

Crooked Lake Aquatic Vegetation Management Plan 2008 Update Steuben County, Indiana

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Executive Summary

Aquatic Control was contracted by the Crooked Lake Association (CLA) to complete aquatic vegetation sampling in order to update their lakewide, long-term integrated aquatic vegetation management plan which was originally completed in 2007. Funding for the update of this plan was obtained from the Crooked Lake Association 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. The major items covered include the 2008 sampling results, a review of the 2008 vegetation controls, and updates to the budget and action plans.

The primary nuisance species within Crooked Lake is the invasive plant Eurasian watermilfoil (*Myriophyllum spicatum*), hereafter called milfoil. Curlyleaf pondweed (*Potamogeton crispus*) is another invasive species abundant in Crooked Lake. A total of 133.8 acres of milfoil was documented as dense in Crooked Lake during the spring 2006 Tier I survey and was present at 60% of sample sites during the summer 2006 Tier II survey (Aquatic Control 2007). In 2007, LARE and the CLA funded treatment of the entire third basin of Crooked Lake (184 acres) with fluridone along with treatment of 62.0 acres of milfoil in first and second basin with 2,4-D. These treatments significantly reduced milfoil abundance.

An update to the original plan was completed in February of 2008. The plan update recommended pre-treatment invasive species mapping surveys of the entire lake for milfoil and curlyleaf pondweed. Treatment of curlyleaf using endothall (trade name Aquathol K) was to occur once the water had reached 50 degrees Fahrenheit (10° C) and milfoil was to be treated wherever it occurred using 2,4-D in mid to late May. A follow up Tier II survey was suggested for mid summer to assess the treatment efficacy and affects on native vegetation. The update also recommended the continued involvement and education of the general public through meetings, newsletters, and public postings. In March of 2008, CLA received funds from LARE for treatment of milfoil, plant sampling, and another vegetation plan update.

Aquatic Control Inc. completed invasive species sampling on April 22 and May 27, 2008. The sampling completed on April 22, 2008 was conducted to assess the distribution of curlyleaf pondweed for early season treatment of this species. Curlyleaf pondweed was found growing in 8.0 acres of basins one and two. The majority of curlyleaf growth was found in basin three where it was observed growing in 117.6 acres. On April 29, Aquatic Weed Control Inc. treated 117 acres of curlyleaf pondweed in the third basin. Invasive species sampling was completed again on May 27, 2008 and focused on mapping areas of beds containing milfoil. This sampling indicated the presence of 40.7 acres of Eurasian watermilfoil in the first and second basins, and Eurasian watermilfoil was observed growing in 1.3 acres along the southern part of the third basin. On June 6, 2008, 42 acres of Eurasian watermilfoil was treated throughout the first, second, and third basins with liquid and granular 2,4-D herbicide. A summer Tier II survey was completed on August 12, 2008. A total of 13 native submersed species were collected. Slender naiad (*Najas*

flexilis) was the most abundant species observed followed by sago pondweed (*Potamogeton pectinatus*). Eurasian watermilfoil was collected at fewer sites than in previous surveys. Curlyleaf pondweed also occurred at fewer sites when compared to 2007 survey results.

In 2009, it is unlikely that milfoil will be abundant in the third basin; however, it will be present in the first and second basins but possibly at a lower abundance. It is important that beds of milfoil be treated with systemic herbicides wherever they exist in the 2009 season. It is estimated that up to 42 acres of milfoil may require treatment with 2,4-D next season. In addition, curlyleaf pondweed should be treated in the same areas for the next two years. Ideally, areas of curlyleaf pondweed in the first and second basin would be treated in order to prevent downstream movement of curlyleaf.

It is recommended that the Crooked Lake Association request \$15,000 for treatment of up to 42 acres of milfoil with 2,4-D herbicide, \$38,750 for a second year of early season treatment of up to 126 acres of curlyleaf pondweed, and \$6,000 for basic plant sampling and plan update.

Acknowledgements

Funding for the vegetation sampling and preparation of an aquatic vegetation management plan was provided by the Crooked Lake Association and the Indiana Department of Natural Resources Lake and River Enhancement Program. Aquatic Control, Inc. completed the vegetation sampling, data processing, and map generation. Contributors to this plan include Keith Hoskins and the Crooked Lake Association, Neil Ledet with the Indiana Department of Natural Resources-Division of Fish and Wildlife, Gwen White and Angela Sturdevant Aquatic Biologist from the Lake and River Enhancement Program (LARE), and Jim Donahoe with Aquatic Weed Control Inc. Author of this report update is Brendan Hastie of Aquatic Control. The author would like to acknowledge the valuable input from Brian Isaacs, Barbie Huber, and Nate Long of Aquatic Control for their field assistance, map generation, review, and editing of this report.

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1.0 INTRODUCTION

This report was created in order to update the Crooked 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. The major items covered include the 2008 sampling results, a review of the 2008 vegetation controls, and updates to the budget and action plans. The plan update was funded by the Indiana Department of Natural Resources Lake and River Enhancement Program (LARE) and the Crooked Lake Association (CLA).

LARE and the CLA funded the vegetation sampling and creation of the original Crooked Lake Aquatic Vegetation Management Plan in 2006. The original plan was completed in February of 2007 and updated in February of 2008. In addition to funding the plan and updates, LARE and CLA have also funded lakewide invasive species controls on Crooked Lake in 2007 and 2008. Table 1 is a summary of the recent lakewide invasive species controls.

Table 1. LARE and CLA funded invasive species treatments in 2007 and 2008.

Year	Basin	Targeted Species	Acreage	Treatment Applied
2007	1st & 2nd	Milfoil	62	2,4-D
2007	3rd	Milfoil & Curlyleaf	184	Fluridone
2008	1st & 2nd	Milfoil	42	2,4-D
2008	3rd	Curlyleaf	117.6	Aquathol K

2.0 PROBLEM STATEMENT

Aquatic vegetation is an important component of lakes in Indiana. 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 Crooked Lake is the invasive species Eurasian watermilfoil. Curlyleaf pondweed is another invasive species that is present in Crooked Lake and reaches nuisance levels. Purple loosestrife is an invasive emergent species that was also detected. It is unlikely that purple loosestrife will create nuisance conditions for lake users, but this species could have negative impacts on native wetland species in and around Crooked Lake.

3.0 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 Crooked Lake Association along with objectives designed to help meet these 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

- Maintain and enhance the diversity of emergent/rooted floating plant community
 - Maintain the diversity of submersed vegetation in the third basin and enhance diversity in the first and second basins
2. Direct efforts to preventing and/or controlling the negative impacts of aquatic invasive species.
 - Reduce milfoil abundance to less than 10% frequency of occurrence in summer Tier II surveys
 - Reduce curlyleaf pondweed abundance to less than 10% littoral coverage in spring invasive species mapping surveys
 - Prevent further spread of purple loosestrife
 - Create public awareness of the potential for hydrilla invasion and post signs for cleaning off boats at all private and public access sites
 3. Provide reasonable public recreational access while minimizing the negative impacts on plant and fish and wildlife resources.
 - Keep boating lanes open between basins, in channels, and in and around the public access site
 - Control vegetation around docks if restricting boat access

4.0 WATERSHED AND WATER BODY CHARACTERISTICS (Summarized from JFNew & Associates, Inc. 2003 & IDNR 2001)

Crooked Lake is an approximately 802 acre natural lake that consists of three sections called the first (401 acres), second (217 acres), and third basins (184 acres). The average depth of Crooked Lake is 12.0 feet and the maximum depth is 77 feet. The third basin is by far the shallowest of the three basins. Crooked Lake is classified as Mesotrophic, which means the lake is moderately productive. Secchi measurements taken during plant surveys ranged from 8.0 to 10.5 feet in the first and second basins and from 4.0-5.0 feet in the third basin. The Crooked Lake watershed encompasses 7,512 acres in central Steuben County.

5.0 PRESENT WATER BODY USES

Crooked Lake is used for a variety of activities. A public access site and beach are located in the eastern end of the first basin of Crooked Lake at a Steuben County Park. Several private boat ramps are located on all three basins. The entire shoreline of the first and second basin is developed residentially. The eastern shore of the third basin is also residentially developed while the western shore of the third basin remains primarily undeveloped. Swimming, boating and fishing are popular activities on Crooked Lake. At a recent public meeting, lake users indicated that 87% use the lake for swimming, 80% use the lake for boating, 53% use the lake for fishing, 47% use the lake for irrigation, and 13% had other uses (survey included 15 individuals, all were property owners on the Lake). IDNR manages the fishery in Crooked Lake. No fisheries surveys have been completed on this lake since the last update.

6.0 2008 SAMPLING RESULTS

Aquatic Control completed three plant surveys on Crooked Lake in 2008. Two invasive species mapping surveys were completed on April 22 and May 27. The invasive mapping surveys allowed for the determination of potential control areas and the documentation of

any changes in the abundance of invasive species. A Tier II survey was completed on August 12. This survey was completed in order to document success or failure of the control techniques, document changes in the native plant community, and aid in the planning for future actions. The data from the Tier II survey was also analyzed by individual basin due to the different characteristics and control techniques used in the different basins.

6.1 Spring Invasive Mapping Results

6.1.1 April 22 Invasive Mapping Survey Results

On April 22, 2008, an invasive mapping survey was completed on Crooked Lake to identify possible areas for the treatment of curlyleaf pondweed. A Secchi disc reading was taken and found to be 13.0 feet. The water temperature was 58° F (14.4°C) and dissolved oxygen was 11.0 mg/L at the surface. Sampling indicated the presence of approximately 7.9 acres of curlyleaf pondweed in the first and second basins (Figure 1). Curlyleaf pondweed was documented in 117.6 acres of the third basin (Figure 2). The focus of the survey was curlyleaf pondweed, but obvious beds of Eurasian watermilfoil were also documented. Approximately 13 acres of milfoil was found through the first and second basin (Figure 3). No milfoil was observed in the third basin during the April survey.

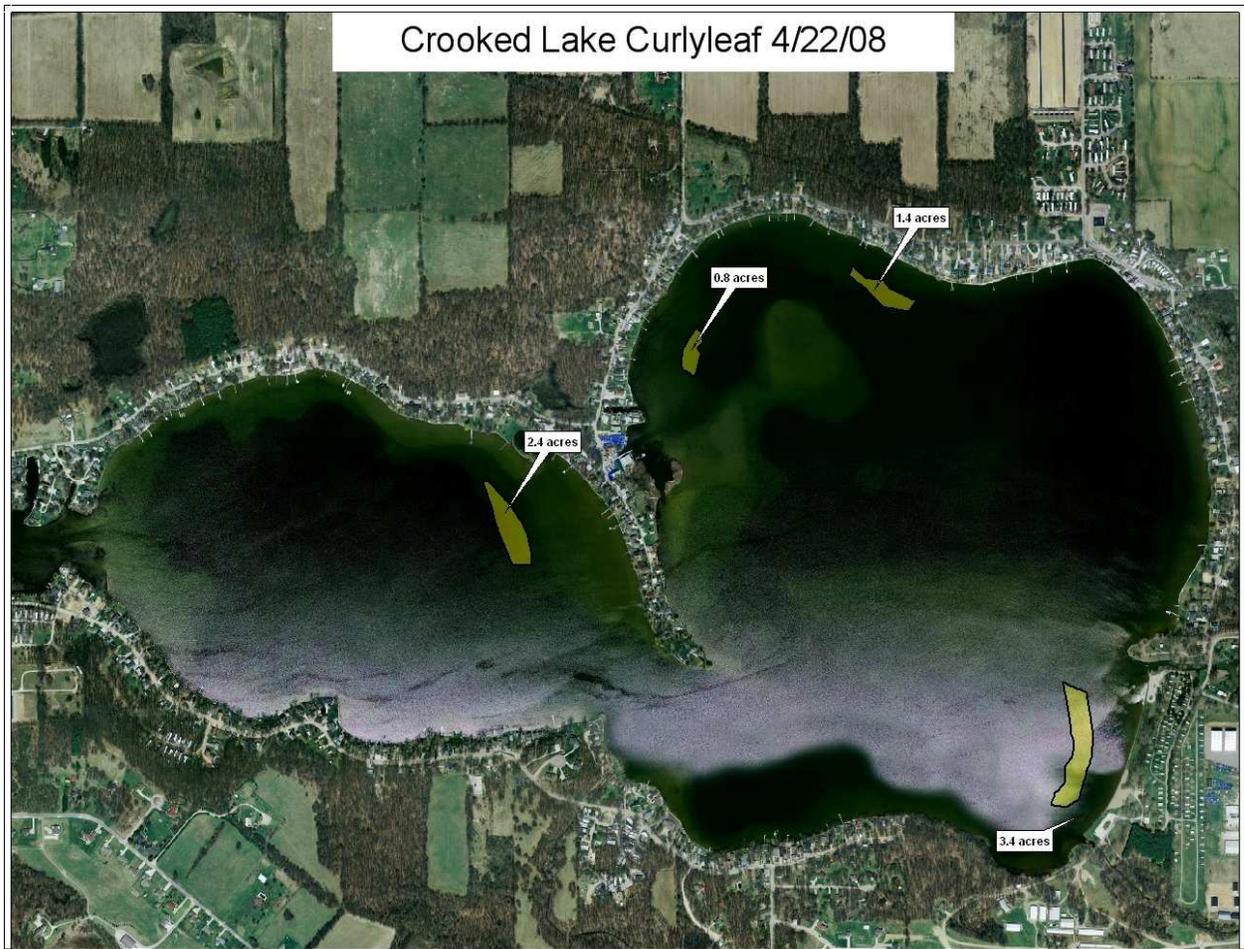


Figure 1. Curlyleaf pondweed beds, Crooked Lake, first and second basin, April 22, 2008

