2011 Lake Manitou Aquatic Vegetation Management Plan Update
Fulton County, IN
January 16, 2012

Prepared for:
Indiana Department of Natural Resources
402 W. Washington St. Rm. W273
Indianapolis, IN 46204

Prepared by:
SePRO Corporation, Aquatic Control, Aquatic Weed Control, and ReMetrix

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 provided by IDNR. SePRO completed updates in 2007, 2008, 2009, and 2010 following whole lake Sonar treatments for control of hydrilla (*Hydrilla verticillata*) (SePRO 2008, 2009, 2010, & 2011). Items covered in this update include the 2011 sampling results and discussion, a review of the 2011 vegetation management effort, and updates to the budget and action plans.

The focus of the Lake Manitou vegetation management plan was adjusted due to the discovery of hydrilla in 2006. Eradication of hydrilla has been the primary aquatic plant management goal for Lake Manitou since the discovery. Hydrilla is an invasive species that can form dense populations that disrupt ecosystems, displace native species, and impair fish and wildlife habitat. This was the first confirmed case of hydrilla in the Midwest. 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.

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 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. Applications were completed with a combination of Sonar AS and Sonar Q. No hydrilla was detected during the August 27th Tier 2 survey. Hydrilla tuber sampling was completed just prior to and 5 months after initial treatment and revealed hydrilla tuber numbers were significantly reduced (86% total reduction) from pretreatment densities, however, as expected viable tubers remained.

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. An initial treatment was completed in mid-May and followed by three bump applications in order to maintain fluridone levels. No hydrilla was detected during the 2008 Tier 2 surveys, but fragments were observed during FasTEST sample collection. The public boat ramp was opened in late June 2008. Tuber sampling indicated a 43% reduction had occurred in the tuber bank.

The same fluridone prescription used in 2008 was to be applied to the 2009 treatment program. No hydrilla was detected during either Tier 2 survey. One damaged hydrilla fragment was

discovered during the June 22nd vegetation monitoring. This was the only documented observation of vegetative hydrilla during the 2009 season. The six permanent tuber sampling sites were sampled on October 5th. Sampling indicated that a further 19% reduction in the tuber bank occurred in 2009.

A Manitou Summit meeting to review and discuss the hydrilla eradication program with outside personnel was held on December 8, 2009. Following this meeting it was decided that the general direction of the management using Sonar should be continued. The 2010 treatment prescription called for use of multiple Sonar formulations and further refined target doses with an initial 6 ppb target followed by maintenance of 2.5 to 5 ppb throughout the growing season. The initial 2010 application was completed on May 7th with a combination of Sonar AS and Sonar PR. Bump applications were completed on three occasions during the 2010 season. No hydrilla was detected during either Tier 2 survey; however, supplemental dive surveys conducted June 9, 2010 did readily detect herbicide-stressed, vegetative hydrilla growing from tubers at multiple permanent tuber sampling stations. Five permanent tuber sampling stations were sampled in the fall of 2010. Sampling indicated that a further 75% reduction in the tuber bank occurred in 2010 and levels of unsprouted tubers have been reduced 96% since the beginning of the IDNR hydrilla eradication efforts on Manitou starting in the spring of 2007.

The Indiana Department of Administration and IDNR issued another Request for Proposal for continuation of hydrilla eradication on Lake Manitou on January 21, 2011. SePRO was again awarded the contract and once again teamed with ReMetrix, Aquatic Control, and Aquatic Weed Control in order to complete the project. The same treatment strategy that was employed in 2010 was used in 2011. The initial 2011 application was completed on May 13th with a combination of Sonar AS and Sonar PR. Bump applications were completed on June 3rd, June 23rd, and August 12th. No hydrilla was detected during either Tier 2 survey. Hydrilla was detected at three locations during a lake-wide dive survey of 140 total sites on June 17th. Three of six original permanent tuber sampling stations along with two new sampling stations based on dive survey finds, were sampled on September 26th. One sprouted hydrilla tuber each was found at one of the original stations (#2) and one of the new stations off the western shore of the mid-lake island.

Control efforts continue to bring the project closer to the goal of hydrilla eradication. Five years of management have significantly reduced hydrilla tuber densities, prevented new hydrilla tuber production, and restricted the potential for hydrilla to spread to other waters in the region. Modified vegetation assessment protocols incorporating intensive dive surveys in mid June were successful in detecting vegetative hydrilla growth where standard Tier 2 surveys had not been successful. With large declines in hydrilla tuber densities since the start of the Manitou eradication effort and greatly reduced efficiency and power of tuber bank sediment sampling, late spring dive survey is now the best assessment technique for detection of hydrilla in the lake.

The following is a list of recommended actions specifically designed to continue toward the goal of hydrilla eradication in Lake Manitou:

1. Continue a multiple Sonar formulation strategy with similar scope and application strategy as the most recent years of management.

2. Complete two Tier 2 surveys and regularly scheduled reconnaissance surveys in order to monitor the treatment effectiveness and impacts on native vegetation.

3. Previous discussions of the duration of the eradication program described the goal of consecutive annual sampling events without finding tubers at the monitoring stations before aborting the active control phase of the eradication program. In 2011, patches of 10 – 40 hydrilla plants were found at three different Manitou dive survey locations. Only single sprouted tubers were collected at two of the same locations during the fall sediment assessment of hydrilla tuber density. It is recommended going forward that IDNR substitute fall sediment sampling with an expanded level of late-spring dive survey. For improved power in detecting hydrilla, an expanded dive survey would focus on the northern half of the lake where hydrilla finds were noted historically.

4. In past management cycles from 2007 - 2010, public ramps were closed until sampling was completed that indicated no vegetative hydrilla present in Lake Manitou. In 2011, it was recommended that this procedure be followed again but IDNR made decision to have the public ramps on Manitou open for the full season. Since the 2011 dive survey found a very low-level of hydrilla infestation with negligible risk of hydrilla off-site movement during future Sonar cycles, SePRO supports the new season-long policy unless Sonar management was not continued in 2012, or early 2012 field observations unexpectedly indicate increased risk of off-site movement due to public ramp activity. 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. On-going dialogue with regional DNRs and other resource managers is also encouraged to prioritize management on Manitou and have regional response plans ready and updated to address new hydrilla infestations.

5. Amidst a variety of critical invasive aquatic species issues in the region including ongoing Asian carp challenges and new invasions like starry stonewort, IDNR should continue as much as feasible with public education efforts in an attempt to prevent additional hydrilla introductions to Lake Manitou and other lakes in the region. As IDNR intervention with Manitou's management approaches successful eradication outcome, it will become important for local private stakeholders to be educated on the implications for the lake and its future management.

Acknowledgements

Funding for vegetation sampling, herbicide treatment, and preparation of the aquatic vegetation management plan was provided by the IDNR through Great Lakes Restoration Initiative Funds. Aquatic Control, Inc., Aquatic Weed Control, Inc., ReMetrix LLC, and SePRO Corporation completed the fieldwork, data processing, and map generation. Special thanks to Mr. Doug Keller, Aquatic 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 efforts. Authors of this report are Dr. Mark Heilman of SePRO, Mr. Nathan Long of Aquatic Control, Inc., and Mr. Richard Dirks of ReMetrix LLC. The authors would like to acknowledge the valuable input from the staff of SePRO Corp., Aquatic Control, Inc., Aquatic Weed Control, Inc., and ReMetrix LLC. The authors would also like to acknowledge Dr. Robert Richardson and his graduate students at North Carolina State University including Justin Nawrocki for their collaborative interaction on monoecious hydrilla tuber distribution and management.

Table of Contents

This page intentionally left blank

List of Figures

This page intentionally left blank

List of Tables

List of Charts

This page intentionally left blank

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.

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).

The primary purpose of the 2011 vegetation sampling and plan update is to document recent hydrilla eradication activities and to adjust the management plan as needed following the discovery of hydrilla in Lake Manitou in 2006. SePRO completed updates to the plan in 2008, 2009, 2010, and 2011 (SePRO 2008, 2009, 2010 & 2011). Items covered in this update include the 2011 sampling results, a review of the 2011 vegetation management activities, and updates to the action plan. Recent Lake Manitou invasive species treatment history is summarized below in Table 1.0.1.

Table 1.0.1. Lake Manitou Invasive Species Control History 2005-2011.

Year	Invasive Species Treated	Acres Treated	Product(s) Applied
2005	Eurasian watermilfoil	45	2,4-D
2006	Eurasian watermilfoil & Hydrilla	95 milfoil & 20 hydrilla	2,4-D & Copper (Komeen)
2007	Hydrilla	809 (whole lake)	Fluridone (Sonar AS & Sonar Q)
2008	Hydrilla	809 (whole lake)	Fluridone (Sonar AS & Sonar PR)
2009	Hydrilla	809 (whole lake)	Fluridone (Sonar AS & Sonar PR)
2010	Hydrilla	809 (whole lake)	Fluridone (Sonar AS & Sonar PR)
2011	Hydrilla	809 (whole lake)	Fluridone (Sonar AS & Sonar PR)

Lake Manitou is an 809-acre lake located in Fulton County, Indiana. The control of Eurasian watermilfoil was the primary objective of the original plan. This changed in August of 2006 when IDNR discovered hydrilla during a routine Tier 2 survey. This discovery precipitated a rapid response by IDNR Aquatic Invasive Species Coordinator, Doug Keller.

Upon confirmation of 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). Due to a lack of viable hydrilla fragments following treatment, the public ramp was re-opened in June of 2008. In 2009 and 2010 the public ramp was closed, prior to treatment, and then reopened on July 1st of each year. The ramps were left open during the 2011 season.

Figure 1.01. 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 1.01). If hydrilla was not eradicated or its 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 continues to be the primary goal of vegetation management in Lake Manitou.

Figure 1.02. Photograph examples of dense, surface-matted hydrilla.

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; 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 (the Poet's Point area in the northern section of the lake, and near the City ramp) with Komeen™ aquatic herbicide. 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 1.03) 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.

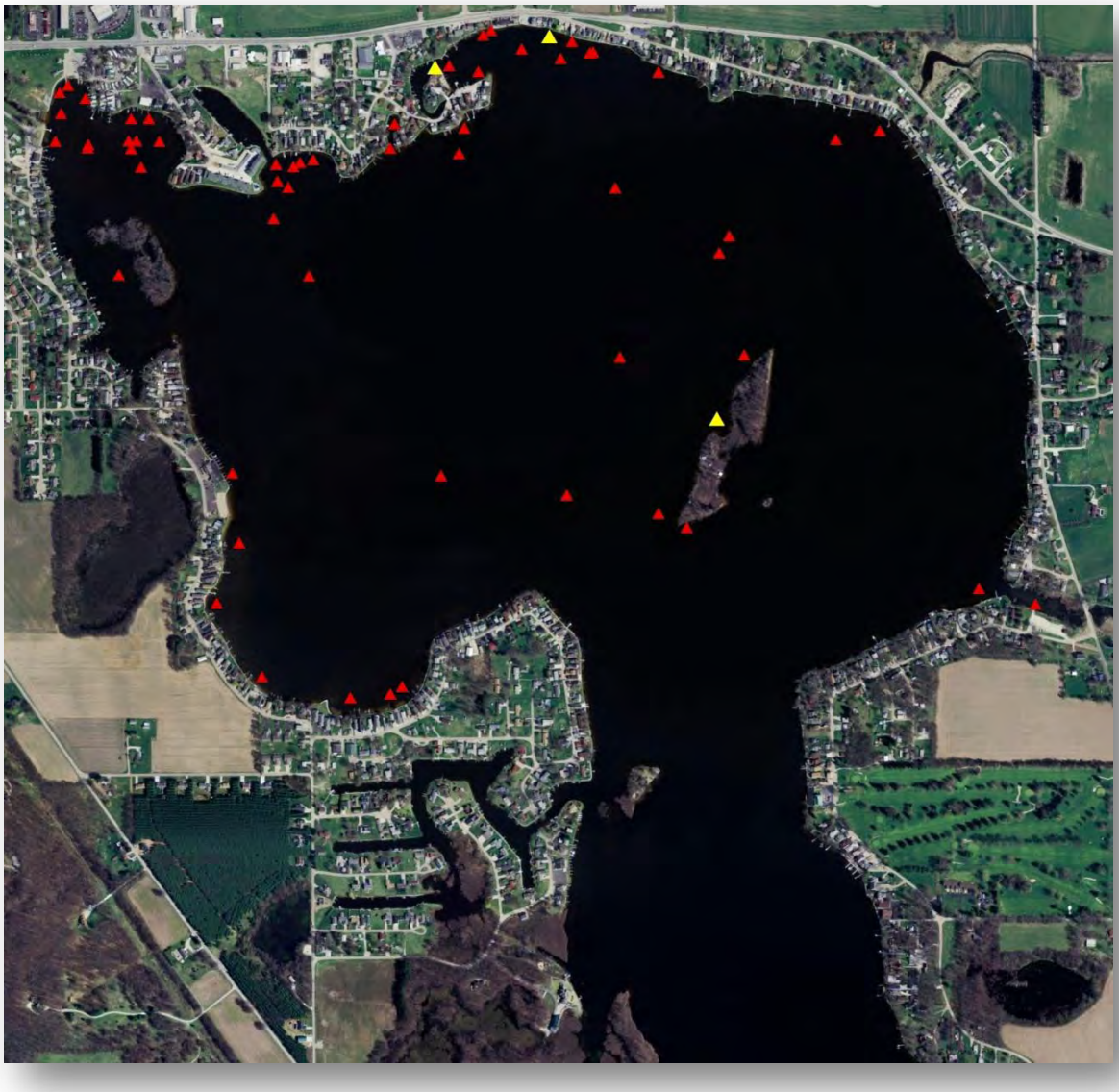


Figure 1.03. Lake Manitou hydrilla sightings 2006-2011. Note vegetative sightings by diver survey in 2011 indicated by yellow markers. (Includes all sightings recorded by the project team and IDNR.)

SePRO Corporation was awarded the 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

greater than 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 2 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 27th Tier 2 survey. Hydrilla tuber sampling was completed just prior to, and five months after initial treatment and revealed hydrilla tuber numbers were significantly reduced (86% 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.

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.

In 2008, Sonar treatments were initiated on May 14th. Sonar PR (2.2 ppb) was applied to 18 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 2 vegetation surveys were completed on June 16th and August 27th. No hydrilla was detected during either survey, and Chara (*Chara spp.)* was dominant in both surveys. Following the June Tier 2 survey, IDNR opened the public boat launch. However, during the June 26th reconnaissance survey four hydrilla plants and fragments 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 an additional 43% reduction in the tuber bank occurred in 2008.

In 2009 the hydrilla eradication team remained the same and a program similar to 2008 was initiated. The initial fluridone application was completed on May 14th as a combination of Sonar AS and PR. Sonar PR was applied to 19 different locations where hydrilla had been documented during previous surveys and one location at the inflow. Sonar AS (6 ppb) was applied to the entire lake at rates that varied according to water depth. Bump applications were completed on June 17th, July 29th, and September 9th. A combination of Sonar AS and PR were applied during the June and July bumps while only Sonar AS was applied during the September bump. Tier II vegetation surveys were completed on June 16th and August 31st. No hydrilla was detected during either survey. One damaged hydrilla fragment was discovered during the June 22nd reconnaissance monitoring. This was the only documented observation of vegetative hydrilla during the 2009 season. The six permanent tuber sampling sites were sampled on October 5th. Sampling indicated that a further 19% reduction in the tuber bank occurred in 2009.

A Manitou Summit meeting to review and discuss the hydrilla eradication program with outside personnel was held on December 8, 2009. Following this meeting it was decided that the general direction of the management using Sonar should be continued. The 2010 treatment prescription called for use of multiple Sonar formulations and further refined target doses with an initial 6 ppb target followed by maintenance of 2.5 to 5 ppb throughout the growing season. The initial 2010 application was completed on May 7th with a combination of Sonar AS and Sonar PR. Bump applications were completed on three occasions during the 2010 season. No hydrilla was detected during either Tier 2 survey; however, supplemental dive surveys conducted June 9, 2010 did readily detect herbicide-stressed, vegetative hydrilla growing from tubers at multiple permanent tuber sampling stations. Five permanent tuber sampling stations were sampled in the fall of 2010. Sampling indicated that a further 75% reduction in the tuber bank occurred in 2010 and levels of unsprouted tubers had been reduced 96% since the beginning of the IDNR hydrilla eradication efforts on Manitou starting in the spring of 2007.

The Indiana Department of Administration and IDNR issued another Request for Proposal for continuation of hydrilla eradication on Lake Manitou on January 21, 2011. SePRO was again awarded the contract and once again teamed with ReMetrix, Aquatic Control, and Aquatic Weed Control in order to complete the project. The same treatment strategy that was employed in 2010 was again used in 2011. The following sections will detail the progress of the 2011 hydrilla eradication program along with future Lake Manitou plant management plans.

2.0 VEGETATION SAMPLING

Vegetation sampling in 2011 was similar to past sampling efforts with the exception of a dive survey which was added to more accurately pinpoint vegetative hydrilla locations. The dive survey was completed on June 17th. Standard Tier 2 surveys (IDNR 2010) were completed on June 16th and August 31st to monitor the hydrilla population and quantify native species abundance. In addition, visual observations of the plant community were recorded throughout the season during FasTEST sampling. These observations aided in the timing of initial Sonar application, surveyed for potential hydrilla biomass, and provided insight into the progress of the treatments. Hydrilla tuber sampling was completed on September 26th to monitor depletion of the tuber bank. Table 2.0.1 is a summary of 2011 plant survey activities on Lake Manitou.

Table 2.0.1. Summary of 2011 Plant Surveys on Lake Manitou. 2011 herbicide treatment dates: May 13 (initial Sonar); June 3, June 23, and August 12 (Sonar bumps).

Date (2011)	Type of Survey
May 16	Reconnaissance Survey
June 13	Reconnaissance Survey
June 16	Tier 2 Survey
June 17	Dive Survey
July 6	Reconnaissance Survey
July 18	Reconnaissance Survey
August 1	Reconnaissance Survey
August 15	Reconnaissance Survey
August 29	Reconnaissance Survey
August 31	Tier 2 Survey
September 12	Reconnaissance Survey
September 26	Reconnaissance Survey
September 26	Tuber sampling
October 10	Reconnaissance Survey

2.1 Reconnaissance Surveys

For reference: the initial Sonar treatment was conducted on May 13, 2011; bump treatments were conducted on June 3, June 23, and August 12, 2011. Details of the treatments can be found in Section 4.0.

Reconnaissance surveys were completed during FasTEST collections, and were the most frequent type of survey completed (Table 2.0.1). Surveyors followed a pre-established route designed to maneuver over formerly known areas of hydrilla (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, and growth ratings, Secchi depth, and surface temperature. Dissolved oxygen/temperature profiles were also taken at the predetermined FasTEST site 2.

