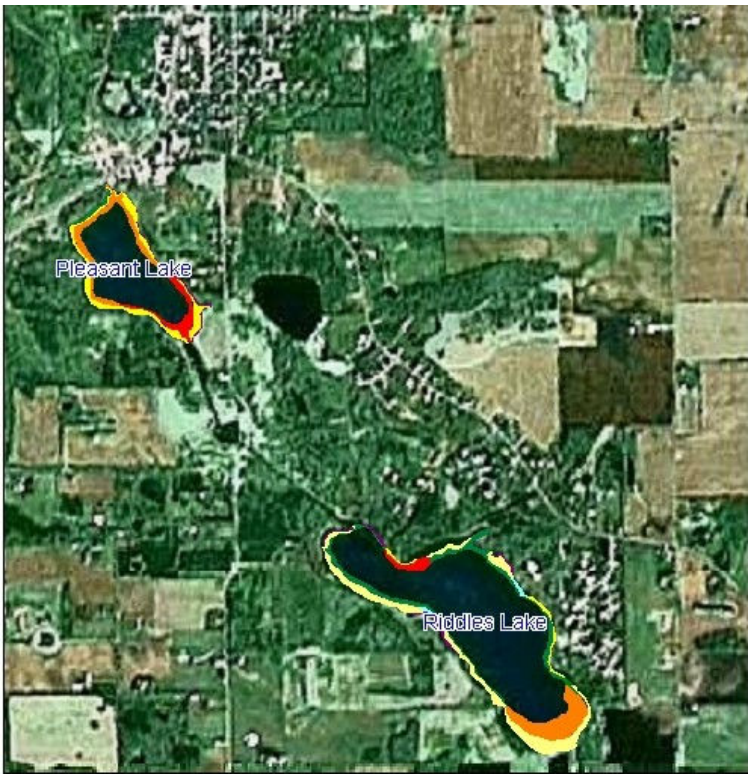

Pleasant and Riddles Lakes Aquatic Vegetation Management Plan 2007-2011

February 22, 2006

Prepared for:
Lakeville Business Owner's Association
PO Box 468
Lakeville, IN 46536

Prepared by:
Aquatic Control, Inc.
PO Box 100
Seymour, Indiana 47274

Executive Summary

Aquatic Control was contracted by the Lakeville Business Owner's Association (LBOA) to complete aquatic vegetation sampling in order to create a lakewide, long-term integrated aquatic vegetation management plan. Pleasant and Riddles Lakes are located in south of Lakeville in St. Joseph County, Indiana. This plan was created in order to more effectively document and control nuisance aquatic vegetation within the lake. This plan was also created as a prerequisite to eligibility for LARE program funding to control nuisance exotic vegetation.

Aquatic vegetation is an important component of Indiana Lakes. Aquatic vegetation provides fish habitat, food for wildlife, prevents erosion, and can improve overall water quality. However, as a result of many factors, this vegetation can develop to a nuisance level. Nuisance aquatic vegetation, as used in this paper, describes plant growth that negatively impacts the present uses of the lake including fishing, boating, swimming, aesthetic, and lakefront property values. The primary nuisance species within the Pleasant and Riddles Lake is the invasive exotic plant Eurasian watermilfoil (*Myriophyllum spicatum*). The negative impact of this species on native aquatic vegetation, fish populations, water quality, and other factors is well documented and will be discussed in further detail. The invasive exotic species curlyleaf pondweed (*Potamogeton crispus*) was also present at potentially nuisance levels.

The primary recommendation for plant control within the Pleasant and Riddles Lake chain involves the use of a combination of herbicides for early season selective control of Eurasian watermilfoil and curlyleaf pondweed throughout the lakes. This type of treatment should preserve and enhance the population of native vegetation and relieve nuisance conditions created by these species. Ideally, the goal of the treatment would be to eliminate both invasive species. However, this may be a difficult goal to achieve due to the abundance of this species in other nearby lakes and this plants ability to be easily transported from lake to lake. A more realistic goal should be to reduce Eurasian watermilfoil and curlyleaf pondweed to a more manageable level where LBOA can easily afford future spot treatments of this species.

Currently, there is a lack of abundance and diversity within the submersed native plant community. This is likely due to the fact that both of these lakes are suffering the effects of eutrophication caused by poor watershed practices. Efforts to correct the poor water quality should take precedence over plant management. Improved water quality along with control of invasive plant species, should help increase the abundance and diversity of native vegetation.

Acknowledgements

Funding for the vegetation sampling and preparation of an aquatic vegetation management plan was provided by the Lakeville Business Owner's Association and the Indiana Department of Natural Resources Lake and River Enhancement Program. Aquatic Control, Inc. completed the fieldwork, data processing, and map generation. Special thanks are due to Bob Feitz and the Lakeville Business Owner's Association for their help in initiating and completing this project. Special thanks are given to Bob Robertson and Jeremy Price, Fisheries Biologists for the Indiana Department of Natural Resources-Division of Fish And Wildlife, for their assistance and review of this plan. Special thanks is also given to Robin Longenbaugh with IDNR for her assistance in obtaining past reports. Special thanks are also given to Gwen White and Angela Studevant, Aquatic Biologist from the Lake and River Enhancement Program (LARE) for their review and assistance on this plan. Special thanks are also given to Sara Peel with JFNew and Associates for supplying a copy us with a copy of the Diagnostic Study. Nathan Long is the primary author of this report. The author would like to acknowledge the valuable input from David Isaacs, Brian Isaacs, Joey Leach, Brendan Hastie, Matt Johnson, Steve Lee, Kyle Richardson, and Barbie Huber of Aquatic Control for their field assistance, map generation, review, and editing of this report.

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1.0 INTRODUCTION

Aquatic Control was contracted by the Lakeville Business Owner's Association (LBOA) to complete aquatic vegetation sampling in order to create a lakewide, long-term integrated aquatic vegetation management plan. The study area includes Pleasant and Riddles Lakes, which are located south of Lakeville in St. Joseph County, Indiana. This plan was created in order to more accurately document the aquatic vegetation community and create a feasible plan for managing nuisance vegetation within Pleasant and Riddles Lake. The plan is also a prerequisite to eligibility for the Lake and River Enhancement (LARE) program funding to control exotic or nuisance species. Two aquatic vegetation surveys were completed in 2006 in order to document the plant community. The surveys will provide valuable information that will allow for scientifically based recommendations for aquatic plant management. The focus of aquatic plant management will be on the control of exotic invasive species. However, some native vegetation in high-use areas may require some form of control.

The primary nuisance plant species in Pleasant and Riddles Lakes is the exotic species Eurasian watermilfoil. The invasive exotic species curlyleaf pondweed was also detected at potentially nuisance levels. In addition, the exotic emergent species, purple loosestrife (*Lythrum salicaria*), was present within the margins of the lakes. It is important to initiate management of these species in order to reduce nuisance conditions and stop their spread. In order to successfully manage aquatic vegetation on a public body of water concerns of fishermen, lot owners, biologists, and the general public will have to be addressed. The purpose of this plan is to provide plant management recommendations that will balance the concerns of these interest groups while effectively relieving Pleasant and Riddles Lakes of nuisance aquatic plant growth while working towards the goals of the plant management program.

2.0 WATERSHED AND WATERBODY CHARACTERISTICS (Summarized from JFNew, 2006)

Pleasant and Riddles lakes are 29-acre and 77-acre lakes, respectively that lie south of Lakeville in St. Joseph County, Indiana. The lakes lie in the headwaters of the Yellow River Basin which carries water south and west to the Kankakee River. Their watershed encompasses approximately 7,730 acres. Most of the watershed (68%) is utilized for agricultural purposes. Remnants of the native landscape, including forested areas and wetlands, cover approximately 20% of the watershed, while residential and commercial land uses account for approximately 10% of the watershed's total acreage.

Pleasant Lake has two primary tributaries, Heston and Bunch ditches. Both streams possessed poor biotic communities reflecting the poor water quality. Bunch Ditch contained low dissolved oxygen and elevated *E. coli*, total phosphorus, and total Kjeldahl nitrogen concentrations. Pleasant lake possesses a relatively large watershed area to lake ratio (192:1). In terms of management, Pleasant Lake's large ratio means that watershed activities and processes can potentially exert a significant influence on the health of the lake.

Riddles Lake also has two primary tributaries, Heston and Walters ditches. Walters Ditch exhibited poor water quality during normal conditions and high E. coli, total phosphorus, and total suspended solids concentrations during storm flow conditions. Riddles Lake also possesses a relatively large watershed ratio of 99:1.

Concerning water body characteristics, Pleasant Lake is roughly triangular shaped with the widest area of the lake being located in the northern portion. Pleasant Lake is 29 acres and has one basin. The lake reaches a maximum depth of 39 feet and possesses and average depth of 17 feet. Pleasant Lake holds approximately 663 acre-feet of water. Pleasant Lake has a shoreline development ration of 1.38 which is relatively low. Pleasant Lake lacks extensive shoreline channeling similar to Riddles Lake.

Riddles Lake is long and narrow with a northwest to southeast orientation (Figure 1). The lake encompasses an area of 77-acres and has an average depth of 8.1 feet. Riddles Lake has large expanses of shallow water. Twenty-seven acres of the lake is covered with less than 5-feet of water. The lake consists of two deeper holes surrounded by even shallower water. The lake's deepest point lies in the southern portion of the lake where the maximum depth is 20 feet. One shallower hole lies in the northern portion of the lake reaching a depth of 15 feet. Riddles Lake has a shoreline development ratio of 1.46.

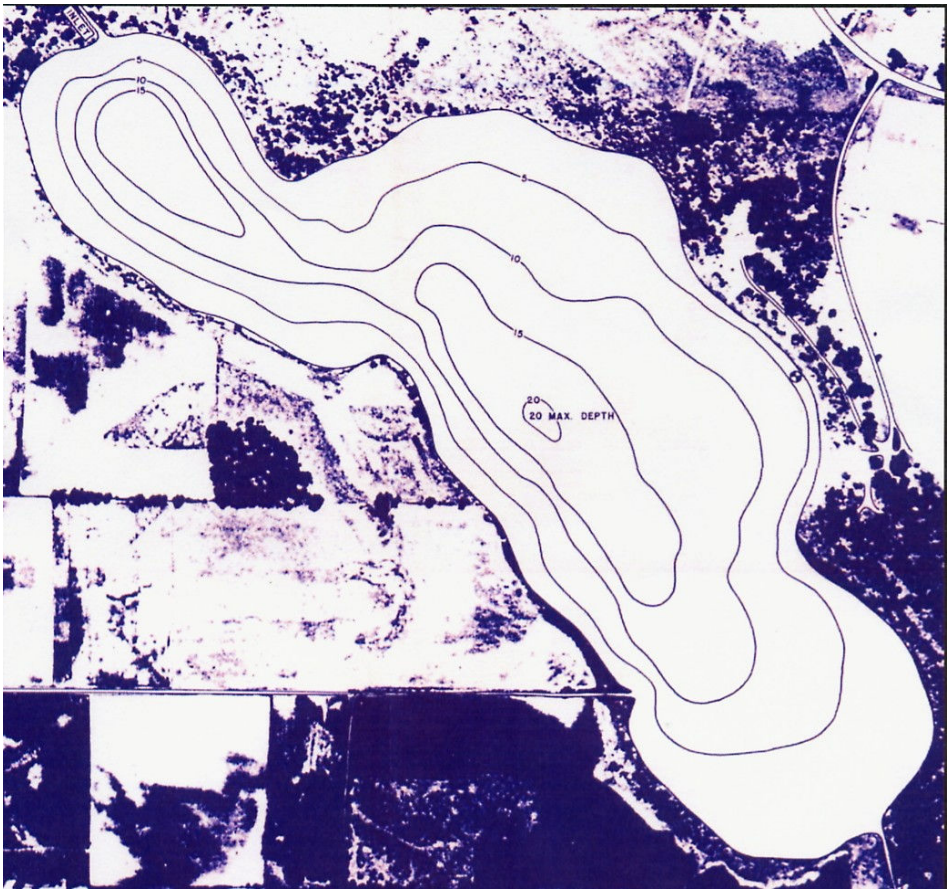

Figure 1. Riddles Lake Bathymetric Map (IDNR, 1955 cited in JFNew, 2006)

Improving water quality in Pleasant and Riddles lakes will require watershed management. The lakes' large watershed area to lake ratios suggests near watershed practices have substantial control over influencing the health of these lakes. Recommended watershed management techniques include: wastewater treatment plant maintenance, erosion control practices for existing and future developments, homeowner best management practices, wetland restoration, use of the Conservation Reserve Program and conservation tillage, and livestock restriction (JFNew, 2006).

3.0 PRESENT WATER BODY USES

A public access site is located along the western shore of Pleasant Lake (Figure 2). Boating and fishing are the primary activities on Pleasant and Riddles lakes. High speed boating is not allowed on either lake. However, lake users should keep in mind that boating even at slow speeds could potentially fragment and distribute Eurasian watermilfoil. Large boats with a deep draft can produce a wake that affects aquatic plants, even at slow speeds. Some boats sit lower and push more water at slow speed than when they are up on plane. The majority of boaters on the lakes are fishing or cruising (JFNew, 2006). Unlike most northern Indiana Lakes, Pleasant and Riddles lakes have limited development along the shoreline (Figure 2). Approximately 10% of Pleasant Lake and 25% of Riddles Lake are developed. At a recent public meeting, lake users indicated that 94% used the lake for fishing, 50% for boating, 37% for swimming, 6% for drinking, and none of the respondents used the lake for irrigation (survey included only 16 individuals).

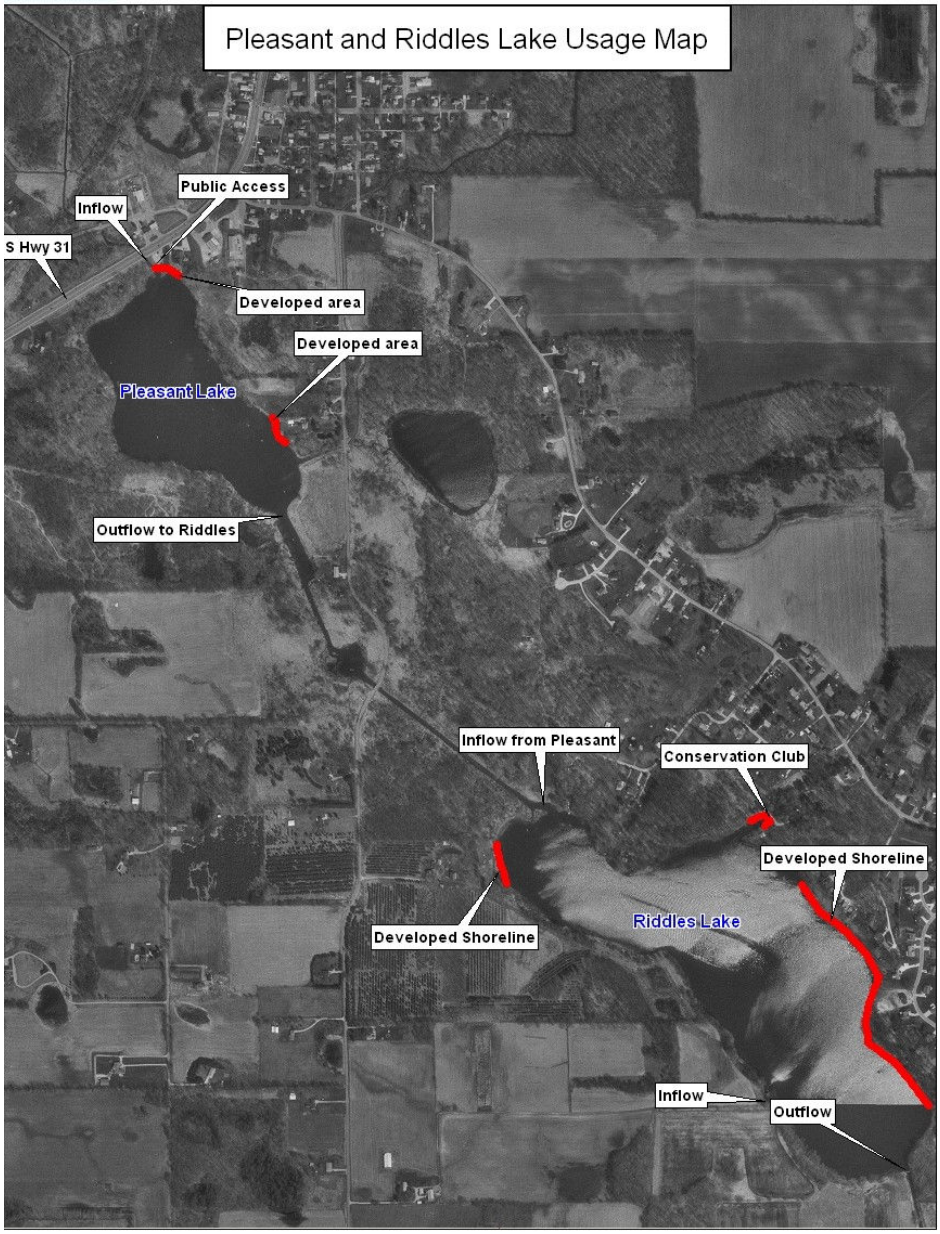

Figure 2. Pleasant and Riddles Lakes Usage Map

4.0 FISHERIES

Pleasant and Riddles lakes share similar fisheries due to their proximity and connection to one another. Fish are able to migrate freely in each of the lakes, which in some ways act more like sub-basins within one lake rather than two separate lakes (JFNew, 2006). The Indiana Department of Natural Resources conducted creel and fishery surveys on both Riddles and Pleasant lakes during the summer of 2006. Results are still in the preliminary stages but will be available for the next plan update.

4.1 Pleasant Lake

The Indiana Department of Natural Resources has completed seven fish surveys on Pleasant Lake, the most recent occurring in 2003. A selective shad kill was completed by

IDNR in 1974. Pleasant lake has been stocked with channel catfish in 1979, tiger muskellunge in 1981, 1983, and 1985 and hybrid striped bass in 1991 and 1992. The 1986 survey found Pleasant Lake to be in fairly good condition despite a large biomass of gizzard shad. Bluegill were the most abundant species collected in the survey comprising nearly 40% of the sample by number. Gizzard shad followed closely with 38.5%. Bass were also abundant at 9.6%. Bluegill and bass growth were average. No tiger muskies were collected in the 1986 survey.

In 2003, eleven species of fish totaling 286 individuals were collected. Bluegill (39.2%), gizzard shad (23.1%), largemouth bass (14.3%), and readear (14.0%) were the most abundant species collected. Bluegill ranged from 2.0 to 8.8 inches. Growth of bluegill was slightly below normal. Largemouth bass ranged in size from 7.8 to 19.0 inches. Growth of largemouth bass was considered normal. The survey concluded that Pleasant Lake provided quality-fishing opportunities for bluegill, largemouth bass, and redear. The population structure of these species was shifted towards larger individuals. One concern raised from the survey was the lack of young-of-the-year largemouth bass and bluegill which may be related to gizzard shad abundance. The survey also recommended fall electrofishing in order to document recruitment along with consideration for stocking walleye in order to reduce the abundant forage (IDNR, 2003).

4.2 Riddles Lake

The Riddles Lake fishery has historically seen drastic changes in its fish community since IDNR first surveyed the lake in 1964. Poor water quality coupled with the introduction of gizzard shad can both be attributed to these changes. Despite this, Riddles Lake continues to support a fairly diverse fishery. A total of 24 species representing 9 families have been collected from the lake during the IDNR surveys (JFNew, 2006).

Previous IDNR surveys were completed on Riddles Lake in 1964, 1974, 1985, 1987, and 2003. Hybrid striped bass surveys were completed in 1989, 1990, and 1991. A selective gizzard shad kill was completed in 1975. Surveys in 1985 and 1987 showed that gizzard shad were the most abundant fish species accounting for an average of 49% of the relative abundance. Bluegill growth rates continued to be above average while largemouth bass showed a significant increase in catch rates. Largemouth bass growth rates were also considered to be above average. It was recommended that hybrid striped bass be stocked in the lake at a rate of 10 per acre (IDNR, 1988 cited in JFNew, 2006).

Hybrid striped bass were first stocked in 1989 and continued to be stocked until 1991. Further stockings were discontinued when no hybrids were collected during follow-up evaluations. Despite the failed stockings, gizzard shad declined in relative abundance from 50.0% in 1987 to 15.7% in 2003. No explanation for the decline in shad number was given in the 2004 report. In 1996, walleye were stocked for the first time by the Lakeville Conservation Club and have been stocked annually except in 2002. Walleye were collected in the 2003 survey and ranged in size from 10.2 to 22.2 inches. Bluegill was the most abundant species in the 2003 survey. This was the first time that bluegill ranked first in abundance since 1964. Bluegill growth continued to be good.

Largemouth bass accounted for 9.5% of the sample and growth rates were considered to be above average (IDNR, 2004).

4.3 Aquatic Vegetation and Fish Management

Aquatic vegetation is an important component in fisheries management. Aquatic vegetation provides cover for adult and juvenile fish, supports aquatic invertebrates that are eaten by fish, and shelters small fish from predators. However, dense vegetation, especially Eurasian watermilfoil, can have negative effects on fish growth. Dr. Mike Maceina of Auburn University found that dense stands of Eurasian watermilfoil on Lake Guntersville proved to be detrimental to bass reproduction due to the survival of too many small bass. This led to below normal growth rates for largemouth bass and lower survival to age 1. Maceina found higher age 1 bass density in areas that contained no plants verses dense Eurasian watermilfoil stands (Maceina, 2001). Bluegill growth rates can also be affected by dense stands of Eurasian watermilfoil. It is well known by fisheries biologists that overabundant dense plant cover gives bluegill an increased ability to avoid predation and increases the survival of small young fish, which can lead to stunted growth. At this time, it is unlikely that Pleasant and Riddles lakes have levels of vegetation that are negatively affecting the fish population. This is due to the fact that low levels of light penetration limits the depth to which submersed vegetation can grow.

5.0 PROBLEM STATEMENT

Aquatic vegetation is an important component of lakes in Indiana. Aquatic vegetation provides fish habitat, food for wildlife, helps slow and prevent erosion, and can improve overall water quality. However, as a result of many factors, this vegetation can develop to a nuisance level. Nuisance aquatic vegetation, as used in this paper, describes plant growth that negatively impacts the present uses of the lake including fishing, boating, swimming, aesthetic, and lakefront property values. The primary nuisance species within Pleasant and Riddles lakes are the exotic species Eurasian watermilfoil and curlyleaf pondweed. Purple loosestrife is an invasive exotic emergent species that was also detected during sampling. Purple loosestrife will not likely create nuisance conditions for lake users, but could have negative impacts on native wetland species in and around Pleasant and Riddles lakes.

5.1 Problems Caused By Eurasian Watermilfoil

Eurasian watermilfoil is an exotic invasive species of submersed vegetation that was likely introduced into our region prior to the 1940's (Figure 3). This species commonly reaches nuisance levels in Indiana Lakes. Once established, growth and physiological characteristics of milfoil enable it to form a surface canopy and develop into immense stands of weedy vegetation, outcompeting most submersed species and displacing the native plant community. These surface mats can severely impair many of the functional aspects of waterbodies such as maintenance of water quality for wildlife habitat and public health, navigation, and recreation. Furthermore, a milfoil-dominated community can greatly reduce the biodiversity of an aquatic system and negatively impact fish populations (Getsinger et. al., 1997).

Figure 3. Illustration of Eurasian watermilfoil (Illustration provided by Applied Biochemist).

5.2 Problems Caused by Curlyleaf Pondweed

Curlyleaf pondweed is an invasive exotic submersed species that was likely introduced in the early 1900's. It is present in many Indiana natural lakes and manmade impoundments. Curlyleaf pondweed's wavy serrated leaves give it a rather unique appearance (Figure 4). Richardon's pondweed (*Potamogeton richarsonii*) is probably the only species that it can be easily confused with. Curlyleaf pondweed has the tendency to create dense surface mats in the spring and early summer. These mats can interfere with recreation and limit the growth of native species. Another problem associated with this species is caused by its summer die-off that tends to lead to algae blooms. The summer die-off also tends to lessen the impact of this species on lake recreation.

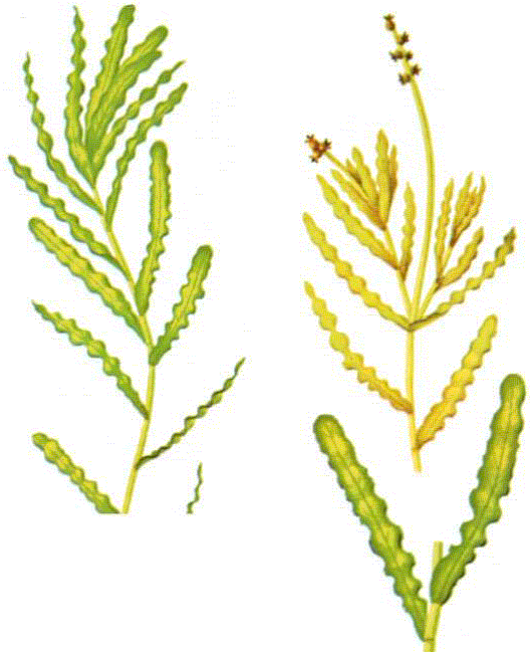

Figure 4. Illustration of curlyleaf pondweed (Illustration provided by Applied Biochemist).

5.3 Problems Caused by Purple Loosestrife

Purple loosestrife is an exotic invasive species of emergent vegetation that has invaded many wetlands and lake margins throughout Indiana (Figure 5). This species was introduced from Eurasia and became established in the estuaries of northeastern North America by the early 1800's. The impact of purple loosestrife on native vegetation has been disastrous, with more than 50% of the biomass of some wetland communities displaced. Impacts on wildlife have not been well studied, but indicate serious reduction in waterfowl and aquatic furbearer productivity (Thompson et. al., 1987).

Figure 5. Illustration of Purple Loosestrife (Illustration provided by Applied Biochemist).

6.0 VEGETATION MANAGEMENT GOALS

An effective aquatic vegetation management plan must include well-defined goals and objectives. Listed below are three goals formulated by LARE program staff and Division of Fish and Wildlife Biologists and approved by the Lakeville Business Owner's Association. The objectives and actions used to meet the objectives will be discussed in section 12.0. One must have a better understanding of the plant community before the objectives and actions can be discussed.

Vegetation Management Goals

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

7.0 PLANT MANAGEMENT HISTORY

There are no records of any aquatic plant management on Pleasant Lake with the exception of a beetle release at the public access site for control of purple loosestrife (JFNew, 2006). However, there have been several small-scale spot treatments completed on Riddles Lake. Permits reports from 2005 indicate that Pinecrest Industries treated 1.84 acres of nuisance vegetation on May 31. The treatment focused on control of Eurasian watermilfoil, curlyleaf pondweed, and elodea. It is not clear from the report as to what was used for control. Aquatic Weed Control also treated a total of 3.07 acres of submersed vegetation on June 14, 2005. It is also not clear what herbicide was used in this treatment. The treatment focused on control of common coontail, curlyleaf pondweed, and filamentous algae. In 2006, Pinecrest Industries treated 1.84 acres of Eurasian watermilfoil, elodea, and curlyleaf pondweed. Aquatic Weed Control treated 0.23 acres of Eurasian watermilfoil on August 8. It is not clear from the permit reports as to where on Riddles Lake the treatments were completed.

8.0 AQUATIC PLANT COMMUNITY CHARACTERIZATION

Aquatic vegetation sampling must be completed in order to create an effective aquatic vegetation management plan. Sampling provides valuable data that allows managers to accomplish several tasks: locate areas of nuisance and beneficial vegetation; monitor changes in density, abundance, and location of native and exotic species; monitor and react to changes in the overall plant community; monitor the effectiveness of management techniques; and compare the Pleasant and Riddles lakes plant community to other populations. A complete list of plants surveyed on Riddles and Pleasant lakes are presented in Table 1.

