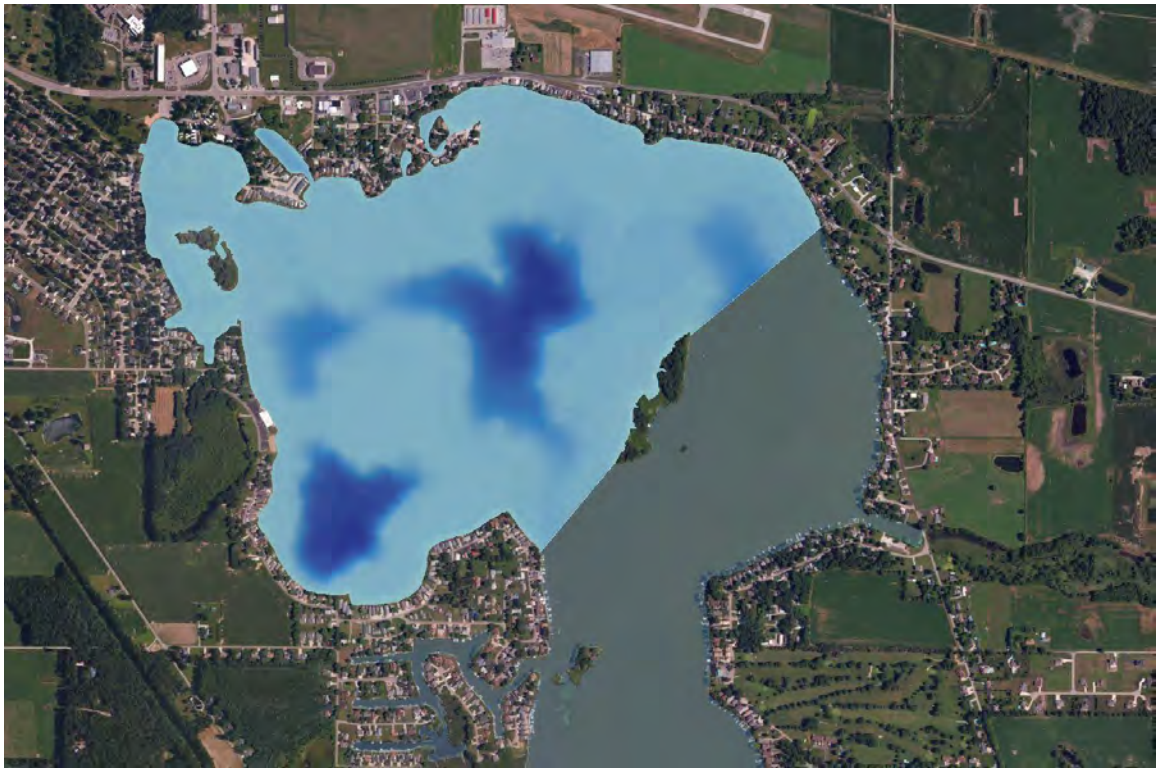

2014 Lake Manitou Aquatic Vegetation Management Plan Update
Fulton County, IN
February 17, 2015

Prepared for:
Indiana Department of Natural Resources
402 W. Washington St. Rm. W273
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Prepared by:
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Executive Summary

SePRO Corporation was contracted by the Indiana Department of Natural Resources (IDNR) to update the 2005 Lake Manitou long-term integrated aquatic vegetation management plan. SePRO completed updates in 2007-2013 following Sonar treatments for control of hydrilla (*Hydrilla verticillata*) (SePRO 2008-2014). Items covered in this update include the 2014 sampling results and discussion, a review of the 2014 vegetation management effort, and updates to the budget and action plans.

The focus of the original 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. This was the first confirmed case of hydrilla in the Midwest. IDNR took quick action by closing all ramps on the lake and treated hydrilla beds with 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 teamed with ReMetrix LLC (Carmel, IN), Aquatic Control, Inc. (Seymour, IN) and Aquatic Weed Control, Inc. (Syracuse, IN) to complete the project. Fluridone treatments, with multiple formulations of Sonar® Aquatic Herbicide (a.i., fluridone), were initiated in 2007 with the objective of maintaining > 6 ppb for 180 days. 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. 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. No hydrilla was detected during either 2010 Tier 2 survey; however, supplemental dive surveys conducted June 9th 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 used in 2011. The initial 2011 application was completed on May 13th with a combination of Sonar AS and Sonar PR. Three bump treatments were required in 2011. No hydrilla was detected during either Tier 2 survey. Hydrilla was detected at three locations during a dive survey of 140 sites on June 12th. Five tuber sampling stations were sampled in the fall of 2011. Three of the six original permanent tuber sampling stations along with two new sampling stations were sampled on September 26th. Only two sprouted tubers were collected.

Control efforts in 2012 were similar to 2011. Due to a very warm late winter/early spring, the initial application was completed on March 29th. Sonar AS and Sonar PR were both applied and three bump applications were completed. Tuber sampling was not performed in the fall of 2012 based on mutual agreement with IDNR that tuber depletion had reached a point where tuber sampling was highly inefficient to detect hydrilla presence. Assessment efforts were shifted to an expanded 1.5-day mid-June 2012 dive survey that focused on areas of hydrilla detected during the June 2011 survey. 35 survey blocks distributed across 58 acres of lake bottom were assessed by divers, and hydrilla was detected at 7 discrete locations in 5 of the survey blocks.

In 2013, in an effort to allow for increased native growth in the southern portion of the lake, only the northern 75% of the lake was actively treated per a strategy developed in early 2013 meetings with IDNR. Sonar AS and Sonar PR were again the herbicide formulations used for 2013 hydrilla management. No hydrilla was found during either Tier 2 survey. A dive survey was completed on June 18 & 19. The survey located vegetative hydrilla (just four total plants) at three locations: two along the north shore and one location west of Big Island.

Control efforts in 2014 were further modified to focus management to the northern end of the lake. An initial application with Sonar AS and Sonar PR was completed on May 21st with AS applied to only 423 of the lake's 809 total acres. Bump applications were completed on July 14th and August 21st with Sonar PR. Sonar PR was applied to areas where hydrilla had historically been documented with zone-specific increases in rates for 2014 to minimize use of Sonar AS and overall lake-wide concentrations. 2014 had the latest start date of any of the annual eradication treatments with Sonar. Due to the greater focus on pellet use, the 2014 program also had the fewest amount of bumps required since the inception of the eradication program. A dive survey was completed on June 18th and 19th. The survey was unable to detect

any vegetative hydrilla. Tier 2 surveys completed on June 26th and August 27th failed to detect hydrilla and found increases in native diversity and abundance.

Control efforts have brought the project very close to its ultimate goal of hydrilla eradication. Nine years of management (eight cycles using Sonar) 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. 2014 marked the first year since the start of the eradication program where hydrilla was not detected in the lake through any survey effort. Adaptive modifications to assessment protocols for vegetative hydrilla detection and quantification, and modified management designs have allowed the final eradication objective to very nearly be attained while seeking to promote native plant re-establishment and spread. Preliminary discussions with IDNR suggest that a pellet-focused, season-long Sonar treatment program identical to 2014 be implemented in 2015 along with an identical diver assessment in mid-June. If hydrilla is again not detected, it is likely that large-scale eradication treatment with Sonar in 2016 would not be planned, but diver assessment would continue for several years to insure hydrilla eradication was achieved.

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 identical to 2014 focused on use of Sonar PR pellets in areas with original hydrilla detection with seasonal flexibility to shift management strategy based on monitoring and revised quantitative assessment results throughout the coming use season. Continue to exclude upper (southern) 48% of lake from active treatment (including AS application) in an effort to enhance native growth.

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

3. Continue with the hydrilla detection surveys using divers. The same exact design of dive survey would be utilized in 2015 and in any subsequent years. At this point, the design appears optimized for hydrilla detection in areas of remaining infestation and maintenance of the same design will assist comparing recent and future datasets.

4. There was no Manitou public ramp closure in 2014, and there continues to be no need for such closures in 2015. The management actions taken by IDNR to eradicate and isolate hydrilla to Lake Manitou have, without question, effectively eliminated the potential for spread to other waters in Indiana and the Midwest. On-going dialogue with other state DNRs and resource managers in the region is also encouraged to have regional response plans ready and updated to address new hydrilla infestations should they occur.

5. Amidst a variety of critical invasive aquatic species issues in the region including Asian carp, 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 the Great Lakes Restoration Initiative. Aquatic Control, Inc., Aquatic Weed Control, Inc., ReMetrix LLC, and SePRO Corporation completed the fieldwork, data processing, and map generation. Special thanks to Mr. Eric Fischer and Mr. Doug Keller from the IDNR for their assistance on design and implementation of 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. J.T. Gravelie and Mr. Doug Henderson 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.

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Table of Contents

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List of Figures

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List of Tables

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List of Charts

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1.0 INTRODUCTION

This report was created in order to update the Lake Manitou Aquatic Vegetation Management Plan. In 2004, the Lake Manitou Association was awarded a grant through the Lake and River Enhancement (LARE) program to complete the original Lake Manitou Aquatic Vegetation Management Plan. Aquatic Weed Control completed the original plan in March 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 2014 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 each year from 2008 through 2013 (SePRO 2008, 2009, 2010, 2011, 2012,2013). Items covered in this 2014 update include the 2014 sampling results, a review of the 2014 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 2005-2014.

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)
2012	Hydrilla	809 (whole lake)	Fluridone (Sonar AS & Sonar PR)
2013	Hydrilla	592 (partial lake)	Fluridone (Sonar AS & Sonar PR)
2014	Hydrilla	423 (partial 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 by July 1st of each year. The ramps were left open during the 2011 - 2014 seasons.

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

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

Location of Resources: http://www.northeastans.org/resources.html

Summary ppt: http://www.northeastans.org/docs/hydrillalitsearch12.14.12.pdf

Actual review: http://www.northeastans.org/docs/hydrillalitsearch12.31.12.pdf

Figure 1.0.2. Photograph examples of dense, surface-matted hydrilla.

Eradication of hydrilla continues to be the primary goal of vegetation management in Lake Manitou. 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 completed through physical means (filling small pond); recently hydrilla was identified in New York, Idaho, Kansas, and Missouri with aggressive control programs initiated. Many of these programs have, at a minimum, minimized the potential for further spread of hydrilla within the state by keeping the population at the lowest possible level and decreasing vegetative production.

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

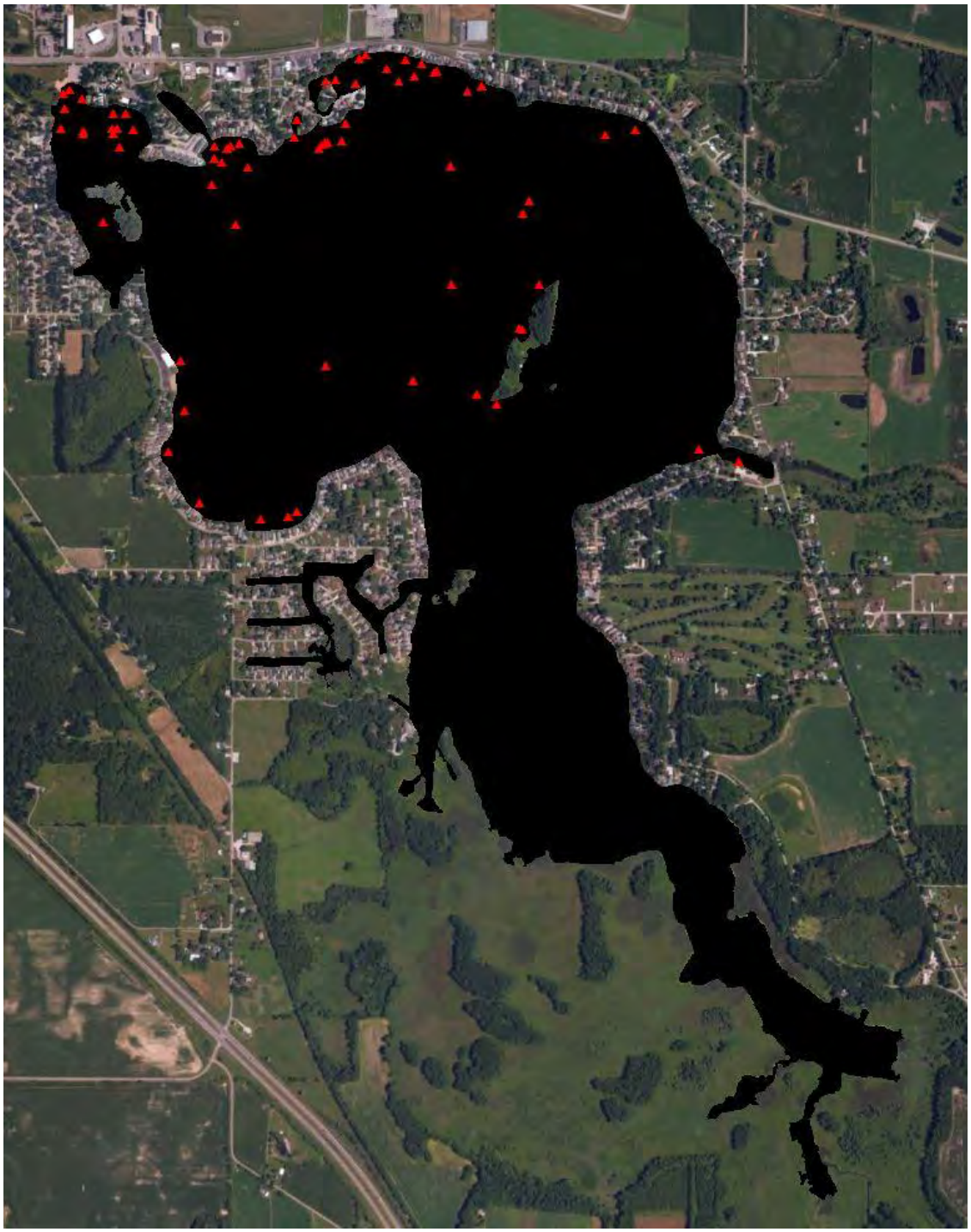

Figure 1.0.3. Lake Manitou hydrilla sightings 2006-2014. (Includes all sightings recorded by the project team and IDNR.)

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. Sonar® Aquatic Herbicide (a.i. 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 herbicide application was completed on May 14th as a combination of Sonar AS and PR. Thirty-six gallons of Sonar AS and 1,010 pounds of Sonar PR were strategically applied to the lake. 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 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 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 initial 2011 application was completed on May 13th with a combination of Sonar AS and Sonar PR. Three bump treatments were required in 2011. No hydrilla was detected during either Tier 2 survey. Hydrilla was detected at three locations during a dive survey of 140 sites on June 12th. Five tuber sampling stations were sampled in the fall of 2011. Three of the six original permanent tuber sampling stations along with two new sampling stations were sampled on September 26th. Only two spouted tubers were collected.

Control efforts in 2012 were similar to 2011. Due to a very warm late winter/early spring, the initial application was completed on March 29th. Sonar AS and Sonar PR were both initially applied and three bump applications were completed. Tuber sampling was not performed in the fall of 2012 based on mutual agreement with IDNR that tuber depletion had reached a point where tuber sampling was highly inefficient to detect hydrilla presence. Assessment efforts were shifted to an expanded 1.5-day mid-June 2012 dive survey that focused on areas of hydrilla detected during the June 2011 survey. 35 survey blocks distributed across 58 acres of lake bottom were assessed by divers, and hydrilla was detected at 7 discrete locations in 5 of the survey blocks.

In 2013, in an effort to allow for increased native growth in the southern portion of the lake, only the northern 75% of the lake was actively treated per a strategy developed in early 2013 meetings with IDNR. Sonar AS and Sonar PR were again the herbicide formulations used for 2013 hydrilla management. No hydrilla was found during either Tier 2 survey. A dive survey was completed on June 18 & 19. The survey located vegetative hydrilla (just four total plants) at three locations: two along the north shore and one location west of Big Island.

The following sections will detail the progress of the 2014 hydrilla eradication program along with future Lake Manitou plant management plans.

2.0 VEGETATION SAMPLING

Several vegetation sampling events were completed in 2014 (Table 2.0.1). Sampling was similar to past efforts with the exception of tuber sampling which was not completed in 2013 or 2014. A dive survey has been a component of the project assessment activities since 2011 to more accurately pinpoint and monitor for the presence of vegetative hydrilla. The 2014 dive survey was completed on June 18th and 19th. Standard Tier 2 surveys (IDNR 2014) were completed on June 26th and August 27th to monitor the hydrilla population (if detectable) and quantify native species abundance. In addition, visual observations of the plant community were recorded throughout the season during FasTEST sampling.

