Hill Lake Aquatic Vegetation Management Plan Update
2009
Kosciusko County, Indiana

Prepared for:

The Diamond Lake Conservation Club
5119 Tomahawk Trail
Fort Wayne, Indiana 46804

March 1, 2010

Prepared by:

Aquatic Weed Control
P. O. Box 325
Syracuse, IN 46567

Executive Summary

On June 17, 2009, Hill Lake was treated for control of Eurasian watermilfoil (*Myriophyllum Spicatum*) with an herbicide called Sonar at a target rate of 6 parts per billion. Funding for this treatment was provided by the Diamond Lake Conservation Club and the IDNR Division of Fish and Wildlife through the Lake and River Enhancement Program (LARE). The goal of this treatment strategy was to greatly reduce the amount of invasive milfoil in Hill Lake to help beneficial native plants compete with Eurasian watermilfoil (EWM). Reducing EWM in Hill Lake could also benefit Diamond Lake and other downstream lakes by reducing EWM fragments flowing through the water system.

The 2009 Sonar treatment was originally scheduled for much earlier in spring (May 14, 2009), but a red planktonic algal bloom decreased water clarity and delayed EWM growth and treatment. By June 17, the algal bloom had experienced a natural die off. Water clarity had improved and viable milfoil was observed growing by SePRO Aquatic Specialist Bob Johnson. Treatment was then promptly scheduled.

Actual Sonar concentration was measured on June 22, 2009 at 7.6 parts per billion using a water sample collected by Aquatic Weed Control and sent to SePRO Corporation Labs (manufacturers of Sonar herbicide). This actual concentration was 1.6 parts per billion over the target concentration of 6 parts per billion.

Water samples were taken periodically throughout the summer of 2009 to monitor the Sonar herbicide concentration in Hill Lake. On July 7, 2009 a water sample was collected and the Sonar concentration was 6.0 parts per billion. On August 14, 2009 Sonar concentration was determined to be 3.2 parts per billion. On September 9, 2009 the Sonar concentration in Hill Lake was 1.7 parts per billion. Based on recommendations from Aquatic Weed Control and SePRO Corporation, the IDNR permitted a Sonar "bump" to increase herbicide concentration back to a target of 4 parts per billion. This was done to extend EWM's exposure time to lethal doses of Sonar. One major factor influencing the recommendation for a fall Sonar bump was the red algal bloom that took place in spring of 2009. There was a concern that shading from the algal bloom may have caused some natural die off of EWM vegetation. If a natural decline had occurred in spring, EWM root crowns could exist that did not have vegetation to take in the herbicide. A fall bump would hopefully provide additional control for re-growth from root crowns in fall. EWM often undergoes a period of rapid growth in fall as water temperatures begin to cool down and water clarity increases.

The bump application took place on September 21, 2009. A dissolved oxygen and temperature meter (Hach HQ 40d multi-meter) was used to determine the depth of the thermocline, but the lake had already de-stratified, most likely as a result of cold nights and windy weather prior to the bump. Actual concentration following the Sonar bump was 5.5 parts per billion, again 1.5 parts per billion over the target.

All Sonar calculations for Hill Lake were calculated using a total lake volume of 1,282 acre feet as specified and required by 2009 LARE bid documents. Based on J.F. New's 2008 management plan, Hill Lake had 67 acres and an average depth of 18.9 feet. However, actual herbicide applications based on these required figures produced concentrations of 1.5 ppb over target in spring and 1.6 ppb over target for the fall Sonar bump. These calculations

were made using an 11 foot thermocline in spring and no thermocline in fall. Lake volume can be back-calculated using actual 2009 herbicide concentrations. Based on back-calculations, using a lake acreage of between 50 and 55 acres may result in more accurate herbicide concentrations.

A late season quantitative aquatic vegetation survey called a Tier II survey was conducted on August 20, 2009 to collect data on the plant community of Hill Lake. The August vegetation survey found that Eurasian watermilfoil had been reduced to the point that it was undetectable in Hill Lake. The native plant community showed low diversity (0.49) with only 3 native plants being collected. Chara was fairly common, being collected at 35% of sample sites. Coontail was collected at 12.5% of sample sites while sago pondweed was collected at 5.0% of sample sites.

It is important to note that Sonar treatments will not eradicate EWM, and EWM is expected to return to Hill Lake in some capacity over the next 3 years.

No herbicide treatments for native species will be permitted on Hill Lake in 2010 without an on site inspection and approval by the DNR. This will give native plants a chance to re-establish themselves. Spot treatments will take place for any areas of Eurasian watermilfoil re-growth. The two major herbicides used in spot treatments for Eurasian watermilfoil are 2, 4-D and Renovate. 2, 4-D is recommended for use in Hill Lake. It is very similar in chemistry to Renovate and provides very similar results. It is also much less expensive than Renovate.

Based on past whole lake Sonar treatments, any Eurasian watermilfoil re-growth in 2010 should be very minimal. It is recommended that funding be set aside to treat up to 10 acres of Eurasian watermilfoil re-growth with DMA-4 (2, 4-D) herbicide. DMA-4 herbicide provides effective seasonal control for spot treatments of Eurasian watermilfoil re-growth. It can also be applied to small areas without having to treat the entire lake. Control from DMA-4 treatments generally does not last for multiple seasons and is not expected to reduce Eurasian milfoil acreage from one year to the next. A spring visual survey should be conducted to identify any areas of Eurasian watermilfoil re-growth. A late season tier II survey should be conducted to document changes in the native plant community and search for Eurasian watermilfoil re-growth.

2010 Proposed Budget

Treat up to 10 acres of EWM re-growth with DMA-4 (2, 4-D)	$3,700

Surveys

Option 1

Spring Visual Survey, Late Season Tier II survey and AVMP update	$4,700

Option 2

Spring Visual Survey, Late Season Tier II survey with data summary table and Invasive Species Map only (no AVMP update)	$2,000

Total 2010 Project Costs	**up to $8,400**
Lake and River Enhancement Share	up to $7,560
Diamond/Hill Lake Association Share	up to $840

Acknowledgements

Aquatic vegetation surveys conducted on Hill Lake were made possible by funding from the Diamond Lake Conservation Club and the Indiana Department of Natural Resources through the Lake and River Enhancement Program (LARE). Aquatic Weed Control would like to extend special thanks to Indiana Department of Natural Resources (IDNR) District 3 biologist Jed Pearson for providing procedural training for both Tier I and Tier II aquatic vegetation surveys in 2005. Angela Sturdevant, an aquatic biologist for the LARE program, provided valuable consultation regarding the requirements and objectives of this lake management plan. IDNR Fisheries Biologists, Jed Pearson and Rod Edgell, provided consultation for this AVMP as well. Aquatic Weed Control would also like to thank the members of the Diamond Lake Conservation Club and Hill Lake Residents for their commitments to lake improvement and valuable input brought forward at the public meeting on August 12, 2009.

Table of Contents

Executive Summary II

Acknowledgements V

Table of Contents VI

List of Figures VII

List of Tables VIII

1.0 Introduction 8

2.0 Watershed and Lake Characteristics Update 11

3.0 Lake Uses Update 15

4.0 Fisheries 16

5.0 Problem Statement 16

6.0 Vegetation Management Goals and Objectives 17

7.0 Past Management Efforts 17

8.0 Aquatic Plant Community Characterization 19

- 8.1 Methods Update 21
- 8.2 Results 23
  - 8.2.1 Tier II Results 23
- 8.3 Macrophyte Inventory Discussion 29

9.0 Aquatic Plant Management Alternatives 30

- 9.1 No Action 31
- 9.2 Institutional-Protection of Beneficial Vegetation 31
- 9.3 Environmental Manipulation 31
  - 9.3.1 Water Level Manipulation 31
  - 9.3.2 Nutrient Reduction 32
- 9.4 Mechanical Controls 32
  - 9.4.1 Mechanical Cutting and Harvesting 32
- 9.5 Manual Controls 33
  - 9.5.1 Hand Pulling, Cutting, Raking 33
  - 9.5.2 Bottom Barriers 33
- 9.6 Biological Controls 34
  - 9.6.1 Water Milfoil Weevil 34
  - 9.6.2 Grass Carp 34
- 9.7 Chemical Controls 35
  - 9.7.1 Aquatic Herbicides 35

10.0 Public Involvement 36

11.0 Public Education 38

12.0 Integrated Treatment Action Strategy 39

13.0 Project Budget 40

14.0 Monitoring and Plan Update Procedures 40

15.0 References 41

16.0 Appendices 43

16.1 Calculations 43
16.2 Common Aquatic Plants of Indiana 46
16.3 Pesticide Use Restrictions Summary: 53
16.4 Resources for Aquatic Management 54
16.5 State Regulations for Aquatic Plant Management 55
16.6 Data Sheets 57
16.7 IDNR Aquatic Vegetation Control Permit 61

List of Figures

Figure 1: Hill Lake Secchi History 11
Figure 2: Hill Lake Dissolved Oxygen Profile - 8/20/2009 12
Figure 3: Hill Lake Temperature Profile - 8/20/2009 13
Figure 4: Hill Lake Undeveloped Shoreline - South Shore 14
Figure 5: Hill Lake Access Point - North Shore 15
Figure 6: Hill Lake North Shore 16
Figure 7: Coontail Showing Chlorosis from Sonar Herbicide at Shipshewana Lake 18
Figure 8: J. F. New- Map - Eurasian Watermilfoil Abundance – 8/14/2008 (Ewoldt, 2009) 20
Figure 9: J.F. New-- Map - Eurasian Watermilfoil Abundance - 5/19/2008 (Ewoldt, 2009) 21
Figure 10: Hill Lake Tier II Rake Sample Locations 23
Figure 11: Hill Lake 2009 Coontail Locations 27
Figure 12: Hill Lake 2009 Chara Locations 28
Figure 13: Hill Lake 2009 Sago Pondweed Locations 29

List of Tables

Table 1: Hill Lake LARE History 8
Table 2: Common and Scientific Aquatic Plant Names 9
Table 3: Sample Depth by Trophic State 22
Table 4: Sample Sites by Lake Size and Trophic State 22
Table 5: Hill Lake 2009 Data Analysis Table 24
Table 6: Hill Lake Tier II Data History 25
Table 7: Diamond/Hill Lakes 2009 Public Questionnaire Summary 37
Table 8: Pesticide Use Restrictions 53

1.0 Introduction

The year 2009 was the first that Hill Lake received treatment funding through the LARE program. A whole lake Sonar treatment for systemic control of EWM was conducted on June 17, 2009. This treatment was originally scheduled for earlier in spring, but a significant planktonic algal bloom delayed treatment. Target concentration was 6ppb and actual concentration was 7.6 ppb. Sonar concentration was monitored throughout the summer with FasTESTs (water samples determining Sonar concentration) being collected on June 22, July 7, August 14, and September 9, 2009. A sonar bump was performed on September 21, 2009 and another FasTEST was collected on September 23, 2009. Target concentration was 4ppb, and actual concentration was 5.5 ppb. Table 1 summarizes all LARE funded activities on Hill Lake.

Table 1: Hill Lake LARE History

Year	Action	Date	Funding Source
2008	Spring Tier II Survey (J.F. NEW) Late Season Tier II Survey (J.F. New)	May 19, 2008 August 14, 2008	Lake and River Enhancement and Diamond Lake Conservation Club
2009	Whole Lake Sonar Treatment Late Season Tier II Survey Sonar Bump Application	June 17, 2009 August 20, 2009 September 21, 2009	Lake and River Enhancement and Diamond Lake Conservation Club

Table 2, provided by the IDNR, includes both common and scientific names of aquatic plants that are present in Indiana and may be referenced in AVMPs. It also contains species codes that may appear on some data sheets.

Table 2: Common and Scientific Aquatic Plant Names

Species Code	Scientific Name	Common Name	Vegetation Type
ALGA	Any species of filamentous alga (incl. *Spyrogyra, Cladophora, Hydrodictyon*)	algae	N
AZO001	*Azolla* sp.	A mosquito fern species	N
AZOCAR	*Azolla caroliniana*	Carolina mosquito fern	N
AZOMEX	*Azolla mexicana*	Mexican mosquito fern	N
CERDEM	*Ceratophyllum demersum*	coontail	S
CHARA	*Chara* sp.	A chara species	S
EGEDEN	*EGERIA DENSA*	BRAZILIAN ELODEA	S
ELOCAN	*Elodea Canadensis*	Canada waterweed	S
ELONUT	*Elodea nuttallii*	western waterweed	S
HYIVER	*HYDRILLA VERTICILLATA*	HYDRILLA	S
LEM001	*Lemna* sp.	duckweeds (species within Lemnaceae)	N
LEMMIO	*Lemna minor*	small or common duckweed	N
LEMTRI	*Lemna trisulca*	star duckweed	N
LUDDEC	*Ludwigia decurrens*	primrose-willow	F
MYRSIB	*Myriophyllum sibiricum*	northern watermilfoil	S
MYRSPI	*MYRIOPHYLLUM SPICATUM*	EURASIAN WATERMILFOIL	S
MYR001	*Myriophyllum* sp.	a watermilfoil species	S
NAJFLE	*Najas flexilis*	slender naiad	S
NAJGRA	*Najas gracillima*	Northern naiad	S
NAJGUA	*Najas guadalupensis*	Southern naiad	S
NAJMIN	*NAJAS MINOR*	BRITTLE WATERNYMPH	S
NELLUT	*Nelumbo lutea*	American lotus	F
NITELL	*Nitella* sp.	a nitella species	S
NOAQVG		no aquatic vegetation at site	N
NUPADV	*Nuphar advena*	spatterdock	F
NUPVAR	*Nuphar variegata* (formerly *N. luteum*)	bullhead lily (yellow pond lily)	F
NYMODT	*Nymphaea oderata subsp. tuberosa*	white water lily (fragrant water lily)	F

POTCRI	*POTAMOGETON CRISPUS*	CURLY-LEAF PONDWEED	S
POTEPI	*Potamogeton epihydrus*	ribbon-leaf pondweed	S
POTFOF	*Potamogeton foliosus*	leafy pondweed	S
POTGRA	*Potamogeton gramineus*	variable pondweed	S
POTILL	*Potamogeton illinoensis*	Illinois pondweed	S
POTNLV	*Potamogeton foliosus*, *P. pusillus*, or other unidentified narrow-leaved pondweeds	narrow-leaved pondweeds	S
POTNOD	*Potamogeton nodosus* (formerly *P. americanus*)	American pondweed	S
POTPRA	*Potamogeton praelongus*	white-stemmed pondweed	S
POTPUP	*Potamogeton pusillus*	small pondweed	S
POTRIC	*Potamogeton richardsonii*	Richardson's pondweed	S
POTZOS	*Potamogeton zosteriformis*	flat-stemmed pondweed	S
RANFLA	*Ranunculus flabellaris*	yellow water crowfoot (yellow water buttercup)	S
RANLON	*Ranunculus longirostris* (incl. *R. trichophyllus*)	white water crowfoot (rigid white water crowfoot)	S
RICCIA	*Riccia* sp., *Ricciocarpus* sp.	A liverwort species	N
SPIPOL	*Spirodela polyrhiza*	greater duckweed	N
STUPEC	*Stuckenia pectinata*	sago pondweed	S
UNKN01		Unknown specimen No. 1	
UNKN02		Unknown specimen No. 2	
UTRMAC	*Utricularia macrorhiza* (also known as *U. vulgaris*)	common bladderwort	S
VALAME	*Vallisneria americana*	wild celery or eel grass	S
WOA001	*Wolffia* sp.	A watermeal species	N
WOACOL	*Wolffia columbiana*	watermeal	N
ZANPAL	*Zannichellia palustris*	horned pondweed	S
ZOSDUB	*Zosterella dubia* (also known as *Heteranthera dubia*)	water stargrass	S

Note: The scientific and common names of EXOTIC species are shown in ALL CAPITAL LETTERS.

