Management Plan for Hope Lake

2011

Jefferson County Land and
Water Conservation Department

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INTRODUCTION

Hope Lake is 126 acre spring lake located in the Towns of Oakland and Lake Mills.

This document was developed by the Jefferson County Land and Water Conservation Department with the assistance of Underwater Habitat Investigations LCC who was hired to lead the field work portion of the project. A Lake Planning grant from the Wisconsin Department of Natural Resources helped to fund the project. The Land and Water Conservation Department contributed staff time for the required local match for the grant money.

CHARACTERISTICS OF HOPE LAKE AND ITS WATERSHED

Hope Lake is a 126 acre spring lake located in the Towns of Oakland and Lake Mills in Jefferson County (Appendix A). The lake is part of the Lower Koshkonong Creek subwatershed of the Rock River. Physical characteristics of the lake are contained in Table 1. Seepage lakes have an outlet and the water supply is contributed primarily from groundwater.

Table 1. Physical Characteristics of Hope Lake

Watershed Area (mi^2)	Lake Area (acres)	Maximum Depth (ft)	Mean Depth (ft)	Volume (acre ft)	Shoreline Length (miles)
2.1	126	24	5.4	573	1.97

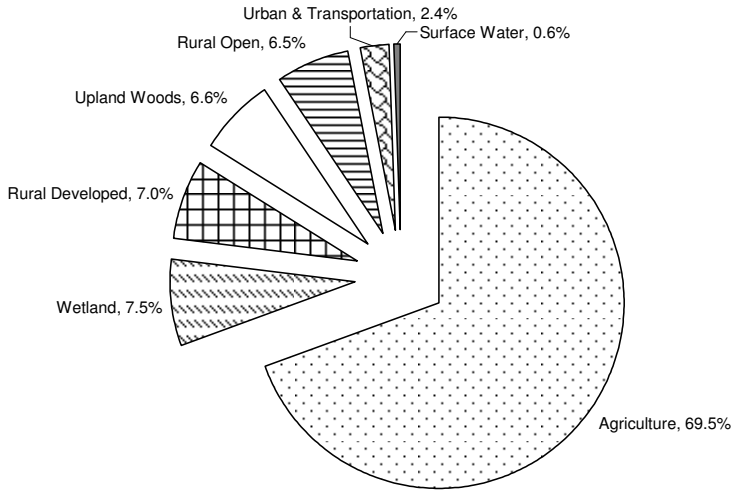
As part of the aquatic plant survey, depths throughout the lake were recorded and a new bathymetry map was developed (Appendix A).

A boat launch is located on private property on the east side of the lake. Users can access the launch by driving through a farm on Hope Lake Road. A minimal fee is requested by the owners and can be deposited into a box located by a barn. As set forth by the Town of Lake Mills, motors are not allowed on boats using the lake. Therefore, the lake is a slow-no-wake lake.

Land Uses

Chart 1 displays the land uses in the Hope Lake watershed. Agriculture is the main land use covering just under 70% of the land area in the watershed. See Appendix A for the map showing the location of the different land uses.

Chart 1. Land Uses in the Hope Lake Watershed



Water Quality

Hope Lake has not received extensive water quality sampling in the past. The 1968 DNR report, Surface Water Resources of Jefferson County, stated that the water is "clear and of high alkalinity" (DNR 1968). The DNR State of the Rock River Basin publication classifies Hope Lake as having a phosphorus sensitivity classification of IB (DNR 2002). This means that the lake is sensitive to increased phosphorus loading and that the existing water quality is poor to very poor. The report also lists the source of impairment as "unspecified nonpoint sources of pollution". The impact is listed as "aquatic or terrestrial habitat degradation." Finally, the DNR website contains water quality data from 1980 and 2000 which will be illustrated below.

Some lake characteristics can give some insight into the water quality conditions of Hope Lake. These are detailed below.

Watershed-to-Lake Ratio

The watershed-to-lake size ratio is used as a measure of the potential nutrient and pollutant loading to a lake from its watershed. If there are two lakes with the same surface acreage but one has a much larger watershed, then there is greater likelihood that the lake with the larger watershed will have more nutrient and pollutant loading from runoff. Runoff occurs when rainwater and snowmelt transport nutrients, sediment, and other pollutants to water. Lakes with watershed-to-lake size ratios greater than 10:1 are known to more often experience water quality problems when compared to lakes with smaller ratios. The watershed-to-lake size ratio for Hope Lake is 11:1.

Stratification

Thermal stratification occurs during the summer in lakes that are more than 20 feet deep. The stratification is characterized by three distinct horizontal layers based on temperature and water densities. The upper layer, called the epilimnion, is characterized by warmer, lighter surface water. The cold, dense bottom water is called the hypolimnion. Separating these two layers is the thermocline or metalimnion characterized by a temperature gradient.

Lakes that are deep enough to sustain their stratification in the summer typically have two times during the year where the lake water fully mixes: spring and fall. In the fall, the upper water will cool until it is similar to the temperature of the lower layer and mixing will occur. Over the winter, another stratification occurs that is characterized by a water temperature under the ice at about 32 degrees and 39 degrees near the bottom of the lake. Mixing does not occur because the ice shields the water from the wind. In the spring when the ice melts, the temperature and density of the water is consistent which allows the water to mix.

Lake stratification is important because water quality and sustainable fisheries can be impacted by the extent of stratification. During the summer in stratified lakes, algae,

plant debris, and other organic material will fall to the bottom of the lake and decay. If the lake produces too much of this organic material, then the decaying process can deplete the oxygen in the hypolimnion causing unsuitable conditions for fish. If the oxygen is totally depleted, then phosphorus bound to sediment particles can be released into the water. Then when the lake mixes in the spring and fall, algae blooms can occur due to the increased availability of phosphorus in the water column.

The dissolved oxygen and temperature profiles measured on Hope Lake indicates that the lake stratifies. The degree to which the lake stratifies can be determined by the stratification factor:

$$\text{Stratification Factor} = \frac{\text{Maximum Depth (ft) + 4.5}}{\text{Log of surface area (acres)}}$$

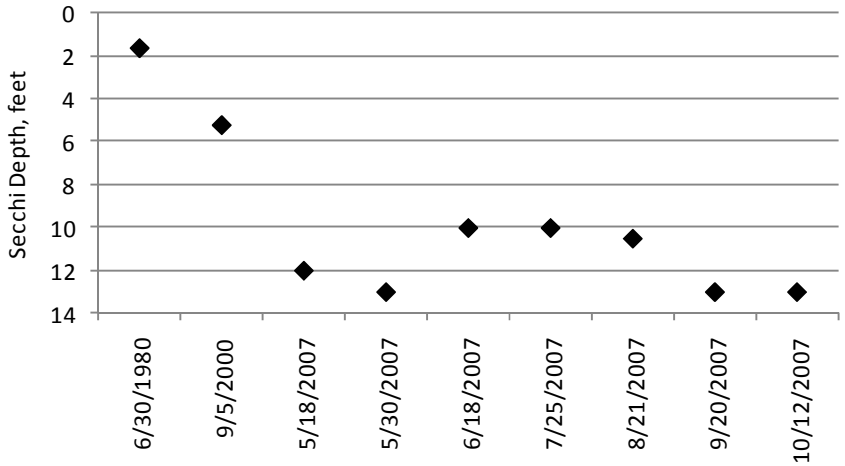
Higher ratios indicate more stratification, with ratios of 13.5 and higher being more strongly stratified. Lakes that are more strongly stratified are more sensitive to additional nutrient inputs then lakes that do not sustain stratification. The stratification factor for Hope Lake is 13.6.

During the 2007 sampling period, the temperature and dissolved oxygen profiles indicate that Hope Lake stratifies. During the October sampling date, the lake was experiencing fall mixing.

Water Clarity

A Secchi disc is an 8-inch disc that is painted black and white. It is lowered into the water until it disappears from sight, then raised until it becomes visible – that depth is recorded as the water clarity reading. Materials suspended (especially algae) and dissolved in the water will impact the water clarity of a lake. Water clarity measurements can indicate the overall water quality of a lake. Chart 2 displays the water clarity readings that were taken during the project in 2007 along with readings in the DNR data base of previous years.

Chart 2. Water Clarity Measurements in Hope Lake



Trophic State

By determining a lake's trophic state, its water quality can be characterized as eutrophic, mesotrophic, or oligotrophic. These trophic states are based on water clarity, total phosphorus concentration, and chlorophyll *a* concentration.

Oligotrophic lakes are clear, deep, and free of weeds or large algae blooms. They contain low amounts of nutrients and therefore do not support large fish populations. However, they can develop a food chain capable of sustaining a desirable fishery of large game fish. Mesotrophic lakes have moderately clear water. They can have deep waters that are low in dissolved oxygen during the summer, and as a consequence, can limit cold water fish and cause phosphorus release from the bottom sediments. Eutrophic lakes are high in nutrients and support a large biomass that include weeds, or frequent algae blooms, or both. Rough fish are often common in eutrophic lakes.

A natural aging process occurs in all lakes to shallower and more eutrophic lakes. It is important to point out that this aging process is accelerated by human activities that increase sediment and nutrient delivery to our lakes including agriculture, existing and new development, fertilizers, storm drains, etc.

The Trophic State Index is determined using mathematical formulas that convert Secchi disc, total phosphorus, and chlorophyll *a* measurements into a TSI score on a scale of 0 to 110. Lakes that are less fertile have a low TSI. The scale is described in Table 2.