Table 2.0.1. Summary of 2014 Plant Surveys on Lake Manitou. 2014 herbicide treatment dates: May 21 (initial Sonar AS and PR), July 14, and August 21 (Sonar PR bumps).

Date (2014)	Type of Survey
May 27	Reconnaissance Survey
June 9	Reconnaissance Survey
June 18 & 19	Dive Survey
June 23	Reconnaissance Survey
June 26	Tier 2 Survey
July 8	Reconnaissance Survey
July 22	Reconnaissance Survey
August 4	Reconnaissance Survey
August 18	Reconnaissance Survey
August 27	Tier 2 Survey
September 3	Reconnaissance Survey
September 15	Reconnaissance Survey
September 30	Reconnaissance Survey
October 13	Reconnaissance Survey

2.1 Reconnaissance Surveys

For reference: The initial Sonar AS and PR treatment was conducted on May 21, 2014; bump Sonar PR treatments were conducted on July 14 and August 21, 2014. 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. Individual monitoring data sheets are included in the Appendix.

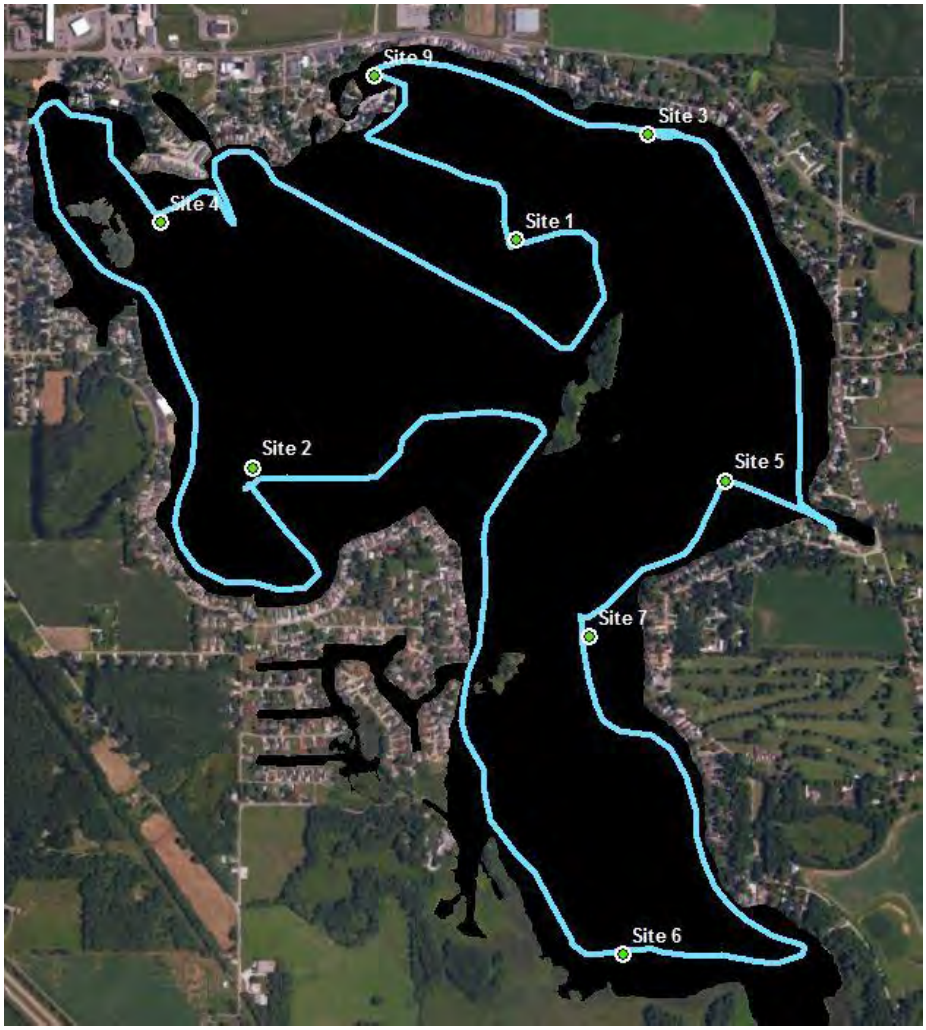

Figure 2.1.1. FasTEST monitoring/vegetation reconnaissance survey route. Route shown is representative track from May 27, 2014 survey. Tracks of all recon surveys are available upon request.

Surveying, in conjunction with water sampling, provided a rapid and cost effective means of confirming the effectiveness of the treatment program. A summary of the reconnaissance survey results for 2014 is provided below in Table 2.1.1

Table 2.1.1. 2014 FasTEST collection plant monitoring summary

Collection Date	Surface-Temp. Range (˚F)	Secchi Depth (ft)	Species Observed and Injury Rating[a]
May 27	75.2 – 77.9	2.8 – 8.2	Coontail (2), Curly-leaf pondweed (2), small pondweed (2)
June 9	74.3 – 76.5	6.7 – 10.1	Coontail (3), Chara (2)
June 23	80.6 – 81.9	4.0 – 6.6	Chara (2)
July 8	75.4 – 77.8	2.7 – 4.4	Chara (4)
July 22	78.6 – 81.5	2.7 – 3.9	Chara (no rating)
August 4	77.6 – 80.6	2.8 – 4.1	Chara (4)
August 18	74.5 – 77.6	2.4 – 4.3	n/a
September 3	76.7 – 80.1	2.3 – 3.9	n/a
September 15	65.0 – 66.2	3.1 – 3.6	n/a
September 30	65.3 – 69.9	2.5 – 3.9	n/a
October 13	58.1 – 59.7	3.2 – 4.6	n/a

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

<*continued on next page*>

2.2 Tuber Sampling

Sampling for hydrilla tubers in the fall of the treatment cycle was discontinued in 2012 after results of fall 2011 survey indicated 99.5% reduction in tuber bank densities at permanent stations established in earlier years. For review of 2007 – 2011 tuber assessment results, please reference 2011 Lake Manitou Aquatic Vegetation Management Plan Update: http://www.in.gov/dnr/fishwild/files/fw-Lake_Manitou_AVMP_2011_Update_Fulton_County_Jan_2012.pdf.

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2.3 Tier 2 Surveys

For reference: The initial Sonar AS and PR treatment was conducted on May 21, 2014; bump Sonar PR treatments were conducted on July 14 and August 21,, 2014. Details of the treatments can be found in Section 4.0.

Tier 2 surveys were completed on June 26th and August 27th. 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 potentially locate additional areas of hydrilla. The design of the Lake Manitou point-intercept survey was based on the LARE protocol (IDNR 2014). A total of 122 sites were sampled in the spring and late summer (Figure 2.3.1).

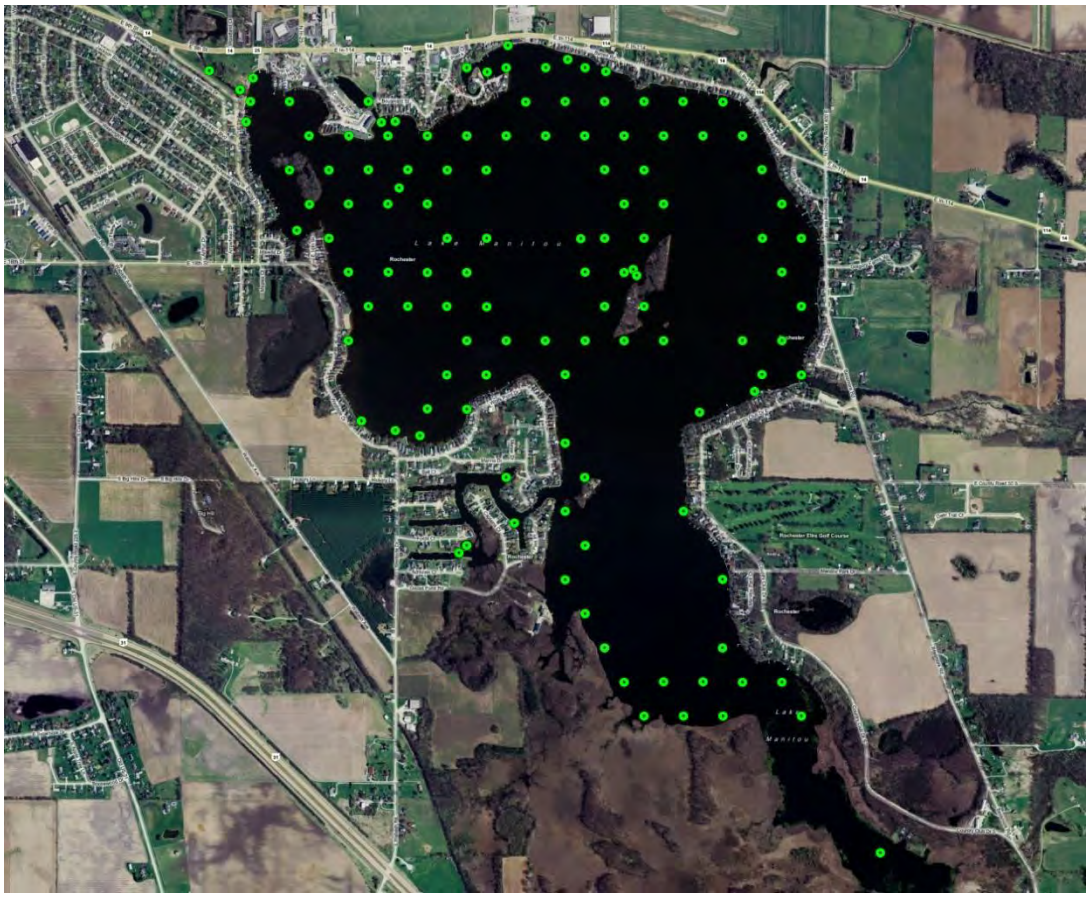

Figure 2.3.1. Tier 2 vegetation sample sites visited in 2014.

2.3.1 Spring Tier 2 Survey Results

The spring survey was conducted on June 26th. 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 eleven feet. Aquatic vegetation was present at 63.1% of the sites. Eight native submersed species were collected. The maximum number of species per site was 5; the mean species collected per site was 0.73. 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

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Table 2.3.2. Occurrence and Abundance of Submersed Aquatic Plants in Lake Manitou. All depths: June 25, 2014.

Occurrence and Abundance of Submersed Aquatic Plants in Lake Manitou (all depths).								
County:	Fulton	Total Sites:	122				Mean species/site:	0.73
Date:	6.26.14	Sites with plants:	77				SE Mean species/site:	0.06
Secchi (ft):	6.5	Sites with native plants:	77				Mean native species/site:	0.73
Max Plant Depth (ft):	11.0	Number of species:	8				SE Mean natives/site:	0.06
Trophic Status:	Meso	# of native species:	8				Species diversity:	0.44
		Maximum species/site:	5				Native species diversity:	0.44
All Depths		**Frequency of Occurrence**	**Rake score frequency per sp.**				**Plant Dominance**	
Species			**0**	**1**	**3**	**5**		
Chara		**52.5**	**47.5**	**41.8**	**4.1**	**6.6**	**17.4**	
Coontail		**14.8**	**85.2**	**13.1**	**0.0**	**1.6**	**4.3**	
Largeleaf pondweed		**1.6**	**98.4**	**1.6**	**0.0**	**0.0**	**0.3**	
Bladderwort		**0.8**	**99.2**	**0.0**	**0.8**	**0.0**	**0.5**	
Horned pondweed		**0.8**	**99.2**	**0.8**	**0.0**	**0.0**	**0.2**	
Leafy pondweed		**0.8**	**99.2**	**0.8**	**0.0**	**0.0**	**0.2**	
Sago pondweed		**0.8**	**99.2**	**0.8**	**0.0**	**0.0**	**0.2**	
Water stargrass		**0.8**	**99.2**	**0.8**	**0.0**	**0.0**	**0.2**	
Filamentous Algae		**69.7**						
Other species observed: Water willow, arrowhead, cattail, spatterdock, white water lily, duckweed, arrow arum, Hibiscus, and Phragmites.								
Occurrence and Abundance of Submersed Aquatic Plants in Lake Manitou (0-5 ft).								
County:	Fulton	Total Sites:	91				Mean species/site:	0.79
Date:	6.26.14	Sites with plants:	62				SE Mean species/site:	0.08
Secchi (ft):	6.5	Sites with native plants:	62				Mean native species/site:	0.79
Max Plant Depth (ft):	11.0	Number of species:	8				SE Mean natives/site:	0.08
Trophic Status:	Meso	# of native species:	8				Species diversity:	0.47
		Maximum species/site:	5				Native diversity:	0.47
Depth: 0 to 5 ft		**Frequency of Occurrence**	**Rake score frequency per sp.**				**Plant Dominance**	
Species			**0**	**1**	**3**	**5**		
Chara		**54.9**	**45.1**	**44.0**	**3.3**	**7.7**	**18.5**	
Coontail		**16.5**	**83.5**	**14.3**	**0.0**	**2.2**	**5.1**	
Largeleaf pondweed		**2.2**	**97.8**	**2.2**	**0.0**	**0.0**	**0.4**	
Bladderwort		**1.1**	**98.9**	**0.0**	**1.1**	**0.0**	**0.7**	
Horned pondweed		**1.1**	**98.9**	**1.1**	**0.0**	**0.0**	**0.2**	
Leafy pondweed		**1.1**	**98.9**	**1.1**	**0.0**	**0.0**	**0.2**	
Sago pondweed		**1.1**	**98.9**	**1.1**	**0.0**	**0.0**	**0.2**	
Water stargrass		**1.1**	**98.9**	**1.1**	**0.0**	**0.0**	**0.2**	
Filamentous Algae		**79.1**						
Occurrence and Abundance of Submersed Aquatic Plants in Lake Manitou (5-10 ft).								
County:	Fulton	Total Sites:	29				Mean species/site:	0.52
Date:	6.26.14	Sites with plants:	14				SE Mean species/site:	0.11
Secchi (ft):	6.5	Sites with native plants:	14				Mean native species/site:	0.52
Max Plant Depth (ft):	11.0	Number of species:	2				SE Mean natives/site:	0.11
Trophic Status:	Meso	# of native species:	2				Species diversity:	0.23
		Maximum species/site:	2				Native diversity:	0.23
Depth: 5 to 10 ft		**Frequency of Occurrence**	**Rake score frequency per sp.**				**Plant Dominance**	
Species			**0**	**1**	**3**	**5**		
Chara		**44.8**	**55.2**	**34.5**	**6.9**	**3.4**	**14.5**	
Coontail		**6.9**	**93.1**	**6.9**	**0.0**	**0.0**	**1.4**	
Filamentous Algae		**41.4**						
Occurrence and Abundance of Submersed Aquatic Plants in Lake Manitou (10-15 ft).								
County:	Fulton	Total Sites:	2				Mean species/site:	1.00
Date:	6.26.14	Sites with plants:	1				SE Mean species/site:	1.00
Secchi (ft):	6.5	Sites with native plants:	1				Mean native species/site:	1.00
Max Plant Depth (ft):	11.0	Number of species:	2				SE Mean natives/site:	1.00
Trophic Status:	Meso	# of native species:	2				Species diversity:	0.50
		Maximum species/site:	2				Native diversity:	0.50
Depth: 10 to 15 ft		**Frequency of Occurrence**	**Rake score frequency per sp.**				**Plant Dominance**	
Species			**0**	**1**	**3**	**5**		
Chara		**50.0**	**50.0**	**50.0**	**0.0**	**0.0**	**10.0**	
Coontail		**50.0**	**50.0**	**50.0**	**0.0**	**0.0**	**10.0**	
Filamentous Algae		**50.0**						

Chara (*Chara sp*.) and common coontail (*Ceratophyllum demersum)* were present at the highest percentage of sample sites (54.9% & 16.5% respectively) (Figure 2.3.2 & 2.3.3). Largeleaf pondweed (*Potamogeton amplifolius*) was collected at two sites, while bladderwort (*Utricularia sp.),* sago pondweed (*Potamogeton pectinatus*), leafy pondweed (*Potamogeton foliosus*), horned pondweed (*Zannichellia palustris*), and water stargrass (*Heteranthera dubia*) were only collected at single sites. Filamentous algae was present at 69.7% of sites.

