Waveland Lake
Aquatic Vegetation Management Plan
2009 Update
Montgomery & Parke County, Indiana

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Executive Summary

Aquatic Control was contracted by the Waveland Lake Department of Parks and Recreation (WLDPR) to complete aquatic vegetation sampling in order to update their aquatic vegetation management plan which was originally completed in 2005. Funding for the update of this plan was obtained from the Waveland Lake Department of Parks and Recreation and the Indiana Department of Natural Resources-Division of Fish and Wildlife as part of the Lake and River Enhancement program (LARE). The update will serve as a tool to track changes in the vegetation community, to adjust the action plan as needed, and to maintain eligibility for additional LARE funds.

Waveland Lake is a 383 acre lake with a littoral zone of approximately 178 acres. Aquatic vegetation is an important component of Waveland Lake; however, as a result of many factors this vegetation can develop to a nuisance level. Nuisance aquatic vegetation, as used in this paper, is described as plant growth that negatively impacts the present uses of the lake including fishing, boating, swimming, aesthetic, and lakefront property values. Historically, the primary nuisance species within Waveland Lake was the native plant common coontail (*Ceratophyllum demersum*). Eurasian watermilfoil (*Myriophyllum spicatum*), hereafter called milfoil and curlyleaf pondweed (*Potamogeton crispus*) are invasive species that have been found in Waveland Lake at nuisance levels.

In 2007, the LARE program granted the WLDPR $18,000.00 for milfoil control and $4,500.00 for plan updates and plant survey work. The 2007 spring survey revealed that 51.6 acres of milfoil existed at nuisance levels within Waveland Lake. Aquatic Control Inc. was contracted by the WLDPR to treat 50 acres of milfoil with 2,4-D granular herbicide (Navigate). The summer Tier 2 survey showed that milfoil percent occurrence decreased from 40% in 2006 to 10% in 2007. The 2007 plan update recommended that two surveys should occur in 2008 to document changes in the aquatic vegetation community and to measure the success of management actions taken. The update also recommended that milfoil should be treated wherever it was found with 2,4-D herbicide.

LARE funding was not applied for in 2008, so no invasive species treatments or plan updates were completed. IDNR fisheries biologists completed a Tier 2 plant survey in the summer of 2008. The survey showed that there was still a relatively large amount of milfoil in Waveland Lake. Coontail was not found during this survey. The Department of Parks and Recreation funded a spot treatment for 20 acres of aquatic vegetation to relieve nuisance conditions for recreational uses.

In 2009, LARE granted the WLDPR $20,000 for the treatment of milfoil and $4,500 for vegetation sampling and a plan update. Aquatic Control Inc. was selected to perform the surveys and update the management plan. An invasive species mapping survey took place on May 28, 2009. The survey revealed that 4.4 acres of curlyleaf pondweed existed in 7 plant beds within the lake. It was also noted during the survey that Phragmites (*Phragmites australis*) had spread to 1.8 acres along the north, south, and west shorelines. Milfoil was not observed during the invasive species mapping survey. A summer Tier 2 survey was completed on August 10, 2009. Sago pondweed and leafy pondweed were

the only species collected and only a single fragment of milfoil was observed in the lake. Spot treatment for nuisance native vegetation occurred on July 1 to 4.5 acres of high use areas on the lake.

The results from the 2009 Tier 2 survey indicate that there is not an abundant and diverse native plant population in Waveland Lake. The reduction in native species diversity may be attributed to reduced water clarity which has been documented over the last several years. In addition, a drawdown was completed during the 2008-2009 winter season. The drawdown was recommended by the IDNR as part of a shad population control program and is expected to take place again in the winter of 2009-2010. The drawdown is likely having a greater impact on the reduction of milfoil.

It is unlikely that milfoil will be present in high densities in 2010. Early season invasive species mapping should take place in 2010 to record any areas of milfoil growth. Milfoil should be treated with 2,4-D herbicide wherever it exists to prevent further spreading to other parts of the lake. A summer Tier 2 survey should be conducted to document changes in the native plant community. It is likely that some native vegetation and filamentous algae will need to be treated in high use areas of the lake in 2010. Treatments of native plant beds should be limited due to the low amount of vegetation in the lake. Treatments should also be completed for control of phragmites along the lakes shoreline. Much of this vegetation is on private land, so it is recommended that WLDPR work with the SWCD in an effort to obtain permission from landowners.

The following is a condensed list of actions discussed above that should be initiated in 2010:

1. Complete an invasive species mapping survey in the spring of 2010 in order to locate any areas of Eurasian watermilfoil and continue these surveys through 2011. Complete Tier 2 surveys in mid to late summer in order to document changes in the native community following treatments and detect the presence of invasive species.
2. If detected, treat Eurasian watermilfoil wherever it is detected with 2,4-D aquatic herbicide in an effort to keep milfoil from returning to previous levels.
3. Complete controls on native vegetation in high use areas to reduce potential nuisance conditions. Treatment should be limited due to the low amount of overall vegetation.
4. Treat phragmites beds along shoreline. This will require working with landowners in order to gain permission. Suggest contacting SWCD for assistance in this endeavor.
5. Continue to assess, adjust, and update the Waveland Lake Management Plan through 2011.
6. Work with farmers in the immediate watershed to improve agricultural practices.

It is recommended that the Waveland Lake Department of Parks and Recreation request $5,000 for treatment of up to 10 acres of milfoil with 2,4-D herbicide, $2,500 for treatment of phragmites, and $4,500 for plant sampling and plan update.

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1.0 INTRODUCTION

This report was created in order to update the Waveland Lake Aquatic Vegetation Management Plan. The update will serve as a tool to track changes in the vegetation community, to adjust the action plan as needed, and to maintain eligibility for additional LARE funds. Items covered include the 2008 and 2009 plant survey results, a review of the 2008 and 2009 vegetation controls, and updates to the budget and action plan. The plan update was funded by the Indiana Department of Natural Resources Lake and River Enhancement Program (LARE) and the Waveland Lake Department of Parks and Recreation (WLDPR).

