2008 Lake Manitou Aquatic Vegetation Management Plan Update, Fulton County, IN February 27, 2009

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Executive Summary

SePRO Corporation was contracted by the Indiana Department of Natural Resources (IDNR) to update the 2005 Lake Manitou long-term integrated aquatic vegetation management plan. Funding for development of this update was obtained from IDNR. SePRO completed an update in 2007 following the first season of Sonar treatments for control of hydrilla (*Hydrilla verticillata*). Items covered in this update include the 2008 sampling results and discussion, a review of the 2008 vegetation management effort, and updates to the budget and action plans.

The focus of the Lake Manitou vegetation management has shifted due to the discovery of hydrilla in August 2006. Eradication of hydrilla is currently the primary aquatic plant management goal for Lake Manitou. Hydrilla is an exotic invasive species that can form a dense population that disrupts ecosystems, displaces native species, and impairs fish and wildlife habitat. This was the first confirmed case of hydrilla in the Midwest. Hydrilla can be easily spread through fragmentation. Control of this species took precedent over all other aquatic vegetation management in Lake Manitou.

Hydrilla is described as "The Perfect Aquatic Weed" due to its growth habit, multiple modes of propagation, and other competitive advantages compared to some native plant species (Langeland 1996). Hydrilla could rapidly spread inter-lake and intra-lake to depths of 20-feet or more (depending on water clarity), displace most other submersed vegetation, and severely restrict boating and other recreational activities. IDNR took quick action by closing all ramps, public and private, on the lake, and contracted the application of a fast-acting contact herbicide (i.e. Komeen; a.i. chelated copper) to reduce the potential for spread of vegetative fragments. Komeen was applied to approximately 20 acres of hydrilla (the Poet's Point area in the northern section of the lake, and near the City ramp).

The Indiana Department of Administration and IDNR issued a Request For Proposal for hydrilla eradication on Lake Manitou on January 26, 2007. SePRO was awarded a three year contract for the hydrilla eradication project, and quickly teamed with ReMetrix LLC (Carmel, IN), Aquatic Control, Inc. (Seymour, IN) and Aquatic Weed Control, Inc (Syracuse, IN) to complete the project. Fluridone treatments were initiated in 2007 with the objective of maintaining >6 ppb for 180 days. Fluridone applications began on May 18th with a bump application on June 26th. Applications were completed with a combination of Sonar AS and Sonar Q. A Tier II aquatic vegetation survey was completed on May 31 and indicated that hydrilla was severely damaged by the initial treatment. No hydrilla was detected during the August 27 Tier II survey. Hydrilla tuber sampling was completed just prior to and five months after initial treatment and revealed hydrilla tuber numbers were significantly reduced (88% total reduction – previously reported first year tuber attrition of 86% in 2007 LVMP due to reporting error) from pretreatment densities, however, as expected viable tubers remained.

Modifications were made to the 2008 treatment prescription in an attempt to increase selectivity and to utilize the lowest amount of herbicide possible. Sonar pellet

formulations were switched from Sonar Q, which was applied throughout the littoral zone in 2007, to Sonar PR, which was only applied to areas where hydrilla was previously documented and in a small inflow area. In addition, the whole lake concentration was to be maintained above 3 ppb instead of 6 ppb, with more frequent bump applications to minimize exposure of native species to relatively high concentrations.

The 2008 Lake Manitou hydrilla eradication project began on April 10 with a team meeting. The meeting was conducted in order to assign duties and coordinate plans for the 2008 season. Tuber sampling occurred May 12 and 13th. This sampling event was conducted in order to continue to search for sediments containing tubers. As a result of this sampling, a new permanent tuber monitoring station was established along the north shore.

Sonar treatments were initiated on May 14. Sonar PR was applied to 19 different locations where hydrilla had been documented in previous surveys and one location at the inflow. Sonar AS (6 ppb) was spread evenly over the entire lake. Bump applications were completed on June 30th, August 19th, and October 8th. A combination of Sonar AS and PR were applied during the June and August bumps while only Sonar AS was applied during the October bump. Tier II vegetation surveys were completed on June 16 and August 27. No hydrilla was detected during either survey, Chara (*Chara spp.)* was the dominant vegetation in both surveys. Following the June Tier II survey, IDNR opened the public boat launch. However, during the June 26th reconnaissance survey, four hydrilla plants and fragments, with significant herbicide injury, were detected floating along the north shore. This was the only confirmed observation of hydrilla during the 2008 season, with the exception of sprouting tubers. The six permanent tuber sampling sites were sampled on September 19th. Sampling indicated that a 43% reduction in the tuber bank occurred as a result of the 2008 treatment. Tuber reduction as a result of the 2007 and 2008 treatments is estimated at 93%, but viable tubers remained.

The hydrilla control efforts on Lake Manitou have been extremely successful in taking steps towards the stated goal of eradication. At a minimum it is depleting hydrilla tuber densities, preventing new hydrilla tuber production, and minimizing the potential for hydrilla to spread to other waters in the region. The following is a list of planned actions specifically designed to continue toward the goal of hydrilla eradication in Lake Manitou:

1. Continue with similar Sonar applications and residue monitoring in 2009, localizing Sonar PR to areas previously identified with hydrilla, and maintaining dosing at critical levels with Sonar A.S.

2. Complete two Tier II surveys and regular reconnaissance surveys in order to monitor the treatment effectiveness and impacts on native vegetation, as well as survey for hydrilla.

3. Focus tuber sampling efforts to the permanent monitoring stations in the fall (September/October), and cancel collection events in the spring that primarily focused on finding sediments that contained tubers. State-approved modifications

to the methods used to target hydrilla may occur and may be needed in future years. Increased sampling is expected as tuber densities decrease. Modifications to existing plans will take into consideration tuber densities, distribution, and attrition level in relation to control methods. Additionally, a goal for consecutive sampling events without finding tubers at the monitoring stations will be considered before aborting the active control phase of the eradication program.

4. Maintain ramp closures and boat inspections during periods when vegetative hydrilla is likely or known to be present, and continue monitoring adjacent lakes and lakes within the watershed for hydrilla. The actions to eradicate and isolate hydrilla to Lake Manitou have, without question, reduced the potential for spread to other waters in Indiana and the Midwest.

5. IDNR should continue with public education efforts in an attempt to prevent additional hydrilla introductions to Lake Manitou and other lakes in the region.

6. Monitoring the tuber bank is crucial, and increased sampling intensity should be anticipated. Based on modeling, it will take longer than three years to deplete the tuber bank even with no new tuber production. Therefore, a program outline and goals for the subsequent three years of the hydrilla eradication plan should be developed. There should be continued consultation with others (e.g. personnel from other states and other researchers) that are working with monoecious hydrilla to develop the subsequent strategy.

Acknowledgements

Funding for vegetation sampling, herbicide treatment, and preparation of the aquatic vegetation management plan was provided by the IDNR. Aquatic Control, Inc., Aquatic Weed Control, Inc., ReMetrix LLC, and SePRO completed the fieldwork, data processing, and map generation. Special thanks to Mr. Doug Keller, Invasive Species Coordinator from the IDNR, for his assistance on this plan. In addition, special thanks are given to the Lake Manitou Association for their assistance with this project. Authors of this report are Mr. Nathan Long of Aquatic Control, Inc., Dr. Tyler Koschnick and Mr. Bob Johnson of SePRO, and Mr. Doug Henderson of ReMetrix LLC. The authors would like to acknowledge the valuable input from the staff of SePRO, Aquatic Control, Inc., Aquatic Weed Control, Inc., and ReMetrix LLC.

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1.0 INTRODUCTION

This report was created in order to update the Lake Manitou Aquatic Vegetation Management Plan. In 2004, the Lake Manitou Association was awarded a grant through the Lake and River Enhancement (LARE) program to complete the original Lake Manitou Aquatic Vegetation Management Plan. Aquatic Weed Control completed the original plan in March of 2005 (Donahoe & Keister 2005). The Association was awarded grants again in 2005 and 2006 to update the plan and these updates were also completed by Aquatic Weed Control (Donahoe & Keister 2006 & 2007). The Indiana Department of Natural Resources (IDNR) took over funding vegetation management on Lake Manitou in 2007 following the discovery of hydrilla. SePRO completed the most recent vegetation management plan update in March, 2008 (SePRO 2008). The following management goals were established by the original plan:

1. Develop or maintain a stable diverse aquatic plant community that supports a good balance of predator and prey fish and wildlife species, good water quality, and is resistant to minor habitat disturbances and invasive species.
2. Direct efforts to preventing and/or controlling the negative impacts of aquatic invasive species.
3. Provide reasonable public access while minimizing the negative impacts on plant and wildlife species (Donahoe & Keister 2005).

Lake Manitou is an 809-acre lake located in Fulton County, Indiana. The primary purpose of the vegetation sampling and this plan update is to document hydrilla eradication activities and to adjust the management plan as needed following the discovery of hydrilla into Lake Manitou in 2006. Items covered include the 2008 sampling results, a review of the 2008 vegetation management activities, and updates to the action plan. Once reviewed and approved, the update should be included in the original vegetation management plan, following the 2007 update but prior to the appendix.

The original Lake Manitou Aquatic Vegetation Management Plan was created in 2004 and updates were completed in 2005, 2006, and 2007. The control of Eurasian watermilfoil was the primary objective of the previous plan and updates. This changed in August of 2006 when IDNR discovered hydrilla during a routine Tier II survey. This discovery precipitated a rapid response by IDNR Invasive Species Coordinator, Mr. Doug Keller.

Upon confirmation of the species, access to the lake was immediately closed to the public to prevent the potential for spread through boats and boat trailers (Figure 1.0.1). The ramps were only open at predetermined times during 2006, 2007 and early 2008 to allow those living around the lake an opportunity to get their boats on the lake or remove them for winter storage. During these times, boats were inspected for potential hydrilla fragments. The IDNR public ramp was opened on June 28, 2008 and was still open at the time of the creation of this update. The decision to open the ramps was based upon the results of the June 16, 2008, Tier II survey which did not detect any hydrilla or hydrilla

fragments, and based on the fact that no vegetative hydrilla was identified in 2007 after the middle of June.

Figure 1.0.1. Public notices posted at Lake Manitou public launches.

Hydrilla is an exotic invasive species that can form dense populations that disrupt ecosystems, displace native species, and impair fish and wildlife habitat. It has unique physiological and biological characteristics that can create a competitive advantage over many native submersed plant species, and has been termed "The Perfect Aquatic Weed" (Langeland 1996). Hydrilla has a low light and CO_2 compensation point compared to some native submersed plant species (Van et al. 1976); can switch between C_3 and C_4 carbon utilization under limiting conditions (Rao et al. 2002); forms dense canopies at the water surface which limits light penetration (Haller and Sutton 1975); and can have up to 85% of its biomass in the top 2 feet of water. Hydrilla can create an environment that is difficult for other plant species to effectively grow and compete (Figure 1.0.2). If hydrilla was not eradicated or the spread contained, it likely would rapidly spread to other waters, form monocultures of vegetation, impede recreation, reduce biodiversity, and result in biological pollution in many shallow lakes of Indiana. Eradication of hydrilla is now the primary goal of vegetation management in Lake Manitou.

Figure 1.0.2. Example of the ecological and recreational impacts that hydrilla can cause.

Lake Manitou was the first confirmed location of hydrilla in the Midwest. Hydrilla is the number one aquatic plant problem in the U.S. with more money expended on management than for any other aquatic plant species. Other states have taken aggressive approaches against hydrilla recognizing the potential impact this species can have on recreation, water conveyance, biodiversity, and water use. California legislatively mandated an eradication program after the plant was identified in the State in 1976; Washington and Maine enacted eradication programs shortly after identifying hydrilla; hydrilla was discovered in Wisconsin in 2007 with eradication efforts underway; and recently hydrilla was identified in New York, Idaho, and Kansas with aggressive control programs being initiated. Many of these programs have, at a minimum, minimized the potential for further spread of hydrilla within the state by keeping the population at the lowest possible level and decreasing vegetative production.

Hydrilla can be easily spread through fragmentation, so control of this species took precedence over all other aquatic vegetation control efforts on Lake Manitou. Shortly after discovery, IDNR personnel mapped the hydrilla population in Lake Manitou and contracted Aquatic Weed Control, Inc., to treat approximately 20 acres of hydrilla in the lake with Komeen (a.i. chelated copper) (the Poet's Point area in the northern section of the lake, and near the City ramp). The treatment was effective in controlling extant hydrilla biomass in the treatment areas to reduce potential for vegetation spread in Lake Manitou and downstream. Further surveys conducted independently by IDNR personnel and SePRO personnel (Figure 1.0.3) confirmed additional sites in the lake with hydrilla. This led to a Request For Proposal (RFP) for a comprehensive hydrilla eradication program for Lake Manitou.

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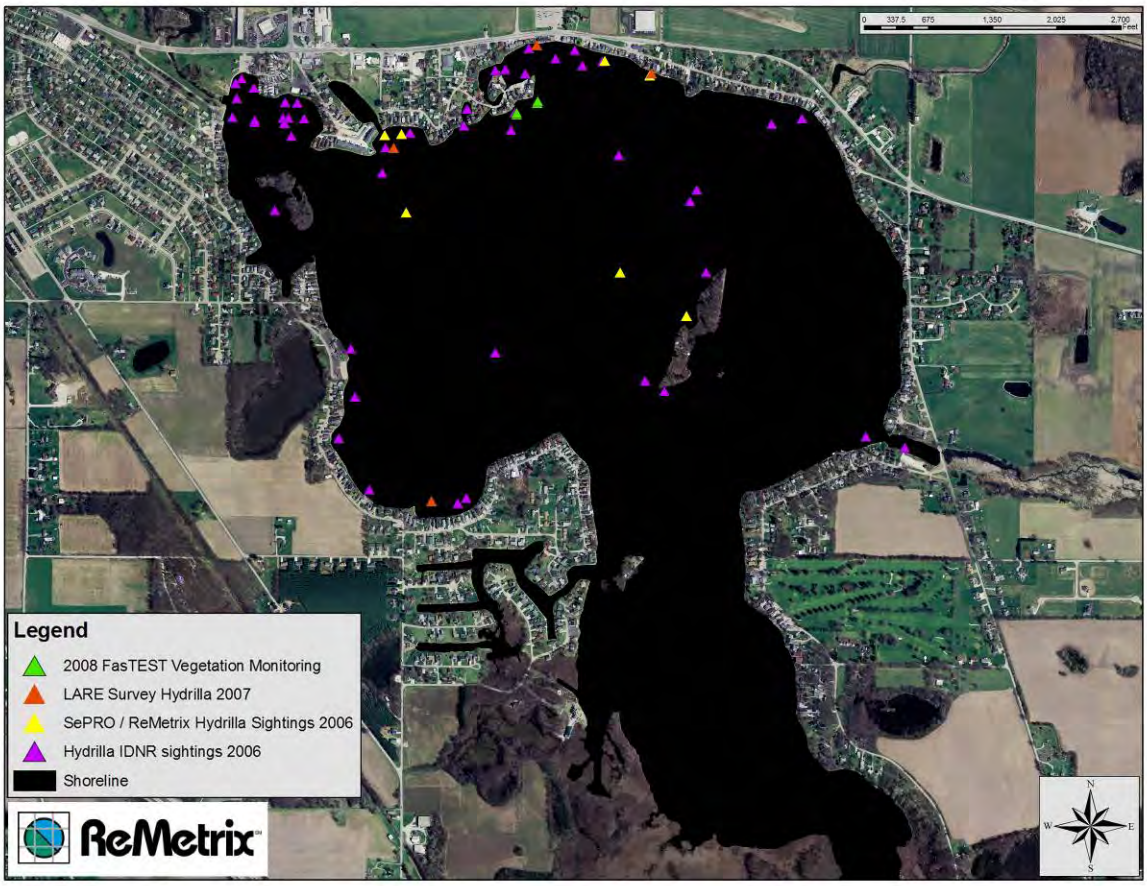

Figure 1.0.3. Lake Manitou hydrilla sightings 2006-2008.
(Includes all sightings recorded by the project team and IDNR.)

SePRO Corporation was awarded a three-year contract and assembled a team focused on the management of vegetation in Lake Manitou, with the objective of hydrilla eradication. The team consisted of personnel from Aquatic Control, Inc., Aquatic Weed Control, Inc., ReMetrix LLC, and SePRO. Fluridone treatments were initiated in 2007 with the objective of maintaining > 6 ppb for 180 days. Applications were on May 18 with a bump application on June 26. Applications were completed with a combination of Sonar AS and Sonar Q. A Tier II aquatic vegetation survey was completed on May 31 and indicated that hydrilla was severely damaged by the initial treatment. No hydrilla was detected during the August 27 Tier II survey. Hydrilla tuber sampling was completed just prior to and five months after initial treatment and revealed hydrilla tuber numbers were significantly reduced (88% total reduction) from pretreatment densities, however, as expected viable tubers remained. In addition to the tuber reduction, the treatment program also provided successful control of hydrilla biomass throughout the 2007 season.

In 2008 the hydrilla eradication team remained the same and a similar program was initiated. The following sections will detail the eradication program along with future Lake Manitou aquatic plant management plans.

2.0 SAMPLING METHODS

Vegetation survey methods varied little from 2007 with the exception of the spring tuber sampling along with minor adjustments to the reconnaissance surveys. Hydrilla tuber sampling was initiated on May 12th in order to continue to search for sediments that may contain relatively high densities of tubers to establish additional permanent monitoring stations. As a result of this effort, a sixth permanent station was established. On September 15th, sampling was conducted at all six permanent tuber sampling stations to monitor depletion of the tuber bank. Standard Tier II surveys (Indiana Department of Natural Resources, 2006) were completed on June 16th and August 27th to monitor hydrilla population and quantify native species abundance. In addition, visual observations of the plant community were recorded throughout the season during FasTEST sampling events. These observations aided in the timing of initial Sonar application, surveyed for potential hydrilla biomass, and provided insight into the progress of the treatments. Table 2.0.1 is a summary of 2008 plant survey activities on Lake Manitou.

Table 2.0.1. Summary of 2008 Plant Surveys on Lake Manitou. 2008 herbicide treatment dates: May 14 (initial Sonar); June 30, August 19, and October 8 (Sonar bumps).

Date (2008)	Type of Survey
May 12-13	Tuber sampling
May 19	Reconnaissance Survey
June 2	Reconnaissance Survey
June 16	Tier II Survey, Reconnaissance Survey
June 26	Reconnaissance Survey
July 14	Reconnaissance Survey
July 28	Reconnaissance Survey
August 11	Reconnaissance Survey
August 27	Tier II Survey
September 2	Reconnaissance Survey
September 15	Tuber sampling, Reconnaissance Survey
September 29	Reconnaissance Survey
October 13	Reconnaissance Survey
November 17	Reconnaissance Survey

2.1 Reconnaissance Surveys

For reference: the initial Sonar treatment was conducted on May 14, 2008; bump treatments were conducted on June 30, August 19, and October 8, 2008. Details of the treatments can be found in Section 4.0.

2.1.1 Pre-treatment Reconnaissance Surveys

Treatment timing was largely based on 2007 data, and confirmed by the Spring tuber sampling event. At that time, hydrilla was found sprouting from tubers with minimal above ground tissue. Treatments were thus initiated (see 2.2.1 for further discussion).

Table 2.1.1. Lake Manitou water temperature profile, May 13, 2008. Thermocline depths are indicated by a thicker line between rows. A consistent lake-wide thermocline depth was not determined on May 13. Data collected by SePRO Corporation.

Waypoint 039		
Depth (m)	Temp (C)	D.O. (mg/L)
Subsurface	15.9	10.59
1	15.8	10.47
2	15.6	10.46
3	14.5	9.69
4	14.2	9.53
5	14.1	9.49
6	13.9	9.24
7	13.4	8.49
8	13.0	7.56
9	9.8	0.11
10	9.0	0.09
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Waypoint 040		
Depth (m)	Temp (C)	D.O. (mg/L)
Subsurface	15.8	10.32
1	15.8	10.12
2	15.6	9.92
3	15.1	9.66
4	14.6	9.35
5	14.5	9.35
6	14.3	9.17
7	14.0	8.76
8	13.8	8.46
9	13.6	8.14
10	13.2	7.22
11	12.9	6.11
12	11.4	0.62

2.1.2 Post-treatment Reconnaissance Surveys

Reconnaissance surveys were completed during each FasTEST collection, and were the most frequent type of survey conducted at the lake (Table 2.0.1). Surveyors followed a pre-established route designed to maneuver over areas of previous hydrilla finds (Figure 2.1.1). Along with collecting FasTEST samples, personnel recorded information at each of the eight sample sites on plant species presence, injury, cover, growth ratings, secchi depth, and surface temperature. Dissolved oxygen/temperature profiles were also taken at FasTEST Site 2. Water samples were collected on two separate occasions at FasTEST Site 2 to monitor orthophosphate, total phosphorus, and chlorophyll *a* (water quality monitoring will be discussed further in Section 3.0). Individual monitoring data sheets are included in the Appendix.

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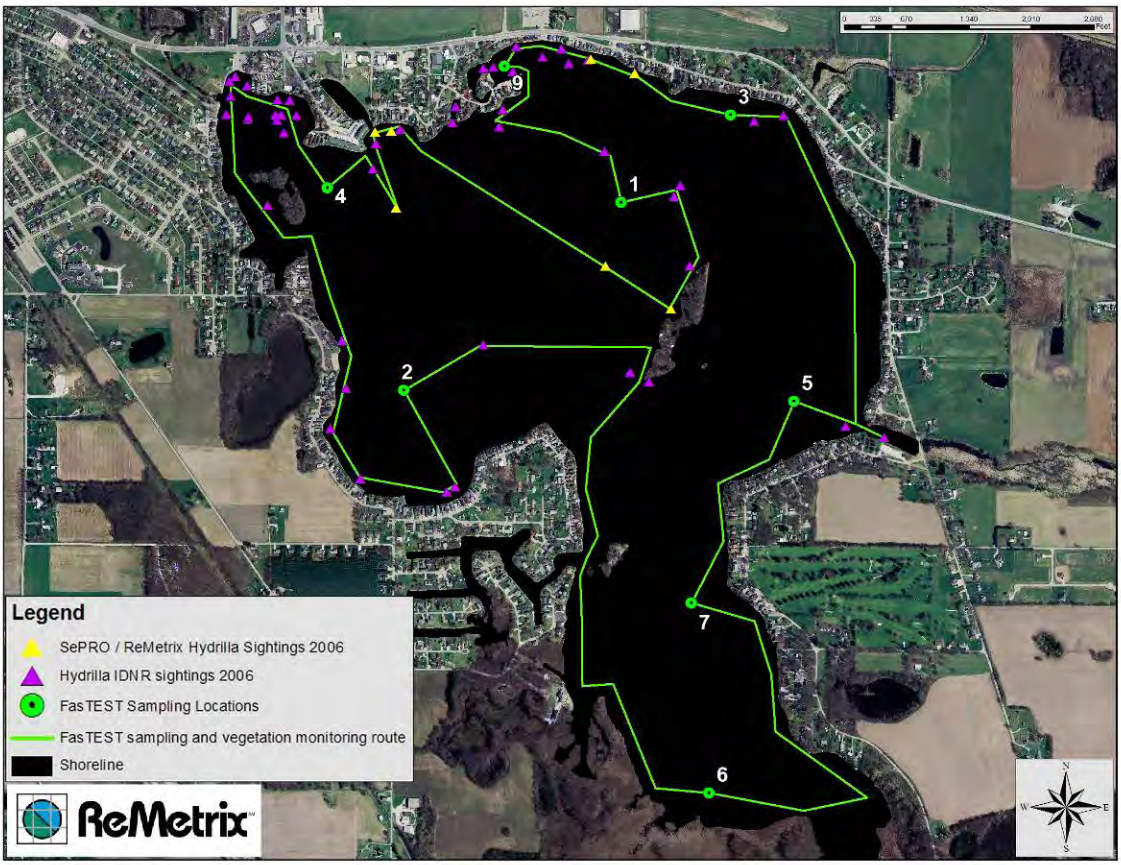

Figure 2.1.1. FasTEST monitoring/vegetation reconnaissance survey route. The green line shows the route. Green points are the FasTEST monitoring sites with corresponding site numbers. Magenta triangles are 2006 IDNR hydrilla finds and yellow triangles are October 2006 hydrilla finds by SePRO. Hydrilla finds are displayed to show that the reconnaissance survey was designed to include some known hydrilla sites as part of the regular monitoring route.

2.1.3 Reconnaissance Survey Discussion

The reconnaissance sampling route was established to provide routine visual observations to monitor plant response to Sonar treatment program, and search for vegetative hydrilla growth. This route and additional random sampling activities were completed on each FasTEST sampling date. Surveying, in conjunction with water sampling, provided a rapid and cost effective means of regularly monitoring the effectiveness of the treatment program. This information, combined with the FasTEST results, contributed to determining the timing and necessity of bump applications. This survey resulted in the only observation and collection of hydrilla found since the initial 2008 Sonar application (with the exception of tuber sampling). Four hydrilla plants and fragments, with significant herbicide injury, were found near the Poet's Point area during the June 26th survey (Figures 2.1.2 and 2.1.3). A summary of the reconnaissance survey results for 2008 is provided below in Table 2.1.2.

Figure 2.1.2. Photos from hydrilla discovery, June 26, 2008.

Figure 2.1.3. Locations of hydrilla discovery, June 26, 2008. Four hydrilla fragments were found.

Table 2.1.2. Lake Manitou FasTEST collection plant monitoring summary.

Collection Date	Surface-T range (°F)	Secchi depth (ft)	Species Observed and Injury Rating[a]
May 19	60.5–62.5	8.5–8.6	Chara (2), sago pw (2), CLP (2)
June 2	72.6–75.1	6.1–7.3	Chara x3 (2), sago pw x3 (2)
June 16	76.1–77.4	3.0–3.6	Chara x2 (2), sago pw (2)
June 26	75.0–76.4	2.1–3.1	Chara x2 (2) *[Note: hydrilla also observed near the survey route]*
July 14	76.1–78.7	2.3–3.1	Chara x3 (2)
July 28	78.5–80.7	2.8–3.6	Chara (2)
Aug 11	74.4–76.9	3.8–4.8	Chara (2)
Sept 2	77.5–80.1	2.9–4.2	n/a
Sept 15	68.9–71.2	4.5–7.0	Chara (not ranked)
Sept 29	69.0–71.8	3.0–6.0	Chara (2)
Oct 13	64.3–67.6	4.5–5.8	Chara (3)
Nov 17	41.7–44.6	4.5–5.6	n/a

[a] Injury rating from 1-6 (1-healthy, 2-slight injury, 3-moderate injury, 4-severe injury, 5-dead plant, 6-not present). CLP = curlyleaf pondweed; sago pw = sago pondweed; n/a = no plants found.

2.2 Tuber Sampling

2.2.1 Spring Tuber Sampling

At the discretion of IDNR, in lieu of sampling for subterranean hydrilla turions (hereinafter referred to as tubers) at the five permanent stations that were established at the start of the hydrilla eradication project (May 2007), new areas were surveyed for tubers during May 2008. The survey was predominately conducted in areas that were not sampled in 2007. The primary focus of sampling was in locations identified by IDNR/SePRO in August 2006 that previously supported hydrilla colonization. IDNR personnel provided GPS coordinates for hydrilla locations identified during the August 2006 aquatic vegetation surveys (Figure 2.2.1). The purpose was to sample at known hydrilla sites that potentially contained sufficient tubers to establish additional permanent monitoring stations. Although the objective of tuber sampling is not to document the distribution of the tuber bank, finding potential areas of high tuber densities would allow for greater accuracy when monitoring the attrition rate of hydrilla propagules. The success and direction of the eradication efforts on Lake Manitou likely will be largely based on the persistence of the hydrilla tuber bank. Ensuring sufficient sample size and effort to monitor the rate of tuber depletion is crucial.