8.1 Historical Surveys

Prior to 2006, aquatic vegetation had been sampled on Pleasant and Riddles lakes by IDNR prior to their fish surveys, and by JFNew for the Diagnostic Study.

Pleasant Lake (Summarized from JFNew, 2006)

Historical studies recorded many of the same species that currently dominate Pleasant Lake also dominated Pleasant Lake in recent history. The 1977 IDNR survey of the lake noted that milfoil and curlyleaf pondweed each covered 30% of Pleasant Lake, while water lily and coontail covered an additional 20 and 10% respectively. Arrowhead, duckweed, and water willow were also noted for their presence (IDNR, 1977 cited in JFNew, 2006). Data from the 1978 survey indicate that the same species were present in similar densities as those observed in 1976. Milfoil, purple loosestrife, cattails, spatterdock, coontail, and duckweed were noted for their presence during the 1986 assessment (IDNR, 1987 cited in JFNew, 2006). In 2003, IDNR noted arrow arum, humped bladderwort, leafy pondweed, and watermeal to the list of species observed in Pleasant Lake (IDNR, 2004).

The study completed by JFNew was much more detailed than past IDNR studies, especially concerning the emergent plant community. In 2005, JFNew documented 26

species within Pleasant Lake compared to a total of 15 species which were documented by IDNR in four previous studies. JFNew noted an extensive rooted plant community in Pleasant Lake. Vegetation grew to a depth of 5-feet. A total of 26 species were observed and covered approximately 17.3 acres or 75% of Pleasant Lake's surface area. A plant bed composed primarily of coontail, spatterdock, filamentous algae, and watermeal ringed the entire shoreline of Pleasant Lake. White water lily, pickerel weed, cattails, arrow arum, duckweed, and Eurasian watermilfoil were also prevalent within the lake (JFNew, 2006).

Riddles Lake (Summarized from JFNew, 2006)
In 1964, IDNR noted that spatterdock and white water lily were the most common emergent species and coontail was the dominant submersed species growing within Riddles Lake. The rooted floating species formed an almost contiguous circle around the shoreline of the lake. Submerged species were found only to a depth of 4 feet. Sago pondweed, curlyleaf pondweed, and narrow leaf pondweed were the only other submerged species identified (IDNR, 1966 cited in JFNew, 2006). Subsequent surveys indicated that similar species dominated the plant community, but noted that although plant growth was heavy, it did not reach nuisance levels or restrict access to the lake. There was very little change noted in the plant community in 1985 and 1987 surveys. In 2003, IDNR noted the presence of coontail to a depth of 6.75 feet and Eurasian watermilfoil to a depth of 5.0 feet. In total, four submerged species, including coontail, Eurasian watermilfoil, leafy pondweed, and American elodea were observed (IDNR, 2004). During a Tier II assessment completed by IDNR, coontail was present at 82% of sites, while Eurasian watermilfoil and leafy pondweed were present at 20.5 and 15.4% respectively (Pearson, 2004 cited in JFNew, 2006).

JFNew surveyed Riddles Lake in 2005 and found that it supported an extensive rooted plant community that extended from the shoreline to just over a depth of 5 feet. JFNew divided the lake into four distinct plant beds. In total, approximately 40 aquatic plant species were documented. The northern and southern ends of the lake possessed the greatest diversity and density of plants. Emergent plant species accounted for 65% of the documented species. Only seven submersed species were documented of which two were non-native. Coontail was present at potentially nuisance levels within some areas. It was determined that plant beds covered approximately 37% of the lake's surface area (JFNew, 2006).

8.2 Methods
In 2006, Tier I and Tier II surveys were completed on Pleasant and Riddles lakes by Aquatic Control. These surveys were completed using IDNR Tier I and Tier II survey protocols. The survey methods are discussed below along with a list of scientific and common names of species collected by Aquatic Control in 2006.

Table 1. Scientific and common names of species surveyed in Riddles and Pleasant Lakes.

Scientific Name	*Common Name*
Chara spp.	Chara
Cephalanthus occidentalis	button bush
Ceratophyllum demersum	common coontail
Decodon verticillatus	swamp loosestrife
Iris versicolor	blue flag iris
Justicia americana	water willow
Lemna minor	small/common duckweed
Lemna triscula	star duckweed
Lythrum salicaria	purple loosesrtife
Myriophyllum spicatum	Eurasian watermilfoil
Najas flexilis	slender naiad
Najas guadalupensis	southern naiad
Nuphar variegetum	spatterdock
Nymphaea tuberosa	white water lily
Peltandra virginica	arrow arum
Polygonum amphibium	water smartweed
Pontederia cordata	pickerel weed
Potamogeton crispus	curlyleaf pondweed
Potamogeton foliosus	leafy pondweed
Potamogeton zosteriformis	flatstemm pondweed
Sagittaria spp.	arrowhead
Scirpus validus	soft-stem bulrush
Spirodela polyrhiza	giant duckweed
Typha latifolia	common cattail
Wolffia spp.	watermeal

8.2.1 Tier I Methods

The Tier I survey is also known as a reconnaissance survey. This method was developed to serve as a qualitative surveying mechanism for aquatic plants. This survey method serves to meet the following objectives:

1. to provide a distribution map of the aquatic plant species within a waterbody
2. to document gross changes in the extent of a particular plant bed or the relative abundance of a species within a waterbody

This survey strategy was augmented with the Tier II survey to gain more quantitative data if desired. The major advantage of this type of survey is the relatively small amount of time required to complete a survey. Prior to beginning a Tier I survey, information is gathered on the lake being surveyed. This information includes lake size, maximum depth, historical species lists, and historical Secchi depth data. The entire littoral zone (area of the lake which can grow vegetation) of the lake is briefly examined during the survey. A counter clock-wise path is taken around the littoral zone of the lake. While the boat is slowly zigzagging, aquatic plant abundances are recorded based on visual observation. Abundance rating are based on 1-4 increments with 1 being less than 2% and 4 representing greater than 61% abundance. Rake throws are made if there is dense surface cover or if there is difficulty in visually assessing plant species. The littoral zone

is broken up into individual plant beds (plant beds are defined as contiguous consistent plant communities). Vegetation cover ratings, substrate types, and canopy coverage are also determined during the survey (IDNR, 2006).

8.2.2 Tier II Methods

The Tier II survey helps meet the following objectives:

1. to document the distribution and abundance of submersed and floating-leaved aquatic vegetation
2. to compare present distribution and abundance with past distribution and abundance within select areas

Tier II sampling took place following the Tier I sampling on August 17, 2006. Secchi disk readings were taken prior to sampling and were found to be 2.0 feet on Riddles and 3.0 feet on Pleasant. Plants were present to a maximum of 7.0 feet on Riddles and 7.0 feet on Pleasant. Forty sample sites were selected on Riddles Lake and thirty sites on Pleasant Lake based upon IDNR sampling protocol, which calls for a pre-set number of sites to be sampled within each 5-foot depth contour. For Riddles Lake, 10 sites were sampled between 0-5 feet, 10 sites from 5-10 feet, 10 sites from 10-15 feet, and 10 sites from 15-20 feet. For Pleasant Lake, 10 sites were sampled between 0-5 feet, 10 sites from 5-10 feet, and 10 sites from 10-15 feet. As directed by IDNR protocol, ten sites were sampled that were deeper than 15.0 feet on Riddles and 10 sites deeper than 10.0 feet on Pleasant Lake even though plants were not present in the deeper water. In 2007, all sample sites should be no deeper than 7.0 feet on either lake. Once a site was reached the boat was slowed to a stop and the coordinates were recorded on a hand-held GPS unit and later downloaded into a mapping program. A depth measurement was taken by dropping a two-headed standard sampling rake that was attached to a rope marked off in 1-foot increments (Figure 6). An additional ten feet of rope was released and the boat was reversed at minimum operating speed for a distance of ten feet. Once the rake is retrieved the overall plant abundance on the rake is scored with either a 0 (no plants retrieved), 1 (1-20% of rake teeth filled), 3 (21-99% of rake teeth filled), or 5 (100% of rake teeth filled) and then individual species are placed back on the rake and scored separately.

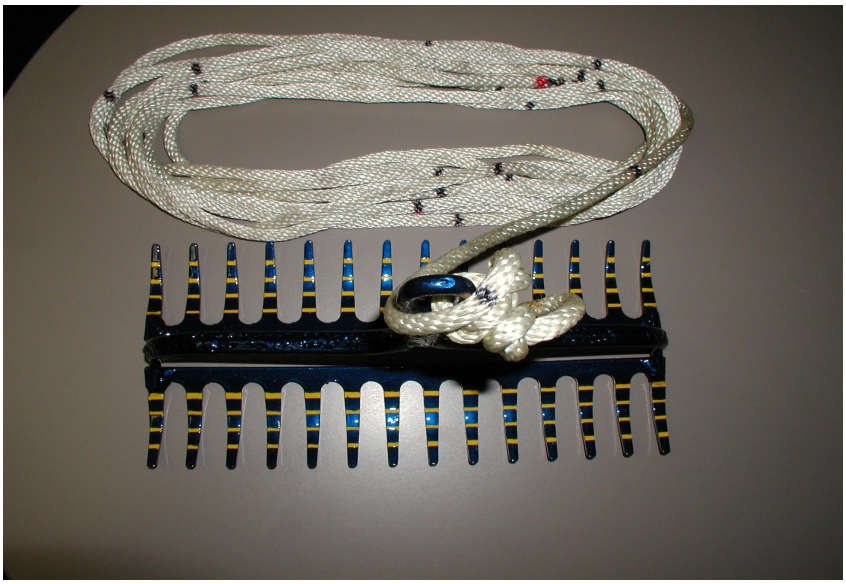

Figure 6. Sampling Rake

The data is used to calculate different lake characteristics and community and species metrics. The different characteristics and metrics calculated from the Tier II method are defined below:

Littoral depth: Maximum depth that aquatic vegetation is present.
Total sites: Total number of sites sampled.
Littoral sites: Number of sites within the littoral depth.
Secchi depth: Measurement of the transparency of water.
Species richness: count of all submersed plant species collected.
Native species richness: count of all native submersed plant species collected.
Maximum number of species per site: highest number of species collected at any site.
Mean number of species per site: The average number of all species collected per littoral site.
Mean number of native species per site: The average number of native species per site.
Species diversity index: This is a modified Simpson's diversity index which is a measure that provides a means of comparing plant community structure and stability over time.
Frequency of occurrence: Measurement of the proportion of sites where each species is present.
Relative frequency of occurrence: Measures how the plants occur throughout the lake in relation to each other.
Dominance index: Combines the frequency of occurrence and relative density into a dominance value that characterizes how dominant a species is within the macrophyte community (IDNR, 2006).

8.3 Results

Aquatic Control Inc. completed two surveys on Pleasant and Riddles lakes in 2006. A Tier I survey was completed on June 6 and Tier I and II surveys were completed on August 17. The results of the surveys are discussed in the following sections.

8.3.1 Pleasant Lake

Spring Survey (Pleasant Lake)

On June 6, 2006, Aquatic Control completed a Tier I survey on Pleasant Lake. A Secchi measurement was taken and found to be 3.0 feet. The Tier I survey revealed 4 distinct plant beds within Pleasant Lake totaling 10.8 acres. Plants were growing to a maximum depth of 7.0 feet and sixteen different species were observed (Table 2 & Figure 7).

Table 2. Pleasant Lake Tier I Survey Results, June 6, 2006

Lake: Pleasant	**Number of plant beds: 4**			
Date: 6/6/06	**Number of species: 16**			
Secchi: 3.0	**Littoral zone size: 10.8**			
	Littoral zone max depth: 7.0			
Plant Bed I.D.	**1**	**2**	**3**	**4**
Plant Bed Size (acres	**6.1**	**3.5**	**1.6**	**0.4**
spatterdock	4	-	-	1
Eurasian watermilfoil	1	2	3	-
common coontail	2	3	3	-
curlyleaf pondweed	1	1	1	-
button bush	1	-	-	-
purple loosestrife	1	-	-	1
blue flag iris	1	-	-	-
common cattail	1	-	-	4
common duckweed	1	1	1	-
watermeal	1	1	1	-
smartweed	1	-	-	-
arrow arum	1	-	-	-
arrow head	1	-	-	-
white water lily	1	1	-	-
leafy pondweed	-	1	-	-
slender naiad	-	1	-	-

*Rating based on score of 1-4 with 1 being least dense and 4 being most dense

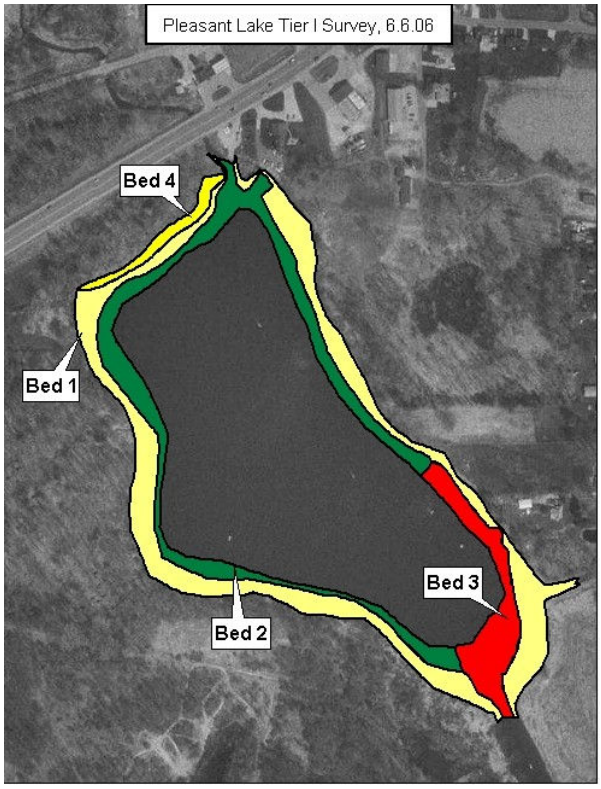

Figure 7. Tier I Plant Beds, Pleasant Lake, June 6, 2006

Plant bed 1 was the largest plant bed and encompassed the entire shoreline of Pleasant Lake. This bed was composed primarily of emergent and rooted floating vegetation. Spatterdock was the most abundant species in bed 1. This bed likely provides many benefits to the overall health of the Pleasant Lake ecosystem.

Beds 2 and 3 were primarily composed of submersed vegetation and located on the lake side of bed 1. Bed 2 was 3.5 acres and dominated by common coontail. Eurasian watermilfoil received an abundance rating of 2 in this bed. Bed 3 was located near the outlet of Pleasant Lake and encompassed 1.6 acres. The main difference in beds 2 and 3 was the fact that Eurasian watermilfoil was more dense in bed 3. Curlyleaf pondweed was present in both of these plant beds but at a low abundance.

Plant bed 4 was located on the north side of Pleasant Lake and encompassed an area of 0.4 acres. Common cattail was the most abundant species in this bed. The presence of purple loosestrife was also noted in plant bed 4.

Summer Survey (Pleasant Lake)
Tier I and II surveys were completed on August 17, 2006. The Tier I survey was completed prior to a Tier II survey. A Secchi measurement was taken prior to the survey and found to be 3.0 feet. The Tier I survey revealed 5 distinct plant beds containing twelve different species totaling 12.3 acres. (Table 3 & Figure 8). Vegetation was present to a maximum depth of 7.0 feet. Tier II sampling for 2007 should be done to a maximum depth of 10.0 feet as no plants were found growing below 7.0 feet in 2006.

Table 3. Pleasant Lake Tier I Survey Results, August 17, 2006.

Lake: Pleasant			**Number of plant beds: 5**			
Date:8/17/06			**Number of species: 12**			
Secchi: 3.0			**Littoral zone size: 12.3**			
			Littoral zone max depth: 7.0			
Plant Bed I.D.	**1**	**2**	**3**	**4**	**5**	**channel**
Plant Bed Size (acres)	**5.1**	**3.6**	**2.5**	**0.5**	**0.6**	**4.5**
spatterdock	4	-	-	-	-	4
white water lily	3	-	-	-	-	1
arrow arum	2	-	-	-	-	1
pickeral weed	2	-	-	-	-	2
watermeal	2	2	4	-	-	3
water willow	1	-	-	-	-	-
duckweed	1	1	2	-	-	-
swamp loosestrife	2	-	-	-	-	1
common coontail	-	4	3	-	-	-
Eurasian watermilfoil	-	4	4	-	-	-
common cattail	-	-	-	4	-	1
purple loosestrife	-	-	-	2	4	2

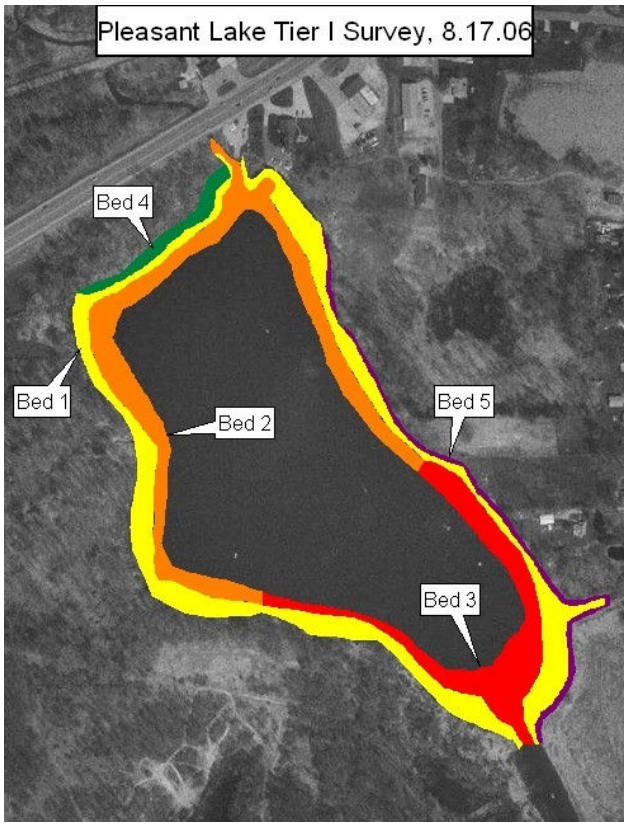

Figure 8. Tier I Plant Beds, Pleasant Lake, August 17, 2006

Much like the spring survey, plant bed 1 was the largest bed and encompassed the entire shoreline. Spatterdock was the most abundant species in bed 1 followed by white water lily. Several other emergent species were documented.

One of the biggest differences in the surveys was the increase in abundance of Eurasian watermilfoil. This species received an abundance rating of 4 in plant beds 2 and 3 which totaled 6.1 acres. Watermeal, duckweed, and common coontail were the only other species documented in beds 2 and 3.

Plant bed 4 changed little in the two surveys with the exception of a slight increase in abundance of purple loosestrife. Plant bed 5 was a new plant bed located along the eastern shore. This bed only measured 0.6 acres and was dominated by purple loosestrife.

The channel connecting Pleasant and Riddles lakes was also sampled and included with the Pleasant Lake data. The channel plant bed measured approximately 4.5 acres. A total of 8 species were observed within the channel. Spatterdock was the most abundant species and received an abundance rating of 4. Watermeal was the second most abundant species with a rating of 3. Pickerel weed, purple loosestrife, common cattail, swamp loosestrife, arrow arum, and white water lily were also observed. Common coontail was the only submersed species observed within the channel.

Tier II survey (Pleasant Lake)
Tier II sampling took place on August 17, 2006 immediately following the Tier I sampling. Plants were present to a maximum depth of 7.0 feet. Thirty sites were selected within the littoral zone. The number and depth of the sites was determined prior to the survey and based on lake size and trophic status. Ten sites were sampled from 0-5 feet, 5-10 feet, and 10-15 feet (no plants were detected below 7.0 feet, so the sampling protocol should have been adjusted so that no sites were deeper than 7.0 feet). Results of the sampling are listed in Table 4. Overall vegetation density and abundance is illustrated in Figure 9. A total of 6 species were collected of which 5 of the species were natives (only 3 submersed species were collected, in future surveys floating vegetation should be excluded from the sampling data). The maximum number of species collected at a site was 5 and the mean species collected per site was 0.97 while the mean number of native species collected per site was 0.73. Several of the sites sampled were outside of the littoral area so the density metrics are likely skewed.

Table 4. Occurrence and abundance of submersed aquatic plants in Pleasant Lake, August 17, 2006.

Occurrence and abundance of submersed aquatic plants in Pleasant Lake						
County:	St. Joseph	Sites with plants:	13	Mean species/site:	0.97	
Date:	8/17/2006	Sites with native plants:	12	Standard error (ms/s):	0.27	
Secchi (ft):	3	Number of species:	6	Mean native species/site:	0.73	
Maximum plant depth (ft):	7	Number of native species:	5	Standard error (mns/s):	0.22	
Trophic status	Mesotrophic	Maximum species/site:	5	Species diversity:	0.73	
Total sites:	30			Native species diversity:	0.46	

All depths (0 to 15 ft)	Frequency of	Rake score frequency per species				Plant Dominance
Species	Occurrence	0	1	3	5	
common coontail	40.0	60.0	6.7	6.7	26.7	29.3
Eurasian watermilfoil	23.3	76.7	0.0	3.3	20.0	14.0
duckweed sp.	13.3	86.7	0.0	0.0	13.3	2.7
greater duckweed	10.0	90.0	0.0	0.0	10.0	2.0
watermeal sp.	6.7	93.3	0.0	0.0	6.7	1.3
slender naiad		96.7	0.0	0.0	3.3	0.7

Depth: 0 to 5 ft	Frequency of	Rake score frequency per species				Plant Dominance
Species	Occurrence	0	1	3	5	
common coontail	100.0	0.0	0.0	20.0	80.0	84.0
Eurasian watermilfoil	60.0	40.0	0.0	10.0	50.0	32.0
duckweed sp.	40.0	60.0	0.0	0.0	40.0	8.0
greater duckweed	30.0	70.0	0.0	0.0	30.0	6.0
watermeal sp.	20.0	80.0	0.0	0.0	50.0	4.0
slender naiad	10.0	90.0	0.0	0.0	10.0	2.0

Depth: 5 to 10 ft	Frequency of	Rake score frequency per species				Plant Dominance
Species	Occurrence	0	1	3	5	
common coontail	20.0	80.0	20.0	0.0	0.0	4.0
Eurasian watermilfoil	10.0	90.0	0.0	0.0	10.0	10.0

Depth: 10 to 15 ft	Frequency of	Rake score frequency per species				Plant Dominance
Species	Occurrence	0	1	3	5	
No Plants Collected	0.0	100.0	0.0	0.0	0.0	0.0

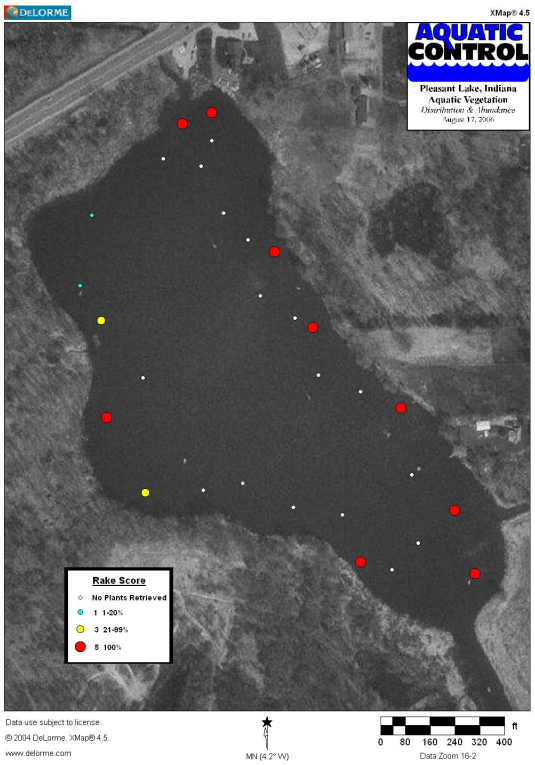

Figure 9. Pleasant Lake, aquatic vegetation distribution and abundance, August 17, 2006.

Common coontail was the most frequently occurring and most dominant species. Coontail was present at 100% of the sites less than 5.0 feet. Location and density of coontail is illustrated in Figure 10 (in species location and density figures, plant location is illustrated by a color coded dot, the color and size of the dot represents the density of the species and sample sites without that species are illustrated by smaller white diamond). Eurasian watermilfoil was the only exotic species collected. Eurasian watermilfoil was present at the second highest percentage of sample sites (23.3%) and ranked second in dominance (Figure 11). Common naiad (*Najas flexilis*) was the only other submersed species collected. This species only present in water less than 5.0 feet.

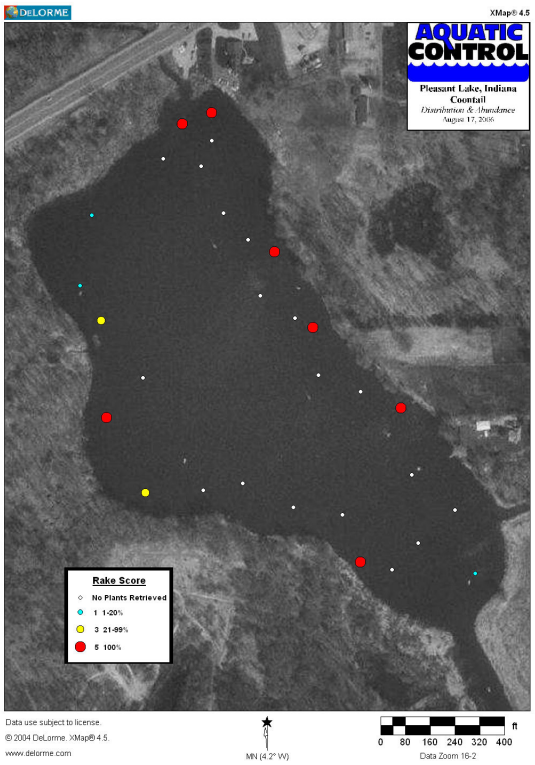

Figure 10. Pleasant Lake, common coontail distribution and abundance, August 17, 2006.

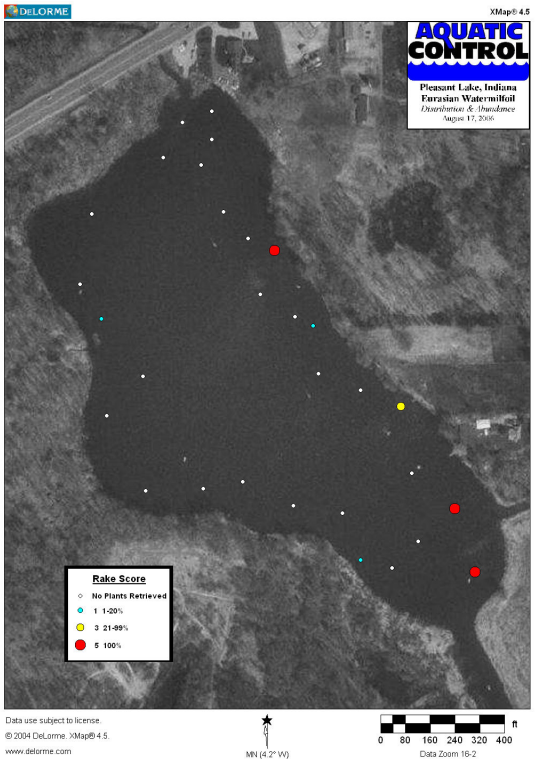

Figure 11. Pleasant Lake, Eurasian watermilfoil distribution and abundance, August 17, 2006.

8.3.2 Riddles Lake

Spring Survey (Riddles Lake)

On June 6, 2006, Aquatic Control completed a Tier I survey on Riddles Lake. A Secchi measurement was taken and found to be 2.0 feet. The Tier I survey revealed 16 distinct plant beds within Riddles Lake totaling 23.9 acres. Plants were growing to a maximum depth of 4.0 feet and eighteen different species were observed (Table 5 & Figure 12). The majority of species were either emergent, rooted floating, or floating vegetation. There were only five submersed species observed and two of those species were non-native.

