the early summer (VS 3) and late summer (VS 5) survey events in the entire lake, all Tiers and at specific MZL's. Any value greater than 35 is consdiered to be good.

710/143.075 Plant Community Diversity and Structural Complexity

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

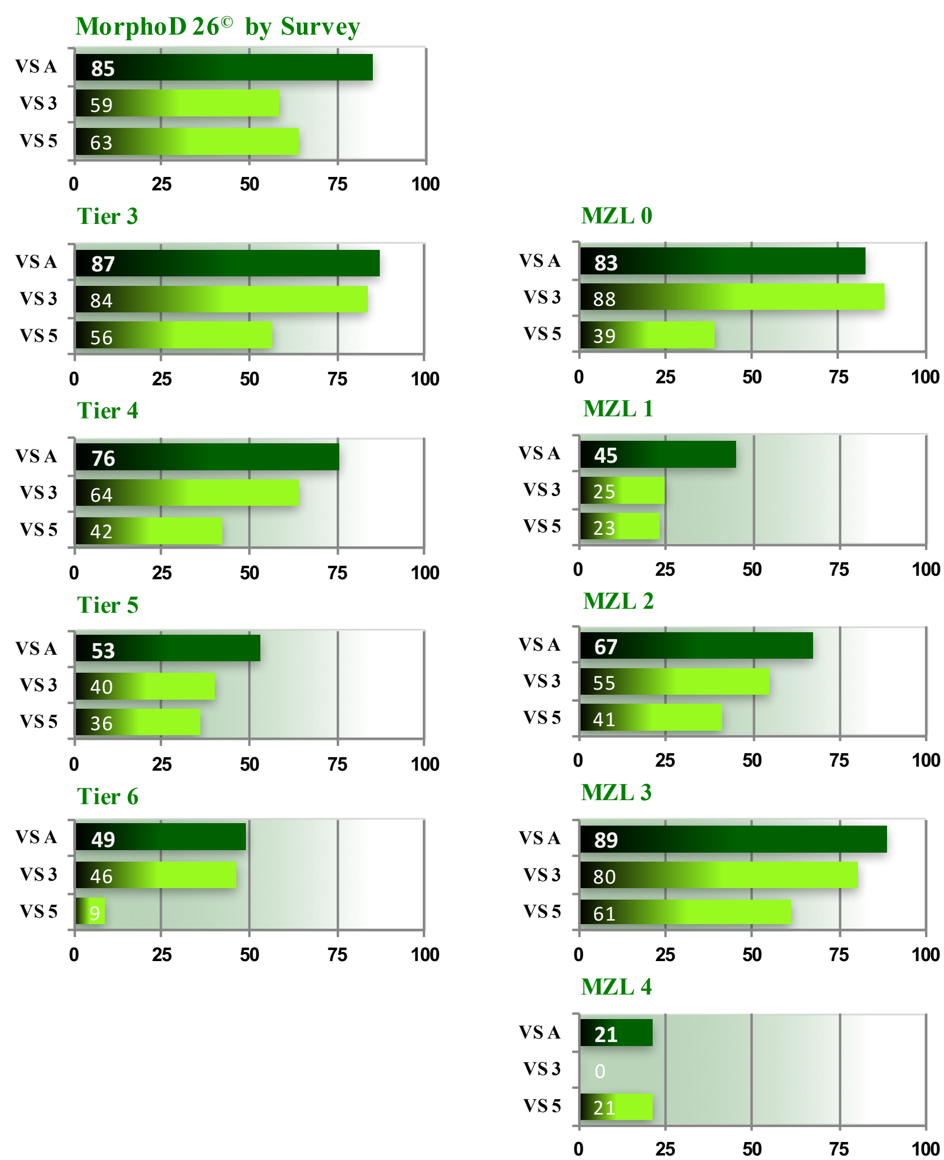


Figure 710/13,43.075 The LakeScan™ MorphoD 26© index value for all plant species of target rating T2 or greater calculated for the entire lake during the entire summer (VS A) and at distinct survey events that occurred in the early summer (VS 3) and late summer (VS 5) survey events in the entire lake, all Tiers and at specific MZL's. Any value above 80 is considered to be good.

710/13,42.084 Weediness Index (Event)

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

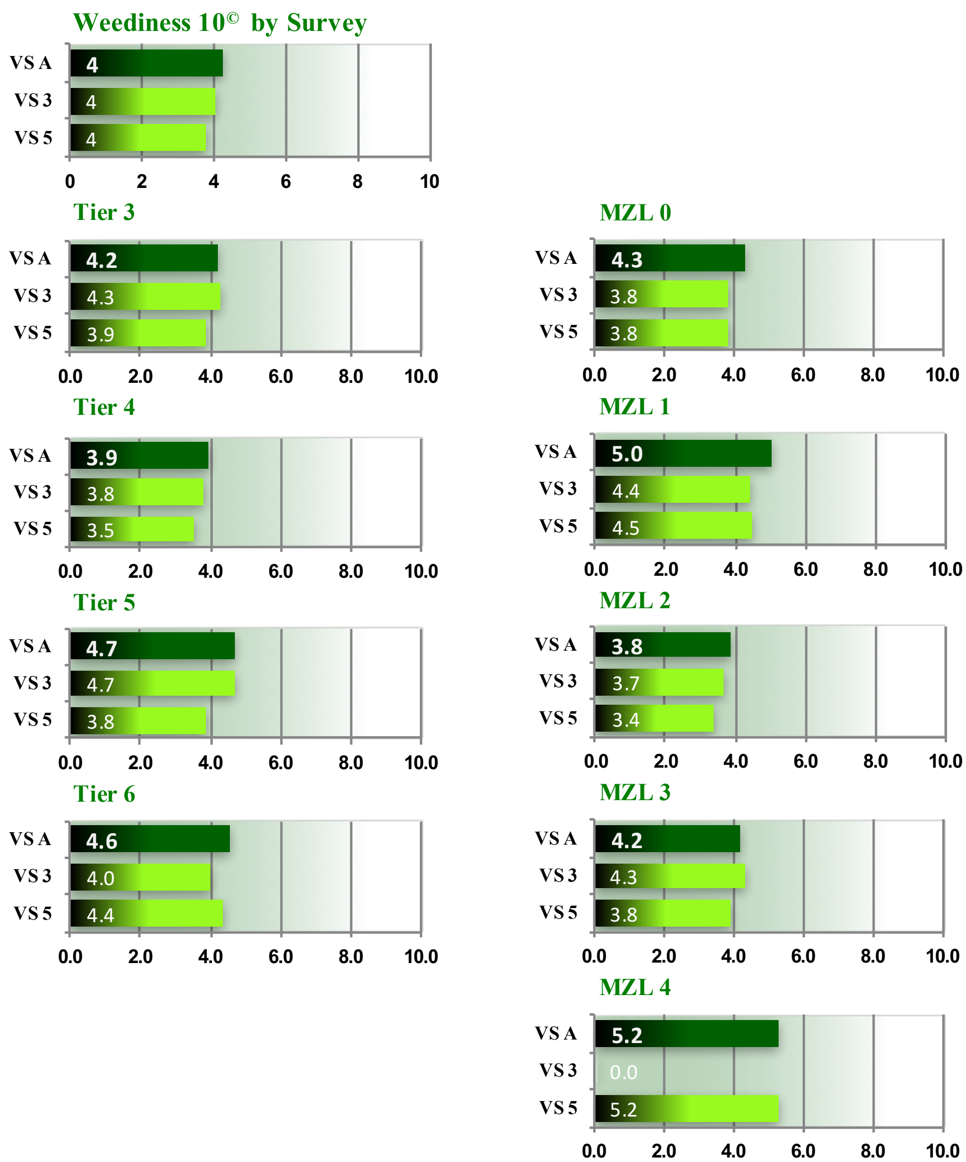


Figure 710/13,42.084 The LakeScan™ Weediness 10© index value of plant species calculated for the entire lake during the entire summer (VS) and at early summer (V1), mid summer (V2) and late summer (V3) survey events for the whole lake and selected Tiers and MZL's. Any index value that is less than 5.0 is considered good.

710/13,42.084 Perceived Nuisance Level Index (Event)

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

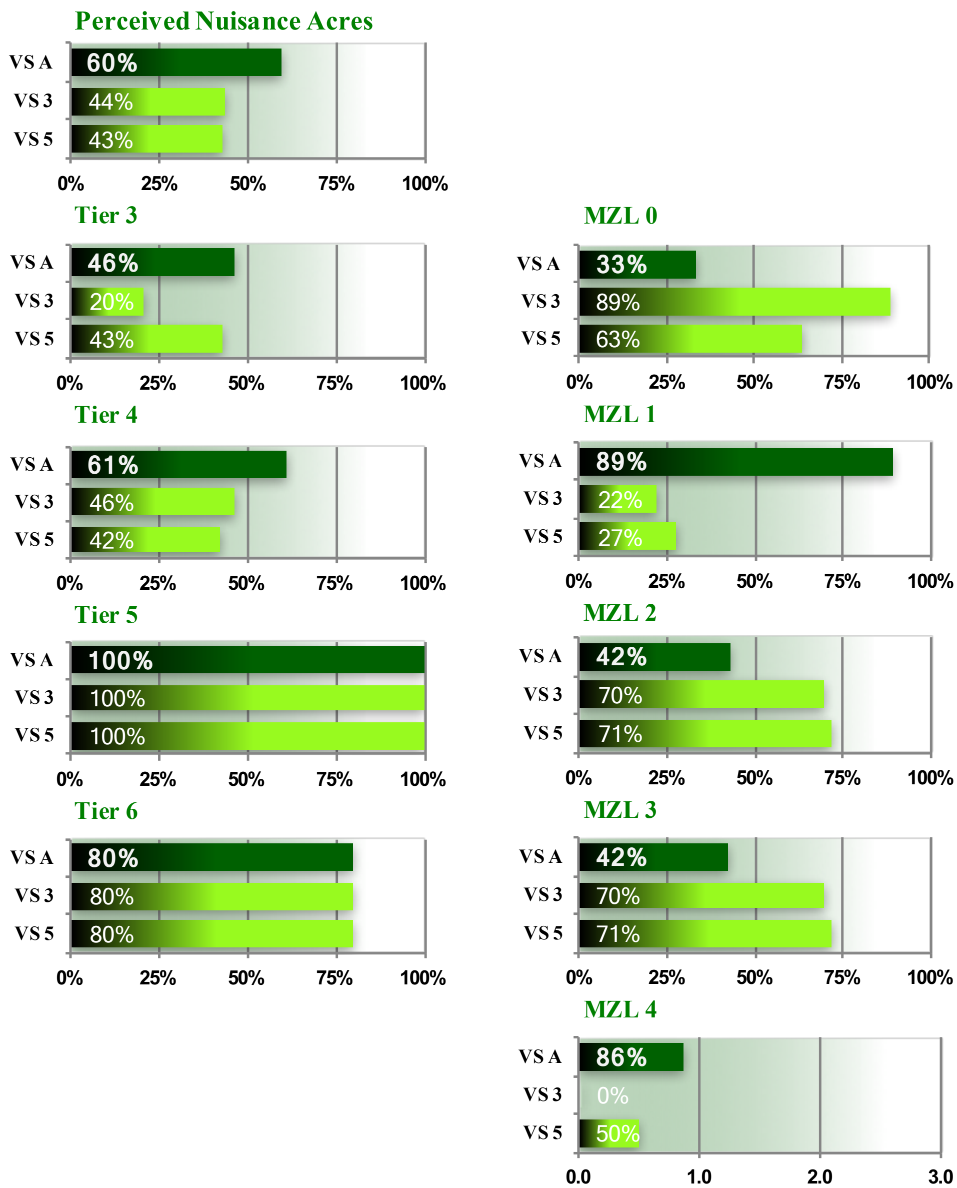


Figure 710/13,42.094 The LakeScan™ Perceived Nuisance Level (PNL©) index value of plant species calculated for the entire lake during the entire summer (VS) and at early summer (V1), mid summer (V2) and late summer (V3) survey events for the whole lake and selected Tiers and MZL's. PNL 0 = no percieved nuisance, PNL 1 = ecological nuisance, PNL 2 = equivocal recreational nuisance, PNL 4 = unequivocally a recreational or aesthetic nuisance

