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Adaptive Lake Management Plan

Black Otter Lake District
Hortonville, Wisconsin

STS Project No. 200800520

Prepared by:
STS in Cooperation with Wisconsin Lake & Pond Resource LLC
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Executive Summary

As a result of receiving a Lake Planning Grant award from the Wisconsin Department of Natural Resources (WDNR), the Black Otter Lake District has coordinated completion of several recent lake management planning activities. Goals and objectives of recent planning activities included:

- Conducting a bathymetric survey of the lake to map current water depths
- In conjunction with bathymetric surveying, completing a sediment analysis to characterize the extent and composition of sediments in the lake.
- Utilizing results of surveying and sediment analysis work to facilitate Lake Drawdown planning including development of conceptual lake drawdown scenarios for potential control of invasive plant species.
- Preparing an updated comprehensive management plan for the Lake that incorporates historical information regarding lake characteristics in addition to results of recent and anticipated planning activities.

An overall objective in completing the work is to provide guiding information and data that can be used to support the District's lake management decision-making processes. With completion of recent activities and updating of lake management information, multiple conclusions and recommendations were developed (refer to Section 4.0 of this report). The District reviewed related information, solicited input, and established a number of action items related to aquatic plant management, water quality and other important lake management aspects. These action items include:

- Contingent on the ability to conduct fish transfers, complete and implement plans for a full lake drawdown project to promote reduction and control of invasive plant species
- After completing a full lake drawdown, plan for less frequent partial drawdown projects (i.e. every 4 to 5 years) to promote continued control of invasive plants and establishment/maintenance of native emergent plants
- Collaborate with WDNR to develop and implement plans for redirecting the routine annual small scale lake drawdowns to coincide with natural fish and habitat cycles
- Complete lake leader training
- Promote avoidance of phosphorous containing fertilizers in the lake watershed
- Explore land acquisition opportunities that may be strategic for lake protection and maintain undeveloped shoreline area on the lake
- Initiate longer-term planning related to erosion control and storm water management
- Investigate and monitor dissolved oxygen levels in the lake and consider potential modifications to the lake aeration system depending on oxygen data

- Utilize oxygen monitoring data to identify and address watershed issues related to nutrient and other impacts to the lake over the coming two to three years
- Support public use/enjoyment enhancements at lake access locations
- Solicit public input regarding lake management objectives by completing a survey/questionnaire every five years and share information with the public via establishment of an internet website
- Continue plant and water quality monitoring activities
- Investigate options related to the use of harvesting equipment at the lake
- Promote education/prevention initiatives
- Pursue financial support for lake management activities

The District considers this Lake Management Plan document to be adaptive in nature. The District intends to periodically review progression of lake management efforts in conjunction with new lake characterization information/data as it becomes available. District objectives will be refined and plan amendments accomplished accordingly. The District anticipates review of lake management information, reprioritizing of objectives and updating of lake management plan elements on a yearly basis

1.0 Introduction

1.1 Description of Lake Area

Black Otter Lake is a shallow 75-acre impoundment located in the village of Hortonville (Figure 1). The lake was constructed as a mill pond in approximately 1847 to support operation of a saw mill that has long since discontinued. Two intermittent tributaries that drain an agricultural area of Outagamie County and one storm water drainage inlet feed the lake. Black Otter Creek drains from the lake directly into the Wolf River. The total watershed area for Black Otter Lake is estimated to be nearly 16 square miles (10,193 acres).

With two public boat launches, a county park and village park on its shores, Black Otter Lake receives substantial recreational use throughout the year. As the only lake in Outagamie County having public access, area residents consider Black Otter Lake an important natural resource.

1.2 Historical Lake Management Activities

Due to its shallowness and nutrient inputs from the watershed, Black Otter Lake has a history of nuisance aquatic plants, periodic poor water quality, and problems with sedimentation accumulation. Since the early 1950's there have been various efforts to improve lake conditions. The Black Otter Lake District was formed in 1976 to help restore and protect the lake.

In 1982, 1992, and again in 2002, lake studies that resulted in management plans were completed. Both the Village of Hortonville and Black Otter Lake District (District) have followed up on many of the recommendations proposed from past management plans. The Black Otter Lake District has used a variety of lake management practices to encourage water quality and promote a healthy biotic community. These practices include the use and maintenance of the lake aeration system, exotic species control, and implementation of Best Management Practices within the watershed. There has been much support from the Black Otter Lake District, the Village of Hortonville, and many other local groups and individuals.

In 1989, the lake was drained and approximately 120,000 cubic yards of sediment were removed from a 55-acre portion of the lake located between the railroad bridge and the dam. While the lake was drained, three upland and one internal sediment basins were constructed. Black Otter Creek was also rerouted through a wetland area before it entered the lake (as it had been before the 1950's). The lake was refilled in 1990. In December 1991, an additional sediment basin was constructed on the east side of the lake. These activities were completed in an effort to limit the potential for sediment deposition recurrence in the lake.

In January, 2003 the most recent comprehensive lake management study was completed. This study found that high levels of nutrients continued to enter the lake. It was also documented that much of the lake turned anoxic during the summer months. A small-scale aeration system was initially installed in Black Otter Lake in order to maintain a viable fishery by preventing winter and summer fish kills. Although, there have been some summer fish kills since it has been installed, the system has generally been successful in maintaining the fishery.

In recent years, non-native/exotic plants have been problematic in the lake and the District has implemented efforts related to control of invasive vegetation. In April 2003, a large-scale treatment for curly-leaf pondweed (*Potamogeton crispus*) totaling 25 acres was conducted using the herbicide endothall. This treatment was duplicated in April 2004, and was followed by an aquatic plant restoration project funded in part by a Lake Management Planning Grant. As part of the plant restoration project, 5.1 acres of Black Otter Lake were planted with native macrophytes. These plants were placed in the inlet areas to help filter excessive nutrients entering the lake and reestablish native plant communities displaced by nuisance exotics. In April 2005, a treatment targeting 37.4 acres of both curly-leaf pondweed and Eurasian watermilfoil (*Myriophyllum spicatum*) was conducted using a combination of endothall and 2,4-D. The Black Otter Lake District received further financial support from the Wisconsin Department of Natural Resources' Lake Management Planning Grant program in 2005 to help fund a small-scale project. This project focused on monitoring exotic plant species, determining the level of success of the plant restoration project, and assessing ongoing lake management activities.

On April 21, 2005 a mapping effort was conducted to assess the submergent aquatic plant community in Black Otter Lake. Numerous areas of the lake were surveyed. The plant species found in these areas, including exotic species, were identified and ranked according to their abundance.

In June 2006 approximately 15 acres of milfoil were treated with granular 2,4-D. A year later on April 20, 2007, 14.3 acres of curly-leaf pondweed were treated with endothall. A permit to treat Eurasian watermilfoil in 2007 was denied by the DNR. However, on June 20, 2007 7.25 acres of navigation lanes were treated using a three-way mix of herbicides (Cutrine Plus®, Reward®, and Aquathol K®); each applied at a rate of 1.0 gallon per surface acre.

In 2006 and 2007, additional assessments of the aquatic plant community and basic water quality were conducted. This report presents the results of recent assessment activities.

1.3 Objectives of Recent Planning Activities

Goals and objectives of recent planning activities include:

- Conduct a bathymetric survey of the lake to map current water depths
- In conjunction with bathymetric surveying, complete a sediment analysis to characterize the extent and composition of sediments that may have accumulated in the lake.

- Utilize results of surveying and sediment analysis work to facilitate Lake Drawdown planning including development of conceptual lake drawdown scenarios.

- Prepare an updated comprehensive management plan for the Lake that incorporates results of recent and anticipated planning activities.

An overall objective in completing the work is to provide guiding information and data that can be used to support the District's comprehensive lake management decision-making processes regarding important lake characteristics/resources such as water quality, fish and plant habitat, sediment loading, and the public's recreational use of the lake.

1.4 Supporting Partners

This management plan document was sponsored by the Black Otter Lake District and the Wisconsin Department of Natural Resources through the Lake Management Planning Grant Program. The project was endorsed/supported by officials from The Village of Hortonville and Outagamie County.

2.0 Inventory of Lake Characteristics

2.1 Water Quality

2.1.1 Historical Assessments

While a number of parameters may be tested to assess water quality and the trophic state or relative age of a lake, three commonly assessed parameters include chlorophyll a concentration, total phosphorus concentration and Secchi disc depth. Another important parameter that can be used to assess trophic state is dissolved oxygen concentration. While no single parameter can be a reliable gauge of lake water quality, taken collectively over time, these parameters can form a basis for comparative analysis. Results of related water quality tests taken in the main lake during the 2002 season are shown in Table 1.

Chlorophyll is a pigment found in all plants. It is the only pigment that can convert light to chemical energy in photosynthesis. Chlorophyll a concentrations are often used to gauge algal abundance. Because algal abundance is often related to nutrient inputs in a lake, chlorophyll a can be a good indicator of water quality. Average chlorophyll a readings were high for Black Otter Lake in 2002, indicating that much of the plant biomass was in the form of planktonic algae. These values rank Black Otter Lake in the “poor” range on the Chlorophyll a Water Quality Index as shown in Figure 2.

Phosphorus is the most common growth-limiting element for aquatic plants. 2002 testing results indicated that it was indeed the limiting factor for plant growth in Black Otter Lake. Total phosphorus is a measure of available phosphorus plus phosphorus tied up in living cells. Results indicated that ample phosphorus was available for algae growth. Black Otter Lake ranked in the “poor” range on the Total Phosphorus Water Quality Index as depicted on Figure 3 (Note: this ranking is typical for impoundments).

A Secchi disc is an eight-inch diameter black and white plate that is lowered into the water on a calibrated cord. The depth at which the disc is last visible is used as the standard measure of water clarity. Water clarity is often a function of suspended solids and/or phytoplankton density, and is thus often related to water quality. Secchi disc readings on Black Otter Lake were at their lowest in August and at their highest in November. In 2002, average readings ranked in the “poor” range on the Secchi Disc Depth Water Quality index as shown in Figure 4.

Dissolved oxygen and temperature data are typically measured simultaneously, as dissolved oxygen saturation concentrations are inversely related to temperature. Seasonal profiles for these two parameters taken from Black Otter Lake in 2002 are shown on Figures 5 and 6. This inverse relationship is apparent in the November, 2002 readings when water temperatures were at their coolest and dissolved oxygen readings were at their highest. Conversely, when water temperatures are at their highest in July and August, dissolved oxygen concentrations were at their lowest.

In most cases, more productive lakes will have a greater oxygen deficit in the depths than less productive lakes. Therefore the productivity of a lake can often be estimated from the nature of its oxygen curve (Ruttner, 1953). There was a distinct oxycline apparent on each 2002 sampling date except during April when a high volume of water was moving through the lake. On all the other dates, the bottom layers of the water column were devoid of oxygen. The extent of this anoxic layer varied through the season. In June, good oxygen levels remained in the top two feet of water. Below six feet deep, the lake was devoid of oxygen. In July, following a die-off of curly-leaf pondweed, dissolved oxygen became depleted in the upper water column as well. By August, dense mats of duckweed and algae had killed off most rooted plants causing high turbidity and a high oxygen demand. Below a depth of two feet, oxygen levels became too low for most fish species. By November however, cooling water temperatures slowed productivity and oxygen was once again replenished. Only a thin layer of water above the bottom was depleted in oxygen.

Along with the parameters discussed above, additional water chemistry parameters were tested on the lake during April, 2002 after the spring turnover. The results of these analyses are given in Table 1. Averaged results from the 2002 survey are compared to water chemistry analysis results from 1991 and 1978 surveys in Table 2. A description of each parameter and the implications of the results found for Black Otter Lake are discussed in the following paragraphs.

Phosphorus has been found to be the nutrient that limits plant and algae growth in more than 80% of Wisconsin lakes. As phosphorus levels increase, so does plant productivity. Failing septic systems, detergents, lawn and crop fertilizers, soil erosion, and feedlot runoff are all major sources of phosphorus found in lakes. Phosphorus analyses done in Black Otter Lake included total phosphorus and dissolved phosphorus. Dissolved phosphorus is phosphorus that is in solution in the water column that is readily available for plant growth. Total phosphorus is dissolved phosphorus plus the phosphorus found in living cells, such as algae, that are suspended in the water column. Total phosphorus therefore, is more often a better estimator of lake productivity.

Dissolved phosphorus concentrations were not detectable in 2002. This indicates that available phosphorus was tied up in living cells. Total phosphorus concentrations were high but typical for impoundments during April and June. Total phosphorus concentrations were highest during July and August when little stream flow entered the lake. These high concentrations are likely the result of nutrient release from decaying plant matter caused by die-offs of rooted plants that occurred then. These findings suggest that internal nutrient cycling may be more influential of Black Otter Lake's water quality than the watershed.

2002 concentrations were similar to those found in 1978, but much lower that those found in the 1991 survey.

Next to phosphorus, nitrogen is the nutrient most likely to contribute to excessive weed and algae growth. Nitrogen can enter lakes from groundwater, surface runoff, and precipitation. In drainage lakes though, nitrogen concentrations most often correspond to local land uses. Nitrogen analyses for Black Otter Lake included ammonia, nitrate + nitrite and Kjeldahl nitrogen, which is organic nitrogen plus ammonia. Total nitrogen is determined by adding nitrate + nitrite to Kjeldahl nitrogen. When the ratio of total nitrogen to total phosphorus is less than 15:1, a lake is considered nitrogen limited. When this occurs, additions of nitrogen to the lake can lead to increases plant productivity.

The nitrogen to phosphorus ratio found for Black Otter Lake was 39:1 in 2002, indicating that the lake was phosphorus limited. Nitrate + nitrite levels varied considerably through the season, from non-detectable to 1480 ug/l. At times concentrations were high enough to be considered a health hazard to humans. High levels of nitrate and nitrite are generally the result agricultural runoff, lawn fertilizers or failing septic systems. Highest nitrate + nitrite concentrations were found at the south inlet (refer to Table 3). The non-detectable levels found in July and August correspond to low oxygen levels. Low oxygen levels facilitate de-nitrification reactions.

pH is the negative logarithm of the H+ (hydrogen ion) concentration. The product of H+ and OH- (hydroxyl) ions present in water is a constant. This constant is known as the dissociation constant of water. Theoretically, pure water has equal concentrations of H+ and OH- and is neutral in reaction. Neutral water has a pH of 7. When OH- becomes greater than H+, pH rises and water is considered basic or alkaline. When H+ becomes greater than OH-, water is considered acidic. Since pH is a logarithmic scale, an increase of 1.0 in pH equals a ten-fold increase in OH- concentration. Thus water with a pH of 9 is 100 times more alkaline than water with a pH of 7.

The pH of lakes is affected by many factors. Rainwater is acidic and can lower pH. However this reaction is often buffered by calcium bicarbonate. Plant productivity will raise pH. Calcium bicarbonate is actively broken down by plants in the reactions of photosynthesis. The release of OH- from this reaction raises pH (Ruttner, 1953).

Extremes in pH can have negative effects on aquatic life. In Wisconsin, most pH –related problems with lakes are due to low pH. Low pH can inhibit fish spawning and even cause fish kills. Low pH can also lead to the precipitation of mercury, zinc, and aluminum from bedrock. These metals can cause health problems for fish and animals that feed upon them, notably: loons, eagles, and humans (Shaw, et.al., 2000). Fortunately the pH found for Black Otter Lake is high, and these are not concerns. The high pH found in Black Otter Lake is partly the result of local geology, as area lakes tend to be alkaline, and partly the result of plant productivity.

Alkalinity is a measure of the calcium carbonate concentration of water. In reactions where acid is added to water containing calcium bicarbonate in solution, bicarbonates combine with hydrogen ions thereby limiting changes in pH. Not until additions of acids have exhausted available carbonates will pH values drop sharply. This buffering capacity is very important for organisms in aquatic environments in its ability to prevent major fluctuations in pH. Not surprisingly, alkaline lakes tend to have a greater abundance of aquatic life than acidic lakes.

Lakes that have an alkalinity of 10 mg/l or less are considered moderately to highly susceptible to acid rain. With an alkalinity of 232 mg/l, Black Otter Lake is most certainly not sensitive to acid rain.

While chloride ions are essential for plant photosynthesis, free chlorine is highly toxic to living cells. Chlorine kills by oxidation of cell membranes, but the process quickly converts it to harmless chloride ions. Thus chloride concentration is used to identify chlorinated waste discharges in lakes. Other sources of chloride are septic effluent, feedlot runoff, lawn fertilizers, and road salts. Elevated levels of chloride indicate that these sources may be affecting the lake.

Chloride occurs naturally in the surface waters of Wisconsin. At typical concentrations it is not harmful to aquatic life. Typical values for area lakes are 3 – 10 mg/l. The chloride concentration of 31.2 mg/l further indicates that runoff-borne pollutants are likely impacting Black Otter Lake.

Dissolved solids are a measure of dissolved organic compounds present in water. Sources of dissolved solids commonly include decomposing plant matter and tannins leached from bogs. Water having high concentrations of dissolved solids limits the depth at which photosynthesis can take place. Thus it is an important parameter that can affect lake ecosystems. The high concentrations of dissolved solids found in Black Otter Lake likely affect the aquatic plant community.

Suspended solids are a measure of a lake’s turbidity. Suspended solids can include clay particle and decaying plant matter as well as living organisms such as zooplankton and phytoplankton. More productive lakes and lakes having large watersheds with eroding soils tend to have higher concentrations of suspended solids. Suspended solids and dissolved solids affect Secchi disc depth, and are thus determinants for a major water quality parameter. Suspended solids concentrations for Black Otter Lake were surprisingly low when the water was sampled in April. 1991 values were 68 times higher when samples were taken in August, 2002.

The ability of water to conduct an electrical current is called conductivity. Conductivity is dependent on the concentration of inorganic compounds suspended in the water column. Like chloride, conductivity can be used to determine if human activities are influencing water quality. A general guideline is that conductivity should be about two times the hardness of water. Higher concentrations may indicate sources of pollution. The conductivity of Black Otter Lake exceeded this guideline in 2002 and in 1978. This provided additional evidence that non-point source pollutants were affecting the lake.

2.1.2 Recent Analyses

In recent years, additional analyses of water quality parameters has been completed. Dissolved oxygen and temperature data for Black Otter Lake were used to develop profile graphs for September 18, 2006 (refer to Table 4 and Figure 7). The profiles shown for Black Otter Lake indicate dissolved oxygen levels at the time of sampling were lower than expected, particularly for a lake with an active aeration system. Surface oxygen levels were below 8 mg/L. The threshold level of oxygen needed for fish such as bass, perch, and sunfish to survive and grow is 5 mg/L (Shaw, et al., 2004). The data show that at a depth of 7 feet, oxygen levels had dropped below this threshold. This sudden decline in oxygen is referred to as the oxycline. In many lakes of Wisconsin, a similar decrease in oxygen is seen. These oxygen conditions produce an effect referred to as lake stratification. Below the oxycline there was insufficient oxygen to support many fish species.

Oxygen concentration is one of the greatest limiting factors in aquatic ecosystems. Because water is only capable of holding low levels of oxygen relative to air, oxygen is easily depleted by respiration and decomposition unless continually replenished. Atmospheric diffusion and photosynthesis are the main sources of dissolved oxygen. However, photosynthesized oxygen concentrations vary considerably. In the case of Black Otter Lake, the small-scale aeration system also contributes oxygen to the system. As is evident in the data for Black Otter Lake, even with numerous sources of available oxygen, very productive lakes experience periods of oxygen depletion.

Data collected in the spring of 2005 indicated very high levels of oxygen (>13 mg/L) at the surface. However, below a depth of 6 feet the levels had dropped below the 5 mg/L threshold. Both the 2005 and 2006 results raise concern regarding the productivity of Black Otter Lake and the effect it has on the availability of oxygen. Such fluctuations in oxygen levels can cause undue stress on the biotic community, in particular, many fish and invertebrate species. In addition, it is likely a lack of oxygen at the bottom of the lake, a condition referred to as anoxia, occurs during the warmer summer months in the lake. Under anoxic conditions, nutrients, in particular phosphorus, can readily be released into the water column. This release of nutrients can cause even further problems with excessive weed and algae growth.

Historic surface dissolved oxygen data obtained from the Wisconsin DNR are presented in Figure 8. Results from this time period (1986 to 1997) averaged between 4 and 5 feet of transparency. This is indicative of a highly turbid system under eutrophic conditions. This may be due to high nutrient levels fueling early-season algal growth and/or high levels of suspended solids in the water. Although there are years without data, the general trend suggests a slight improvement in oxygen conditions for that time period. Data are not available for a number of years. Higher dissolved oxygen readings were recorded in 2007. However, these data were collected later in the season when cooler waters slow biological activity and water clarity tends to improve. Even while considering the recent data available, it is likely that unfavorable oxygen conditions will continue to plague Black Otter Lake. Note: The District purchased a dissolved oxygen meter in 2008 and intends to conduct routine dissolved oxygen monitoring. Oxygen monitoring data will be used to assess effectiveness of the existing lake aeration system. Oxygen data can also be used during the coming years to identify and address watershed issues related to nutrient and other impacts to the lake, Water clarity is often used as a quick and easy test for a lake's overall water quality. In addition to measuring the water clarity of a lake, Secchi disks are also used to gauge water quality and productivity of a lake. There is an inverse relationship between Secchi depth and the amount of suspended matter, including algae, in the water column. The less suspended matter, the deeper the Secchi disk is visible. Table 4 indicates that the water transparency at the time of the September 18, 2006 sampling was 6.2 feet. In addition, Figure 9 presents water transparency data obtained from the Wisconsin DNR for the time period dating from 1986 through 1997.

Secchi readings can be used to determine the trophic state or productivity of a lake, an indicator of water quality. Lakes can be categorized by their productivity or trophic state. When productivity is discussed, it is normally a reflection of the amount of plant and animal biomass a lake produces or has the potential to produce. The most significant and often detrimental result of high productivity is large amounts of macrophytes and/or algae.

Lakes are generally categorized into three trophic levels:

- oligotrophic - low productivity, high water quality
- mesotrophic - medium productivity and water quality
- eutrophic - high productivity, low water quality

These trophic levels represent a spectrum of water quality conditions. Oligotrophic lakes are typically deep and clear with exposed rock bottoms and limited plant growth. Eutrophic lakes are often shallow and marsh-like, typically having heavy layers of organic silt and abundant plant growth. Mesotrophic lakes are typically deeper than eutrophic lakes with significant plant growth, and areas of exposed sand, gravel or cobble bottom substrates.

Lakes can naturally become more eutrophic with time. However, trophic state can be significantly influenced by nutrient inputs. Although lakes can naturally evolve from oligotrophic conditions to eutrophic, this process is often highly influenced by human activity. When humans influence the trophic state of a lake the process is called *cultural eutrophication*. Cultural eutrophication typically results in an accelerated change in trophic state. A sudden influx of available nutrients may cause a rapid change in a lake's ecology. Opportunistic plants such as algae may be able to out-compete macrophytes. The resultant appearance is typical of poor water quality.

During the time of sampling on September 18, 2006, a Secchi disk was visible 6.2 feet (1.9 meters) below the water surface. Readings below three feet are indicative of a eutrophic system and very poor water quality. The low water quality readings taken on Black Otter Lake, a relatively small lake, early in the season is a sign of an unhealthy aquatic system. Sometimes, in lakes infested with large amounts of exotic species, the water quality of a lake will decline. This is normally due to the large amounts of plant matter transporting nutrients from the sediments to the water column.

Secchi depth data are often used as indicators of productivity (trophic state) in lakes. Values measured can be used to calculate Trophic State Index (TSI) values (Carlson 1977). The formula for calculating the TSI value from Secchi depth is:

TSI = 60 - 14.41 ln Secchi disk (meters)

The higher the TSI calculated for a lake, the more eutrophic it is (refer to Figure 10). Classic eutrophic lakes have TSI values starting around 50. The value calculated for Black Otter Lake from the September 2006 sampling was 50.83. The value calculated from the April 2005 was 64.51. As expected, water quality measurements taken over the past two years place Black Otter Lake within the boundaries of a eutrophic lake.

pH is the measure of a lake's acidity level. It is calculated as the negative log of the hydrogen ion concentration in the water. A pH of 7 is neutral. Values below 7 are considered acid while those above 7 are considered alkaline. Low pH values are much more detrimental to a lake system than higher pH levels. Many factors influence pH including geology, productivity, pollution, etc. The pH value recorded for Black Otter Lake in September, 2006 was 8.57. pH levels of this type are common for hard water, high productivity lakes throughout Wisconsin.

2.1.3 Historical Nutrient Budget

A nutrient budget assessment was conducted for Black Otter Lake in 2002. Water velocity and flow data as well as nutrient concentrations for the north inlet, south inlet and the outlet to Black Otter Lake are summarized in Table 3. These data were used to estimate nutrient and water budgets for the lake. Because it is nearly impossible to account for all variables affecting the lake, and because flow rates frequently fell below limits of detection, several assumptions, and estimates were made, as follows:

1. Because water levels were relatively stable, water inputs = water outputs.
2. Given the soil types, groundwater influences were considered insignificant.
3. Evaporation was considered to be equal to precipitation.
4. Water flow from the south and east inlets was estimated to occur 240 days /year. Water inputs were assumed to be proportional to sub-watershed acreage.
5. Water flow from the north inlet was estimated to occur 30 days / year.

Accordingly, the following water budget information was calculated:

Water inputs:

Source	**Volume (acre-ft./year)**
North Inlet	4998
East Inlet	3000
South Inlet	24,275
Precipitation	197

Water outputs:

<u>Source</u> <u>Volume (acre-ft./year)</u>

Outlet 32,273

Evaporation 197

Lake volume: 384 acre-ft.

Residence time: 4.32 days

Using the water budget data above along with total phosphorus concentrations found in Table 3, and export coefficients from Holdren, et. al. (2001), the following results were obtained:

Phosphorus imports:

Source	**Total annual P load (lbs.)**	**Phosphorus lbs./acre/year**
North Inlet	2139	6.08
East Inlet (estimated)	823	0.76
South Inlet	3568	0.41
Precipitation	19	0.25
TOTAL	6549	

Phosphorus exports:

Source	**Total annual P load (lbs.)**
Outlet	6100

Regional average values:

Source	**Phosphorus lbs./acre/year**
Agricultural	2.14
Residential	0.76
Residential/Commercial	0.60

As can be seen, phosphorus imports exceeded exports by a rate of 449 lbs. per year. Black Otter Lake is effectively acting as a nutrient sink. While this is beneficial for downstream waters, it will lead to significant declines in water quality for Black Otter Lake over time.

A comparison of calculated values with regional averages provides more useful management information. The south inlet phosphorus load of 0.41 lbs/acre/year is well below the average value of 2.14 lbs/acre/year. While the north inlet phosphorus load of 6.08 lbs/acre/year is more than ten times the average value of 0.60 lbs/acre/year. This suggests that significant areas for nutrient controls exist in the north sub-watershed (refer to report Section 2.6 for additional watershed boundary information).

2.2 Lake Bed

2.2.1 Bathymetric Mapping

Water depth data was collected in December 2007 (in conjunction with aquatic plant surveying) to update the depth contour (bathymetric) map for Black Otter Lake. Figure 11 depicts the locations of 284 sampling sites included in this survey. At each location a boat-mounted sonar device was used to determine the depth of water. Areas found to be not navigable were assigned a depth of 1 foot for the purposes of this mapping effort. The data obtained was used to develop a detailed map depicting 2-foot depth intervals.

Figure 12 depicts the updated bathymetric map for Black Otter Lake. The average depth of the lake is approximately 4.0 feet with a maximum depth of 11 feet. Table 5 includes the water depths measured at various sampling sites during the December 2007 survey.

2.2.2 Sediment Analysis

In order to characterize lakebed substrate types in Black Otter Lake, sediment samples were collected at 37 locations throughout the lake in December 2007 as generally indicated on Figure 13. Sediment samples were collected with a piston sediment corer. The uppermost layer of soft sediment (approximately six inches) was collected. Samples were sent for analysis to Badger Laboratories in Neenah, WI. Analyses included percent solids and percent volatile solids. Analysis of percent volatile solids indicates the organic content of the sample. In addition, at each location water depths were measured by lowering a weighted Secchi disk to the lakebed (upper surface of the soft sediment). Also, the thickness of soft sediment was determined at each location by inserting a pole to the depth of hard sediment. This allowed for a measurement of the thickness of soft sediment at each location (depth to hard sediment – depth of water = depth of soft sediment). The data collected was used to characterize sediment types in the lake and develop maps of sediment types and depths.

Table 5 summarizes the results of the sediment depth and thickness measurements and the sediment analysis by Badger Laboratories. These results show that the thicknesses of the sediments in the lake vary as generally depicted on Figure 14. The average soft sediment thickness was approximately 2.4 feet. Artificially impounded shallow lakes of this type have the potential to accumulate large amounts of organic and inorganic sediments. Organic sediments can often accumulate from the annual life cycle of aquatic plants. As winter approaches, aquatic plants begin to die back and decompose. However, the plants do not decompose completely and over time this process results in a build up of organic matter. This process is accelerated under anoxic conditions. The soft sediments of Black Otter Lake are not particularly thick. Although aquatic vegetation grows densely in much if the lake, it appears that there is sufficient oxygen for active decomposition of plant matter; thereby preventing rapid sediment accumulation

Further, the results show variability in the percent solids content of the lake sediments. Higher solids content are generally indicative of denser, more mineral sediments. Sediments of this type often include clays and sand. Conversely, sediments with lower solids content are less dense and tend to be more muck–like. The data for percent solids do not suggest trends or patterns exist within the lake. This variability was also qualitatively noted at the time of sampling.

The results of the volatile solids analysis are more conclusive and help better visualize the sediments within Black Otter Lake. Figure 15 displays the distribution of organic sediments in Black Otter Lake. As expected, the areas with the thickest layers of soft sediments also tended to be the lighter, more muck-like sediments with higher organic solid content. This is evident by comparing Figures 14 and 15. Sediments with higher volatile solids concentrations also have high levels of humic substance. Humic substances are naturally occurring, organic compounds that are degradation-resistant. They are most commonly formed during the decomposition of vegetation.

2.3 Fish Habitat

The shallow, warm waters and abundant rooted vegetation found in Black Otter Lake create an environment best suited to a fishery containing largemouth bass (Micropterus salmoides), bluegill (Lepomis macrochirus), pumpkinseed (L. gibbosus), black crappie (Pomoxis nigromaculatus), northern pike (Esox lucius), bullheads (Ictalurus spp.), golden shiner (Notomegonus crysoluecas), and other minnow species.

Centrarchids (bass, bluegill, pumkinseed, and crappie) have been observed spawning over hard-bottomed areas adjacent to undeveloped shores. These areas contained the highest diversity of submergent and emergent plants as well. Yellow perch spawning habitat was found amongst the areas of flooded brush (shrub carr), and the submerged stumps and logs near the middle inlet. Preferred northern pike spawning habitat includes flooded emergent vegetation such as cattails. This type of habitat was found north of the railroad bridge and at the creek inlet south of the railroad bridge.

The locations of fish spawning habitats, as they were assessed in 2002, are depicted in Figure 16. This information is not intended to be used as a fishing guide. Instead, it is to be used for guidance in lake management and development activities with an objective that these habitats could be protected.

A comprehensive fisheries survey was conducted on the lake in 2005. The main purpose of the survey was to evaluate the lake’s sport fishery to support decisions regarding fish stocking and water quality enhancement programs. Specific objectives were to collect data regarding species diversity, length frequency and length at age on all sport fish and total population estimates on large mouth bass and Northern Pike.

Conclusions from the 2005 included:

- Bluegill and large mouth bass populations were doing well
- Previous stocking efforts for black crappie and yellow perch were successful but additional stocking would be needed for these populations to remain a viable fishery
- Northern pike data was insubstantial and reliable population estimates could not be made but the data did indicate a lack of large adult pike. Angling pressure was assumed to be the explanation for the shortage of adult pike

A copy of the 2005 Fishery Survey Results report is included in Appendix A.

2.4 Wildlife Habitat

The undeveloped eastern shore of the lake contains a wealth of habitat types including deep marsh, shallow marsh, shrub carr, hardwood swamp, and floodplain forest. These habitats provide homes for a variety of reptiles, amphibians, mammals, and birds. Wood ducks, mallards, teal, and Canada geese find feeding and nesting areas in the lake. The bay upstream of the railroad bridge provides excellent waterfowl forage as well as refuge from disturbance by boaters. Mowed lawns along the residential areas provide excellent grazing opportunities for Canada geese.