The aquatic vegetation management goals of the original plan are listed below:

- 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
- Direct efforts to preventing and controlling the negative impacts of aquatic invasive species
- Provide reasonable public recreational access while minimizing the negative impacts on plant, fish, and wildlife resources

More specific objectives, designed to help meet the goals listed above, were also included in the original plan along with specific actions designed to achieve these objectives. These objectives are listed below:

- Maintain and enhance the abundance of rooted floating and emergent aquatic plant species
- Maintain the density and diversity of submersed vegetation
- Reduce Eurasian watermilfoil density and abundance
- Monitor the curlyleaf pondweed and phragmites populations and control if necessary
- Create public awareness of the potential for hydrilla invasion and post signs for cleaning off boats at all private and public access sites
- Control vegetation in high use areas in order to allow for recreational use

In addition to funding the plan and updates, LARE and WLPDR also funded lakewide invasive species controls on Waveland Lake in 2007, 2008, and 2009 (Table 1).

Table 1. LARE and WLDPR funded invasive species treatments in 2007, 2008 and 2009.

Year	Targeted Species	Acreage	Treatment Applied	Funding Source
2007	Milfoil, Coontail, and Pondweeds	70.8*	Navigate (milfoil), Aquathol K, Reward, Komeen (natives)	LARE 50 acres EWM, WLDPR 20.8 acres mixed species
2008	Coontail and Pondweeds	24.0	Aquathol K and Komeen (natives)	WLDPR/Lot Owners
2009	Coontail, Pondweed, and Filamentous Algae	7.5	Copper Sulfate (algae), Aquathol K, and Komeen (natives)	Lot Owners

2.0 PROBLEM STATEMENT

Native aquatic vegetation is an important component of lakes in Indiana. This vegetation provides habitat for fish and invertebrates, food for wildlife, and may also help improve water quality. Invasive species are typically the main problem causing plants in aquatic ecosystems. In the past, the primary invasive species of concern within Waveland Lake was Eurasian watermilfoil. Milfoil was found to be abundant in Waveland Lake during the plant surveys conducted from 2005 through 2008. Curlyleaf pondweed is another submersed invasive species that is present in Waveland Lake and has the potential to create nuisance conditions. Phragmites is an invasive emergent species that was also detected and appears to be spreading along the north, south, and west shorelines. Phragmites will not likely create nuisance conditions for lake users, but could have negative impacts on native wetland species in and around Waveland Lake.

3.0 WATERSHED AND WATERBODY CHARACTERISTICS

Waveland Lake is located approximately two miles northwest of Waveland Indiana. Although most of the lake is located in Montgomery County, a portion of the western shore is located in Parke County. The lake covers about 383 acres at normal pool level, has a gross storage capacity of about 1,198 million gallons of water, and has a watershed of about 11.3 square miles. The watershed is predominantly in agricultural use, and is entirely rural. The lake was created in 1970 by the Little Raccoon Conservancy District in cooperation with the Soil Conservation Service. There is a lakeside residential development along a portion of the northwest shore in Parke County.

WW Engineering and Science completed a feasibility study on Waveland Lake in 1989. The study found that Waveland Lake had a Eutrophication Index of 52 points, which places it in the category of Indiana lakes with the lowest water quality and highest eutrophication. They concluded that the sediment and nutrient inputs to the lake appeared to be the result of agricultural practices in the watershed. The study recommended implementing a series of land treatment measures for farmland in the watershed in order to reduce the flow of sediment and nutrients into the lake (Keith, 1991). At the time of the study, Waveland Lake was dominated by bluegreen algae and had relatively low Secchi readings.

IDNR fisheries biologist completed a complete fish renovation of Waveland Lake in 2002 in an effort to remove gizzard shad and common carp. The lake was restocked in the fall of 2002 and in the spring of 2003. Fish surveys in 2003 found gizzard shad still present in the lake (Keller 2003). In 2005, a largemouth bass, bluegill, and gizzard shad survey, a selective eradication of gizzard shad, a pre and post-selective gizzard shad survey, a submersed aquatic vegetation survey, and a spring and fall muskie evaluation were conducted (Long 2005). Another selective shad kill and survey routine similar to 2005 was done in 2007 by IDNR fisheries biologist Rhett Wisener and staff with further fish surveys being completed in 2008 and 2009.

4.0 PLANT SAMPLING RESULTS

A Tier 2 survey was performed by IDNR fisheries biologists in 2008 as part of a fish community evaluation survey. Two LARE funded vegetation surveys were completed in 2009 in order to document changes in the plant community and to determine success or failure of control techniques.

4.1 IDNR 2008 TIER 2 SAMPLING RESULTS

On July 16, 2008 a Tier 2 sampling survey was completed on Waveland Lake by IDNR fisheries biologists as part of a fish community study. A Secchi depth was taken prior to sampling and was found to be 2.5 feet. Plants were found to a maximum depth of 7 feet. Seventy sites were sampled throughout the littoral zone of the lake. Vegetation was detected at 33 of the sites. Five species were collected 4 of which were natives. The maximum number of species collected at a site was 4 and the average number of species per site was 1.00. Table 2 shows the overall results from the Tier 2 survey. Coontail (*Ceratophyllum demersum*) was found at 40% of the sites and exhibited the highest plant dominance rating (9.7). Eurasian watermilfoil was the second most frequently occurring species (28.6%) followed by leafy pondweed (*Potamogeton foliosus*) (21.4%), Chara (*Chara spp.*) (5.7%), and American pondweed (*Potamogeton nodosus*) (4.3%). Filamentous algae was present at 31.4% of the sites.

Table 2. **Occurrence and abundance of submersed aquatic plants in Waveland Lake July 16, 2008 (0-7 ft).**

Occurrence and Abundance of Submersed Aquatic Plants in Waveland Lake (all depths).