Category 711: LakeScan™ Metric and Index Year to Year Comparisons

711/122.014 Species Richness (Total Species) Historical Record

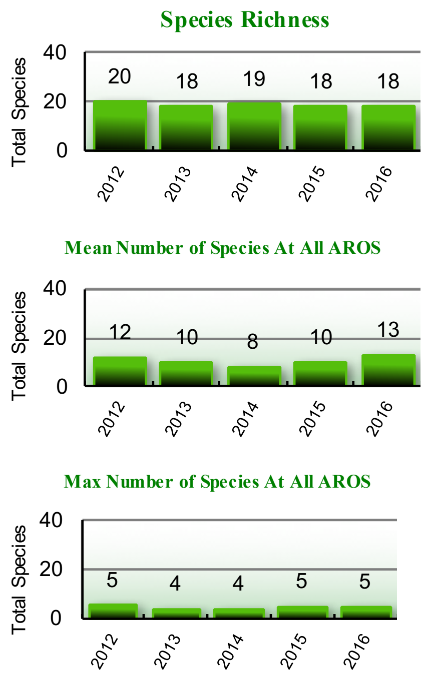


Figure 711/121.014 The total species richness found in the years of record and the mean and the maximum number of species found at the lake AROS's.

Species Richness

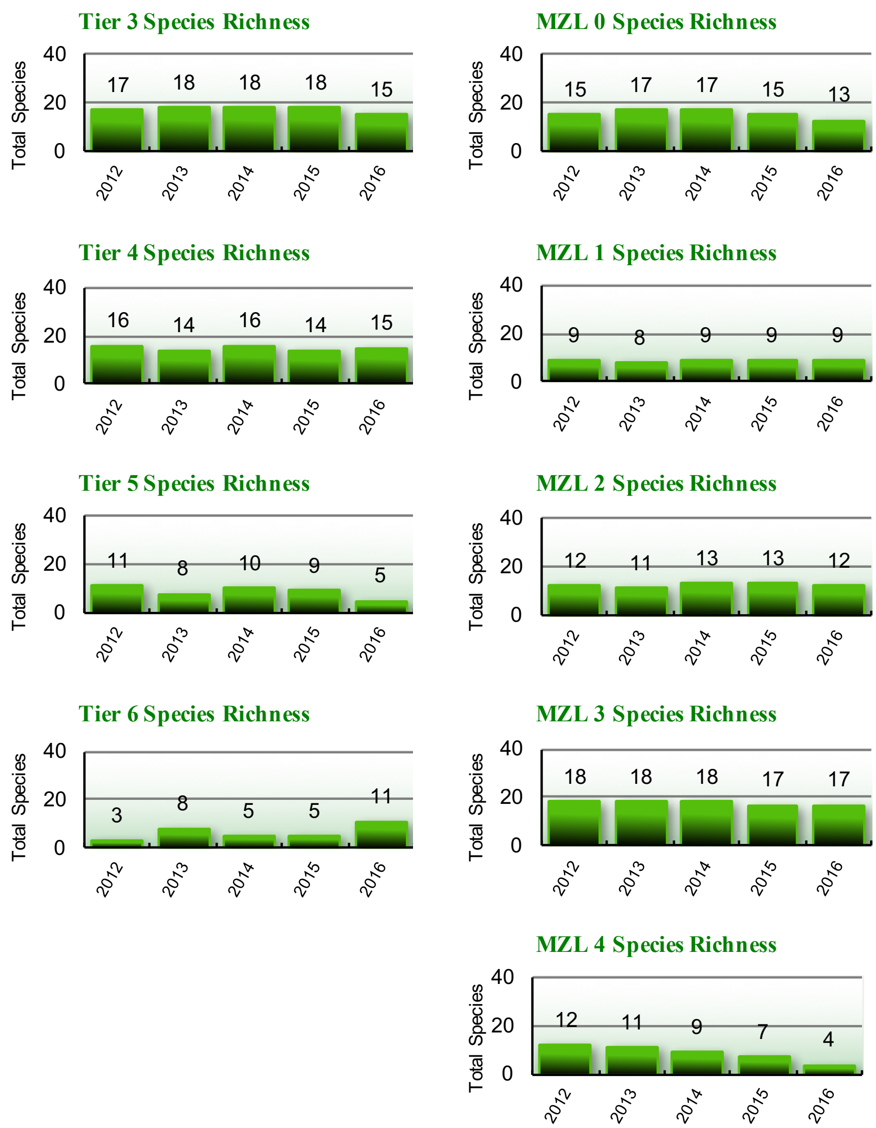


Figure 711/121.014 The total species richness found in the years of record at AROS in each tier and at each management zone (MZL).

711/121.041 A Historical Record of Plant Species Quality.

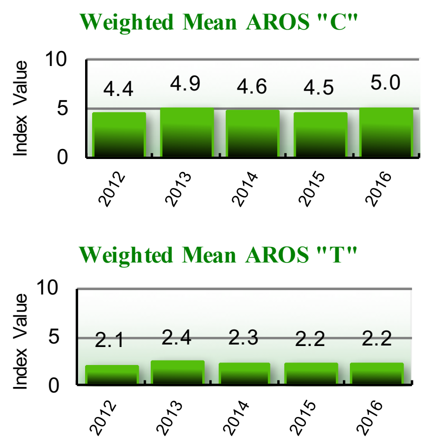


Figure 711/121.041 Historical record of plant community species quality. The upper figure is the AROS occurrence frequency weighted, mean species C value grouping from all of the AROS for each year of record. The middle figure is the mean weighted AROS average species T value from all of the AROS and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

711/121.054 A Historical Record of Occurrence and Dominance.

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

SPECIES OCCURRENCE															
No.	Species Short Name	Percent of AROS's Where Species Was Observed													
		2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016
1	EWMx	63%	63%	2%	51%	57%	57%	53%	39%	79%	61%	38%	43%	43%	42%
2	NWM								1%						
3	GWM										9%				
4	BLAD	1%	1%	0%	1%	4%	1%	12%		2%		1%	3%		
5	MiniB	4%	4%	2%	26%	4%	44%	52%							
6	CNTL	25%	25%	58%	16%	61%	11%	21%					1%	1%	1%
7	ELD	35%	35%	9%	15%	14%	14%	17%	1%	2%	4%	5%	8%	2%	8%
8	NAID	17%	17%	2%	0%	5%	13%	1%	9%	6%	43%	26%	11%	9%	0%
9	CHARA	5%	5%	33%	9%	1%	9%	9%	48%	66%	72%	100%	73%	66%	80%
10	StSt								36%	60%	51%	19%	15%	23%	9%
11	CLP	2%	2%	1%	4%	12%	11%	10%	14%	4%	8%	7%	14%	11%	23%
12	FSP	3%	3%						3%	3%	13%	30%	9%	4%	13%
13	WSG	26%	26%	57%	36%	0%	5%	22%	0%	3%				2%	
14	Rich									2%		2%			0%
15	AMER	1%	1%						0%						
16	HPW	11%	11%	2%	15%	15%	22%	10%	49%	79%	80%	60%	52%	53%	76%
17	WBLP	54%	54%	30%	21%	12%	46%	54%	24%	53%	72%	25%	31%	32%	68%
18	Stuk	44%	44%	1%	13%	34%	39%	12%	26%	47%	26%	25%	2%	40%	18%
19	TLP								3%		1%	4%	7%		
20	ZAN									3%	0%		8%		
21	VAL	3%	3%						42%	74%	74%	51%	44%	47%	40%
22	SAG								2%		7%	2%	4%	4%	1%
23	WL	5%	5%	13%		47%	13%	37%	17%	23%	17%	17%	20%	24%	25%
24	SPAD	22%	22%			0%		3%	3%	12%	1%	2%	3%	3%	4%
25	FLP	1%	1%	40%	48%	7%	5%	24%							
26	TLFP										2%			1%	0%
27	SMTW	10%	10%			3%		9%			1%				

Table 711/121.054 b The percent species occurrence of plant species present at the AROS's in the lake in 2016 and comparisons to mean historical data during the years of LakeScan™ analysis.

SPECIES OCCURRENCE

Total Years on Record = 14		Total Years When Species Was Present	Percent Years Present	Mean Occurence at AROS's	Minimum Occurence at AROS's	Maximum Occurence at AROS's
2016		#	%	Value	Value	Value
EWMx	42%	14	100%	49%	2%	79%
NWM		1	7%	1%	1%	1%
GWM		1	7%	9%	9%	9%
BLAD		10	71%	3%	0%	12%
MiniB		7	50%	19%	2%	52%
CNTL	1%	10	71%	22%	1%	61%
ELD	8%	14	100%	12%	1%	35%
NAID	0%	14	100%	11%	0%	43%
CHARA	80%	14	100%	41%	1%	100%
StSt	9%	7	50%	31%	9%	60%
CLP	23%	14	100%	9%	1%	23%
FSP	13%	9	64%	9%	3%	30%
WSG		10	71%	18%	0%	57%
Rich	0%	3	21%	2%	0%	2%
AMER		3	21%	1%	0%	1%
HPW	76%	14	100%	38%	2%	80%
WBLP	68%	14	100%	41%	12%	72%
Stuk	18%	14	100%	27%	1%	47%
TLP		4	29%	4%	1%	7%
ZAN		3	21%	4%	0%	8%
VAL	40%	9	64%	42%	3%	74%
SAG	1%	6	43%	4%	1%	7%
WL	25%	13	93%	20%	5%	47%
SPAD	4%	11	79%	7%	0%	22%
FLP		7	50%	18%	1%	48%
TLFP	0%	3	21%	1%	0%	2%
SMTW		5	36%	7%	1%	10%