The quality of wildlife habitat relates directly to the diversity of aquatic plants. The diversity of emergent plants was recorded during a 2002 shoreline aquatic plant survey (refer to Table 6). Emergent plant diversity correlated strongly with riparian land use. The undeveloped east shore and the lightly developed north shore, which had a buffer strip of natural vegetation, both had excellent plant diversity. The undeveloped shoreline (transects VII - XVI and XXII – XXV) had an average of 13.5 species / transect, and the lightly developed shoreline (transects I – VI) had and average of 14.3 species / transect. In contrast, the heavily developed south shore (transects XVII –XXI) averaged only 2.0 species / transect.

2.5 Aquatic Plants

2.5.1 Historical Plant Surveying

A submergent plant survey conducted in 2002 found 12 species of rooted plants, four genera of filamentous and colonial algae, and three species of free-floating plants (refer to Table 7). The exotic curly-leaf pondweed was the most commonly found plant, occurring at 74.3% of sample points. Coontail (Ceratophyllum demersum) was next most abundant at 60.7% frequency. Horsehair algae (Pithophora spp.) and lesser duckweed (Lemna minor) followed in abundance at 38.6% and 34.3% frequency, respectively.

Native macrophytes, plants generally associated with good water quality, comprised only 40% of the total species composition. Algae and free-floating plants, such as duckweed (Lemna spp.) and watermeal (Wolffia columbiana), made up 32.2% of the species composition. As the 2002 season progressed, these plants became dominant at the upstream portions of the lake. This resulted in serious environmental consequences. As water flow decreased and temperatures increased, duckweed and algae formed solid floating mats that covered large areas of the lake. Anoxic conditions occurred under these mats, forcing fish to the downstream parts of the lake. These dense surface mats also blocked sunlight from rooted plants, causing them to die and decompose. The resultant suspended dead plant matter gradually drifted down the lake, increasing the biological oxygen demand and producing more anoxic conditions in the rest of the lake. The dead plant matter also reduced light penetration, causing further die-off of rooted plants and worsening the situation. Along with the decomposition dead plant matter came a nutrient release that fueled further algae growth.

The die-off of curly-leaf pondweed greatly magnified the problems caused by algae and duckweed. Curly-leaf pondweed gains a competitive advantage over other species by growing rapidly in cold water. As water temps approach 80° F though, the plant begins to die. Just as algae and duckweed were reaching problem levels in Black Otter Lake, curly-leaf pondweed experienced a massive die-off. The resultant suspended plant matter and nutrient release created very turbid conditions and fueled an even heavier algae bloom. Oxygen became so depleted that fish could only survive in the top two feet of the water column over the deepest portions of the lake.

A comparison of the 2002 survey data with older aquatic plant survey data from 1978 suggested that environmental conditions in the lake had deteriorated considerably (refer to Table 8). Four species of macrophytes that were found in 1978 were completely absent in 2002. These species, flatstem pondweed (P. zosteriformis), small pondweed (P. pusillus), elodea (Anacharis canadensis) and water stargrass (Zosterella dubia), are often found in lakes with good water quality. While most of these species are able to tolerate somewhat turbid conditions, water quality may have become too poor in Black Otter Lake for their continued survival. Perhaps the most important difference in the 1978 data is that exotic plants were not previously identified.

Submergent plant distribution in 2002 correlated closely with depth (refer to Table 9). The two exotic species found, curly-leaf pondweed and Eurasian watermilfoil, were most abundant in waters greater than four feet deep. Both of these species grow rapidly in cooler water, giving them a head start over native species. Early growth may also allow them to reach the surface before turbidity inhibits other plants. Native macrophytes were most commonly found in less than four feet of water. In fact, the greatest percent frequency for many of these species was found in less than two feet of water.

Eurasian watermilfoil was not found in dense beds during the 2002 survey. This and the fact that Eurasian watermilfoil was only found at 19.3% of sample points suggests that a large-scale milfoil treatment conducted in 2000 may have provided some control. Curly-leaf pondweed was found in dense beds primarily along the south shore, which drops off quickly. It was also found along the deeper channels and surrounding the deeper hole in the center of the lake. The distribution of curly-leaf pondweed in 2002 is shown in Figure 17. The area of this monotypic plant stand was about 20 acres.

In contrast to the submergent plant survey, an incredible diversity of emergent plants was found in 2002. A total of 28 species were encountered (Table 6). Most abundant were Kentucky bluegrass (Poa pratensis), floating-leaf pondweed (Potamogeton natans), bottlebrush sedge (Carex comosa), soft rush (Juncus effusus) and narrow-leaved cattail (Typha angustifolia). Emergent species were not as affected by turbidity or competition from exotic species, things that limited submergent plants in Black Otter Lake. The primary reason for the wealth of emergent plants found though, lies in the fact that substantial areas of shoreline remained undeveloped. Conversely, the heavily developed south shore contained very few emergents.

2.5.2 Recent Plant Surveying

On September 18, 2006, an aquatic plant survey was conducted utilizing reproducible methods so that future surveys can accurately assess changes to the plant community. Under the guidance of Jennifer Hauxwell from the Wisconsin DNR, an approved plant survey map for Black Otter Lake was provided (refer to Figure 11). In summary, a series of grid points spaced 33 meters apart were mapped across the lake. At each point, aquatic plant samples were collected from a boat with a single rake tow. In total, 284 points were mapped. Following DNR guidelines, the rake consisted of two short-toothed garden rake heads welded together and attached to a rope. At each sample point, the rake was thrown from the boat and dragged along the bottom for approximately 2.5 feet to collect plants. All plant samples collected were identified to *genus* and *species* whenever possible, and recorded. An abundance rating was given for exotic species collected using the criteria described in Figure 18. In addition to the plant data, depth and bottom substrate composition were recorded for each point intercept. Data collected were used to determine species composition, percent frequency, and relative abundance.

In 2006 and 2007, the distribution of exotic species in Black Otter Lake was assessed at least twice annually. Eurasian watermilfoil was assessed on September 18, 2006 and September 28, 2007. Curly-leaf pondweed was assessed on October 23, 2006, April 25, 2007, and September 28, 2007. The distribution of these species was determined from surface observations and rake tows. The surveys used the point-intercept aquatic plant survey map as a reference. The locations of the beds were mapped with the use of a Garmin V GPS unit and drawn on a lake map using shoreline features and survey points as references. Acreage grid analysis was used to determine the area of each location.

Fall surveys are not considered the best time to assess distribution of curly-leaf pondweed. At the time of the October 23, 2006 and September 28, 2007 surveys, little curly-leaf pondweed was expected to be found. This is due to the life cycle of this species which causes it to die back during the warmest time of the year. By fall, a majority of the curly-leaf pondweed in Black Otter Lake had entered a dormant stage. As a result, the April 25, 2007 survey was also scheduled to better assess the distribution of curly-leaf pondweed.

Of the 284 sampling points mapped across the flowage, 265 were sampled. The remaining 19 sites were located in the far eastern and southern portions of the lake where the two tributary streams enter. Because of very shallow water and dense vegetation, these sites could not be reached. Coordinates for the sampling points within Black Otter Lake can be found in Appendix B.

Table 10 and Figure 19 summarize results of the aquatic plant survey conducted on Black Otter Lake on September 18, 2006. As expected, both native and exotic aquatic plants were plentiful in Black Otter Lake. The native submergent plants were dominated by coontail (*Ceratophyllum demersum*), common waterweed (*Elodea canadensis*), and sago pondweed (*Stuckenia pectinata*). Similar results were found during a plant assessment conducted in 2005 (Wisconsin Lake and Pond Resource, 2005). In addition, much of the lake at the time of the plant survey was covered in floating species, including duckweeds (*Lemna* spp.), watermeal (*Wolffia columbiana*) and filamentous algae (*Pithophora, Cladophora*, etc.). Although these are primarily native species, their abundance is indicative of low water quality and stagnant conditions. Percent frequency values reflect the relationship between the number of locations where a particular species was found versus the total number of locations sampled. Relative frequency values reflect the abundance of a particular species in relation to all other species found.

Raw data for the 2006 submergent aquatic plant survey can be found in Appendix C.

The plant data collected for Black Otter Lake in 2006 were used to assess the "floristic quality" of the lake. The method used assigns a value to each native plant species called a Coefficient of Conservatism. Coefficient values range from 0 -10 and reflect a particular species' likelihood of occurring in a relatively undisturbed landscape. Species with low coefficient values, such as cattails, are likely to be found in a variety of habitat types and can tolerate high levels of human disturbance. On the other hand, species with higher coefficient values, such as Robbins pondweed, are much more likely to be restricted to high quality natural areas. Eurasian watermilfoil and curly-leaf pondweed are exotic species and therefore are not assigned coefficient values. By averaging the coefficient values available for the submergent and emergent species found in Black Otter Lake a lake-wide value of 4.91 was calculated (refer to Table as summarized below.

By utilizing the Coefficients of Conservatism for the plant species of Black Otter Lake, further assessment of floristic quality can be made. By multiplying the average coefficient values for Black Otter Lake by the square root of the number of plant species found (not including exotic species) a Floristic Quality Index (FQI) value was calculated at 16.28 (Table 11). In general, higher FQI values reflect higher lake quality. The average for Wisconsin lakes is 22.2.

Both Coefficient of Conservatism and the Floristic Quality Index values suggest the quality of Black Otter Lake specifically in terms of the plant community, is below average. This is not surprising for a shallow, artificially created lake.

Aquatic plants serve an important purpose in the aquatic environment. They play an instrumental role in maintaining ecological balance in ponds, lakes, wetlands, rivers, and streams. Native aquatic plants have many values. They serve as important buffers against nutrient loading and toxic chemicals, act as filters that capture runoff-borne sediments, stabilize lakebed sediments, protect shorelines from erosion, and provide critical fish and wildlife habitat. Therefore, it is essential that the native aquatic plant community in Black Otter Lake be protected. Appendix D provides a list of the more abundant native aquatic plant species that were found in Black Otter Lake. Ecological values and a description are given for each species.

A total of 46.4 acres of Eurasian watermilfoil were identified in Black Otter Lake on September 18, 2006 (refer to Figure 20). A year later in 2007, there were 39.4 acres in approximately the same areas (Figure 21). The total acreage of milfoil decreased by approximately seven acres over this time period. This may be due to the effect of a spring 2007 herbicide (Aquathol K®) treatment. It may also be due to an increase in the areas not reachable by boat. It was very difficult to access and map the shallower areas of the lake due not only to water depth but also dense plant growth. In general, the densest milfoil was found in these shallower areas of the lake at the time of the surveys.

Approximately 14.3 acres of curly-leaf pondweed were identified on October 23, 2006. It was expected, that 14.3 acres would be an underestimation of the true distribution of curly-leaf pondweed in Black Otter Lake. During the summer, the curly-leaf pondweed within a lake dies back. By fall, as the water temperatures cool, some re-growth will begin to become apparent. However, it is not until the spring that the true distribution of curly-leaf pondweed can be accurately assessed in a lake. A second survey was conducted on April 25, 2007. As expected, additional curly-leaf pondweed was identified. In total, approximately 50 acres of curly-leaf pondweed were identified in the lake as summarized on Figure 22. However, by the time the full distribution of curly-leaf pondweed was determined, treatment of the original 14.3 acres had been permitted and taken place and it was too late in the year to request a permit to treat the additional acreage. A second treatment was not conducted in 2007.

As expected, very little curly-leaf pondweed was found during the September 2007 survey of Black Otter Lake. Only 4.1 acres of curly-leaf pondweed were identified in the shallow areas in the northern portion of the lake (refer to Figure 23). However, it is anticipated that additional growth of curly-leaf pondweed will occur before the spring of 2008. It is likely that a large portion of the lake continues to be infested with curly-leaf pondweed.

2.6 Watershed Analysis

As a result of prior lake study efforts completed in 2002, the total watershed area for Black Otter Lake was estimated to be 10,193 acres. The watershed is composed of three drainage basins. These were termed the upper-, mid- and lower-subwatersheds. Maps of these watershed boundaries are found in Figures 24 – 27.

The composition of land uses within the Black Otter Lake watershed was found to be 62% agricultural, 15% upland forest, 12% residential, 8% swamp forest, and 3% Conservation Reserve Program set-aside. The upper subwatershed was predominantly residential, while the mid- and lower subwatersheds were predominantly agricultural.

Summaries of general assessments conducted within the watershed in 2002 are provided below. Generally, it appeared that many of the soil conservation programs initiated in the watershed have been effective. Agricultural sites reviewed had good erosion control practices and vegetative buffer zones in place. Areas of concern that were identified included runoff from roadways, and residential and commercial areas in the upper subwatershed, and runoff from residential areas adjacent to the lake in the lower subwatershed.

Upper Sub-watershed

Total acres = 352

Potential nutrient loading sources

•Includes the inlet area in town where residential runoff is directed underground and then enters the lake; runoff is coming directly from Hwy 45 and parking lots from near-by businesses and schools

Runoff coming from the school athletic fields and large lawns may contain fertilizers

Potential sediment loading sources

•Large rain events are likely to carry loose soil on hwy 45 and surrounding parking lots directly into the lake

Other Observations

•Much of this watershed is made up of rural cropland with many surrounding grasslands serving as buffer strips

Mid Sub-watershed

Total acres = 1,086

Potential nutrient loading sources

•Includes the inlet area on the eastern finger of the lake; Approximately 8 farms with livestock pastures and 2 scattered subdivisions are contained in this watershed, both of the potential sources appear to have plenty of buffer land before lake/stream and are not considered a problem

Potential sediment loading sources

•Watershed appears to be well buffered with vegetation. limited sediment loading may come from erosion along water courses

Lower Sub-watershed

Total acres = 8,755

Potential nutrient loading sources

•Includes southern inlet area and western lake residential area; western residential area has approximately 29 homes boarding the lake that may contribute to lawn fertilizers and other nutrient sources entering the lake; runoff from streets and other nearby homes in the residential area is also a concern

•Surrounding cropland and pastureland all appear to have good buffer zones and are not a concern

Potential sediment loading sources
•Large rain events are likely to carry loose soil on residential streets and surrounding driveways directly into the lake

Other Observations
•The rural portion of this watershed appears to have good vegetated buffers (marshes, swamps, forests, grasslands) that help stop excess nutrient and sediment loading, it is the residential area that appears to be a concern.

The results of a literature review of categorical best management practices directed at enhancing lake water quality that are relevant for Black Otter Lake are summarized below.

Urban Runoff

Objective:

Minimize and filter the direct runoff coming from the urban areas, especially during large rain events. The runoff coming from much of the urban area is directly flushed into Black Otter Lake; this appears to be a major contributor to poor water quality.

Methods:

Wet Detention Ponds

The most common practice used to control urban runoff. The system consists of a single pool that treats stormwater. Ponds usually hold 3 to 7 feet of standing water. The detention pond traps stormwater and allows pollutants to settle out. Past evidence shows that a majority of suspended solids, phosphorus, nitrogen, and many other elements are filtered out if stormwater is allowed to settle before being released.

Stormwater Wetlands

Constructed stormwater wetlands consist of shallow pools that contain aquatic plants. The artificial wetland removes pollutants through infiltration, absorption, microbial interactions, and uptake by aquatic plants. Past evidence shows that wetland construction works for filtering a majority of stormwater pollutants.

Infiltration Basins

Basins are large open depressions that catch and store urban runoff. Infiltration basins allow runoff to percolate into the soil, which filters the water. Infiltration basins require correct soil conditions and annual maintenance.

Vegetative Buffer Zones

A buffer zone consists of an area of native vegetation that filters urban runoff before it reaches a main water source. Vegetative buffer zones play an important role in utilizing excess nutrients, trapping loose sediment and stabilizing soil. Large areas of vegetative buffers are needed to handle high flow runoff events.

Lawn Fertilizer Use

Avoid using lawn fertilizers near the lake, if you feel it necessary to fertilize your lawn use a fertilizer with 0 phosphorus levels. Most standard fertilizers contain high levels of phosphorus. Phosphorus is the main cause for algae blooms and excessive weed growth in most lakes.

Rural Runoff

Objective:

Prevent sources of nutrient rich contaminants from entering into rural inlet tributaries. Past evidence (1991) shows direct sources of pollutants coming from rural runoff. However our studies found no readily identifiable pollutant sources coming from the rural inlets.

Methods:

Vegetative Buffer Zones

A buffer zone consists of an area of native vegetation that is allowed to filter rural runoff before it reaches a main water source. Vegetative buffer zones play an important role in utilizing excess nutrients, trapping loose sediment and stabilizing soil. Vegetation in these zones consists of a variety of grassland, shrub, and tree species. Large areas of vegetative buffers are needed to handle high flow runoff events.

Pasture and Cropland Runoff Diversion

Prevent any direct runoff into the inlet tributaries from cattle feedlots and cropland. Runoff from these sources is nutrient rich. Nutrient loading causes algae blooms, excessive weed growth, and high sediment loads. A vegetative buffer zone is a key component to prevent nutrient loading from pasture and cropland runoff.

Conservation Programs

Many federal and state funded programs exist that encourage conservation and nutrient management. These programs help reduce erosion, increase wildlife habitat, restore wetlands, increase vegetative buffer strips, and improve water quality.

In Lake Components

Plants

Protect native submersed and emergent aquatic plants; aquatic plants are very important in stabilizing bottom sediment, utilizing excess nutrients, providing dissolved oxygen, providing fish and wildlife habitat, and helping overall water quality.

Control exotic vegetation; exotic species tend to have aggressive growth rates and rapid dispersal, which is a threat to native plants. Exotics also tend to reach nuisance levels and become a problem for recreational activities. Exotic species like Eurasian watermilfoil, purple loosestrife, and curly-leaved pondweed have been attributed to significant declines in the habitat diversity in many Wisconsin lakes.

Aeration

Continue future aeration; oxygenating the water is very important for speeding up sediment decomposition and better overall water quality. Aeration also helps prevent algae blooms. Adding oxygen into the water column is also important in preventing winter and summer fish kills.

Future Monitoring

Continue future water quality and dissolved oxygen monitoring to help aid in proper management decisions. Annual water analysis is an important ingredient in monitoring nutrient loading and overall water quality.

3.0 Aquatic Plant Management Planning

3.1 Invasive Species Management Options

Results of aquatic plant surveying conducted since 2006 confirm that both Eurasian watermilfoil and curly-leaf pondweed continue to infest the waters of Black Otter Lake. Because of the risks posed by these exotic species to the health of the lake, it is important that control measures continue. The following sub-sections include information regarding potential aquatic plant management options for Black Otter Lake. The pros and cons of main management alternatives and associated costs are provided. Appendix E includes general information regarding exotic species and relevant management techniques.

3.1.1 Large-scale Herbicide Treatments

Several large-scale herbicide treatments have been conducted on Black Otter Lake in the past. Treatment with granular 2,4-D herbicide has proven to be effective for control of Eurasian watermilfoil. Season-long control of curly-leaf pondweed has been provided with treatments of endothall and endothall/2,4-D. Prior treatments have improved recreational uses and native aquatic plants and made dramatic improvements to water quality. Multi-season control of curly-leaf pondweed however, has likely been compromised by the fact that large beds of this plant have existed in non-navigable portions of the lake, and thus have never been treated. Eurasian watermilfoil is also now found in these same areas. Since they have not been treated, these plant beds can serve as sources for repopulating treated portions of the lake.

Since large areas of exotic plants have gone untreated in the last two years in Black Otter Lake, Eurasian watermilfoil and curly-leaf pondweed combined can now be found in approximately 61 acres of the lake. The cost to treat the estimated 49.5 acres of curly-leaf pondweed with Aquathol K® would be approximately $18,500 annually (2007/2008 dollars). After three consecutive years of treatment, treatment needs should be significantly reduced. Eurasian watermilfoil could also be targeted during these treatments by applying liquid 2,4-D. Additional annual costs for this treatment would begin at approximately $7,000. A treatment of this type would need to be repeated annually for three years, for a total project cost of approximately $76,500 (includes chemical application costs only).

Comparative advantages of this alternative include:

- Good in-season control of invasive plants
- Improves water quality
- Moderate cost relative to harvesting option

Comparative Disadvantages include:

- Limited ability to affect shallow/non-navigable areas
- No control of nuisance native plants

- Potential concerns/public acceptance regarding chemical use
- Treating large areas of the lake may not be permitted by the WDNR
- Costs for chemical applications could be considered expensive

3.1.2 Mechanical Harvesting

Mechanical harvesting can provide immediate, targeted relief of nuisance aquatic plants – both exotic and native. Harvesting can be done throughout the season as well. There are many benefits of mechanical harvesting as a tool for managing native plants. In many cases it is a preferred method, particularly in the absence of exotic species. However, for a lake like Black Otter Lake there is little evidence to suggest that harvesting will induce a shift from exotic to native aquatic plant species. It is also unlikely that mechanical harvesting would result in any long-term control of exotic plants, thus the lake would harbor high densities of these plants indefinitely. As a result, curly-leaf pondweed could exhibit extensive die-offs each season during the warmest times of year. In the past, die-offs of curly-leaf pondweed have resulted in anoxia and poor water quality. In addition, harvesting can actually encourage the spread of exotic species, especially Eurasian watermilfoil. As a result, this method is most often recommended after exotic species have been successfully managed by other means.

Drawbacks of mechanical harvesting are the inability to harvest in shallow littoral areas and high costs. Given the densities attained by exotic plants though, the District would likely need to own and operate its own harvester in order to provide effective relief for large areas of the lake. The cost of purchasing a relatively small harvesting system including harvester, conveyor, and trailer equipment would be about $150,000. Hauling to a disposal site, would also need to be arranged or contracted. Unless volunteers could run the program, annual operating costs may be in the range of $30,000 to $50,000 depending on how much harvesting effort/time is required, proximity to disposal site location, fuel costs, and other factors.

Maintaining navigation lanes via mechanical harvesting could also be considered an interim option until a harvester could be purchased. This could be accomplished on a contracting or rental basis. Costs would be contingent upon plant density and the extent of lane clearing desired by the District. An approximate cost for contracting a small harvesting crew would be about $150/hour. The crew could likely achieve a production/harvest rate in the range of 0.2 to 0.3 acres per hour (average including unloading). With these approximate rates, costs for harvesting 20 acres of lake area would be about $15,000. Additional costs related to hauling and disposal could also apply.

Comparative advantages of this alternative include:

- In addition to exotics, can remove nuisance native plants including string algae
- Targeted control capabilities and can be used throughout the season for immediate relief
- Public is typically accepting of this method

Disadvantages include:

- Can cause spreading of exotic plants (EWM) and is not a preferred option unless exotic species have been controlled
- Not practicable/effective in shallow/non-navigable areas
- High costs for purchase or rental of harvesting equipment
- High operating costs for labor and disposal
- Does not offer high potential for long-term control

3.1.3 Lake Drawdown

Since it is an impoundment, the water level of Black Otter Lake can be lowered. Drawdown is a proven aquatic plant management technique. Anecdotal evidence, and experiences with nearby lakes, suggests that control of Eurasian watermilfoil can be attained with a lake drawdown. It is unclear what impact a drawdown may have on curly-leaf pondweed, the lake's primary nuisance. Some sources indicate that curly-leaf pondweed turions will survive and regrow following a drawdown. A distinct advantage of a lake drawdown over the other methods is that it would affect the shallow, non-navigable areas of the lake. While some follow-up herbicide treatment would likely be required in the seasons following a drawdown, treatment needs should be greatly reduced.

The greatest advantage of drawing down Black Otter Lake could be the restoration of emergent plant beds that once dominated the upper ends of the impoundment. Since most emergent species require fluctuating water levels to regenerate, these plant beds have gradually disappeared as a result of the high and constant water levels that have been maintained. The restoration of emergent plant beds would reduce areas where exotic submergent species can grow. Additionally the emergent plant beds would help to improve lake water quality and fishery habitat. For drawdowns to be effective in restoring native vegetation however, they would likely need to be repeated periodically (i.e. every few years).

Stream flow data into and out of Black Otter Lake was collected in conjunction with 2003 management plan development. The data was used to calculate the residence time, or the time it takes for the entire volume of a lake to be replaced by inflowing water. For Black Otter Lake it was calculated at 4.32 days. As a result, the timeframe from drawing down or refilling the lake would be expected to take less than a week.

Both partial and full drawdowns could be effective in restoring native emergent plant beds if implemented on a regular basis. Both could provide control for exotic plants; however a full drawdown would likely provide a greater degree of control. Regardless of the extent of drawdown, some follow-up herbicide treatments will likely be needed, particularly in the relatively deep areas of the lake that are not fully exposed to freezing conditions.

Bathymetric mapping indicates that it will not be possible to completely expose the lake bed with a full drawdown. The practical extent/magnitude of a “full” drawdown is limited by the elevation of the flume culvert through which the lake can be drained. The invert elevation of the culvert is about 6.5 feet below the concrete dam spillway and about 8 ft below the typical summer season lake surface elevation. Accordingly, several deeper pool areas in the lake would not be completely drained during a drawdown (assuming pumping systems are not used to drain these areas). Based on review of bathymetric mapping information and consideration of practical limitations regarding lake drainage capabilities, approximately nine to ten acres of surface water would likely remain after a full drawdown (approximately an 8 ft drawdown condition relative to summer season condition).

A full drawdown could be beneficial for sediment management. However, lab analysis indicates that lakebed sediments are predominately mineral in nature, thus decomposition of organic sediments would not be a big factor. The only practical lake management option available to reduce existing mineral-dominated sediments is physical removal/dredging. As a result, dredging would most likely be required in addition to a full drawdown to achieve an overall significant reduction of sediment thickness in Black Otter Lake.

Perhaps the biggest negative attribute of a full lake drawdown from the lake user perspective would be the loss of the fishery. As the only public water in Outagamie County, the fishery of Black Otter Lake is very important to area anglers. Past public meetings have garnered little support for a full lake drawdown. With the discovery of VHS in Wisconsin waters, the opportunities are limited/restricted for transfer of wild or transferred fish to restock the lake. If fish transfers are not allowed, the cost of restocking with certified hatchery-reared fish would be high. Approximate costs for fingerling fish from a certified private hatchery are as follows:

Summary of fingerling fish restocking costs for Black Otter Lake

Fish species	size	recommended qty/acre	quantity for 84 acres	unit cost	total cost
Bluegill	2-3"	300	25,200	$0.44	$11,088.00
Largemouth Bass	3-5"	100	8,400	$1.08	$9,072.00
Black Crappie	2-3"	200	16,800	$0.64	$10,752.00
Yellow Perch	3-5"	300	25,200	$0.80	$20,160.00
Northern Pike	10-16"	4	336	$10.00	$3,360.00
Golden Shiner**		25	2,100	$6.25	$13,125.00
Total					**$67,557.00**

** in lbs

* Recommended quantities and costs from Keystone Hatcheries.

Since fingerling fish would take a minimum of 4-5 years to reach harvestable size, it could be desirable to stock 2-3 year old fish. However likely costs would be much higher for larger fish as summarized below.

Summary of larger fish restocking costs for Black Otter Lake

Fish species	size	recommended qty/acre	quantity for 84 acres	unit cost	total cost
Bluegill	5-7"	150	12600	$1.40	$17,640.00
Largemouth Bass**	10"+	50**	4200**	$11.20	$47,040.00
Black Crappie	5-8"	100	8400	$2.56	$21,504.00
Yellow Perch**	7"+	60**	5040**	$10.00	$50,400.00
Northern Pike	16"+	2	168	$25.00	$4,200.00
Golden Shiner**		25**	2100**	$6.25	$13,125.00
Total					**$153,909.00**

** in lbs

*Recommended quantities and costs from Keystone Hatcheries.

By utilizing the bathymetric map developed in Figure 12, a series of sequential drawdown scenarios were developed and are summarized in Figure 28. These scenarios allow for visualization of the impact of a number of drawdown possibilities. As is evident from these maps, even if a full drawdown were to be implemented, some water will remain in the lake basin. Deeper areas near and away from the dam will hold water after the water level is lowered. In addition, three streams contribute water to Black Otter Lake. These streams will continue to flow along the lake bed and out of the lake. In the process, these streams would likely cause some downcutting of the sediments leading to the formation of channels through the lakebed. Figure 29 illustrates the likely locations of these channels. The most significant of these will be from Black Otter Creek to the south which has the highest stream flow rate.

If a partial drawdown of 4 feet were done, approximately 64% of the lake bed would be exposed. The remaining water area would be about 30.2 acres with an average depth of 4.5 feet. (Note: Some type of water level control structure would need to be implemented to facilitate execution of a partial drawdown. In concept, this could involve a decanting structure with adjustable weir elevation or adjustable gate that allows water above a certain elevation to flow into the discharge flume culvert.) Given the continuous inflow of Black Otter Creek and the other un-named tributary, and the existing aeration system, there should be sufficient water depth and oxygen to over-winter a significant percentage of the fishery – reducing or eliminating the need for restocking. As examples of similar conditions, Table 12 is a summary of nearby shallow impoundments that sustain fisheries. Such a drawdown scenario may improve the fishery by allowing increased predation of abundant small panfish. The remaining 30.2 acres could even be sufficient to provide a winter ice-fishery.

Following a drawdown, some survival of Eurasian watermilfoil and curly-leaf would be expected. As a result, follow-up herbicide treatments could be used to maintain exotic species below nuisance levels. Treatments would also serve to reduce the plant biomass that remains following drawdown, thereby enhancing fish survival. There is uncertainty to the level of control of curly-leaf pondweed achieved by a drawdown. As a result, it may be necessary to treat the entire 49.5 acres of curly-leaf pondweed with endothall in the years following a drawdown. However, it will be important to monitor the distribution of curly-leaf pondweed in subsequent years and treat the areas of infestation appropriately.

As generally described above, costs for implementing a drawdown project can be influenced significantly by plans for fish re-stocking. If fish transfers are allowed and the WDNR is able to support the drawdown project with fish re-stocking and transfer resources, then overall project costs would likely be low relative to other alternatives. If fish transfers are not allowed and the District must bear the costs of re-stocking the lake from private hatcheries, then costs for a drawdown project could exceed $200,000 depending on the extent of re-stocking. Fish re-stocking costs could potentially be limited if a partial drawdown is conducted and a significant number of fish are retained in the lake (and survive the drawdown). Regardless, costs for a water level control structure would be necessary for a partial drawdown scenario. Costs for a structure are uncertain but could be quite expensive depending on design characteristics (i.e. temporary versus permanent design, stop logs versus sliding gate, etc.).

Comparative advantages of a drawdown alternative include:

- Promotes restoration of native emergent plants
- If fish re-stocking costs are avoided/limited, this alternative could be cost effective relative to other alternatives
- Reduced need for herbicide treatments after a drawdown
- Can impact nuisance native plants
- Potential for consolidation of lake sediments (although recent analyses indicates that significant consolidation is unlikely)

Disadvantages include:

- Loss of fishery with full drawdown
- May be difficult to gain public support due to loss of fishery and limited ability for recreational use of the lake during a drawdown
- Fish re-stocking costs could be significant if fish transfers are not allowed
- Uncertain effectiveness on curly leaf pond weed

3.1.4 Herbicide Treatment of Navigation Lanes

As was evident from the results of the aquatic plant survey, native aquatic plants played a large part in interfering with navigation in Black Otter Lake in 2006. If in the future, this continues, herbicide treatments could be used to open lanes of navigation. A broad spectrum herbicide or mixture of herbicides could target nearly all plant species in a treatment area. If individual species are targeted, a more specific herbicide may be applied in a manner that would target that particular species. The method used for this type of treatment involves spraying herbicides to the surface of the water within the treatment area. Often a mixture of three chemicals (Cutrine®, Aquathol K®, and Reward®), is used to target multiple plant and algae species. If possible, this approach should be used as early in the season as possible on low-growing plants to minimize the amount of plant matter dying off at once. However, sometimes a later season follow-up treatment is needed to maintain open water. If this approach is used, it is likely that annual treatments would be needed to maintain effective control.

3.1.5 Shoreline Vegetation Management

Aquatic vegetation can grow to nuisance levels in the near-shore areas of a lake. Since conventional weed harvesting equipment is unable to operate in the shallow waters along shore, other management options are available to riparian property owners. Typically, there are four management options for control of aquatic vegetation. They are biological, physical, manual/mechanical or chemical. Biological and physical options are used in very specific circumstances. For the homeowners living on Black Otter Lake, manual removal and chemical control are the best options for successful control. It is important to note that the removal of native vegetation from a lake regardless of the method being employed can create conditions favorable for colonization by opportunistic plants. This is particularly the case for more aggressive exotic species such a Eurasian watermilfoil.

Individuals can remove aquatic vegetation in front of their homes, however, there are limitations as to where it can occur and how much can be removed. In most instances, control of native aquatic plants is discouraged or should be limited to areas next to piers and docks.

While larger-scale mechanical removal of vegetation requires a permit from the Wisconsin DNR, manually removing plants along shore (i.e. hand-pulling or using rakes) does not. However, when aquatic vegetation is manually removed it is restricted to an area that is 30 feet or less in width along the shore. The non-native invasive plants (Eurasian watermilfoil, curly-leaf pondweed, and purple loosestrife) may be manually removed beyond 30 feet without a permit, as long as native plants are not harmed.

