Aquest

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White Lake

Oakland County
Highland and White Lake Townships
Michigan

Management Program Update
2009

A LakeScan™ Analysis

White Lake

Management Program Update
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Executive Summary

Lake Conditions

~ A herbicide tolerant hybrid milfoil has been the focus of the lake remediation program since it was discovered by Aquest Corporation in 2003. A combination of contact herbicides and an application of fluridone (Sonar) has directly and indirectly provided control of the various genotypes of the invasive milfoil populations in White Lake. However, the discovery of starry stonewort in 2007 and the spread of this aggressive and opportunistic invasive species has had the greatest impact on milfoil populations in White Lake for the past 3 summers. Plant biodiversity is good; however, individual plant species densities and distributions appear to be compromised as a result of the spread and domination of the lake submersed flora by starry stonewort.

~ Invasive and weedy Eurasian and hybrid milfoil, weedy broad leaf pondweed, and starry stonewort are expected to grow at nuisance levels throughout White Lake in 2010. Aggressive, but selective control is recommended for all of these plants. The management program has historically provided relief from weedy conditions for most of the summer recreation season so the benefits of the program may not be particularly obvious to most lake users. However, these data clearly indicate that failure to control these species will seriously impact recreation on the lake. Fortunately, these data also suggest that the application of a measured vegetation management program will not seriously compromise critical lake systems.

~ It is strongly recommended that the LakeScan monitoring program be continued to provide the empirical data necessary to evaluate lake conditions and the effectiveness and impact of the remediation and management program. Furthermore, the lake must be monitored to detect the invasion of several submersed plant species that have recently been found in Michigan lakes. These species include, cylindro (blue green algae), invasive pondweed hybrids, java or taiwanese moss, fanwort, and red ludwigia. Fanwort has already been found in Springfield Township in Oakland County.

Management Recommendations

~ A combination of contact herbicides and algaecides are recommended for the control of milfoil, curly leaf pondweed, weedy pondweed, and starry stonewort near shore as permitted by the MI DEQ. Broad spectrum weed control is not permitted off shore by the MI DEQ where only milfoil control is allowed. Starry stonewort is expected to overtake the plants in the deeper, off shore areas of the lake as it spreads throughout the lake.

Preface

This update report is the result of decades of effort to create a reader accessible report that still contains enough information that it might be useful for a broad group of readers with a wide range of understanding and experience with lake ecology and lake management. On one level, the charts that are presented herein may be all that a reader may want to review. The relative height of a bar is indicative of how conditions are trending in a lake. Narrative is provided to summarize how the author interprets the data and how that interpretation may influence management prescriptives. Obviously, there are many parts of the report that will not change very much from year to year. For example, the overall lake management goal of the lake management program may not change for decades. I have added a note at the bottom of each section to indicate the last time that section was modified or edited. Explanatory information (boiler plates) have been placed in text boxes so that they are available to the reader but don't just create "bulk" in the narrative. How should the report be read? That's up to the reader and their level of experience. Some may only wish to look at the charts and read the summary at the beginning of the report. Others may wish to consider the updated narratives. First time readers are encouraged to read the entire report.

The methods used to collect data and analyze those data are part of the LakeScan system. LakeScan emerged in 1991 and has seen continual development since that time. The current system contains a variety of analytical tools that are expressly designed to be used to guide lake management program decisions. Wherever possible, metrics or indices have been culled from the established and accepted peer reviewed scientific literature. In some cases, the algorithms have been modified to meet the demands of lake data analysis. Some metrics, such as the weediness index, are based on established ecological indices but have been modified to meet a specific need. This required that certain assumptions had to be adopted by the developers of LakeScan. The reader is cautioned that these indices have not been subjected to peer review; however, they are so useful, that they are offered anyway.

Update reports are "living documents". Time and resources restrict how much effort is can be dedicated to each report each year. There is some missing data and parts of the report are still being developed. Each year, efforts are made to make the report "more complete", but we are confident that the reader will not find a more useful, sensible, or meaningful report format. Input and comments are always welcome and appreciated.

Introduction

Primary Goal of the White Lake Management Plan

The primary goal of White Lake Management Plan is to modify conditions within the lake to enhance species and habitat diversity and thereby stabilize the ecosystem by promoting the production of conservative species and inhibiting the production of those plants that are weedy or more opportunistic. The attainment of this goal is expected to support conditions that will make White 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.

Accepted: 2007

Proximal Management Goals

Nuisance Plant Production Management: The primary goal of the vegetation management plan is to mitigate against cultural and natural disturbances by modifying the quality of the White Lake flora through the prescriptive use of selective plant management agents and strategies. Eurasian watermilfoil has been the most serious nuisance plant in the recent past and is expected to be the primary nuisance in the lake in 2009. Selective plant management agents are used to suppress the production of opportunistic and invasive species that are prone to form monocultures and suppress the production of preferred, conservative plant species. The density and distribution of all invasive and aggressive weeds in White Lake is being closely monitored. The management program has been reasonably successful in the suppression of the targeted species.

Water Quality Management: Water quality management is typically focused on matters related to lake fertility, and the production of suspended algae (phytoplankton) and the fishery. Anecdotal, historical evidence, gathered from lake shore residents, indicate that water clarity can vary considerably in White Lake. Water clarity was poor in White Lake in 2004 and 2005 and fair in 2006 and 2007 suggesting that frequent rains flushed the adjacent wetlands and cause the water column to be burdened with wetland plant debris. The water clarity was poor in in 2008 which seemed to be a consequence of the aggressive milfoil suppression program. Water clarity is expected to improve with time as these debris settle out of the water column and starry stonewort spreads throughout the system. The proliferation and production of zebra mussel is likely to play a significant role as a determinant of water transparency, plant nutrient dynamics, and ultimately, fisheries production. The spread of zebra mussels is typically accompanied by tremendous increases in water clarity and a shift to undesirable algae that are not consumed by the zebra mussel. Plant nutrient concentrations in the sediments are obviously capable of support luxuriant rooted plant production and concentrations in the water column appear to be very capable of supporting enough algae production to support a vibrant fishery. Blue green algae blooms can be a public health concern. Efforts should be made to limit unnecessary nutrient loading in White Lake because internal sources appear to be more than adequate to support a thriving freshwater fishery. Water quality conditions should be maintained or altered to favor the greatest degree of phytoplankton species diversity and if possible, restrict the production of harmful, blue green algae blooms.

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.

Other Considerations

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

Summary Management Opinion

Primary Considerations

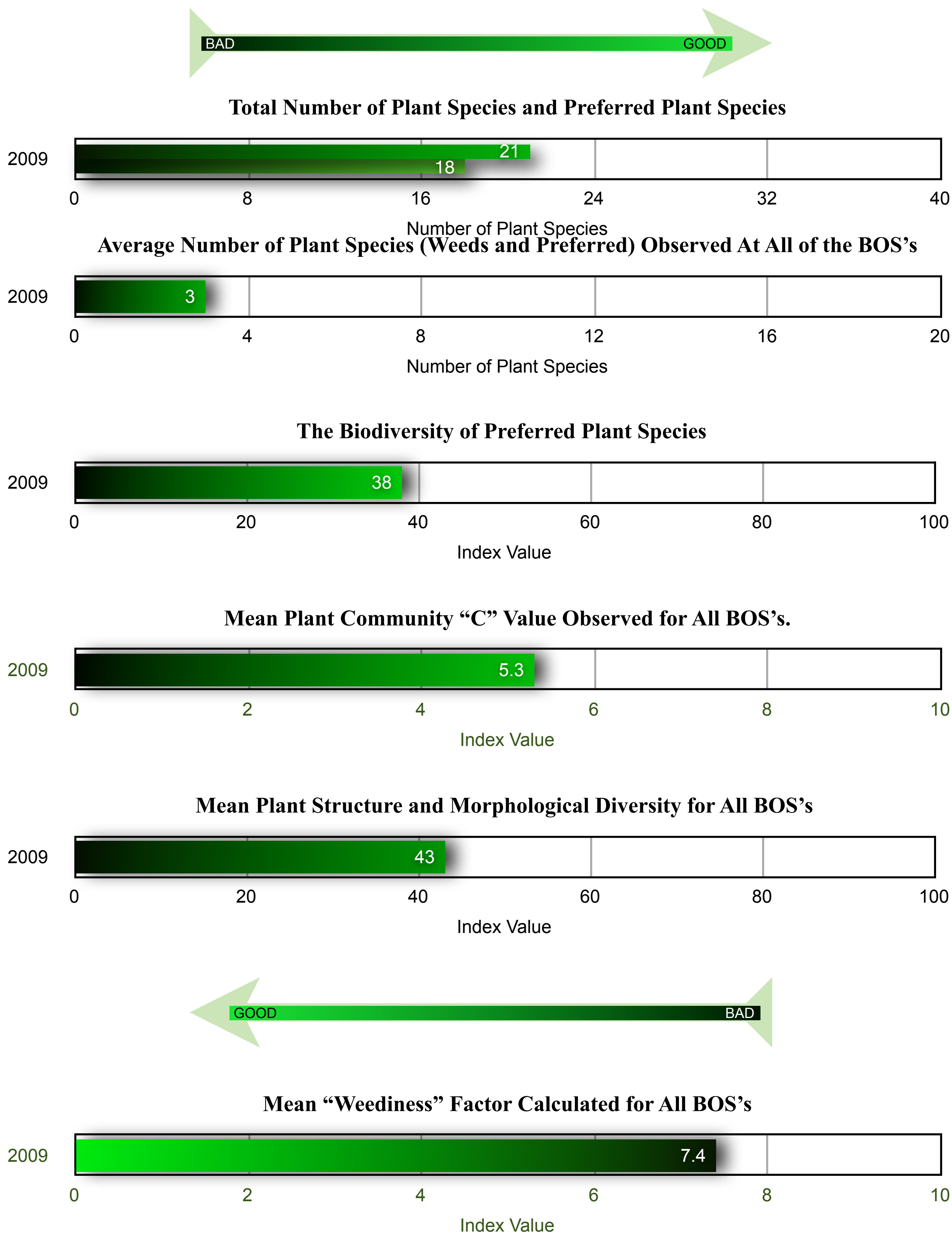
- The plant distribution and density patterns that characterize the submersed aquatic plant communities in White Lake are considered to be only fair relative to other area lakes. The production of preferred plant species is expected to remain the same in 2010 despite efforts to suppress the herbicide tolerant milfoil genotypes in the lake and as starry stonewort continues to have an increasing influence on vegetation community dynamics. Target species, milfoil and curly leaf pondweed may also decline in 2010 as a result of starry stonewort growth.
- According to studies conducted by Aquest and the University of Michigan - Flint, the milfoil in White Lake appears to be represented by a wide range of genotypes. These genotypes are extremely tolerant of herbicides. Aggressive management actions will be required again in 2010 to suppress this milfoil. Discrete management of some native species is recommended, but should be limited to only small areas. Most plant community quality indices are not expected to decline in 2010, but there may be little improvement.
- Total planktonic primary production appears to be adequate to support a productive fishery. Spawning habitat may become dominated by starry stonewort and that may compromise the warm water fishery. See the accompanying fishery report for more details.
- White Lake is considered to be susceptible to blue green algae blooms. Recent studies and anecdotal evidence indicate that the domination of plankton communities by blue green algae may be a result of filter feeding zebra mussel and possibly starry stonewort production.