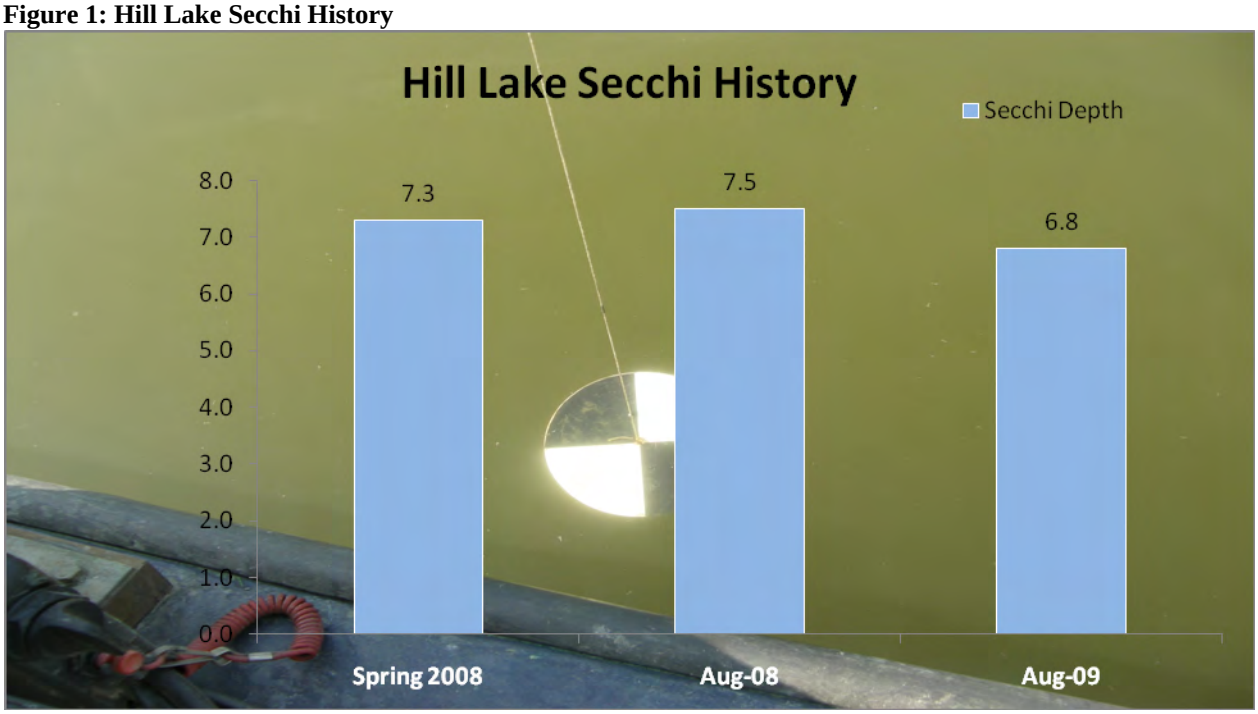
Key to Vegetation Types:
F = floating-leaved, rooted vegetation
N = non-rooted floating vegetation
S = submersed vegetation

2.0 Watershed and Lake Characteristics Update

Hill Lake is located in south central Kosciusko County, Indiana just east of State Road 15 and approximately 2.5 miles north of Silver Lake, Indiana. It has 67 surface acres with a maximum depth of 18 to 19 feet. According to the Diamond and Hill Lake AVMP completed by J.F. New in 2009, Hill Lake's watershed is approximately 479 acres, and the lake area ratio is very low at 6 to 1. The major land use in the watershed is row crops at 74.9% (Ewoldt, 2009).

Water clarity and quality in Hill Lake is good to moderate, with Hill Lake being classified as mesotrophic by the IDNR. Secchi depth was measured at 6.8 feet on August 20, 2009 by Aquatic Weed Control. In spring of 2008, Secchi depth was measured at 7.3 feet by J.F. New. In August of 2008, Secchi depth was measured at 7.5 feet. Figure 1 tracks Hill Lake Secchi depths throughout Hill Lake's involvement in the LARE program.

Figure 1: Hill Lake Secchi History

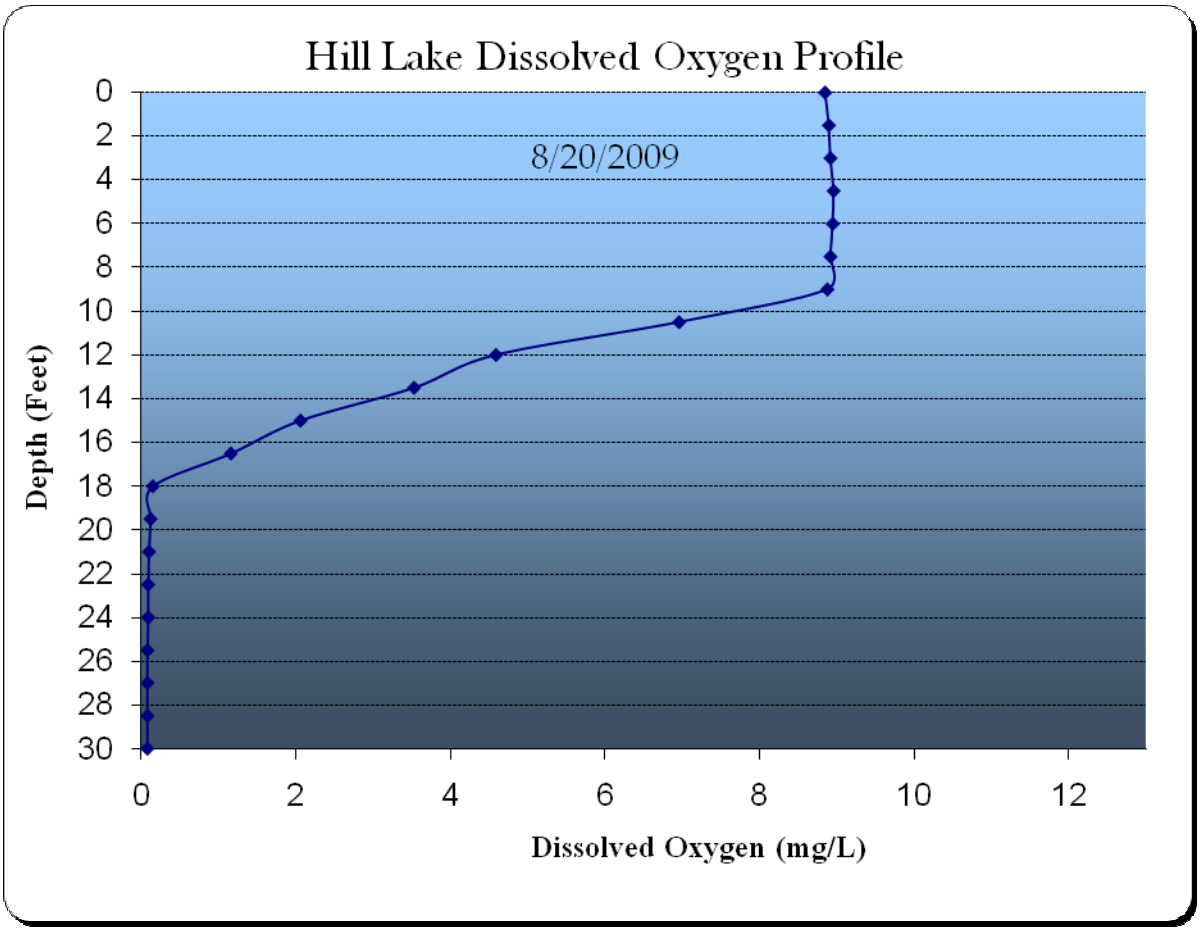


Dissolved Oxygen

Dissolved oxygen requirements to maintain healthy fish populations of warm-water species are at least 2-5 mg of oxygen per liter of water, while cold-water fish species require 5-9 mg of oxygen per liter of water (Kalff, 2002, p237).

The metalimnion is the transition zone between the surface water and the deep water. It is usually accompanied by rapid changes in dissolved oxygen and temperature. On August 20, 2009, Hill Lake showed rapid changes in dissolved oxygen between 10 and 18 feet. Hill Lake showed adequate oxygen to support fish down to at least 14 feet.

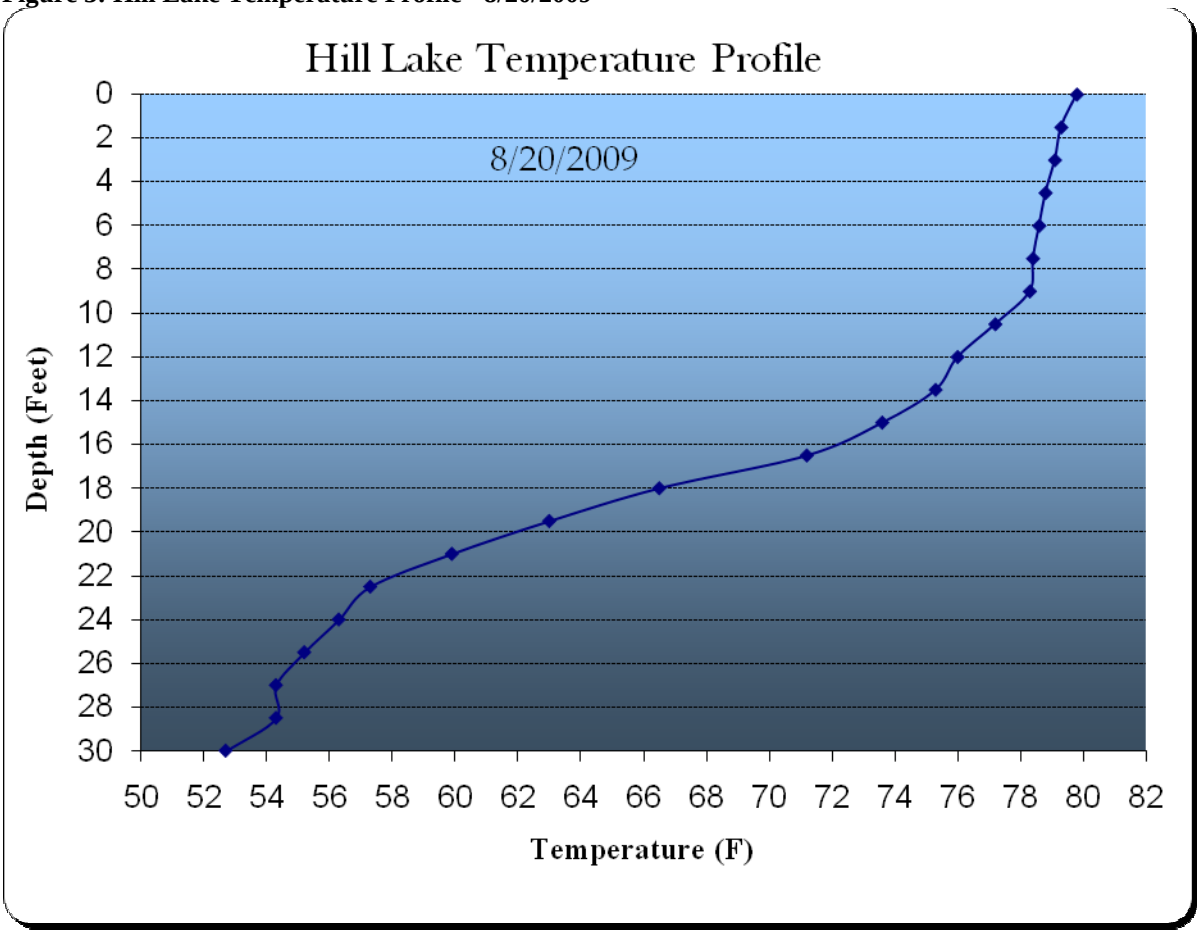
Figure 2: Hill Lake Dissolved Oxygen Profile - 8/20/2009



Temperature Profile

The thermocline is a rapid temperature change associated with the transition from surface water to deep water. The thermocline is scientifically defined as the area where water temperature changes by 1 degree Celsius (1.8 degrees F) for every meter (3 feet) of depth change. On August 20, 2009 the water temperature in Hill Lake remained stable from the surface down to 10 feet. The thermocline started at about 10 to 11 feet on Hill Lake when this data was collected.

Figure 3: Hill Lake Temperature Profile - 8/20/2009



Hill Lake has no inlet, so all of its water comes from runoff and from ground water. The lack of an inlet may help to maintain water quality and clarity. There is a very large section of undeveloped shoreline on the lake's south shore (Figure 4). This area appears to be used for hay production, which may also help reduce soil erosion. Many emergent plants including white lily, spatterdock, and water willow are also present in shallow water along this stretch of shoreline. This is a beneficial emergent plant area and should be protected if possible.