Table 2. Description of the Trophic State Index Scale

TSI Score	Description
TSI < 30	Classical oligotrophic: clear water, many algal species, oxygen throughout the year in bottom water, cold water, oxygen-sensitive fish species in deep lakes. Excellent water quality.
TSI 30-40	Deeper lakes still oligotrophic, but bottom water of some shallower lakes will become oxygen-depleted during the summer.
TSI 40-50	Water moderately clear, but increasing chance of low dissolved oxygen in deep water during the summer.
TSI 50-60	Lakes becoming eutrophic: decreased clarity, fewer algal species, oxygen-depleted bottom waters during the summer, plant overgrowth evident, warm-water fisheries (pike, perch, bass, etc.) only.
TSI 60-70	Blue-green algae become dominant and algal scums are possible, extensive plant overgrowth problems possible.
TSI 70-80	Becoming very eutrophic. Heavy algal blooms possible throughout summer, dense plant beds, but extent limited by light penetration (blue-green algae blocks sunlight).
TSI > 80	Algal scums, summer fish kills, few plants, rough fish dominant. Very poor water quality.

Chlorophyll *a* is the photosynthetic pigment found in plants. When filtered from lake water, it will signify the lake's algae biomass with higher concentrations indicating algal blooms. For most Wisconsin lakes, concentrations less than 7 µg/l indicate good water quality. Hope Lake's average summer (July-August) chlorophyll *a* concentrations for 2007 was 8.6 µg/l. Table 3 lists all of the chlorophyll *a* data on Hope Lake.

Table 3. Cholorphyll *a* Concentrations in Hope Lake

Date	**Chlorophyll *a* (µg/l)**
June 30, 1980	28
September 5, 2000	13
July 25,2007	9.89
August 21, 2007	7.32
September 20, 2007	7.26
October 12, 2007	9.47

Phosphorus is a nutrient that is often referred to as the "limiting nutrient" because its concentration in the water will affect the amount of algae and plant growth more than nitrogen. One pound of phosphorus delivered to a lake can produce up to 500 pounds of algae. Sources of phosphorus include runoff from farmland, animal lots, and lawns, as well as shoreline erosion.

Phosphorus mostly is held in insoluble particles with calcium, iron, and aluminum. Phosphorus is only released from particle form when the water is anoxic (has no oxygen). Anoxic conditions occur in the bottom waters of deep lakes during the summer when dead plant and animal matter uses up the oxygen during decomposition. During the summer, the phosphorus released from the sediments is held in the bottom waters and only enters the upper waters during strong winds that can mix the upper waters with the bottom waters. When the lake's water mixes in the fall, the phosphorus that had been contained in the bottom waters will mix with the surface water and cause fall algal blooms. Hope Lake's total phosphorus in the 1st 6 feet of the lake was sampled throughout 2007 and the results are shown in Table 4. One other phosphorus measurement was on record for 2000 and is also included in the table.

Table 4. Total Phosphorus in Hope Lake.

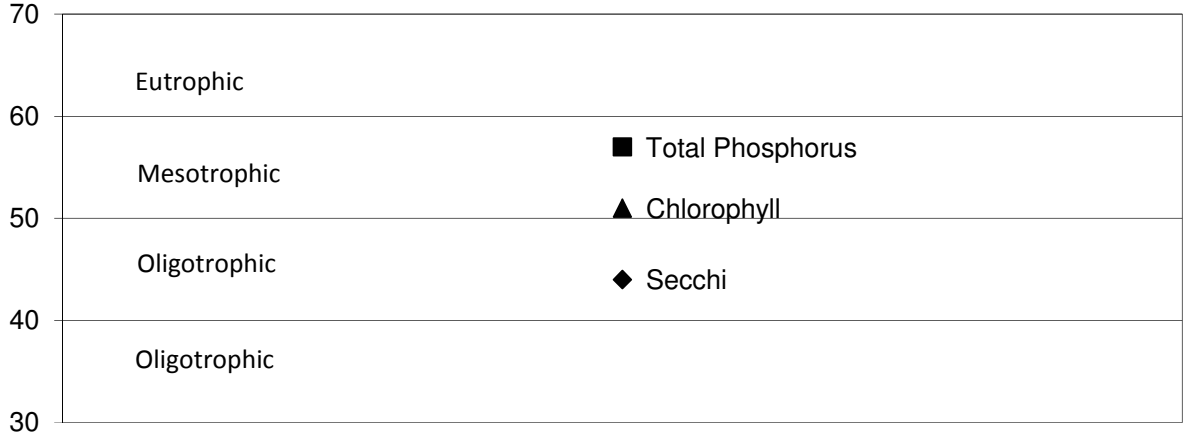
Date	Total Phosphorus (ug/l)
September 5, 2000	62
May 18, 2007	32
July 25, 2007	33
August 21, 2007	52
September 20, 2007	49
October 12, 2007	58

The average 2007 summer(July/August) phosphorus concentration in Hope Lake was 42.5 ug/l in the surface waters. In terms of phosphorus, this average indicates that the water quality condition of the lake is fair and the lake is classified as mesotrophic.

The total phosphorus in the bottom of the lake was also measured on August 21, 2007 and was found to be 384 ug/l. During the same sampling time, the dissolved oxygen in the bottom of the lake was very low at 0.25 mg/l. Therefore, the bottom waters were basically anoxic, and under these conditions, phosphorus is released from the sediments. The dissolved oxygen profiles throughout the sampling period show very low dissolved oxygen in May, June, July, August, and September. During these months, phosphorus was likely being released into the bottom waters. In October, when the lake was fully mixed (constant dissolved oxygen & temperature throughout the depth profile), the lake had dissolved oxygen at 5.3 – 5.7 mg/l throughout the depth profile. The water quality standard for a warm water lake such as Hope Lake is 5 mg/l because this is the minimum amount of oxygen needed for fish to survive and grow.

The Trophic State Index for Hope Lake in 2007 is displayed in Chart 3. It represents average July and August measurements of water clarity, total phosphorus, and chlorophyll *a*. Hope Lake is characterized as a mesotrophic lake.

Chart 3. Trophic State Index for Hope Lake (Note: This chart does not contain the entire Trophic State Index scale. Not shown is classic oligotrophic of 0-30 and eutrophic scales greater than 70.)



A water quality index was developed for Wisconsin lakes using data collected in July and August (Lillie and Mason 1983). Table 5 shows this index and contains the 2007 data on Hope Lake.

Table 5. Water Quality Index for Wisconsin Lakes with 2007 Hope Lake Data Indicated (adapted from Lillie and Mason 1983)

Water Quality Index	Secchi Depth (feet)	Chlorophyll a (ug/l)	Total Phosphorus (ug/l)
Excellent	> 19.7	< 1	< 1
Very Good	9.8-19.7 Hope Lake = 10.6	1-5	1-10
Good	6.6-9.8	5-10 Hope Lake = 8.6	10-30
Fair	4.9-6.6	10-15	30-50 Hope Lake = 42.5
Poor	3.3-4.9	15-30	50-150
Very Poor	< 3.3	> 30	> 150

pH

Hydrogen ion concentrations are measured as pH. During the summer of 2007, the pH of Hope Lake ranged from 6.06 to 9.5 and falls mainly on the alkaline side of the pH scale (pH of 7 is neutral).

Conductivity

Conductivity measurements indicate the total dissolved solids in the water. In July 2007, conductivity averaged 367 umhos/cm in the upper waters and 441 umhos/cm in the deeper waters.

Aquatic Plants

Aquatic plants are a vital part of a healthy lake ecosystem. In fact, 90% of a lake's ecosystem depends of what happens in the vegetated shallow areas. Some valuable characteristics of aquatic plants are the following:

- Aquatic plants create a thriving habitat supplying food, shade, and shelter for a large variety of aquatic and terrestrial animals.
- Fruits and tubers of aquatic plants provide food for mammals, waterfowl, insects and fish.
- Aquatic plants are essential to the spawning success of many fish species.
- Aquatic plants photosynthesize, creating oxygen for the animals that live in the shallow area.
- Aquatic plants filter runoff from uplands to protect lake water quality.
- Plant roots create networks that stabilize sediments at the water's edge where waves might otherwise erode the lakeshore.
- Submersed plants absorb phosphorus and nitrogen over their leaf surface and through their roots.
- Plant use nutrients, making them less available for nuisance algae.

- Native aquatic plants can limit growth of exotic plants.

Aquatic plants can reveal a lot about the quality of a lake. The aquatic plant communities were sampled in Hope Lake by use of the point intercept method developed by Jen Hauxwell (DNR). Details of the procedure can be found in Aquatic Plant Management in Wisconsin (DNR & UWEX). Sampling was conducted in June and July of 2007. Herbarium specimens were collected and submitted to the UW Madison Herbarium.

There were a total of 23 species of aquatic plants (either sampled or visually observed) in Hope Lake. The distribution and density of the plants are shown on maps in Appendix B. The species found in the survey are listed in Table 6.