County:	Montg	Total Sites:	70	Mean species/site:	1.00
Date:	7/16/08	Sites with plants:	33	SE Mean species/site:	0.15
Secchi (ft):	2.5	Sites with native plants:	-	Mean native species/site:	0.71
Max Plant Depth (ft):	7	Number of species:	5	SE Mean natives/site:	0.11
Trophic Status:	Meso	# of native species:	4	Species diversity:	0.71
		Maximum species/site:	4	Native species diversity:	0.59

All Depths (0 to 15 ft)	Frequency of Occurrence	Rake score frequency per sp.				Plant Dominance
Species		**0**	**1**	**3**	**5**	
Coontail	40.0	60.0	37.1	1.4	1.4	9.7
Eurasian watermilfoil	28.6	71.4	25.7	1.4	1.4	7.4
Leafy pondweed	21.4	78.6	18.6	2.9	0.0	5.4
Chara	5.7	94.3	4.3	1.4	0.0	1.7
American pondweed	4.3	95.7	4.3	0.0	0.0	0.9
Filamentous Algae	31.4					

Other species observed: Brittle naiad, sago pondweed, duckweed, cattail, sweet flag, phragmites

4.2 2009 SURVEY RESULTS

4.2.1 Aquatic Control Spring Invasive Species Mapping Results

On May 28, 2009 an invasive species survey was completed on Waveland Lake. A Secchi depth was taken prior to sampling and was found to be 3.5 feet. No Eurasian watermilfoil was detected during the survey, however, 4.4 acres of curlyleaf pondweed was mapped (Figure 1). Curlyleaf was distributed mostly along the eastern side of the lake with a small bed in a western cove. Phragmites was found growing in six areas

along the north, south, and west shorelines (Figure 2). A total of 1.8 acres of phragmites was recorded during the 2009 invasive species mapping survey.

Figure 1. Curlyleaf pondweed beds, Waveland Lake, May 28, 2009.

Figure 2. Phragmites distribution, Waveland Lake, May 28, 2009.

4.2.2 Aquatic Control Summer Survey Results (Tier 2 Survey)

Tier 2 sampling took place on August 10, 2009. A Secchi disk reading was taken prior to sampling and was found to be 2.0 feet. Plants were present to a maximum depth of 6 feet. Seventy sites were sampled throughout the littoral zone. The same points used in the 2007 Tier 2 survey were used in the 2009 survey. Only two species were collected and both were natives. Six of the seventy sites contained vegetation. The maximum number of species collected at a site was 2 and the average number of species per site was 0.10. Table 3 shows the overall results from the Tier 2 survey. Sago pondweed (*Potamogeton pectinatus*) was found at the most sites (5.7%) (Figure 3) followed by leafy pondweed (4.3%) (Figure 4). Other species that were observed but not collected include: American pondweed, Phragmites, primrose (*Ludwigia spp.*), water willow (*Justicia americana*), and Eurasian watermilfoil.

Table 3. Occurrence and abundance of submersed aquatic plants in Waveland Lake August 10, 2009 (0-13 ft).

Occurrence and Abundance of Submersed Aquatic Plants in Waveland Lake (all depths).					
County:	Montg	Total Sites:	70	Mean species/site:	0.10
Date:	8/10/09	Sites with plants:	6	SE Mean species/site:	0.04
Secchi (ft):	2	Sites with native plants:	6	Mean native species/site:	0.10
Max Plant Depth (ft):	6	Number of species:	2	SE Mean natives/site:	0.04
Trophic Status:	Meso	# of native species:	2	Species diversity:	0.49
		Maximum species/site:	2	Native species diversity:	0.49

All Depths (0 to 13 ft)	Frequency of Occurrence	Rake score frequency per sp.				Plant Dominance
Species		**0**	**1**	**3**	**5**	
Sago Pondweed	5.7	94.3	2.9	2.9	0.0	2.3
Leafy pondweed	4.3	95.7	4.3	0.0	0.0	0.9
Filamentous Algae	32.9					

Other species observed: American pondweed, Phragmities, sweetflag, primrose, water willow, Eurasian watermilfoil (fragment)

Figure 3. Waveland Lake, sago pondweed distribution and abundance, August 10, 2009.

Figure 4. Waveland Lake, leafy pondweed distribution and abundance, August 10, 2009.

It is also important to look at the species distribution throughout different depth ranges. Twenty-seven sites were sampled from 0-5 feet. Five of the shallow sites contained vegetation. Two species were found and both were natives. The maximum number of species collected at a single site was 1 and the mean number of native species per site was 0.19. Sago pondweed was found at 11.1% of the sites. Leafy pondweed was only present at 7.4% of the sites. This data is illustrated in Table 4.

Table 4. Occurrence and abundance of submersed aquatic plants in Waveland Lake 0-5 feet, August 10, 2009.

Occurrence and Abundance of Submersed Aquatic Plants in Waveland Lake (0-5 ft).								
County:	Montg	Total Sites:	27				Mean species/site:	0.19
Date:	8/10/09	Sites with plants:	5				SE Mean species/site:	0.08
Secchi (ft):	2	Sites with native plants:	5				Mean native species/site:	0.19
Max Plant Depth (ft):	6	Number of species:	2				SE Mean natives/site:	0.08
Trophic Status:	Meso	# of native species:	2				Species diversity:	0.48
		Maximum species/site:	1				Native diversity:	0.48
Depth: 0 to 5 ft		Frequency of Occurrence	Rake score frequency per sp.				Plant Dominance	
Species			**0**	**1**	**3**	**5**		
Sago Pondweed		11.1	88.9	3.7	7.4	0.0	5.2	
Leafy pondweed		7.4	92.6	7.4	0.0	0.0	1.5	
Filamentous Algae		70.4						

Forty-one sample sites were present at the 5-10 feet stratum. Plants were collected at only a single site. Leafy pondweed and sago pondweed both occurred at that site. Data collected from the 5.0-10.0 deep sample sites is illustrated in Table 5.

Table 5. Occurrence and abundance of submersed aquatic plants in Waveland Lake 5-10 feet, August 10, 2009.

Occurrence and Abundance of Submersed Aquatic Plants in Waveland Lake (5-10 ft).								
County:	Montg	Total Sites:	41				Mean species/site:	0.05
Date:	8/10/09	Sites with plants:	1				SE Mean species/site:	0.05
Secchi (ft):	2	Sites with native plants:	1				Mean native species/site:	0.05
Max Plant Depth (ft):	6	Number of species:	2				SE Mean natives/site:	0.05
Trophic Status:	Meso	# of native species:	2				Species diversity:	0.50
		Maximum species/site:	2				Native diversity:	0.50
Depth: 5 to 10 ft		Frequency of Occurrence	Rake score frequency per sp.				Plant Dominance	
Species			**0**	**1**	**3**	**5**		
Leafy pondweed		2.4	97.6	2.4	0.0	0.0	0.5	
Sago Pondweed		2.4	97.6	2.4	0.0	0.0	0.5	
Filamentous Algae		9.8						

4.2.3 IDNR Summer Survey Results (Tier 2 Survey)

IDNR fisheries biologists completed a Tier 2 survey on July 14, 2009. A Secchi depth was taken prior to sampling and was found to be 2.4 feet. Plants were present to a maximum depth of 8 feet. Seventy sites were sampled and 20 of those sites contained plants. The same points used in the 2008 Tier 2 survey were used in the 2009 survey. A total of 4 species were collected of which all were natives. The maximum number of species collected at a site was 3 and the average number of species per site was 0.43. Table 6 shows the overall results from the Tier 2 survey. Leafy pondweed was the most frequently collected species (25.7%) followed by sago pondweed (8.6%), southern naiad (*Najas guadalupensis*) (5.7%), and American pondweed (2.9%). Filamentous algae was present at 57.1% of the sites.