Table 5. Riddles Lake Tier I Survey Results, June 6, 2006

Lake:Riddles	**Number of plant beds: 16**								**Littoral zone max depth: 4.0**							
Date:6/6/06	**Number of species: 18**															
Secchi:2.0	**Littoral zone size: 23.9**															
Plant Bed I.D.	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**	**16**
Plant Bed Size (acres)	**3.2**	**<0.1**	**1.7**	**4.9**	**<0.1**	**0.3**	**0.5**	**0.1**	**0.7**	**0.8**	**<0.1**	**1.6**	**0.7**	**3.7**	**3.7**	**1.8**
spatterdock	4	-	4	4	-	-	-	4	4	-	-	-	-	-	-	-
white water lily	2	3	3	2	-	-	4	2	1	3	-	-	-	-	-	-
curlyleaf pondweed	1	2	2	2	-	-	-	-	1	1	-	3	3	4	2	3
Eurasian watermilfoil	1	2	2	2	-	-	-	2	2	3	-	3	3	2	4	3
common coontail	1	1	1	2	-	-	-	2	1	1	-	3	3	1	2	3
arrow arum	1	1	1	-	-	-	-	-	-	-	-	-	-	-	-	-
pickeral weed	1	3	1	1	1	1	1	1	-	-	-	-	2	-	-	-
star duckweed	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
common duckweed	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
watermeal	1	1	1	1	-	-	-	1	1	-	-	1	1	-	1	1
smartweed	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
purple loosestrife	1	-	-	-	1	1	-	-	-	-	-	-	-	-	-	-
common cattail	1	-	-	-	4	4	3	-	-	-	4	-	-	-	-	-
softstem bulrush	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-
duckweed	-	1	1	1	-	-	-	1	1	1	-	-	1	-	1	1
blue flag iris	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-
flatstem pondweed	-	-	-	-	-	-	-	-	-	-	-	1	-	1	-	-
Chara	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-

*Rating based on score of 1-4 with 1 being least dense and 4 being most dense

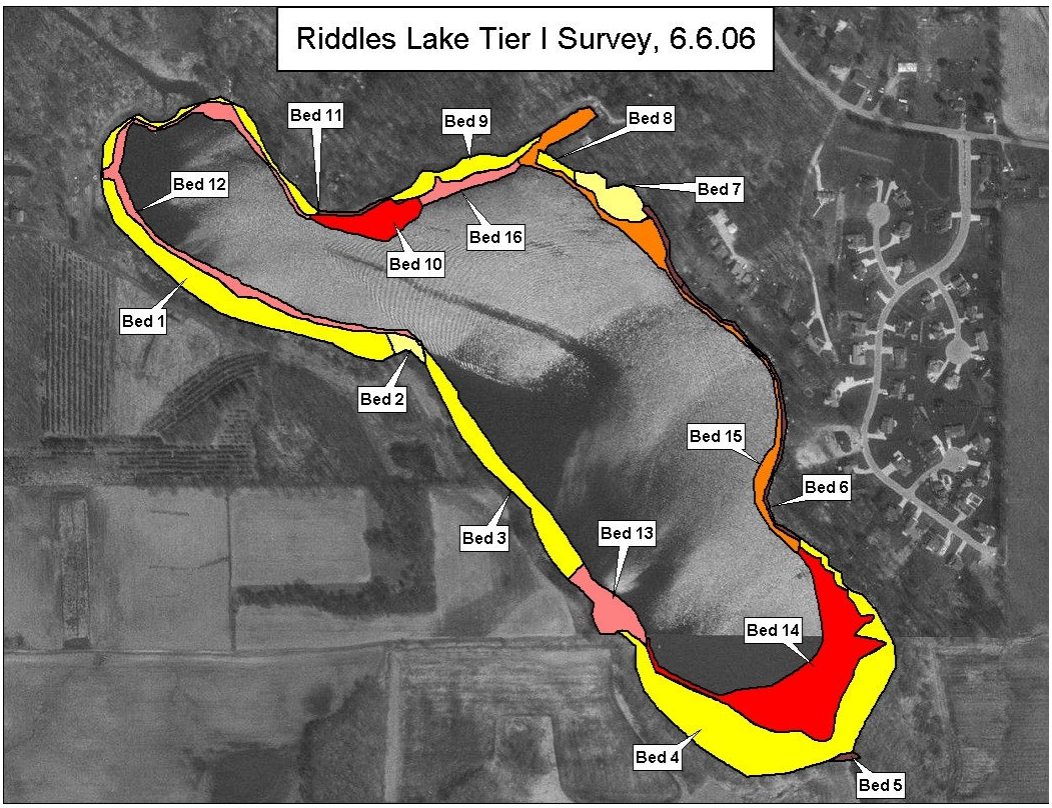

Figure 12. Tier I Plant Beds, Riddles Lake, June 6, 2006

Plant bed 1, 3, 4, 8 and 9 composed the majority of the shoreline vegetation and totaled 10.6 acres. Spatterdock was these most abundant species within these plant beds. White water lily and pickerel weed were also abundant along the shoreline of Riddles Lake. These beds likely provide many benefits to the overall quality of Riddles Lake and should be protected.

Eurasian watermilfoil received an abundance rating of 2 or higher in 8 different plant beds totaling 18.2 acres. Milfoil was most abundant in plant bed 15 which was located along the southeastern shore and encompassed an area of 3.7 acres. Plant bed 15 was located along one of the developed areas of Riddles Lake where emergent and rooted floating vegetation was not present. The removal of the beneficial vegetation likely paved the way for Eurasian watermilfoil infestation.

Plant bed 14 contained some of the densest vegetation. This bed was located in the southeast corner of Riddles Lake and measured 3.7 acres. Curyleaf pondweed was very dense in this area and received an abundance rating of 4. Eurasian watermilfoil was also present in bed 14.

Summer Survey (Riddles Lake)
Tier I and II surveys were completed on August 17, 2006. The Tier I survey was completed prior to a Tier II survey. A Secchi measurement was taken prior to the survey and found to be 2.0 feet. The Tier I survey revealed 8 distinct plant beds containing

twelve different species totaling 23.9 acres. (Table 6 & Figure 13). Vegetation was present to a maximum depth of 7.0 feet. Common coontail, southern naiad, and Eurasian watermilfoil were the only submersed species observed.

Table 6. Riddles Lake Tier I Survey Results, August 17, 2006.

Lake: Riddles			**Number of plant beds: 8**					
Date:8/17/06			**Number of species: 12**					
Secchi: 2.0			**Littoral zone size: 23.9**					
			Littoral zone max depth: 7.0					
Plant Bed I.D.	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**
Plant Bed Size (acres)	**9.3**	**5.1**	**5.3**	**0.9**	**0.1**	**1.2**	**0.2**	**1.2**
white water lily	4	-	-	-	3	-	-	3
spatterdock	2	-	-	2	-	-	-	-
pickeral weed	2	-	-	-	4	-	-	-
common duckweed	2	-	2	-	-	-	-	3
watermeal	3	-	4	-	-	-	-	4
giant duckweed	1	-	1	-	-	-	-	1
swamp loosestrife	1	-	-	-	-	-	-	-
Eurasian watermilfoil	-	1	4	-	-	-	1	4
common coontail	-	3	3	-	-	-	1	4
common cattail	-	-	-	4	-	2	-	-
purple loosestrife	-	-	-	-	-	4	-	-
southern naiad	-	-	-	-	-	-	3	-

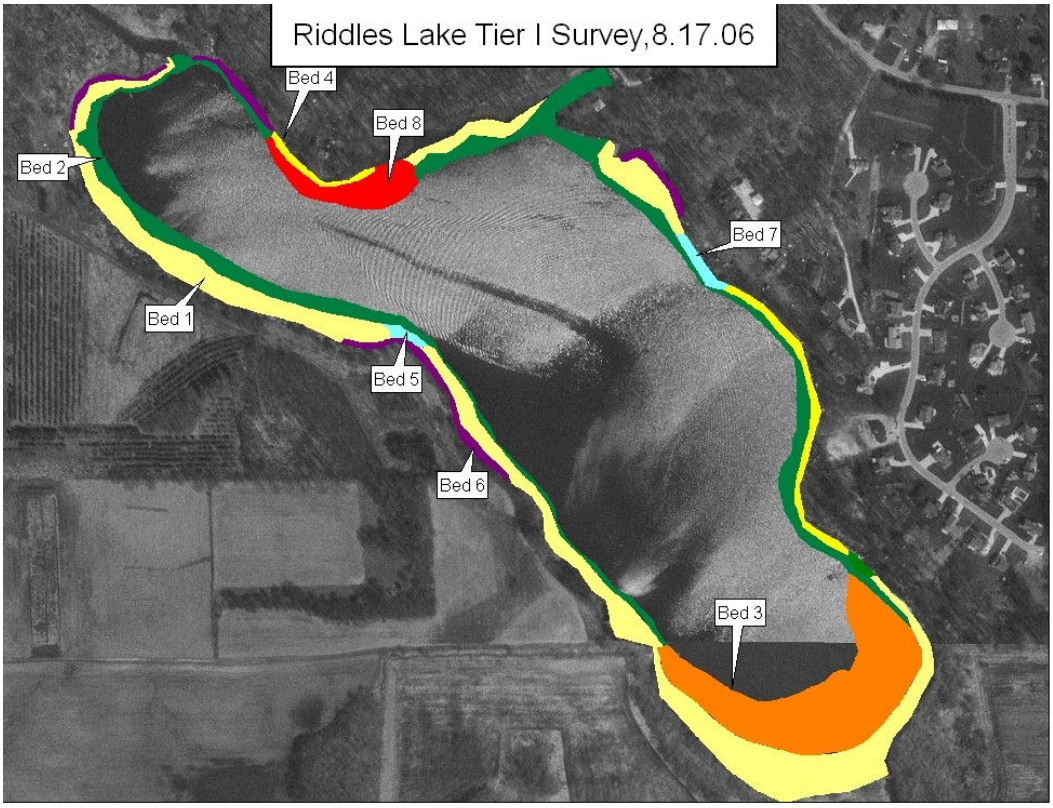

Figure 13. Tier I Plant Beds, Riddles Lake, August 17, 2006

Plant beds were not separated into as many different areas in the summer survey as they were in the spring survey. Plant bed 1 was the largest bed (9.3 acres) and encompassed the same area as beds 1, 3, 4, 8, and 9 in the spring survey. Bed 1 was located around the majority of the shoreline. The composition of this bed changed from being dominated by spatterdock in the spring to being dominated by white water lily in the summer.

Eurasian watermilfoil was present in beds 2, 3, 7, and 8, but was dense only in beds 3 and 8. Beds 3 and 8 encompassed an area of 6.5 acres. Bed 3 was the largest Eurasian watermilfoil dominated bed and was located in the southeast corner of Riddles Lake. This area was dominated by curlyleaf pondweed in the spring survey.

Tier II survey (Riddles Lake)
Tier II sampling took place on August 17, 2006 immediately following the Tier I sampling. Plants were present to a maximum depth of 7.0 feet. Forty sites were selected within the littoral zone. The number and depth of the sites was determined prior to the survey and based on lake size and trophic status. Seventeen sites were sampled from 0-5 feet, thirteen from 5-10 feet, and ten sites from 10-15 feet (no plants were detected below 7.0 feet, so the sampling protocol should have been adjusted so that no sites were deeper than 7.0 feet). Results of the sampling are listed in Table 7. Overall vegetation density and abundance is illustrated in Figure 14. A total of 9 species were collected of which 8 of the species were natives (only 5 submersed species were collected, in future surveys floating vegetation should be excluded from the sampling data). The maximum number of species collected at a site was 5 and the mean species collected per site was 0.85 while the mean number of native species collected per site was 0.68. Several of the sites sampled were outside of the littoral area so the density metrics are likely skewed.

Table 7. Occurrence and abundance of submersed aquatic plants in Riddles Lake, August 17, 2006.

Occurrence and abundance of submersed aquatic plants in Riddles Lake							
County:	St. Joseph	Sites with plants:	17	Mean species/site:	0.85		
Date:	8/17/2006	Sites with native plants:	16	Standard error (ms/s):	0.20		
Secchi (ft):	2	Number of species:	9	Mean native species/site:	0.68		
Maximum plant depth (ft):	7	Number of native species:	8	Standard error (mns/s):	0.17		
Trophic status	Eutrophic	Maximum species/site:	5	Species diversity:	0.75		
Total sites:	40			Native species diversity:	0.68		
All depths (0 to 15 ft)	**Frequency of**	**Rake score frequency per species**				**Plant Dominance**	
Species	**Occurrence**	**0**	**1**	**3**	**5**		
common coontail	40.0	6.0	20.0	5.0	15.0	21.0	
Eurasian watermilfoil	17.5	82.5	5.0	2.5	10.0	7.5	
watermeal sp.	7.5	92.5	2.5	2.5	2.5	1.5	
duckweed sp.	7.5	92.5	2.5	2.5	2.5	1.5	
greater duckweed	7.5	92.5	2.5	2.5	2.5	1.5	
star duckweed	5.0	95.0	2.5	0.0	2.5	1.0	
leafy pondweed	2.5	97.5	0.0	0.0	2.5	1.5	
common bladderwort	2.5	97.5	2.5	0.0	0.0	0.5	
southern naiad	2.5	97.5	2.5	0.0	0.0	0.5	
Depth: 0 to 5 ft	**Frequency of**	**Rake score frequency per species**				**Plant Dominance**	
Species	**Occurrence**	**0**	**1**	**3**	**5**		
common coontail	82.4	17.6	35.3	11.8	35.3	47.1	
Eurasian watermilfoil	41.2	58.8	11.8	5.9	23.5	17.6	
Wolffia	17.6	83.4	5.9	5.9	5.9	3.5	
Lemnaceae sp.	17.6	82.4	5.9	5.9	5.9	3.5	
greater duckweed	17.6	82.4	5.9	5.9	5.9	3.5	
star duckweed	11.8	88.2	5.9	0.0	5.9	2.4	
leafy pondweed	5.9	94.1	0.0	0.0	5.9	3.5	
common bladderwort	5.9	94.1	5.9	0.0	0.0	1.2	
southern naiad	5.9	94.1	5.9	0.0	0.0	1.2	
Depth: 5 to 10 ft	**Frequency of**	**Rake score frequency per species**				**Plant Dominance**	
Species	**Occurrence**	**0**	**1**	**3**	**5**		
common coontail	15.4	84.6	15.4	0.0	0.0	**3.1**	
Depth: 10 to 15 ft	**Frequency of**	**Rake score frequency per species**				**Plant Dominance**	
Species	**Occurrence**	**0**	**1**	**3**	**5**		
No Plants Collected	0.0	100.0	0.0	0.0	0.0	0.0	

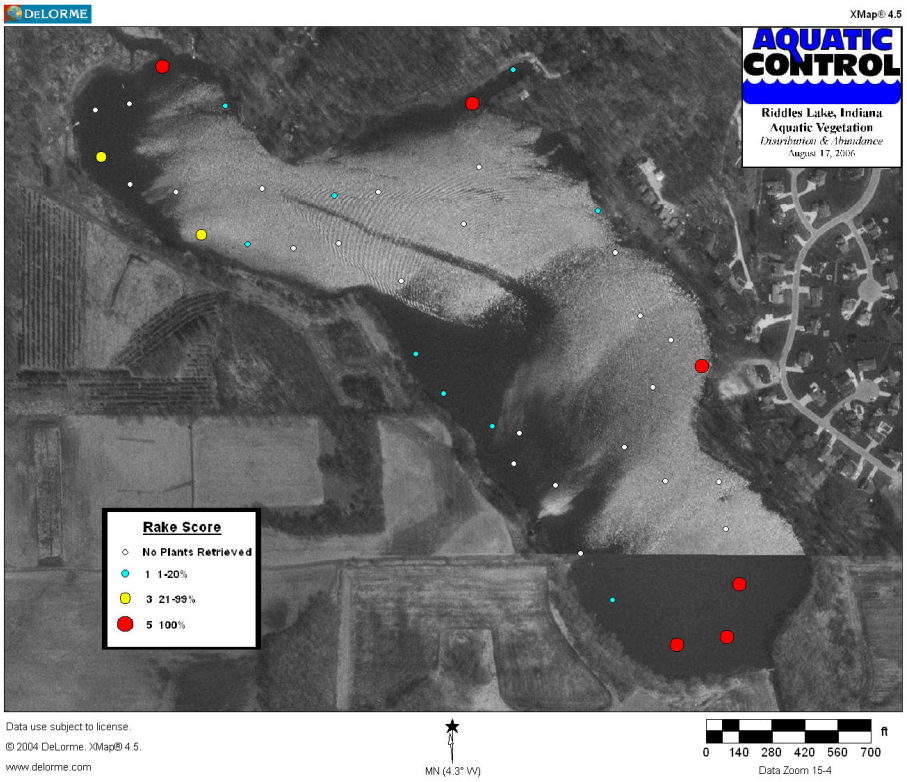

Figure 14. Riddles Lake, aquatic vegetation distribution and abundance, August 17, 2006.

Common coontail was the most frequently occurring and most dominant species. Coontail was present at 82.4% of the sites less than 5.0 feet. Location and density of coontail is illustrated in Figure 15. Eurasian watermilfoil was the only exotic species collected. Eurasian watermilfoil was present at the second highest percentage of sample sites (17.5%) and ranked second in dominance (Figure 16). Eurasian watermilfoil was present at 41.2% of sites the were less than 5.0 feet. Southern naiad (*Najas guadalupensis),* leafy pondweed, and common bladderwort (*Utricularia vulgaris*) were the only other submersed species present in the sample.

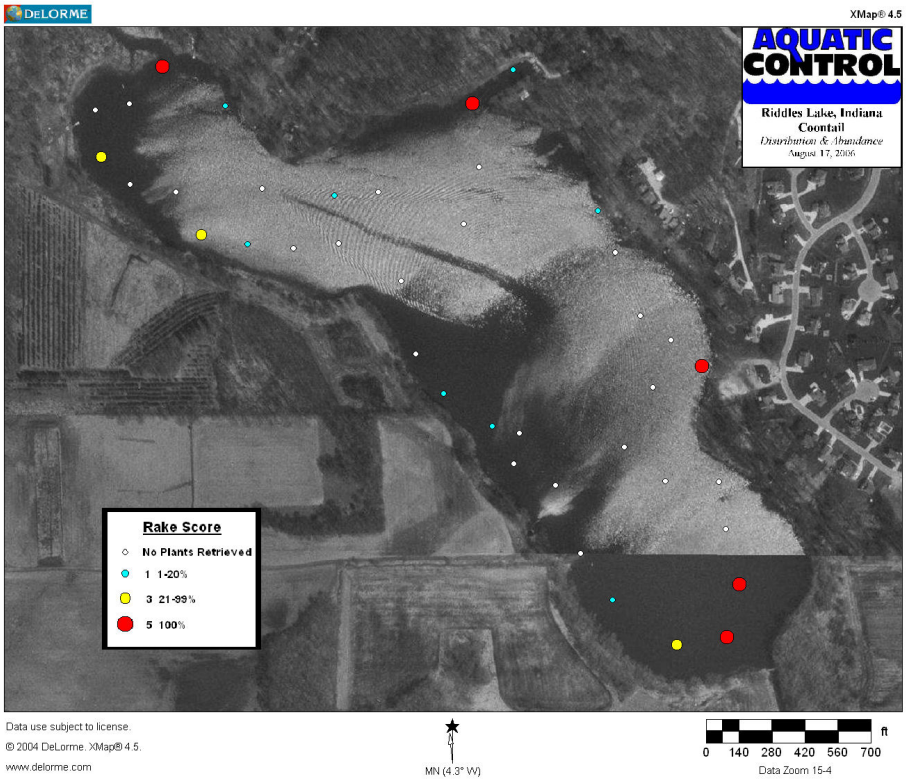

Figure 15. Riddles Lake, common coontail distribution and abundance, August 17, 2006.

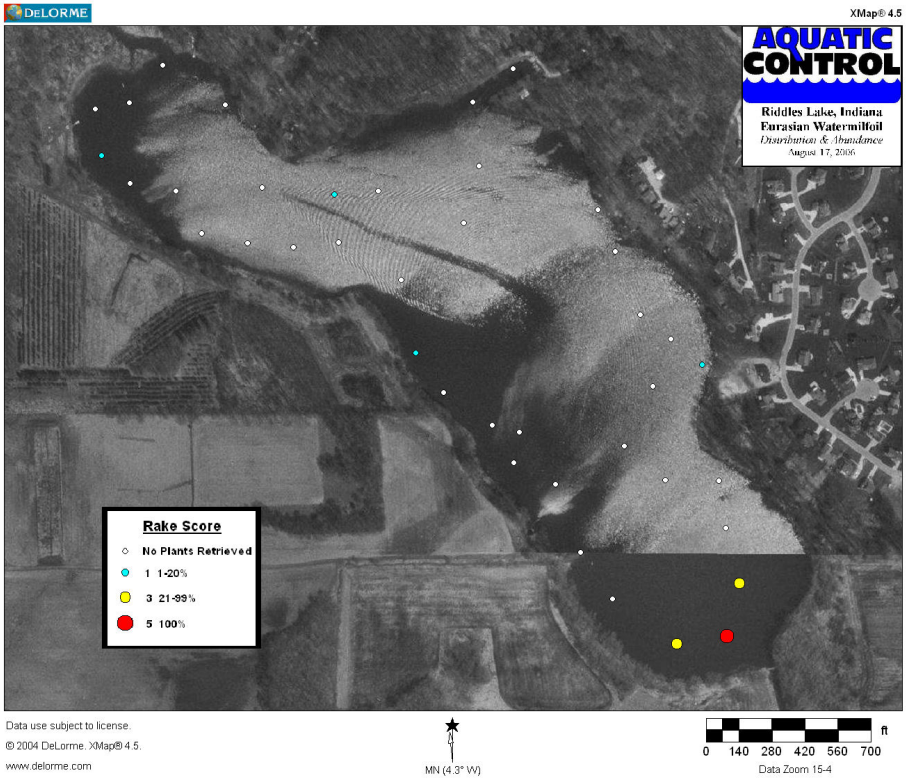

Figure 16. Riddles Lake, Eurasian watermilfoil distribution and abundance, August 17, 2006.

8.4 Macrophyte Survey Discussion

Despite poor water quality, Pleasant and Riddles lakes contain a relatively dense and diverse aquatic plant community. This plant community is dominated by shallow water emergent, floating, and rooted-floating species. White water lily and spatterdock ring the shorelines of both lakes. The only areas that don't contain these species are developed stretches of shoreline where these species were likely mechanically or chemically controlled. This vegetation likely provides excellent fish cover, filters nutrients, and reduces shoreline erosion.

There was also abundant duckweed and watermeal present in both lakes. This vegetation is classified as floating vegetation since it does not have roots that are anchored to the sediment. Since floating vegetation does not attach to the sediment it must obtain nutrients from the water column. According to the diagnostic study and Secchi measurements, Pleasant and Riddles lakes are very productive and contain high nutrient levels. This fact allows floating vegetation to thrive within Pleasant and Riddles lakes.

Pleasant and Riddles lakes' high productivity also affects the submersed plant population. There was lack of vegetation in waters deeper than 7.0 feet. The lack of deep-water vegetation is likely a result of high turbidity that limits light penetration. The turbidity is primarily caused by abundant phytoplankton that is feeding off high levels of nutrients found within the lakes. The productivity of the lakes also affects submersed plant diversity. Common coontail was the most abundant submersed species. This species has the ability to obtain nutrients from the water column giving them a competitive advantage over other submersed species that obtain nutrients for the lakes' sediments. Typically, lakes with better water quality contain a higher diversity of native submersed plant species. Many of the beneficial native pondweed species are not tolerant of eutrophic waters.

The presence of Eurasian watermilfoil at high densities is of concern for plant management in Pleasant and Riddles lakes. This species was dense in several areas in both lakes. As previously discussed, this species can lead to a wide variety of environmental and recreational problems. Control of this species should be a high priority to lake users. Currently, this species is being limited by competition with coontail and poor light penetration. If watershed management practices are improved and the lakes begin to clear, Eurasian watermilfoil may become a much bigger nuisance within the lakes.

Curlyleaf pondweed was abundant in several areas during the spring survey. This species was not detected during the summer sampling (curlyleaf pondweed typically reaches its maximum abundance in late spring and dies back by summer). As previously mentioned, this exotic species can have adverse affects on the ecosystem and should be controlled in conjunction with Eurasian watermilfoil. Much like Eurasian watermilfoil, the nuisance level of this species is being limited by the turbidity of the lakes.

Purple loosestrife was detected in several areas of both lakes. Control of this species can be very difficult due to its location in marshy areas and its abundance throughout the

northern lakes region. Beetles have been released near the boat ramp in an effort to control the spread of this species, but it appears that they have had little long-term success. Despite the difficulty in controlling this species, steps should be taken to keep this species at a low level.

9.0 AQUATIC PLANT MANAGEMENT ALTERNATIVES

Pleasant and Riddles lakes contain a diverse emergent plant community that is beneficial to the overall quality of the lakes. The submersed plant community is limited by poor water quality. The abundance of dense beds of Eurasian watermilfoil and curlyleaf pondweed within the limited submersed community is a cause of concern. These species can create a variety of problems if left unchecked. Eurasian watermilfoil and curlyleaf pondweed can negatively impact native species abundance, create nuisance conditions, and also negatively effect fish populations. Once established, growth and physiological characteristics of Eurasian watermilfoil enable it to form a surface canopy and develop into immense stands of weedy vegetation, out competing most submersed species and displacing the native plant community (Madsen et al., 1988). Many effective control techniques are available for targeting these species. Purple loosestrife is also a species that should be considered for control.

In order to develop a scientifically sound and effective action plan for control of nuisance vegetation, all aquatic management alternatives need to be considered. The alternatives that will be discussed include: no action; institutional; environmental manipulation; mechanical control; manual control; biological control; chemical control; and any combination of these methods.

A number of different techniques have been successfully used to control nuisance vegetation. These techniques vary in terms of their efficacy, rapidity, and selectivity, as well as the thoroughness and longevity of control they are capable of achieving. Each technique has advantages and disadvantages, depending on the circumstances. Selectivity is a particularly important characteristic of control techniques. Nearly all aquatic plant control techniques are at least somewhat selective, in that they affect some plant species more than others. Even techniques such as harvesting that have little selectivity within the areas to which they are applied can be used selectively, by choosing only certain areas in which to apply them. Selectivity can also occur after the fact, as when a technique controls all plants equally but some grow back more rapidly. One facet of selecting an appropriate aquatic plant control technique is matching the selectivity of the control technique with the goals of aquatic plant management. When controlling Eurasian watermilfoil, for example, it is typically desirable to use techniques that control Eurasian watermilfoil with minimal impact on most native species (Smith, 2002).

9.1 No Action

What if no aquatic plant management activity took place on the Pleasant and Riddles lakes? Past management practices have included herbicide treatments of selected shoreline areas. These treatments were successful for short-term control of nuisance

species. Steps should be taken that provide longer-term control. If left unchecked, exotic species would likely continue to spread and may increase in abundance and density. Control of curlyleaf pondweed and Eurasian watermilfoil is especially important if water quality of these lakes is improved. Improved water clarity will allow these species to become much more of a nuisance to lake users.

9.2 Institutional-Protection of Beneficial Vegetation

Presence of beneficial vegetation can inhibit the growth of species which may be more prone to create nuisance conditions. For example, if a bed of largeleaf pondweed is controlled, that area will likely be quickly infested by Eurasian watermilfoil. Largeleaf pondweed rarely reaches the surface and if it does, it typically does not develop the density of a milfoil bed. Dense milfoil beds are impossible to boat across, difficult to fish, and provide poor habitat. On the other hand, largeleaf pondweed rarely reaches the density of Eurasian watermilfoil and provides excellent habitat for fish and aquatic invertebrates. Many associations attempt to control all vegetation. This can create a competitive advantage for aggressive species like Eurasian milfoil which can quickly colonize a controlled area. Protection of beneficial vegetation should be part of any vegetation management plan.