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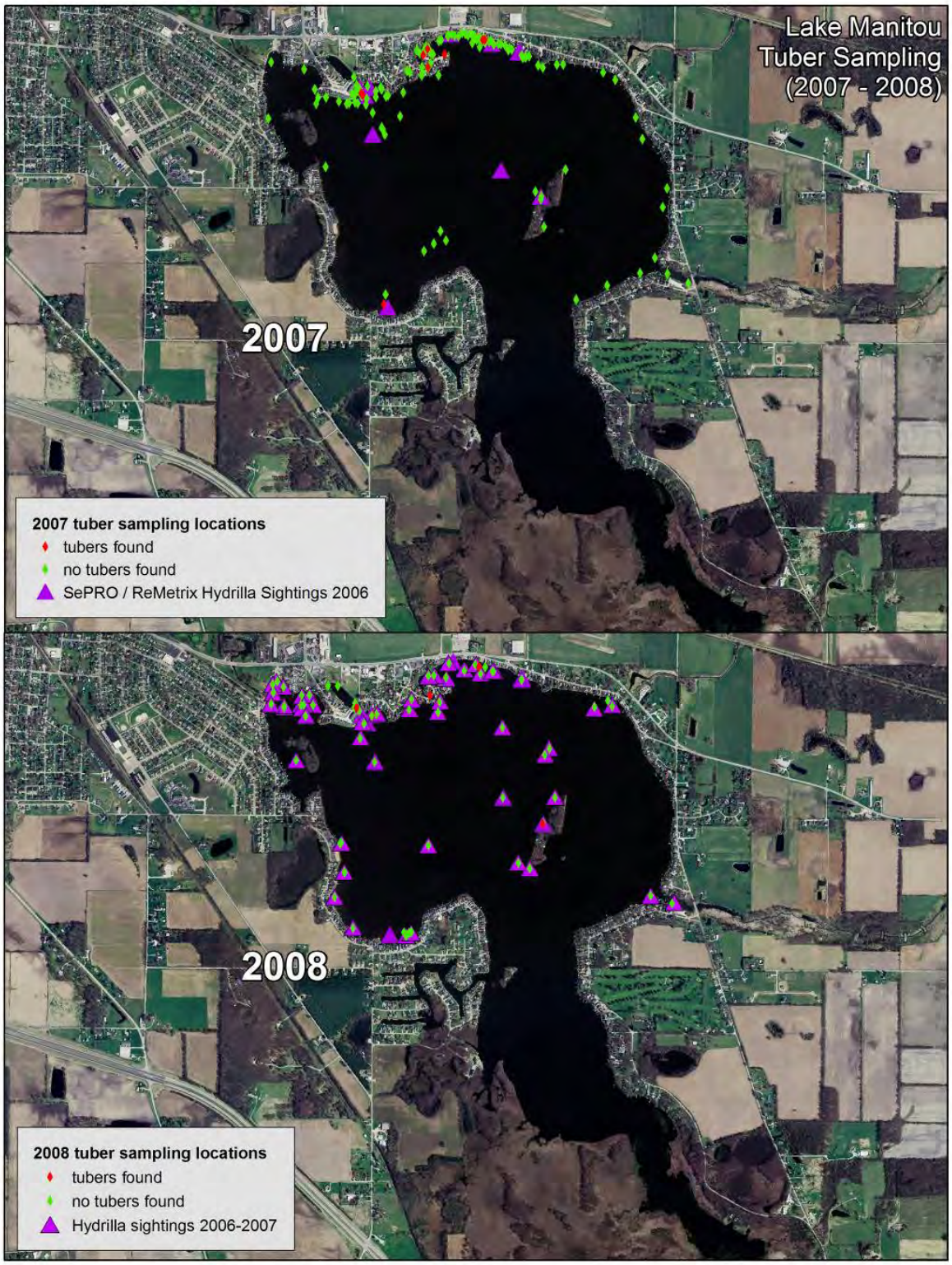

Figure 2.2.1. Tuber sampling locations in 2007 *(upper map)* and 2008 *(lower map)*.

Tuber sampling was conducted May 12 to the 14th, 2008 (Figure 2.2.2). Generally, ten sediment cores were collected around the coordinates where hydrilla was previously

identified, with varying intensity at some sites. No aboveground/vegetative hydrilla was found during the survey. A description of the sediment sampling methods and objectives were previously described in the *Lake Manitou Aquatic Vegetation Management Plan Update, Fulton County, IN, March 14, 2008*. Water temperatures were cooler (maximum 15.9C) compared to May 16th, 2007 (maximum 19.6C), and hydrilla sprouting from tubers were generally shorter in stature compared to those found in May 2007.

Figure 2.2.2. Tuber sampling on Lake Manitou, May 2008.

A total of 710 sediment cores (4-inch diameter, minimum 6-inch depth) were collected from 68 locations, including at 51 out of the 54 GPS coordinates for previous hydrilla finds provided by IDNR (remaining three sites were sampled previously in May 2007). A total of nine tubers were found; all sprouts were less than 2 inches in length and likely just emerging in sediments (Figure 2.2.3). A single sprouted tuber was found at waypoint 069 (lighthouse channel) and a single non-viable tuber was found at waypoint 027 (near island). Due to low abundance of tubers, there was no permanent station established at either of these 2 locations. There were four sprouted and two non-sprouted (dormant or quiescent) tubers found at waypoint 056 along with one floating sprouted tuber. Due to

the relatively high number of tubers found at this site, a permanent tuber monitoring station was established (Station 6 of 6: waypoint 057; Lighthouse Bay - North).

Hydrilla tubers were not found in the cove near the dam, although there were several GPS waypoints identifying hydrilla presence in 2006. It was not clear if hydrilla was rooted previously at these sites or simply floating and unable to form tubers. In subsequent years, any effort to find additional sediments that contain tubers may be concentrated to this area.

Figure 2.2.3. Tubers found on Lake Manitou, May 2008. (One non-viable tuber missing from photo).

This survey again supports the hypothesis that hydrilla was identified in Lake Manitou at an incipient stage due to the lack of a widespread, dense tuber bank (with limitations or ability to sample a broad geography). While recognizing the limited data and the fact the other permanent stations were not sampled, the remaining tubers were sprouting at a relatively high percentage (six of eight viable tubers were sprouting). The two non-sprouted tubers were placed in spring water at room temperature and produced viable sprouts within six days.

2.2.2 Fall Tuber Sampling

On September 15th, 2008 (near the completion of the 2nd year of consecutive whole-lake eradication efforts) the six (6) permanent tuber sampling stations were sampled to monitor tuber abundance (Figure 2.2.4). A total of 19 tubers were collected from 400 core samples: 17 in core samples and two floating (likely dislodged by the core sampler or anchor) (Table 2.2.1). Only tubers found in sediment cores were included in subsequent tables, figures, and analysis. Tubers found sprouting had no obvious above ground stem tissue. Two tubers were found that had sprouted and the tuber was necrotic

with negligible stem tissue (Figure 2.2.5). This could indicate that upon sprouting and emergence from sediments, these plants were immediately controlled under the presence of Sonar. Non-sprouting tubers were placed in spring water at room temperature, and 10 of the 12 tubers produced viable sprouts within two weeks.

Figure 2.2.4. Location of the six permanent tuber sampling stations. Sites 1 through 5 were established May 2007. Site 6 was established May 2008 based on density of tubers found at that location.

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Table 2.2.1. Summary data for six permanent hydrilla tuber monitoring stations sampled September 2008. Fifty 4-inch (0.0876 ft^2=0.167'*0.167'*3.142) core samples were taken from Stations 2, 3, 4 and 5, and 100 cores were taken from Stations 1 and 6.

Site	GPS Waypoint	Sprouting hydrilla tubers	Non-sprouting hydrilla tubers	Sprouting hydrilla turions	Eelgrass tubers / winterbuds	# of core samples
Lighthouse Bay – Station 1	083 T1	0	0	0	0	100
Dollar Store Bay – Station 2	084 T1	4	6	0	0	50
White dock – Station 3	085 T1	0	1	0	0	50
Poet's Point – Station 4	086 T1	0	2	0	0	50
Poet's Bay – Station 5	087 T1	1	1	0	0	50
Lighthouse North - Station 6	057 T1	0 [a]	2	0	0	100
TOTAL	**-**	**5**	**12**	**0**	**0**	**400**

[a] Two floating sprouting tubers located while sampling (not included); one with attached necrotic tuber and other with 3 to 4 inch sprout.

Figure 2.2.5. Photos of hydrilla tubers collected on September 15, 2008. Clockwise from top left: two sprouted tubers at Station 2 (one necrotic tuber); one non-sprouted and one sprouted tuber from Station 5; two non-sprouted tubers from Station 4; two non-sprouted and one rotting tuber from Station 6; one additional sprouted tuber from Station 6 (found floating).

2.2.3 Tuber Sampling Summary (2007 and 2008 data)

Between the combined sampling efforts of 2007 and 2008, a relatively large distribution of Lake Manitou has been surveyed for tubers, with more intense sampling around the Northern shoreline (Figure 2.2.6). Larger samples or sampling larger area could possibly assist in finding additional pockets of tubers, but the areas with high densities of tubers appear to be very isolated. There is increasing evidence that the distribution of hydrilla in

Lake Manitou was likely localized to relatively small colonizing areas prior to initiating eradication efforts with a relatively short period of tuber production.

There was no eelgrass tubers (e.g. winterbuds) found during the 2008 sampling. The dormancy mechanism of eelgrass tubers and survival strategy appears to be very different than hydrilla. There were 328 eelgrass tubers found at the five permanent stations in 2007 (1.3 tubers/core), and 0 in September 2007 (0/core), May 2008, and September 2008 (0/core). Depending on recruitment and desire to have eelgrass as a desired component of the submersed vegetation community on Lake Manitou, it eventually may have to be reintroduced following hydrilla eradication although the Sonar was not expected to have that level of impact on the population. Sonar doses were decreased and application strategy adjusted following year one treatment to enhance potential selectivity without compromising hydrilla efficacy. Sago pondweed tubers were collected, but abundance has not been logged.

The hydrilla management plan on Lake Manitou and associated control methods have been successful at reducing hydrilla tuber densities. Following two consecutive Sonar treatments, sprouting tuber abundance has decreased at the permanent sampling stations from 109 in May 2007 (pre-treatment) to five in September 2008 (Table 2.2.2). Non-sprouting tuber abundance has decreased over that same period of time from 40 to 12. When data are corrected for the sampling effort for each site and date (per number of core samples), the total number of tubers (sprouting and non-sprouting) was reduced by 88% following the 1st year of Sonar treatment, with an additional 43% reduction after the second year; overall tuber abundance has been reduced by 93% from May 2007 to September 2008 (Table 2.2.3). The attrition rate of sprouting tubers has decreased more dramatically than non-sprouted tubers over the same two years. Overall, sprouted tuber abundance has decreased by 98% and non-sprouted tubers by 81%. Non-sprouted tuber abundance was reduced 69% after the first year of Sonar treatment, and an additional 40% following the second year.

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Figure 2.2.6. All sites sampled for hydrilla tubers from 2007 and 2008.

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Table 2.2.2. Tubers found at each permanent monitoring station in sediments for each sample event (nd=not determined).

	Sprouting hydrilla tubers				Non-sprouting hydrilla tubers			
	May 14-17 2007	Sept. 17 2007	May 12-14 2008	Sept. 15 2008	May 14-17 2007	Sept. 17 2007	May 12-14 2008[a]	Sept. 15 2008[d]
Station 1 (WPT83)	8	2[c]	nd	0	0	0	nd	0
Station 2 (WPT84)	16	0	nd	4	21	2	nd	6
Station 3 (WPT85)	34	2	nd	0	14	2	nd	1
Station 4 (WPT86)	40	2	nd	0	2	8	nd	2
Station 5 (WPT87)	11	1	nd	1	3	5	nd	1
Station 6 (WPT57)	nd	nd	4[e]	0[b]	nd	nd	2	2
TOTAL	**109**	**7**	**4**	**5**	**40**	**17**	**2**	**12**

nd = not determined
[a] Non-sprouting tubers were placed in spring water at room temperature, and all were viable producing sprouts on or before May 20, 2008.
[b] Two floating tubers found while sampling or after anchor removal (not included).
[c] Two sprouting tubers (footnoted in 2007 LVMP) found in expanded area at the channel – one at the entrance and exit to the channel on the N side.
[d] Non-sprouting tubers were placed in spring water at room temperature, and 10 of 12 were viable producing sprouts on or before September 30th, 2008.
[e] A single floating tuber was found while sampling or after anchor removal (not included)

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Table 2.2.3. Total number of tubers, corrected for number of core samples, at each station (tubers/core) (nd=not determined).

	Sprouting hydrilla tubers/sediment core (cores)				Non-sprouting hydrilla tubers/sediment core (cores)			
	May 14-17 2007 (250)	Sept. 17 2007 (330)	May 12-14 2008 (50)	Sept. 15 2008 (400)	May 14-17 2007 (250)	Sept. 17 2007 (330)	May 12-14 2008 (50)	Sept. 15 2008 (400)
Station 1 (WPT83)	0.16	0.02	nd	0.00	0.00	0.00	nd	0.00
Station 2 (WPT84)	0.32	0.00	nd	0.08	0.42	0.04	nd	0.12
Station 3 (WPT85)	0.68	0.04	nd	0.00	0.28	0.04	nd	0.02
Station 4 (WPT86)	0.80	0.04	nd	0.00	0.04	0.15	nd	0.04
Station 5 (WPT87)	0.22	0.01	nd	0.02	0.06	0.07	nd	0.02
Station 6 (WPT57)	nd	nd	0.08	0.00	nd	nd	0.04	0.02
TOTAL	**0.44**	**0.02**	**0.08**	**0.01**	**0.16**	**0.05**	**0.04**	**0.03**
% reduction from original [a]	**-**	**95%**	**-**	**98%**	**-**	**69%**	**-**	**81%**

nd = not determined
[a] Previously reported first year tuber attrition of 86% on Lake Manitou due to error in reporting.

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Overall, tremendous impacts have been observed on hydrilla tuber abundance in Lake Manitou following the Sonar treatments in 2007 and 2008 (Chart 2.2.1). Tubers/plants that sprouted under the presence of Sonar were subsequently controlled; hydrilla has unlikely produced any new tubers from May 2007 to November 2008. However, as long as there are non-sprouting tubers, a certain percentage will continue to sprout until tubers become non-viable. The percentage of sprouting tubers will influence the longevity of the tuber bank, and sprouting is also necessary to deplete the population under continuous control pressure. Initially, 73% of tubers were sprouting upon collection in May 2007 (spring) before Sonar treatments were initiated. Sprouting rates have been similar for the two consecutive fall sampling periods (September 2007 and 2008) with 29% of tubers found sprouting upon collection. There likely will be a low percentage of tubers that continue to indiscriminately sprout (Netherland 1997) and the rate of sprouting could change, but an environmental stimulus that encourages broad-scale sprouting is unlikely. It is also expected that the Sonar treatments have depleted the hydrilla axillary turion bank at this point due to their short-term strategy, and only tubers remain.

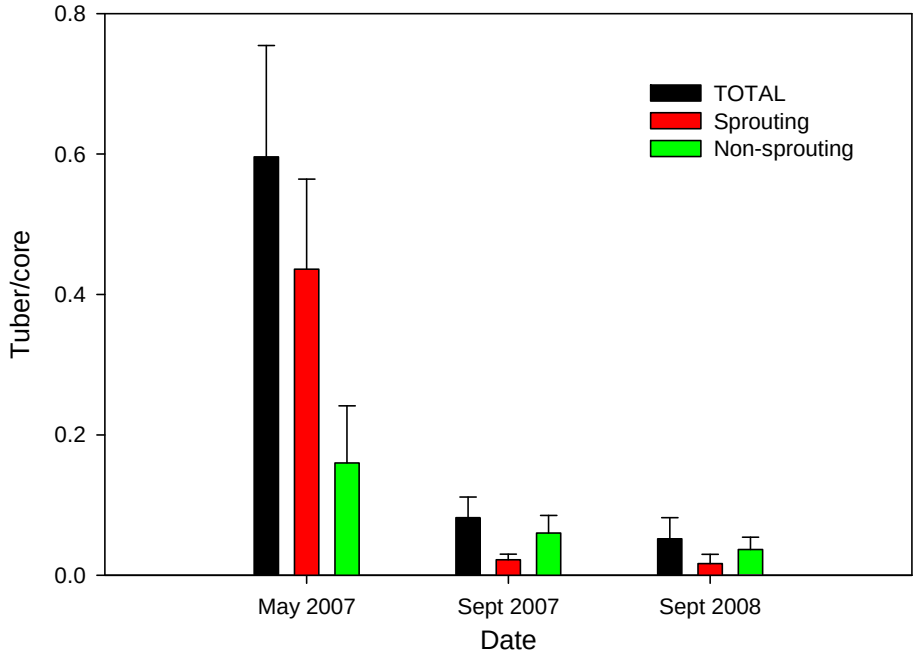

Chart 2.2.1. Overall changes in tuber abundance following two consecutive years of Sonar treatments (spouting + non-sprouting = total).

SePRO has been working in cooperation with Dr. Rob Richardson, North Carolina State University, to analyze attrition rates of monoecious hydrilla tubers from Lake Manitou and sites in N.C. Findings have been presented at various Aquatic Plant Management Society (APMS) annual meetings[†]. From this research, it was hypothesized that the age of the hydrilla population may play a role in the time required to deplete the tuber bank. Tuber abundance decreased by 55 to 88%[‡] after a single year of control, and hydrilla has been present for various years across the sites. If the rate of attrition remained constant, it would take three to seven years to reduce tuber abundance by 99.5% (Nawrocki et al. 2008.). Lake Manitou was estimated to require the shortest time to deplete the tuber bank of the study sites and contained what is suspected to be the youngest known population.

However, as observed on Lake Manitou, the attrition rate will likely vary between years (Table 2.2.3.).

Depending on dormancy and viability, it is hard to predict the longevity of the quiescent tuber bank. Understanding this aspect will likely be the primary factor influencing the decisions for how to continue to progress towards hydrilla eradication on Lake Manitou. Hydrilla is not in a visible state in Lake Manitou. The fact that dormant tubers remain require continued persistence to control them and to ultimately achieve the goal of eradication.

There has been a 93% reduction in total tuber (sprouting+non-sprouting) abundance after the 2 years of whole-lake Sonar treatment (88% year 1 and 43% year 2 =74% annualized reduction). An exponential decay model can be used to calculate longevity of the tubers (with two years of actual data from Lake Manitou) assuming all subsequent reductions are similar to those observed from 2007 to 2008 (43%). It could take 2.6 to 4.5 years to deplete the tuber bank by 99.5 to 99.99% (Chart 2.2.2). Attrition rates may actually be slightly higher as a number of tubers were sprouted upon collection and subsequently would have been eliminated from the tuber bank. Sprouting tubers were considered a component of the overall propagule bank because sprouted tubers can remain viable underground and emerge from sediments months later (Netherland 1999).

There are limitations to the model and it should not be considered absolute. The objective was not to create a definitive model; rather create a guide to establish some level of expectation. It will become more reliable over time. Any decision based on the models should be extremely conservative recognizing the ultimate goal of the eradication program. The time required to achieve a 99.99% (0.01% remain) reduction will depend on the viability and dormancy of the non-sprouting tubers. Sites should continue to be monitored even if no tubers are found during a single sample event, as finding the “last” viable tuber will be difficult. It could take several more years to “eradicate” hydrilla. A goal for consecutive no tuber finds at the monitoring stations should be established before aborting the active control phase of the eradication program. There needs to be consideration of: a) the tuber densities, distribution, and attrition level that would result in a switch to different control methods; b) the number of consecutive years without a tuber find that might result in suspending control activities and/or declaring “eradication”.

The hydrilla control efforts on Lake Manitou have been extremely successful in taking steps towards the stated goal of eradication. At a minimum it is reducing hydrilla tuber densities, limiting new hydrilla tuber production, and restricting the potential for hydrilla to spread to other waters in the region.

Due to limitations of sampling and rapid initiation of the eradication program, it is hard to assume all areas of the lake were identified that may contain viable hydrilla tubers. The objective of sampling has been to find sediments that contained tubers to document attrition rates, although a relatively large geography has been sampled that establishes some depiction of distribution. Continued management on a broader scale is likely necessary at this time even though a relatively small number of hydrilla propagules remain. Unfortunately, there are no practical methods to simply target control of a

dormant tuber, and if a tuber produces a viable sprout under the lack of a control measure, it could quickly reproduce (produce tubers in as little as 30-days).

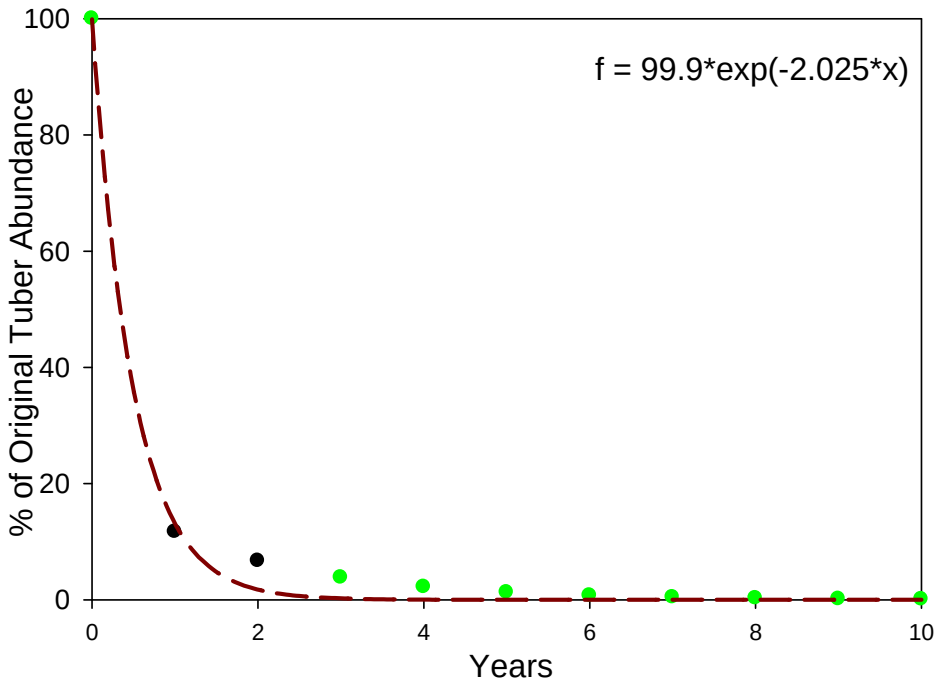

Chart 2.2.2. The attrition rate of hydrilla tubers on Lake Manitou. Year 1 (88%) and 2 (43%) reductions (black dots) are from actual data; all subsequent reductions (years three through 10 – green dots) were based on reductions observed during year two (43%). Dashed line represents predicted attrition rate based on non-linear regression analysis. Includes both sprouting and non-sprouting tubers (% tubers found sprouting: May 2007 = 73%; September 2007 = 29%; September 2008 = 29%).

End notes for Section 2.2.3:

[†]Aquatic Plant Management Society. Joint annual meeting with SCAPMS: Charleston, SC. Monoecious hydrilla tuber bank response to management *(Student Presentation).* J. Nawrocki, A. Gardner, R. Roten, R. Richardson, T. Koschnick, and M. Heilman.

Northeast Aquatic Plant Management Society. Annual meeting: West Dover, VT. Monoecious hydrilla tuber bank response to management and volunteer-based mapping of aquatic weeds. R. Richardson

Midwest Aquatic Plant Management Society. Annual meeting: Sandusky, OH: Relative changes in hydrilla tuber density following applications of Sonar (a.i. fluridone). T. Koschnick, R. Richardson, M. Heilman, A. Gardner, and B. Johnson.

[‡] An error occurred in reporting first-year tuber attrition on Lake Manitou.

2.3 Tier II Surveys

For reference: the initial Sonar treatment was conducted on May 14, 2008; bump treatments were conducted on June 30, August 19, and October 8, 2008. Details of the treatments can be found in Section 4.0.

Tier II surveys were completed on June 16th and August 27th. These surveys were included in the vegetation monitoring program to quantify species diversity and abundance, allow for pre- and post-treatment comparisons of the plant community, and locate additional areas of hydrilla. A total of 121 individual points in the littoral zone were sampled using the Tier II method originally described in Donahoe and Keister (2005) (Figure 2.3.1).

The design of the Lake Manitou point-intercept survey was based on LARE recommendations. Although the Tier II LARE recommendation for an 809-acre lake is to sample 100 randomly selected points within specified depth ranges of the lake, a total of 121 locations were sampled for this survey. Of the 121 sites, seven were located within formerly known hydrilla beds, one was a pre-existing bladderwort site, two were located below the dam, ten were selected by IDNR, and the remaining 101 sites were distributed as a grid within the October 2006 littoral zone according to Tier II depth ranges. The littoral zone was defined for this project using an October 2006 hydroacoustic survey of the lake by ReMetrix. The hydroacoustic data recorded the depths at which submersed vegetation existed in the lake. The littoral zone was defined as the regions of the lake that supported submersed vegetation as of October 2006, and extended to depths of 20 feet. No sampling locations were placed in formerly non-vegetated depths of the lake.

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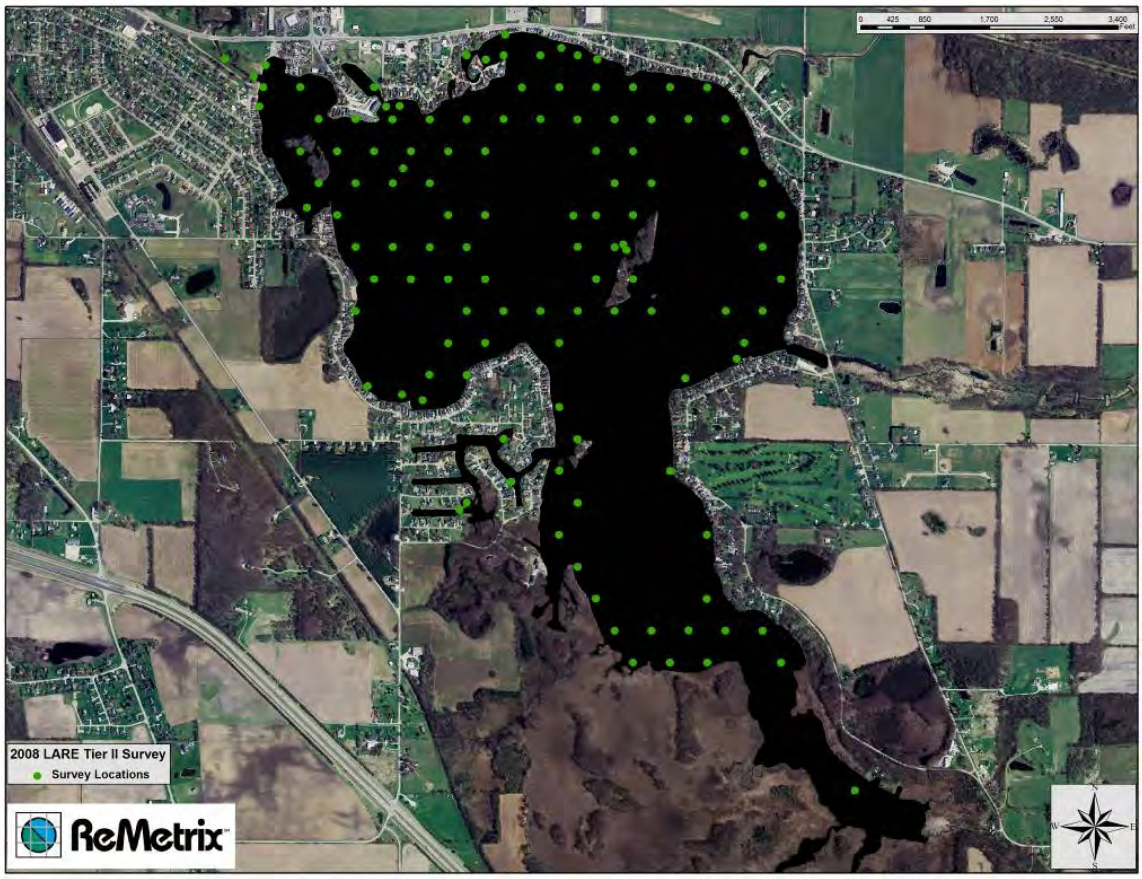

Figure 2.3.1. LARE Tier II vegetation sampling sites (121 sites).

2.3.1 Spring Tier II Survey Results

The spring survey was conducted on June 16th. Vegetation was collected to a maximum depth of 6.0 feet. Aquatic vegetation was present at 54.8% of the sites. Two native submersed plant species were collected. The maximum number of species per site was two, the mean species per site was 0.56. The overall diversity index was 0.20. Table 2.3.1 outlines the plant density and injury ratings used in the survey, and Table 2.3.2 outlines the results of the survey.

Table 2.3.1. Plant rating scales used during the Tier II surveys.

DENSITY RATINGS	INJURY RATINGS
0: No plants retrieved	1: Healthy
1: 1-20% of rake teeth filled	2: Slight Injury
3: 20-99% of rake teeth filled	3: Moderate Injury
5: 100%+ of rake teeth filled	4: Severe Injury
8: Plant present but unranked	5: Dead Plant

Table 2.3.2. Occurrence and Abundance of Submersed Aquatic Plants in Lake Manitou, June 16, 2008.