Table 6. Occurrence and abundance of submersed aquatic plants in Waveland Lake 5-8 feet, July 14, 2009.

Occurrence and Abundance of Submersed Aquatic Plants in Waveland Lake (all depths).					
County:	Montg	Total Sites:	70	Mean species/site:	0.43
Date:	7/14/09	Sites with plants:	20	SE Mean species/site:	0.09
Secchi (ft):	2.4	Sites with native plants:	-	Mean native species/site:	0.43
Max Plant Depth (ft):	8	Number of species:	4	SE Mean natives/site:	0.09
Trophic Status:	Meso	# of native species:	4	Species diversity:	0.58
		Maximum species/site:	3	Native species diversity:	0.59
					0.58

All Depths (0 to 15 ft)	Frequency of Occurrence	Rake score frequency per sp.				Plant Dominance
Species		**0**	**1**	**3**	**5**	
Leafy pondweed	25.7	74.3	22.9	2.9	0.0	6.3
Sago pondweed	8.6	91.4	7.1	0.0	1.4	2.9
Southern naiad	5.7	94.3	5.7	0.0	0.0	1.1
American pondweed	2.9	97.1	1.4	1.4	0.0	1.1
Filamentous Algae	57.1					

Other species observed: Duckweed, cattail, sweet flag, phragmites, reed canary grass

4.3 Aquatic Vegetation Sampling Discussion

There has been a reduction in the percent occurrence of all of the individual species since 2004 (Table 7). Invasive Eurasian watermilfoil was found at 40.0% of the sites in the IDNR 2006 summer Tier 2 survey, in 51.6 acres of the Aquatic Control 2007 invasive species mapping survey, at 10.0% of the sites in the Aquatic Control 2007 Tier 2 survey, and 28.6% in the IDNR 2008 summer Tier 2 survey. No Eurasian watermilfoil was found in Waveland Lake in the 2009 surveys.

Curlyleaf pondweed appears to be low in abundance over the last 7 years. Curlyleaf was found at a frequency of occurrence of 1.4% during the 2005 IDNR Tier 2 survey, 4.3% in the 2006 IDNR Tier 2 survey, 2.9% in the 2007 Aquatic Control Tier 2 survey, and was found growing sparsely in a 65 acre plant bed during the Aquatic Control Tier I sampling in 2007. Only 4.4 acres of curlyleaf pondweed were observed during the 2009 invasive species mapping survey.

Common coontail has been the most abundant native species within Waveland Lake in past Tier 2 surveys. Coontail was at 49.2% of the sampling sites during the 2004 Aquatic Control Tier 2 survey, 86.1% in the 2005 IDNR Tier 2 survey, 77.1% in 2006, 78.6% during the Aquatic Control Tier 2 survey and 40.0% of the sites in the 2008 IDNR Tier 2 survey. No coontail was collected in either of the 2009 Tier 2 summer surveys.

Southern naiad is another plant that has been present in high abundance in past years. It was found at a high frequency of occurrence during the 2004, 2005, and 2006 Tier 2 summer surveys. The data shows that this species has not been a prominent part of the plant community for the past 3 years.

Table 7. Waveland Lake, percent occurrence of submersed species in the last eight summer Tier 2 surveys.

Species	% of survey sites (8/16/04)	% of survey sites* (8/11/05)	% of survey sites* (8/15/06)	% of survey sites (8/6/07)	% of survey sites* (8/8/07)	% of survey sites* (7/16/08)	% of survey sites* (7/14/09)	% of survey sites (8/10/09)
Eurasian watermilfoil *(Myriophyllum spicatum)*	0.0%	22.2%	40.0%	10.0%	21.4%	28.6%	0.0%	0.0%
curlyleaf pondweed *(Potamogeton crispus)*	3.1%	1.4%	4.3%	2.9%	1.1%	0.0%	0.0%	0.0%
common coontail *(Ceratophyllum demersum)*	49.2%	86.1%	77.1%	78.6%	72.9%	40.0%	0.0%	0.0%
Chara (*Chara spp .*)	3.1%	5.6%	8.6%	2.9%	4.3%	5.7%	0.0%	0.0%
Slender naiad *(Najas flexillis)*	0.0%	0.0%	0.0%	1.4%	0.0%	4.3%	0.0%	0.0%
sago pondweed *(Potamogeton pectinatus)*	21.5%	8.3%	10.0%	0.0%	5.7%	0.0%	8.6%	5.7%
small pondweed *(Potamogeton pusillus)*	16.9%	0.0%	0.0%	10.0%	0.0%	0.0%	0.0%	0.0%
southern naiad *(Najas guadalupensis)*	46.2%	52.8%	32.9%	0.0%	11.4%	0.0%	5.7%	0.0%
leafy pondweed *(Potamogeton foliosus)*	0.0%	30.6%	11.4%	0.0%	20.0%	0.0%	25.7%	4.3%
American pondweed *(Potamogeton nodosus)*	41.5%	30.6%	14.3%	5.7%	18.6%	0.0%	2.9%	0.0%
brittle naiad *(Najas minor)*	0.0%	18.1%	27.1%	5.7%	12.9%	0.0%	0.0%	0.0%
algae	-	38.9%	45.7%	45.7%	45.7%	31.4%	57.1%	32.9%

* Data providerd by Indiana Department of Natural Resources

Data collected concerning overall diversity and abundance metrics from the past six years of Tier 2 surveys is displayed in Table 8. The data suggests that there has been a decrease in native species diversity and abundance since 2004. The reason for the decreased abundance and diversity is not entirely clear, but may be related to an overall reduction in water clarity seen during that same time period. Declines seen in Eurasian watermilfoil in 2009 may also be attributed to the winter 2008-2009 drawdown. Large portions of the littoral zone were likely exposed to freezing temperatures during the drawdown. This exposure can lead to desiccation of milfoil root crowns resulting in a dramatic reduction in the overall milfoil population the following spring.