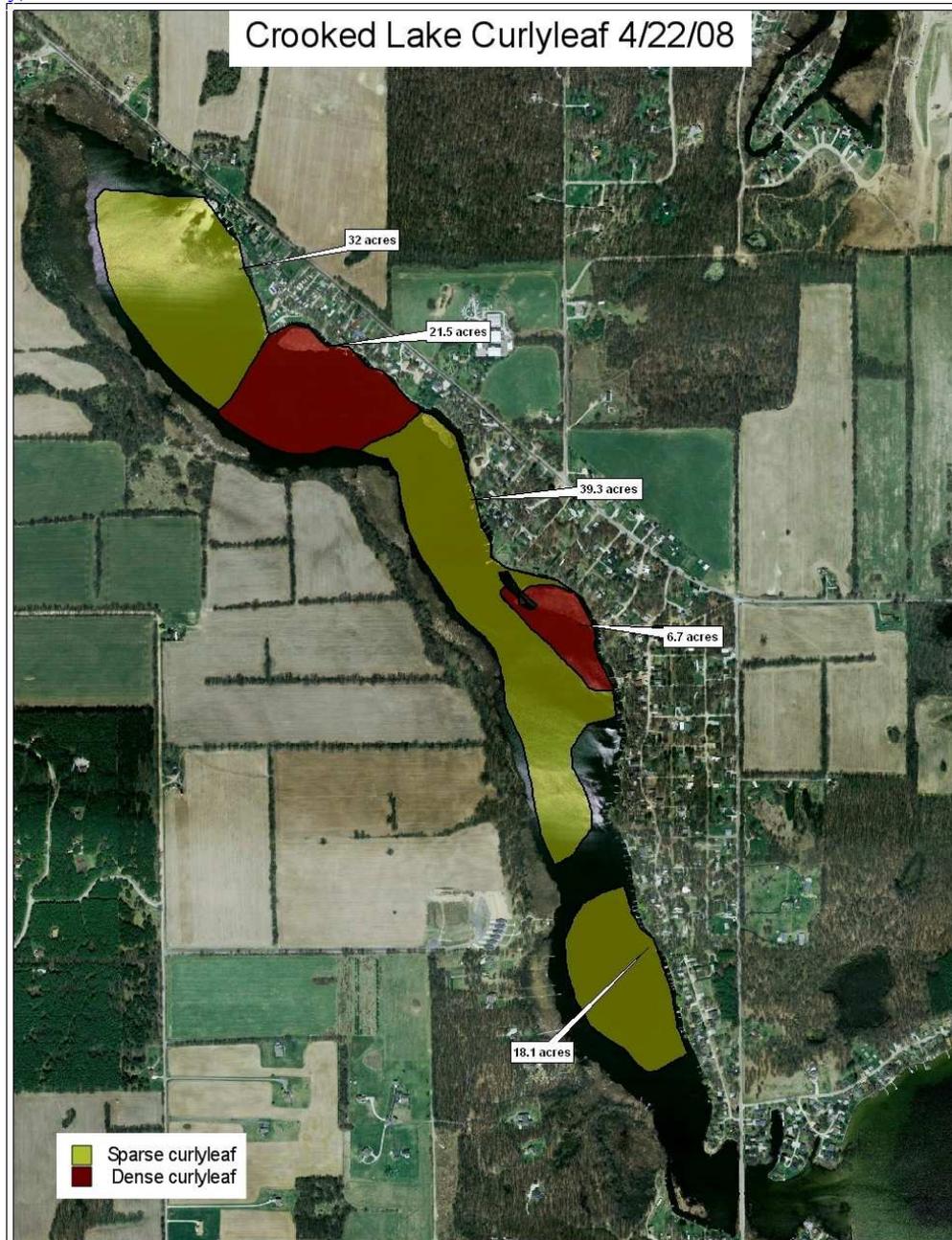


Figure 2. Curlyleaf pondweed beds, Crooked Lake, third basin April 22, 2008

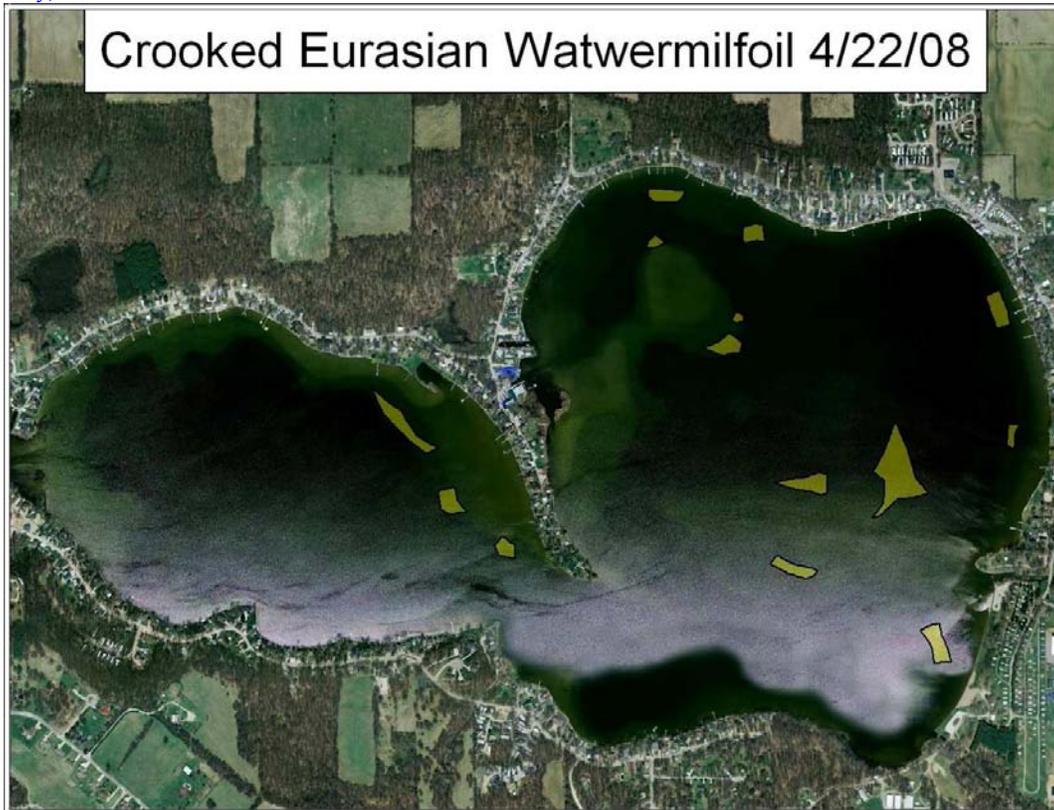


Figure 3. Eurasian watermilfoil beds, Crooked Lake, first and second basin, April 22, 2008

6.1.2 May 27 Invasive Mapping Survey Results

On May 27, 2008 an invasive mapping survey was completed on Crooked Lake to locate beds of milfoil and to assess the efficacy of the early treatment on curlyleaf pondweed. A Secchi disc reading was taken and found to be 14.0 feet. The water temperature was 64°F (17.8°C) at the surface. Milfoil was found growing in 40.7 acres of basins one and two. The only milfoil found in the third basin was a 1.3 acre patch growing in the very southern part along the boundary with the second basin (Figure 4). Curlyleaf pondweed was not detected in the third basin at the time of this survey.

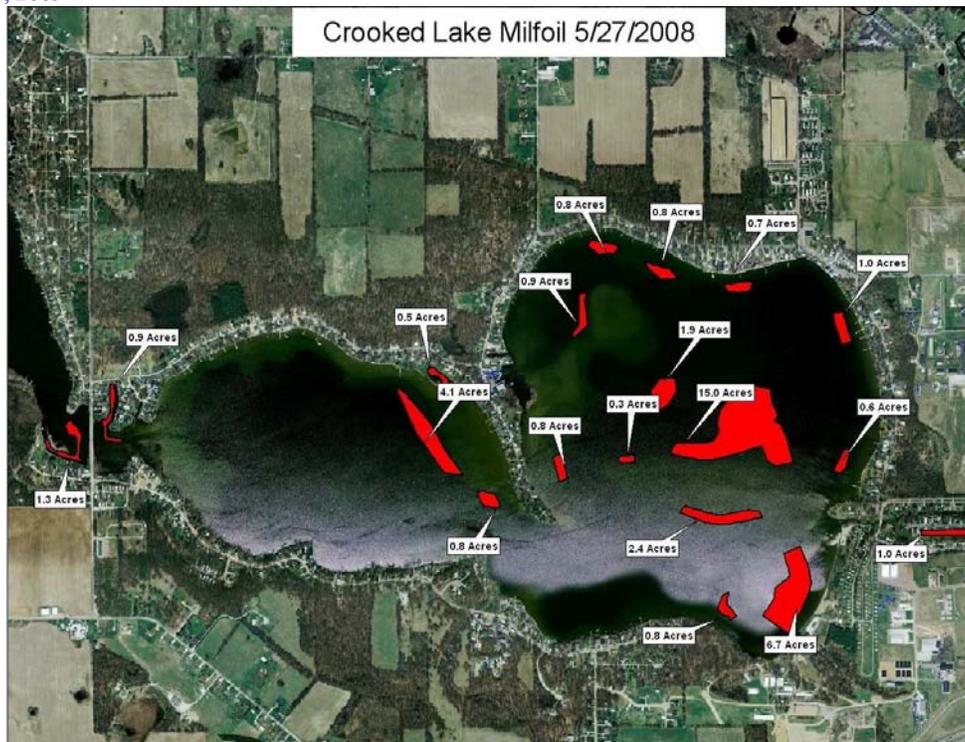


Figure 4. Eurasian watermilfoil beds, Crooked Lake, May 27, 2008.

6.2 Summer Tier II Survey

In 2008, a single Tier II survey was completed on Crooked Lake. Data from the survey will be presented and analyzed as Whole Lake, Basin 1, Basin 2, and Basin 3.

6.2.1 Summer Tier II Survey results for the Whole Lake

On August 12, 2008 a Tier II survey was completed on Crooked Lake. A Secchi disk reading was taken in the first basin prior to sampling and was found to be 7.5 feet. Plants were present to a maximum depth of 16.0 feet. The same 100 sites that were sampled in 2006 and 2007 were again sampled in 2008. Based on the sampling results no changes are necessary in the depth of plant sampling. Plants were present at 65 of the sample sites and native plants were present at all 65 of these sites. A total of 15 species were collected of which 13 of the species were native. The mean number of species collected per site was 1.50 and the mean number of native species collected was 1.40. The species diversity index was 0.87 and the native species diversity index was 0.85 (Table 2).

Table 2. Occurrence and abundance of submersed aquatic plants in Crooked Lake all basins combined, August 12, 2008.

Occurrence and abundance of submersed aquatic plants in Crooked Lake						
County: Stuben	Sites with plants: 65	Mean species/site: 1.50				
Date: 8/12/2008	Sites with native plants: 65	Standard error (ms/s): 0.16				
Secchi (ft): 7.5	Number of species: 15	Mean native species/site: 1.30				
Maximum plant depth (ft): 16	Number of native species: 12	Standard error (mns/s): 0.13				
Trophic status Mesotrophic	Maximum species/site: 6	Species diversity: 0.86				
Total sites: 100		Native species diversity: 0.83				
Depths 0 to 16 ft		Rake score frequency per species				Plant Dominance
Species	Percent Occurrence	0	1	3	5	
slender naiad	43.0	57.0	19.0	16.0	8.0	21.4
sago pondweed	18.0	82.0	17.0	0.0	1.0	4.4
large leaf pondweed	14.0	86.0	10.0	4.0	0.0	4.4
Chara	13.0	87.0	9.0	1.0	3.0	5.4
Eurasian watermilfoil	10.0	90.0	9.0	1.0	0.0	2.4
variable pondweed	10.0	90.0	10.0	0.0	0.0	2.0
American elodea	9.0	91.0	6.0	2.0	1.0	3.4
Brittle naiad	7.0	93.0	5.0	2.0	0.0	2.2
common coontail	5.0	95.0	3.0	1.0	1.0	2.2
Richardson's pondweed	5.0	95.0	4.0	0.0	1.0	1.8
eel grass	4.0	96.0	3.0	1.0	0.0	1.2
leafy pondweed	4.0	96.0	3.0	1.0	0.0	1.2
Illinois pondweed	4.0	96.0	4.0	0.0	0.0	0.8
curlyleaf pondweed	3.0	97.0	2.0	1.0	0.0	1.0
flatstemmed pondweed	1.0	99.0	1.0	0.0	0.0	0.2
Depths 0 to 5 ft		Rake score frequency per species				Plant Dominance
Species	Percent Occurrence	0	1	3	5	
slender naiad	30.8	69.2	15.4	13.5	1.9	13.1
Chara	23.1	76.9	15.4	1.9	5.8	10.0
sago pondweed	21.2	78.8	19.2	0.0	1.9	5.8
large leaf pondweed	21.2	78.8	13.5	7.7	0.0	7.3
variable pondweed	11.5	88.5	11.5	0.0	0.0	2.3
common coontail	5.8	94.2	3.8	0.0	1.9	2.7
eel grass	5.8	94.2	5.8	0.0	0.0	1.2
Richardson's pondweed	3.8	96.2	3.8	0.0	0.0	0.8
Eurasian watermilfoil	1.9	98.1	1.9	0.0	0.0	0.4
American elodea	1.9	98.1	1.9	0.0	0.0	0.4
Illinois pondweed	1.9	98.1	1.9	0.0	0.0	0.4
Depths 5 to 10 ft		Rake score frequency per species				Plant Dominance
Species	Percent Occurrence	0	1	3	5	
slender naiad	70.0	30.0	26.7	23.3	20.0	39.3
Brittle naiad	20.0	80.0	16.7	3.3	0.0	5.3
sago pondweed	20.0	80.0	20.0	0.0	0.0	4.0
American elodea	20.0	80.0	13.3	3.3	3.3	8.0
Eurasian watermilfoil	16.7	83.3	13.3	3.3	0.0	4.7
leafy pondweed	13.3	86.7	10.0	3.3	0.0	4.0
variable pondweed	13.3	86.7	13.3	0.0	0.0	2.7
curlyleaf pondweed	10.0	90.0	6.7	3.3	0.0	3.3
Richardson's pondweed	10.0	90.0	6.7	0.0	3.3	4.7
large leaf pondweed	10.0	90.0	10.0	0.0	0.0	2.0
Illinois pondweed	10.0	90.0	10.0	0.0	0.0	2.0
Chara	3.3	96.7	3.3	0.0	0.0	0.7
flatstemmed pondweed	3.3	96.7	3.3	0.0	0.0	0.7
Depths 10 to 15 ft		Rake score frequency per species				Plant Dominance
Species	Percent Occurrence	0	1	3	5	
slender naiad	50.0	50.0	20.0	20.0	10.0	26.0
Eurasian watermilfoil	40.0	60.0	40.0	0.0	0.0	8.0
common coontail	20.0	80.0	10.0	10.0	0.0	8.0
American elodea	20.0	80.0	10.0	10.0	0.0	8.0
Brittle naiad	10.0	90.0	0.0	10.0	0.0	6.0
sago pondweed	10.0	90.0	10.0	0.0	0.0	2.0
eel grass	10.0	90.0	0.0	10.0	0.0	6.0
Depths 15 to 16 ft		Rake score frequency per species				Plant Dominance
Species	Percent Occurrence	0	1	3	5	
slender naiad	12.5	87.5	12.5	0.0	0.0	2.5

species observed but not collected: Purple loosestrife, swamp loosestrife, bulrush, and water willow

Slender naiad (*Najas flexillis*) ranked first in frequency of occurrence (43.0%) and in dominance (21.4). Location and density of slender naiad is illustrated in Figure 5. Sago pondweed was the second most frequently occurring species (18.0%) but ranked third in dominance (Figure 6). Largeleaf pondweed was collected at 14.0% of the sample sites. Chara was the fourth most frequently occurring species (13.0%) and showed the second highest dominance (Figure 7). Eurasian watermilfoil was collected at 10.0% of sample sites making it the most frequently occurring exotic species and ranking fifth in overall frequency (Figure 8). Variable pondweed (*Potamogeton gramineus*) ranked sixth in frequency, followed by American elodea (*Elodea canadensis*), brittle naiad (*Najas minor*), common coontail (*Ceratophyllum demersum*), Richardson's pondweed (Figure 9), listed as imperiled and rare in the state of Indiana, (*Potamogeton richardsonii*), eel grass (*Vallisneria americana*), leafy pondweed (*Potamogeton foliosus*), Illinois pondweed (*Potamogeton illinoensis*), curlyleaf pondweed (*Potamogeton pectinatus*)(Figure 10), and flatstem pondweed (*Potamogeton zosteriformis*).