9.3 Environmental Manipulation

9.3.1 Water Level Manipulation

Water level manipulation refers to the raising of water levels to control aquatic vegetation by drowning or lowering to control aquatic vegetation by exposing them to freezing, drying or heat. Use of water level manipulation for aquatic plant management is limited to lake and reservoirs with adequate water control structures. Pleasant and Riddles lakes do not have adequate water control structures, so this technique should not be considered.

9.3.2 Nutrient Reduction

Plant growth can be limited if at least one nutrient, which is critical for growth, is in short supply. Nitrogen, phosphorus or carbon are usually the nutrients limiting plant growth in lakes. Therefore, if at least one of these nutrients can be limited sufficiently so that plants do not grow to a nuisance level, this nutrient limitation can be used as a method of aquatic plant management. This technique is most effective at controlling floating plant species and planktonic algae, which obtain their nutrients from the water column. Generally, however, plants in northern Indiana can obtain the majority of necessary nutrients from the soil. Reduction of turbidity can actually aggravate an existing problem by increasing light penetration leading to an expansion in plant growth (Hoyer & Canfield, 1997).

9.4 Mechanical Control-Harvesting, Cutting, Dredging

Mechanical control includes cutting and/or harvesting of aquatic vegetation or dredging the bottom sediments to eliminate aquatic plant growth. The main advantage to

mechanical control is the immediate removal of the plant growth from control areas and the removal of organic matter and nutrients.

One of the most common mechanical control techniques used on larger lakes in Indiana is mechanical harvesting. Mechanical harvesting uses machines which cut plant stems and, in most cases, pick up the cut fragments for disposal. This type of mechanical control has little selectivity. Where a mix of Eurasian watermilfoil and native species exists, harvesting favors the plant species that grow back most rapidly following harvesting. In most cases, Eurasian watermilfoil recovers from harvesting much more rapidly than native plants. Thus, repeated harvesting hastens the replacement of native species by Eurasian watermilfoil and often leads to dense monocultures of Eurasian watermilfoil in frequently harvested areas. Harvesting also stirs up bottom sediments thus reducing water clarity, kills fish and many invertebrates, and hastens the spread of Eurasian watermilfoil via fragmentation.

Dredging of shallow areas may reduce nuisance conditions caused by vegetation in the short-term, but studies and personal experience have shown that Eurasian watermilfoil is often the first species to colonize these disturbed areas. Dredging is expensive, especially if a nearby disposal sight is not available. Careful consideration to secondary environmental effects must be considered and permits from regulatory agencies are usually necessary before conducting dredging operations. Dredging is usually short lived if not done deeper than the photic zone.

9.5 Manual Control-Hand Pulling, Cutting, Raking

Removal of small amounts of vegetation by hand, which interfere with beach areas or boat docks, may be the only vegetation control necessary in some areas. Of course, hand removal is labor intensive and must be conducted on a routine basis. The frequency and practicality of continued hand removal will depend on availability of labor, regrowth or reintroduction potential of the vegetation, and the level of control desired (Hoyer & Canfield, 1997). Residents of Pleasant and Riddles lakes have the option to harvest areas of submersed vegetation in and around their docks or swimming areas. Residents should keep in mind that only a 625 square foot area can be harvested without obtaining a permit from IDNR.

9.6 Biological Controls

Biological controls reduce aquatic vegetation using other organisms that consume aquatic plants or cause them to become diseased. The main biological controls for nuisance vegetation used in Indiana are the grass carp, milfoil weevil, and a variety of insects which prey upon purple loosestrife. All biological control methods require a permit from IDNR.

9.6.1 Grass Carp

The grass carp (*Ctenopharyngodon idella)* is an herbivorous fish imported from Asia. Triploid grass carp, the sterile genetic derivative of the diploid grass carp, while legal for

use in Indiana, are not permitted for stocking in any of the natural lakes in northern Indiana. Grass carp tend to produce all or nothing aquatic plant control. It is very difficult to achieve a stocking rate sufficient to selectively control nuisance species without eliminating all submersed vegetation. They are not particularly appropriate for Eurasian watermilfoil control because this species is low on their feeding preference list; thus, they eat most native plants before consuming Eurasian watermilfoil (Smith, 2002). Grass carp are also difficult to remove from a lake once they have been stocked. Grass carp cannot be stocked in the Pleasant and Riddles Lake.

9.6.2 Milfoil Weevil

The milfoil weevil, *Euhrychiopsis lecontei,* is a native North American insect that consumes Eurasian and Northern watermilfoil. The weevil was discovered following a natural decline of Eurasian watermilfoil in Brownington Pond, Vermont (Creed and Sheldon, 1993), and has apparently caused declines in several other water bodies. Weevil larvae burrow in the stem of Eurasian watermilfoil and consume the vascular tissue thus interrupting the flow of sugars and other materials between the upper and lower parts of the plant. Holes where the larvae burrow into and out of the stem allow disease organisms a foothold in the plants and allow gases to escape from the stem, causing the plants to lose buoyancy and sink (Creed et al. 1992).

Concerns about the use of the weevil as a biological control agent relate to whether introductions of the milfoil weevil will reliably produce reductions in Eurasian watermilfoil and whether the resulting reductions will be sufficient to satisfy users of the lake (Smith, 2002). Following our research, no conclusive data concerning the role of weevils in reducing Eurasian watermilfoil populations has been made available. In 2003, Scribailo and Alix conducted a weevil release study on three Indiana lakes and had no conclusive evidence supporting the use of weevils in reducing milfoil populations. Weevils may reduce milfoil populations in some lakes, but predicting which lakes and how much, if any, control will be achieved has not been documented (Scribailo & Alix, 2003).

9.6.3 Purple Loosestrife Insects (Summarized from JFNew & Associates, 2005)

Some control of purple loosestrife has been achieved through the use of several insects. A pilot project in Ontario, Canada reported a decrease in 95% of the purple loosestrife population from pretreatment population (Cornell Cooperative Extension, 1996 cited in JFNew, 2005). Four different insects were used to achieve this control. These insects have been identified as natural predators of purple loosestrife in its native habitat. Insect releases in Indiana to date have had mixed results. After six years, the loosestrife of Fish Lake in LaPorte County is showing signs of deterioration. Likewise, seven years after the release at Pleasant Lake in St. Joseph County, purple loosestrife populations appear to have declined around the boat ramp (IDNR, 2004 cited in JFNew, 2005). Biological control is not a quick solution; many estimates suggest that it may take 5-15 years to achieve a large impact on purple loosestrife populations. However, biological control

was attempted at the public access site on Pleasant Lake and purple loosestrife is still abundant in this area.

9.7 Chemical Control

Chemical control uses chemical herbicides to reduce or eliminate aquatic plant growth. The main disadvantage to the use of chemicals is the publics concern over safety. Extensive testing is required of aquatic herbicides to ensure that the herbicides are low in toxicity to human and animal life and they are not overly persistent or bioaccumulated in fish or other organisms. It often takes several decades of testing by the Environmental Protection Agency (E.P.A.) before a herbicide is approved for aquatic use. After E.P.A approval and registration, the herbicide must go through the registration process in each state.

Another disadvantage to the use of aquatic herbicides is water use restrictions. These restrictions must be posted prior to treatment on a public body of water. The most common restriction is irrigation. Another disadvantage to the use of herbicides is the release of nutrients that can occur if large areas of vegetation are controlled. This can be avoided by early application that controls vegetation before it reaches its maximum biomass. These perceived disadvantages are often times out-weighed by this technique's proven rapid effectiveness and selectivity.

There are two different types of aquatic herbicides, systemic and contact. Systemic herbicides are translocated throughout the plants and thereby kill the entire plants. Fluridone (trade name Sonar & Avast!), 2,4-D (trade name Navigate, Aqua-Kleen, & DMA4 IVM), and trichlopyr (trade name Renovate) are systemic herbicides that can effectively control Eurasian watermilfoil. Triclopyr, imazypry, and glyphosate are systemic herbicides that can control purple loosestrife.

Based upon the author's experience and personal communication with an array of North American aquatic plant managers, whole-lake fluridone applications are by far the most effective means of controlling Eurasian watermilfoil. Successful fluridone treatments yield a dramatic reduction in the abundance of Eurasian watermilfoil, often reducing it to the point that Eurasian watermilfoil plants are difficult to detect following treatment (Smith, 2002). An advantage to using fluridone over most contact herbicides is its selectivity. Most strains of Eurasian watermilfoil have a lower tolerance to fluridone than the majority of native species, so if the proper rates are applied Eurasian water milfoil can be controlled with little harm to the majority of native species.

Aquatic Control has completed whole lake fluridone treatments on two public natural lakes in Indiana. Webster Lake was treated in 1999 and 2002. Eurasian watermilfoil was not detectable in the late summer the year of treatment or the year following treatment. Re-infestation of Eurasian watermilfoil occurred within three years, but that was likely due to presence of milfoil in the immediate watershed (lakes that contained Eurasian watermilfoil in the immediate watershed were not permitted for treatment). Wolf Lake, a 451-acre lake in northwest corner of Indiana, was treated with fluridone in 2004 and no Eurasian watermilfoil has been detected since the treatment. The long-term success of a

fluridone treatment is variable from lake to lake. Since milfoil can spread by fragmentation, success of the treatment is dependent on eliminating all of the plants from the watershed.

Triclopyr is a systemic herbicide that has recently been approved for use in aquatics. Triclopyr typically is used for treating isolated milfoil beds as opposed to whole lake treatments. This herbicide is very selective to Eurasian watermilfoil. A study was conducted in 1997 during the registration process of this herbicide. The study found Eurasian watermilfoil biomass was reduced by 99% in treated areas at 4 weeks post-treatment, remained low one year later, and was still at acceptable levels of control at two years post-treatment. Non-target native plant biomass increased 500-1000% by one year post-treatment, and remained significantly higher in the cove plot at two years post-treatment. Native species diversity doubled following herbicide treatment, and the restoration of the community delayed the re-establishment and dominance of Eurasian watermilfoil for three growing seasons (Getsinger et. al., 1997). Triclopyr is a good alternative to fluridone when Eurasian watermilfoil is not abundant throughout an entire water body. It would likely be impossible to completely eliminate Eurasian watermilfoil with this type of herbicide, but an aggressive treatment program could significantly reduce milfoil density and abundance to a more manageable level. Eurasian watermilfoil must be treated everywhere it is located in the lake. The only water use restriction following a triclopyr treatment is irrigation. An assay is needed to monitor the concentration in the water before irrigation can take place. One of the drawbacks to using triclopyr has been the fact that only a liquid formulation has been available. This can dramatically increase costs for treatment in deep water areas. In 2007, a granular formulation called Renovate OTF should be approved for aquatic use in Indiana.

Applied properly, 2,4-D can also yield major reductions in the abundance of Eurasian watermilfoil. Much like triclopyr, treatments must be even and dose rates accurate. This formulation should be used much like Triclopyr. Unlike Triclopyr, 2,4-D can impact the native species coontail. This herbicide can be applied for less cost than triclopyr, but damage will likely occur to coontail. 2,4-D herbicide should be considered as an alternative to triclopyr applications if the Association's budget is restricted. 2,4-D is also available in liquid and granular formulations.

Contact herbicides can also be effective for controlling submersed vegetation in the short term. The three primary contact herbicides used for control of submersed vegetation are diquat (trade name Reward), endothal (trade name Aquathol), and copper based formulations (trade names Komeen, Nautique, and Clearigate).

Historically, a drawback to the use of contact herbicides has been the lack of selectivity exhibited by these herbicides. However, a study completed by Skogerboe and Getsinger in 2002 outlines how endothal can be used for control of the exotic species curlyleaf pondweed and Eurasian watermilfoil with little effect on the majority of native species. They found early season treatments with endothall effectively controlled Eurasian watermilfoil and curlyleaf pondweed at several application rates with no regrowth eight weeks after treatment. Sago pondweed, eel grass, and Illinois pondweed biomass were

also significantly reduced following the endothall application, but regrowth was observed at eight weeks post-treatment. Coontail and elodea showed no effects from endothall at three of the lower application rates. Spatterdock, pickerelweed, cattail, and smartweed were not injured at any of the application rates (Skogerboe & Getsinger 2002). Endothal could also be an effective the year after whole lake sonar treatments where curlyleaf pondweed typically returns the following season. Treatment using a combination of endothal and either triclopyr or 2,4-D, are now being used to successfully control both curlyleaf pondweed and Eurasian watermilfoil. These treatments should be repeated for 3-4 years in order to exhaust the curlyleaf pondweed turion supply (turions can last for several years in the soil before germinating).

Diquat and many of the copper formulations are effective fast acting contact herbicides. These formulations are typically used when control of all submersed vegetation is desired. These herbicides are commonly used for control of nuisance vegetation around docks and near-shore high-use areas. Diquat and the copper based herbicides are not as selective as many of the other herbicides and plants can often times recover in 4-8 weeks after treatment. There are no water use restrictions following the use of chelated copper based herbicide, which makes them popular choices for lakes used for irrigation or drinking water.

10.0 PUBLIC INVOLVEMENT

An effective aquatic vegetation management plan must include input from lake users. A public meeting was conducted on September 26, 2006 at the Lakeville Conservation Club. The meeting was advertised in local newspapers. Approximately twenty individuals attended the meeting.

The goals of the meeting were as follows:

1. Inform lake users of the planning process
2. Document important high-use areas of the lake
3. Educate those in attendance on aquatic plant ecology
4. Describe results of the plant sampling
5. Discuss plant management alternatives
6. Discuss implementation of the potential management strategies and monitoring programs
7. Obtain user input by filling out a survey (see appendix for survey form)

A survey form was handed out at the meeting in order to gain further input from the lake users (see appendix for survey form). According to surveys forms, 60% of those in attendance were property owners on Pleasant and/or Riddles Lake. Fifty percent of those surveyed used the lake for boating, 94% for fishing, 37% used the lake for swimming, 6% for drinking water and none of those surveyed used the lake for irrigation. On survey questions concerning lake problems; 81% believed there were too many aquatic plants, 87% thought dredging was needed, 12% thought there was overuse by non-residents, 6% of those surveyed believed there were not enough plants, 6% thought there was a fish population problem, 87% believed there was a water quality problem, and 12% believed too much fishing pressure was a problem. On survey questions dealing with aquatic

vegetation; 100% believed vegetation interfered with lake use, 100% believed it affected property value, 92% believed vegetation was at a nuisance level, and 100% were in favor of continuing vegetation control efforts.

11.0 PUBLIC EDUCATION

In order to effectively manage aquatic vegetation lake users must gain an understanding of the ecology of the lake ecosystem and the effects individual actions may have on this resource. The Lakeville Business Owner's Association should be commended on their efforts to understand and improve the lakes and surrounding watershed. A Diagnostic Study was commissioned by the LBOA and completed by JFNew in 2006. The LBOA has also received funding for dredging on the lakes and this was started in the summer of 2006. However, it is still important to continue education efforts in order to reinforce many of the actions that have been recommended by these studies. The following is a list of potential actions that individuals can undertake:

1. Reduce the frequency and amount of fertilizer, herbicide, or pesticide used for lawn care.
2. Use only phosphorus-free fertilizer.
3. Consider re-landscaping lawn edges, particularly those along the watershed's lakes, to include low profile prairie species that are capable of filtering runoff water better than turf grass
4. Consider resurfacing concrete or wooden seawalls with glacial stone, then planting native emergent vegetation along shorelines or in front of resurfaced or existing concrete or wooden seawalls to provide fish and invertebrate habitat and dampen wave energy.
5. Keep organic debris like lawn clipping, leaves, and animal waste out of the water
6. Examine all drains that lead from roads, driveways, and rooftops to the watershed
7. Obey speed limits through the lakes
8. Clean all vegetation and sediment from boat propellers and trailers after lake use and refrain from dumping bait buckets into the lake to prevent the spread of exotic species (JFNew, 2005). More information on stopping the spread of exotics can be found at www.protectyourwaters.net.

These points should be reinforced annually at future meetings and in newsletters.

12.0 INTEGRATED MANAGEMENT ACTION STRATEGY

The focus of the action strategy should be designed to meet the goals and objectives of the aquatic plant management plan. To review, the goals are as follows:

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 fish and wildlife resources.

Each goal, along with objectives to meet this goal, is listed below. Following each objective are the actions which should be taken in order to achieve the objective.

12.1 Goal #1-Develop and Maintain a Stable, Diverse Aquatic Plant Community

The first goal focuses on developing and maintaining a stable, diverse aquatic plant community. In order to address the objectives for meeting this goal the plant community will be divided into two categories: emergent/floating vegetation and submersed vegetation. The focus of the LARE program is primarily on control of nuisance exotic submersed vegetation, but seeing how this is an aquatic vegetation management plan one cannot ignore the emergent and rooted floating plant community.

Objective 1: Maintain and Enhance Diversity of the Rooted Floating/Emergent Aquatic Plant Community

Pleasant and Riddles lakes contain an abundant and relatively diverse rooted floating and emergent plant community. This community serves several beneficial purposes to Pleasant and Riddles Lake that includes reducing erosion, providing fish and wildlife food and habitat, and filtering excessive nutrients. This plant community is rather unique when compared to most other northern Indiana Lakes. Most of the lakes in northern Indiana have been developed and homeowners have removed this type of vegetation due to the belief that it negatively impacts property value and limits access to the lake. Rooted floating and emergent vegetation remain abundant in Pleasant and Riddles lakes due to the fact that there has been limited development. However, this beneficial vegetation has been removed in many of the areas that have been developed. New developments should be encouraged to leave this beneficial vegetation, and current property owners should be encouraged to allow this vegetation to grow along their shorelines. Figure 17 is an example of a developed shoreline on Crooked Lake in Steuben County. This home site has allowed native vegetation to flourish along their shoreline yet still has good lake access.

Figure 17. Crooked Lake, emergent plant community along developed shoreline, June 2006.

Purple loosestrife was abundant in several of the emergent plant communities. LARE has yet to fund treatment of this plant, so it is important that residents take action in securing funds from other sources and conduct their own controls. Residents should become familiar with this species and dig it up if it is found on their property. Biological controls show a lot of promise and are less expensive and controversial than herbicide applications (there are a lot of issues with applying herbicides on private property as opposed to treating the water which is public property). The association should stay abreast of any funding or studies being completed with these biological controls and make all attempts to secure funds.

Objective 2: Develop a more diverse submersed plant community.

Pleasant and Riddles lakes have a very limited submersed plant community due to poor water quality. Improvement in water quality will likely improve the diversity of this plant community. Potential projects designed to improve the lakes' watersheds and overall water quality were outlined in the 2006 Diagnostic Study. Listed below is a summary of recommendations from the study:

1. Work with the town of Lakeville to correct wastewater treatment plant issues.
2. Work with the owners of the existing residential developments located on the northeast and northwest corners of the Town of Lakeville to correct erosion issues.

3. Implement stormwater management techniques throughout the Town of Lakeville including creation of a wetland filter at the southeast corner of the lake Trail and Linden Road.
4. Implement individual property owner management techniques (discussed previously in section 11.0).
5. Minimize the impact of exotic species on the lakes.
6. Post informational signage at the boat launches on Pleasant and Riddles lakes to inform lake users of best management practices to prevent the spread of invasive species.
7. Monitor and improve erosion control techniques on residential development sites and along the Lakeville Conservation Club channel.
8. Become active volunteers in the Indiana Clean lakes Program.
9. Work with the St. Joseph County Health Department to determine the cause of the extremely high *E. coli* concentration observed in Walters Ditch.
10. Increase usage of the Conservation Reserve Program in the watershed.
11. Fence livestock out of the Pleasant and Riddles lakes watershed water bodies.
12. Complete sediment removal work as outlined in the sediment removal plan (JFNew, 2006).

Following the above recommendations should help improve the water quality within the lakes, thus improving the diversity of native species.

12.2 Goal #2-Reduce Negative Impacts Caused by Exotic Vegetation

The second goal of the vegetation management plan is to prevent and reduce negative impacts of aquatic invasive species. Goal one and two are somewhat related because one of the negative impacts of invasive species is their tendency to displace beneficial native vegetation.

Objective 1: Reduce and Control Eurasian watermilfoil and curlyleaf pondweed density and abundance

Eurasian watermilfoil and curlyleaf pondweed are the two main invasive submersed plant species. These species can reproduce through fragmentation and can rapidly reach nuisance levels. This makes them of special concern when it comes to aquatic plant management. These species can also displace native vegetation due to their rapid growth and its tendency to form a canopy shading out native species.

Whole lake fluridone treatments have historically been the best method for long-term control of Eurasian watermilfoil. This technique is not ideal for Pleasant and Riddles lakes since there is an abundance of Eurasian watermilfoil in other lakes and since the plants are limited to narrow bands around the shoreline of the lake. Whole lake fluridone treatments can also impact coontail if not completed correctly and coontail is the main submersed species in the lakes. The benefits of a whole lake treatment would likely be short-lived. The costs of a whole lake treatment would likely outweigh the benefits.

It is the author's opinion that the best action plan for controlling Eurasian watermilfoil and curlyleaf pondweed in Pleasant and Riddles lakes involves the use of Renovate herbicide (active ingredient triclopyr) combined with Aquathol K (active ingredient endothal). This action will be very selective towards Eurasian watermilfoil and curlyleaf pondweed and has the potential to provide long-term control. In order to effectively complete this treatment, areas containing these species will have to be mapped out prior to treatment. All areas containing these should be treated in late spring, following creation of a treatment map. These areas should be treated with 1.0-1.5 ppm of Aquathol K and 0.5-0.75 ppm of Renovate (Renovate was chosen over 2,4-D due to it's lack of effect of coontail). The curlyleaf treatment may be needed for 3-4 years in order to control plants that come up from dormant turions (turions can be active for several years). Eurasian watermilfoil treatments will likely need to be repeated the following season due to the difficulty in finding and controlling all milfoil plants and due the presence of this species in other connected lakes. However, the abundance of this species should be significantly reduced in following years. The goal of this control is to keep Eurasian watermilfoil frequency of occurrence below 5% so that the Association can easily fund future controls. Based on last season's sampling, approximately 17.9 acres will require treatment (Figure 18). A total of 6.1 acres may require treatment in Pleasant Lake, and 11.8 acres in Riddles Lake. A 14 day-irrigation restriction will be the primary lake-use restriction following treatment. There are no swimming or fishing restrictions associated with use of these herbicides.

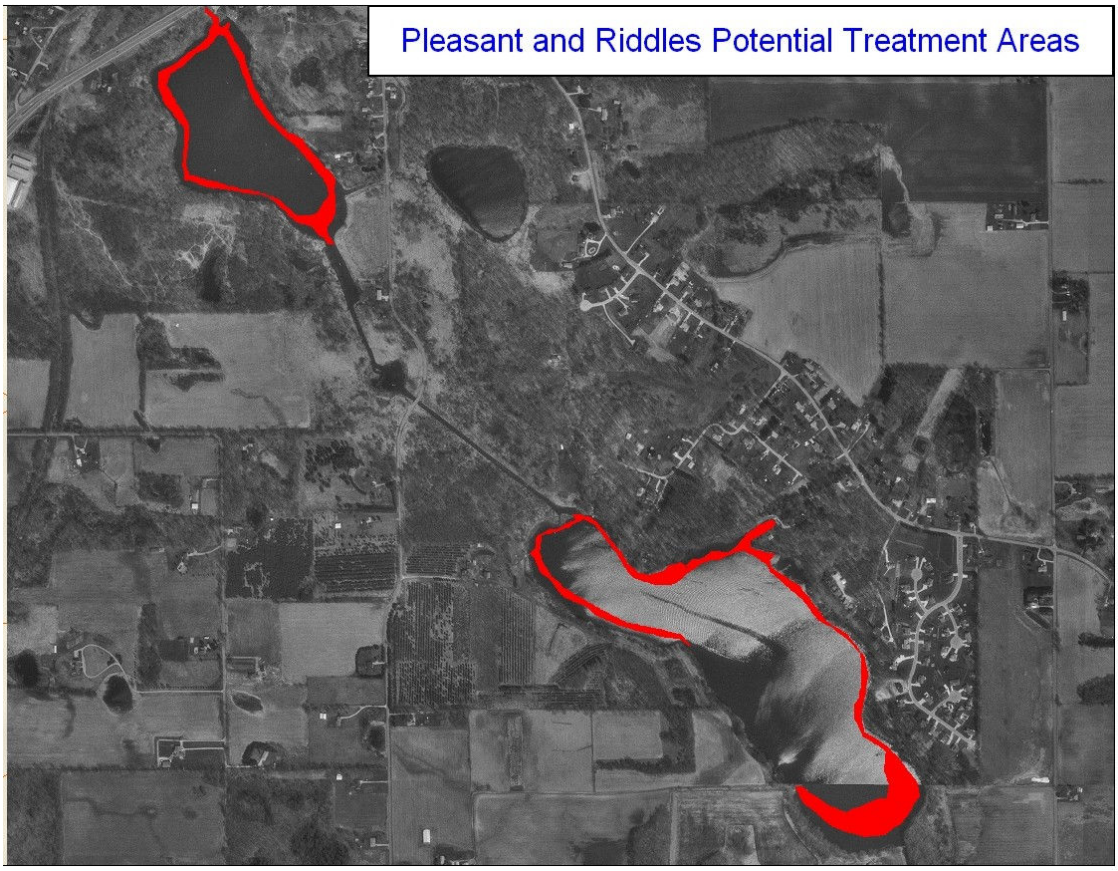

Figure 18. Pleasant and Riddles lakes, potential Eurasian watermilfoil and curlyleaf pondweed treatment areas.

Along with chemical control, it will be important for lake users to do their part in controlling these exotic species. Eurasian watermilfoil and curlyleaf pondweed spread through fragmentation, so it is easy to introduce this species to new areas. It is important that boaters avoid driving through any plant beds. This can chop up the plants causing them to float into new areas. It is also important that boaters check their props and trailers when traveling from lake to lake removing any plant fragments. One fragment of milfoil can lead to an entire colony. Signs should also be placed at all access points warning boaters to check for plant fragments. This is especially important since the discovery of hydrilla (*Hydrilla verticillata)* in Lake Manitou.

Objective 2: Prevent further spread of Purple Loosestrife
As mentioned when discussing goal number one, purple loosestrife can be detrimental to native wetland species. Control of this species may be funded by LARE depending on availability and prioritization of funds. However if this species is discovered on one's property, it will be important to individual homeowners to dig up and remove the entire plant. An illustration of this species was included in Figure 5 located on page 9 of this plan.

Objective 4: *Create public awareness of the potential for hydrilla invasion and post signs for cleaning off boats at all private and public access sites*
Hydrilla, an extremely aggressive submersed aquatic plant species, has been recently discovered in Lake Manitou, which is located in north central, Indiana. Currently, it is believed that this plant is isolated in the Lake Manitou area, but much like Eurasian watermilfoil, this species has the ability to reproduce by fragmentation. This allows it to be spread easily from lake to lake. Hydrilla can be easily confused with native elodea. The best way to distinguish hydrilla is that it typically has five leaves along each whorl along with visible serrated edges along the leaf margin. It is very important that lake users understand the importance of thoroughly cleaning off their boats when entering and exiting Pleasant and Riddles lakes. Posting signs at the ramp will help reinforce this point. Warnings about this plant should also be sent to members of the Association. An illustration of hydrilla compared to native elodea follows in Figure 19.

Figure 19. Illustration of Hydrilla on the left compared to native elodea on the right. Hydrilla typically contains five toothed leaves per whorl while native elodea typically has three leaves per whorl and the teeth are not visible on the leaves (Illustrations provided by Applied Biochemist).

12.3 Goal #3: Provide Reasonable Recreational Access While Minimizing the Negative Impacts on Plant, Fish, and Wildlife Resources

The focus of plant control should be on nuisance exotic species, but even if all exotic species were eliminated it may be necessary to control some small areas of native plants in order to provide access to docks and high-use areas. Control of the invasive species may eventually lead to an increase in nuisance conditions caused by native plants.