Management Recommendations

- Milfoil, and to a lesser degree, curly leaf pondweed and weedy broad leaf pondweed are expected to return to nuisance levels in White Lake in 2010. The number of BOS's that contain milfoil in White Lake has trended upward since 2004. However, milfoil has not been as great a nuisance for recreation in recent years. Native pondweeds were found in roughly one half of all observation sites and are expected to grow at nuisance levels in some parts of the lake in 2010. These may require some control in near shore areas. Generally, treatment of these species beyond the 5' contour is not allowed by the MI DEQ. Starry stonewort was found in just under 50% of all observation sites in 2008. The nearshore areas of the lake should be concurrently treated for milfoil, curly leaf pondweed, weedy broad leaf pondweed and starry stonewort. Two to three herbicide applications may be necessary to maintain acceptable conditions. The first should occur just after Memorial Day, the second after the Fourth of July, and the last treatment should occur just before Labor Day. Some benthic algae (filamentous algae or chara) management may be required in 2010.
- Plant community monitoring must be continued in 2009 to monitor trends in ecosystem development.

  No opportunistic, nonnative, problem fish species were detected in the lake in 2008.
- The impact of charoid species on fisheries habitat components needs to be carefully monitored to allow appropriate management of fish spawning habitats.

Figure 1.1 A graphical representation of major metrics measured in 2009.



Physical and Geopolitical Characteristics

1.5 Observation and Sampling Sites

White Lake BOS Descriptions

Tiers 3 and 4 dominate White Lake. There is relatively little area in White Lake that can be described as a “drop off” zone or area of rapidly increasing depth.

Table 1.2. The total number of BOSs assigned to each tier in Figure 1.

	BOS TOTALS
Whole Lake	261
Tier 3	169
Tier 4	83
Tier 5	9

1.5 Tiers and Observation and Sampling Sites

Observations are recorded at predetermined Bio Assessment Sites (BOS) and are recorded on maps or in spread sheet format. In many cases, these sites are also georeferenced to UTM’s. These records are used for a broad range of analyses and to represent the location of key species or habitats. The Bio-Assessment Sites (BOS) are depicted on Figure 1. Tiers 1 and 2 are used to delineate shoreline areas that are dominated by emergent ore wetland vegetation. By convention, the near shore BOS are considered collectively as part of Tier 3 and can support submersed vegetation. Often, the Tier 3 BOS are very shallow, sandy, and plant-free because of wind, ice, and wave action. However, Tier 3 BOS may also play a role as a deposition zone juxtaposed to wetland outflows (diffuse shoreline) or influent streams. Tier 3 zones are strongly influenced by shoreline conditions and development. The tier 4 zone is characterized by deeper water and is generally more plant productive than the near-shore Tier 3 BOS. Plants in this zone are not as subject to wind and wave disturbance. The Tier 4 zone is often located just beyond boat docks. The Tier 5 observation sites are in deeper water and are generally associated with the “drop-off” zone in a lake and are commonly characterized by steep slopes. Some lakes have submerged islands, located off shore, and beyond typical Tier 5 zones. These are classified as Tier 6 BOS.

1. Physical and Geopolitical Characteristics

1.1 Location

State:	Michigan
County:	Oakland
Township:	White Lake
Township/Range:	T3N, R7,8E
Section:	Sec. Many

1.2 Morphometry

Total Area:	540 acres
Shoreline Length	
Littoral Zone Depth:	11 feet
Littoral Zone Area:	
Maximum Depth:	35 feet
Mean Depth:	3 feet
Volume:	acre feet (upper 10’ volume = acre feet)

1.3 Watershed Factors

Tributaries:	Influent stream on south end of lake from wetland. Storm Drains
Outlet Type:	Adjustable Dam on North End of Lake
Diffuse Connections:	
Diffuse Connection Length:	
Developed Shoreline Length:	
Percent Commercial Shoreline:	
Percent Residential Shoreline:	%
Percent Community Shoreline:	%

1.4 Administrative Management Authority

Management Authority:	White Lake Lake Improvement BOard
Years in LakeScan Program:	2 (Observations made since 1991)
First Year of Monitoring Program:	2004

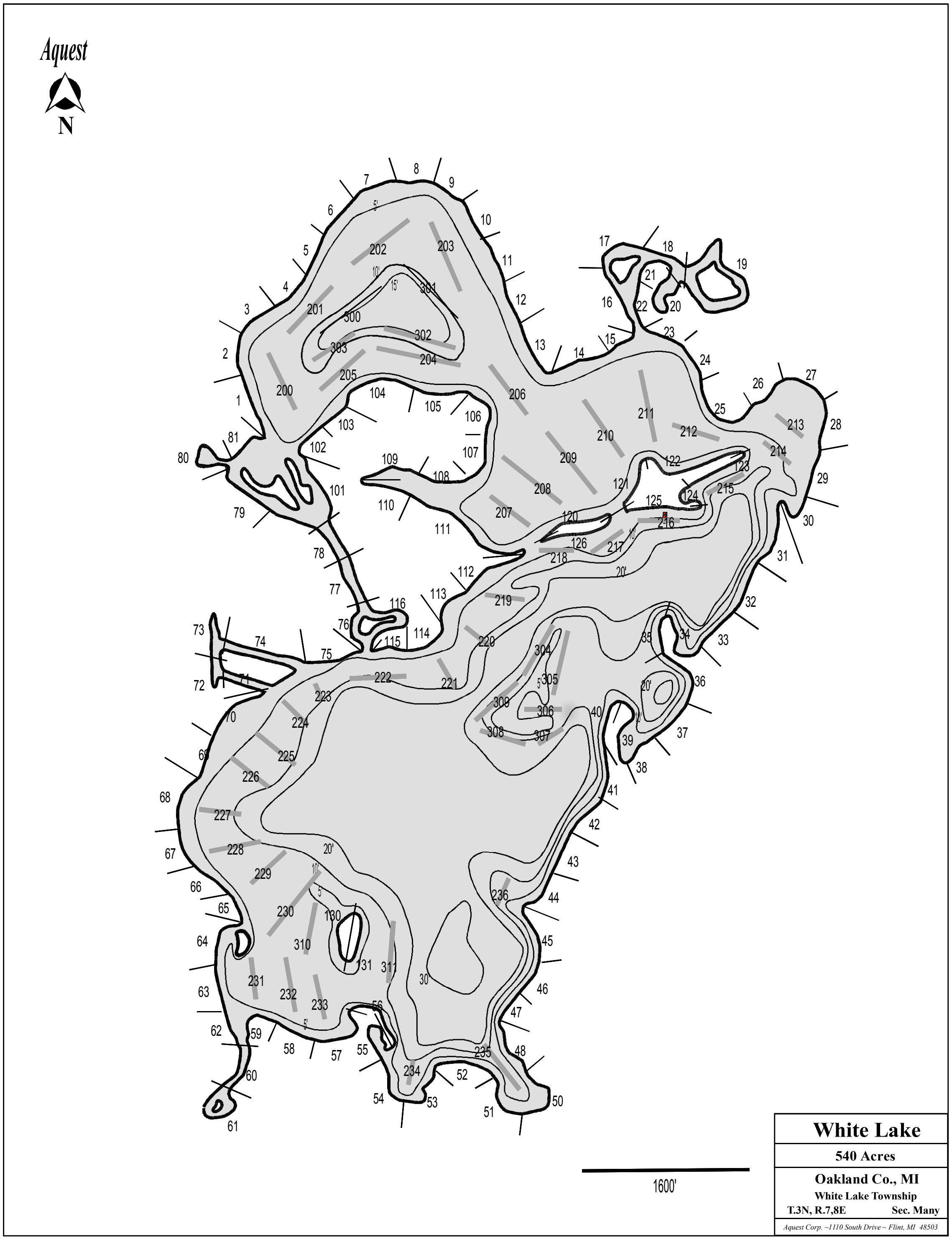


Figure 1.1 Biological Observation Sites (BOS) on White Lake.

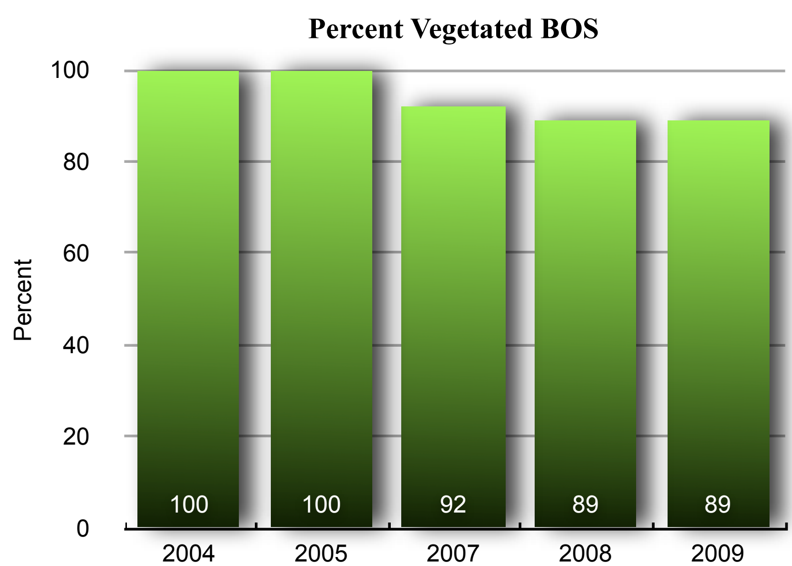
4.0 Aquatic Vegetation :

The submersed flora of White Lake was surveyed on:

23 September 2003
02 September 2004
13 August 2007
23 September 2008 and,
05 August 2009

Aquatic vegetation grows in three distinct zones or Tiers in White Lake that roughly correlate with increasing depth and distance from shore. The near shore areas are referred to as Tier 3 and are referenced by numbers 1 to 199 on Figure 1. The Tier 4 zones are the areas more distant from shore, that seem to support a similar flora as that found in the near shore areas, but lies outside of an area that is permitted for broad spectrum plant treatment by the MI DEQ. The Tier 4 observation sites are numbered from 200 to 299 on Figure 1. The deeper areas are referred to as Tier 5 and are numbered from 300 +.