Table 8. Comparison of Tier 2 data from Waveland Lake.

Tier II Metric	2004	2005*	2006*	2007	2008*	2009*	2009
Secchi	4.5	3.0	3.0	3.5	2.5	2.4	2.0
Max Plant Depth	8	8	11	9	7	8	6
Total Sites	66	70	70	70	70	70	70
Sites with Plants	62	70	59	58	33	20	6
Sites with Native Plants	62	70	59	57	-	-	6
Number of Species	7	9	9	8	5	4	2
Number of Native Species	6	7	7	6	4	4	2
Maximum Species/Site	4	6	6	6	4	3	2
Mean Species/Site	1.82	2.63	2.23	1.17	1.00	0.43	0.10
Mean Native Species/Site	1.82	2.39	1.79	1.07	0.71	0.43	0.10
Species Diversity Index	0.79	0.81	0.81	0.53	0.71	0.58	0.49
Native Species Diversity Index	0.78	0.78	0.75	0.42	0.59	0.58	0.49

*Data provided by the Indiana Department of Natural Resources

5.0 VEGETATION CONTROL

A single treatment was funded by the WLDPR in 2008 to relieve nuisance vegetative growth in 24 acres of high use areas on Waveland Lake (Figure 5). Areas of concern were mapped and waypoints were transferred to handheld GPS units to ensure accuracy of application. Aquathol K and Komeen were applied by Aquatic Control on June 16, 2008 to the treatment areas via drop hose injection. The species within the treatment areas were small pondweed, American pondweed, common coontail, curlyleaf pondweed, Eurasian watermilfoil, and duckweed (*Lemna spp.*).

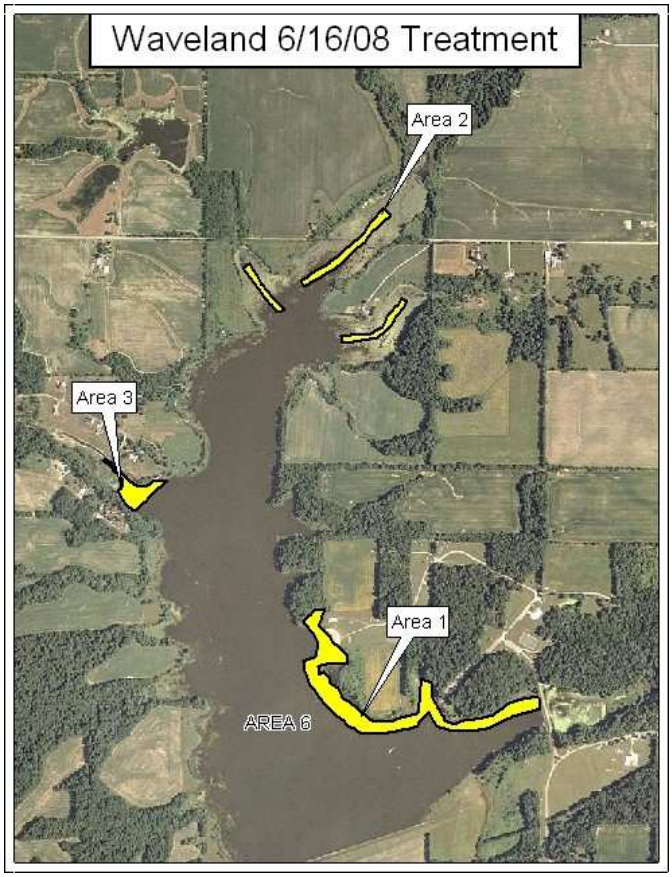

Figure 5. Waveland Lake Aquathol K and Komeen treatment areas, June 16, 2008.

Treatments occurred on Waveland Lake in 2009 to control nuisance submersed vegetation and filamentous algae. Aquatic Control completed the first treatment on June 9, 2009. Aquathol K and Komeen were applied to control nuisance growth of curlyleaf pondweed, small pondweed, sago pondweed, American pondweed, and filamentous algae in 7.5 acres of developed shoreline (Figure 6). A second treatment was completed on July 1, 2009. Copper sulfate was applied to control the nuisance growth of filamentous algae. A total of two acres of algal was treated in July.

Figure 6. Waveland Lake plant and algae treatment areas, June 9, 2009 and July 1, 2009.

6.0 ACTION PLAN AND BUDGET UPDATE

The objectives of the original plan are as follows:

- Maintain and enhance the abundance of rooted floating and emergent aquatic plant species
- Maintain the density and diversity of submersed vegetation
- Reduce Eurasian watermilfoil density and abundance
- Monitor the curlyleaf pondweed population and control if necessary
- Create public awareness of the potential for hydrilla invasion and post signs for cleaning off boats at all private and public access sites
- Control vegetation in high use areas in order to allow for recreational use

The primary plant management action for the 2009 season was vegetation sampling. This action allowed managers to assess if the objective of reducing milfoil abundance is being achieved as well as monitoring the curlyleaf pondweed population and assessing changes in native plant populations. The data shows that major changes have occurred in the plant community over the past several years. The reduction in native species abundance and diversity is may be a result of reduced water clarity and possibly impacted by winter drawdowns of the lake.

Despite reduced levels of nuisance aquatic vegetation it is still important to proactively manage Waveland Lake's aquatic plants. Milfoil is currently at very low levels and it

would be beneficial to keep it at this level. If left alone milfoil may return to past levels when it covered over 50 acres of the lake. Vegetation monitoring should be an important component of the 2010 action plan. Two plants surveys should occur in 2010. The first survey should be completed in early to mid May and be focused on detecting any areas of Eurasian watermilfoil or curlyleaf pondweed. If any areas of milfoil are located, the location should be recorded on a GPS device and downloaded onto a GIS program. These areas should be treated with 2,4-D aquatic herbicide as soon as possible to avoid further spreading of the plant. A second survey should be completed in late summer and focus on assessing the native plant community and also locating potential areas of Eurasian watermilfoil that may not have been present or detected during the spring invasive survey. A Tier 2 survey, similar to the one completed in 2009, should be sufficient, but sampling should focus on shallower sites due to the reduced water clarity.