Objective 1: Control vegetation around docks and the boat ramp in order to allow for boat access

If left unchecked, some homeowners may be negatively impacted by native vegetation. Some homeowners may have the ability to physically remove the vegetation from these areas (625 square feet can be removed without a permit). It is recommended that if possible, and if needed, homeowners control only 625 square feet. However, some areas may be too dense or some homeowners may not be capable of completing this task. In this case it will be necessary to contact professionals to complete the work. Applied properly, aquatic herbicides are typically the best method for control of dense vegetation growth. Treatment should be limited to near shore high-use areas. Width of shoreline treatments should not exceed 100 feet out from shore. Treatment of rooted floating vegetation should be limited to a wide enough area for boats to pass (20-30 feet). It has also been IDNR's policy to only permit treatment of native vegetation in half of the shoreline areas of any given lake.

12.4 List of Actions To Be Initiated

The purpose of the LARE grant was to fund aquatic vegetation control on public lakes. Listed below, in order of importance, are recommended actions in order to meet the goals and objectives of the aquatic vegetation management plan. Some of these actions may be funded by LARE, but many will require funds from the Association.

1. Initiate recommendations laid out in 2006 Diagnostic Study in an effort to improve the water quality of Pleasant and Riddles lakes (summary of recommendation is listed in section 12.1).
2. Initiate treatment of Eurasian watermilfoil and curlyleaf pondweed in Pleasant and Riddles Lake with a combination of Renovate and Aquathol K herbicides. Treatment should take place in the spring of 2007 following sampling that will determine actual treatment areas. Repeat treatments will likely be needed the following seasons and should be included in the long-term budget.
3. Monitor plant community with plant surveys for next five years in order to assess the effectiveness of controls and response of native plant community. Plant surveys will also be invaluable to quickly detect and control potential reinfestation of invasive species. Surveys should consist of a spring treatment map survey and a summer Tier II survey in 2007. Tier II points should be limited to a maximum depth of 7.0 feet and not include floating vegetation. These surveys should be continued through 2011.
4. Post signs at access sites warning boaters of the potential for invasive plant species introductions from boat trailers. Signs should implore boaters to clean trailers, props, and boats of all vegetation fragments when entering and leaving Pleasant and Riddles Lake. Information concerning the potential spread of Eurasian watermilfoil and hydrilla should be distributed to all lake users.
5. Remove purple loosestrife from individuals' property and pursue funding source to biological controls.
6. Educate lake users on best management practices in order to improve water quality.
7. Maintain dock areas with physical plant removal when possible or by contracting professional applicators. Treatments should not exceed 100 feet from shoreline for submersed vegetation and treatment of rooted floating vegetation should be limited to boating lanes.
8. If lake clarity improves, following initiation of watershed management recommendations, it may be necessary to introduce native plant species which have been eliminated from the lakes.

13.0 PROJECT BUDGET

Table 8 is an estimated budget for the aquatic vegetation management action plan (this budget does not include potential expenses associated with the Diagnostic Study recommendations). The majority of the initial cost will be for treatment of Eurasian watermilfoil and curlyleaf pondweed. It is hard to predict how much of these species will return in following years, but the estimate below is based on past experience. Plant sampling will be one of the most important actions in order to monitor the effects of the

control techniques. Sampling should consist of a Tier I or visual survey in the spring to map treatment areas along with a Tier II survey in the summer. It is proposed that IDNR fund treatment of these species and plant survey updates (this will require a 10% match from the Association). **It is our recommendation that the Lakeville Business Owner's Association requests $8,000 for treatment of Eurasian watermilfoil and curlyleaf pondweed in 2007. The Association should also request $4,000 plant sampling and plan updates.** A permit has been created for this treatment and is included in the Appendix. This permit should be handled by the association and once a contractor is selected for the treatment the permit can be completed. It is possible that this project may not be fully funded due to a recent hydrilla infestation in Lake Manitou that may use a large percentage of potential LARE funds.

Table 8. Budget estimate for action plan

	2007	2008	2009	2010	2011
Selective treatment of Eurasian watermilfoil and curlyleaf pondweed with Renovate and Aquathol herbicide	$8,000	$7,000	$5,000	$4,000	$3,000
Plant sampling and plan updates (potential LARE funding with 10% match)	$4,000	$4,000	$4,000	$4,000	$4,000
Total:	**$12,000**	**$11,000**	**$9,000**	**$8,000**	**$7,000**

*Request $12,000 from LARE program in 2007.

14.0 MONITORING AND PLAN UPDATE PROCEDURES

One of the most important actions in the aquatic vegetation management plan is the continued monitoring of the plant population. Continued monitoring will provide valuable data to the aquatic plant manager. This data can be used to complete the following tasks: allow for needed changes to be made to the plan; monitor success or failure of controls; monitor improvements or damage to native plants; and detect potential new invasive species at an early stage of infestation. In 2007, monitoring should consist of a Tier I or treatment map survey in the spring along with a Tier II survey in July or August. The Tier II survey provides managers with quantitative data that can point out trends in the plant community. This survey should only include water depths where plants are growing and floating vegetation (duckweed and watermeal) should not be included in the results. Each winter this data should be analyzed and included in an update to the aquatic vegetation management plan. The surveys may lead to changes in the recommended actions of the plan.

15.0 REFERENCES CITED

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16.0 APPENDICES

16.1 Plant Sampling Data Sheets

Pleasant Lake

Tier 1

Aquatic Vegetation Reconnaissance Sampling

Waterbody Cover Sheet

Surveying Organization: Aquatic Control

Waterbody Name: Pleasant Lake Lake ID:

County: St. Joseph Date: 6-6-6

Habitat Stratum: 1L Ave. Lake Depth (ft): 17 Ft Lake Level: Norm

Crew Leader: N. Long

GPS Metadata

Datum: Nad27 Zone: 16 Accuracy: 3M

Recorder: K. McCreary Method: D

Secchi Depth (ft): 4.0 Total # of Plant Beds Surveyed: 4 Total # of Species: 17

Littoral Zone Size (acres): 10.8

- [x] Measured
- [ ] Estimated

Littoral Zone Max. Depth (ft): 7.0

- [x] Measured
- [ ] Estimate (historical Secchi)
- [ ] Estimated (current Secchi)

Notable Conditions:

Aquatic Vegetation Plant Bed Data Sheet

Page 1 of 4

State of Indiana Department of Natural Resources

ORGANIZATION: A. Control

DATE: 6-06-06

SITE INFORMATION

Plant Bed ID: 01
Bed Size: 6.1
Substrate: 02
Marl? 0
High Organic? 1

Waterbody Name: Pleasant Lake
Waterbody ID:
Total # of Species 13

CanopyAbundance at Site
S: 1 N: 1 F: 4 E: 1

SITE COORDINATES

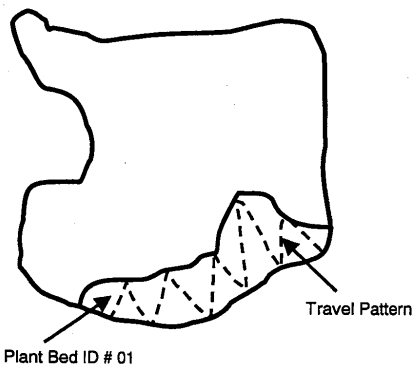
Center of the Bed
Latitude: N41.51439
Longitude: W86.27483

Max. Lakeward Extent of Bed
Latitude: N 41.51453
Longitude: W86.27319

SPECIES INFORMATION

Species Code	Abundance	QE	Vchr.	Ref. ID
NULU	4	1	0	
MYSP2	1	0	0	
CEDE4	2	0	0	
POCR3	1	0	0	
CEOC (B,B)	1	1	0	
LYSA (P. Loose)	1	1	0	
IRVE (LF iris)	1	0	0	
TYLA	1	0	0	
LEMI	1 2m	2	0	
WOCO (S. coal)	1	0	0	
[illegible] NV (Smartweed)	1	1	0	
PEVI (A. Arum)	1	0	0	
SAGI (A. Head)	1	0	0	
NYTU	1	0	0	

Individual Plant Bed Survey



Comments:
Mainly Spatterdock ringing shoreline of entire

Secchi 4ft
Plants Max Depth 7Ft

REMINDER INFORMATION

Substrate:
1 = Silt/Clay
2 = Silt w/Sand
3 = Sand w/Silt
4 = Hard Clay
5 = Gravel/Rock
6 = Sand

Marl
1 = Present
0 = absent

High Organic
1 = Present
0 = absent

Overall Surface Cover
N = Nonrooted floating
F = Floating, rooted
E = Emergent
S = Submersed

Canopy:
1 = < 2%
2 = 2-20%
3 = 21-60%
4 = > 60%

Abundance:
1 = < 2%
2 = 2-20%
3 = 21-60%
4 = > 60%

QE Code:
0 = as defined
1 = Species suspe
2 = Genus suspected
3 = Unknown

Voucher:
0 = Not Taken
1 = Taken, not varified
2 = Taken, varifie

Reference ID:
Unique number or letter to denote specific location of a species; referenced on attached map

Aquatic Vegetation Plant Bed Data Sheet

State of Indiana Department of Natural Resources

Page 2 of 4

ORGANIZATION: A. Control

DATE: 6-6-06

SITE INFORMATION

Plant Bed ID: 02

Bed Size: 3,5

Substrate: 2

Marl? 0

High Organic? 1

Waterbody Name: Pleasant Lake

Waterbody ID:

Total # of Species 8

Canopy Abundance at Site: S: 2 N: 1 F: 1 E: 1

SITE COORDINATES

Center of the Bed

Latitude: N41.51794

Longitude: W86.27844

Max. Lakeward Extent of Bed

Latitude: N41.51706

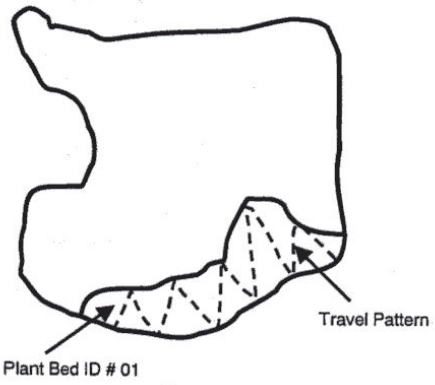
Longitude: W86.27834

SPECIES INFORMATION

Species Code	Abundance	QE	Vchr.	Ref. ID
CEDE4	3	0	0	
MYSP2	2	0	0	
POFO	1	1	0	
LEMN	1	2	0	
WOCO	1	2	0	
NOFL	1	2	0	
NYTU	1	0	0	
POCR3	1	0	0	

P. nod

Individual Plant Bed Survey



Comments:

Mainly Coontail around entire lake
Mixed w/ some EWM

REMINDER INFORMATION

Substrate:
1 = Silt/Clay
2 = Silt w/Sand
3 = Sand w/Silt
4 = Hard Clay
5 = Gravel/Rock
6 = Sand

Marl
1 = Present
0 = absent

High Organic
1 = Present
0 = absent

Overall Surface Cover
N = Nonrooted floating
F = Floating, rooted
E = Emergent
S = Submersed

Canopy:
1 = < 2%
2 = 2-20%
3 = 21-60%
4 = > 60%

Abundance:
1 = < 2%
2 = 2-20%
3 = 21-60%
4 = > 60%

QE Code:
0 = as defined
1 = Species suspe
2 = Genus suspected
3 = Unknown

Voucher:
0 = Not Taken
1 = Taken, not varified
2 = Taken, varifie

Reference ID:
Unique number or letter to denote specific location of a species; referenced on attached map

Aquatic Vegetation Plant Bed Data Sheet

Page 3 of 4

State of Indiana Department of Natural Resources

ORGANIZATION: A.C. DATE: 6-6-6

SITE INFORMATION

Plant Bed ID: 03
Bed Size: 1.6
Substrate: 02
Marl? 0
High Organic? 1
Waterbody Name: Pleasant Lake
Waterbody ID:
Total # of Species 5

CanopyAbundance at Site: S: 3 N: 1 F: 1 E: 1

SITE COORDINATES

Center of the Bed
Latitude: N41.51502
Longitude: W86.27405

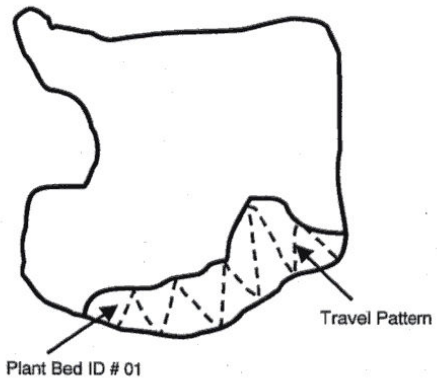
Max. Lakeward Extent of Bed
Latitude: N41.51617
Longitude: W86.27501

SPECIES INFORMATION

Species Code	Abundance	QE	Vchr.	Ref. ID
MYSP2	3	0	0	
CEDE4	3	0	0	
POCR3	1	0	0	
LEMN	1	2	0	
WOCO	1	2	0	

J. marl

Individual Plant Bed Survey



Comments: EWM more abundant in this area

REMINDER INFORMATION

Substrate:
1 = Silt/Clay
2 = Silt w/Sand
3 = Sand w/Silt
4 = Hard Clay
5 = Gravel/Rock
6 = Sand

Marl
1 = Present
0 = absent

High Organic
1 = Present
0 = absent

Overall Surface Cover
N = Nonrooted floating
F = Floating, rooted
E = Emergent
S = Submersed

Canopy:
1 = < 2%
2 = 2-20%
3 = 21-60%
4 = > 60%

Abundance:
1 = < 2%
2 = 2-20%
3 = 21-60%
4 = > 60%

QE Code:
0 = as defined
1 = Species suspe
2 = Genus suspected
3 = Unknown

Voucher:
0 = Not Taken
1 = Taken, not varified
2 = Taken, varifie

Reference ID:
Unique number or letter to denote specific location of a species; referenced on attached map

AQUATIC CONTROL

Aquatic Vegetation Plant Bed Data Sheet

Page 4 of 4

State of Indiana Department of Natural Resources

ORGANIZATION:

DATE: 6-6-6

SITE INFORMATION

Plant Bed ID: 04
Bed Size: 0.4
Substrate: 02
Marl? 0
High Organic? 1

Waterbody Name: Pleasant Lake
Waterbody ID:
Total # of Species 3

CanopyAbundance at Site

S: 1 N: 1 F: 1 E: 4

SITE COORDINATES

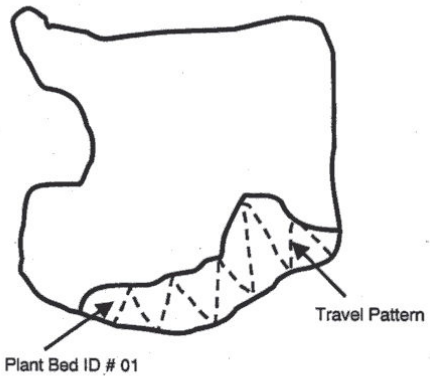
Center of the Bed
Latitude: N41.51831
Longitude: W86.27811

Max. Lakeward Extent of Bed
Latitude: N41.51824
Longitude: W86.27814

SPECIES INFORMATION

Species Code	Abundance	QE	Vchr.	Ref. ID
TYLA	4	0	0	
P. Lus LYSA	1	0	0	
NU ~~FY~~ NULU	1	1	0	

Individual Plant Bed Survey



Comments:

Cattail Stand

REMINDER INFORMATION

Substrate:
1 = Silt/Clay
2 = Silt w/Sand
3 = Sand w/Silt
4 = Hard Clay
5 = Gravel/Rock
6 = Sand

Marl
1 = Present
0 = absent

High Organic
1 = Present
0 = absent

Overall Surface Cover
N = Nonrooted floating
F = Floating, rooted
E = Emergent
S = Submersed

Canopy:
1 = < 2%
2 = 2-20%
3 = 21-60%
4 = > 60%

Abundance:
1 = < 2%
2 = 2-20%
3 = 21-60%
4 = > 60%

QE Code:
0 = as defined
1 = Species suspe
2 = Genus suspected
3 = Unknown

Voucher:
0 = Not Taken
1 = Taken, not varified
2 = Taken, varifie

Reference ID:
Unique number or letter to denote specific location of a species; referenced on attached map

Tier 1

Aquatic Vegetation Reconnaissance Sampling

Waterbody Cover Sheet

Surveying Organization: Aquatic Control

Waterbody Name: Pleasant Lake Lake ID:

County: St. Joseph Date: 8-17-06

Habitat Stratum: IL Ave. Lake Depth (ft): 17Ft Lake Level: Norm

Crew Leader: Joey Leach

GPS Metadata

Datum: Wgs27 Zone: 16 Accuracy: 3M

Recorder: Kyle McCreary Method: D

Secchi Depth (ft): 3.0 Total # of Plant Beds Surveyed: 5 Total # of Species: 11

Littoral Zone Size (acres): 12.3

- ☒ Measured
- ☐ Estimated

Littoral Zone Max. Depth (ft): 7

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

Notable Conditions:

Aquatic Vegetation Plant Bed Data Sheet

Page 1 of 5

State of Indiana Department of Natural Resources

ORGANIZATION: Aquatic Control

DATE: 8/17/06

SITE INFORMATION

Plant Bed ID: 1

Waterbody Name: Pleasant Lake

Bed Size: 5.1

Substrate: 2

Waterbody ID:

Marl? 0

Total # of Species 8

High Organic? 1

CanopyAbundance at Site

S: 1 N: 2 F: 4 E: 1

SITE COORDINATES

Center of the Bed

Latitude:

Longitude:

Max. Lakeward Extent of Bed

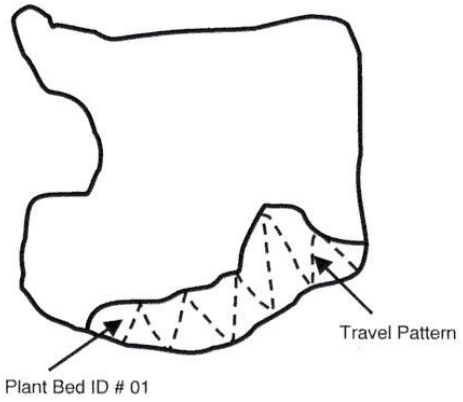
Latitude: N41.51656

Longitude: W86.27823

SPECIES INFORMATION

Species Code	Abundance	QE	Vchr.	Ref. ID
NULU	4	0	0	
NYTU	3	0	0	
ARSU ARVU PEVI Pickerel weed POCO	2	0	0	
WO?LF	2	0	0	
JUAM	1	0	0	
LEMN	1/2 1	0	0	
DEVE	2	0	0	

Individual Plant Bed Survey



Comments:

Shallow rooted floating around entire LK

REMINDER INFORMATION

Substrate:
1 = Silt/Clay
2 = Silt w/Sand
3 = Sand w/Silt
4 = Hard Clay
5 = Gravel/Rock
6 = Sand

Marl
1 = Present
0 = absent

High Organic
1 = Present
0 = absent

Overall Surface Cover
N = Nonrooted floating
F = Floating, rooted
E = Emergent
S = Submersed

Canopy:
1 = < 2%
2 = 2-20%
3 = 21-60%
4 = > 60%

Abundance:
1 = < 2%
2 = 2-20%
3 = 21-60%
4 = > 60%

QE Code:
0 = as defined
1 = Species suspe
2 = Genus suspected
3 = Unknown

Voucher:
0 = Not Taken
1 = Taken, not varified
2 = Taken, varifie

Reference ID:
Unique number or letter to denote specific location of a species; referenced on attached map

Aquatic Vegetation Plant Bed Data Sheet

Page 2 of 5

State of Indiana Department of Natural Resources

ORGANIZATION:	Aquatic Control
DATE:	8/17/06

SITE INFORMATION

Plant Bed ID:	2
Bed Size:	3.6
Substrate:	2
Marl?	0
High Organic?	1
Waterbody Name:	Pleasant Lake
Waterbody ID:	
Total # of Species	4

CanopyAbundance at Site

S:	N:	F:	E:
4	3	1	1

SITE COORDINATES

Center of the Bed

Latitude: N41.51801

Longitude: W86.27830

Max. Lakeward Extent of Bed

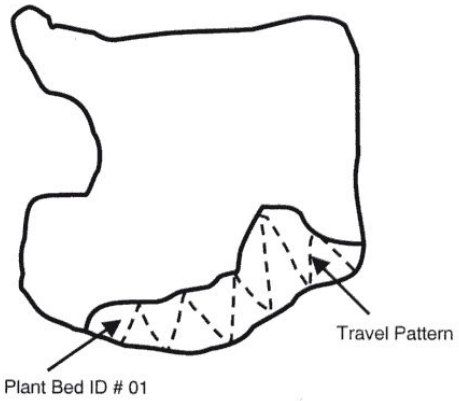
Latitude: N41.51675

Longitude: W86.27813

SPECIES INFORMATION

Species Code	Abundance	QE	Vchr.	Ref. ID
CEDE4	4	0	0	
MYSP2 EWM	3-4	0	0	
NO?LF	2	0	0	
LEMN	1	0	0	

Individual Plant Bed Survey



Comments:

REMINDER INFORMATION

Substrate:
1 = Silt/Clay
2 = Silt w/Sand
3 = Sand w/Silt
4 = Hard Clay
5 = Gravel/Rock
6 = Sand

Marl
1 = Present
0 = absent

High Organic
1 = Present
0 = absent

Overall Surface Cover
N = Nonrooted floating
F = Floating, rooted
E = Emergent
S = Submersed

Canopy:
1 = < 2%
2 = 2-20%
3 = 21-60%
4 = > 60%

Abundance:
1 = < 2%
2 = 2-20%
3 = 21-60%
4 = > 60%

QE Code:
0 = as defined
1 = Species suspe
2 = Genus suspected
3 = Unknown

Voucher:
0 = Not Taken
1 = Taken, not varified
2 = Taken, varifie

Reference ID:
Unique number or letter to denote specific location of a species; referenced on attached map

Aquatic Vegetation Plant Bed Data Sheet

Page 3 of 5

State of Indiana Department of Natural Resources

ORGANIZATION: Aquatic Control

DATE: 8/17/06

SITE INFORMATION

Plant Bed ID: 3

Waterbody Name: Pleasant Lake

Bed Size: 2.5

Substrate: 2

Waterbody ID:

Marl? 0

Total # of Species 4

High Organic? 1

CanopyAbundance at Site

S: 4 N: 4 F: 1 E: 1

SITE COORDINATES

Center of the Bed

Latitude: N41.51466

Longitude: W86.27426

Max. Lakeward Extent of Bed

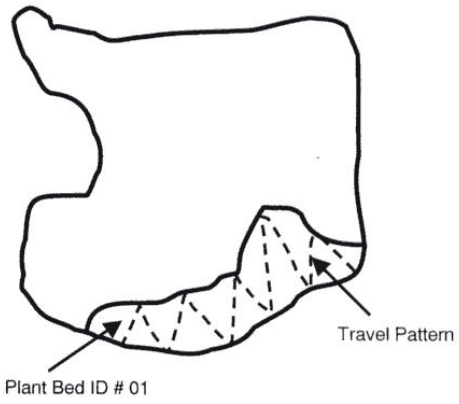
Latitude: N41.51497

Longitude: W86.27427

SPECIES INFORMATION

Species Code	Abundance	QE	Vchr.	Ref. ID
MYSP2	4	0	0	
CEDE	3	0	0	
WOLF	4	0	0	
LEMN	2	0	0	

Individual Plant Bed Survey



Comments:

REMINDER INFORMATION

Substrate:
1 = Silt/Clay
2 = Silt w/Sand
3 = Sand w/Silt
4 = Hard Clay
5 = Gravel/Rock
6 = Sand

Marl
1 = Present
0 = absent

High Organic
1 = Present
0 = absent

Overall Surface Cover
N = Nonrooted floating
F = Floating, rooted
E = Emergent
S = Submersed

Canopy:
1 = < 2%
2 = 2-20%
3 = 21-60%
4 = > 60%

Abundance:
1 = < 2%
2 = 2-20%
3 = 21-60%
4 = > 60%

QE Code:
0 = as defined
1 = Species suspe
2 = Genus suspected
3 = Unknown

Voucher:
0 = Not Taken
1 = Taken, not varified
2 = Taken, varifie

Reference ID:
Unique number or letter to denote specific location of a species; referenced on attached map

Aquatic Vegetation Plant Bed Data Sheet

Page 4 of 5

State of Indiana Department of Natural Resources

ORGANIZATION: Aquatic Control

DATE: 8/17/06

SITE INFORMATION

Plant Bed ID: 4

Waterbody Name: Pleasant Lake

Bed Size: 0.5

Substrate: 2

Waterbody ID:

Marl? 0

Total # of Species 2

High Organic? 1

CanopyAbundance at Site

S: 1 N: 1 F: 1 E: 4

SITE COORDINATES

Center of the Bed

Latitude: N41.51837

Longitude: W86.27808

Max. Lakeward Extent of Bed

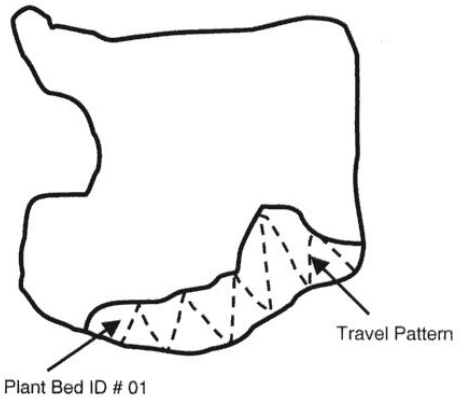
Latitude: N41.51851

Longitude: W86.27745

SPECIES INFORMATION

Species Code	Abundance	QE	Vchr.	Ref. ID
Coontail TYLA	4	0	0	
Purple Loosestrife LYSA	2	0	0	

Individual Plant Bed Survey



Comments:

REMINDER INFORMATION

Substrate:
1 = Silt/Clay
2 = Silt w/Sand
3 = Sand w/Silt
4 = Hard Clay
5 = Gravel/Rock
6 = Sand

Marl
1 = Present
0 = absent

High Organic
1 = Present
0 = absent

Overall Surface Cover
N = Nonrooted floating
F = Floating, rooted
E = Emergent
S = Submersed

Canopy:
1 = < 2%
2 = 2-20%
3 = 21-60%
4 = > 60%

Abundance:
1 = < 2%
2 = 2-20%
3 = 21-60%
4 = > 60%

QE Code:
0 = as defined
1 = Species suspe
2 = Genus suspected
3 = Unknown

Voucher:
0 = Not Taken
1 = Taken, not varified
2 = Taken, varifie

Reference ID:
Unique number or letter to denote specific location of a species; referenced on attached map

Aquatic Vegetation Plant Bed Data Sheet

Page 5 of 5

State of Indiana Department of Natural Resources

ORGANIZATION: Aquatic Control | DATE: 8/17/06

SITE INFORMATION

Plant Bed ID: 5 | Waterbody Name: Pleasant

Bed Size: 0.6

Substrate: 2 | Waterbody ID:

Marl? 0 | Total # of Species 1

High Organic? 1

CanopyAbundance at Site

S: 1 | N: 1 | F: 1 | E: 4

SITE COORDINATES

Center of the Bed

Latitude: N 41.51436

Longitude: W 86.27472

Max. Lakeward Extent of Bed

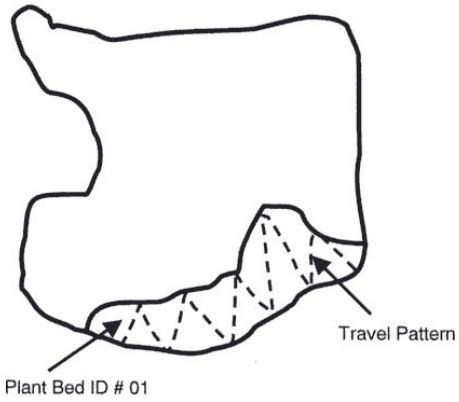
Latitude: —

Longitude: —

SPECIES INFORMATION

Species Code	Abundance	QE	Vchr.	Ref. ID
Purple Loosestrife LYSA	4	0	0	

Individual Plant Bed Survey



Comments:

Purple Loose along the eastern shore

REMINDER INFORMATION

Substrate:
1 = Silt/Clay
2 = Silt w/Sand
3 = Sand w/Silt
4 = Hard Clay
5 = Gravel/Rock
6 = Sand

Marl
1 = Present
0 = absent

High Organic
1 = Present
0 = absent

Overall Surface Cover
N = Nonrooted floating
F = Floating, rooted
E = Emergent
S = Submersed

Canopy:
1 = < 2%
2 = 2-20%
3 = 21-60%
4 = > 60%

Abundance:
1 = < 2%
2 = 2-20%
3 = 21-60%
4 = > 60%

QE Code:
0 = as defined
1 = Species suspe
2 = Genus suspected
3 = Unknown

Voucher:
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1 = Taken, not varified
2 = Taken, varifie

Reference ID:
Unique number or letter to denote specific location of a species; referenced on attached map

Aquatic Vegetation Random Sampling

Waterbody Cover Sheet

Organization Name: Aquatic Control

Waterbody Name: Pleasant Lake Lake ID:

County: St. Joseph Date: 8-17-06

Habitat Stratum: IL Ave. Lake Depth (ft): 17.0 Lake Level: Norm

GPS Metadata

Crew Leader: Joey Leach Datum: NAD27 Zone: 16 Accuracy: 3m

Recorder: Kyle McCreary Method: D

Secchi Depth (ft): 3.0 Total # of Sites Surveyed: 30 Total # of Species: 6

Littoral Zone Size (acres): 12.3
- ☒ Measured
- ☐ Estimated

Littoral Zone Max. Depth (ft): 7.0
- ☒ Measured
- ☐ Estimate (historical Secchi)
- ☐ Estimated (current Secchi)

Notable Conditions:

APPENDIX A

Submersed Aquatic Plant Survey Form

Page 1 of 1

WATER BODY NAME Pleasant Lake
COUNTY St. Joseph
DATE 8/17/06
CREW LEADER J. Leach
RECORDER K. McCrary
SECCHI 3-f7
MAX PLANT DEPTH 7ft
WEATHER Sunny 70°
COMMENTS

Rake score (1-5), observed only (9), algae present (p)
Use acronyms for species, V1, V2...for voucher codes

Species Code: MYSP2 = ✓ Coon; CEDE4 = Duck; LEMN = ✓ wm; WOLF = Slimy; NAFL = GW; SPPO

Site	Northing	Easting	Depth	All	MYSP2	CEDE4	LEMN	WOLF	NAFL	SPPO	Note
281			4	5		5					
282			11	NP							
283			9	1		1					
284			6	1		1					
285			5	3	1	3					
286			11	NP							
287			5	5		5					
288			5	3		3					
289			7	NP							
290			12	NP							
291			7	NP							
292			12	NP							
293			3	5	1	5					
294			7	NP							
295			12	NP							
296			3	5	5	1	1	1	1		
297			7	5	5						
298			12	NP							
299			4	5	3	5	1	1 Xkn	Xkn	1	
300			9	NP							
301			15	NP							
302			5	5	1	5	1		Xkn	1	
303			6	NP							
304			11	NP							
305			5	5	5	5					
306			9	NP							
307			13	NP							
308			14	NP							
309			8	NP							
310			3	5		5	1	1		1	

Other plant species observed at lake: NULU, NYTU, PEVE, LYSA, TYLA

Plant Database

Lake	Date	Latitude	Longitude	Design	Site	Depth	RAKE	MYSP2	LEMN	CEDE4	WO?LF	SPPO	NAFL
Pleasant Lake	8/17/06	41.51864	-86.277384		281	4.0	5			5			
Pleasant Lake	8/17/06	41.51832	-86.277608		282	11.0	0						
Pleasant Lake	8/17/06	41.51783	-86.278446		283	9.0	1			1			
Pleasant Lake	8/17/06	41.5172	-86.27859		284	6.0	1			1			
Pleasant Lake	8/17/06	41.5169	-86.278338		285	5.0	3	1		3			
Pleasant Lake	8/17/06	41.51639	-86.277845		286	11.0	0						
Pleasant Lake	8/17/06	41.51604	-86.278273		287	5.0	5			5			
Pleasant Lake	8/17/06	41.51538	-86.277815		288	5.0	3			3			
Pleasant Lake	8/17/06	41.5154	-86.277135		289	7.0	0						
Pleasant Lake	8/17/06	41.51546	-86.27667		290	12.0	0						
Pleasant Lake	8/17/06	41.51525	-86.276077		291	7.0	0						
Pleasant Lake	8/17/06	41.51518	-86.275495		292	12.0	0						
Pleasant Lake	8/17/06	41.51477	-86.275286		293	3.0	5	1		5			
Pleasant Lake	8/17/06	41.5147	-86.274912		294	7.0	0						
Pleasant Lake	8/17/06	41.51494	-86.274603		295	12.0	0						
Pleasant Lake	8/17/06	41.51467	-86.273936		296	3.0	5	5	1	1	1		1
Pleasant Lake	8/17/06	41.51523	-86.274172		297	7.0	5	5					
Pleasant Lake	8/17/06	41.51554	-86.274682		298	12.0	0						
Pleasant Lake	8/17/06	41.51613	-86.274808		299	4.0	5	3	1	5		1	
Pleasant Lake	8/17/06	41.51627	-86.275285		300	9.0	0						
Pleasant Lake	8/17/06	41.51642	-86.275778		301	15.0	0						
Pleasant Lake	8/17/06	41.51684	-86.275845		302	5.0	5	1	1	5		1	
Pleasant Lake	8/17/06	41.51692	-86.276058		303	6.0	0						
Pleasant Lake	8/17/06	41.51712	-86.276463		304	11.0	0						
Pleasant Lake	8/17/06	41.51751	-86.276294		305	5.0	5	5		5			
Pleasant Lake	8/17/06	41.51761	-86.276607		306	9.0	0						
Pleasant Lake	8/17/06	41.51785	-86.2769		307	13.0	0						
Pleasant Lake	8/17/06	41.51826	-86.27716		308	14.0	0						
Pleasant Lake	8/17/06	41.51849	-86.277033		309	8.0	0						
Pleasant Lake	8/17/06	41.51873	-86.277038		310	3.0	5		1	5	1	1	

Tier 1

Aquatic Vegetation Reconnaissance Sampling

Waterbody Cover Sheet

Surveying Organization: Aquatic Control

Waterbody Name: Riddles Lake Lake ID:

County: St. Joseph Date: 6-6-06

Habitat Stratum: IL Ave. Lake Depth (ft): 8.1 Lake Level: Normal

GPS Metadata

Crew Leader: Nathan Long Datum: WGS84 Zone: 16 Accuracy: 3M

Recorder: K. McCreary Method: D

Secchi Depth (ft): 2.0 Total # of Plant Beds Surveyed: 16 Total # of Species: 16

Littoral Zone Size (acres): 23.9
- [x] Measured
- [ ] Estimated

Littoral Zone Max. Depth (ft): 4.0
- [x] Measured
- [ ] Estimate (historical Secchi)
- [ ] Estimated (current Secchi)

Notable Conditions: Microscopic Algae Bloom

Aquatic Vegetation Plant Bed Data Sheet

Page 12 of 16

State of Indiana Department of Natural Resources

ORGANIZATION: A.C. DATE: 6-6-6

SITE INFORMATION

Plant Bed ID: 021
Bed Size: 3.2
Substrate: 2
Marl? 0
High Organic? 1
Waterbody Name: Riddles
Waterbody ID:
Total # of Species 13

CanopyAbundance at Site: S: 1 N: 1 F: 4 E: 1

SITE COORDINATES

Center of the Bed
Latitude: N41.50580
Longitude: W86.26633

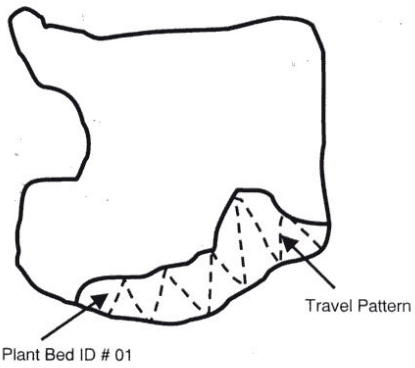
Max. Lakeward Extent of Bed
Latitude: N41.50626
Longitude: W86.26665

SPECIES INFORMATION

Species Code	Abundance	QE	Vchr.	Ref. ID
NUAU	4	0	0	
NYTU	2	0	0	
POCR3	1	0	0	
MYSP2	1	0	0	
CEDE4	1	0	0	
PEVI	1	0	0	
POCO	1	0	0	
LETR	1	0	0	
LEMI	1	02	0	
WOCO	1	02	0	
POFL	1	02	0	
LYSA	1	0	0	
TYLA	1	0	0	

A. Arum
P. weed
Star DW
DW
WM
Sma-tw
P. Lwrt
TYLA

Individual Plant Bed Survey



Comments:

Spat & Lilie Beds

REMINDER INFORMATION

Substrate:
1 = Silt/Clay
2 = Silt w/Sand
3 = Sand w/Silt
4 = Hard Clay
5 = Gravel/Rock
6 = Sand

Marl
1 = Present
0 = absent

High Organic
1 = Present
0 = absent

Overall Surface Cover
N = Nonrooted floating
F = Floating, rooted
E = Emergent
S = Submersed

Canopy:
1 = < 2%
2 = 2-20%
3 = 21-60%
4 = > 60%

Abundance:
1 = < 2%
2 = 2-20%
3 = 21-60%
4 = > 60%

QE Code:
0 = as defined
1 = Species suspe
2 = Genus suspected
3 = Unknown

Voucher:
0 = Not Taken
1 = Taken, not varified
2 = Taken, varifie

Reference ID:
Unique number or letter to denote specific location of a species; referenced on attached map

Aquatic Vegetation Plant Bed Data Sheet

Page 2 of 16

State of Indiana Department of Natural Resources

ORGANIZATION: A. Control DATE: 6-6-06

SITE INFORMATION

Plant Bed ID: 02
Bed Size: <0.1
Substrate: 02
Marl? 0
High Organic? 1
Waterbody Name: Riddles
Waterbody ID:
Total # of Species
CanopyAbundance at Site
S: 1 N: 1 F: 3 E: 3

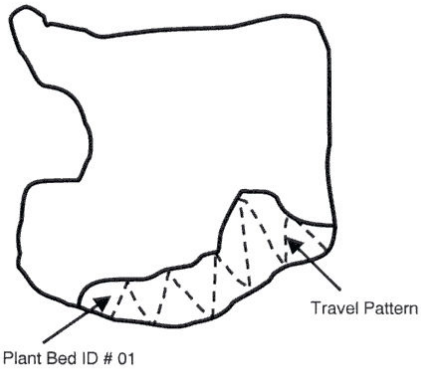
SITE COORDINATES

Center of the Bed
Latitude:
Longitude:
Max. Lakeward Extent of Bed
Latitude:
Longitude:

SPECIES INFORMATION

	Species Code	Abundance	QE	Vchr.	Ref. ID
P. weed	POCO	3	0	0	
	NYTU	3	0	0	
	MYSP2	2	0	0	
	POCR3	2	0	0	
	LEDE4	1	0	0	
V. Arrow	PEVI	1	0	0	
Stem BR	SCIR	1	0	0	
	LEMN	1	2	0	
V. Nat	WOCO	1	02	0	

Individual Plant Bed Survey



Comments:

REMINDER INFORMATION

Substrate:
1 = Silt/Clay
2 = Silt w/Sand
3 = Sand w/Silt
4 = Hard Clay
5 = Gravel/Rock
6 = Sand

Marl
1 = Present
0 = absent

High Organic
1 = Present
0 = absent

Overall Surface Cover
N = Nonrooted floating
F = Floating, rooted
E = Emergent
S = Submersed

Canopy:
1 = < 2%
2 = 2-20%
3 = 21-60%
4 = > 60%

Abundance:
1 = < 2%
2 = 2-20%
3 = 21-60%
4 = > 60%

QE Code:
0 = as defined
1 = Species suspe
2 = Genus suspected
3 = Unknown

Voucher:
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1 = Taken, not varified
2 = Taken, varifie

Reference ID:
Unique number or letter to denote specific location of a species; referenced on attached map

Aquatic Vegetation Plant Bed Data Sheet

Page 3 of 16

State of Indiana Department of Natural Resources

ORGANIZATION: A. Control

DATE: 6-6-06

SITE INFORMATION

Plant Bed ID: 03
Bed Size: 1.7
Substrate: 02
Marl? 0
High Organic? 1

Waterbody Name: Riddles
Waterbody ID:
Total # of Species 9

CanopyAbundance at Site

S: 1 N: 1 F: 4 E: 1

SITE COORDINATES

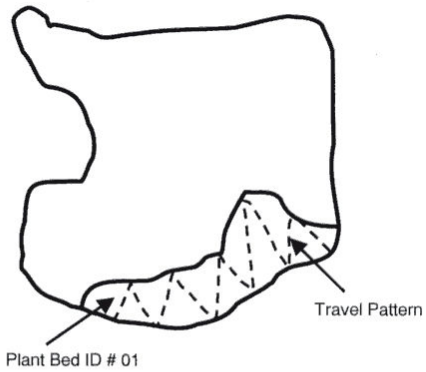
Center of the Bed
Latitude: N41.50431
Longitude: W86.26274

Max. Lakeward Extent of Bed
Latitude: N41.50433
Longitude: W86.26261

SPECIES INFORMATION

Species Code	Abundance	QE	Vchr.	Ref. ID
NuLu	4	0	0	
NyTu	3	0	0	
MySP2	2	0	0	
POCR3	2	0	0	
CEDE4	1	0	0	
A. Arum PEVI	1	0	0	
LEMN	1	2	0	
W. Mud WOCO	1	02	0	
P. Weed POCO	1	0	0	

Individual Plant Bed Survey



Comments:

REMINDER INFORMATION

Substrate:
1 = Silt/Clay
2 = Silt w/Sand
3 = Sand w/Silt
4 = Hard Clay
5 = Gravel/Rock
6 = Sand

Marl
1 = Present
0 = absent

High Organic
1 = Present
0 = absent

Overall Surface Cover
N = Nonrooted floating
F = Floating, rooted
E = Emergent
S = Submersed

Canopy:
1 = < 2%
2 = 2-20%
3 = 21-60%
4 = > 60%

Abundance:
1 = < 2%
2 = 2-20%
3 = 21-60%
4 = > 60%

QE Code:
0 = as defined
1 = Species suspe
2 = Genus suspected
3 = Unknown

Voucher:
0 = Not Taken
1 = Taken, not varified
2 = Taken, varifie

Reference ID:
Unique number or letter to denote specific location of a species; referenced on attached map

Aquatic Vegetation Plant Bed Data Sheet

Page 4 of 16

State of Indiana Department of Natural Resources

ORGANIZATION: A. Control

DATE: 6-6-6

SITE INFORMATION

Plant Bed ID: 04

Bed Size: 4.9

Substrate: 02

Marl? 0

High Organic? 1

Waterbody Name: Riddles

Waterbody ID:

Total # of Species 8

CanopyAbundance at Site

S: 1 N: 1 F: 4 E: 1

SITE COORDINATES

Center of the Bed

Latitude: N41.50133

Longitude: W86.25765

Max. Lakeward Extent of Bed

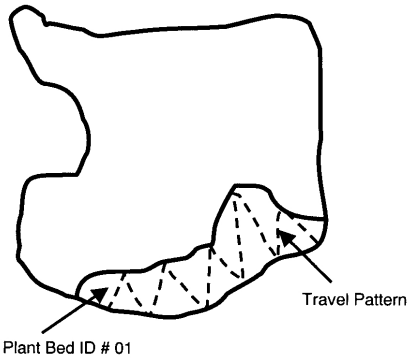
Latitude: N41.50166

Longitude: W86.25933

SPECIES INFORMATION

Species Code	Abundance	QE	Vchr.	Ref. ID
NULU	4	0	0	
NYTU	2	0	0	
MYSP2	2	0	0	
POCR3	2	0	0	
CEDE4	2	0	0	
P. Veed POCO	1	0	0	
LEMN	1	2	0	
W. meal WOCO	1	2	0	

Individual Plant Bed Survey



Comments:

Spat bed

REMINDER INFORMATION

Substrate:
1 = Silt/Clay
2 = Silt w/Sand
3 = Sand w/Silt
4 = Hard Clay
5 = Gravel/Rock
6 = Sand

Marl
1 = Present
0 = absent

High Organic
1 = Present
0 = absent

Overall Surface Cover
N = Nonrooted floating
F = Floating, rooted
E = Emergent
S = Submersed

Canopy:
1 = < 2%
2 = 2-20%
3 = 21-60%
4 = > 60%

Abundance:
1 = < 2%
2 = 2-20%
3 = 21-60%
4 = > 60%

QE Code:
0 = as defined
1 = Species suspe
2 = Genus suspected
3 = Unknown

Voucher:
0 = Not Taken
1 = Taken, not varified
2 = Taken, varifie

Reference ID:
Unique number or letter to denote specific location of a species; referenced on attached map

AQUATIC CONTROL

Aquatic Vegetation Plant Bed Data Sheet

Page 5 of 16

State of Indiana Department of Natural Resources

ORGANIZATION: A. Control DATE: 6-6-6

SITE INFORMATION

Plant Bed ID: OM5
Bed Size: 20.1
Substrate: 02
Marl? 0
High Organic? 1
Waterbody Name: Riddles
Waterbody ID:
Total # of Species 4

CanopyAbundance at Site

S: 1 N: 1 F: 1 E: 4

SITE COORDINATES

Center of the Bed
Latitude: N41.501092
Longitude: W86.257618

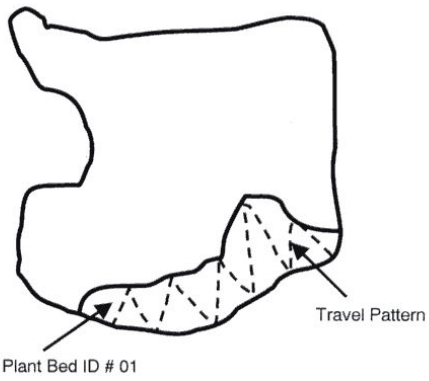
Max. Lakeward Extent of Bed
Latitude: N41.501119
Longitude: W86.257683

SPECIES INFORMATION

Species Code	Abundance	QE	Vchr.	Ref. ID
TYLA	4	0	0	
IRVE	1	0	0	
POCO	1	0	0	
LYSA	1	0	0	

This weed loose

Individual Plant Bed Survey



Comments:

REMINDER INFORMATION

Substrate:
1 = Silt/Clay
2 = Silt w/Sand
3 = Sand w/Silt
4 = Hard Clay
5 = Gravel/Rock
6 = Sand

Marl
1 = Present
0 = absent

High Organic
1 = Present
0 = absent

Overall Surface Cover
N = Nonrooted floating
F = Floating, rooted
E = Emergent
S = Submersed

Canopy:
1 = < 2%
2 = 2-20%
3 = 21-60%
4 = > 60%

Abundance:
1 = < 2%
2 = 2-20%
3 = 21-60%
4 = > 60%

QE Code:
0 = as defined
1 = Species suspe
2 = Genus suspected
3 = Unknown

Voucher:
0 = Not Taken
1 = Taken, not varified
2 = Taken, varifie

Reference ID:
Unique number or letter to denote specific location of a species; referenced on attached map

Aquatic Vegetation Plant Bed Data Sheet

Page 5 of 16

State of Indiana Department of Natural Resources

ORGANIZATION: A. Control

DATE: 6-6-6

SITE INFORMATION

Plant Bed ID: 06
Bed Size: 0.25
Substrate: 02
Marl? 0
High Organic? 1
Waterbody Name: Riddles
Waterbody ID:
Total # of Species 3

CanopyAbundance at Site
S: 1 N: 1 F: 1 E: 4

SITE COORDINATES

Center of the Bed
Latitude: N 41.505212
Longitude: W86. 258628

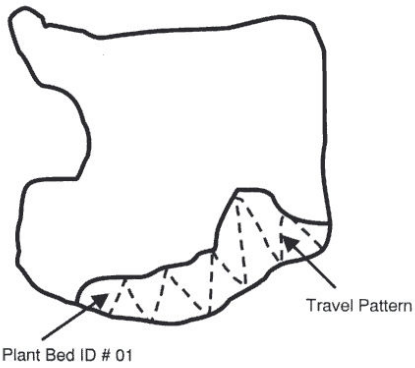
Max. Lakeward Extent of Bed
Latitude: N41.505453
Longitude: W 86.258872

SPECIES INFORMATION

Species Code	Abundance	QE	Vchr.	Ref. ID
TYLA	4	0	0	
LYSA	1	0	0	
POCO	1	0	0	

Plowed

Individual Plant Bed Survey



Comments:

Cattail Bed

REMINDER INFORMATION

Substrate:
1 = Silt/Clay
2 = Silt w/Sand
3 = Sand w/Silt
4 = Hard Clay
5 = Gravel/Rock
6 = Sand

Marl
1 = Present
0 = absent

High Organic
1 = Present
0 = absent

Overall Surface Cover
N = Nonrooted floating
F = Floating, rooted
E = Emergent
S = Submersed

Canopy:
1 = < 2%
2 = 2-20%
3 = 21-60%
4 = > 60%

Abundance:
1 = < 2%
2 = 2-20%
3 = 21-60%
4 = > 60%

QE Code:
0 = as defined
1 = Species suspe
2 = Genus suspected
3 = Unknown

Voucher:
0 = Not Taken
1 = Taken, not varified
2 = Taken, varifie

Reference ID:
Unique number or letter to denote specific location of a species; referenced on attached map

Aquatic Vegetation Plant Bed Data Sheet

Page 7 of ___

State of Indiana Department of Natural Resources

ORGANIZATION: A. Control DATE: 6-6-6

SITE INFORMATION

Plant Bed ID: 07
Waterbody Name: Riddles
Bed Size: 0.5
Substrate: 2
Waterbody ID:
Marl? 0
Total # of Species 3
High Organic? 1
CanopyAbundance at Site
S: 1 N: 1 F: 1 E: 4

SITE COORDINATES

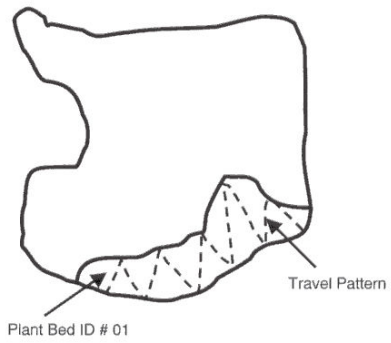
Center of the Bed
Latitude: N41.507100
Longitude: W86.266978
Max. Lakeward Extent of Bed
Latitude: N41.506939
Longitude: W86.261021

SPECIES INFORMATION

Species Code	Abundance	QE	Vchr.	Ref. ID
TYLA	3	0	6	
POCO	1	0	0	
NYTU	4	0	0	

P.W

Individual Plant Bed Survey



Comments:

REMINDER INFORMATION

Substrate:
1 = Silt/Clay
2 = Silt w/Sand
3 = Sand w/Silt
4 = Hard Clay
5 = Gravel/Rock
6 = Sand

Marl
1 = Present
0 = absent

High Organic
1 = Present
0 = absent

Overall Surface Cover
N = Nonrooted floating
F = Floating, rooted
E = Emergent
S = Submersed

Canopy:
1 = < 2%
2 = 2-20%
3 = 21-60%
4 = > 60%

Abundance:
1 = < 2%
2 = 2-20%
3 = 21-60%
4 = > 60%

QE Code:
0 = as defined
1 = Species suspe
2 = Genus suspected
3 = Unknown

Voucher:
0 = Not Taken
1 = Taken, not varified
2 = Taken, varifie

Reference ID:
Unique number or letter to denote specific location of a species; referenced on attached map

[redacted]

Aquatic Vegetation Plant Bed Data Sheet

Page 3 of 16

State of Indiana Department of Natural Resources

ORGANIZATION: A. Control

DATE: 6-6-6

SITE INFORMATION

Plant Bed ID: 08
Bed Size: 0.1
Substrate: 02
Marl? 0
High Organic? 1

Waterbody Name: Riddles
Waterbody ID:
Total # of Species 7

CanopyAbundance at Site
S: 1 N: 1 F: 4 E: 1

SITE COORDINATES

Center of the Bed
Latitude: N41.507481
Longitude: W86.261780

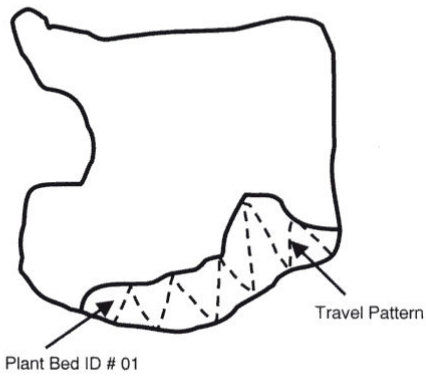
Max. Lakeward Extent of Bed
Latitude: N41.507433
Longitude: W86.261852

SPECIES INFORMATION

Species Code	Abundance	QE	Vchr.	Ref. ID
NYLU	4	0	0	
NYTU	2	0	0	
CEDE4	2	0	0	
MYSP2	2	0	0	
LEMN	1	2	0	
WOCO	1	2	0	
POCO	1	0	0	

W. marl
Pivoted

Individual Plant Bed Survey



Comments: Spat Bed

REMINDER INFORMATION

Substrate:
1 = Silt/Clay
2 = Silt w/Sand
3 = Sand w/Silt
4 = Hard Clay
5 = Gravel/Rock
6 = Sand

Marl
1 = Present
0 = absent

High Organic
1 = Present
0 = absent

Overall Surface Cover
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F = Floating, rooted
E = Emergent
S = Submersed

Canopy:
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Abundance:
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3 = 21-60%
4 = > 60%

QE Code:
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1 = Species suspe
2 = Genus suspected
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Voucher:
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Reference ID:
Unique number or letter to denote specific location of a species; referenced on attached map

Aquatic Vegetation Plant Bed Data Sheet

Page 9 of 16

State of Indiana Department of Natural Resources

ORGANIZATION: A.Control DATE: 6-6-6

SITE INFORMATION

Plant Bed ID: 09
Bed Size: 0.7
Substrate: 02
Marl? 0
High Organic? 1
Waterbody Name: Riddles
Waterbody ID:
Total # of Species 7

CanopyAbundance at Site

S: NL 3 N: 1 F: NL 4 E: 1

SITE COORDINATES

Center of the Bed
Latitude: N 41.507449
Longitude: W 86.263163

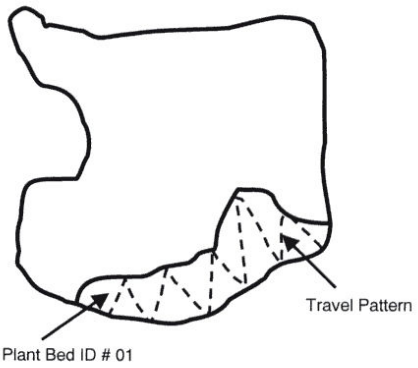
Max. Lakeward Extent of Bed
Latitude: N 41.507309
Longitude: W 86.263213

SPECIES INFORMATION

Species Code	Abundance	QE	Vchr.	Ref. ID
NULU	4	0	0	
NYSY	1	0	0	
CEDE4	1	0	0	
MYSP2	2	0	0	
POCR3	1	0	0	
LEMN	1	2	0	
WOCO	1	2	0	

W. Marl

Individual Plant Bed Survey



Comments:

REMINDER INFORMATION

Substrate:
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2 = Silt w/Sand
3 = Sand w/Silt
4 = Hard Clay
5 = Gravel/Rock
6 = Sand

Marl
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0 = absent

High Organic
1 = Present
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Overall Surface Cover
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E = Emergent
S = Submersed

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2 = 2-20%
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4 = > 60%

Abundance:
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Reference ID:
Unique number or letter to denote specific location of a species; referenced on attached map