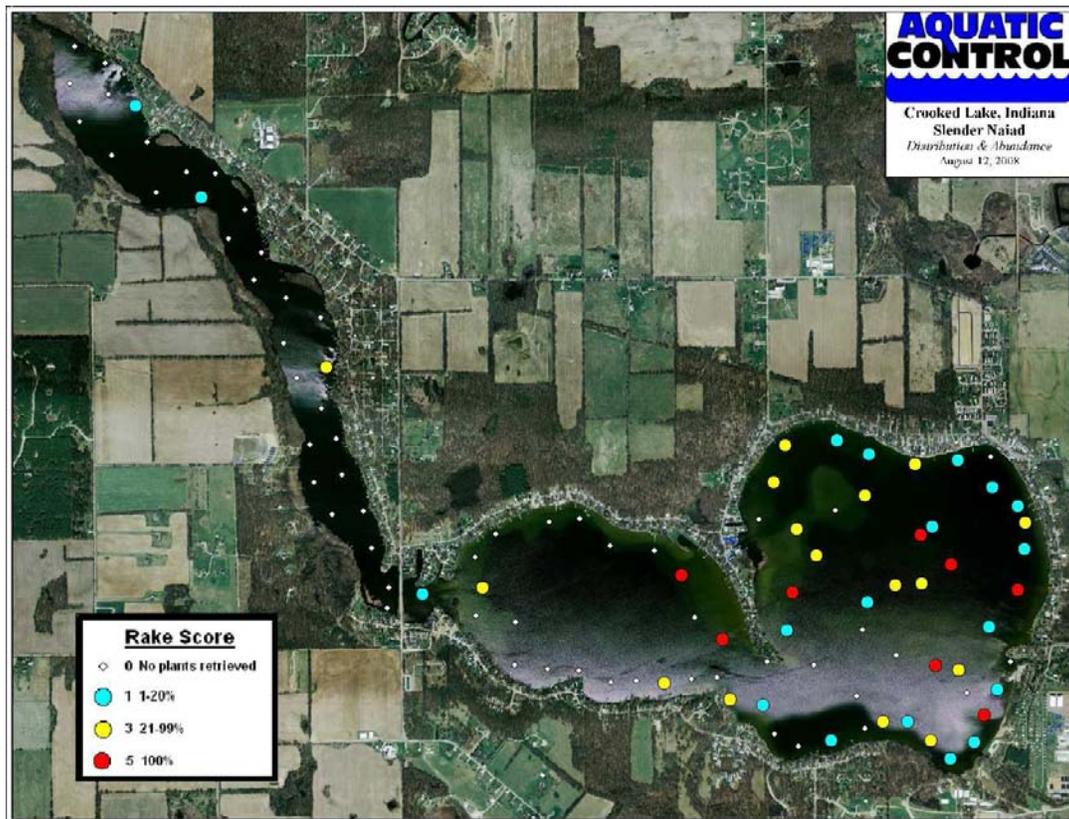


Figure 5. Crooked Lake, slender naiad distribution and abundance, August 12, 2008.

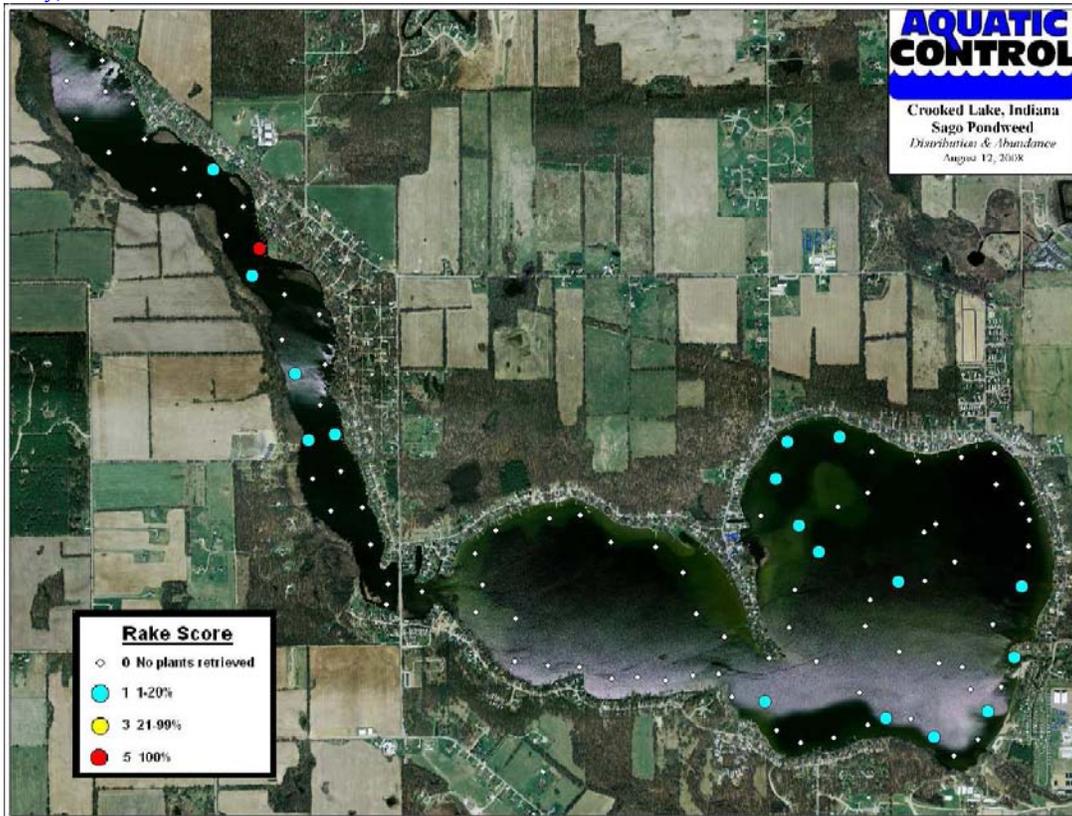


Figure 6. Crooked Lake, sago pondweed distribution and abundance, August 12, 2008.

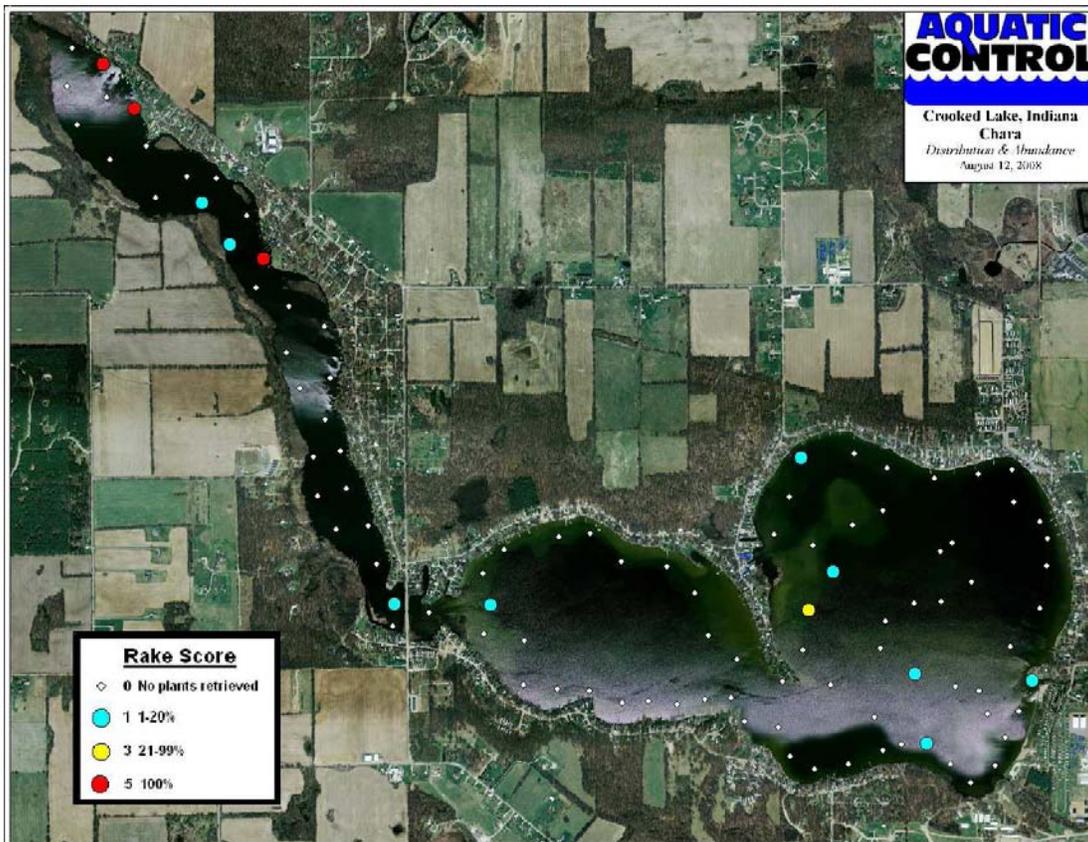


Figure 7. Crooked Lake, Chara distribution and abundance, August 12, 2008.

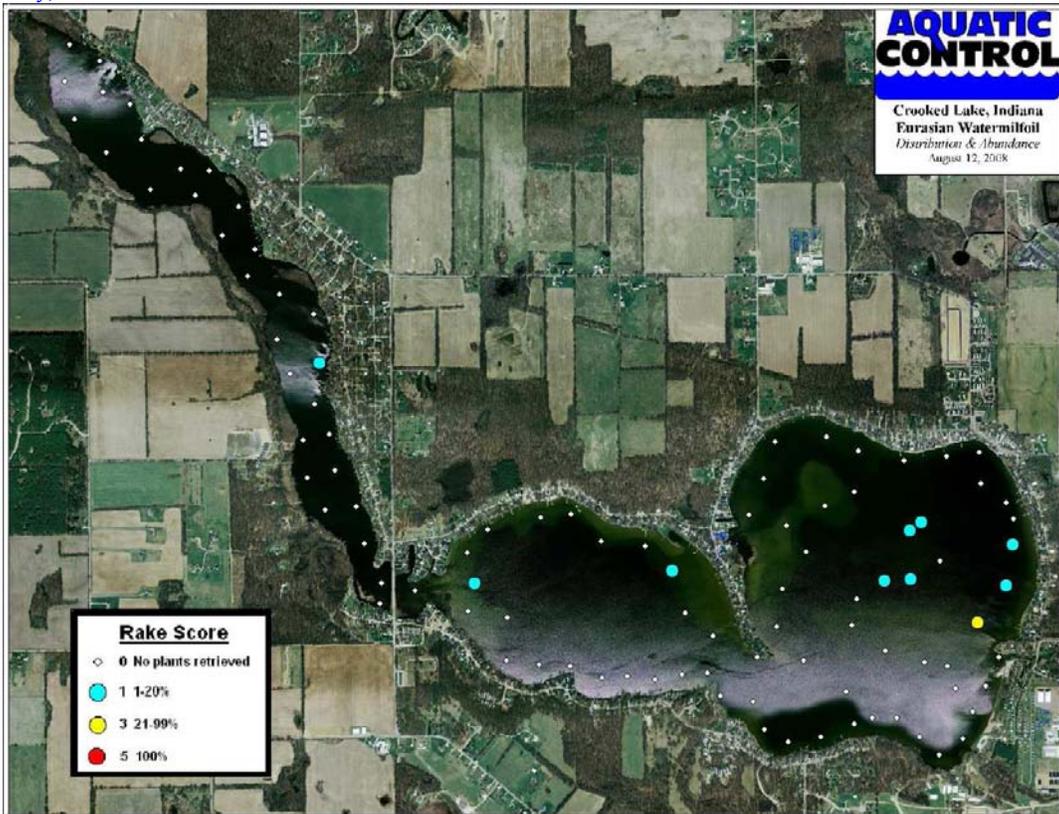


Figure 8. Crooked Lake, Eurasian watermilfoil distribution and abundance, August 12, 2008.