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

SPECIES DOMINANCE														
Species Short	LakeScan™ Dom 100© Index Value													
Name	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016
EWMx	49.1	49.1	2.4	39.3	34.7	50.8	32.1	28.5	38.5	28.8	26.4	29.7	27.6	26.4
NWM								3.3						
GWM										11.0				
BLAD	4.0	4.0	1.1	2.6	8.1	3.5	13.1		1.6		3.3	3.1		
MiniB	5.9	5.9	2.4	24.2	6.0	33.3	39.8							
CNTL	17.3	17.3	44.0	16.2	48.4	10.7	21.6					2.5	3.0	1.6
ELD	22.7	22.7	11.9	19.5	14.3	12.6	13.0	3.4	3.9	5.2	7.7	10.2	4.4	8.3
NAID	14.4	14.4	2.4	1.3	7.9	15.0	2.7	11.5	6.3	22.9	21.4	13.3	9.6	2.0
CHARA	7.1	7.1	25.6	10.9	2.6	7.9	9.9	36.9	37.0	45.7	68.7	46.9	42.2	47.0
StSt								31.1	35.0	31.0	17.4	16.0	20.3	11.5
CLP	4.0	4.0	1.6	7.7	13.6	14.1	10.2	11.8	6.5	9.0	14.5	13.9	11.1	18.4
FSP	6.2	6.2						5.2	4.8	10.8	20.7	9.3	4.7	10.0
WSG	19.3	19.3	33.5	25.9	2.0	11.0	17.4	1.7	4.6				2.0	
Rich									3.9		5.1			1.9
AMER	3.8	3.8						2.0						
HPW	6.6	6.6	2.4	15.4	16.9	18.4	11.1	35.1	39.1	41.5	33.1	34.2	31.1	39.3
WBLP	29.8	29.8	26.3	16.9	14.0	30.2	34.5	20.0	23.5	38.4	19.5	26.9	22.9	39.2
Stuk	29.4	29.4	2.2	16.3	26.6	26.4	11.8	20.4	21.3	15.2	20.1	3.3	24.3	16.1
TLP								5.6		2.5	5.8	7.2		
ZAN									5.5	3.6		10.9		
VAL	6.4	6.4						30.5	37.9	35.2	27.7	29.6	27.3	24.3
SAG								5.4		6.8	6.1	8.4	6.2	4.6
WL	10.1	10.1	17.5		35.7	15.2	25.5	17.9	15.8	14.8	17.2	20.7	21.9	21.1
SPAD	17.1	17.1			2.3		7.1	5.9	11.3	3.3	5.2	5.8	7.0	7.0
FLP	2.1	2.1	30.0	33.8	12.2	7.0	20.2							
TLFP										7.1			4.2	3.6
SMTW	14.4	14.4			6.2		9.6			3.2				

Table 711/121.064 b The LakeScan™ Dom 100© plant species dominance factor for all of plant species present at the AROS's in the lake during the summer of 2016 compared to historical averages from the years of record.

SPECIES DOMINANCE						
Total Years of Record = 14		Total Years When Species Was Present	Percent Years Present	Mean Dominance at AROS's	Minimum Dominance at AROS's	Maximum Dominance at AROS's
2016		#	%	Value	Value	Value
EWMx	26	14	100%	33	2	51
NWM		1	7%	3	3	3
GWM		1	7%	11	11	11
BLAD		10	71%	4	1	13
MiniB		7	50%	17	2	40
CNTL	2	10	71%	18	2	48
ELD	8	14	100%	11	3	23
NAID	2	14	100%	10	1	23
CHARA	47	14	100%	28	3	69
StSt	12	7	50%	23	12	35
CLP	18	14	100%	10	2	18
FSP	10	9	64%	9	5	21
WSG		10	71%	14	2	34
Rich	2	3	21%	4	2	5
AMER		3	21%	3	2	4
HPW	39	14	100%	24	2	41
WBLP	39	14	100%	27	14	39
Stuk	16	14	100%	19	2	29
TLP		4	29%	5	3	7
ZAN		3	21%	7	4	11
VAL	24	9	64%	25	6	38
SAG	5	6	43%	6	5	8
WL	21	13	93%	19	10	36
SPAD	7	11	79%	8	2	17
FLP		7	50%	15	2	34
TLFP	4	3	21%	5	4	7
SMTW		5	36%	10	3	14

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

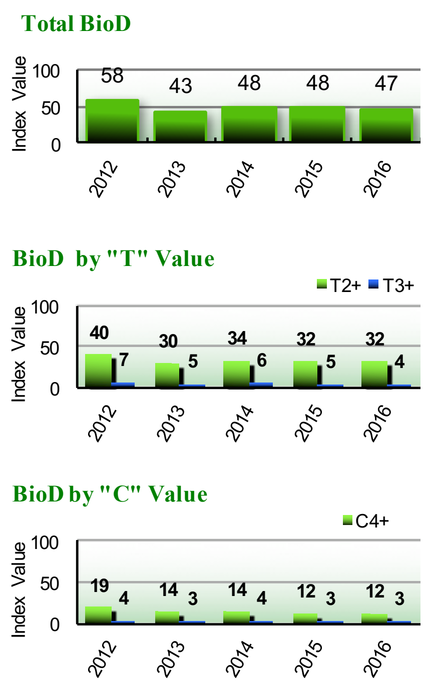


Figure 711/121.074a Total LakeScan™ BioD 60© Plant Community Diversity and the diversity of plants grouped according to management target "t" value and coefficient of conservatism "C" value.

LakeScan BioD 60©

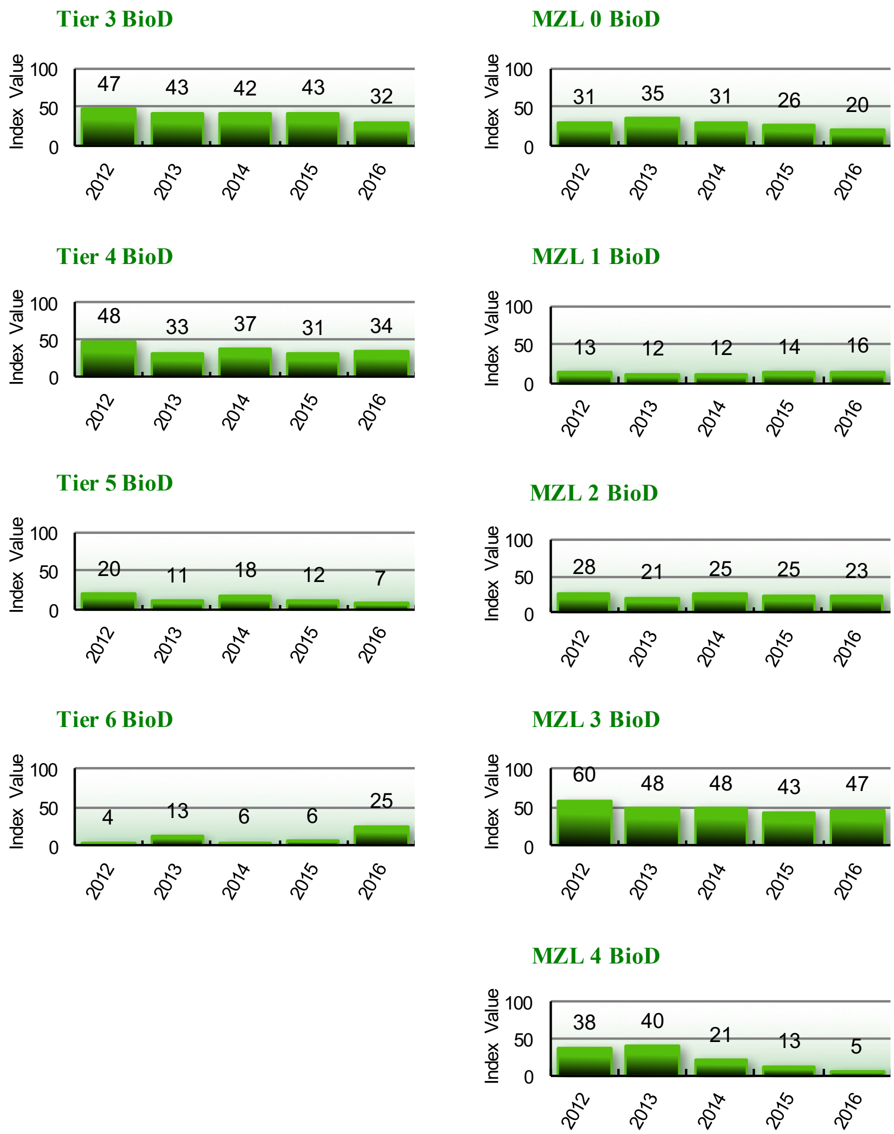


Figure 711/121.074b The LakeScan™ BioD 60© Plant Community Diversity at various tiers and management zones (MZL) determined from survey compiled each year for the entire growing season.

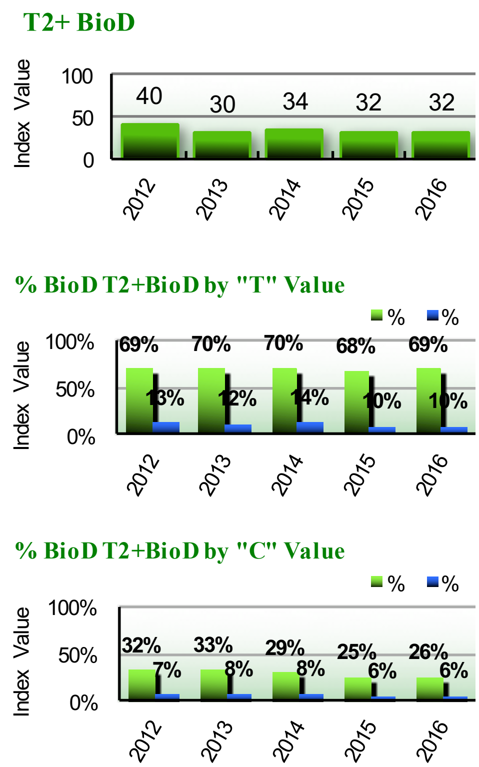


Figure 711/121.074c Total LakeScan™ BioD 60© T2+ Plant Community Diversity and the diversity of plants grouped according to management target "t" value and coefficient of conservatism "C" value.