Occurrence and abundance of submersed aquatic plants in Lake Manitou – June 16, 2008						
County:	Fulton	Sites with plants:	68		Mean species/site:	0.56
Date:	6.16.2008	Sites with native plants:	68		Standard error (ms/s):	0.05
Secchi (ft):		Number of species:	2		Mean native species/site:	0.56
Maximum plant depth (ft):	6	Number of native species:	2		Standard error (mns/s):	0.05
Trophic status	Mesotrophic	Maximum species/site:	2		Species diversity:	0.20
Total sites:	124				Native species diversity:	0.20
Depths 0 to 20 ft	**Frequency of Occurrence**	**Rake score frequency per species**				**Plant Dominance**
Species		**0**	**1**	**3**	**5**	
Chara	50.0	50.0	37.1	6.5	6.5	17.7
sago pondweed	6.5	93.5	4.8	0.0	1.6	2.6
Depths 0 to 5 ft	**Frequency of Occurrence**	**Rake score frequency per species**				**Plant Dominance**
Species		**0**	**1**	**3**	**5**	
Chara	55.9	44.1	40.2	7.8	7.8	20.6
sago pondweed	6.9	93.1	4.9	0.0	2.0	2.9
Depths 5 to 10 ft	**Frequency of Occurrence**	**Rake score frequency per species**				**Plant Dominance**
Species		**0**	**1**	**3**	**5**	
Chara	35.7	64.3	35.7	0.0	0.0	7.1
sago pondweed	7.1	92.9	7.1	0.0	0.0	1.4

Chara was present at the highest percentage of sample sites (50.0%) and had the highest dominance rating (Figure 2.3.2). The only other species collected was sago pondweed (*Potamogeton pectinatus*) which occurred at 6.5% of sample sites (Figure 2.3.3).

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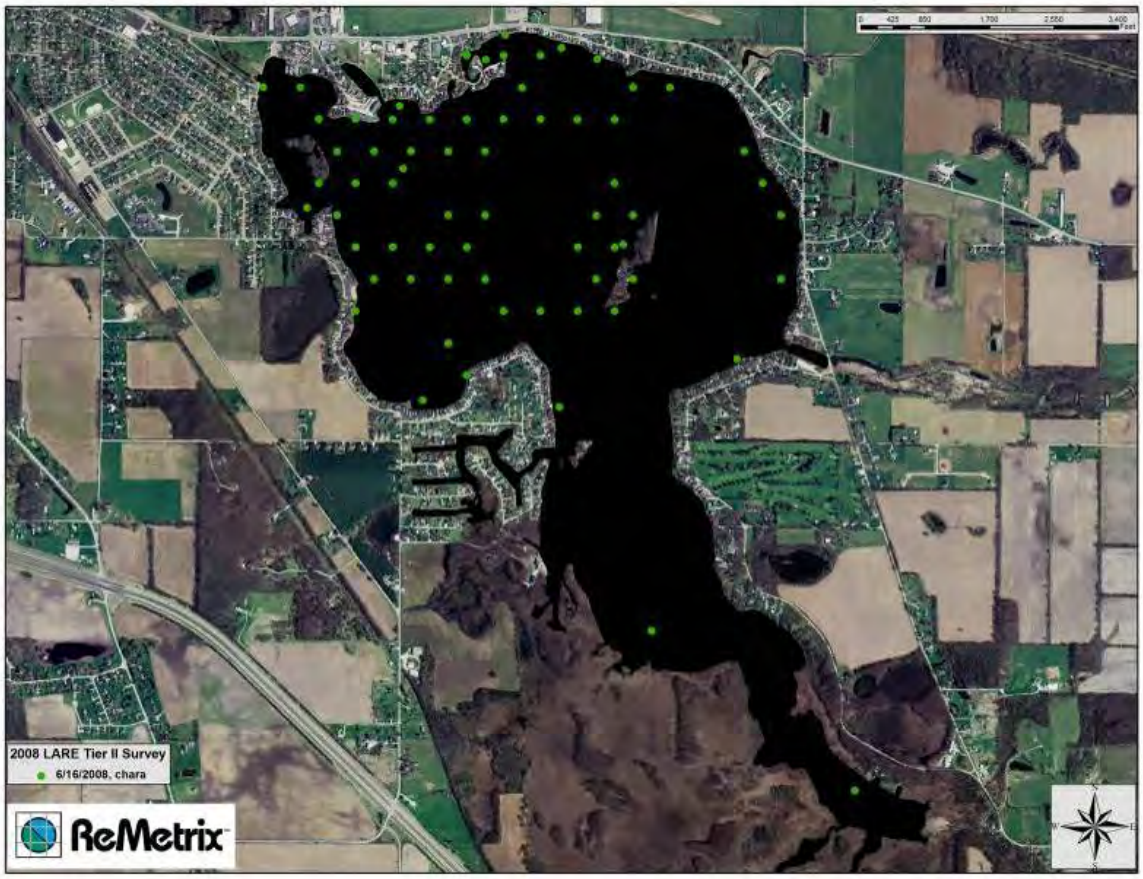

Figure 2.3.2. Chara distribution, June 16, 2008.

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Figure 2.3.3. Sago pondweed distribution, June 16, 2008.

2.3.2 Summer Tier II Survey Results

The same sites and methods described in Section 2.3.1 were utilized again on August 27, 2008 (summer survey). Results of the sampling are listed in Table 2.3.3. Plants were growing to a maximum depth of 10.0 feet. Aquatic vegetation was present at 38.7% of the sites. A total of five species were collected. The maximum number of species per site was two, the mean species collected per site was 0.40, and the species diversity index was 0.26. No exotic species were collected.

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Table 2.3.3. Occurrence and Abundance of Submersed Aquatic Plants in Lake Manitou, August 27, 2008.

Occurrence and abundance of submersed aquatic plants in Lake Manitou – August 27, 2008						
County:	Fulton	Sites with plants:	48	Mean species/site:	0.40	
Date:	8.27.2008	Sites with native plants:	48	Standard error (ms/s):	0.05	
Secchi (ft):		Number of species:	5	Mean native species/site:	0.40	
Maximum plant depth (ft):	10	Number of native species:	5	Standard error (mns/s):	0.05	
Trophic status	Mesotrophic	Maximum species/site:	2	Species diversity:	0.26	
Total sites:	124			Native species diversity:	0.26	
Depths 0 to 20 ft	**Frequency of Occurrence**	**Rake score frequency per species**				**Plant Dominance**
Species		**0**	**1**	**3**	**5**	
Chara	33.9	66.1	32.3	0.8	0.8	7.7
sago pondweed	3.2	96.8	3.2	0.0	0.0	0.6
common coontail	0.8	99.2	0.8	0.0	0.0	0.2
slender naiad	0.8	99.2	0.8	0.0	0.0	0.2
common bladderwort	0.8	99.2	0.0	0.8	0.0	0.5
Depths 0 to 5 ft	**Frequency of Occurrence**	**Rake score frequency per species**				**Plant Dominance**
Species		**0**	**1**	**3**	**5**	
Chara	38.1	61.9	36.2	1.0	1.0	8.8
sago pondweed	3.8	96.2	3.8	0.0	0.0	0.8
common coontail	1.0	99.0	1.0	0.0	0.0	0.2
slender naiad	1.0	99.0	1.0	0.0	0.0	0.2
common bladderwort	1.0	99.0	0.0	1.0	0.0	0.6
Depths 5 to 10 ft	**Frequency of Occurrence**	**Rake score frequency per species**				**Plant Dominance**
Species		**0**	**1**	**3**	**5**	
Chara	14.3	85.7	14.3	0.0	0.0	2.9

Chara was present at the highest percentage of sample sites (33.9%) and also had the highest dominance rating (Figure 2.3.4). Chara was also the only species collected in deeper than 5.0 feet. Sago pondweed ranked second in percent occurrence (3.8%) (Figure 2.3.5). Common coontail (*Ceratophyllum demersum*), slender naiad (*Najas flexilus*), and common bladderwort (*Utricularia vulgaris*) were only collected at single sites in less than 5.0 feet of water (Figures 2.3.6, 2.3.7, and 2.3.8).

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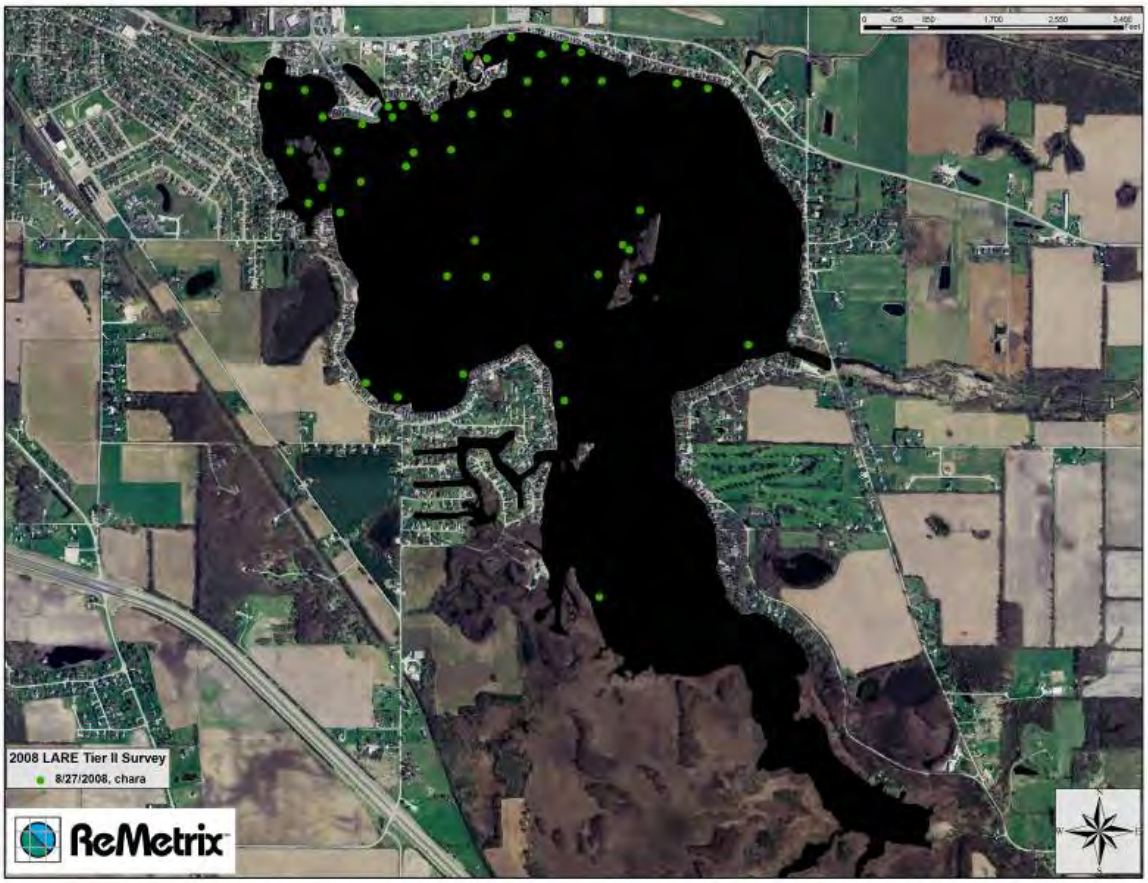

Figure 2.3.4. Chara distribution, August 27, 2008.

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Figure 2.3.5. Sago pondweed distribution, August 27, 2008.

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Figure 2.3.6. Common coontail distribution, August 27, 2008. Only one common coontail site was identified during the August 27 survey.

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Figure 2.3.7. Slender naiad distribution, August 27, 2008. Only one slender naiad site was identified during the August 27 survey.

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Figure 2.3.8. Common bladderwort distribution, August 27, 2008. (The single bladderwort site is circled in yellow to help the reader identify its location.)

2.3.3 Tier II Survey Discussion

For reference: the initial Sonar treatment was conducted on May 14, 2008; bump treatments were conducted on June 30, August 19, and October 8, 2008. Details of the treatments can be found in Section 4.0.

Annual Tier II surveys have been completed on Lake Manitou since 2004. Aquatic Weed Control, Inc. completed surveys in 2004, 2005 and 2006 and Aquatic Control and ReMetrix completed Tier II surveys in 2007 and 2008. The primary objective of this vegetation management plan is the eradication of hydrilla. Hydrilla was detected shortly after the initial Sonar application. No hydrilla was observed or collected during the 2008 Tier II surveys (hydrilla was observed during the June 26th reconnaissance survey). Before the introduction of hydrilla, Eurasian watermilfoil was the primary objective of vegetation management. Milfoil is highly susceptible to low doses of Sonar, and was not collected since the 2006 survey. The Sonar treatment would also be effective on curlyleaf pondweed, and the timing of the application should prevent new curlyleaf turions from being produced.

The hydrilla eradication treatment with Sonar was expected to impact some submersed native plant species (e.g. coontail, naiad, etc.) due to the exposure times that were

maintained throughout the growing season. The treatment protocol called for relatively low levels of Sonar to be maintained for an extended period in order to control hydrilla biomass and plants sprouting from tubers throughout the season. This effect on non-target vegetation was evident when comparing percent occurrence of individual species over the last seven Tier II surveys (Table 2.3.4, Chart 2.3.1). Eelgrass typically dominated the submersed fauna during the summer months, but in 2007 was reduced to 6.6% occurrence and was not collected in 2008. The Sonar treatments were not anticipated to have this level of impact on the eelgrass population. The treatment program was modified in 2008 in an attempt to improve selectivity, although native plant populations were minimal.

Due to the limited number of species present in 2007, the changes to the treatment protocol in 2008 did not immediately result in any significant increase in native species frequency or distribution. The treatments still maintained residues throughout the growing season, albeit at a lower dose than in 2007, and minimized the distribution of Sonar pellets to encourage native plant recruitment. Plants will be recruited that can tolerate sustained exposure to the Sonar doses being applied, but the lake appears to have supported only 6 to 7 native species (and up to 3 exotic species) in years immediately prior to the 2007 initiation of eradication efforts (August 2004, 2005, 2006, and May 2007). (Eleven native species have been recorded since 2004.) The lake had low native species richness and diversity (index <0.74 in August 2006; Table 2.3.5) immediately prior to the 2007 treatments and will likely require some time to increase richness and distribution, and may not occur until after eradication efforts are complete. However, Sonar doses should continue to be targeted at the lowest effective level to encourage native plant recruitment without sacrificing hydrilla efficacy.

Flatstem pondweed, large-leaf pondweed, variable-leaf pondweed, and Illinois pondweed were not detected post-treatment at the 121 sample sites. These species had a relatively low abundance prior to treatment (generally <5%). Increased sampling effort may be necessary to document changes in abundance of these species with small populations, as many of them are relatively tolerant to Sonar doses being applied in 2008.

Chara was the only species with an increase in percent occurrence when compared to pre-treatment Tier II surveys. This was likely due to Chara's high tolerance of Sonar. Chara abundance appears to have increased in areas once dominated by vascular plants.

<Section continued on next page...>

Table 2.3.4. Percent occurrence of species in Lake Manitou in the last seven Tier II surveys.

Species:	% of survey sites identified:						
	Aug 2004[1]	Aug 2005[2]	Aug 2006[3]	May 2007	Aug 2007	June 2008	Aug 2008
hydrilla (*Hydrilla verticillata*)				3.3%			
Eurasian watermilfoil (*Myriophyllum spicatum*)	27.5%	30.0%	2.9%	5.0%			
curlyleaf pondweed (*Potamogeton crispus*)				3.3%			
common coontail (*Ceratophyllum demersum*)	26.4%	11.0%	24.3%	36.4%	7.4%		0.8%
Chara (*Chara spp.*)	12.1%	10.0%	10.0%	24.0%	38.8%	50.0%	33.9%
Naiad species (*Najas spp.*)	11.0%	23.0%					
Slender naiad (*Najas flexillis*)			8.6%				0.8%
sago pondweed (*Potamogeton pectinatus*)	14.3%	16.0%	10.0%	20.7%	0.8%	6.5%	3.2%
eel grass (*Vallisneria americana*)	50.5%	61.0%	42.9%	60.3%	6.6%		
flatstem pondweed (*Potamogeton zosteriformis*)			1.4%	4.1%			
large leaf pondweed (*Potamogeton amplifolius*)				2.5%			
variable pondweed (*Potamogeton gramineus*)				0.8%			
common bladderwort (*Utricularia vulgaris*)					0.8%		0.8%
Illinois pondweed (*Potamogeton illinoensis*)	1.1%	2.0%	5.7%				

[1]Donahoe & Keister 2005. [2]Donahoe & Keister 2006. [3]Donahoe & Keister 2007.

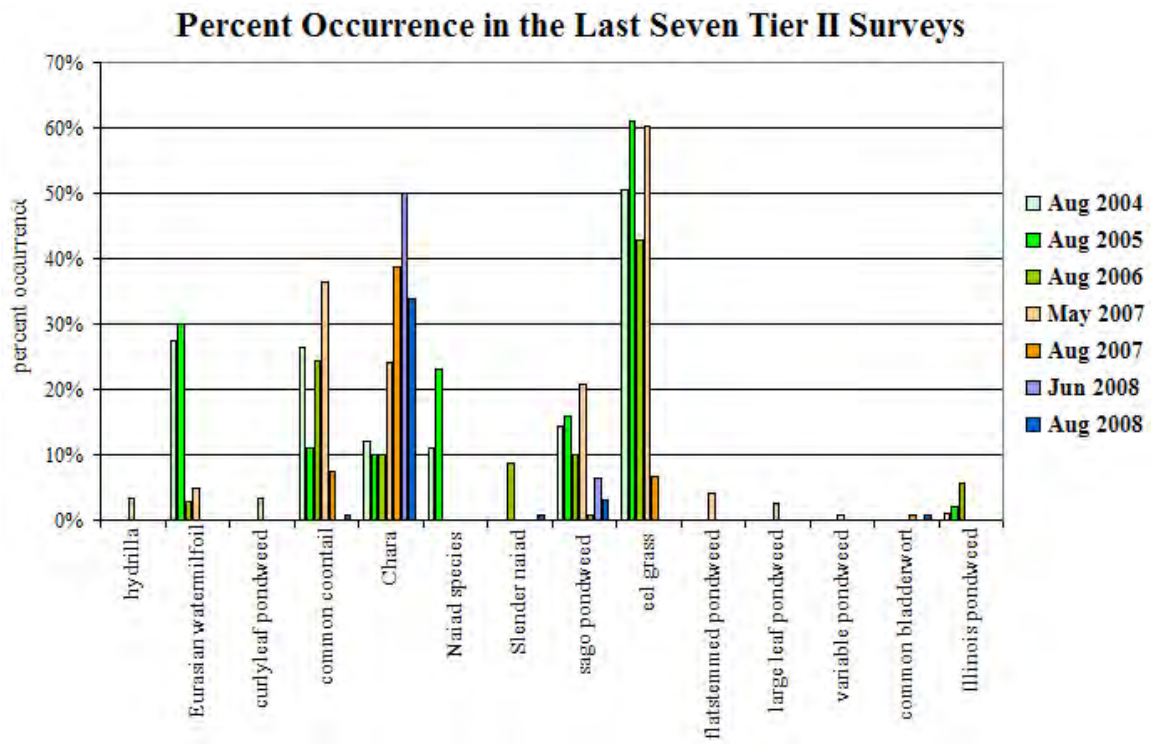


Chart 2.3.1. Percent occurrence of species in Lake Manitou in the last seven Tier II surveys. (Data are from Table 2.3.4).

Tier II surveys not only provide information on species response, they also provide data on lake-wide changes of submersed aquatic plant diversity and abundance. Table 2.3.5, Chart 2.3.2, and Figure 2.3.9 compare the percentage of sample sites with vegetation, native diversity index, and the number of native species collected in the last seven surveys. There is a decline in all post-treatment metrics and these should continue to be monitored over time.

Table 2.3.5. Comparison of number of sample sites, % of sites with vegetation, native diversity index, and number of native species collected in the last seven Tier II surveys at Lake Manitou.

Survey Date	Number of Sample Sites	% of sites with vegetation	Native Diversity Index	Number of Native Species Collected
Aug 2004[1]	95	83.5%	0.72	6
Aug 2005[2]	100	79.0%	0.72	6
Aug 2006[3]	70	56.0%	0.74	7
May 2007	119	92.0%	0.73	7
Aug 2007	111	47.0%	0.46	5
June 2008	121	56.2%	0.20	2
Aug 2008	121	39.7%	0.26	5

[1]Donahoe & Keister 2005. [2]Donahoe & Keister 2006. [3]Donahoe & Keister 2007.

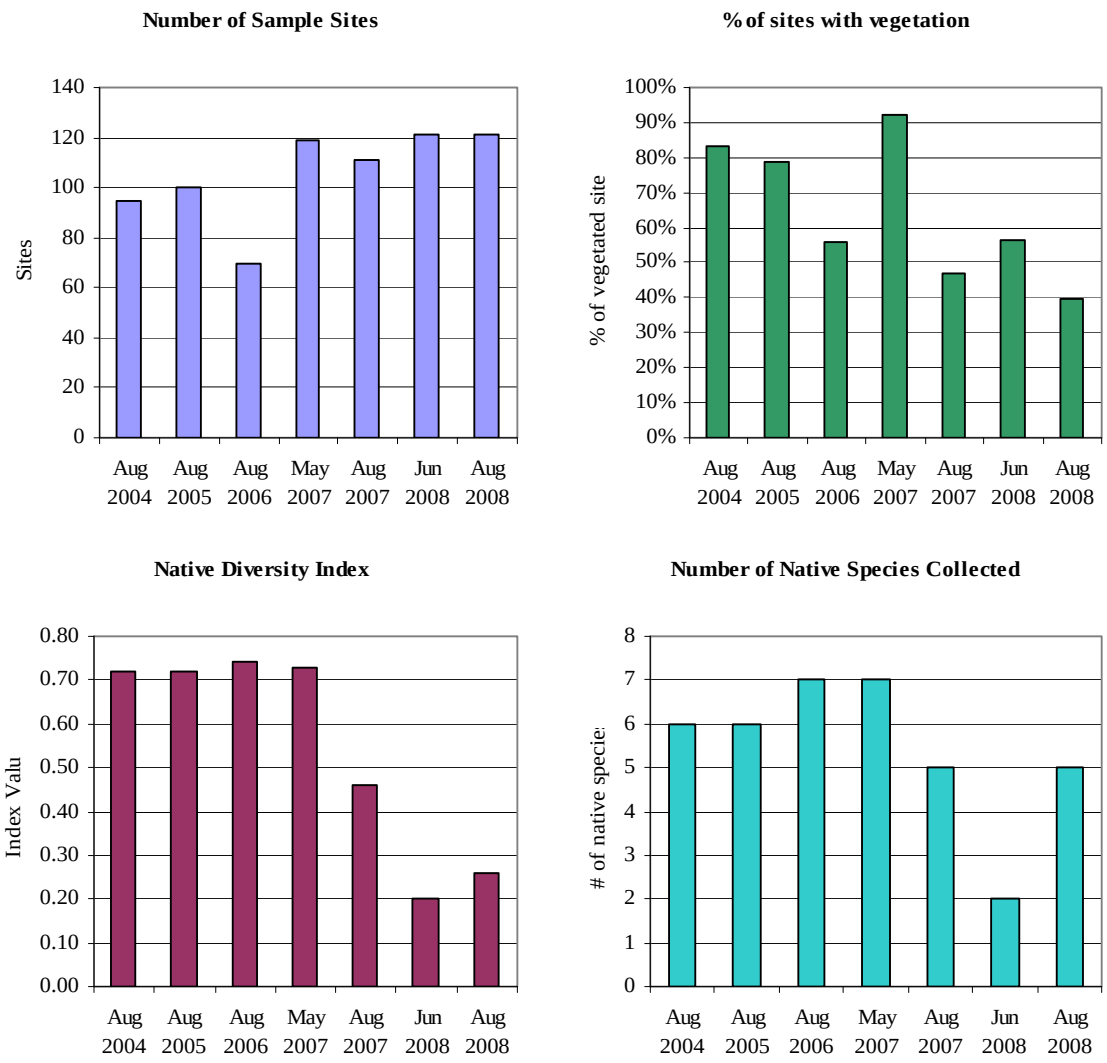


Chart 2.3.2. Comparison of number of sample sites, % of sites with vegetation, native diversity index, and number of native species collected in the last seven Tier II surveys. (Data are from Table 2.3.5.)

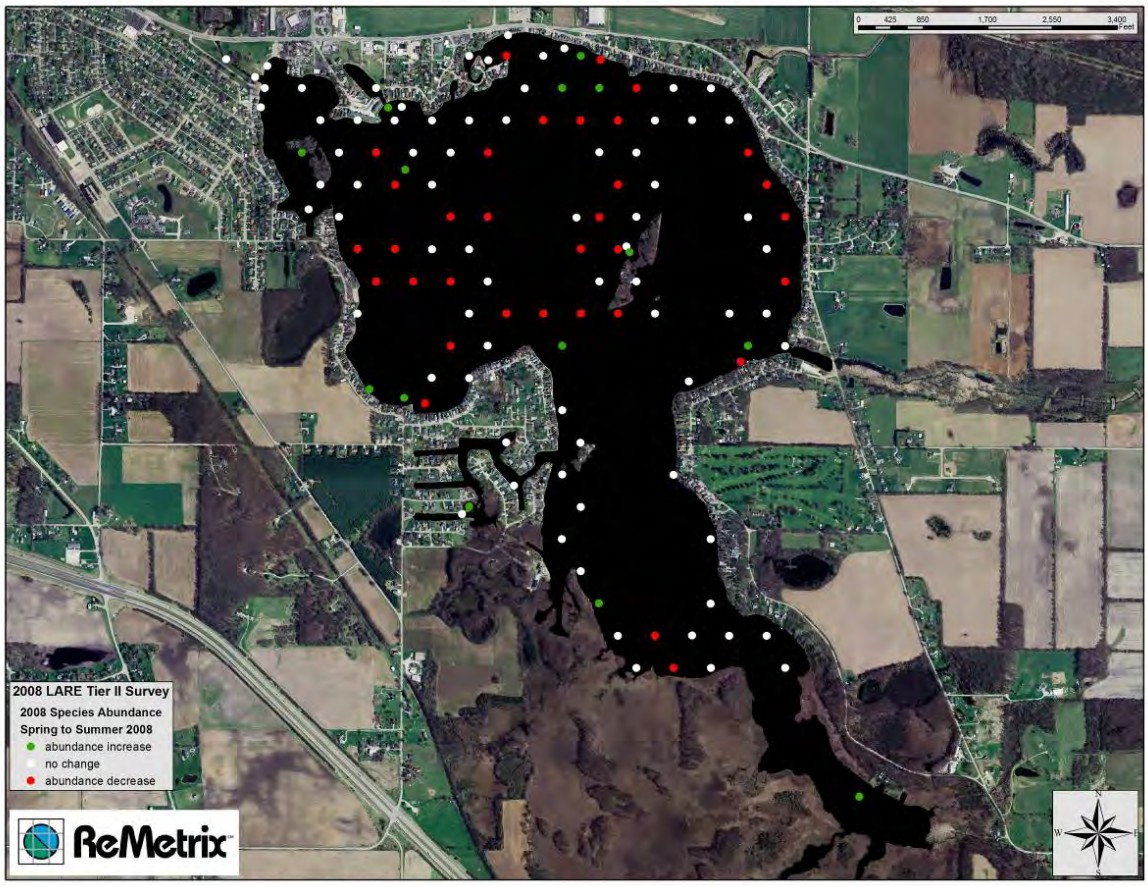


Figure 2.3.9. Lake-wide change in total species abundance, June 16, 2008 to August 27, 2008. Red dots = a decrease in total species found at that site from June to August (e.g., from 4 species to two, or from 1 to 0). White dots = no change in total species. Green dots = an increase in total species found.

The reduction in submersed vegetation decreased nuisance conditions created by several species, allowing for better access for lake users. Submersed vegetation metrics are expected to increase once the hydrilla eradication project is completed, and changes are being made to the application rates attempting to increase selectivity without jeopardizing the primary objective of hydrilla eradication.