Members of the Black Otter Lake District must contend with the problems associated with excessive growth of both native and exotic aquatic plants. One option commonly utilized by individual property owners involves near shore chemical treatment of aquatic plants. Individuals can obtain a permit from the Wisconsin DNR to chemically treat aquatic plants in a 30-foot strip along their property extending out 150 feet if necessary. The same three chemicals used in treating navigation lanes could be used in this approach as well.

3.1.6 Herbicide Considerations

Before any herbicide treatment plan is adopted for a lake, a number of concerns should be addressed:

Are these herbicides safe for humans? Aquathol K® (chemical name: endothall) and Reward® (Chemical name: diquat) are both organic herbicides, while Cutrine® is a copper-based herbicide. The Environmental Protection Agency (EPA) lists endothall as a Class D herbicide. This classification means that there are insufficient data to suggest that this compound causes cancer or is harmful to humans. Diquat is classified as Class E herbicide. This means diquat is a chemical for which there is no evidence of carcinogenicity for humans based on a lack of evidence in studies with two species, rat and mouse. At the rates applied with this approach the concentration of copper in the water column is at such a low concentration that there are no health risks to humans.

The EPA product label for endothall lists a three-day fish consumption waiting period, while the diquat label lists a three-day waiting period for drinking and a five-day waiting period for irrigation of food crops. Copper-containing herbicides do not have such use restrictions. While it is not possible to guarantee that any herbicide is 100% safe, the overwhelming body of evidence suggests that these herbicides when properly used pose minimal risks to humans.

Are these herbicides safe for the environment? All three of these herbicides are organic in nature and biodegrade quickly in aquatic environments and do not bioaccumulate. Generally, fish species are tolerant of the Aquathol® formulation of endothall at concentrations of approximately 100 ppm or over. Meanwhile, concentrations of only 0.5 to 5.0 ppm are generally required for aquatic weed control. Endothall also has a low toxicity to crustaceans and a medium toxicity to aquatic insects. Diquat is a broad-spectrum contact herbicide. It is used to control a wide variety of submersed, floating and marginal aquatic weeds as well as algae. For this reason, it is important to minimize the use of such chemicals. Impacts to desirable native plants can be minimized by treating early in the season only in areas of highest priority. Diquat dissipates so quickly it is often undetectable 1-3 days following treatment. Although copper is considered to be toxic to mollusk and fish, it is applied at a low enough rate to target only aquatic plants, algae in particular.

Are they effective? These herbicides have been used on thousands of lakes throughout North America. When applied together at labeled rates, this combination of herbicides will target nearly all aquatic plant species in the treatment area.

Are they economical? While no control method could be considered cheap, herbicide treatments are among the least costly of methods. This is in part due to the relatively low labor costs in comparison to measures such as hand-pulling, mechanical harvesting, etc. Perhaps the greatest consideration is that these herbicides typically produce long-term control of exotics. This means that lake management units seldom need to spend as much in the long-term as they do for the initial treatments. Once the target species are brought under control, the costs of annual maintenance treatments, if needed, are minimal.

What are the disadvantages? The greatest disadvantage of herbicide treatments is that they rarely produce 100% control. In most cases, herbicides tend to work only where applied. This is more so the case with granular formulations. Unnoticed and untreated plants may eventually grow to dense beds if left unchecked. Factors such as pH and plant maturity may also reduce treatment efficacy. Several follow-up treatments, whether in-season or in subsequent years, may be needed to reduce exotic species to target levels.

3.2 Emergent Plant Restoration

Restoration of emergent plants continues to be a long-term management objective for the Black Otter Lake District. Aerial photos taken over the last 50 years document a gradual decline in emergent plant beds in the upper reaches of Black Otter Lake. It is likely that that this decline has been due to maintaining continuous high water levels. Most emergent plant species rely on fluctuating water levels in order to propagate. In the absence of significant water level fluctuations, many emergent plants have gradually died out. At present, the shallow upper reaches of the lake are dominated by algae, duckweed, Eurasian watermilfoil, and curly-leaf pondweed (see Figure 30). It is expected that restoring native emergent species to these locations would help reduce nuisance algae and duckweed growth as well as helping with gaining long-term control of invasive exotic plants. For this restoration to be effective though, it would be imperative that partial (min.) lake drawdowns be conducted every 4-6 years.

The restoration of the emergent plant community could be accelerated by planting native plant species in key locations in the lake. Figure 31 depicts areas of Black Otter Lake most optimal for planting. Conceptually, a planting project could be done in concert with a lake drawdown project. Timing of the planting would be in early September, after lake levels have been drawn down approximately 12 -18". Maintaining some water in the shallows would be necessary in order to gain boat access to the targeted planting areas. After the plants have been established, the lake drawdown could continue.

During May 2004, an effort was made to restore emergent plants to these same locations. This project was funded in part by a grant from the Wisconsin Department of Natural Resources. Planting was done entirely by volunteers, including students from Hortonville High School. A total of 6,300 native plants were planted. Unfortunately, this planting effort was followed by a 100-year flood event that destroyed most of the work.

The planting strategy outlined was designed to greatly reduce the risk of further flooding losses. With the exception of wild rice, all species would be planted as fully mature stock possessing dense root mass. The timing of the planting would also be a factor. Immediately after planting, all planting locations would be exposed by drawdown. The plants should quickly root into the exposed mud flats – making them more resistant to flood damage. To reduce damage from geese and muskrats after the pool has been restored, chicken wire enclosures would be placed around certain sensitive species.

Table 13 includes a list of species recommended for a potential planting project along with approximate costs. All species listed are native Wisconsin genotype plants that have been selected for the type of habitat found in Black Otter Lake. It is expected that volunteer labor would again be used for planting. The Black Otter Lake District could apply for a grant from the WDNR Lake Protection Grant Program or the AIS Grant Program to help fund the project. Assuming additional point-intercept aquatic plant surveys would be scheduled in the future, data from these surveys could be used to assess the effectiveness of the planting project. Appendix D provides descriptions of these species including benefits to habitat and water quality.

4.0 Conclusions and Recommendations

The conclusions and recommendations summarized in this section were developed based on review and assessment of historical and recent lake management planning activities. Recommendations are provided for the Black Otter Lake District's consideration in the context of the District's overall lake management efforts (refer to Section 5.0 of this report for information regarding District action plans).

4.1 Aquatic Plant Management

The Black Otter Lake District has several viable options for managing the two main exotic submersed plant species that have negatively impacted the lake. It is recommended that the Black Otter Lake District establish the goal of reducing and maintaining both Eurasian watermilfoil and curly-leaf pondweed at or below 10% frequency (as determined by a point-intercept aquatic plant survey).

Based on data collected and management options summarized in preceding report sections, the following are recommendations for managing aquatic plants in Black Otter Lake:

Considering the advantages and disadvantages of various options for controlling exotic plants, it is recommended that a drawdown project be implemented for Black Otter Lake. Assuming that the WDNR will allow fish transfers in the future and that overall costs for fish re-stocking could be limited to an acceptable level, a full lake drawdown (i.e. approximately 8 feet) should be conducted in the fall of 2008 or 2009. If fish transfers are not allowed, the District could consider conducting a partial lake drawdown with an objective of retaining fish and limiting potential costs associated with re-stocking. A partial drawdown of four feet could be a viable option. This would leave approximately 30.2 acres of water remaining in the lake. To better promote survival of retained fish with a partial drawdown scenario, it would also be recommended to reposition the aeration diffusers prior to initiation of the drawdown. To facilitate control of the lake level during a partial drawdown, a decanting or overflow type water level control structure would be recommended. This structure would allow for accurate control of the lake level during the drawdown.

Within the past two years, the millpond in Marion, Wisconsin was drawn down for the purposes of managing aquatic plant growth including Eurasian watermilfoil. In 2007, the water level was returned to normal in the millpond. The Black Otter Lake District should remain in communication with the City of Marion to monitor the short- and long-term effects of this drawdown. As with any lake management project, public support is a critical issue. It will be important to continue an open dialogue with the public. Included in this should be the placement of signs at public access points around the lake informing the public of the status of the drawdown and indicating any concerns related to the use of the lake (e.g. muddy conditions, thin ice, etc).

Because of the uncertainty of the effectiveness of managing curly-leaf pondweed with a lake drawdown, it is recommended that the full distribution of this species be chemically treated in 2008. Beginning a treatment regiment prior to drawdown would facilitate recreational use of the lake, as well as protection of lake water quality in 2008. Following a drawdown, it is recommended the District continue to monitor Eurasian watermilfoil and curly-leaf pondweed in Black Otter Lake and chemically treat these species accordingly.

If native aquatic plant growth becomes a nuisance, it is recommended that the Lake District consider mechanical harvesting and/or chemical treatment. If desired, these activities could be limited to opening lanes of navigation. However, harvesting should only take place after exotics have been successfully managed or outside areas of exotic infestations. Similar means should be used by riparian property owners wishing to manage aquatic plants near the shore.

It is further recommended that the Black Otter Lake District implement an emergent plant restoration project as generally outlined in Section 3.2. The installation of plants should take place in the fall of 2008 or at the time the drawdown is initiated.

In the summer of 2009 or after completion of the drawdown, a fishery survey similar to the one conducted in 2005 (Aquatic Biologists, Inc., 2005), would be advisable. This survey would be used to assess impacts of the partial drawdown on the lake's fish communities and determine possible restocking needs.

4.2 Water Quality Management

Dissolved oxygen data suggest that even with the existing aeration system installed on Black Otter Lake, periods of anoxia continue to occur. In addition, water transparency data indicate that poor conditions dominate Black Otter Lake. These conditions indicate that management of Black Otter Lake's water quality must continue to be a high priority. The Black Otter Lake District should continue to pursue and support several of the recommended nutrient and water quality management practices discussed in the 2003 and 1992 lake management plan documents. These recommendations include:

- Encourage or require owners of properties within the contributing lake watershed to discontinue the use of phosphorus-containing fertilizers
- Support implementation and enforcement of site erosion control Best Management Practices within the lake watershed
- Support local units of government and owners in improving storm water management measures in the upper sub-watershed area (Note: the upper sub-watershed appeared to be the most significant contributor of nutrients to the lake based on prior studies)
- Encourage development of projects that prevent direct runoff of sediment and nutrients into Black Otter Lake and its contributing streams (i.e. wetland detention ponds, agricultural buffer strips, land acquisition/preservation, wetland restoration, animal waste management, etc.)

A number of potential water quality and shoreline improvement options are described in Appendix F. Improved land use practices within watershed will help promote improvements to the water quality in Black Otter Lake.

Because periods of anoxia continue to occur in the lake, the District should also consider expanding the aeration system to effectively alleviate conditions associated with summer oxygen depletion.

4.3 Sediment Management

Sediment accumulation should continue to be monitored in Black Otter Lake. In addition, practices which mitigate the accumulation of sediments should continue or be implemented. However, given the current level of sediments in the lake, their management should not necessarily be considered the highest of priorities in terms of the overall management of Black Otter Lake. The management of aquatic plants in Black Otter Lake has long been and should continue to be a higher priority than the management of sediments.

Appendix F provides a number of sediment management recommendations for both the District as well as individual property owners.

4.4 Education and Prevention

The District and lake residents should undertake an active monitoring program for the purpose of identifying and preventing the spread of exotic species. Education should play a big part in this program. All individuals willing to participate should be taught to identify exotic species. The District should make it a priority to include such measures during all normally scheduled meetings whenever possible. In addition, special meetings should be considered to focus primarily on the identification of exotic species for riparian property owners and frequent lake users. Appendix E gives information regarding the identification and life history of four species which have been introduced to lakes throughout Wisconsin. These include Eurasian watermilfoil, curly-leaf pondweed, purple loosestrife (Lythrum salicaria), and zebra mussels (Dreissena polymorpha). Although purple loosestrife and zebra mussels have not been found in Black Otter Lake, it would be prudent to educate as many District members as possible to identify these species and to the threats these species pose to lakes in Wisconsin. Further information and education materials are available through the Wisconsin DNR and the local UW-Extension office.

The extent of an exotic species infestation often dictates which management option is most likely to result in successful control. Preceding sections and Appendix E contain information regarding management options for the exotic species. As always, education should be a key component of any exotic species management effort.

The District should encourage awareness of conservation and water quality protection measures among landowners and residents in the watershed. The District should also create opportunities for people in the watershed to become active participants in managing the lake. Enlisting volunteers, school groups, or others to participate in lake monitoring efforts and other lake management projects would promote education and public support for lake management efforts.

4.5 Future Lake Monitoring

With implementation of aquatic plant management and water quality improvement initiatives, the District should continue lake monitoring efforts to gauge effectiveness of implemented projects and facilitate adaptation of future lake management plans. Specifically, routine aquatic plant surveying should be continued in the coming years. The District should continue collaborating with the WDNR regarding fishery assessments (pre- and post-drawdown monitoring is particularly important). A future comprehensive lake survey would also be prudent in the future after substantial completion of strategic lake management efforts.

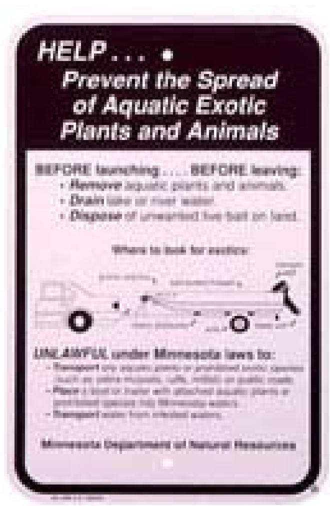
4.6 Future Revisions of Lake Management Plan

The District should consider this lake management planning document adaptive in nature and should revise its contents as substantial information/data becomes available and lake management efforts evolve. In this regard, future amendments to the document should be completed and the plan re-issued according to the discretion of the District. An annual review frequency is recommended.

4.7 Additional District Involvement

Improved public awareness is one of the most important aspects of any lake management effort. By becoming knowledgeable about the condition of Black Otter Lake, District residents can learn what practices are necessary to reduce nutrient inputs and keep the lake healthy. There are a number of activities that District members can carry out to improve lake users' awareness of the problems facing Black Otter Lake.

Exotic species prevention signs available through the Wisconsin DNR.



It is important that the boat landings on Black Otter Lake be posted with exotic species prevention signs. There are signs available through the Wisconsin DNR (see below). These signs should be posted and maintained at all access points to Black Otter Lake including boat launches and walk-ins. Many lake organizations choose to design and erect larger signs designed to call attention to specific concerns related to their lake. Since exotic species currently infest Black Otter Lake, the focus of these signs should be education and the prevention of the spread of exotic species. It is recommended that all signs posted around the Lake encourage boaters entering or leaving the lake to remove any plant or animal material from their watercrafts.

Several other prevention and educational awareness activities should be planned. This can include public notices regarding exotic species, distribution of Wisconsin DNR educational literature to public lake users, and conducting watercraft inspections. These volunteer efforts should focus on preventing the spread of Eurasian watermilfoil and curly-leaf pondweed. Watercraft inspections can also be used as a tool to document potential watercraft infestations that can be communicated to the Wisconsin DNR.

Clean Boats, Clean Waters

The Wisconsin DNR in cooperation with the UW-Extension Lakes Program have developed a volunteer watercraft inspection program designed to educate motivated lake organizations in preventing the spread of exotic plant and animal species in Wisconsin lakes. This program would be particularly useful to Black Otter Lake since Eurasian watermilfoil has been found in nearby lakes. Through the Clean Boats, Clean Waters program volunteers are trained to organize and conduct boater education programs.

For more information contact
Erin Henegar
Clean Boats, Clean Waters Program Coordinator
Wisconsin Invasive Species Program
Ph: 715-346-4978
ehenegar@uwsp.edu

To download a printable brochure regarding the Clean Boats, Clean Waters program go to http://www.uwsp.edu/cnr/uwexlakes/CBCW/Pubs/CBCW_brochure.pdf.

Wisconsin Citizen Lake Monitoring Network

The Wisconsin DNR's Self-Help Lake Volunteer Monitoring Network provides an opportunity for volunteers from lake organizations to assist in state-wide water quality monitoring. Through this program volunteers collect a variety of water quality data in order to gain a better understanding of lake conditions. Through a database managed by the DNR, information gathered can be shared and archived. The types of data collected depend on what concerns and interests are for a particular lake as well as the amount of time available for monitoring. Monitoring of this type has not occurred on Black Otter Lake in nearly ten years.

The most common type of monitoring is for water transparency with the use of a Secchi disc. Volunteers collect water clarity data during spring and fall turnovers as well as throughout the summer. After collecting Secchi data for one or more years, some organizations begin collecting additional water quality data. Volunteers can collect phosphorus and chlorophyll samples in addition to collecting Secchi data. The data collected allows lake managers and the Wisconsin DNR to assess the nutrients present in a lake. In addition, temperature and dissolved oxygen data are also commonly collected on lakes. Other volunteer activities include monitoring for zebra mussels, Eurasian watermilfoil, Purple loosestrife, and curly-leaf pondweed. The Black Otter Lake District is encouraged to again participate in this program.

For more information contact Laura Herman, Citizen Lake Monitoring Network Educator, at (715) 346-3989 (Stevens Point) or (715) 365-8984 (Rhinelander), or by email at Laura.Herman@uwsp.edu.

For more information visit: http://dnr.wi.gov/org/water/fhp/lakes/selfhelp/

To download a printable manual for the Self-Help Lake Volunteer Monitoring program
go to: http://dnr.wi.gov/org/water/fhp/lakes/selfhelp/manual/lakesmanual_2006rev.pdf

State and Federal Grants

A number of grants are available to lake organizations wishing to implement effective lake management efforts or conduct lake related research. Appendix G describes a number of the most applicable grants, who qualifies and what type of projects can be funded. Considering the limited financial resources of the District, financial support for various lake management efforts should be considered and pursued.

5.0 Black Otter Lake District Action Plans

5.1 Lake Management Plan Development and Approval Process

Goals and objectives of recent lake management planning activities included:

- Conducting a bathymetric survey of the lake to map current water depths
- In conjunction with bathymetric surveying, completing a sediment analysis to characterize the extent and composition of sediments that may have accumulated in the lake;
- Utilizing results of surveying and sediment analysis work to facilitate Lake Drawdown planning including development of conceptual lake drawdown scenarios; and
- Preparing an updated comprehensive management plan for the Lake that incorporates historical information regarding lake characteristics in addition to results of recent and anticipated planning activities.

An overall objective in completing the work was to develop information and data that the District can use to support lake management decision-making processes regarding important lake characteristics/resources such as water quality, fish and plant habitat, sediment loading, and the public's recreational use of the lake.

The District is appreciative of financial support for recent planning activities made possible through a Lake Management Planning Grant award from the WDNR.

District officials have reviewed the information and recommendations presented in preceding sections of this report (before authorizing completion of this revision), and have solicited input from members of the public to facilitate development of District objectives/action items. These action items are summarized in the following sections. The District considers this management plant adaptive in nature and anticipates that annual review, prioritizing, and refinement of District objectives will be completed. Amendments or revisions to this lake management plan will be accomplished accordingly.

5.2 District Objectives and Action Items

5.2.1 Aquatic Plant Management

The District intends to continue collaborating with the WDNR and other stakeholders to establish plans for a full lake drawdown project with an objective of reducing and controlling exotic/invasive plant species. Specifically, the District's goal is to reduce and maintain both eurasian watermilfoil and curly-leaf pondweed at or below 10% frequency in the lake (as determined by routine point-intercept aquatic plant surveys).

Fishery related aspects will be critical for gaining public support for a drawdown project. Based on collaboration with local representatives, support for a drawdown project will be contingent on plans for re-establishing the fishery as soon as possible following a drawdown. With a full drawdown, it is anticipated that the fishery could be re-established by conducting fish transfers (i.e. transfer fish from the lake prior to the drawdown and transferring fish back after the drawdown). Currently, the WDNR does not allow transfers of native fish due to concerns for spreading of the VHS virus. Without the ability to conduct transfers, the fishery would need to be re-established via expensive re-stocking which the District cannot afford. Accordingly, plans for a full lake drawdown are contingent on the ability to re-establish the lake's fishery through the use of fish transfers. The District has initiated investigation of potential sites that could be suitable for retention of fish (i.e. other ponds).

To facilitate a potential drawdown project, a Chapter 30 Water Regulatory Permit application was submitted to the WDNR in 2007 and the District has initiated pre-planning and collaboration with the WDNR. The District would like to complete the permitting process on a schedule that could allow a drawdown project to proceed in the fall of 2008, however, if fish transfers are not allowed in 2008, the District would wait until 2009 for project initiation. If fish transfers are still not allowed in 2009, the District would likely reconsider and reprioritize other options (i.e. harvesting, chemical applications, etc.). The District intends to continue discussions with the WDNR regarding a timeline for execution of the drawdown project including establishment of target dates for draining and re-filling of the lake.

Upon completion of a full drawdown, the District intends to collaborate with the WDNR regarding an appropriate schedule/frequency for conducting periodic partial lake drawdowns to sustain beneficial drawdown related effects (i.e. freeze out of invasive plants in shallow areas, promote emergent plant growth, etc.). Based on preliminary discussions with WDNR personnel, the anticipated scope/extent of a partial drawdown could be approximately three to four feet below the normal winter water level and the frequency could be approximately every four to five years. The District also intends to collaborate further with WDNR regarding the timing of annual small scale drawdowns to more closely align with natural habitat cycles.

The District intends to monitor beneficial impacts of a full drawdown on the native and emergent plant community. Based on monitoring results, the District will consider supplemental plantings of desired native species during partial drawdown projects that occur about every four to five years.

Considering that a drawdown project is not likely to eliminate invasive plants (particularly CLPW), the District recognizes that an uncertain amount of chemical treatment will likely be appropriate after a drawdown project to support efforts related to control of invasive plants. The District intends to base the scope of future chemical applications on results of the drawdown, plant monitoring data (see below), and collaboration with the WDNR.

5.2.2 Lake Leader Training

With endorsement/support of the WDNR, the District would like at least one of the District officials to complete the Wisconsin Lake Leader training program in 2008. With completion of the training, the District anticipates that the training program graduate will bring new skills and networking connections back to the Black Otter Lake community to help promote advancement of overall goals.

5.2.3 Water Quality

As short term goals that could promote improvement of water quality in Black Otter Lake, the District intends to promote the restriction of phosphorous containing fertilizers in the watershed area. This will be accomplished through education activities on a voluntary basis. The District will also investigate the feasibility of developing a local fertilizer ordinance and intends to support state-wide related efforts.

The District has purchased a dissolved oxygen meter and has initiated routine monitoring of dissolved oxygen concentrations in the lake. Dissolved oxygen data will be used to evaluate effectiveness of the existing aeration system. Data will also be used to identify and address watershed impacts to the lake. Phosphorous and nitrate monitoring will also be conducted by 2009 to aid assessment of watershed impacts.

As another short term goal (next one to two years), the District intends to explore land acquisition opportunities that may be strategic for protection of Black Otter Lake. In general, the concept would be to preserve certain waterfront areas in an un-developed status as a protective buffer for the lake (i.e. possible options could include wetland restoration/preservation, habitat protection, native plant restoration). The District would like to maintain the percentage of undeveloped shoreland at approximately 50% and is in the process of identifying potential shoreland that could be acquired.

Longer term goals related to water quality management include follow-up action on recommendations related to erosion control practices and storm water management in the watershed areas that influence Black Otter Lake. A prudent schedule for this evaluation could be influenced by drawdown project plans and results.

5.2.4 Public Use/Recreational Enhancements

The District supports public access and enjoyment of Black Otter Lake. Related District objectives in the next one to two years include exploring the opportunity to install dockage at one of the boat launch ramp located on the southwest of the lake. The District also intends to support the Village of Hortonville in efforts related to maintenance/restoration of the Village fishing pier. It is relevant to note in this section that the District's management efforts related to aquatic plant management and water quality are also closely related to overall public use/recreational objectives.

In an effort to promote citizen participation and communication, the District is in the process of implementing a questionnaire/survey to solicit feedback from local residents. The District has also developed an internet website to share information regarding status of lake management efforts, plans, and facilitate feedback from lake users.

5.2.5 Future Monitoring

With implementation of aquatic plant management strategies, the District intends to continue routine monitoring/surveying of plant species in the lake in the coming years (along with certain water quality parameter monitoring that typically occurs with chemical treatment projects). Results of plant monitoring will be used to gauge the effectiveness of control strategies and for adaptation of future strategies. With execution of a potential drawdown project, the District would also anticipate completion of pre- and post-drawdown fishery assessments. The District intends to continue ongoing collaboration with the WDNR regarding fishery assessments.

As a longer term goal the District intends to continue promotion of volunteer self help monitoring on the lake with guidance and collaboration from the WDNR. The District would also like to complete a comprehensive water quality survey of the lake at some point in the future, after substantial improvement efforts have been completed (i.e. completion of drawdown, fertilizer ordinance established, etc.).

5.2.6 Consideration of Harvesting Equipment

Although harvesting may not be considered a primary option at this time for control of exotic plants, the District intends to explore financial and practical issues associated with potential vegetation harvesting at Black Otter Lake. Purchase and contracting/rental options may be considered viable options after non-native invasive plants such as EWM and CLPW have been largely controlled. .

5.2.7 Education and Prevention

The District intends to promote public awareness of important issues facing Black Otter Lake including aspects related to exotic species control and water quality management. Public participation in Lake District meetings will continue to be promoted and the District anticipates that the new ideas for education/prevention initiatives will evolve as a District representative completes the Wisconsin Lake Leader training program.

5.2.8 Financial Support/Grants

Considering the District's limited financial resources, the District intends to continue pursuing financial support opportunities. Specifically, the District anticipates preparing Aquatic Invasive Species related grant applications for submission to the WDNR. Future grant opportunities related to land acquisition (i.e. lake protection grant), education initiatives, harvesting equipment, and other lake management efforts may be pursued.

5.3 Routine Planning Updates

The District intends to maintain a list of planning items in condensed format. This list will be used to summarize schedule and status of important action items that the District is actively managing or pursuing. The list will be updated and revised on an ongoing and as-needed basis. Section 6.0 of this Adaptive Lake Management Plan is designated as a place holder for this condensed format list.

6.0 Condensed Schedule and Status of Planning Items

The Black Otter Lake District maintains a condensed list of planning items being managed and/or pursued by the District. The list is updated as planning items adapt and as schedule or status changes occur. This report section is reserved for a current version of the condensed list.

Black Otter Lake District
Adaptive Plan - Schedule and Status
2008/2009

Date August 21, 2007
Updated June 5, 2008

The goal of the Black Otter Lake District is to significantly improve the lake quality status in keeping with the Adaptive Management Plan of 2008 and to involve and inform the public.

Action	Responsibility	Estimated Date	Completion Date	Status
Complete Comprehensive Lake Management Plan	STS Consultants/BOLD/DNR	April 30, 2008		Current draft submitted to us February 21 - DNR has commented on issues within the plan on April 4. BOLD has agreed to proceed per there recommendations.
Inspect Aerator Network	BOLD	October 15, 2007	October 10, 2007	Todd inspected the aerator.
Shutdown Aerator Network	BOLD	November 17, 2007	November 10, 2007	Todd shut down the network for winter. One will be turned on after sufficient ice.
Complete sediment analysis study for lake plan	WL&P	December 15, 2007	December 11, 2007	Complete
Install Pylons	BOLD	December 15, 2007	December 16, 2007	Completed by John Christensen, Randy Kluge & Todd Lavey.
Application for Aquatic Plant Harvester Grant	BOLD/STS Consultants	January 30, 2008		Will fall into a 2009 or 2010 project. Further investigation later this year.
Application for Invasive Species Grant a. Application submitted for AIS Grant to control Curly Leaf Pondweed for three years - $70,670 Total - State - $53,003	BOLD/STS Consultants	January 30, 2008	Denied April 14, 2008	Applications Submitted January 31 We were verbally informed that our grant requests were not approved as of March 13. Haven't received confirmation but understand this is partially because we don't have a completed Lake Plan.
b. Application submitted for AIS Grant for Drawdown, Emergent Plant Re-establishment, Eurasian Milfoil Monitoring & Control - $ 86,572 Total - State - $64,929			Denied April 14, 2008	See above
Approve Updated Lake Plan	BOLD	May 30, 2008		Current draft submitted to us February 21. STS to complete per DNR recommendations
Submit 2008 Invasive plant control permit request	STS Consultants/BOLD	February 15, 2008	January 31, 2008	Application for 50 acres Curly Leaf Pondweed submitted January 31. Permitting is also currently in question due to Lake Plan issues.