Figure 4.1.1 The percentage of the total BOS's that support aquatic vegetation growth.



and,

Table 4.1.2 Characteristics and values assigned to plant species observed in White Lake.

PLANT NAME, CODES, AND SELECTED ATTRIBUTES							
	CODE #	SHORT NAME	COMMON NAME	SCIENTIFIC NAME	"C" VALUE	"i" VALUE	MORPHOTYPE
1	1	EWM	Eurasian Watermilfoil	*Myriophyllum spicatum L*	3	9	feathery
2	4	GWM	Green/Variable Watermilfo	*Myriophyllum verticillatum L. or M*	7	6	feathery
3	15	BLAD	Common Bladderwort	*Utricularia vulgaris L.*	7	4	feathery
4	17	MiniB	Mini-Bladderwort	*Utricularia sp.*	9	4	feathery
5	20	CNTL	Coontail	*Ceratophyllum sp.*	3	7	bushy
6	27	ELD	Elodea	*Elodea sp.*	3	6	bushy
7	35	NAID	Naiad	*Najas sp.*	4	7	bushy
8	40	CHARA	Chara	*Chara sp.*	6	3	bushy
9	43	NitT	Tufted Nitella	*Nitella sp.*	6	3	bushy
10	45	StSt	Starry Stonewort	*Nitellopsis obtusa (Desv.) J.Groves*	3	9	bushy
11	50	CLP	Curly Leaf Pondweed	*Potamogeton crispus L.*	2	9	narrow leafy
12	51	FSP	Flat Stem Pondweed	*Potamogeton zosteriformis Fern.*	6	5	narrow leafy
13	52	WSG	Water Star Grass	*Zosterella dubia (Jacq.) Small*	6	5	narrow leafy
14	54	ROB	Robbins Pondweed	*Potamogeton robbinsii Oakes*	8	2	narrow leafy
15	55	ClsP	Clasping Leaved Pondwee	*Potamogeton perfoliatus L.*	8	3	broad leafy
16	56	Rich	Richardsons Pondweed	*Potamogeton richardsonii (Benn.)*	5	5	broad leafy
17	60	MLF	Medium Leaf Pondweed	*Potamogeton alpinus Balb.*	8	2	broad leafy
18	61	VP	Variable Pondweed	*Potamogeton graminius L.*	7	5	broad leafy
19	62	ILP	Illinois Pondweed	*Potamogetion illinoensis Morong*	6	5	broad leafy
20	63	BLP	Broadleaf Pondweed	*Potamogeton amplifolius Tuckerma*	7	5	broad leafy
21	64	HPW	Hybrid Pondweed	*Potamogeton Hybrid*	5	5	broad leafy
22	65	WBLP	Weedy Broad Leaf Pondwe	*Potamogeton amplifolius Hybrid*	4	6	broad leafy
23	67	FLP	Floating Leaf Pondweed	*Potamogeton sp.*	7	6	floating leaf pondw
24	70	Stuk	Sago Pondweed	*Stuckenia sp.*	3	6	stringy
25	71	TLP	Thin Leaf Pondweed	*Potamogeton sp.*	5	5	stringy
26	80	VAL	Wild Celery	*Vallisneria americana Michaux*	3	7	grassy
27	81	SAG	Sagittaria	Sagittaria (4)	7	0	grassy
28	85	FR	Flowering Rush	Flowering Rush (submersed)	4	2	grassy
29	100	WL	Waterlily	Waterlily (2)	6	5	floating leaf
30	101	SPAD	Spadderdock	Spadderdock (3)	6	5	floating leaf
31	102	WSh	Water Shield	Water Shield	7	5	floating leaf
32	108	SMTW	Smartweed	Smartweed (2)	5	4	floating leaf
33	120	DUCK	Common Duckweed	Common Duckweed (4)	5	6	floating

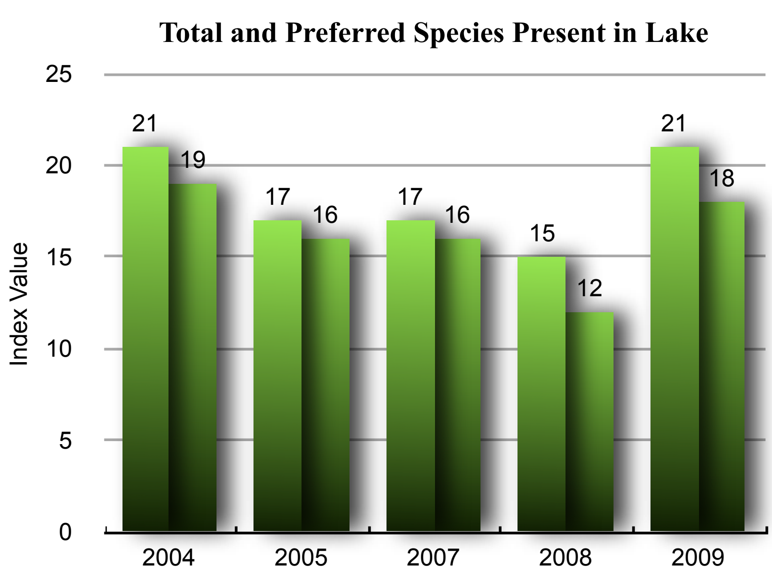
4.2 Species Richness (Total Species Present):

Thirty-three different aquatic plant species species have been found in White Lake during the past five years. Only 13 species were found in 2008; however, the trend toward fewer species each year was reversed in 2009 when 21 species were observed in the lake. Preferred species include everything but milfoil (EWM), curly leaf pondweed (CLP), and starry stonewort (StSt) which are referred to as target species. EWM and CLP have historically been regarded as nuisance species in White Lake and have been targeted for control. Large scale treatment of starry stonewort has not been implemented. The species richness or total species present in White Lake is expected to continue to decline if starry stonewort is not adequately managed.

The maximum number of aquatic plant species found at any of individual BOS's in White Lake has remained fairly constant for the past several years. The total number is slightly greater than what is typically found in most lakes in Michigan. However, the average number of plant species found at the White Lake BOS's was lower than the average number that is normally found in other Michigan lakes and and the 2009 value was lower than the number determined from data collected in 2008. More than have of the species observed in White Lake in 2009 were found at fewer than 5% of all BOS's.

These data point to the importance of isolated habitats that seem to be capable of the support of a wide range of aquatic plant species, while most of the lake appears to be loosing species richness. There were a few BOS's that supported a large number of species in 2009 and these need to be protected. Efforts to control herbicide tolerant milfoil and the spread of starry stonewort is expected to cause this metric to decline in 2009.

Revised: 2009



Plant Species Richness

The total number of plant species present in a lake is an important measurement when considered within the context of biodiversity estimates. The number of species may be high in a given lake but if this does not correspond with high biodiversity, it would indicate that there are species present, but at very low levels. Rarely are more than 20 macrophyte species found during a single survey event and it is rare that the total number of species found in an inland lakes is greater than 25 during the course of the year.

Figure 4.2.1 Total number of plant species (species richness) and preferred species (preferred species richness) observed in White Lake. The preferred number of species is the total observed species minus the target species.

Table 4.1.1 Plant species observed in White Lake. 0% is less than 0.5%.

SPECIES OCCURRENCE					
Species Short Name	Percent of BOS's Where Species Was Observed				
	2004	2005	2007	2008	2009
EWM	52%	33%	50%	31%	45%
GWM				3%	4%
BLAD	6%	1%		5%	3%
MiniB	1%	8%	3%		1%
CNTL	3%				
ELD	3%				3%
NAID	1%	1%	17%		4%
CHARA	58%	60%	25%	6%	4%
NitT			1%		
StSt				75%	67%
CLP	47%		21%		1%
FSP				1%	1%
WSG	1%			1%	1%
ROB	42%	40%	4%		1%
ClsP				4%	
Rich					28%
MLF					1%
VP	35%	3%	0%		
ILP	21%	21%	8%	1%	
BLP	53%	38%	28%		
HPW					3%
WBLP				32%	50%
FLP		4%			
Stuk	4%			3%	7%
TLP	4%	3%	6%		
VAL	25%	11%	16%	27%	30%
SAG	4%	5%	8%		
FR	16%	9%	3%		
WL		23%	17%	24%	26%
SPAD		12%	16%	1%	8%
WSh		25%	20%		
SMTW					1%
DUCK				1%	

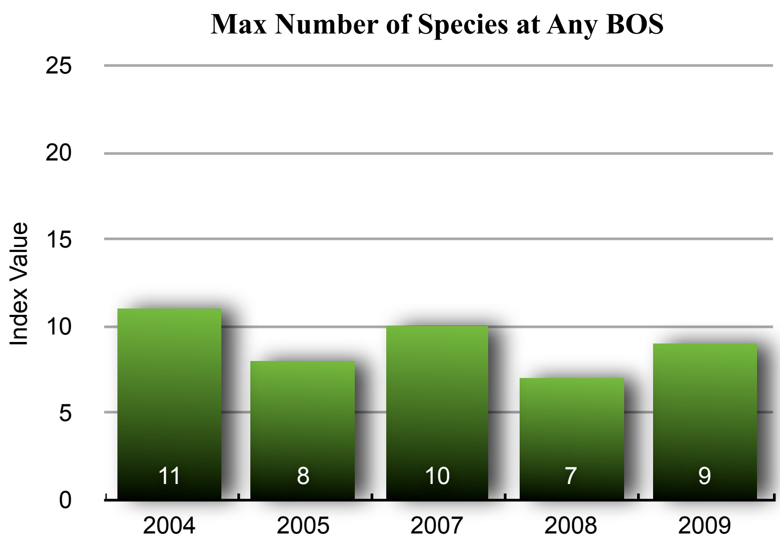


Figure 4.2.3 Total maximum number of plant species found at any single or multiple BOS's.