Figure 4: Hill Lake Undeveloped Shoreline - South Shore

Other Sources of Information

The Yellow Creek Lakes Watershed Diagnostic Study was completed in 2009 by J.F. New and is an excellent source of information about Hill Lake and the surrounding watershed. It can be found on the Lake and River Enhancement website under the link titled "LARE Project Reports."

3.0 Lake Uses Update

Hill Lake has two points of access that can be used by permission. One access point is the beach on the northwest shoreline and the other is a beach located on the southeast shoreline. Lake users access the lake by backing across the sand to launch boats. Figure 5 shows the area along the north shore of Hill Lake where lake users can launch boats. There are no restrictions posted at access locations but Hill Lake's small size (67 ac) keeps high speed boat traffic to a minimum.

Figure 5: Hill Lake Access Point - North Shore

Fishing and boating are popular activities on Hill Lake. There are also multiple beaches on the lake used for swimming. On the north shore and the west shore of the lake there are numerous mobile homes, most of which have pier space on the lake. This enables many users to access the lake. Many of these homes are summer cottages. Most boats observed on Hill Lake are pontoons or smaller fishing boats. Figure 6 shows mobile homes and pier access on the north shore of Hill Lake.

Figure 6: Hill Lake North Shore

4.0 Fisheries

District 3 Fisheries Biologist Jed Pearson was contacted to obtain any new fisheries data available in 2009. No new data is available. The most recent fisheries survey conducted on Hill Lake took place in 1994 and is explained in detail in JF New's 2009-2013 AVMP. Bluegills, Largemouth Bass, Yellow Perch, and Redears were the most commonly collected fish in this survey.

5.0 Problem Statement

Current problems include the inability to predict areas of EWM re-growth for 2010 and the need for increased native diversity in Hill Lake. Eurasian watermilfoil was greatly reduced by the Sonar treatment in 2009. Vegetative EWM in Hill Lake was undetectable in Hill Lake in fall of 2009. However, it is important for all parties to understand this Sonar treatment will not eradicate EWM in Hill Lake and increasing re-growth is expected in the coming years. The challenge in 2010 will be to identify areas of EWM re-growth through proper vegetation survey techniques and manage them effectively with herbicide treatments. Since some EWM re-growth might be expected in 2010, spot treatments should be used to manage these smaller areas, as opposed to a whole lake treatment. Spot treatments will use 2, 4-D to control Eurasian watermilfoil.

6.0 Vegetation Management Goals and Objectives

The following management goals have been established by the IDNR for all Indiana lakes, including those applying for LARE funding. Any management practices implemented on Hill Lake are to directly facilitate the achievement of these three 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 recreational access while minimizing the negative impacts on plant and wildlife resources.

Specific Objectives

Two measurable goals for Hill 2010 would be that EWM is found at less than 10% of sample locations and that no more than 10 acres of EWM would need treatment in Hill Lake. Re-growth is expected over time, but ideally, this re-growth would be very minimal in 2010. The figure of 10 acres is only an estimate, but based on whole lake Sonar treatments on Lake of the Woods, Shipshewana Lake, and Dewart Lake (all in Northern Indiana), 10 acres of re-growth is likely the maximum acreage for re-growth in 2010.

The major objective for Hill Lake has changed from a large scale treatment effort to reduce the dominant milfoil population, to smaller scale treatments in areas where re-growth is observed in the future. These areas of re-growth will be treated with 2, 4-D herbicide.

7.0 Past Management Efforts

There are no records indicating any aquatic vegetation control practices on Hill Lake prior to the Sonar treatment in 2009.

2009 Sonar Treatment

Based on recommendations from the 2008 – 2012 AVMP, Sonar was a preferred choice for EWM control in Hill Lake. Sonar is a systemic herbicide that prevents plants from making chlorophyll. Since plants need chlorophyll to produce food for themselves, plants treated with Sonar outgrow their nutrient reserves and “starve themselves”. This lack of chlorophyll is also known as chlorosis. The new growth of plants treated with Sonar will often appear white or pink since these areas of new growth will have no chlorophyll. Figure 7 shows chlorosis in coontail following a whole lake Sonar treatment on Shipshewana Lake in 2007.

Figure 7: Coontail Showing Chlorosis from Sonar Herbicide at Shipshewana Lake

On June 17, 2009 Hill Lake was treated for control of Eurasian watermilfoil (*Myriophyllum Spicatum*) with an herbicide called Sonar at a target rate of 6 parts per billion (ppb). This was part of treatment specifications designed by the LARE program. These specifications called for an initial treatment with Sonar at 6 ppb. After this initial concentration has dropped to 3 ppb, the specs call for bumping the concentration back to 4 ppb.

Funding for this treatment was provided by the Diamond Lake Conservation Club and the IDNR Division of Fish and Wildlife through the Lake and River Enhancement Program (LARE). The goal of this treatment strategy was to greatly reduce the amount of invasive milfoil in Hill Lake to help beneficial native plants compete with Eurasian watermilfoil (EWM). Reducing EWM in Hill Lake should also be beneficial to lakes downstream of Hill Lake, including Diamond Lake in Kosciusko County.

The 2009 Sonar treatment was originally scheduled for much earlier in spring, but a red planktonic algal bloom decreased water clarity and delayed treatment. By June 17, the algal bloom had experienced a natural die off. Water clarity had improved and viable milfoil was observed growing by SePro Aquatic Specialist Bob Johnson. Treatment was then promptly scheduled.

Actual Sonar concentration was measured on June 22, 2009 at 7.6 parts per billion using a water sample collected by Aquatic Weed Control and sent to SePRO Corporation Labs (manufacturers of Sonar herbicide). This actual concentration was within 1.6 parts per billion of the target concentration.

Water samples were taken periodically throughout the summer of 2009 to monitor the Sonar herbicide concentration in Hill Lake. On July 7, 2009 a water sample was collected and the Sonar concentration was 6.0 parts per billion. On August 14, 2009 Sonar concentration was determined to be 3.2 parts per billion. On September 9, 2009 the Sonar concentration in Hill Lake was 1.7 parts per billion. Based on recommendations from Aquatic Weed Control and

SePRO Corporation, the IDNR permitted a Sonar "bump" to increase herbicide concentration back to a target of 4 parts per billion. One major factor influencing the recommendation for a fall Sonar bump was the red algal bloom that took place in spring of 2009. There was a concern that shading from the algal bloom may have caused some natural die off of EWM vegetation. If a natural decline had occurred in spring, EWM root crowns could exist that did not have vegetation to take in the herbicide. A fall bump would hopefully provide additional control for re-growth from root crowns in fall. EWM often undergoes a period of rapid growth in fall as water temperatures begin to cool down and water clarity increases.

The bump application took place on September 21, 2009. A dissolved oxygen and temperature meter (Hach HQ 40d multi-meter) was used to determine the depth of the thermocline, but the lake had already de-stratified, most likely as a result of cold nights and windy weather prior to the bump. Actual concentration following the Sonar bump was 5.5 parts per billion, again within 1.5 parts per billion of the target.

8.0 Aquatic Plant Community Characterization

Survey protocol was last updated by the IDNR in 2007. Survey intensity is now being tailored to individual lakes, depending on their own unique set of circumstances and management activities. Some lakes which may have been surveyed twice annually in the past may only be surveyed once each season. Surveys on some lakes that have been intensely surveyed in recent years may change to visual surveys as opposed to more time consuming quantitative vegetation surveys. These changes provide better quality of service and more efficient use of funding on Indiana lakes.

No submersed invasive plants were found in Hill Lake in 2009. In 2008, J.F. NEW conducted both a spring and late season Tier II survey in preparation for the 2008 – 2012 Diamond and Hill Lake AVMP. Eurasian watermilfoil was the only invasive submersed aquatic plant found in Hill Lake. Figure 8 and Figure 9 are taken directly from J.F. New's 2008 – 2012 AVMP. They describe the most recent data on EWM abundance in Hill Lake prior to the 2009 Sonar treatment.

Figure 8: J. F. New- Map - Eurasian Watermilfoil Abundance – 8/14/2008 (Ewoldt, 2009)

Figure 9: J.F. New-- Map - Eurasian Watermilfoil Abundance - 5/19/2008 (Ewoldt, 2009)

8.1 Methods Update

The Tier II survey protocol was updated by the IDNR in 2007. The 2006 LARE Tier II protocol required that sample sites be stratified by depth contour and that data analysis be provided for each depth contour. Rake scores for plant species are recorded as 1, 3, or 5, as opposed to the original scoring system of 1, 2, 3, 4, or 5.

The number of sample sites needed for a Tier II survey is still based on lake size as it was in 2006. Trophic state describes the productivity of a lake and is correlated with plant growth, Secchi depth, and nutrient availability. There are 4 different trophic states listed by the IDNR: oligotrophic, mesotrophic, eutrophic, and hypereutrophic. Oligotrophic lakes usually have clear water and few nutrients, while hypereutrophic lakes usually have deeply stained water and are nutrient rich. Table 3 is taken from the IDNR 2006 Tier II protocol and shows the maximum depth that must be sampled for a lake in each trophic state. In oligotrophic lakes, where water is clear, plants may be able to grow in up to 25 feet of water because sunlight may still reach the lake bottom in deep water. In hypereutrophic lakes where water is turbid, lack of sunlight will prevent plants from growing in deep water, so the maximum sampling depth is only 10 feet.

Table 3: Sample Depth by Trophic State

Trophic State	Maximum Depth of Sampling (ft)
Hypereutrophic	10
Eutrophic	15
Mesotrophic	20
Oligotrophic	25

Table 4 is used to calculate the number of sample sites needed in each depth contour by using lake size and trophic status. The new protocol attempts to more accurately describe the entire littoral zone of a lake and provide more detailed data analysis by separating the littoral zone into 5 foot depth segments.

Table 4: Sample Sites by Lake Size and Trophic State

Tier II Sampling 3

Table 3 Sample size requirements as determined by lake size, trophic state, and apportioned by depth class.

		Hypereutrophic		Eutrophic			Mesotrophic				Oligotrophic				
Lake Acres	Total # of Sites	0-5 foot contour	5-10 foot contour	0-5 foot contour	5-10 foot contour	10-15 foot contour	0-5 foot contour	5-10 foot contour	10-15 foot contour	15-20 foot contour	0-5 foot contour	5-10 foot contour	10-15 foot contour	15-20 foot contour	20-25 foot contour
<10	20	10	10	10	7	3	10	5	3	2	10	4	3	2	1
10-49	30	20	10	10	10	10	10	10	7	3	10	10	5	3	2
50-99	40	30	10	17	13	10	10	10	10	10	10	10	10	7	3
100-199	50	40	10	23	17	10	14	14	12	10	10	10	10	10	10
200-299	60	50	10	30	20	10	18	16	16	10	14	12	12	12	10
300-399	70	60	10	37	23	10	22	20	16	10	17	15	14	14	10
400-699	80	70	10	43	27	10	25	23	22	10	19	18	17	16	10
500-799	90	80	10	50	30	10	29	27	24	10	22	21	19	18	10
>=800	100	90	10	57	33	10	33	31	26	10	25	23	22	20	10

Hill Lake is classified as mesotrophic by the IDNR with a surface area of 67 acres. Based on these characteristics, 40 sites are divided between the following contours: 0 to 5 feet, 5 to 10 feet, 10 to 15 feet, and 15 to 20 feet.

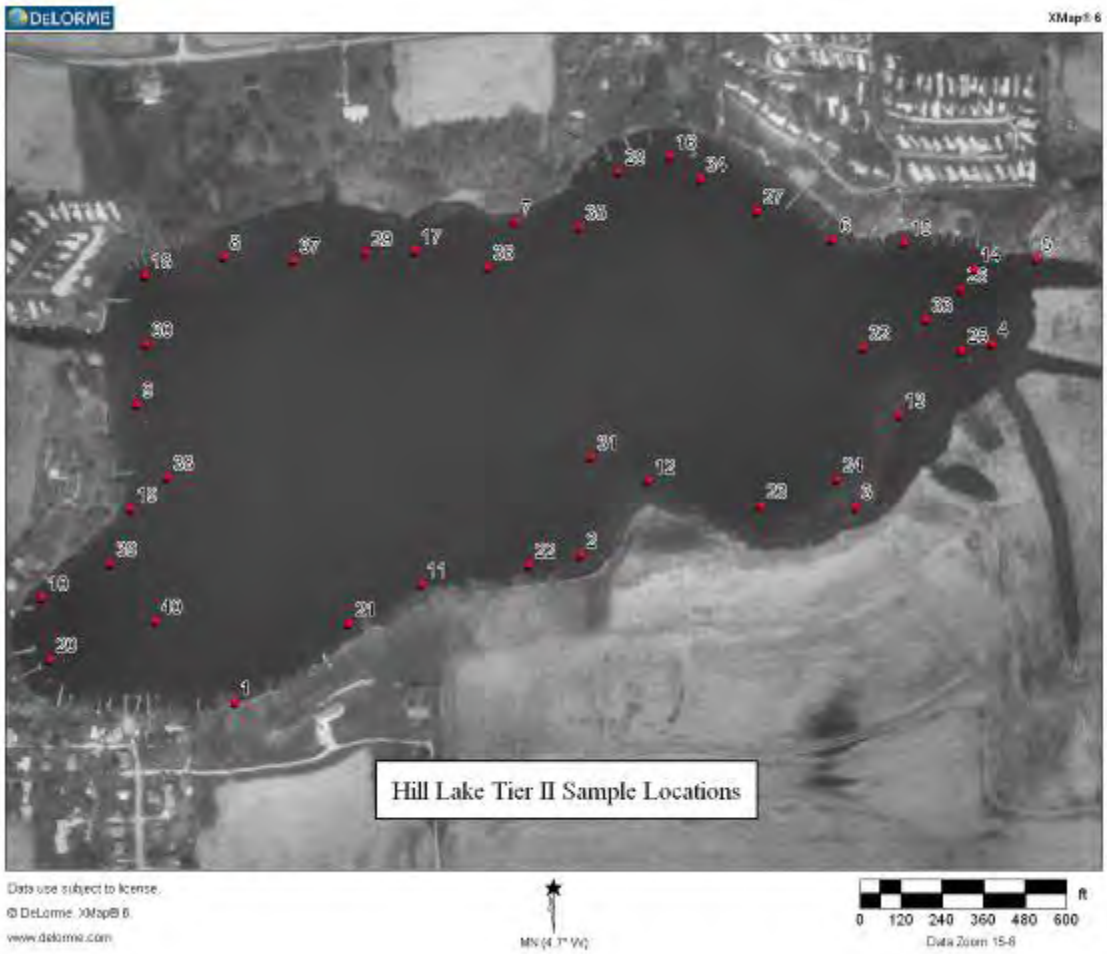
8.2 Results

8.2.1 Tier II Results

In 2009, one Tier II survey was conducted on Hill Lake on August 20, 2009. Secchi depth was measured at 6.8 feet. In this survey, maximum plant depth was approximately 16 feet deep.