2.4 Other Surveys

2.4.1 Hydroacoustic Survey for Precision Sonar Application

ReMetrix completed a bathymetric analysis of Lake Manitou based on hydroacoustic data collected October 5, 2006. A grid of single-beam hydroacoustic depth points were collected across the lake, and data between transects were modeled to create contours and a bathymetric surface for the entire lake. The results of the bathymetric analysis were used to help plan details of all 2007 and 2008 Sonar liquid and granular applications at Lake Manitou. Accurate annual determinations of water volume to treat are calculated based on measured thermocline depth (Table 2.4.1, paired with Table 4.1.1) to ensure accurate Sonar treatments. The data have enabled treatments to achieve more consistent, evenly distributed lake wide Sonar concentrations than would otherwise have been achieved using regular application techniques.

Table 2.4.1. Water volume estimation calculations for Lake Manitou.

Water volume calculations for Lake Manitou								
Mean Depth = 10.67 feet		Total Volume = 8,631 Acre Feet			*Based on hydroacoustic data collected 10-5-06.*		ReMetrix	
Interval (ft)	Surface Acres	Acre Feet	Cumulative Acre Feet		**Interval (ft)**	Surface Acres	Acre Feet	Cumulative Acre Feet
Surface – 1'	808	768	8,631		**23'- 24'**	129	124	1,234
1'-2'	740	719	7,863		**24'- 25'**	121	117	1,109
2'-3'	697	673	7,144		**25'- 26'**	114	111	992
3'-4'	644	609	6,471		**26'- 27'**	108	105	881
4'-5'	565	496	5,862		**27'- 28'**	102	98	776
5'-6'	432	391	5,366		**28'- 29'**	95	91	678
6'-7'	357	334	4,975		**29'- 30'**	88	85	587
7'- 8'	318	307	4,641		**30'- 31'**	82	79	502
8'- 9'	297	288	4,334		**31'- 32'**	76	73	423
9'- 10'	280	273	4,046		**32'- 33'**	69	66	350
10'- 11'	266	260	3,773		**33'-34'**	62	58	284
11'- 12'	254	248	3,513		**34'-35'**	54	51	226
12'- 13'	242	236	3,265		**35'-36'**	47	43	175
13'- 14'	231	225	3,029		**36'-37'**	39	37	133
14'- 15'	220	215	2,804		**37'-38'**	34	31	96
15'- 16'	209	204	2,589		**38'-39'**	28	24	65
16'- 17'	199	194	2,385		**39'-40'**	21	18	40
17'- 18'	189	184	2,191		**40'-41'**	15	11	22
18'- 19'	179	174	2,007		**41'-42'**	8	7	11
19'- 20'	169	164	1,833		**42'-43'**	5	3	5
20'- 21'	159	155	1,668		**43'-44'**	2	1	1
21'- 22'	150	145	1,513		**44'-45'**	<1	<1	0
22'- 23'	140	135	1,368					

2.4.2 IDNR Surveys

In an effort to ensure hydrilla was isolated to Lake Manitou, IDNR conducted several surveys in a 60-mile radius of the lake in 2008 (Table 2.4.2). No hydrilla was detected in these surveys. Additionally, no hydrilla was found in any of the 49 lakes funded by the LARE program for aquatic vegetation management in 2008 (several of these lakes are beyond the 60-mile radius from Lake Manitou).

Table 2.4.2. Water bodies within 60-mile radius of Lake Manitou sampled for plants in 2008. There are 88 lakes/lake groups in the table. IDNR surveyed 66 lakes via Tier II or hydrilla spot-checks; 21 lakes were surveyed via LARE program; Lake Maxinkuckee was contracted to Aquatic Control for hydrilla rake and diver surveys. (Data provided by Doug Keller, IDNR.)

County	Water Body	Survey Method	County	Water Body	Survey Method
Allen	Lake Everett	District 3 Tier 2	Kosciusko	Wyland Lake	D3 spot-check
Elkhart	Simonton Lake	D2 spot-check	Kosciusko	Diamond Lake	LARE
Elkhart	Heaton Lake	LARE	Kosciusko	Hill Lake	LARE
Fulton	Fletcher Lake	Doug spot-check	Kosciusko	Ridinger Lake	LARE
Fulton	Nyona Lake	Doug spot-check	Kosciusko	Silver Lake	LARE
Fulton	South Mud Lake	Doug spot-check	LaGrange	Adam's Lake	D2 spot-check
Fulton	Tippecanoe River	D1 float trip	LaGrange	Atwood Lake	LARE
Grant/Wabash	Mississinewa Lake	District 4 Tier 2	LaGrange	Big Long Lake	District 2 Tier 2
Howard	Kokomo Reservoir	District 4 Tier 2	LaGrange	Cass Lake	District 2 Tier 2
Huntington	Clare Lake	District 4 Tier 2	LaGrange	Emma Lake	District 2 Tier 2
Kosciusko	Backwater/Webster Lakes	LARE	LaGrange	Oliver Lake	D2 spot-check
Kosciusko	Barrel & 1/2 Lake	D3 spot-check	LaGrange	Pretty Lake	District 2 Tier 2
Kosciusko	Beaver Dam Lake	D4 spot-check	LaGrange	Shipshewana Lake	LARE
Kosciusko	Carr Lake	District 4 Tier 2	Lagrange	Little Turkey	LARE
Kosciusko	Center Lake	LARE	Lagrange	Stone and Brokesha Lakes	LARE
Kosciusko	Chapman Lake	D3 spot-check	Lagrange	Wall Lake	LARE
Kosciusko	Dewart Lake	LARE	LaPorte	Clear Lake	LARE
Kosciusko	Goldeneye Pond	D3 spot-check	LaPorte	Pine Lake	D1 spot-check
Kosciusko	Hammond Lake	D3 spot-check	LaPorte	Stone Lake	D1 spot-check
Kosciusko	Kuhn Lake	D3 spot-check	LaPorte	Hudson Lake	LARE
Kosciusko	Lake Wawasee	District 3 and LARE	Marshall	Dixon Lake	Doug spot-check
Kosciusko	Palestine Lake	District 4 Tier 2	Marshall	Koontz Lake	Doug spot-check
Kosciusko	Pike Lake	District 4 Tier 2	Marshall	Lake Maxinkuckee	LMEC contract: Aquatic Control dive
Kosciusko	Price Lake	D3 spot-check	Marshall	Lake of the Woods	LARE
Kosciusko	Shock Lake	D3 spot-check	Marshall	Lawrence Lake	Doug spot-check
Kosciusko	Spear Lake	D3 spot-check	Marshall	Mill Pond	Doug spot-check
Kosciusko	Syracuse Lake	D3 spot-check	Marshall	Pretty Lake	LARE
Kosciusko	Tippecanoe, James & Oswego Lakes	D3 spot-check	Noble	Bear Lake	D3 spot-check
Kosciusko	Waubee Lake	D3 spot-check	Noble	Big Lake	LARE
Kosciusko	Winona Lake	D4 spot-check	Noble	Cree Lake	D3 spot-check

** all surveys are Tier II unless specified as 'spot-check'*

Table 2.4.2 (continued). Water bodies within 60-mile radius of Lake Manitou sampled for plants in 2008. There are 88 lakes/lake groups in the table. IDNR surveyed 66 lakes via Tier II or hydrilla spot-checks; 21 lakes were surveyed via LARE program; Lake Maxinkuckee was contracted to Aquatic Control for hydrilla rake and diver surveys. (Data provided by Doug Keller, IDNR.)

County	Water Body	Survey Method	County	Water Body	Survey Method
Noble	Crooked Lake	D3 spot-check	Noble/Whitley	Crane Lake	District 3 Tier 2
Noble	Diamond Lake	D3 spot-check	Noble/Whitley	Loon Lake	D3 spot-check
Noble	Dock Lake	D3 spot-check	Porter	Long Lake	LARE
Noble	Eagle Lake	D3 spot-check	Pulaski	Bruce Lake	Doug spot-check
Noble	Engle Lake	D3 spot-check	St Joseph	Worster Lake	Doug spot-check
Noble	Knapp Lake	D3 spot-check	St. Joseph	Pleasant Lake	Doug spot-check
Noble	Sacarider Lake	D3 spot-check	Starke	Bass Lake	LARE
Noble	Sand-River Lakes	D3 spot-check	Wabash	Lukens Lake	District 4 Tier 2
Noble	Skinner Lake	District 3 Tier 2	White	Lake Freeman	D1 spot-check
Noble	Smalley Lake	D3 spot-check	White	Lake Shafer	D1 spot-check
Noble	Sparta Lake	D3 spot-check	Whitley	Blue Lake	D4 spot-check
Noble	Sylvan Lake	LARE	Whitley	Round and Cedar Lakes	District 4 Tier 2
Noble	Upper Long Lake	D3 spot-check	Whitley	Shriner Lake	District 4 Tier 2
Noble	West Lakes	D3 spot-check	Whitley	Robinson Lake	District 4 Tier 2

** all surveys are Tier II unless specified as 'spot-check'*

3.0 WATER QUALITY MONITORING

Basic water quality monitoring was included in the management plan to document these parameters throughout the treatment season. Several modifications to the water quality sampling program were made for the 2008 season at the request of Doug Keller, IDNR Invasive Species Coordinator. Sampling stations were reduced from two to one, sampling frequency was reduced from monthly to three samples collected May, July and September. Laboratory analysis parameters were reduced to phosphorous (total and ortho) and chlorophyll *a*. These data are added to this report update and will be compared to past and future data as appropriate.

Water samples were collected at one-foot depths from FasTEST Site 2. Water samples were collected by Aquatic Weed Control, Inc and shipped to GEI Consultants Laboratory in Littleton, Colorado for analysis. This laboratory was utilized because of their low detection limits on phosphorous and nitrogen nutrients (2 μg/L - parts per billion). Chlorophyll detection limits were 0.0001 mg/L (0.1 mg/cubic meter).

In addition to the periodic water quality sampling, an Aquatic Weed Control biologist recorded dissolved oxygen and temperature profiles at FasTEST sample Site 2 on May 19, June 2 & 26, July 14 & 28, August 11, September 2, 15, & 29, October 13 (Table 3.0.1). These data were used to monitor thermocline depths for calculating Sonar bump treatments. The thermocline depth is important in calculating Sonar application rates and placement of Sonar pellets. Sonar generally does not mix below the thermocline, and slight thermal stratification can inhibit mixing into deeper waters. A thermocline defines a narrow, horizontal stratification boundary between cooler, deeper water and warmer, shallow water.

A thermocline is defined as a 1ºC temperature change over a depth of 1-meter. Each stratification zone has a discrete water volume that can be calculated and used to more precisely calibrate treatment rates (Table 2.4.1), often reducing the amount of Sonar applied. However, the thermocline depth changes throughout the season and must continually be monitored.

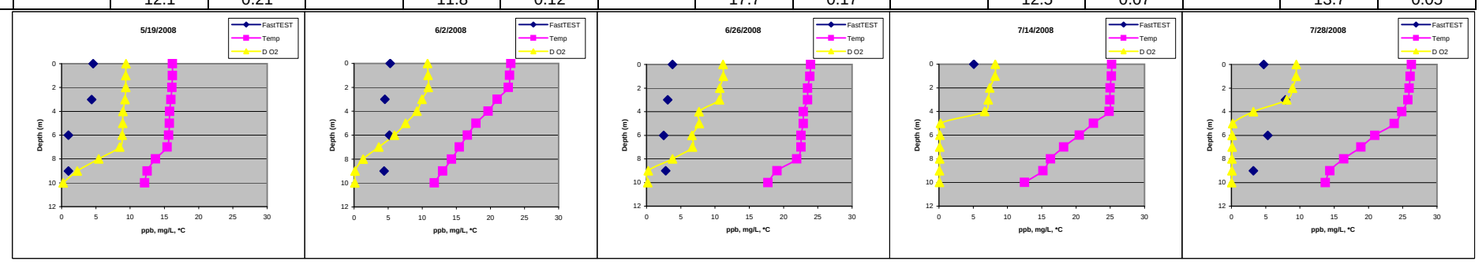
Secchi transparency readings were taken throughout the 2008 season (Table 3.0.2, Chart 3.0.1). Secchi measurements ranged from a maximum of 8.6 feet on May 19 to a low of 2.1 feet on June 26. The secchi reading of 2.1 feet was the lowest on record since 1999 (Table 3.0.3, Chart 3.0.2). Overall, secchi depths in 2008 seemed to average about 0.5-feet less than in 2007, although likely similar when considering variation. The July-August mean was consistent with the lower end of recent July-August means at the lake (1999-2004 and 2007).

Table 3.0.1. 2008 Temperature and Dissolved Oxygen Depth Profiles (FasTEST also included)

Application:

Initial	Bump	Bump 2	Bump 3
5/14/2008	6/30/2008	8/19/2008	10/8/2008

		5/19/2008			6/2/2008			6/26/2008			7/14/2008			7/28/2008		
	DAT -->	5			19			43			14			28		
	Depth (m)	FastTEST	Temp	D O_2	FastTEST	Temp	D O_2	FastTEST	Temp	D O_2	FastTEST	Temp	D O_2	FastTEST	Temp	D O_2
Site 2	0	4.6	16.2	9.40	5.3	23.0	10.76	3.8	23.9	11.15	5.1	25.2	8.21	4.7	26.3	9.47
	1		16.2	9.36		22.8	10.85		23.8	11.20		25.2	8.20		26.1	9.42
	2		16.1	9.35		22.6	10.88		23.5	10.67		25.0	7.39		25.9	8.93
	3	4.4	15.9	9.25	4.5	21.0	9.95	3.1	23.5	10.65		24.9	7.17	7.9	25.8	8.07
	4		15.8	8.96		19.7	9.24		22.9	7.66		24.8	6.66		24.9	3.21
	5		15.7	8.91		17.9	7.55		22.9	7.72		22.6	0.22		23.8	0.18
	6	1.0	15.6	8.86	5.2	16.6	5.91	2.5	22.6	6.65		20.5	0.15	5.3	20.9	0.12
	7		15.4	8.49		15.4	3.64		22.6	6.71		18.2	0.12		18.9	0.10
	8		13.7	5.41		14.3	1.34		21.9	3.79		16.3	0.10		16.4	0.07
	9	1.0	12.5	2.29	4.4	13.0	0.16	2.8	19.1	0.27		15.2	0.08	3.2	14.4	0.06
	10		12.1	0.21		11.8	0.12		17.7	0.17		12.5	0.07		13.7	0.05



		8/11/2008			9/2/2008			9/15/2008			9/29/2008			10/13/2008		
	DAT -->	42			14			27			41			5		
	Depth (m)	FastTEST	Temp	D O_2	FastTEST	Temp	D O_2	FastTEST	Temp	D O_2	FastTEST	Temp	D O_2	FastTEST	Temp	D O_2
Site 2	0	3.8	23.6	7.50	6.0	25.9	7.91	2.7	20.9	7.41	3.2	21.5	8.56	5.5	18.2	11.33
	1		23.4	7.41		25.6	7.98		21.2	7.32		21.3	8.52		18.1	11.39
	2		23.4	7.25		25.4	7.70		21.3	7.25		21.3	8.35		18.0	11.35
	3		23.2	6.85	6.4	25.1	7.47		21.3	7.18	3.2	21.2	8.20	6.3	16.8	11.10
	4		23.1	6.76		24.6	5.51		21.3	7.09		21.2	8.39		16.2	7.95
	5		22.9	6.83		23.4	0.99		21.2	6.48		21.1	7.65		15.9	7.00
	6		22.2	5.26	6.0	22.4	0.20		21.2	6.36	2.4	20.8	6.19	5.2	15.8	5.15
	7		18.3	0.17		17.0	0.13		20.9	4.26		20.0	0.25		15.7	4.06
	8		15.6	0.15		17.6	0.11		18.5	0.26		18.2	0.16		15.7	2.78
	9		14.2	0.12	2.1	15.4	0.09		15.5	0.18	2.9	15.9	0.11	4.6	15.5	0.31
	10		13.1	0.10		15.2	0.07		14.3	0.15		14.1	0.10		15.1	0.19

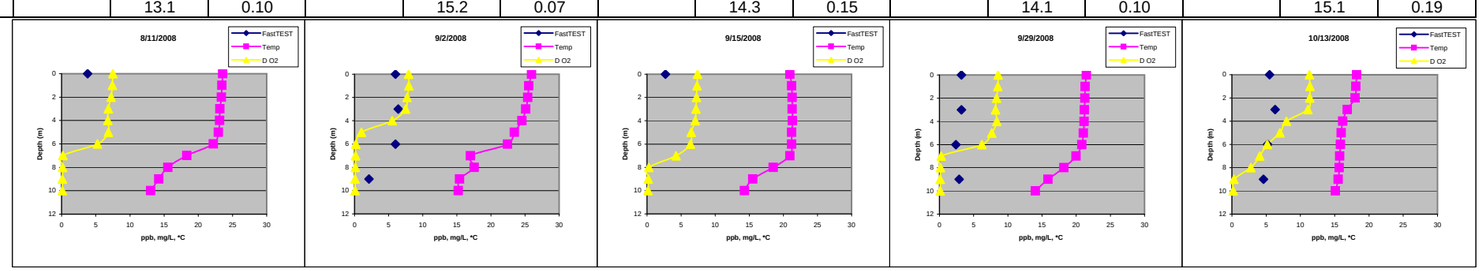


Table 3.0.2. 2008 Secchi depths recorded on Lake Manitou (May to November, 2008).

Site	5/19	6/2	6/16	6/26	7/14	7/28	8/11	9/2	9/15	9/29	10/13	11/17
1	bv: 6.5 ft	bv: 6.5 ft	3.2	2.9	3.0	3.2	4.1	3.2	6.0	5.0	5.0	4.3
2	8.5	7.3	3.5	2.5	2.8	3.1	4.3	4.1	7.0	6.0	5.8	5.3
3	bv: 5 ft	bv: 5 ft	3.0	2.1	2.5	2.9	4.3	3.3	bv: 5 ft	4.5	4.5	4.5
4	bv: 5 ft	bv: 5 ft	3.1	3.1	2.3	2.8	3.8	2.9	bv: 5 ft	3.0	4.7	4.1
5	8.6	6.1	3.6	2.6	3.1	3.0	3.9	4.1	5.0	5.2	5.3	5.1
6	bv: 4 ft	bv: 4 ft	3.5	3.1	2.9	2.9	4.0	3.8	bv: 4 ft	4.0	bv: 4 ft	bv: 4 ft
7	8.5	6.1	3.4	2.9	3.1	3.6	4.8	4.2	4.5	5.1	5.7	5.6
9	n.r.	bv: 5 ft	3.1	2.5	2.3	2.5	bv: 5 ft	2.9	bv: 5 ft	bv: 5 ft	bv: 5 ft	bv: 5 ft
mean	**8.5**	**6.5**	**3.3**	**2.7**	**2.8**	**3.0**	**4.2**	**3.6**	**5.6**	**4.7**	**5.2**	**4.8**

"bv: *x* ft" means the lake bottom was visible at the water depth listed after the colon.
"n.r." means "not reported"
Site locations can be seen in Figures 2.1.1 or 4.2.1.

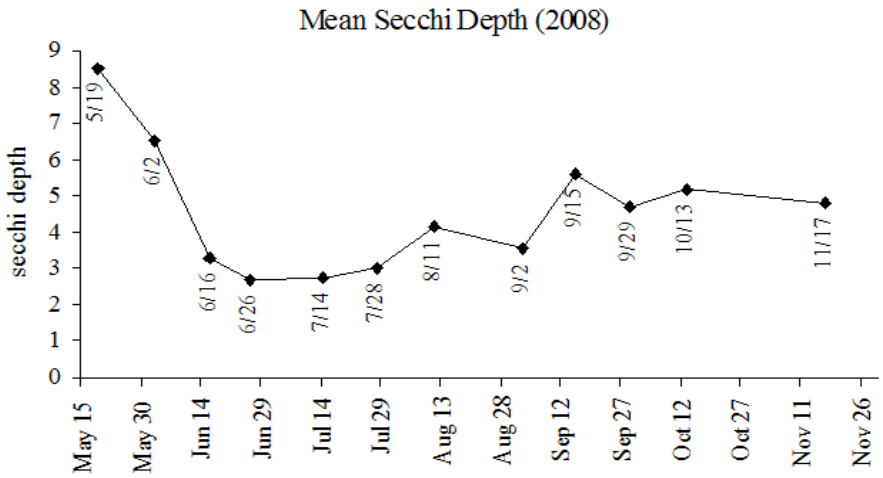


Chart 3.0.1. Mean 2008 secchi disk readings from Lake Manitou. (Data are from Table 3.0.2)

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Table 3.0.3. Summary of secchi depths recorded on Lake Manitou 1999-2008. (1999 to 2004 data from Fascher & Jones 2006.)

	Minimum	Maximum	Jul-Aug Mean	Observations
1999	2.8	5.4	3.1	10
2000	2.6	6.3	3.2	11
2001	2.5	5.5	3.7	13
2002	2.5	7.2	3.8	15
2003	2.5	10.4	3.3	14
2004	2.7	4.1	3.3	12
2007*	2.6	9.0	3.9	80
2008*	2.1	8.6	3.3	95

*2007 & 2008 data are by authors of this report and are added for comparison with historical data.

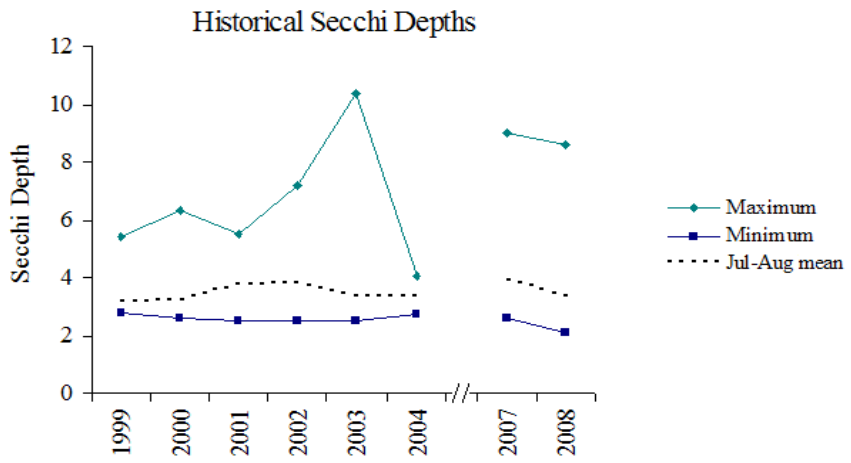

Chart 3.0.2. Historical secchi disk readings from Lake Manitou. (Data are from Table 3.0.3)

Water quality data were collected on three dates in 2008 (Table 3.0.4). No historical ortho-phosphorus measurements were found as a comparison to these results, but total phosphorus and chlorophyll *a* readings were collected from 1999-2004 by the Indiana Volunteer Lake Monitors (summarized in Table 3.0.5). A comparison of the data indicates little change in these metrics following the Sonar treatment. Chlorophyll *a* levels peaked July 28, 2008 but were within historical ranges. The Sonar treatment did not appear to have a deleterious effect on chlorophyll *a* ranges or effect intra-lake nutrient release. Total P ranged from 17 to 38 ppb, and Ortho P reached a maximum of 3 ppb on July 28th.

Table 3.0.4. Water quality data collected from Lake Manitou in 2008.

Sample Date	Total P (µg/L)	Ortho P (µg/L)	Chlorophyll *a* (mg/L)
6/2/08	17	1	0.0071
7/28/08	38	3	0.0124
9/29/08*	21.5	<2	0.0112

*average of two samples from same site

Table 3.0.5. Total phosphorus, ortho-phosphorus, and chlorophyll *a* measurements collected from Lake Manitou, 1999-2008. (Data from 1999 to 2004 from Fascher & Jones 2006.)

	Minimum Total P (µg/L)	Maximum Total P (µg/L)	Minimum Ortho P (µg/L)	Maximum Ortho P (µg/L)	Minimum Chl *a* (mg/L)	Maximum Chl *a* (mg/L)
1999	47.0	63.0	n.a.	n.a.	0.0048	0.0174
2000	58.0	71.0	n.a.	n.a.	0.0097	0.0189
2001	1.8	10.3	n.a.	n.a.	0.0350	0.0660
2002	0.0	7.1	n.a.	n.a.	0.0240	0.0770
2003	2.5	10.4	n.a.	n.a.	0.0200	0.0370
2004	12.3	15.9	n.a.	n.a.	0.0310	0.0660
2007*	15	37	<2	5	0.0038	0.0127
2008*	17	38	1	3	0.0071	0.0124

Chl *a* units originally expressed as µg/L in Fascher & Jones, 2006.
"n.a." means "not available"
*2007 & 2008 data are by authors of this report and are added for comparison with historical data.

Similar to 2007, treatments appeared to have negligible effect on water quality, even though cumulative plant cover has been reduced. It would be beneficial to continue with a similar water quality monitoring program in 2009.

4.0 2008 VEGETATION CONTROL

The eradication of hydrilla was the primary objective of this Lake Manitou Aquatic Vegetation Management Plan. Due to the extensive reproductive capability of monoecious hydrilla through fragmentation, turions, and tubers, an aggressive prescription using the systemic herbicide Sonar was selected for the eradication project. Similar approaches have been taken in the states of Washington, Massachusetts, Maine, Wisconsin, and California.

The initial lack of flow data for Lake Manitou resulted in the preparation of a treatment protocol based on static water conditions, with inclusion of additional "bump" treatments to sustain a Sonar residual in the lake for a period of 180 days at a lethal dose for hydrilla. Subsequent water flow data provided by the Indiana Department of Water indicated relatively long retention times, with a long-term (18-year) average of ~50% volume turnover from the period of April to September. This period would coincide with chemical control operations. However, large rain events cause the retention time to be much shorter (<30 days). Therefore, maintenance of an effective dose of Sonar for hydrilla required regularly scheduled monitoring of Sonar residue and periodic "bump" treatments as necessary.

SePRO collected hydrilla samples from Lake Manitou and conducted a PlanTEST at the SePRO Research and Technology Campus (SRTC) in Whitakers N.C. The PlanTEST is a proprietary test developed by SePRO Corporation that uses key biochemical parameters (Sprecher et al. 1998) to determine the plants inherent susceptibility to Sonar. The test was used to direct Sonar treatment recommendations by providing an indication of concentrations necessary for control. Plants were collected from Lake Manitou in September 2006 to conduct preliminary PlanTEST. The hydrilla in Lake Manitou responded favorably to Sonar under laboratory conditions (Figure 4.0.1) and biochemical observations suggested the hydrilla was susceptible to doses as low as 3 ppb (Chart 4.0.1), although visual bleaching wasn't necessarily obvious until concentrations reached 6 ppb. SePRO's recommended treatment protocol was based on results of the initial/preliminary PlanTEST, extensive experience in hydrilla control throughout the U.S., and proprietary modeling of Sonar dissipation from various formulations.

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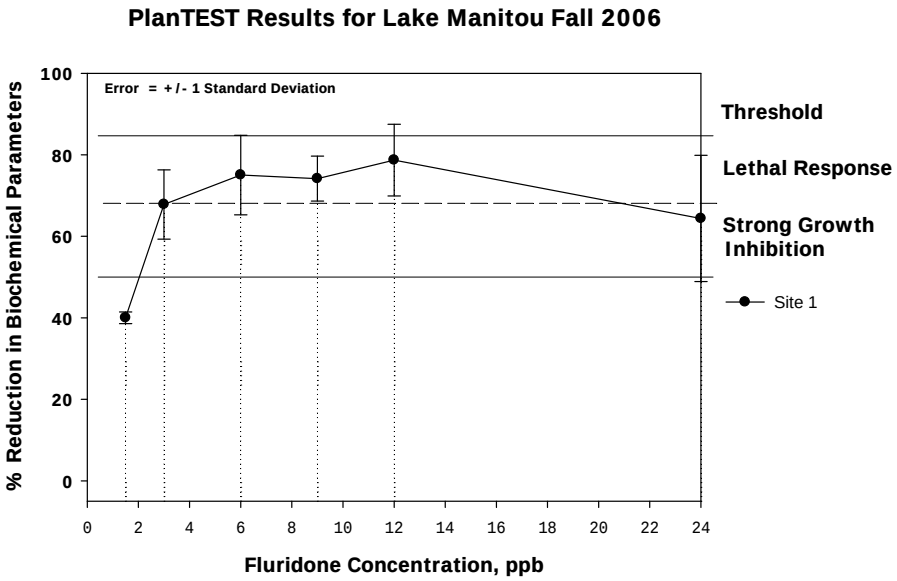

Chart 4.0.1. PlanTEST Results for Lake Manitou, Fall 2006.

Figure 4.0.1. Lake Manitou hydrilla susceptibility to Sonar (PlanTEST).