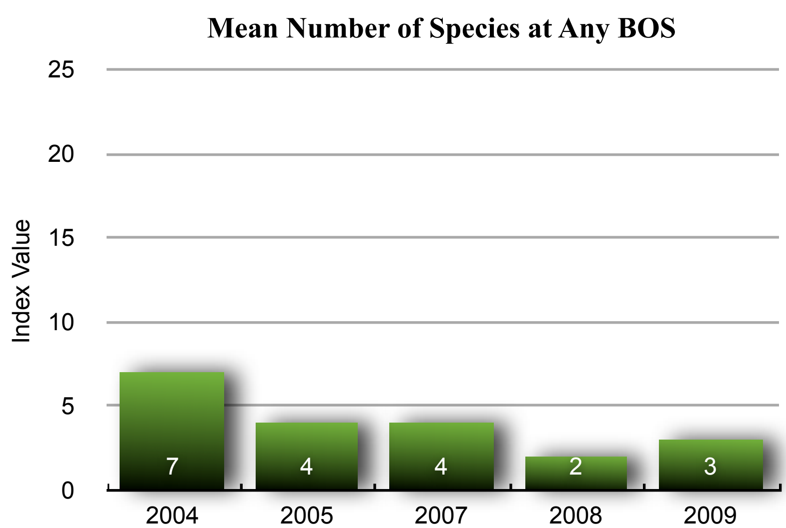


Figure 4.2.4 The mean number of plant species found at the BOS's in White Lake.

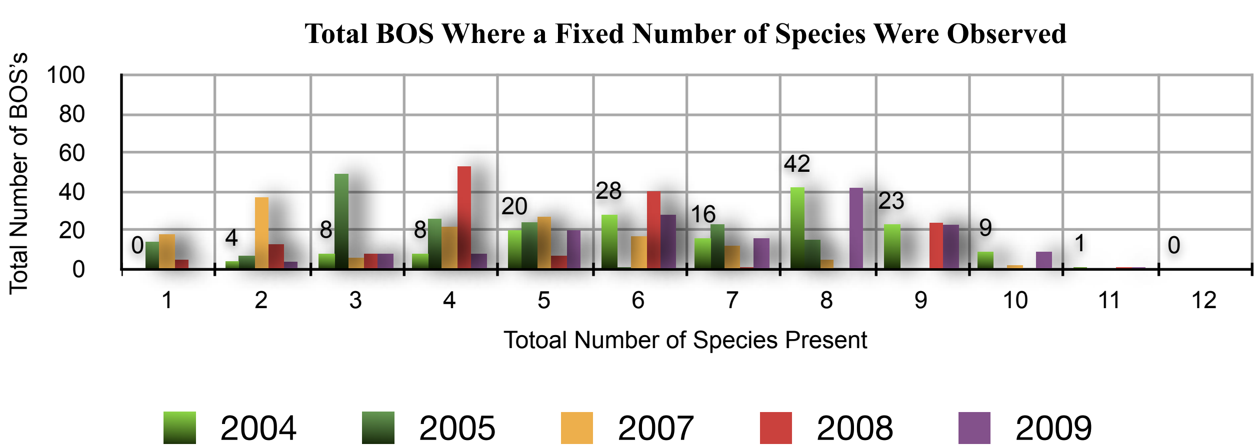


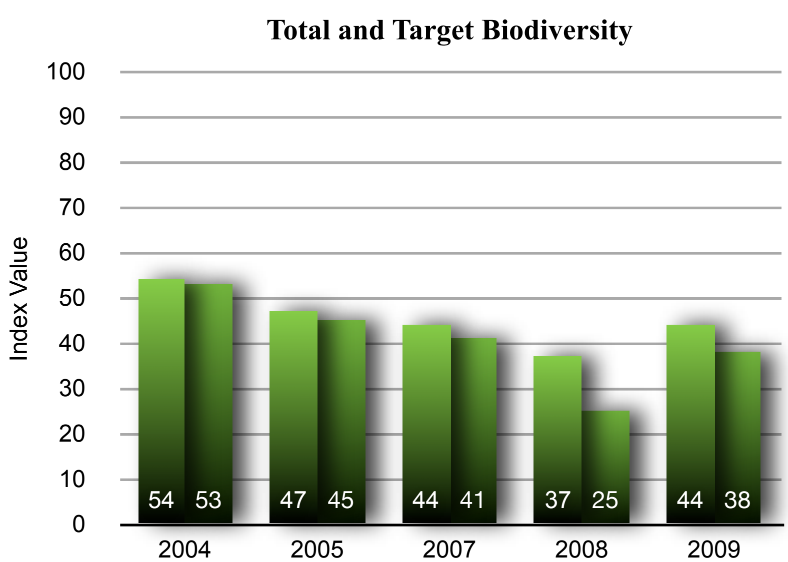
Figure 4.2.5 The total number of BOS's where a fixed number of plant species were found. The number labels is the number of BOS's.

4.3 Plant Community Biodiversity:

The aquatic plant biodiversity of White Lake has been reasonably constant and is considered to be good relative to other Michigan inland lakes. It is important to note that it appears to be declining. The invasion and spread of starry stonewort was expected to have a serious negative impact on this metric, however, it is common to see a single plant or several plants that are different species, still growing in dense starry stonewort beds. This can cause this metric to return a value that fails to demonstrate the impact of starry stonewort on biodiversity. New metrics are being considered to deal with this anomaly.

It is important to note that should all milfoil, and curly leaf pondweed pondweed were to be selectively removed from the lake, it would not have a dramatic impact on this biodiversity as demonstrated by the target biodiversity (light green or gray bar). It is fortunate that conditions can be improved for recreation and aesthetics without having an extremely negative impact on import metrics.

Revised: 2009



Biodiversity Indices:
Biodiversity is a measure of the number of species present and the total number of BOS's where the species are observed. The current index was created by LakeScan and is currently under evalutaion. The index is arithmetically adjusted to range from 0 to 100, based on a maximum number of 40 plant species. The higher the biodiversity value, the better. The lighter shaded bars represent the biodiversity calculated for desired species only and without nuisance species species.

Figure 4.3.1 An experimental, LakeScan developed biodiversity index for the entire plant community and the plant community with nuisance species deleted from the analysis (Target Biodiversity)

4.4 Plant Community Quality (Coefficient of Conservatism) "c" value:

Index values of 5 or more are considered to be desirable. A value that is greater than 6 is rare. Based on this metric, the quality of the plant community in White Lake is good compared to other Michigan lakes. The mean "C" value for White Lake may decline in the coming years as a result of increasing domination of the plant community by starry stonewort. Roughly 5% or fewer of the BOS's contain a wide range of higher quality plant species. These areas may help to support higher "C" values if they are not overcome by starry stonewort.

Revised: 2009

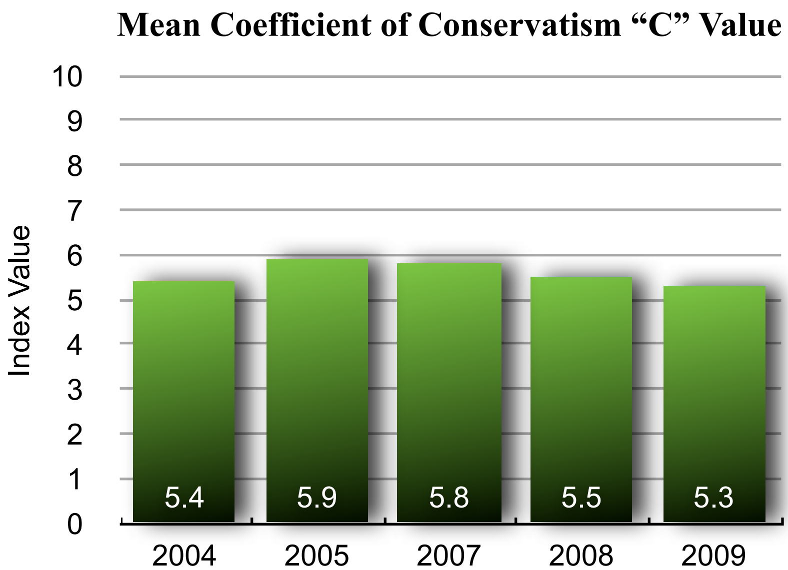


Figure 4.4.1 Area weighted plant community mean "C" values (coefficient of conservatism) in White Lake.

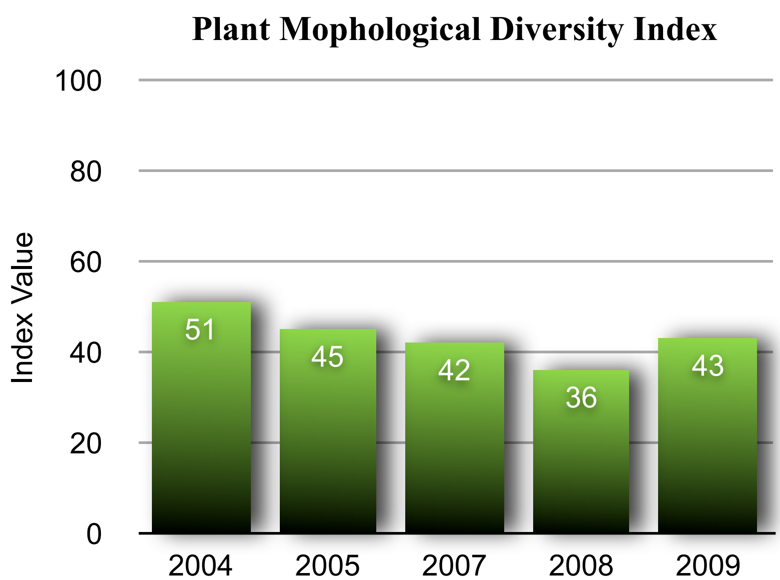
"C" Values:

Submersed plant communities that are dominated by conservative, rather than opportunistic species are generally considered to be more desirable by persons who use lakes for a variety of purposes. Lakes that are dominated by opportunistic species are generally considered to be "too weedy". A "c" value (coefficient of conservatism), ranging from 1 to 10, is assigned to each species to describe how likely a plant is to be found in either disturbed or conservative (stable) ecosystems. Opportunistic plants, that are more tolerant of cultural disturbance are usually considered to be the worst weeds and are assigned lower "c" values. Plant species found in stable, less disturbed lakes are not usually considered to be "weedy" and are assigned higher values. The mean "c" value can be used to roughly estimate the quality of the lake flora.