Figure 2.1.1. FasTEST monitoring/vegetation reconnaissance survey route

Surveying, in conjunction with water sampling, provided a rapid and cost effective means of assessing the effectiveness of the treatment program. This information, combined with the FasTEST results, helped determine the timing and necessity of bump applications. A summary of the reconnaissance survey results for 2011 is provided below in Table 2.1.1

Table 2.1.1. 2011 FasTEST collection plant monitoring summary

Collection Date	Surface-Temp. Range (˚F)	Secchi Depth (ft)	Species Observed and Injury Rating[a]
5/16/2011	60.4-63.0	5.0-5.9	Chara (2)
6/13/2011	74.9-76.7	4.0-4.8	Chara (2); coontail (2)
7/6/2011	82.1-85.1	2.3-3.1	Chara (2)
7/18/2011	84.0-86.3	1.7-2.8	Chara (2)
8/1/2011	84.3-85.9	2.0-3.3	n/a
8/15/2011	76.5-77.4	2.8-4.1	n/a
8/29/2011	74.6-76.2	2.8-4.2	Chara (2)
9/12/2011	71.6-73.8	3.1-4.9	Chara (2)
9/26/2011	63.4-65.2	2.9-4.2	Coontail (3)
10/10/2011	64.6-66.4	2.9-4.0	Coontail (3)

[a] Injury rating from 1-6 (1-healthy, 2-slight injury, 3-moderate injury, 4-severe injury, 5- dead plant, 6 – not present). Chara = *Chara* sp.; n/a = no plants found.

2.2 Tuber Sampling

2.2.1 Fall Tuber Sampling

Since the initiation of whole-lake hydrilla eradication efforts on Lake Manitou in 2007, the attrition of subterranean hydrilla turions (hereinafter referred to as tubers) has been monitored to confirm impacts of the multiple-year Sonar treatment program. On September 26, 2011, near the completion of the 5th year of consecutive whole-lake eradication treatment, tubers were monitored at three of six permanent stations established in 2007 – 2008 (Figure 2.2.1) and two new stations established based on vegetative hydrilla finds during mid June 2011 dive survey. Stations 1 - 5 were established at the start of the hydrilla eradication project in May 2007. Station 6 was added during sampling in May 2008. All six stations were monitored in September 2008 and October 2009. Station 1 was dropped from 2010 sampling since no tubers had been collected there for two consecutive seasons. Stations 5 and 6 were dropped from 2011 sampling to allow collection at new stations 7 and 8 located where most dense vegetative hydrilla growth was detected during June 17, 2011 dive survey. The 2011 collection protocol called for an initial collection of 100 sediment cores at each station. At stations where the initial 100 cores did not yield collection of a tuber, an additional 50 cores were collected to boost sampling intensity. A through 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*.

In fall 2011 sampling, a total of 2 sprouted tubers were collected from 704 total core samples. (Table 2.2.1). No unsprouted tubers were collected. Given the density of vegetative hydrilla growth at some dive survey locations in June, the lack of unsprouted tuber finds is almost certainly a statistical artifact from much reduced tuber densities after 5 cycles of Sonar

management rather than an accurate indication of complete depletion of unsprouted tubers at the monitored stations.

Table 2.2.1. Summary data for five hydrilla tuber monitoring stations sampled September 26, 2011. 100 4-inch diameter (0.0876 $ft^2 = \pi \times 0.167' \times 0.167'$) core samples were taken at Station 2. 154 cores were taken at Station 3. 150 cores were taken at Stations 4, 7, 8. Sediment cores for tuber density were not collected from original stations 1, 5, 6. No aboveground turions were found at any of the stations.

Site	Sprouting hydrilla tubers	Non-sprouting hydrilla tubers	Number of core samples
Dollar Store Bay Station 2	1	0	100
White Dock Station 3	0	0	154
Poet's Point Station 4	0	0	150
Dollar Store Bay Station 7	0	0	150
Big Island Station 8	1	0	150
Total	**2**	**0**	**704**

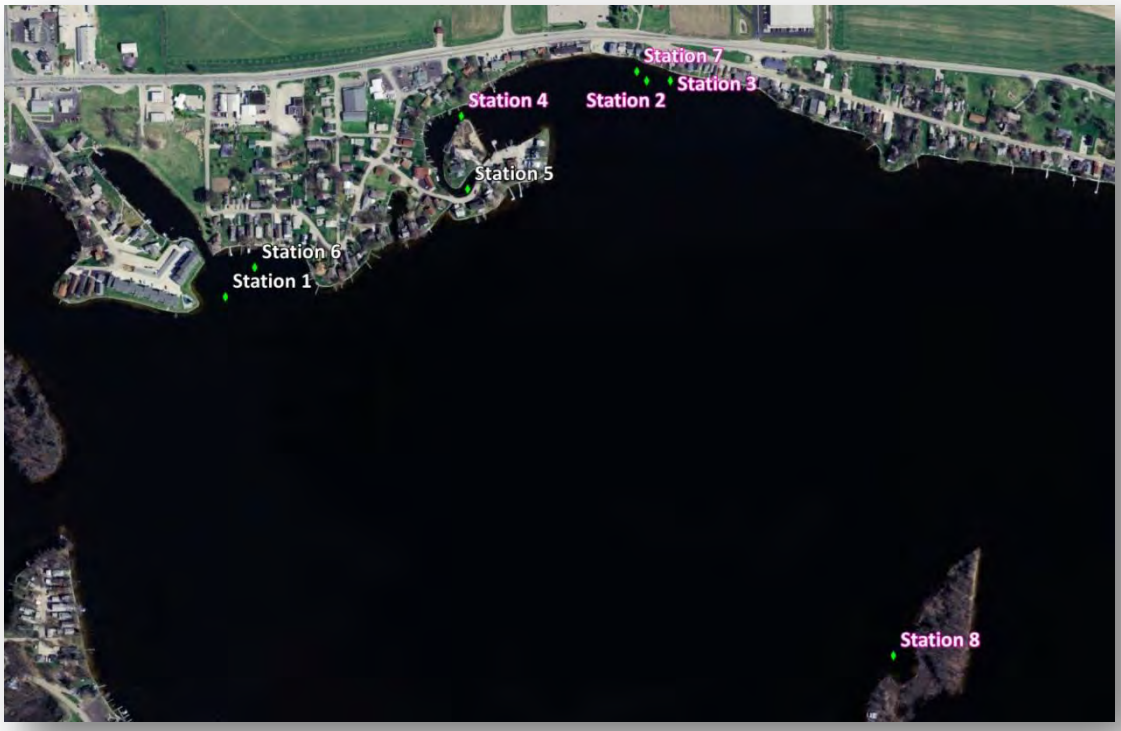


Figure 2.2.1. Location of the eight permanent tuber sampling stations. Stations 1 through 5 were established May 2007. Station 6 was established May 2008. Stations 7 and 8 were added in 2011 based on vegetative hydrilla finds during the mid June diver survey. Note: Station 1 was abandoned in 2010 since no tubers had been collected there for the two prior seasons. Stations 5 and 6 were abandoned in 2011 based on limited 2010 finds and allowed focus on the new diver survey finds. (Only highlighted stations were sampled in 2011.)

2.2.2 Tuber Sampling Summary (2007-2011 data)

The hydrilla management plan on Lake Manitou and associated control methods have been highly successful at reducing hydrilla tuber densities. Following five consecutive Sonar treatments, overall measured tuber abundance (sprouted and non-sprouting with corrections for sampling area) has decreased by a calculated 99.5% at various sampling stations between May 2007 (pre-treatment) and September 2011 (Table 2.2.2 and Chart 2.2.1). Over the five seasons of intensive management, sprouting tuber density has decreased 99.3%. Since no unsprouted tubers were collected in the fall 2011 survey, the calculated unsprouted tuber reduction is 100% in theory but the common finds of hydrilla at several locations in the intensive June dive survey suggest rather statistical limitations in ability to sample sufficient area of lake bottom to find tubers at this stage of the multi-year eradication effort. Looking at annual trends in attrition rate, the total tuber density (sprouting and non-sprouting) was reduced by 88% following the 1st year of Sonar treatment, 42% reduction after the second year, 19% reduction after the third year, 75% reduction after the fourth year, and now an additional 67% reduction after the fifth annual treatment.

Analysis of these multiple-year results indicates a variable tuber attrition rate at the various monitoring stations on the lake but overall, demonstrates a highly successful eradication effort with over 99% tuber depletion (Charts 2.2.1, 2.2.2). During the first three cycles of Sonar treatment, measured attrition rate declined by approximately half each annual cycle of management. In 2010 and 2011, tuber attrition was greater than 2008 or 2009. While it is not possible to ascertain with certainty the mechanisms behind these trends, they could be the result of different year-to-year climatic conditions along with some statistical variance.

The latest figures on tuber attrition suggest a time frame for reaching theoretical hydrilla tuber bank depletion or eradication similar to that determined using earlier 2010 results. At the end of 2010, projections of decline in tuber abundance was extrapolated to 4.8 to 6.7 seasons of management. At the start of 2011, that projection suggested between 1-3 additional cycles of Sonar management similar to the last four cycles would produce 99.5% reduction in the tuber bank. With a lack of unsprouted tuber finds in September 2011, this projection at first glance would appear to be increasing in accuracy. As noted in this section of the 2010 report, the increasing difficulty associated with finding decreasing numbers of tubers at various monitoring stations required consideration of alternate monitoring strategies in future management cycles. In mid June 2011, a comprehensive dive survey (Section 2.4) was performed to complement tuber bank assessment and other monitoring for hydrilla presence. With Tier 2 surveys not finding hydrilla and tuber densities now at levels very difficult to quantify with great logistical effort, intensive dive survey effort will need to be the primary method for solid quantitative data to guide future program direction on Manitou.

As described in previous project updates, the overall reductions in the hydrilla tuber bank on Lake Manitou have achieved containment and prevented spread to other Indiana lakes. However, a full eradication goal remains to be achieved. Annual changes in rate of tuber bank attrition as indicated by tuber collections at the various permanent monitoring stations have made projections of final tuber bank depletion difficult from year to year. However, 2010 and

2011 results provide reason for greater optimism on prospects for full eradication in the coming years. However, although very limited in number, continued tuber finds with the relatively small overall bottom area represented by current sediment core collection protocol along with diver observations of relatively common (20 – 40 plants in 1000 sq foot areas) spring 2011 abundance in some areas indicate that hydrilla remains capable of rebounding in Lake Manitou without continued management. With the shorter window projected for tuber reductions approaching 100%, the stated IDNR objective of complete hydrilla eradication appears more achievable and should remain as the program's ultimate goal. Dive survey results should now provide the best quantitative data to depict hydrilla disappearance from Manitou. The near-term outlook for Manitou hydrilla eradication should remain tempered by findings of hydrilla recovery 10 years or more into eradication efforts in the Northeast and the West, but the risk that hydrilla poses to other Indiana lakes and aquatic ecosystems throughout the Upper Midwest continues to merit a highly aggressive management philosophy for complete long-term eradication / containment.

Table 2.2.2. Sprouted, Unsprouted, and Total Hydrilla Tubers Corrected For Sampled Area: A – Per Square Foot; B – Per Acre. Also presented are Annual Percent Reductions and Percent Reductions since 2007 Start of Manitou Hydrilla Management Program

A. Tubers Per Square Foot	Sprouted Tubers Per Square Foot							Unsprouted Tubers Per Square Foot							Total Tubers Per Square Foot (Sprouted and Unsprouted)						
	May 14-17 2007	Sept. 17 2007	May 12-14 2008	Sept. 15 2008	Oct. 5-6 2009	Oct. 4 2010	Sept. 26 2011	May 14-17 2007	Sept. 17 2007	May 12-14 2008	Sept. 15 2008	Oct. 5-6 2009	Oct. 4 2010	Sept. 26 2011	May 14-17 2007	Sept. 17 2007	May 12-14 2008	Sept. 15 2008	Oct. 5-6 2009	Oct. 4 2010	Sept. 26 2011
Station 1	1.83	0.22	ns	0.00	0.00	ns	**ns**	0.00	0.00	ns	0.00	0.00	ns	**ns**	1.83	0.22	ns	0.00	0.00	ns	**ns**
Station 2	3.65	0.00	ns	0.91	0.00	0.00	**0.11**	4.79	0.46	ns	1.37	0.11	0.34	**0.00**	8.45	0.46	ns	2.28	0.11	0.34	**0.11**
Station 3	7.76	0.46	ns	0.00	0.00	0.08	**0.00**	3.20	0.46	ns	0.23	0.00	0.00	**0.00**	10.96	0.91	ns	0.23	0.00	0.08	**0.00**
Station 4	9.13	0.43	ns	0.00	0.00	0.08	**0.00**	0.46	1.72	ns	0.46	0.34	0.00	**0.00**	9.59	2.15	ns	0.46	0.34	0.08	**0.00**
Station 5	2.51	0.15	ns	0.23	0.34	0.00	**ns**	0.68	0.76	ns	0.23	1.48	0.08	**ns**	3.20	0.91	ns	0.46	1.83	0.08	**ns**
Station 6	ns	ns	0.91	0.00	0.34	0.00	**ns**	ns	ns	0.46	0.23	0.11	0.00	**ns**	ns	ns	1.37	0.23	0.46	0.00	**ns**
Station 7	ns	ns	ns	ns	ns	ns	**0.00**	ns	ns	ns	ns	ns	ns	**0.00**	ns	ns	ns	ns	ns	ns	**0.00**
Station 8	ns	ns	ns	ns	ns	ns	**0.08**	ns	ns	ns	ns	ns	ns	**0.00**	ns	ns	ns	ns	ns	ns	**0.08**
MEAN - ALL STATIONS	**4.98**	**0.24**	**0.91**	**0.14**	**0.10**	**0.03**	**0.03**	**1.83**	**0.59**	**0.46**	**0.34**	**0.29**	**0.07**	**0.00**	**6.80**	**0.83**	**1.37**	**0.49**	**0.39**	**0.10**	**0.03**

B. Tubers Per Acre	Sprouted Tubers Per Acre							Unsprouted Tubers Per Acre							Total Tubers Per Acre (Sprouted and Unsprouted)						
	May 14-17 2007	Sept. 17 2007	May 12-14 2008	Sept. 15 2008	Oct. 5-6 2009	Oct. 4 2010	Sept. 26 2011	May 14-17 2007	Sept. 17 2007	May 12-14 2008	Sept. 15 2008	Oct. 5-6 2009	Oct. 4 2010	Sept. 26 2011	May 14-17 2007	Sept. 17 2007	May 12-14 2008	Sept. 15 2008	Oct. 5-6 2009	Oct. 4 2010	Sept. 26 2011
Station 1	79,562	9,750	ns	0	0	ns	**ns**	0	0	ns	0	0	ns	**ns**	79,562	9,750	ns	0	0	ns	**ns**
Station 2	159,123	0	ns	39,781	0	0	**4,973**	208,849	19,890	ns	59,671	4,973	14,918	**0**	367,973	19,890	ns	99,452	4,973	14,918	**4,973**
Station 3	338,137	19,890	ns	0	0	3,315	**0**	139,233	19,890	ns	9,945	0	0	**0**	477,370	39,781	ns	9,945	0	3,315	**0**
Station 4	397,808	18,765	ns	0	0	3,315	**0**	19,890	75,058	ns	19,890	14,918	0	**0**	417,699	93,823	ns	19,890	14,918	3,315	**0**
Station 5	109,397	6,630	ns	9,945	14,918	0	**ns**	29,836	33,151	ns	9,945	64,644	3,315	**ns**	139,233	39,781	ns	19,890	79,562	3,315	**ns**
Station 6	ns	ns	39,781	0	14,918	0	**ns**	ns	ns	19,890	9,945	4,973	0	**ns**	ns	ns	59,671	9,945	19,890	0	**ns**
Station 7	ns	ns	ns	ns	ns	ns	**0**	ns	ns	ns	ns	ns	ns	**0**	ns	ns	ns	ns	ns	ns	**0**
Station 8	ns	ns	ns	ns	ns	ns	**3,315**	ns	ns	ns	ns	ns	ns	**0**	ns	ns	ns	ns	ns	ns	**3,315**
MEAN - ALL STATIONS	**216,805**	**10,548**	**39,781**	**6,216**	**4,262**	**1,421**	**1,413**	**79,562**	**25,616**	**19,890**	**14,918**	**12,787**	**2,841**	**0**	**296,367**	**36,164**	**59,671**	**21,134**	**17,049**	**4,262**	**1,413**
Percent Reduction Year to Year	**n/a**	**95.1**	**n/a**	**41.1**	**31.4**	**66.7**	**0.6**	**n/a**	**67.8**	**n/a**	**41.8**	**14.3**	**77.8**	**100.0**	**n/a**	**87.8**	**n/a**	**41.6**	**19.3**	**75.0**	**66.9**
Percent Reduction Since May 2007	**n/a**	**95.1**	**n/a**	**97.1**	**98.0**	**99.3**	**99.3**	**n/a**	**67.8**	**n/a**	**81.3**	**83.9**	**96.4**	**100.0**	**n/a**	**87.8**	**n/a**	**92.9**	**94.2**	**98.6**	**99.5**

TABLE NOTE: 'ns' indicates station was not sampled

This page intentionally left blank

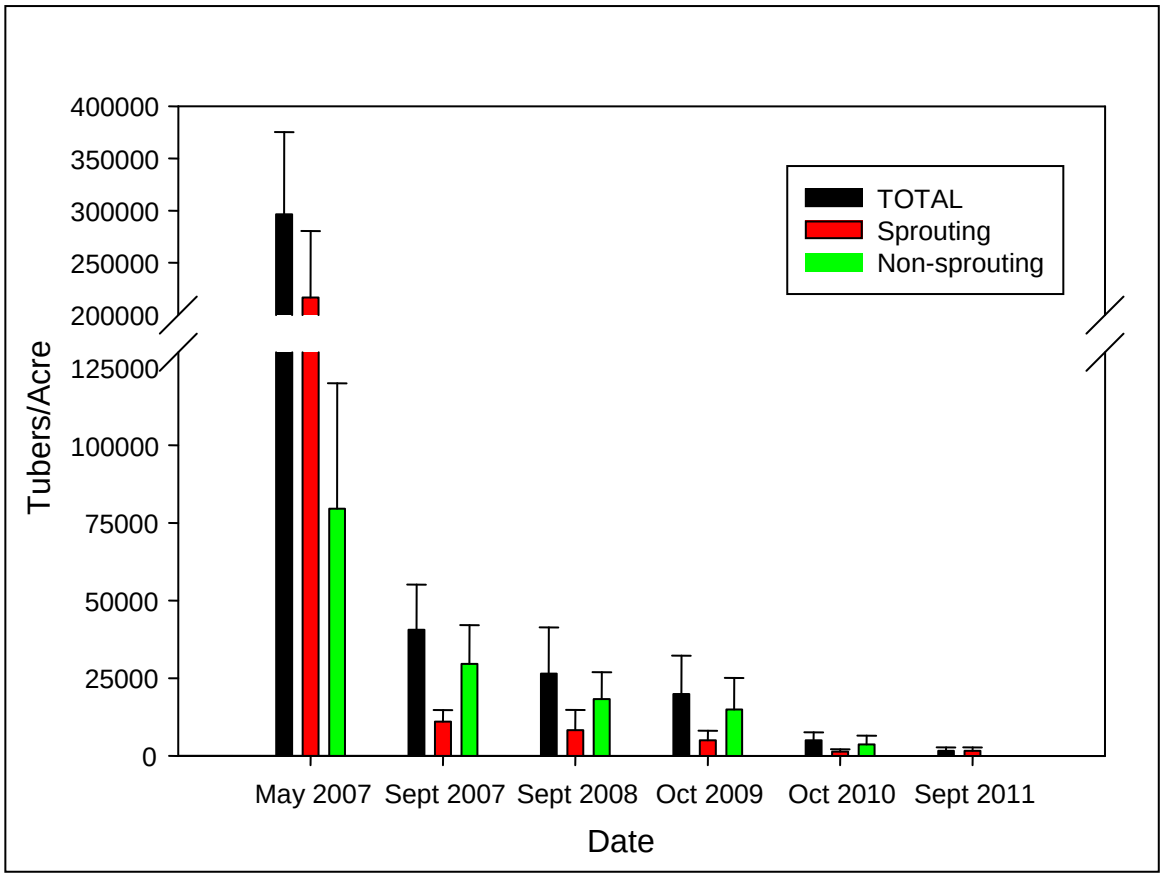


Chart 2.2.1. Overall changes in monoecious hydrilla tuber abundance in Lake Manitou following five consecutive years of Sonar treatments (spouting + non-sprouting = total).