Table 6. Ecological Significance and Coefficient of Conservatism for Aquatic Plants in Hope Lake, 2007

Aquatic Plant *Species name* Common name	**Plant Type**	**Coefficient of Conservatism**	**Ecological Significance**
Glyceria borealis Northern manna grass	T/E	8	Important food source for ducks and is grazed by muskrats and deer. Submerged portions of plant provide spawning habitat for a variety of fish.
Potamogeton parelongis Whitestem pondweed	S	8	Good habitat for game fish and provides grazing opportunities for waterfowl and muskrats.
Pontederia cordata Pickerelweed	E	8	Important habitat for a variety of invertebrates. Provides food and cover for waterfowl and wetland mammals. Also offers cover for fish.
Ranuculus flabellaris Stiffwater crow foot	S	8	Supports insects and other invertebrates that are an important food source for game fish. Wetland birds and waterfowl graze heavily on fruits.
Chara spp. Muskgrass	S	7	Excellent producer of fish and waterfowl food, stabilizes bottom sediments, has a softening effect on water by removing lime and carbon dioxide.
Utricularia vulgaris Common bladderwort	S	7	Provides good habitat for a variety of fish and some invertebrates.
Heteranthera dubia Water star grass	S	6	Locally important food source for ducks and geese. Provides cover and food for some fish.
Myriophyllum sibiricum Northern water milfoil	S	6	Leaves and fruit are often eaten by waterfowl. Provides excellent habitat for invertebrates as well as game fish.
Nuphar variegate Spatterdock	FL	6	Provides shade and shelter for fish and habitat for invertebrates. Seeds are eaten by a variety of waterfowl. Leaves,

Aquatic Plant *Species name* Common name	**Plant Type**	**Coefficient of Conservatism**	**Ecological Significance**
			stems, and flowers are eaten by deer. Rhizomes eaten by muskrat, beaver, and porcupine.
Nymphaea odorata White water lily	FL	6	Provides shade and cover for fish and invertebrates. A food source for waterfowl, muskrat, and beaver.
Potamogeton foliosus Leafy pondweed	S	6	Early season nutlets provide important food source for waterfowl. Leaves and stems are grazed by muskrat and beaver.
Potamogeton zosteriformis Flatstem pondweed	S	6	Food source for waterfowl and wetland mammals. Provides cover for fish and invertebrates. Supports insects valuable as food source for fish and waterfowl.
Carex comosa Bottle brush sedge	E	5	Nutlets are eaten by a variety of waterfowl.
Iris versicolor Blue flag iris	T/E	5	Provides food and cover for a variety of wildlife including wetland birds, mammals and insects.
Spirodela polyrhiza Large duckweed	FF	5	Important food source for a variety of wildlife, capable of satisfying most dietary needs of ducks and geese. Provides essential shade and cover for fish and insects.
Lemmna minor Small duckweed	FF	4	Important food source for ducks and geese. Consumed by muskrats, beaver, and fish. Provides shade and cover for fish and invertebrates. Extensive mats of duckweed can inhibit mosquito breeding.
Schoenoplectus tabernaemontani Softstem bulrush	E	4	Important nesting habitat and cover for wide variety of wetland birds and waterfowl. Shoots are grazed by muskrats. Provides fish spawning habitat and cover for juvenile fish.
Ceratophyllum demersum Coontail	S	3	Provides good shelter for young fish, supports insects valuable as food for fish and ducklings, and fruits are eaten by waterfowl.
Sagittaria latifolia Common arrowhead	E	3	Tubers and seeds are eaten by waterfowl and provide cover for young fish.
Stuckenia pectinata Sago Pondweed	S	3	Fruits and tubers are a very important food source for a variety of waterfowl. Supports insects that are eaten by game fish and also provides cover for young game fish.

Aquatic Plant *Species name* Common name	**Plant Type**	**Coefficient of Conservatism**	**Ecological Significance**
Typha latifolia Broad-leaved cattail	E	1	Provides nesting habitat for waterfowl and wetland birds. Roots and shoots are often eaten by muskrats and beaver. Provides spawning habitat for some game fish.
Hybrid water milfoil	S	0	
Lythrum saalicaria Purple loosestrife	T/E	0	Invasive exotic that is capable of creating a monoculture. Provides poor food and cover for wildlife.
Myrophyllum Spicatum Eurasian water milfoil - Invasive Species -	S	0	Invasive exotic that aggressively takes over and creates a thick monoculture which provides poor habitat.
Phalaris arundinacea Reed canary grass - Invasive Species -	T/E	0	Invasive species that creates a monoculture. It grows in thick mats that can collect sediment and block waterways. Provides poor cover and food for wildlife.
Potamogeton crispus Curly-leaf pondweed - Invasive Species -	S	0	Invasive exotic. Provides winter and spring habitat for fish and invertebrates. Mid-summer die-off releases nutrients which may trigger algae blooms and create turbid water conditions.
Typha angustifolia Narrow-leaved cattail	E	0	Naturalized exotic, provides nesting habitat for waterfowl and wetland birds. Roots and shoots are often eaten by muskrats and beaver. Provides spawning habitat for some game fish.

Key:
E = Emergent – plants with leaves that extend above the water surface
FL = Floating Leaf – plants with leaves that float on the water surface
FF = Free Floating – plants that float freely on the water surface
S = Submersed – plants with most of their leaves growing below the water surface
T/E = Terrestrial/Emergent plants

The summary of statistics from the plant sampling is contained in Table 7.

Table 7. Summary of Plant Sampling Statistics for Hope Lake

Total number of points sampled	252
Total number of sites with vegetation	239
Total number of sites shallower than maximum depth of plants	245
Maximum depth of plants	12.7 feet
Average number of all species per site (shallower than max depth)	2.58
Average number of all species per site (veg. sites only)	2.65
Average number of native species per site (shallower than max depth)	2.21
Average number of native species per site (veg. sites only)	2.31

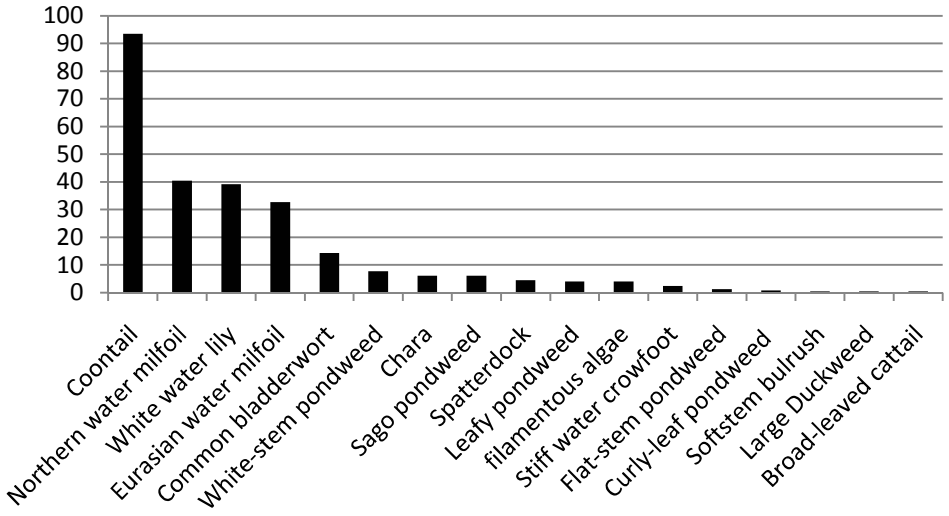
There are several ways to analyze aquatic plant data for a lake. These include the coefficient of conservatism, the floristic quality index, the frequency of occurrence, the relative frequency of occurrence, and the Simpson Diversity Index.

The Coefficient of Conservatism is a number on a scale from 0 to 10 that represents an estimated probability that a plant species is likely to occur in a lake unaltered from what is believed to be pre-settlement conditions. A coefficient of 10 indicates the plant is almost certain to be found only in an undegraded natural community, and a coefficient of 0 indicates the probability is almost 0. Introduced plants were not part of the pre-settlement flora, so no coefficient is assigned to them. In addition, hybrid species do not have an assigned coefficient. Table 4 lists the species from highest coefficient to lowest. The average Coefficient of Conservatism for Hope Lake is 4.3.

The floristic quality index (FQI) is used to assess a lake's quality using the aquatic plants that live in it. Developed by Stan Nichols (WI Geological and Natural History Survey), the floristic quality index is the average coefficient of conservatism multiplied by the square root of the number of plants in the lake. The FQI varies around Wisconsin but ranges from 3.0 to 44.6 with a median of 22.2. Generally, higher FQI numbers mean better lake quality. The floristic quality index for Hope Lake is 22.1.

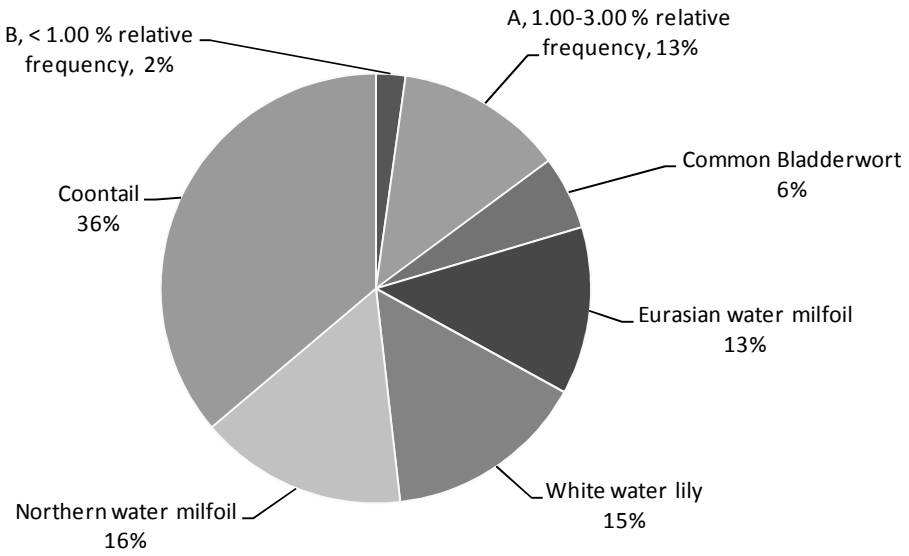
The frequency of occurrence for a plant species is the number of times a species is observed, divided by the total number of sampling points contained within the area shallower than the maximum depth of plants in a lake. The maximum rooting depth of Hope Lake is 12.7 feet. The frequency of occurrence is expressed as a percentage and the results from the 2007 survey are displayed in Chart 4. The Frequency of Occurrence does not factor in plant species that were visually noted in the survey and not sampled with the rake.