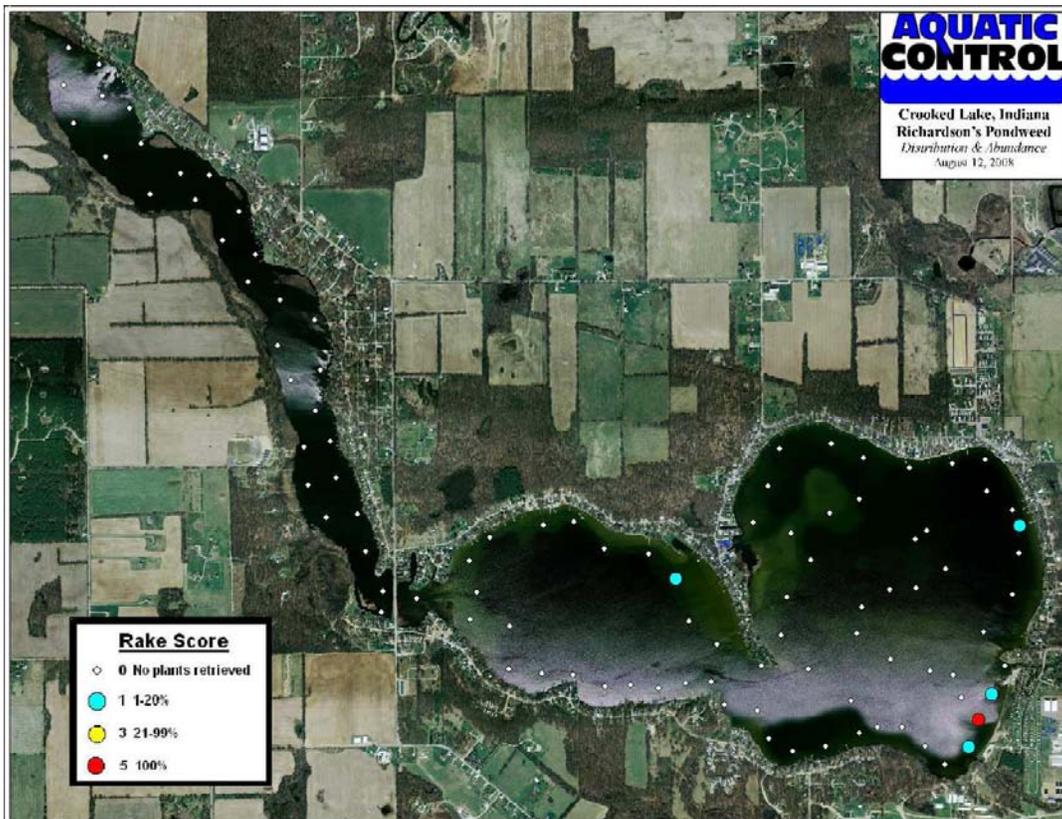


Figure 9. Crooked Lake, Richardson's pondweed distribution and abundance, August 12, 2008.

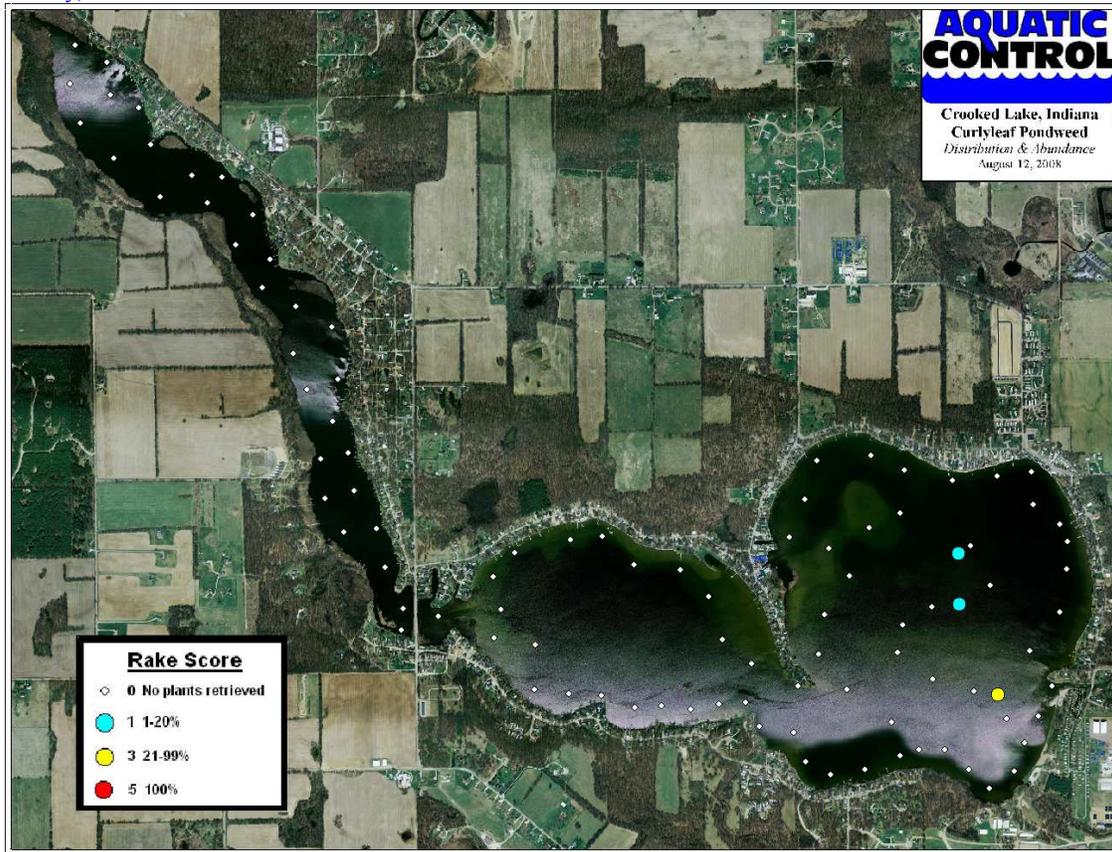


Figure 10. Crooked Lake, curlyleaf pondweed distribution and abundance, August 12, 2008.

6.2.2 Summer Tier II Survey results for the First Basin

A total of 48 sample sites were included in the survey of the first basin. Slender naiad was at 75.0% of the sampling sites in the first basin and showed the highest dominance (Table 3). Sago pondweed was the second most frequently occurring species (25.0%) followed by American elodea (18.8%), Eurasian watermilfoil (16.7%), variable pondweed (16.7%), brittle naiad (14.6%), chara (12.5%), common coontail (8.3%), leafy pondweed (8.3%), Richardson's pondweed (8.3%), Illinois pondweed (8.3%), curlyleaf pondweed (6.3%), eel grass (6.3%), large leaf pondweed (4.2%), and flatstem pondweed (2.1%).

Table 3. Occurrence and abundance of submersed aquatic plants in Crooked Lake, first basin, August 12, 2008.

Occurrence and abundance of submersed aquatic plants in Crooked Lake, basin 1						
County: Stuben		Sites with plants: 39		Mean species/site: 2.31		
Date: 8/12/2008		Sites with native plants: 39		Standard error (ms/s): 0.23		
Secchi (ft): 7.5		Number of species: 15		Mean native species/site: 1.94		
Maximum plant depth (ft): 16		Number of native species: 12		Standard error (mns/s): 0.20		
Trophic status Mesotrophic		Maximum species/site: 6		Species diversity: 0.84		
Total sites: 48				Native species diversity: 0.80		
Depths 0 to 16 ft		Frequency of Occurrence				Plant Dominance
Species	Frequency of Occurrence	Rake score frequency per species				Plant Dominance
		0	1	3	5	
slender naiad	75.0	25.0	33.3	29.2	12.5	36.7
sago pondweed	25.0	75.0	25.0	0.0	0.0	5.0
American elodea	18.8	81.3	12.5	4.2	2.1	7.1
Eurasian watermilfoil	16.7	83.3	14.6	2.1	0.0	4.2
variable pondweed	16.7	83.3	16.7	0.0	0.0	3.3
Brittle naiad	14.6	85.4	10.4	4.2	0.0	4.6
Chara	12.5	87.5	10.4	2.1	0.0	3.3
common coontail	8.3	91.7	4.2	2.1	2.1	4.2
leafy pondweed	8.3	91.7	6.3	2.1	0.0	2.5
Richardson's pondweed	8.3	91.7	6.3	0.0	2.1	3.3
Illinois pondweed	8.3	91.7	8.3	0.0	0.0	1.7
curlyleaf pondweed	6.3	93.8	4.2	2.1	0.0	2.1
eel grass	6.3	93.8	4.2	2.1	0.0	2.1
large leaf pondweed	4.2	95.8	4.2	0.0	0.0	0.8
flatstemmed pondweed	2.1	97.9	2.1	0.0	0.0	0.4
Depths 0 to 5 ft		Frequency of Occurrence				Plant Dominance
Species	Frequency of Occurrence	Rake score frequency per species				Plant Dominance
		0	1	3	5	
slender naiad	75.0	25.0	31.3	37.5	6.3	35.0
sago pondweed	37.5	62.5	37.5	0.0	0.0	7.5
Chara	31.3	68.8	25.0	6.3	0.0	8.8
variable pondweed	31.3	68.8	31.3	0.0	0.0	6.3
common coontail	12.5	87.5	6.3	0.0	6.3	7.5
eel grass	12.5	87.5	12.5	0.0	0.0	2.5
Richardson's pondweed	12.5	87.5	12.5	0.0	0.0	2.5
American elodea	6.3	93.8	6.3	0.0	0.0	1.3
large leaf pondweed	6.3	93.8	6.3	0.0	0.0	1.3
ribbonleaf pondweed	6.3	93.8	0.0	0.0	0.0	0.0
Illinois pondweed	6.3	93.8	6.3	0.0	0.0	1.3
Depths 5 to 10 ft		Frequency of Occurrence				Plant Dominance
Species	Frequency of Occurrence	Rake score frequency per species				Plant Dominance
		0	1	3	5	
slender naiad	90.0	10.0	40.0	30.0	20.0	46.0
Brittle naiad	30.0	70.0	25.0	5.0	0.0	8.0
American elodea	30.0	70.0	20.0	5.0	5.0	12.0
sago pondweed	25.0	75.0	25.0	0.0	0.0	5.0
Eurasian watermilfoil	20.0	80.0	15.0	5.0	0.0	6.0
leafy pondweed	20.0	80.0	15.0	5.0	0.0	6.0
curlyleaf pondweed	15.0	85.0	10.0	5.0	0.0	5.0
variable pondweed	15.0	85.0	15.0	0.0	0.0	3.0
Illinois pondweed	15.0	85.0	15.0	0.0	0.0	3.0
Richardson's pondweed	10.0	90.0	5.0	0.0	5.0	6.0
Chara	5.0	95.0	5.0	0.0	0.0	1.0
flatstemmed pondweed	5.0	95.0	5.0	0.0	0.0	1.0
large leaf pondweed	5.0	95.0	5.0	0.0	0.0	1.0
Depths 10 to 15 ft		Frequency of Occurrence				Plant Dominance
Species	Frequency of Occurrence	Rake score frequency per species				Plant Dominance
		0	1	3	5	
slender naiad	83.3	16.7	33.3	33.3	16.7	43.3
Eurasian watermilfoil	66.7	33.3	66.7	0.0	0.0	13.3
common coontail	33.3	66.7	16.7	16.7	0.0	13.3
American elodea	33.3	66.7	16.7	16.7	0.0	13.3
Brittle naiad	16.7	83.3	0.0	16.7	0.0	10.0
sago pondweed	16.7	83.3	16.7	0.0	0.0	3.3
eel grass	16.7	83.3	0.0	16.7	0.0	10.0
Depths 15 to 16 ft		Frequency of Occurrence				Plant Dominance
Species	Frequency of Occurrence	Rake score frequency per species				Plant Dominance
		0	1	3	5	
slender naiad	16.7	83.3	16.7	0.0	0.0	3.3

6.2.3 Summer Tier II Survey results for the Second Basin

A total of 21 sample sites were included in the survey of the second basin. Slender naiad was the most frequently collected species (19.0%) in the second basin (Table 4). Eurasian watermilfoil, largeleaf pondweed, and variable pondweed were the next most frequently occurring species (9.5% each) followed by common coontail, chara, eel grass, and Richardson's pondweed (4.8% each). Table 4 displays Tier II data for the second basin.

Table 4. Occurrence and abundance of submersed aquatic plants in Crooked Lake, second basin, August 12, 2008.

Occurrence and abundance of submersed aquatic plants in Crooked Lake						
County: Stuben	Sites with plants: 6	Mean species/site: 0.67				
Date: 8/12/2008	Sites with native plants: 6	Standard error (ms/s): 0.33				
Secchi (ft):	Number of species: 8	Mean native species/site: 0.57				
Maximum plant depth (ft): 7	Number of native species: 7	Standard error (mns/s): 0.27				
Trophic status Mesotrophic	Maximum species/site: 6	Species diversity: 0.84				
Total sites: 21		Native species diversity: 0.81				
Depths 0 to 7 ft		Frequency of Rake score frequency per species				Plant Dominance
Species	Occurrence	0	1	3	5	
slender naiad	19.0	81.0	0.0	9.5	9.5	15.2
Eurasian watermilfoil	9.5	90.5	9.5	0.0	0.0	1.9
large leaf pondweed	9.5	90.5	4.8	4.8	0.0	3.8
variable pondweed	9.5	90.5	9.5	0.0	0.0	1.9
common coontail	4.8	95.2	4.8	0.0	0.0	1.0
Chara	4.8	95.2	4.8	0.0	0.0	1.0
eel grass	4.8	95.2	4.8	0.0	0.0	1.0
Richardson's pondweed	4.8	95.2	4.8	0.0	0.0	1.0
Depths 0 to 5 ft		Frequency of Rake score frequency per species				Plant Dominance
Species	Occurrence	0	1	3	5	
Eurasian watermilfoil	14.3	85.7	14.3	0.0	0.0	2.9
common coontail	14.3	85.7	14.3	0.0	0.0	2.9
Chara	14.3	85.7	14.3	0.0	0.0	2.9
slender naiad	14.3	85.7	0.0	14.3	0.0	8.6
eel grass	14.3	85.7	14.3	0.0	0.0	2.9
large leaf pondweed	14.3	85.7	0.0	14.3	0.0	8.6
variable pondweed	14.3	85.7	14.3	0.0	0.0	2.9
Depths 5 to 7 ft		Frequency of Rake score frequency per species				Plant Dominance
Species	Occurrence	0	1	3	5	
slender naiad	37.5	62.5	0.0	12.5	25.0	32.5
Eurasian watermilfoil	12.5	87.5	12.5	0.0	0.0	2.5
Richardson's pondweed	12.5	87.5	12.5	0.0	0.0	2.5
large leaf pondweed	12.5	87.5	12.5	0.0	0.0	2.5
variable pondweed	12.5	87.5	12.5	0.0	0.0	2.5

6.2.4 Summer Tier II Survey results for the Third Basin

A total of 31 sample sites were included in the survey of third basin. Largeleaf pondweed was the most frequently occurring plant (32.3%) in the third basin at the time of the Tier II survey (Table 5). Chara and sago pondweed were the second most frequently occurring species (19.4%) followed by slender naiad (9.7%). The Tier II data is summarized in Table 5.

Table 5. Occurrence and abundance of submersed aquatic plants in Crooked Lake, third basin, August 12, 2008.