Receive Chemical Treatment Permit		**Wisconsin DNR**	**April 15, 2008**	**April 11, 2008**	**Application received with conditions to meet with approval of Mark Sesing & Kathy Dax. BOLD will treat no more than 20 acres of curly leaf unless recommended by DNR.**
Purchase Dissolved Oxygen Meter		**BOLD**	**April 15, 2008**	**April 26, 2008**	**Complete & received**
Attended Annual WAL Conference, Green Bay		**BOLD - John Abitz, BillCurtis**	**April 17, 2008**	**April 19, 2008**	**Complete**
Begin testing dissolved oxygen		**BOLD**	**May 1, 2008**	**Ongoing**	**First test completed May 1**
First Combination weed treatment - Eurasian Watermilfoil & Curly Leaf Pondweed		**Wisconsin Lake & Pond Resource**	**May 1, 2008**	**May 6, 2008**	**Treatment was very late due to late ice conditions. Treated 30 acres, 22 on man lake & 8 above trestle.**
Aerial photo of Lake		**BOLD**	**May 1, 2008**		**Have requested twice with no reply.**
Complete UW-EX Lake Leaders Institute		**Bill Curtis - BOLD**	**May 21, 2008**	**October 31, 2008**	**Six days of learning - May, September & October.**
Make determination and purchase weed harvester		**BOLD**	**May 30, 2008**		**Project will be reviewed again in 2009 but will likely begin in 2010 depending on drawdown timing.**
Meet with Kendall Kamke, Scott Koehnke & John Kelly for initial inspection of retention pond	**Drawdown**	**BOLD/DNR**	**June 9, 2008**		
Post notice of public meeting in POST Crescent	**Drawdown**	**BOLD**	**June 30, 2008**		**Need to prepare notice prior to June**
Contract engineer as required to determine flume modification for future water level adjustments, include costs & installation	**Drawdown**	**BOLD**	**June 30, 2008**		**Req approximate costs**
Review with DNR potential emergents for 2009	**Drawdown**	**BOLD/DNR/WL&P**	**June 30, 2008**		**Req approximate costs**
Written approval DNR for use of John Kelly's pond	**Drawdown**	**DNR/BOLD**	**June 30, 2008**		
Meeting with DPW to develop plan for daily reduction of water level	**Drawdown**	**BOLD**	**June 30, 2008**		
Consider application for grant for obtaining property on lake			**July 8, 2008**		**Req approximate costs**
Work with Kendall to develop initial fish transfer plan/ include possible fish planting	**Drawdown**	**BOLD/DNR**	**July 8, 2008**		**Req approximate costs**
Finalize requirements for AIS grant request for drawdown project 2008/2009	**Drawdown**	**BOLD**	**July 8, 2008**		**Define elements & estimated costs for submission of request prior to 7/31. Include costs for treatment John**
Hold public meeting to discuss objectives and process for full drawdown.	**Drawdown**	**BOLD/DNR**	**July 15, 2008**		**Schedule will be publicized in Village Voice as well as Post Cresent**
Weed Cutting		**BOLD**	**July 20, 2008**		**Not Planning for 2008**

Watershed survey to assess public opinion on potential full drawdown for 2008.	Drawdown	BOLD	July 31, 2008	Survey will be mailed out with Hortonville Village Voice June 19 to receive responses by July 1.
Meet will consultant, DNR and BOLD to develop concensus for drawdown to proceed for fall 2008.	Drawdown	BOLD/DNR	July 31, 2008	
Develop final plan for fish removal & transportation	Drawdown	BOLD/DNR	July 31, 2008	Req approximate costs
Grant request relative to drawdown expenses must be submitted	Drawdown	BOLD	July 31, 2008	Req approximate costs
Review of weed condition & supplemental treatment		Wisconsin Lake & Pond Resource	August 1, 2008	
Meet with watershed governmental bodies to discuss drawdown project	Drawdown	BOLD	August 8, 2008	
Aerial photo of Lake		BOLD	August 15, 2008	
Drawdown Consideration	Drawdown	BOLD/Village/County	August 15, 2008	
Annual Meeting & Budget Approval		**BOLD**	**August 18, 2008**	
Confirm final approval of drawdown 2008	Drawdown	BOLD	August 19, 2008	Will be approved at Annual Meeting
Aerators removed & moved to fish retention pond.	Drawdown	BOLD/WL&P	August 22, 2008	Req approximate costs
Drawdown Approval & Initiation	Drawdown	BOLD	August 30, 2008	Daily water level reduction to begin no more than 6" per day.
Fish removal and transfer to take place	Drawdown	BOLD/DNR	October 1, 2008	Req approximate costs
Weekly inspection of drawdown status	Drawdown	BOLD	October 8, 2008	
Inspect Aerator Network at Rentention Site	Drawdown	BOLD	October 15, 2008	
Application for Invasive Species Grant		BOLD	January 30, 2008	Req approximate costs
Discuss potential curly leaf treatment for 2009		BOLD/WL&P/DNR	January 5, 2009	
Submit 2009 Invasive plant control permit request		BOLD/WL&P	February 15, 2009	Req approximate costs
Receive Chemical Treatment Permit		Wisconsin DNR	April 15, 2009	Req approximate costs
Plant emergents on main lake	Drawdown	BOLD	April 15, 2009	Req approximate costs
Attend annual WAL Conference		New Treasurer	May 1, 2009	
Attend certification training for chemical analysis		Bill Curtis	May 1, 2009	
Attend certification training for Clean Boats Clean Waters		John Abitz	May 1, 2009	
Close flume & begin lake restoration	Drawdown	BOLD	May 1, 2009	
Remove any required physical structure from drawdown	Drawdown		May 1, 2009	Req approximate costs
Retrieve fish from retention pond & return to Black Otter/ Inspect Kelly's pond for aquatic plant s	Drawdown	DNR/BOLD	May 15, 2009	Req approximate costs

Restore aerators on Black Otter	Drawdown	WL&P/BOLD	May 31, 2009	Req approximate costs
Complete chemical treatment for Eurasian Milfoil		WL&P/BOLD	June 1, 2009	
Initiate broad survey for public interest in future direction for Lake District		UWEX/BOLD	June 1, 2009	
Acquire fish as required for replenishment	Drawdown	BOLD/DNR	June 1, 2009	Req approximate costs
Complete point intercept aquatic plant study	Drawdown		July 15, 2009	Req approximate costs
Complete sediment & water quality analysis study	Drawdown	WL&P/BOLD or DNR	July 31, 2009	Req approximate costs
Apply for grant for chemical treatment & planting as required		BOLD	July 31, 2009	Req approximate costs
Assess results of survey for discussion at annual meeting		BOLD	August 8, 2009	
Review whether harvestor will be required for 2010		BOLD/DNR	August 15, 2009	
Annual Meeting & Budget Approval		BOLD	August 18, 2009	
Complete fish study	Drawdown	DNR	September 31, 2009	
Determine if fish supplemental planting required	Drawdown	DNR/BOLD	November 15, 2009	Req approximate costs
Shutdown aerators for winter			November 15, 2009	
Install pylons & restore one aerator			December 15, 2009	
Apply for Aquatic Plant Harvestor Grant		BOLD	January 31, 2010	
Apply for chemical treatment permit		BOLD	Februsry 15, 2010	

Insert Current Condensed List Here

7.0 References

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Tables

Table 1 – Summary of 2002 Black Otter Lake Water Analysis Data Collected One Foot Below the Surface Over the Deepest Point of the Lake

		sample date					
parameter	unit	24-Apr-02	17-Jun-02	12-Jul-02	7-Aug-02	4-Nov-02	Average Value
alkalinity	mg/l	232					232
chloride	mg/l	31.2					31.2
chlorophyll *a*	ug/l	33	10	54.4	17	4	23.7
conductivity	um/cm	567					567
dissolved oxygen - bottom	mg/l	11.8	0.10	0.10	0.08	5.44	3.5
dissolved oxygen - surface	mg/l	12.6	11.2	5.7	5.43	13.35	9.66
ammonia as N	ug/l	34					34
Kjeldahl nitrogen	ug/l	1520					1520
nitrate + nitrite as N	ug/l	798	482	N.D.	N.D.	1480	552
total phosphorus	ug/l	60	63	89	90	31	66.6
dissolved phosphorus	ug/l	N.D.					N.D.
nitrogen / phosphorus ratio		39/1					
pH, field	s.u.	8.7	8.48	8.2	8.06	8.6	8.41
pH, lab	s.u.		8.57	7.88		8.53	8.3
secchi disc depth	ft.	3.1	3.4	3.1	2.5	6.9	3.8
temperature - bottom	C	12.2	12.3	14.2	17.7	4.7	12.22
temperature - surface	C	12.2	24.9	25.6	24	4.8	18.3
total dissolved solids	mg/l	354					354
total suspended solids	mg/l	7					7
weather conditions		rainy,windy	sunny	calm	sunny	calm	
air temperature	C		29.1	25.2	24	1.7	20
cloud cover	%	100.00	20	20	0	0	28
gauge height	ft.	2.25	2.25	2.21	2.2	3.17	2.42

N.D. = not detected, concentration below limit of detection
Gauge height = distance between bottom of iron RR bridge and water's surface.

Table 2 – A Comparison of Averaged Water Quality Parameters from Black Otter Lake Between 1978, 1991, and 2002

parameter	Location	unit	1978	1991	2002
alkalinity	lake	mg/l	204	278	232
chloride	lake	ug/l	17	30	31.2
Chlorophyll a	lake	ug/l	34	*	23.7
dissolved oxygen - surface	lake	mg/l	9.6	10.2	9.66
conductivity	lake	um/cm	590	*	567
dissolved (reactive) phosphorus	lake	ug/l	44	14	N.D.
Kjeldahl Nitrogen	lake	ug/l	*	510	1520
Nitrate + Nitrite as N	lake	ug/l	*	32	552
pH, field	lake	s.u.	9.1	7.8	8.41
secchi disc depth	lake	ft.	3.8	4	3.8
temperature - surface	lake	C	21.7	19.3	18.3
total phosphorus	lake	ug/l	70	222	66.6
total suspended solids	lake	mg/l	*	478	7
conductivity	inlet (south)	um/cm	610	*	*
dissolved (reactive) phosphorus	inlet (south)	ug/l	16	*	*
total phosphorus	inlet (south)	ug/l	52.3	*	54.2
total suspended solids	inlet (south)	mg/l	51	*	*
conductivity	outlet (dam)	um/cm	510	*	*
discharge	outlet (dam)	cfs	10.4	*	67.8
dissolved (reactive) phosphorus	outlet (dam)	ug/l	48	*	*
total phosphorus	outlet (dam)	ug/l	90.8	*	69.4
total suspended solids	outlet (dam)	mg/l	23	*	*

* = no data available
N.D. = not detected, concentration below limit of detection

Averaged values from the water quality parameters were calculated from samples within the time period of April - November. The data was compared at the most similar times allowed for each sample year.

Table 3 – 2002 Black Otter Lake Water Analysis Data Collected from North and South Inlets

parameter	unit	sample date 24-Apr-02	17-Jun-02	8-Jul-02	7-Aug-02	4-Nov-02	Average
dissolved oxygen	mg/l	8.3	14.5	5.8	2.65	14	9.05
nitrate + nitrite as N	ug/l	172	63	10	N.D.	820	213
total phosphorus	ug/l	445	126	87	96	33	157.4
pH, field	s.u.	8.54	8.82	8.3	7.76	8.59	8.4
water temperature	C	14.2	25	26.7	22.3	5.0	18.6
weather conditions		rainy,windy	sunny	humid	sunny	calm	
air temperature	C		29.1	25.2	24	1.7	20
cloud cover	%	100	20	20	0	0	28

North Inlet Data

parameter	unit	sample date 24-Apr-02	17-Jun-02	12-Jul-02	7-Aug-02	4-Nov-02	Average
dissolved oxygen	mg/l	13.3	11.39	0.9	0.83	17.77	8.84
nitrate + nitrite as N	ug/l	2200	2640	3100	1080	7710	3346
total phosphorus	ug/l	32	98	44	69	28	54.2
pH, field	s.u.	8.9	7.9	7.7	7.7	8.55	8.15
water temperature	C	11.4	20.7	20.1	22.1	5.4	15.94
weather conditions		rainy,windy	sunny	calm	sunny	calm	
air temperature	C		29.1	25.2	24	1.7	20
cloud cover	%	100	20	20	0	0	28

South Inlet Data

Table 4 – Black Otter Lake Water Quality Data for September 18, 2006

Depth (ft)	September 18, 2006 Temp (°F)	D.O. (mg/L)	% Sat.
0	67.7	7.79	89.1
1	67.5	7.84	89.4
2	67.0	7.88	89.1
3	67.0	7.84	88.9
4	66.9	7.83	88.6
5	66.6	7.58	85.5
6	66.4	7.37	83.1
7	66.0	6.63	74.4
8	65.5	2.55	30.1
9	65.1	1.98	21.9
10	63.7	1.31	14.5
11	62.6	0.14	1.9

Water transparency (Secchi depth):	6.2 ft

pH:	8.57

Table 5 – Soft Sediment Thicknesses and Water Depths Measured on December 10-11, 2007 on Black Otter Lake, Outagamie County

Site #	Water depth (depth to soft sediment)(ft)*	Depth to hard sediment (ft)	Soft sediment thickness (ft, in)	Soft sediment thickness (dec. ft)	Total Solids (%)	Volatile Solids (%)
1	8' 7"	9' 8"	1' 1"	1.08	14.4	15.5
16	6' 10"	9' 2"	2' 4"	2.33	13.2	31.3
19	7' 6"	9' 3"	1' 9"	1.75	7.3	13.4
32	2' 11"	5' 0"	2' 1"	2.08	39.8	5.9
35	6' 5"	8' 1"	1' 8"	1.67	3.8	18.3
55	2' 4"	4' 7"	2' 3"	2.42	17.4	9.6
58	5' 4"	7' 8"	2' 4"	2.33	27.1	7.8
61	10' 3"	11' 5"	1' 2"	1.17	53.1	4
64	6' 4"	8' 4"	2' 0"	2.00	65.1	2.2
67	5' 9"	7' 11"	2' 2"	2.17	19.1	8.2
97	1' 11"	3' 6"	1' 7"	1.58	18.5	8.7
100	6' 9"	9' 2"	2' 3"	2.25	12.6	13.9
103	4' 11"	8' 6"	3' 7"	3.58	23.6	7.7
106	5' 11"	8' 6"	2' 7"	2.58	16.2	15
136	0' 11"	2' 0"	1' 11"	1.92	32.3	7.5
139	7' 11"	10' 5"	2' 6"	2.50	38.2	7.1
142	1' 6"	3' 10'	2' 4"	2.33	39	7.5
145	1' 9"	3' 5'	1' 8"	1.67	26	9.7
148	2' 7"	4' 5"	1' 10"	1.83	12.8	12.1
178	4' 5"	7' 1"	2' 8"	2.67	22.5	10
181	2' 1"	3' 11'	1' 10"	1.83	20.8	14
183	0' 9"	1' 11"	1' 2"	1.17	25.6	13.7
186	5' 9"	7' 4'	1' 7"	1.58	9.1	11.5
189	0' 9"	3' 5"	2' 8"	2.67	12.5	20.1
192	1' 0"	4' 1"	3' 1"	3.08	9.2	17.7
195	0' 1"	5' 3"	5' 2"	5.17	17.9	17
236	1' 2"	3' 7"	2' 5"	2.42	24.5	13.1
237	0' 1"	2' 3"	2' 2"	2.17	13.4	31.1
240	5' 0"	6' 7'	1' 7"	1.58	19.3	6.2
243	1' 7"	4' 7'	3' 0"	3.00	15.2	17.6
244	1' 0"	4' 6"	3' 6"	3.50	14.2	19.7
247	0' 11"	3' 7'	2' 8"	2.67	25.6	16.5
248	0' 2"	3' 3"	3' 2"	3.17	16.2	20.8
275	1' 7"	4' 0"	2' 5"	2.42	12.4	16.9
277	0' 8"	2' 7"	1' 11"	1.92	28.5	14.6
280	1' 7"	5' 1"	3' 6"	3.50	16.8	16.3
284	1' 0"	3' 11"	2' 11"	2.92	25.2	10.1
		Average:	2' 4"	2.37		

* water depths based on fixed head of dam. Summer depths may be set 6-18 inches higher

Collectors: C. Cason
J. Nicholson

Table 6 – Shoreline Aquatic Plant Transcet Data from Black Otter Lake, June 2002

Species common name	scientific name	Transect/Abundance Ranking I	II	III	IV	V	VI	VII	VIII	IX
Blue Flag Iris	*Iris versicolor*			1	1			1	2	
Bottlebrush Sedge	*Carex comosa*		1	1	1	2	2	1	1	2
Broad Leaved Arrowhead	*Sagittaria latifolia*						1			1
Broad Leaved Cattail	*Typha latifolia*				2	2	4	2		
Canada Bluejoint Grass	*Calamagrostis canadensis*				1	3				
Creeping Spikerush	*Eleocharis palustris*			1						
Curly Dock	*Rumex Crispus*								1	1
Dogwood	*Cornus spp.*									
Floating Leaf Pondweed	*Potamogeton natans*		2	3	3	4	4	3		
Hardstem Bulrush	*Scripus acutus*	1								
Jewelweed	*Impatiens capensis*		4	4				2		
Kentucky Bluegrass	*Poa pratensis*	3	4	4	4	4	2	4	4	4
Lake Sedge	*Carex lacustris*					2				
Marsh Marigold	*Caltha Palustris*							1		
Marsh Milkweed	*Asclepias incarnata*				1					
Narrow Leaved Cattail	*Typha angustifolia*					2				
Needle Rush	*Eleocharis acicularis*									
Reed Canary Grass	*Phalaris arundinacea*				2			1		
River Bulrush	*Scripus fluviatilis*				2					
Sage Willow	*Salix canadensis*									
Soft Rush	*Juncus effusus*		1	2	1	2		1	1	
Softstem Bulrush	*Scripus validus*									
Spadderdock	*Nuphar variegata*									
Stalk Grained Sedge	*Carex stipata*			1						
Tag Alder	*Alnus*							1	2	3
Tussock Sedge	*Carex*					1		1		
Water Smartweed	*Polygonum amphibium*								2	
Water Smartweed spp.	*Polygonum longistylum*								1	
Willow	*Salix spp.*							1	1	
total per transect		**4**	**12**	**17**	**18**	**22**	**13**	**19**	**15**	**11**

Relative abundance Ranking

1 Rare — found along less than 5% of transect
2 Present — foung along 5-25% of transect
3 Common — found along 25-50% of transect
4 Abundant — found along more than 50% of transect

Table 7 – Results of the Submergent Aquatic Plant Survey Conducted on Black Otter Lake During June 2002

Species common name	scientific name	Percent Frequency	Percent Composition
Curly Leaf Pondweed	*Potamogeton crispus*	74.3	22.1
Coontail	*Ceratophyllum demersum*	60.7	18.1
Horsehair algae	*Pithophora spp.*	38.6	11.5
Lesser Duckweed	*Lemna Minor*	34.3	10.2
Eurasian Watermilfoil	*Myriophyllum spicatum*	19.3	5.7
Sago Pondweed	*Potamogeton pectinatus*	15.0	4.5
Watermeal	*Wolffia columbiana*	14.3	4.3
Filamentous Green Algae	*Spirogyra spp.*	14.3	4.3
Northern Watermilfoil	*Myriophyllum sibericum*	12.9	3.8
White Water Crowfoot	*Ranunculus longirostris*	12.1	3.6
Whorled Watermilfoil	*Myriophyllum verticillatum*	10.7	3.2
Floating Leaf Pondweed	*Potamogeton natans*	9.3	2.8
Musk Grass	*Chara spp.*	7.1	2.1
Star Duckwed	*Lemna trisulca*	5.7	1.7
Water Moss	*Drepanoclaclus spp.*	2.9	0.9
Colonial BlueGreen Algae	*Oscillatoria*	1.4	0.4
Stonewort	*Nitella spp.*	1.4	0.4
Various-Leaved Watermilfoil	*Myriophyllum heterophyllum*	0.7	0.2
Filamentous Green Algae	*Cladophora spp.*	0.7	0.2
No Plants Found		0.7	

Table 8 – A Comparison of Black Otter Lake Submergent Plant Survey Data from 1978 and 2002

Species common name	scientific name	Percent Frequency 2002	1978
Curly Leaf Pondweed	*Potamogeton crispus*	74.3	
Coontail	*Ceratophyllum demersum*	60.7	88
Horsehair algae	*Pithophora spp.*	38.6	
Watermilfoil	*Myriophyllum spp.*	*	76
Lesser Duckweed	*Lemna Minor*	34.3	
Eurasian Watermilfoil	*Myriophyllum spicatum*	19.3	
Sago Pondweed	*Potamogeton pectinatus*	15.0	11
Watermeal	*Wolffia columbiana*	14.3	
Filamentous Green Algae	*Spirogyra spp.*	14.3	
Northern Watermilfoil	*Myriophyllum sibericum*	12.9	
White Water Crowfoot	*Ranunculus longirostris*	12.1	16
Whorled Watermilfoil	*Myriophyllum verticillatum*	10.7	
Floating Leaf Pondweed	*Potamogeton natans*	9.3	30
Musk Grass	*Chara spp.*	7.1	1
Star Duckwed	*Lemna trisulca*	5.7	
Spadderdock	*Nuphar variegata*	4	1
Water Moss	*Drepanoclaclus spp.*	2.9	
Colonial BlueGreen Algae	*Oscillatoria*	1.4	
Stonewort	*Nitella spp.*	1.4	
Various-Leaved Watermilfoil	*Myriophyllum heterophyllum*	0.7	
Filamentous Green Algae	*Cladophora spp.*	0.7	
No Plants Found		0.7	
Flatstem Pondweed	*Potamogeton zosteriformis*	0	75
Small Pondweed	*Potamogeton pusillus*	0	63
Elodea	*Anacharis canadensis*	0	13
Water Stargrass	*Heterathera dubia*	0	3

* sorted to genus

Table 9 - Aquatic Plant Frequency of Occurrence by Depth from 2002 Black Otter Lake Survey

Species common name	scientific name	Precent Frequency / Depth (ft.) 0-1.9	2.0-3.9	4.0-5.9	6.0-7.9	8+
Curly Leaf Pondweed	*Potamogeton crispus*	45.8	66.7	95.8	90.4	37.5
Coontail	*Ceratophyllum demersum*	95.8	62.5	79.2	44.2	37.5
Horsehair algae	*Pithophora spp.*	70.8	25.0	8.3	38.5	50.0
Lesser Duckweed	*Lemna Minor*	70.8	50.0	37.5	13.5	18.8
Eurasian Watermilfoil	*Myriophyllum spicatum*	12.5	0.0	50.0	23.1	0.0
Sago Pondweed	*Potamogeton pectinatus*	79.2	8.3	0.0	0.0	0.0
Watermeal	*Wolffia columbiana*	37.5	20.8	25.0	0.0	0.0
Filamentous Green Algae	*Spirogyra spp.*	37.5	16.7	8.3	5.8	12.5
Northern Watermilfoil	*Myriophyllum sibericum*	37.5	8.3	4.2	1.9	0.0
White Water Crowfoot	*Ranunculus longirostris*	41.7	25.0	4.2	0.0	0.0
Whorled Watermilfoil	*Myriophyllum verticillatum*	16.7	12.5	16.7	3.8	12.5
Floating Leaf Pondweed	*Potamogeton natans*	12.5	37.5	4.2	0.0	0.0
Musk Grass	*Chara spp.*	12.5	29.2	0.0	0.0	0.0
Star Duckweed	*Lemna trisulca*	20.8	16.7	0.0	3.8	6.8
Water Moss	*Drepanocladus spp.*	0.0	0.0	0.0	1.9	18.8
Colonial BlueGreen Algae	*Oscillatoria*	8.3	0.0	0.0	0.0	0.0
Stonewort	*Nitella spp.*	0.0	8.3	0.0	0.0	0.0
Various-Leaved Watermilfoil	*Myriophyllum heterophyllum*	0.0	4.2	0.0	0.0	0.0
Filamentous Green Algae	*Cladophora spp.*	0.0	0.0	4.2	0.0	0.0
No Plants Found		0.0	0.0	0.0	0.0	6.3

Table 10 – Results of the Aquatic Plant Survey Conducted on Black Otter Lake on September 18, 2006

Species common name	scientific name	Frequency	Percent Frequency	Relative Frequency
Coontail	*Ceratophyllum demersum*	249	98.8	27.7
Eurasian water milfoil	*Myriophyllum spicatum*	169	67.1	18.8
Watermeal	*Wolffia columbiana*	163	64.7	18.2
Filamentous Algae	*Pithophora,Cladophora, etc.*	153	60.7	17.0
Small duckweed	*Lemna minor*	49	19.4	5.5
Common waterweed	*Elodea canadensis*	35	13.9	3.9
Sago pondweed	*Stuckenia pectinata*	33	13.1	3.7
Floating-leaf pondweed	*Potamogeton natans*	27	10.7	3.0
Water marigold	*Megalodonta beckii*	5	2.0	0.6
Robbins pondweed	*Potamogeton robbinsii*	4	1.6	0.4
Broad-leaved cattail	*Typha latifolia*	4	1.6	0.4
Muskgrasses	*Chara*	3	1.2	0.3
Forked duckweed	*Lemna trisulca*	2	0.8	0.2
Curly-leaf pondweed	*Potamogeton crispus*	2	0.8	0.2

Table 11 – Black Otter Lake Floristic Quality Index (FQI) Analysis Table

Common Name	Scientific Name	C
Coontail	*Ceratophyllum demersum*	3
Muskgrasses	*Chara*	7
Common waterweed	*Elodea canadensis*	3
Small duckweed	*Lemna minor*	5
Forked Duckweed	*Lemna trisulca*	6
Water marigold	*Megalodonta beckii*	8
Floating-leaf	*Potamogeton natans*	5
Robbins pondweed	*Potamogeton robbinsii*	8
Sogo pondweed	*Stuckenia pectinata*	3
Broad-leaved cattail	*Typha latifolia*	1
Common watermeal	*Wolffia columbiana*	5
	N	11
	mean C	4.91
	FQI	16.28

Table 12 – Nearby Impounded Lakes Having Depths of Five Feet of Less that Sustain Fisheries.

Location	Lake Name	Surface Area (acres)	Max Depth (feet)
Calumet County			
	Hayton Pond	36	5
Waupaca County			
	Cincoe Lake	169	4
	Junction Lake	16	4
	Peterson Creek Millpond	6	4
	Waupaca Millpond	22	5
Waushara County			
	Auroraville Millpond	209	5
	Clarks Millpond	68	5
	Pine River Millpond	28	4
	Saxeville Millpond	13	4
Winnebabo County			
	Rush	3070	5

Source: *Wisconsin Lakes,* Wisconsin Department of Natural Resources, PUB-FH-800, 2001.

Table 13 – Recommended Emergent Plant Species and Planting Quantities for Black Otter Lake.

Species common name	scientific name	type	quantity	cost/plant	total cost
Common Arrowhead	*Sagittaria latifolia*	M	400	$4.00	$1,600
Common Bur-reed	*Sparganium eurycarpum*	M	800	$4.00	$3,200
Pickerelweed	*Pontederia cordata*	M	200	$4.00	$800
River Bulrush	*Bolboschoenus fluviatilis*	M	400	$4.00	$1,600
Softstem Bulrush	*Schoenoplectus tabernaemontani*	P	1000	$4.00	$4,000
Spatterdock	*Nuphar variegata*	R	100	$7.00	$700
Water Plantain	*Alisma subcordatum*	M	200	$4.00	$800
Wild Rice	*Zizania spp.*	S	200 lbs	$12.00	$2,400
Total plant material					**$15,100**
Herbivore barrier materials					**$2,000**
labor (400 volunteer hours)					**$3,200**
Total project cost					**$20,300**

M = Mature Plant

R = Rhizome

S = Seed

Figures

Figure 1 – Black Otter Lake and the Surrounding Area, Outagamie County, Wisconsin

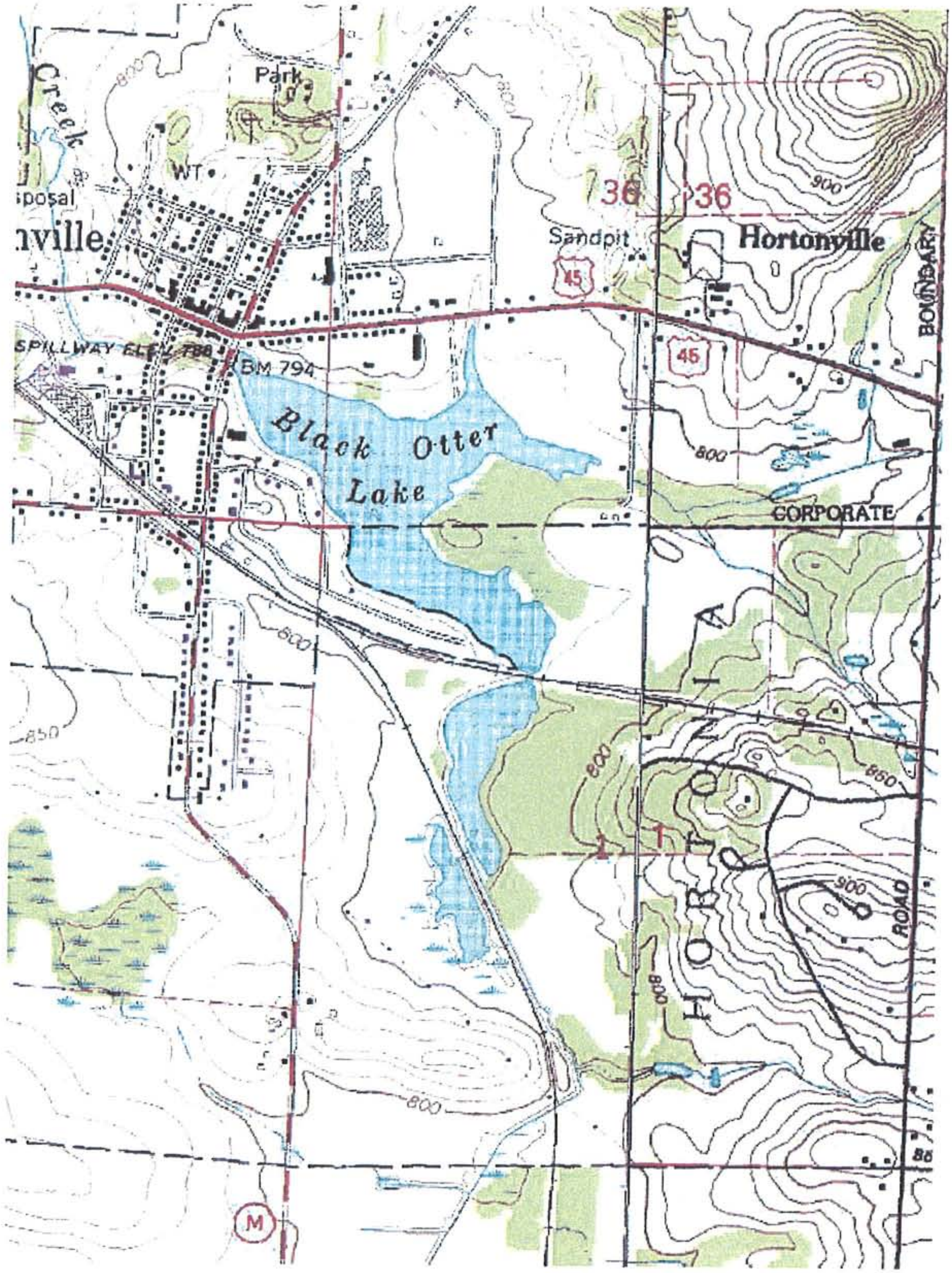
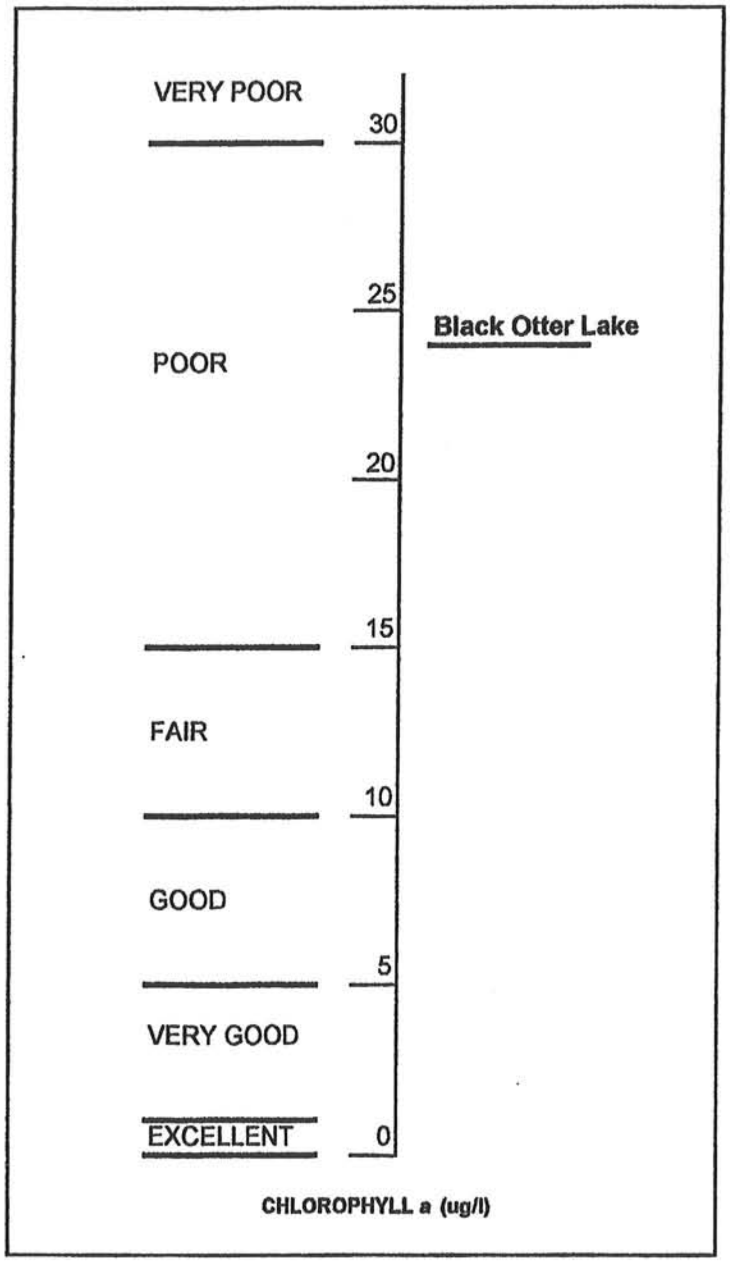
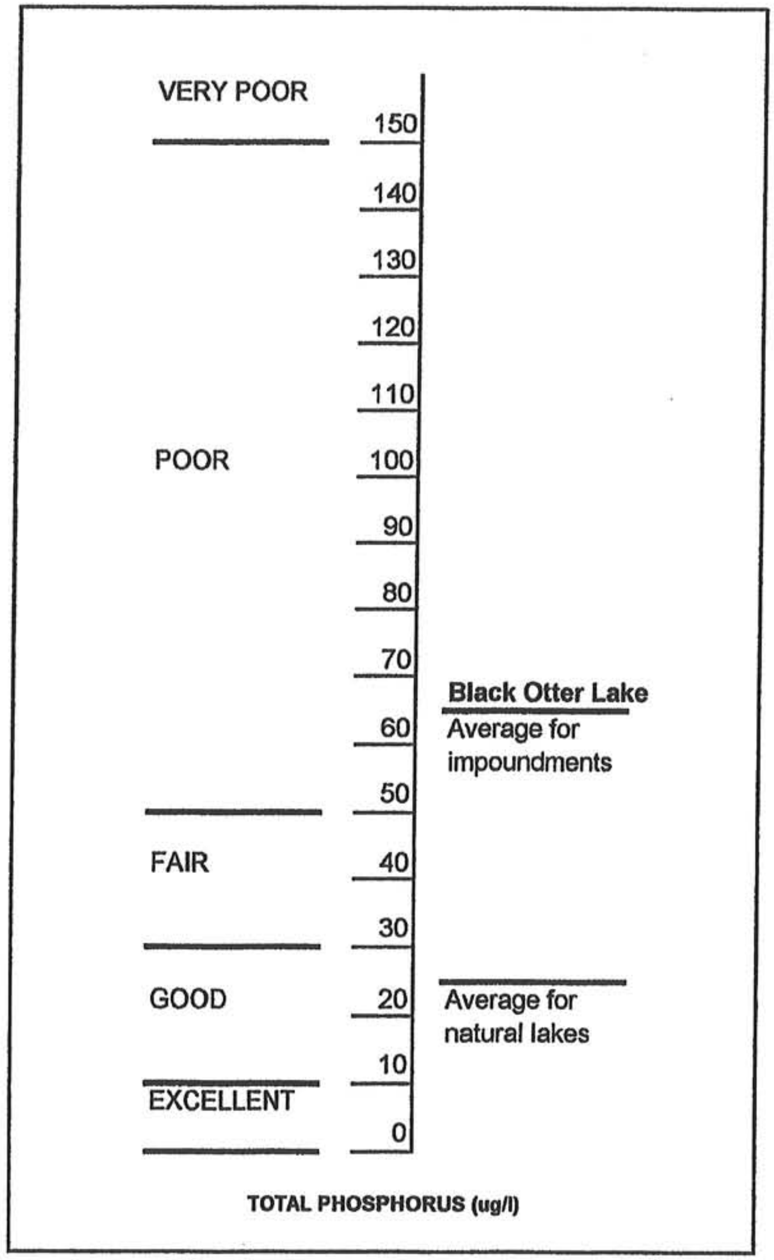


Figure 2 – Chlorophyll a Water Quality Index



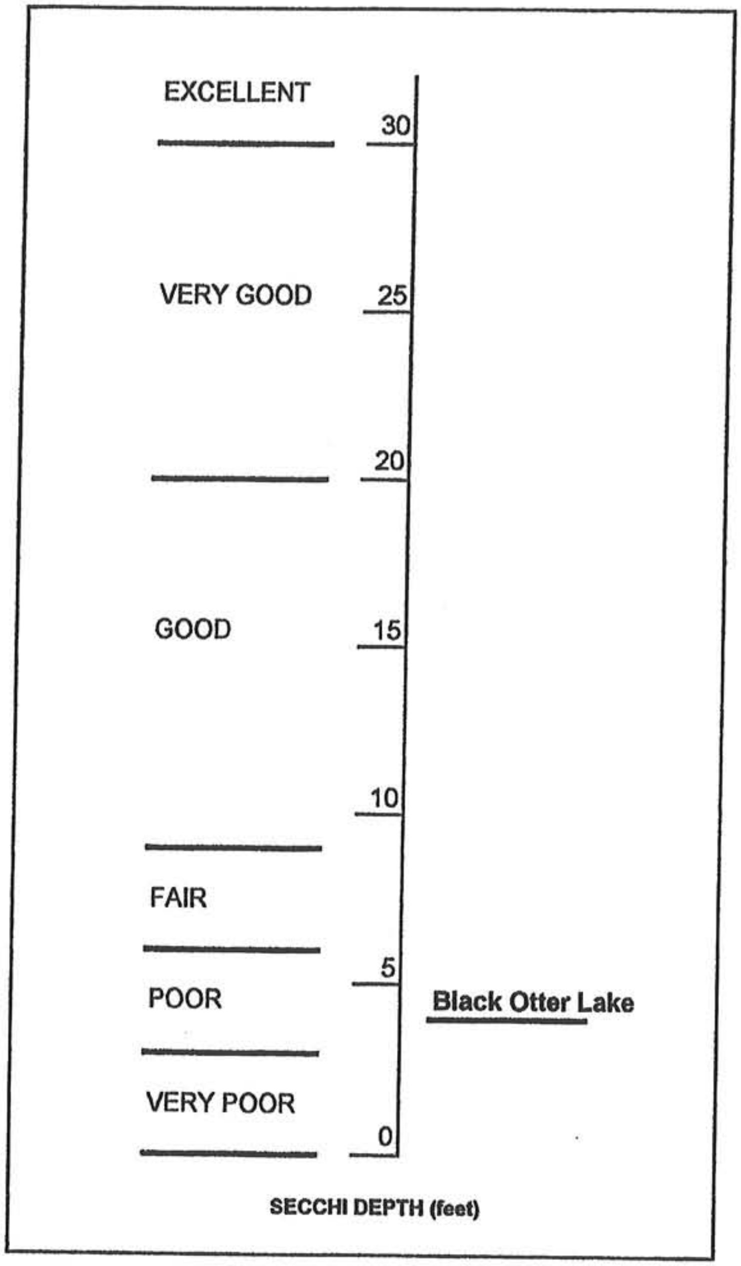
Adapted from Shaw, et. al. (2000).