Initially, the treatment prescription recommended for Lake Manitou was a minimum three year program, followed by comprehensive analysis of collected data and recommendations for either extension of this program or alternative management procedures to achieve eradication of hydrilla. Each year, relatively long exposure time to Sonar will be necessary to control the standing crop of hydrilla, prevent production of new tubers, and to control biomass sprouting from existing tubers.

The 2007 application maintained targeted levels of fluridone throughout the growing season and no hydrilla was observed that year. Modifications were made to the 2008 treatment prescription in an attempt to increase selectivity. Sonar pellet formulations were switched from Sonar Q, which was applied throughout the littoral zone in 2007, to Sonar PR, which was only applied to areas where hydrilla was previously documented and in a small inflow area. In addition, the whole lake concentration was to be

maintained above 3 ppb instead of 6 ppb, with more frequent bump applications to minimize exposure of native species to relatively high concentrations.

4.1 Sonar Application

For reference: the initial Sonar treatment was conducted on May 14, 2008; bump treatments were conducted on June 30, August 19, and October 8, 2008. Details of the treatments can be found in Section 4.0.

The initial Sonar application was completed on May 14, 2008 by Aquatic Control, Inc., with SePRO Corporation and ReMetrix personnel on site for technical assistance. The lake was posted with signs for public notification prior to Sonar application. Sonar AS was applied to the whole-lake at a concentration of 6.0 ppb along with pelletized Sonar PR to 19 zones (Figure 4.1.2) at concentrations ranging from 40 to 100 ppb(total of 2.2 ppb). No consistent lake-wide thermocline was identified prior to the May 14 treatment (Table 2.1.1), and only weak stratification was observed at depths >25 feet. Therefore, isothermal conditions were assumed and the whole-lake volume of 8,361 acre feet was treated at these concentrations.

Sonar AS was applied with a custom built Carolina Skiff, 19-foot fiberglass boat equipped with a 90hp engine. The boat was equipped with a custom built herbicide application unit designed for accurate application of low dose Sonar AS. Travel routes and rates were pre-determined using information generated by the one-foot bathymetric contour survey and water volume table provided by ReMetrix. The actual Sonar AS and Sonar PR application travel routes are illustrated in Figure 4.1.1. Sonar PR was applied to 19 different locations (18 previous hydrilla locations and one inflow location) (Figure 4.1.2). Zone 19 was added during the morning of the first application following consultation with IDNR (i.e., Mr. Doug Keller). Concerns about hydrilla previously being found in the channel leading to the small bay directed the decision to include the area in the Sonar PR application. Initially, it was proposed not to apply pellets to this area. A custom built herbicide blower on a 19-foot Carolina Skiff was used for application of the pellets.

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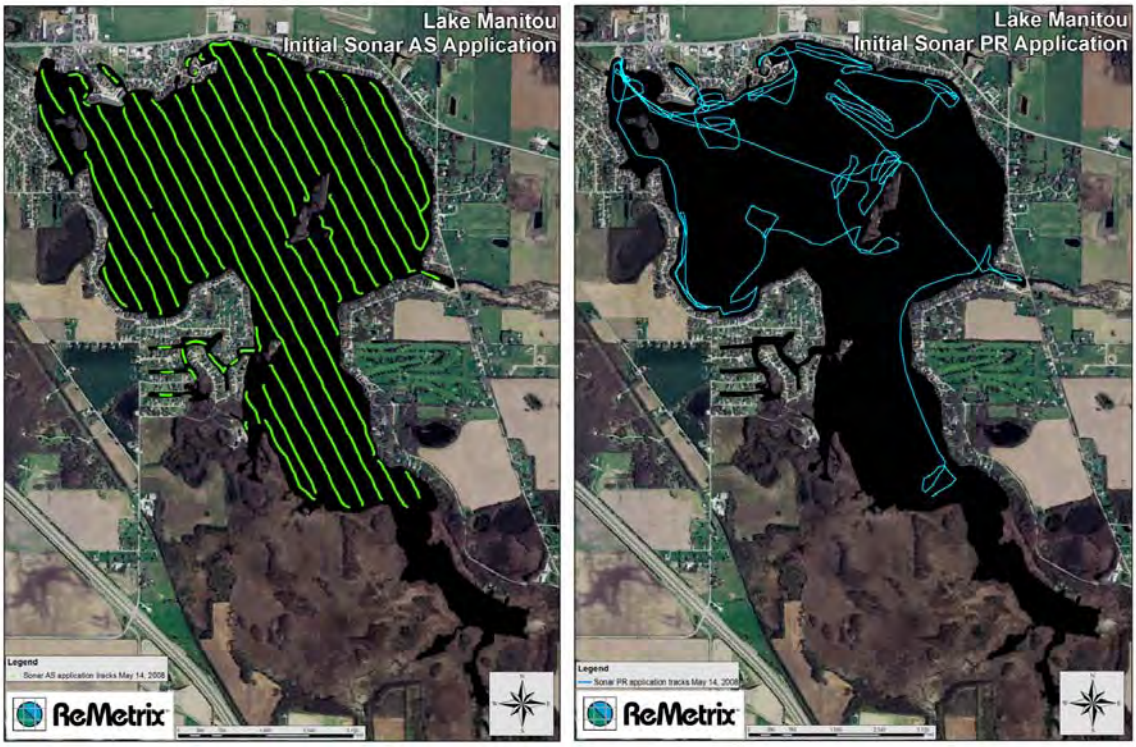

Figure 4.1.1. Initial application tracks for Sonar AS *(left map)* and Sonar PR *(right map)*, May 14, 2008.

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Figure 4.1.2. Sonar PR application map, May 14, 2008.

The first bump treatment was completed on June 30 (47 days after initial treatment) with a combination of Sonar AS and PR. The bump treatment was conducted when residues had dropped to 3.5 ppb on June 26th, but was pre-planned to make a second application of Sonar PR at that time. Sonar AS was applied at concentration of 2.5 ppb and Sonar PR

was applied at a concentration of 1.2 ppb. Sonar AS was applied evenly over the entire lake while Sonar PR was applied to the 19 previously selected locations. Figure 4.1.3 displays the actual application routes from the first bump treatment.

Although not a thermocline by definition (Δ1ºC over 1-meter of depth), evidence of weak stratification was observed at 3-4 meters of depth near the date of the first bump treatment, as was a thermocline at 8-9 meters depth (Table 4.1.1). A thermocline (by definition) was established at 6-7 meters on August 11, and at 7-8 meters on September 29 (Table 4.1.1). Thermocline data were factored into the application planning for each bump treatment.

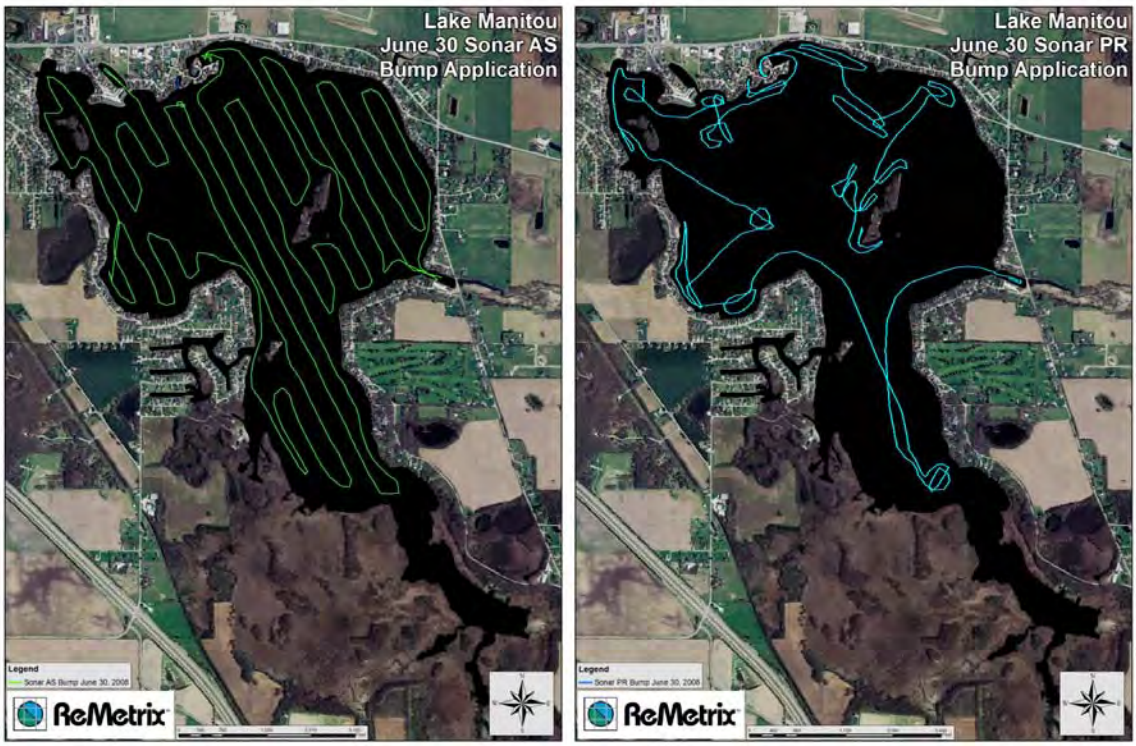

Figure 4.1.3. First "bump application" tracks for Sonar AS *(left map)* and Sonar PR *(right map)*, June 30, 2008.

Table 4.1.1. Water temperature and dissolved oxygen profiles associated with Sonar bump treatment dates (collected at FasTEST Station 2).
Treatment dates are included just below the table. Thermocline depths are indicated by a thicker line between rows.

June 26 (Trtmt 6/30)		
Depth (m)	Temp (C)	D.O. (mg/L)
Subsurface	23.9	11.15
1	23.8	11.20
2	23.5	10.67
3	23.5	10.65
4	22.9	7.66
5	22.9	7.72
6	22.6	6.65
7	22.6	6.71
8	21.9	3.79
9	19.1	0.27
10	17.7	0.17

Aug 11 (Trtmt 8/19)		
Depth (m)	Temp (C)	D.O. (mg/L)
Subsurface	23.6	7.50
1	23.4	7.41
2	23.4	7.25
3	23.2	6.85
4	23.1	6.76
5	22.9	6.83
6	22.2	5.26
7	18.3	0.17
8	15.6	0.15
9	14.2	0.12
10	13.1	0.10

Sep 29 (Trtmt 10/8)		
Depth (m)	Temp (C)	D.O. (mg/L)
Subsurface	21.5	8.56
1	21.3	8.52
2	21.3	8.35
3	21.2	8.20
4	21.2	8.39
5	21.1	7.65
6	20.8	6.19
7	20.0	0.25
8	18.2	0.16
9	15.9	0.11
10	14.1	0.10

2008 Sonar treatment dates: May 14 (initial Sonar); June 30, August 19, October 8 (Sonar bumps).

A second bump treatment was completed on August 19 (97 days after initial treatment) with a combination of Sonar AS and PR. Residues had dropped to 4.0 ppb on August 11, but the treatment was pre-planned to make a third application of Sonar PR at that time and to bump the dose with Sonar AS. Once again, Sonar AS was applied at concentration of 2.5 ppb and Sonar PR was applied at a concentration of 1.2 ppb. Sonar AS was applied evenly over the entire lake while Sonar PR was applied to the same 19 previously selected locations. Figure 4.1.4 displays the actual treatment routes from the second bump application.

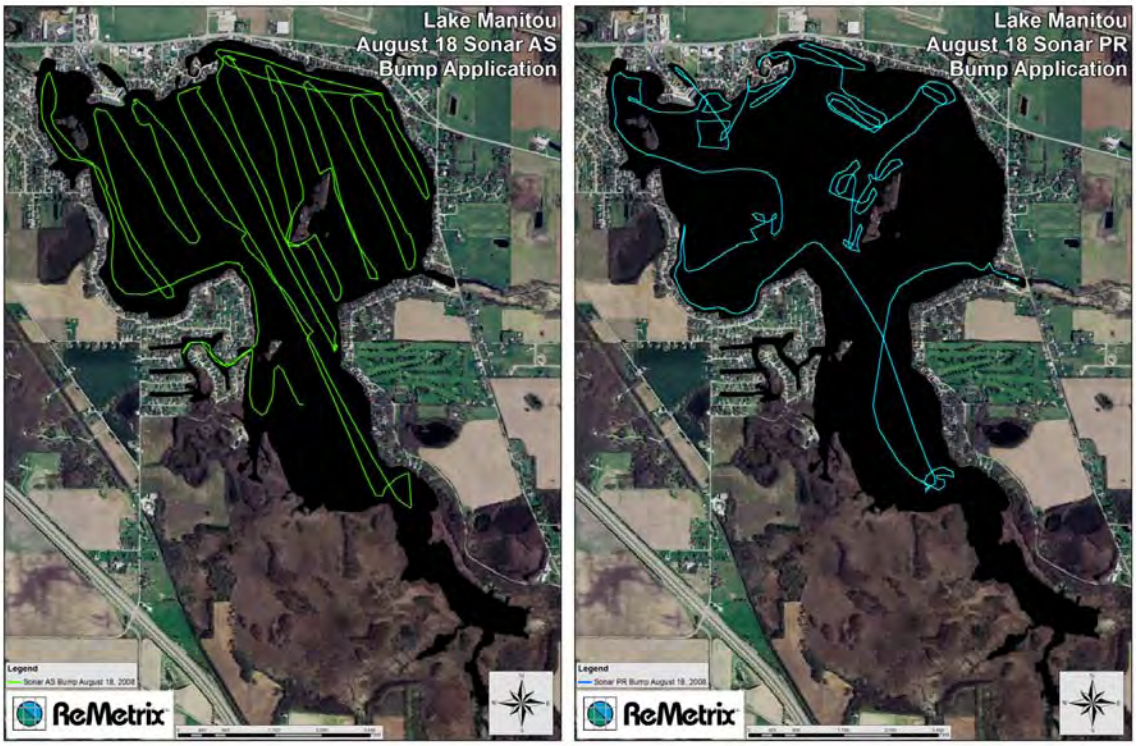

Figure 4.1.4. Second "bump application" tracks for Sonar AS *(left map)* and Sonar PR *(right map)*, August 19, 2008.

Sonar concentrations had dropped to a mean or 3.2 ppb on September 15 and 22nd. Therefore, a final bump application was made on October 8 with Sonar AS in order to maintain lethal residues through the period when tubers could possibly sprout. Sonar AS was applied evenly throughout the lake at a concentration of 2.8 ppb (Figure 4.1.5).

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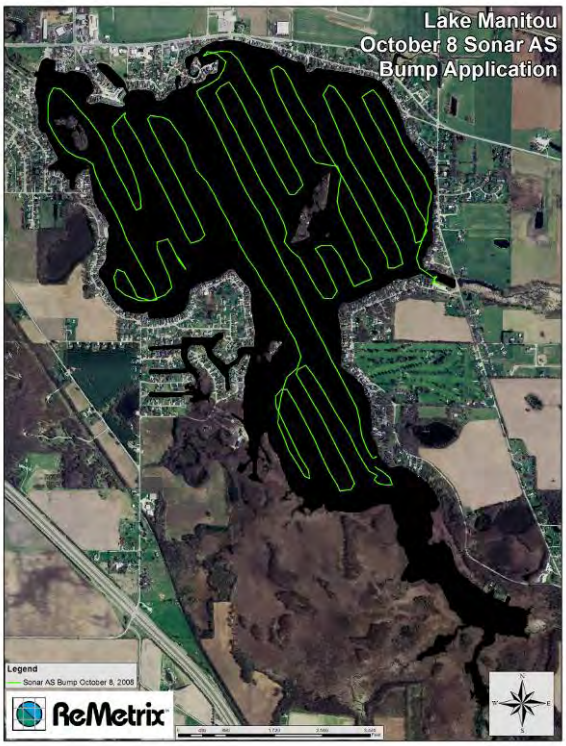

Figure 4.1.5. Third "bump application" track for Sonar AS, October 8, 2008.

4.2 Herbicide Residue Monitoring

The FasTEST was used to monitor Sonar residues 5, 19, 33, 43, 61, 75, 89, 111, 124, 138, 152, and 187 days following initial treatment. The FasTEST ensured the target concentrations were achieved and maintained through October 15th. FasTEST samples were collected from seven (plus one additional site added by SePRO) permanent stations located throughout Lake Manitou (Figures 4.2.1 and 4.2.2, Table 4.2.1). Twelve sets of subsurface FasTEST samples were collected and results are summarized in Table 4.2.2, Chart 4.2.1, and Figure 4.2.3. (In addition, Table 3.0.1 contains the seven sets of FasTEST depth-profile data collected at Site 2.) FasTEST results indicate the concentration was maintained above 3 ppb for the 2008 growing season. The objective was to maintain >3 ppb until October 15th as it was determined that hydrilla would unlikely be able to sprout from a tuber and form a new tuber after that period.

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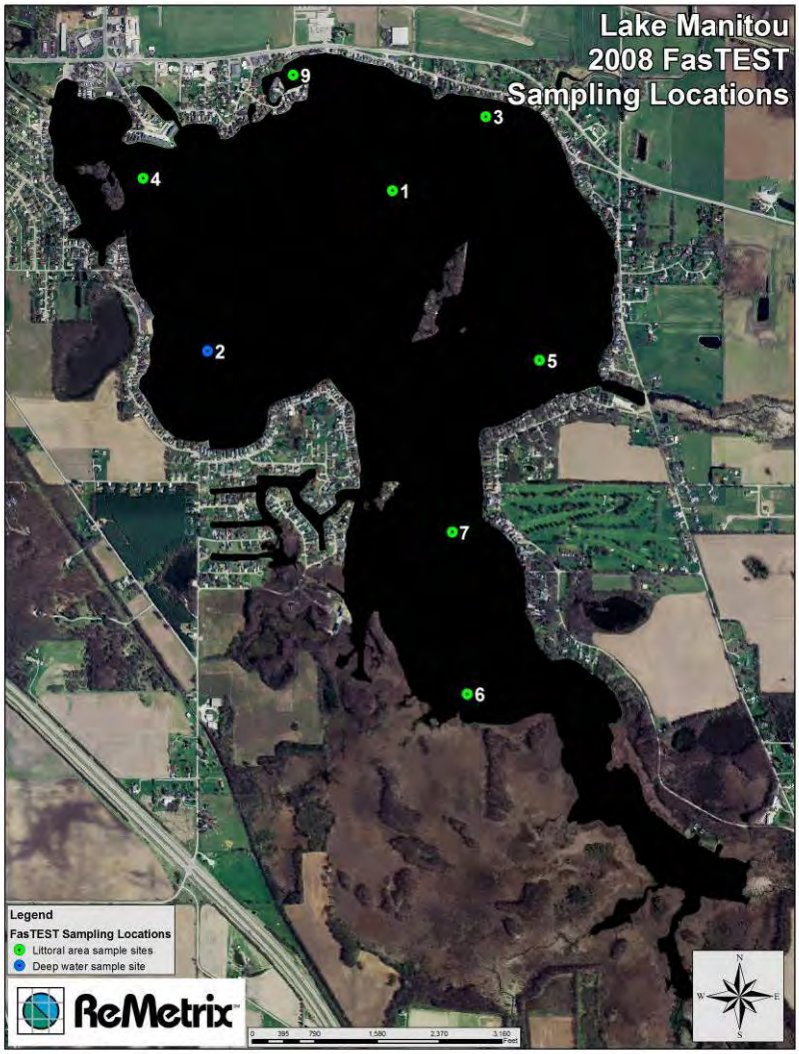

Figure 4.2.1. Permanent FasTEST sample locations during 2008.
Green points are the FasTEST monitoring sites with corresponding site numbers. Blue point is the deep-water profiling site. (See Table 4.2.1 for site coordinates.)

Table 4.2.1. Latitude and longitude coordinates for the eight FasTEST monitoring stations.

Site #	Latitude	Longitude
1	41.05724171	-86.17915369
2	41.05164445	-86.18758863
3	41.05983264	-86.17489663
4*	41.05761950	-86.19060382
5	41.05139196	-86.17236042
6	41.03981273	-86.17558691
7	41.04542102	-86.17632601
9*	41.06123257	-86.18373992

*new coordinates in 2008

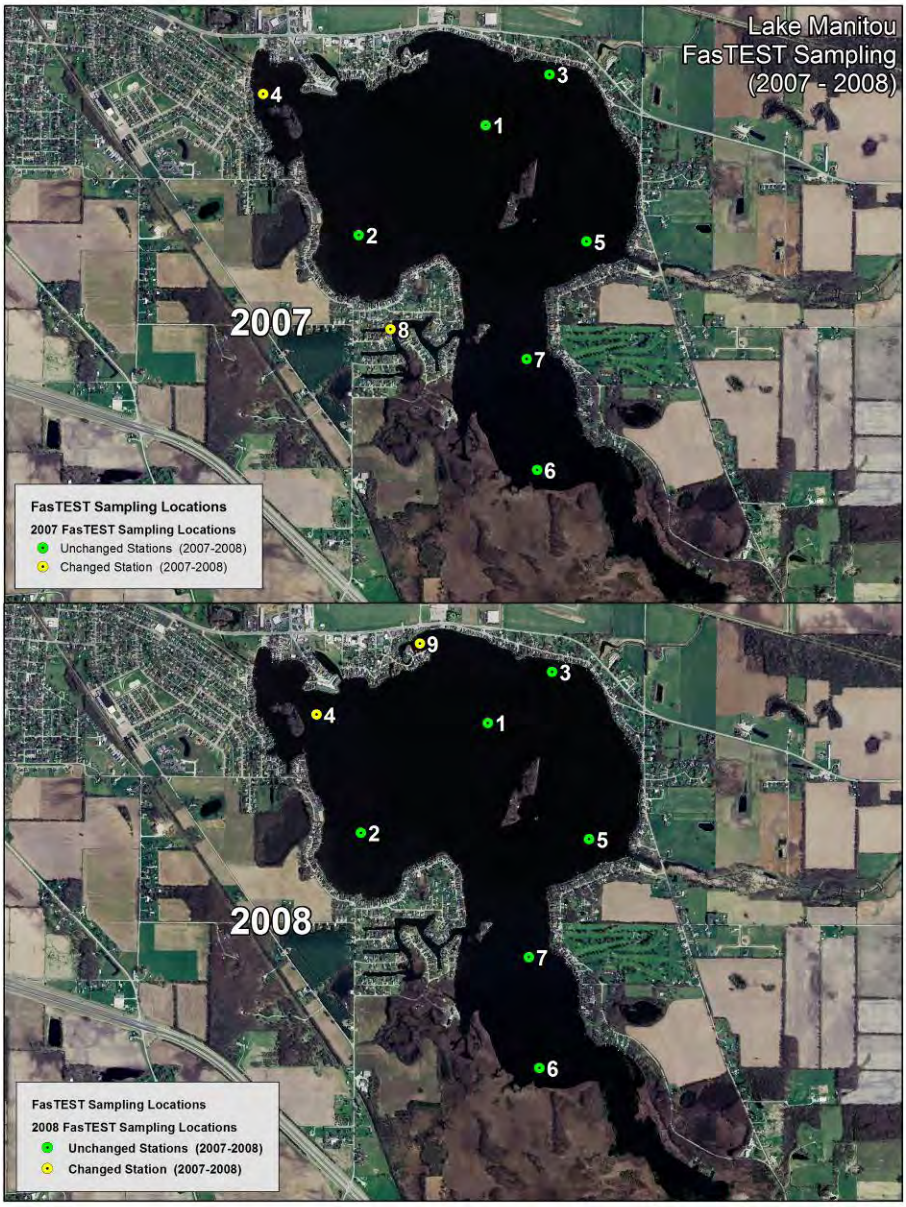

Figure 4.2.2. FasTEST sampling locations, 2007 and 2008.
Yellow dots are sites that changed between the two years. Also note that both Sites 2 and 7 were deep-water profile sites in 2007, whereas only Site 2 was a deep-water profile site in 2008.

Table 4.2.2. Concentrations of 2008 FasTEST results from surface water samples. (Refer to Table 3.0.1 for the deeper water FasTEST profile results at Site 2.)

Lake Manitou FasTEST results for 2008

Treatment Dates:	Initial AS+PR	Bump AS+PR	Bump AS+PR	Bump AS
	5/14/2008	6/30/2008	8/19/2008	10/8/2008
Target Concentration:				
AS	6.0	2.5	2.0	2.8
+ PR	2.2	1.2	1.2	0.0
Total	~6.0	~2.5	~2.0	~2.8
Ideal	0+6.0=6.0	3.5+2.5=6.0	4.0+2.0=6.0	3.2+2.8=6.0

		FasTEST Sample Collection Dates												
		5/19/2008	6/2/2008	6/16/2008	6/26/2008	7/14/2008	7/28/2008	8/11/2008	9/2/2008	9/15/2008	9/29/2008	10/13/2008	11/17/2008	Season Long
	DAT -->	5	19	33	43	14	28	42	14	27	41	5	40	187
		Sonar Concentration (ppb)												
Sites	1	5.1	5.8	4.7	3.9	4.7	3.4	4.1	6.5	2.8	3.0	5.9	3.9	4.5
	2	4.6	5.3	4.6	3.8	5.1	4.7	3.8	6.0	2.7	3.2	5.5	4.1	4.5
	3	5.5	5.4	4.2	3.4	6.4	5.9	4.0	6.8	4.7	3.0	5.5	4.2	4.9
	4	4.6	5.9	4.9	3.9	5.0	4.2	4.0	6.8	3.9	3.1	5.6	4.1	4.7
	5	4.6	4.9	4.6	3.8	4.7	4.2	3.6	5.8	2.2	3.0	5.2	3.9	4.2
	6	4.7	4.7	4.2	3.4	4.8	3.7	3.1	6.1	1.9	3.1	5.2	3.8	4.1
	7	5.1	4.4	3.3	2.3	4.9	3.7	4.7	5.6	3.7	3.8	5.3	4.4	4.3
	9	5.5	6.3	4.8	3.8	6.1	5.4	4.4	6.7	3.4	3.1	5.7	4.2	5.0
	Lake Avg	5.0	5.3	4.4	3.5	5.2	4.4	4.0	6.3	3.2	3.2	5.5	4.1	4.5

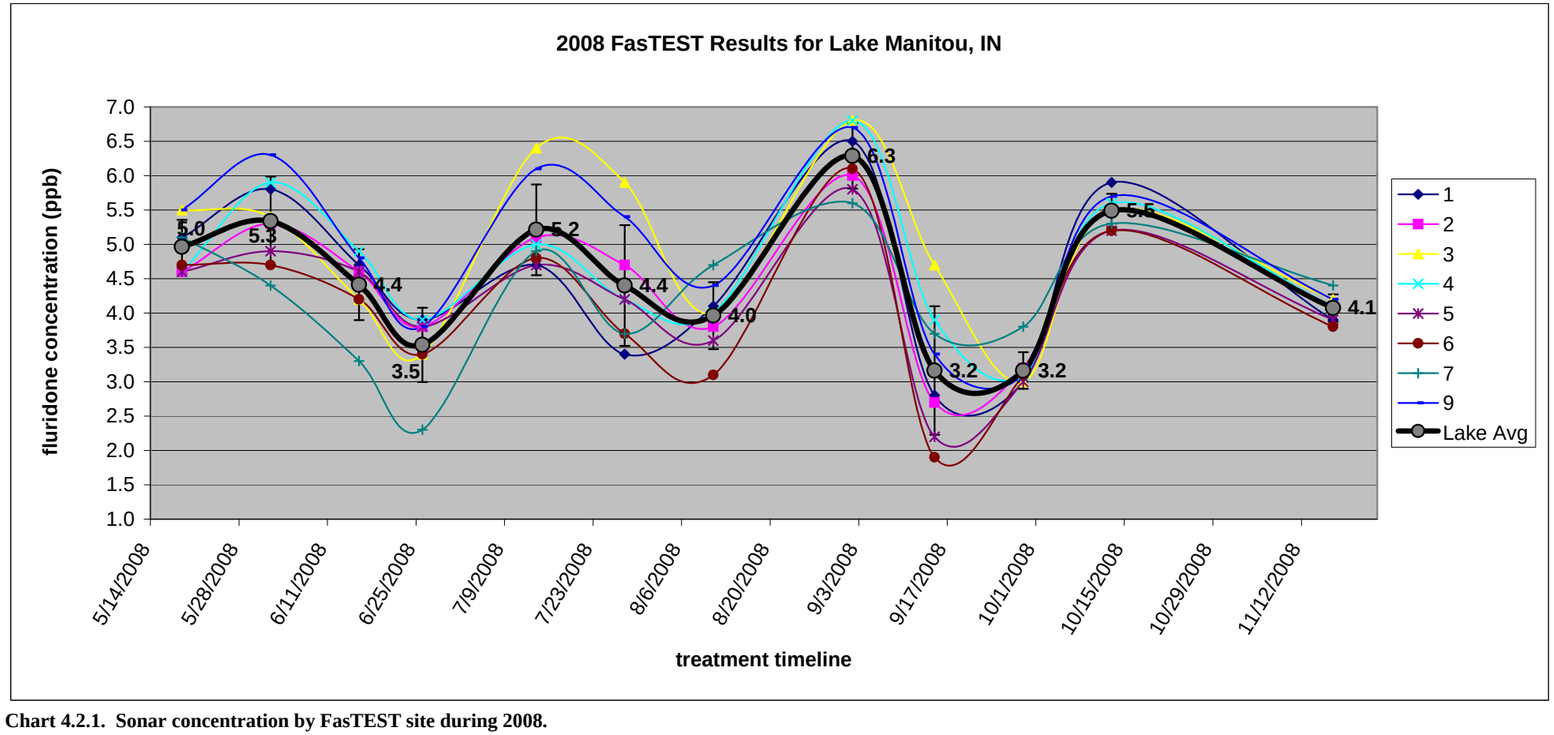

Chart 4.2.1. Sonar concentration by FasTEST site during 2008.