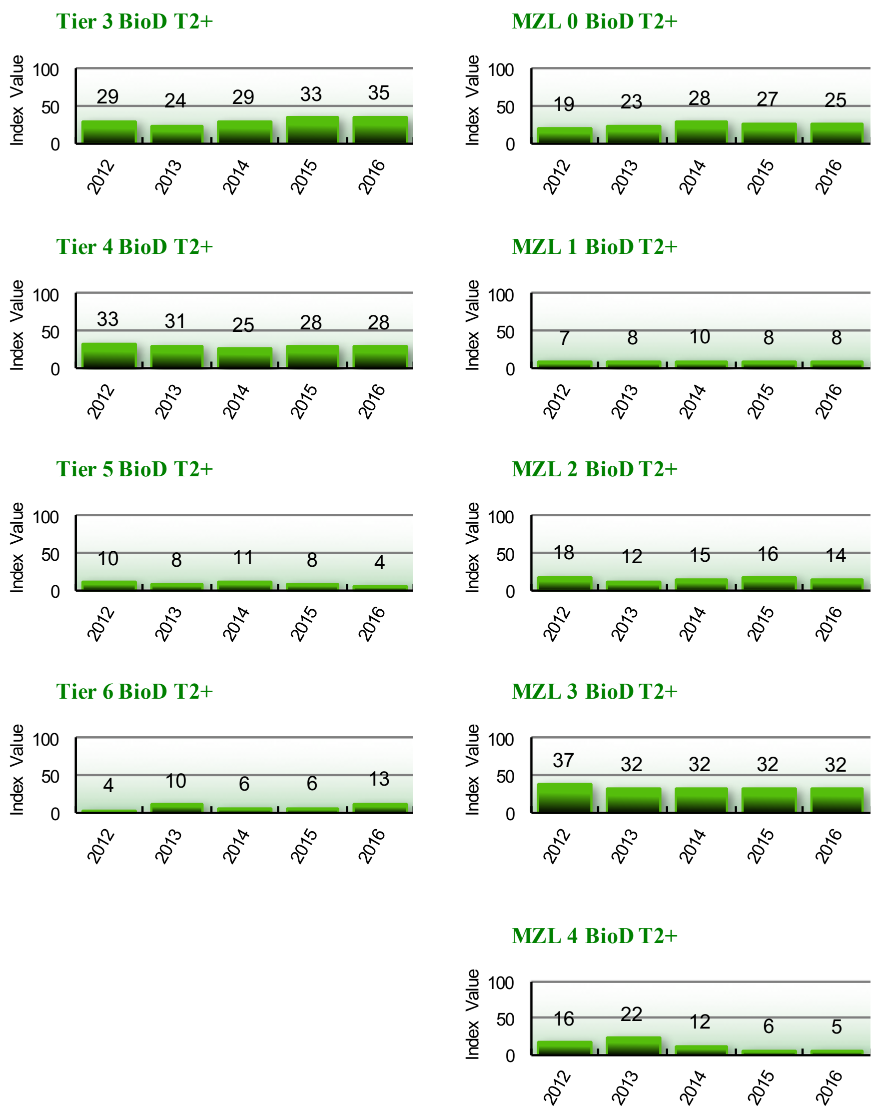


Figure 711/121.074d The LakeScan™ BioD 60© T2+ Plant Community Diversity at various tiers and management zones (MZL) determined from survey compiled each year for the entire growing season.

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

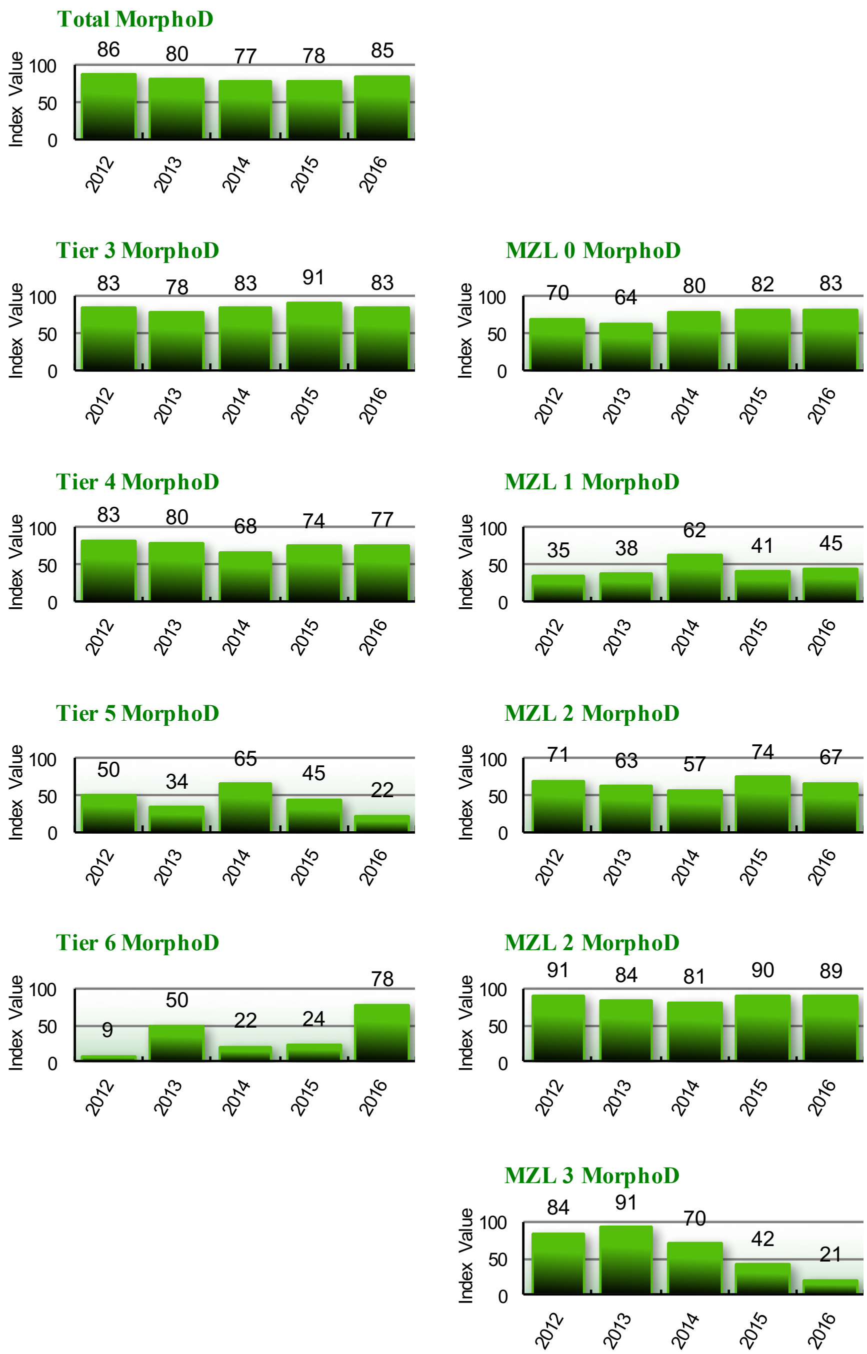


Figure 711/121.075 Total LakeScan™ MorphoD 26© plant community morphological diversity and the morpho-diversity of plants grouped at the AROS in each tier and at each MZL. Data compiled for the entire growing season from each year of record.

711/121.020 Historical Record of Plant Community Biovolume.

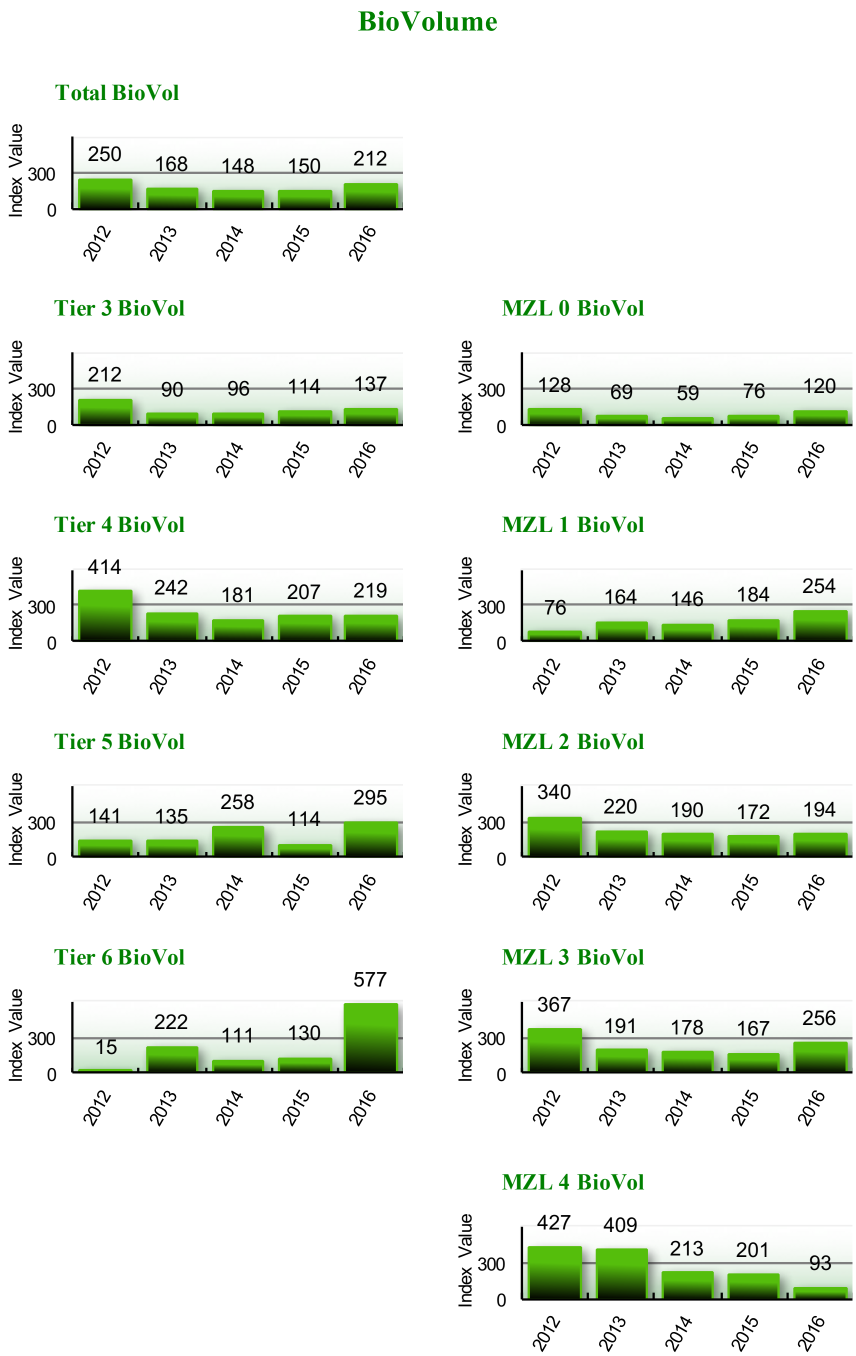


Figure 711/121.024 The LakeScan™ BioV plant community average AROS biovolume the lake and in each tier and management zone (MZL). Data was compiled for the entire growing season for each year.

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

BIOVOLUME AS MEAN AROS PLANT FT3/ACRE FOOT														
Species Short	Mean Plant Species BioVol Ft^3 per Acre Ft.													
Name	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016
EWMx	35	35	0	12	14	8	11	15	14	11	10	12	16	24
NWM								0						
GWM										9				
BLAD	26	26	0	0	20	32	18		0		1	0		
MiniB	2	2	0	3	1	6	3							
CNTL	4	4	3	19	6	11	6					0	0	0
ELD	1	1	7	7	8	10	9	3	15	18	24	9	27	32
NAID	8	8	0	0	18	29	6	24	8	21	11	5	18	46
CHARA	11	11	18	21	0	3	25	13	11	9	6	7	7	11
StSt								14	11	6	8	10	8	12
CLP	0	0	0	23	19	13	13	7	34	27	17	14	20	25
FSP	13	13						8	3	11	13	4	1	6
WSG	6	6	7	13	0	13	11	15	12				0	
Rich									11		18			7
AMER	31	31						9						
HPW	0	0	0	6	11	9	7	8	14	18	5	11	6	17
WBLP	5	5	1	7	6	13	10	7	7	11	8	11	14	21
Stuk	8	8	0	9	14	15	10	11	9	12	11	3	7	7
TLP								2		3	7	2		
ZAN									31	41		11		
VAL	2	2						4	8	3	5	6	6	14
SAG								3		0	3	1	3	30
WL	3	3	5		9	5	7	6	6	6	6	6	5	11
SPAD	3	3			7		6	5	6	6	5	3	4	13
FLP	0	0	3	6	8	2	9							
TLFP										7			1	13
SMTW	5	5			7		5			20				

Table 711/121.024 b The sum LakeScan™ BioVol© factor for all of plant species present at the AROS's in the lake during the summer of 2016 compared to average historical data from all the years of LakeScan™ analysis.