Occurrence and abundance of submersed aquatic plants in Crooked Lake, Basin 3						
County: Stuben	Sites with plants: 20	Mean species/site: 0.81				
Date: 8/12/2008	Sites with native plants: 20	Standard error (ms/s): 0.13				
Secchi (ft):	Number of species: 4	Mean native species/site: 0.81				
Maximum plant depth (ft): 7	Number of native species: 4	Standard error (mns/s): 0.13				
Trophic status Mesotrophic	Maximum species/site: 2	Species diversity: 0.71				
Total sites: 31		Native species diversity: 0.71				
Depths 0 to 5 ft		Rake score frequency per species				Plant Dominance
Species	Frequency of Occurrence	0	1	3	5	
large leaf pondweed	32.3	67.7	22.6	9.7	0.0	10.3
Chara	19.4	80.6	9.7	0.0	9.7	11.6
sago pondweed	19.4	80.6	16.1	0.0	3.2	6.5
slender naiad	9.7	90.3	9.7	0.0	0.0	1.9
Depths 0 to 5 ft		Rake score frequency per species				Plant Dominance
Species	Frequency of Occurrence	0	1	3	5	
large leaf pondweed	31.0	69.0	20.7	10.3	0.0	10.3
Chara	20.7	79.3	10.3	0.0	10.3	12.4
sago pondweed	17.2	82.8	13.8	0.0	3.4	6.2
slender naiad	10.3	89.7	10.3	0.0	0.0	2.1
Depths to 5 to 7 ft		Rake score frequency per species				Plant Dominance
Species	Frequency of Occurrence	0	1	3	5	
sago pondweed	50.0	50.0	50.0	0.0	0.0	10.0
large leaf pondweed	50.0	50.0	50.0	0.0	0.0	10.0

IDNR also performed a Tier II survey on the third basin on July 28, 2008. Plants were found down to 5 feet and a Secchi reading of 3 feet was noted. Twenty-five points were sampled. Chara was the most abundant species found at the time of this survey (48%), followed by largeleaf pondweed (8%), bladderwort (4%), sago pondweed (4%), variable pondweed (4%), water bulrush (4%), and coontail (4%). Table 6 shows the results from the survey performed by the IDNR.

Table 6. Occurrence and abundance of submersed aquatic plants in Crooked Lake, third basin, July 28, 2008. (data supplied by IDNR)

Occurrence and abundance of submersed aquatic plants in Crooked Lake Basin 3						
County: Stuben	Sites with plants: 13	Mean species/site: 0.76				
Date: 7/28/2008	Sites with native plants: 13	Standard error (ms/s): 0.18				
Secchi (ft): 3	Number of species: 7	Mean native species/site: 0.76				
Maximum plant depth (ft): 5	Number of native species: 7	Standard error (mns/s): 0.18				
Trophic status Mesotrophic	Maximum species/site: 3	Species diversity: 0.58				
Total sites: 25		Native species diversity: 0.58				
Depths 0 to 5 ft	Frequency of Occurrence	Rake score frequency per species				Plant Dominance
Species		0	1	3	5	
common coontail	4.0	96.0	4.0	0.0	0.0	0.8
Chara	48.0	52.0	16.0	12.0	20.0	30.4
sago pondweed	4.0	96.0	4.0	0.0	0.0	0.8
large leaf pondweed	8.0	92.0	4.0	4.0	0.0	3.2
variable pondweed	4.0	96.0	4.0	0.0	0.0	0.8
common bladderwort	4.0	96.0	4.0	0.0	0.0	0.8
water bulrush	4.0	96.0	4.0	0.0	0.0	0.8

6.3 Aquatic Vegetation Sampling Discussion

One of the primary goals of the plan is to reduce the negative impacts caused by invasive species. The primary species of concern in Crooked Lake is Eurasian watermilfoil.

Table 7 shows the steady decline of milfoil abundance in basins one and three over the last three years. Milfoil remained at low levels in basin 2 when compared to the 2006 survey results (Figure 11).

Table 7. Percent occurrence of milfoil by basin in Crooked Lake, Tier II surveys 2006 through 2008.

Percentage of sites with milfoil			
Survey Date	Basin 1	Basin 2	Basin 3
Aug, 2006	62.5%	28.6%	80.6%
Aug, 2007	20.8%	4.8%	16.1%
Aug, 2008	16.7%	9.5%	0.0%

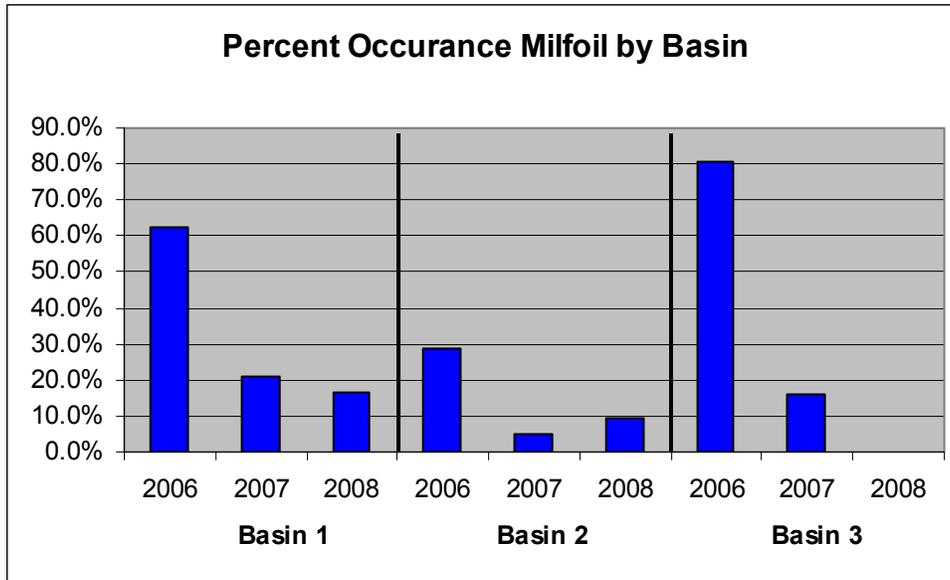


Figure 11. Crooked Lake, Eurasian watermilfoil percent occurrence in the last three summer surveys. (Data from Table 6)

Curlyleaf pondweed is the second invasive species of concern in Crooked Lake. This species tends to decline by late summer, but has been documented in past summer surveys. Curlyleaf pondweed was not detected in basins two and three at the time of the 2008 Tier II summer survey (Table 8) (Figure 12). The absence of curlyleaf pondweed in basin three can probably be attributed to the vegetation controls that have taken place in this basin over the last two seasons, but the reason for decline in basin 1 and 2 is not clear. It is also unknown why there was a spike in the occurrence of curlyleaf during the 2007 growing season. Aquatic Weed Control Inc. performed an early season application of endothall based herbicide that targeted curlyleaf pondweed in the third basin in late April 2008. No early season treatments were performed on the other two basins for the control of curlyleaf pondweed.

Table 8. Percent occurrence of curlyleaf pondweed by basin in Crooked Lake, Tier II surveys 2006 through 2008.

Percentage of sites with curlyleaf pondweed			
Survey Date	Basin 1	Basin 2	Basin 3
Aug, 2006	0.0%	0.0%	3.2%
Aug, 2007	10.4%	23.8%	0.0%
Aug, 2008	6.3%	0.0%	0.0%

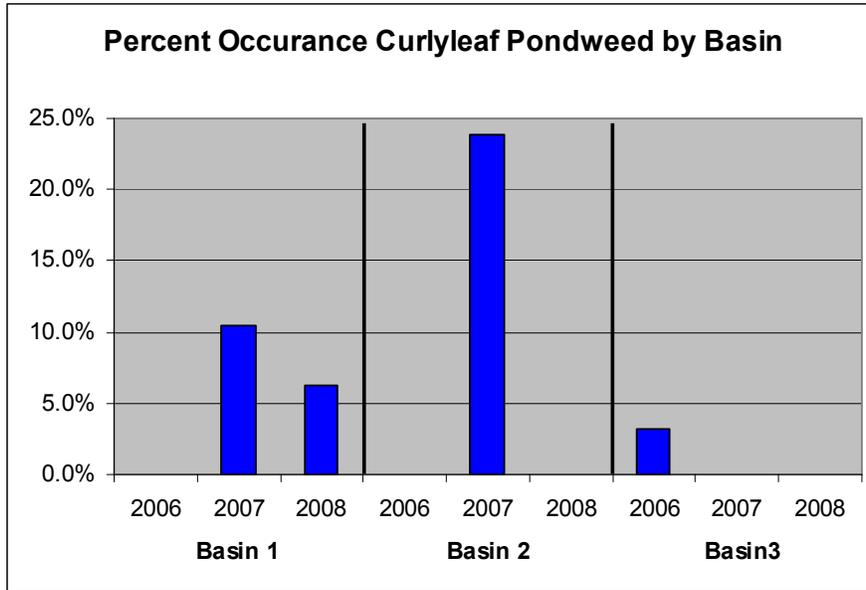


Figure 12. Crooked Lake, curlyleaf pondweed percent occurrence in the last three summer surveys. (Data from Table 7)

Secchi measurements have been taken from the first basin during the last four summer Tier II surveys. Figure 13 illustrates the changes in clarity over this time period.

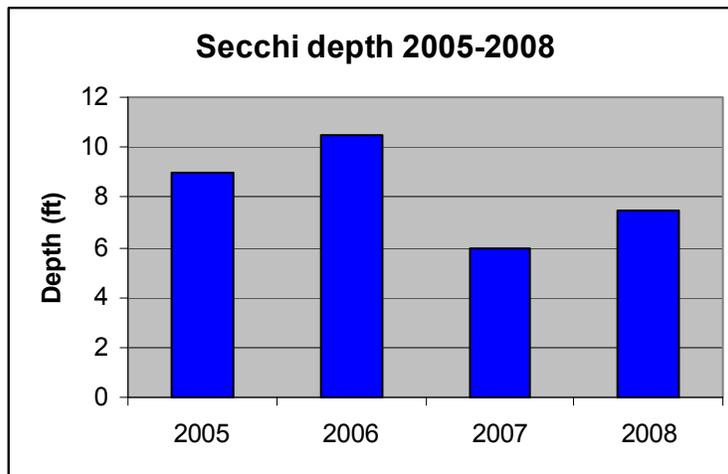


Figure 13. Crooked Lake Secchi depth from 2005-2008 (2005 data collected by IDNR and 2006-2008 data from Aquatic Control)

Another goal of the original plan was to maintain a stable, diverse, aquatic plant community. The Tier II surveys offer a tool for quantifying changes in the submersed native plant population. An increase in native species distribution can be seen in the first and third basins over the last three years of summer sampling while basin two shows a sharp decrease (Table 9) (Figures 14). The decrease in abundance and distribution of native vegetation in the second basin could be due to the decrease in occurrence of chara from 2007 to 2008 in this basin. Table 10 shows a gradual increase in the number of native species collected per site in the first basin and a slight decline in basins two and three (Figure 15). The gradual decline of the mean number of species found per site may have occurred in basin three due to the fluridone treatment that was performed in 2007. This trend is expected to change as native species reestablish.

Table 9. Percentage of sites with native vegetation by basin in Crooked Lake, Tier II surveys 2006 through 2008.

Percentage of sites with native vegetation			
Survey Date	Basin 1	Basin 2	Basin 3
Aug, 2006	64.6%	47.6%	61.3%
Aug, 2007	70.8%	61.9%	51.6%
Aug, 2008	81.3%	28.6%	64.5%

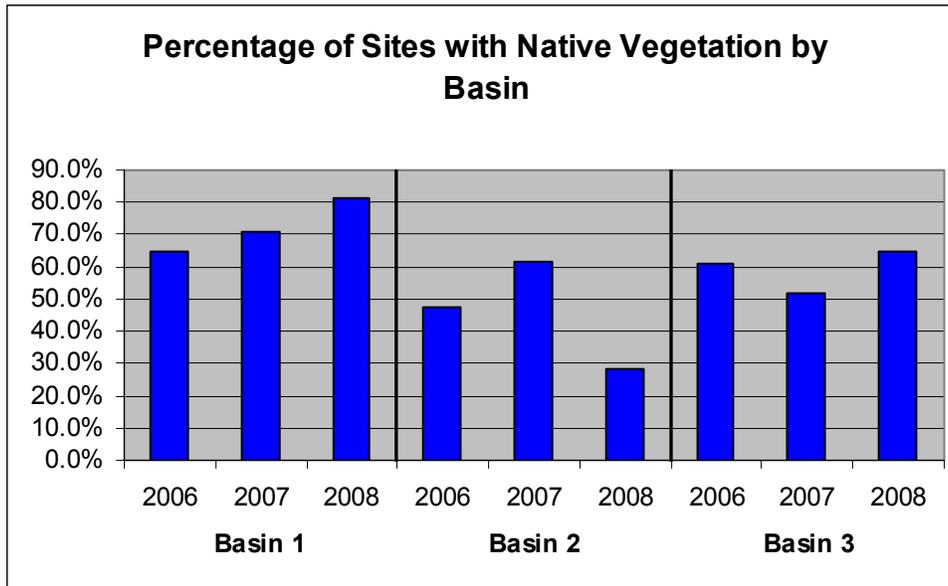


Figure 14. Crooked Lake, percentage of sample sites with native vegetation in the last three summer surveys. (Data from Table 8)

Table 10. Mean number of native species collect per site by basin in Crooked Lake, Tier II surveys 2006 through 2008.