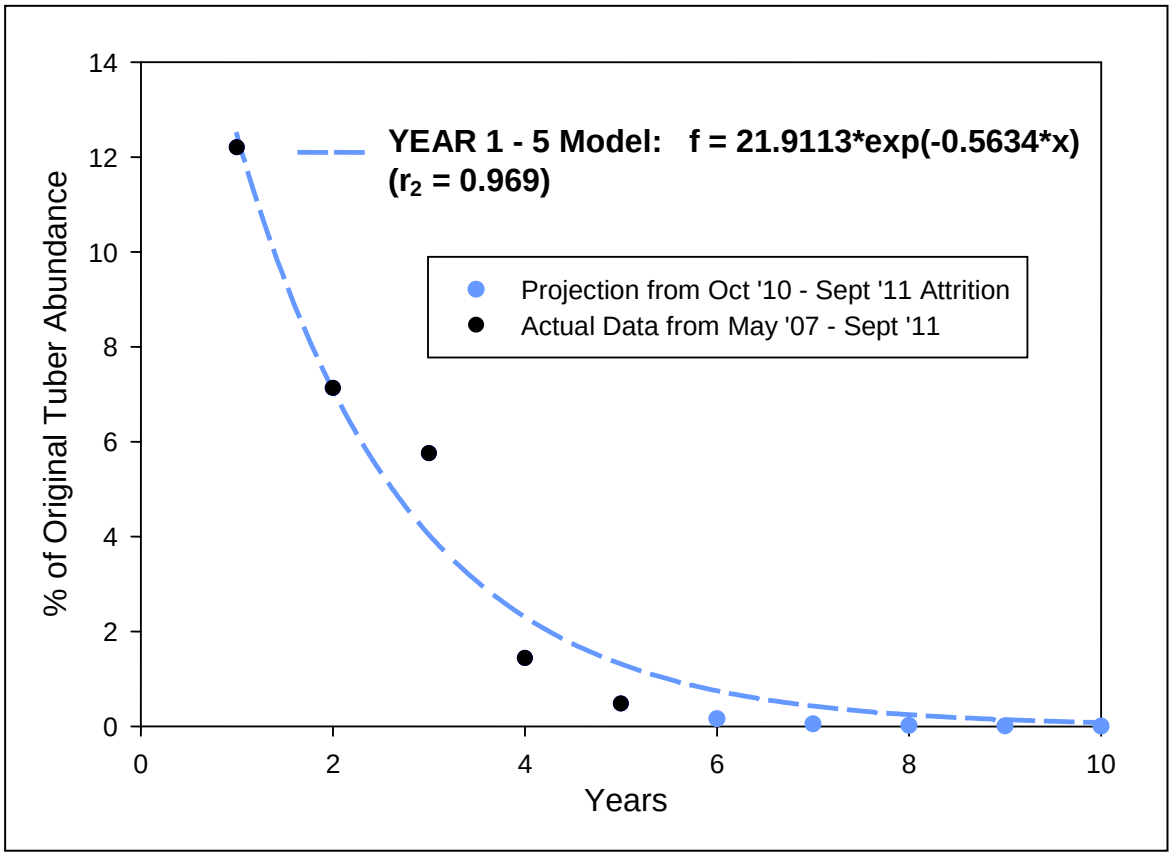


Chart 2.2.2. The attrition rate of hydrilla tubers on Lake Manitou based on 2011 Results and 2012 Projections. Year 1 (88%), Year 2 (42%), Year 3 (19%), Year 4 (75%), and Year 5 (67%) reductions (black dots) are from actual data and include both sprouted and unsprouted tubers; all subsequent reductions (years 6 through 10 –blue dots) were based on reductions observed during year five (Oct '10 – Sept '11: 67%). The blue dotted line represents predicted attrition rate based on non-linear regression analysis incorporating Year 1 – 5 data.

2.3 Tier 2 Surveys

For reference: the initial Sonar treatment was conducted on May 13, 2011; bump treatments were conducted on June 3, June 23, and August 12, 2011. Details of the treatments can be found in Section 4.0.

Tier 2 surveys were completed on June 16th and August 31st. Tier 2 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. The design of the Lake Manitou point-intercept survey was based on the LARE protocol (IDNR 2006). A total of 122 sites were sampled in the spring and late summer (Figure 2.3.1).

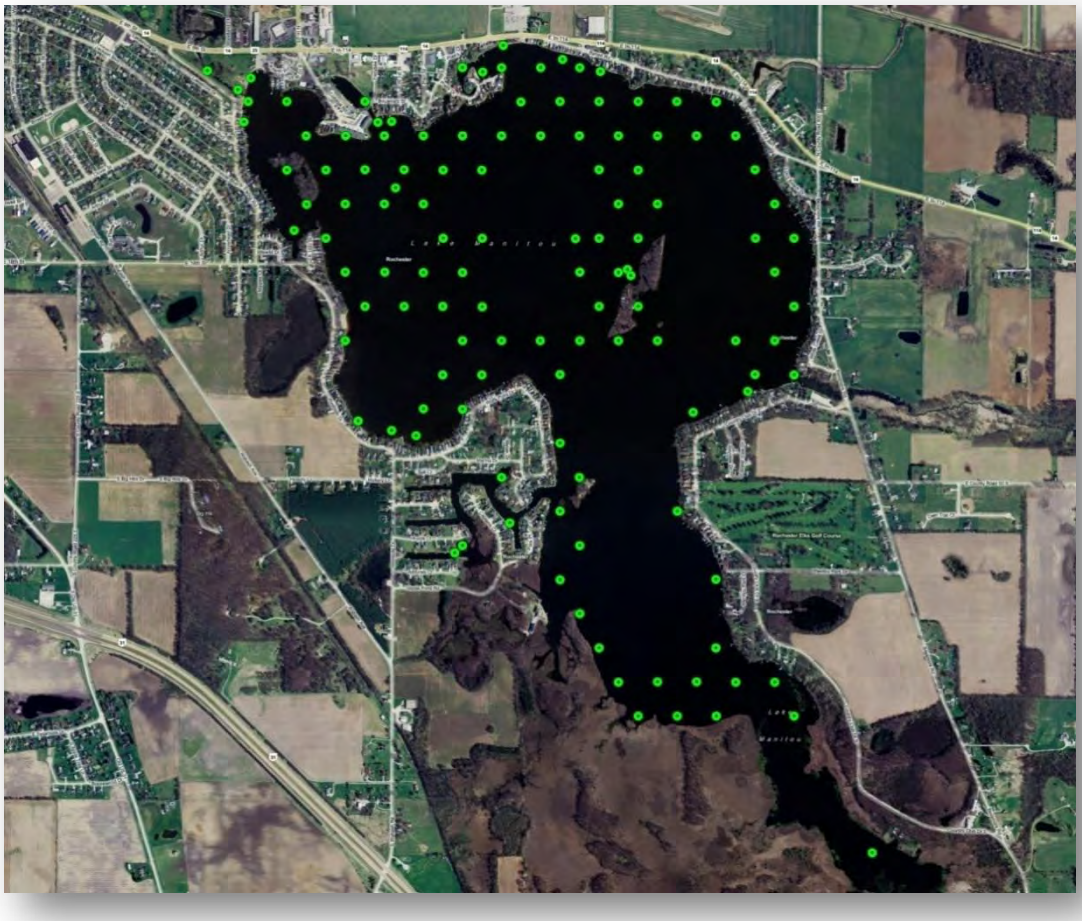


Figure 2.3.1. Tier 2 vegetation sample sites visited in 2011.

2.3.1 Spring Tier 2 Survey Results

The spring survey was conducted on June 16th. One rake drag was completed at each survey location. Plant density and injury ratings were recorded for individual species (Table 2.3.1). Vegetation was collected to a maximum depth of six feet. Aquatic vegetation was present at

38.5% of the sites. Three native submersed species were collected. The maximum number of species per site was 3; the mean species collected per site was 0.41. The species diversity index was 0.44 (Table 2.3.2).

Table 2.3.1. Plant rating scales used during the Tier 2 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. All depths: June 16, 2011.

Occurrence and Abundance of Submersed Aquatic Plants in Lake Manitou (all depths).					
County:	Fulton	Total Sites:	122	Mean species/site:	0.43
Date:	6/16/2011	Sites with plants:	50	SE Mean species/site:	0.05
Secchi (ft):	3.0	Sites with native plants:	50	Mean native species/site:	0.43
Maximum Plant Depth (ft):	6.0	Number of species:	3	SE Mean natives/site:	0.05
Trophic Status:	Meso	# of native species:	3	Species diversity:	0.45
		Maximum species/site:	3	Native species diversity:	0.45

All Depths (0 to 6 ft)	Frequency of Occurrence	Rake score frequency per species				Plant Dominance
Species		0	1	3	5	
Chara	31.1	68.9	27.9	2.5	0.8	7.9
Sago pondweed	6.6	93.4	4.9	0.8	0.8	2.3
Coontail	5.7	94.3	4.1	0.0	1.6	2.5
Bladderwort	0.0	100.0	0.0	0.0	0.0	0.0
Filamentous Algae	59.8					
Other species observed:	waterwillow, largeleaf pondweed, bladderwort, spatterdock, duckweed, white lily, cattail, arrowhead					

Chara (*Chara sp*.) was present at the highest percentage of sample sites (31.1%) and had the highest dominance rating (Figure 2.3.2). Sago pondweed (*Potamogeton pectinatus*) and common coontail (*Ceratophylum demersum*) were present at 6.6 and 5.7% of sample sites respectively. Cattail (*Typha sp*.), spatterdock (*Nuphar sp.)*, white water lily (*Nymphaea tuberosa),* duckweed (*Lemna sp.*), bladderwort (*Utricularia sp.),* largeleaf pondweed (*Potamogeton amplifolius*), and arrowhead (*Sagitiaria sp.)* were observed but not collected with the rake. Filamentous algae were present at 59.8% of sites.

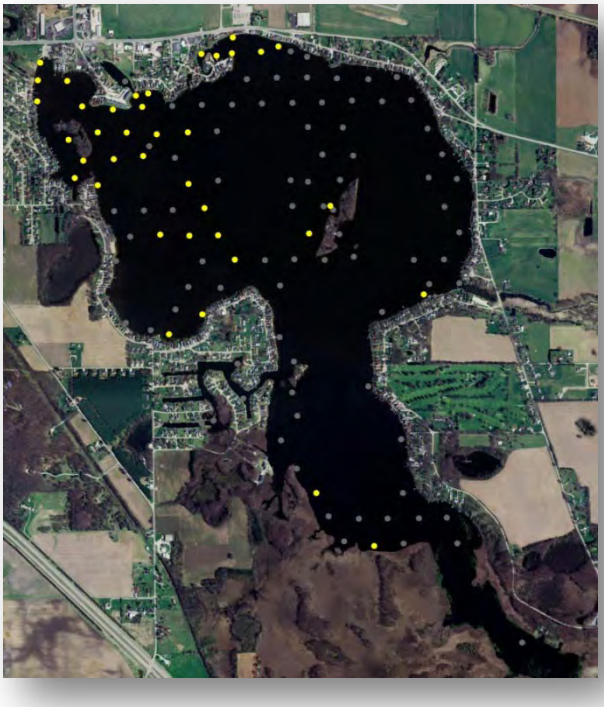


Figure 2.3.2. Lake Manitou, Chara distribution, June 16, 2011.

Figure 2.3.3. Lake Manitou, sago pondweed distribution, June 16, 2011.

Figure 2.3.4. Lake Manitou, coontail distribution, June 16, 2011.

It is also important to look at the species distribution throughout different depth ranges. Most of the plant growth was limited to shallow water. Ninety-seven sites were sampled in the 0-5 foot depth range. Aquatic vegetation was present at 49.5% of the shallow sites. A total of 3 species were collected and the average number of species collected per site was 0.53. Chara occurred at the highest percentage of shallow sites (38.1%) and also had the highest dominance rating. Filamentous algae were present at 66% of the shallow sites (Table 2.3.3).

Table 2.3.3. Occurrence and Abundance of Submersed Aquatic Plants in Lake Manitou. 0-5 feet: June 16, 2011.

Occurrence and Abundance of Submersed Aquatic Plants in Lake Manitou (0-5 ft).					
County:	Fulton	Total Sites:	97	Mean species/site:	0.53
Date:	6/16/2011	Sites with plants:	48	SE Mean species/site:	0.06
Secchi (ft):	3.0	Sites with native plants:	48	Mean native species/site:	0.53
Maximum Plant Depth (ft):	6.0	Number of species:	3	SE Mean natives/site:	0.06
Trophic Status:	Meso	# of native species:	3	Species diversity:	0.44
		Maximum species/site:	3	Native diversity:	0.44

Depth: 0 to 5 ft	**Frequency of Occurrence**	**Rake score frequency per species**				**Plant Dominance**
Species		**0**	**1**	**3**	**5**	
Chara	38.1	61.9	34.0	3.1	1.0	9.7
Sago pondweed	8.2	91.8	6.2	1.0	1.0	2.9
Coontail	6.2	93.8	4.1	0.0	2.1	2.9
Filamentous Algae	66.0					

The 5-10 foot depth range also contained vegetation, but at a very low level. Twenty-two sites were sampled within this range. Chara and coontail each occurred at only a single site. Filamentous algae were present at 40.9% of the sample sites within the 5-10 foot range (Table 2.3.4).

Table 2.3.4. Occurrence and Abundance of Submersed Aquatic Plants in Lake Manitou. 5-10 feet: June 16, 2011.

Occurrence and Abundance of Submersed Aquatic Plants in Lake Manitou (5-10 ft).					
County:	Fulton	Total Sites:	22	Mean species/site:	0.09
Date:	6/16/2011	Sites with plants:	2	SE Mean species/site:	0.06
Secchi (ft):	3	Sites with native plants:	2	Mean native species/site:	0.09
Maximum Plant Depth (ft):	6	Number of species:	2	SE Mean natives/site:	0.06
Trophic Status:	Meso	# of native species:	2	Species diversity:	0.50
		Maximum species/site:	1	Native diversity:	0.50

Depth: 5 to 6 ft	Frequency of Occurrence	Rake score frequency per species				Plant Dominance
Species		0	1	3	5	
Chara	4.5	95.5	4.5	0.0	0.0	0.9
Coontail	4.5	95.5	4.5	0.0	0.0	0.9
Filamentous Algae	40.9					

2.3.2 Summer Tier 2 Survey Results

The methods used in the spring survey were applied again on August 31, 2011 (summer survey). Results of the sampling are listed in Table 2.3.5. Plants were growing to a maximum depth of 7 feet. Aquatic vegetation was present at 16.4% of the sites. A total of four species were collected. The maximum number of species per site was 2, the mean species collected per site was 0.18, and the species diversity index was 0.53.

Table 2.3.5. Occurrence and Abundance of Submersed Aquatic Plants in Lake Manitou. All depths: August 31, 2011.

Occurrence and Abundance of Submersed Aquatic Plants in Lake Manitou (all depths).					
County:	Fulton	Total Sites:	122	Mean species/site:	0.18
Date:	8/31/2011	Sites with plants:	20	SE Mean species/site:	0.04
Secchi (ft):	3.0	Sites with native plants:	20	Mean native species/site:	0.18
Maximum Plant Depth (ft):	7.0	Number of species:	4	SE Mean natives/site:	0.04
Trophic Status:	Meso	# of native species:	4	Species diversity:	0.53
		Maximum species/site:	2	Native species diversity:	0.53

All Depths (0 to 6 ft)	Frequency of Occurrence	Rake score frequency per species				Plant Dominance
Species		0	1	3	5	
Coontail	11.5	88.5	9.0	0.8	1.6	3.9
Sago pondweed	4.1	95.9	3.3	0.8	0.0	1.1
Bladderwort	1.6	98.4	1.6	0.0	0.0	0.3
Chara	0.8	99.2	0.8	0.0	0.0	0.2
Filamentous Algae	75.4					
Other species observed:	spatterdock, Hibiscus spp., white water lily, cattail, purple loosestrife					

Coontail was present at the highest percentage of sample sites and also had the highest dominance rating (Figure and Table 2.3.5). Sago pondweed ranked second in percent occurrence (4.1%) (Figure 2.3.6). Bladderwort ranked third in frequency, (1.6%) while Chara was only collected at a single site. Filamentous algae were collected at 75.4% of sites. Spatterdock, hibiscus, white water lily, cattail, and purple loosestrife were observed but not collected in a rake sample.

Figure 2.3.5. Lake Manitou, coontail distribution, August 31, 2011.

Figure 2.3.6. Lake Manitou, sago pondweed distribution, August 31, 2011.

Ninety-three sites were sampled in the 0-5 foot depth range. Aquatic vegetation was present at 19.3% of the shallow sites. A total of 4 species were collected and the average number of species collected per site was 0.22. Coontail occurred at the highest percentage of shallow sites (12.9%) and also had the highest dominance rating. Sago pondweed ranked second in frequency followed by bladderwort and Chara. Filamentous algae were present at 77.4% of the shallow sites (Table 2.3.6).

Table 2.3.6. Occurrence and Abundance of Submersed Aquatic Plants in Lake Manitou. 0-5 feet: August 30, 2010.

Occurrence and Abundance of Submersed Aquatic Plants in Lake Manitou (0-5 ft).							
County:	Fulton	Total Sites:	93	Mean species/site:			0.22
Date:	8/31/2011	Sites with plants:	18	SE Mean species/site:			0.05
Secchi (ft):	3.0	Sites with native plants:	18	Mean native species/site:			0.22
Maximum Plant Depth (ft):	7.0	Number of species:	4	SE Mean natives/site:			0.05
Trophic Status:	Meso	# of native species:	4	Species diversity:			0.57
		Maximum species/site:	2	Native diversity:			0.57
Depth: 0 to 5 ft		**Frequency of Occurrence**	**Rake score frequency per species**				**Plant Dominance**
Species			**0**	**1**	**3**	**5**	
Coontail		12.9	87.1	9.7	1.1	2.2	4.7
Sago pondweed		5.4	94.6	4.3	1.1	0.0	1.5
Bladderwort		2.2	97.8	2.2	0.0	0.0	0.4
Chara		1.1	98.9	1.1	0.0	0.0	0.2
Filamentous Algae		77.4					

Twenty-six sites fell within the 5-10 foot depth range and only 2 of the sites contained vegetation. Coontail was the only species collected in this depth range. Filamentous algae were present at 65.4% of the sample sites within the 5-10 foot range (Table 2.3.7).