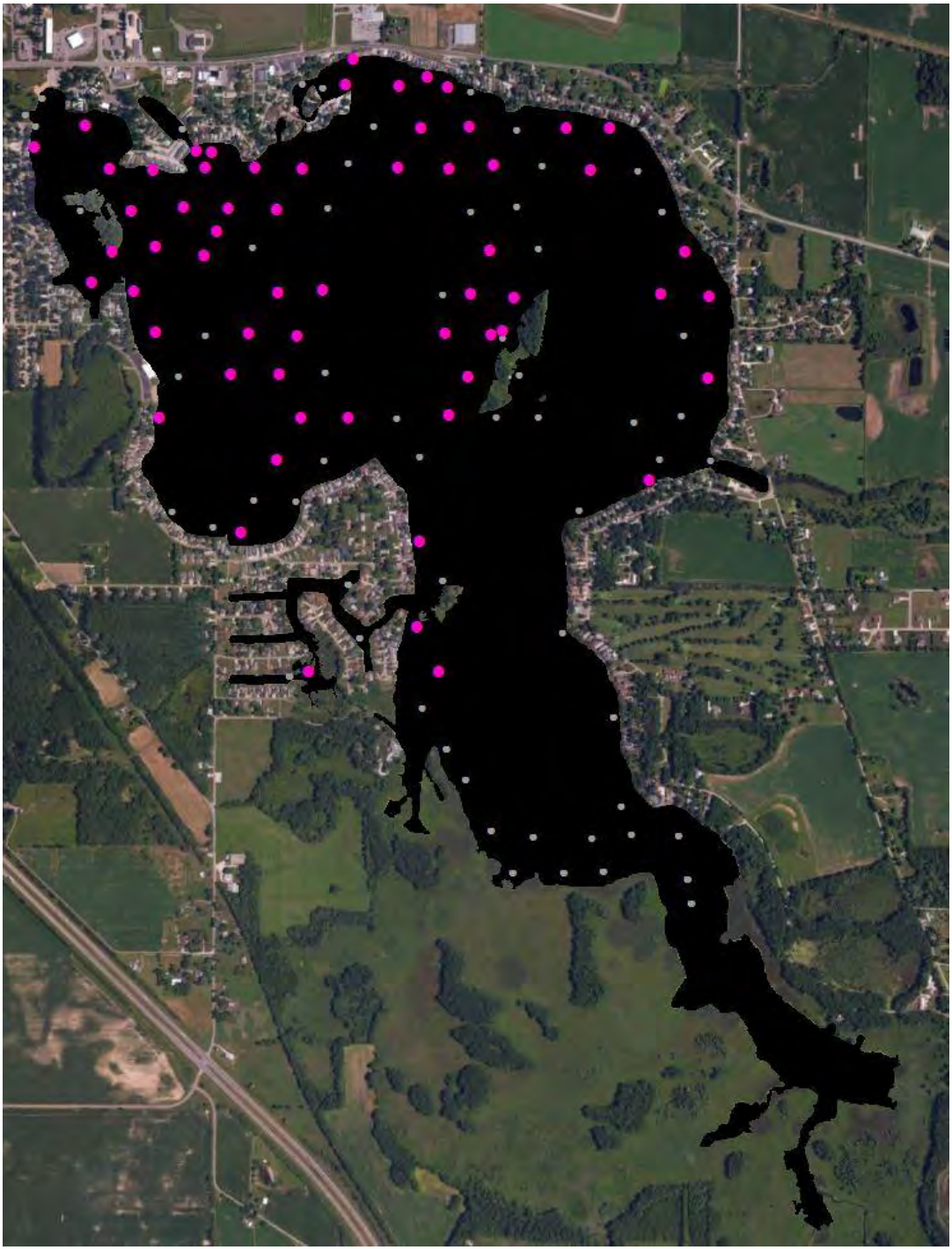

Figure 2.3.2. Lake Manitou, Chara distribution, June 26, 2014.

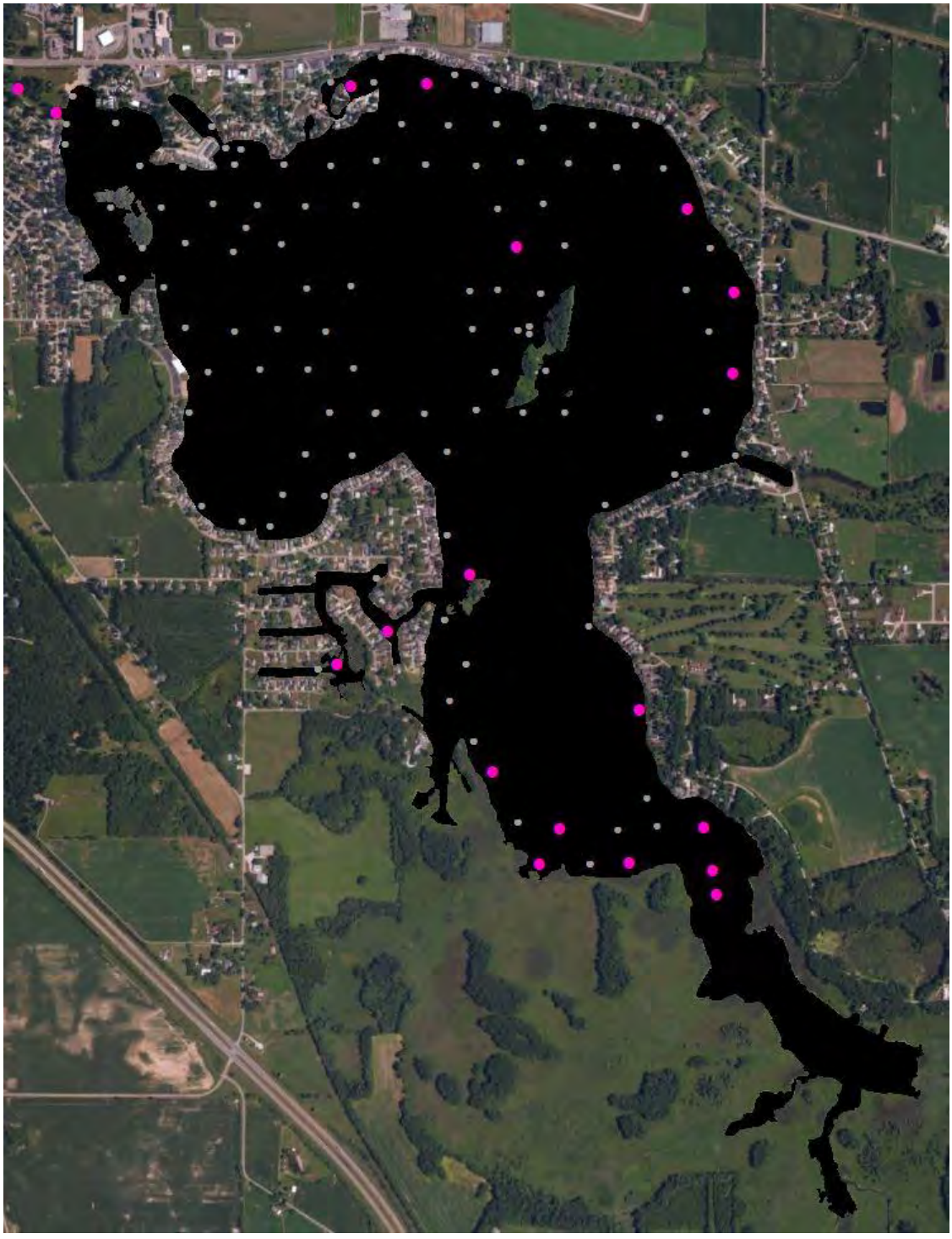

Figure 2.3.3. Lake Manitou, common coontail distribution, June 26, 2014.

2.3.2 Summer Tier 2 Survey Results

The methods used in the spring survey were applied again on August 27, 2014 (summer survey). Results of the sampling are listed in Table 2.3.3. Plants were growing to a maximum depth of 5 feet. Aquatic vegetation was present at 23.0% of the sites. A total of seven species were collected. The maximum number of species per site was 2, the mean species collected per site was 0.26, and the species diversity index was 0.61.

Table 2.3.3. Occurrence and Abundance of Submersed Aquatic Plants in Lake Manitou. All depths: August 27, 2014.

Occurrence and Abundance of Submersed Aquatic Plants in Lake Manitou (all depths).								
County:	Fulton	Total Sites:	122				Mean species/site:	0.26
Date:	8.27.14	Sites with plants:	28				SE Mean species/site:	0.05
Secchi (ft):	3.5	Sites with native plants:	28				Mean native species/site:	0.26
Max Plant Depth (ft):	5.0	Number of species:	7				SE Mean natives/site:	0.05
Trophic Status:	Meso	# of native species:	7				Species diversity:	0.61
		Maximum species/site:	3				Native species diversity:	0.61
All Depths		Frequency of Occurrence	Rake score frequency per sp.				Plant Dominance	
Species			**0**	**1**	**3**	**5**		
Chara		15.6	85.2	9.8	3.3	1.6	6.2	
Coontail		4.1	95.9	1.6	0.8	1.6	2.5	
Bladderwort		1.6	98.4	1.6	0.0	0.0	0.3	
Largeleaf pondweed		1.6	98.4	0.8	0.0	0.8	1.0	
Water stargrass		1.6	98.4	0.0	0.8	0.8	1.3	
Flatstem pondweed		0.8	99.2	0.8	0.0	0.0	0.2	
Sago pondweed		0.8	99.2	0.8	0.0	0.0	0.2	
Filamentous Algae		47.5						
Other species observed: Hibiscus, purple loosestrife, cattail, spatterdock, duckweed, white waterlily, watermeal, sago pondweed,								
	smartweed, water willow, arrow arum.							

Chara was still present at the highest percentage of sample sites (Figure 2.3.4). Coontail ranked second in percent occurrence (4.1%) (Figure 2.3.5). Bladderwort, largeleaf pondweed, water stargrass, flatstem pondweed (*Potamogeton zosteriformis*), and sago pondweed were also collected. Filamentous algae was present at 47.5% of sites.

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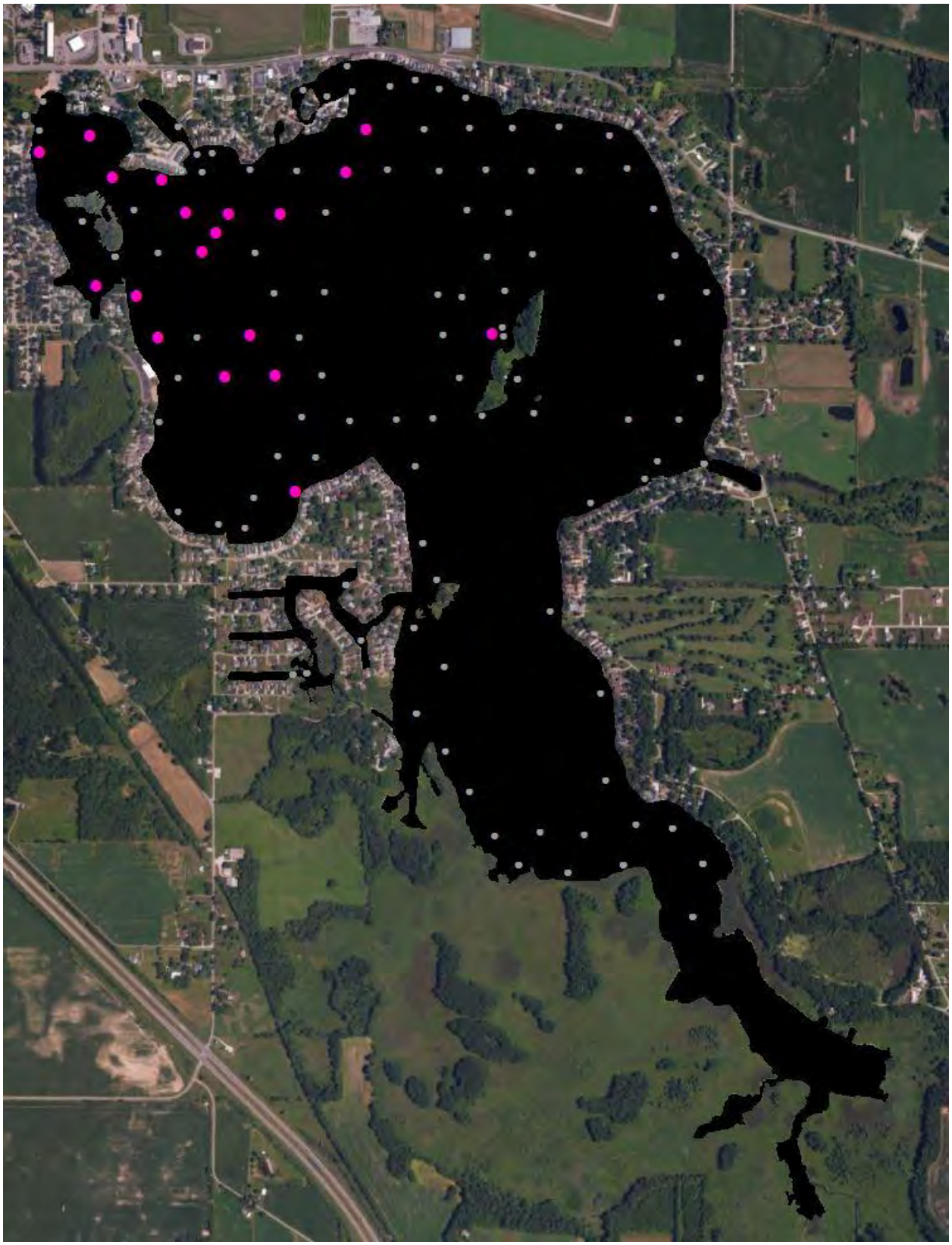

Figure 2.3.4. Lake Manitou, Chara distribution, August 27, 2014.

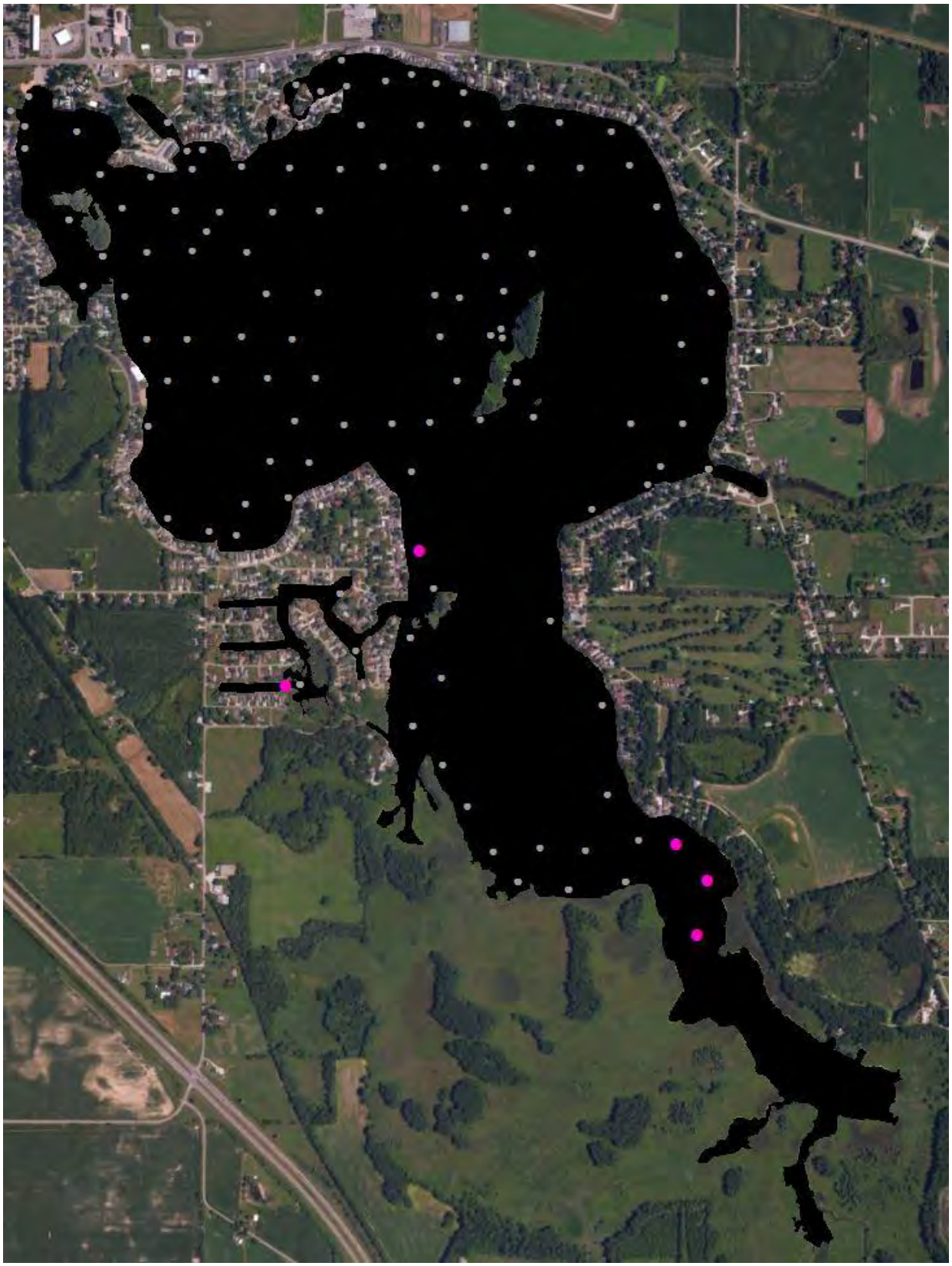

Figure 2.3.5. Lake Manitou, common coontail distribution, August 27, 2014.