BIOVOLUME AS MEAN AROS PLANT FT3/ACRE FOOT						
Total Years of Record = 14		Total Years When Species Was Present	Percent Years Present	Mean BioVol at AROS's	Minimum BioVol at AROS's	Maximum BioVol at AROS's
2016		#	%	Value	Value	Value
EWMx	24	14	100%	15	0	35
NWM		1	7%	0	0	0
GWM		1	7%	9	9	9
BLAD		10	71%	12	0	32
MiniB		7	50%	2	0	6
CNTL	0	10	71%	5	0	19
ELD	32	14	100%	12	1	32
NAID	46	14	100%	14	0	46
CHARA	11	14	100%	11	0	25
StSt	12	7	50%	10	6	14
CLP	25	14	100%	15	0	34
FSP	6	9	64%	8	1	13
WSG		10	71%	8	0	15
Rich	7	3	21%	12	7	18
AMER		3	21%	24	9	31
HPW	17	14	100%	8	0	18
WBLP	21	14	100%	9	1	21
Stuk	7	14	100%	9	0	15
TLP		4	29%	4	2	7
ZAN		3	21%	28	11	41
VAL	14	9	64%	6	2	14
SAG	30	6	43%	7	0	30
WL	11	13	93%	6	3	11
SPAD	13	11	79%	6	3	13
FLP		7	50%	4	0	9
TLFP	13	3	21%	7	1	13
SMTW		5	36%	8	5	20

711/121.084 Historical Record of Plant Community Weediness.

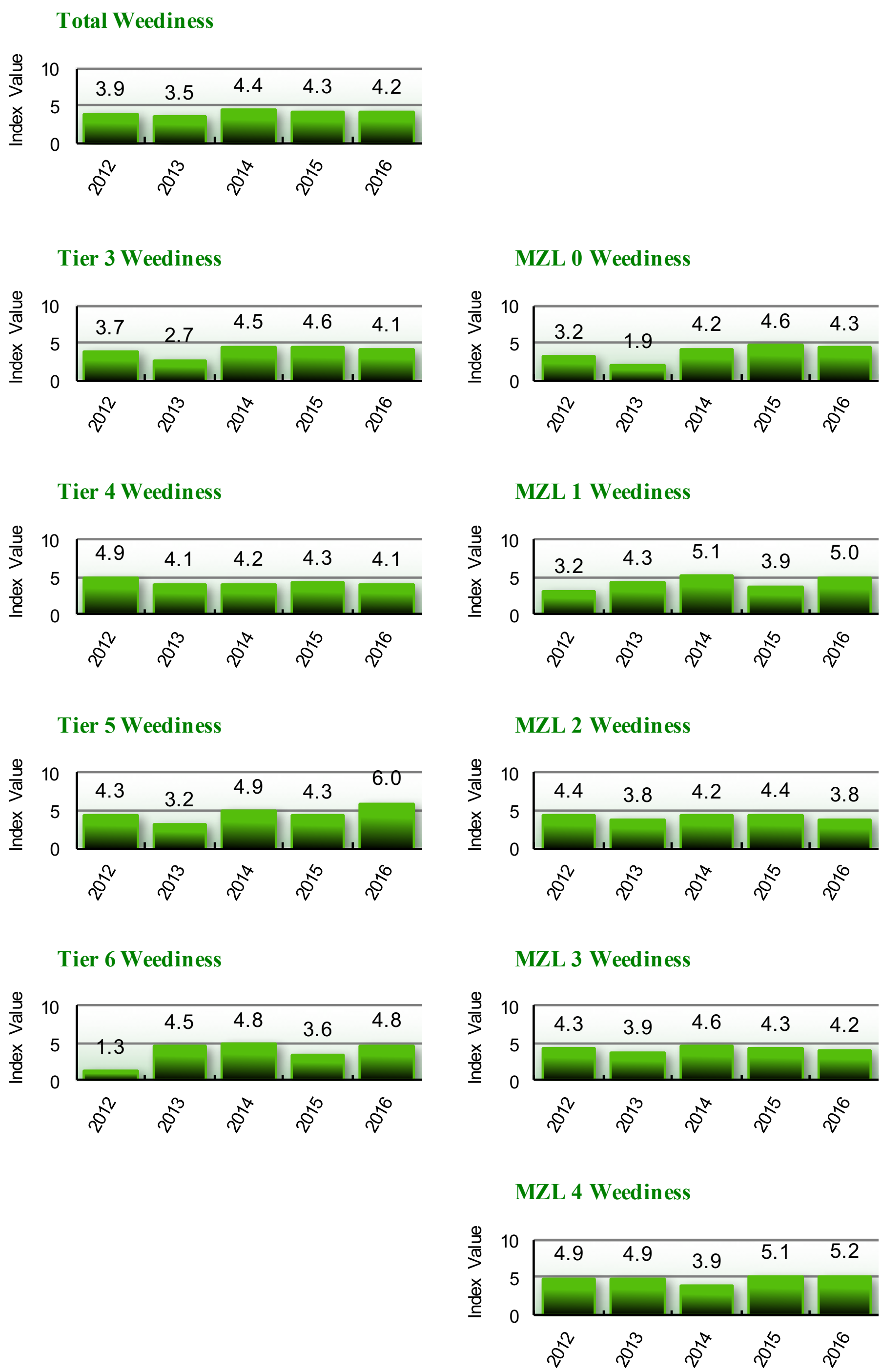


Figure 711/121.084 Total LakeScan™ Weediness 10© and the weediness of the plant community at the AROS in each tier and at each MZL.

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

711/143.014 A Historical Record of Species Richness.

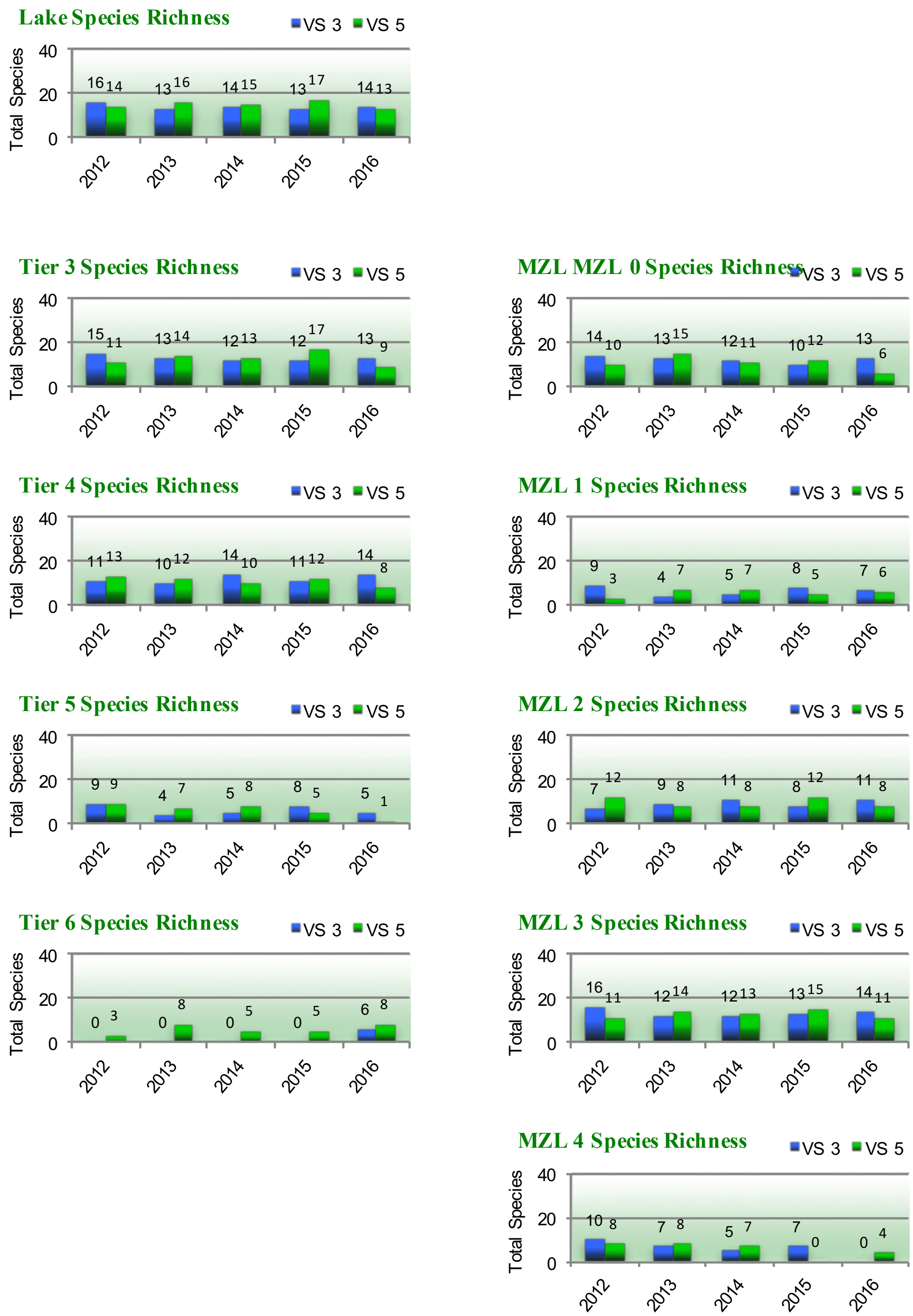


Figure 711/143.014 Total species richness or species present the lake AROS at selected Tiers and MZL's during vegetation community surveys conducted at different times of the year.

711/143.017 Historical Record of Species Attributes.