Figure 3 – Total Phosphorus Water Quality Index



Adapted from Shaw, et. al. (2000).

Figure 4 – Secchi Disc Depth Water Quality Index



Adapted from Shaw, et. al. (2000).

Figure 5 – Black Otter Lake 2002 Dissolved Oxygen Profiles

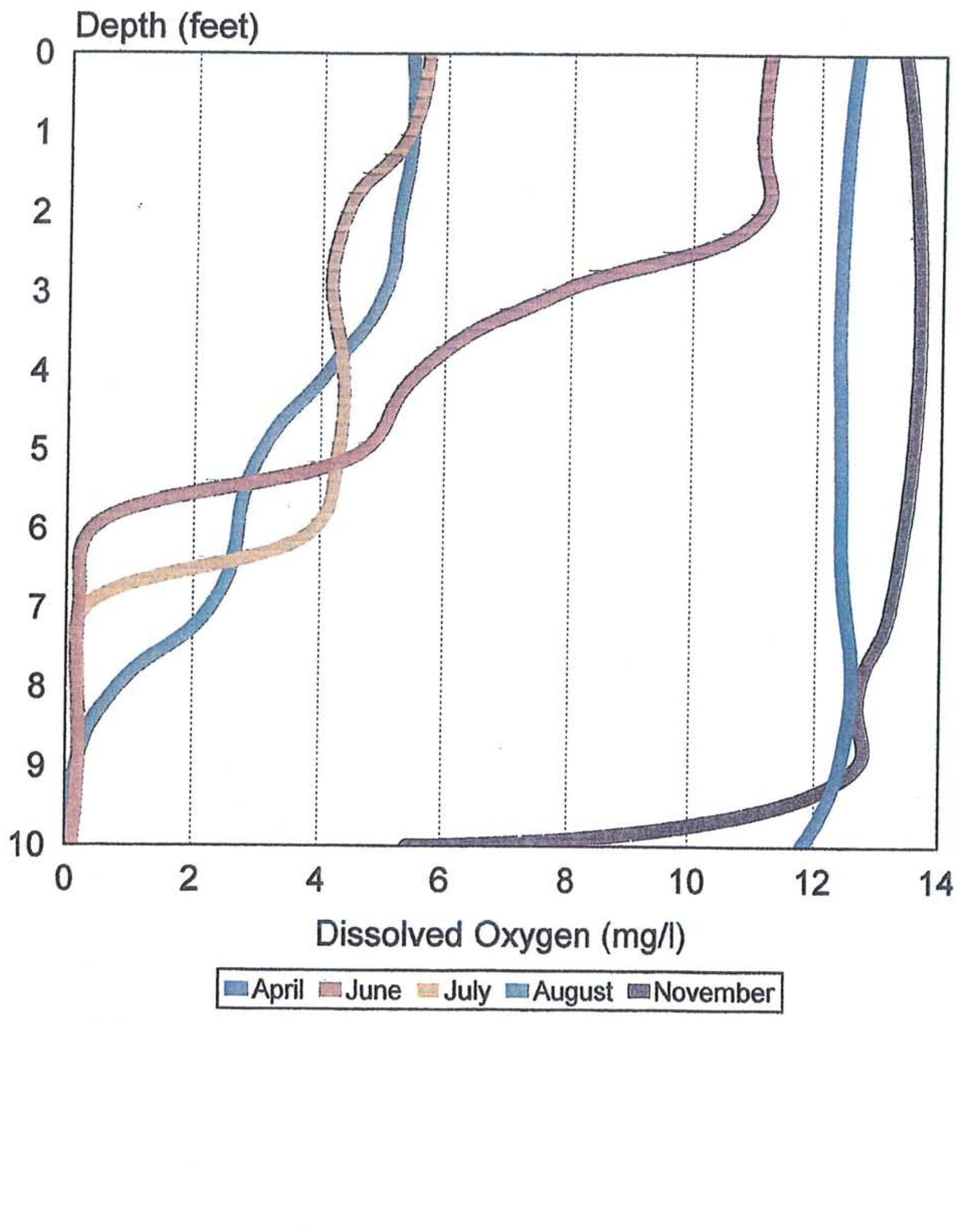


Figure 6 – Black Otter Lake 2002 Temperature Profiles

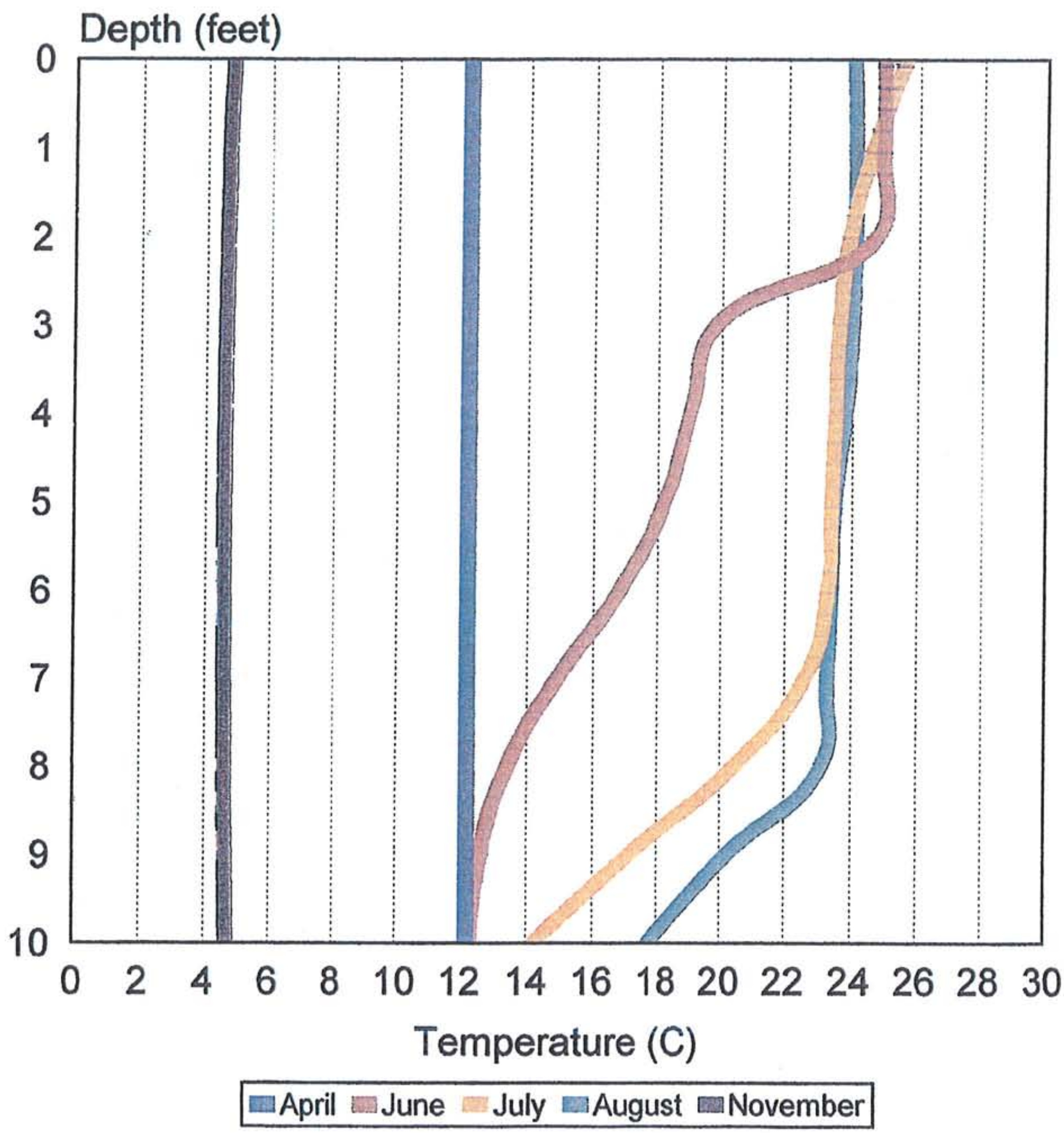


Figure 7 – Black Otter Lake Dissolved Oxygen and Temperature Profiles for September 18, 2006

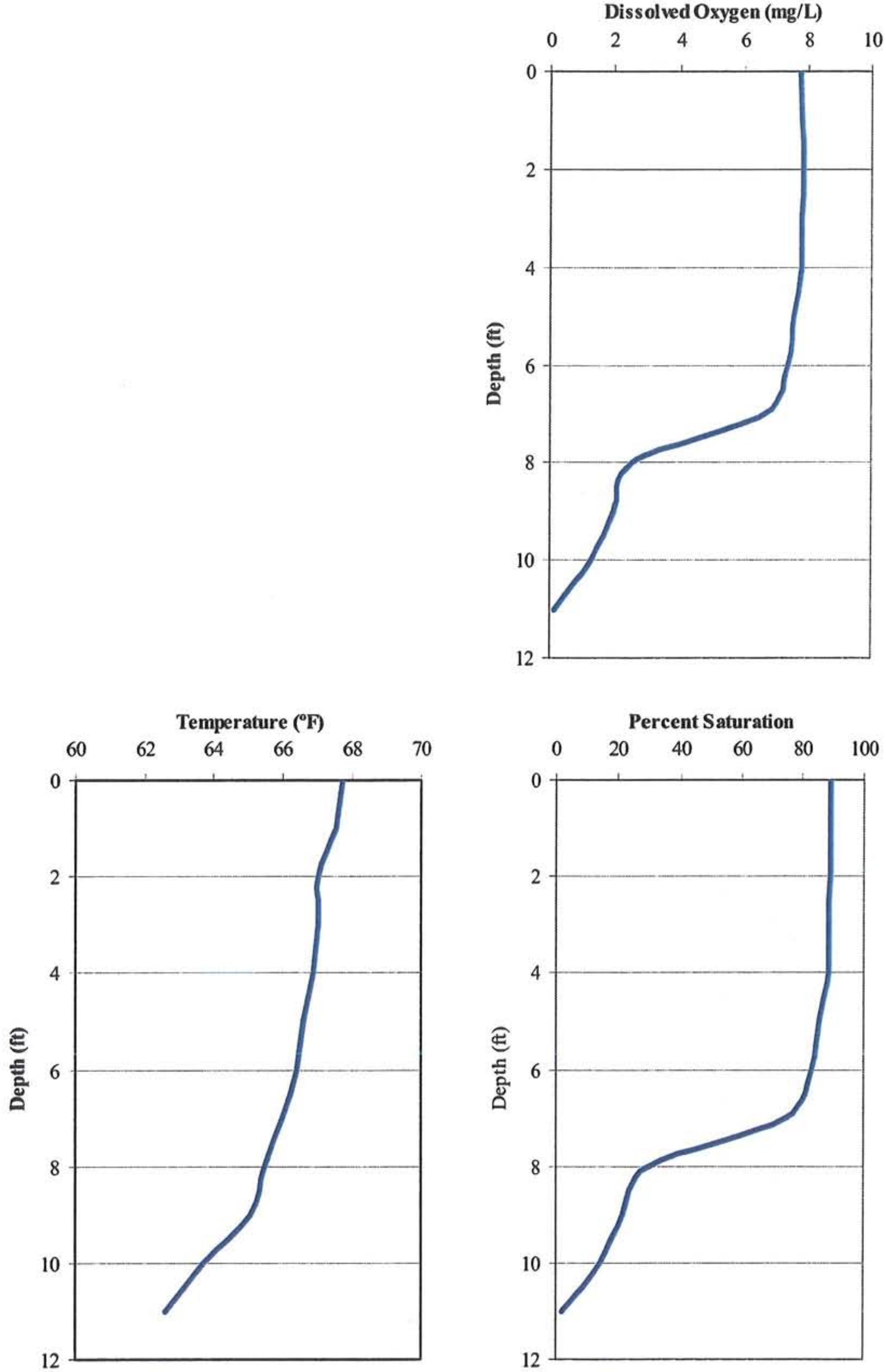


Figure 8 – Dissolved Oxygen Data Collected from 1987 through 1997 for Black Otter Lake, Outagamie County, Wisconsin.

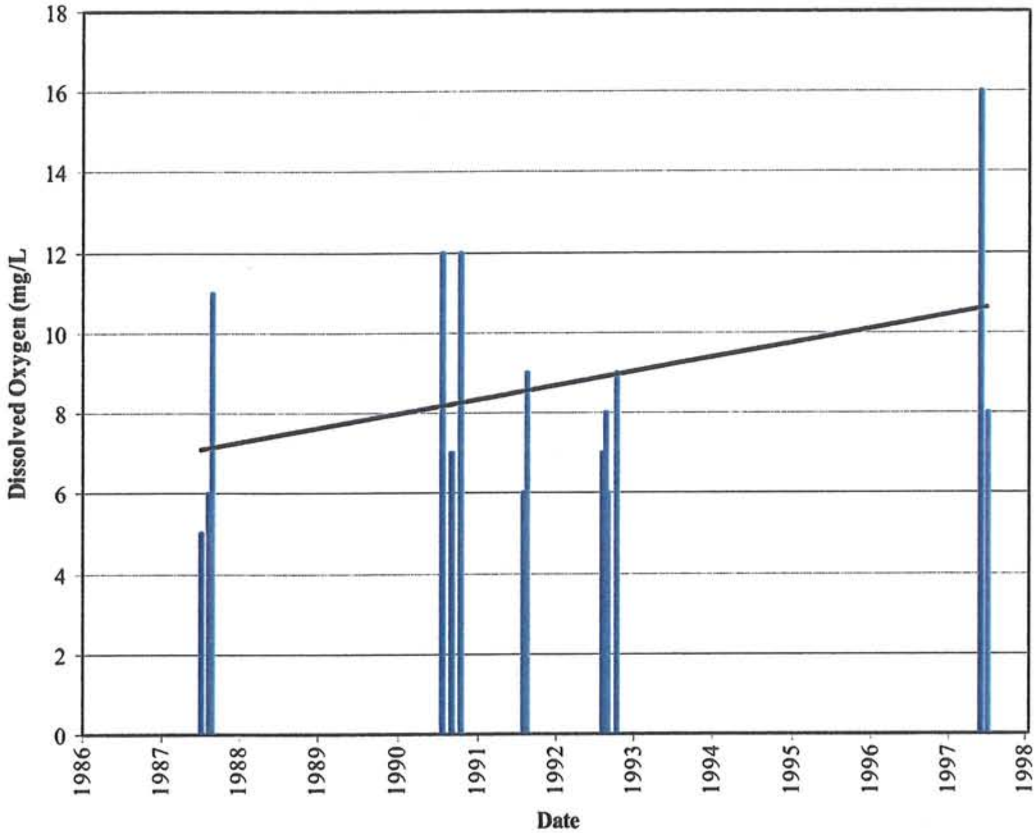


Figure 9 – Water Transparency Data Collected from 1986 through 1997 for Black Otter Lake, Outagamie County, Wisconsin.

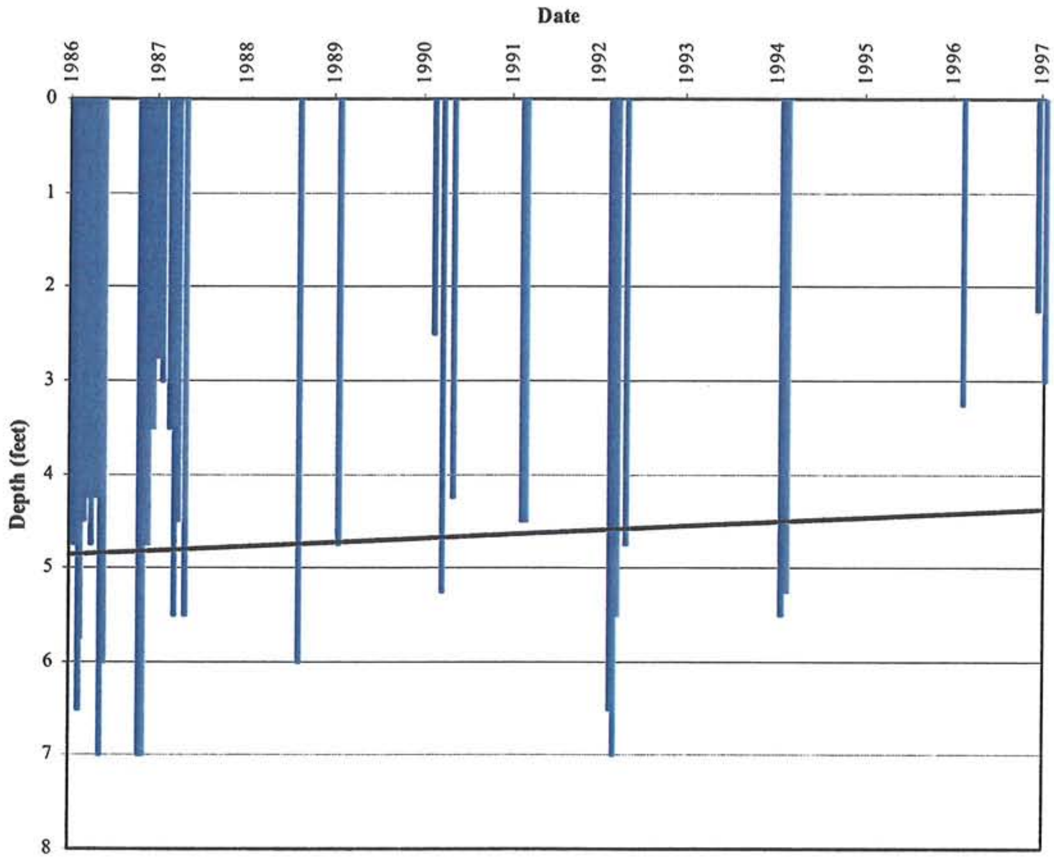


Figure 10 – Relationship between Trophic State in Lakes and Water Transparency

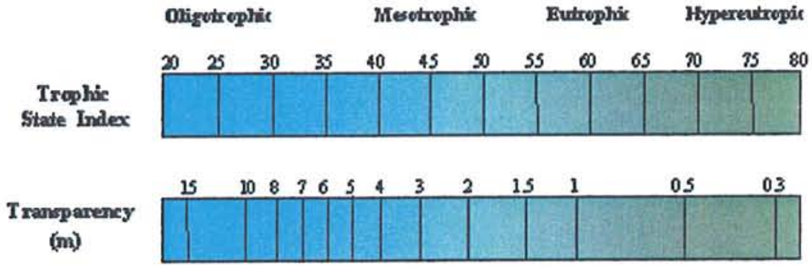


Figure 11 – Black Otter Lake Aquatic Plant Survey Map

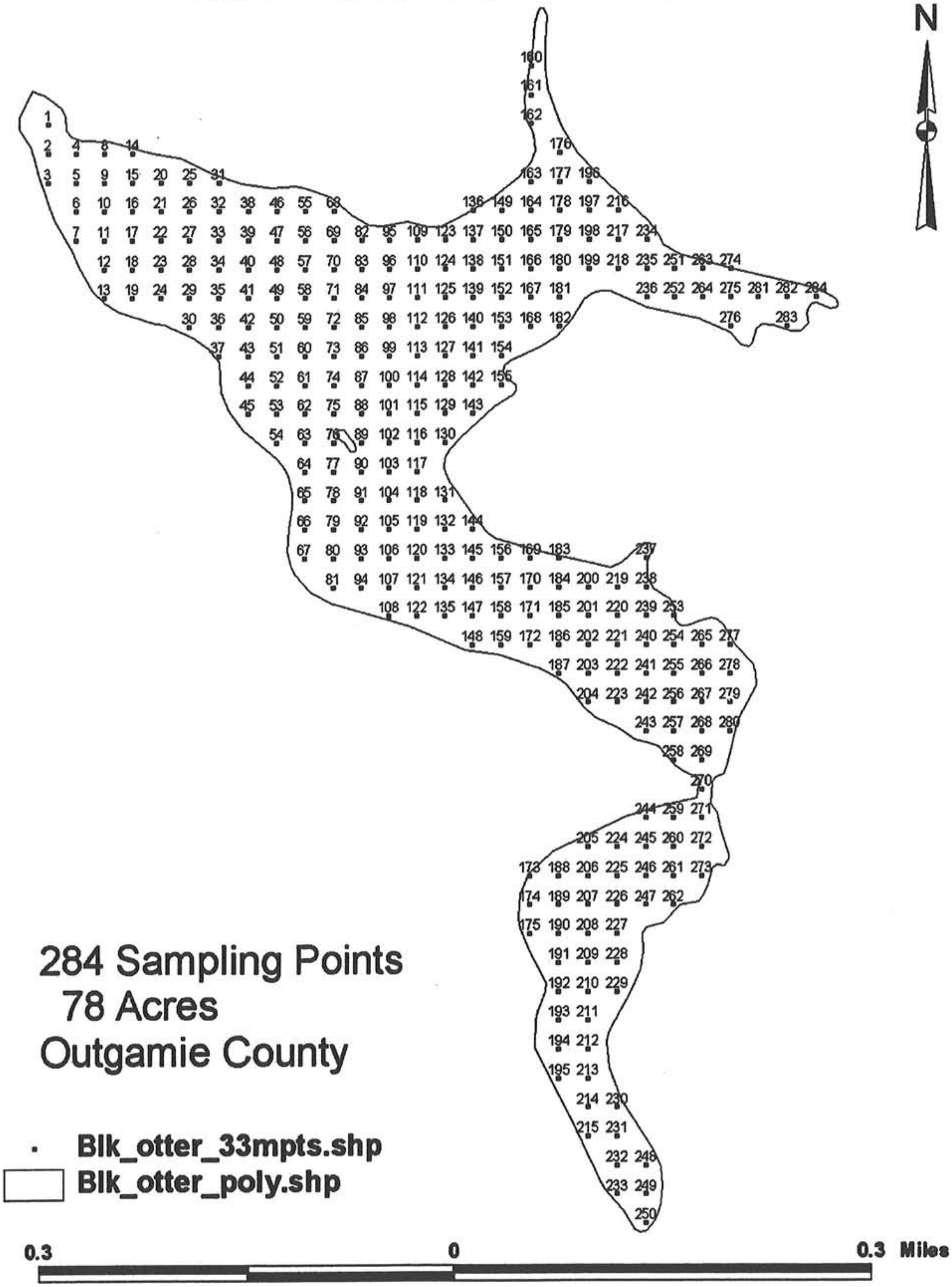


Figure 12 – Bathymetric Map of Black Otter Lake, Outagamie County, Wisconsin

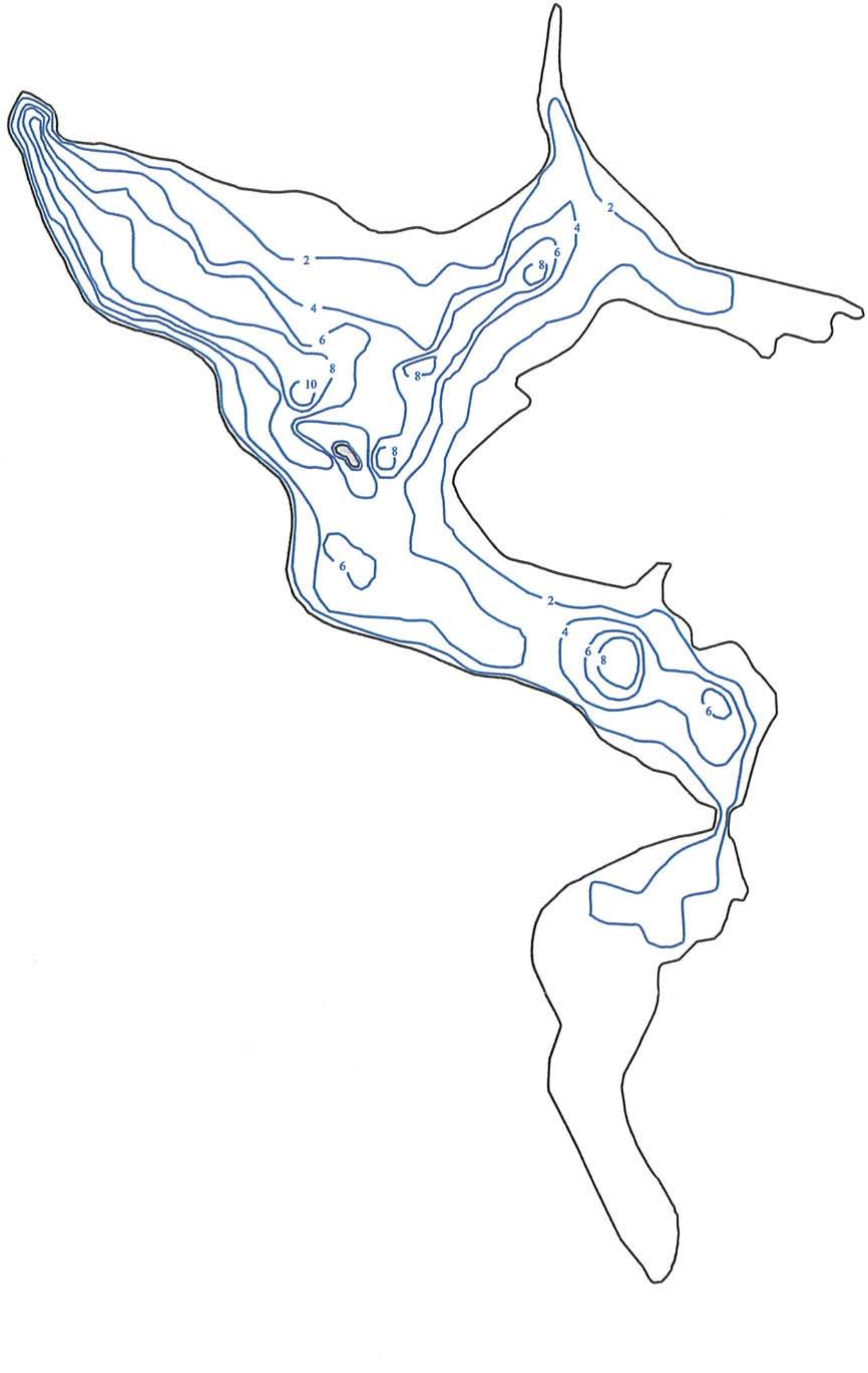


Figure 13 – Sediment Sampling Locations for Black Otter Lake, Outagamie County, Wisconsin

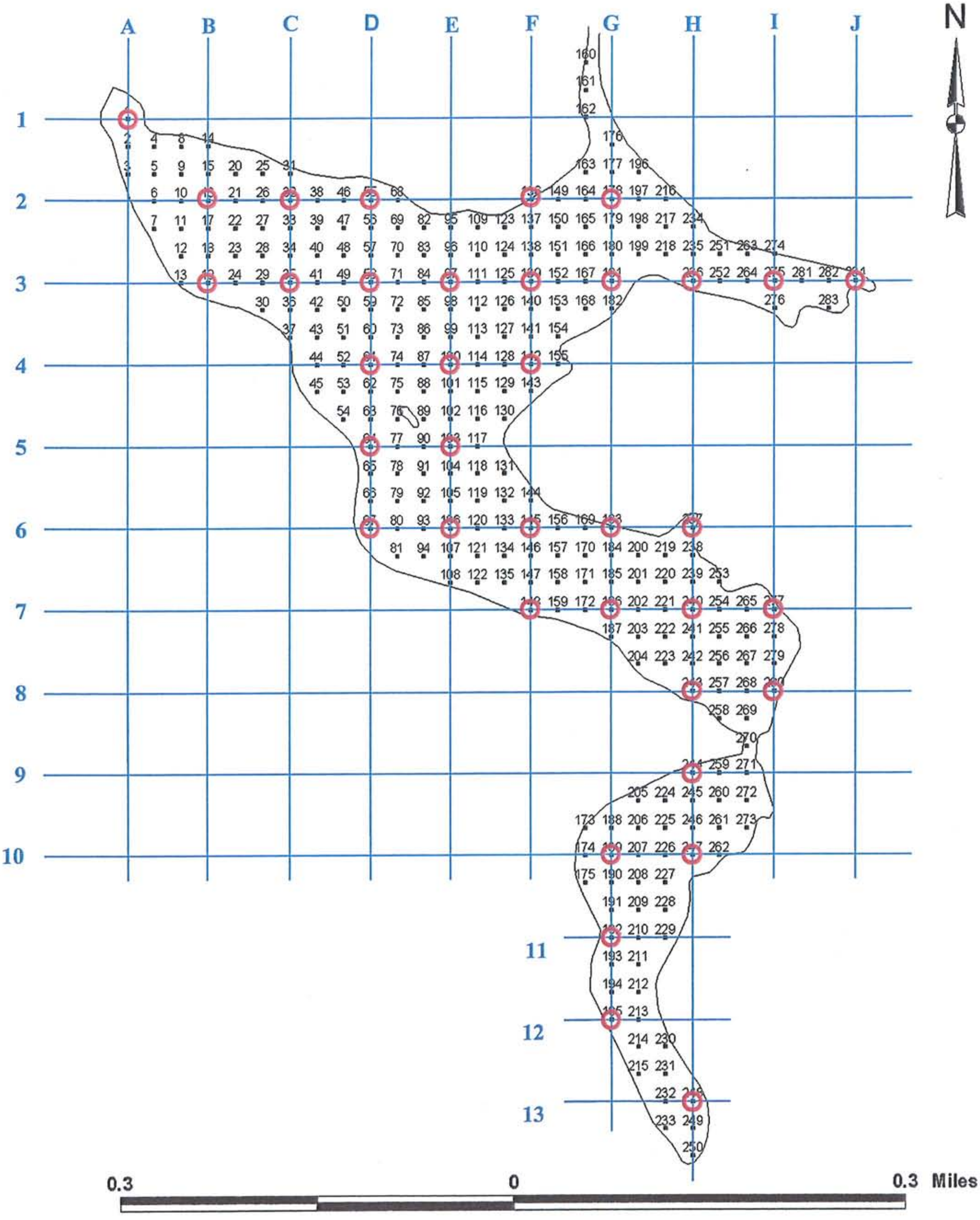


Figure 14 – Thickness of Soft Sediment in Black Otter Lake, Outagamie County, Sampled in December 2007.