2.3.3 Tier 2 Survey Discussion

For reference: The initial Sonar AS and PR treatment was conducted on May 21, 2014; bump Sonar PR treatments were conducted on July 14 and August 21, 2014. 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 2007-2014. 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 2008-2014 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 began. Chara, common coontail, and sago pondweed are now the most frequently occurring species since initiation of the eradication program. After posting declines during the last two years, occurrence of these species appears to have slightly increased in 2014. In addition, water stargrass, which was only collected once in the past two seasons, was collected in both 2014 surveys and horned pondweed was collected for the first time. The changes in percent occurrence in the last nineteen Tier 2 surveys are illustrated in Table 2.3.4and Chart 2.3.1.

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Table 2.3.4. Percent occurrence of species in Lake Manitou since 2004.

Species	% of survey sites identified																		
	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	Jun-12	Aug-12	Jun-13	Aug-13	Jun-14	Aug-14
hydrilla *(Hydrilla verticillata)*				3.3%															
Eurasian watermilfoil *(Myriophyllum spicatum)*	27.5%	30.0%	2.9%	5.0%															
curlyleaf pondweed *(Potamogeton crispus)*				3.3%				1.6%		1.6%	0.8%					1.7%			
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%	13.1%	2.5%	3.3%	2.5%	14.8%	4.1%
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%	29.5%	0.8%	13.9%	4.1%	3.3%		52.5%	15.6%
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%	5.7%	4.1%	3.3%		2.5%	3.3%	0.8%	0.8%
eelgrass *(Vallisneria americana)*	50.5%	61.0%	42.9%	60.3%	6.6%			0.8%						0.8%	0.8%				
flatstem pondweed (Potamogeton				4.1%						0.8%									0.8%
largeleaf pondweed Potamogeton amplifolius)				2.5%				0.8%								0.8%		1.6%	1.6%
Illinois pondweed *(Potamogeton illinoensis)*	1.1%	2.0%	5.7%												0.8%				
Leafy pondweed *(Potamogeton foliosus)*																0.8%		0.8%	
variable pondweed *(Potamogeton gramineus)*				0.8%															
common bladderwort (Utricularia vulgaris)					0.8%		0.8%	0.8%	0.8%		0.8%		1.6%					0.8%	1.6%
Aquatic Moss *(Riccia sp.)*																	0.8%		
Nitella *(Nitella sp.)*														0.3%					
Water stargrass *(Heteranthera dubia)*																		0.8%	1.6%
Horned pondweed *(Zannichellia palustris L.)*																		0.8%	
Flatstem pondweed *(Potamogeton zosteriformis)*																			0.8%

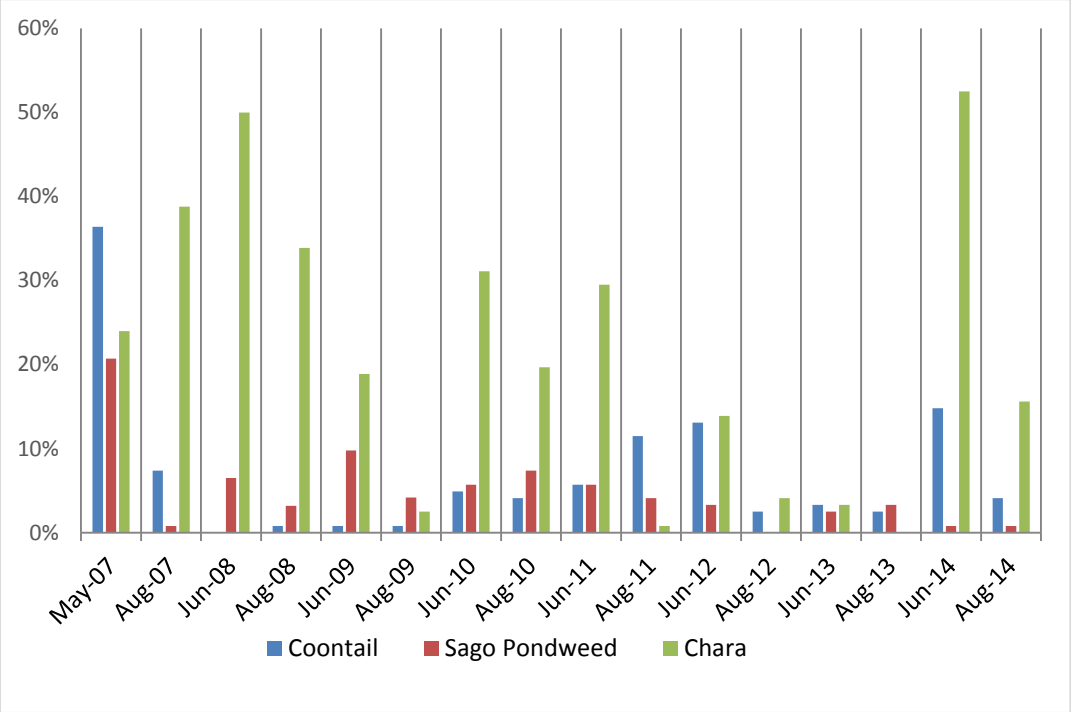

Chart 2.3.1. Percent occurrence of common coontail, sago pondweed, and Chara in Lake Manitou since 2007 (data from Table 2.3.4).

Tier 2 surveys also provide insight into changes of submersed aquatic plant diversity and abundance. Table 2.3.5 and Chart 2.3.2 compare the percentage of sample sites with vegetation, native species per site, and the number of native species collected in the last decade. Figure 2.3.6 shows the change in total species abundance between the spring and summer surveys. The 2014 spring survey posted the highest diversity and number of sites with vegetation since 2007. A trend of increased water clarity, the decrease in the size of the active treatment area, the greater use of Sonar pellets versus liquid formulation, and a later start to treatments may have contributed to the uptick in observed native plants. Submersed vegetation metrics are expected to further increase once the hydrilla eradication project is completed. There are well-established populations of coontail and pondweeds in the upper end of the lake that will likely repopulate Lake Manitou once the eradication of hydrilla is complete.

Table 2.3.5. Comparison of number of sample sites, % of sites with vegetation, native diversity index, and number of native species collected in since 2004.

Survey Date	Number of Sample Sites	% of sites with vegetation	Mean Native Species/Site	Number of Native Species Collected
Aug 2004[1]	95	83.5%	1.15	6
Aug 2005[2]	100	79.0%	1.07	6
Aug 2006[3]	70	56.0%	1.03	7
May 2007	119	92.0%	1.49	7
Aug 2007	111	47.0%	0.55	5
June 2008	121	56.2%	0.56	2
Aug 2008	121	39.7%	0.40	5
June 2009	122	28.7%	0.32	6
Aug 2009	119	8.4%	0.09	5
June 2010	122	40.9%	0.43	5
Aug 2010	122	28.6%	0.32	4
June 2011	122	38.5%	0.41	3
Aug 2011	122	16.4%	0.18	4
June 2012	122	30.3%	0.33	6
Aug 2012	122	7.4%	0.08	4
June 2013	122	8.3%	0.11	5
Aug 2013	122	4.9%	0.07	3
June 2014	122	63.1%	0.73	8
Aug 2014	122	23.0%	0.26	7

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

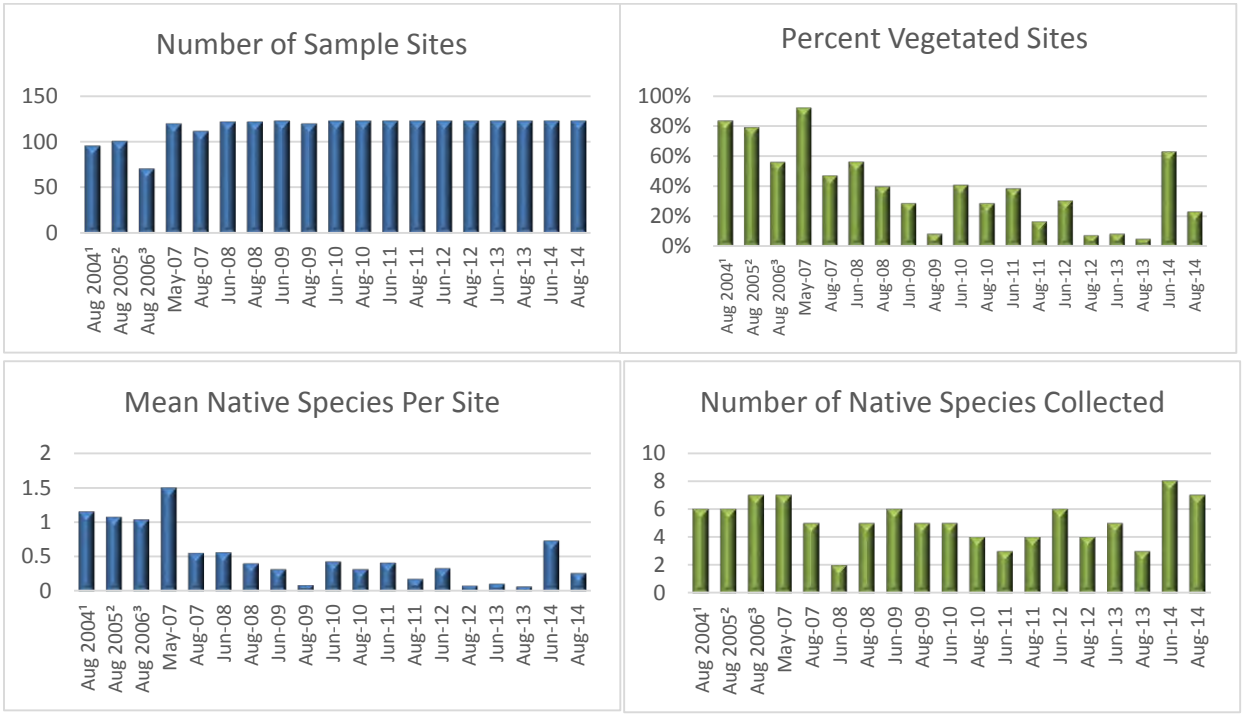

Chart 2.3.2. Comparison of number of sample sites, percentage of sites with vegetation, mean native species per site, and number of native species collected since 2004. (Data are from Table 2.3.5)

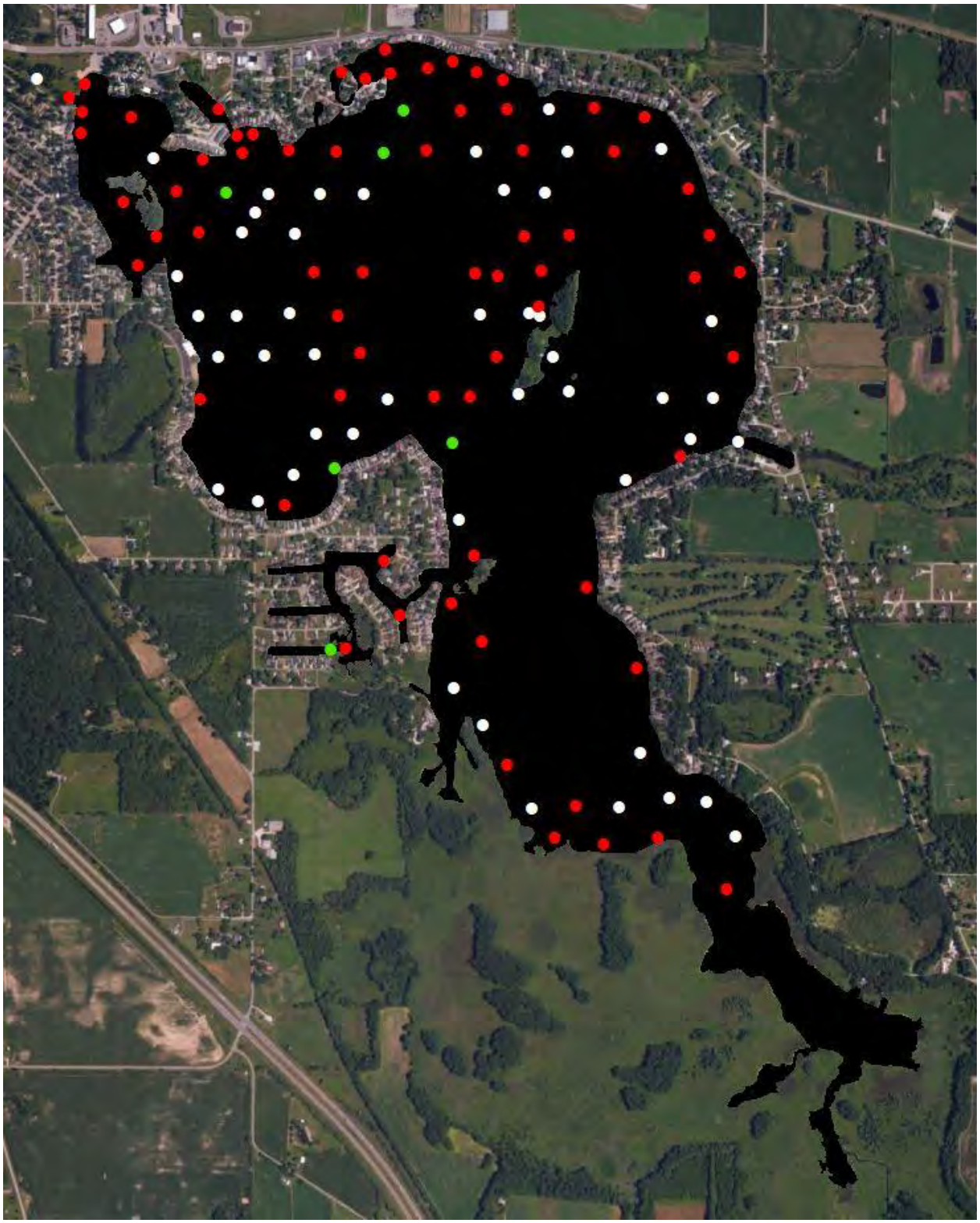

Figure 2.3.6. Lake-wide change in total species abundance, June 26, 2014 to August 27, 2014. Green markers indicate an increase in species present, white markers indicate no change, and red markers indicate a decrease in species present from June to August.

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2.4 Dive Survey for Vegetative Hydrilla Detection

2.4.1. Dive Survey Background and Methods Summary

In a day-long survey in 2011, SCUBA divers surveyed ~1,000 square-foot areas centered around 140 total sites of past hydrilla finds by IDNR and relevant lake wide LARE Tier II points between 2 and 8 feet in depth. The objective was detection of vegetative hydrilla growth as an indicator of status relative to the management objective of eradicating hydrilla from the lake. Prior to 2011, hydrilla tuber sampling was the method utilized to track the progress towards eradication, but 99.5% reduction in tuber density during five years of management with Sonar® had greatly reduced the efficiency of tuber sampling as a tracking method. The 2011 survey detected vegetative hydrilla growth in two areas: the north shoreline of the lake and immediately west of the mid-lake island, also known as Big Island.

To enhance detection of hydrilla in these two regions of the lake, the 2012 dive survey was expanded to a day and a half effort (all-day June 14 and the morning of June 15) and conducted in 35 zones in littoral areas of the north shore and west of Big Island. During the survey, the zones were marked by temporary buoys at the corners of each zone based on pre-determined GPS coordinates. The 35 zones totaled 58 acres, and divers completed between 3 and 8 transects through each zone depending on its morphology. In general, although conditions were quite favorable for the survey (sunny and light winds), water visibility was notably reduced versus 2011. Where 2011 visibility was generally 4+ feet, 2014 visibility was approximately 2 – 3 feet. Despite the reduced visibility, divers visually inspected 184 transects with an average 'swath' of 5 feet and typical length of 120 meters (394 feet). This translates to 363,000 square feet, or approximately 2.5 times more bottom area covered than the 2011 survey. When a diver found hydrilla, they deployed a small additional temporary buoy, which when the zone survey was complete, was collected and located with a new GPS point.