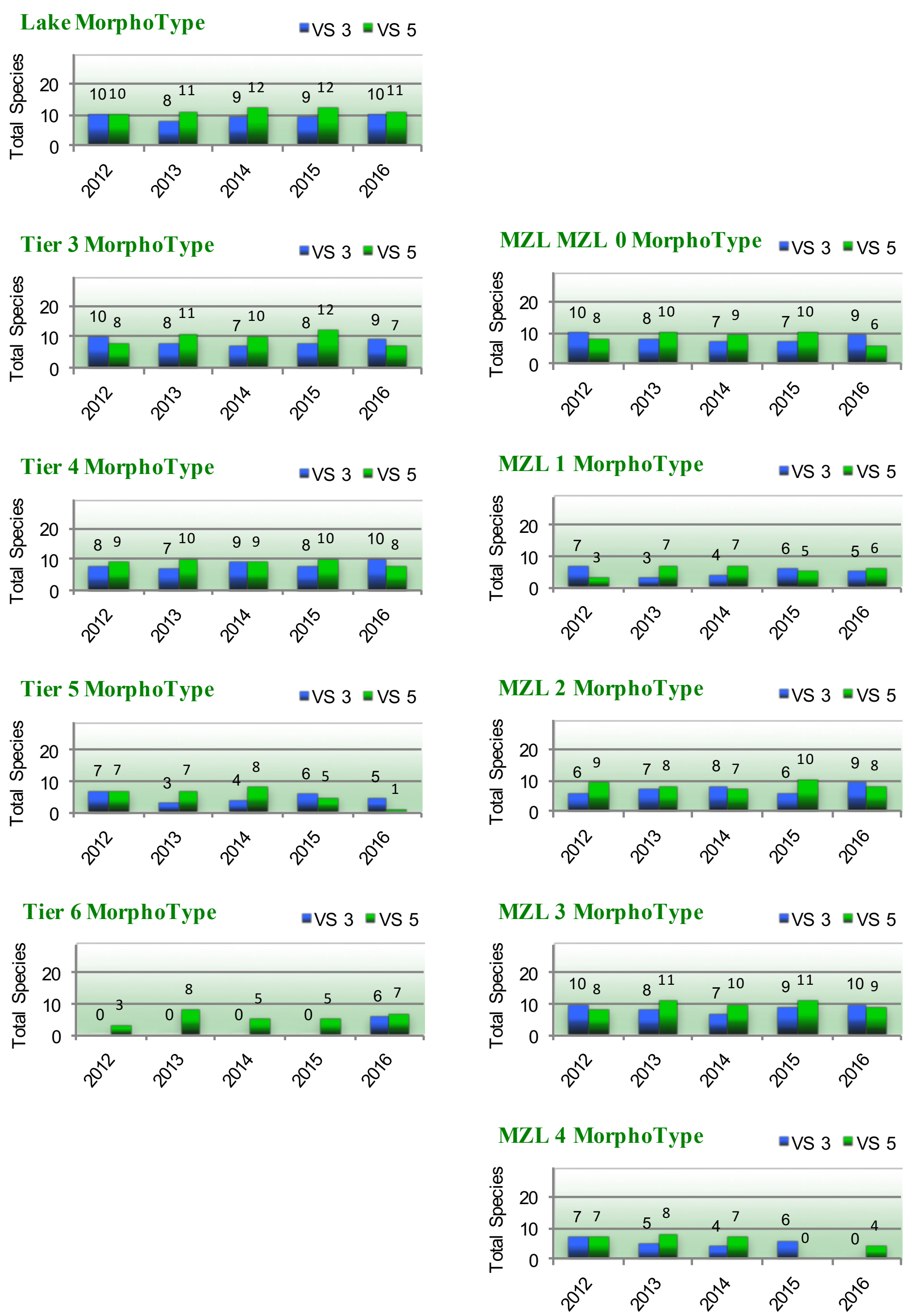


Figure 711/143.017 Total morphotye richness or present the lake AROS at selected Tiers and MZL's at different survey times in each year for selected years of record.

711/143.074 Historical Record of Biodiversity.

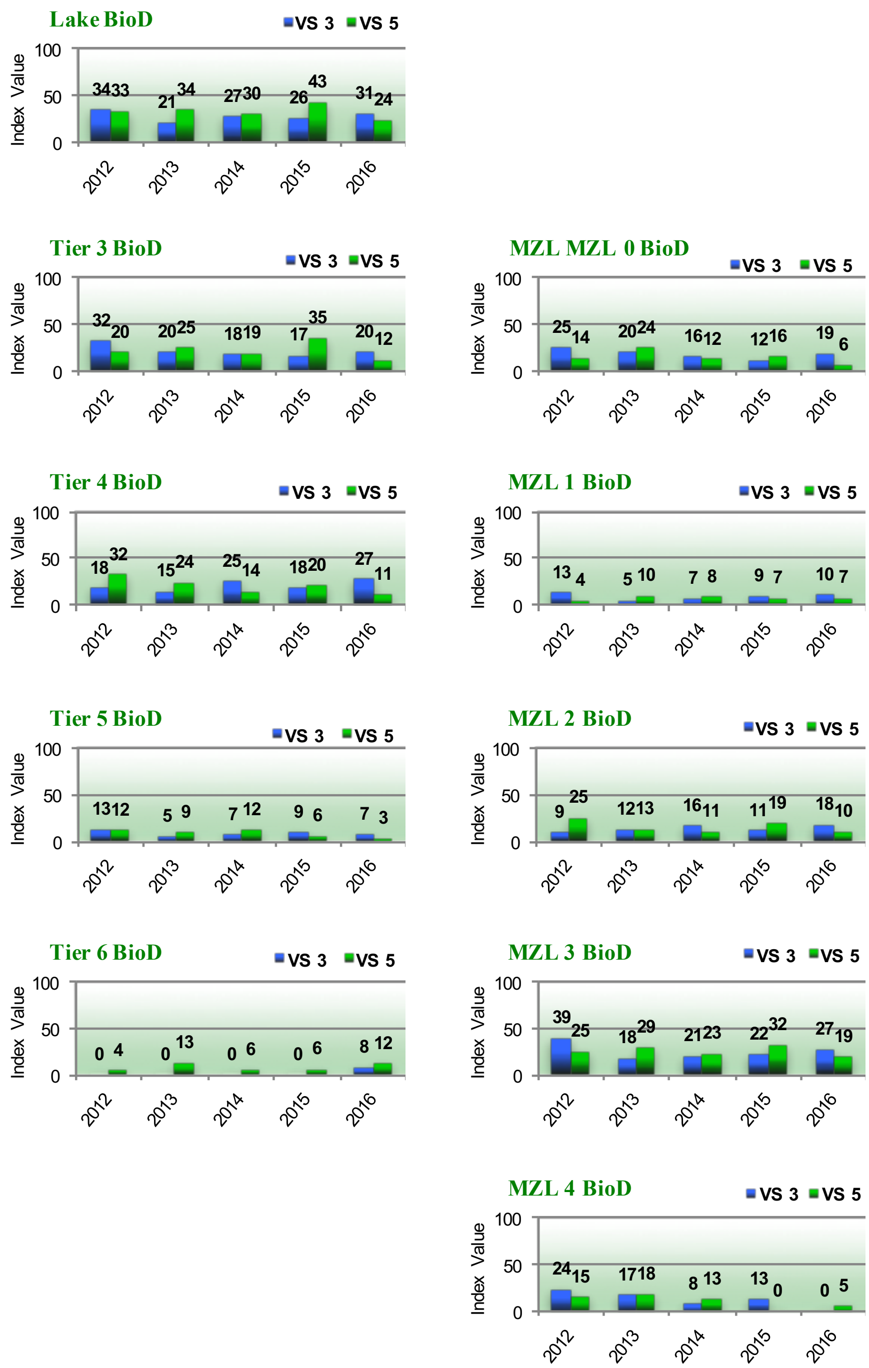


Figure 711/143.074b Total LakeScan BioD 60© plant community biodiversity at the AROS in the lake and at selected Tiers and MZL's at different survey times in each year.

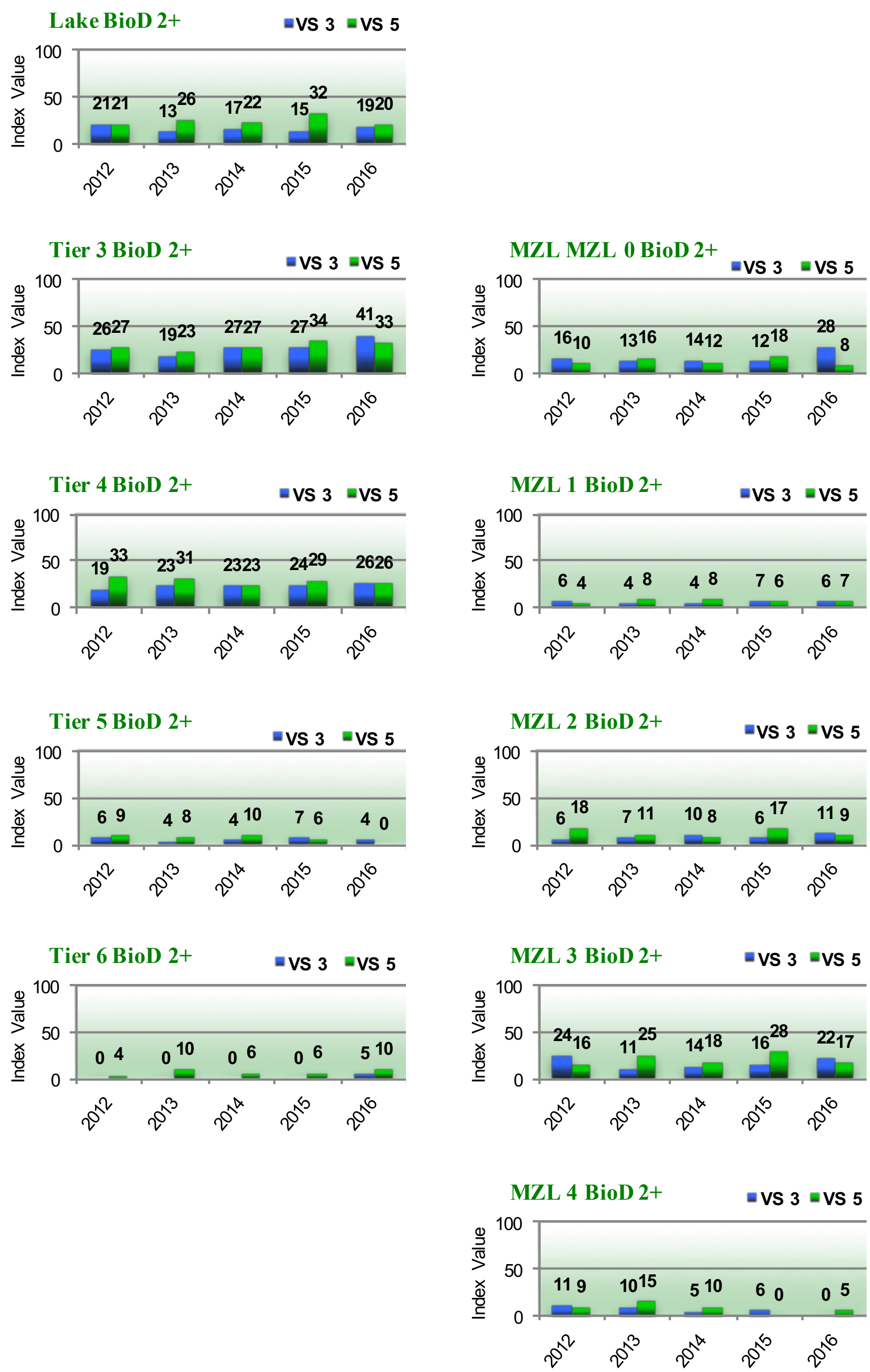


Figure 711/143.074 Total LakeScan BioD 60© T2+ plant community biodiversity for T species 2 through 4 at the AROS in the lake and at selected Tiers and MZL's at different survey times in each year.