Chart 4. Frequency of Occurrence of Plants in Hope Lake, 2007



The relative frequency of occurrence gives an indication of how the plants occur throughout a lake in relation to each other. It is the frequency of a species divided by the sum of the frequencies of all species. The sum of the relative frequencies should be equal to 100%. The data from the 2007 survey is displayed in Chart 5.

Chart 5. Relative Frequency of Plants in Hope Lake, 2007



A = leafy pondweed, spatterdock, chara, sago pondweed, white stem pondweed, filamentous algae
B = softstem bulrush, large duckweed, broad-leafed cattail, curly-leaf pondweed, flat-stem pondweed, stiff water crowfoot

Based on the Simpson Diversity Index (one minus the sum of the relative frequencies squared) for the community, the closer the index value is to one, the greater the diversity within the lake. The Simpson Diversity Index for Hope Lake is 0.80.

Fish

The Surface Water Resources of Jefferson County (DNR 1968) states that the fishery consisted of yellow perch, bullheads, golden shiners, and panfish. The report also states that winter kill is a problem and may be caused by water level fluctuations.

During the summer of 2007, a variety of fish sampling was performed and a total of 5 species were identified. Sampling gear included dipnets, minnow traps, and seines (1/8" mesh size). Previous sampling was done in June of 1974 with a small mesh seine, and October of 1981 with a mini-boom. The fish found in all of these efforts are listed in Table 8. Please note that different gear types can select for different fish species. It should be noted that the lower number of species sampled in 2007 does not necessarily mean that the fish found in previous years are no longer in the lake.

Table 8. Fish Species of Hope Lake

Fish Species	1974	1981	2007
Bluegill		x	x
Black Bullhead	x	x	
Brown Bullhead	x	x	
Central Mudminnow	x		x
Golden Shiner	x		
Green Sunfish	x		
Iowa Darter	x		
Largemouth Bass	x	x	x
Northern Pike			x
Pumpkinseed	x	x	x
Yellow Perch		x	

In 2007, a total of 4 minnow traps (with and without bait) were set in Hope Lake on 3 different occasions for a period of approximately 24 hours. Out of the 12 attempts, only 3 traps resulted in a total of 4 fish. One of the traps resulted in 2 dead bluegills. It is theorized that not many fish were caught in the minnow traps because the oxygen may likely get depleted in the shallow areas of the lake overnight.

It is important to note that Iowa darters, an environmentally/habitat sensitive fish, was not found in 2007, though it was documented in the lake in 1974.

Wildlife

The DNR 1968 Surface Water Resource report (DNR 1968) noted that "mallards and blue-winged teal nest here and on the adjoining 99 acres of wetland."

Wildlife observed on or adjacent to the lake was document in 2007. The following is the list of species observed:

Black Tern
Great Blue Heron
Canada Geese
Turkey Vulture
Muskrat
Bullfrog
Green Frog
Northern Water Snake
Snapping Turtle

The Black Tern (Chlidonias niger) is a Wisconsin Species of Greatest Conservation Need. Species of Greatest Conservation Need have low and/or declining populations that are in need of conservation action.

Black terns nest in emergent marshes associated with large lake and wetland complexes. In Hope Lake, the black terns were seen protecting their nests and young – both of which were on the lily pads.

Habitat loss and degradation, and habitat isolation and fragmentation are the principal threats to black terns. The State Rank for black terns is defined as "Imperiled in Wisconsin because of rarity (6 to 20 occurrences or few remaining individuals or acres) or because of some factor(s) making it very vulnerable to extirpation from the state." Conservation actions identified by the Department of Natural Resources to protect black terns include:

- Initiation of lake or wetland renovation projects where breeding habitat is declining.
- Control of carp and purple loosestrife.
- Use of artificial nesting platforms may benefit black terns and should be evaluated on a site-by-site basis.
- Black terns may benefit from creation or restoration of marshes.

The restoration of Zeloski Marsh to the north of Hope Lake will hopefully benefit the population at Hope Lake. In 2009, black tern nesting platforms were built in Zeloski Marsh.

During the sampling efforts of 2007, crawfish traps were also set. No crawfish were found.

Habitat, Biological Diversity

The Lower Rock River Basin: Water Quality Management Plan (DNR 1998) identifies the Hope Lake bog as a resource of concern. The bog is located on the north end of the lake. The Madison Audubon Society owns the 35 acre bog. The DNR report states that the site "has been studied by University of Wisconsin ecologists. It's one of the best southern bogs and contains many northern plants uncommon in this region. Tamaracks to 8-inch diameter breast height dominate the woody vegetation. A shallow moat and a large amount of poison sumac make entry difficult." The Glacial Heritage Area report (DNR 2009) also states that common plants include pitcher plant, cotton grass, leatherleaf, bog rosemary, bog birch, and cranberry. There is no public access to the bog.

The Jefferson County Parks, Recreation, and Open Space Plan (2005-2010) contains a list of sites for future parks. This plan includes Hope Lake. The Glacial Heritage Area report identifies Hope Lake as a proposed conservation park. It is important to note that the State and the County only work with willing landowners to obtain park land.

PUBLIC INPUT

During the course of the project, the public's input on Hope Lake was obtained in a variety of ways. Project managers talked to boaters on the lake during the times when they were sampling. In addition, the project was discussed by a project manager at a meeting of the Rock Lake Improvement Association. Finally, a public meeting was held on Monday, June 27, 2011 at the Town Hall of the Town of Lake Mills.

Citizens who attended the public meeting included landowners adjacent to Hope Lake and fisherman who use the lake.

The landowners stated that aerators were used in the past in the winter to ensure there was adequate oxygen for the fish. The Oakland Conservation Club used to install the aerator from the west shoreline. It is not known why this was stopped. The fisherman stated that Hope Lake is used by fisherman more in the winter than in the summer.

There were concerns about the amount of vegetation in the lake that makes it hard to navigate in some areas. In addition, the fishermen were interested in fish stocking which was done in the past.

It was also noted that the area by the boat launch is shallow and sometimes hard to launch a boat and move it out to the lake.

FACTORS IMPACTING HOPE LAKE AND ITS WATERSHED

Nonpoint Source Pollution

Nonpoint source pollution is runoff from the land that can contain pollutants such as sediment nutrients, salt, fertilizers, livestock manure, etc. A pollutant of concern to lakes is phosphorus because excess phosphorus in a lake can cause rapid and excessive growth of algae and aquatic plants. This in turn can deteriorate water quality and impair recreational enjoyment.

In order to estimate the amount of nonpoint source phosphorus inputs into Hope Lake, the Wisconsin Lake Modeling Suite (WiLMS) was used. This model estimates phosphorus loading to lakes. For Hope Lake, the "most likely" estimated phosphorus loading is 871 lbs/year. It is important to note that models give estimates of loading, and the actual loading could be different. The WiLMS model provided a range of phosphorus loading to Hope Lake from 432.5 lbs/year to 2,547.7 lbs/year.

Agricultural Nonpoint Source Pollution

The vast majority of the agricultural land in the watershed is farmed according to conservation plans whose purpose it is to keep the soil on the land.

There is a small agricultural ditch/stream on the east side of the lake (just south of the boat launch) and north of Hope Lake Road. The agricultural land that the ditch drains is classified as "highly erodable land". However, a grass filter strip is planted on either side of the ditch to protect the water from runoff. In addition, the farm has a conservation plan and the land is farmed in a manner to minimize erosion from the cropped areas. The ditch/stream continues south of Hope Lake Road.

Shoreland Erosion

A survey of the shoreland area did not find any shoreland erosion. A vast majority of the shoreland area has no development and the shoreland vegetation has been left intact. There is a farm road fairly close to the lake on the east side of the lake north of the boat landing. This dirt road could possibly be a source of sediment during runoff events. Much of the shoreland area is protected by wave action by the large areas of lily pads that effectively break up any wave action. Because of the size and shape of the lake it is not thought that ice heave is an issue.

Construction Site Erosion

Erosion from construction sites can be a significant sediment and phosphorus source to water resources. One estimate is that one acre under construction with no erosion control delivers, on average, as much sediment to local waterways as 75 acres of cropland.

There is a portion (south-west) of the Hope Lake watershed that is part of the Urban Service Area of the City of Cambridge. Therefore the potential exists for future development to occur in the watershed. In addition, agriculturally zoned areas could have residential lots developed on them.

Recreation

There is a boat launch located on the east side of the lake that is on private property. The launch is available for public use and the launch fee at the time of sampling was $5.00. The Town of Lake Mills has an ordinance that does not allow motors of any kind on the lake.