Phragmites continues to be present on the north, south, and west shorelines on Waveland Lake. This invasive species seems to have spread to several areas of the lake when compared to the 2007 observations. These beds should be treated with a combination of imazapyr (Trade Name: Habitat) and glyphosate based EPA registered aquatic herbicides. Much of this phragmites likely occurs on private land. WLDPR should work with the local soil and water conservation districts in order to obtain permission from private land owners to treat this invasive species.

There may be a need for limited shoreline spot treatments for control of native nuisance species and filamentous algae. These treatments would need to be funded by individual lot owners and the WLDPR. WLDPR should continue with treatments around high use areas like the public boat ramp and public beach. However, control of native species should be limited due to the overall lack of vegetation in this lake. If over 625 square feet is treated it will require a permit from IDNR.

The vegetation management plan will need to be updated in 2010. The update should include all data gathered from 2010 surveys, 2010 vegetation controls, and action plan and budget updates. Along with the plan update, a public meeting should be planned for next fall. This meeting will allow for lake user input and education.

The reduction in native vegetation is concerning. It appears that Waveland Lake may be reverting from a macrophyte dominated community to a turbid algae dominated system. The root cause of this problem is not clear, but Waveland is surrounded by agricultural fields that eventually drain into the lake. This may be contributing to the increased turbidity that has been documented over the last several years. WLDPR should work with local soil and water conservation districts in an effort to get local farmers switched from traditional row crop farming to no-till practices and increase their use of filter strips within fields and along the shoreline of Waveland Lake. WLDPR should refer to their Feasibility Study for more details on steps that can be taken to improve Waveland Lake's water quality.

Table 9 shows the projected budget estimate for the next three years. It is recommended that the Association request $5,000 for treating up to 10 acres of Eurasian watermilfoil

with 2,4-D if it returns, $2,500 for treatment of phragmites beds, and $4,500 for plant sampling and updating the 2010 plan.

Table 9. Budget estimates for management options

Action	2010	2011	2012
Selective treatment of Eurasian watermilfoil with 2,4-D herbicide	$5,000	$5,000	$5,000
Treatment of approximately 1.8 acres of phragmites along shoreline	$2,500	$1,500	$1,000
Plant sampling and plan updates (potential LARE funding with 10% match)	$4,500	$4,500	$4,500
Potential LARE Funded Total:	**$12,000**	**$11,000**	**$10,500**

The LARE program has several different steps that must be followed in order for a grant recipient and LARE contractor to fulfill all requirements and remain eligible for funding. Table 10 outlines the anticipated LARE schedule for the upcoming season. All grant recipient responsibilities are highlighted in yellow.

Table 10. LARE actions, due dates, and responsible parties (grant recipient actions highlighted in yellow).

Action	Due date	Responsible Party
IDNR funding decision	March 10, 2010	IDNR
Vegetation control & plan update bids sent out to eligible contractors	March 20, 2010	Grant Recipient
Grant recipient selects contractor(s)	April 15, 2010	Grant Recipient
Invasive plant mapping survey	May, 2010	Contractor
Milfoil treatment	May, 2010	Contractor
Tier II survey	July/August, 2010	Contractor
Phragmites treatment	July/August, 2010	Contractor
Public meeting held to discuss 2010 results and future plans	August-October, 2010	Contractor
AVMP summary due to IDNR biologists	November 1, 2010	Contractor
Meeting with IDNR biologists	November 15, 2010	Contractor
First draft due	December 15, 2010	Contractor
LARE grant application due	January 15, 2011	Grant Recipient
Vegetation control permit submitted	January 15, 2011	Grant Recipient
IDNR review returned to contractor	February 1, 2011	IDNR
Revised plan/update due	March 1, 2011	Contractor

7.0 PUBLIC PARTICIPATION

An effective aquatic vegetation management plan must include input from lake users. A public meeting was held on December 7, 2009 in Waveland. The public meeting was held in order to gain input concerning the plan from lake users, educate lake users on the benefits of native vegetation, inform lake users about the 2009 vegetation controls, and to

update lake users on 2010 plans. Twenty people were present at the meeting and twelve filled out lake user surveys (Table 11). Thirty three percent of those surveyed were members of the park board and 42% had been there for 10 years or more. As far as uses of the lake, 50% of them used the lake for fishing, 42% used the lake for boating and other uses, and 17% used the lake for swimming.

Despite what appears to be a reduction in plant abundance over the past several years, a surprisingly high percentage of respondents (50%) said they had nuisance levels of vegetation along their shorelines. Ninety-two percent of those that took the survey were in favor of continuing efforts to control vegetation on the lake. Seventy-five percent of the respondents were aware that the LARE funds only apply to invasive exotic species.

Concerning problems with the lake, 92% said dredging was needed, 58% feel there were too many aquatic plants, 33% believe the lake has poor water quality, 17% say there is overuse of jet skis, 9% believe there is a fish population problem, and 8%feel that too many boats access the lake. The results from the survey are presented below in Table 11.

Table 11. Waveland Lake, public meeting survey results, December 7, 2009.

Waveland Lake User Survey 12/7/09		
Are you currently a member of your parks board?	Yes 33%	No 58%
How many years have you been at the lake?	2 or Less: 0%	5 to 10: 18%
	2 to 5: 33%	Over 10: 42%
How do you use the lake (mark all that apply)	Swimming 17%	Irrigation 0%
	Boating 42%	Drinking water 0%
	Fishing 50%	Other 42%
Do you have aquatic plants in nuisance quantities?	Yes: 50% No: 25%	
Does aquatic vegetation interfere with your use or enjoyment of the lake?	Yes: 58% No: 33%	
Are you in favor of continuing efforts to control vegetation on the lake?	Yes: 92% No: 0%	
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: 75% No: 17%	
Mark any of these you think are problems on your lake:		
8% Too many boats access the lake		
17% Use of jet skis on the lake		
0% Too much fishing		
9% Fish population problem		
92% Dredging needed		
58% Too many aquatic plants		
0% Not enough aquatic plants		
33% Poor water quality		

It is also beneficial to examine the public perception of lake problems and management actions taken thus far over the course of the LARE funded AVMP project. Table 12 displays the results from the public surveys from 2007 and 2009. It was surprising to see increased numbers of individuals thought they had nuisance levels of vegetation and that there was an increase in the percentage that thought the lake had too many aquatic plants. It is important that lakes users continue to be educated on the benefits of aquatic vegetation via the public meeting and potentially through newsletters or other workshops focusing on lake related management issues.