Mean number of native species collected per site			
Survey Date	Basin 1	Basin 2	Basin 3
Aug, 2006	1.31	1.05	1.32
Aug, 2007	1.71	1.10	0.94
Aug, 2008	2.15	0.57	0.81

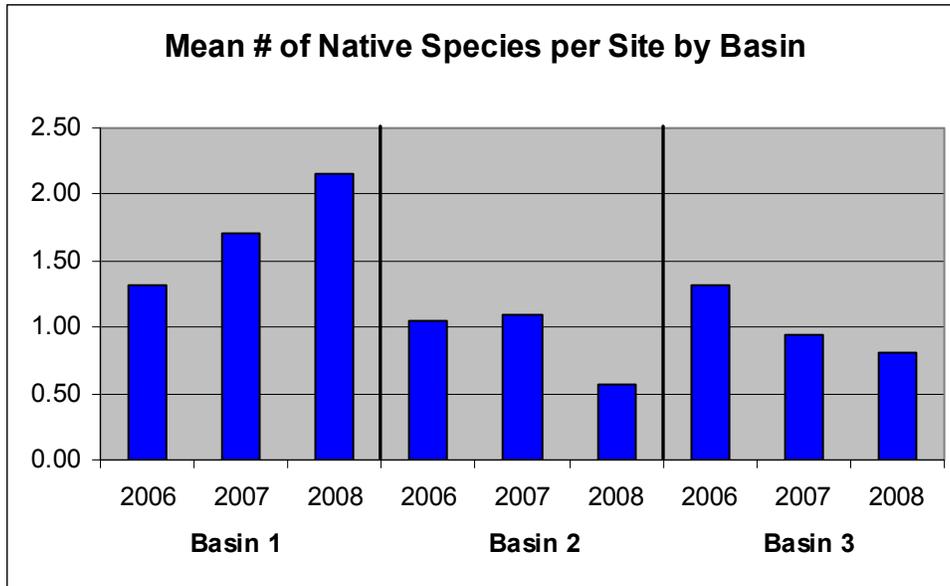


Figure 15. Crooked Lake, mean number of native species per site in the last three summer surveys. (data from Table 9)

Table 11 summarizes the data from the past four surveys as it relates to percent occurrence of individual species in all three basins combined. Southern naiad and common bladderwort were collected in 2007 but not in 2008. These species were found at a very low percentage in 2007. Variable pondweed, brittle naiad, and Illinois pondweed were all collected in the 2008 survey but not collected in 2007. Reduction in frequency of occurrence was most evident in Chara which dropped from 33.0% to 13.0% occurrence. Slender naiad showed the greatest increase in frequency of occurrence from 29.0% in 2007 to 43% in 2008.

Table 11. Percent occurrence of species collected in the last four Tier II surveys on Crooked Lake all 3 basins combined (2005 data provided by IDNR).

Species	% of survey sites (9/05)	% of survey sites (8/06)	% of survey sites (8/07)	% of survey sites (8/08)
Eurasian watermilfoil (<i>Myriophyllum spicatum</i>)	32.1%	60.0%	16.0%	10.0%
curlyleaf pondweed (<i>Potamogeton crispus</i>)	6.7%	1.0%	10.0%	3.0%
common coontail (<i>Ceratophyllum demersum</i>)	11.2%	10.0%	14.0%	5.0%
Chara (Chara spp.)	13.4%	29.0%	33.0%	13.0%
Slender naiad (<i>Najas flexillis</i>)	7.5%	40.0%	29.0%	43.0%
sago pondweed (<i>Potamogeton pectinatus</i>)	19.4%	5.0%	10.0%	18.0%
small pondweed (<i>Potamogeton pusillus</i>)	-	1.0%	-	-
eel grass (<i>Vallisneria americana</i>)	2.2%	1.0%	3.0%	4.0%
American elodea (<i>Elodea canadensis</i>)	1.5%	1.0%	9.0%	9.0%
southern naiad (<i>Najas guadalupensis</i>)	-	-	2.0%	-
spiny naiad (<i>Najas marina</i>)	0.7%	-	-	-
leafy pondweed (<i>Potamogeton foliosus</i>)	-	-	1.0%	4.0%
flatstemmed pondweed (<i>Potamogeton zosteriformis</i>)	1.5%	-	5.0%	1.0%
Richardson's pondweed (<i>Potamogeton richardsonii</i>)	3.0%	1.0%	8.0%	5.0%
large leaf pondweed (<i>Potamogeton amplifolius</i>)	-	8.0%	9.0%	14.0%
variable pondweed (<i>Potamogeton gramineus</i>)	23.1%	10.0%	-	10.0%
variable milfoil (<i>Myriophyllum heterophyllum</i>)	-	2.0%	-	-
water stargrass (<i>Zosterella dubia</i>)	3.0%	3.0%	-	-
common bladderwort (<i>Utricularia vulgaris</i>)	2.2%	4.0%	1.0%	-
western elodea (<i>Elodea nuttali</i>)	-	1.0%	-	-
brittle naiad (<i>Najas minor</i>)	-	3.0%	-	7.0%
Illinois pondweed (<i>Potamogeton illinoensis</i>)	1.5%	5.0%	-	4.0%

Crooked Lake has three distinct basins that received different treatments during the 2007 and 2008 season. It is advantageous to view the plant communities of the three basins separately. The results of the past three years of Tier II sampling within the first basin can be viewed in Table 12. There was a slight decrease in the amount of Eurasian watermilfoil and curlyleaf pondweed between the 2007 and 2008 Tier II surveys. Slender naiad showed the greatest increase of the native species when compared to the 2007 Tier II results. Richardson's pondweed, a plant listed as rare in Indiana, had a slight decrease in frequency from 14.6% in 2007 to 8.3% in 2008, but was still more abundant when compared to the 2006 population. Variable pondweed, Illinois pondweed, and brittle naiad were all found in 2008, but were not detected in 2007. Southern naiad was not found in 2008 but was in 2007. Slender naiad, leafy pondweed, sago pondweed, American elodea, and large leaf pondweed all exhibited increases in frequency, while Eurasian watermilfoil, curlyleaf pondweed, Chara, common coontail, Richardson's pondweed, southern naiad, and flatstem pondweed decreased in frequency. Eel grass remained at 6.3% frequency of occurrence from 2007 to 2008.

Table 12. Percent occurrence of species collected in the last three Tier II surveys on Crooked Lake, Basin 1.

Species Basin 1	% of survey sites (8/06)	% of survey sites (8/07)	% of survey sites (8/08)
Eurasian watermilfoil (<i>Myriophyllum spicatum</i>)	62.5%	20.8%	16.7%
curlyleaf pondweed (<i>Potamogeton crispus</i>)	-	10.4%	6.3%
Slender naiad (<i>Najas flexillis</i>)	56.3%	45.8%	75.0%
Chara (Chara spp.)	20.8%	29.2%	12.5%
common coontail (<i>Ceratophyllum demersum</i>)	18.8%	25.0%	8.3%
leafy pondweed (<i>Potamogeton foliosus</i>)	6.3%	2.1%	8.3%
variable pondweed (<i>Potamogeton gramineus</i>)	6.3%	-	16.7%
Illinois pondweed (<i>Potamogeton illinoensis</i>)	6.3%	-	8.3%
sago pondweed (<i>Potamogeton pectinatus</i>)	4.2%	10.4%	25.0%
water stargrass (<i>Zostera dubia</i>)	4.2%	-	-
western elodea (<i>Elodea nuttali</i>)	2.1%	-	-
brittle naiad (<i>Najas minor</i>)	2.1%	-	14.6%
Richardson's pondweed (<i>Potamogeton richardsonii</i>)	2.1%	14.6%	8.3%
American elodea (<i>Elodea canadensis</i>)	2.1%	16.7%	18.8%
southern naiad (<i>Najas guadalupensis</i>)	-	4.2%	-
large leaf pondweed (<i>Potamogeton amplifolius</i>)	-	2.1%	4.2%
eel grass (<i>Vallisneria americana</i>)	-	6.3%	6.3%
flatstem pondweed (<i>Potamogeton zosteriformis</i>)	-	4.2%	2.1%

The frequency of occurrence of individual species in the past three years of Tier II surveys conducted in the second basin is shown in Table 13. The frequency of occurrence of Eurasian watermilfoil increased slightly from 4.8% in 2007 to 9.5% in 2008. The amount of milfoil found in 2008 was still much lower than what was found in the 2006 survey. Curlyleaf pondweed was not detected during the 2008 Tier II survey but was found at 23.8% of the sites in 2007. Sago pondweed, small pondweed, brittle naiad, Illinois pondweed, and flatstem pondweed were found in 2007 but not in 2008. Variable pondweed, eel grass, and common coontail were found in 2008 but not 2007. Largeleaf pondweed increased in occurrence from 2007 to 2008 while slender naiad and Chara decreased. There was no difference in the frequency of occurrence for Richardson's pondweed from the previous year.

Table 13. Percent occurrence of species collected in the last three Tier II surveys on Crooked Lake, Basin 2.

	% of survey sites (8/06)	% of survey sites (8/07)	% of survey sites (8/08)
Species Basin 2			
Eurasian watermilfoil (<i>Myriophyllum spicatum</i>)	28.6%	4.8%	9.5%
curlyleaf pondweed (<i>Potamogeton crispus</i>)	-	23.8%	-
Slender naiad (<i>Najas flexillis</i>)	38.1%	28.6%	19.0%
Chara (Chara spp.)	19.0%	28.6%	4.8%
sago pondweed (<i>Potamogeton pectinatus</i>)	9.5%	14.3%	-
large leaf pondweed (<i>Potamogeton amplifolius</i>)	9.5%	4.8%	9.5%
variable pondweed (<i>Potamogeton gramineus</i>)	9.5%	-	9.5%
small pondweed (<i>Potamogeton pusillus</i>)	4.8%	-	-
eel grass (<i>Vallisneria americana</i>)	4.8%	-	4.8%
brittle naiad (<i>Najas minor</i>)	4.8%	-	-
Illinois pondweed (<i>Potamogeton illinoensis</i>)	4.8%	-	-
common coontail (<i>Ceratophyllum demersum</i>)	-	-	4.8%
flatstem pondweed (<i>Potamogeton zosteriformis</i>)	-	4.8%	-
Richardson's pondweed (<i>Potamogeton richardsonii</i>)	-	4.8%	4.8%

Eurasian watermilfoil and curlyleaf were not detected in the third basin during the 2008 Tier II survey (Table 14). There were also decreases in the frequencies of Chara, common bladderwort, common coontail, American elodea, and flat stemmed pondweed. Largeleaf pondweed, sago pondweed, and slender naiad all increased in frequency.

Table 14. Percent occurrence of species collected in the last three Tier II surveys on Crooked Lake, Basin 3.

	% of survey sites (8/06)	% of survey sites (8/07)	% of survey sites (8/08)
Species Basin 3			
Eurasian watermilfoil (<i>Myriophyllum spicatum</i>)	80.6%	16.1%	-
curlyleaf pondweed (<i>Potamogeton crispus</i>)	3.2%	-	-
Chara (Chara spp.)	48.4%	41.9%	19.4%
large leaf pondweed (<i>Potamogeton amplifolius</i>)	19.4%	22.6%	32.3%
variable pondweed (<i>Potamogeton gramineus</i>)	16.1%	-	-
common bladderwort (<i>Utricularia vulgaris</i>)	12.9%	3.2%	-
Slender naiad (<i>Najas flexillis</i>)	12.9%	3.2%	9.7%
common coontail (<i>Ceratophyllum demersum</i>)	6.5%	6.5%	-
variable milfoil (<i>Myriophyllum heterophyllum</i>)	6.5%	-	-
Illinois pondweed (<i>Potamogeton illinoensis</i>)	3.2%	-	-
sago pondweed (<i>Potamogeton pectinatus</i>)	3.2%	6.5%	19.4%
water stargrass (<i>Zosterella dubia</i>)	3.2%	-	-
American elodea (<i>Elodea canadensis</i>)	-	3.2%	-
flatstem pondweed (<i>Potamogeton zosteriformis</i>)	-	6.5%	-

No surveys designed to document rooted floating or emergent vegetation were completed this season. Third basin continues to have an abundant emergent and rooted floating plant community despite high speed boating and expanding development. This community is very important for erosion control, fish and wildlife habitat, and the overall water quality of the lake. For the most part, residents of third basin appear to have

recognized the importance of this plant community and have allowed these species to flourish along their docks and shorelines (Figure 16). These residents should be commended for their actions and those living on first and second basin should also be encouraged to allow this vegetation to establish.



Figure 16. Crooked Lake, rooted floating and emergent plant beds, August 12, 2008.

7.0 2008 VEGETATION CONTROLS

Eurasian watermilfoil and curlyleaf pondweed were the primary species targeted for management in 2008. The 2007 action plan called for spot treating of milfoil using 2,4-D herbicide wherever the plant was discovered. The plan also suggested that as much as 155 acres of curlyleaf pondweed might need to be treated with an endotholl based aquatic herbicide in 2008.

On April 29, Aquatic Weed Control Inc. treated approximately 117 acres of curlyleaf pondweed in the third basin (Figure 17). Treatment areas were mapped out during the April 22 invasive species survey performed by Aquatic Control. The treatment maps and GPS coordinates were then given to Aquatic Weed Control to ensure proper treatment of submersed species. Aquathol K (active ingredient endotholl salt) was used at a rate of 1.0 parts per million (ppm) and was injected directly into the water column via drop hoses.

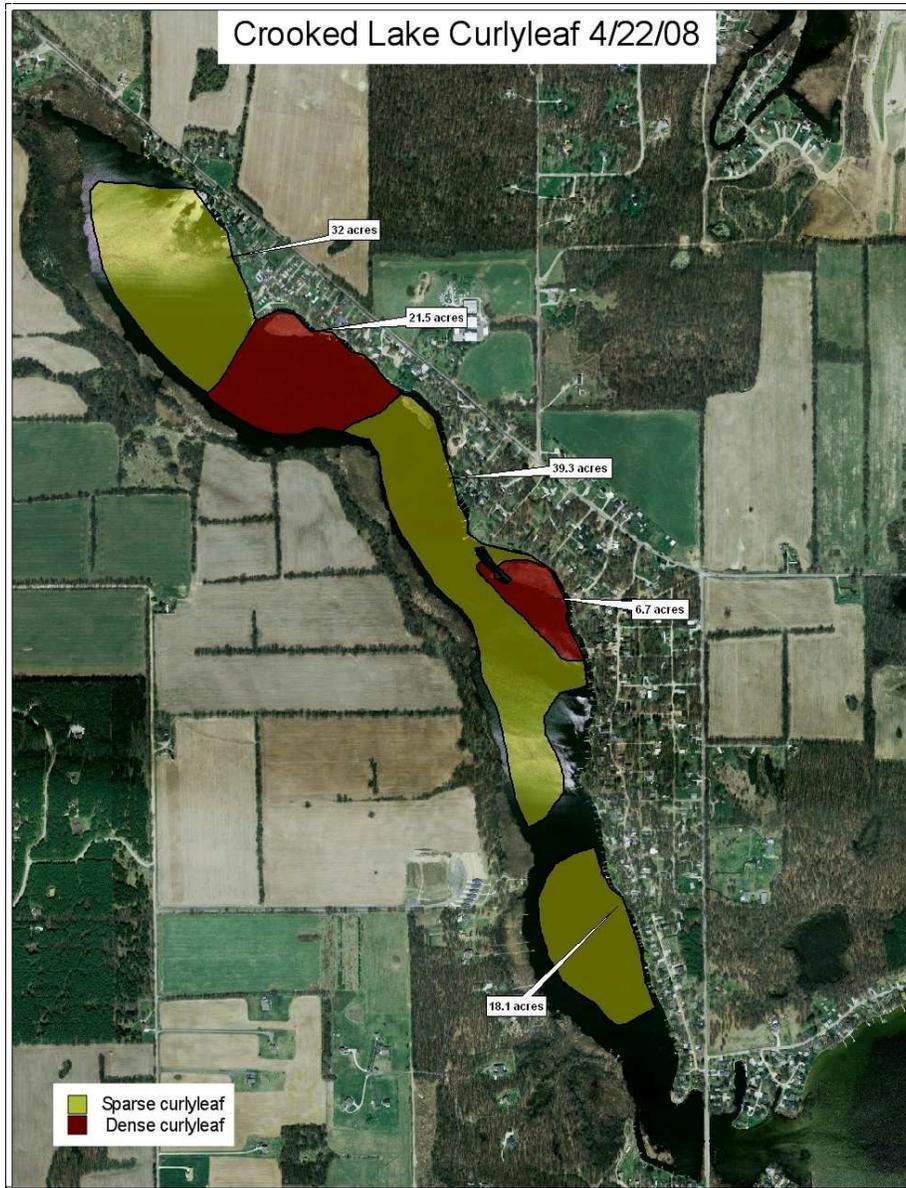


Figure 17. Crooked Lake third basin endotholl treatment areas. April 29, 2008.