All of the sampling for this project was done during the weekdays between 8 am and 4:30 pm. At these times the boat traffic was very minimal: sometimes we were the only boat on the lake, other times there were as many as 2 other boats on the lake. It is not known whether this is different on the weekends.

The Jefferson County Parks, Recreation, and Open Space Plan (2005-2010) contains several visions for the parks systems. One is the following: "Jefferson County continues to acquire unique recreational lands and natural resource areas of public use." Under this vision, is a vision to acquire areas adjacent to lakes to provide access to water, to preserve habitat, and to improve water quality. Hope Lake is one of the lakes that is named for this goal.

The Glacial Heritage Area Plan (2009) identifies the Hope Lake area as a potential park to provide resource protection and recreational opportunities. It is the case with both the State and the County that future land purchases are dependant on willing landowners.

Shoreland Development

The few farms and homes near Hope Lake are at least 200 feet away from the water. The natural vegetation in the shoreland areas for the most part has not been disturbed. Jefferson County shoreland zoning rules are such that any shoreland cutting or clearing of vegetation would be regulated. In addition, walkways, stairs, and boathouses are the only structures allowed within 75 feet from the water and are regulated by the county ordinance.

Institutional Framework

Boating rules and the County's shoreland zoning ordinance were reviewed to determine if any improvements would benefit the lake.

As the Town of Lake Mills has a no-motor ordinance for Hope Lake, the boating rules are adequate for the lake. However, if sensitive areas are designated in the future, the Town should consider placing buoys to mark the site(s).
The vast majority of Hope Lake's shoreline is wetland areas that have not been disturbed. These areas have some protections because of the presence of the wetlands and therefore are not likely to be disturbed in the future. The Jefferson County Zoning Department has not yet adopted the new State minimum zoning rules. This is set to happen by February 2012. These rules should be adequate to protect the lake.

In addition, the land division rules in Jefferson County are such that future shoreland development on the lake will be minimal. Any new residential development will be required to follow the shoreland ordinance.

GOALS, RECOMMENDATIONS, AND IMPLEMENTATION

Problem Identification

In the course of this study, a number of problems facing Hope Lake were identified.

Aquatic Exotic Plants

The lake contains two exotic plant species: Eurasian water milfoil, and curly-leaf pondweed.

Eurasian water milfoil is found throughout the lake. A complication of the plant survey was that Hope Lake might have a hybrid water milfoil (a mix of Northern water milfoil and Eurasian water milfoil). As such, it is not possible to visibly distinguish between the Eurasian water milfoil and the hybrid milfoil. Instead, identification of hybrid water milfoil must be done through DNA analysis. The study did not pursue this analysis because a expert to perform the test was not available at the time. When a milfoil species appeared to have Eurasian and Northern water milfoil characteristics, then it was recorded as a possible hybrid. However, these could have been mis-identifications. At this time, it is not known whether the possible hybrid water milfoil is a detriment to Hope Lake's ecology.

Curly-leaf pondweed was only found in 2 locations in the lake during the survey (though it might be found in additional locations). Curly-leaf pondweed is a plant that dies off in late June or early July. Because the plant survey occurred at the end of June and middle of July, it is likely that the curly-leaf pondweed was under sampled and it is found in more than 2 location in the lake.

Both Eurasian water milfoil and curly-leaf pondweed potentially have negative impacts to a lake ecosystem. Eurasian water milfoil and curly-leaf pondweed can grow to the surface of the water (and the milfoil continues to grow across the surface). This can significantly hamper boat passage and other recreational activities such as swimming. Both Eurasian water milfoil and curly-leaf pondweed can out-compete native plant species and form dense beds. These growth patterns negatively impact the native plants that provide many benefits to the lake. Fish are also impacted by the growth patterns of exotic species because the dense beds of exotic species prevent fish passage and do not supply ideal fish habitat.

Curly-leaf pondweed completes its life cycle in June and July when it dies off. The decaying plant matter releases phosphorus into the water, resulting in algae blooms and sometimes decreases in oxygen.

Eurasian water milfoil is a nuisance in Hope Lake because it grows to the surface of the water. Other detrimental ecological impacts may also be occurring because of the

presence of milfoil. Therefore, if the Eurasian water milfoil was targeted for control/management, then there would be recreational and ecological benefits.

More information on aquatic exotic species and their impacts on recreation and lake ecology can be found at the following DNR website: http://dnr.wi.gov/invasives/aquatic/.

Sometimes native plants can become a nuisance in a lake. This is the case for coontail in Hope Lake. Coontail is the most prevalent plant in the lake as it was found in 229 points of the 239 vegetated points sampled. It can grow in dense beds. The average density of coontail (scored 1-3) was a 2 in the 2007 survey.

Dissolved Oxygen

There is evidence (dead minnows in the minnow traps left over night) that dissolved oxygen in the shallow areas of the lake may decline overnight because of the high productivity of plants and algae in the shallow areas. During the day, photosynthesis results in the production of oxygen. However, during the night, the plants are not photosynthesizing and instead are using oxygen. This can lead to low or depleted oxygen levels at the end of the night or early morning.

The 1968 DNR report on the Surface Water Resources of Jefferson County stated that winter kill of fish could be due to fluctuations in water levels. However, it might be the case that the winter kill happens because oxygen levels are being depleted when plants and algae decay and use oxygen.

Low dissolved oxygen is a concern for aquatic life. Fish need adequate dissolved oxygen to live in the lake – a minimal amount is 5 mg/l of dissolved oxygen. During 2007, the surface waters in May through September always had adequate oxygen for fish, though the bottom waters were depleted of oxygen. In October, the dissolved oxygen was on the low side, but was greater than 5 mg/l. Throughout the water column in October, the dissolved oxygen ranged from 5.3 mg/l to 5.7 mg/l.

Reducing the amount of productivity in the lake by controlling Eurasian water milfoil (and potentially coontail) could help the oxygen depletion problems in the lake and therefore benefit fish and other aquatic animals. However, the change could be minimal given the productivity of the native plant species.

Phosphorus

The sampling done in 2007 revealed high total phosphorus in Hope Lake's surface water. There is also significant internal phosphorus loading that occurred in the bottom waters as shown by a sample taking in August (384 µg/l). This internal phosphorus loading is likely happening from May through September because the measured dissolved oxygen was extremely low in the bottom of the lake. The highest total phosphorus amount sampled in the surface waters (58 µg/l) was during the October

sampling when the lake was fully mixed. This makes sense because the very high phosphorus concentration in the bottom waters was mixed with the surface waters.

High total phosphorus in Hope Lake is probably the main reason why the lake is so productive with an abundance of aquatic plants. This problem could be alleviated in two ways: reducing the phosphorus pollution from overland flow, and reducing the plant productivity in the lake by controlling Eurasian water milfoil. Again, the effects on the lake by reducing Eurasian water milfoil could be minimal given the large productivity of the native plants in the lake.

Goals

Hope Lake is a lake that does not currently have a lake association or similar group. In order for the recommendations of the plan to be implemented, such a group is essential. Therefore, the first goal of the management plan is:

- Establishment of a lake association or other group whose goal is to take action to benefit Hope Lake

The other goals are as follows:

- Collect water clarity and water quality data through the Citizen Lake Monitoring Network.
- Enhance the water quality of the lake by reducing nonpoint source pollution to the lake and watershed.
- Reduce the amount of internal phosphorus loading in the lake.
- Improve the night-time dissolved oxygen levels in the shallow areas.
- Prevent the invasion and spread of exotic species.
- Protect black tern nesting and rearing areas.
- Enhance public access to Hope Lake.
- Determine if hybrid water milfoil is contained in the lake.

Recommendations

<u>Lake Association</u>

Landowners in the Hope Lake watershed and users of the lake should be encouraged to develop a lake group with the goal of taking action to benefit Hope Lake. Assistance with developing such a group could be provided by the Jefferson County Land & Water Conservation Department, the Wisconsin Association of Lakes, and the UW-Extension Lakes program. *Implementers: Jefferson County LWCD, citizens; Timeframe: ongoing; Funding: not needed.*

Nonpoint Source Pollution Reduction

Because almost 70% of Hope Lake watershed's land use is agriculture, implementing conservation practices to control erosion and runoff from agricultural land are important to the protection of Hope Lake's water quality. The pollutant reduction goal should be a 50% reduction of sediment and phosphorus loading to the lake.