Aquatic Vegetation Plant Bed Data Sheet

Page 10 of 16

State of Indiana Department of Natural Resources

ORGANIZATION: A. Control

DATE: 6-6-6

SITE INFORMATION

Plant Bed ID: 10

Bed Size: ~~<0.1~~ 0.8

Substrate: 02

Marl? 0

High Organic? 1

Waterbody Name: Riddles

Waterbody ID:

Total # of Species 5

CanopyAbundance at Site

S: 3 N: 1 F: 3 E: 1

SITE COORDINATES

Center of the Bed

Latitude: ~~N41.506966~~ N41.506864

Longitude: ~~W86.264688~~ W86.264352

Max. Lakeward Extent of Bed

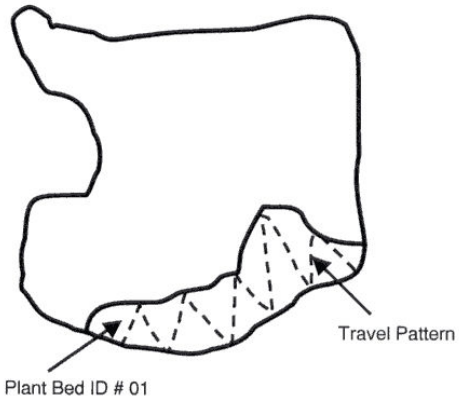
Latitude: ~~N41.506434~~ N41.506660

Longitude: ~~W86.264631~~ W86.264230

SPECIES INFORMATION

Species Code	Abundance	QE	Vchr.	Ref. ID
MYSP2	3	0	0	
NYTY	3	0	0	
POCR3	1	0	0	
CEDE4	1	0	0	
LEMN	1	2	0	

Individual Plant Bed Survey



Comments:

REMINDER INFORMATION

Substrate:
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3 = Sand w/Silt
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6 = Sand

Marl
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High Organic
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S = Submersed

Canopy:
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3 = 21-60%
4 = > 60%

Abundance:
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4 = > 60%

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3 = Unknown

Voucher:
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2 = Taken, varifie

Reference ID:
Unique number or letter to denote specific location of a species; referenced on attached map

Aquatic Vegetation Plant Bed Data Sheet

Page 11 of 16

State of Indiana Department of Natural Resources

ORGANIZATION: A.C. DATE: 6-6-6

SITE INFORMATION

Plant Bed ID: 11
Bed Size: 20.1
Substrate: 2
Marl? 0
High Organic? 1

Waterbody Name: Riddles
Waterbody ID:
Total # of Species 1

CanopyAbundance at Site

S: 1 N: 1 F: 1 E: 4

SITE COORDINATES

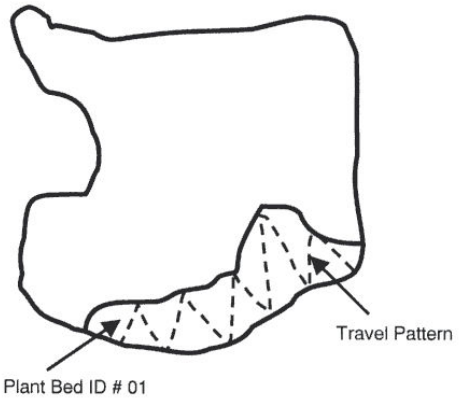
Center of the Bed
Latitude: N 41.506966
Longitude: W86.264688

Max. Lakeward Extent of Bed
Latitude: N41.506434
Longitude: W86.264631

SPECIES INFORMATION

Species Code	Abundance	QE	Vchr.	Ref. ID
TYLA	4	0	0	

Individual Plant Bed Survey



Comments:

REMINDER INFORMATION

Substrate:
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2 = Silt w/Sand
3 = Sand w/Silt
4 = Hard Clay
5 = Gravel/Rock
6 = Sand

Marl
1 = Present
0 = absent

High Organic
1 = Present
0 = absent

Overall Surface Cover
N = Nonrooted floating
F = Floating, rooted
E = Emergent
S = Submersed

Canopy:
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2 = 2-20%
3 = 21-60%
4 = > 60%

Abundance:
1 = < 2%
2 = 2-20%
3 = 21-60%
4 = > 60%

QE Code:
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1 = Species suspe
2 = Genus suspected
3 = Unknown

Voucher:
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1 = Taken, not varified
2 = Taken, varifie

Reference ID:
Unique number or letter to denote specific location of a species; referenced on attached map

AQUATIC CONTROL

Aquatic Vegetation Plant Bed Data Sheet

Page 12 of 16

State of Indiana Department of Natural Resources

ORGANIZATION: A. Control

DATE: 6-6-6

SITE INFORMATION

Plant Bed ID: 12
Bed Size: 1.6
Substrate: 02
Marl? 0
High Organic? 1

Waterbody Name: Riddles
Waterbody ID:
Total # of Species 6

CanopyAbundance at Site

S:	N:	F:	E:
3	1	1	1

SITE COORDINATES

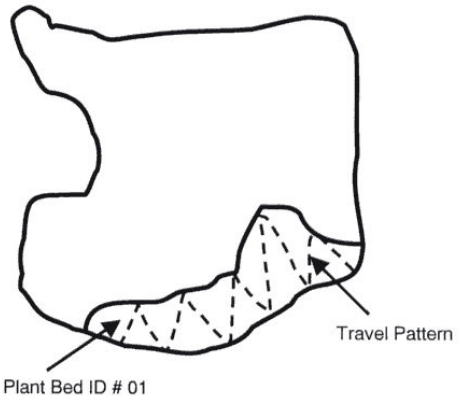
Center of the Bed
Latitude: N41.506623
Longitude: W86.267496

Max. Lakeward Extent of Bed
Latitude: N41.506258
Longitude: W86.266372

SPECIES INFORMATION

Species Code	Abundance	QE	Vchr.	Ref. ID
MYSP2	3	0	0	
POCR3	3	0	0	
CEDEMYSP2 VL	3	0	0	
POZO	1	1	2	WPT 70
LEMN	1	2	0	
WOCO	1	02	0	

Individual Plant Bed Survey



Comments:

Submersed community along emergent edge

REMINDER INFORMATION

Substrate:
1 = Silt/Clay
2 = Silt w/Sand
3 = Sand w/Silt
4 = Hard Clay
5 = Gravel/Rock
6 = Sand

Marl
1 = Present
0 = absent

High Organic
1 = Present
0 = absent

Overall Surface Cover
N = Nonrooted floating
F = Floating, rooted
E = Emergent
S = Submersed

Canopy:
1 = < 2%
2 = 2-20%
3 = 21-60%
4 = > 60%

Abundance:
1 = < 2%
2 = 2-20%
3 = 21-60%
4 = > 60%

QE Code:
0 = as defined
1 = Species suspe
2 = Genus suspected
3 = Unknown

Voucher:
0 = Not Taken
1 = Taken, not varified
2 = Taken, varifie

Reference ID:
Unique number or letter to denote specific location of a species; referenced on attached map

Aquatic Vegetation Plant Bed Data Sheet

Page 13 of 16

State of Indiana Department of Natural Resources

ORGANIZATION: A. Control

DATE: 6-6-6

SITE INFORMATION

Plant Bed ID: 13

Waterbody Name: Riddles

Bed Size: 0.7

Substrate: 02

Waterbody ID:

Marl? 0

Total # of Species 6

High Organic? 1

CanopyAbundance at Site

S: 2 N: 1 F: 1 E: 2

SITE COORDINATES

Center of the Bed

Latitude: N41.502664

Longitude: W86.261064

Max. Lakeward Extent of Bed

Latitude: N41.502760

Longitude: W86.260792

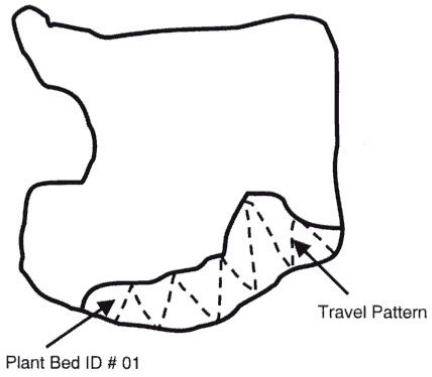
SPECIES INFORMATION

Species Code	Abundance	QE	Vchr.	Ref. ID
MYSP2	3	0	0	
POCR3	3	0	0	
CLEDG4	3	0	0	
POCO	2	0	0	
LEMN	1	2	0	
WOCO	1	02	0	

2. Weed

1. Marl

Individual Plant Bed Survey



Comments:

REMINDER INFORMATION

Substrate:
1 = Silt/Clay
2 = Silt w/Sand
3 = Sand w/Silt
4 = Hard Clay
5 = Gravel/Rock
6 = Sand

Marl
1 = Present
0 = absent

High Organic
1 = Present
0 = absent

Overall Surface Cover
N = Nonrooted floating
F = Floating, rooted
E = Emergent
S = Submersed

Canopy:
1 = < 2%
2 = 2-20%
3 = 21-60%
4 = > 60%

Abundance:
1 = < 2%
2 = 2-20%
3 = 21-60%
4 = > 60%

QE Code:
0 = as defined
1 = Species suspe
2 = Genus suspected
3 = Unknown

Voucher:
0 = Not Taken
1 = Taken, not varified
2 = Taken, varifie

Reference ID:
Unique number or letter to denote specific location of a species; referenced on attached map

Aquatic Vegetation Plant Bed Data Sheet

Page 14 of 16

State of Indiana Department of Natural Resources

ORGANIZATION: A.C. DATE: 6-6-6

SITE INFORMATION

Plant Bed ID: 14
Waterbody Name: Riddles
Bed Size: 3.7
Substrate: 02
Waterbody ID:
Marl? 0
Total # of Species 5
High Organic? 1

CanopyAbundance at Site

S: 4 N: 1 F: 1 E: 1

SITE COORDINATES

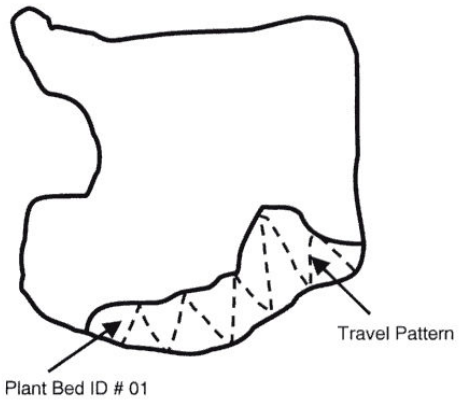
Center of the Bed
Latitude: N41.561836
Longitude: W86.257970

Max. Lakeward Extent of Bed
Latitude: N41.562020
Longitude: W86.258335

SPECIES INFORMATION

Species Code	Abundance	QE	Vchr.	Ref. ID
POCR3	4	0	0	
MYSP2	2	0	0	
CEDE4	1	0	0	
CHARA	1	2	0	
PO20	1	D	0	

Individual Plant Bed Survey



Comments:

Topped out CLP

REMINDER INFORMATION

Substrate:
1 = Silt/Clay
2 = Silt w/Sand
3 = Sand w/Silt
4 = Hard Clay
5 = Gravel/Rock
6 = Sand

Marl
1 = Present
0 = absent

High Organic
1 = Present
0 = absent

Overall Surface Cover
N = Nonrooted floating
F = Floating, rooted
E = Emergent
S = Submersed

Canopy:
1 = < 2%
2 = 2-20%
3 = 21-60%
4 = > 60%

Abundance:
1 = < 2%
2 = 2-20%
3 = 21-60%
4 = > 60%

QE Code:
0 = as defined
1 = Species suspe
2 = Genus suspected
3 = Unknown

Voucher:
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2 = Taken, varifie

Reference ID:
Unique number or letter to denote specific location of a species; referenced on attached map

AQUATIC CONTROL

Aquatic Vegetation Plant Bed Data Sheet

Page 15 of 16

State of Indiana Department of Natural Resources

ORGANIZATION: A. Control DATE: 6-6-6

SITE INFORMATION

Plant Bed ID: 15
Waterbody Name: Riddles
Bed Size: 3.7
Substrate: 02
Waterbody ID:
Marl? 0
Total # of Species 5
High Organic? 1

CanopyAbundance at Site

S: 3 N: 1 F: 1 E: 1

SITE COORDINATES

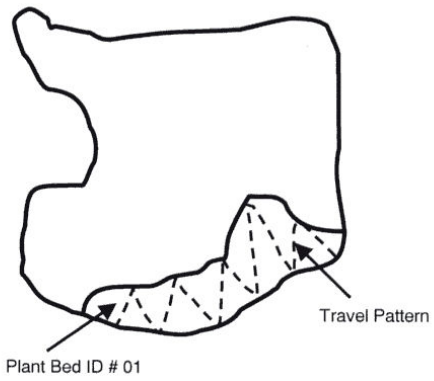
Center of the Bed
Latitude: N41.502020
Longitude: W86.258335

Max. Lakeward Extent of Bed
Latitude: N41.501838
Longitude: W86.257984

SPECIES INFORMATION

Species Code	Abundance	QE	Vchr.	Ref. ID
MYSP2	4	0	0	
CEDE4	2	0	0	
POCR3	2	0	0	
LE-MN	1	2	0	
N. Med LOCO	1	12"	0	

Individual Plant Bed Survey



Comments:

REMINDER INFORMATION

Substrate:
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2 = Silt w/Sand
3 = Sand w/Silt
4 = Hard Clay
5 = Gravel/Rock
6 = Sand

Marl
1 = Present
0 = absent

High Organic
1 = Present
0 = absent

Overall Surface Cover
N = Nonrooted floating
F = Floating, rooted
E = Emergent
S = Submersed

Canopy:
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Voucher:
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2 = Taken, varifie

Reference ID:
Unique number or letter to denote specific location of a species; referenced on attached map

Aquatic Vegetation Plant Bed Data Sheet

Page 16 of 16

State of Indiana Department of Natural Resources

ORGANIZATION: A. Control | DATE: 6-6-6

SITE INFORMATION

Plant Bed ID: 16
Bed Size: 1.8
Substrate: 2
Marl? 0
High Organic? 1
Waterbody Name: Riddles
Waterbody ID:
Total # of Species 5

CanopyAbundance at Site

S: 2 N: 1 F: 1 E: 1

SITE COORDINATES

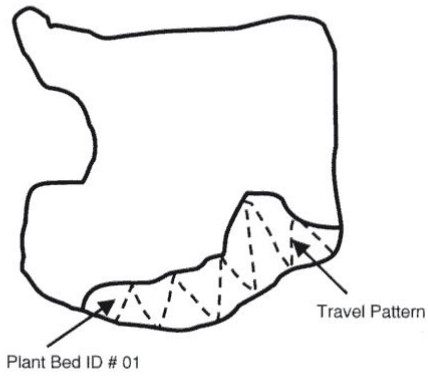
Center of the Bed
Latitude: N41.50603
Longitude: W86.25990

Max. Lakeward Extent of Bed
Latitude: N41.504236
Longitude: W86.258872

SPECIES INFORMATION

Species Code	Abundance	QE	Vchr.	Ref. ID
MYSP2	3	0	0	
CEDE4	3	0	0	
POCR3	3	0	0	
LEMN	1	2	0	
WOLO	1	02	0	

Individual Plant Bed Survey



Comments:

REMINDER INFORMATION

Substrate:
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3 = Sand w/Silt
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5 = Gravel/Rock
6 = Sand

Marl
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High Organic
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2 = Taken, varifie

Reference ID:
Unique number or letter to denote specific location of a species; referenced on attached map

Tier 1

Aquatic Vegetation Reconnaissance Sampling

Waterbody Cover Sheet

Surveying Organization: Aquatic Control

Waterbody Name: Riddle LK Lake ID:

County: St. Joseph Date: 8-17-06

Habitat Stratum: 1L Ave. Lake Depth (ft): 8.1 Lake Level: Norm

GPS Metadata

Crew Leader: Joey Leach Datum: NAD27 Zone: 16 Accuracy: 3M

Recorder: Kyle McCreary Method: D

Secchi Depth (ft): 2.0 Total # of Plant Beds Surveyed: 8 Total # of Species: 12

Littoral Zone Size (acres): 23.9
- [x] Measured
- [ ] Estimated

Littoral Zone Max. Depth (ft): 7.0
- [x] Measured
- [ ] Estimate (historical Secchi)
- [ ] Estimated (current Secchi)

Notable Conditions:

Aquatic Vegetation Plant Bed Data Sheet

Page 1 of 3

State of Indiana Department of Natural Resources

ORGANIZATION: AQUATIC CONTROL

DATE: 8/17/06

SITE INFORMATION

Plant Bed ID: 1

Waterbody Name: RIDDLES LAKE

Bed Size: 9.3

Substrate: 3

Waterbody ID:

Marl? 0

Total # of Species 6

High Organic? 1

CanopyAbundance at Site

S: 1 N: 3 F: 4 E: 1

SITE COORDINATES

Center of the Bed

Latitude: —

Longitude: —

Max. Lakeward Extent of Bed

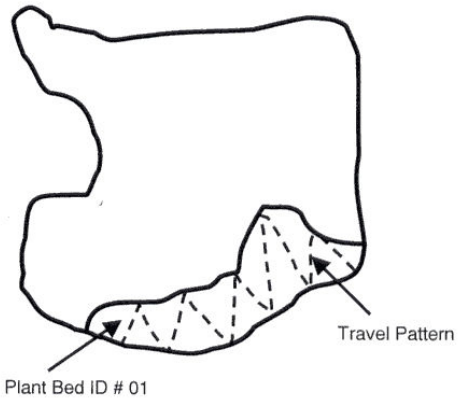
Latitude: N41 50 711

Longitude: W86.26 132

SPECIES INFORMATION

Species Code	Abundance	QE	Vchr.	Ref. ID
NYTU	4	0	0	
NULU	2	0	0	
Pickerelweed POCO	2	0	0	
LEMN	2	0	0	
WOLF	3	0	0	
Bur-reed SPPO	1	0	0	
DEVE	1	0	0	

Individual Plant Bed Survey



Comments:

REMINDER INFORMATION

Substrate:
1 = Silt/Clay
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4 = Hard Clay
5 = Gravel/Rock
6 = Sand

Marl
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2 = Taken, varifie

Reference ID:
Unique number or letter to denote specific location of a species; referenced on attached map

Aquatic Vegetation Plant Bed Data Sheet

Page 2 of 8

State of Indiana Department of Natural Resources

ORGANIZATION: Aquatic Control

DATE: 8/17/06

SITE INFORMATION

Plant Bed ID: 2

Waterbody Name: Riddles Lake

Bed Size: 5.1

Substrate: 3

Waterbody ID:

Marl? 0

Total # of Species 2

High Organic? 1

CanopyAbundance at Site

S: 4 N: 3 F: 1 E: 1

SITE COORDINATES

Center of the Bed

Latitude:

Longitude:

Max. Lakeward Extent of Bed

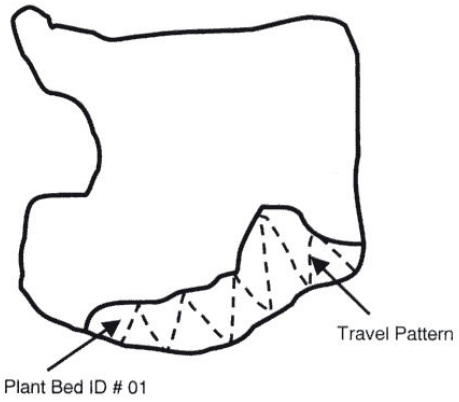
Latitude: N 41.50407

Longitude: W 86.25898

SPECIES INFORMATION

Species Code	Abundance	QE	Vchr.	Ref. ID
MYSP2	1	U	0	
CEDE4	3	U	0	

Individual Plant Bed Survey



Comments:

REMINDER INFORMATION

Substrate:
1 = Silt/Clay
2 = Silt w/Sand
3 = Sand w/Silt
4 = Hard Clay
5 = Gravel/Rock
6 = Sand

Marl
1 = Present
0 = absent

High Organic
1 = Present
0 = absent

Overall Surface Cover
N = Nonrooted floating
F = Floating, rooted
E = Emergent
S = Submersed

Canopy:
1 = < 2%
2 = 2-20%
3 = 21-60%
4 = > 60%

Abundance:
1 = < 2%
2 = 2-20%
3 = 21-60%
4 = > 60%

QE Code:
0 = as defined
1 = Species suspe
2 = Genus suspected
3 = Unknown

Voucher:
0 = Not Taken
1 = Taken, not varified
2 = Taken, varifie

Reference ID:
Unique number or letter to denote specific location of a species; referenced on attached map

Aquatic Vegetation Plant Bed Data Sheet

Page 3 of 5

State of Indiana Department of Natural Resources

ORGANIZATION: Aquatic Control DATE: 8/17/06

SITE INFORMATION

Plant Bed ID: 3
Waterbody Name: Riddles Lake
Bed Size: 5.3
Substrate: 3 2
Waterbody ID:
Marl? 0
Total # of Species 5
High Organic? 1

CanopyAbundance at Site

S: 4 N: 3 F: 1 E: 1

SITE COORDINATES

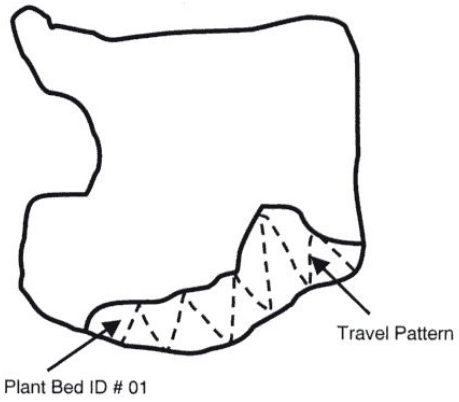
Center of the Bed
Latitude: N41.50174
Longitude: W86.25808

Max. Lakeward Extent of Bed
Latitude: N41.50282
Longitude: W86.25808

SPECIES INFORMATION

Species Code	Abundance	QE	Vchr.	Ref. ID
MYSP2	4	0	0	
CEDE4	3	0	0	
LEMN	2	0	0	
WOLF	4	0	0	
Spirodela SPP0	1	0	0	

Individual Plant Bed Survey



Comments:

REMINDER INFORMATION

Substrate:
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2 = Silt w/Sand
3 = Sand w/Silt
4 = Hard Clay
5 = Gravel/Rock
6 = Sand

Marl
1 = Present
0 = absent

High Organic
1 = Present
0 = absent

Overall Surface Cover
N = Nonrooted floating
F = Floating, rooted
E = Emergent
S = Submersed

Canopy:
1 = < 2%
2 = 2-20%
3 = 21-60%
4 = > 60%

Abundance:
1 = < 2%
2 = 2-20%
3 = 21-60%
4 = > 60%

QE Code:
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1 = Species suspe
2 = Genus suspected
3 = Unknown

Voucher:
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2 = Taken, varifie

Reference ID:
Unique number or letter to denote specific location of a species; referenced on attached map

Aquatic Vegetation Plant Bed Data Sheet

Page 4 of 9

State of Indiana Department of Natural Resources

ORGANIZATION:

DATE: 8-17-06

SITE INFORMATION

Plant Bed ID: 4

Waterbody Name: Riddles Lake

Bed Size: 0.9

Substrate: 3

Waterbody ID:

Marl? 0

Total # of Species 2

High Organic? 1

CanopyAbundance at Site

S: 1 N: 1 F: 1 E: 4

SITE COORDINATES

Center of the Bed

Latitude:

Longitude:

Max. Lakeward Extent of Bed

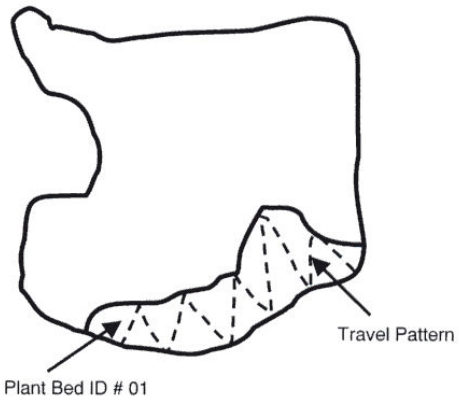
Latitude:

Longitude:

SPECIES INFORMATION

Species Code	Abundance	QE	Vchr.	Ref. ID
TYLA	4	0	0	
NULU	2	0	0	

Individual Plant Bed Survey



Comments:

REMINDER INFORMATION

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2 = Silt w/Sand
3 = Sand w/Silt
4 = Hard Clay
5 = Gravel/Rock
6 = Sand

Marl
1 = Present
0 = absent

High Organic
1 = Present
0 = absent

Overall Surface Cover
N = Nonrooted floating
F = Floating, rooted
E = Emergent
S = Submersed

Canopy:
1 = < 2%
2 = 2-20%
3 = 21-60%
4 = > 60%

Abundance:
1 = < 2%
2 = 2-20%
3 = 21-60%
4 = > 60%

QE Code:
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1 = Species suspe
2 = Genus suspected
3 = Unknown

Voucher:
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2 = Taken, varifie

Reference ID:
Unique number or letter to denote specific location of a species; referenced on attached map

AQUATIC CONTROL

Aquatic Vegetation Plant Bed Data Sheet

Page 5 of 9

State of Indiana Department of Natural Resources

ORGANIZATION: Aquatic Control | DATE: 8/17/06

SITE INFORMATION

Plant Bed ID: 5
Waterbody Name: Riddles Lake
Bed Size: 0.1
Substrate: 3
Waterbody ID:
Marl? 0
Total # of Species 2
High Organic? 1

CanopyAbundance at Site

S: 1 | N: 1 | F: 1 | E: 4

SITE COORDINATES

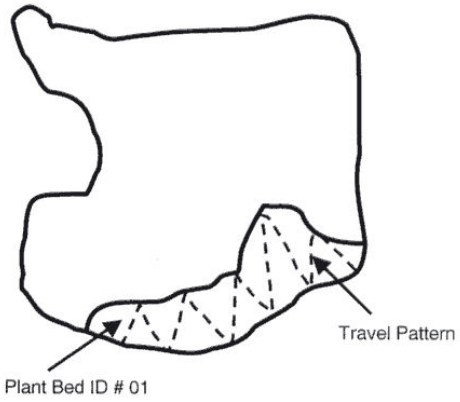
Center of the Bed
Latitude: N41.50549
Longitude: W86.26392

Max. Lakeward Extent of Bed
Latitude: N41.50959
Longitude: W86.26401

SPECIES INFORMATION

Species Code	Abundance	QE	Vchr.	Ref. ID
Pickerelweed POCO	4	0	0	
NYTU	3	0	0	

Individual Plant Bed Survey



Comments:

REMINDER INFORMATION

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2 = Silt w/Sand
3 = Sand w/Silt
4 = Hard Clay
5 = Gravel/Rock
6 = Sand

Marl
1 = Present
0 = absent

High Organic
1 = Present
0 = absent

Overall Surface Cover
N = Nonrooted floating
F = Floating, rooted
E = Emergent
S = Submersed

Canopy:
1 = < 2%
2 = 2-20%
3 = 21-60%
4 = > 60%

Abundance:
1 = < 2%
2 = 2-20%
3 = 21-60%
4 = > 60%

QE Code:
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1 = Species suspe
2 = Genus suspected
3 = Unknown

Voucher:
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2 = Taken, varifie

Reference ID:
Unique number or letter to denote specific location of a species; referenced on attached map

Aquatic Vegetation Plant Bed Data Sheet

Page 6 of 8

State of Indiana Department of Natural Resources

ORGANIZATION: Aquatic Control | DATE: 8/17/06

SITE INFORMATION

Plant Bed ID: 6
Waterbody Name: Riddles Lake
Bed Size: 1.2
Substrate: 3
Waterbody ID:
Marl? 0
Total # of Species 2
High Organic? 1