Table 2.3.7. Occurrence and Abundance of Submersed Aquatic Plants in Lake Manitou. 5-10 feet: August 31, 2010.

Occurrence and Abundance of Submersed Aquatic Plants in Lake Manitou (5-10 ft).							
County:	Fulton	Total Sites:	26	Mean species/site:			0.08
Date:	8/31/2011	Sites with plants:	2	SE Mean species/site:			0.05
Secchi (ft):	3.0	Sites with native plants:	2	Mean native species/site:			0.08
Maximum Plant Depth (ft):	7.0	Number of species:	1	SE Mean natives/site:			0.05
Trophic Status:	Meso	# of native species:	1	Species diversity:			0.00
		Maximum species/site:	1	Native diversity:			0.00
Depth: 5 to 7 ft		**Frequency of Occurrence**	**Rake score frequency per species**				**Plant Dominance**
Species			**0**	**1**	**3**	**5**	
Coontail		7.7	92.3	7.7	0.0	0.0	1.5
Filamentous Algae		65.4					

2.3.3 Tier 2 Survey Discussion

For reference: the initial Sonar treatment was conducted on May 13, 2011; bump treatments were conducted on June 3, June 23, and August 12, 2011. Details of the treatments can be found in Section 4.0.

Annual Tier 2 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 2 surveys in 2007-2011. The primary objective of this vegetation management plan is the eradication of hydrilla. Hydrilla was detected during the 2007 spring Tier 2 survey but was not observed or collected during the 2008-2011 surveys. Before the introduction of hydrilla, Eurasian watermilfoil control was the primary objective of vegetation management. Milfoil is highly susceptible to low doses of Sonar, and has not been observed since the May 2007 survey.

The hydrilla eradication treatment with Sonar was expected to temporarily alter the makeup of the submersed native plant community. Prior to the whole lake treatments, eelgrass occurred at the highest percentage of sample sites, but was either not collected or collected at low levels since treatment. Chara, sago pondweed and common coontail are now the most frequently occurring species since initiation of the eradication program. There were increases in coontail abundance this season but significant decreases in Chara occurred. It is not clear what caused these changes in percent occurrence. The changes in percent occurrence in the last thirteen Tier 2 surveys are illustrated in Table 2.3.7 and Chart 2.3.1.

Table 2.3.8. Percent occurrence of species in Lake Manitou in the last thirteen Tier 2 surveys.

	% of survey sites identified												
Species	**Aug-04**	**Aug-05**	**Aug-06**	**May-07**	**Aug-07**	**Jun-08**	**Aug-08**	**Jun-09**	**Aug-09**	**Jun-10**	**Aug-10**	**Jun-11**	**Aug-11**
hydrilla *(Hydrilla verticillata)*				3.3%									
Eurasian watermilfoil *(Myriophyllum spicatum)*	27.5%	30.0%	2.90%	5.0%									
curlyleaf pondweed (Potamogeton crispus)				3.3%				1.6%		1.6%	0.8		
common coontail *(Ceratophyllum demersum)*	26.4%	11.0%	24.3%	36.4%	7.4%		0.8%	0.8%	0.8%	4.9%	4.1%	5.7%	11.5%
Chara *(Chara spp.)*	12.1%	10.0%	10.0%	24.0%	38.8%	50.0%	33.9%	18.9%	2.5%	31.1%	19.7%	31.1%	0.8%
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%	9.8%	4.2%	5.7%	7.4%	6.6%	4.1%
eelgrass *(Vallisneria americana)*	50.5%	61.0%	42.9%	60.3%	6.6%			0.80%					
flatstem pondweed *(Potamogeton zosteriformis)*				4.1%						0.8%			
largeleaf pondweed *Potamogeton amplifolius)*				2.5%				0.8%					
variable pondweed *(Potamogeton gramineus)*				0.8%									
common bladderwort *(Utricularia vulgaris)*					0.8%		0.8%	0.8%	0.8%		0.8%		1.6%
Illinois pondweed *(Potamogeton illinoensis)*	1.1%	2.0%	5.7%										

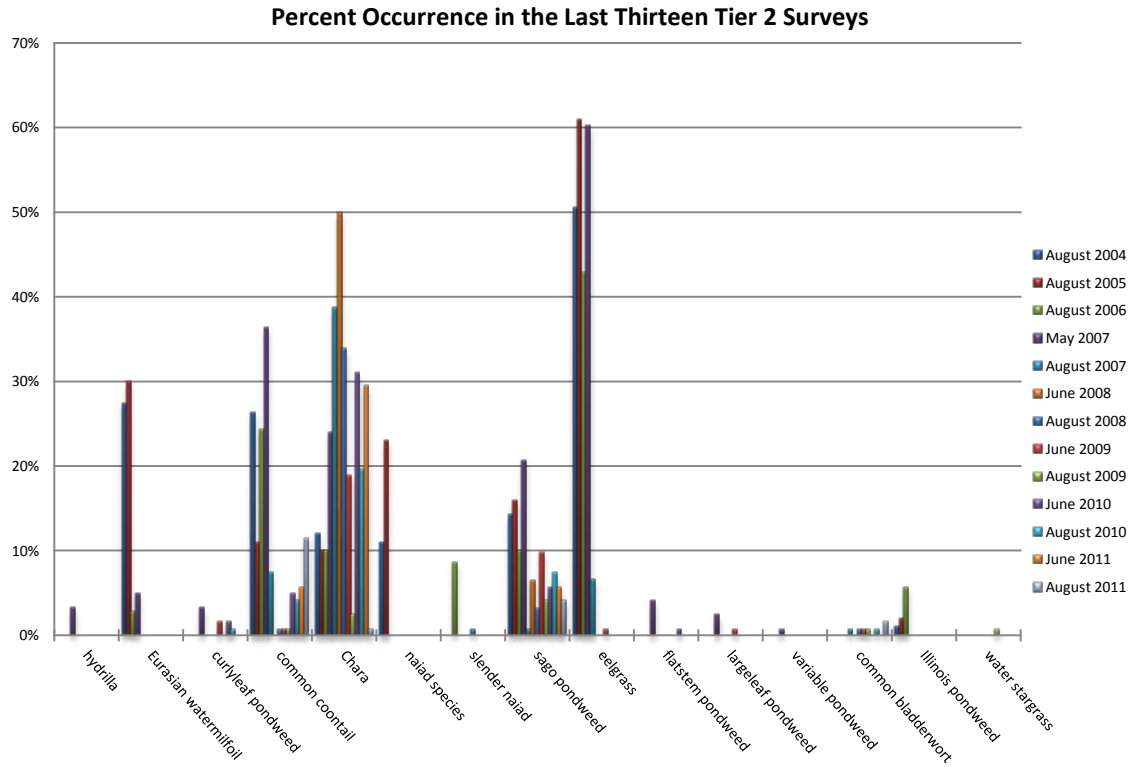


Chart 2.3.1. Percent occurrence of species in Lake Manitou in the last thirteen Tier 2 surveys (data from Table 2.3.8). (As discussed elsewhere in this report, hydrilla was found on Lake Manitou June 26, 2008, June 22, 2009, June 15, 2010, and June 17, 2011. However these discoveries were not made as a result of a Tier 2 survey and therefore are not represented within these data).

Tier 2 surveys not only provide information on individual species changes, they also provide data on lake-wide changes of submersed aquatic plant diversity and abundance. Table 2.3.9 and Chart 2.3.2 compare the percentage of sample sites with vegetation, native diversity index, and the number of native species collected in the last eleven surveys. Figure 2.3.8 shows the change in total species abundance between the spring and summer surveys. All whole-lake post-treatment metrics have declined when compared to pre-treatment data. The decreases seen in the 2011 summer survey metrics are likely the result of the decline in the Chara population. Chara typically was the most abundant species during every survey since the initiation of the eradication program. The reason for the decline is unclear, but a similar phenomenon occurred in 2009 and Chara numbers recovered in 2010. These metrics should continue to be monitored over time. Submersed vegetation metrics are expected to increase once the hydrilla eradication project is completed. There is well established population of coontail and pondweeds in the upper end of the lake that will likely repopulate Lake Manitou once the eradication of hydrilla is complete.

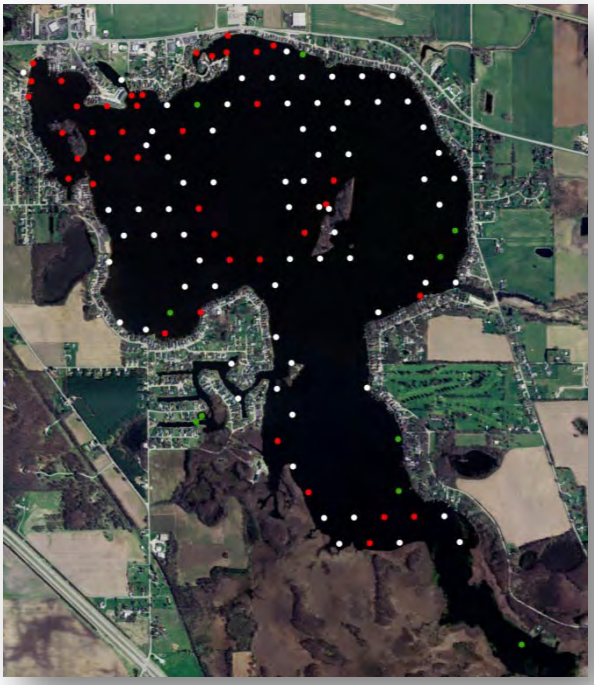


Figure 2.3.7. Lake-wide change in total species abundance, June 16, 2011 to August 31, 2011. Green markers indicate an increase in species present, white markers indicate no change, and red markers indicate a decrease in species present from June to August.

Table 2.3.9. Comparison of number of sample sites, % of sites with vegetation, native diversity index, and number of native species collected in the last eleven Tier 2 surveys.

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
June 2009	122	28.7%	0.55	6
Aug 2009	119	8.4%	0.69	5
June 2010	122	40.9%	0.43	5
Aug 2010	122	28.6%	0.55	4
June 2011	122	38.5%	0.44	3
Aug 2011	122	16.4%	0.53	4

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

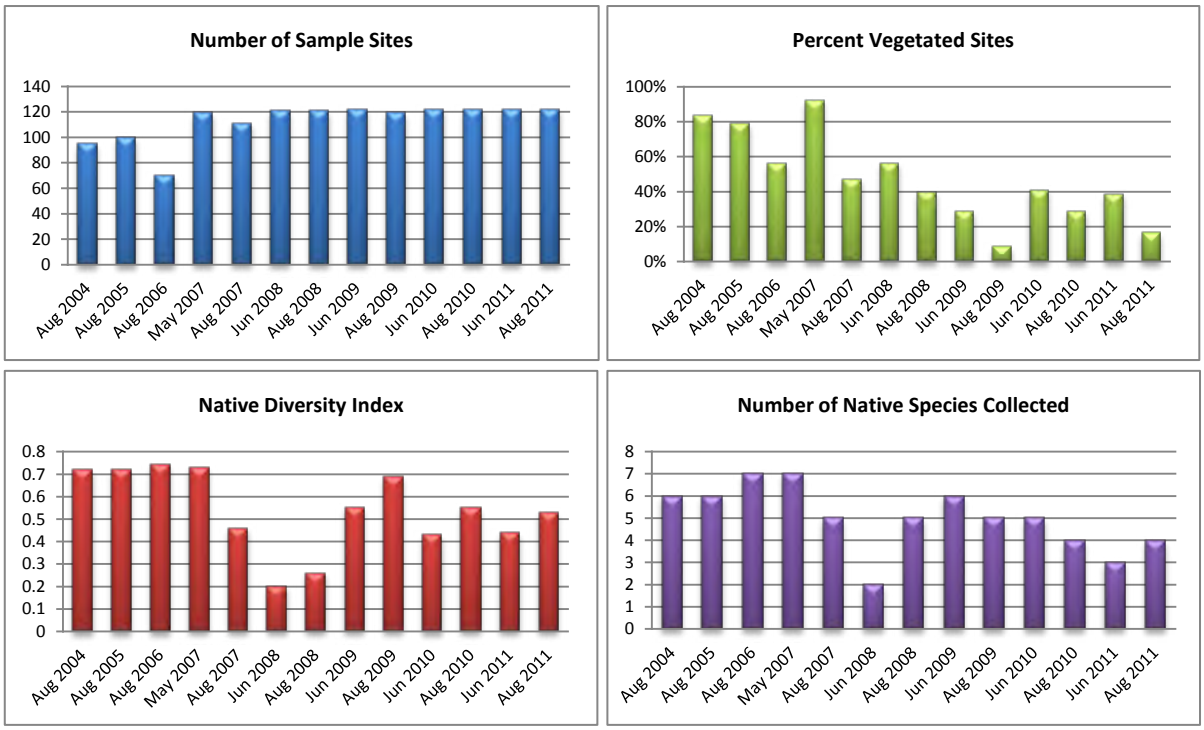


Chart 2.3.2. Comparison of number of sample sites, % of sites with vegetation, native diversity index, and number of native species collected in the last thirteen Tier 2 surveys. (Data are from Table 2.3.9)

2.4 Additional Surveys

2.4.1 Diver Survey

In order to improve quantitative detection of hydrilla abundance on Lake Manitou to better guide future decisions on application design and other management efforts, SePRO coordinated with Aquatic Control to implement a full-lake dive survey on June 17, 2011. The survey was designed to complement other survey techniques associated with the eradication effort in 2011. A combination of Tier II survey sites (with or without past hydrilla finds) and previous 2006 IDNR survey locations where hydrilla was detected were focus areas for the 2011 dive assessment (Figure 2.4.1).

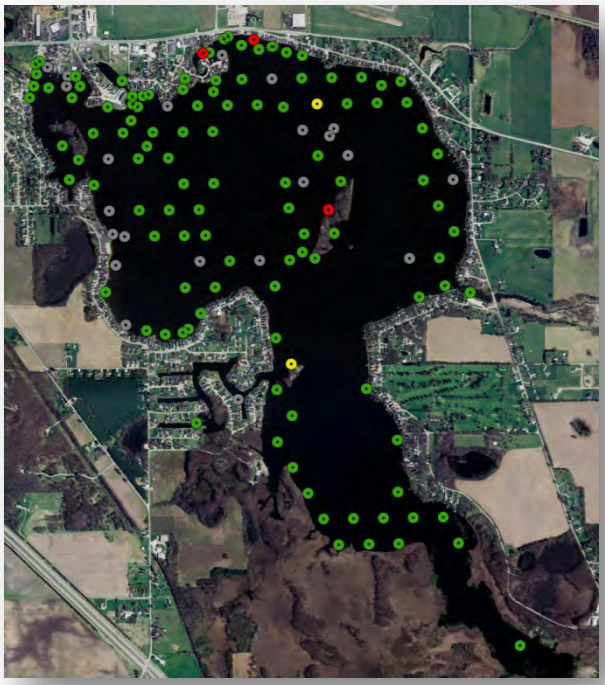


Figure 2.4.1 Results of diver survey conducted 6/17/2011. Red markers show hydrilla finds, green markers indicate non-hydrilla submerged aquatic vegetation, yellow markers indicate filamentous algae only, and gray markers indicate no plants or algae found.

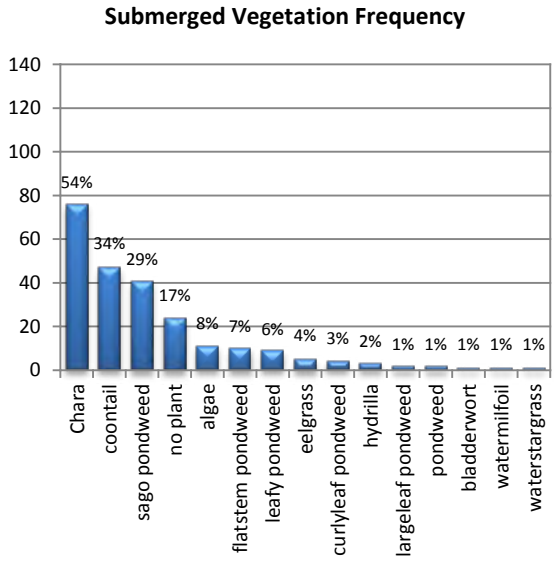
Relevant Tier II/IDNR sites with water depths between 2 and 8 feet were included in the assessment. The overall survey objective was documentation of hydrilla vegetative growth during the early stages of Sonar treatment when 1) hydrilla will be actively growing but symptomatic of Sonar treatment and 2) yet sufficiently healthy and intact to allow effective visual detection by divers. On-board WAAS-Corrected GPS units were used to locate various historical vegetation sites. Divers closely surveyed approximately 1,000 square feet of bottom area centered on each location of previous hydrilla finds. Presence of hydrilla and approximate number of hydrilla plants found at each location were noted. Presence of other aquatic plant species were noted secondarily to compare to traditional Tier II results but intensity and efficiency of hydrilla survey was the primary focus. Within surveyed areas of the bottom, exact

locations of any notable hydrilla 'clumps' (densities of 5 – 10 plants or more per square yard/meter) were marked by divers with a temporary pole or buoy. Before leaving the particular site, submeter-accurate Trimble AgGPS 162 systems were used to collect coordinates of these high density locations for use as refined tuber sampling locations (Section 2.2 – two new tuber monitoring sites were added based on these observations).

The June 2011 diver survey found three sites out of 140 surveyed locations with active vegetative hydrilla growth (Figure 2.4.1). Two of these locations with the largest number of hydrilla plants found—one site near the original tuber monitoring station 2 and the other on the western shore of 'Big Island' in the middle of the lake—were added to the list of stations for the late September 2011 tuber survey (Section 2.2). In terms of native species, divers found 13 total submerged species with Chara, coontail, and sago pondweed being the three most common (Table 2.4.1). Full raw data for the June 2011 dive survey is available upon request.

Table 2.4.1 Frequency of submerged aquatic vegetation from diver survey conducted June 17, 2011. Only SAV, algae or no plant finds are reported here.

SAV Species	Frequency	% total
Chara	76	54%
coontail	47	34%
sago pondweed	41	29%
no plant	24	17%
algae	11	8%
flatstem pondweed	10	7%
leafy pondweed	9	6%
eelgrass	5	4%
curlyleaf pondweed	4	3%
hydrilla	3	2%
largeleaf pondweed	2	1%
pondweed	2	1%
bladderwort	1	1%
watermilfoil	1	1%
waterstargrass	1	1%
total sites sampled	**140**	**-**



2.4.2 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 have been used to help plan every Sonar application. An accurate determination of water volume at the time of treatment is 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 2.4.2. Water volume estimation calculations for Lake Manitou.

Water volume calculations for Lake Manitou based on hydroacoustic data collected 10/5/2006.