If the farm road that is just north of the boat landing is not needed in the future, then the owners should consider abandoning it and planting native vegetation to prevent any erosion. *Implementer: landowner; Timeframe: as needed; Funding: possibly federal, state, and county cost-sharing.*

There is a ditch that enters Hope Lake just south of the boat launch. The part of the ditch that is north of Hope Lake Road is currently buffered by a filter strip. The remainder of the ditch is located south of Hope Lake Road. The landowners that border this ditch should be contacted to determine if they are interested in leaving a vegetated buffer adjacent to the ditch/stream. Cost-sharing could be available from county and federal sources. *Implementer: Jefferson County LWCD; Timeframe: ongoing; Funding: federal, state, and county cost-sharing*

It is possible that there will be additional rural development in the watershed. In addition, the urban service area of Cambridge may expand further into the Hope Lake watershed. If future development happens in the watershed, construction site erosion control should be properly installed and maintained to prevent pollution. The Towns of Oakland and Lakes Mills should make sure their ordinances are sufficient on this topic and involve citations for violations. *Implementer: Towns of Oakland and Lake Mills and building inspectors; Timeframe: ongoing; Funding: Town funding.*

Water Quality Monitoring

It is also important to collect monthly water clarity and water quality measurements throughout the summer in Hope Lake. This information would assist in future lake management decision making. The Department of Natural Resources has a Citizen Lake Monitoring Network program in which a citizen volunteer is trained to take measurements and collect water samples for phosphorus and chlorophyll analysis. The Jefferson County Land and Water Conservation Department could assist with the training of a volunteer. *Implementer: Jefferson County LWCD; Timeframe: ongoing; Funding: DNR program.*

Aquatic Plants

Reducing the population of Eurasian water milfoil (EWM) in Hope Lake could help to reduce the internal loading of phosphorus in the lake and help to deter the loss of dissolved oxygen in the shallow areas over night. It should be noted however, that these benefits may be very minimal given the productivity of the native plants in the lake. However, additional benefits could include: better navigation because EWM

grows to the surface of the lake and makes paddling difficult; and benefits to the fish population because they would have greater passage through areas once densely populated by Eurasian water milfoil.

Selective mechanical harvesting of Eurasian water milfoil could improve both recreational use of the lake and the low dissolved oxygen conditions.

The control of coontail should also be explored. Though this plant is native, it has become a nuisance in Hope Lake. Reducing its production throughout the lake could help the internal phosphorus levels and dissolved oxygen level much more than solely concentrating on reduction of Eurasian water milfoil.

It is important to note that aquatic invasive species control through herbicides or mechanical harvesting is an expensive endeavor. Even with DNR grants, there will always be a local match. Lakes in Wisconsin that do this control typically have lake districts with taxing authority. Until a lake group is formed for Hope Lake, aquatic plant control is probably not viable.

The DNR should be consulted for guidance in terms of aquatic plant control and permit requirements. Herbicides, mechanical removal, and in some instances hand removal of plants require a permit. In addition, DNR Rapid Response grants are available throughout the year to combat new discoveries of invasive species in a lake. *Implementers: future lake group, Jefferson County LWCD, Town of Lake Mills; Timeframe: as needed; Funding: DNR grants.*

The population of curly-leaf pondweed in Hope Lake should be re-assessed. An assessment of the lake should be completed in early June to get a better understanding of the extent of curly-leaf pondweed in the lake. *Implementer: Jefferson County LWCD; Timeframe: 2012, then every 3 years; Funding: LWCD staff time.*

Education is key to preventing the spread of invasive exotic species. The signage at the boat launch should be determined. A new aquatic invasive species sign is now available and should be posted at the launch if it is not already there. The launch owner should be contacted for permission to install this sign. *Implementer: Town of Lake Mills; Timeframe: 2011; Funding: not needed.*

Fish

More extensive fish surveys (including the use of electroshocking gear) could be performed to determine the present state of the fish in Hope Lake. Specifically, it would be interesting to know if Iowa darters (an environmentally/habitat sensitive fish found in 1974) are still in the lake. *Implementer: DNR fish biologist; Timeframe: to be determined by new fish biologist; Funding: not needed.*

Critical Habitat Area Designation

The large expanses of white water lilies in the northern and southern parts of the lake should be considered for Critical Habitat Area designations by the Department of Natural Resources. These floating plants are providing nesting and rearing habitat for Black terns, a Species of Greatest Conservation Need. *Implementer: DNR; Timeframe: to be determined by DNR; Funding: DNR staff time.*

If Sensitive or Critical Habitat Areas are designated in the future, then the Town of Lake Mills should consider marking these areas with buoys. *Implementer: Town of Lake Mills; Timeframe: if areas are designated; Funding: Town funds to purchase and place buoys.*

Public Access and Parkland

The boat launch is located on private property but is open for use for a minimal fee paid to the landowners. The site is not found on access maps and is not identified with any signage on the road. However, it is known by lake users and fishermen. The launch is a primitive site and at the time of the sampling, the pier was in disrepair. It would be a benefit to the public to improve the launch with signage and a safer pier for access. At the public meeting, some fishermen offered to improve the pier, so this could happen in the future.

Some of the land around Hope Lake has been identified in the past as a potential area for Jefferson County parkland. It is important to note that Jefferson County would only move forward on such a purchase with a willing landowner.

If the State or County purchases land for park and conservation areas adjacent to Hope Lake in the future, then several recommendations could be implemented. These include:

- Sediment and phosphorus runoff from agricultural fields could be reduced through converting farmland to native landscapes such as prairie.
- The boat launch could be improved and/or located on public property which would improve the public assess to the lake.

Implementers: DNR, Jefferson County Parks Department; Timeframe: if there is a willing landowner; Funding: DNR and/or Jefferson County.

Public Involvement and Education

As with any management activity on the lake, the public should be informed and involved in future decisions. *Implementer: Jefferson County LWCD; Timeframe: as needed; Funding: LWCD staff time.*

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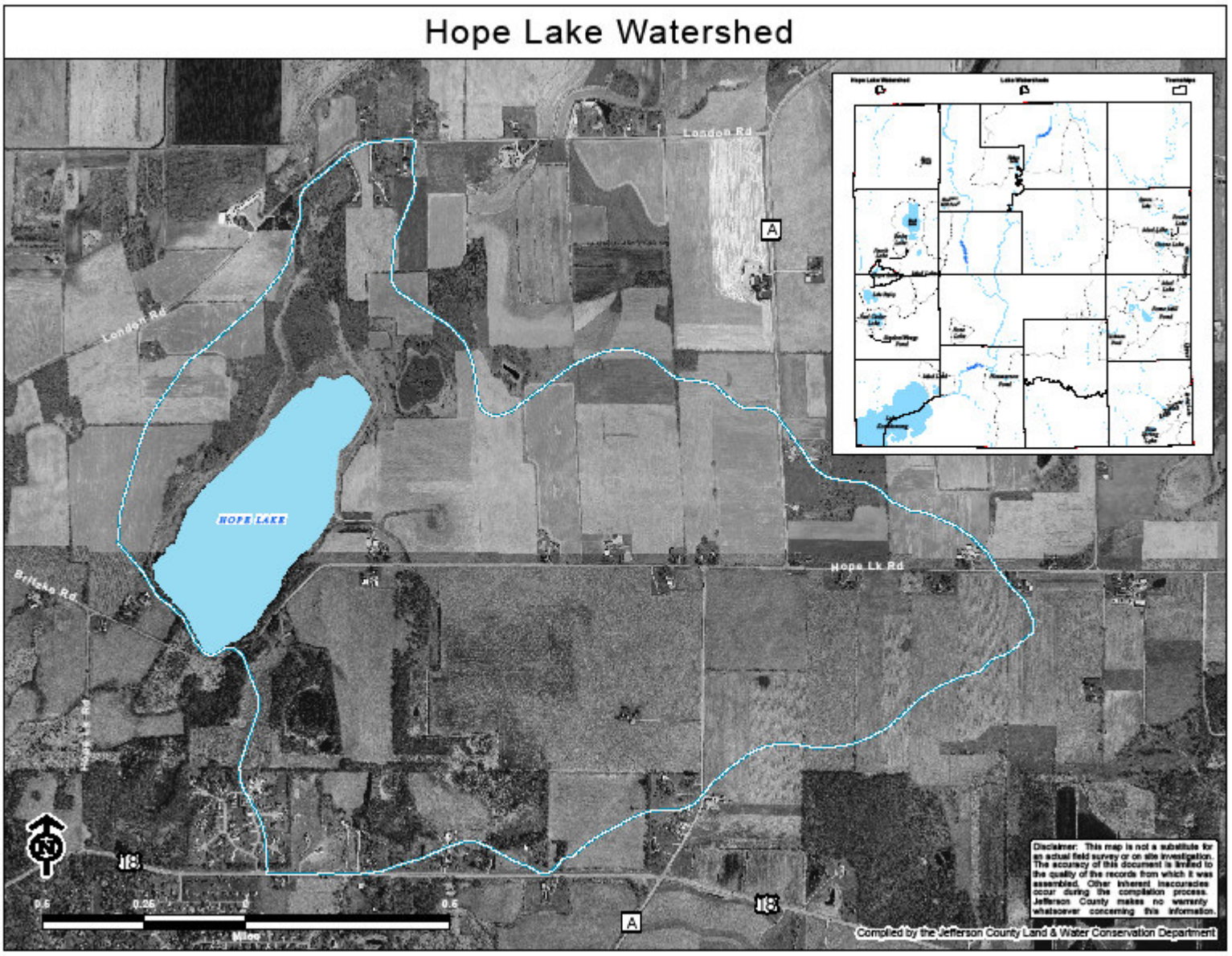
Department of Natural Resources. 2002. The State of the Rock River Basin. PUBL # WT-668-2002.

Department of Natural Resources. October 1, 2009. Feasibility Study, Master Plan, and Environmental Impact Statement for the proposed Glacial Heritage Area. PUBL # LF-050.