4.5 Plant Bio-Structure Diversity and Vertical Placement Diversity.

The variety and diversity of leaf type and morphometry of the plant community in White Lake is considered to be good. Values above 50 would be desirable and will remain as a target for White Lake. The vertical diversity of the plant productive zones is dominated by vertical species. It appears that low-growing, vertical, and canopy forming species (waterlilies) are not likely to be as integrated as they are in most Michigan lakes. This could have some implications for fishery production.

Revised: 2008



Plant Bio-Structure Diversity

Habitat complexity and structural diversity are generally considered to be positive attributes in aquatic ecosystems. Like species biodiversity, structural diversity contributes to ecosystem stability. Aquatic plants present a wide variety of leaf types and growth habits. A number value, ranging from 1 to 26, has been assigned to each distinct leaf type and these values are used to compute a bio-structure diversity index in exactly the same manner as the plant species biodiversity index. The higher the value, the better.

Figure 4.5.1 Area weighted plant community mean plant morphology diversity values for 26 different

Table 4.5.1 Plant bio-structural diversity as leaf type found at the percent of the total

		YEAR				
LEAF TYPE	leaf value	2004	2005	2007	2008	2009
feathery	1 - 3	15%	17%	28%	21%	19%
bushy	4 - 9	17%	25%	18%	31%	28%
narrow leaf	10	17%	19%	11%	16%	1%
large leaf	11 - 14	31%	25%	24%	21%	29%
sub & floating leaf	15	0%	1%	0%	0%	0%
stringy leaf	16	1%	1%	2%	0%	3%
grassy leaf	17 - 20	12%	6%	8%	6%	11%
floating leaf	21 - 23	6%	7%	9%	6%	9%
free floating	24 - 26	0%	0%	0%	0%	0%

Plant Bio-Structure - Vertical Position Diversity, Con't.

The greater the spread and distribution of leaf types over the greatest number of BOS's is considered to be a positive attribute as is the distribution of different vertical positions in the water column. The vertical structure diversity index value for White Lake is considered to be lower than most Michigan lakes. The domination of starry stonewort is expected to result in a decline in this metric in the near future. Values for the past 3 years are virtually the same.

Revised: 2009

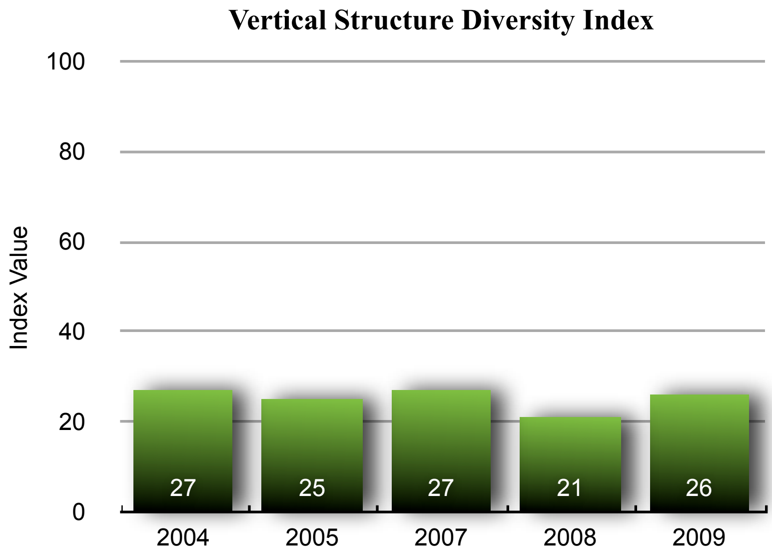


Figure 4.5.2 Area weighted plant community vertical diversity index values for 3 vertical positions in the water column.

Vertical Structure Diversity

The vertical position of plants in the water column are recorded during LakeScan surveys. Like species biodiversity, vertical position diversity contributes to ecosystem stability. Aquatic plants occupy different parts of the water column during the course of the growing season. However, some of these characteristics are inherent to the plant, such as bottom dwelling, meadow-forming species. Other species, such as water lilies, are always canopy formers.These values are used to compute a bio-structure diversity index in exactly the same manner as the plant species biodiversity index. The higher the value, the better.

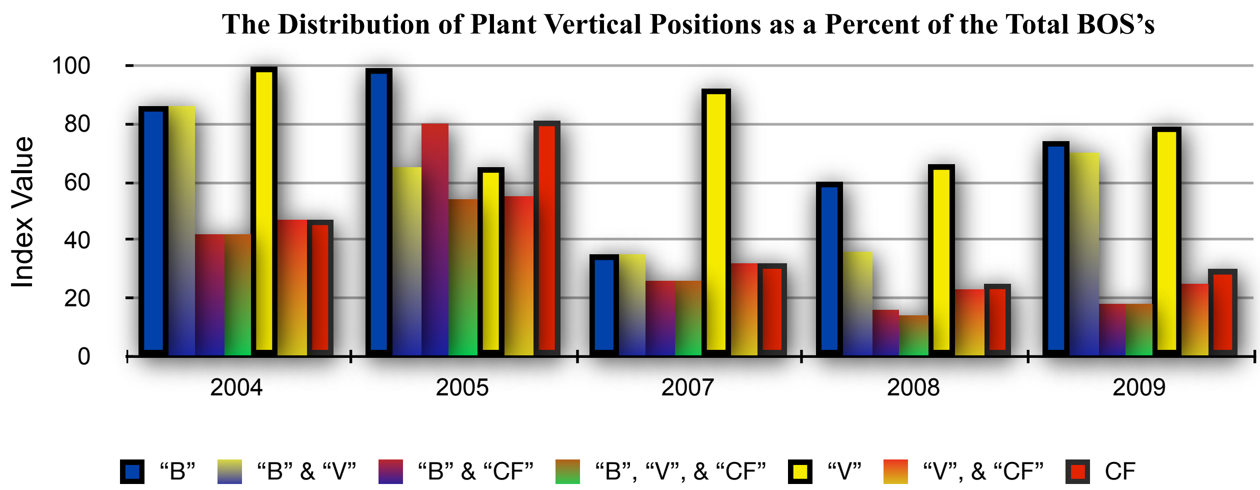


Figure 4.5.3 The percentage of BOS's where different vertical plant habits are observed. "B" refers to the growth of bottom dwelling, low-growing species. "V" refers to those species that are observed growing vertically in the water column. And, "CF" is used to refer to those species like water lilies that form a canopty of vegeation at the surface of the water. The multi-colored bars refer to the percentage of BOS's that may contain more than a single plant habit, or a combination of vertical habits as found when there are several species at the BOS. It is believed that the greater the variety and mixture of vertical habit, the better.

4.6 Plant Distribution and Density:

Plant Distribution and Density:

The quality of the plant communites are also considered from the perspective of density and distribution. Density and Distribution are subjective values that are assigned to each species in each BOS during a survey and are used to describe how much vegetation is observed per unit area and how it distributed within the BOS. The relative “value” of these assessments are considered to vary with species. Obviously, the presence of a highly invasive species at “c” density and “cp” distribution would be considered to be a negative lake attribute; however, a similar density and distribution pattern for a non-invasive species could be considered to be highly desirable. These data are critical for the determination of degree of “weediness” in a lake. Field data are evaluated as follows:

Density “a”	Rare: The plant species has been observed; however, it is unlikely that the plant could be found again if the observer were to return to the observation site.
Density “b”	Present: This designation is an artifact from methods used in the early 1990’s and should not be used. It is listed here; however, because the term is still used by the MI DEQ. The “b” value is used instead of the “c-” value that is used in the field. This value is used to describe plants that could be found if the observer were to return the observation site, but the plant is not common or dominant in the observation zone.
Density “c”	Common: This term is used to describe plant species that are common throughout the observation site.
Density “d”	Dense: This term is used to describe the production of a species or perhaps several species that totally dominate the observation site where they form dense low-growing meadows or impenetrable surface mats of vegetation.
Distribution “s”	Scattered: The plant is observed to be randomly scattered around the observation site, usually as a single plant or small clump of plants comprised of several stems.
Distribution “sp.”	Scattered Patches: The plant is observed as clumps of several plants scattered around the observation site.
Distribution “p”	Patchy: The plant is observed to cover large patches or areas within the observation site; however, the plant does not cover more than 50% of the total area.
Distribution “cp”	Contiguous Patches: This term is used to describe plant growth that is usually dense and where places that are not occupied by the described species appear to be patches within the mass of vegetation produced by the described

4.6.1 Plant Community "Weediness":

The mean "weediness" index recorded for the White Lake BOS's is very high and has trended upward in the past three years. The higher the value, the greater the "weediness" of the lake and values above 5 are considered to be weedy. The values reported for White Lake are higher than most Michigan lakes. Nearly all of the observations sites contained at least one weedy species in 2009. This does not mean that all of the BOS were "weedy", but demonstrates how important that the management program be maintained or all productive areas of the lake would be capable of producing very weedy conditions. This would result in a serious decline in the recreational value of the lake. This metric clearly proves that if the plant community in White Lake were not managed properly, that any recreation in the lake would be seriously threatened.