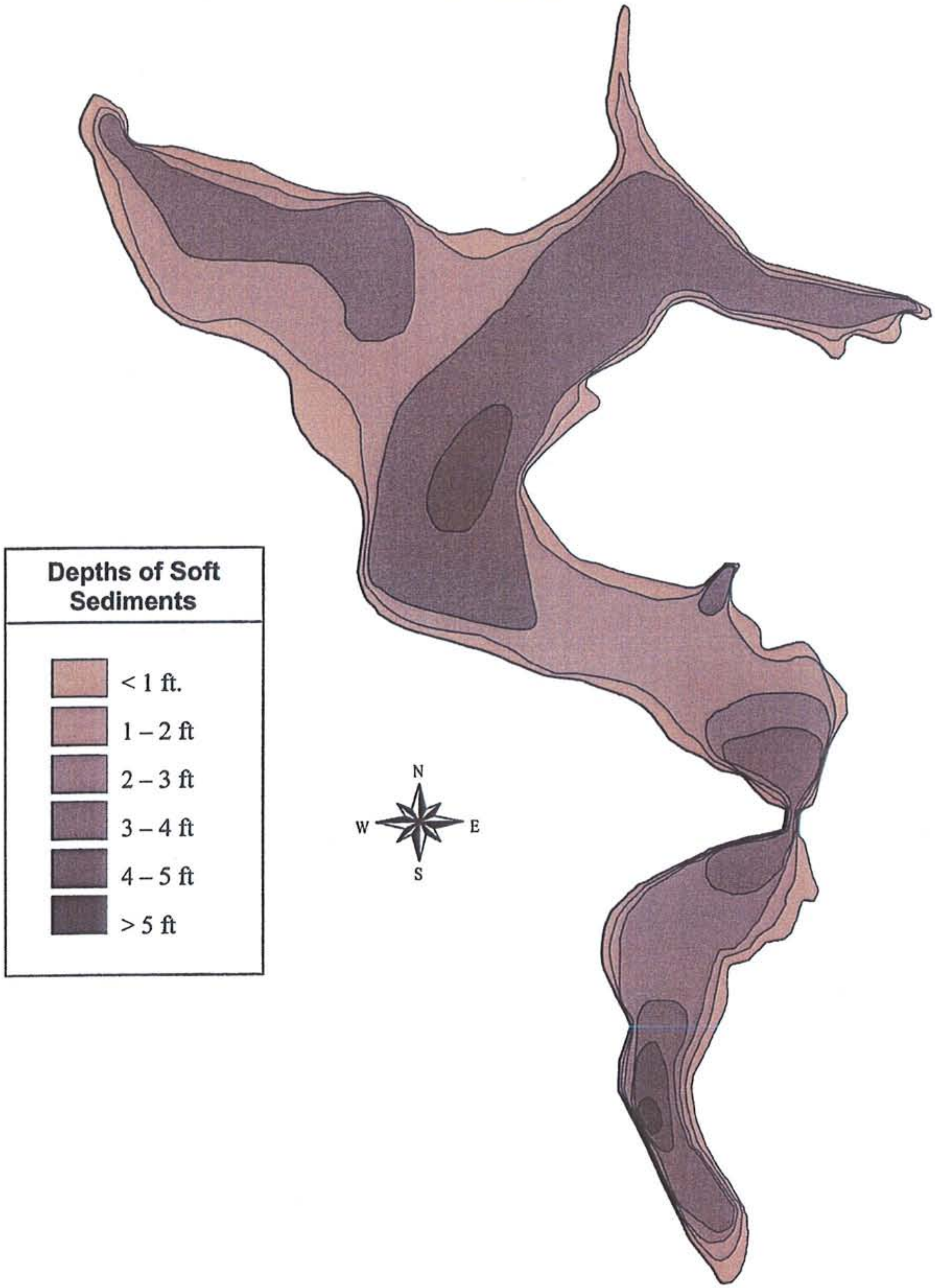


Figure 15 – Volatile Organic Content of Lake Sediment Sampled in Black Otter Lake, Outagamie County in December 2007

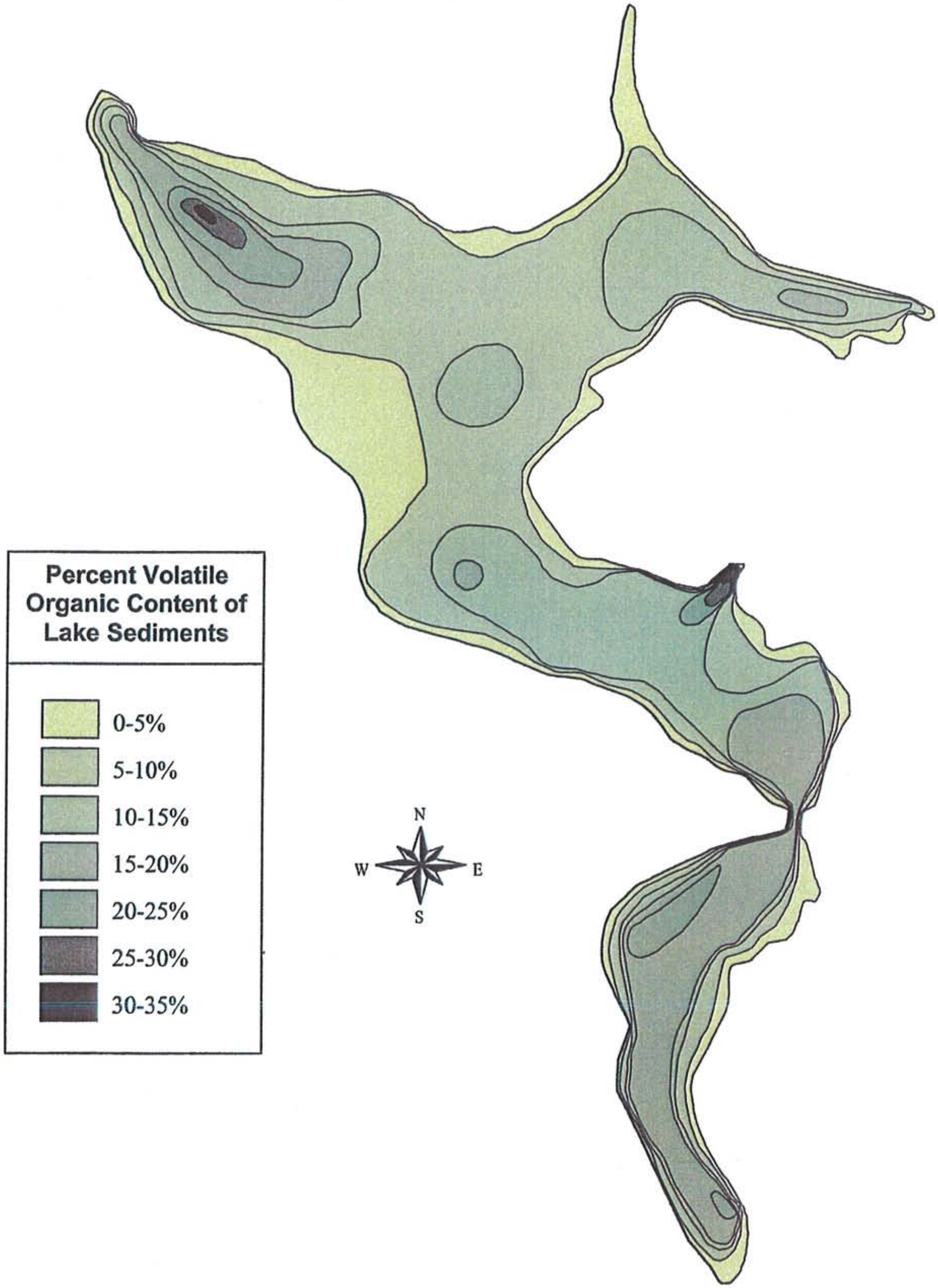


Figure 16 – Black Otter Lake Habitat Map

Figure 17 – 2002 Distribution of Curly-Leaf Pondweed in Black Otter Lake

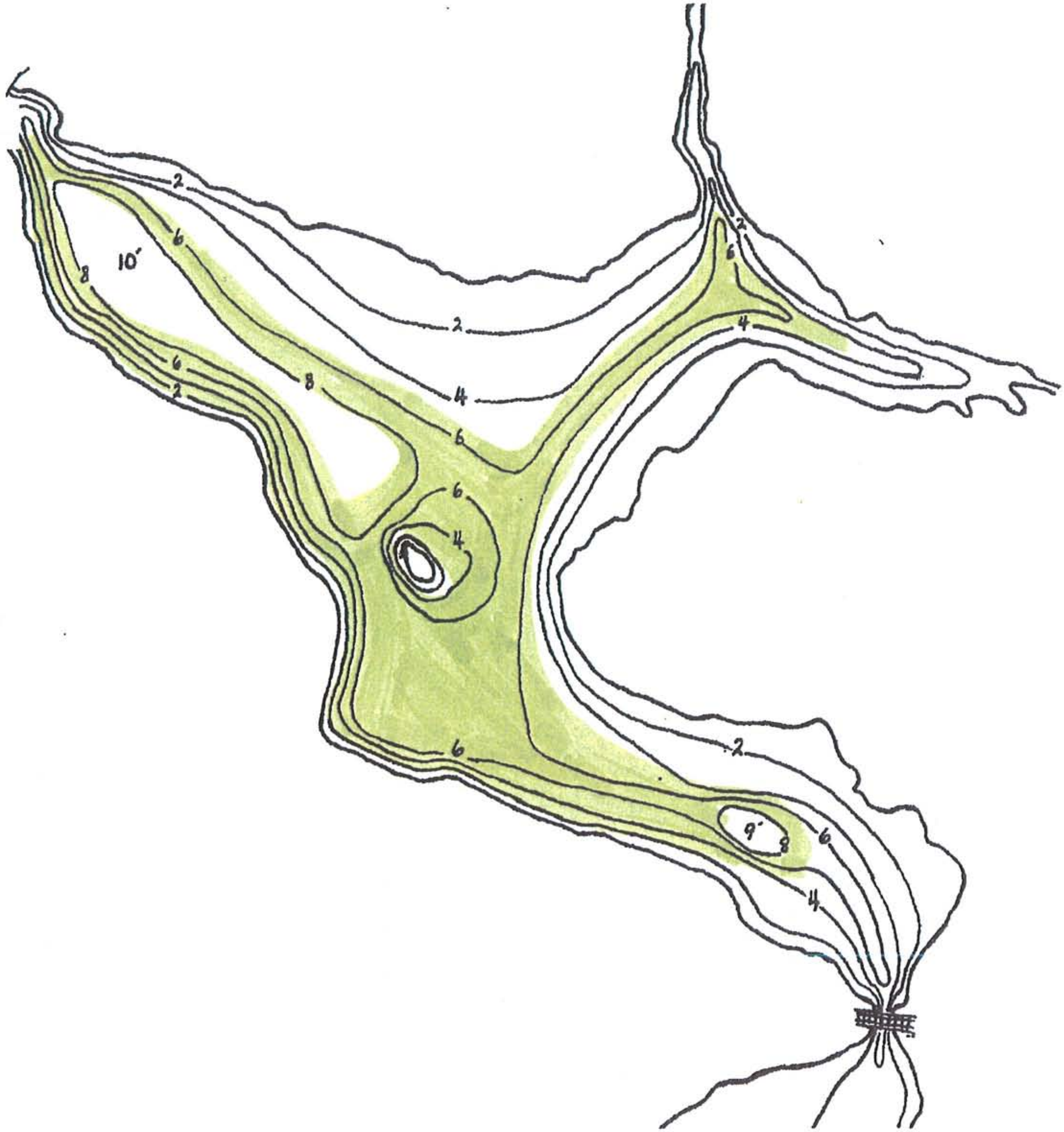


Figure 18 – Plant Abundance Rating Criteria Used in Aquatic Plant Surveys

Rating	Coverage	Description
1		A few plants on rake head
2		Rake head is about ½ full Can easily see top of rake head
3		Overflowing Cannot see top of rake head

Figure 19 – Aquatic Plant Community Composition for Black Otter Lake, Outagamie County, Wisconsin, September 2006

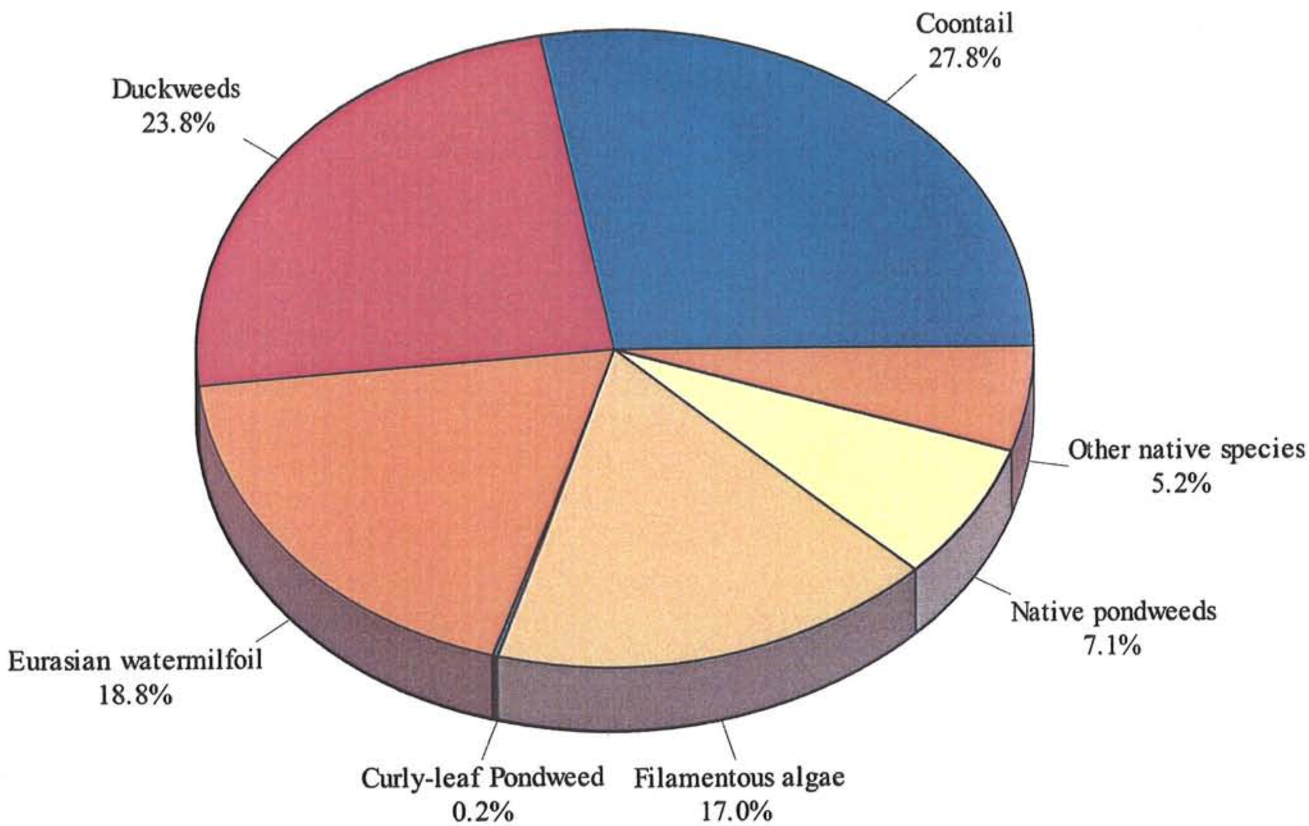


Figure 20 – Eurasian Watermilfoil Distribution in Black Otter Lake, Outagamie County, on September 18, 2006

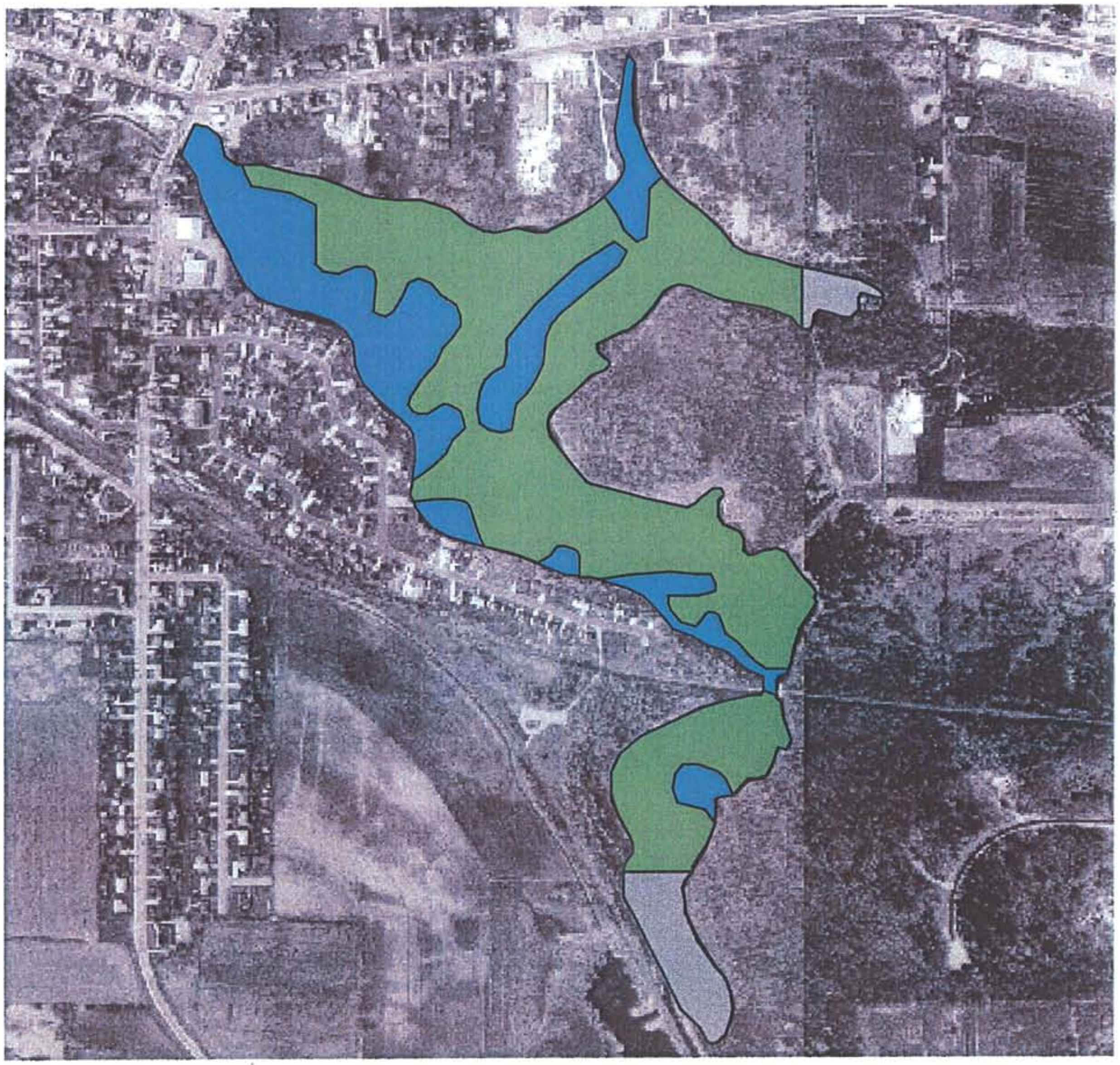


Figure 21 – Eurasian Watermilfoil Distribution in Black Otter Lake, Outagamie County on September 28, 2007

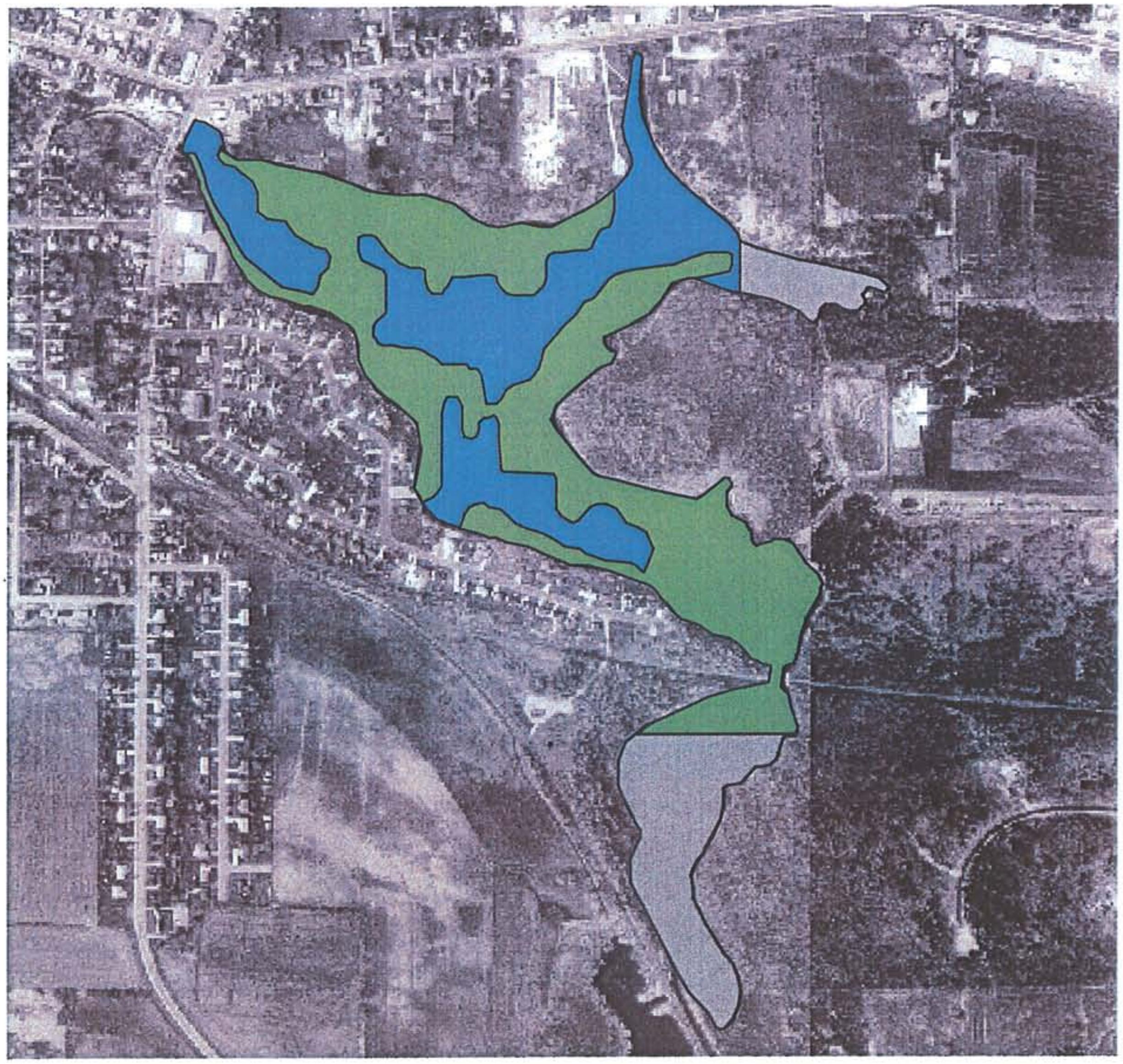


Figure 22 – Curly-Leaf Pondweed Distribution in Black Otter Lake, Outagamie County on October 23, 2006 and April 25, 2007

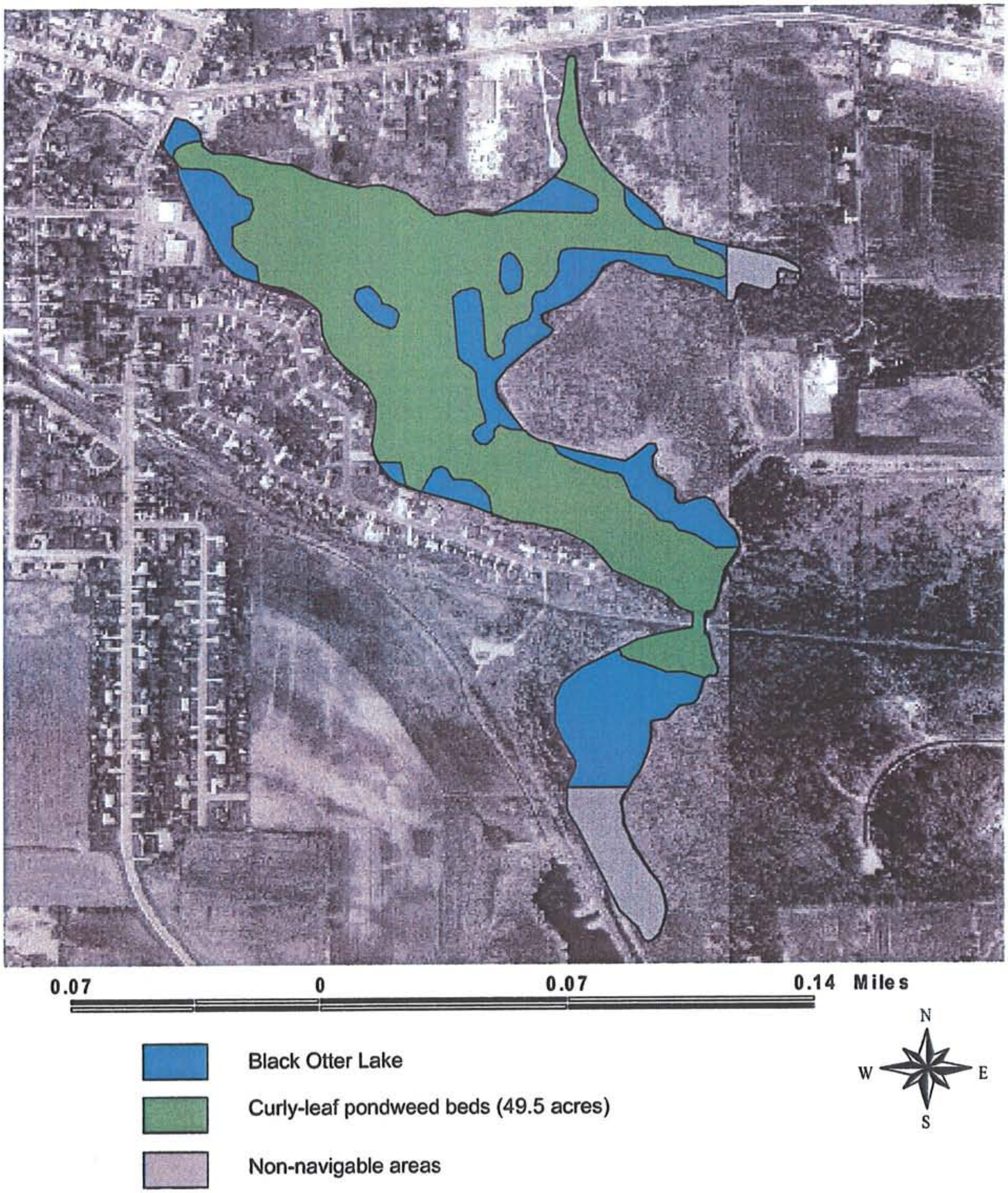
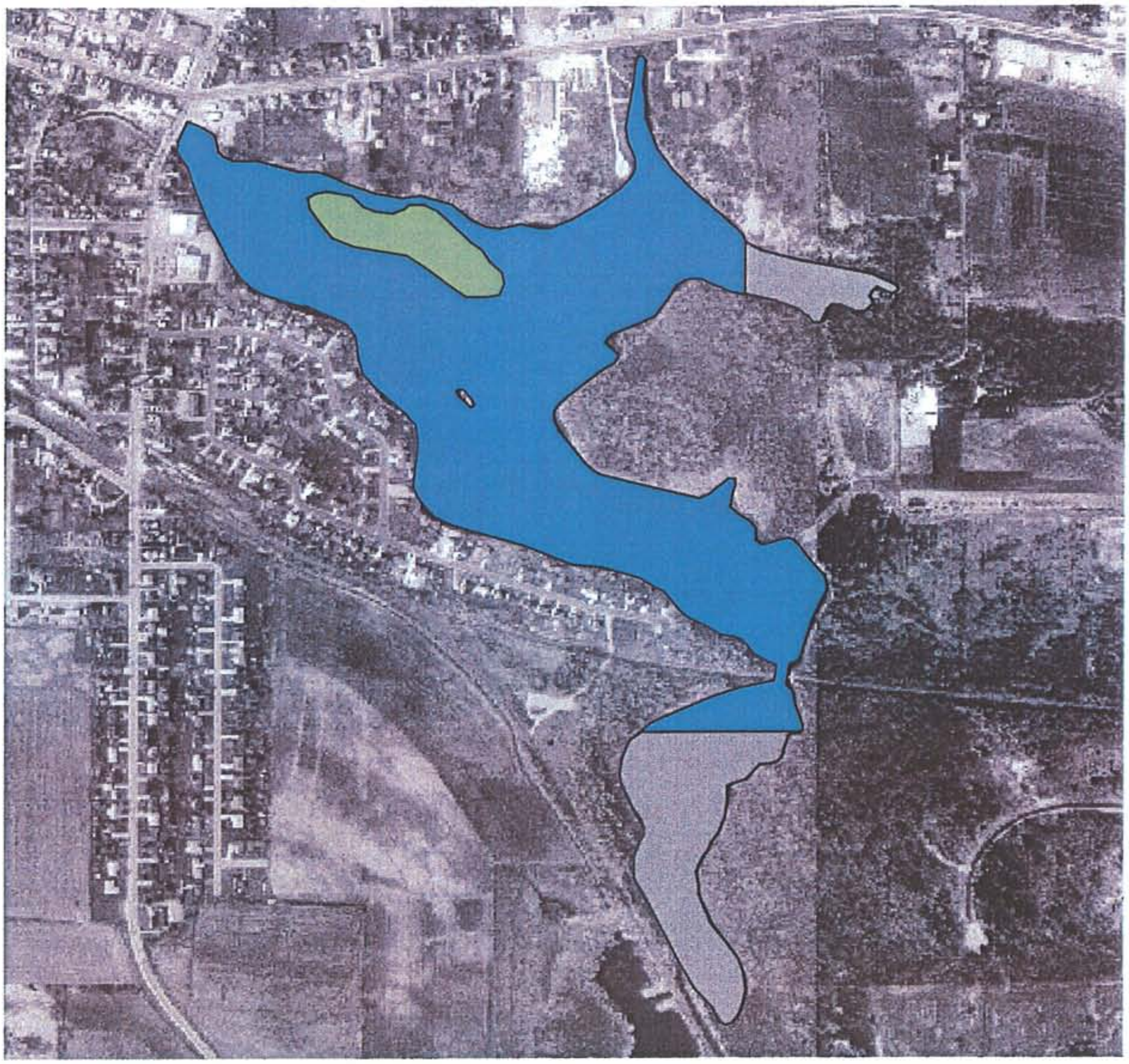


Figure 23 – Curly-Leaf Pondweed Distrubition in Black Otter Lake, Outagamie County on September 28, 2007