Mean Depth = 10.67 Feet				Total Volume = 8,631 Acre Feet			
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	1,110
2’-3’	697	673	7,144	25’- 26’	114	111	993
3’-4’	644	609	6,471	26’- 27’	108	105	882
4’-5’	565	496	5,862	27’- 28’	102	98	777
5’-6’	432	391	5,366	28’- 29’	95	91	679
6’-7’	357	334	4,975	29’- 30’	88	85	588
7’- 8’	318	307	4,641	30’- 31’	82	79	503
8’- 9’	297	288	4,334	31’- 32’	76	73	424
9’- 10’	280	273	4,046	32’- 33’	69	66	351
10’- 11’	266	260	3,773	33’-34’	62	58	285
11’- 12’	254	248	3,513	34’-35’	54	51	227
12’- 13’	242	236	3,265	35’-36’	47	43	176
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	41
17’- 18’	189	184	2,191	40’-41’	15	11	23
18’- 19’	179	174	2,007	41’-42’	8	7	12
19’- 20’	169	164	1,833	42’-43’	5	3	5
20’- 21’	159	155	1,669	43’-44’	2	1	2
21’- 22’	150	145	1,514	44’-45’	<1	<1	1
22’- 23’	140	135	1,369				

ReMetrix

3.0 WATER QUALITY MONITORING

As in previous years an Aquatic Weed Control biologist recorded dissolved oxygen and temperature profiles at FasTEST sample Site 2 on May 16, May 23, May 31, June 13 & 20, July 6 & 18, August 1, 15 & 29, September 12 & 26, and October 10 (Table 3.0.3). In addition to these dates, Aquatic Control personnel collected dissolved oxygen and temperature profiles immediately prior to each treatment, (Table 4.1.1). 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 1˚C 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 2.4.2), 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 2011 season (Table 3.0.1). Secchi measurements ranged from a maximum of 6.1 feet on June 13 to a low of 1.7 feet on July 18 (Table 3.0.2). Overall, minimum Secchi depths in 2011 seemed slightly lower than the historical average while maximum Secchi depths remained consistent with historical averages.

Table 3.0.1. 2011 Secchi depths recorded on Lake Manitou (May to October, 2011).

Site	5/16	6/13	7/6	7/18	8/1	8/15	8/29	9/12	9/26	10/10
1	5.9	**6.5**	3.1	2.4	2.2	3.6	3.1	4.1	3.6	3.5
2	5.0	4.0	2.7	2.0	2.6	3.8	4.2	4.5	4.2	4.0
3	**5**	4.8	3.1	2.1	2.3	3.5	3.9	3.5	3.3	3.4
4	**5**	**5**	2.3	1.7	2.0	3.2	2.8	3.6	3.0	2.9
5	5.4	4.8	3.1	2.1	2.1	3.2	2.8	4.5	3.9	4.0
6	**4**	4.3	2.9	2.7	3.1	3.2	3.1	**4**	3.8	4.0
7	5.0	4.3	2.8	2.7	3.3	4.1	3.8	4.9	4.1	4.0
9	**5**	**5**	2.6	1.8	2.0	2.8	2.9	3.1	**2.9**	**2.9**
mean	**5.0**	**4.8**	**2.8**	**2.2**	**2.5**	**3.4**	**3.3**	**4.0**	**3.6**	**3.6**

Bold text indicates the lake bottom was visible at the water depth listed.
Site locations can be seen in Figures 2.1.1 or 4.2.1.

Table 3.0.2. Summary of Secchi depths recorded on Lake Manitou 1999-2011. (1999 to 2004 data from Fascher & Jones 2006.)

Year	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
2009*	2.3	6.2	3.8	96
2010*	2.1	10.1	3.5	96
2011*	1.7	6.5	2.8	80

*2007 - 2011 data are by authors of this report and are added for comparison with historical data.

Table 3.0.3. 2011 Temperature and Dissolved Oxygen Profiles collected from Sampling Site 2, (FasTEST also included for reference).

DAT -->	5/16/2011	3		5/23/2011	31		5/31/2011	45		6/13/2011	7		7/6/2011	20		7/18/2011	34	
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	FastTEST	Temp	D O_2
0	6.6	15.8	8.7	4.3	19.9	8.3	3.3	22.2	9.9	3.5	24.0	8.4	3.8	28.3	12.6	4.3	29.7	11.4
1		15.8	8.7		19.8	8.3		21.9	10.0		23.8	8.3		27.9	12.7		29.4	11.4
2		15.9	8.6		19.7	8.2		21.8	9.9		23.1	7.9		27.1	10.8		29.1	10.3
3		15.8	8.2		19.6	8.2		20.7	8.7		22.8	7.3		25.9	8.1		27.3	6.9
4		15.7	8.2		16.8	7.0		18.9	7.3		22.6	6.5		24.1	2.9		25.5	0.9
5		15.6	7.2		16.1	7.0		18.0	6.4		21.7	3.7		22.4	0.3		22.9	0.2
6		15.4	7.1		15.8	6.9		16.4	4.7		17.6	0.3		20.4	0.2		20.9	0.2
7		14.9	6.7		15.2	5.7		15.4	4.2		16.5	0.2		18.9	0.2		18.8	0.2
8		14.5	5.6		14.6	3.8		14.6	1.5		15.3	0.2		16.4	0.2		16.4	0.2
9		11.9	1.2		13.6	0.6		13.9	0.3		13.9	0.2		14.8	0.2		15.2	0.1
10		11.1	0.3		12.5	0.3		13.2	0.2		13.0	0.2		14.8	0.1		13.6	0.1

DAT -->	8/1/2011	4		8/15/2011	18		8/29/2011	5		9/12/2011	20		9/26/2011	33		10/10/2011	54	
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	FastTEST	Temp	D O_2
0	3.3	29.7	8.7	5.2	25.3	7.5	4.2	24.6	8.0	4.2	23.2	10.9	3.4	17.4	9.4	2.9	19.0	13.8
1		29.6	8.7		25.2	7.5		24.5	7.9		22.5	11.1		16.9	9.4		18.9	13.8
2		29.2	8.1		25.1	7.5		24.4	7.9		21.4	10.0		17.4	9.4		18.8	13.5
3		28.0	5.7		24.8	7.3		24.1	7.4		20.5	9.3		17.4	9.4		15.6	10.6
4		26.5	0.4		24.8	7.2		24.1	7.3		19.7	6.4		17.3	9.2		15.0	8.4
5		24.1	0.2		24.4	4.9		23.9	7.3		19.5	5.8		17.3	9.1		14.7	6.9
6		21.4	0.2		23.2	1.5		23.7	7.3		19.4	5.2		17.3	9.0		14.5	6.4
7		18.1	0.1		18.2	0.2		19.2	0.3		19.3	4.5		17.3	8.7		14.4	5.8
8		16.3	0.1		16.4	0.2		16.8	0.3		19.1	3.8		17.3	7.9		14.3	5.0
9		15.1	0.1		15.4	0.2		15.3	0.2		18.9	3.1		17.3	0.4		14.2	3.0
10		13.9	0.1		14.3	0.2		14.2	0.2		16.9	0.2		17.3	0.4		14.2	2.7

This page intentionally left blank

4.0 2011 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, California and Kansas.

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). 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.

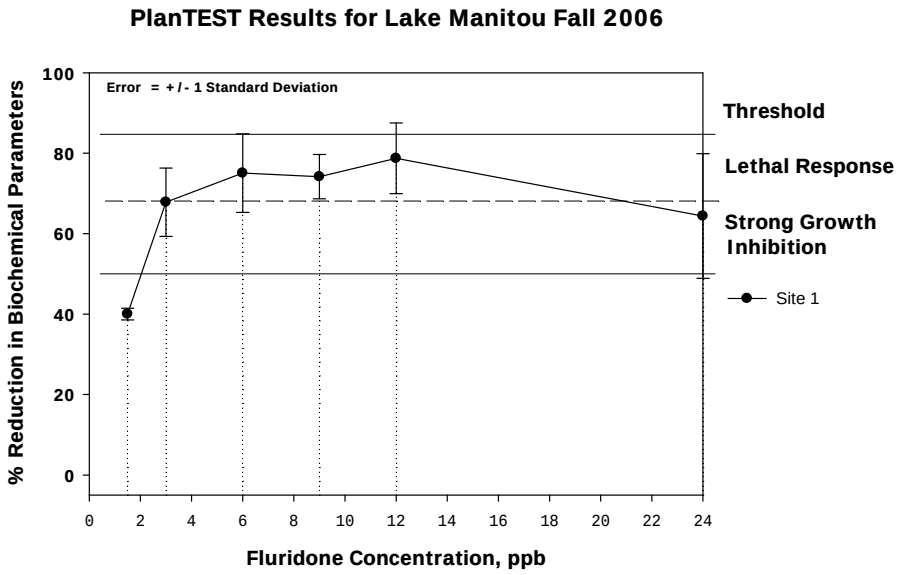


Chart 4.0.1 PlanTEST Results for Lake Manitou.

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. This same treatment strategy was used in 2008 and 2009. In 2010, target Sonar rates were further refined based on successful target rate attainment and control outcomes in past seasons. In 2010, an initial 6 ppb target rate was utilized with repeat 'bump' applications seeking to maintain herbicide rate in a range of 2.5 – 5 ppb. This treatment strategy was continued in 2011

4.1 Sonar Application

For reference: the initial Sonar treatment was conducted on May 13, 2011; bump treatments were conducted on June 3, June 23, and August 12, 2011. Details of the treatments can be found in Section 4.0

On May 13, 2011, the first application was made by Aquatic Control, Inc., with SePRO Corporation and ReMetrix personnel on site for technical assistance. Sonar AS was applied at a concentration of 6.0 ppb along with pelletized Sonar PR to 19 zones at concentrations ranging from 40-100 ppb (total of 2.2 ppb). A thermocline was detected at 12 ft. (Table 4.1.1). The lake volume of 5,366 acre feet was used in the Sonar AS calculation.

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). A custom built herbicide blower on a 19-foot Carolina Skiff was used for application of the granular Sonar PR product.

Table 4.1.1. Water Temperature and dissolved oxygen profiles associated with Sonar application dates. (Thermocline depths are indicated by a thicker line between rows).

	Trtmt 5/13		Trtmt 6/3		Trtmt 6/23		Trtmt 8/12	
Depth (m)	Temp (C)	D.O. (mg/L)	Temp (C)	D.O. (mg/L)	Temp (C)	D.O. (mg/L)	Temp (C)	D.O. (mg/L)
Subsurface	23.1	11.4	23.0	13.1	22.3	8.0	28.2	7.9
1	22.5	11.5	23.1	12.9	22.7	7.8	27.8	7.9
2	21.8	11.6	23.1	12.3	22.9	7.6	27.7	8.1
3	21.0	11.8	22.7	9.1	23.1	7.5	26.9	6.8
4	17.0	8.9	22.3	8.3	23.2	7.4	26.4	5.9
5	16.1	8.7	20.0	4.6	23.2	7.3	26.2	5.6
6	15.5	8.2	18.2	3.7	21.1	0.4	24.9	3.9
7	14.6	8.8			19.2	0.2	22.2	0.4
8	14.2	6.8			17.4	0.2	19.5	0.2
9	13.6	6.2			15.9	0.2	17.9	0.2
10	13.2	5.3			15.0	0.2		
11	13.0	5.2			14.6	0.2		
12	12.8	2.0			14.0	0.2		
13	12.2	1.1			13.9	0.2		

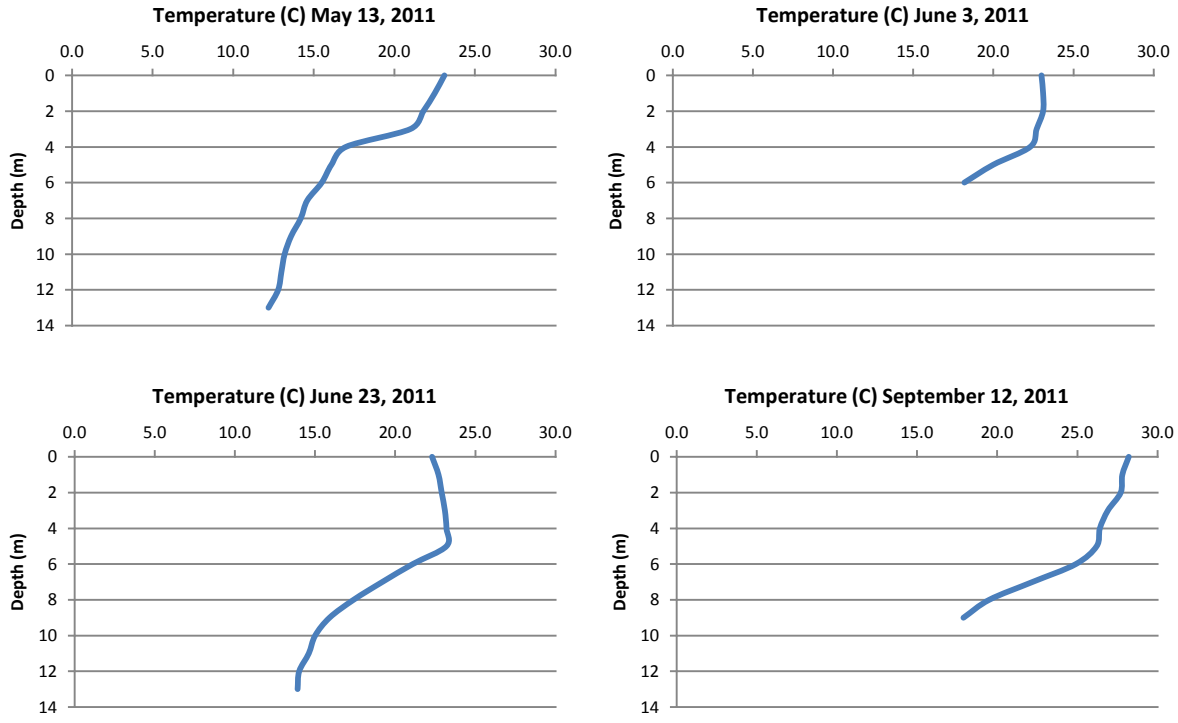


Chart 4.1.1. Water Temperature profiles associated with Sonar application dates.

Figure 4.1.1. Initial application tracks for Sonar AS (*left map*) and Sonar PR (*right map*), May 13, 2011.

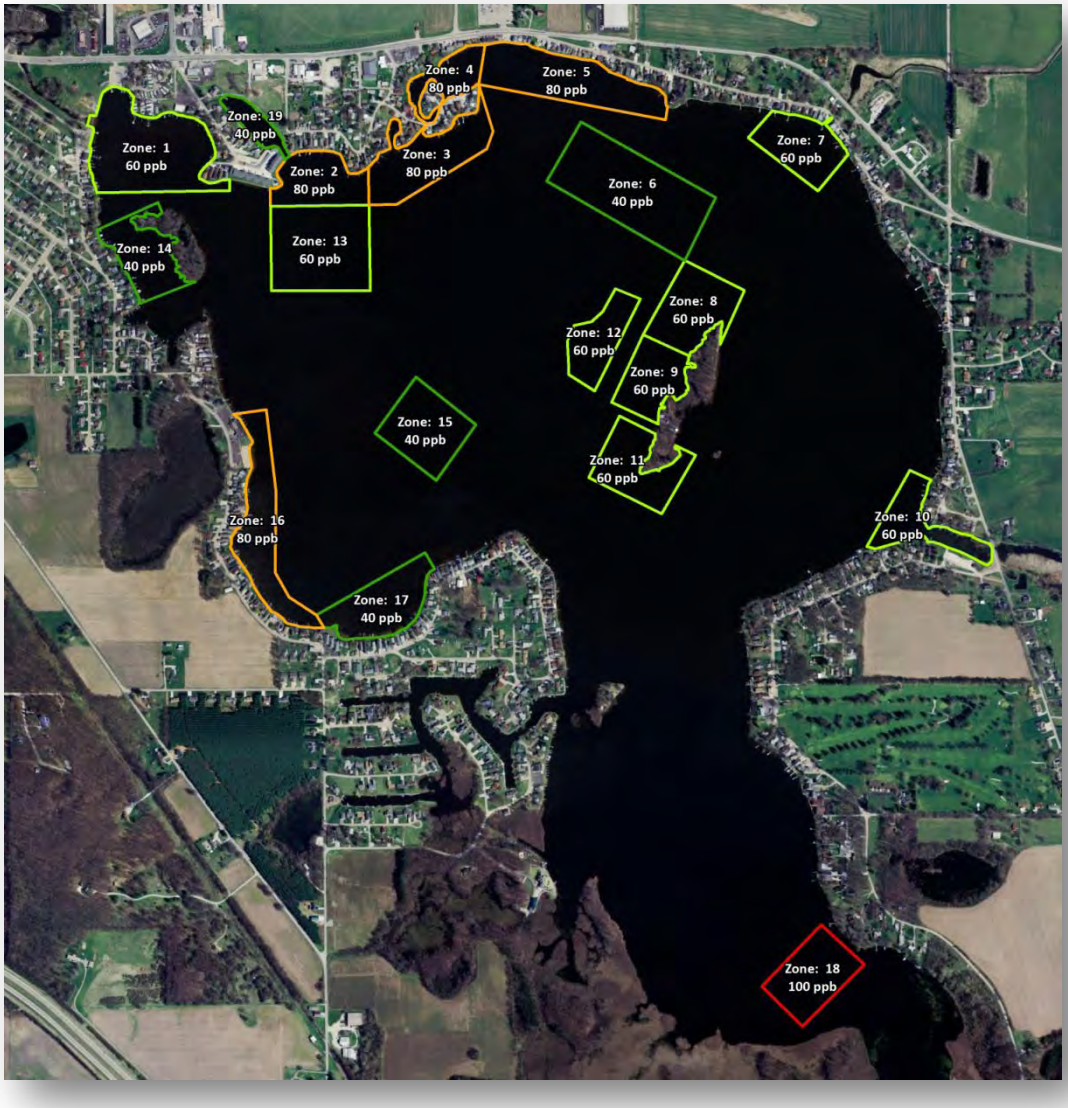


Figure 4.1.2. Sonar PR application prescription map, May 13, 2011.

The first bump treatment was completed on June 3 (21 days after initial treatment) with Sonar AS due to the fact that fluridone levels had dropped to a lake-wide average of 3.3 ppb. Sonar AS was applied at concentration of 1.7 ppb. Sonar AS was applied evenly over the entire lake. A thermocline had formed at 15 feet, so the 1.7 ppb concentration was figured for only the upper 15 ft of the water column (Table 4.1.1). Figure 4.1.3 displays the actual application routes from the first bump treatment.

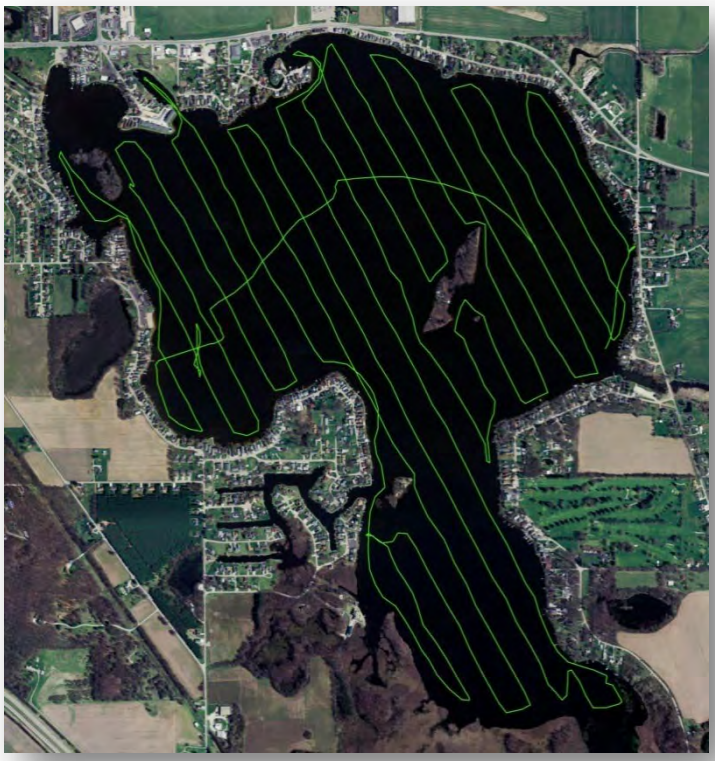


Figure 4.1.3. First "bump application" tracks for Sonar AS, June 3, 2011.