Aquatic Weed Control completed treatment of 42 acres of Eurasian watermilfoil on June 5, 2008 (Figure 18). Treatment areas were mapped during the May 27 invasive species survey. Treatment maps and GPS coordinates were supplied to Aquatic Weed Control to insure that the herbicide was being applied to the correct areas of the lake. Liquid and granular 2,4-D (trade names Navigate and DMA 4) were applied to the treatment areas via gas powered spreaders and direct injection spray equipment. It appears that the treatments effectively controlled the targeted species.

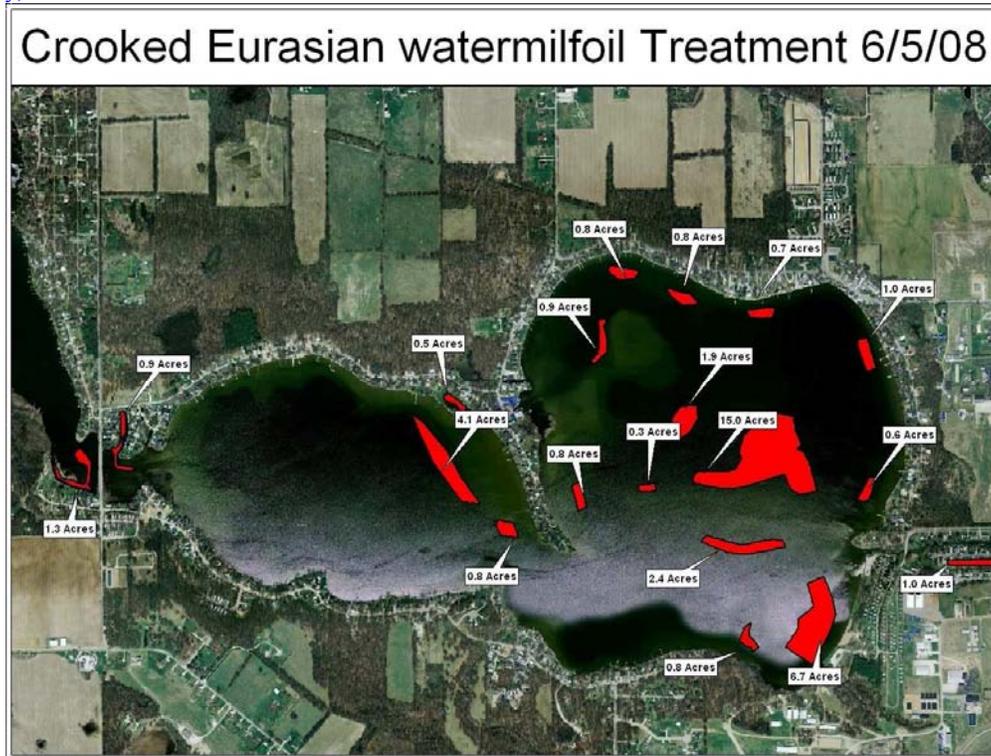


Figure 18. Crooked Lake third basin 2,4-D treatment areas. June 5, 2008.

8.0 PUBLIC INVOLVEMENT

A public meeting was held on October 15, 2008 at a real estate office near Crooked Lake. Approximately 15 lake users attended the meeting of which all were property owners. This was a typical turnout when compared to past public meetings and survey results were similar to past results. Aquatic Control presented information on plant management activities, plant sampling, invasive species, and property owner best management practices.

A survey of lake users was also distributed at the meeting. Of those that responded: 100% were property owners and 87% had lived on the lake for over 10 years. When responding to individual uses of the lake, 87% responded that they use it for swimming, 80% use it for boating, 53% used it for fishing, 47% use it for irrigation, and 13% used it for other purposes.

On questions concerning aquatic vegetation in Crooked Lake: 0% of respondents felt that they had plants at their shorelines in nuisance amounts, 20% said that aquatic vegetation interfered with their use and enjoyment of the lake, 50% felt that the level of vegetation affected their property values, 100% were in favor of continuing efforts to control vegetation in the lake, and 100% were satisfied with the LARE funded invasive treatment for the season.

When asked about issues of concern with the lake: 60% responded that the use of jet skies was a problem, 53% said there were pier/funneling problems, 40% felt that there were too many boats with access to the lake and that there is overuse by nonresidents,

33% said there were not enough aquatic plants, 27% expressed that dredging was needed and there is a fish population problem, and 7% felt there are too many aquatic plants. Results of this survey are summarized in Table 15.

Table 15. Crooked Lake, lake user survey, October 15, 2008.

Crooked Lake User Survey 10/15/08		
Are you a lake property owner?	Yes 100%	No 0%
Are you currently a member of your lake association?	Yes 100%	No 0%
How many years have you been at the lake?	2 or Less: 0%	5 to 10: 0%
	2 to 5: 13%	Over 10: 87%
How do you use the lake (mark all that apply)	Swimming 87%	Irrigation 47%
	Boating 80%	Drinking water 0%
	Fishing 53%	Other? 13%
Do you have aquatic plants at your shoreline in nuisance quantities?	Yes: 0% No: 100%	
Does aquatic vegetation interfere with your use or enjoyment of the lake?	Yes: 20% No: 80%	
Does the level of vegetation in the lake affect your property values?	Yes: 50% No: 50%	
Are you in favor of continuing efforts to control vegetation on the lake?	Yes: 100% 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: 100% No: 0%	
Were you satisfied with the results of the LARE funded invasive treatments this season?	Yes: 100% No: 0%	
Mark any of these you think are problems on your lake:		
40% Too many boats access the lake		
60% Use of jet skis on the lake		
0% Too much fishing		
27% Fish population problem		
27% Dredging needed		
40% Overuse by nonresidents		
7% Too many aquatic plants		
33% Not enough aquatic plants		
0% Poor water quality		
53% Pier/funneling problem		

Overall, participants expressed their satisfaction with the direction of the plan, but were concerned about continued funding. They expressed their need for LARE funds for continuation of the curlyleaf treatment program.

Another topic discussed at the public meeting was the 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 is that it typically has five leaves along each whorl along with visible serrated edges along the leaf margin (Figure 19). 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 Crooked Lake.** More information about controlling the spread of hydrilla can be found at www.protectyourwaters.net.



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).

9.0 ACTION PLAN AND BUDGET UPDATE

In 2008, the primary vegetation management action focused on the control of milfoil with a specific objective of maintaining milfoil below 10% occurrence in the summer Tier II survey. A combination of spot treatments with 2,4-D in the first, second, and small portion of the third basins was completed. LARE funded \$15,750 of the treatment cost while the Association picked up the remaining expenses. The treatment was effective at significantly reducing milfoil abundance and relieving nuisance conditions in 2008 and milfoil percent occurrence was 10% for all basins. The key to the plan is providing long-term control of milfoil. In order to achieve long term control, any remaining areas of milfoil will have to be addressed. It is unlikely that milfoil will be eradicated with the 2,4-D treatments in the first and second basins, but it is possible that next season's abundance will be reduced. Milfoil was detected during the summer survey which adds

to the likelihood that some will be present in 2009. Based on the summer survey and past experience it is estimated 42 acres or less of milfoil will be present in 2009. Figure 20 illustrates areas of concern for next season. These are areas in the first and second basins where milfoil was detected during the summer Tier II survey. It is unlikely that the third basin will require significant treatment since it was treated with fluridone in 2007. If any milfoil is detected in third basin it should be treated. A permit application for this treatment is located in the Appendix. The permit application is for treatment of up to 75 acres of milfoil due to the uncertainty of the exact amount that may be mapped in the spring invasive species mapping survey. It is unlikely that 75 acres will require treatment.

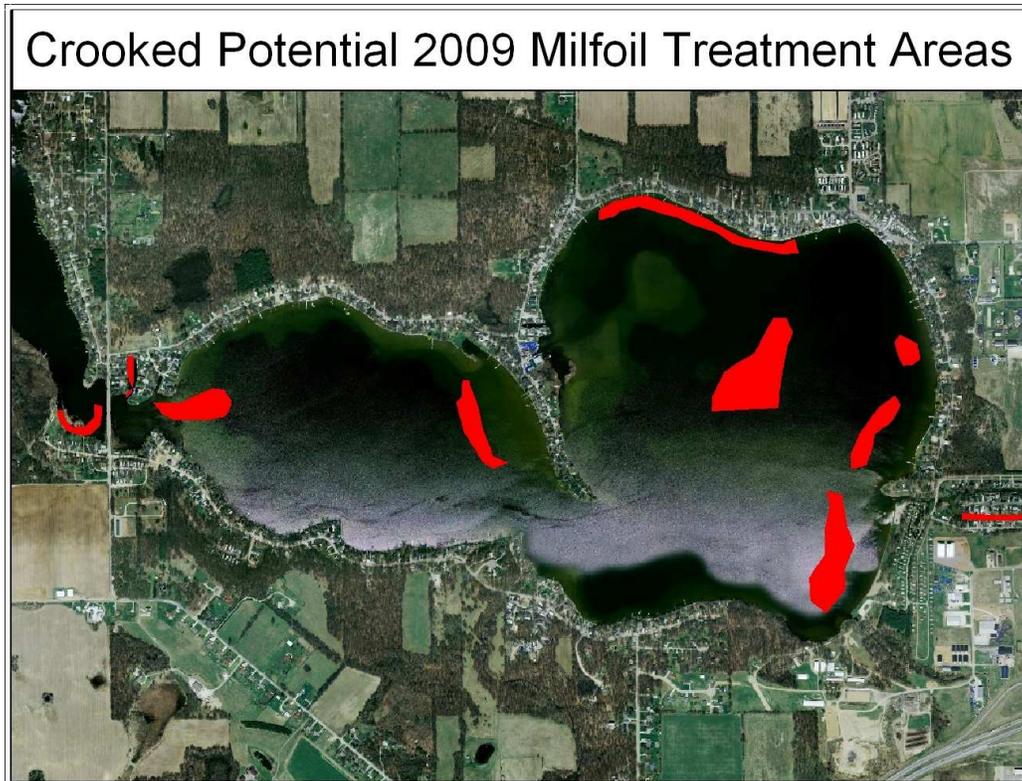


Figure 20. Crooked Lake, milfoil areas of concern for the 2009 season.

One of the more difficult but important aspects of the action plan will be detection and mapping of the milfoil areas. This should be completed in early to mid May with treatment being completed in mid to late May in order to lessen the likelihood of milfoil spread. If Secchi readings are normal, the majority of mapping can be completed by driving a boat in a tight zigzag fashion over the littoral area. When milfoil is located a GPS unit should be used to outline the plant bed. A rake should be used to check for milfoil throughout historical areas of infestation and in the areas marked in Figure 18. A follow-up Tier II survey should also be completed in the summer of 2009 in order to monitor native vegetation to check the effectiveness of the potential controls.

The association funded a curlyleaf pondweed treatment in 2008. The 2007 fluridone treatment and the 2008 endotholl treatment in the third basin may have reduced the amount of turions produced by curlyleaf in that area. Since curlyleaf turions can survive

for several seasons before sprouting, the same areas should be treated for one or two more seasons. In addition, areas containing curlyleaf in the first and second basin should be treated. Turion formation typically occurs at peak biomass (Woolf & Madsen, 2003), so treatment of curlyleaf should occur well before this time. In northern Indiana peak biomass usually occurs in late May or early June. Based on past experience, personal communication with product manufacturers and researchers, along with a journal review, we believe that treatment should occur once the water reaches a consistent 50 degrees Fahrenheit. In addition to reduced turion production, early applications may improve the selective potential of the herbicide because fewer native plant species are actively growing in cooler water temperatures and therefore are less susceptible to herbicide treatment (Poovey et. al. 2002). In addition, algae blooms have been associated with senescence in response to the release of nutrients following decline of large stands of curlyleaf pondweed (Hill 1979, Hill and Webster 1982 cited in Netherland et. al., 2000). Early season control of curlyleaf should help reduce the amount of nutrients taken from the substrate and made available to microscopic algae in the water column.

Up to 150 acres of curlyleaf pondweed may be present in Crooked Lake next season (Figure 21). This estimate is based upon the findings from the 2008 invasive plant mapping survey. Curlyleaf pondweed will likely be most abundant in the third basin (117.6 acres). This basin is relatively shallow with an average depth of approximately 4.0 feet, so that would reduce the cost of treatment compared to treating lakes with much deeper areas (in order to achieve 1.0 ppm in 133 acres of the third basin you would need 2.4 gallons of Aquathol K per acre). The same areas that were treated in 2008 should at least be treated for the next two seasons to exhaust turion supplies.