In this survey, 40 rake samples were distributed throughout each 5 foot depth contour of the littoral zone. A total of 3 species of submersed aquatic plants were collected during the 2009 Tier II survey. All of these species are considered beneficial native plants. Figure 10 shows the locations of all sample sites for the 2009 Tier II survey.

Figure 10: Hill Lake Tier II Rake Sample Locations



Data from Aquatic Weed Control's 2009 Tier II survey was compiled and analyzed according to depth contour and as a whole lake system. Table 5 describes all data collected in the 2009 survey. Parameters and data evaluation are explained later in this section.

Table 5: Hill Lake 2009 Data Analysis Table

Occurrence and Abundance of Submersed Aquatic Plants in Hill Lake

County:	Kosciusko	Total Sites:	40	Mean species/site:	0.53
Date:	8/20/2009	Sites with plants:	17	SE Mean species/site:	0.11
Secchi (ft):	6.8	Sites with native plants:	17	Mean native species/site:	0.53
Maximum Plant Depth (ft):	16.0	Number of species:	3	SE Mean natives/site:	0.11
Trophic Status:	Mesotrophic	Number of native species:	3	Species diversity:	0.49
		Maximum species/site:	2	Native species diversity:	0.49

All Depths (0 to 16 ft)	**Frequency of**	**Rake score frequency per species**				**Plant**
Species	**Occurrence**	**0**	**1**	**3**	**5**	**Dominance**
Chara	35.0	65.0	22.5	10.0	2.5	13.0
Coontail	12.5	87.5	10.0	2.5	0.0	3.5
Sago Pondweed	5.0	95.0	5.0	0.0	0.0	1.0
Filamentous Algae	10.0					
Depth: 0 to 5 ft	**Frequency of**	**Rake score frequency per species**				**Plant**
Species	**Occurrence**	**0.0**	**1.0**	**3.0**	**5.0**	**Dominance**
Chara	70.0	30.0	40.0	20.0	10.0	30.0
Coontail	20.0	80.0	10.0	10.0	0.0	8.0
Sago Pondweed	20.0	80.0	20.0	0.0	0.0	4.0
Filamentous Algae	20.0					
Depth: 5 to 10 ft	**Frequency of**	**Rake score frequency per species**				**Plant**
Species	**Occurrence**	**0.0**	**1.0**	**3.0**	**5.0**	**Dominance**
Chara	60.0	40.0	50.0	10.0	0.0	16.0
Coontail	20.0	80.0	20.0	0.0	0.0	4.0
Filamentous Algae	10.0					
Depth: 10 to 15 ft	**Frequency of**	**Rake score frequency per species**				**Plant**
Species	**Occurrence**	**0.0**	**1.0**	**3.0**	**5.0**	**Dominance**
Chara	10.0	90.0	0.0	10.0	0.0	6.0
Filamentous Algae	10.0					
Depth: 15 to 20 ft	**Frequency of**	**Rake score frequency per species**				**Plant**
Species	**Occurrence**	**0.0**	**1.0**	**3.0**	**5.0**	**Dominance**
Coontail	10.0	90.0	10.0	0.0	0.0	2.0
Filamentous Algae	0.0					

Table 6 was compiled by Aquatic Weed Control using a format developed by District 3 Fisheries Biologist Jed Pearson. It summarizes data collected by Aquatic Weed Control in 2009 and data collected by J.F. New in 2008. In future years, more data can be added to this table as surveys are performed. This will provide a quick and concise way to look for long term trends in species frequency and dominance, as well as other lakewide metrics.

Table 6: Hill Lake Tier II Data History

Hill Lake Tier II Data History

	Spring Surveys			Fall Surveys				
Parameter (0-20 ft)	**JFNEW**			**JFNEW**	**AWC**			
Date	5/19/08			8/14/08	8/20/09			
Sample sites (n)	40			40	40			
Secchi (ft)	7.3			7.5	6.8			
Littoral depth (ft)	14.0			14.0	16.0			
Species (N)	9			9	3			
Native species (N)	8			8	3			
Species/site (max)	4			5	2			
Species/site (mean)	0.98			1.38	0.53			
Native species/site (mean)	0.78			1.13	0.53			
Species diversity	0.73			0.80	0.49			
Native species diversity	0.64			0.75	0.49			
Species Occurrence (%)	**2008**			**2008**	**2009**	**2010**	**2011**	**2012**
Eurasian water milfoil	20.0			25.7				
Chara	17.5			25.7	35.0			
Coontail	42.5			46.2	12.5			
Sago pondweed	5.0			15.4	5.0			
Illinois pondweed				10.3				
Variable pondweed				2.6				
Large-leaf pondweed	2.5			5.1				
Eel grass	2.5							
Northern water milfoil	2.5			2.6				
Variable leaf watermilfoil	2.5							
Southern naiad	2.5			5.1				
Filamentous algae	10.0			2.6	10.0			
Species Dominance	**2008**			**2008**	**2009**	**2010**	**2011**	**2012**
Eurasian water milfoil	5.0			7.2				
Chara	6.5			17.4	13.0			
Coontail	8.5			12.3	3.5			
Sago pondweed	1.0			3.1	1.0			
Illinois pondweed				2.1				
Variable pondweed	0.5			0.5				
Large-leaf pondweed	0.5			1.0				
Eel grass	0.5							
Northern water milfoil	0.5			0.51				
Southern Naiad	0.5			2.05				

Site Frequency

Site frequency is a measure of how often a species was collected during the Tier II survey. It can be calculated by the following equation:

$$\text{Site Frequency} = \frac{\text{(\# of sites where the species was collected)}}{\text{Total \# of littoral sample sites}} \times 100$$

Site frequency of Eurasian watermilfoil in 2008 was measured at 20.0% in spring and 25.7% in fall by J.F. New. In the 2009 Tier II survey (conducted after the Sonar treatment) EWM had been reduced to an undetectable level.

Site frequencies of most native plants were greatly reduced from 2008, which is expected and has been observed in other lakes in northern Indiana (Lake of the Woods-2005, Dewart Lake-2006, Shipshewana Lake-2007). Coontail frequency dropped from 46.2% in fall of 2008 to 12.5% in fall of 2009. Sago pondweed decreased from 15.4% in 2008 to 5.0% in 2009. Many plants found at only one or two sites in 2008 were not collected in 2009.The reduction of submersed aquatic vegetation in 2009 is likely linked to the Sonar treatment.

Chara was the only plant which showed an increase in site frequency. It increased from 25.7% in 2008 to 35.0% in 2009. Chara is a beneficial native plant and is very resistant to fluridone treatments. Chara provides excellent water filtration, good fish habitat, and usually forms a low growing carpet on the lake bottom that poses little interference to boating.

Species Diversity

The species diversity indices listed in the data analysis tables help to describe the overall plant community. A species diversity index is actually measured as a value of uncertainty (H). If a species is chosen at random from a collection containing a certain number of species, the diversity index (H) is the probability that a chosen species will be different from the previous random selection. The diversity index (H) will always be between 0 and 1. The higher the H value, the more likely it is that the next species chosen from the collection at random will be different from the previous selection (Smith, 2001). This index is dependent upon species richness and species evenness, meaning that species diversity is a function of how many different species are present and how evenly they are spread throughout the ecosystem.

The overall species diversity index for Hill Lake in August 2009 was 0.49. This value is low when compared to the average species diversity (0.66) for Indiana lakes (Pearson 2004). Native plant diversity in August of 2009 was 0.49, meaning that no invasive plants were found in 2009.

Species diversity in spring 2008 was 0.73, while native diversity was 0.64. Diversity in fall 2008 was 0.80 while native diversity was 0.75. This reduction in native diversity is expected in the Sonar treatment year and should increase over the next 3 years.

Species Dominance

Species dominance is dependent upon how many times a species occurs and its relative coverage area or biomass within the system. In this survey, the abundance rating given to each species at each sample site was used to determine dominance. The dominance of a particular species in this Tier II survey increases as its site frequency and relative abundance increase.

Dominance values in the 2009 Tier II survey closely followed frequency of occurrence. Chara was by far the most dominant species in the 2009 survey with a dominance score of 13.0. Coontail and sago pondweed were the only other species found with dominance scores of 12.5 and 5.0 respectively. Dominance values for all of these plants were down from 2008.

Species Distribution

Coontail, chara and sago pondweed were the three species found in Hill Lake in the 2009 Tier II survey. Figure 11, Figure 12, and Figure 13 describe locations of these species.