A second bump application was completed on June 23rd with a combination of Sonar AS and Sonar PR. Sonar AS was applied at a concentration of 1.6 ppb and Sonar PR was applied at a concentration of 1.1 ppb. Sonar AS was applied evenly over the entire lake while PR was applied to the 19 areas outlined in Figure 4.1.2. The Sonar AS application was initiated due to fact that fluridone levels had dropped to a lake-wide average of 3.4 ppb. Sonar AS was applied to the upper 19.5 feet due to the presence of a thermocline. Figure 4.1.4 displays the actual application routes from these applications.

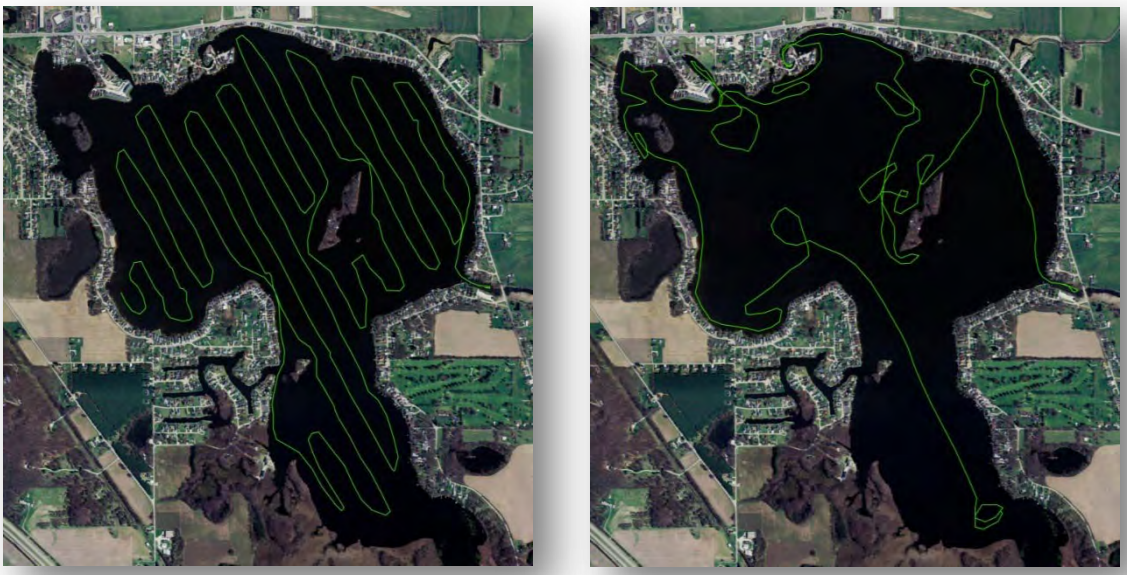


Figure 4.1.4. Second "bump application" tracks for Sonar AS (*left map*), and Sonar PR on June 23, 2011 (*right map*).

FasTEST samples indicated that the fluridone concentration had dropped to a lake-wide average of 3.27 ppb by August 1st. A third and final bump treatment was completed with Sonar AS and Sonar PR on August 12th. Sonar AS was applied at concentration of 1.7 ppb and Sonar PR was applied at 1.1 ppb. The Sonar AS treatment was calculated for the upper 18 feet due to the presence of a thermocline at that water depth. Figure 4.1.5 displays the actual application routes from the final bump treatment.

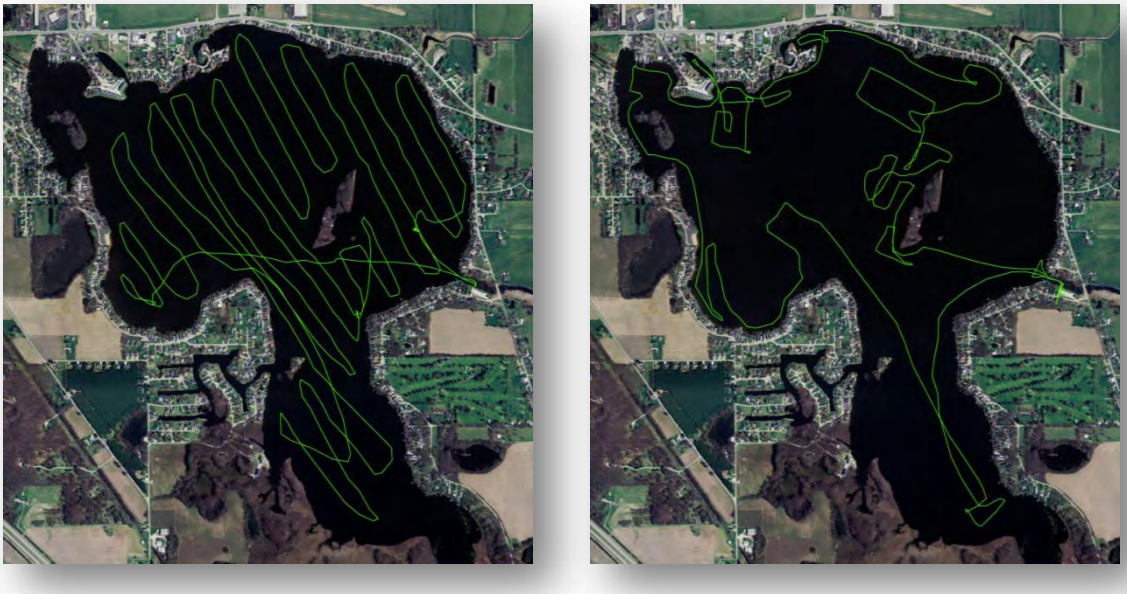


Figure 4.1.5. Final "bump application" tracks for Sonar AS (*left map*), and Sonar PR on August 12, 2011 (*right map*).

This page intentionally left blank

4.2 Herbicide Residue Monitoring

The FasTEST was used to monitor fluridone concentration 3, 10, 18, 31, 38, 54, 66, 80, 94, 108, 122, 136, and 150 days following initial treatment. The FasTEST ensured the target concentrations were achieved and maintained through October 10th. FasTEST samples were collected from eight permanent stations located throughout Lake Manitou (Figure 4.2.1 & Table 4.2.1). Thirteen sets of surface samples were collected and results are summarized in Table 4.2.2, and Chart 4.2.1. Results indicate the lake wide concentration was maintained above 2.5 ppb for the all of the 2011 growing season. The objective was to maintain >2.5 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.

Figure 4.2.1. Permanent FasTEST sample locations during 2011.

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

Site	Latitude	Longitude
1	N 41˚ 03' 26.0"	W 86˚ 10' 44.9"
2	N 41˚ 03' 05.9"	W 86˚ 11' 15.3"
3	N 41˚ 03' 35.3"	W 86˚ 10' 29.6"
4	N 41˚ 03' 31.5"	W 86˚ 11' 26.1"
5	N 41˚ 03' 05.0"	W 86˚ 10' 20.4"
6	N 41˚ 02' 23.3"	W 86˚ 10' 32.1"
7	N 41˚ 02' 43.5"	W 86˚ 10' 34.7"
9*	N 41˚ 02' 48.8"	W 86˚ 11' 01.4"

*Station 8 was removed after 2007; Station 9 was added in 2008.

Table 4.2.2. Concentration of 2011 FasTEST results from surface water samples. Vertical black lines indicate when "bump" treatments were made.

	5/16	5/23	5/31	6/13	6/20	7/6	7/18	8/1	8/15	8/29	9/12	9/26	10/10	Season
DATa -->	**3**	**10**	**18**	**10**	**17**	**13**	**25**	**39**	**3**	**17**	**31**	**45**	**59**	**150**
Sites	---------- Sonar Concentration (ppb) ----------													
1	6.0	4.0	3.8	3.7	3.5	3.3	6.3	3.7	5.2	4.3	4.5	4.0	3.0	**3.9**
2	6.7	4.3	3.8	3.6	3.4	4.7	4.0	3.4	5.1	4.3	4.3	3.5	3.0	**4.5**
3	6.0	4.5	3.7	3.2	3.6	3.9	4.0	3.0	4.7	4.1	4.5	3.2	3.0	**4.4**
4	6.7	4.3	3.8	3.7	3.8	4.4	4.3	3.9	5.5	4.1	4.6	3.4	3.2	**4.1**
5	5.9	4.1	3.7	3.9	3.4	3.6	3.9	3.3	5.0	4.0	4.0	3.5	2.9	**4.1**
6	6.5	3.7	3.4	3.0	2.9	2.8	3.3	2.5	4.7	3.8	3.6	3.3	2.7	**4.1**
7	6.8	4.1	2.2	3.0	2.7	3.4	3.4	3.0	4.7	4.3	3.7	3.1	2.8	**3.8**
9	8.0	5.6	2.1	3.6	4.2	4.1	5.0	3.4	6.5	4.7	4.7	3.5	2.8	**4.6**
Lake Avg	**6.6**	**4.3**	**3.3**	**3.5**	**3.4**	**3.8**	**4.3**	**3.3**	**5.2**	**4.2**	**4.2**	**3.4**	**2.9**	**4.2**

[a] DAT represents the number of days after the last treatment.

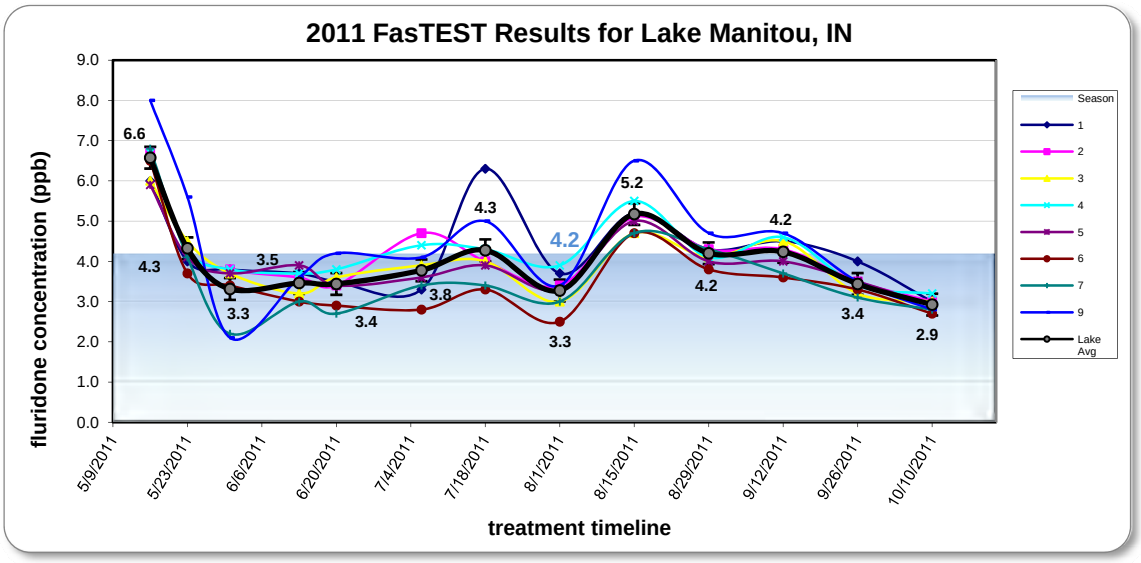


Chart 4.2.1. Sonar concentration by FasTEST site during 2011. The heavy black line, error bars and data labels represent the whole-lake average at each sampling. The blue background and data label represent the season-long average concentration from May through October 2011.

5.0 ACTION PLAN UPDATE

Five consecutive years of whole-lake Sonar (fluridone) applications have continued to control vegetative hydrilla, reduce hydrilla tuber banks, helped prevent the spread of hydrilla to other lakes and have had minimal impacts on the overall water quality of Lake Manitou. These treatments have come at an expense to the state of Indiana, but the expense of this aggressive action can be well justified in comparison to the outcome of less proactive management that unfortunately led to aggressive expansion of hydrilla into the Southeast and Mid-Atlantic US with major ecological and economic impact in the last several decades. The state should be commended for its aggressive commitment to containing and eradicating hydrilla on Lake Manitou and preventing this invasive species expansion into Indiana waters.

The continued recommendation to IDNR for 2012 will be initiation of a Sonar management plan at the same scale and intensity conducted in the last three years. The primary benefit of whole-lake Sonar treatment is an ability to target submersed invasive species like hydrilla throughout an infested body of water. In an eradication program, unless spatial distribution of the target species—in this case hydrilla—can be determined with absolute certainty, partial treatment strategies cannot insure complete treatment of an invasive population and therefore significantly increase risk that the target species will escape direct treatment, successfully reproduce, and pose an on-going threat for expansion within the managed system. Large-scale or whole-lake management protocols with Sonar greatly increase confidence that isolated, difficult to locate hydrilla throughout an entire system will receive lethal doses of herbicide and eliminate risk of plant establishment and successful new tuber deposition. Any successful hydrilla establishment and tuber formation, no matter how isolated, poses a clear risk to reaching eradication objectives and can translate rapidly into a complete loss of multiple-year management success.

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. Based on both 2010 and current 2011 tuber attrition rates observed on Lake Manitou to date as part of a growing nationwide dataset on monoecious hydrilla population response to management, projected number of consecutive annual treatments with Sonar to reach tuber bank eradication in Manitou has decreased relative to earlier 2009 projections. Following three years of slowing rates of tuber attrition, the higher attrition measured following the fourth annual cycle of management in 2010 projected to a 4.8 to 6.7-year horizon for complete eradication. The lack of unsprouted tuber finds in the September 2011 assessment supports near-complete tuber bank removal but relatively easy finds by divers in 2010 and 2011 suggest viable hydrilla remains in Manitou. Surveys of long-term hydrilla eradication lakes such as Pipe-Lucerne in Washington and Pickerel Pond in Maine are showing a lack of hydrilla finds in most recent years of monitoring. The Pipe-Lucerne system has now had two seasons without hydrilla finds and also no management with Sonar after nearly a decade of earlier Sonar treatment. The state of Maine has not found

hydrilla in the last two years of dive surveys and after 9 cycles of Sonar treatment is considering a change in strategy. Lack of hydrilla following 8 – 9 years of treatment in these projects suggests a narrowing window perhaps for improved expectations of monoecious hydrilla tuber longevity under eradication programs with Sonar.

The first five years of Sonar application have resulted in successful control of hydrilla in Lake Manitou with greater than 99% reductions in tubers and apparent prevention of hydrilla spread to other waters of Indiana. The timing of treatments coincided with hydrilla tuber sprouting, which is expected to be similar in 2012. Over the five cycles of management, the eradication program has impacted 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 modifications were continued in 2009 with no major adjustment. After multiple reviews of past Sonar dissipation and performance in Manitou, two potential management options were described for the 2010 program. One based on a multiple formulation strategy, while the other focused on partial targeted application with Sonar pellets. Ultimately, refinements were made to the program for 2010 that changed the criteria for triggering bump applications. In previous years, residue values of 3.0 ppb or less triggered a bump application to return whole-lake average residue values to 6.0 ppb, (initial dose). The changes in 2010 dictated a lower residue value of 2.5 ppb would initiate a bump application to target lower lake-wide average residues of 5.0 ppb. In 2011, new observations regarding hydrilla tuber bank attrition and outcomes of various monitoring efforts suggest that the history of Sonar management is approaching a potential successful eradication outcome. While IDNR has reinforced that reducing herbicide pressure and encouraging greater growth and expansion of native aquatic vegetation in Manitou is a desirable, future management goal, the notable tuber declines in the last two cycles and recent status of other US long-term eradication efforts suggest that 'staying the course' with similar intensity of management may be the most appropriate course of action unless non-technical factors merit a shift in strategy. In light of the on-going eradication objective and documentation of tuber depletion approaching that objective, the following management initiatives are broadly recommended for future hydrilla control efforts on Manitou:

1) Shift focus of future hydrilla assessments towards late spring dive survey efforts at intensities equal to or greater than the 2011 effort. Current use of standard spring and late summer Tier 2 LARE vegetation assessments should be continued for understanding broad long-term trends in aquatic plant diversity on the lake. While of great importance in documenting progress towards hydrilla eradication from Manitou in 2007 - 2011, the sharp reductions in hydrilla tuber density since the beginning of the eradication effort have reached an endpoint of effective and efficient hydrilla detection. In 2010, only four unsprouted tubers were found in 700 sediment cores. In 2011, only 2 sprouted hydrilla tubers were found and no unsprouted hydrilla tubers were collected. It is recommended that IDNR consider shifting past tuber bank assessment effort into

enhanced dive survey methods with a much enhanced ability to detect hydrilla as confirmed in limited 2010 efforts and the comprehensive 2011 dive survey. It is recommended that fall survey effort for tubers be replaced with an additional day of spring dive survey time to enhance intensity and resolution of dive survey efforts with greater focus on the northern portion of the lake.

2) Implement another large-scale (whole-lake) Sonar application plan similar to 2007-2010 that will continue to build off of historical experiences on the lake. In the last four years, an application protocol utilizing multiple formulations of Sonar (fluridone) has been designed and further refined to best meet the hydrilla eradication objectives for the project. 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. The overall rate of Sonar used compared to early years with this integrated approach has been adjusted down slightly in recent seasons based on management experience on the lake. In 2010 and 2011, the maintenance range for Sonar dose to 2.5 – 5 ppb (following initial 6 ppb target) was formally refined and successfully implemented. However, a continued analysis of historic precipitation records during May through September over the last 20+ years (Table 5.1.1) indicates a drier than normal pattern of precipitation in the Manitou watershed during most of the five seasons of Sonar use on Manitou. An above average rainfall pattern throughout the 2012 treatment cycle could dictate greater Sonar quantities than recent cycles to achieve target herbicide levels. While more targeted, partial treatments relying entirely on Sonar pellets might be feasible, any improvements in efficiency from such a change in approach likely are outweighed by risk of hydrilla escapes at this point in the eradication effort. The finds of hydrilla both in the north end of the lake and in central areas near 'Big Island' indicate a wide area of potential remaining hydrilla infestation that continues to merit similar scale of management as recent years. Any Sonar program should continue routine FasTEST collection to follow herbicide levels and adjust with bump treatment modifications as needed.

Table 5.1.1. May through September monthly precipitation records from 1990-2011 for the Fulton County Airport just north of Lake Manitou in Rochester, Indiana. 2007 – 2011 records are compared to 20-year mean and median seasonal precipitation.