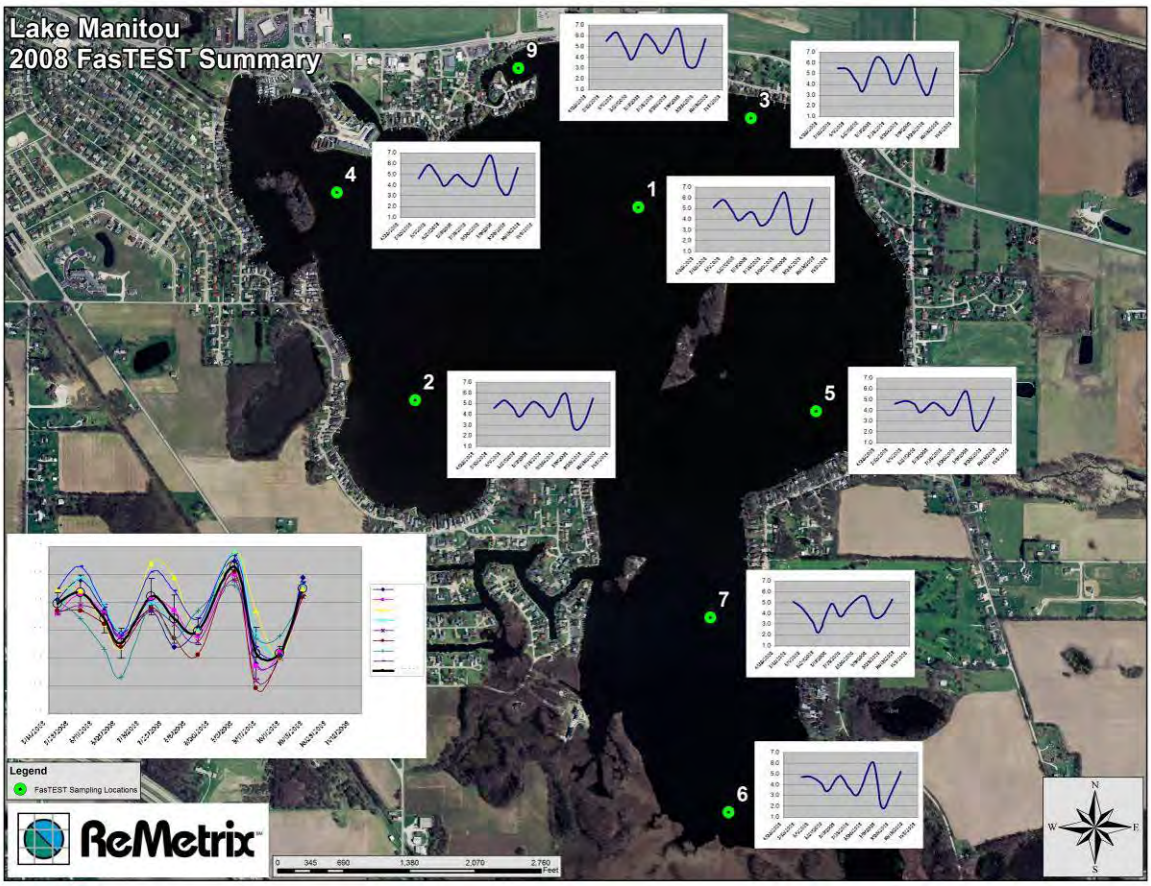

Figure 4.2.3. Map-graph of near-surface FasTEST results per sample location.
Green dots are the FasTEST monitoring sites with corresponding site numbers. Data indicate a lake wide average was achieved 5 days after the initial treatment (5.0 ppb). Residues were maintained above 3.2 ppb throughout the active growth period of hydrilla defined by this program (May-October 15th).

5.0 ACTION PLAN UPDATE

5.1 Diagnostic Data for Precision Sonar Application

Hydrilla produces large numbers of tubers that can remain dormant in the sediment for several years. This fact makes eradication difficult but not impossible. It will be necessary to continue control efforts for more than three consecutive years in order to deplete the tuber bank. This is based on current tuber attrition rates observed on Lake Manitou to date. If treatments were not completed in 2009 tuber densities may return to pre-treatment levels rapidly, likely within a year or two. The first two years of Sonar application have resulted in successful control of hydrilla with subsequent reductions in tubers. The timing of treatments coincided with hydrilla tuber sprouting, which is expected to be similar in 2009. The treatments resulted in impact to the native submersed plant community, which was expected due to the importance placed on successful hydrilla control and the overall low species richness. In 2008, modifications were made to the Sonar formulation, concentration, and application frequency and distribution to maintain emphasis on hydrilla control and attempt to improve selectivity. These methods should be continued in 2009 with no major adjustment suggested. The Sonar concentration should be maintained at a minimum of 3ppb throughout the growing season. The whole lake (above the thermocline) should be treated with Sonar A.S. at a rate of 6 ppb and maintained above 3 ppb with subsequent bump treatments. This lake-wide treatment would control any hydrilla not accounted for in surveys or previously detected. In addition, Sonar PR should be applied to the 19 areas where hydrilla was previously identified (and one area at the inflow)—similar to the areas applied in 2008, shown in Figure 4.1.2 above. These areas range in size from 4.1 to 17.7 acres and total 161 acres (average depth approximately four feet). The concentration applied to theses areas should remain the same, and will range from 40 to 100 ppb in the treated area. In-water concentrations will only be a fraction of that applied due to the sustained release of the pellets and rapid dilution from these areas. The total Sonar PR applied will be split into three treatments: 50% on day 1, and 25% each on day 45 and 90. This protocol allows for higher concentrations applied to areas with known hydrilla while minimizing concentrations on the whole lake and minimizing pellet application to the entire littoral zone.

IDNR personnel chose to cancel the spring tuber survey after considering cost-benefit of this survey. A fall survey will be conducted at the six permanent stations. This survey expected to involve increased effort as tuber densities decline. Future tuber sampling effort may have to be adjusted as the tuber bank becomes depleted, as previously mentioned. Tuber sampling can increase to a point as tuber densities decrease, but “zero” tubers at the sampling sites should not be extrapolated to the whole lake or sampling area once zero is achieved. For example, no tubers were found at Station 1 for two consecutive years – September 2007 and 2008 (minus the expanded area). However, this station should not be aborted and surveys for tubers should continue with expectations that tubers will be found. Stations should be monitored for three consecutive years with no hydrilla tubers before they are aborted. For example, if no tubers are found at Station 1 in 2009 (three consecutive years after the last find), it should then be aborted. If tubers

are found in 2009, then sampling should continue at this station for three more years with no tubers before it is abandoned.

It is also important to continue monitoring the submersed vegetation community with two Tier II surveys in 2009 (one late spring and one late summer). This will allow plant managers the ability to quantify changes in the native plant community and assist in potential detection of vegetative hydrilla. Similar surveys should be continued after the Sonar treatments are complete in order to detect any reintroductions of invasive species and monitor native vegetation recovery.

Finally, both Eurasian watermilfoil and curlyleaf pondweed (low abundance) were also present in Lake Manitou prior to the eradication effort on hydrilla. Both these species are susceptible to the Sonar concentrations being applied to control hydrilla, and were controlled by the Sonar treatments. Therefore, unless the seed bank of Eurasian watermilfoil and turion/seed bank of curlyleaf pondweed are long-lived, then eradication of these two invasive species may also be attainable in Lake Manitou with repeated Sonar treatments.

The original AMVP established three management goals:

1) Develop or maintain a stable diverse aquatic plant community that supports a good balance of predator and prey fish and wildlife species, good water quality, and is resistant to minor habitat disturbances and invasive species.
2) Direct efforts to preventing and/or controlling the negative impacts of aquatic invasive species.
3) Provide reasonable public access while minimizing the negative impacts on plant and wildlife species.

Even after the introduction of hydrilla to Lake Manitou, the overall aquatic plant management objectives remain relatively the same: establish a diverse aquatic plant community, control aquatic invasive species, and provide reasonable public access. Currently, controlling hydrilla and eradicating this invasive species is paramount to the other objectives outlined in this plan. It is not unreasonable and should remain a goal to implement the other objectives long-term. Some of these objectives are realistic while hydrilla control is ongoing, and minor changes to the hydrilla control program were implemented to balance eradication efforts vs. other lake management objectives. Although the native species richness in Lake Manitou has historically been low, these species should recover to some extent during and/or following eradication efforts. Some minor introduction of additional native species may be justified long-term, as the plant community was historically dominated by a single species (i.e. eelgrass).

At this stage of the eradication effort, there should be continued consultation with others (e.g. personnel from other states and other researchers) that are working with monoecious hydrilla. This may aid in future planning and development of longer-term eradication strategies. Timing of such event may coincide with the completion of the 2009 control program and before completion of the draft update to the AVMP.

5.2 Budget Update

Budget review and updated cost projections are based on contract parameters.

Like 2007, the 2008 project cost was below budget as a result of planned adaptive management (Table 5.2.1). Less Sonar was needed for a number of reasons including lower than expected flow, precise FasTEST residue monitoring, and project management.

Table 5.2.1. Budget update for 2008 and following year projections.

Year	Budget anticipated	Actual expenditures
2007	$500,000 (plus contingency $150,000)	$331,991
2008	$425,000	$317,579
2009	$425,000	

6.0 PUBLIC INVOLVEMENT

Public involvement is an important aspect of any vegetation management plan, but it takes on a whole new level of importance when dealing with an invasive species like hydrilla. IDNR Aquatic Invasive Species Coordinator, Doug Keller has headed up the public involvement aspect of the vegetation management plan. Actions which Mr. Keller has undertaken in order to educate and inform the public concerning hydrilla are summarized below:

- Development of a joint hydrilla/Brazilian elodea watchcard. Illinois-Indiana Sea Grant is overseeing the development of this watchcard. Funding for the card is from the Mississippi Basin Panel on ANS. Cards will be available in early 2009.
- Lake Manitou Association meeting on 3/20/08 to advise on how the 2008 treatment will proceed.
- Manitou ramp opening on 6/28/08 including news release announcing such.
- Presented the Manitou hydrilla story at the following meetings: (Aquatic Control Workshop, Cygnet Workshop, Milwaukee hydrilla and AIS symposium, Indiana Lake Management Society, Division of Fish and Wildlife Annual Conference).
- Developed new compliance agreements with all businesses doing work on Manitou (as a result of relaxed access restrictions).

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Appendix

Lake Manitou Hydrilla Eradication Program – YEAR 2
Initial Sonar Application Summary - May 14, 2008 (Wednesday).

Contractor (SePRO) and sub-contractors (Aquatic Control and ReMetrix, LLC) made the initial Sonar (fluridone) treatment for year two targeting hydrilla eradication in Lake Manitou, IN.

Prescription Planning

A slight modification to the treatment prescription was made this year attempting to increase selectivity while not sacrificing hydrilla control. It is assumed this will require more bump treatments due to the tighter range of targeted concentrations and smaller distribution of Sonar slow-release pellets. The strategy employed the use of initial Sonar liquid and pellet application to start the season, followed by at least two subsequent "bump" treatments to maintain lake-wide concentrations. A temperature and DO_2 profile completed 13 May 2008 indicated minimal thermal stratification. Assuming isothermal conditions, herbicide prescription maps were adjusted to apply Sonar liquid to the entire water volume. Sonar granular product was prescribed for littoral areas only; no adjustments to calculated doses were thus necessary. Like 2007, Sonar liquid was applied using variable rate technology. Output varied according to depth of the water and speed of the vessel. Sonar PR (Precision Release) was applied to 19 zones that historically contained hydrilla. Target ppb rates were prescribed based upon potential for dilution, lake morphometry, and tuber presence. No pellet applications were planned to water deeper than 12 feet.

Application Equipment

Sonar A.S. (liquid) was applied using a GPS-coupled precision-application injection pump that adjusted rate based upon speed and water depth. A feedback log was saved to produce an "as applied" map. Northwest-southeast transect lines on 100 meter spacing were used to guide the liquid application. Sonar PR (pellet) was applied at varied ppb rates with a hopper-fed blower. GPS positioning was used to insure applications were kept within prescription boundaries.

Application notes

Prescription maps were derived from hydroacoustic depth data taken on 5 October 2006. Not all areas displayed within the Web Atlas as "shoreline" were accessible to the Sonar AS application vessel. GPS tracks and the "as-applied" log record the precise spatial positioning of the application. The equipment was triple rinsed according to standard procedures and rinsate applied over the deepest areas in the lake. A total of 34 gallons of Sonar AS was applied.

Sonar PR was applied to all areas as prescribed. The day before application, site 19 was added at the request of IDNR due to concerns about potential hydrilla presence (D. Keller). A GPS record was kept to track the position of the vessel. The tracks do not necessarily represent the exact locations where granular applications were made, but rather a record of the granular vessel's position throughout the day's activities. A total of 1009 lbs of Sonar PR was applied to the 19 zones.

See the ReMetrix Web Atlas for an interactive map display of the aforementioned data.
http://ims.remetrix.com

LARE Survey Raw Data
06/16/08 Survey Date

Site ID	Name	Species	Density	Sample Date	Depth	H2O Level
DK_001	alga	filamentous algae	--	6/16/2008	3.0	8.26
DK_001	waterwillow	JUSTICIA AMERICANA	--	6/16/2008	3.0	8.26
DK_002	no plants on rake	no plants on rake	0	6/16/2008	4.0	8.26
DK_003	muskgrass	CHARA SPECIES	1	6/16/2008	2.0	8.26
DK_003	alga	filamentous algae	--	6/16/2008	2.0	8.26
DK_003	duckweed	LEMNA SPECIES	--	6/16/2008	2.0	8.26
DK_004	muskgrass	CHARA SPECIES	1	6/16/2008	2.0	8.26
DK_004	alga	filamentous algae	--	6/16/2008	2.0	8.26
DK_004	duckweed	LEMNA SPECIES	--	6/16/2008	2.0	8.26
DK_005	muskgrass	CHARA SPECIES	1	6/16/2008	3.0	8.26
DK_005	alga	filamentous algae	--	6/16/2008	3.0	8.26
DK_006	muskgrass	CHARA SPECIES	3	6/16/2008	4.0	8.26
DK_006	alga	filamentous algae	--	6/16/2008	4.0	8.26
DK_007	alga	filamentous algae	--	6/16/2008	6.0	8.26
DK_008	alga	filamentous algae	--	6/16/2008	6.0	8.26
DK_008	no plants on rake	no plants on rake	0	6/16/2008	6.0	8.26
DK_008	spatterdock	NUPHAR LUTEA	--	6/16/2008	6.0	8.26
DK_009	no plants on rake	no plants on rake	0	6/16/2008	16.0	8.26
DK_010	muskgrass	CHARA SPECIES	5	6/16/2008	3.0	8.26
dnr_001	alga	filamentous algae	--	6/16/2008	5.0	8.26
MA_001	muskgrass	CHARA SPECIES	1	6/16/2008	4.0	8.26
MA_001	alga	filamentous algae	--	6/16/2008	4.0	8.26
MA_001	duckweed	LEMNA SPECIES	--	6/16/2008	4.0	8.26
MA_002	muskgrass	CHARA SPECIES	1	6/16/2008	4.0	8.26
MA_002	alga	filamentous algae	--	6/16/2008	4.0	8.26
MA_003	muskgrass	CHARA SPECIES	1	6/16/2008	4.0	8.26
MA_003	alga	filamentous algae	--	6/16/2008	4.0	8.26
MA_004	alga	filamentous algae	--	6/16/2008	4.0	8.26
MA_005	alga	filamentous algae	--	6/16/2008	7.0	8.26
MA_006	muskgrass	CHARA SPECIES	5	6/16/2008	0.0	8.26
MA_006	alga	filamentous algae	--	6/16/2008	0.0	8.26
MA_007	alga	filamentous algae	--	6/16/2008	4.0	8.26
MA_007	spatterdock	NUPHAR LUTEA	--	6/16/2008	4.0	8.26
MA_007	waterwillow	JUSTICIA AMERICANA	--	6/16/2008	4.0	8.26
MA_008	sago pondweed	POTAMOGETON PECTINATUS	1	6/16/2008	5.0	8.26
MA_008	alga	filamentous algae	--	6/16/2008	5.0	8.26
MA_009	alga	filamentous algae	--	6/16/2008	3.0	8.26
MA_009	waterwillow	JUSTICIA AMERICANA	--	6/16/2008	3.0	8.26
MA_010	alga	filamentous algae	--	6/16/2008	3.0	8.26
MA_010	waterwillow	JUSTICIA AMERICANA	--	6/16/2008	3.0	8.26
MA_011	muskgrass	CHARA SPECIES	1	6/16/2008	1.0	8.26
MA_011	alga	filamentous algae	--	6/16/2008	1.0	8.26
MA_011	duckweed	LEMNA SPECIES	--	6/16/2008	1.0	8.26
MA_011	fragrant waterlilly	NYMPHAEA ODORATA	--	6/16/2008	1.0	8.26
MA_012	cattail	TYPHA SPECIES	--	6/16/2008	0.0	8.26
MA_013	sago pondweed	POTAMOGETON PECTINATUS	1	6/16/2008	3.0	8.26
MA_013	alga	filamentous algae	--	6/16/2008	3.0	8.26
MA_013	cattail	TYPHA SPECIES	--	6/16/2008	3.0	8.26
MA_013	spatterdock	NUPHAR LUTEA	--	6/16/2008	3.0	8.26
MA_014	sago pondweed	POTAMOGETON PECTINATUS	5	6/16/2008	3.0	8.26
MA_014	alga	filamentous algae	--	6/16/2008	3.0	8.26
MA_014	cattail	TYPHA SPECIES	--	6/16/2008	3.0	8.26
MA_014	spatterdock	NUPHAR LUTEA	--	6/16/2008	3.0	8.26
MA_015	sago pondweed	POTAMOGETON PECTINATUS	5	6/16/2008	3.0	8.26
MA_015	duckweed	LEMNA SPECIES	--	6/16/2008	3.0	8.26
MA_015	fragrant waterlilly	NYMPHAEA ODORATA	--	6/16/2008	3.0	8.26
MA_015	fragrant waterlily	NYMPHAEA ODORATA	--	6/16/2008	3.0	8.26
MA_015	giant duckweed	SPIRODELA POLYRHIZA	--	6/16/2008	3.0	8.26

"--" indicates "not determined"

LARE Survey Raw Data
06/16/08 Survey Date

Site ID	Name	Species	Density	Sample Date	Depth	H2O Level
MA_016	alga	filamentous algae	--	6/16/2008	3.0	8.26
MA_017	muskgrass	CHARA SPECIES	1	6/16/2008	6.0	8.26
MA_017	alga	filamentous algae	--	6/16/2008	6.0	8.26
MA_018	alga	filamentous algae	--	6/16/2008	5.0	8.26
MA_019	alga	filamentous algae	--	6/16/2008	3.0	8.26
MA_020	alga	filamentous algae	--	6/16/2008	5.0	8.26
MA_020	duckweed	LEMNA SPECIES	--	6/16/2008	5.0	8.26
MA_022	alga	filamentous algae	--	6/16/2008	3.0	8.26
MA_022	cattail	TYPHA SPECIES	--	6/16/2008	3.0	8.26
MA_022	duckweed	LEMNA SPECIES	--	6/16/2008	3.0	8.26
MA_022	spatterdock	NUPHAR LUTEA	--	6/16/2008	3.0	8.26
MA_023	alga	filamentous algae	--	6/16/2008	7.0	8.26
MA_024	alga	filamentous algae	--	6/16/2008	3.0	8.26
MA_024	cattail	TYPHA SPECIES	--	6/16/2008	3.0	8.26
MA_024	spatterdock	NUPHAR LUTEA	--	6/16/2008	3.0	8.26
MA_026	alga	filamentous algae	--	6/16/2008	7.0	8.26
MA_027	alga	filamentous algae	--	6/16/2008	5.0	8.26
MA_028	spatterdock	NUPHAR LUTEA	--	6/16/2008	1.0	8.26
MA_029	alga	filamentous algae	--	6/16/2008	3.0	8.26
MA_029	duckweed	LEMNA SPECIES	--	6/16/2008	3.0	8.26
MA_030	alga	filamentous algae	--	6/16/2008	2.0	8.26
MA_030	cattail	TYPHA SPECIES	--	6/16/2008	2.0	8.26
MA_030	duckweed	LEMNA SPECIES	--	6/16/2008	2.0	8.26
MA_030	waterwillow	JUSTICIA AMERICANA	--	6/16/2008	2.0	8.26
MA_031	no plants on rake	no plants on rake	0	6/16/2008	17.0	8.26
MA_032	alga	filamentous algae	--	6/16/2008	5.0	8.26
MA_032	spatterdock	NUPHAR LUTEA	--	6/16/2008	5.0	8.26
MA_033	alga	filamentous algae	--	6/16/2008	1.0	8.26
MA_033	arrowhead	SAGITTARIA LANCIFOLIA	--	6/16/2008	1.0	8.26
MA_033	cattail	TYPHA SPECIES	--	6/16/2008	1.0	8.26
MA_033	swamp mallow	HIBICUS SPP	--	6/16/2008	1.0	8.26
MA_034	muskgrass	CHARA SPECIES	1	6/16/2008	4.0	8.26
MA_034	alga	filamentous algae	--	6/16/2008	4.0	8.26
MA_035	no plants on rake	no plants on rake	0	6/16/2008	5.0	8.26
MA_036	muskgrass	CHARA SPECIES	1	6/16/2008	3.0	8.26
MA_036	alga	filamentous algae	--	6/16/2008	3.0	8.26
MA_037	muskgrass	CHARA SPECIES	1	6/16/2008	6.0	8.26
MA_037	alga	filamentous algae	--	6/16/2008	6.0	8.26
MA_038	alga	filamentous algae	--	6/16/2008	4.0	8.26
MA_039	no plants on rake	no plants on rake	0	6/16/2008	6.0	8.26
MA_040	no plants on rake	no plants on rake	0	6/16/2008	5.0	8.26
MA_042	alga	filamentous algae	--	6/16/2008	4.0	8.26
MA_042	muskgrass	CHARA SPECIES	--	6/16/2008	4.0	8.26
MA_043	no plants on rake	no plants on rake	0	6/16/2008	5.0	8.26
MA_044	muskgrass	CHARA SPECIES	1	6/16/2008	0.0	8.26
MA_044	alga	filamentous algae	--	6/16/2008	0.0	8.26
MA_045	muskgrass	CHARA SPECIES	1	6/16/2008	5.0	8.26
MA_045	alga	filamentous algae	--	6/16/2008	5.0	8.26
MA_046	muskgrass	CHARA SPECIES	1	6/16/2008	5.0	8.26
MA_046	alga	filamentous algae	--	6/16/2008	5.0	8.26
MA_047	muskgrass	CHARA SPECIES	1	6/16/2008	3.0	8.26
MA_047	alga	filamentous algae	--	6/16/2008	3.0	8.26
MA_048	alga	filamentous algae	--	6/16/2008	0.0	8.26
MA_049	alga	filamentous algae	--	6/16/2008	7.0	8.26
MA_050	alga	filamentous algae	--	6/16/2008	5.0	8.26
MA_051	muskgrass	CHARA SPECIES	3	6/16/2008	5.0	8.26
MA_051	alga	filamentous algae	--	6/16/2008	5.0	8.26

"--" indicates "not determined"

LARE Survey Raw Data
06/16/08 Survey Date

Site ID	Name	Species	Density	Sample Date	Depth	H2O Level
MA_052	muskgrass	CHARA SPECIES	3	6/16/2008	4.0	8.26
MA_052	alga	filamentous algae	--	6/16/2008	4.0	8.26
MA_053	arrowhead	SAGITTARIA LANCIFOLIA	1	6/16/2008	4.0	8.26
MA_053	muskgrass	CHARA SPECIES	1	6/16/2008	4.0	8.26
MA_053	sago pondweed	POTAMOGETON PECTINATUS	1	6/16/2008	4.0	8.26
MA_053	alga	filamentous algae	--	6/16/2008	4.0	8.26
MA_054	muskgrass	CHARA SPECIES	1	6/16/2008	5.0	8.26
MA_055	muskgrass	CHARA SPECIES	1	6/16/2008	4.0	8.26
MA_055	alga	filamentous algae	--	6/16/2008	4.0	8.26
MA_056	muskgrass	CHARA SPECIES	1	6/16/2008	4.0	8.26
MA_056	alga	filamentous algae	--	6/16/2008	4.0	8.26
MA_057	muskgrass	CHARA SPECIES	1	6/16/2008	5.0	8.26
MA_057	alga	filamentous algae	--	6/16/2008	5.0	8.26
MA_058	muskgrass	CHARA SPECIES	1	6/16/2008	6.0	8.26
MA_059	muskgrass	CHARA SPECIES	1	6/16/2008	5.0	8.26
MA_059	alga	filamentous algae	--	6/16/2008	5.0	8.26
MA_060	muskgrass	CHARA SPECIES	1	6/16/2008	4.0	8.26
MA_061	muskgrass	CHARA SPECIES	1	6/16/2008	4.0	8.26
MA_062	alga	filamentous algae	1	6/16/2008	5.0	8.26
MA_062	muskgrass	CHARA SPECIES	1	6/16/2008	5.0	8.26
MA_062	sago pondweed	POTAMOGETON PECTINATUS	1	6/16/2008	5.0	8.26
MA_063	muskgrass	CHARA SPECIES	1	6/16/2008	4.0	8.26
MA_063	alga	filamentous algae	--	6/16/2008	4.0	8.26
MA_064	alga	filamentous algae	--	6/16/2008	5.0	8.26
MA_065	muskgrass	CHARA SPECIES	1	6/16/2008	4.0	8.26
MA_065	alga	filamentous algae	--	6/16/2008	4.0	8.26
MA_066	muskgrass	CHARA SPECIES	5	6/16/2008	4.0	8.26
MA_066	alga	filamentous algae	--	6/16/2008	4.0	8.26
MA_067	muskgrass	CHARA SPECIES	1	6/16/2008	5.0	8.26
MA_067	alga	filamentous algae	--	6/16/2008	5.0	8.26
MA_068	muskgrass	CHARA SPECIES	1	6/16/2008	5.0	8.26
MA_068	alga	filamentous algae	--	6/16/2008	5.0	8.26
MA_069	muskgrass	CHARA SPECIES	3	6/16/2008	4.0	8.26
MA_069	alga	filamentous algae	--	6/16/2008	4.0	8.26
MA_070	alga	filamentous algae	--	6/16/2008	5.0	8.26
MA_071	muskgrass	CHARA SPECIES	1	6/16/2008	6.0	8.26
MA_071	alga	filamentous algae	--	6/16/2008	6.0	8.26
MA_072	muskgrass	CHARA SPECIES	5	6/16/2008	4.0	8.26
MA_072	alga	filamentous algae	--	6/16/2008	4.0	8.26
MA_073	muskgrass	CHARA SPECIES	3	6/16/2008	4.0	8.26
MA_073	alga	filamentous algae	--	6/16/2008	4.0	8.26
MA_074	muskgrass	CHARA SPECIES	5	6/16/2008	5.0	8.26
MA_074	alga	filamentous algae	--	6/16/2008	5.0	8.26
MA_075	no plants on rake	no plants on rake	0	6/16/2008	6.0	8.26
MA_076	muskgrass	CHARA SPECIES	1	6/16/2008	6.0	8.26
MA_076	sago pondweed	POTAMOGETON PECTINATUS	1	6/16/2008	6.0	8.26
MA_077	alga	filamentous algae	--	6/16/2008	5.0	8.26
MA_078	muskgrass	CHARA SPECIES	1	6/16/2008	5.0	8.26
MA_078	sago pondweed	POTAMOGETON PECTINATUS	1	6/16/2008	5.0	8.26
MA_079	alga	filamentous algae	--	6/16/2008	1.0	8.26
MA_080	muskgrass	CHARA SPECIES	1	6/16/2008	5.0	8.26
MA_080	alga	filamentous algae	--	6/16/2008	5.0	8.26
MA_081	muskgrass	CHARA SPECIES	5	6/16/2008	5.0	8.26
MA_081	alga	filamentous algae	--	6/16/2008	5.0	8.26
MA_082	muskgrass	CHARA SPECIES	5	6/16/2008	4.0	8.26
MA_082	alga	filamentous algae	--	6/16/2008	4.0	8.26