Figure 11: Hill Lake 2009 Coontail Locations

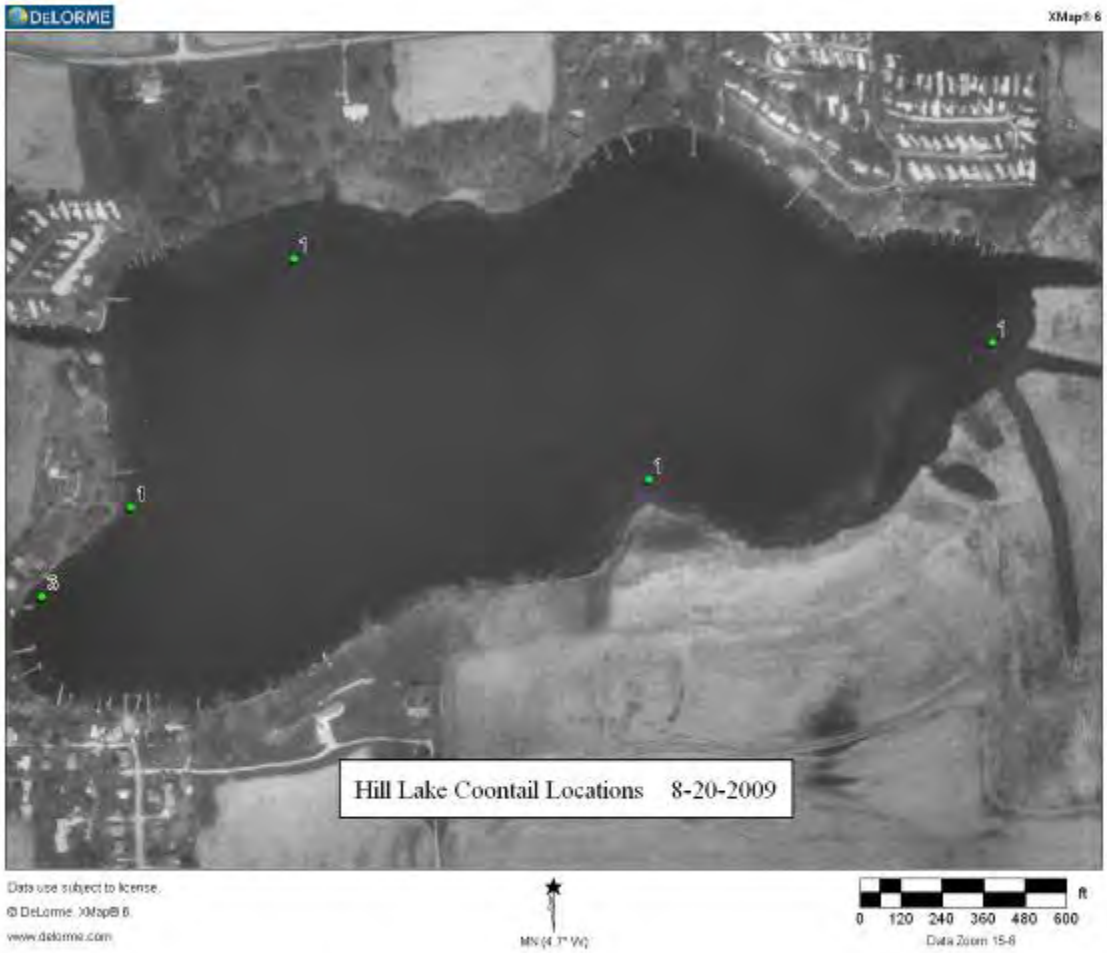


Figure 12: Hill Lake 2009 Chara Locations

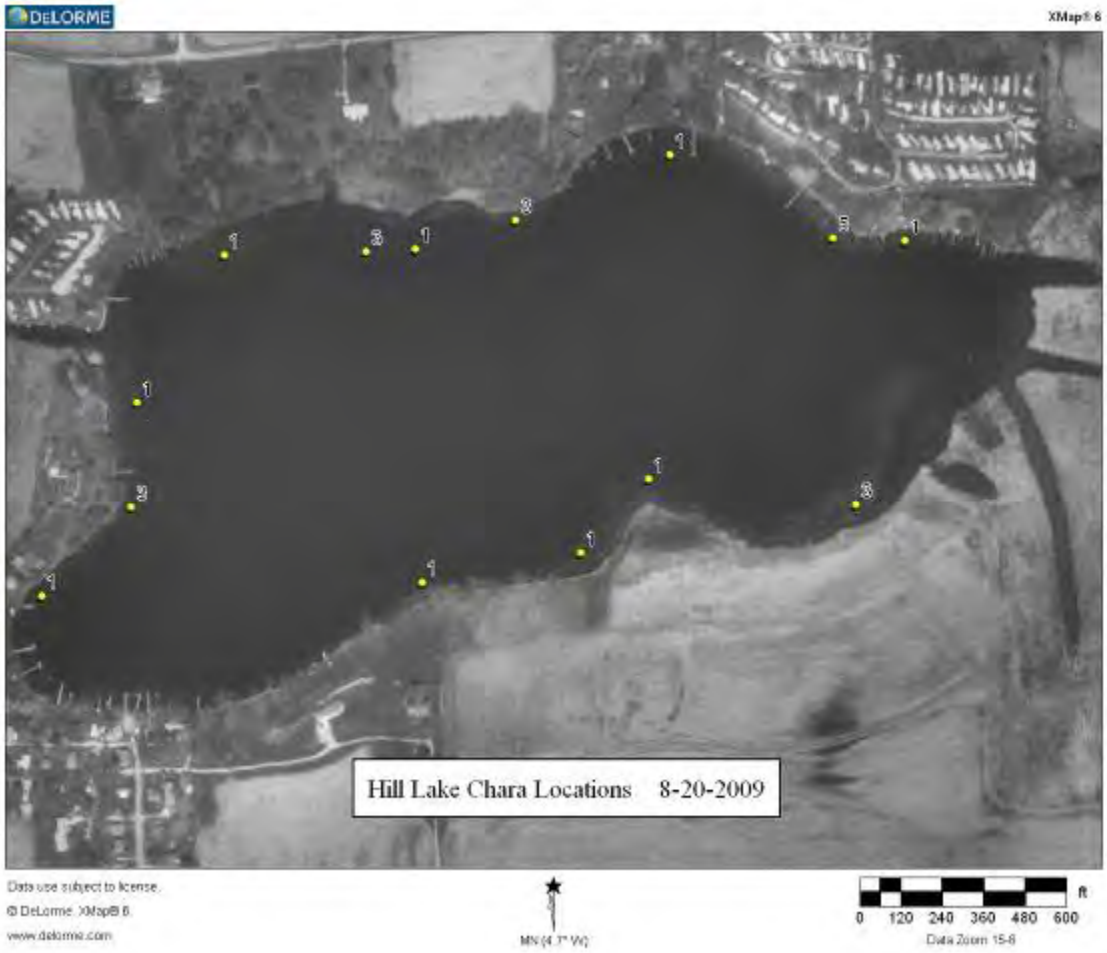


Figure 13: Hill Lake 2009 Sago Pondweed Locations

8.3 Macrophyte Inventory Discussion

Based upon 2009 survey data, Hill Lake currently has a low diversity of submersed aquatic plants when compared with other Indiana lakes. Species richness in Hill Lake was low with only 3 submersed species collected in August of 2009. All of these species are beneficial native plants. This species richness is down from 8 species in 2008, although four of those species were found at only two sites or less. This low diversity is common in fall of the treatment year when Sonar herbicide has been applied in spring. Actual herbicide concentrations were consistently 1.5 parts per billion above target concentrations, which could have an effect on both native plants and EWM. Actual herbicide concentrations indicate that 1282 acre feet used for lake volume (required by bid specs) may be too high.

Chara is by far the most dominant plant species and will likely continue its dominance over the next three years. Coontail and sago pondweed were collected in low abundance. It is expected that native diversity and abundance will increase over the next three years as plants re-establish themselves after the Sonar treatment.

A planktonic algal bloom occurred early in spring of 2009 prior to treatment. According to lake residents, this is abnormal, and has never been seen before on Hill Lake. Water clarity should continue to be monitored in subsequent years. With reduced plant growth from the Sonar treatment, planktonic algal growth could potentially be aided by extra nutrients

suspended in the water column. However, historical data suggests that phosphorus and other nutrient levels are generally low in Hill Lake when compared to other area lakes. Hill Lake phosphorus levels were also the lowest of any lake in the Yellow Creek Lakes Watershed (J.F. New, 2009).

Eurasian watermilfoil site frequency declined from 25.7% in fall of 2008 to 0% in fall of 2009 after the Sonar treatment. It is important to note that Sonar will not eradicate EWM from Hill Lake, and re-growth will most likely begin in the next two years. Based on results from other Sonar treatments, beneficial native plants such as chara, sago pondweed, and waterstargrass may be expected to increase in the two years following Sonar treatments. The invasive EWM usually re-establishes itself much slower than many natives, giving native plants a chance to compete with milfoil when water clarity and quality allow.

Threatened and Endangered Species

The Indiana Natural Heritage Data Center has compiled a list of Indiana plant species that are federally or state listed as endangered, threatened, or rare. The following is an excerpt taken directly from the Indiana Natural Heritage Database website. Link: Indiana Natural Heritage Data Center.

"The Indiana Natural Heritage Data Center, set up in 1978, represents a comprehensive attempt to determine the state's most significant natural areas through an intensive statewide inventory. The Indiana Natural Heritage Data Center is part of the Natural Heritage Network, a worldwide system of Heritage Programs. This program is designed to provide information about Indiana's diversity of natural ecosystems, species, landscape features, and outdoor amenities, and to assure adequate methods for evaluating this information and setting sound land protection priorities. The inventory is a continuous process, becoming an increasingly valuable tool for decision makers and scientists as it progresses."

No state or federally listed plant species were found in Hill Lake in 2009 and no vouchers were taken.

9.0 Aquatic Plant Management Alternatives

Hill Lake is currently involved in a Eurasian watermilfoil treatment strategy.
Eurasian watermilfoil is believed to have arrived in North America in the mid 1940's and has spread throughout the east coast to northern Florida. The Midwest Eurasian watermilfoil spreads by fragmentation and seed dispersal, and it has the ability to over-winter from year to year. Once it is in a lake it can become the dominant plant species because it forms dense canopies which shade out the native, more beneficial plant species below. There is also evidence that mat forming species like Eurasian watermilfoil and curly leaf pondweed exert significant negative impacts on a broad range of aquatic organisms (Pullman, 1998)

Many management strategies have been used to control Eurasian watermilfoil in Indiana lakes. A management strategy should be chosen based on its selectivity of the pest in question, its long term effectiveness, and its environmental risks. The main goal of this plan is to choose a management option that can effectively control the Eurasian watermilfoil with little or no environmental risk, while causing no harm to native plant or fish species.

9.1 No Action

If no action is taken, the Eurasian milfoil abundance may increase from year to year. Eurasian milfoil grows by fragmentation, meaning that if the plant is cut, the fragment has the ability to form an entirely new plant. Eurasian milfoil also over-winters as an adult plant so new generations are created in each growing season. These reproductive characteristics cause milfoil beds to become more dense over time, which can create a monoculture as it may eliminate more and more native species from a lake.

9.2 Institutional-Protection of Beneficial Vegetation

Lake users can play an important role in the protection of beneficial aquatic vegetation. Aquatic invasive species often gain a foothold in an ecosystem in areas disturbed by human activity or natural processes. In many cases, boating may be restricted in certain areas of a lake to prevent harm to native plants, especially many emergent species. Boating lanes may be established through areas of emergent vegetations, and protected ecological zones may be created to prevent erosion off shoreline vegetation caused by intense wave action from boating activities. Shallow areas of a lake may also be marked with buoys to prevent injury to boaters and water skiers. It is important to obey boating restrictions to protect beneficial plant species and even prevent personal injury.

A healthy aquatic plant community is absolutely essential for the maintenance of a stable, diverse ecosystem. Aquatic plants provide habitat for plankton, insects, crustaceans, fish, and amphibians. They take nutrients like phosphorus and nitrogen out of the water column, increase water clarity, prevent harmful algal blooms, produce oxygen, and provide food for waterfowl. Aquatic plants can even remove pollutants from contaminated water and prevent the suspension of particulate matter by stabilizing sediment and preventing erosion from wave action or current.

The LARE aquatic vegetation management program recognizes the importance of beneficial aquatic vegetation, and its protection is a top priority. The most basic goal for the LARE aquatic vegetation program is to maintain healthy aquatic ecosystems by maintaining or improving biodiversity in Indiana lakes. The purpose of conducting aquatic vegetation surveys is to document the overall health of plant communities and identify any ecosystem whose stability is threatened by invasive plant species.

Once a problem area is identified, a management strategy must be formulated that directly impacts the aquatic plant community in a positive way. While eradicating invasive plants is a major component of many management strategies, it is important to note the ultimate goal is not to eradicate aquatic vegetation but to protect beneficial vegetation and protect lake ecosystems.

9.3 Environmental Manipulation

9.3.1 Water Level Manipulation

Draw down of the lake water level is one option that may help a Eurasian milfoil problem. Lower water levels expose the Eurasian milfoil roots to freezing and thawing, which may kill milfoil root systems. However, a lake draw down will not only kill Eurasian milfoil but

native plants as well. Also, reducing the lake level would make new areas of the lake available for vegetative growth, and Eurasian milfoil may have an advantage in the colonization of these new areas if it is not eradicated prior to the lake draw down. This option is probably not feasible and certainly not cost effective for most lakes.

9.3.2 Nutrient Reduction

Limiting factors for plant growth include light, lake morphometry and depth, substrate, and the availability of nutrients like phosphorus and nitrogen. While lake morphometry is most highly correlated with plant biomass, the availability of phosphorus and nitrogen have a tremendous impact on the amount of plant growth in a body of water. If the vast majority of phosphorus in a system is tied up in plant matter, it may be difficult for an invasive species to gain a foothold and spread rapidly in the lake. If phosphorus is constantly being added to the system and is readily available in the water, then invasive species will have an unlimited food supply should a disturbance create the opportunity for them to proliferate in a body of water.

Phosphorus and nitrogen are added to aquatic systems by many natural sources, such as the decomposition of plant material and animal waste, but human activity is often responsible for excessive phosphorus loading that contributes to blue-green algal blooms, overabundant vegetation growth, and a general decline in water quality. Major contributions of excess phosphorus come from sources such as septic system inputs, agricultural runoff, storm water drainage, lawn fertilizer applications, , and improper disposal of grass clippings and tree leaves. Owners of lake front property can significantly reduce the amount of phosphorus entering the lake by taking actions outlined in the public education section.

www.epa.gov

9.4 Mechanical Controls

9.4.1 Mechanical Cutting and Harvesting

Mechanical harvesting uses a large machine to cut and collect unwanted aquatic plants. These machines pick up the cut weeds but will still leave small fragments that will have the ability to re-grow. Also, after an area is harvested the Eurasian milfoil generally re-grows first causing the native plants to be shaded out again. Mechanical harvesting is also not selective in its control. The harvesting will cut the native plant species as well as the exotics if both are present in the same area. For these reasons, mechanical harvesting is not recommended. Harvesting can be accomplished by individual owners around their dock areas. A lake property

www.cleanlake.com

owner can legally harvest a 625 square foot area. (25 feet by 25 feet).

9.5 Manual Controls

9.5.1 Hand Pulling, Cutting, Raking

Manual controls such as hand pulling, cutting, and raking can be effective ways to control unwanted plants in certain situations. In very shallow clear water, small areas of vegetation can be identified and cleared effectively by hand. Large areas of vegetation, especially those in deeper water, can be extremely difficult to control using these methods. Many of the harvested weeds will break apart, leaving the root system in the lake bottom. Failure to remove root structures will result in re-growth.

Plants that possess the ability to reproduce through fragmentation can seldom be effectively controlled by these methods if they are distributed throughout a lake. Identifying every area of infestation would be difficult, as would harvesting the plants without causing fragmentation of individual plants. Any plant fragments not removed from the water can form new plants, meaning that hand pulling and cutting can facilitate the spread of the unwanted plant species.

9.5.2 Bottom Barriers

Bottom barriers prevent the growth of aquatic plants by lining the bottom of a lake or pond with a material that prohibits light from reaching the lake bottom and that is difficult for plants to penetrate. Many times plastic or concrete barriers are used to prevent the growth of aquatic vegetation during construction of a lake or pond. This form of control is best implemented during construction of a new pond, and placing a bottom barrier in an existing lake would involve significant challenges and be extremely expensive. A draw down of the lake may be necessary to install the barrier, and if the lake level is not regulated by control structures, this can be almost impossible. For a large lake, material costs alone would be enormous.

Once in place, the barrier would prevent not only invasive plant growth but native plant growth as well, destabilizing the lake ecosystem and having a negative impact on insect and fish communities. Sediment would gradually accumulate on top of the barrier, and aquatic plant growth would return as plants begin to take root in the sediment on top of the barrier. An IDNR permit is required for the placement of a bottom barrier.

9.6 Biological Controls

9.6.1 Water Milfoil Weevil

www.pca.state.mn.us

The watermilfoil weevil is a native North American insect that consumes Eurasian milfoil and northern milfoil. The weevil was discovered after a decline in the Eurasian milfoil population was observed in Brownington Pond, Vermont (Creed and Sheldon, 1993). The milfoil weevil burrows down into the stem of the plant and consumes the tissue of the plant. Holes in the milfoil stem bored by weevil larvae allow disease to enter the plant. These same holes also cause a release of the plants' gases which reduces buoyancy and causes the plant to sink (Creed et. Al. 1992).

Studies conducted to evaluate the effectiveness of the water milfoil weevil have not yielded consistent results. Factors influencing the weevil's success or failure in a body of water are not well documented. In 2003, Scribailo and Alix conducted a weevil test on Round Lake in Indiana and results were inconclusive. An IDNR permit is required for the stocking of the watermilfoil weevil.

9.6.2 Grass Carp

The Asian grass carp or white amur (*Ctenopharyngodon idella*) is an herbivorous fish that is native to eastern Russia and China. This fish has been introduced into the U.S. to help control aquatic vegetation. To prevent their uncontrolled proliferation, all fish stocked in Indiana must be triploid, meaning that they cannot reproduce. Stocking is restricted to privately owned bodies of water, and suppliers must obtain a special permit from the IDNR. Grass carp are completely vegetarian, feeding on many species of submersed plants, along with some floating plants such as duckweed. Hydrilla, a highly invasive plant found in many southern states is a preferred food of grass carp and efforts to control hydrilla with grass carp have been successful.

www.tpwd.state.tx.us

According to the Aquatic Ecosystem Restoration Foundation, grass carp avoid Eurasian milfoil and prefer almost every other native plant to EWM. Grass carp show strong preferences for many native plants along with invasive hydrilla. The success of grass carp stockings is highly dependent upon the food sources available to the fish. When Eurasian milfoil occurs along with native plant populations, grass carp are not recommended. Grass carp are not currently permitted for stocking in pubic waters.