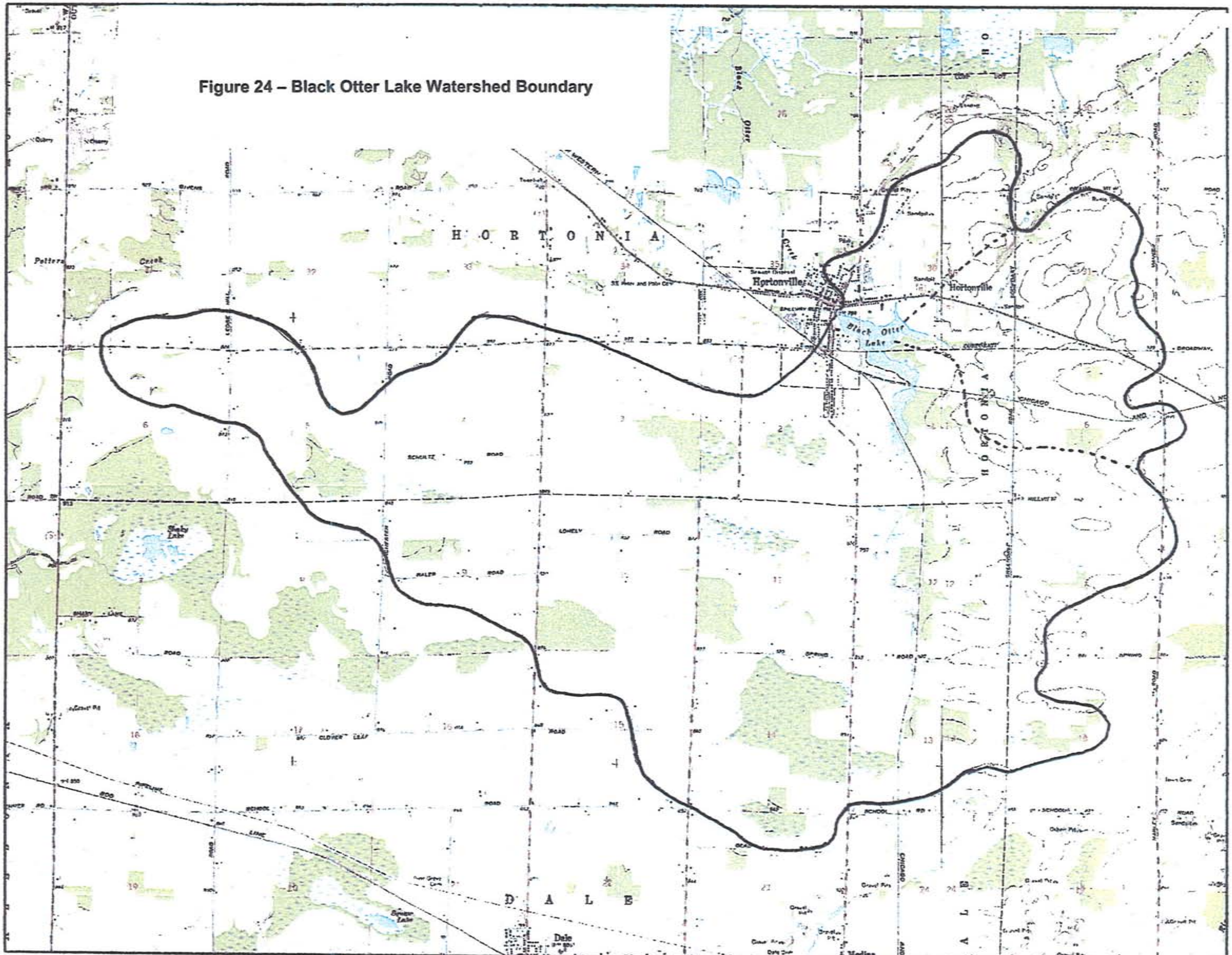


Figure 24 – Black Otter Lake Watershed Boundary

Figure 25 – Upper Sub-Watershed Boundary

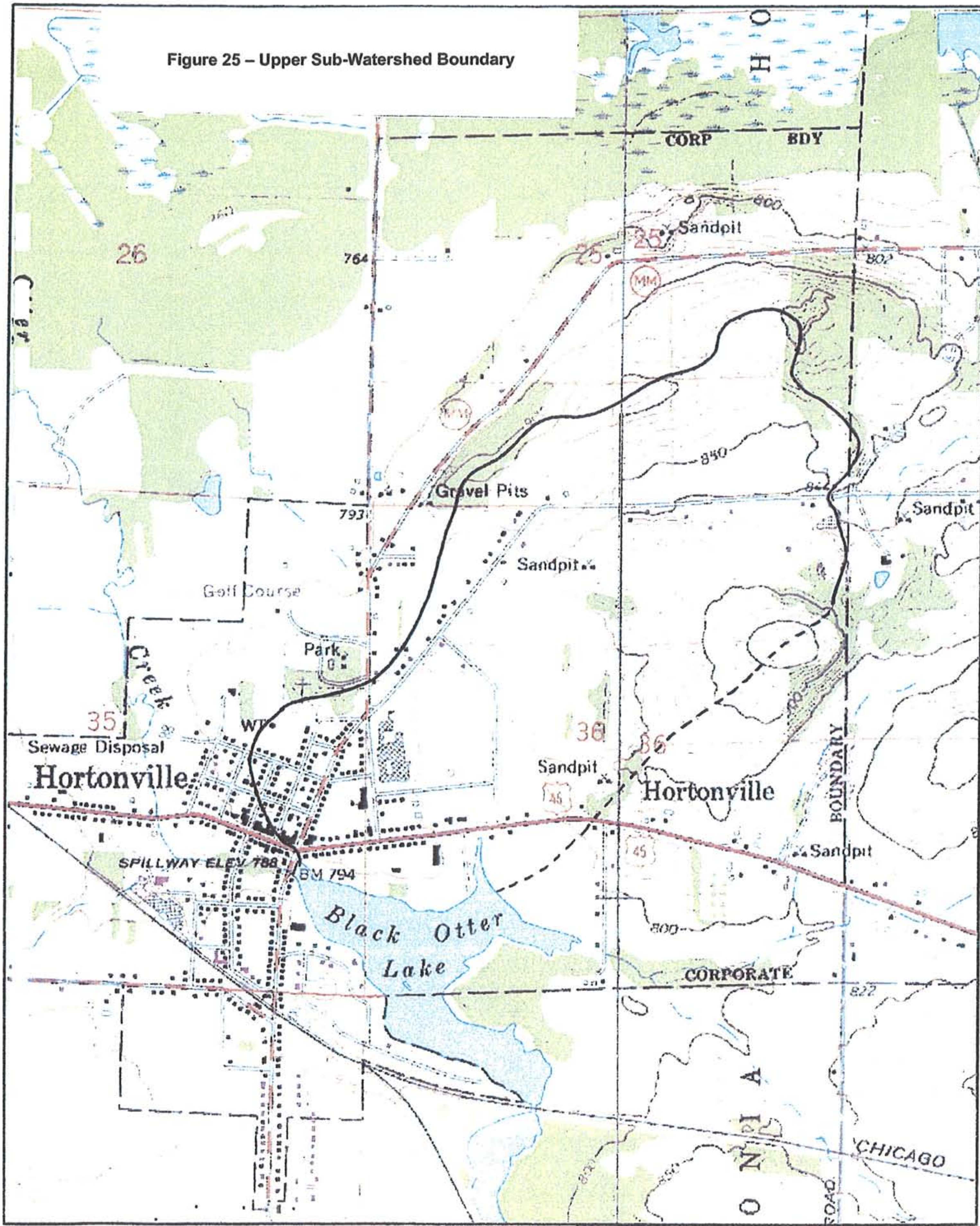


Figure 26 – Mid Sub-Watershed Boundary

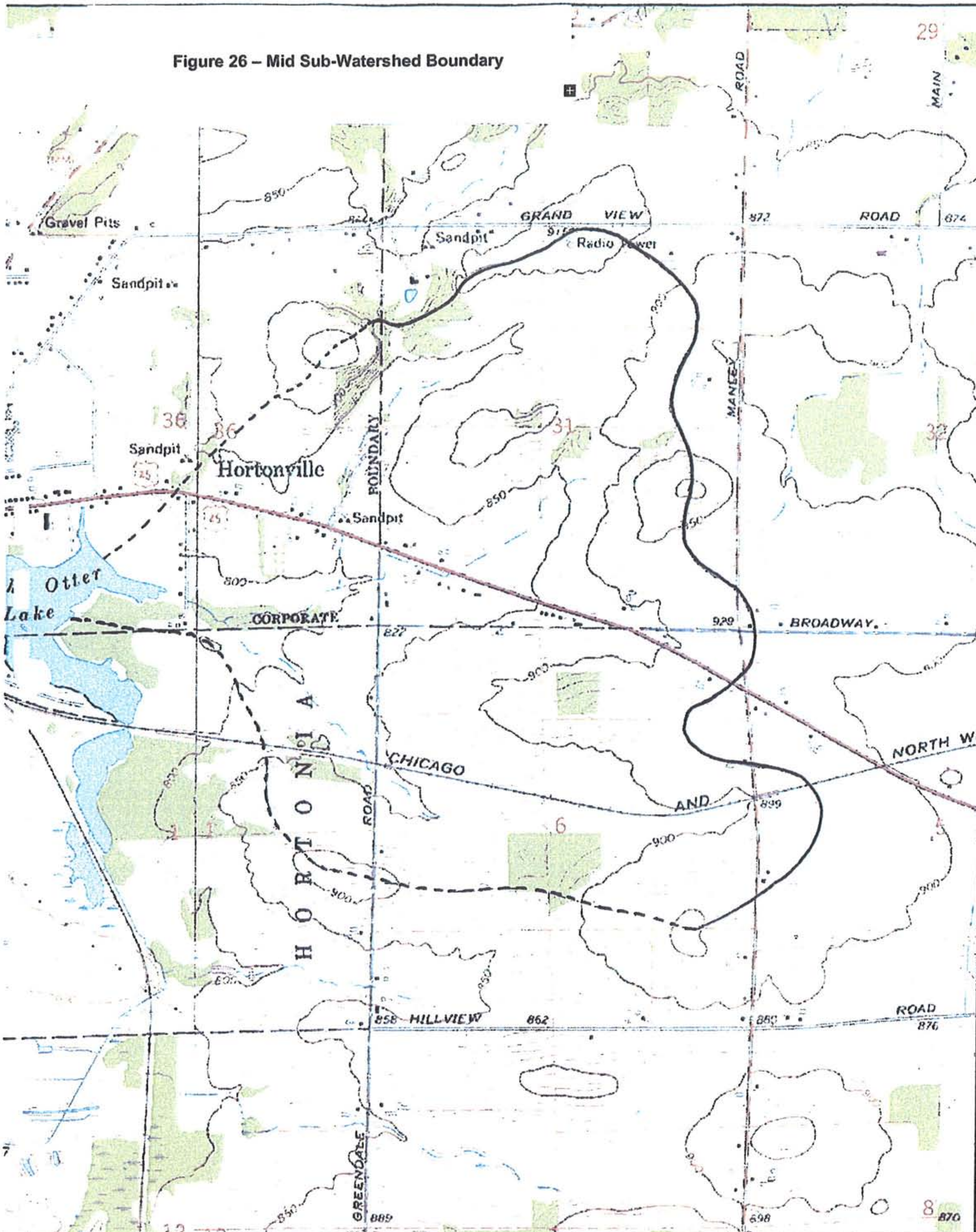


Figure 27 – Lower Sub-Watershed Boundary

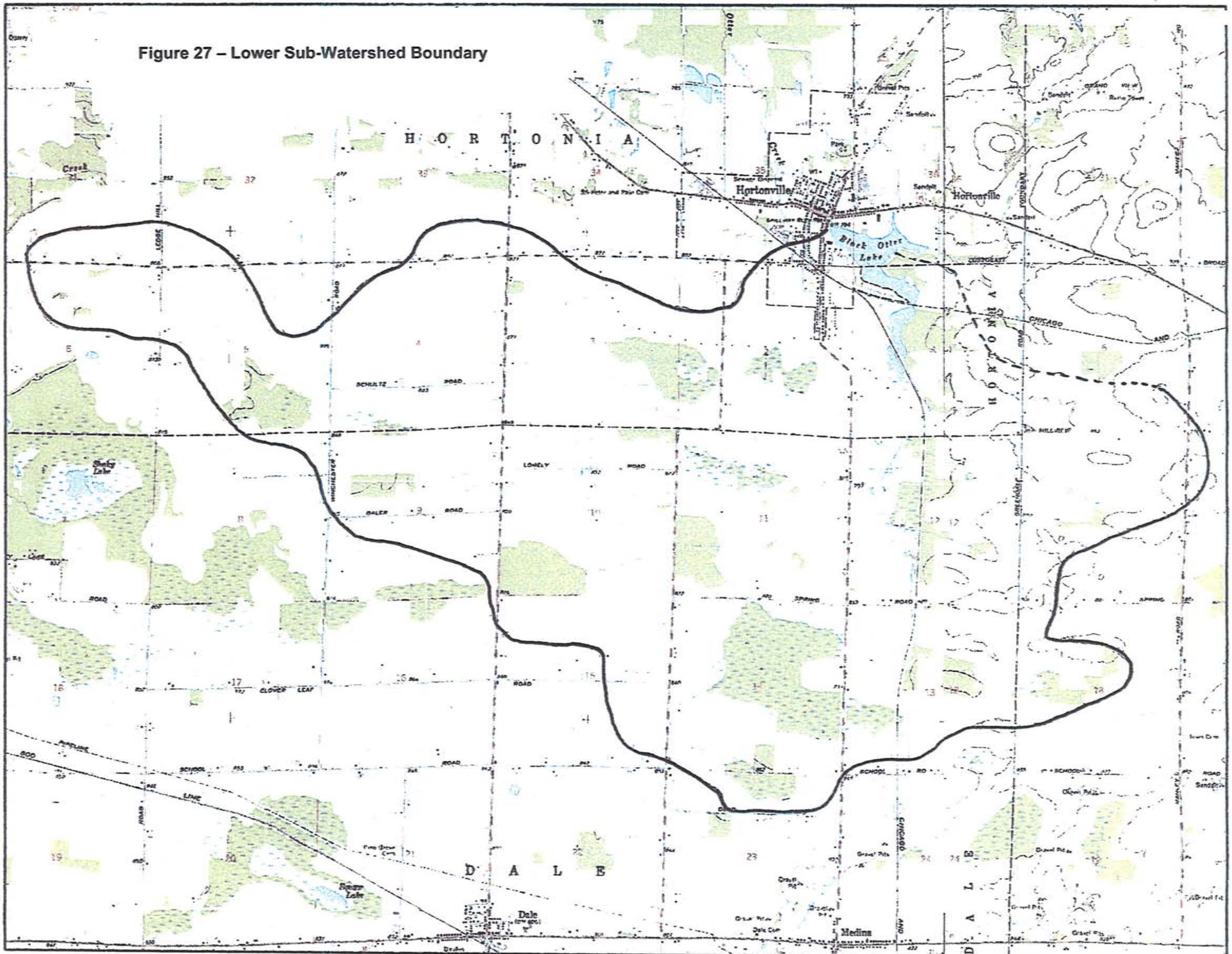


Figure 28 – Drawdown Scenarios for Black Otter Lake, Outagamie County, Wisconsin based on 2-foot Increments

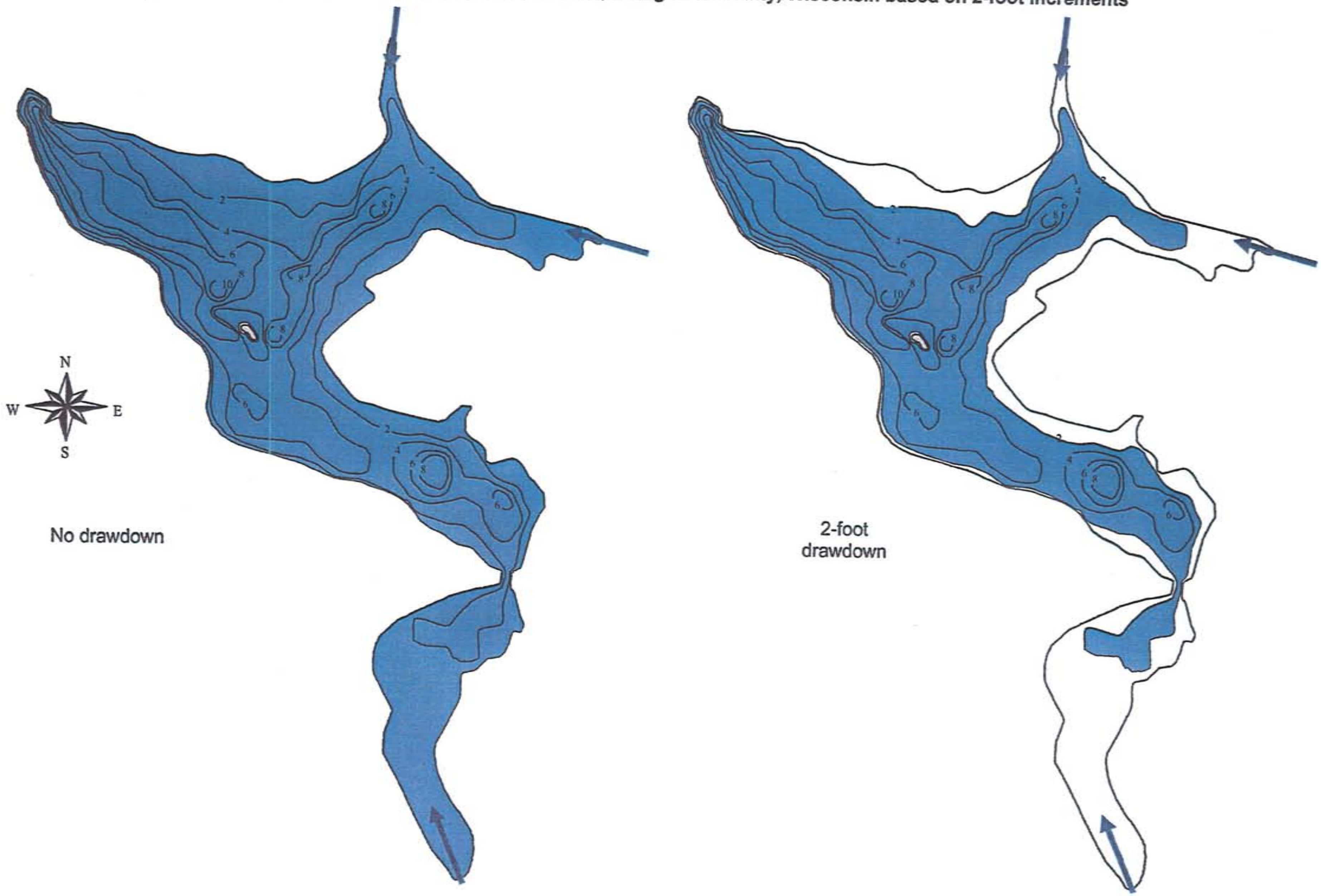
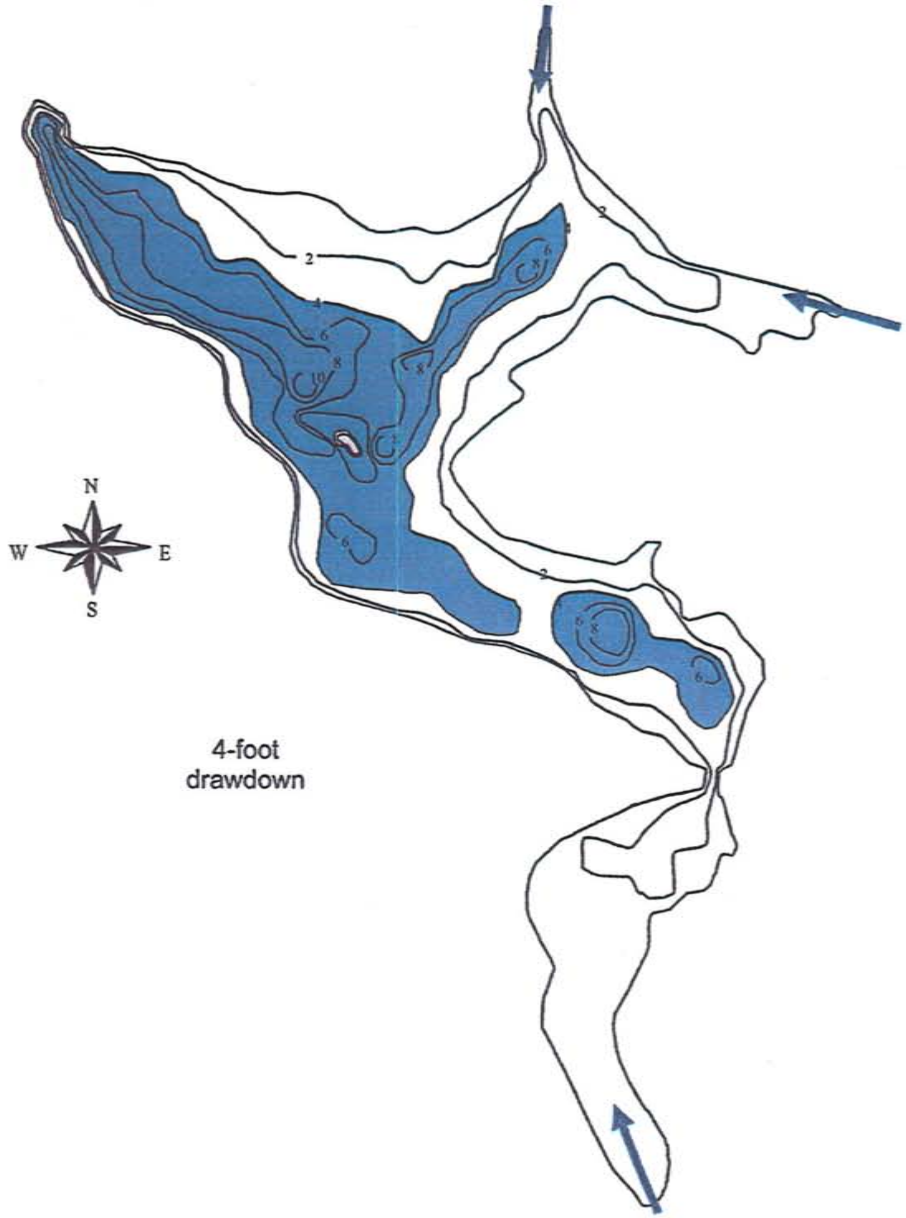
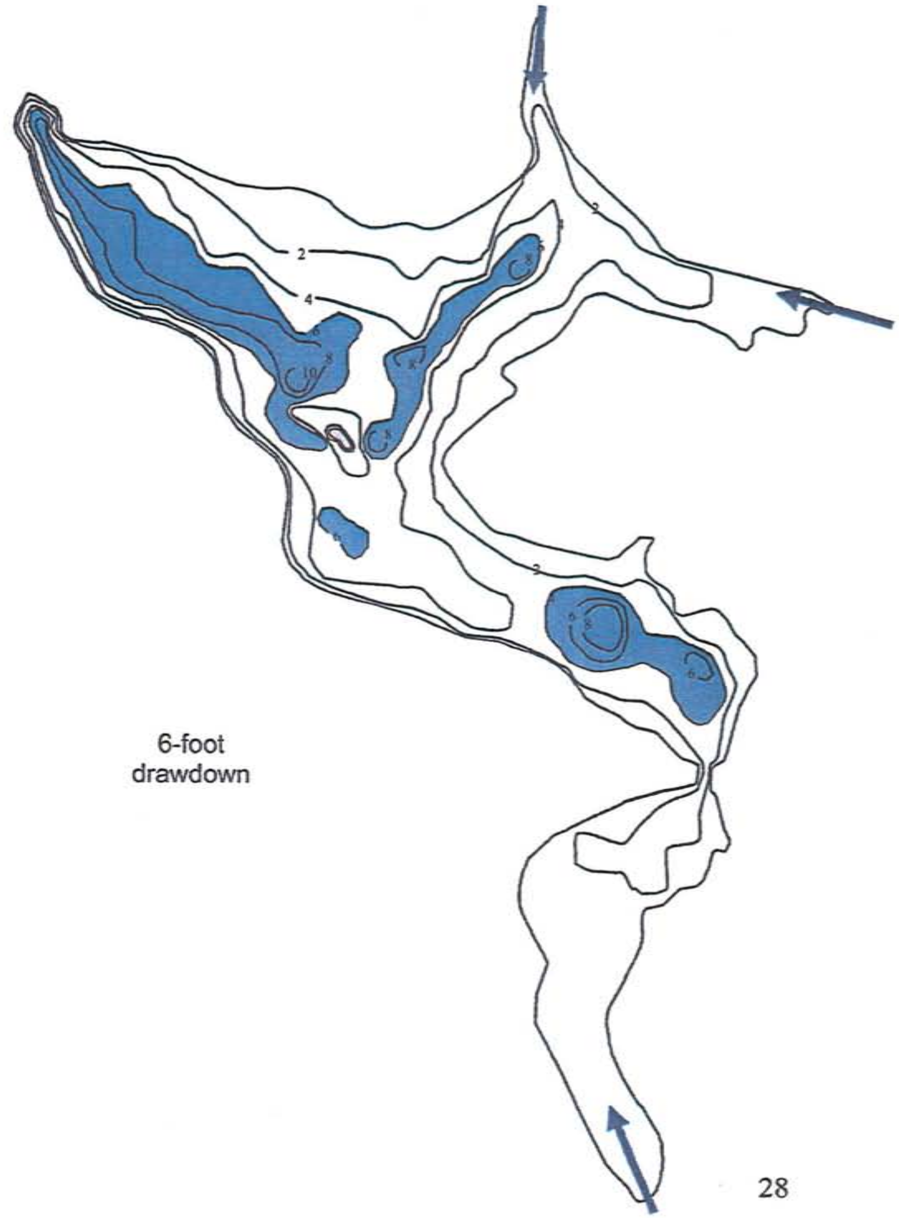


Figure 28 (Continued) – Drawdown Scenarios for Black Otter Lake, Outagamie County, Wisconsin based on 2-foot Increments



4-foot
drawdown



6-foot
drawdown

Figure 28 (Continued) – Drawdown Scenarios for Black Otter Lake, Outagamie County, Wisconsin based on 2-foot Increments

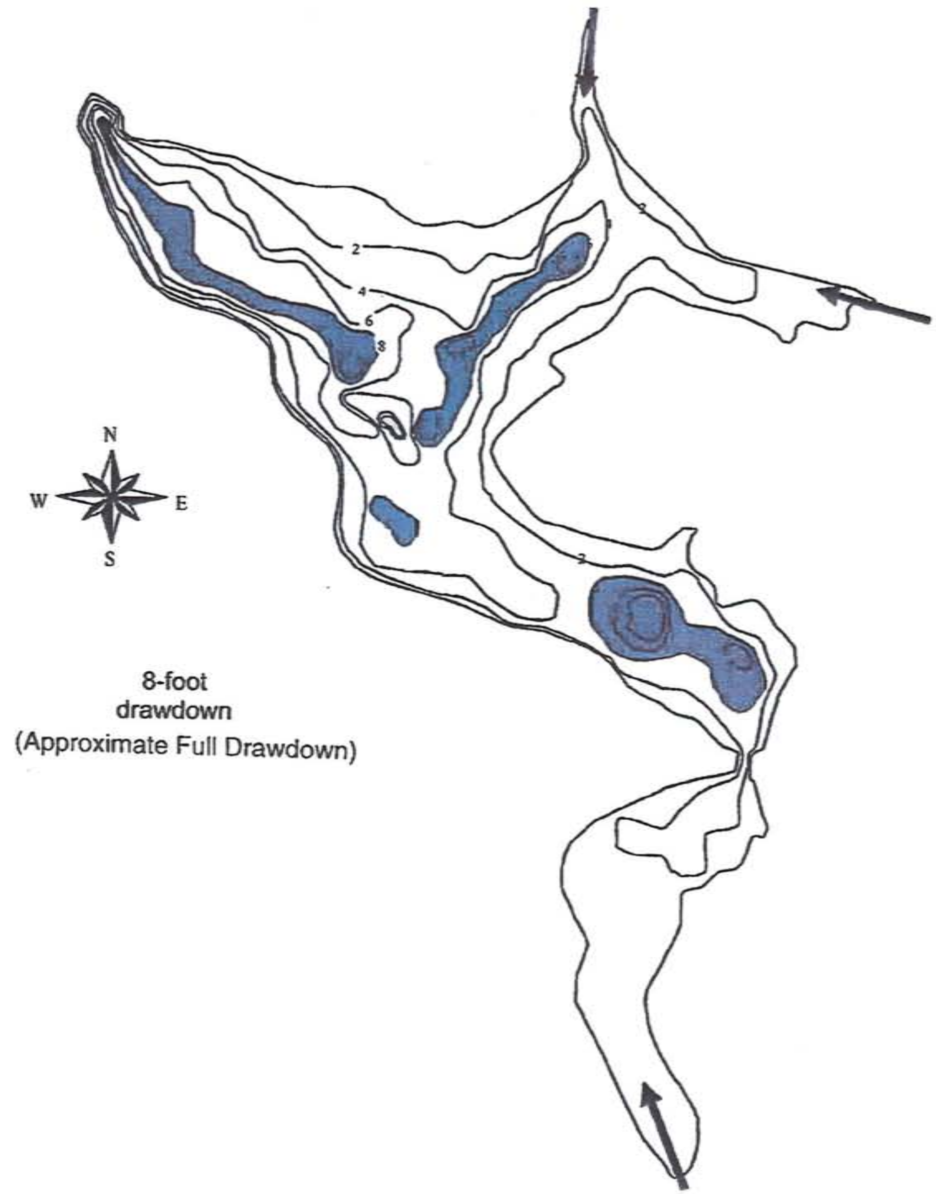


Figure 29 – Likely Location of Stream Channels Following Drawdown of Black Otter Lake, Outagamie County, Wisconsin

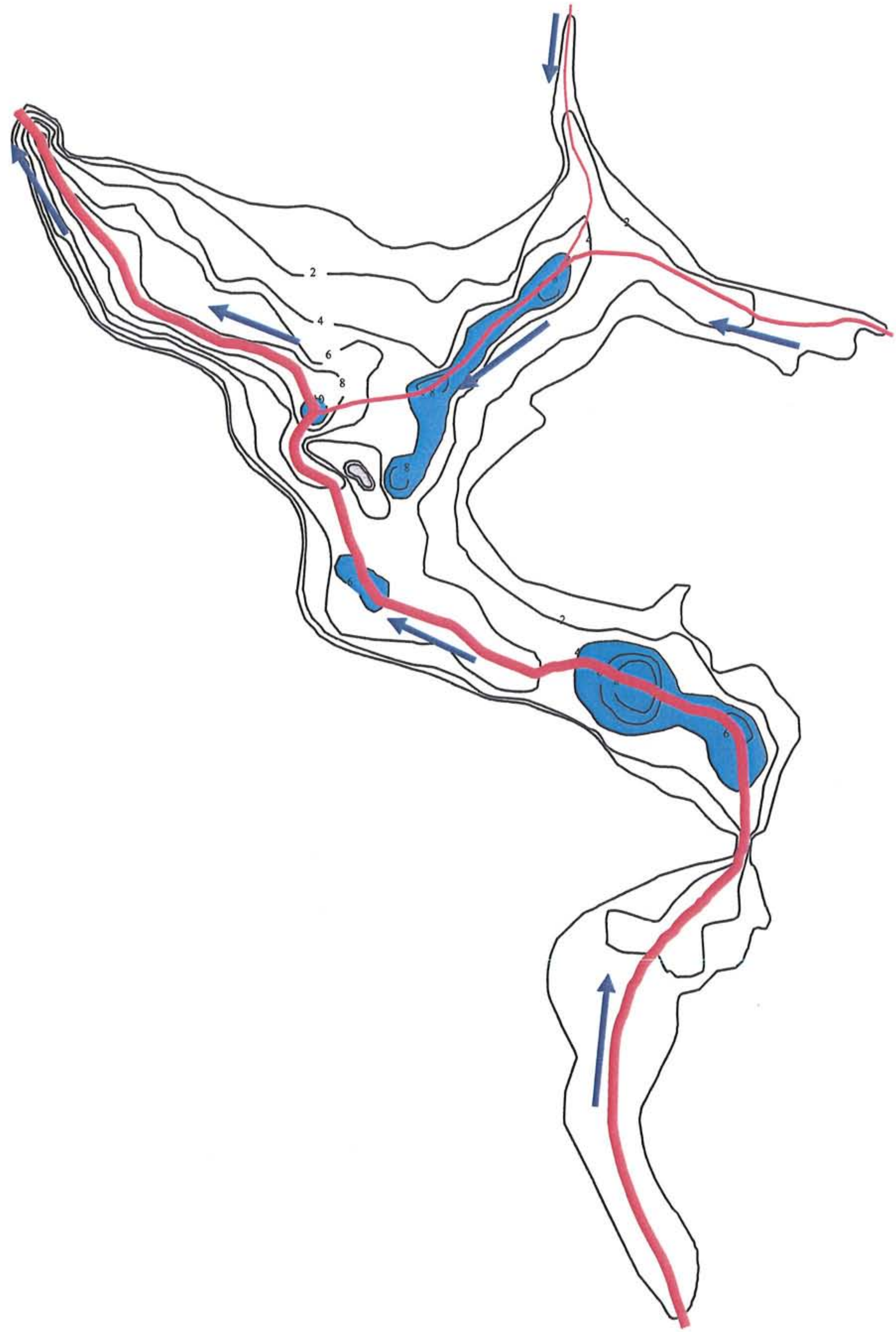


Figure 30 – A view of the upper reaches of Black Otter Lake. An area that was once dominated by emergent plant beds is now dominated by duckweed, algae, Eurasian Watermilfoil and curly-leaf pondweed.