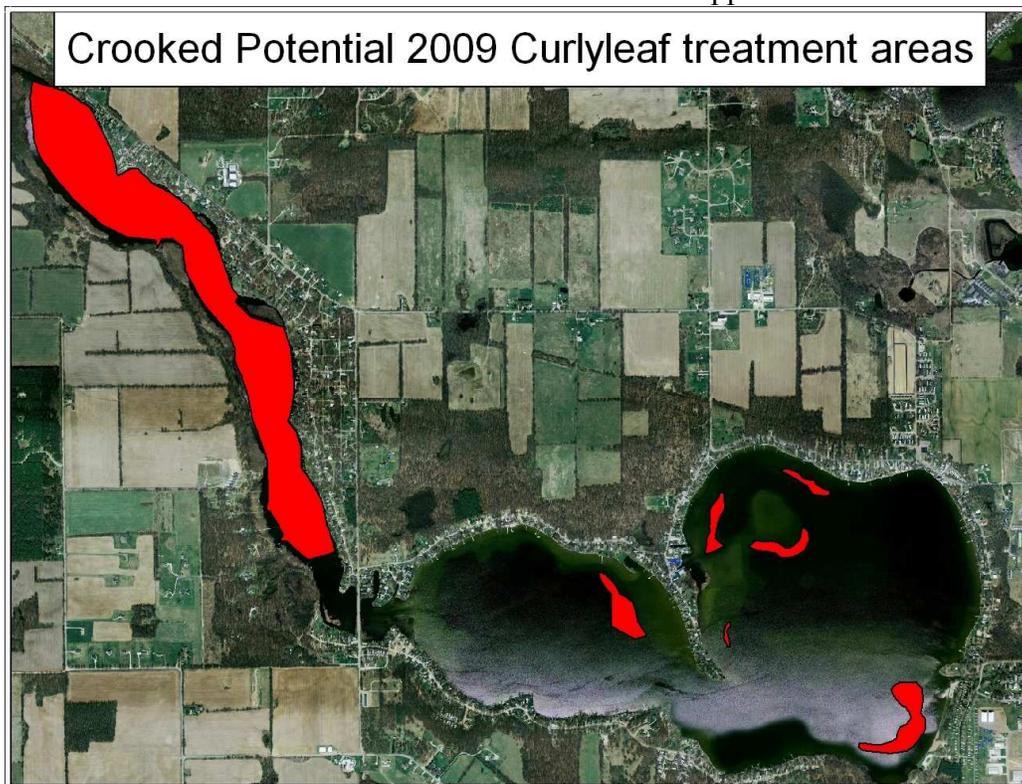


Figure 21. Crooked Lake, 2009 potential curlyleaf pondweed treatment areas.

There are high use areas of the lake that may require some control of native vegetation. These areas include docks, boat ramps, and beaches. Treatment of native vegetation should be limited to these high-use areas and only completed where native vegetation is actually impacting lake use. Registered contact herbicides are effective for short term relief of nuisance conditions and ideally a professional should complete the treatment. A professional applicator will have to apply for permits in order to complete such a treatment. However, homeowner's can legally control vegetation in a 625 square-foot areas of their shoreline without a permit. Any vegetation treated with herbicides or manually removed that extends beyond the 625 square foot area will require an IDNR permit.

Efforts to educate residents on the benefits of native vegetation should be continued. This may include annual meetings, newsletters, ILMS conferences or workshops and website postings. Educating residents on the value of native vegetation and proper shoreline maintenance may help enhance the Crooked Lake ecosystem. In addition, educating residents on the need to properly clean boats and trailers may help reduce the movement of invasive species into or out of Crooked Lake. It is our recommendation that public meetings should be scheduled in the future to address these concerns and further the education of the general public.

It is recommended that the Association request \$59,750 from the LARE program for treatment and the plan update. A total of \$15,000 would be for treatment of approximately 42 acres of milfoil, \$38,750 would be used for treatment of approximately 126 acres of curlyleaf pondweed and \$6,000 would go towards plant sampling and plan updates (Table 16). The Association supports this proposed budget plan and is prepared to pay the cost share. The only change in the budget was the increase in sampling and plan updates due to the need for two invasive species mapping surveys.

Table 16. Crooked Lake, updated three year budget estimate

	2009	2010	2011
2,4-D Treatment for control of Eurasian watermilfoil (Eurasian watermilfoil only)	\$15,000	\$12,500	\$10,000
Early season Endotholl treatment for control of curlyleaf pondweed	\$38,750	\$38,750	\$3,000
Vegetation Sampling & Plan Update	\$6,000	\$6,000	\$5,000
Total w/curlyleaf:	\$59,750	\$57,250	\$18,000

10.0 References Cited

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- Netherland, M.D., Skogerboe, J.D., Owens, C.S., & Madsen, J.D. 2000. Influence of Water Temperature on the Efficacy of Diquat and Endothall versus Curlyleaf Pondweed. *Journal of Aquatic Plant Management* 38: 25-32.
- Poovey, A.G., Skogerboe, J.G., & Owens, C.S. 2002. Spring Treatments of Diquat and Endothall for Curlyleaf Pondweed Control. *Journal of Aquatic Plant Management* 40: 63-67.
- Woolf, T.E. & Madsen, J.D. 2003. Seasonal Biomass and Carbohydrate Allocation Patterns in Southern Minnesota Curlyleaf Pondweed Population. *Journal of Aquatic Plant Management* 41:113-118

11.0 Appendix Update

11.1 2008 Sampling Data-Tier II Survey

Site	Depth	RAKE	MYSP2	POCR3	CEDE4	CH?AR	NAFL	POPE6	VAAM3	ELCA7	POFO3	POZO	POR12	POAM	POGR8	NAMI	POIL
1	11.0	5	1				3			3							
2	17.0	0															
3	7.0	5					5			1	1					1	
4	5.0	1						1									
5	20.0	0															
6	8.0	3	1				3	1		1							
7	10.0	5	1	1			3										
8	6.0	5					5			1		1		1		1	
9	9.0	3	3				1										
10	11.0	5					5	1		1							
11	11.0	3	1				1										
12	10.0	1			3		1			1	1					1	
13	15.0	0															
14	5.0	1					1										
15	6.0	3					3										1
16	5.0	1					1		1								
17	8.0	1					1	1									
18	5.0	5				1	3	1							1		
19	3.0	3					3	1							1		
20	2.0	0															
21	5.0	3					3	1									1
22	16.0	0															
23	5.0	3					3										
24	5.0	3				1	3	1									
25	4.0	5				3	5								1		
26	6.0	1					1										
27	19.0	0															
28	17.0	0															
29	3.0	1														1	
30	7.0	5					5										
31	5.0	0															
32	6.0	5	1				5						1	1			
33	11.0	0															
34	15.0	0															
35	5.0	0															
36	12.0	0															
37	4.0	0															
38	5.0	0															
39	3.0	5	1		1	1	3		1					3			
40	3.0	1					1										
41	5.0	1				1											
42	4.0	1													1		
43	5.0	1													1		
44	5.0	3													3		
45	7.0	1						1							1		
46	5.0	1													1		
47	5.0	0															
48	5.0	0															
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89	5.0	3					3	1									
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91	3.0	5			5		1		1				1				
92	6.0	5					5	1		3			5		1	1	
93	3.0	1					1						1		1		
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96	8.0	5					1									3	1
97	10.0	5	1	1			5				3						
98	12.0	3	1		1		1										
99	16.0	1					1										
100	9.0	3					3						1			1	

11.2 2008 Vegetation Control 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 4
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 Crooked Lake Association		Lake Assoc. Name Crooked Lake Association	
Rural Route or Street 801 West Coliseum Blvd.		Phone Number 260-482-7665	
City and State Fort Wayne, IN		ZIP Code 46808	
Certified Applicator (if applicable)		Company or Inc. Name	
Rural Route or Street		Phone Number	
City and State		ZIP Code	

Lake (One application per lake) Crooked Lake	Nearest Town Angola	County Stueben
Does water flow into a water supply <input type="checkbox"/> Yes <input checked="" type="checkbox"/> 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 Areas TBD following spring survey potential map attached	
Total acres to be controlled <75	Proposed shoreline treatment length (ft)	Perpendicular distance from shoreline (ft)
Maximum Depth of Treatment (ft) 12	Expected date(s) of treatment(s) mid to late May	
Treatment method: <input checked="" type="checkbox"/> Chemical <input type="checkbox"/> Physical <input type="checkbox"/> Biological Control <input type="checkbox"/> 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. Eurasian watermilfoil spot treated with 2,4-D herbicide following mapping survey		

Plant survey method: Rake Visual Other (specify) Data collected during summer 2008 T-2 survey

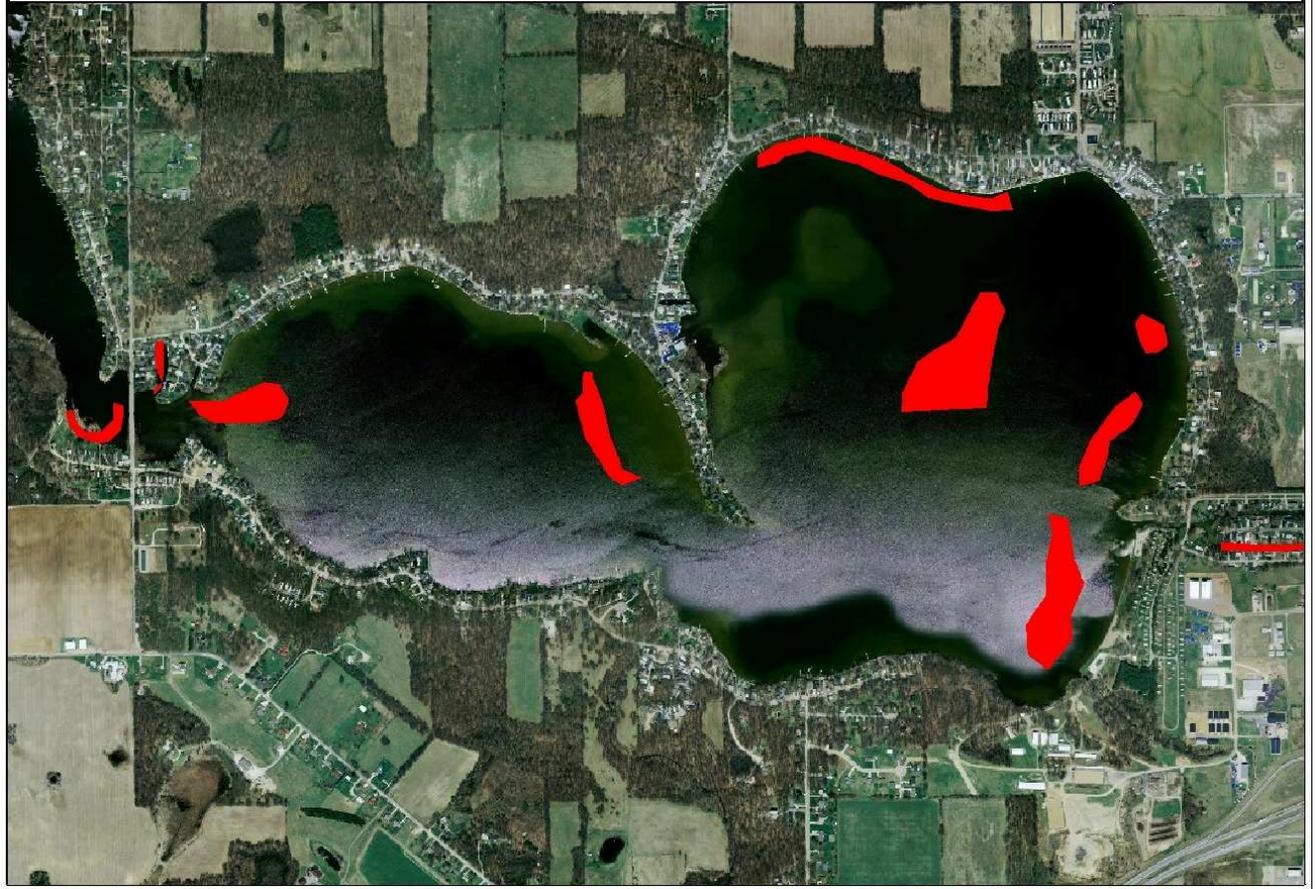
Aquatic Plant Name	Check if Target Species	Relative Abundance % of Community
Eurasian Watermilfoil	x	10
Curlyleaf pondweed		1
Chara		10
Coontail		10
eel grass		5
Largeleaf pondweed		15
sago pondweed		15
Common Bladderwort		5
Slender naiad		25
Richardsons pondweed		2
leafy pondweed		1
flatstem pondweed		1

Treatment Area #	2	LAT/LONG or UTM's		Areas TBD following spring mapping
Total acres to be controlled	155	Proposed shoreline treatment length (ft)		Perpendicular distance from shoreline (ft)
Maximum Depth of Treatment (ft)	12	Expected date(s) of treatment(s) April or when water temp is consistent 50 degrees		
Treatment method:	<input checked="" type="checkbox"/> Chemical	<input type="checkbox"/> Physical	<input type="checkbox"/> Biological Control	<input type="checkbox"/> 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. <u>Early season aquathol K at 1 ppm when water reaches consistent 50 degrees</u>				
Plant survey method:	<input checked="" type="checkbox"/> Rake	<input type="checkbox"/> Visual	<input type="checkbox"/> Other (specify) <u>Data collected in summer T2 survey</u>	
Aquatic Plant Name	Check if Target Species		Relative Abundance % of Community	
Eurasian Watermilfoil			10	
Curlyleaf pondweed	x		1	
Chara			10	
Coontail			10	
eel grass			5	
Largeleaf pondweed			15	
sago pondweed			15	
Common Bladderwort			5	
Slender naiad			25	
Richardsons pondweed			2	
leafy pondweed			1	
flatstem pondweed			1	
<p><i>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.</i></p>				
Applicant Signature			Date	
Certified Applicant's Signature			Date	

FOR OFFICE ONLY			
<input type="checkbox"/> Approved	<input type="checkbox"/> Disapproved	Fisheries Staff Specialist	
<input type="checkbox"/> Approved	<input type="checkbox"/> Disapproved	Environmental Staff Specialist	
<p>Mail check or money order in the amount of \$5.00 to:</p> <p style="text-align: center;">DEPARTMENT OF NATURAL RESOURCES DIVISION OF FISH AND WILDLIFE COMMERCIAL LICENSE CLERK 402 WEST WASHINGTON STREET ROOM W273 INDIANAPOLIS, IN 46204</p>			

Vegetation Control Permit Application Map (page 3 of 4)

Crooked Potential 2009 Milfoil Treatment Areas



Vegetation Control Permit Additions (Page 4 of 4)