9.7 Chemical Controls

9.7.1 Aquatic Herbicides

There are two major categories of aquatic herbicides: contact and systemic herbicides. Contact herbicides are best used to control the majority of the weeds close to shore, around piers, and in man-made channels. Examples of contact herbicides are Reward (active ingredient: diquat) and Aquathol (active ingredient: endothal).

Contact herbicides would not be a wise choice for a whole lake treatment because of their lack of selectivity and their inability to eliminate the root systems of treated plants. These characteristics could result in unnecessary damage to native species, as well as greater potential for the re-infestation of Eurasian milfoil.

Systemic herbicides are absorbed by the plant and transported to the root systems where they eliminate both the roots and the plant. Examples of systemic herbicides are Sonar, Avast, (active ingredient: fluridone), Navigate, Aqua Kleen, DMA4 (active ingredient 2, 4-D), and Renovate (active ingredient: triclopyr). All of these chemicals effectively kill Eurasian milfoil plants and roots. Based on the author's experience and other lake managers in the Midwest, whole lake treatments using fluridone are the most effective way to control Eurasian water milfoil in lakes that have become severely infested. Fluridone can be applied at low rates to control the Eurasian milfoil while causing little or no harm to the majority of the native weed species present in the lake.

2, 4-D and Renovate (active ingredient: triclopyr) are both root control herbicides which can be used for spot treatments in small areas of Eurasian milfoil infestation, while the whole lake must be treated if Sonar (fluridone) is used. The major difference between 2, 4-D and triclopyr is that triclopyr may have the ability to control the Eurasian milfoil longer than 2,4-D. Renovate (triclopyr) has only been available for use for the past three seasons, and the ability of Renovate to provide more long term control of Eurasian milfoil than 2,4-D in spot treatment situations is still being documented. 2, 4-D is less expensive to use, but if triclopyr shows better long term control in treated areas it may become the most cost effective long term investment. In Hill Lake water depth in the treatment area would make Renovate much more expensive than 2, 4-D. For this reason, 2, 4-D is recommended for the control of Eurasian Watermilfoil.

The public's primary concern with the use of aquatic herbicides is safety. Every chemical registered for aquatic applications has undergone extensive testing prior to becoming available for use. The purpose of these tests is to bring products to market that minimize any human or environmental risk when applied properly at labeled rates.

10.0 Public Involvement

A LARE meeting was held on November 19, 2009 to discuss issues pertaining to the LARE Program and lakes currently involved in the LARE program. Aquatic Weed Control, District 3 fisheries biologists, LARE aquatic biologist Angela Sturdevant, Diamond/Hill Lake Representative John Bender, and many other IDNR and LARE staff were present.

There are many methods that can be used to keep the public informed of management practices. Association news letters are an excellent avenue. Posters can be placed at public access points, and information can be posted on any association websites or in local newspapers as well. Attending regularly held association meetings will also serve to keep the public informed of management practices.

A public meeting for Diamond and Hill Lakes was held on August 12, 2009. Most residents in attendance were from Diamond Lake and were happy that the LARE program funded EWM treatment on Hill Lake. No more than 3 people in attendance lived on Hill Lake. Some concerns over Hill Lake were the algal/diatom bloom that took place in early spring before the Sonar treatment, as well as a possible decrease in fishing success on Hill Lake in summer of 2009.

Table 7: Diamond/Hill Lakes 2009 Public Questionnaire Summary

Lake Use Survey — Lake name Diamond/Hill Lakes

Are you a lake property owner? Yes 12 No 1

Are you currently a member of your lake association? Yes 13 No ___

How many years have you been at the lake? 2 or less (1)
2 – 5 years (2)
5-10 years (2)
Over 10 years (8)

How do you use the lake (mark all that apply)

- 11 Swimming
- 11 Boating
- 11 Fishing
- 1 Irrigation
- ___ Drinking water
- 1 Other ___

Do you have aquatic plants at your shoreline in nuisance quantities? Yes 4 No 6

Do you currently participate in a weed control project on the lake? Yes 9 No 3

Does aquatic vegetation interfere with your use or enjoyment of the lake? Yes 7 No 5

Does the level of vegetation in the lake affect your property values? Yes 6 No 4

Are you in favor of continuing efforts to control vegetation on the lake? Yes 11 No 1

Are you aware that the LARE funds will only apply to work controlling invasive exotic species, and more work may need to be privately funded? Yes 10 No —

Mark any of these you think are problems on your lake:

- ___ Too many boats access the lake
- ___ Use of jet skis on the lake
- ___ Too much fishing
- 3 Fish population problem
- 2 Dredging needed
- 1 Overuse by nonresidents
- 1 Too many aquatic plants
- ___ Not enough aquatic plants
- 2 Poor water quality
- 1 Pier/funneling problem

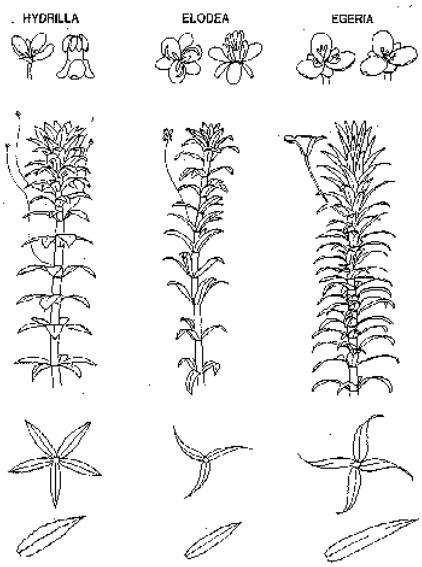
Please add any comments:
Shad are a fish population problem.
Poor water quality is number one problem

11.0 Public Education

More information on stopping the spread of invasive aquatic organisms can be found at http://www.protectyourwaters.net/. These items include thoroughly cleaning equipment after use in a lake and removing all water from bilges, livewells, etc.

Hydrilla

Hydrilla (*Hydrilla verticillata*) is an invasive aquatic plant species common throughout the southern United States. It it federally listed as a noxious weed and causes severe ecological and recreational problems wherever it grows. It is considered to be much more destructive than other invasives like Eurasian watermilfoil and curly leaf pondweed because of its reproductive adaptations. It grows by fragmentation, as does Eurasian watermilfoil, but it also produces turions which can remain dormant in the sediment for 4 years or more (Van and Steward, 1990). It produces tubers at its root tips which can also reproduce after multiple years of dormancy. It can grow 1 inch each day and it quickly out-competes native plants. It forms dense beds that eliminate native plants, stunt fish populations, impede recreation and cause a drastic decrease in biodiversity (Colle and Shireman, 1980). Millions of dollars are spent each year for hydrilla maintenance each year in Florida alone. Eradication is unlikely once a population has been well established, although eradication has been achieved in newly infested waters using a herbicide called Sonar. Sonar is applied at a rate of 6 parts per billion and this concentration is maintained in the water for 180 days. Early detection can be crucial to an effective eradication program, and all lake residents and users are encouraged to be on the look-out for this invader.



In fall of 2006, this plant was found in Lake Manitou, in Rochester, Indiana. This is the first instance of hydrilla in the upper Midwest. Prior to its appearance in Lake Manitou, The closest infestations of hydrilla were in Tennessee and Pennsylvania.

Hydrilla can easily be confused with native elodea. The major difference is that elodea has sets of leaves on the stem in whorls of three, while hydrilla usually has whorls of 5 leaves, although 4 to 9 leaves per whorl are possible with hydrilla. Hydrilla will also have small serrations on the leaf edges. More information on hydrilla can be found at the University of Florida's Center for Aquatic Invasive Plants (http://plants.ifas.ufl.edu/). Other aquatic invasive plant species in Indiana include, Eurasian watermilfoil, curly leaf pondweed, egeria, brazilian elodea and starry stonewort. More general information on aquatic invaders can be found at www.protectyourwaters.net.

12.0 Integrated Treatment Action Strategy

Based on past whole lake Sonar treatments, any Eurasian watermilfoil re-growth on Hill Lake in 2010 should be very minimal. It is recommended that funding be set aside to treat up to 10 acres of Eurasian watermilfoil re-growth with DMA-4 (2, 4-D) herbicide. DMA-4 herbicide provides effective seasonal control for spot treatments of Eurasian watermilfoil re-growth. It can also be applied to small areas without having to treat the entire lake. Control from DMA-4 treatments will not last for multiple seasons and is not expected to reduce Eurasian milfoil acreage from one year to the next. Any areas treated in 2010 would need treatment in 2011 as well.

DMA-4 and Renovate are the most common herbicides used for spot treatments of Eurasian watermilfoil. Both herbicides provide effective control, but using 2, 4-D will greatly reduce costs to the association. A vegetation control permit will be submitted without a treatment area for 2010, since no re-growth has occurred to this point. The permit will request treatment of up to 10 acres of Eurasian watermilfoil. If Eurasian watermilfoil returns to the lake in 2010, it will be detected in the vegetation survey and treated for seasonal control.

Maintenance of the Eurasian watermilfoil population should be the highest priority. Spot herbicide treatments should be limited to areas of Eurasian watermilfoil infestation to protect the native species that are re-colonizing the lake. Treatment of native plants along shorelines of the main lake will not be permitted in 2010. This may help give the native plants a competitive advantage over Eurasian watermilfoil.

In addition to herbicide treatments, all stakeholders in the Hill and Diamond Lake watersheds are encouraged to take actions to reduce nutrient flow into the water system. Those living near the lake should try to minimize runoff of nutrients into the lake from their property. Using low phosphorus fertilizer and ensuring proper septic maintenance are small steps that could help improve water quality. Farmers within the watershed may want to take advantage of financial assistance from the Indiana Conservation Reserve Program. Cost shares and yearly payments are available for the construction of sod waterways and warm season grass plantings that can help reduce runoff in highly erodible areas. Improving water quality will be more conducive to native plant growth and will also promote healthy fisheries.

This action plan has not been changed from the original 2008-2012 AVMP, where J.F. New recommended a whole lake Sonar treatment program for Hill Lake.

Herbicide Specifications
In treatment areas on Hill Lake 2, 4-D should be applied at a rate of 1.76 parts per million to achieve adequate control of Eurasian watermilfoil.

13.0 Project Budget

Funding should be set aside to treat up to 10 acres of EWM re-growth in 2010. Treatment may not be necessary, but funds must be in place in case re-growth does occur. Up to $3,700 should be set aside for this treatment.

A 2010 spring visual survey should be conducted to search for EWM in Hill Lake. A late season Tier II survey should be conducted to quantitatively evaluate the native plant community and continue to search for EWM re-growth. Two options for survey and planning costs are presented below, based on whether a full AVMP update is required in 2010.

2010 Proposed Budget

Treat up to 10 acres of EWM re-growth with DMA-4 (2, 4-D)	$3,700
<u>Surveys</u>	
Option 1 Spring Visual Survey, Late Season Tier II survey and AVMP update	$4,700
Option 2 Spring Visual Survey, Late Season Tier II survey with data summary table and invasive species map only (no AVMP update)	$2,000
Total 2010 Project Costs	**up to $8,400**
Lake and River Enhancement Share	up to $7,560
Diamond/Hill Lake Association Share	up to $840

14.0 Monitoring and Plan Update Procedures

In 2010, a spring visual survey will be conducted to search for any areas of Eurasian watermilfoil re-growth. Should any Eurasian watermilfoil be found, a treatment map will be submitted to the IDNR. Herbicide treatment would follow the approval of the treatment map.

A late season Tier II vegetation survey is recommended for Hill Lake in 2010 as well. This survey will help to quantitatively describe how the plant community is responding to the whole lake Sonar treatment.

In the years that follow, additional surveys should be conducted to determine how the Eurasian milfoil population is reacting to the management strategy over a long period of time. These surveys will provide a basis for evaluation of the management strategy and can be presented to the public should the need arise to modify the management strategy. They will also serve to keep the public interested and informed about management practices on Hill Lake so they will be motivated and equipped to actively participate in conservation efforts. The intensity and frequency of vegetation surveys may change from year to year.

Survey and planning needs should be re-evaluated each year to reduce unnecessary cost to the lake association while still providing adequate data to characterize the plant community.

15.0 References

Blessing, Arlene. 2004. Fundamentals of Pesticide Use: Indiana Pesticide Applicator Core Training Manual. Purdue University. West Lafayette, Indiana 106 pp.

Cunningham, Willam P., and Saigo, Barwbara W. 2001. Environmental Science: a Global Concern. McGraw Hill Inc. Boston, Massachusetts 646.

Dow Agrosciences Invasive Species Management. 1998-2007. Dow Agrosciences LLC. http://www.dowagro.com/ivm/invasive/prod/dma.htm

Ewoldt, Betsy. 2009. Diamond and Hill Lakes Aquatic Vegetation Management Plan: 2008 – 2012. J. F. New. 708 Roosevelt Road, Walkerton, IN 46574.

Getsinger, Kurt Ph.D. 2005. Aquatic Plant Management: Best Management Practices in Support of Fish and Wildlife Habitat. The Aquatic Ecosystem Restoration Foundation. 78 pp.

J.F. New. 2009. Yellow Creek Lakes Watershed Diagnostic Study. J.F. New Inc. 708 Roosevelt Road, Walkerton In, 46574.

IDNR. 2004. Procedure Manual for Surveying Aquatic Vegetation: Tier II Reconnaissance Surveys. IN Department of Natural Resources, Division of Soil Conservation.

IDNR 2004. Procedure manual for surveying Aquatic Vegetation: Tier I and Tier II, Indiana Department of Natural Resources, Indianapolis, Indiana.

Kalff, Jacob. 2002. Limnology: Inland Water Ecosystems. Prentice Hall. Upper Saddle River, New Jersey. 592 pp.

Kannenburg, James R., and Schmidt, James C. 1998. How to Identify and Control Water Weeds and Algae: 5th edition. Applied Biochemists. Milwaukee, Wisconsin. 128pp.

Lembi, Carole 1997. Aquatic Pest Control: Category 5. Department of Botany and Plant Pathology: Purdue University. West Lafayette, Indiana. 58pp.