Table 12. Waveland Lake, lake user survey results, 2007 and 2009.

Survey participant information	2007	2009
Is a lake property owner	0%	not asked
Is a member of the park board	0%	33%
Have been on the lake for more than 10 years	33%	42%
Uses of lake		
Swimming	0%	17%
Boating	60%	42%
Fishing	80%	50%
Irrigation	0%	0%
Drinking water	0%	0%
Other	0%	42%
Perception of aquatic vegetation and management		
Plants at shoreline in nuisance quanities	40%	58%
Vegetation interferes with lake use and enjoyment	80%	92%
Aquatic vegetation affects property valus	0%	not asked
In favor of continuing vegetation control on lake	100%	92%
Are aware that LARE funds are only for control of invasive plants	100%	75%
Are satisfied with results from LARE funded activities	100%	not asked
Problems on lake		
Too many boats access the lake	0%	8%
Use of jet skis is a problem on the lake	40%	17%
Too much fishing	0%	0%
Fish population problems	0%	9%
Dredging is needed	80%	92%
Overuse by nonresidents	0%	not asked
Too many aquatic plants in lake	40%	58%
Not enough aquatic plants in lake	0%	0%
Poor water quality	20%	33%
Pier/funneling problems exist on lake	0%	not asked

Another topic discussed at the public meeting was the recent discovery of hydrilla (*Hydrilla verticillata*) in Lake Manitou. Hydrilla is an invasive aquatic species that was originally discovered in Florida in the 1960's. There are many characteristics of hydrilla that make it a threat to Indiana waterways. This species can grow in lower light conditions than most native species, grows faster than most native species, and can shade out other species by forming a surface canopy. Hydrilla can be easily confused with native elodea. The best way to distinguish hydrilla from native elodea is that hydrilla typically has five leaves along each whorl along with visible serrated edges along the leaf

margin (Figure 12). What makes controlling the spread of hydrilla difficult is the fact that it can be spread by fragments. **That is why it is vitally important that lake users remove all plants and sediment from their boats when entering and leaving Waveland Lake.** At this time, hydrilla has not been discovered in Waveland Lake. More information about controlling the spread of hydrilla can be found at www.protectyourwaters.net.

Figure 7. 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).

8.0 REFERENCES CITED

Aquatic Control Inc. 2007. Waveland Lake Aquatic Vegetation Management Plan. Prepared for the Waveland Lake Department of Parks and Recreation

IDNR, 2004. Procedure Manual For Surveying Aquatic Vegetation: Tier 2 Reconnaissance Surveys. IN Department of Natural Resources, Division of Soil Conservation.

IDNR, 2007. Procedure Manual For Surveying Aquatic Vegetation: Tier 2 Reconnaissance Surveys. IN Department of Natural Resources, Division of Soil Conservation.

Keith, J. H. 1991. Feasibility study of Lake Waveland and its watershed Montgomery County and Parke County, Indiana. WW Engineering and Science. Bloomington,IN.

Keller, D. C. 2003. Lake Waveland Renovation Summary. Fisheries Section Indiana Department of Natural Resources. Division of Fish and Wildlife. Indianapolis, IN.

Long, C. C. 2007. Waveland Lake 2005 Fish Management Report. Fisheries Section. Indiana Department of Natural Resources. Division of Fish and Wildlife. Indianapolis, IN.

9.0 APPENDIX UPDATE

9.1 August Tier 2 Survey Data

WPT	Depth	Rake score	Fil. Algae	Leafy pondweed	Sago Pondweed
1	7	0	P		
2	5	0	P		
3	4	0	P		
4	10	0			
5	8	0	P		
6	6	0	P		
7	6	0			
8	5	0			
9	9	0			
10	4	0	P		
11	9	0			
12	5	0	P		
13	3	1	P	1	
14	4	0	P		
15	6	0			
16	12	0			
17	2	0	P		
18	5	0			
19	4	1	P	1	
20	13	0			
21	6	1	P	1	1
22	5	0	P		
23	7	0			
24	7	0			
25	7	0			
26	7	0			
27	6	0			
28	3	0	P		
29	5	0	P		
30	7	0			
31	7	0			
32	7	0			
33	5	0			
34	3	3			3
35	6	0			
36	3	3	P		3
37	3	0	P		
38	5	0	P		
39	4	0			
40	7	0			
41	7	0			
42	7	0			
43	5	0			
44	7	0			
45	8	0			
46	3	0	P		
47	4	0	P		
48	7	0			
49	5	0			
50	7	0			
51	4	0	P		
52	8	0			
53	7	0			
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55	8	0			
56	3	0	P		
57	6	0			
58	6	0			
59	6	0			
60	10	0			
61	5	1	P		1
62	5	0			
63	6	0			
64	10	0			
65	10	0			
66	10	0			
67	8	0			
68	6	0			
69	6	0			
70	8	0			

9.2 2010 Vegetation Control 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 6
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: Mark McDaniel	Lake Assoc. Name: Lake Waveland Department of Parks	
Rural Route or Street: PO Box 162		Phone Number: 765-435-2073
City and State: Waveland, IN		ZIP Code: 47989
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): Waveland	Nearest Town: Waveland	County: Montgomery/Parke
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: Treat milfoil where it is located during Spring Invasive Survey	
Total acres to be controlled <10	Proposed shoreline treatment length (ft) n.a.	Perpendicular distance from shoreline (ft) n.a.
Maximum Depth of Treatment (ft) 8	Expected date(s) of treatment(s) Late May/early June	

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. 2,4-D or Triclopyr for control of milfoil if it is found growing in spring invasive mapping survey

Plant survey method: [X] Rake [x] Visual [ ] Other (specify) 2009 Data

Aquatic Plant Name	Check if Target Species	Relative Abundance % of Community
Sago pondweed		30
Eurasian watermilfoil	x	0
Leafy pondweed		30
Filamentous algae		40