"--" indicates "not determined"

LARE Survey Raw Data
06/16/08 Survey Date

Site ID	Name	Species	Density	Sample Date	Depth	H2O Level
MA_083	muskgrass	CHARA SPECIES	5	6/16/2008	5.0	8.26
MA_083	alga	filamentous algae	--	6/16/2008	5.0	8.26
MA_083	duckweed	LEMNA SPECIES	--	6/16/2008	5.0	8.26
MA_084	muskgrass	CHARA SPECIES	1	6/16/2008	5.0	8.26
MA_085	alga	filamentous algae	--	6/16/2008	5.0	8.26
MA_086	no plants on rake	no plants on rake	0	6/16/2008	5.0	8.26
MA_087	muskgrass	CHARA SPECIES	1	6/16/2008	5.0	8.26
MA_087	alga	filamentous algae	--	6/16/2008	5.0	8.26
MA_087	duckweed	LEMNA SPECIES	--	6/16/2008	5.0	8.26
MA_088	muskgrass	CHARA SPECIES	5	6/16/2008	4.0	8.26
MA_088	alga	filamentous algae	--	6/16/2008	4.0	8.26
MA_089	muskgrass	CHARA SPECIES	1	6/16/2008	4.0	8.26
MA_089	alga	filamentous algae	--	6/16/2008	4.0	8.26
MA_090	muskgrass	CHARA SPECIES	1	6/16/2008	4.0	8.26
MA_090	alga	filamentous algae	--	6/16/2008	4.0	8.26
MA_091	muskgrass	CHARA SPECIES	1	6/16/2008	4.0	8.26
MA_091	alga	filamentous algae	--	6/16/2008	4.0	8.26
MA_092	muskgrass	CHARA SPECIES	3	6/16/2008	5.0	8.26
MA_092	alga	filamentous algae	--	6/16/2008	5.0	8.26
MA_093	muskgrass	CHARA SPECIES	1	6/16/2008	4.0	8.26
MA_094	muskgrass	CHARA SPECIES	1	6/16/2008	4.0	8.26
MA_095	muskgrass	CHARA SPECIES	5	6/16/2008	5.0	8.26
MA_095	alga	filamentous algae	--	6/16/2008	5.0	8.26
MA_096	muskgrass	CHARA SPECIES	1	6/16/2008	4.0	8.26
MA_096	alga	filamentous algae	--	6/16/2008	4.0	8.26
MA_097	alga	filamentous algae	--	6/16/2008	5.0	8.26
MA_097	duckweed	LEMNA SPECIES	--	6/16/2008	5.0	8.26
MA_098	alga	filamentous algae	--	6/16/2008	5.0	8.26
MA_099	alga	filamentous algae	--	6/16/2008	5.0	8.26
MA_100	muskgrass	CHARA SPECIES	1	6/16/2008	3.0	8.26
MA_100	alga	filamentous algae	--	6/16/2008	3.0	8.26
MA_101	muskgrass	CHARA SPECIES	3	6/16/2008	3.0	8.26
MA_101	alga	filamentous algae	--	6/16/2008	3.0	8.26
MA_101	duckweed	LEMNA SPECIES	--	6/16/2008	3.0	8.26
MA_102	alga	filamentous algae	--	6/16/2008	6.0	8.26
MA_102	duckweed	LEMNA SPECIES	--	6/16/2008	6.0	8.26
MA_102	spatterdock	NUPHAR LUTEA	--	6/16/2008	6.0	8.26
MA_103	muskgrass	CHARA SPECIES	1	6/16/2008	5.0	8.26
MA_103	alga	filamentous algae	--	6/16/2008	5.0	8.26
MA_104	alga	filamentous algae	--	6/16/2008	4.0	8.26
MA_105	alga	filamentous algae	--	6/16/2008	4.0	8.26
MA_106	muskgrass	CHARA SPECIES	1	6/16/2008	5.0	8.26
MA_106	alga	filamentous algae	--	6/16/2008	5.0	8.26
MA_107	muskgrass	CHARA SPECIES	3	6/16/2008	4.0	8.26
MA_107	alga	filamentous algae	--	6/16/2008	4.0	8.26
MA_108	sago pondweed	POTAMOGETON PECTINATUS	1	6/16/2008	4.0	8.26
MA_108	alga	filamentous algae	--	6/16/2008	4.0	8.26
MA_109	muskgrass	CHARA SPECIES	1	6/16/2008	4.0	8.26
MA_109	alga	filamentous algae	--	6/16/2008	4.0	8.26
MA_110	muskgrass	CHARA SPECIES	1	6/16/2008	3.0	8.26
MA_110	alga	filamentous algae	--	6/16/2008	3.0	8.26
MA_111	muskgrass	CHARA SPECIES	1	6/16/2008	4.0	8.26
MA_111	alga	filamentous algae	--	6/16/2008	4.0	8.26
MA_112	alga	filamentous algae	--	6/16/2008	5.0	8.26
MA_113	muskgrass	CHARA SPECIES	1	6/16/2008	4.0	8.26
MA_113	alga	filamentous algae	--	6/16/2008	4.0	8.26

"--" indicates "not determined"

LARE Survey Raw Data
08/27/08 Survey Date

Site ID	Name	Species	Density	Sample Date	Depth	H2O Level
DK_001	alga	filamentous algae	--	8/27/2008	4.0	8.08
DK_001	cattail	TYPHA SPECIES	--	8/27/2008	4.0	8.08
DK_001	no plants on rake	no plants on rake	0	8/27/2008	4.0	8.08
DK_001	waterwillow	JUSTICIA AMERICANA	--	8/27/2008	4.0	8.08
DK_002	no plants on rake	no plants on rake	0	8/27/2008	5.0	8.08
DK_003	muskgrass	CHARA SPECIES	5	8/27/2008	3.0	8.08
DK_003	alga	filamentous algae	--	8/27/2008	3.0	8.08
DK_004	alga	filamentous algae	--	8/27/2008	2.0	8.08
DK_004	muskgrass	CHARA SPECIES	--	8/27/2008	2.0	8.08
DK_005	muskgrass	CHARA SPECIES	1	8/27/2008	3.0	8.08
DK_005	alga	filamentous algae	--	8/27/2008	3.0	8.08
DK_006	alga	filamentous algae	--	8/27/2008	4.0	8.08
DK_007	muskgrass	CHARA SPECIES	1	8/27/2008	4.0	8.08
DK_007	sago pondweed	POTAMOGETON PECTINATUS	1	8/27/2008	4.0	8.08
DK_007	alga	filamentous algae	--	8/27/2008	4.0	8.08
DK_008	no plants on rake	no plants on rake	0	8/27/2008	15.0	8.08
DK_008	watermeal	WOLFFIA COLUMBIANA	--	8/27/2008	15.0	8.08
DK_009	no plants on rake	no plants on rake	0	8/27/2008	15.0	8.08
DK_010	no plants on rake	no plants on rake	0	8/27/2008	3.0	8.08
dnr_001	muskgrass	CHARA SPECIES	1	8/27/2008	5.0	8.08
dnr_001	alga	filamentous algae	--	8/27/2008	5.0	8.08
MA_001	no plants on rake	no plants on rake	0	8/27/2008	3.0	8.08
MA_002	muskgrass	CHARA SPECIES	1	8/27/2008	4.0	8.08
MA_003	muskgrass	CHARA SPECIES	1	8/27/2008	3.0	8.08
MA_004	muskgrass	CHARA SPECIES	1	8/27/2008	4.0	8.08
MA_005	alga	filamentous algae	--	8/27/2008	6.0	8.08
MA_005	no plants on rake	no plants on rake	0	8/27/2008	6.0	8.08
MA_006	muskgrass	CHARA SPECIES	--	8/27/2008	4.0	8.08
MA_007	muskgrass	CHARA SPECIES	1	8/27/2008	4.0	8.08
MA_007	alga	filamentous algae	--	8/27/2008	4.0	8.08
MA_008	bladderwort	UTRICULARIA SPECIES	1	8/27/2008	2.0	8.08
MA_008	alga	filamentous algae	--	8/27/2008	2.0	8.08
MA_008	water stargrass	HETERANTHERA DUBIA	--	8/27/2008	2.0	8.08
MA_009	purple loostrife	LYTHRUM SALICARIA	--	8/27/2008	1.0	8.08
MA_009	waterwillow	JUSTICIA AMERICANA	--	8/27/2008	1.0	8.08
MA_010	bulrush	SCIRPUS CALIFORNICUS	--	8/27/2008	2.0	8.08
MA_010	purple loostrife	LYTHRUM SALICARIA	--	8/27/2008	2.0	8.08
MA_010	swamp smartweed	POLYGONUM HYDROPIPEROIDES	--	8/27/2008	2.0	8.08
MA_010	waterwillow	JUSTICIA AMERICANA	--	8/27/2008	2.0	8.08
MA_011	coontail	CERATOPHYLLUM DEMERSUM	1	8/27/2008	1.0	8.08
MA_011	alga	filamentous algae	--	8/27/2008	1.0	8.08
MA_011	duckweed	LEMNA SPECIES	--	8/27/2008	1.0	8.08
MA_011	watermeal	WOLFFIA COLUMBIANA	--	8/27/2008	1.0	8.08
MA_012	bulrush	SCIRPUS CALIFORNICUS	--	8/27/2008	2.0	8.08
MA_012	cattail	TYPHA SPECIES	--	8/27/2008	2.0	8.08
MA_012	no plants on rake	no plants on rake	0	8/27/2008	2.0	8.08
MA_012	purple loostrife	LYTHRUM SALICARIA	--	8/27/2008	2.0	8.08
MA_012	spatterdock	NUPHAR LUTEA	--	8/27/2008	2.0	8.08
MA_013	no plants on rake	no plants on rake	0	8/27/2008	3.0	8.08
MA_014	sago pondweed	POTAMOGETON PECTINATUS	1	8/27/2008	2.0	8.08

"--" indicates "not determined"

LARE Survey Raw Data
08/27/08 Survey Date

Site ID	Name	Species	Density	Sample Date	Depth	H2O Level
MA_015	sago pondweed	POTAMOGETON PECTINATUS	1	8/27/2008	2.0	8.08
MA_015	alga	filamentous algae	--	8/27/2008	2.0	8.08
MA_016	alga	filamentous algae	--	8/27/2008	4.0	8.08
MA_016	no plants on rake	no plants on rake	0	8/27/2008	4.0	8.08
MA_016	spatterdock	NUPHAR LUTEA	--	8/27/2008	4.0	8.08
MA_017	no plants on rake	no plants on rake	0	8/27/2008	6.0	8.08
MA_018	alga	filamentous algae	--	8/27/2008	5.0	8.08
MA_018	no plants on rake	no plants on rake	0	8/27/2008	5.0	8.08
MA_019	alga	filamentous algae	--	8/27/2008	3.0	8.08
MA_019	no plants on rake	no plants on rake	0	8/27/2008	3.0	8.08
MA_020	alga	filamentous algae	--	8/27/2008	4.0	8.08
MA_020	no plants on rake	no plants on rake	0	8/27/2008	4.0	8.08
MA_022	muskgrass	CHARA SPECIES	1	8/27/2008	4.0	8.08
MA_022	alga	filamentous algae	--	8/27/2008	4.0	8.08
MA_022	spatterdock	NUPHAR LUTEA	--	8/27/2008	4.0	8.08
MA_022	swamp mallow	HIBICUS SPP	--	8/27/2008	4.0	8.08
MA_023	alga	filamentous algae	--	8/27/2008	4.0	8.08
MA_023	no plants on rake	no plants on rake	0	8/27/2008	4.0	8.08
MA_024	alga	filamentous algae	--	8/27/2008	2.0	8.08
MA_024	no plants on rake	no plants on rake	0	8/27/2008	2.0	8.08
MA_026	alga	filamentous algae	--	8/27/2008	4.0	8.08
MA_026	no plants on rake	no plants on rake	0	8/27/2008	4.0	8.08
MA_027	no plants on rake	no plants on rake	0	8/27/2008	4.0	8.08
MA_028	bladderwort	UTRICULARIA SPECIES	3	8/27/2008	4.0	8.08
MA_028	alga	filamentous algae	--	8/27/2008	4.0	8.08
MA_028	fragrant waterlily	NYMPHAEA ODORATA	--	8/27/2008	4.0	8.08
MA_028	spatterdock	NUPHAR LUTEA	--	8/27/2008	4.0	8.08
MA_029	alga	filamentous algae	--	8/27/2008	1.0	8.08
MA_029	no plants on rake	no plants on rake	0	8/27/2008	1.0	8.08
MA_030	alga	filamentous algae	--	8/27/2008	1.0	8.08
MA_030	no plants on rake	no plants on rake	0	8/27/2008	1.0	8.08
MA_030	purple loostrife	LYTHRUM SALICARIA	--	8/27/2008	1.0	8.08
MA_030	spatterdock	NUPHAR LUTEA	--	8/27/2008	1.0	8.08
MA_031	no plants on rake	no plants on rake	0	8/27/2008	1.0	8.08
MA_032	no plants on rake	no plants on rake	0	8/27/2008	14.0	8.08
MA_032	spatterdock	NUPHAR LUTEA	--	8/27/2008	14.0	8.08
MA_033	alga	filamentous algae	--	8/27/2008	4.0	8.08
MA_033	no plants on rake	no plants on rake	0	8/27/2008	4.0	8.08
MA_034	muskgrass	CHARA SPECIES	1	8/27/2008	5.0	8.08
MA_034	alga	filamentous algae	--	8/27/2008	5.0	8.08
MA_035	no plants on rake	no plants on rake	0	8/27/2008	5.0	8.08
MA_036	muskgrass	CHARA SPECIES	1	8/27/2008	3.0	8.08
MA_037	no plants on rake	no plants on rake	0	8/27/2008	6.0	8.08
MA_038	alga	filamentous algae	--	8/27/2008	4.0	8.08
MA_038	no plants on rake	no plants on rake	0	8/27/2008	4.0	8.08
MA_039	muskgrass	CHARA SPECIES	1	8/27/2008	6.0	8.08
MA_040	muskgrass	CHARA SPECIES	1	8/27/2008	10.0	8.08
MA_040	alga	filamentous algae	--	8/27/2008	10.0	8.08
MA_041	alga	filamentous algae	--	8/27/2008	4.0	8.08
MA_041	no plants on rake	no plants on rake	0	8/27/2008	4.0	8.08
MA_041	purple loostrife	LYTHRUM SALICARIA	--	8/27/2008	4.0	8.08
MA_042	sago pondweed	POTAMOGETON PECTINATUS	1	8/27/2008	4.0	8.08
MA_043	no plants on rake	no plants on rake	0	8/27/2008	5.0	8.08
MA_044	alga	filamentous algae	--	8/27/2008	4.0	8.08
MA_044	no plants on rake	no plants on rake	0	8/27/2008	4.0	8.08
MA_045	alga	filamentous algae	--	8/27/2008	4.0	8.08
MA_045	no plants on rake	no plants on rake	0	8/27/2008	4.0	8.08
MA_046	no plants on rake	no plants on rake	0	8/27/2008	6.0	8.08

"--" indicates "not determined"

LARE Survey Raw Data
08/27/08 Survey Date

Site ID	Name	Species	Density	Sample Date	Depth	H2O Level
MA_047	alga	filamentous algae	--	8/27/2008	4.0	8.08
MA_047	no plants on rake	no plants on rake	0	8/27/2008	4.0	8.08
MA_048	alga	filamentous algae	--	8/27/2008	6.0	8.08
MA_048	duckweed	LEMNA SPECIES	--	8/27/2008	6.0	8.08
MA_048	no plants on rake	no plants on rake	0	8/27/2008	6.0	8.08
MA_049	no plants on rake	no plants on rake	0	8/27/2008	6.0	8.08
MA_050	alga	filamentous algae	--	8/27/2008	5.0	8.08
MA_050	no plants on rake	no plants on rake	0	8/27/2008	5.0	8.08
MA_051	no plants on rake	no plants on rake	0	8/27/2008	5.0	8.08
MA_052	no plants on rake	no plants on rake	0	8/27/2008	4.0	8.08
MA_053	muskgrass	CHARA SPECIES	1	8/27/2008	4.0	8.08
MA_054	muskgrass	CHARA SPECIES	--	8/27/2008	5.0	8.08
MA_055	muskgrass	CHARA SPECIES	1	8/27/2008	5.0	8.08
MA_055	alga	filamentous algae	--	8/27/2008	5.0	8.08
MA_056	muskgrass	CHARA SPECIES	1	8/27/2008	3.0	8.08
MA_056	alga	filamentous algae	--	8/27/2008	3.0	8.08
MA_056	purple loostrife	LYTHRUM SALICARIA	--	8/27/2008	3.0	8.08
MA_056	swamp mallow	HIBICUS SPP	--	8/27/2008	3.0	8.08
MA_057	alga	filamentous algae	--	8/27/2008	6.0	8.08
MA_057	no plants on rake	no plants on rake	0	8/27/2008	6.0	8.08
MA_058	no plants on rake	no plants on rake	0	8/27/2008	5.0	8.08
MA_059	no plants on rake	no plants on rake	0	8/27/2008	5.0	8.08
MA_060	slender naiad	NAJAS SPECIES	1	8/27/2008	4.0	8.08
MA_061	muskgrass	CHARA SPECIES	1	8/27/2008	4.0	8.08
MA_062	no plants on rake	no plants on rake	0	8/27/2008	5.0	8.08
MA_063	alga	filamentous algae	--	8/27/2008	4.0	8.08
MA_063	no plants on rake	no plants on rake	0	8/27/2008	4.0	8.08
MA_064	no plants on rake	no plants on rake	0	8/27/2008	5.0	8.08
MA_065	muskgrass	CHARA SPECIES	1	8/27/2008	4.0	8.08
MA_065	alga	filamentous algae	--	8/27/2008	4.0	8.08
MA_066	no plants on rake	no plants on rake	0	8/27/2008	5.0	8.08
MA_067	no plants on rake	no plants on rake	0	8/27/2008	5.0	8.08
MA_068	alga	filamentous algae	--	8/27/2008	5.0	8.08
MA_068	no plants on rake	no plants on rake	0	8/27/2008	5.0	8.08
MA_069	muskgrass	CHARA SPECIES	1	8/27/2008	4.0	8.08
MA_069	alga	filamentous algae	--	8/27/2008	4.0	8.08
MA_070	no plants on rake	no plants on rake	0	8/27/2008	5.0	8.08
MA_071	alga	filamentous algae	--	8/27/2008	5.0	8.08
MA_072	muskgrass	CHARA SPECIES	1	8/27/2008	2.0	8.08
MA_072	purple loostrife	LYTHRUM SALICARIA	--	8/27/2008	2.0	8.08
MA_072	swamp mallow	HIBICUS SPP	--	8/27/2008	2.0	8.08
MA_073	muskgrass	CHARA SPECIES	1	8/27/2008	4.0	8.08
MA_073	alga	filamentous algae	--	8/27/2008	4.0	8.08
MA_074	no plants on rake	no plants on rake	0	8/27/2008	5.0	8.08
MA_075	no plants on rake	no plants on rake	0	8/27/2008	9.0	8.08
MA_076	alga	filamentous algae	--	8/27/2008	5.0	8.08
MA_076	no plants on rake	no plants on rake	0	8/27/2008	5.0	8.08
MA_077	no plants on rake	no plants on rake	0	8/27/2008	5.0	8.08
MA_078	no plants on rake	no plants on rake	0	8/27/2008	4.0	8.08
MA_079	muskgrass	CHARA SPECIES	3	8/27/2008	1.0	8.08
MA_080	muskgrass	CHARA SPECIES	1	8/27/2008	5.0	8.08
MA_081	no plants on rake	no plants on rake	0	8/27/2008	4.0	8.08
MA_082	muskgrass	CHARA SPECIES	1	8/27/2008	4.0	8.08
MA_083	muskgrass	CHARA SPECIES	1	8/27/2008	5.0	8.08
MA_084	no plants on rake	no plants on rake	0	8/27/2008	5.0	8.08
MA_085	no plants on rake	no plants on rake	0	8/27/2008	6.0	8.08
MA_086	no plants on rake	no plants on rake	0	8/27/2008	6.0	8.08

"--" indicates "not determined"

LARE Survey Raw Data
08/27/08 Survey Date

Site ID	Name	Species	Density	Sample Date	Depth	H2O Level
MA_087	alga	filamentous algae	--	8/27/2008	5.0	8.08
MA_087	no plants on rake	no plants on rake	0	8/27/2008	5.0	8.08
MA_088	muskgrass	CHARA SPECIES	1	8/27/2008	3.0	8.08
MA_088	alga	filamentous algae	--	8/27/2008	3.0	8.08
MA_088	spatterdock	NUPHAR LUTEA	--	8/27/2008	3.0	8.08
MA_089	muskgrass	CHARA SPECIES	1	8/27/2008	4.0	8.08
MA_089	alga	filamentous algae	--	8/27/2008	4.0	8.08
MA_090	muskgrass	CHARA SPECIES	1	8/27/2008	4.0	8.08
MA_090	alga	filamentous algae	--	8/27/2008	4.0	8.08
MA_091	muskgrass	CHARA SPECIES	1	8/27/2008	4.0	8.08
MA_091	alga	filamentous algae	--	8/27/2008	4.0	8.08
MA_092	muskgrass	CHARA SPECIES	1	8/27/2008	4.0	8.08
MA_092	alga	filamentous algae	--	8/27/2008	4.0	8.08
MA_093	muskgrass	CHARA SPECIES	1	8/27/2008	5.0	8.08
MA_094	no plants on rake	no plants on rake	0	8/27/2008	5.0	8.08
MA_095	no plants on rake	no plants on rake	0	8/27/2008	5.0	8.08
MA_096	alga	filamentous algae	--	8/27/2008	5.0	8.08
MA_096	no plants on rake	no plants on rake	0	8/27/2008	5.0	8.08
MA_097	no plants on rake	no plants on rake	0	8/27/2008	5.0	8.08
MA_098	alga	filamentous algae	--	8/27/2008	6.0	8.08
MA_098	no plants on rake	no plants on rake	0	8/27/2008	6.0	8.08
MA_099	alga	filamentous algae	--	8/27/2008	5.0	8.08
MA_099	no plants on rake	no plants on rake	0	8/27/2008	5.0	8.08
MA_100	muskgrass	CHARA SPECIES	1	8/27/2008	4.0	8.08
MA_100	alga	filamentous algae	--	8/27/2008	4.0	8.08
MA_101	muskgrass	CHARA SPECIES	1	8/27/2008	3.0	8.08
MA_101	alga	filamentous algae	--	8/27/2008	3.0	8.08
MA_102	alga	filamentous algae	--	8/27/2008	6.0	8.08
MA_102	arrow arum	PELTANDRA VIRGINICA	--	8/27/2008	6.0	8.08
MA_102	cattail	TYPHA SPECIES	--	8/27/2008	6.0	8.08
MA_102	purple loostrife	LYTHRUM SALICARIA	--	8/27/2008	6.0	8.08
MA_102	spatterdock	NUPHAR LUTEA	--	8/27/2008	6.0	8.08
MA_103	muskgrass	CHARA SPECIES	1	8/27/2008	4.0	8.08
MA_103	alga	filamentous algae	--	8/27/2008	4.0	8.08
MA_104	muskgrass	CHARA SPECIES	1	8/27/2008	4.0	8.08
MA_104	alga	filamentous algae	--	8/27/2008	4.0	8.08
MA_105	muskgrass	CHARA SPECIES	1	8/27/2008	4.0	8.08
MA_105	alga	filamentous algae	--	8/27/2008	4.0	8.08
MA_106	no plants on rake	no plants on rake	0	8/27/2008	3.0	8.08
MA_107	muskgrass	CHARA SPECIES	1	8/27/2008	4.0	8.08
MA_107	alga	filamentous algae	--	8/27/2008	4.0	8.08
MA_108	muskgrass	CHARA SPECIES	1	8/27/2008	4.0	8.08
MA_108	alga	filamentous algae	--	8/27/2008	4.0	8.08
MA_108	cattail	TYPHA SPECIES	--	8/27/2008	4.0	8.08
MA_109	muskgrass	CHARA SPECIES	1	8/27/2008	2.0	8.08
MA_110	alga	filamentous algae	--	8/27/2008	2.0	8.08
MA_111	muskgrass	CHARA SPECIES	1	8/27/2008	4.0	8.08
MA_111	alga	filamentous algae	--	8/27/2008	4.0	8.08
MA_112	muskgrass	CHARA SPECIES	1	8/27/2008	4.0	8.08
MA_113	muskgrass	CHARA SPECIES	1	8/27/2008	4.0	8.08
MA_113	alga	filamentous algae	--	8/27/2008	4.0	8.08

"--" indicates "not determined"

Aquatic Weed Control:
2008 Field Sampling Sheets
(organized by survey date)

Lake Manitou Sample Collection

Injury:		Cover:		Growth:		Other Indicators:		
1	Healthy	1	80-100	1	From Apical Tips or Nodes	T	Topped out Vegetation	Biologist Name:
2	Slight injury	2	60-79	2	From Seeds	I	Suspected Insect Damage	
3	Moderate injury	3	40-59	3	From Root Crown or Rhizomes	P	Suspected Pathogen Damage	David Keister
4	Severe Injury	4	20-39	4	From Turions or Tubers	M	Mechanical Damage	Aquatic Weed Control
5	Dead plant	5	<19	5	From Perennial - shrub, tree, etc.	W	Water Fluctuation Damage	
6	Not present	6	Not present	6	No growth	E	End of Life Cycle	

Survey Date: 19-May-08
Date of Treatment: 14-May-08
Gauge Reading: 8.34 (20080519_dkAWC_gauge)

Site	Species	Injury	Cover	Growth	Other	Photos	Secchi	Depth	H_2OTemp	D O_2	Notes
1	Curly leaf pondweed	2	5	4			bottom visible		60.5	-	depth 6.5 feet
2	no plants	6					8.5	surface	61.1	9.40	depth 30 feet
								1m	61.1	9.36	
								2m	61.0	9.35	
								3m	60.7	9.25	
								4m	60.4	8.96	
								5m	60.3	8.91	
								6m	60.1	8.86	
								7m	59.7	8.49	
								8m	56.7	5.41	
								9m	54.5	2.29	
								10m	53.8	0.21	
3	no plants	6					bottom visible		60.5		depth 5 feet
4	chara	2	5	3			bottom visible		61.4	-	depth 5 feet
5	no plants	6					8.6		62.0	-	depth 18 feet
6	sago pondweed	2	5	2			bottom visible		62.5	-	depth 4 feet
7	no plants	6					8.5	surface	62.1	9.10	depth 39 feet
								1m	61.8	9.06	
								2m	61.6	9.00	
								3m	61.3	8.86	
								4m	61.3	8.84	
								5m	61.2	8.81	
								6m	61.1	8.71	
								7m	60.9	8.56	
								8m	60.4	8.21	
								9m	59.7	7.18	
								10m	58.0	5.25	
9	algae present									-	depth 5 feet
											Summary
											water temp 60.5 - 62.5 F
											secchi 8.5- 8.6 feet
											sunny,breezy, temp in low 60's
											rake samples taken at each shallow fastest point
											Submersed vegetation very scarce
											Sago Pondweed, chara, and curly leaf pondweed all collected on rake.
											Gauge reading 8.34 see photo (20080519_dkAWC_gauge)
											no hydrilla found

Aquatic Weed Control:
2008 Field Sampling Sheets
(organized by survey date)