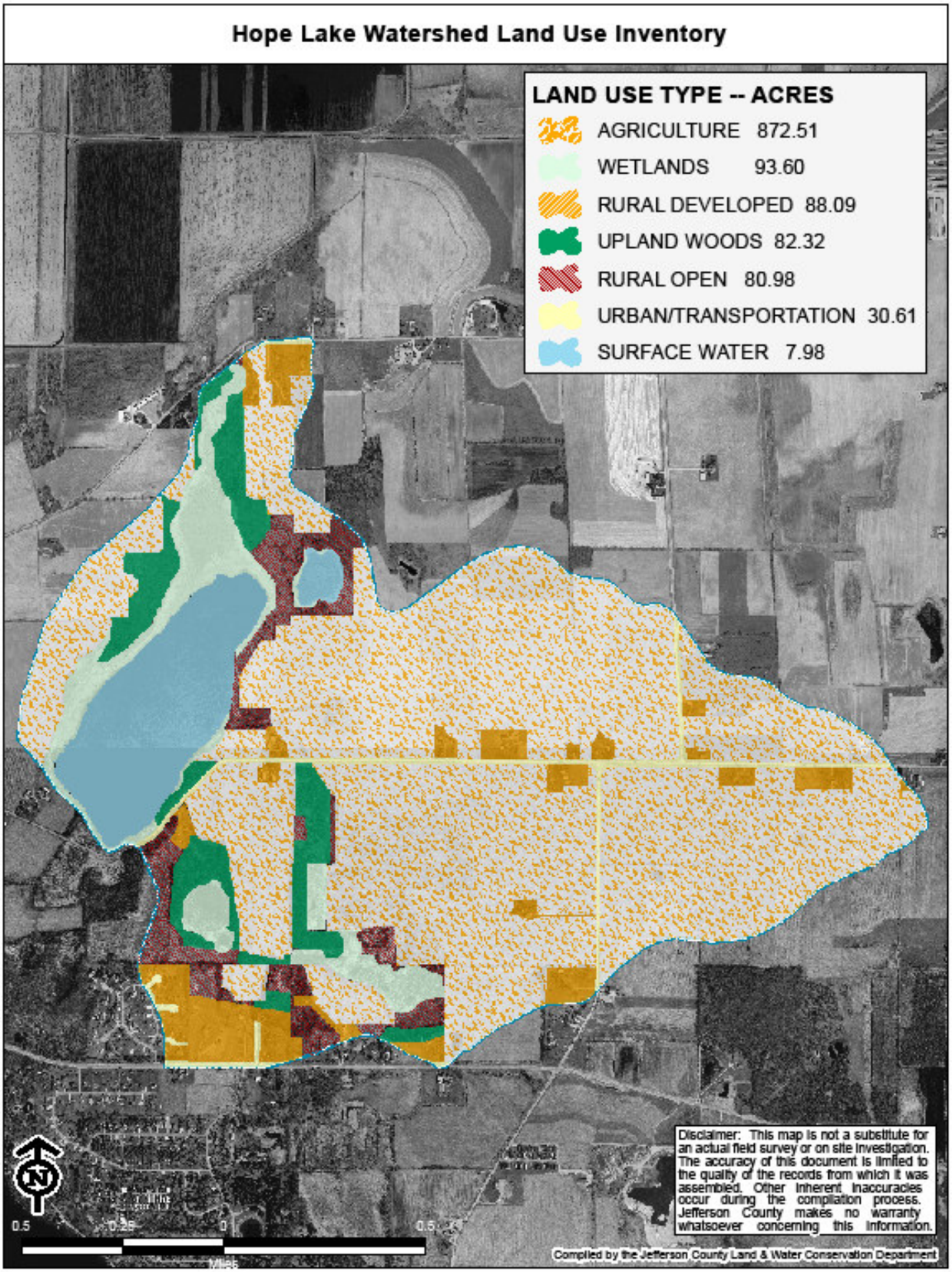
Jefferson County Parks Committee and LanDesign. March 1, 2005. Jefferson County Parks, Recreation, and Open Space Plan 2005-2010.

APPENDIX A

LAKE CHARACTERISTICS MAPS


Hope Lake Watershed
London Rd
London Rd
A
HOPE LAKE
Hope Lk Rd
Briteke Rd
Hope Lk Rd
18
18
A
0.6
0.25
0
0.6
Miles
Disclaimer: This map is not a substitute for an actual field survey or on site investigation. The accuracy of this document is limited to the quality of the records from which it was assembled. Other inherent inaccuracies occur during the compilation process. Jefferson County makes no warranty whatsoever concerning this information.
Compiled by the Jefferson County Land & Water Conservation Department


Hope Lake Bathymetry
3.0
6.0
22.5
15.0
20.0
18.0
13.5
10.0
5.0
7.5
3.0
1.5
N
660
330
0
660
1,320
Feet
Disclaimer: This map is not a substitute for an actual field survey or on site investigation. The accuracy of this document is limited to the quality of the records from which it was assembled. Other inherent inaccuracies occur during the compilation process. Jefferson County makes no warranty whatsoever concerning this information
Compiled by the Jefferson County Land & Water Conservation Department

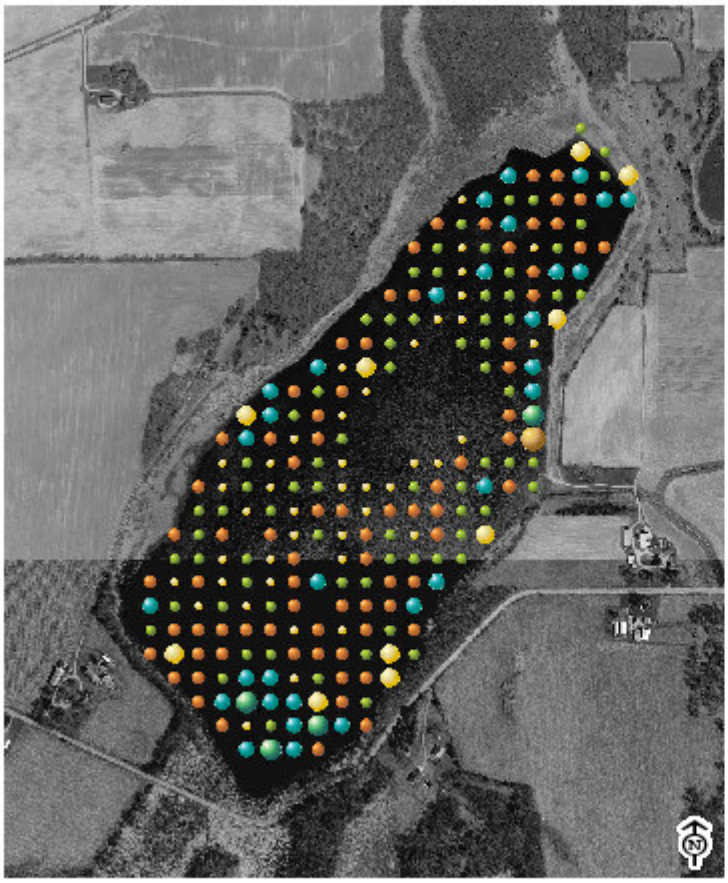

Hope Lake Watershed Land Use Inventory
LAND USE TYPE -- ACRES
AGRICULTURE 872.51
WETLANDS 93.60
RURAL DEVELOPED 88.09
UPLAND WOODS 82.32
RURAL OPEN 80.98
URBAN/TRANSPORTATION 30.61
SURFACE WATER 7.98
Disclaimer: This map is not a substitute for an actual field survey or on site investigation. The accuracy of this document is limited to the quality of the records from which it was assembled. Other inherent inaccuracies occur during the compilation process. Jefferson County makes no warranty whatsoever concerning this information.
Compiled by the Jefferson County Land & Water Conservation Department
0.5
0.25
0
0.5
Miles

APPENDIX B

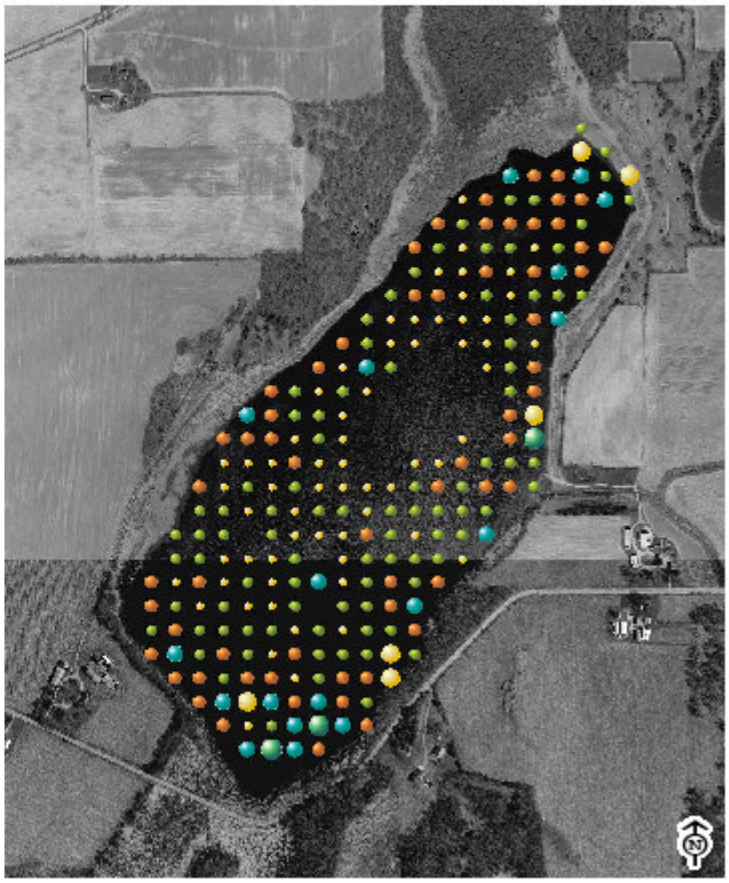
AQUATIC PLANT DISTRIBUTION AND DENSITY MAPS