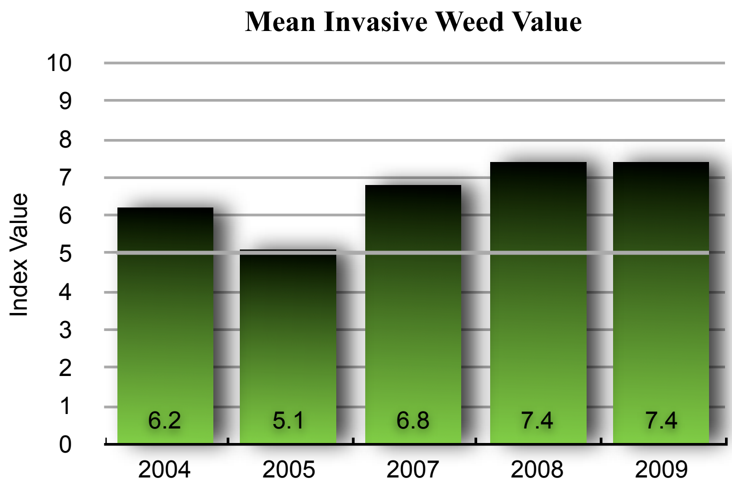


Figure 4.6.1 The mean weediness index value in White Lake.

"i" Values:

An invasive index value or "i" value is assigned to all of the aquatic plants or plant groups found in a lake as part of an empirical measure of the weediness. Higher values are assigned to plants that are more commonly found growing as invasive plants. It is important to remember that the "i" value must be considered within the context of the lake where the plant is found and the density and distribution of the specific plant population and not be considered as an absolute value. This is because a plant specie or hybrid may be considered to be "weedy" some lakes, but not all lakes. "i" values range from 1 to 10 and the higher the value, the greater the probability that the plant will grow invasively in a given lake. The weediness index values that are calculated for a lake and based on the density, distribution, and of all observed plant species and their respective "i" values also ranges from 1 to 10. Lakes that yield values above 5 are considered to be weedy.

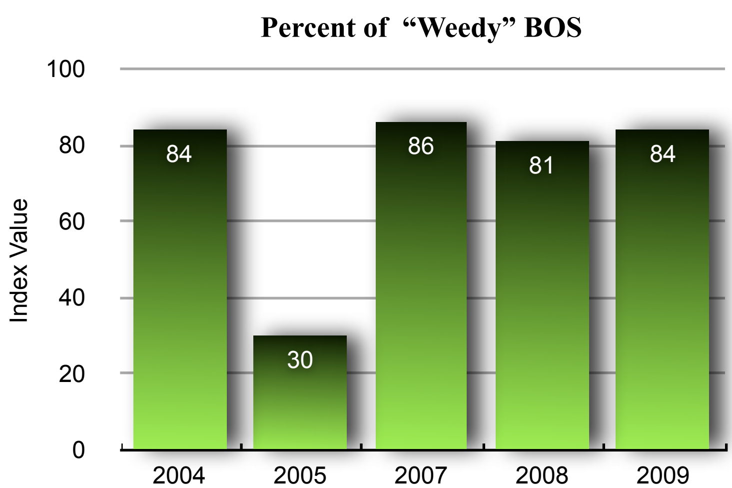


Figure 4.6.2 The percentage of the total BOS's in White Lake where the Weed Index Value exceeded 5.

4.7 Selected Plant Species and Other Considerations

Nuisance Plant Production:

The spread and domination of the White Lake flora by milfoil and starry stonewort is clearly evident in the weediness index values presented in this report. One or more of the either or both of these two species were found in 84% to 93% of all BOS's during the past three years. The average weediness index values are far greater than what is considered to be acceptable. A target goal of 50 is desirable.

Eurasian watermilfoil and milfoil hybrids s are usually the dominant weed in any Michigan lake and this is still true in White Lake. A review of major the LakeScan lake quality indices strongly suggest that the lake can tolerate a considerabl amount of plant suppression in 95% of the lake without seeing a decline in key ecosystem indices and functions.

Aquest Corp. discovered the presence of a hybrid milfoil in Michigan inland lakes in 2003. White Lake was one of the four lakes where milfoil hybrids were found that year. Some of the milfoil hybrids appear to be more tolerant of the common aquatic herbicides than other genotypes and this seemed to be true in White Lake in 2003. Data suggests that the milfoil in White Lake is now a combination of Eurasian and hybrid genotypes, and generally appear tolerate management efforts. Aggressive action will certainly be required to control these species will be 2010.

The chara-like alga, starry stonewort, was first identified in a southeastern Michigan inland lake by Aquest in 2006. This plant is very aggressive and can have a dramatic impact on ecosystem stability and recreation. Aquest is involved in cutting edge research on the emergence and significance of nuisance plant genotypes at the University of Michigan and University of Connecticut.

Revised: 2009

Milfoil:

The total number of BOSs where a Eurasian type milfoil has been found has trended upwards from 2005 to present. Furthermore the density and distribution of this species has also increased. Annual management efforts have succeeded in preventing milfoil from becoming a significant nuisance throughout most of the recreational use season; however, the plant continues to cover most of the BOS's. There did not appear to be a significant difference in the total area covered by milfoil in 2009 as a result of the 2008 fluridone application when compared to the area covered by milfoil following the application of contact herbicides. The spread and domination of the lake by starry stonewort may have had a greater impact on the amount of milfoil found in the lake in 2009 than any residual impact of the 2008 milfoil management program.

The milfoil genetic strain currently found in the lake is known to tolerate many aquatic herbicides. Cutting edge research is guiding the remediation program at this time. The emergence of herbicide tolerance in milfoil populations provides a strong argument for the use of a wide variety of selective agents to prevent the emergence of a dominant biotype that is tolerant of a single herbicide even though tolerance to a specific herbicide has never been observed. The White Lake Improvement Board is to be commended for seeking and implementing a variety of control strategies in the lake. A combination of contact herbicides is recommended for 2009.

Revised: 2009

Milfoil

Percent BOS Presence and Relative Density

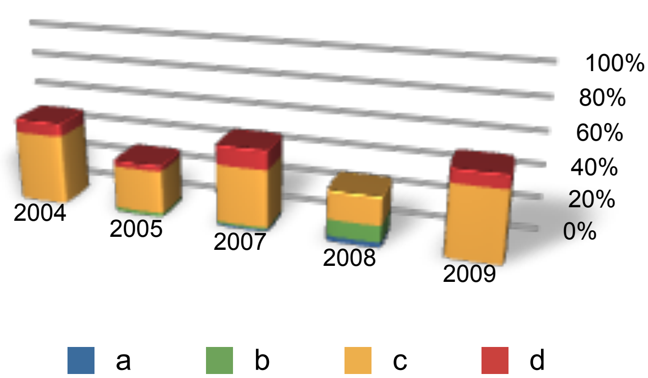


Table 4.7.1 The percentage of BOS's where milfoil was found represented as the percent of each density estimate as the percent total.


Hybrid water milfoil from White Lake, 2003.

Charoid Algae:

The epithet, chara, is used as a term that refers to a large and diverse group of, highly desirable, low growing, aquatic macrophytes that look like higher, rooted plants but are really large algae. Nitella is another genus of charoid algae that is quite distinct, but is often referred to as chara. Chara was present in the lake in approximately 60% of all BOS's in 2004 and 2005. An aquatic herbicide that contains fluridone has been applied repeatedly to White Lake for the control of watermilfoil for the past two decades. The use of fluridone was first developed by Elanco Products Company as a potential cotton herbicide, aquatic herbicide, and as a seed coating to enhance germination. It was introduced to the market place as an aquatic herbicide in 1987 and no other uses were pursued. Low dose fluridone applications for watermilfoil control made in the early 1990's clearly seemed to promote the growth of chara and water stargrass (see MI DEQ reports by Kenaga et. al from early 1990's). It is believed that fluridone may enhance the germination of water stargrass seed and chara oocytes, which are seed like structures produced by charoid algae.

A new type of charoid algae began to appear in Michigan inland lakes in the late 1990's and early 2000's that was far more aggressive and seemed to be capable of growing much taller than what had been previously seen with any charoid species in Michigan. The new plant was identified as starry stonewort, for the first time in a Michigan inland lake, by G. Douglas Pullman in 2006. Since that time, it has been identified in lakes in all parts of Michigan.

Starry stonewort was first identified in White Lake in 2008 and was found in more than 50% the BOS's. It was observed in 67% of all BOS's in 2008. It may have been present in the lake prior to 2008, but was not clearly evident. Starry stonewort has the potential to be the most aggressive plant in White Lake and is now the dominant aquatic plant species. It is more aggressive and invasive than watermilfoil in White Lake. Fortunately, starry stonewort is relatively easy and inexpensive to control.

Revised: 2009

Starry Stonewort

Percent BOS Presence and Relative Density

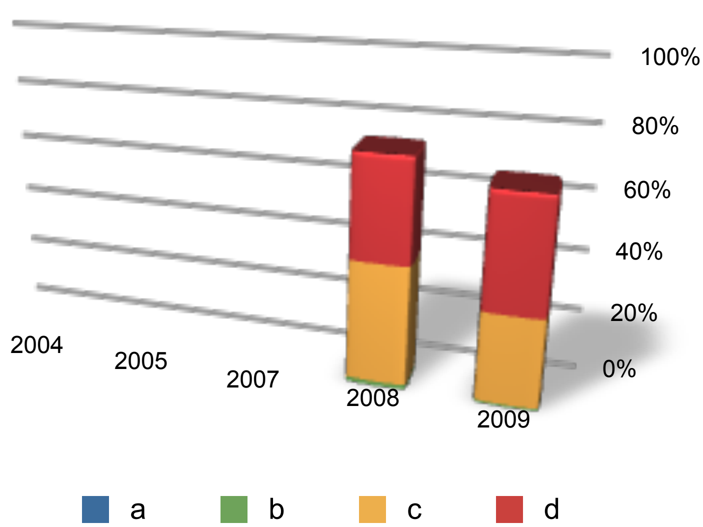


Table 4.7.2 The percentage of BOS's where starry stonewort was found represented as the percent of each density estimate as the percent total.

Starry stonewort rhizoids (Stars) near bottom of plant.

Starry stonewort competition with other plant species and crowding milfoil.

Weedy Broad Leaf Pondweed:

An invasive and aggresive form of pondweed appears to have evolved in Michigan inland lakes as a response to the proliferation of exotic invasive species and the continual cultural disturbance of aquatic ecosystems. On form of the weedy pondweed is very likely a hybrid of several genotypes that certainly includes broad leaf pondweed (*Potamogeton amplifolius*). Weedy broad leaf pondweed has been found to be very aggressive and invasive in many Michigan Lakes. It is known to be equally invasive as milfoil and has dominated areas that were previously inhabited by nuisance levels of milfoil. It is as much of an impediment to recreation as is water milfoil. Because it is so invasive, it may need to be targeted for control so that it does not adversely impact the biodiversity and structural complexity of the White Lake aquatic flora. Unlike most "normal" native pondweeds, weedy broad leaf pondweed appears to be relatively easy to control by selective means. A combination of contact herbicides should be used in 2010 to suppress the growth of this hybrid and possibly impede the spread of the plant to even more of the BOS's.