In 2013, the 1.5-day dive survey design was further refined with goal to have a long-term approach for diver assessment to support the remainder of the hydrilla eradication efforts on Manitou. Seven new 'high-intensity' survey areas were established in blocks surrounding discrete locations of diver hydrilla finds in 2011 and 2012. Each high-intensity zone was 6600 square feet in size (60 by 100 feet). Divers traversed these zones with objective of visual coverage of the entire bottom for maximum ability to detect vegetative hydrilla growth. 21 additional 'low intensity' blocks were surveyed that were a select number of the 35 zones surveyed in 2012 that immediately surrounded the new high-intensity blocks of past hydrilla finds. This design (shown in Figures 2.4.1, 2.4.2, and 2.4.3) balanced the objectives of 1) developing data on discrete number of vegetative hydrilla plants within the high intensity areas to track hydrilla decline through time as a metric for late-stage eradication success while also 2) surveying the broader area of past infestation to provide a wider look in case 'hot spots' of remaining hydrilla might still be detected for closer assessment in the future. This same design was used again in 2014. The 2014 dive survey was conducted on June 18 and 19. To focus efforts on hydrilla detection, other submersed plant species were not individually tracked but were qualitatively noted for the diver survey overall.

Figure 2.4.1 Dive survey design.

Figure 2.4.2 and 2.4.3 Dive survey design close ups.

2.4.2 Dive Survey Results and Discussion

No hydrilla was detected during the 2014 dive survey. Native species observed during the survey included chara, coontail, Illinois pondweed, spatterdock (small 'seeding' plants) and naiad. Based on water visibility at time of the 2014 survey (~3 ft.), total bottom areal coverage by diver in the 2014 survey is estimated at 296,000 square feet.

The lack of hydrilla in the 2014 survey is a positive development relative to the multi-year objective of hydrilla eradication in Lake Manitou. Qualitatively, there were ~ 20 plants detected across seven locations (3 in close proximity) during the 2012 dive survey versus four single plants detected in 2013. The results support that repeat cycles of Sonar herbicide use have

depleted hydrilla tuber numbers to extremely low levels approaching the eradication goal. It is hoped that a 2015 survey will also not locate vegetative hydrilla based on the 2014 survey outcome. With the goal to maintain a consistent dive survey design from this point forward to allow straightforward comparability from year to year, no changes in survey design would be proposed for 2015 unless IDNR would request modification.

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3.0 WATER QUALITY MONITORING

Aquatic Weed Control biologist recorded dissolved oxygen and temperature profiles at FasTEST sample sites 2 and 7 on May 27, June 9, June 23, July 8, July 22, August 4 ,August 18, September 3, September 15, September 30, and October 13. Profiles for the Site 7 data are listed in Table 3.0.1. Along with general understanding of lake's physical behavior during 2014, these data were used to monitor thermocline depths for calculating possible Sonar bump treatments. The thermocline depth is important in calculating Sonar application rates and placement of Sonar pellets. Sonar generally does not mix below the thermocline, and slight thermal stratification can inhibit mixing into deeper waters. A thermocline defines a narrow, horizontal stratification boundary between cooler, deeper water and warmer, shallow water.

A thermocline is generally defined as a 1˚C (1.8 ˚F) 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, often reducing the amount of Sonar applied. However, the thermocline depth changes throughout the season and must continually be monitored. In 2014, the initial application of Sonar AS disregarded thermocline position per IDNR directive, and thermocline information was not needed for bump applications since no Sonar AS was needed following the initial May 21 application.

Secchi transparency readings were taken throughout the 2014 season (Table 3.0.2). Secchi measurements ranged from a maximum of 10.1 feet on June 9 to a low of 2.3 feet on September 3. Overall, 2014 minimum Secchi depth and July-August 2014 average Secchi depth were within typical ranges when compared with historical data, while maximum Secchi depths were on the high-end of historical depth values (Table 3.0.3).

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Table 3.0.1. 2014 Temperature and Dissolved Oxygen Profiles for Site 7 (FasTEST also included).

DAT -->	5/27/14	6		6/9/14	19		6/23/14	33		7/8/14	48		7/22/14	62		8/4/14	75		8/18/14	89	
Depth (m)	FasTEST	Temp	D O_2	FasTEST	Temp	D O_2	FasTEST	Temp	D O_2	FasTEST	Temp	D O_2	FasTEST	Temp	D O_2	FasTEST	Temp	D O_2	FasTEST	Temp	D O_2
0	3.8	77.9	6.40	2.9	76.5	8.94	2.7	81.6	9.12	2.6	77.8	8.68	2.4	79.1	11.92	2.2	80.1	10.41	2.4	77.4	8.93
1		77.1	6.41		75.8	9.02		81.5	9.15		77.7	8.71		79.1	11.94		79.1	10.80		76.7	8.91
2		76.4	6.37		75.0	8.42		81.3	9.09		77.6	8.67		78.8	12.02		78.5	10.48		75.8	8.25
3		73.8	5.96		74.8	8.09		81.1	8.72		77.8	8.63		76.9	10.44		75.7	8.31		75.5	8.05
4		67.7	3.77		74.4	7.66		78.2	5.26		76.7	7.45		75.4	7.99		74.3	6.54		74.5	7.08
5		64.3	2.69		73.9	6.68		75.1	3.03		76.0	6.60		74.2	4.21		72.9	4.44		73.9	5.78
6		61.2	1.59		68.0	0.50		72.5	1.40		74.8	5.14		73.7	4.00		72.2	3.49		73.2	3.78
7		59.6	0.93		60.6	0.19		67.9	0.17		71.7	1.42		71.6	1.02		72.1	3.42		72.2	1.46
8		58.3	0.21		58.8	0.16		60.9	0.12		64.8	0.20		67.2	0.19		71.3	1.84		67.7	0.27
9		57.3	0.16		57.3	0.14		58.2	0.10		61.3	0.15		61.5	0.13		68.6	0.21		64.1	0.16
10		56.6	0.15		56.3	0.13		56.7	0.09		58.4	0.12		59.1	0.12		64.0	0.16		60.0	0.13

DAT -->	9/3/14	105		9/15/14	117		9/30/14	132		10/13/14	145	
Depth (m)	FasTEST	Temp	D O_2	FasTEST	Temp	D O_2	FasTEST	Temp	D O_2	FasTEST	Temp	D O_2
0	3.4	78.7	7.98	3.0	66.2	7.08	2.8	69.5	10.25	2.6	59.4	7.69
1		78.0	8.04		66.3	7.04		69.5	10.24		58.6	7.73
2		77.2	7.56		66.4	6.99		68.5	9.88		58.2	7.71
3		76.9	7.25		66.5	6.95		69.3	9.72		58.2	7.68
4		76.9	7.21		66.6	6.81		68.1	9.59		57.9	7.61
5		76.7	6.64		66.6	6.73		65.9	5.71		57.7	7.57
6		75.9	3.48		66.6	6.41		65.1	4.41		57.5	7.53
7		74.4	0.71		66.4	6.08		64.3	3.78		57.4	7.50
8		68.5	0.18		66.3	6.04		64.5	1.93		57.3	7.40
9		64.8	0.12		66.1	4.61		64.2	0.63		56.7	6.79
10		61.1	0.10		65.7	3.78		62.6	0.21		56.6	6.65

NC = Not collected

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Table 3.0.2. 2014 Secchi depths recorded on Lake Manitou (April to October, 2014).

Site	27-May	9-Jun	23-Jun	8-Jul	22-Jul	4-Aug	18-Aug	3-Sep	15-Sep	30-Sep	13-Oct
1	6.0	**6.5**	4.2	3.9	3.0	3.5	3.9	3.5	3.2	3.2	4.2
2	8.2	10.1	6.6	4.4	3.8	3.7	3.3	3.7	3.3	2.9	4.4
3	3.8	**5.0**	4.8	3.8	3.2	3.1	3.3	2.8	3.2	3.9	3.2
4	**5.0**	**5.0**	4.0	3.9	2.9	2.8	2.8	2.7	3.2	2.5	3.4
5	7.5	6.9	5.8	--	--	--	--	--	--	--	--
6	**4.0**	**4.0**	**4.0**	**4.0**	3.9	3.9	3.9	3.9	3.5	3.2	**4.0**
7	7.5	6.7	6.2	4.2	3.9	4.1	4.3	3.4	3.2	3.4	4.6
9	2.8	5.0	**5.0**	2.7	2.7	2.8	2.4	2.3	3.1	2.5	3.2
10	--	**8.0**	6.1	3.8	3.2	3.2	3.3	3.5	3.6	3.7	4.6
mean	**5.6**	**6.4**	**5.2**	**3.8**	**3.3**	**3.4**	**3.4**	**3.3**	**3.3**	**3.2**	**4.0**

Bold text indicates the lake bottom was visible at the water depth listed.
-- indicates no reading taken
Site locations can be seen in Figures 2.1.1 or 4.2.1.

Table 3.0.3. Summary of Secchi depths recorded on Lake Manitou 1999-2014.

(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
2012*	1.2	7.5	3.3	107
2013*	1.8	6.5	2.7	40
2014*	2.3	10.1	3.5	90

*2007 - 2014 data are by authors of this report and are added for comparison with historical data.

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4.0 2014 VEGETATION CONTROL

The eradication of hydrilla is 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, Kansas, Missouri, and North Carolina.

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 in 2006 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. The hydrilla in Lake Manitou responded favorably to Sonar under laboratory conditions (Chart 4.0.1 and Figure 4.0.1). SePRO's recommended treatment protocol was based on results of the PlanTEST, extensive experience in hydrilla control throughout the U.S., and proprietary modeling of Sonar dissipation from various formulations.

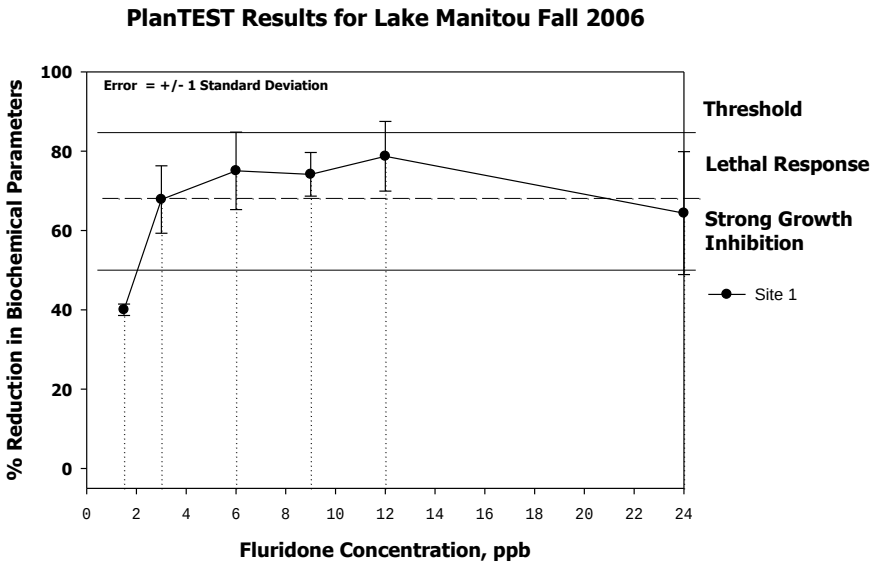

Chart 4.0.1 PlanTEST Results for Lake Manitou.

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 2011 and 2012, 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 2013 and 2014, however, only the lower 423 acres was included in the 2014 treatment. This change was made in an effort to promote increased native plant growth. In addition, hydrilla had never been detected in the upper (southern) reaches of Lake Manitou, so hydrilla control should not be affected by this continued adjustment.

4.1 Sonar Application

On May 21, 2014, 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 7.0 ppb to the lower (northern) 423 acres of the lake along with pelletized Sonar PR to 18 zones (Figure 4.1.2) at concentrations ranging from 20-70 ppb (total of 4.1 ppb based on lake volume). A thermocline was detected at ~10 feet, but based on direction from IDNR, Sonar AS quantity was calculated based on the total water column volume in the 423 target acres (3,704 acre-feet versus whole-lake water volume of 8,994 acre-feet). The whole water column depth was used for calculation based on the assumption from most past treatment results that the initial thermocline on Manitou is generally unstable. Table 4.1.1 illustrates the updated volume calculations of the northern treatment zone.

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Table 4.1.1. Volumetric calculations for Manitou north treatment area.

Volumetric Calculations for Manitou 2014 AS Treatment Area			
Depth	**Cumulative Acre Feet**	**Surface Acres**	**Acre Feet**
0Foot-1Foot	3703.95	423.35	419.69
1Foot-2Foot	3284.27	415.08	409.80
2Foot-3Foot	2874.47	405.11	399.21
3Foot-4Foot	2475.26	391.65	375.20
4Foot-5Foot	2100.07	350.82	288.55
5Foot-6Foot	1811.52	225.06	186.44
6Foot-7Foot	1625.08	155.17	136.31
7Foot-8Foot	1488.78	122.42	116.00
8Foot-9Foot	1372.78	110.47	105.82
9Foot-10Foot	1266.96	101.71	98.38
10Foot-11Foot	1168.58	95.30	92.46
11Foot-12Foot	1076.12	89.80	87.16
12Foot-13Foot	988.96	84.64	82.16
13Foot-14Foot	906.80	79.80	77.39
14Foot-15Foot	829.41	75.01	72.59
15Foot-16Foot	756.82	70.26	67.93
16Foot-17Foot	688.89	65.70	63.53
17Foot-18Foot	625.37	61.45	59.19
18Foot-19Foot	566.18	56.95	55.07
19Foot-20Foot	511.11	53.20	51.37
20Foot-21Foot	459.74	49.67	48.13
21Foot-22Foot	411.60	46.70	45.43
22Foot-23Foot	366.18	44.19	42.93
23Foot-24Foot	323.25	41.69	40.38
24Foot-25Foot	282.87	39.07	37.86
25Foot-26Foot	245.01	36.72	35.60
26Foot-27Foot	209.41	34.52	33.40
27Foot-28Foot	176.01	32.30	31.14
28Foot-29Foot	144.86	29.99	28.79
29Foot-30Foot	116.08	27.60	26.34
30Foot-31Foot	89.74	25.07	23.68
31Foot-32Foot	66.06	22.22	20.71
32Foot-33Foot	45.35	19.22	17.62
33Foot-34Foot	27.73	15.88	13.42
34Foot-35Foot	14.31	10.69	8.59
35Foot-36Foot	5.73	6.77	4.87
36Foot-37Foot	0.86	2.52	0.86

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 18 different locations, all sites of historic hydrilla finds (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.

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Figure 4.1.1. Initial application tracks for Sonar AS (*left map*) and Sonar PR (*right map*), May 21, 2014.

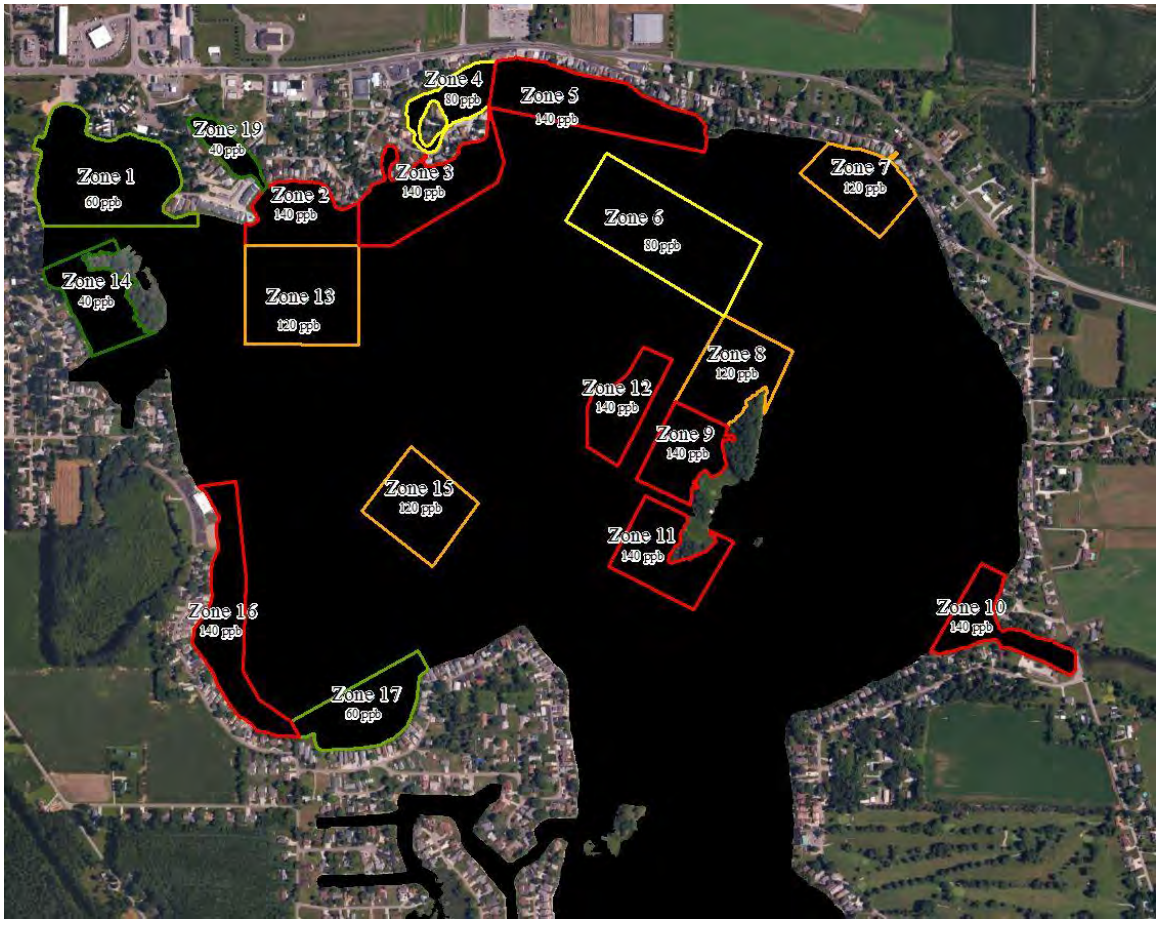


Figure 4.1.2. Sonar PR application prescription map for May 21, July 14, and August 21, 2014 applications. Use rates represent total seasonal application split across the three events.