Page 2 of 6

Treatment Area # 2	LAT/LONG or UTM's Center of bed @ N39.89543 W87.09447		
Total acres to be controlled 2.6	Proposed shoreline treatment length (ft) 1600	Perpendicular distance from shoreline (ft) 200	
Maximum Depth of Treatment (ft) 6	Expected date(s) of treatment(s) mid to late 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. Reward, Komeen, and Aquathol			
Plant survey method: [X] Rake [X] Visual [ ] Other (specify)			

Aquatic Plant Name	Check if Target Species	Relative Abundance % of Community
Sago pondweed		30
Filamentous algae		40
Leafy pondweed		30

Treatment Area # 3	LAT/LONG or UTM's Center of bed @ N39.89106 W87.09295		
Total acres to be controlled 2	Proposed shoreline treatment length (ft) 1000	Perpendicular distance from shoreline (ft) 200	
Maximum Depth of Treatment (ft) 6	Expected date(s) of treatment(s) mid to late 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. Aquathol, komeen, and reward			
Plant survey method: [x] Rake [X] Visual [ ] Other (specify)			

Aquatic Plant Name	Check if Target Species	Relative Abundance % of Community
Sago pondweed		30
Filamentous algae		40
Leafy pondweed		30

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Treatment Area # 4	LAT/LONG or UTM's Center of bed @ N39.88921 W87.09245		
Total acres to be controlled 3	Proposed shoreline treatment length (ft) 1200	Perpendicular distance from shoreline (ft) 200	
Maximum Depth of Treatment (ft) 6	Expected date(s) of treatment(s) mid to late 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. Reward, Komeen, and Aquathol			
Plant survey method: [X] Rake [X] Visual [ ] Other (specify)			

Aquatic Plant Name	Check if Target Species	Relative Abundance % of Community
Sago pondweed		30
Filamentous algae		40
Leafy pondweed		30

Treatment Area # 5	LAT/LONG or UTM's See Map of Phragmites Beds		
Total acres to be controlled 2	Proposed shoreline treatment length (ft) 2800	Perpendicular distance from shoreline (ft) n.a.	
Maximum Depth of Treatment (ft) 1	Expected date(s) of treatment(s) July		
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. Treat Phrag where it is growing along lake with Habitat, Glyphosate, and/or ClearCast			
Plant survey method: [x] Rake [X] Visual [ ] Other (specify)			

Aquatic Plant Name	Check if Target Species	Relative Abundance % of Community
Pharagmites	x	100

Page 4 of 6

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) mid to late 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.

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

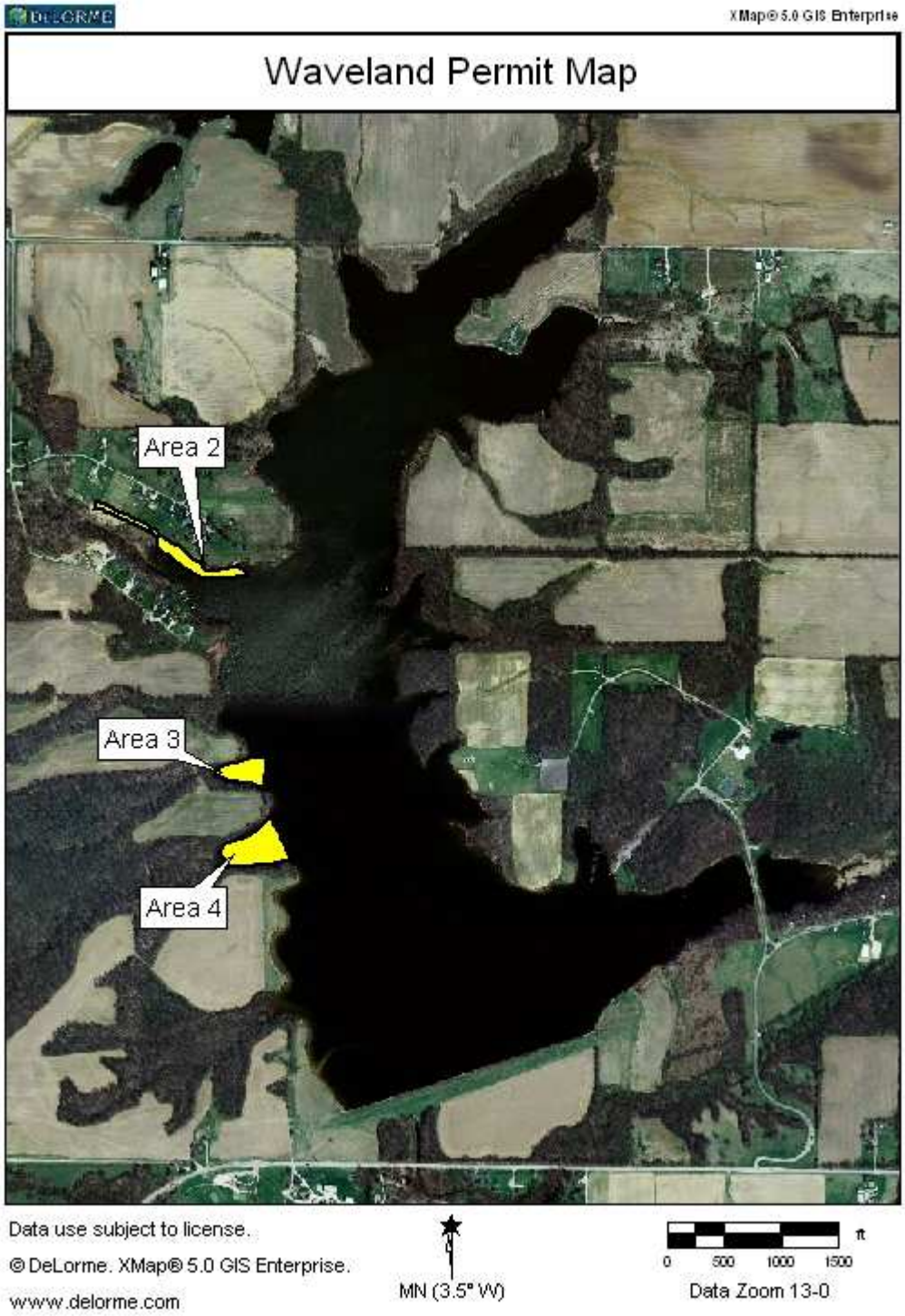
FOR OFFICE ONLY

[ ] 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

Submersed Treatment Permit Map-Page 5 of 6



Potential Phragmites Permit Map-Page 6 of 6