Lake Manitou Sample Collection

Injury:		Cover:		Growth:		Other Indicators:		
1	Healthy	1	80-100	1	From Apical Tips or Nodes	T	Topped out Vegetation	Biologist Name:
2	Slight injury	2	60-79	2	From Seeds	I	Suspected Insect Damage	
3	Moderate injury	3	40-59	3	From Root Crown or Rhizomes	P	Suspected Pathogen Damage	David Keister
4	Severe Injury	4	20-39	4	From Turions or Tubers	M	Mechanical Damage	Aquatic Weed Control
5	Dead plant	5	<19	5	From Perennial - shrub, tree, etc.	W	Water Fluctuation Damage	
6	Not present	6	Not present	6	No growth	E	End of Life Cycle	

Survey Date: 2-Jun-08
Date of Treatment: 14-May-08
Gauge Reading: 8.37 (20080602_dkAWC_gauge)

Site	Species	Injury	Cover	Growth	Other	Photos	Secchi	Depth	H_2OTemp	D O_2	Notes
1	Sago Pondweed	2	5	2			bottom visible		72.6	-	depth 6.5 feet
2	no plants	6					7.3	surface	73.4	10.76	depth 30 feet
								1m	73.1	10.85	
								2m	72.7	10.88	
								3m	69.8	9.95	
								4m	67.4	9.24	
								5m	64.2	7.55	
								6m	61.9	5.91	
								7m	59.8	3.64	
								8m	57.7	1.34	
								9m	55.4	0.16	
								10m	53.2	0.12	
3	algae present						bottom visible		72.8		depth 5 feet
4	chara	2	5	3			bottom visible		73.2	-	depth 5 feet
	algae present										
5	no plants	6					6.1		74.8	-	depth 18 feet
6	sago pondweed	2	5	2			bottom visible		75.1	-	depth 4 feet
	chara	2	5	3							
7	no plants	6					6.1	surface	75.0	12.49	depth 39 feet
								1m	74.5	12.66	
								2m	73.6	12.07	
								3m	70.0	9.80	
								4m	69.3	9.62	
								5m	68.3	9.32	
								6m	65.8	8.43	
								7m	63.3	6.61	
								8m	61.6	5.26	
								9m	59.7	2.86	
								10m	58.9	1.72	
9	chara	2	5	3			bottom visible		73.4	-	depth 5 feet
	sago pondweed	2	5	2							
	algae present										**Summary**
											water temp 72.6 - 75.1 F
											secchi 6.1 - 7.3feet
											sunny, temp in upper 70's
											rake samples taken at each shallow fastest point
											Curly leaf, sago, Leafy, chara, duckweed, watermeal all observed
											Sago Pondweed and chara collected on rake.
											Gauge reading 8.37 see photo (20080602_dkAWC_gauge)
											no hydrilla found

Aquatic Weed Control:
2008 Field Sampling Sheets
(organized by survey date)

Lake Manitou Sample Collection

Injury:		Cover:		Growth:		Other Indicators:		
1	Healthy	1	80-100	1	From Apical Tips or Nodes	T	Topped out Vegetation	Biologist Name:
2	Slight injury	2	60-79	2	From Seeds	I	Suspected Insect Damage	
3	Moderate injury	3	40-59	3	From Root Crown or Rhizomes	P	Suspected Pathogen Damage	David Keister
4	Severe Injury	4	20-39	4	From Turions or Tubers	M	Mechanical Damage	Aquatic Weed Control
5	Dead plant	5	<19	5	From Perennial - shrub, tree, etc.	W	Water Fluctuation Damage	
6	Not present	6	Not present	6	No growth	E	End of Life Cycle	

Survey Date: 16-Jun-08
Date of Treatment: 14-May-08
Gauge Reading: 8.28 (20080616_dkAWC_gauge)

Site	Species	Injury	Cover	Growth	Other	Photos	Secchi	Depth	H_2OTemp	D O_2	Notes
1	algae present						3.2		76.9	-	depth 6.5 feet
2	no plants	6					3.5	surface	77.2	9.34	depth 30 feet
								1m	76.8	9.43	
								2m	76.2	9.27	
								3m	75.7	8.10	
								4m	75.3	7.59	
								5m	70.4	1.72	
								6m	64.7	0.23	
								7m	61.8	0.16	
								8m	58.8	0.12	
								9m	58.6	0.09	
								10m	58.6	0.08	
3	algae present						3		77.0		depth 5 feet
4	chara	2	5	3			3.1		76.1	-	depth 5 feet
	algae present										
5	no plants	6					3.6		76.7	-	depth 18 feet
6	sago pondweed	2	5	2			3.5		77.4	-	depth 4 feet
	algae present										
7	no plants	6					3.4	surface	76.9	9.78	depth 39 feet
								1m	76.9	9.71	
								2m	76.7	9.55	
								3m	76.1	8.98	
								4m	75.9	8.78	
								5m	75.8	8.56	
								6m	74.4	6.69	
								7m	69.2	1.53	
								8m	64.4	0.25	
								9m	60.7	0.15	
								10m	59.2	0.12	
9	chara	2	5	3			3.1		77.2	-	depth 5 feet
	algae present										**Summary**
											water temp 76.1 - 77.4 F
											secchi 3.0 - 3.6 feet
											sunny, temp in mid 70's
											rake samples taken at each shallow fastest point
											sago, chara, duckweed, watermeal all observed
											Sago Pondweed and chara collected on rake.
											Gauge reading 8.28 see photo (20080616_dkAWC_gauge)
											no hydrilla found

Aquatic Weed Control:
2008 Field Sampling Sheets
(organized by survey date)

Lake Manitou Sample Collection

Injury:		Cover:		Growth:		Other Indicators:		
1	Healthy	1	80-100	1	From Apical Tips or Nodes	T	Topped out Vegetation	Biologist Name:
2	Slight injury	2	60-79	2	From Seeds	I	Suspected Insect Damage	
3	Moderate injury	3	40-59	3	From Root Crown or Rhizomes	P	Suspected Pathogen Damage	David Keister
4	Severe Injury	4	20-39	4	From Turions or Tubers	M	Mechanical Damage	Aquatic Weed Control
5	Dead plant	5	<19	5	From Perennial - shrub, tree, etc.	W	Water Fluctuation Damage	
6	Not present	6	Not present	6	No growth	E	End of Life Cycle	

Survey Date: 26-Jun-08
Date of Treatment: 14-May-08
Gauge Reading: 8.27 (20080626_dkAWC_gauge)

Site	Species	Injury	Cover	Growth	Other	Photos	Secchi	Depth	H_2OTemp	D O_2	Notes
1	no plants	6					2.9		75.8	-	depth 6.5 feet
2	no plants	6					2.5	surface	75.1	11.15	depth 30 feet
								1m	74.9	11.20	
								2m	74.3	10.67	
								3m	74.3	10.65	
								4m	73.2	7.66	
								5m	73.2	7.72	
								6m	72.6	6.65	
								7m	72.6	6.71	
								8m	71.5	3.79	
								9m	66.3	0.27	
								10m	63.9	0.17	
3	algae present						2.1		75.0		depth 5 feet
4	chara	2	5	3			3.1		75.7	-	depth 5 feet
5	no plants	6					2.6		76.4	-	depth 18 feet
6	algae present						3.1		75.2	-	depth 4 feet
7	no plants	6					2.9	surface	76.4	11.49	depth 39 feet
								1m	75.9	11.63	
								2m	75.4	11.66	
								3m	74.7	10.68	
								4m	74.3	8.82	
								5m	73.5	5.71	
								6m	73.0	4.70	
								7m	71.5	1.69	
								8m	68.2	0.15	
								9m	63.0	0.11	
								10m	59.8	0.09	
9	chara	2	5	3			2.5		75.8	-	depth 5 feet
	algae present										**Summary**
											water temp 75.0 - 76.4 F
											secchi 2.1- 3.1 feet
											cloudy, temp in low 80's's
											rake samples taken at each shallow fastest point
											Curly leaf, sago, Leafy, chara, coontail, waterstargrass, duckweed, watermeal all observed
											Sago Pondweed and chara collected on rake.
											Gauge reading 8.37 see photo (20080602_dkAWC_gauge)
											4 different hydrilla plants/fragments found floating- all near poets point (see pictures)

Aquatic Weed Control:
2008 Field Sampling Sheets
(organized by survey date)

Lake Manitou Sample Collection

Injury:		Cover:		Growth:		Other Indicators:		
1	Healthy	1	80-100	1	From Apical Tips or Nodes	T	Topped out Vegetation	Biologist Name:
2	Slight injury	2	60-79	2	From Seeds	I	Suspected Insect Damage	
3	Moderate injury	3	40-59	3	From Root Crown or Rhizomes	P	Suspected Pathogen Damage	David Keister
4	Severe Injury	4	20-39	4	From Turions or Tubers	M	Mechanical Damage	Aquatic Weed Control
5	Dead plant	5	<19	5	From Perennial - shrub, tree, etc.	W	Water Fluctuation Damage	
6	Not present	6	Not present	6	No growth	E	End of Life Cycle	

Survey Date: 14-Jul-08
Date of Treatment: 14-May-08
Gauge Reading: 8.22 (20080714_dkAWC_gauge)

Site	Species	Injury	Cover	Growth	Other	Photos	Secchi	Depth	H_2OTemp	D O_2	Notes
1	no plants	6					3		77.0	-	depth 6.5 feet
2	no plants	6					2.8	surface	77.4	8.21	depth 30 feet
								1m	77.3	8.20	
								2m	77.0	7.39	
								3m	76.9	7.17	
								4m	76.7	6.66	
								5m	72.6	0.22	
								6m	68.9	0.15	
								7m	64.8	0.12	
								8m	61.3	0.10	
								9m	59.3	0.0.8	
								10m	54.5	0.07	
3	algae present						2.5		76.4		depth 5 feet
4	chara	2	5	3			2.3		77.3	-	depth 5 feet
5	no plants	6					3.1		78.0	-	depth 18 feet
6	chara	2	5	3			2.9		78.6	-	depth 4 feet
7	no plants	6					3.1	surface	78.7	9.64	depth 39 feet
								1m	78.7	9.65	
								2m	78.2	8.52	
								3m	78.0	8.24	
								4m	77.4	6.43	
								5m	77.1	4.71	
								6m	75.3	0.88	
								7m	72.8	0.16	
								8m	70.9	0.13	
								9m	67.7	0.11	
								10m	62.3	0.08	
9	chara	2	5	3			2.3		76.1	-	depth 5 feet
											Summary
											water temp 76.1 - 78.7 F
											secchi 2.3- 3.1 feet
											sunny, temp in mid 80's's
											rake samples taken at each shallow fastest point
											much less vegetation observed: both living and floating on surface
											chara was the only species collected on rake.
											Gauge reading down from 8.27 to 8.22 see photo (20080714_dkAWC_gauge)
											no hydrilla found

Aquatic Weed Control:
2008 Field Sampling Sheets
(organized by survey date)

Lake Manitou Sample Collection

Injury:		Cover:		Growth:		Other Indicators:		
1	Healthy	1	80-100	1	From Apical Tips or Nodes	T	Topped out Vegetation	Biologist Name:
2	Slight injury	2	60-79	2	From Seeds	I	Suspected Insect Damage	
3	Moderate injury	3	40-59	3	From Root Crown or Rhizomes	P	Suspected Pathogen Damage	David Keister
4	Severe Injury	4	20-39	4	From Turions or Tubers	M	Mechanical Damage	Aquatic Weed Control
5	Dead plant	5	<19	5	From Perennial - shrub, tree, etc.	W	Water Fluctuation Damage	
6	Not present	6	Not present	6	No growth	E	End of Life Cycle	

Survey Date:	Date of Treatment:	Gauge Reading:
28-Jul-08	14-May-08	8.12 (20080728_dkAWC_gauge)

Site	Species	Injury	Cover	Growth	Other	Photos	Secchi	Depth	H_2OTemp	D O_2	Notes
1	no plants	6					3.2		79.0	-	depth 6.5 feet
2	no plants	6					3.1	surface	79.3	9.47	depth 30 feet
								1m	79.0	9.42	
								2m	78.7	8.93	
								3m	78.4	8.07	
								4m	76.8	3.21	
								5m	74.8	0.18	
								6m	69.7	0.12	
								7m	66.0	0.10	
								8m	61.5	0.07	
								9m	57.9	0.06	
								10m	56.7	0.05	
3	no plants	6					2.9		78.5		depth 5 feet
4	chara	2	5	3			2.8		79.0	-	depth 5 feet
5	no plants	6					3		80.5	-	depth 18 feet
6	algae present						2.9		80.0	-	depth 4 feet
7	no plants	6					3.6	surface	80.7	10.16	depth 39 feet
								1m	79.8	10.00	
								2m	79.5	9.53	
								3m	79.3	8.74	
								4m	78.8	7.24	
								5m	78.0	2.72	
								6m	76.5	0.15	
								7m	74.4	0.12	
								8m	70.8	0.09	
								9m	66.8	0.07	
								10m	63.1	0.06	
9	no plants	6					2.5		78.9	-	depth 5 feet
											Summary
											water temp 78.5 - 80.7 F
											secchi 2.8 - 3.6 feet
											cloudy, temp in mid 80's's
											rake samples taken at each shallow fastest point
											sago pondweed beds may be increasing in south end of lake
											chara was the only species collected on rake.
											Gauge reading down from 8.22 to 8.12 see photo (20080728_dkAWC_gauge)
											no hydrilla found

Aquatic Weed Control:
2008 Field Sampling Sheets
(organized by survey date)

Lake Manitou Sample Collection

Injury:		Cover:		Growth:		Other Indicators:		
1	Healthy	1	80-100	1	From Apical Tips or Nodes	T	Topped out Vegetation	Biologist Name:
2	Slight injury	2	60-79	2	From Seeds	I	Suspected Insect Damage	
3	Moderate injury	3	40-59	3	From Root Crown or Rhizomes	P	Suspected Pathogen Damage	David Keister
4	Severe Injury	4	20-39	4	From Turions or Tubers	M	Mechanical Damage	Aquatic Weed Control
5	Dead plant	5	<19	5	From Perennial - shrub, tree, etc.	W	Water Fluctuation Damage	
6	Not present	6	Not present	6	No growth	E	End of Life Cycle	

Survey Date: 11-Aug-08
Date of Treatment: 14-May-08
Gauge Reading: 8.19 (20080811_dkAWC_gauge)

Site	Species	Injury	Cover	Growth	Other	Photos	Secchi	Depth	H_2OTemp	D O_2	Notes
1	no plants	6					4.1		75.4	-	depth 6.5 feet
2	no plants	6					4.3	surface	74.4	7.50	depth 30 feet
								1m	74.2	7.41	
								2m	74.1	7.25	
								3m	73.7	6.85	
								4m	73.6	6.76	
								5m	73.3	6.83	
								6m	72.0	5.26	
								7m	65.0	0.17	
								8m	60.0	0.15	
								9m	57.6	0.12	
								10m	55.5	0.10	
3	chara	2	5	3			4.3		76.4		depth 5 feet
4	algae present	6					3.8		74.5	-	depth 5 feet
5	no plants	6					3.9		76.5	-	depth 18 feet
6	no plants	6					4		76.1	-	depth 4 feet
7	no plants	6					4.8	surface	76.9	8.27	depth 39 feet
								1m	76.4	8.23	
								2m	75.7	7.56	
								3m	75.4	7.16	
								4m	75.3	6.97	
								5m	75.1	6.89	
								6m	74.8	6.49	
								7m	74.6	6.41	
								8m	73.4	4.96	
								9m	66.6	0.19	
								10m	62.0	0.14	
9	no plants	6					botton visible		74.9	-	depth 5 feet
											Summary
											water temp 74.4 - 76.9 F
											secchi 3.8 - 4.8 feet
											sunny temp in upper 70's
											rake samples taken at each shallow fastest point
											increased waer clarity: looks like some planktonic algae died off
											chara was the only species collected on rake.
											Gauge reading up from 8.12 to 8.19 see photo (20080811_dkAWC_gauge)
											no hydrilla found

Aquatic Weed Control:
2008 Field Sampling Sheets
(organized by survey date)

Lake Manitou Sample Collection

Injury:		Cover:		Growth:		Other Indicators:		
1	Healthy	1	80-100	1	From Apical Tips or Nodes	T	Topped out Vegetation	Biologist Name:
2	Slight injury	2	60-79	2	From Seeds	I	Suspected Insect Damage	
3	Moderate injury	3	40-59	3	From Root Crown or Rhizomes	P	Suspected Pathogen Damage	David Keister
4	Severe Injury	4	20-39	4	From Turions or Tubers	M	Mechanical Damage	Aquatic Weed Control
5	Dead plant	5	<19	5	From Perennial - shrub, tree, etc.	W	Water Fluctuation Damage	
6	Not present	6	Not present	6	No growth	E	End of Life Cycle	

Survey Date: 2-Sep-08
Date of Treatment: 14-May-08
Gauge Reading: 8.04 (20080902_dkAWC_gauge)

Site	Species	Injury	Cover	Growth	Other	Photos	Secchi	Depth	H_2OTemp	D O_2	Notes
1	Algae present	6					3.2		77.8	-	depth 6.5 feet
2	no plants	6					4.1	surface	78.7	7.91	depth 30 feet
								1m	78.0	7.98	
								2m	77.7	7.70	
								3m	77.2	7.47	
								4m	76.2	5.51	
								5m	74.2	0.99	
								6m	72.4	0.20	
								7m	62.6	0.13	
								8m	63.6	0.11	
								9m	59.7	0.09	
								10m	59.4	0.07	
3	no plants	6					3.3		77.9		depth 5 feet
4	no plants	6					2.9		78.2	-	depth 5 feet
5	no plants	6					4.1		80.1	-	depth 18 feet
6	Algae present	6					3.8		79.3	-	depth 4 feet
7	no plants	6					4.2	surface	80.0	8.59	depth 39 feet
								1m	78.6	8.52	
								2m	78.2	8.56	
								3m	77.8	8.08	
								4m	77.2	6.00	
								5m	76.5	3.50	
								6m	75.6	1.00	
								7m	74.6	0.19	
								8m	72.1	0.15	
								9m	69.3	0.11	
								10m	63.9	0.09	
9	no plants	6					2.9		77.5	-	depth 5 feet
											Summary
											water temp 77.5 - 80.1 F
											secchi 2.9 - 4.2 feet
											sunny temp in lower 90's
											rake samples taken at each shallow fastest point
											slight decrease in water clarity
											no plant species collected on rake: Sago pondweed observed in south end of lake
											Gauge reading 8.04 (20080902_dkAWC_gauge)
											no hydrilla found

Aquatic Weed Control:
2008 Field Sampling Sheets
(organized by survey date)

Lake Manitou Sample Collection

Injury:		Cover:		Growth:		Other Indicators:		
1	Healthy	1	80-100	1	From Apical Tips or Nodes	T	Topped out Vegetation	Biologist Name:
2	Slight injury	2	60-79	2	From Seeds	I	Suspected Insect Damage	
3	Moderate injury	3	40-59	3	From Root Crown or Rhizomes	P	Suspected Pathogen Damage	David Keister
4	Severe Injury	4	20-39	4	From Turions or Tubers	M	Mechanical Damage	Aquatic Weed Control
5	Dead plant	5	<19	5	From Perennial - shrub, tree, etc.	W	Water Fluctuation Damage	
6	Not present	6	Not present	6	No growth	E	End of Life Cycle	

Survey Date: 15-Sep-08
Date of Treatment: 14-May-08
Gauge Reading: 8.04 (20080902_dkAWC_gauge)

Site	Species	Injury	Cover	Growth	Other	Photos	Secchi	Depth	H_2OTemp	D O_2	Notes
1	no plants	6					6		70.9	-	depth 6.5 feet
2	no plants	6					7	surface	69.7	7.41	depth 30 feet
								1m	70.2	7.32	
								2m	70.3	7.25	
								3m	70.3	7.18	
								4m	70.4	7.09	
								5m	70.2	6.48	
								6m	70.2	6.36	
								7m	69.7	4.26	
								8m	65.3	0.26	
								9m	59.9	0.18	
								10m	57.7	0.15	
3	Chara	6					bottom visible		70.1		depth 5 feet
	algae present										
4	no plants	6					bottom visible		70.5	-	depth 5 feet
5	no plants	6					5		71.1	-	depth 18 feet
6	Algae present	6					bottom visible		71.0	-	depth 4 feet
7	no plants	6					4.5	surface	70.3	6.95	depth 39 feet
								1m	70.7	6.82	
								2m	71.0	6.75	
								3m	71.0	6.72	
								4m	71.1	6.70	
								5m	71.1	6.65	
								6m	71.1	6.43	
								7m	71.0	6.39	
								8m	70.3	5.53	
								9m	69.8	0.67	
								10m	68.4	1.90	
9	no plants	6					bottom visible		68.9	-	depth 5 feet
											Summary
											water temp 68.9 - 71.2 F
											secchi 4.5 - 7.0 feet
											cloudy, temp in upper 60's
											rake samples taken at each shallow fastest point
											increased water clarity, decreased stratification
											chara was the only plant species collected on the rake
											Gauge reading up from 8.04 on Sep. 2 to 8.30 (20080902_dkAWC_gauge)
											no hydrilla found

Aquatic Weed Control:
2008 Field Sampling Sheets
(organized by survey date)

Lake Manitou Sample Collection

Injury:		Cover:		Growth:		Other Indicators:		
1	Healthy	1	80-100	1	From Apical Tips or Nodes	T	Topped out Vegetation	Biologist Name:
2	Slight injury	2	60-79	2	From Seeds	I	Suspected Insect Damage	
3	Moderate injury	3	40-59	3	From Root Crown or Rhizomes	P	Suspected Pathogen Damage	David Keister
4	Severe Injury	4	20-39	4	From Turions or Tubers	M	Mechanical Damage	Aquatic Weed Control
5	Dead plant	5	<19	5	From Perennial - shrub, tree, etc.	W	Water Fluctuation Damage	
6	Not present	6	Not present	6	No growth	E	End of Life Cycle	

Survey Date: 29-Sep-08
Date of Treatment: 14-May-08
Gauge Reading: 8.06 (20080929_dkAWC_gauge)

Site	Species	Injury	Cover	Growth	Other	Photos	Secchi	Depth	H_2OTemp	D O_2	Notes
1	no plants	6					5.0		70.0	-	depth 6.5 feet
2	no plants	6					6.0	surface	70.70	8.56	depth 30 feet
								1m	70.40	8.52	
								2m	70.30	8.35	
								3m	70.20	8.20	
								4m	70.10	8.39	
								5m	69.90	7.65	
								6m	69.50	6.19	
								7m	68.00	0.25	
								8m	64.80	0.16	
								9m	60.60	0.11	
								10m	57.30	0.10	
3	algae present	6					4.5		70.2		depth 5 feet
4	no plants	6					3.0		70.2	-	depth 5 feet
5	no plants	6					5.2		71.8	-	depth 18 feet
6	no plants	6					4.0		71.5	-	depth 4 feet
7	algae present	6					5.1	surface	71.2	9.77	depth 39 feet
								1m	71.2	9.76	
								2m	71.0	9.16	
								3m	70.9	8.93	
								4m	70.6	7.31	
								5m	70.5	7.90	
								6m	70.3	5.56	
								7m	70.1	2.41	
								8m	69.7	0.20	
								9m	69.3	0.15	
								10m	66.3	0.12	
9	chara	2	5	3			botton visible		69	-	depth 5 feet
											Summary
											water temp 69.0 - 71.8 F
											secchi 3.0 - 6.0 feet
											sunny, temp in lower 70's
											rake samples taken at each shallow fastest point
											no sago pondweed observed in the south end of the lake
											chara was the only species collected on rake.
											Gauge reading 8.06 (20080929_dkAWC_gauge)
											no hydrilla found

Aquatic Weed Control:
2008 Field Sampling Sheets
(organized by survey date)

Lake Manitou Sample Collection

Injury:		Cover:		Growth:		Other Indicators:		
1	Healthy	1	80-100	1	From Apical Tips or Nodes	T	Topped out Vegetation	Biologist Name:
2	Slight injury	2	60-79	2	From Seeds	I	Suspected Insect Damage	
3	Moderate injury	3	40-59	3	From Root Crown or Rhizomes	P	Suspected Pathogen Damage	David Keister
4	Severe Injury	4	20-39	4	From Turions or Tubers	M	Mechanical Damage	Aquatic Weed Control
5	Dead plant	5	<19	5	From Perennial - shrub, tree, etc.	W	Water Fluctuation Damage	
6	Not present	6	Not present	6	No growth	E	End of Life Cycle	

Survey Date: 13-Oct-08
Date of Treatment: 14-May-08
Gauge Reading: 8.08 (20081013_dkAWC_gauge)

Site	Species	Injury	Cover	Growth	Other	Photos	Secchi	Depth	H_2OTemp	D O_2	Notes
1	no plants	6					5.0		65.4	-	depth 6.5 feet
2	no plants	6					5.8	surface	64.8	11.33	depth 30 feet
								1m	64.6	11.39	
								2m	64.4	11.35	
								3m	62.3	11.10	
								4m	61.1	7.95	
								5m	60.7	7.00	
								6m	60.5	5.15	
								7m	60.3	4.06	
								8m	60.2	2.78	
								9m	59.9	0.31	
								10m	59.2	0.19	
3	algae present	6					4.5		67.6		depth 5 feet
4	no plants	6					4.7		65.2	-	depth 5 feet
5	no plants	6					5.3		64.8	-	depth 18 feet
6	algae present	6					bottom visible		64.3	-	depth 4 feet
7	no plants	6					5.7	surface	64.3	10.98	depth 39 feet
								1m	64.1	10.98	
								2m	63.5	10.69	
								3m	62.6	9.48	
								4m	62.2	8.31	
								5m	61.5	6.84	
								6m	61.4	6.05	
								7m	61.2	5.31	
								8m	61.2	4.85	
								9m	61.1	4.36	
								10m	61.0	4.16	
9	Chara	3	5	3			botton visible		66.7	-	depth 5 feet
											Summary
											water temp 64.3 - 67.6 F
											secchi 4.5 - 5.8 feet
											sunny temp in mid 70's
											rake samples taken at each shallow fastest point
											chara was the only species collected on rake.
											Gauge reading 8.08 (20081013_dkAWC_gauge)
											no hydrilla found

Aquatic Weed Control:
2008 Field Sampling Sheets
(organized by survey date)

Lake Manitou Sample Collection

Injury:		Cover:		Growth:		Other Indicators:		
1	Healthy	1	80-100	1	From Apical Tips or Nodes	T	Topped out Vegetation	Biologist Name:
2	Slight injury	2	60-79	2	From Seeds	I	Suspected Insect Damage	
3	Moderate injury	3	40-59	3	From Root Crown or Rhizomes	P	Suspected Pathogen Damage	David Keister
4	Severe Injury	4	20-39	4	From Turions or Tubers	M	Mechanical Damage	Aquatic Weed Control
5	Dead plant	5	<19	5	From Perennial - shrub, tree, etc.	W	Water Fluctuation Damage	
6	Not present	6	Not present	6	No growth	E	End of Life Cycle	

Survey Date: 17-Nov-08
Date of Treatment: 14-May-08
Gauge Reading: 8.14 (20081117_dkAWC_gauge)

Site	Species	Injury	Cover	Growth	Other	Photos	Secchi	Depth	H_2OTemp	D O_2	Notes
1	no plants	6					4.3		43.8	-	depth 6.5 feet
2	no plants	6					5.3	surface	43.8	11.53	depth 30 feet
								1m	44.1	11.40	
								2m	44.2	11.33	
								3m	44.2	11.30	
								4m	44.2	11.26	
								5m	44.2	11.24	
								6m	44.2	11.23	
								7m	44.1	11.21	
								8m	44.1	11.21	
								9m	44.1	11.22	
								10m	43.9	11.22	
3	algae present	6					4.5		42.4		depth 5 feet
4	no plants	6					4.1		44.4	-	depth 5 feet
5	no plants	6		@			5.1		44.2	-	depth 18 feet
6	algae present	6					bottom visible		44.2	-	depth 4 feet
7	no plants	6					5.6	surface	44.1	11.31	depth 39 feet
								1m	44.3	11.22	
								2m	44.4	11.17	
								3m	44.5	11.12	
								4m	44.5	11.06	
								5m	44.5	11.04	
								6m	44.6	11.04	
								7m	44.6	11.04	
								8m	44.5	10.99	
								9m	44.6	10.96	
								10m	44.6	10.96	
9	no plants	6					botton visible		41.7	-	depth 5 feet
											Summary
											water temp 41.7 - 44.6 F
											secchi 4.5 - 5.6 feet
											cold, cloudy. Temp in 30"s
											rake samples taken at each shallow fastest point
											no plants collected on rake
											Gauge reading 8.14 (20081117_dkAWC_gauge)
											no hydrilla found