711/143.077 Historical Record of Morphodiversity.

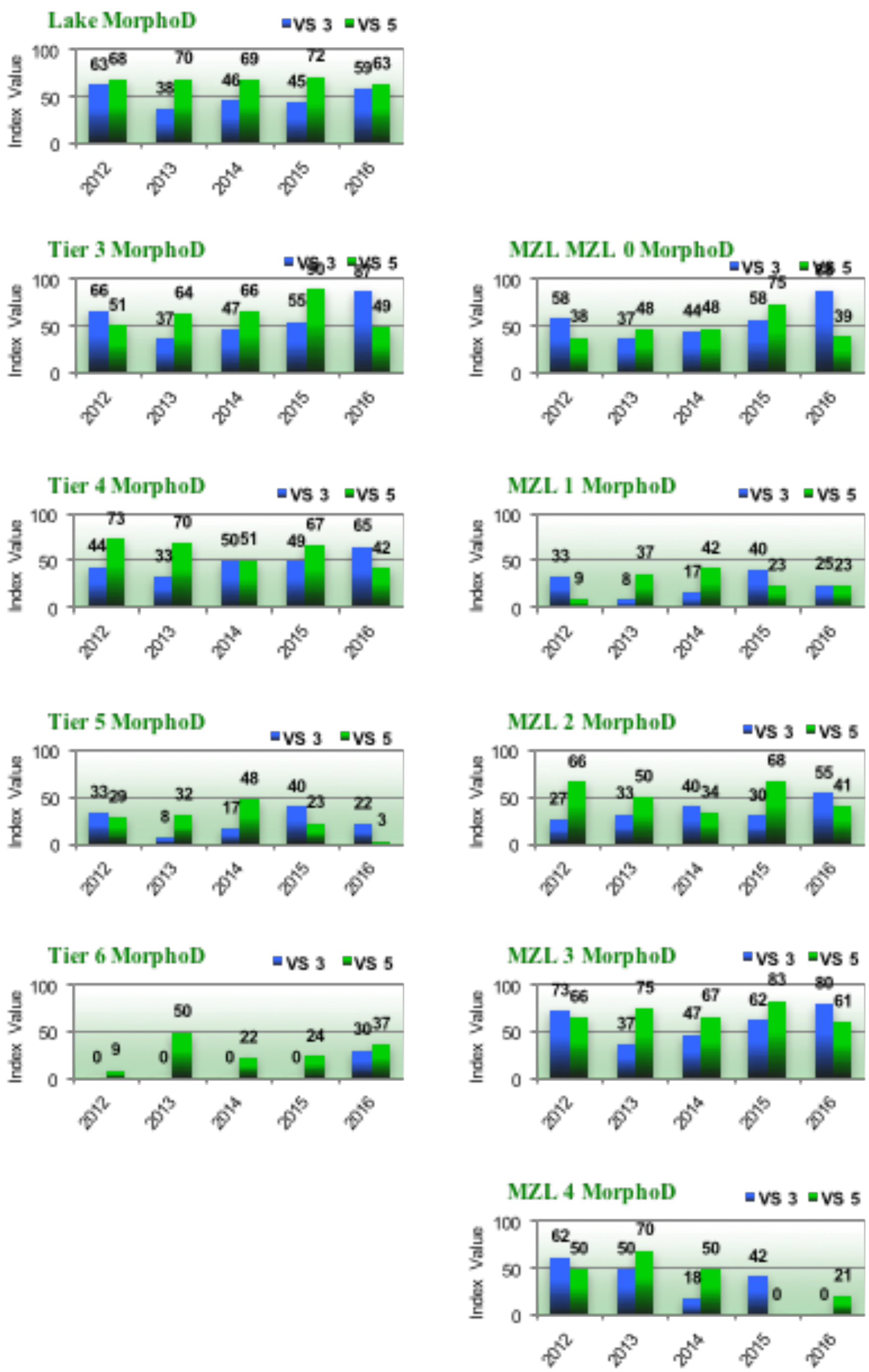


Figure 711/143.074b Total LakeScan MorphoD 26© plant community biodiversity at the AROS in the lake and at selected Tiers and MZL's at different survey times in each year for selected years of record.

711/143.084 Historical Record of Community Weediness.

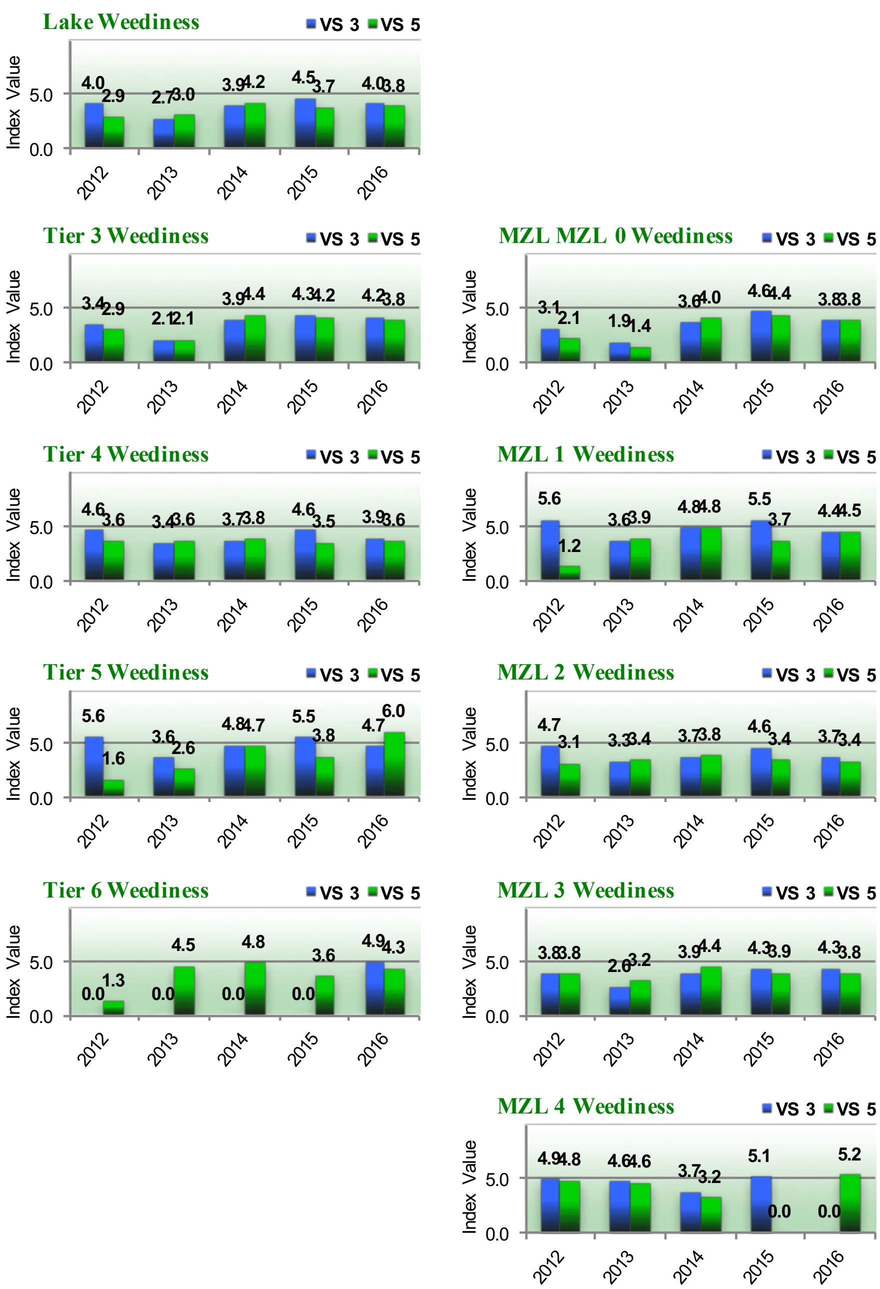


Figure 711.143.084 Total LakeScan™ Weediness Index© plant at the AROS in the lake and at selected Tiers and MZL's at different survey times in selected years of record.

Category 750 Macrophyte Management Program

This section is currently under development and is presented in part in 2016. Lake management objectives are usually established on an annual basis and the strategic elements of the plan (the things that we apply or do to the lake) are subject to change. For this reason, the treatment information is compiled at the end of the growing season so that the actual management strategies that were used in a given season are considered as a part of the LakeScan™ analysis. Pertinent data appears in other parts of the LakeScan™ report. For example, biometric data such as species richness and biodiversity collected at different surveys that are conducted during the course of the year are presented in both the annual data section and year-to-year comparison sections. Sometimes these data are presented in the management section if it is important from the perspective of the management discussion. As always comments and suggestions are encouraged as we seek to make the LakeScan™ report not just informative, but easy to navigate and understand.

750/122.214 Plants and Weeds

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

PLANT NAME, CODES, AND SELECTED ATTRIBUTES					
"T" VALUE	CODE #	SHORT NAME	COMMON NAME	SCIENTIFIC NAME	MORPHOTYPE
1	2	EWMx	Eurasian Watermilfoil Hybrid	*Myriophyllum spicatum x sibiricum*	feathery
1	65	StSt	Starry Stonewort	*Nitellopsis obtusa (Desv.) J.Groves*	bushy
1	75	CLP	Curly Leaf Pondweed	*Potamogeton crispus L.*	narrow leafy
2	4	GWM	Green/Variable Watermilfoil	*Myriophyllum verticillatum L. or Myriophyllum heterophyllum Michaux*	feathery
2	33	CNTL	Coontail	*Ceratophyllum sp.*	bushy
2	42	ELD	Elodea	*Elodea sp.*	bushy
2	50	NAID	Naiad	*Najas sp.*	bushy
2	76	FSP	Flat Stem Pondweed	*Potamogeton zosteriformis Fern.*	narrow leafy
2	77	WSG	Water Star Grass	*Zosterella dubia (Jacq.) Small*	narrow leafy
2	90	Rich	Richardsons Pondweed	*Potamogeton richardsonii (Benn.) Tydb.*	small leafy
2	109	HPW	Hybrid Pondweed	*Potamogeton Hybrid*	broad leafy
2	110	WBLP	Weedy Broad Leaf Pondweed	*Potamogeton amplifolius Hybrid*	broad leafy
2	115	Stuk	Sago Pondweed	*Stuckenia sp.*	stringy
2	125	VAL	Wild Celery	*Vallisneria americana Michaux*	grassy
2	150	WL	Waterlily	*Nymphaea sp.*	floating leaf
2	153	SPAD	Spadderdock	*Nuphar sp.*	floating leaf
3	3	NWM	Northern Watermilfoil	*Myriophyllum sibiricum Kom.*	feathery
3	25	BLAD	Common Bladderwort	*Utricularia vulgaris L.*	feathery
3	93	AMER	American Pondweed	*Potamogeton nodosus Poiret*	broad leafy
3	120	ZAN	Horned Pondweed	*Zannichellia palustris L.*	stringy
3	165	FLP	Floating Leaf Pondweed	*Potamogeton sp.*	floating leaf pondweed
3	166	TLFP	Thin and Floating Leaf Pondwee	*Potamogeton sp.*	floating leaf pondweed
3	167	SMTW	Smartweed	*Polygonum sp.*	floating leaf
4	27	MiniB	Mini-Bladderwort	*Utricularia sp.*	feathery
4	60	CHARA	Chara	*Chara sp.*	bushy
4	117	TLP	Thin Leaf Pondweed	*Potamogeton sp.*	stringy
4	126	SAG	Sagittaria	*Sagittaria sp.*	grassy