Monthly Precipitation (inches)

	May	Jun	Jul	Aug	Sept	TOTAL
1990	5.8	4.5	8.7	12.4	1.7	**33.1**
1991	3.3	2.1	2.8	3.3	1.7	**13.2**
1992	2.0	2.5	5.7	2.4	5.7	**18.3**
1993	4.4	5.4	4.5	3.2	7.1	**24.6**
1994	2.2	3.9	4.3	2.6	1.4	**14.4**
1995	5.1	5.9	1.8	4.5	0.5	**17.8**
1996	7.0	3.9	9.3	1.5	3.4	**25.1**
1997	5.7	3.6	6.4	4.2	5.9	**25.8**
1998	4.7	7.3	9.5	3.3	1.2	**26.0**
1999	3.2	4.2	1.4	3.2	2.5	**14.5**
2000	5.0	6.3	3.5	5.0	4.4	**24.2**
2001	4.2	4.1	8.5	5.6	3.2	**25.6**
2002	6.4	2.1	3.3	3.3	1.9	**17.0**
2003	6.3	2.0	9.3	2.0	5.3	**24.9**
2004	6.3	4.6	4.0	9.6	1.0	**25.5**
2005	2.3	3.5	4.0	2.7	4.4	**16.9**
2006	6.0	2.6	6.1	5.4	2.7	**22.8**
2007	2.3	2.5	5.1	6.6	1.1	**17.6**
2008	4.1	5.6	1.6	2.6	3.6	**17.5**
2009	5.2	2.9	2.7	5.3	1.5	**17.6**
2010	6.0	5.7	4.2	1.5	3.0	**20.4**
2011	6.9	2.7	4.3	2.0	6.4	**22.2**
MEAN	**4.7**	**4.0**	**5.0**	**4.2**	**3.2**	**21.1**
MEDIAN	**5.1**	**3.9**	**4.3**	**3.3**	**2.9**	**21.3**

Difference from 20-Year Mean Precipitation

	May	Jun	Jul	Aug	Sept	TOTAL	% Diff
2007	-2.4	-1.5	0.1	2.4	-2.1	**-3.5**	**-16.7%**
2008	-0.6	1.6	-3.4	-1.6	0.4	**-3.6**	**-17.2%**
2009	0.5	-1.1	-2.3	1.1	-1.7	**-3.5**	**-16.7%**
2010	1.3	1.7	-0.8	-2.7	-0.2	**-0.7**	**-3.5%**
2011	2.2	-1.3	-0.8	-2.2	3.2	**1.1**	**5.1%**

Difference from 20-Year Median Precipitation

	May	Jun	Jul	Aug	Sept	TOTAL	% Diff
2007	-2.8	-1.4	0.8	3.3	-1.8	**-3.7**	**-17.4%**
2008	-1.0	1.7	-2.7	-0.7	0.8	**-3.8**	**-17.9%**
2009	0.2	-1.0	-1.6	2.0	-1.4	**-3.7**	**-17.4%**
2010	1.0	1.8	-0.1	-1.8	0.2	**-0.9**	**-4.3%**
2011	1.9	-1.2	0.0	-1.3	3.5	**0.9**	**4.3%**

The original Manitou 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 recent changes to the hydrilla control program were implemented and future actions will be considered to balance eradication efforts vs. other lake management objectives. Although the native species richness in Lake Manitou has historically been low, species affected by current management actions 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).

5.2 Budget Update

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

The 2011 project cost was down 7% under 2010 due to minimal precipitation and resulting good Sonar retention in the mid-late summer. Project cost remained well below the anticipated budget cap for the project.

Table 5.2.1. Budget update for 2011.

Year	Actual expenditures
2007	$349,920
2008	$317,549
2009	$351,949
2010	$268,076
2011	$248,315

This page intentionally left blank

6.0 PUBLIC AND REGIONAL REGULATORY INTERACTION

The on-going hydrilla eradication effort on Lake Manitou is a resounding success for preventing spread to other lakes in Indiana and the Midwest. With many aquatic invasive issues, including the recent activity regarding possible Asian carp spread to the Great Lakes, it is important for IDNR to promote successful management in Manitou. This success needs to be put in context with local stakeholders who have enjoyed recreational benefits of weed-free conditions over the last five years but may experience different lake conditions as the hydrilla eradication effort eventually transitions to a lower intensity management approach favoring greater native plant growth.

In terms of 2012 public access to the lake, since the 2011 dive survey found a very low-level of hydrilla infestation with negligible risk of hydrilla off-site movement during future Sonar cycles, SePRO supports the new season-long use policy unless 1) Sonar management were completely ended in 2012 or 2) early 2012 field observations unexpectedly indicate increased risk of off-site movement due to public ramp activity.

Additionally, routine dialogue with Midwest regulators and resource managers on the threat of hydrilla should be maintained to help prevent or limit hydrilla expansion into more Midwest lakes. Rapid response plans should be revisited and adjusted as needed to current regulations and technical considerations (e.g., NPDES, possible improved assessment tools and techniques). The success of Manitou should be appropriately reviewed with various Midwest DNR groups to reinforce the value of past and current management expenditures to help maintain eradication funding for this project and have funds to aggressively react to possible future regional hydrilla infestations.

This page intentionally left blank

7.0 REFERENCES CITED

Donahoe, J., and Keister, D, 2005. Lake Manitou Aquatic Vegetation Management Plan. Report to Lake Manitou Association, Rochester, IN.

Donahoe, J., and Keister, D, 2006. Lake Manitou Aquatic Vegetation Management Plan Update. Report to Lake Manitou Association, Rochester, IN.

Donahoe, J., and Keister, D, 2007. Lake Manitou Aquatic Vegetation Management Plan Update. Report to Lake Manitou Association, Rochester, IN.

Fascher, L. and Jones, W.W. 2006. Indiana Volunteer Lake Monitoring Report 1999 Report to IDEM Office of Water Quality, Indianapolis, IN.

Haller, W.T. and D.L. Sutton. 1975. Community structure and competition between hydrilla and Vallisneria. J. Aquat. Plant Manage. 13: 48-50.

Indiana Department of Natural Resources, Division of Fish and Wildlife. 2006. Tier 2 Aquatic Vegetation Survey Protocol. 26 pp.

Langeland, K.A. 1996. *Hydrilla verticillata* (L.F.) Royle (Hydrocharitaceae), "The Perfect Aquatic Weed". Castanea 61:293-304.

Nawrocki, J. J., R. J. Richardson, S. Hoyle, A. P. Gardner, R. L. Roten. 2009. Monoecious hydrilla phenology and tuber dynamics in North Carolina. Presentation at the 2009 Annual Meeting of the Weed Science Society of America. February 9-13, 2009. Orlando, Florida.

Rao, S. K., N.C. Magnin, J.B. Reiskind and G. Bowes. 2002. Photosynthetic and other phosphoenolpyruvate carboxylase iosforms in the single-cell, facultative C4 system of *Hydrilla verticillata*. Plant Physiology. 130: 876-886.

SePRO, 2008. Lake Manitou Aquatic Vegetation Management Plan Update, March 14, 2008 Report to Indiana Department of Natural Resources. Indianapolis, IN.

SePRO, 2009. 2008 Lake Manitou Aquatic Vegetation Management Plan Update. Report to Indiana Department of Natural Resources. Indianapolis, IN.

SePRO, 2010. 2009 Lake Manitou Aquatic Vegetation Management Plan Update. Report to Indiana Department of Natural Resources. Indianapolis, IN.

SePRO, 2011. 2010 Lake Manitou Aquatic Vegetation Management Plan Update. Report to Indiana Department of Natural Resources. Indianapolis, IN.

Sprecher, S.L., M.D. Netherland and A.B. Stewart. 1998. Phytoene and carotene response of aquatic plants to fluridone under laboratory conditions. J. Aquat. Plant Manage. 36(2): 111-121.

Van T.K., Haller WT, Bowes G. 1976. Comparison of the photosynthetic characteristics of three submersed aquatic plants. Plant Physiol. 58:761-768.

This page intentionally left blank

APPENDIX

This page intentionally left blank

Lake Manitou Hydrilla Eradication Program – YEAR 5

Initial Sonar Application Summary – May 13, 2011 (Friday).

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

Prescription Planning

No modifications were made to the treatment prescription this year. Similar to last year, it is assumed this methodology might 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 May 12, 2011 and indicated the lake was already thermally stratified with a thermocline present at approximately 12 feet. Sonar AS amounts were calculated for treating 5,366 acre feet of water. Sonar granular product was prescribed for littoral areas only; no adjustments to calculated doses were thus necessary. Like 2007-2010, 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 October 5, 2006. Not all areas of "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 23.1 gallons of Sonar AS was applied. Sonar PR was applied to all areas as prescribed. 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 1,010 lbs of Sonar PR was applied to the 19 zones.

This page intentionally left blank

LARE Tier 2 Survey Raw Data 6/16/11

WPT	Lat	Long	Depth	Rake score	Fil. Algae	Chara	Sago pondweed	Coontail	Bladderwort
1	41.06090	-86.17843	4	0	P				
2	41.06142	-86.18021	4	1	P	1			
3	41.05924	-86.18810	3	1	P	1			
4	41.05921	-86.18875	4	1	P	1			
5	41.05530	-86.17996	5	0					
6	41.05695	-86.18784	5	0	P				
7	41.05406	-86.17718	4	0	P				
8	41.04456	-86.18524	4	0	P				
9	41.06030	-86.19520	1	0	P				
10	41.06090	-86.19662	1	0	P				
11	41.03551	-86.16812	1	5				5	
12	41.03916	-86.17678	3	0	P				
13	41.03912	-86.17497	3	3	P	1	1	1	
14	41.03920	-86.17338	3	5	P		5		
15	41.03875	-86.17026	2	5			3	5	
16	41.04039	-86.17759	3	0	P				
17	41.04025	-86.17583	6	0	P				
18	41.04029	-86.17409	5	1	P		1		
19	41.04030	-86.17235	4	1	P			1	
20	41.04031	-86.17057	3	1				1	
22	41.04149	-86.17858	4	1	P	1			
23	41.04152	-86.17311	3	0	P				
24	41.04280	-86.17948	2	0	P				
26	41.04377	-86.18035	6	1	P			1	
27	41.04377	-86.17334	7	0	P				
28	41.04453	-86.18439	2	0	P				
29	41.04501	-86.17950	3	1	P		1		
30	41.04610	-86.18044	2	0	P				
31	41.04595	-86.17508	5	0	P				
32	41.04719	-86.18302	7	0					
33	41.04733	-86.17958	4	0	P				
34	41.04847	-86.18036	4	0	P				
35	41.04945	-86.18648	5	0	P				
36	41.04946	-86.18499	3	1	P	1			
37	41.05072	-86.18577	7	0	P				
38	41.05066	-86.18387	4	0	P				
39	41.05078	-86.18034	6	0	P				
40	41.05064	-86.17142	12	0					
41	41.05074	-86.16973	4	0	P				
42	41.05179	-86.18995	4	0	P				
43	41.05177	-86.18490	6	0	P				
44	41.05178	-86.18318	3	1	P	1			
45	41.05181	-86.18140	4	1	P		1		
46	41.05181	-86.17945	6	0					
47	41.05184	-86.17769	4	0	P				
48	41.05192	-86.17586	7	0					
49	41.05190	-86.17243	8	0					
50	41.05202	-86.17079	6	0	P				
51	41.05301	-86.18918	5	0					
52	41.05298	-86.18740	4	3		3			
53	41.05300	-86.18563	4	1		1			
54	41.05302	-86.18388	5	1	P	1			
55	41.05293	-86.17865	4	1	P	1			
56	41.05296	-86.17679	3	0	P				
57	41.05291	-86.16979	6	0					
58	41.05430	-86.19016	5	0					
59	41.05415	-86.18856	7	0					
60	41.05407	-86.18675	4	0					
61	41.05424	-86.18489	4	1		1			
62	41.05413	-86.17949	5	0	P				
63	41.05412	-86.17764	4	0	P				
64	41.05425	-86.17063	5	0					

65	41.05540	-86.19107	4	1	P	1			
66	41.05523	-86.18561	4	3		3			
67	41.05542	-86.18407	5	0					
68	41.05529	-86.17871	5	0					
69	41.05532	-86.17694	4	1	P		1		
70	41.05537	-86.17161	6	0					
71	41.05542	-86.16978	5	0					
72	41.05641	-86.19216	3	1	P	1			
73	41.05646	-86.19026	4	1	P	1			
74	41.05643	-86.18845	5	1		1			
75	41.05644	-86.18676	8	0					
76	41.05652	-86.17782	6	0					
77	41.05655	-86.17593	5	0					
78	41.05659	-86.17067	4	0					
79	41.05756	-86.19298	3	1	P	1			
80	41.05757	-86.19115	4	1	P	1			
81	41.05761	-86.18916	5	1	P	1			
82	41.05770	-86.18755	4	1		1			
83	41.05762	-86.18570	5	1		1			
84	41.05771	-86.18401	4	0					
85	41.05782	-86.17862	6	0					
86	41.05776	-86.17679	6	0					
87	41.05813	-86.17139	5	0					
88	41.05883	-86.19191	3	1	P	1			
89	41.05858	-86.19007	4	1	P	1			
90	41.05882	-86.18841	4	1	P	1			
91	41.05880	-86.18665	4	0	P				
92	41.05877	-86.18495	5	0					
93	41.05881	-86.18324	5	0					
94	41.05876	-86.18144	5	1			1		
95	41.05882	-86.17971	6	0					
96	41.05880	-86.17796	5	0					
97	41.05890	-86.17607	5	0					
98	41.05893	-86.17439	7	0					
99	41.05894	-86.17246	5	0					
100	41.05986	-86.19466	1	1		1			
101	41.05994	-86.19282	3	5		5			
102	41.05995	-86.18944	6	0	P				
103	41.06005	-86.18215	5	0	P				
104	41.05995	-86.18052	5	0	P				
105	41.05998	-86.17874	5	0	P				
106	41.06002	-86.17694	4	0	P				
107	41.05997	-86.17505	5	0					
108	41.05986	-86.17323	4	1	P				1
109	41.06092	-86.18498	3	1	P	1			
110	41.06113	-86.18318	2	1	P	1			
111	41.06108	-86.18132	4	1	P	1			
112	41.06111	-86.17951	4	0	P				
113	41.05424	-86.1773	4	1	P	1			
DK 1	41.06071	-86.19449	6	1	P	1			
DK 2	41.05927	-86.19456	4	1	P	1			
DK 3	41.06106	-86.18397	2	1	P	1			
DK 4	41.06179	-86.18296	3	1	P	1			
DK 5	41.05555	-86.19245	3	3		3			
DK 6	41.04855	-86.18697	3	1	P	1			
DK 7	41.04933	-86.18957	4	0					
DK 8	41.04548	-86.18241	12	0					
DK 9	41.04945	-86.17431	16	0					
DK 10	41.0502	-86.17181	4	1	P	1			
DNR 1	41.04877	-86.18804	5	0	P				

LARE Tier 2 Survey Raw Data 8/31/2011

WPT	Lat	Long	Depth	Rake score	Fil. Algae	Chara	Sago pondweed	Coontail	Bladderwort
1	41.06090	-86.17843	4	1	P			1	
2	41.06142	-86.18021	4	0	P				
3	41.05924	-86.18810	3	0	P				
4	41.05921	-86.18875	3	0	P				
5	41.05530	-86.17996	6	0					
6	41.05695	-86.18784	5	0					
7	41.05406	-86.17718	3	0	P				
8	41.04456	-86.18524	4	1					1
9	41.06030	-86.19520	1	0	P				
10	41.06090	-86.19662	1	0	P				
11	41.03551	-86.16812	1	5			1	3	
12	41.03916	-86.17678	2	0	P				
13	41.03912	-86.17497	2	1	P		1		
14	41.03920	-86.17338	3	3	P		3		
15	41.03875	-86.17026	4	5			1	5	
16	41.04039	-86.17759	4	0	P				
17	41.04025	-86.17583	6	0	P				
18	41.04029	-86.17409	5	0	P				
19	41.04030	-86.17235	4	0	P				
20	41.04031	-86.17057	4	5	P			5	
22	41.04149	-86.17858	3	0	P				
23	41.04152	-86.17311	4	1	P			1	
24	41.04280	-86.17948	3	0	P				
26	41.04377	-86.18035	4	0	P				
27	41.04377	-86.17334	6	1	P			1	
28	41.04453	-86.18439	0.5	1					1
29	41.04501	-86.17950	3	1	P		1		
30	41.04610	-86.18044	1	0	P				
31	41.04595	-86.17508	3	0	P				
32	41.04719	-86.18302	7	0					
33	41.04733	-86.17958	2	0	P				
34	41.04847	-86.18036	4	0	P				
35	41.04945	-86.18648	7	1				1	
36	41.04946	-86.18499	3	0	P				
37	41.05072	-86.18577	6	0	P				
38	41.05066	-86.18387	5	0	P				
39	41.05078	-86.18034	6	0	P				
40	41.05064	-86.17142	12	0	P				
41	41.05074	-86.16973	4	0	P				
42	41.05179	-86.18995	4	0	P				
43	41.05177	-86.18490	6	0					
44	41.05178	-86.18318	4	0	P				
45	41.05181	-86.18140	5	0	P				
46	41.05181	-86.17945	7	0	P				
47	41.05184	-86.17769	7	0	P				
48	41.05192	-86.17586	8	0	P				
49	41.05190	-86.17243	7	0	P				
50	41.05202	-86.17079	5	1	P			1	
51	41.05301	-86.18918	5	0	P				
52	41.05298	-86.18740	4	1				1	
53	41.05300	-86.18563	5	1				1	
54	41.05302	-86.18388	5	0					
55	41.05293	-86.17865	5	0	P				
56	41.05296	-86.17679	3	0	P				
57	41.05291	-86.16979	5	1	P			1	
58	41.05430	-86.19016	5	0					
59	41.05415	-86.18856	5	0					
60	41.05407	-86.18675	6	0					
61	41.05424	-86.18489	5	0					
62	41.05413	-86.17949	5	0					
63	41.05412	-86.17764	4	0	P				
64	41.05425	-86.17063	5	0					

65	41.05540	-86.19107	4	0	P			
66	41.05523	-86.18561	5	1				1
67	41.05542	-86.18407	5	0				
68	41.05529	-86.17871	6	0				
69	41.05532	-86.17694	5	0	P			
70	41.05537	-86.17161	6	0	P			
71	41.05542	-86.16978	6	0	P			
72	41.05641	-86.19216	1	0	P			
73	41.05646	-86.19026	5	0	P			
74	41.05643	-86.18845	6	0				
75	41.05644	-86.18676	8	0				
76	41.05652	-86.17782	7	0				
77	41.05655	-86.17593	6	0	P			
78	41.05659	-86.17067	4	0	P			
79	41.05756	-86.19298	1	0	P			
80	41.05757	-86.19115	4	0	P			
81	41.05761	-86.18916	5	0	P			
82	41.05770	-86.18755	5	1	P			1
83	41.05762	-86.18570	5	0				
84	41.05771	-86.18401	5	0				
85	41.05782	-86.17862	6	0	P			
86	41.05776	-86.17679	7	0	P			
87	41.05813	-86.17139	4	0	P			
88	41.05883	-86.19191	4	0	P			
89	41.05858	-86.19007	4	0	P			
90	41.05882	-86.18841	4	0	P			
91	41.05880	-86.18665	4	0	P			
92	41.05877	-86.18495	5	1	P	1		
93	41.05881	-86.18324	5	0				
94	41.05876	-86.18144	5	0				
95	41.05882	-86.17971	5	0				
96	41.05880	-86.17796	5	0	P			
97	41.05890	-86.17607	6	0	P			
98	41.05893	-86.17439	8	0	P			
99	41.05894	-86.17246	5	0	P			
100	41.05986	-86.19466	1	0	P			
101	41.05994	-86.19282	3	0	P			
102	41.05995	-86.18944	6	0	P			
103	41.06005	-86.18215	4	0	P			
104	41.05995	-86.18052	5	0	P			
105	41.05998	-86.17874	5	0	P			
106	41.06002	-86.17694	5	0	P			
107	41.05997	-86.17505	5	0	P			
108	41.05986	-86.17323	3	1	P			1
109	41.06092	-86.18498	3	0				
110	41.06113	-86.18318	3	0	P			
111	41.06108	-86.18132	4	0	P			
112	41.06111	-86.17951	4	0	P			
113	41.05424	-86.1773	4	0	P			
DK 1	41.06071	-86.19449	4	0	P			
DK 2	41.05927	-86.19456	5	0	P			
DK 3	41.06106	-86.18397	2	0	P			
DK 4	41.06179	-86.18296	3	0	P			
DK 5	41.05555	-86.19245	3	0	P			
DK 6	41.04855	-86.18697	3	0	P			
DK 7	41.04933	-86.18957	4	0	P			
DK 8	41.04548	-86.18241	11	0	P			
DK 9	41.04945	-86.17431	12	0	P			
DK 10	41.0502	-86.17181	4	0	P			
DNR 1	41.04877	-86.18804	6	0	P			