Pearson, Jed. 2004. A Proposed Sampling Method to Assess Occurrence, Abundance and Distribution of Submersed Aquatic Plants in Indiana Lakes. IN Department of Natural Resources. Division of Fish & Wildlife. Indianapolis, Indiana 37 pp.

Pullman, Douglas G. 1998. The Lake Association Leaders Aquatic Vegetation Management Guidance Manual.

Renovate 3 Specimen Label. 2003. SePRO Corporation. www.sepro.com

Scribailo, Robin W. Ph.D. & Alix, Mitchell S. 2003. Final Report on the Weevil Release Study for Indiana Lakes. Department of Botany and Plant Pathology. Purdue University. West Lafayette, IN.

Smith, Robert Leo and Smith, Thomas M. 2001. Ecology and Field Biology. Addison Wesley Longman, Inc. San Francisco, California. 771 pp.

Stern, Kinsingly R. 2000. Introductory Plant Biology. McGraw Hill. Madison, Wisconsin. 557 pp.

Tyllia, J. 2000. Northeastern Indiana Fishing Map Guide. Superior, Wisconsin. 184 pp.

16.0 Appendices

16.1 Calculations

Fluridone Calculations:
The following paragraph is taken directly from the Sonar A.S. label. It outlines the specific procedures for calculating the amount of Fluridone needed to treat a body of water.

Application Rate Calculation - Ponds, Lakes and Reservoirs

The amount of Sonar A.S. to be applied to provide the desired ppb concentration of active ingredient in treated water may be calculated as follows:
Quarts of Sonar A.S. required per treated surface acre = Average water depth of treatment site (feet)
x Desired ppb concentration of active ingredient
x 0.0027
For example, the quarts per acre of Sonar A.S. required to provide a concentration of 25 ppb of active ingredient in water with an average depth of 5 feet is calculated as follows:
5 **x** 25 **x** 0.0027 = 0.33 quarts per treated surface acre
When measuring quantities of Sonar A.S., quarts may be converted to fluid ounces by multiplying quarts to be measured **x** 32. For example, 0.33 quarts **x** 32 = 10.5 fluid ounces.
Note: Calculated rates should not exceed the maximum allowable rate in quarts per treated surface acre for the water depth listed in the application rate table for the site to be treated.

The following chart outlines rate calculations for DMA – 4 IVM Herbicide. It was taken directly from the DMA – 4 IVM specimen label on Dow AgroSciences website. http://www.dowagro.com/ivm/invasive/prod/dma.htm

Submerged Aquatic Weeds: Including Eurasian Water Milfoil *(Myriophyllum spicatum)*

Treatment Site	Maximum Application Rate [1]	Specific Use Directions
Aquatic Weed Control in Ponds, Lakes, Reservoirs, Marshes, Bayous, Drainage Ditches, Canals, Rivers and Streams that are Quiescent or Slow Moving, Including Programs of the Tennessee Valley Authority	2.84 gallons (10.8 lb of acid equivalent) per acre foot	**Application Timing:** For best results, apply in spring or early summer when aquatic weeds appear. Check for weed growth in areas heavily infested the previous year. A second application may be needed when weeds show signs of recovery, but no later than mid-August in most areas. **Subsurface Application:** Apply DMA 4 IVM undiluted directly to the water through a boat mounted distribution system. Shoreline areas should be treated by subsurface injection application by boat to avoid aerial drift. **Surface Application:** Use power operated boat mounted boom sprayer. If rate is less than 5 gallons per acre, dilute to a minimum spray volume of 5 gallons per surface acre. **Aerial Application:** Use drift control spray equipment or thickening agents mixed with sprays to reduce drift. Apply through standard boom systems in a minimum spray volume of 5 gallons per surface acre. For Microfoil® drift control spray systems, apply DMA 4 IVM in a total spray volume of 12 to 15 gallons per acre. Apply to attain a concentration of 2 to 4 ppm (see table below).

[1] DMA 4 IVM contains 3.8 lb of acid equivalent per gallon of product.

Amount to Apply to Attain a Concentration of 2 to 4 ppm			
Surface Area	**Average Depth (ft)**	**2,4-D Acid Equivalent to Apply (lb/acre)**	**Amount of DMA 4 IVM to Apply (gal/acre)**
1 acre	1	5.4 to 10.8	1.42 to 2.84
	2	10.8 to 21.6	2.84 to 5.68
	3	16.2 to 32.4	4.26 to 8.53
	4	21.6 to 43.2	5.68 to 11.37
	5	27.0 to 54.0	7.10 to 14.21

The following table outlines rate calculations for Renovate 3 herbicide based on desired PPM and average depth of treatment area. It is taken directly from the Renovate 3 specimen label on SePRO Corporation's website: www.sepro.com

Concentration of Triclopyr Acid in Water (ppm ae)					
	Gallons of Renovate 3 per surface acre at specified depth				
Water Depth (feet)	0.75 ppm	1.0 ppm	1.5 ppm	2.0 ppm	2.5 ppm
1	0.7	0.9	1.4	1.8	2.3
2	1.4	1.8	3.3	3.6	4.6
3	2.1	2.9	4.1	5.4	6.8
4	2.7	3.6	5.4	7.2	9.1
5	3.4	4.5	6.8	9.0	11.3
6	4.1	5.4	8.1	10.9	13.6
7	4.8	6.3	9.5	12.7	15.8
8	5.5	7.2	10.9	14.5	18.1
9	6.1	8.1	12.2	16.3	20.4
10	6.8	9.0	13.6	18.1	22.6
15	10.2	13.6	20.4	27.2	33.9
20	13.6	18.1	27.2	36.2	45.3

16.2 Common Aquatic Plants of Indiana

The following appendix was compiled using information found in the 5th edition of How to Identify Water Weeds and Algae, edited by James C. Schmidt and James R. Kannenberg. Some Pictures were taken by Aquatic Weed Control while others are from the Category 5 Aquatic Pest Control Management Manual, written by Dr. Carole Lembi, Head of the Department of Botany and Plant Pathology at Purdue University.

American Pondweed

Scientific name: *Potamogeton americanus*
Classification: Native to Indiana
Distribution: Common throughout the U.S.

Description: American pondweed can be identified by its oval shaped leaves floating on the top of the water. The base of each leaf tapers to a very long petiole that connects the leaf with the stem of the plant. Plant leaves are arranged alternately on the stem and leaves are usually sparsely scattered.

Chara

Scientific name: *Chara sp*.
Classification: Native to Indiana
Distribution: Extremely common worldwide. Usually found in hard water.

Description: Chara is often mistaken for a vascular plant, but it is actually an advanced form of algae. It can be gray, green or yellow in color and is usually forms extremely dense beds that may

cover an entire lake. It can be identified by its distinct musky odor and calcium deposits on the algae's surface make it feel bristly to the touch. It possesses leaf-like structures that are whorled around the hollow stem, and it attaches itself to the lake bottom, although it has no actual roots. It usually grows in shallow, clear water.

Coontail

Scientific name: *Ceratophyllum demersum*

Classification: Native to Indiana

Distribution: Common throughout the U.S., usually in hard water.

Description: Coontail plants are submersed and have no roots, though they appear to be attached to the lake bottom when viewed from above the surface of the water. The free-floating nature of coontail allows it to colonize new areas of a lake quickly, and it often times forms extremely dense weed beds where sufficient light and nutrients are available. Coontail has dark green leaves arranged in whorls around the stem and usually grows in long, bushy strands resembling evergreen trees beneath the surface of the water. Coontail's structure is very similar to Eurasian milfoil but coontail has forked leaves, which distinguishes it from the feather-like projections of milfoil leaves.

Curly Leaf Pondweed

Scientific name: *Potamogeton crispus*

Classification: Exotic to Indiana

Distribution: Found throughout the U.S. in fresh and brackish water.

Description: Curly leaf pondweed usually grows and spreads rapidly in early spring and begins to dies out by midsummer as water temperatures approach 70 degrees Fahrenheit. Curly leaf has extremely thin, membranous leaves arranged alternately on the stem with small teeth-like projections visible along the edge of each leaf. A reproductive spike may be seen protruding from the surface of the water. Curly leaf pondweed may also leave small reproductive structures called turions in the sediment on the lake bottom that can lie dormant throughout the winter and then sprout when spring arrives.

Eel Grass (Wild Celery)

Scientific name: *Vallisneria Americana*

Classification: Native to Indiana

Distribution: Found from the Great Plains to the East Coast of the U.S.

Description: Eel grass has tufts of ribbon-like leaves with a horizontal stem embedded in the sediment connecting each tuft. This native plant grows thick weed beds anchored in the mud by roots. These dense beds often shade out other forms of weeds and provide excellent escape cover for small fish. The flowers of this plant are visible in late summer and sit on the top of a coiled structure protruding to the surface. This plant is found in both lakes and river, but is seldom found in stagnant systems. It is considered an extremely valuable plant to aquatic ecosystems.

Elodea

Scientific Name: *Elodea Canadensis*
Classification: Native to Indiana
Distribution: Common throughout the north and north central united states. Its ranges extends as far south as northern Tennnessee.

Description: Elodea grows in long strands resembling milfoil, but its leaves are broad and oval shaped. Leaves are arranged in whorls with three leaves usually occurring at each node. Leaves near the tip of the plant are closely packed together, with the distance between nodes increasing further down the stem.

Eurasian Milfoil

Scientific Name: *Microphyllum spicatum*

Classification: Exotic in Indiana

Distribution: Common in the Midwest and Eastern U.S. Also spreading along the Pacific coast

Description: This extremely aggressive and extremely destructive plant has leaves in whorls of 4 around a reddish stalk. This plant grows rapidly and can reach lengths of over 10 feet. This plant has the ability to over winter, meaning it can lie dormant during the winter months instead of dying out completely each year. This gives it a distinct advantage over many native species, as it competes for sunlight in early spring. The dormant milfoil plants reach the surface much faster than the native plants sprouting from the lake bottom. This enables the Eurasian milfoil to shade out other plants and form the dense beds that choke the littoral zone of many lakes.

A reproductive process called fragmentation aids the rapid dispersion of Eurasian milfoil. If a milfoil plant is damaged and some fragments are removed from the macrophyte, each small piece of the plant has the ability to grow roots and create a new milfoil plant. Eurasian milfoil is considered one of the most dangerous aquatic nuisance species because of its ability to rapidly disrupt and destroy lake ecosystems.

Flat-stemmed Pondweed

Scientific Name: *Potamogeton zosteriformis*

Classification: Native to Indiana

Distribution: Common throughout the northern half of the U.S.

Description: the most noticeable characteristic is the large, very flat stem. It cannot be rolled between the fingers easily. The ribbon-like leaves extend from the stem toward the surface of the water.

Illinois Pondweed

Scientific name: *Potamogeton illinoensis*

Classification: Native to Indiana

Distribution: Very widespread and very common throughout the upper Midwest and the U.S

Description: Illinois pondweed is common in Indiana, especially in the northern third of the state. This leafy weed has leaves with very broad bases that extend three-fourths of the way around the stem. The upper part of its slender stem is usually branched and very leafy.

www.wvu.edu

Large Leaf Pondweed

Scientific name: *Potamogeton amplifolius*
Classification: Native to Indiana
Distribution: Common throughout the upper Midwest and the northern United States in hard water.

Description: This plant has both submersed and floating leaves. The floating leaves are oval shaped and are similar to those of American pondweed. Submersed leaves are arranged alternately with each leaf becoming extremely narrow as it nears the stem of the plant. Mineral deposits on its leaves often give large leaf pondweed a dark brown appearance.

Naiad

Scientific name: *Najas minor* (brittle naiad)

Classification: Native to Indiana

Distribution: Common throughout the U.S.

Description: The leaves of naiad plants are usually widest at the base and gradually become thinner near the tip of the leaf. Plants are extremely leafy and appear bush-like when viewed from above the surface of the water. Many species of naiad are very common in this area. Plant structure often resembles chara, but the absence of calcium deposits on the surface of the plant help in identification. The leaves of brittle naiad have multiple spines along the margins that are visible to the naked eye.

Nitella

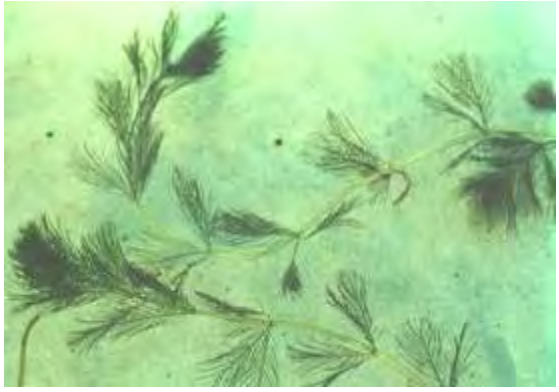
Scientific name: *Nitella sp.*

Classification: Native to Indiana

Distribution: Found worldwide, usually in hard water.

Description: Nitella is very similar to chara, and it is also an advanced form of algae. It has leaf-like projections that are whorled around the stem. It is often found growing in very thick patches, usually in shallow, clear water.

Northern Milfoil



www.io.uwinnipeg.ca

Scientific name: *Myriophyllum sibericum*

Classification: Native to Indiana

Distribution: Found throughout the northern half of the U.S. and also in Europe and Western Asia

Description: Northern milfoil has submersed, feather-like, whorled leaves that closely resemble the leaves of Eurasian milfoil. Distinguishing the native northern milfoil from Eurasian milfoil can be difficult. The leaflet pairs of northern milfoil are generally fewer and more widely spaced than those of Eurasian milfoil. This plant is known to hybridize with Eurasian milfoil, and at times, chemical analysis is necessary to distinguish between the two plants.

Sago Pondweed

Scientific name: *Potemogeton pectinatus*

Classification: Native to Indiana

Distribution: Found throughout the U.S., Common in the northern 2/3 of Indiana.

Description: Sago Pondweed has a bushy appearance with narrow, thread-like leaves that spread out to resemble a fan. Leaves are usually 1/16 of an inch wide and 1 to 6 inches long. Nutlets are formed on a string-like structure and protrude from the surface of the water. While sago pondweed can form dense beds, many times it is found in sparse, loosely distributed arrangements.

16.3 Pesticide Use Restrictions Summary:

The following table was produced by Purdue University and included in the Professional Aquatic Applicators Training Manual. It gives a summary of water use restrictions on all major chemicals available for use in the aquatics market.