No Sonar AS bump treatments were required in 2014. Two pre-planned Sonar PR applications were completed on July 14th and August 21st. Sonar PR was applied to the same locations as the initial Sonar PR treatment but at half the initial rate. Figure 4.1.3 displays the actual application routes from these applications.

Figure 4.1.3. July 14th (*left map*) and August 21st (*right map*) Sonar PR applications.

4.2 FasTEST Herbicide Concentration Monitoring

The FasTEST was used to monitor fluridone concentration on 11 dates between May 27, 2014 and October 13, 2014, a span of 145 days following initial treatment. The FasTEST ensured the target concentrations were achieved and maintained through mid-October 2014. FasTEST samples were collected from eight permanent stations located throughout Lake Manitou (Figure 4.2.1 & Table 4.2.1). Twelve sets of surface samples were collected and results are summarized in Table 4.2.2, and Chart 4.2.1. Results indicate the concentration was maintained above 2.5 ppb for essentially the entire 2014 growing season. The objective was to maintain >2.5 ppb until October 15th based on previous projection that hydrilla would unlikely be able to sprout from a tuber and form a new tuber after that period.

The objective of modifications to the Sonar treatment program for Lake Manitou over the last two seasons has been to decrease herbicide pressure on the lake's native aquatic plant community in the upper (south) end of the lake. In 2013, lakewide seasonal average Sonar concentrations were 3.3 ppb versus 3.9 ppb in 2012, and samples from untreated site 6 in the south end averaged 2.8 ppb in 2013 versus 3.3 ppb in 2012. In 2014, the lakewide seasonal average concentration was effectively the same or slightly lower at 3.2 ppb and the site 6 average tracked in similar fashion at 2.7 ppb. However, spikes of concentration associated with Sonar AS bumps were minimized with the highest lakewide average of 5.3 ppb observed at the start of the program versus 7.2 ppb in 2013. The highest reading observed at site 6 in 2014 was just 3.4 ppb versus 5.8 ppb in 2013 (a 4.6 ppb reading was also measured in 2013). The Sonar program in 2014 with increased emphasis on use of Sonar PR was extremely efficient in maintaining Sonar levels in the target treatment zone in a range of 2.5 – 4 ppb from June to mid-October. No 'reactive' bumps of Sonar AS were needed following the initial planned liquid application at the start of the 2014 treatment. Only the two scheduled Sonar PR pellet re-applications were utilized. This minimized both field labor expenses associated with re-applications as well as avoided spikes of elevated concentrations that can increase impact to non-target native plants.

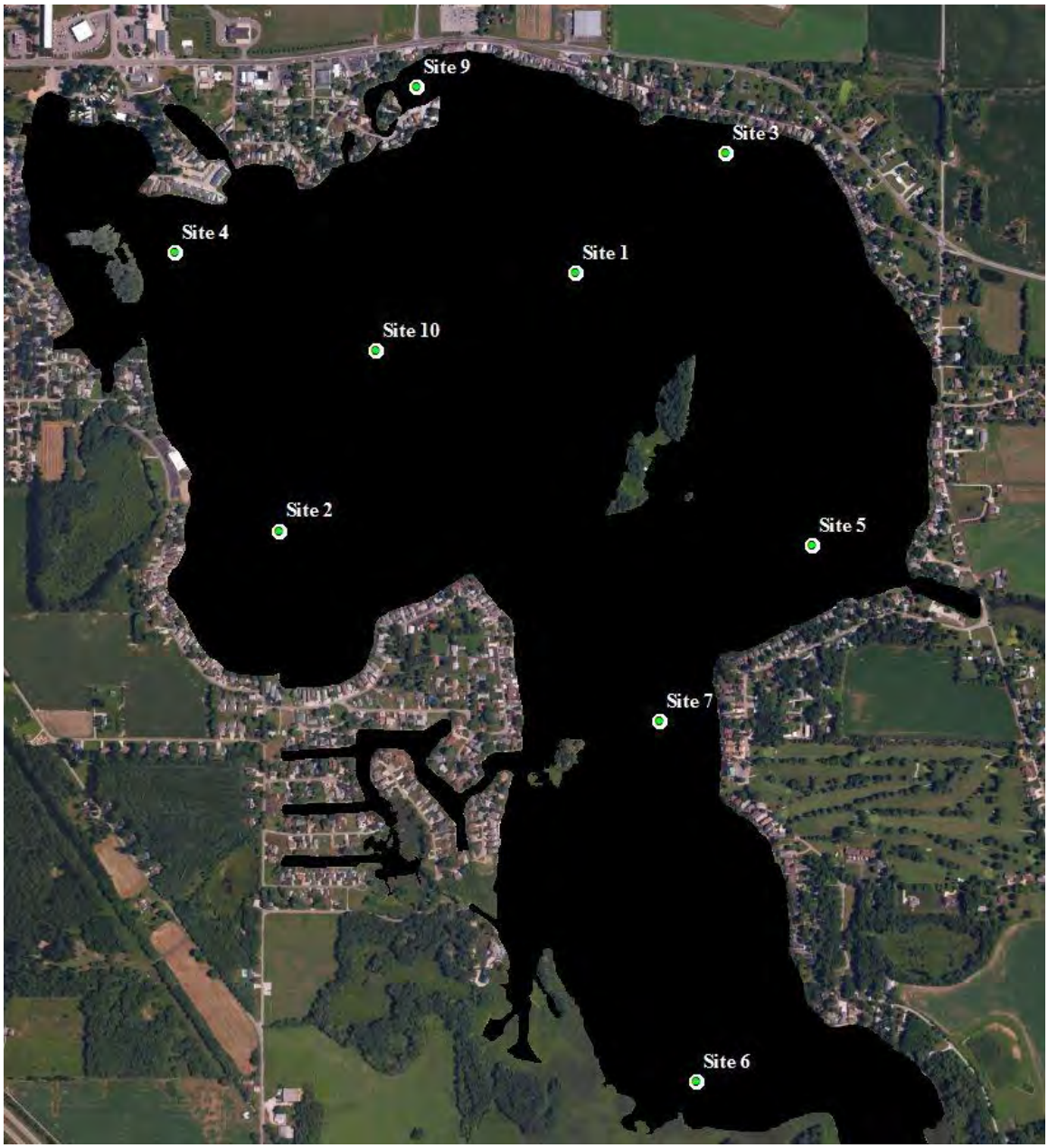


Figure 4.2.1. Permanent FasTEST sample locations during 2014.

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' 27.4"	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' 51.3"	W 86˚ 10' 36.1"
9*	N 41˚ 03' 40.4"	W 86˚ 11' 01.4"
10*	N 41˚ 03' 19.9"	W 86˚ 11' 05.4"

*Station 8 was removed after 2007; Station 9 was added in 2008. Station 7 was moved north of original site in 2013. Station 5 removed and station 10 added in 2014.

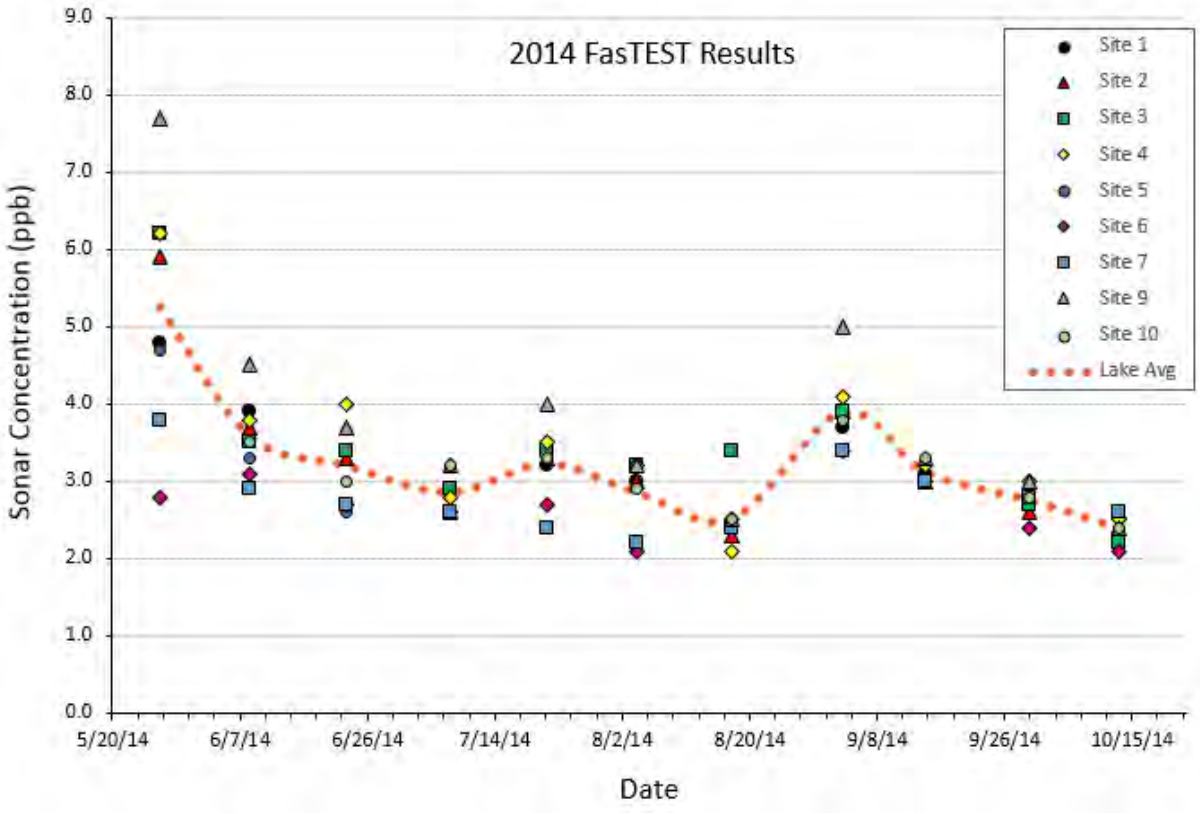
Table 4.2.2. Concentration of 2014 FasTEST results from surface water samples. Vertical black lines indicate when "bump" treatments were made.

5/21/2014	5/27	6/9	6/23	7/8	7/22	8/4	8/18	9/3	9/15	9/30	10/13	Season
DAT[a] -->	6	19	33	48	62	75	89	105	117	132	145	145
Sites	Sonar Concentration (ppb)											
1	4.8	3.9	3.4	2.9	3.2	3.0	2.4	3.7	3.1	2.7	2.3	3.2
2	5.9	3.7	3.3	2.6	3.3	3.0	2.3	3.9	3.0	2.6	2.6	3.3
3	6.2	3.5	3.4	2.9	3.4	3.2	3.4	3.9	3.0	2.7	2.2	3.4
4	6.2	3.8	4.0	2.8	3.5	3.2	2.1	4.1	3.2	3.0	2.5	3.5
5	4.7	3.3	2.6	--	--	--	--	--	--	--	--	3.5
6	2.8	3.1	2.7	2.6	2.7	2.1	2.5	3.4	3.0	2.4	2.1	2.7
7	3.8	2.9	2.7	2.6	2.4	2.2	2.4	3.4	3.0	2.8	2.6	2.8
9	7.7	4.5	3.7	3.2	4.0	3.2	2.5	5.0	3.3	3.0	2.4	3.9
10	--	3.5	3.0	3.2	3.3	2.9	2.5	3.8	3.3	2.8	2.4	3.1
Lake Avg	5.3	3.6	3.2	2.9	3.2	2.9	2.5	3.9	3.1	2.8	2.4	3.2
Treatment Area Avg*	6.2	3.8	3.5	2.9	3.5	3.1	2.5	4.1	3.2	2.8	2.4	3.4
Non-Treatment Area Avg*	3.8	3.1	2.7	2.6	2.6	2.2	2.5	3.4	3.0	2.6	2.4	2.8

[a] Days after initial treatment on May 21, 2014.

* Sites 5, 6, and 7 lie outside of the active treatment area and were not used in determining treatment-area averages. The non-treatment-area averages include only Sites 5, 6, and 7

Chart 4.2.1. Sonar concentration (ppb fluridone on vertical axis) by FasTEST site (nine locations) and lakewide average during 2014.



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5.0 ACTION PLAN UPDATE

Eight consecutive years of fluridone have continued to control vegetative hydrilla, helped prevent the spread of hydrilla to other lakes, and have had minimal impacts on the overall water quality of Lake Manitou. In 2014, while the lake's plant community remains suppressed versus pre-eradication conditions, there were indications of increased native vegetation abundance and diversity per the objective of recent management plant adjustments, and no hydrilla was detected during any of the surveys—the first lack of detection since the initiation of the hydrilla eradication effort.

The continued recommendation to IDNR for 2015 will be initiation of a Sonar management plan at a similar scale and intensity conducted during 2014. In dialogue with IDNR between now and the spring, the program may potentially be modified nominally for 2015 to attempt to increase enhance potential selectivity to native submersed plants in the south/upper end of the lake where hydrilla has never been detected. From 2007 – 2014, lake-wide management (or near lake-wide since 2013) has been pursued on Manitou for purposes of hydrilla eradication. 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 conclusively determined, 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. Understanding this risk but attempting to balance 1) a lack of any historical hydrilla finds in the south end of the lake and 2) the long-term pressure on the lake's fishery after six cycles of management, IDNR requested a plan in 2013 to minimize south end treatment to promote better native submersed plant growth. These efforts appear to be having benefit with some increase in vascular macrophyte diversity and presence in 2014. Efforts will be made to continue that trend in 2015, which may be the final cycle of management associated with the hydrilla management program.

5.1 Diagnostic Data for Precision Sonar Application

Hydrilla produces large numbers of tubers that can remain dormant in the sediment for many years. This fact makes eradication difficult but not impossible. Following the 2010 season—the successful fourth annual cycle of management—a 4.8 to 6.7-year horizon was projected for 99.5% tuber attrition in Manitou, which appears to have been achieved. As presented at the December 2009 summit on status of the Manitou hydrilla program, eradication efforts like Pickerel Pond in Maine (ended at 9 consecutive cycles of Sonar…vegetative hydrilla not found in the last three years without treatment) and Pipe/Lucerne Lakes in Washington (11 cycles of Sonar between 1995 – 2007...no detections through 2014) confirm that complete eradication of

hydrilla tubers requires a sustained long-term commitment. Those findings also align with pattern and timing of hydrilla decline on Manitou suggesting a similar timeline for full eradication. Past data from NC State University monitoring of tuber populations on Lake Gaston in NC/VA indicates that the hydrilla tuber bank can double in a single year without Sonar treatment (Nawrocki et al. 2009). These data reinforce that if treatments end prior to full elimination of the Manitou tuber bank, tuber densities may return to pre-treatment levels within a few years. The first five years of Sonar application resulted in successful control of hydrilla with 99.5% reductions in tubers and prevention of hydrilla spread to other waters of Indiana. The remaining <0.5% has now been depleted further by three additional cycles of treatment making vegetative hydrilla growth now undetectable per 2014 dive survey results. Other successful eradication programs have treated 2 or 3 seasons beyond the last detection of hydrilla to ensure full tuber bank depletion. For Manitou, 2015 would represent the second full season without detection. If DNR follows past precedent with a least a second annual cycle of management without detection, current status would support a projection that 2015 will be the final annual cycle of the multi-year eradication program.