Revised: 2009

Weedy Broad Leaf Pondweed

Percent BOS Presence and Relative Density

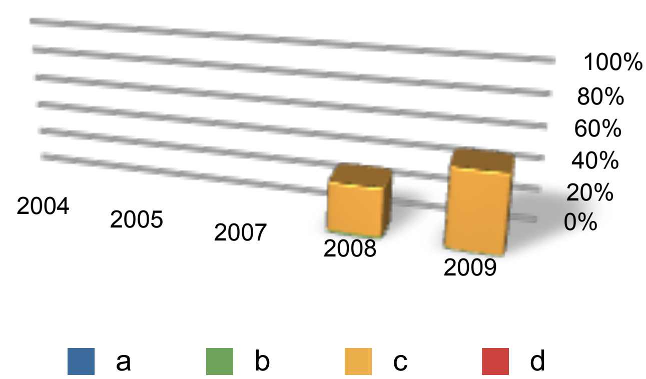
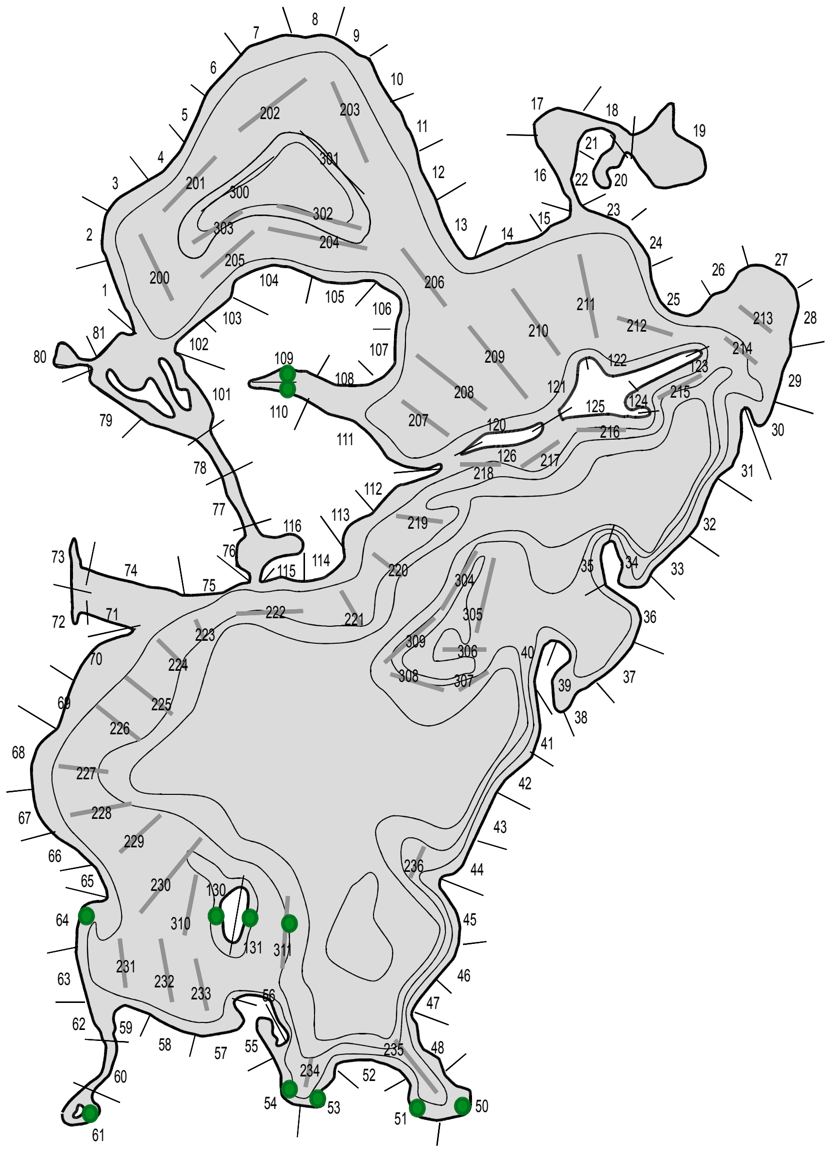


Table 4.7.3 The percentage of BOS's where weedy broad leaf pondweed was found represented as the percent of each density estimate as the percent total.

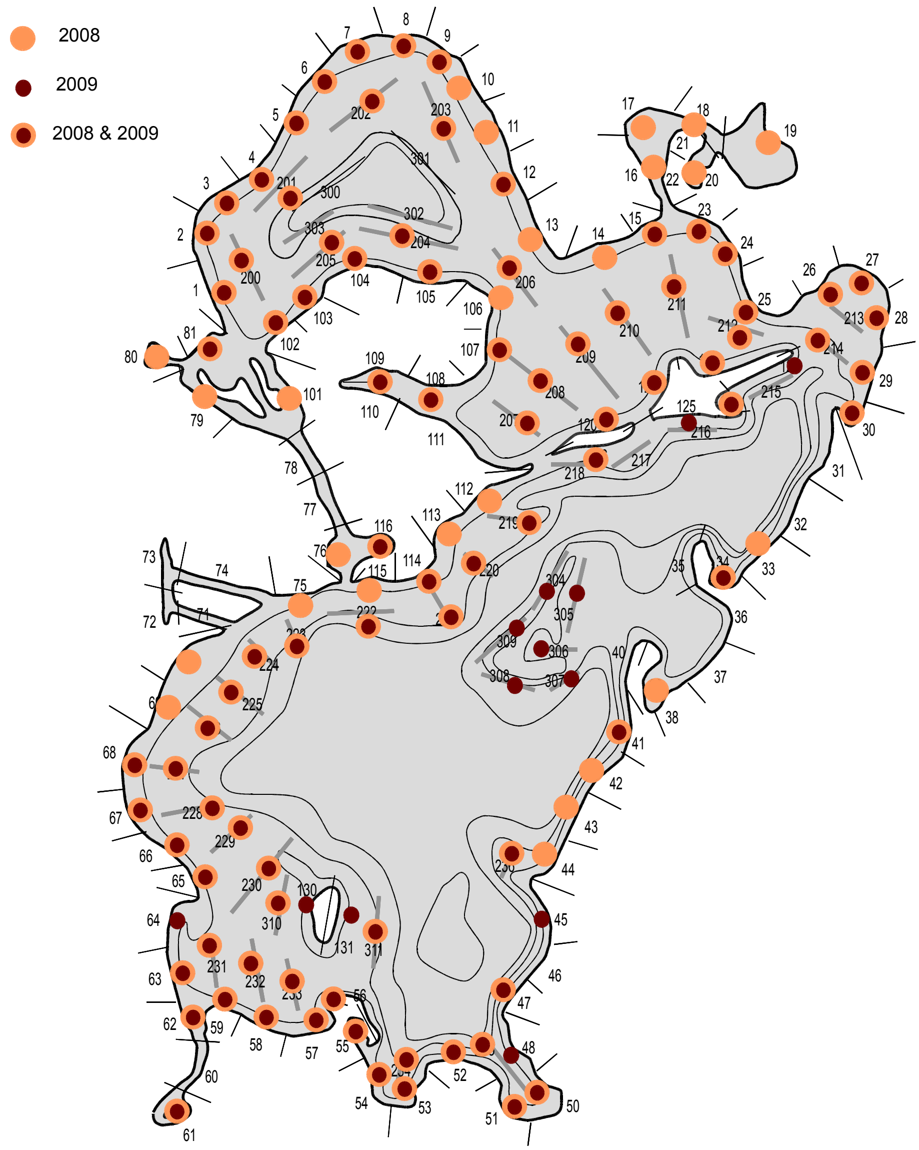
Other Plants:

The diversity of plant species found at most BOS's is considered to be good in White Lake and similar to the level observed in many other Michigan lakes. Normally management activities are focused, selectively on a few offending species. Unfortunately, most of the BOS's in White lake support the nuisance production of several species. These may include, depending on the site: Milfoil, weedy pondweed, curly leaf pondweed and possibly wild celery. Fortunately, the ecological integrity of White Lake can be maintained as the near shore areas of the lake are managed to achieve broad spectrum control of plant species in these areas.

Bio observation sites (BOS's) in White Lake that support the mean number or more plant species found at at all BOS's in 2009.



Bio observations sites where starry stonewort was observed in 2008 and 2009.



AQUEST TIP:

Rationale for Managing Aquatic Vegetation

The need to manage aquatic vegetation arises when vegetation cover and biomass become sufficiently high to disrupt the natural balance of a lake and interfere with recreation. This type of growth is often referred to as nuisance or invasive. Excessive growth of aquatic plants interferes with nearly all forms of recreation and causes many biological problems. 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, conditions which are detrimental to fish and other aquatic life. Production of desirable sport fish (e.g., largemouth bass) is maximized at intermediate levels of plant cover and biomass. Excessive plant cover makes it difficult for larger fish to capture smaller food fish, which can lead to reduced production of larger piscivorous fish and to stunted populations of small forage fish.

Invasive exotic aquatic plants (i.e., plants that do not naturally occur in the same geographical area) often produce particularly severe problems. Exotic species, such as Eurasian watermilfoil (*Myriophyllum spicatum* L.) and curly leaf pondweed (*Potamogeton crispus* L.), expand rapidly to supplant native vegetation and form dense monospecific beds. Compared with most native aquatic plants, these exotic species concentrate their stems and leaves at the water surface. Thus they interfere with recreation to a much greater degree than comparable quantities of native plants. Not all lakes are equally likely to be severely affected by invasive exotic plants. Generally lakes that are characterized by highly developed shorelines and lakes that are subjected to intense recreational use are most susceptible to invasive species problems.

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 nuisances. 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, some areas in every lake should be set aside for little or no management in order to preserve species that are sensitive even to selective controls.