CanopyAbundance at Site

S: 1 | N: 1 | F: 1 | E: 4

SITE COORDINATES

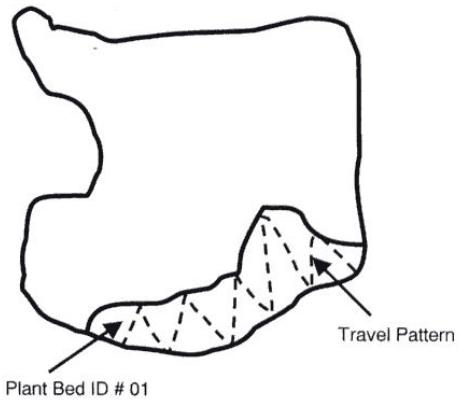
Center of the Bed
Latitude: —
Longitude: —

Max. Lakeward Extent of Bed
Latitude: —
Longitude: —

SPECIES INFORMATION

Species Code	Abundance	QE	Vchr.	Ref. ID
CABBAGE TYLA	2	0	0	
PURPLE LOOSESTRIFE LYSA	4	0	0	

Individual Plant Bed Survey



Comments:

REMINDER INFORMATION

Substrate:
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2 = Silt w/Sand
3 = Sand w/Silt
4 = Hard Clay
5 = Gravel/Rock
6 = Sand

Marl
1 = Present
0 = absent

High Organic
1 = Present
0 = absent

Overall Surface Cover
N = Nonrooted floating
F = Floating, rooted
E = Emergent
S = Submersed

Canopy:
1 = < 2%
2 = 2-20%
3 = 21-60%
4 = > 60%

Abundance:
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2 = 2-20%
3 = 21-60%
4 = > 60%

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1 = Species suspe
2 = Genus suspected
3 = Unknown

Voucher:
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2 = Taken, varifie

Reference ID:
Unique number or letter to denote specific location of a species; referenced on attached map

Aquatic Vegetation Plant Bed Data Sheet

Page 7 of 8

State of Indiana Department of Natural Resources

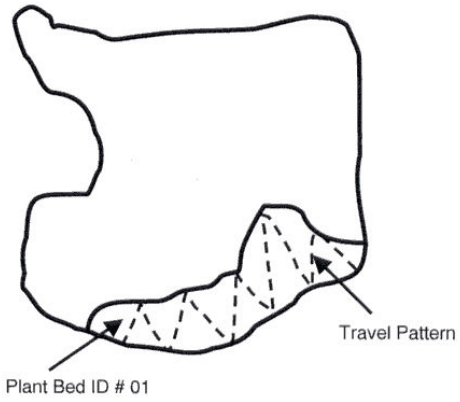
ORGANIZATION: Aquatic Control | DATE: 8/17/06

SITE INFORMATION		SITE COORDINATES
Plant Bed ID: 7	Waterbody Name: Riddles lake	Center of the Bed
Bed Size: 0.2		Latitude: N41.50623
Substrate: 6	Waterbody ID:	Longitude: W86.26004
Marl? 0	Total # of Species 3	Max. Lakeward Extent of Bed
High Organic? 0	CanopyAbundance at Site	Latitude: N41.50599
	S: 2 N: 2 F: 1 E: 1	Longitude: W86.25995

SPECIES INFORMATION

Species Code	Abundance	QE	Vchr.	Ref. ID
NAGU	3	0	0	
CEDI4	1	0	0	
MYSP2	1	0	0	

Individual Plant Bed Survey



Comments:

REMINDER INFORMATION

Substrate:
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2 = Silt w/Sand
3 = Sand w/Silt
4 = Hard Clay
5 = Gravel/Rock
6 = Sand

Marl
1 = Present
0 = absent

High Organic
1 = Present
0 = absent

Overall Surface Cover
N = Nonrooted floating
F = Floating, rooted
E = Emergent
S = Submersed

Canopy:
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2 = 2-20%
3 = 21-60%
4 = > 60%

Abundance:
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1 = Species suspe
2 = Genus suspected
3 = Unknown

Voucher:
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2 = Taken, varifie

Reference ID:
Unique number or letter to denote specific location of a species; referenced on attached map

Aquatic Vegetation Plant Bed Data Sheet

Page B of B

State of Indiana Department of Natural Resources

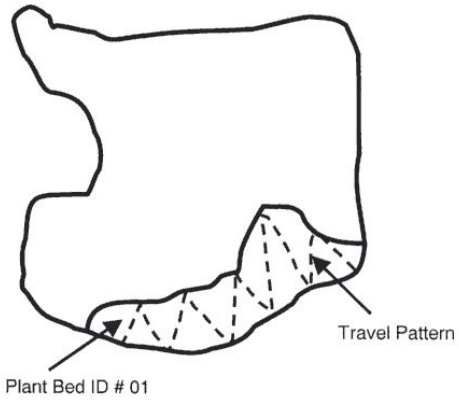
ORGANIZATION: Aquatic Control DATE: 8/17/06

SITE INFORMATION		SITE COORDINATES
Plant Bed ID: B	Waterbody Name: Riddles Lake	Center of the Bed
Bed Size: 1.2		Latitude: N41. 50689
Substrate: 6	Waterbody ID:	Longitude: W 86.26455
Marl? 0	Total # of Species 6	Max. Lakeward Extent of Bed
High Organic? 1	CanopyAbundance at Site	Latitude: N41.50673
	S: 4 N: 4 F: 3 E: 1	Longitude: W86.26424

SPECIES INFORMATION

Species Code	Abundance	QE	Vchr.	Ref. ID
NYTU	3	0	0	
CEDE JL	4	0	0	
MYSE	4	0	0	
NOLF	4	0	0	
LEMN	3	0	0	
SPPO	1	0	0	

Individual Plant Bed Survey



Comments:

REMINDER INFORMATION

Substrate:
1 = Silt/Clay
2 = Silt w/Sand
3 = Sand w/Silt
4 = Hard Clay
5 = Gravel/Rock
6 = Sand

Marl
1 = Present
0 = absent

High Organic
1 = Present
0 = absent

Overall Surface Cover
N = Nonrooted floating
F = Floating, rooted
E = Emergent
S = Submersed

Canopy:
1 = < 2%
2 = 2-20%
3 = 21-60%
4 = > 60%

Abundance:
1 = < 2%
2 = 2-20%
3 = 21-60%
4 = > 60%

QE Code:
0 = as defined
1 = Species suspe
2 = Genus suspected
3 = Unknown

Voucher:
0 = Not Taken
1 = Taken, not varified
2 = Taken, varifie

Reference ID:
Unique number or letter to denote specific location of a species; referenced on attached map

Aquatic Vegetation Random Sampling

Waterbody Cover Sheet

Organization Name: Aquatic Control

Waterbody Name: Riddles LK Lake ID:

County: St. Joseph Date: 8-17-06

Habitat Stratum: IL Ave. Lake Depth (ft): 8.1 Lake Level: Normal

GPS Metadata

Crew Leader: Joey Leach Datum: NAD27 Zone: 16 Accuracy: 3M

Recorder: K. McCreary Method: D

Secchi Depth (ft): 2.0 Total # of Sites Surveyed: 40 Total # of Species: 9

Littoral Zone Size (acres): 23.3
- ☒ Measured
- ☐ Estimated

Littoral Zone Max. Depth (ft): 7.0
- ☒ Measured
- ☐ Estimate (historical Secchi)
- ☐ Estimated (current Secchi)

Notable Conditions:

APPENDIX A

Submersed Aquatic Plant Survey Form

Page 1 of 2

WATER BODY NAME	Riddles Lake				SECCHI	2 ft									
COUNTY	St. Joseph				MAX PLANT DEPTH	7 ft									
DATE	8/17/06				WEATHER	Sunny	85°								
CREW LEADER	J. Leach				COMMENTS										
RECORDER	K McCrary														
					Rake score (1-5), observed only (9), algae present (p)										
					Use acronyms for species, V1, V2...for voucher codes										Note
					Coon			Duck Species Code WM GDW Star							
Site	Northing	Easting	Depth	All	CFDE4	MYSP2	NAGU	LEMN	WD?LF	SPPD	LETR	NAGU			
311			4	5	5										
312			14	NP											
313			7	NP											
314			5	3	3	1		1	1	1					
315			6	NP											
316			11	NP											
317			5	3	3										
318			7	1	1										
319			8	NP											
320			10	NP											
321			12	NP											
322			5	1		1									
323			5	1	1										
324			7	1	1										
325			11	NP											
326			6	NP											
327			11	NP											
328			2	NP											
329			5	1	1										
330			3	5	3	3									
331			3	5	5	5		1	1	1					
332			4	5	5	3					1				
333			6	NP											
334			5	NP											
335			8	NP											
336			13	NP											
337			11	NP											
338			4	5	5	1									
339			10	NP											
340			11	NP											
341			8	NP											
342			1	1	1	Yes	1								
Other plant species observed at lake															

POCO DEVE
TYLA PEVI
LYSA
NYLU
NYTU

APPENDIX A

Submersed Aquatic Plant Survey Form

Page 2 of 2

WATER BODY NAME	Riddles				SECCHI	2ft								
COUNTY	St. Joseph				MAX PLANT DEPTH	7ft								
DATE	8/17/06				WEATHER	Sunny	75°							
CREW LEADER	L. Leach				COMMENTS									
RECORDER	K. McCrary													
					Rake score (1-5), observed only (9), algae present (p)									
					Use acronyms for species, V1, V2...for voucher codes									Note
					Coon			Duck Species Code: Wine		SPW	star			
Site	Northing	Easting	Depth	All	CEDE4	MYSP2	NAS0	LEMN	WOLF	SPPO	LETR	UTM1	POFO3	
343			11	NP										
344			6	NP										
345			2	5	5								3	
346			4	1	1									
347			9	NP										
348			4	1	1	1								
349			11	NP										
350			5	1	1			1	1	1	1	1		
Other plant species observed at lake														

Plant Database

Lake	Date	Latitude	Longitude	Design	Site	Depth	RAKE	MYSP2	CEDE4	WO?LF	SPPO	LETR	NAGU	POFO3	UTMA	LEMN
Riddles Lake	8/17/06	41.50809	-86.266953		311	4.0	5		5							
Riddles Lake	8/17/06	41.50765	-86.267468		312	14.0	0									
Riddles Lake	8/17/06	41.50758	-86.267996		313	7.0	0									
Riddles Lake	8/17/06	41.50704	-86.267902		314	5.0	3	1	3	1	1					1
Riddles Lake	8/17/06	41.50672	-86.267464		315	6.0	0									
Riddles Lake	8/17/06	41.50663	-86.26675		316	11.0	0									
Riddles Lake	8/17/06	41.50614	-86.26635		317	5.0	3		3							
Riddles Lake	8/17/06	41.50603	-86.265642		318	7.0	1		1							
Riddles Lake	8/17/06	41.50598	-86.264929		319	8.0	0									
Riddles Lake	8/17/06	41.50603	-86.264234		320	10.0	0									
Riddles Lake	8/17/06	41.5056	-86.263259		321	12.0	0									
Riddles Lake	8/17/06	41.50475	-86.263032		322	5.0	1	1								
Riddles Lake	8/17/06	41.50429	-86.262608		323	5.0	1		1							
Riddles Lake	8/17/06	41.50391	-86.261851		324	7.0	1		1							
Riddles Lake	8/17/06	41.50384	-86.261428		325	11.0	0									
Riddles Lake	8/17/06	41.50348	-86.261517		326	6.0	0									
Riddles Lake	8/17/06	41.50323	-86.260872		327	11.0	0									
Riddles Lake	8/17/06	41.50244	-86.260487		328	2.0	0									
Riddles Lake	8/17/06	41.5019	-86.259989		329	5.0	1		1							
Riddles Lake	8/17/06	41.50138	-86.258987		330	3.0	5	3	3							
Riddles Lake	8/17/06	41.50147	-86.258218		331	3.0	5	5	5	1	1					1
Riddles Lake	8/17/06	41.50208	-86.25802		332	4.0	5	3	5			1				
Riddles Lake	8/17/06	41.50272	-86.258236		333	6.0	0									
Riddles Lake	8/17/06	41.50327	-86.258341		334	5.0	0									
Riddles Lake	8/17/06	41.50328	-86.259169		335	8.0	0									
Riddles Lake	8/17/06	41.50367	-86.259808		336	13.0	0									
Riddles Lake	8/17/06	41.50437	-86.25937		337	11.0	0									
Riddles Lake	8/17/06	41.50461	-86.258599		338	4.0	5	1	5							
Riddles Lake	8/17/06	41.50491	-86.259088		339	10.0	0									
Riddles Lake	8/17/06	41.5052	-86.259557		340	11.0	0									
Riddles Lake	8/17/06	41.50593	-86.259947		341	8.0	0									
Riddles Lake	8/17/06	41.50641	-86.26022		342	1.0	1		1				1			
Riddles Lake	8/17/06	41.50626	-86.262297		343	11.0	0									
Riddles Lake	8/17/06	41.50692	-86.262052		344	6.0	0									
Riddles Lake	8/17/06	41.50766	-86.262154		345	2.0	5		5					3		
Riddles Lake	8/17/06	41.50805	-86.261526		346	4.0	1		1							
Riddles Lake	8/17/06	41.50663	-86.263613		347	9.0	0									
Riddles Lake	8/17/06	41.50659	-86.264294		348	4.0	1	1	1							
Riddles Lake	8/17/06	41.50667	-86.265415		349	11.0	0									
Riddles Lake	8/17/06	41.50763	-86.265987		350	5.0	1		1	1	1	1			1	1

16.2 Species List.

Macrophyte List for Pleasant Lake.

Common Name	Scientific Name	2006 Tier I	2006 Tier II
Arrow arum	*Peltandra virginica*	X	
Blue-flag Iris	*Iris versicolor*	X	
Button bush	*Cephalanthus occidentalis*	X	
Common arrowhead	*Sagittaria latifolia*	X	
Common cattail	*Typhia latifolia*	X	
Common coontail	*Ceratophyllum demersum*	X	X
Curlyleaf pondweed	*Potamogeton crispus*	X	
Duckweed	*Lemna minor*	X	X
Eurasian watermilfoil	*Myriophyllum spicatum*	X	X
Giant duckweed	*Spirodela polyrhiza*		X
Leafy pondweed	*Potamogeton foliosus*	X	
Pickerel weed	*Pontedaria cordata*	X	
Purple loosestrife	*Lythrum salicaria*	X	
Slender naiad	*Najas flexilis*		X
Smartweed	*Polygonum spp.*	X	
Spatterdock	*Nuphar advena*	X	
Star duckweed	*Lemna trisulca*	X	
Swamp loosestrife	*Decodon verticillatus*	X	
Watermeal	*Wolffia columbiana*	X	X
White water lily	*Nymphaea odorata*	X	

Macrophyte List for Riddles Lake.

Common Name	Scientific Name	2006 Tier I	2006 Tier II
Arrow arum	*Peltandra virginica*	X	
Blue-flag Iris	*Iris versicolor*	X	
Chara	*Chara spp.*	X	
Common bladderwort	*Utricularia vulgaris*		X
Common cattail	*Typhia latifolia*	X	
Common coontail	*Ceratophyllum demersum*	X	X
Curlyleaf pondweed	*Potamogeton crispus*	X	
Duckweed	*Lemna minor*	X	X
Eurasian watermilfoil	*Myriophyllum spicatum*	X	X
Flatstem pondweed	*Potamogeton zosteriformis*	X	
Giant duckweed	*Spirodela polyrhiza*		X
Leafy pondweed	*Potamogeton foliosus*	X	X
Pickerel weed	*Pontedaria cordata*	X	
Purple loosestrife	*Lythrum salicaria*	X	
Softstem bulrush	*Scirpus validus*	X	
Southern naiad	*Najas guadalupensis*	X	X
Smartweed	*Polygonum spp.*	X	
Spatterdock	*Nuphar advena*	X	
Star duckweed	*Lemna trisulca*	X	X
Swamp loosestrife	*Decodon verticillatus*	X	
Watermeal	*Wolffia columbiana*	X	X
White water lily	*Nymphaea odorata*	X	

Common submersed species from Pleasant and Riddles lakes

Common coontail (*Ceratophylum demersum*) is a commonly occurring aquatic plant in the Midwest in neutral to alkaline waters[1]. It is a submersed dicot with coarsely toothed leaves whorled about the stem[2]. This plant is given its name due to its resemblance to the tail of a raccoon. Coontail has been found to be an important food source for wildfowl as well as a good shelter for small animals[2]. This plant is also a good shelter for young fish, and support of insects[2], but has been known to crowd out other species of aquatic plants[3].

Curlyleaf pondweed (*Potamogeton crispus*) is a submersed monocot with slightly clasping, rounded tip leaves. The flowers occur on dense cylindrical spikes and produces distinctive beaked fruit[1]. Curly leaf is eaten by ducks, but may become a weed[2]. This plant provides good food, shelter, and shade for fish and is important for early spawning fish like carp and goldfish[2].

Eurasian watermilfoil (*Myriophyllum spicatum*) is an exotic aquatic plant that has been known to crowd out native species of plants. This species spreads quickly because it can grow from very small plant fragments and survive in low light and nutrient conditions[3]. This dicot has stems that typically grow to the water surface and branch out forming a canopy that shades other species of aquatic plants. Eurasian water-milfoil has characteristic red to pink flowering spikes that protrude from the water surface one to two inches high[1]. The segmented leaves grow in whorls of three to four around the stem[1]. It can grow from very small plant fragments and survive in low light and nutrient conditions. This dicot has stems that typically grow to the water surface and branch out forming a canopy that shades other species of aquatic plants.

[1] Chadde, S. 1998. Great lakes wetland flora. Pocketflora Press, Calumet, Michigan.

[2] Fassett, N. 1957. A manual of aquatic plants, 2nd edition. The University of Wisconsin Press, Madison, Wisconsin.

[3]Applied Biocehmists, 1998. Water weeds and algae, 5th edition. Applied Biochemists, J. C. Schmidt and J. R. Kannenberg, editors. Milwaukee, Wisconsin. (all plant illustrations supplied by Applied Biochemist)

16.3 IDNR VEGETATION PERMIT
2007 Pleasant Lake Permit Application

APPLICATION FOR AQUATIC VEGETATION CONTROL PERMIT
State Form 26727 (R / 11-03)
Approved State Board of Accounts 1987
☐ 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

Return to: Page 1 of 3
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	Lake Assoc. Name	
Lakeville Business Owner's Association	Lakeville Business Owner's Association	
Rural Route or Street: PO Box 468		Phone Number: 574-784-8989
City and State: Lakeville, IN		ZIP Code: 46536
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)	Nearest Town	County
Pleasant Lake	Lakeville	St. Joseph
Does water flow into a water supply	☐ Yes	☒ 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	Treatment of EWM and CLP throughout lake (areas determined following survey, no more than 7 acres)	
Total acres to be controlled <7.0	Proposed shoreline treatment length (ft)	Perpendicular distance from shoreline (ft)	
Maximum Depth of Treatment (ft) 7	Expected date(s) of treatment(s) mid April to early May		

Treatment method: ☒ 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. Combination of Renovate and Aquathol for selective control of Curlyleaf pw and Eurasian WM (see 2006 avmp)

Plant survey method: ☒ Rake ☒ Visual ☐ Other (specify) Overall results from May, 2006 Tier I survey

Aquatic Plant Name	Check if Target Species	Relative Abundance % of Community
Common coontail		40
Eurasian Watermilfoil	X	30
Curlyleaf Pondweed	X	10
white water lily		5
spatterdock		5
duckweed		5
watermeal		5

AQUATIC CONTROL

Page 2 of 3

Treatment Area #	LAT/LONG or UTM's	
Total acres to be controlled	Proposed shoreline treatment length (ft)	Perpendicular distance from shoreline (ft)
Maximum Depth of Treatment (ft)	Expected date(s) of treatment(s)	

Treatment method: ☐ 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.

Plant survey method: ☐ Rake ☐ Visual ☐ Other (specify)

Aquatic Plant Name	Check if Target Species	Relative Abundance % of Community

INSTRUCTIONS: Whoever treats the lake fills in "Applicant's Signature" unless they are a professional. If they are a professional company who specializes in lake treatment, they should sign on the "Certified Applicant" line.

Applicant Signature	Date
Certified Applicant's Signature	Date

FOR OFFICE ONLY

☐ Approved ☐ Disapproved	Fisheries Staff Specialist
☐ Approved ☐ Disapproved	Environmental Staff Specialist

Mail check or money order in the amount of $5.00 to:

DEPARTMENT OF NATURAL RESOURCES
DIVISION OF FISH AND WILDLIFE
COMMERCIAL LICENSE CLERK
402 WEST WASHINGTON STREET ROOM W273
INDIANAPOLIS, IN 46204

AQUATIC CONTROL

Page 3 of 3 (permit map)

2007 Riddles Lake Permit Application

APPLICATION FOR AQUATIC VEGETATION CONTROL PERMIT
State Form 26727 (R / 11-03)
Approved State Board of Accounts 1987
[ ] Whole Lake [X] Multiple Treatment Areas
Check type of permit

INSTRUCTIONS: Please print or type information

FOR OFFICE USE ONLY
License No.
Date Issued
Lake County

Return to: Page 1 of 3
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	Lake Assoc. Name	
Lakeville Business Owner's Association	Lakeville Business Owner's Association	
Rural Route or Street: PO Box 468		Phone Number: 574-784-8989
City and State: Lakeville, IN		ZIP Code: 46536
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)	Nearest Town	County
Riddles Lake	Lakeville	St. Joseph
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	Treatment of EWM and CLP throughout lake (areas determined following survey, no more than 20 acres)	
Total acres to be controlled <20 acres	Proposed shoreline treatment length (ft)	Perpendicular distance from shoreline (ft)	
Maximum Depth of Treatment (ft) 7	Expected date(s) of treatment(s) mid April to early May		

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. Combination of Renovate and Aquathol for selective control of Curlyleaf pw and Eurasian WM (see 2006 avmp)

Plant survey method: [X] Rake [X] Visual [ ] Other (specify) Overall results from May, 2006 Tier I survey

Aquatic Plant Name	Check if Target Species	Relative Abundance % of Community
Common coontail		30
Eurasian Watermilfoil		30
Curlyleaf Pondweed	X	30
Flatstem Pondweed		1
Duckweed		1
Watermeal	X	1
spatterdock		5
white water lily		2

Page 2 of 3

Treatment Area #	LAT/LONG or UTM's	
Total acres to be controlled	Proposed shoreline treatment length (ft)	Perpendicular distance from shoreline (ft)
Maximum Depth of Treatment (ft)	Expected date(s) of treatment(s)	

Treatment method: ☐ 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.

Plant survey method: ☐ Rake ☐ Visual ☐ Other (specify)

Aquatic Plant Name	Check if Target Species	Relative Abundance % of Community

INSTRUCTIONS: Whoever treats the lake fills in "Applicant's Signature" unless they are a professional. If they are a professional company who specializes in lake treatment, they should sign on the "Certified Applicant" line.

Applicant Signature	Date
Certified Applicant's Signature	Date

FOR OFFICE ONLY

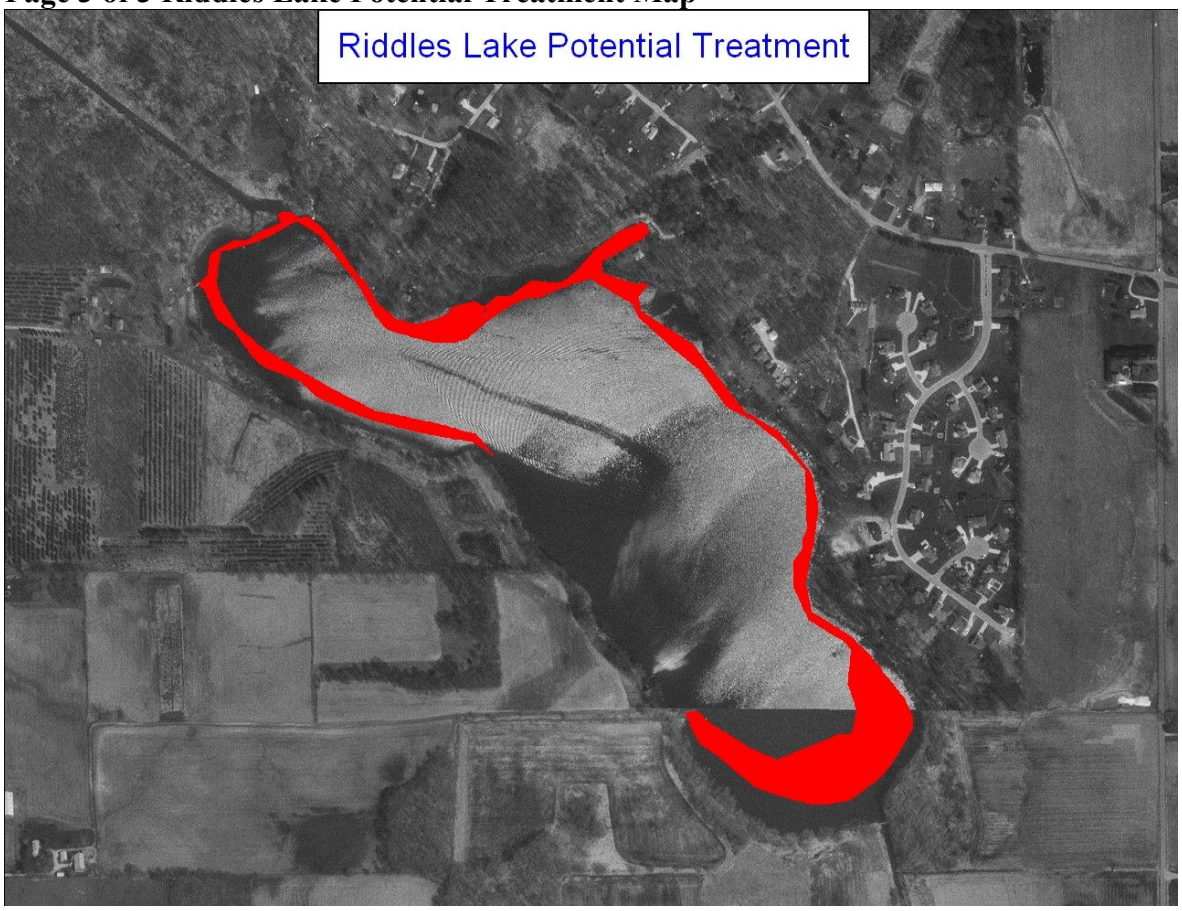
☐ Approved ☐ Disapproved	Fisheries Staff Specialist
☐ Approved ☐ Disapproved	Environmental Staff Specialist

Mail check or money order in the amount of $5.00 to:

DEPARTMENT OF NATURAL RESOURCES
DIVISION OF FISH AND WILDLIFE
COMMERCIAL LICENSE CLERK
402 WEST WASHINGTON STREET ROOM W273
INDIANAPOLIS, IN 46204

AQUATIC CONTROL

Page 3 of 3 Riddles Lake Potential Treatment Map



16.4 PUBLIC INPUT QUESTIONARE

Lake Use Survey Lake name_____

Are you a lake property owner? Yes_____ No_____

Are you currently a member of your lake association? Yes ___ No___

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

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

___Swimming ___Irrigation
___Boating ___Drinking water
___Fishing ___Other _____

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

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

Does aquatic vegetation interfere with your use or enjoyment of the lake? Yes ___ No___
Does the level of vegetation in the lake affect your property values? Yes ___ No ___

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

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 ___ 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
___ Fish population problem
___ Dredging needed
___ Overuse by nonresidents
___ Too many aquatic plants
___ Not enough aquatic plants
___ Poor water quality
___ Pier/funneling problem

Please add any comments:

_____

_____

16.5 RESOURCES FOR AQUATIC VEGETATION MANAGEMENT

Books
Aquatic Plant Management in Lakes and Reservoirs
Aquatic Plants of Illinois
A Manual of Aquatic Plants
Managing Lakes and Reservoirs
Interactions Between Fish and Aquatic Macrophytes in Inland Waters
Lake and Reservoir Restoration

Societies/Wesites
Aquatic Plant Management Society-apms.org
Midwest Aquatic Plant Management Society-mapms.org
North American Lake Management Society-nalms.org
Inidiana Lake Management Society-indianalakes.org