Total Number of Aquatic Plant Species Found - Per Survey Site

All Plants - Including Exotics



Native Plants - Excluding Exotics

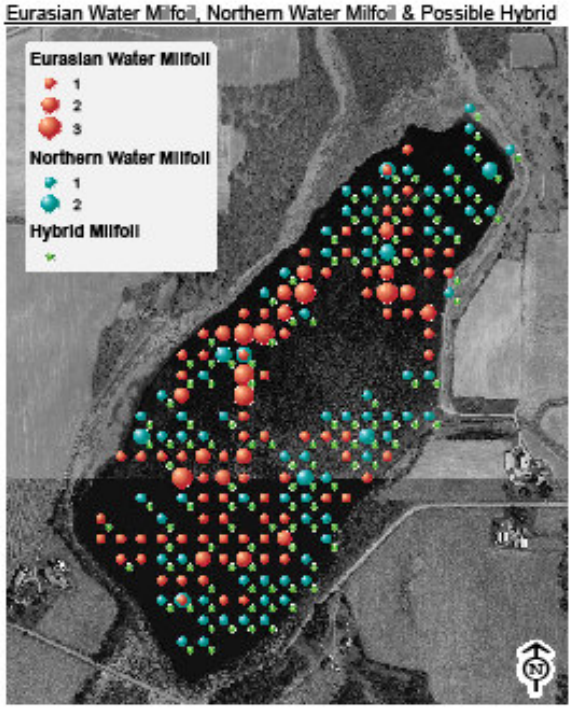


Rake Sampling Plant Density
1 = Few Plants on Rake
2 = Rake 1/2 Full
3 = Rake Overflowing

Hope Lake
Individual Aquatic Plant Densities

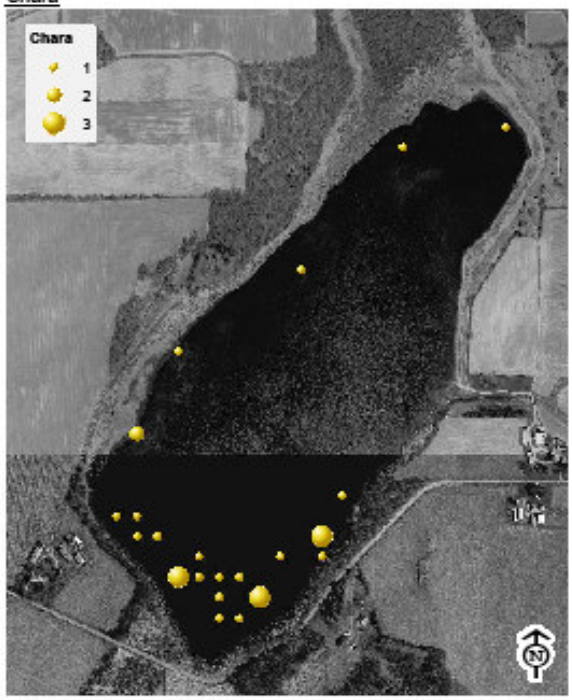
Illustration of Rake Fullness Rating
1 2 3

Eurasian Water Milfoil, Northern Water Milfoil & Possible Hybrid



White Water Lily

Chara



Coontail

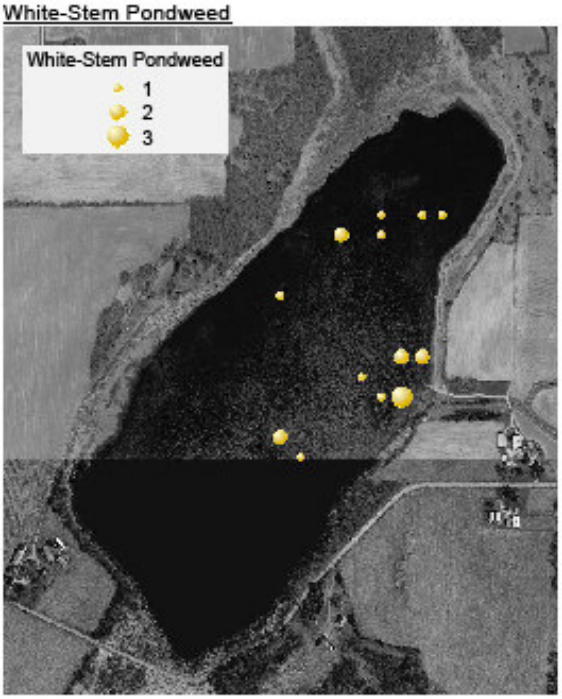
Rake Sampling Plant Density
1 = Few Plants on Rake
2 = Rake 1/2 Full
3 = Rake Overflowing

Hope Lake
Individual Aquatic Plant Densities

Illustration of Rake Fullness Rating

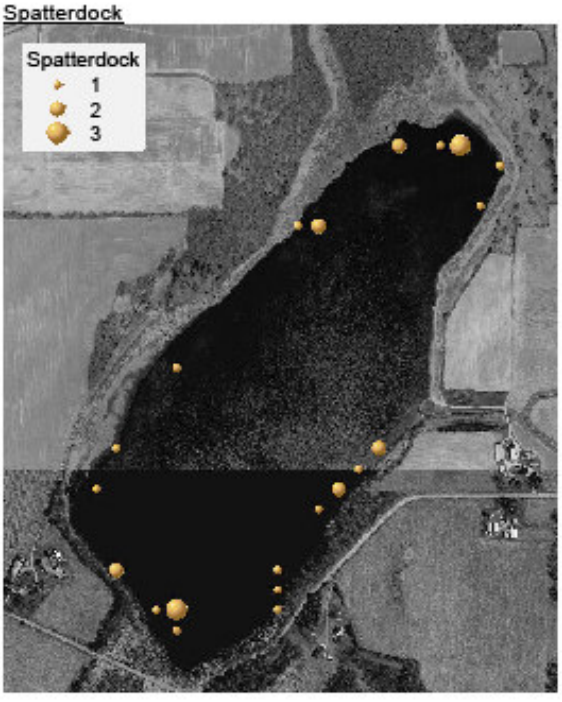
Sago Pondweed

White-Stem Pondweed



Bladderwort

Spatterdock

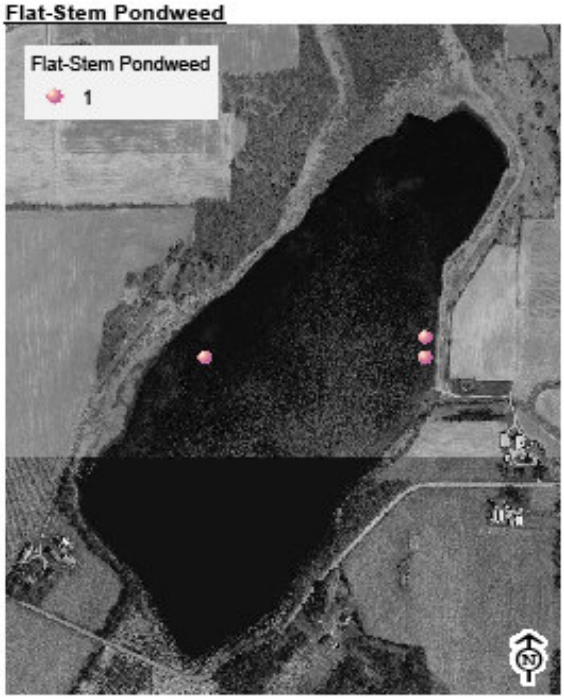


Rake Sampling Plant Density
1 = Few Plants on Rake
2 = Rake 1/2 Full
3 = Rake Overflowing

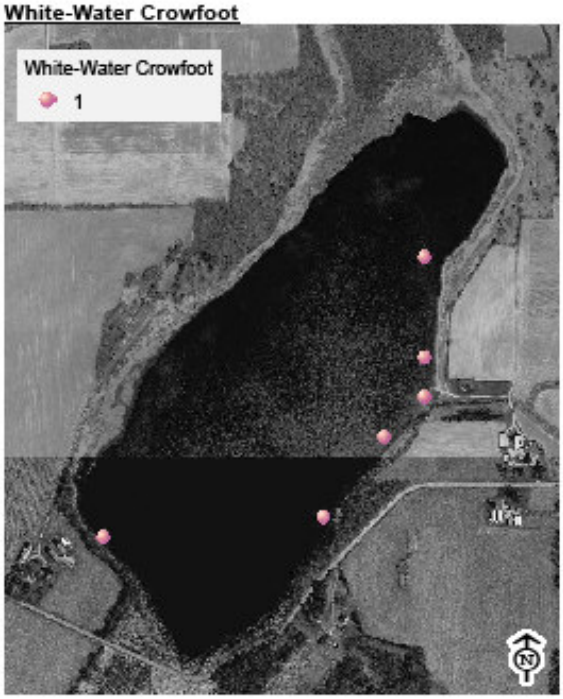
Hope Lake
Individual Aquatic Plant Densities

Illustration of Rake Fullness Rating

Flat-Stem Pondweed



White-Water Crowfoot



Curly-Leaf Pondweed

Leafy Pondweed