Over the now eight cycles of management, the eradication program has impacted the native submersed plant community, which was expected due to the importance placed on successful hydrilla control and the overall low species richness of the lake. 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, Sonar concentrations of 3.0 ppb or less triggered a bump application to return whole-lake average concentration to 6.0 ppb, (initial dose). The changes in 2010 dictated a lower concentration of 2.5 ppb would initiate a bump application to target lower lake-wide average residues of 5.0 ppb. In 2013, the continued detection of vegetative hydrilla growth along the northern shore of the lake and along the west side of Big Island confirmed that hydrilla treatment remained necessary to reach an eradication outcome. In 2014, hydrilla was not detected in the lake. Entering the 2015 season, IDNR continues to reinforce that reducing herbicide pressure and encouraging greater growth and expansion of native aquatic vegetation in Manitou continues as a desirable management goal in what may be the final year of the hydrilla eradication effort barring unexpected detection next season. In light of this continued objective while seeking to insure 100% hydrilla eradication, the following are recommended actions for the 2015 hydrilla control efforts on Manitou:

1) **Continued utilization of hydrilla detection / quantification methods used in 2014**. In 2011, a lake- wide dive survey examining area of past hydrilla finds and LARE Tier II locations supported that hydrilla was likely confined to the northern half of the lake. Based on that result, the June 2012 dive survey re-focused efforts on broad areas where hydrilla was detected in 2011: the northern shore of the lake and around the Big Island area. The 2012 survey confirmed hydrilla presence along the

north shoreline. In 2013, a modified 1.5-day dive survey design included seven 'high-intensity' survey zones along with lower-resolution bottom survey around those areas. That strategy located isolated hydrilla (4 plants total) in three locations. In 2014, a slightly modified strategy designed to further enhance hydrilla detection in the high intensity areas did not detect hydrilla. The exact design of the 2015 dive survey will be replicated in 2015 for comparability between years. This same survey design is planned to be used for all future surveys, and it is strongly recommended that this dive survey be continued for at least three years beyond the last year of application. As Sonar use strategy in the south end of the lake follows a plan similar to the 2014 modification to promote greater native plant growth, it will remain important to closely monitor for any hydrilla detection there through Tier II and general recon surveys during the treatment.

2) **Implement the same strategy for partial Sonar application in 2015 as implemented in 2014.** In 2013 and 2014, a modified large-scale Sonar application was implemented that maintained pressure on hydrilla possibly remaining in the northern section of the lake but intended to reduce herbicide levels in the south (upper) end of the lake to promote better native submersed plant growth. In 2014, modifications focused on greater pellet utilization with good results, including a potential uptick in native submersed vegetation, reduced elevated 'spikes of herbicide associated with past liquid re-applications, and more efficient overall application effort. A very similar design in terms of duration of active treatment, formulation choice and scale of application should be implemented in 2015. Possible minor adjustments to the program can be discussed with DNR as part of project planning over the winter.

The overall rate of Sonar used compared to previous years with an integrated formulation approach has been adjusted down slightly in several of the last few cycles based on management experience on the lake. In 2010, the maintenance range for Sonar dose to 2.5 – 5 ppb (following initial 6 ppb target) was formally refined and successfully implemented. The modified approach for 2013 decreased average Sonar concentration to 3.3 ppb for the season. In 2014, a more consistent Sonar level was maintained with an average of 3.2 ppb lake wide but with fewer elevated readings. The 2013 and 2014 growing seasons have both been somewhat different than most of the first 6 years of the eradication program with late springs and cooler conditions overall that appeared to impact submersed plant communities in lakes throughout the region. A continued analysis of historic precipitation records during the May-Sept period over the last 20 years (Table 5.1.1) indicates that precipitation in most of the eight years of treatment has been below seasonal averages, particularly in the drought year of 2012. 2014 was another season of overall near-normal rainfall versus historical averages but did have lower than normal precipitation in July but above-normal conditions in August and September. An above average rainfall pattern throughout the 2015 treatment cycle could dictate greater Sonar usage versus 2014—specifically incorporation of some liquid AS bump applications to achieve Sonar target levels. The Sonar program should continue routine FasTEST collection identical to most of the 2014 monitoring effort to follow herbicide levels and adjust with bump treatment modifications as needed.

Table 5.1.1. May through September monthly precipitation records from 1995-2014 for the Fulton County Airport just north of Lake Manitou in Rochester, Indiana. 2007 – 2014 records are compared to 20-year mean and median seasonal precipitation.

	Monthly Precipitation (inches)					
	May	Jun	Jul	Aug	Sept	TOTAL
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	25.7
1998	4.7	7.3	9.5	3.3	1.2	26.1
1999	3.2	4.2	1.4	3.2	2.5	14.4
2000	5.0	6.3	3.5	5.0	4.4	24.1
2001	4.2	4.1	8.5	5.6	3.2	25.6
2002	6.4	2.1	3.3	3.3	1.9	16.9
2003	6.3	2.0	9.3	2.0	5.3	24.8
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	22.7
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	22.3
2012	0.8	0.8	3.1	2.6	1.1	8.4
2013	2.8	9.0	1.1	3.9	2.6	19.3
2014	3.5	4.1	1.9	6.6	4.1	20.2
MEAN	4.7	4.2	4.6	4.1	3.0	20.4
MEDIAN	5.0	4.0	4.0	3.6	2.8	20.3

Difference from 20-Year Mean Precipitation

	May	Jun	Jul	Aug	Sept	TOTAL	% Diff
2007	-2.36	-1.69	0.51	2.52	-1.86	-2.9	-14.1
2008	-0.57	1.48	-2.98	-1.46	0.61	-2.9	-14.3
2009	0.54	-1.25	-1.84	1.19	-1.46	-2.8	-13.8
2010	1.31	1.54	-0.35	-2.56	0.02	0.0	-0.2
2011	2.21	-1.46	-0.25	-2.06	3.42	1.9	9.1
2012	-3.89	-3.36	-1.45	-1.46	-1.88	-12.0	-58.9
2013	-1.89	4.80	-3.48	-0.13	-0.40	-1.1	-5.4
2014	-1.2	-0.1	-2.7	2.5	1.1	-0.3	-1.4

Difference from 20-Year Median Precipitation

	May	Jun	Jul	Aug	Sept	TOTAL	% Diff
2007	-2.71	-1.51	1.07	2.95	-1.73	-2.7	-13.4
2008	-0.92	1.67	-2.43	-1.04	0.75	-2.8	-13.6
2009	0.20	-1.07	-1.29	1.62	-1.33	-2.7	-13.1
2010	0.97	1.73	0.21	-2.14	0.16	0.1	0.6
2011	1.87	-1.28	0.31	-1.64	3.56	2.0	10.0
2012	-4.24	-3.18	-0.90	-1.04	-1.75	-11.9	-58.6
2013	-2.24	4.99	-2.93	0.30	-0.27	-0.9	-4.6
2014	-1.6	0.1	-2.1	3.0	1.3	-0.1	-0.6

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 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 2014 project cost was down over 2013 (Table 5.2.1). Anticipated cost savings were the result of a smaller active management zone and just a single initial Sonar AS treatment due to the increased reliance on Sonar pellets in this year's plan. Herbicide concentrations remained rather stable and lower overall throughout the season with just the two pre-planned Sonar PR bump applications.

Table 5.2.1. Budget update for 2014.

Year	Actual expenditures	Year	Actual expenditures
2007	$349,920	**2012**	$268,094
2008	$317,549	**2013**	$299,219
2009	$351,949	**2014**	$253,054
2010	$268,076		
2011	$248,315		

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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 the threat of Asian carp spread into 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 eight 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 2014 public access, successful multi-year eradication efforts have essentially eliminated risk of hydrilla contamination of boats and movement from Manitou to another water body. Therefore, ramp closure and inspections are unnecessary.

Additionally, routine dialogue with Midwest and other northern regulators and resource managers on the threat of hydrilla should be initiated or maintained to help prevent or limit hydrilla expansion into more Indiana 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 and northern 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. In particular, recently discovered, dense infestations in public access areas of the Ohio River, reservoirs in Kentucky, and multiple water bodies in northeast Ohio all pose high risk of invasion to adjacent states like Indiana.

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APPENDIX

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LARE Tier 2 Survey Raw Data 6/26/14

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

LARE Tier 2 Survey Raw Data 6/26/14 Continued

WPT	Lat	Long	Depth	Fil. Algae	Chara	Sago pondweed	Coontail	Bladderwort	Large leaf pondweed	Leafy pondweed	Water stargrass	Horned pondweed
61	41.05424	-86.18489	5		1							
62	41.05413	-86.17949	6		1							
63	41.05412	-86.17764	5	P	1							
64	41.05425	-86.17063	4									
65	41.05540	-86.19107	5		1							
66	41.05523	-86.18561	5		1							
67	41.05542	-86.18407	6		1							
68	41.05529	-86.17871	6		1							
69	41.05532	-86.17694	5	P	1							
70	41.05537	-86.17161	4	P	1							
71	41.05542	-86.16978	4	P	1		1					
72	41.05641	-86.19216	2	P	3							
73	41.05646	-86.19026	5		1							
74	41.05643	-86.18845	6		5							
75	41.05644	-86.18676	8									
76	41.05652	-86.17782	7		3		1					
77	41.05655	-86.17593	6	P								
78	41.05659	-86.17067	3	P	1							
79	41.05756	-86.19298	2	P								
80	41.05757	-86.19115	5		5							
81	41.05761	-86.18916	5		5							
82	41.05770	-86.18755	5		5							
83	41.05762	-86.18570	6		3							
84	41.05771	-86.18401	5									
85	41.05782	-86.17862	7									
86	41.05776	-86.17679	6									
87	41.05813	-86.17139	4	P			1					
88	41.05883	-86.19191	4	P	5							
89	41.05858	-86.19007	4	P	1							
90	41.05882	-86.18841	4	P	1							
91	41.05880	-86.18665	4	P	1							
92	41.05877	-86.18495	6		1							
93	41.05881	-86.18324	5									
94	41.05876	-86.18144	6	P	1							
95	41.05882	-86.17971	6		1							
96	41.05880	-86.17796	3	P	1							
97	41.05890	-86.17607	5	P								
98	41.05893	-86.17439	5	P	1							
99	41.05894	-86.17246	4	P								
100	41.05986	-86.19466	3	P								
101	41.05994	-86.19282	3	P	5							
102	41.05995	-86.18944	7	P								
103	41.06005	-86.18215	5									
104	41.05995	-86.18052	5	P	1							
105	41.05998	-86.17874	5	P	1							
106	41.06002	-86.17694	3	P								
107	41.05997	-86.17505	3	P	1							
108	41.05986	-86.17323	2	P	1		1					
109	41.06092	-86.18498	4	P								
110	41.06113	-86.18318	4	P	1							
111	41.06108	-86.18132	5	P	1		1					
112	41.06111	-86.17951	5	P	1							
113	41.05424	-86.1773	5	P	1							
DK 1	41.06071	-86.19449	4	P								
DK 2	41.05927	-86.19456	4	P	1							
DK 3	41.06106	-86.18397	2	P	1							
DK 4	41.06179	-86.18296	4	P	1							
DK 5	41.05555	-86.19245	3	P	3							
DK 6	41.04855	-86.18697	4	P	1							
DK 7	41.04933	-86.18957	5	P								
DK 8	41.04548	-86.18241	11	P	1		1					
DK 9	41.04945	-86.17431	7									
DK 10	41.0502	-86.17181	2	P	1							
DNR 1	41.04877	-86.18804	6	P								

LARE Tier 2 Survey Raw Data 8/27/14

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

LARE Tier 2 Survey Raw Data 8/27/14 Continued

WPT	Lat	Long	Depth	Fil. Algae	Chara	Sago pondweed	Coontail	Bladderwort	Large leaf pondweed	Water stargrass	Flatstem pondweed
62	41.05413	-86.17949	5	P							
63	41.05412	-86.17764	4	P	1						
64	41.05425	-86.17063	5								
65	41.05540	-86.19107	4				1				
66	41.05523	-86.18561	4								
67	41.05542	-86.18407	4								
68	41.05529	-86.17871	5								
69	41.05532	-86.17694	4	P							
70	41.05537	-86.17161	5								
71	41.05542	-86.16978	5								
72	41.05641	-86.19216	3	P							
73	41.05646	-86.19026	4								
74	41.05643	-86.18845	5		1						
75	41.05644	-86.18676	8								
76	41.05652	-86.17782	6								
77	41.05655	-86.17593	5								
78	41.05659	-86.17067	4								
79	41.05756	-86.19298	2								
80	41.05757	-86.19115	4								
81	41.05761	-86.18916	4		1						1
82	41.05770	-86.18755	4		1						
83	41.05762	-86.18570	4		1						
84	41.05771	-86.18401	4								
85	41.05782	-86.17862	6								
86	41.05776	-86.17679	6								
87	41.05813	-86.17139	5								
88	41.05883	-86.19191	3	P	1						
89	41.05858	-86.19007	4		1						
90	41.05882	-86.18841	3								
91	41.05880	-86.18665	3	P							
92	41.05877	-86.18495	4								
93	41.05881	-86.18324	4		4						
94	41.05876	-86.18144	5								
95	41.05882	-86.17971	6	P							
96	41.05880	-86.17796	4	P							
97	41.05890	-86.17607	5	P							
98	41.05893	-86.17439	8	P							
99	41.05894	-86.17246	5	P							
100	41.05986	-86.19466	3								
101	41.05994	-86.19282	3		5						
102	41.05995	-86.18944	6								
103	41.06005	-86.18215	4	P	1						
104	41.05995	-86.18052	4	P							
105	41.05998	-86.17874	4	P							
106	41.06002	-86.17694	4	P							
107	41.05997	-86.17505	4	P							
108	41.05986	-86.17323	4	P							
109	41.06092	-86.18498	3								
110	41.06113	-86.18318	3								
111	41.06108	-86.18132	5	P	1						
112	41.06111	-86.17951	4	P							
113	41.05424	-86.17730	4	P							
DK 1	41.06071	-86.19449	3								
DK 2	41.05927	-86.19456	3		1						
DK 3	41.06106	-86.18397	2	P							
DK 4	41.06179	-86.18296	2	P							
DK 5	41.05555	-86.19245	2		3						
DK 6	41.04855	-86.18697	3	P							
DK 7	41.04933	-86.18957	5	P							
DK 8	41.04548	-86.18241	6								
DK 9	41.04945	-86.17431	9								
DK 10	41.05020	-86.17181	4								
DNR 1	41.04877	-86.18804	4	P							

RECONNAISSANCE MONITORING DATA SHEETS

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 presen	6	No growth	E	End of Life Cycle	

Survey Date: 5/27/2014

Date of Treatment: 5/21/2014

Gauge Reading: gauge gone

Site	Species	Injury	Cover	Growth	Other	Photos	Secchi	Depth	H_2OTemp	D O_2	Notes
1	No plants						6.0		75.6		depth 6.5 feet
2	No plants						8.2	surface	76.9	5.67	depth 30 feet
								1m	75.7	5.71	
								2m	75.3	5.73	
								3m	71	4.09	
								4m	64.3	1.46	
								5m	60.9	0.27	
								6m	59.6	0.2	
								7m	59	0.16	
								8m	57.7	0.14	
								9m	56.5	0.12	
								10m	55.7	0.11	
3	coontail	2	5	1			3.8		76.1		depth 5 feet
	small pond	2	5	1							
4	No plants						bottom visible		75.5		depth 5 feet
5	No plants						7.5		75.8		depth 18 feet
6	Curly-leaf p	2	5	1			bottom visible		75.2		depth 4 feet
	algae present										
7	No plants						7.5	surface	77.90	6.40	depth 39 feet
								1m	77.10	6.41	
								2m	76.40	6.37	
								3m	7.38	5.96	
								4m	67.70	3.77	
								5m	64.30	2.69	
								6m	61.20	1.59	
								7m	59.60	0.93	
								8m	58.30	0.21	
								9m	57.30	0.16	
								10m	56.60	0.15	
9	coontail						2.8		76.7		depth 5 feet
	algae present										
											Summary
											Weather:warm, breezy, air temp in mid 80's
											water temp range degrees F 75.2 - 77.9
											Secchi Range: 2.8 - 8.2 feet
											coontail and small pondweed, and curly-leaf 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	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 presen	6	No growth	E	End of Life Cycle	