DRAFT – Subject to Revision FasTEST Collection Vegetation Monitoring Data Sheets

May 16 – October 10, 2011

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: 5/16/2011

Date of Treatment: 5/13/2011

Gauge Reading: gauge gone

Site	Species	Injury	Cover	Growth	Other	Photos	Secchi	Depth	H2OTemp	D O2	Notes
1	No plants						5.9		61.6		depth 6.5 feet
2	No plants						5.0	surface	60.4	8.70	depth 30 feet
								1m	60.5	8.65	
								2m	60.6	8.56	
								3m	60.4	8.21	
								4m	60.2	8.15	
								5m	60.0	7.20	
								6m	59.8	7.11	
								7m	58.8	6.74	
								8m	58.1	5.61	
								9m	53.4	1.16	
								10m	51.9	0.27	
3	No plants						Bottom Visible		61.7		depth 5 feet
4	No plants						Bottom Visible		61.7		depth 5 feet
5	No plants						5.4		62.7		depth 18 feet
6	Algae						Bottom Visible		63.0		depth 4 feet
7	No plants						5.0	surface	8.47	62.30	depth 39 feet
								1m	7.40	62.30	
								2m	8.38	62.30	
								3m	8.35	62.40	
								4m	8.30	62.40	
								5m	8.29	62.40	
								6m	7.60	61.20	
								7m	6.83	60.00	
								8m	6.41	58.90	
								9m	5.43	57.90	
								10m	1.74	54.80	
								11m	--	--	
9	Chara	2	5	3			Bottom Visible		60.9		depth 5 feet
	Algae										
											Summary
											Weather: Sunny,windy Temp in low 60's
											water temp range: 60.4 - 63.0 degrees F
											Secchi Range: 5.0 - 5.9 Ft
											Chara collected on rake
											Rake samples taken at each shallow FasTEST Site
											No Hydrilla found

Lake Manitou Sample Collection

Injury:		Cover:		Growth:		Other Indicators:	
1	Healthy	1	80-100	1	From Apical Tips or Nodes	T	Topped out Vegetation
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
4	Severe Injury	4	20-39	4	From Turions or Tubers	M	Mechanical Damage
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

Biologist Name:
David Keister
Aquatic Weed Control

Survey Date: 6/13/2011

Date of Treatment: 5/13/2011

Gauge Reading: gauge gone

Site	Species	Injury	Cover	Growth	Other	Photos	Secchi	Depth	H2OTemp	D O2	Notes
1	Coontail	2	5	1			bottom visible		75.1		depth 6.5 feet
	Chara	2	5	3							
	Algae							surface	75.1	8.39	depth 30 feet
								1m	74.8	8.34	
2	no plants						4.0	2m	73.6	7.93	
								3m	73.1	7.33	
								4m	72.7	6.52	
								5m	71.1	3.70	
								6m	63.6	0.27	
								7m	61.7	0.24	
								8m	59.6	0.21	
								9m	57.0	0.19	
								10m	55.4	0.17	
3	no plants						4.8		75.2		depth 5 feet
4	Chara	2	5	3			bottom visible		74.9		depth 5 feet
	Algae										
5	no plants						4.8		75.9		depth 18 feet
6	Algae						4.3		75.6		depth 4 feet
7	no plants						4.3	surface	76.7	9.74	depth 39 feet
								1m	75.2	9.93	
								2m	74.8	9.04	
								3m	74.2	8.01	
								4m	73.4	6.62	
								5m	72.7	6.27	
								6m	70.5	2.87	
								7m	63.9	0.28	
								8m	61.5	0.23	
								9m	59.5	0.19	
								10m	57.8	0.17	
								11m			
9	Chara	2	5	3			bottom visible		74.2		depth 5 feet
	Algae										
											Summary
											Weather: sunny, tmep in lower 70's
											water temp range degrees F: 74.9-76.7
											Secchi Range: 4.0-4.8
											chara and coontail collected on rake. Curly leaf and sago observed in south end of lake.
											Rake samples taken at each shallow FasTEST Site
											No Hydrilla found

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: 7/6/2011

Date of Treatment: 5/13/2011

Gauge Reading: gauge gone

Site	Species	Injury	Cover	Growth	Other	Photos	Secchi	Depth	H2OTemp	D O2	Notes
1	No Plants						3.1		82.3		depth 6.5 feet
2	No Plants						2.7	surface	83.0	12.56	depth 30 feet
								1m	82.3	12.72	
								2m	80.7	10.82	
								3m	78.7	8.10	
								4m	75.4	2.85	
								5m	72.3	0.28	
								6m	68.8	0.23	
								7m	66.1	0.20	
								8m	61.6	0.17	
								9m	58.7	0.15	
								10m	58.7	0.13	
3	Algae present						3.1		83.9		depth 5 feet
4	Algae present						2.3		82.1		depth 5 feet
5							3.1		85.1		depth 18 feet
6	Algae present						2.9		84.5		depth 4 feet
7	No plants						2.8	surface	84.3	14.10	depth 39 feet
								1m	82.3	14.76	
								2m	80.6	11.19	
								3m	78.9	7.43	
								4m	77.6	5.28	
								5m	75.3	2.85	
								6m	72.6	0.31	
								7m	69.7	0.24	
								8m	66.4	0.19	
								9m	62.6	0.17	
								10m	60.2	0.16	
								11m			
9							2.6		82.8		depth 5 feet
	Chara	2	5	3							
	Algae present										**Summary**
											Weather:sunny, calm, upper 80's
											water temp range degrees F 82.1 - 85.1
											Secchi Range:2.3 - 3.1
											planktonic algae getting heavy and water clarity decreasing
											Rake samples taken at each shallow FasTEST Site
											No Hydrilla found

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: 7/18/2011

Date of Treatment: 5/13/2011

Gauge Reading: gauge gone

Site	Species	Injury	Cover	Growth	Other	Photos	Secchi	Depth	H2OTemp	D O2	Notes
1	no plants						2.4	84.9			depth 6.5 feet
2	no plants						2.0	surface	85.4	11.36	depth 30 feet
								1m	85.0	11.37	
								2m	84.3	10.34	
								3m	81.1	6.85	
								4m	77.9	0.90	
								5m	73.3	0.24	
								6m	69.6	0.20	
								7m	65.8	0.17	
								8m	61.6	0.15	
								9m	59.3	0.14	
								10m	56.5	0.14	
3	algae present						2.1	84			depth 5 feet
4	algae present						1.7	85.3			depth 5 feet
5	no plants						2.1	86.3			depth 18 feet
6	agae present						2.7	84.9			depth 4 feet
7	no plants						2.7	surface	85.9	11.62	depth 39 feet
								1m	85.4	11.74	
								2m	84.7	11.56	
								3m	80.7	6.75	
								4m	78.8	1.04	
								5m	76.8	0.25	
								6m	74.2	0.20	
								7m	69.8	0.17	
								8m	66.2	0.15	
								9m	63.0	0.14	
								10m	60.6	0.13	
								11m			
9	algae present						1.8				depth 5 feet
	chara	2	5	3							
											Summary
											Weather: hot, low 90's, slight breeze
											water temp range degrees F 84.0 - 86.3
											Secchi Range: 1.7 -2.8
											planktonic algae heavy. Secchi disk readings reduced
											Rake samples taken at each shallow FasTEST Site
											No Hydrilla found

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: 8/1/2011 (8/1/2011) Date of Treatment: 5/13/2011 Gauge Reading: gauge gone

Site	Species	Injury	Cover	Growth	Other	Photos	Secchi	Depth	H2OTemp	D O2	Notes
1	no plants						2.2		85.2		depth 6.5 feet
2	no plants						2.6	surface	85.5	8.73	depth 30 feet
								1m	85.3	8.65	
								2m	84.6	8.14	
								3m	82.4	5.65	
								4m	79.7	0.43	
								5m	75.3	0.23	
								6m	70.5	0.18	
								7m	64.5	0.12	
								8m	61.3	0.10	
								9m	59.1	0.10	
								10m	57.1	0.10	
3	Algae present						2.3		85.6		depth 5 feet
4	algae present						2.0		84.3		depth 5 feet
5	no plants						2.1		83.7		depth 18 feet
6	Algae present						3.1		85.0		depth 4 feet
7	no plants						3.3	surface	85.9	9.06	depth 39 feet
								1m	85.7	9.11	
								2m	85.2	9.04	
								3m	84.0	7.31	
								4m	81.7	3.60	
								5m	79.7	0.21	
								6m	74.4	0.16	
								7m	70.5	0.14	
								8m	67.4	0.13	
								9m	65.1	0.12	
								10m	62.0	0.11	
								11m			
9	algae present						2.0		85.3		depth 5 feet
											Summary
											Weather: hot, sunny
											water temp range degrees F 84.3 - 85.9
											Secchi Range: 2.0 - 3.3
											coontail beginning to mat at sound end of the lake (photo)
											Rake samples taken at each shallow FasTEST Site
											No Hydrilla found

Lake Manitou Sample Collection

Injury:		Cover:		Growth:		Other Indicators:	
1	Healthy	1	80-100	1	From Apical Tips or Nodes	T	Topped out Vegetation
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
4	Severe Injury	4	20-39	4	From Turions or Tubers	M	Mechanical Damage
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

Biologist Name:

David Keister
Aquatic Weed Control

Survey Date: 8/15/2011

Date of Treatment: 5/13/2011

Gauge Reading: gauge gone

Site	Species	Injury	Cover	Growth	Other	Photos	Secchi	Depth	H2OTemp	D O2	Notes
1	algae present						3.6		77.4		depth 6.5 feet
2	No plants						3.8	surface	77.5	7.46	depth 30 feet
								1m	77.3	7.46	
								2m	77.1	7.48	
								3m	76.6	7.33	
								4m	76.7	7.19	
								5m	76.0	4.85	
								6m	73.7	1.50	
								7m	64.8	0.19	
								8m	61.5	0.18	
								9m	59.7	0.17	
								10m	57.7	0.16	
3	algae						3.5		77.0		depth 5 feet
4	No plants						3.2		77.0		depth 5 feet
5											depth 18 feet
6	algae						3.2		77.0		depth 4 feet
7	No plants						4.1	surface	77.7	8.56	depth 39 feet
								1m	77.9	8.50	
								2m	77.7	8.20	
								3m	77.5	7.65	
								4m	77.1	7.15	
								5m	77.1	7.05	
								6m	76.5	5.70	
								7m	74.9	4.53	
								8m	67.7	0.24	
								9m	63.5	0.19	
								10m	61.2	0.17	
								11m			
9	algae						2.8		76.5		depth 5 feet
											Summary
											Weather: sunny, breezy, temp in low 80';s
											water temp range degrees F 76.5 - 77.4
											Secchi Range: 2.8 - 4.1
											water clarity low, very little vegetation with the exception of sago and coontail at south end
											Rake samples taken at each shallow FasTEST Site
											No Hydrilla found

Lake Manitou Sample Collection

Injury:		Cover:		Growth:		Other Indicators:	
1	Healthy	1	80-100	1	From Apical Tips or Nodes	T	Topped out Vegetation
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
4	Severe Injury	4	20-39	4	From Turions or Tubers	M	Mechanical Damage
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

Biologist Name:
David Keister
Aquatic Weed Control

Survey Date: 8/29/2011

Date of Treatment: 5/13/2011

Gauge Reading: gauge gone

Site	Species	Injury	Cover	Growth	Other	Photos	Secchi	Depth	H2OTemp	D O2	Notes
1	No plants						3.1		75.8		depth 6.5 feet
2	No Plants						4.2	surface	76.2	8.00	depth 30 feet
								1m	76.1	7.94	
								2m	76.0	7.91	
								3m	75.4	7.37	
								4m	75.3	7.25	
								5m	75.1	7.26	
								6m	74.7	7.32	
								7m	66.5	0.30	
								8m	62.2	0.25	
								9m	59.6	0.22	
								10m	57.6	0.19	
3	Algae						3.9		74.6		depth 5 feet
4	Chara	2	5	3			2.8		75.0		depth 5 feet
5	No Plants						2.8		76.6		depth 18 feet
6	Algae						3.1		75.6		depth 4 feet
7	No Plants						3.8	surface	76.2	8.00	depth 39 feet
								1m	76.1	7.94	
								2m	76.0	7.91	
								3m	75.4	7.37	
								4m	75.3	7.25	
								5m	75.1	7.26	
								6m	74.7	7.32	
								7m	66.5	0.30	
								8m	62.2	0.25	
								9m	59.6	0.22	
								10m	57.6	0.19	
								11m			
9	Chara	2	5	3			2.9		74.8		depth 5 feet
											Summary
											Weather: sunny, temp in upper 70's
											water temp range degrees F 74.6 - 76.2
											Secchi Range(ft): 2.8- 4.2
											coontail, sago, and waterstargrass all observed at south end of lake. Chara found on rake.
											Rake samples taken at each shallow FasTEST Site
											No Hydrilla found

Lake Manitou Sample Collection

Injury:		Cover:		Growth:		Other Indicators:	
1	Healthy	1	80-100	1	From Apical Tips or Nodes	T	Topped out Vegetation
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
4	Severe Injury	4	20-39	4	From Turions or Tubers	M	Mechanical Damage
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

Biologist Name:
David Keister
Aquatic Weed Control

Survey Date: 9/12/2011

Date of Treatment: 5/13/2011

Gauge Reading: gauge gone

Site	Species	Injury	Cover	Growth	Other	Photos	Secchi	Depth	H2OTemp	D O2	Notes
1	no plants						4.1		73.5		depth 6.5 feet
2	no plants						4.5	surface	73.8	10.87	depth 30 feet
								1m	72.5	11.12	
								2m	70.5	9.95	
								3m	68.9	9.34	
								4m	67.4	6.36	
								5m	67.1	5.83	
								6m	66.9	5.24	
								7m	66.7	4.47	
								8m	66.4	3.77	
								9m	66.1	3.06	
								10m	62.5	0.22	
3	Algae present						3.5		71.7		depth 5 feet
4	chara	2	5	3			3.6		71.6		depth 5 feet
5	no plants						4.5		73.6		depth 18 feet
6	Algae present						bottom visible		72.3		depth 4 feet
7	no						4.9	surface	72.9	11.44	depth 39 feet
								1m	72.3	11.62	
								2m	71.0	11.00	
								3m	69.0	8.18	
								4m	68.5	7.20	
								5m	68.1	6.72	
								6m	67.9	5.29	
								7m	62.8	5.03	
								8m	66.7	4.88	
								9m	66.8	2.71	
								10m	65.9	0.25	
								11m			
9	Algae present						3.1		72.6		depth 5 feet
											Summary
											Weather: sunny, temp in upper 70's
											water temp range degrees F 71.6 - 73.8
											Secchi Range: 3.1 -4.9
											very little vegetation, much less stratification, no water going over the dam at outlet.
											Rake samples taken at each shallow FasTEST Site
											No Hydrilla found

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: 9/26/2011

Date of Treatment: 5/13/2011

Gauge Reading: gauge gone

Site	Species	Injury	Cover	Growth	Other	Photos	Secchi	Depth	H2OTemp	D O2	Notes
1	no plants						3.6		64.1		depth 6.5 feet
2	no plants						4.2	surface	63.4	9.39	depth 30 feet
								1m	62.4	9.35	
								2m	63.4	9.37	
								3m	63.4	9.41	
								4m	63.2	9.16	
								5m	63.2	9.12	
								6m	63.1	8.98	
								7m	63.1	8.73	
								8m	63.1	7.91	
								9m	63.2	0.35	
								10m	63.2	0.35	
3	Algae present						3.3		65.2		depth 5 feet
4	Algae						3.0		63.9		depth 5 feet
5	no plants						3.9		63.7		depth 18 feet
6	coontail	3	5	1			3.8		64.4		depth 4 feet
7	no plants						4.1	surface	64.3	8.26	depth 39 feet
								1m	64.3	8.24	
								2m	64.3	8.22	
								3m	64.2	8.11	
								4m	64.2	8.03	
								5m	64.1	7.91	
								6m	64.1	7.73	
								7m	63.9	7.60	
								8m	63.7	7.52	
								9m	63.3	5.97	
								10m	62.9	4.62	
								11m			
9	Algae present						2.9		64.3		depth 5 feet
											Summary
											Weather: Partly cloudy, windy, upper 60's
											water temp range degrees F 63.4-65.2
											Secchi Range: 2.9-4.2
											Lots of water flowing over dam, very little vegetation
											Rake samples taken at each shallow FasTEST Site
											No Hydrilla found

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: 10/10/2011

Date of Treatment: 5/13/2011

Gauge Reading: gauge gone

Site	Species	Injury	Cover	Growth	Other	Photos	Secchi	Depth	H2OTemp	D O2	Notes
1	no plants						3.5		65.8		depth 6.5 feet
2	no plants						4.0	surface	66.2	13.79	depth 30 feet
								1m	66.1	13.83	
								2m	65.8	13.49	
								3m	60	10.6	
								4m	59	8.35	
								5m	58.5	6.86	
								6m	58.1	6.39	
								7m	57.9	5.82	
								8m	57.8	4.95	
								9m	57.6	2.99	
								10m	57.6	2.74	
3	algae present						3.4		65.3		depth 5 feet
4	algae present						2.9		66.4		depth 5 feet
5	no plants						4.0		65.4		depth 18 feet
6	algae present						4.0		65.3		depth 4 feet
7	no plants						4.0	surface	64.6		depth 39 feet
								1m	64.6		
								2m	64.4		
								3m	61.2		
								4m	59.5		
								5m	59.2		
								6m	59.0		
								7m	58.7		
								8m	58.5		
								9m	58.3		
								10m	58.1		
								11m			
9	coontail	3	5	1			2.9		66.4		depth 5 feet
	algae present										
											Summary
											Weather: Partly cloudy, breezy, temp in low 70's
											water temp range degrees F 64.6 - 66.4
											Secchi Range: 2.9-4.0
											coontail collected at sample site 9
											Rake samples taken at each shallow FasTEST Site
											No Hydrilla found