2010 White LAKE MANAGEMENT PLAN RECOMMENDATIONS

Vegetation Management

Milfoil is considered to be a co-dominant weed in White Lake. Control activities are required to protect and preserve recreational values and according to LakeScan analysis will have moderate negative impacts on lake quality indices. The emergence of herbicide tolerant milfoil biotypes emphasizes the need for aggressive management action. Starry stonewort production will certainly require suppression in nearshore areas.

Nuisance Species Management Options

A combination of herbicides should be applied to all inhabited nearshore areas after the Memorial Day holiday. The intent of this application is to provide broad spectrum control of all plant species to facilitate access to the open water for shoreline residents. A second herbicide application, of smaller magnitude will be required in mid to late July to control the growth of late season weed species.

Copper algaecides are effective for the control of starry stonewort. They should be applied where needed for starry stonewort control in 2010. It is recommended that starry stonewort control operations be conducted concurrently with the weed control operations in 2010 to prevent milfoil from quickly dominating those areas where starry stonewort is managed.

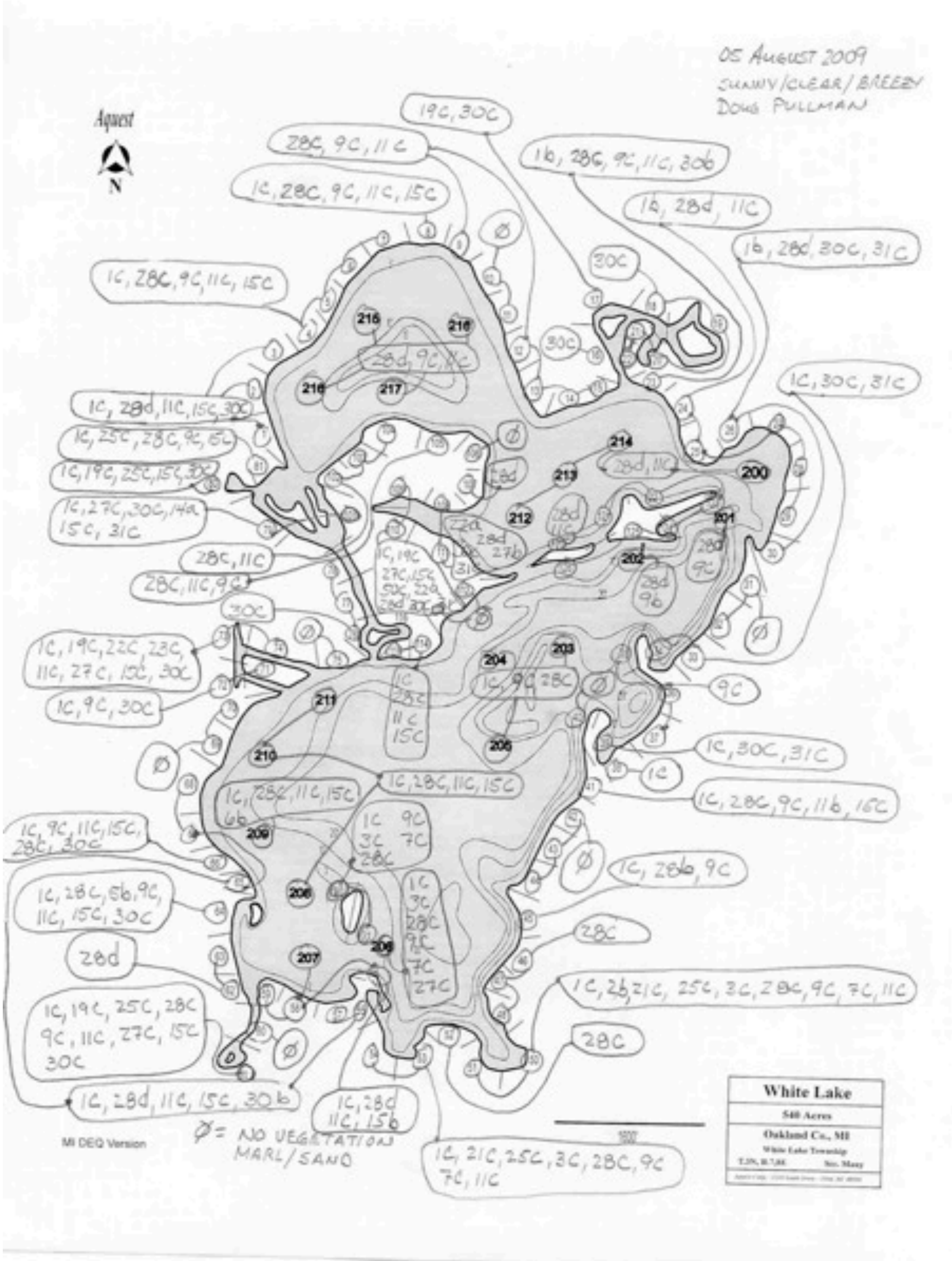
PROPOSED BUDGET 2010

Provided by Aqua Weed Control

Appendix 1.

Michigan Department of Environmental Quality Required Documents.

- ~ AVAS (BOS) map
- ~ AVAS Tabulation Form


05 AUGUST 2009
SUNNY/CLEAR/BREEZY
DOUG PULLMAN
Aquest
N
White Lake
540 Acres
Oakland Co., MI
White Lake Township
MI DEQ Version
Ø = NO VEGETATION
MARL/SAND

LAKE NAME: White Lake COUNTY: Oakland SURVEY DATE: 5-Aug-09

Standard Aquatic Vegetation Summary Sheet SURVEY BY: Aquest Corp., 1110 South Dr., Flint, MI 489503, 810-237-8893

		Total number of AVAS's for each Density Category				Calculations				Sum of Previous Four Columns	Total Number of AVAS's	Quotient Column 9 divided by Column 10		
		A	B	C	D	Category A x 1	Category B x 10	Category C x 40	Category D x 80					
Code No.	Plant Name	1	2	3	4	5	6	7	8	9	10	11	Code No.	Plant Name
1	Eurasian watermilfoil	0	6	52	0	0	60	2,080	0	2,140	125	17	1	Eurasian watermilfoil
2	Curly leaf pondweed	0	2	0	0	0	20	0	0	20	125	0	2	Curly leaf pondweed
3	Chara	0	0	7	0	0	0	280	0	280	125	2	3	Chara
4	Thinleaf pondweed	0	0	0	0	0	0	0	0	0	125	0	4	Thinleaf pondweed
5	Flatstem pondweed	0	1	0	0	0	10	0	0	10	125	0	5	Flatstem pondweed
6	Robbins pondweed	0	1	0	0	0	10	0	0	10	125	0	6	Robbins pondweed
7	Variable pondweed	0	0	7	0	0	0	280	0	280	125	2	7	Variable pondweed
8	Whitestem pondweed	0	0	0	0	0	0	0	0	0	125	0	8	Whitestem pondweed
9	Richardsons pondweed	0	1	37	0	0	10	1,480	0	1,490	125	12	9	Richardsons pondweed
10	Illinois pondweed	0	0	0	0	0	0	0	0	0	125	0	10	Illinois pondweed
11	Large leaf pondweed	0	1	57	0	0	10	2,280	0	2,290	125	18	11	Large leaf pondweed
12	American pondweed	0	0	0	0	0	0	0	0	0	125	0	12	American pondweed
13	Floating leaf pondweed	0	0	0	0	0	0	0	0	0	125	0	13	Floating leaf pondweed
14	Water stargrass	2	0	0	0	2	0	0	0	2	125	0	14	Water stargrass
15	Wild Celery	0	4	32	0	0	40	1,280	0	1,320	125	11	15	Wild Celery
16	Sagitteria	0	0	0	0	0	0	0	0	0	125	0	16	Sagitteria
17	Northern milfoil	0	0	0	0	0	0	0	0	0	125	0	17	Northern milfoil
18	M. Verticillatum	0	0	0	0	0	0	0	0	0	125	0	18	M. Verticillatum
19	M. herterophyllum	0	0	5	0	0	0	200	0	200	125	2	19	M. herterophyllum
20	Coontail	0	0	0	0	0	0	0	0	0	125	0	20	Coontail
21	Elodea	0	0	4	0	0	0	160	0	160	125	1	21	Elodea
22	Utricularia vulgaris	4	0	2	0	4	0	80	0	84	125	1	22	Utricularia vulgaris
23	Bladderwort-mini	0	0	2	0	0	0	80	0	80	125	1	23	Bladderwort-mini
24	Buttercup	0	0	0	0	0	0	0	0	0	125	0	24	Buttercup
25	Southern naiad	0	0	7	0	0	0	280	0	280	125	2	25	Southern naiad
26	Brittle naiad	0	0	0	0	0	0	0	0	0	125	0	26	Brittle naiad
27	Sago pondweed	0	2	8	0	0	20	320	0	340	125	3	27	Sago pondweed
28	Starry Stonewort	0	1	40	41	0	10	1,600	3,280	4,890	125	39		Starry Stonewort
29		0	0	0	0	0	0	0	0	0	125	0		
30	Nymphea	0	6	34	0	0	60	1,360	0	1,420	125	11	30	Nymphea
31	Nuphar	0	0	11	0	0	0	440	0	440	125	4	31	Nuphar
32	Brazinia	0	0	0	0	0	0	0	0	0	125	0	32	Brazinia
33	Lemna minor	0	0	0	0	0	0	0	0	0	125	0	33	Lemna minor
34	Spirodella	0	0	0	0	0	0	0	0	0	125	0	34	Spirodella
35	Watermeal	0	0	0	0	0	0	0	0	0	125	0	35	Watermeal
36	Arrowhead	0	0	0	0	0	0	0	0	0	125	0		
37	Pickerelweed	0	0	0	0	0	0	0	0	0	125	0		
38	Arrow Arum	0	0	0	0	0	0	0	0	0	125	0		
39	Cattails	0	0	0	0	0	0	0	0	0	125	0		
40	Bulrushes	0	0	0	0	0	0	0	0	0	125	0		
41	Iris	0	0	0	0	0	0	0	0	0	125	0		
42	Swamp Loosestrife	0	0	0	0	0	0	0	0	0	125	0		
43	Purple Loosestrife	0	0	0	0	0	0	0	0	0	125	0		
44	Smartweed	0	0	2	0	0	0	80	0	80	125	1	62	Smartweed