Survey Date: 6/9/2014

Date of Treatment: 5/21/2014

Gauge Reading: 8.36

Site	Species	Injury	Cover	Growth	Other	Photos	Secchi	Depth	H_2OTemp	D O_2	Notes
1	No plants						Bottom visible		74.6		depth 6.5 feet
2	No plants						10.1	surface	76.0	7.6	depth 30 feet
								1m	75.8	7.62	
								2m	75.3	7.57	
								3m	74.7	7	
								4m	73.9	6.51	
								5m	62.9	1.36	
								6m	62.0	0.3	
								7m	59.3	0.21	
								8m	58.1	0.16	
								9m	57.1	0.14	
								10m	57.1	0.11	
3	coontail	3	5	6			Bottom Visible		74.6		depth 5 feet
	Algae										
4	Chara	2	5	6			Bottom visible		75.1		depth 5 feet
5	No plants						6.9		76.0		depth 18 feet
6	algae present						bottom visible		75.7		depth 4 feet
7	No plants						6.7	surface	76.5	8.94	depth 39 feet
								1m	75.8	9.02	
								2m	75.0	8.42	
								3m	74.8	8.09	
								4m	74.4	7.66	
								5m	73.9	6.68	
								6m	68.0	0.50	
								7m	60.6	0.19	
								8m	58.8	0.16	
								9m	57.3	0.14	
								10m	56.3	0.13	
9	algae present						bottom visible		74.3		depth 5 feet
10	no plants						bottom visible		75.1		**Summary**
											Weather: sunny, calm temp in mid 70's
											water temp range degrees F 74.3 - 76.5
											Secchi Range: (feet) 6.7 - 10.1
											chara, coontail collected on rake. curly leaf, sago and bladderwort all observed
											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 presen	6	No growth	E	End of Life Cycle	

Survey Date:	Date of Treatment:	Gauge Reading:
6/23/2014	5/21/2014	8.28

Site	Species	Injury	Cover	Growth	Other	Photos	Secchi	Depth	H_2OTemp	D O_2	Notes
1	No plants						4.2		81.4		depth 6.5 feet
2	No plants						6.6	surface	81.7	8.09	depth 30 feet
								1m	81.3	8.08	
								2m	81.2	8.08	
								3m	79.2	6.34	
								4m	75.9	3.61	
								5m	72.2	0.45	
								6m	64.8	0.13	
								7m	61.7	0.11	
								8m	58.5	0.09	
								9m	57.1	0.08	
								10m	55.8	0.07	
3	Algae present						4.8		81.3		depth 5 feet
4	Chara	2	5	6			4.0		81.4		depth 5 feet
5	No plants						5.8		80.6		depth 18 feet
6	Algae present						bottom visible		80.9		depth 4 feet
7	No plants						6.2	surface	81.6	9.12	depth 39 feet
								1m	81.5	9.15	
								2m	81.3	9.09	
								3m	81.1	8.72	
								4m	78.2	5.26	
								5m	75.1	3.03	
								6m	72.5	1.40	
								7m	67.9	0.17	
								8m	60.9	0.12	
								9m	58.2	0.10	
								10m	56.7	0.09	
9	Chara	2	5	6			bottom visible		81.9		depth 5 feet
											Summary
10	Chara	2	5	6			6.1		81.0		
											Weather: cloudy/rainy temp in lower 80's
											water temp range degrees F 80.6 - 81.9
											Secchi Range: 4.0 to 6.6 feet
											Chara collected on rake. Coontail sago and water stargrass 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 presen	6	No growth	E	End of Life Cycle	

Survey Date: 7/8/2014

Date of Treatment: 5/21/2014

Gauge Reading: 8.2

Site	Species	Injury	Cover	Growth	Other	Photos	Secchi	Depth	H_2OTemp	D O_2	Notes
1	No plants						3.9		77.2		depth 6.5 feet
2	No plants						4.4	surface	77.1	8.15	depth 30 feet
								1m	77.0	8.21	
								2m	76.9	8.22	
								3m	76.9	8.23	
								4m	76.7	8.09	
								5m	73.7	2.76	
								6m	70.5	0.23	
								7m	65.2	0.17	
								8m	60.4	0.13	
								9m	57.7	0.11	
								10m	56.7	0.1	
3	algae present						3.8		75.4		depth 5 feet
4	Chara	1	4	3			3.9		77.3		depth 5 feet
											depth 18 feet
6	algae present						bottom visible		77.3		depth 4 feet
7	No plants						4.2	surface	77.8	8.68	depth 39 feet
								1m	77.7	8.71	
								2m	77.6	8.67	
								3m	77.8	8.63	
								4m	76.7	7.45	
								5m	76.0	6.60	
								6m	74.8	5.14	
								7m	71.7	1.42	
								8m	64.8	0.20	
								9m	61.3	0.15	
								10m	58.4	0.12	
9	algae present						2.7		76.7		depth 5 feet
10	Chara	4	5	6			3.8		77.2		**Summary**
											Weather: rainy/breezy : temp in mid 70's
											water temp range degrees F 75.4 -77.8
											Secchi Range: 2.7 - 4.4 feet
											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	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 presen	6	No growth	E	End of Life Cycle	

Survey Date:	Date of Treatment:	Gauge Reading:
7/22/2014	5/21/2014	8.1

Site	Species	Injury	Cover	Growth	Other	Photos	Secchi	Depth	H_2OTemp	D O_2	Notes
1	No plants						3.0		80.0		depth 6.5 feet
2	No plants						3.8	surface	80.7	10.84	depth 30 feet
								1m	79.4	11.05	
								2m	78.8	10.89	
								3m	77.4	9.59	
								4m	74.0	4.63	
								5m	72.7	2.63	
								6m	70.0	0.25	
								7m	66.0	0.19	
								8m	60.6	0.14	
								9m	57.9	0.13	
								10m	56.8	0.12	
3	No plants						3.2		80.0		depth 5 feet
4	Chara						2.9		80.4		depth 5 feet
											depth 18 feet
6	algae present						3.9		78.6		depth 4 feet
7	No plants						3.9	surface	79.1	11.92	depth 39 feet
								1m	79.1	11.94	
								2m	78.8	12.02	
								3m	76.9	10.44	
								4m	75.4	7.99	
								5m	74.2	4.21	
								6m	73.7	4.00	
								7m	71.6	1.02	
								8m	67.2	0.19	
								9m	61.5	0.13	
								10m	59.1	0.12	
9	algae present						2.7		81.5		depth 5 feet
10	No plants						3.2		78.9		**Summary**
											Weather: sunny, windy, temp in low 90's
											water temp range degrees F 78.6 - 81.5
											Secchi Range: 2.7 - 3.9 feet
											chara collected on rake. water stargrass, coontail, sago also observed
											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 presen	6	No growth	E	End of Life Cycle	

Survey Date: 8/4/2014

Date of Treatment: 5/21/2014

Gauge Reading: 8.06

Site	Species	Injury	Cover	Growth	Other	Photos	Secchi	Depth	H_2OTemp	D O_2	Notes
1	No plants						3.5		78.6		depth 6.5 feet
2	No plants						3.7	surface	80.6	9.41	depth 30 feet
								1m	79.7	9.63	
								2m	78.6	9.42	
								3m	76.2	8.26	
								4m	73.4	5.94	
								5m	72.1	3.85	
								6m	70.5	0.29	
								7m	66.4	0.22	
								8m	62.0	0.16	
								9m	58.7	0.14	
								10m	56.7	0.13	
3	Algae present						3.1		77.6		depth 5 feet
4	Chara	4	5	6			2.8		78.6		depth 5 feet
	Algae present										
6	Algae present						3.9		79.8		depth 4 feet
7	No plants						4.1	surface	80.1	10.41	depth 39 feet
								1m	79.1	10.80	
								2m	78.5	10.48	
								3m	75.7	8.31	
								4m	74.3	6.54	
								5m	72.9	4.44	
								6m	72.2	3.49	
								7m	72.1	3.42	
								8m	71.3	1.84	
								9m	68.6	0.21	
								10m	64.0	0.16	
9	Algae present						2.8		77.7		depth 5 feet
											Summary
10	Algae present						3.2		78.7		Weather:sunny, calm, temp in low 80's
											water temp range degrees F : 77.6 - 80.6
											Secchi Range: 2.8 - 4.1 feet
											chara collected on rake. waterstargrass, sago pondweed observed
											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 presen	6	No growth	E	End of Life Cycle	

Survey Date:	Date of Treatment:	Gauge Reading:
8/18/2014	5/21/2014	8.12

Site	Species	Injury	Cover	Growth	Other	Photos	Secchi	Depth	H_2OTemp	D O_2	Notes
1	No plants						3.9		75.8		depth 6.5 feet
2	No plants						3.3	surface	77.6	8.32	depth 30 feet
								1m	76.7	8.36	
								2m	76.1	8.44	
								3m	74.7	7.72	
								4m	73.8	6.77	
								5m	73.0	5.03	
								6m	71.5	1.35	
								7m	67.8	0.25	
								8m	64.7	0.18	
								9m	60.4	0.14	
								10m	57.7	0.12	
3	algae present						3.3		74.8		depth 5 feet
4	No plants						2.8		76.1		depth 5 feet
											depth 18 feet
6	algae present						3.9		76.8		depth 4 feet
7	No plants						4.3	surface	77.4	8.93	depth 39 feet
								1m	76.7	8.91	
								2m	75.8	8.25	
								3m	75.5	8.05	
								4m	74.5	7.08	
								5m	73.9	5.78	
								6m	73.2	3.78	
								7m	72.2	1.46	
								8m	67.7	0.27	
								9m	64.1	0.16	
								10m	60.0	0.13	
9	algae present						2.4		74.5		depth 5 feet
											Summary
10	no plants						3.3		75.4		Weather: calm, sunny, temp in low 80's
											water temp range degrees F: 74.5 - 77.6
											Secchi Range: 2.4 - 4.3 feet
											no plants collected on rake. Sago, coontail, waterstargrass all observed.
											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 presen	6	No growth	E	End of Life Cycle	

Survey Date:	Date of Treatment:	Gauge Reading:
9/3/2014	5/21/2014	8.14

Site	Species	Injury	Cover	Growth	Other	Photos	Secchi	Depth	H_2OTemp	D O_2	Notes
1	No plants						3.5		77.9		depth 6.5 feet
2	No plants						3.7	surface	80.1	7.49	depth 30 feet
								1m	78.1	7.69	
								2m	77.8	7.58	
								3m	77.0	6.94	
								4m	76.0	5.8	
								5m	75.0	1.9	
								6m	71.0	0.19	
								7m	68.0	0.12	
								8m	64.8	0.09	
								9m	60.8	0.08	
								10m	58.5	0.07	
3	No plants						2.8		76.7		depth 5 feet
4	No plants						2.7		77.6		depth 5 feet
											depth 18 feet
6	algae present						3.9		78.2		depth 4 feet
7	No plants						3.4	surface	78.7	7.98	depth 39 feet
								1m	78.0	8.04	
								2m	77.2	7.56	
								3m	76.9	7.25	
								4m	76.9	7.21	
								5m	76.7	6.64	
								6m	75.9	3.48	
								7m	74.4	0.71	
								8m	68.5	0.18	
								9m	64.8	0.12	
								10m	61.1	0.10	
9	algae present						2.3		76.8		depth 5 feet
											Summary
10	No plants						3.5		77.6		Weather: sunny calm, temp in low 80's
											water temp range degrees F 76.7 - 80.1
											Secchi Range: 2.3 - 3.9 feet
											no plants collected on rake. coontail, water stargrass becoming more prevalent 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 presen	6	No growth	E	End of Life Cycle	

Survey Date: 9/15/2014

Date of Treatment: 5/21/2014

Gauge Reading: 8.22

Site	Species	Injury	Cover	Growth	Other	Photos	Secchi	Depth	H_2OTemp	D O_2	Notes
1	No plants						3.2		65.9		depth 6.5 feet
2	No plants						3.3	surface	65.3	6.81	depth 30 feet
								1m	65.3	6.77	
								2m	65.3	6.73	
								3m	65.3	6.68	
								4m	65.3	6.62	
								5m	65.3	6.81	
								6m	65.3	6.87	
								7m	65.3	6.84	
								8m	65.1	5.85	
								9m	63.4	0.31	
								10m	58.5	0.23	
3	algae present						3.2		65.3		depth 5 feet
4	algae present						3.2		65.3		depth 5 feet
5	No plants										depth 18 feet
6	algae present						3.5		66.0		depth 4 feet
7	No plants						3.2	surface	66.2	7.08	depth 39 feet
								1m	66.3	7.04	
								2m	66.4	6.99	
								3m	66.5	6.95	
								4m	66.6	6.81	
								5m	66.6	6.73	
								6m	66.6	6.41	
								7m	66.4	6.08	
								8m	66.3	6.04	
								9m	66.1	4.61	
								10m	65.7	3.78	
9	algae present						3.1		65.0		depth 5 feet
											Summary
10	No plants						3.6		66.1		Weather:Rainy, temps in low 60's
											water temp range degrees F 65.0 - 66.2
											Secchi Range: 3.1 - 3.6 feet
											no plants collected on rake. coontail, sago, waterstargrass, bladderwort observed in 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	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 presen	6	No growth	E	End of Life Cycle	

Survey Date:	Date of Treatment:	Gauge Reading:
9/30/2014	5/21/2014	8.16

Site	Species	Injury	Cover	Growth	Other	Photos	Secchi	Depth	H_2OTemp	D O_2	Notes
1	No plants						3.2		67.5		depth 6.5 feet
2	No plants						2.9	surface	69.9	9.7	depth 30 feet
								1m	69.1	9.71	
								2m	68.9	9.69	
								3m	67.3	8.35	
								4m	66.3	7.01	
								5m	65.0	4.8	
								6m	64.5	3.22	
								7m	64.0	0.77	
								8m	63.7	0.21	
								9m	61.9	0.16	
								10m	59.9	0.13	
3	No plants						3.9		65.3		depth 5 feet
4	No plants						2.5		68.2		depth 5 feet
											depth 18 feet
6	algae present						3.2		65.8		depth 4 feet
7	No plants						3.4	surface	69.5	10.25	depth 39 feet
								1m	69.5	10.24	
								2m	68.5	9.88	
								3m	68.3	9.72	
								4m	68.1	9.59	
								5m	65.9	5.71	
								6m	65.1	4.41	
								7m	64.3	3.78	
								8m	64.5	1.93	
								9m	64.2	0.63	
								10m	62.6	0.21	
9	algae present						2.5		66.5		depth 5 feet
											Summary
10	No plants						3.7		68.6		Weather: cloudy, breezy, temp in 60's
											water temp range degrees F 65.3 - 69.9
											Secchi Range: 2.5 - 3.9 feet
											no plants 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	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 presen	6	No growth	E	End of Life Cycle	

Survey Date: 10/13/2014

Date of Treatment: 5/21/2014

Gauge Reading: 8.28

Site	Species	Injury	Cover	Growth	Other	Photos	Secchi	Depth	H_2OTemp	D O_2	Notes
1	No plants						4.2		58.3		depth 6.5 feet
2	No plants						4.4	surface	58.9	8.64	depth 30 feet
								1m	58.4	8.69	
								2m	58.0	8.7	
								3m	57.0	8.7	
								4m	57.6	8.67	
								5m	57.0	8.13	
								6m	56.6	7.79	
								7m	56.4	7.66	
								8m	56.2	7.62	
								9m	56.1	7.57	
								10m	55.9	7.37	
3	no plants						3.2		59.2		depth 5 feet
4	No plants						3.4		58.6		depth 5 feet
											depth 18 feet
6	algae present						bottom visible		59.7		depth 4 feet
7	No plants						4.6	surface	59.4	7.69	depth 39 feet
								1m	58.6	7.73	
								2m	58.2	7.71	
								3m	58.2	7.68	
								4m	57.9	7.61	
								5m	57.7	7.57	
								6m	57.5	7.53	
								7m	57.4	7.50	
								8m	57.3	7.40	
								9m	56.7	6.79	
								10m	56.6	6.65	
							3.2		59.3		
9	algae present										depth 5 feet
											Summary
							4.6		58.1		
10	algae present										Weather: rainy, temp in upper 60's
											water temp range degrees F 58.1 - 59.7
											Secchi Range: 3.2 - 4.6 feet
											no plants collected on rake.
											Rake samples taken at each shallow FasTEST Site
											No Hydrilla found