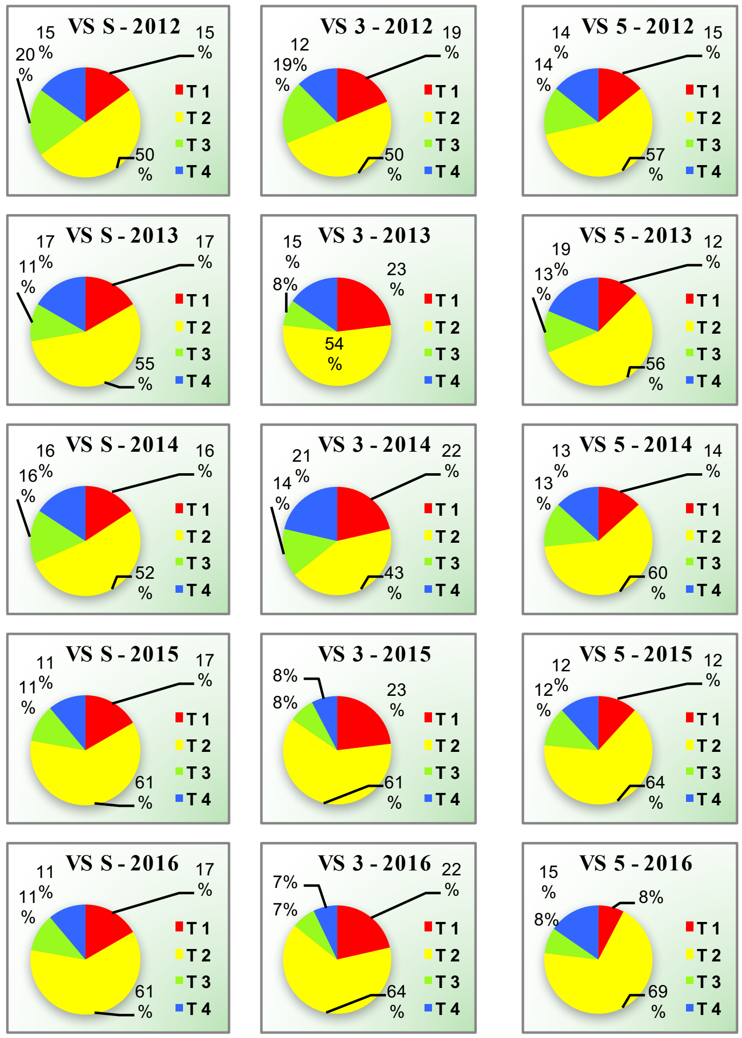
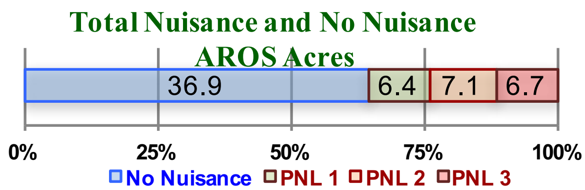
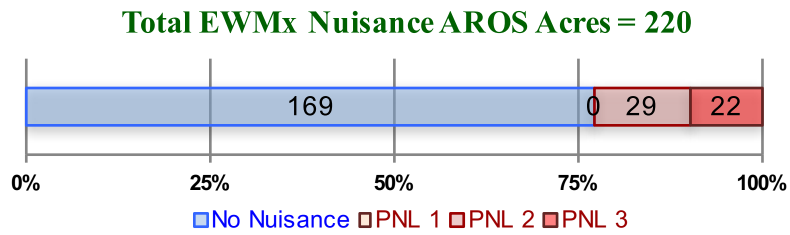


Figure 750/122.214 The relative proportion of T1, T2, T3, & T4 species, expressed as a percentage of the total number of species observed each year of record.



% AROS Acre	PNL Level	Perceived Nuisance Level Description	Total AROS Acres
65%	PNL 0	*"No Nuisance"*	37
11%	PNL 1	*"Ecological Nuisance"*	6
12%	PNL 2	*"Equivocal Nuisance"*	7
12%	PNL 3	*"Obvious Nuisance"*	7

Figure 750/102.090 Perceived nuisance levels by total acres and percent of AROS acres.



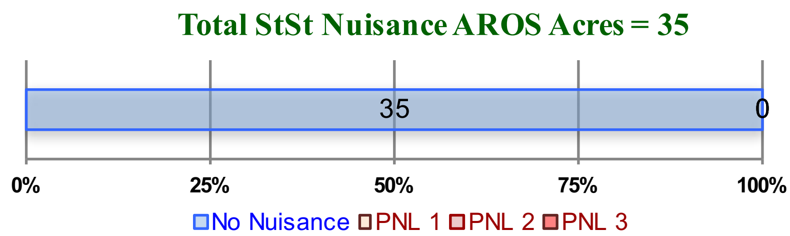


Figure 750/102.091 Perceived nuisance levels by T1 primary target species expressed as a percent of the total AROS acres where the weeds were observed. Numbers contained in the histogram bars are AROS acres.

710/120.000 Characterization of Plant Community and Management Targets

Figure 711/120.000 Key LakeScan™ metric values for this year, the historical average, and the goal value for each metric.

% AROS Acre	PNL Level	Perceived Nuisance Level Description	Total AROS Acres
40%	**PNL 0**	*"No Nuisance"*	177
6%	**PNL 1**	*"Ecological Nuisance"*	25
41%	**PNL 2**	*"Equivocal Nuisance"*	180
13%	**PNL 3**	*"Obvious Nuisance"*	57

Figure 711/120.900 LakeScan™ Perceived Nuisance Level Values (PNL) expressed as a percent of the toal AROS acres in the lake and by the total acres represented by each PNL level.

751/401.264 Plant Community Management T1 Species Data

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

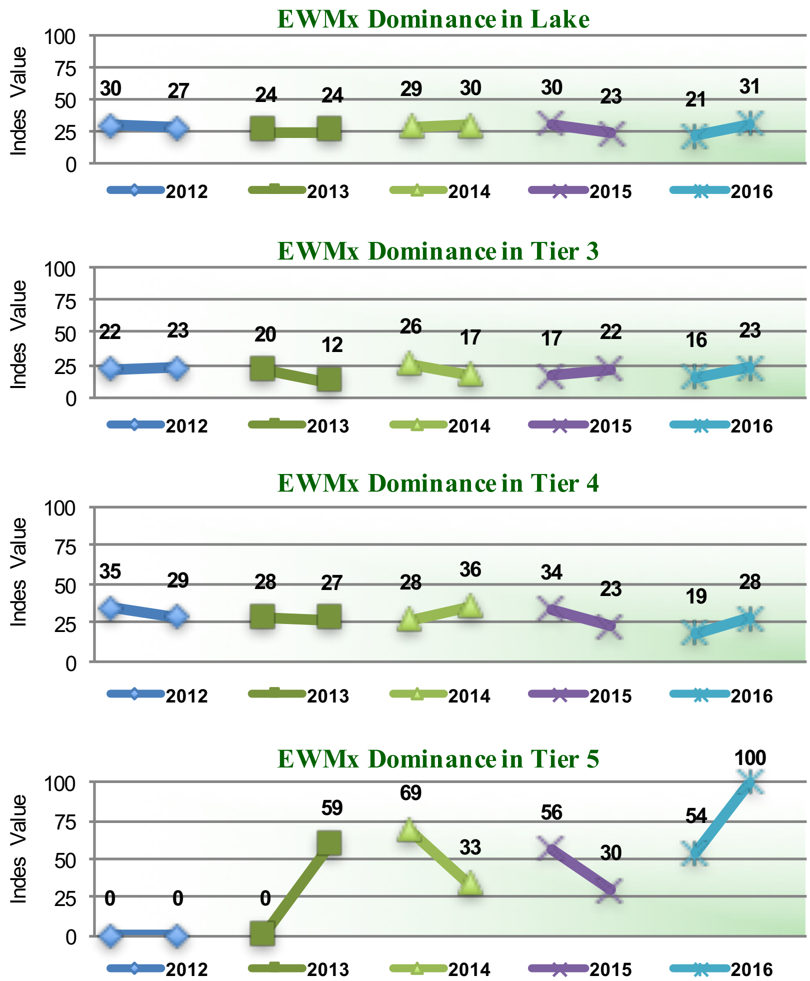


Figure 751/401.264 a The LakeScan™ Dominance factor for Ebrid (Eurasian or hybrid watermilfoil and all sub-genotypes) found in the lake and selected Management Zones (MZL's) for selected years of record.

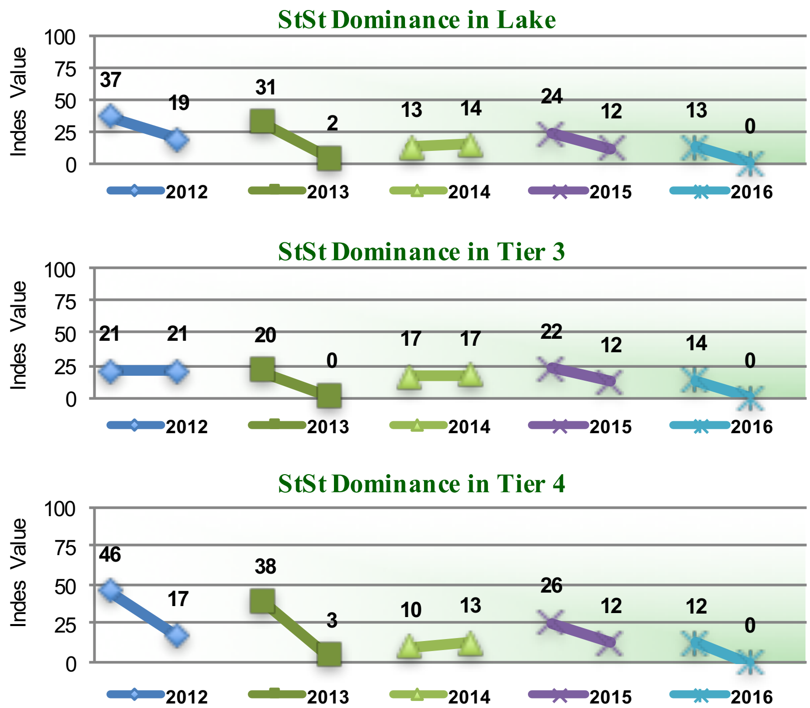


Figure 751/401.264 b The LakeScan™ Dominance factor for Starry Stonewort found in the lake and selected Management Zones (MZL's) for selected years of record.

Photos

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

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

List of Figures

Definitions

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

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

V3 Late Season/Summer.

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

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

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

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

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

Aquest Tip:

Rationale for Managing Aquatic Vegetation

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

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

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