Table 8: Pesticide Use Restrictions

Table 1. Aquatic Herbicides and Their Use Restrictions. Always check the label because these restrictions are subject to change.

	Human			Animal	Irrigation		
	Drinking	Swimming	Fish Consumption	Drinking	Turf	Forage	Food Crops
	waiting period, in days						
Copper Chelate	0	0[a]	0	0	0	0	0
Copper Sulfate	0	0[a]	0	0	0	0	0
Diquat	1–3	0[a]	0	1	1–3	1–3	5
Endothall (granular)[b]	7	0[a]	3	0	7	7	7
Endothall (liquid)[b]	7–25	0[a]	3	7–25	7–25[d]	7–25	7–25
Endothall 191 (granular)[c]	7–25	0[a]	3	7–25	7–25	7–25	7–25
Endothall 191 (liquid)[c]	7–25	0[a]	3	7–25	7–25	7–25	7–25
Fluridone	0[e]	0[a]	0	0	7–30	7–30	7–30
Glyphosate	0[e]	0[a]	0	0	0	0	0
2,4-D (granular)	*	0[a]	0	*	*	*	*

[a]Although this compound has no waiting period for swimming, it is always advisable to wait 24 hours before permitting swimming in the direct area of treatment.

[b]Trade name is Aquathol®.

[c]Trade name is Hydrothol®.

[d]May be used for sprinkling bent grass immediately.

[e]Do not apply this product within 1/4 (fluridone) to 1/2 (glyphosate) mile upstream of potable water intakes.

*Do not use treated water for domestic purposes, livestock watering (2,4-D, dairy animals only), or irrigation.

16.4 Resources for Aquatic Management

In addition to the LARE Program, there are many other sources of potential funding to help improve the quality of Indiana Lakes. Many government agencies assist in projects designed to improve environmental quality.

The USDA has many programs to assist environmental improvement. More information on the following programs can be found at www.usda.gov.

Watershed Protection and Flood Prevention Program (USDA

Conservation Reserve Program (USDA)

Wetlands Reserve Program (USDA)

Grassland Reserve Program (USDA)

Wildlife Habitat Incentive Program (USDA)

Small Watershed Rehabilitation Program (USDA)

The following programs are offered by the U.S. Fish and Wildlife Service. More information about the Fish and Wildlife service can be found at www.fws.gov

Partners for Fish and Wildlife Program (U.S. Fish and Wildlife Service)

Bring Back the Natives Program (U.S. Fish and Wildlife Service)

Native Plant Conservation Program (U.S. Fish and Wildlife Service)

The Environmental Protection Agency, the Indiana Department of Environmental Management, and the U.S. Forest Service also have numerous programs for funding. A few of these are listed below. More information can be found at www.in.gov/idem and www.fs.fed.us/

U.S. Environmental Protection Agency Environmental Education Program (EPA)

NPDES Related State Program Grants (IDEM)

Community Forestry Grant Program (U.S. Forest Service)

16.5 State Regulations for Aquatic Plant Management

The following information is found on the IDNR website and outlines general regulations for the management of aquatic plants in public waters.

AQUATIC PLANT CONTROL PERMIT REGULATIONS
Indiana Department of Natural Resources

Note: In addition to a permit from IDNR, public water supplies cannot be treated without prior written approval from the IDEM Drinking Water Section. **Amended state statute adds biological and mechanical control (use of weed harvesters) to the permit requirements, reduces the area allowed for treatment without a permit to 625 sq ft, and updates the reference to IDEM.** *These changes become effective on July 1, 2002.*

Chapter 9. Regulation of Fishing
IC 14-22-9-10

Sec. 10. (a) This section does not apply to the following:

(1) A privately owned lake, farm pond, or public or private drainage ditch.

(2) A landowner or tenant adjacent to public waters or boundary waters of the state, who chemically, mechanically, or physically controls aquatic vegetation in the immediate vicinity of a boat landing or bathing beach on or adjacent to the real property of the landowner or tenant if the following conditions exist:

(A) The area where vegetation is to be controlled does not exceed:

(i) twenty-five (25) feet along the legally established, average, or normal shoreline;

(ii) a water depth of six (6) feet; and

(iii) a total surface area of six hundred twenty-five (625) square feet.

(B) Control of vegetation does not occur in a public waterway of the state.

(b) A person may not chemically, mechanically, physically, or biologically control aquatic vegetation in the public waters or boundary waters of the state without a permit issued by the department. All procedures to control aquatic vegetation under this section shall be conducted in accordance with rules adopted by the department under IC 4-22-2.

(c) Upon receipt of an application for a permit to control aquatic vegetation and the payment of a fee of five dollars ($5), the department may issue a permit to the applicant. However, if the aquatic vegetation proposed to be controlled is present in a public water supply, the department may not, without prior written approval from the department of environmental management, approve a permit for control of the aquatic vegetation.

(d) This section does not do any of the following:

(1) Act as a bar to a suit or cause of action by a person or governmental agency.

(2) Relieve the permittee from liability, rules, restrictions, or permits that may be required of the permittee by any other governmental agency.

(3) Affect water pollution control laws (as defined in IC 13-11-2-261) and the rules adopted under water pollution control laws (as defined in IC 13-11-2-261).

As added by P.L.1-1995, SEC.15. Amended by P.L.1-1996, SEC.64.

312 IAC 9-10-3 Aquatic vegetation control permits
Authority: IC 14-22-2-6; IC 14-22-9-10
Affected: IC 14-22-9-10

Sec. 3. (a) Except as provided under IC 14-22-9-10(a), a person shall obtain a permit under this section before applying a substance to waters of this state to seek aquatic vegetation control.

(b) An application for an aquatic vegetation control permit shall be made on a departmental form and must include the following information:

(1) The common name of the plants to be controlled.

(2) The acreage to be treated.

(3) The maximum depth of the water where plants are to be treated.

(4) The name and amount of the chemical to be used.

(c) A permit issued under this section is limited to the terms of the application and to conditions imposed on the permit by the department.

(d) Five (5) days before the application of a substance permitted under this section, the permit holder must post clearly, visible signs at the treatment area indicating the substance that will be applied and what precautions should be taken.

(e) A permit issued under this section is void if the waters to be treated are supplied to the public by a private company or governmental agency. *(Natural Resources Commission; 312*

16.6 Data Sheets

Aquatic Vegetation Random Sampling (Tier 2)

Waterbody Cover Sheet

Surveying Organization: Aquatic Weed Control

Contact Information: 574-533-2597

Waterbody Name: Hill Lake

Lake ID: Hill

County(s): Kosciusko

Date: 8-20-2009

Habitat Stratum: IL

Avg. Lake Depth (ft): 19.0

Lake Level: 1.50

Crew Leader: Dave Kreisher

GPS Metadata

Datum: NAD83

Zone: 16

Accuracy: 3m

Recorder: Dave Kreisher

Method: WAAS Enabled GPS

Secchi Depth (ft): 6.8

Total # of Points Surveyed: 40

Total # of Species: 3

Littoral Zone Size (acres): Approx 20 ac

- ☐ Measured
- ☒ Estimated

Littoral Zone Max. Depth (ft): 16.5 → max plant depth

- ☐ Measured
- ☐ Estimate (historical Secchi)
- ☐ Estimated (current Secchi)

Notable Conditions: [illegible]

Submersed Aquatic Vegetation Survey (Tier II) Datasheet

Page 1 of 2

WATERBODY NAME: H.W. Lake	DATE: 8-20-2003
COUNTY: Rockwall Co.	SECCHI DEPTH (FT): 2.0 ft
SITE ID: H.W.	MAX PLANT DEPTH (FT): 10 ft
SURVEYING ORGANIZATION: Aquatic Weed Control	WEATHER: Sunny, 75°F, 0 mph
CREW LEADER: Dave Reeder	COMMENTS (Include voucher codes - V1, V2...): Canada Fleabane 9:50
RECORDER: Dave Reeder	67 acres - accessible by car to 5-10 10-14 15-20
CONTACT INFO: 214-533-2892	*Rake score (1, 3, 5). 9 = algae, emergent or species observed but not sampled.*

Point #	R/T	Latitude	Longitude	Depth	Species Codes: CERA	SAUD	TOOB						Notes
	R	GPS Points	1	2	—								
			2	3	1	1							
			3	7	3								A
			4	4			1						
			5	4		1							
			6	3	5								
			7	2	3								
			8	5	1								
			9	5	1								
			10	5	1		3						A
			11	6	1								
			12	7	1		1						
			13	7	—								A
			14	8	—								
			15	9	1								
			16	6	1								
			17	9	1								
			18	7	—								
			19	8	3		1						
			20	10	—								
			21	11	—								
			22	12	—								
			23	13	—								
			24	13	—								A
			25	12	—								
			26	13	—								
			27	10	—								
			28	11	—								
			29	11	3								
			30	12	—								
			31	18	—								
			32	15	—								
			33	19	—								

Other plant species observed at lake:

Submersed Aquatic Vegetation Survey (Tier II) Datasheet

Page 2 of 2

WATERBODY NAME: Hill Lake	DATE: 8-30-2007
COUNTY: Kosciusko Co.	SECCHI DEPTH (FT): 6.96
SITE ID: 4 n	MAX PLANT DEPTH (FT): 16.6
SURVEYING ORGANIZATION: [illegible]	WEATHER: Sunny, windy
CREW LEADER: Dave Kratz	COMMENTS (Include voucher codes - V1, V2...):
RECORDER: Ro. Kratz	
CONTACT INFO: 574-533-2593	*Rake score (1, 3, 5). 9 = algae, emergent or species observed but not sampled.*

Point #	R/T	Latitude	Longitude	Depth	Species Codes: Coon								Notes
	R	GPS	Points 29	16	—								
	↓	↓	3	19	—								
	↓	↓	36	17	—								
			37	16	1								
			38	17	—								
			39	16	—								
			40	20	—								
		Vertical profile											
	Depth	Temp				depth	temp						
	0	79.8	8.55			25	54.3	5.08					
	1.5	79.3	8.90			30	52.7	0.41					
	3	78.1	8.92										
	4.5	78.8	8.96										
	6	78.6	8.92										
	7.5	78.4	8.92										
	9	78.3	8.85										
	10.5	77.2	6.76										
	12	76.0	4.53										
	13.5	75.2	3.53										
	15	73.6	2.04										
	16.5	71.7	1.16										
	18	68.5	0.15										
	19.5	[illegible]	[illegible]										
	21	[illegible]	[illegible]										
	22.5	[illegible]	0.09										
	24	[illegible]	[illegible]										
	25.5	[illegible]	[illegible]										
	27	[illegible]	[illegible]										

Other plant species observed at lake:

Tier II Rake Sample GPS Coordinates

Site	Latitude	Longitude
1	41.104295	-85.90765
2	41.105464	-85.904023
3	41.105845	-85.901133
4	41.107125	-85.899692
5	41.107808	-85.899237
6	41.107951	-85.901369
7	41.108094	-85.904703
8	41.107818	-85.907761
9	41.106649	-85.908681
10	41.105119	-85.909682
11	41.105227	-85.905683
12	41.106048	-85.903303
13	41.106568	-85.900673
14	41.107719	-85.89988
15	41.107933	-85.900613
16	41.108613	-85.903082
17	41.107864	-85.905759
18	41.107674	-85.908591
19	41.105827	-85.908746
20	41.104635	-85.909593
21	41.104917	-85.906455
22	41.105379	-85.904559
23	41.105849	-85.902131
24	41.106061	-85.901331
25	41.107078	-85.900013
26	41.107556	-85.900025
27	41.108181	-85.902161
28	41.108492	-85.903618
29	41.107849	-85.906272
30	41.10713	-85.908583
31	41.106234	-85.903913
32	41.107098	-85.901048
33	41.107326	-85.900395
34	41.108437	-85.902763
35	41.108057	-85.904027
36	41.107738	-85.904997
37	41.107791	-85.907033
38	41.106073	-85.908364
39	41.105393	-85.908961
40	41.104938	-85.908484

16.7 IDNR Aquatic Vegetation Control Permit

This page intentionally left blank.

Return to: Page 1 of

APPLICATION FOR AQUATIC VEGETATION CONTROL PERMIT

State Form 26727 (R4 / 2-04)
Approved State Board of Accounts 2004

[X] Whole Lake [ ] Multiple Treatment Areas
Check type of permit

INSTRUCTIONS: Please print or type information

FOR OFFICE USE ONLY
License No.
Date Issued
Lake County

DEPARTMENT OF NATURAL RESOURCES
Division of Fish and Wildlife
Commercial License Clerk
402 West Washington Street, Room W273
Indianapolis, IN 46204

FEE: $5.00

Applicant's Name: John Bender	Lake Assoc. Name: Diamond Lake Conservation Club	
Rural Route or Street: 2227 Coral Bay Court		Phone Number: 260-969-9300
City and State: Fort Wayne IN		ZIP Code: 46814
Certified Applicator (if applicable):	Company or Inc. Name:	Certification Number:
Rural Route or Street:		Phone Number:
City and State:		ZIP Code:

Lake (One application per lake): Hill Lake	Nearest Town: Silver Lake	County: Kosciusko
Does water flow into a water supply	[ ] Yes	[X] No

Please complete one section for *EACH* treatment area. Attach lake map showing treatment area and denote location of any water supply intake.

Treatment Area #	1	LAT/LONG or UTM's	whole Lake
Total acres to be controlled	whole	Proposed shoreline treatment length (ft)	Perpendicular distance from shoreline (ft)
Maximum Depth of Treatment (ft)	10	Expected date(s) of treatment(s)	AS specified by SePro prescription

Treatment method: [X] Chemical [ ] Physical [ ] Biological Control [ ] Mechanical

Based on treatment method, describe chemical used, method of physical or mechanical control and disposal area, or the species and stocking rate for biological control. Sonar*

Plant survey method: [ ] Rake [X] Visual [ ] Other (specify)

Aquatic Plant Name	Check if Target Species	Relative Abundance % of Community
Coontail		12.5
Eurasian Watermilfoil	X	0
Sago		5
Search and Destroy for EWM		

Aquatic Weed Control

Hill Lake – Kosciusko County -2010 Treatment areas not yet known- no EWM re-growth as of fall 2009.