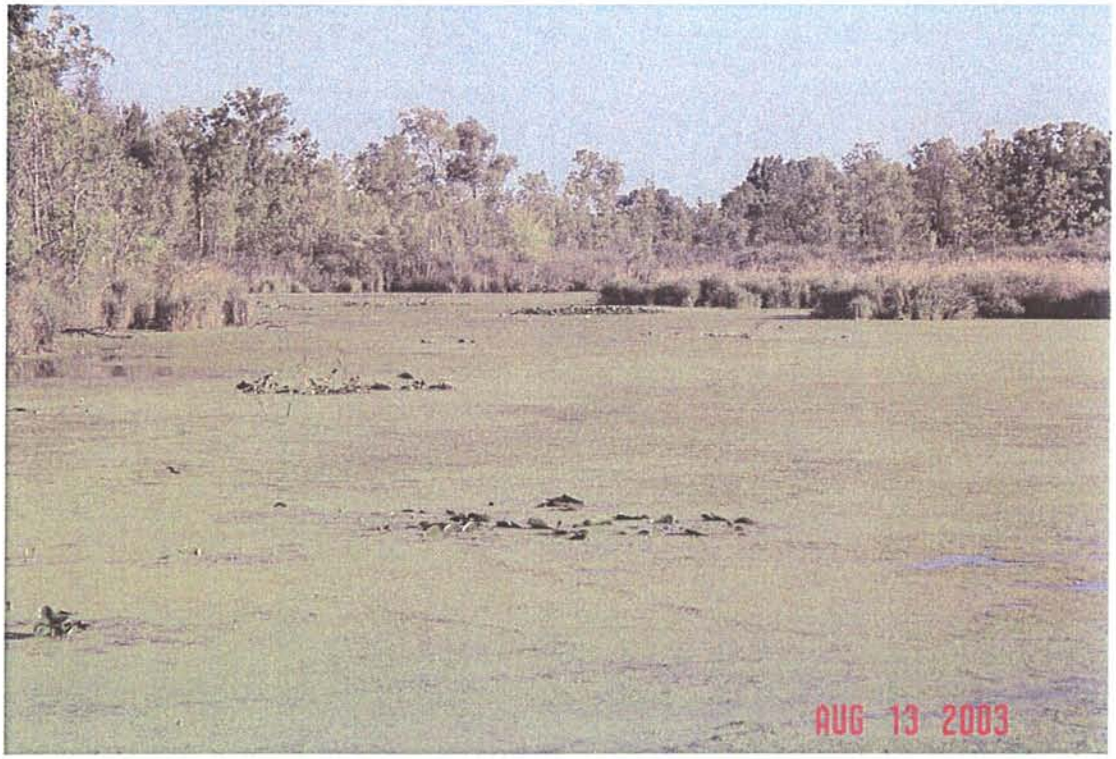
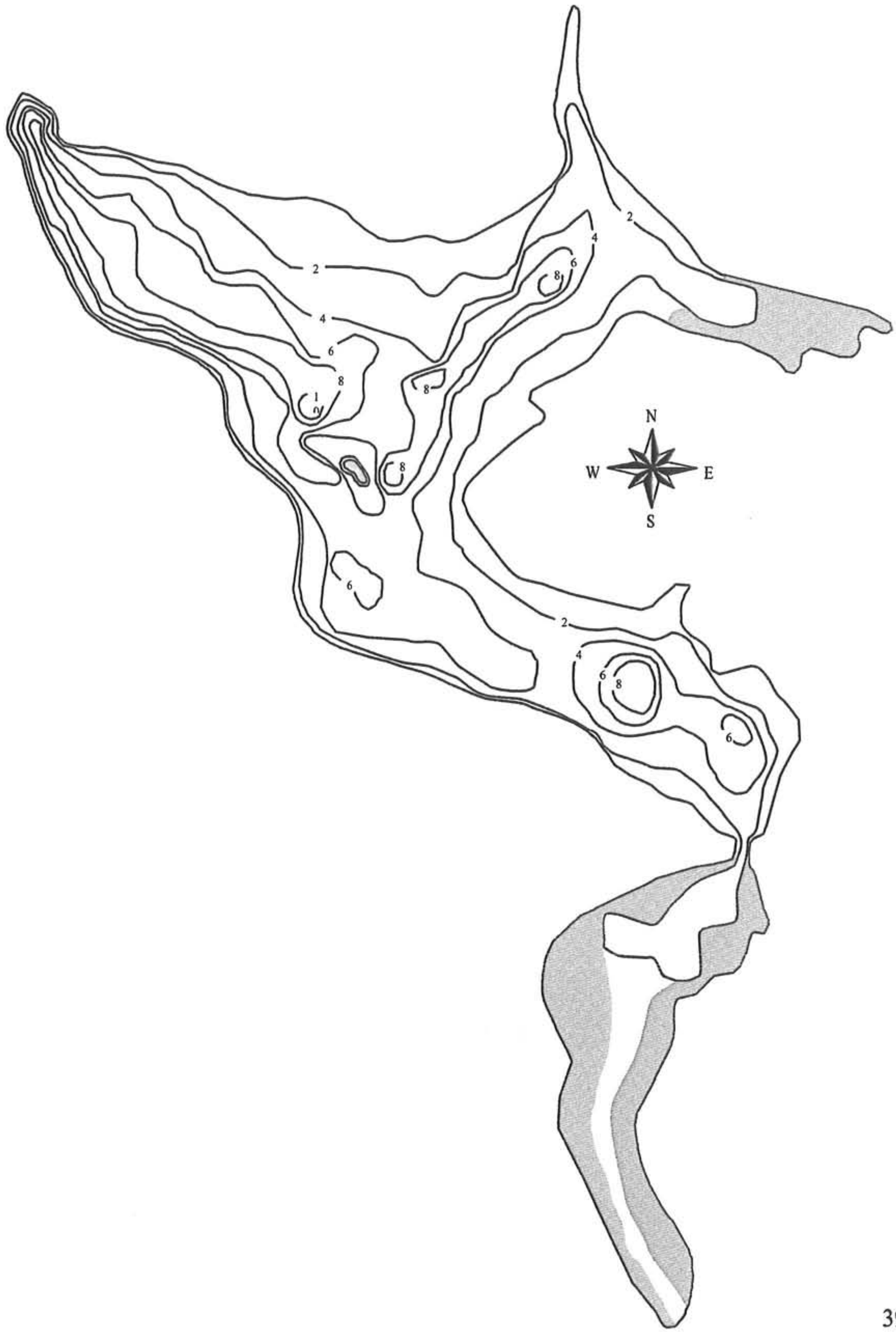


Figure 31 – Areas of Black Otter Lake Proposed for the Planting of Emergent Aquatic Plants



Appendix A

Fishery Survey Results Black Otter Lake Report (report for 2005 fishery survey)

Fishery Survey Results
Black Otter Lake

Hortonville, WI

March 6, 2006

Prepared by:

Jim Nicholson
Joe Cadieux
Aquatic Biologists, Inc.
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Introduction

On April 11^{th}, 2005, a comprehensive fisheries survey began on Black Otter Lake located in Hortonville, Wisconsin. The main purpose of the survey was to evaluate the lake's sport fishery in order to enhance the Black Otter Lake Association's decision making process in regards to future fish stocking and water quality enhancement programs. The specific objectives were to collect data on total species diversity and composition, length frequencies and length at age on all sport fish, and total population estimates on Large Mouth Bass and Northern Pike. This report summarizes the information gathered and observations made during this survey. It also attempts to compare the results with past DNR surveys.

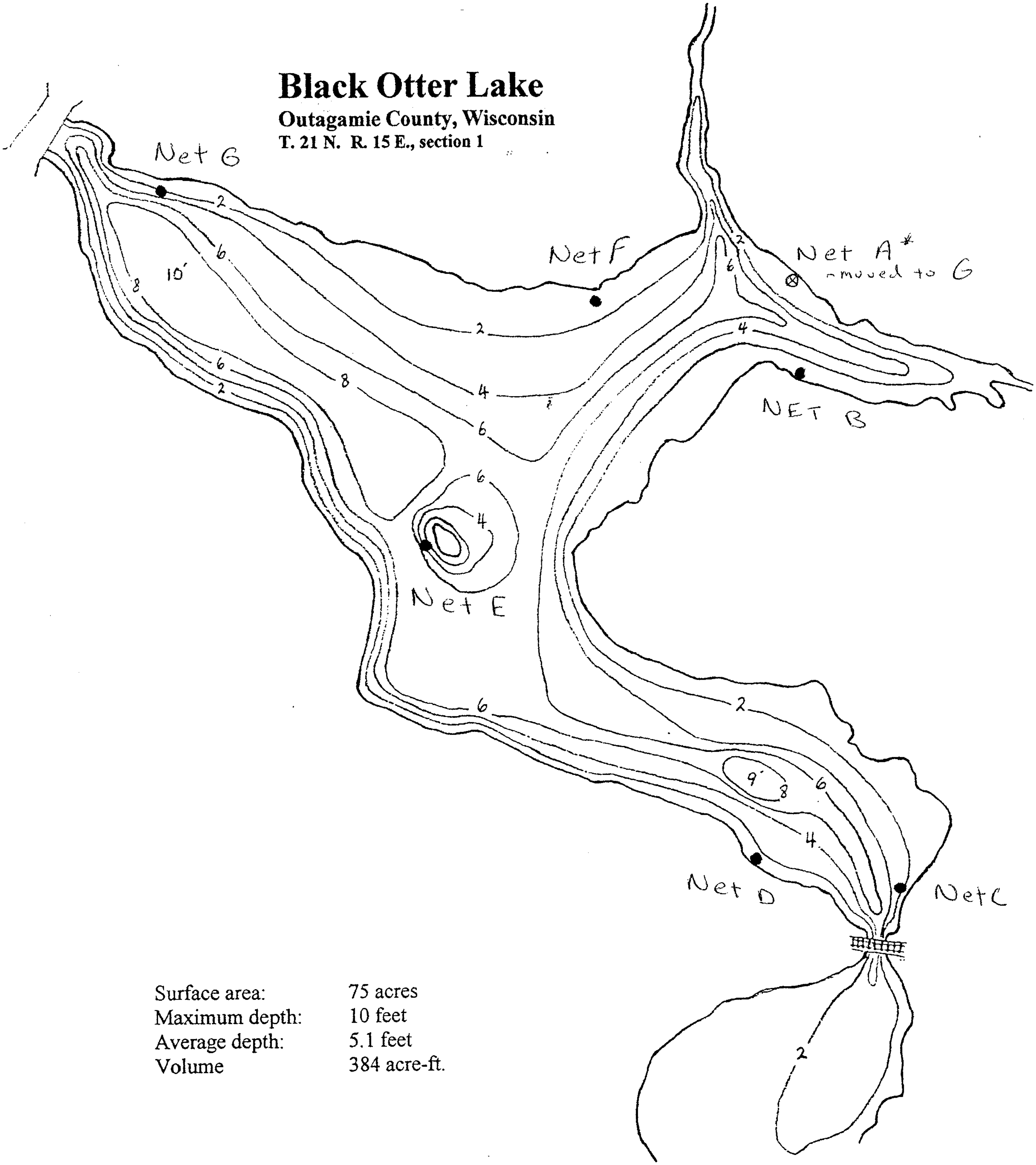
Methods

Two techniques were utilized to survey the lake. The first technique consisted of six fyke nets set in the lake on April 11^{th}, 2005 and lifted every day for the next six days ending on April 17^{th}, 2005. The second technique was an electrofishing boat with bow-mounted booms operated during the evenings of May 27^{th} and May 28^{th}.

Fyke nets are modified hoop nets with one or two wings or a leader of webbing attached to the mouth to guide fish into the enclosure. The net is set so that the wings and leader intercept the movement of fish. When fish follow the wing or leader in an attempt to get around the netting, they swim into the hoop net. To retrieve the captured fish, the hoop net is lifted to the edge of a boat, untied and emptied of its' catch. Placement of the nets is pictured in figure 1. A number count was conducted for every species, and all sport fish were measured. Scale samples were collected from a stratified random sample of all sport fish.

Electrofishing in the strictest sense, is the use of electricity to capture fish. A flat bottomed, aluminum boat with bow mounted booms to support the electrodes, is piloted around the shoreline of the water body, while dip-netters stationed in the front of the boat collect stunned fish and transfer them to a holding tank in the middle of the boat. The process is conducted at night due to the tendencies of larger, predatory fish moving into the shallows to feed. In addition, the lack of sunlight makes it easier for the dip-netters to spot stunned fish and the fish seem less apt to avoid capture at night. The entire shoreline, including the island, was surveyed. The first night, two fifteen minute runs and one entire run around the lake and island was conducted in order to imitate the exact DNR procedures used in the past. A number count was conducted for every species, and all sport fish were measured. Scale samples were collected from a stratified random sample of all sport fish. All Large Mouth Bass and Northern Pike were given a top caudal fin clip and released. On the second night, only one run around the entire lake and island was conducted, specifically targeting Large Mouth Bass and Northern Pike. The main purpose on the second night was to record the ratio of marked to unmarked Large Mouth Bass and Northern Pike to form the basis of a population estimate. Unfortunately,

Figure 1



Surface area: 75 acres
Maximum depth: 10 feet
Average depth: 5.1 feet
Volume 384 acre-ft.

SPRING 2005
Net Locations

the number of re-captures (marked fish) were far too few to form a reliable population estimate. We attribute the lack of re-captures to the fact that the entire lake is relatively shallow and weedy, producing a fairly uniform distribution of predator fish throughout the entire water body and a resulting lack of incentive for larger predatory fish to return to the shoreline to find productive, shallow feeding areas.

Results and Discussion

Fyke netting and electrofishing results were both excellent during the survey. An abundance of fish was encountered, including six sport fish species (Table 1). Bluegills dominated the fishery and a very healthy population of Largemouth Bass was found. Yellow Perch, Black Crappies, Pumpkinseed and Northern Pike were present in limited numbers. White sucker, Green Sunfish, Yellow and Black Bullhead, Golden Shiner and Central Mud Minnow were also found.

Table 1. Sport fish species and length ranges encountered during the Spring 2005 survey.

COMMON NAME	SCIENTIFIC NAME	LENGTH RANGE(INCHES)
Bluegill	*Lepomis macrochirus*	2.1 – 8.5
Pumpkinseed	*Lepomis gibbosus*	3.0 – 8.0
Black Crappie	*Pomoxis nagromaculatus*	5.7 – 10.7
Largemouth Bass	*Micropterus salmoides*	6.5 – 21.5
Yellow Perch	*Perca flavescens*	5.5 – 12.0
Northern Pike	*Esox lucius*	14.9 – 36.3

Bluegill ranged in length from 2.1 to 8.5 inches. The majority of the fish was in the 7.0 to 7.4 inch range and was in excellent condition. The bluegill was by far the most abundant fish and provided the most comprehensive data sets. When compared to previous survey results by the Wisconsin DNR, a distinctive increase in average size is notable. We believe this is attributed to the rigorous aquatic plant management techniques that the Black Otter Lake district has been implementing. The eradication of excessive nuisance aquatic plants such as Eurasian Water Milfoil and Curly Leaf Pondweed has led to the creation of more edge and opened up larger areas in which adult fish can successfully feed. Due to the survey being conducted prior to spawning, no young of the year were captured; however it's obvious that there is no problem with reproduction or recruitment. The numbers of fish over 8.0 inches drops dramatically, most probably to due heavy predation by anglers.

Black Crappie, ranging from 5.7 to 10.7 inches, and Yellow Perch ranging from 5.5 to 12.0 inches, proved to be a very interesting catch. It was obvious from the numbers that some stocking of these species had occurred, but we did not locate the exact dates and amounts of these stockings. Both species showed excellent growth rates and health, but little to no reproduction or recruitment.

Largemouth Bass ranged in length from 6.5 to 21.5 inches and were very abundant. They also showed excellent health and displayed an average increase in growth compared to previous years. Even though very few small largemouth were caught, the numbers and growth rates indicate healthy reproduction and recruitment of new fish. The majority of the largemouth was in the 16.5 to 18.0 inch range. This is a very good average size compared to other area lakes and offers and outstanding fishing opportunity to patient bass anglers.

Northern Pike ranged in length from 14.9 to 36.3 inches with the most abundant being in the 21.0 to 22.9 inch range. Very few northern pike were captured which was by far the most surprising result of the survey. Northern pike traditionally do not electroshock well but they are very susceptible to fyke nets. Several factors could have contributed to the low catch rate, the most obvious being the uniform depth throughout the lake and the vast availability of suitable habitat. Since all six fyke nets were placed on the shorelines, an accurate sampling of northern pike was probably not achieved. Future netting surveys should endeavor to place mid-lake nets to provide a better sampling. In addition to the surprise of the lack of numbers, the size structure of the few that were caught was much smaller than what was expected. This is most likely due to very heavy angling pressure during the winter and the lack of a minimum size limit on the species.

Age Analysis

Length at age analysis was successfully performed on bluegill, largemouth bass, black crappie and yellow perch. The cleithra is normally used to effectively age a northern pike resulting in the fished being killed. Due to this, we chose not to collect age data on northern pike. The pumpkinseed scale samples were too few to effectively interpret the data and therefore also not included.

All aged species showed an impressive growth rate and other very similar trends. A normal length vs. age graph for a healthy fish population that is left untouched by man or experiences very little harvesting will generally show very fast growth rates until attaining adult size, then will diminish rapidly as the fish matures. In the case of Black Otter Lake, all four aged species displayed the expected jump in growth as they reached adult size, however the normal tapering off of the growth rate as the fish mature is not indicated by our graphs. This is due to the almost complete lack of the upper size classes in our sampling. Black Otter Lake experiences significant fishing pressure during both the warm and cold seasons and anglers enjoy a relatively easy lake to harvest fish from. Due to this, adult, mature fish are being harvested virtually as soon as they reach the desired size, yet the bluegill and bass populations continue to flourish without any stunting evidence. The initial growth rates and healthy average size indicates adequate habitat and forage base are both available.

Conclusions

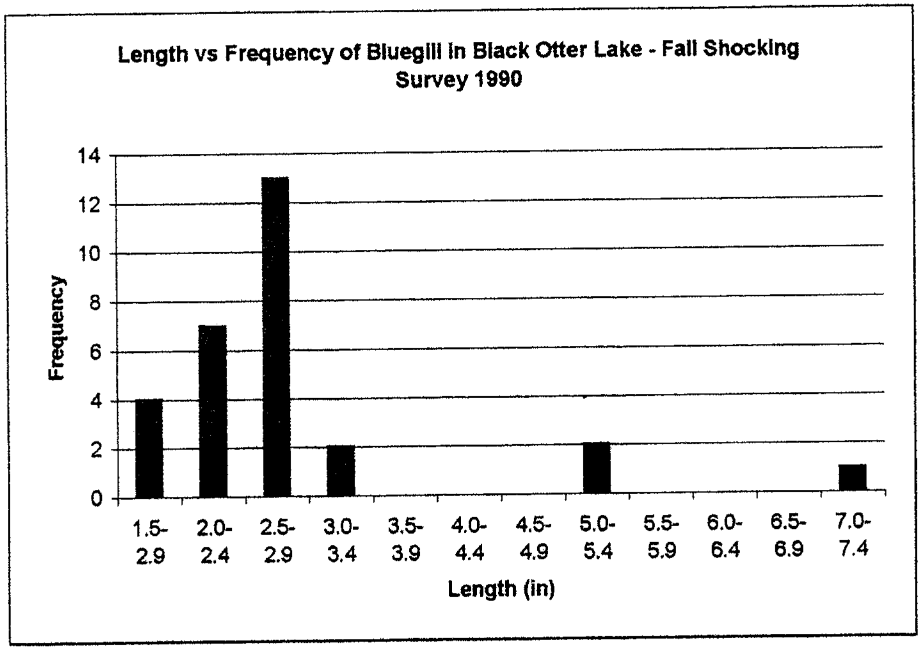
The main purpose of this survey was to provide a comprehensive study in order to establish a baseline for future fisheries and water quality management decisions. To this end we were very successful, and the data provided in this report should help in this regard. The bluegill and largemouth bass populations are doing very well in Black Otter Lake and show no signs of experiencing any difficulties whatsoever. It's very evident that the bluegill and largemouth bass populations in Black Otter Lake are experiencing high angling mortality rates at the larger size classes, and if left alone would achieve significantly higher average size structures. Past stocking operations of black crappie and yellow perch have definitely been successful; however the recent survey data would indicate that in order for those populations to remain a viable fishery in Black Otter Lake, additional stocking programs will have to be implemented. Virtually no reproduction or recruitment of these species was evident and it's reasonable to expect that these populations will continually diminish and eventually disappear. The northern pike data collected in the 2005 study proved too insubstantial to make any reliable population estimates, but did indicate a significant lack of large, adult fish. No current size limit for harvesting northern pike on Black Otter Lake and heavy angling pressure throughout the year is the most likely explanation for this shortage. The Black Otter Lake Association should pursue the possibility of establishing a minimum size limit on northern pike in order to help increase the average size structure of the population.

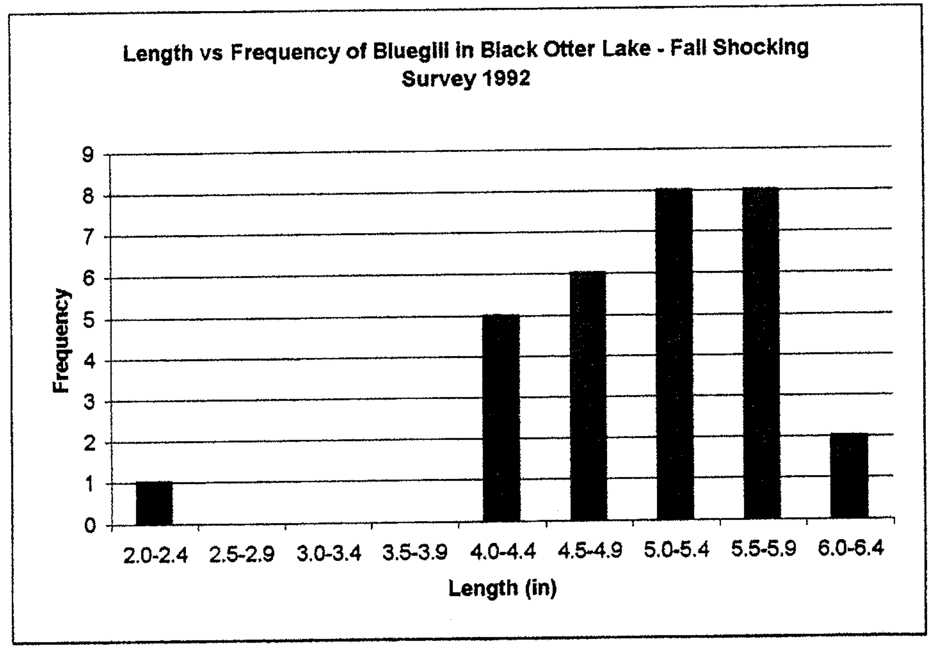
Future studies or surveys should attempt to deviate from the normal procedures used when sampling a large lake. The uniform depth and abundance of viable habitat in Black Otter Lake does not force the game fish to the shorelines in order to feed. Mid-lake shocking and fyke netting is definitely recommended to obtain more thorough data. Black Otter Lake should continue it's aggressive aquatic plant management program as it's clearly evident that the successes of the program are having a direct positive effect on the health of the game fish populations

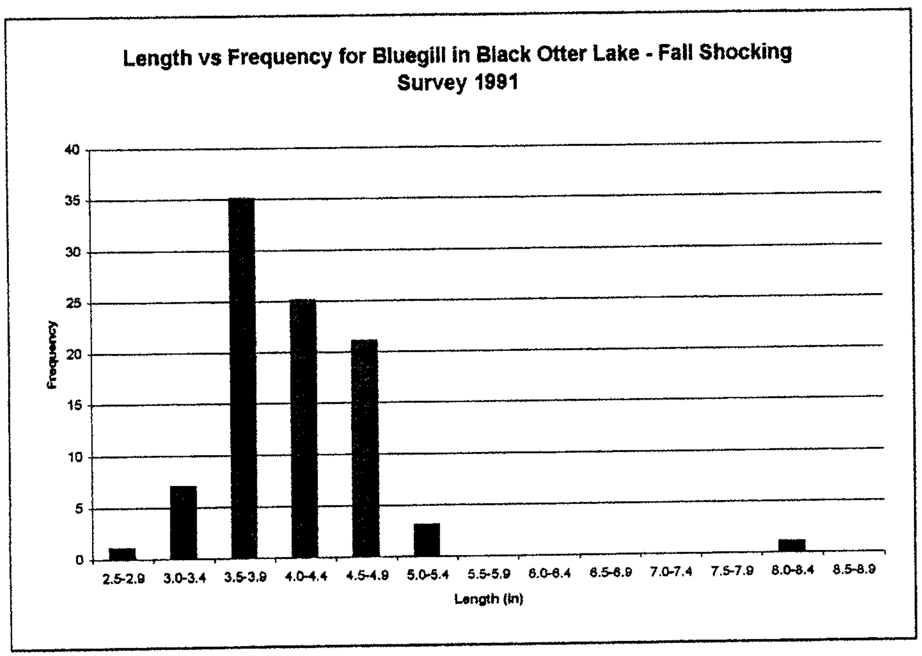
- stocking history

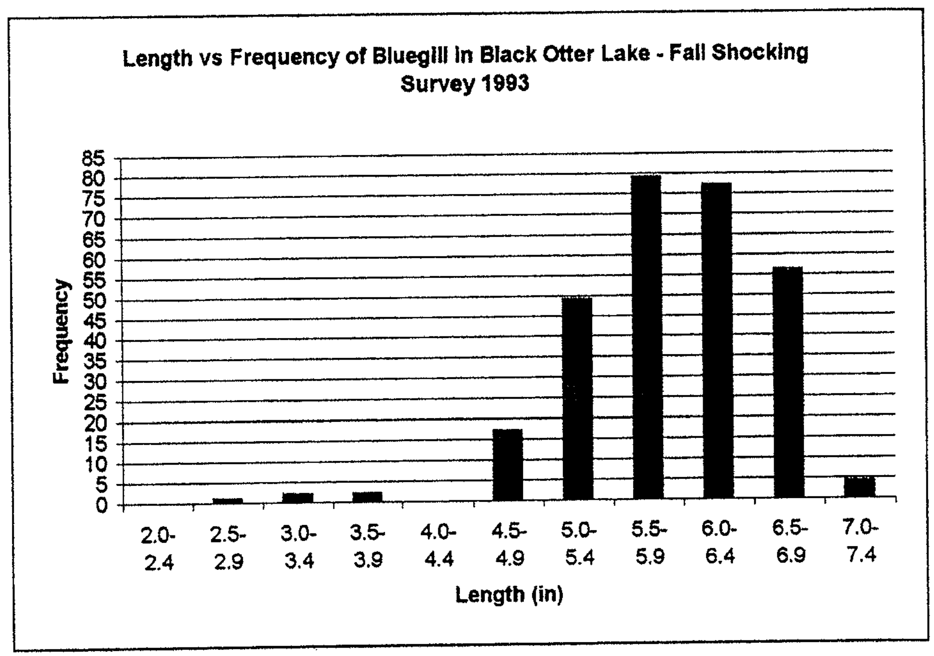
- NP stocking?
  size limit

Bluegill (1990-1993)

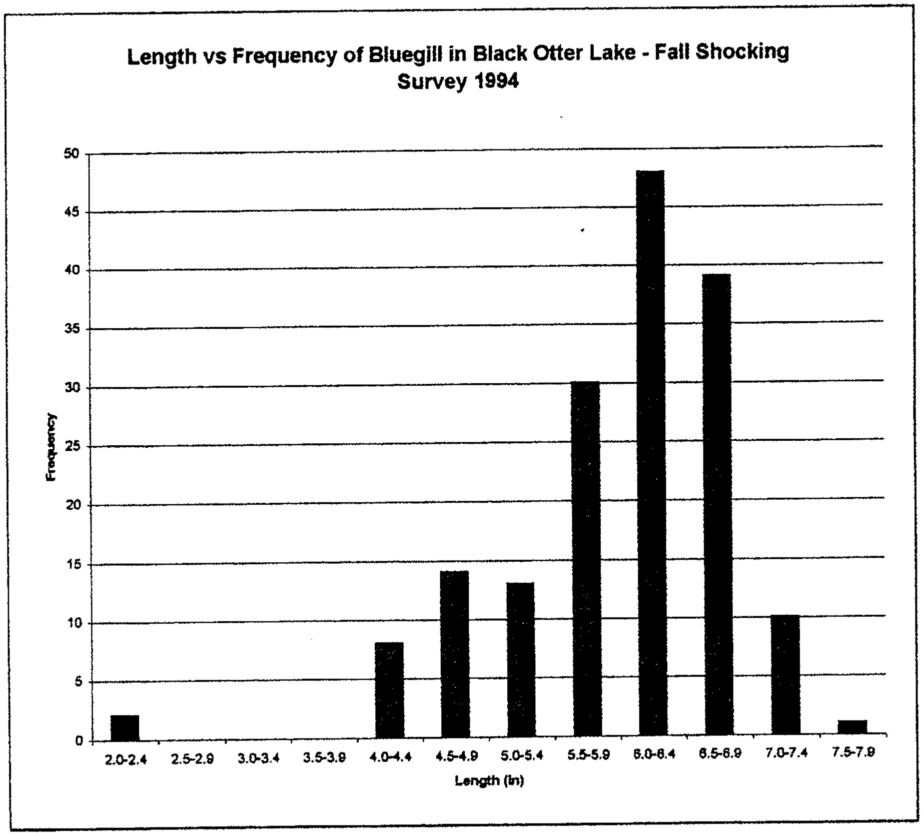


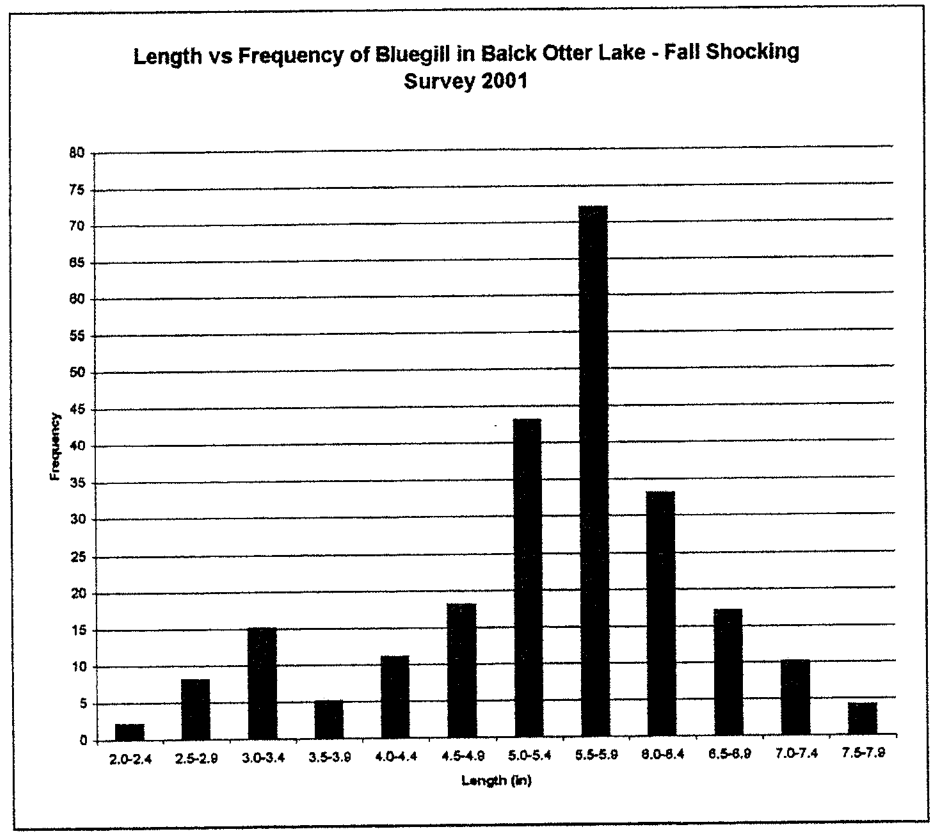






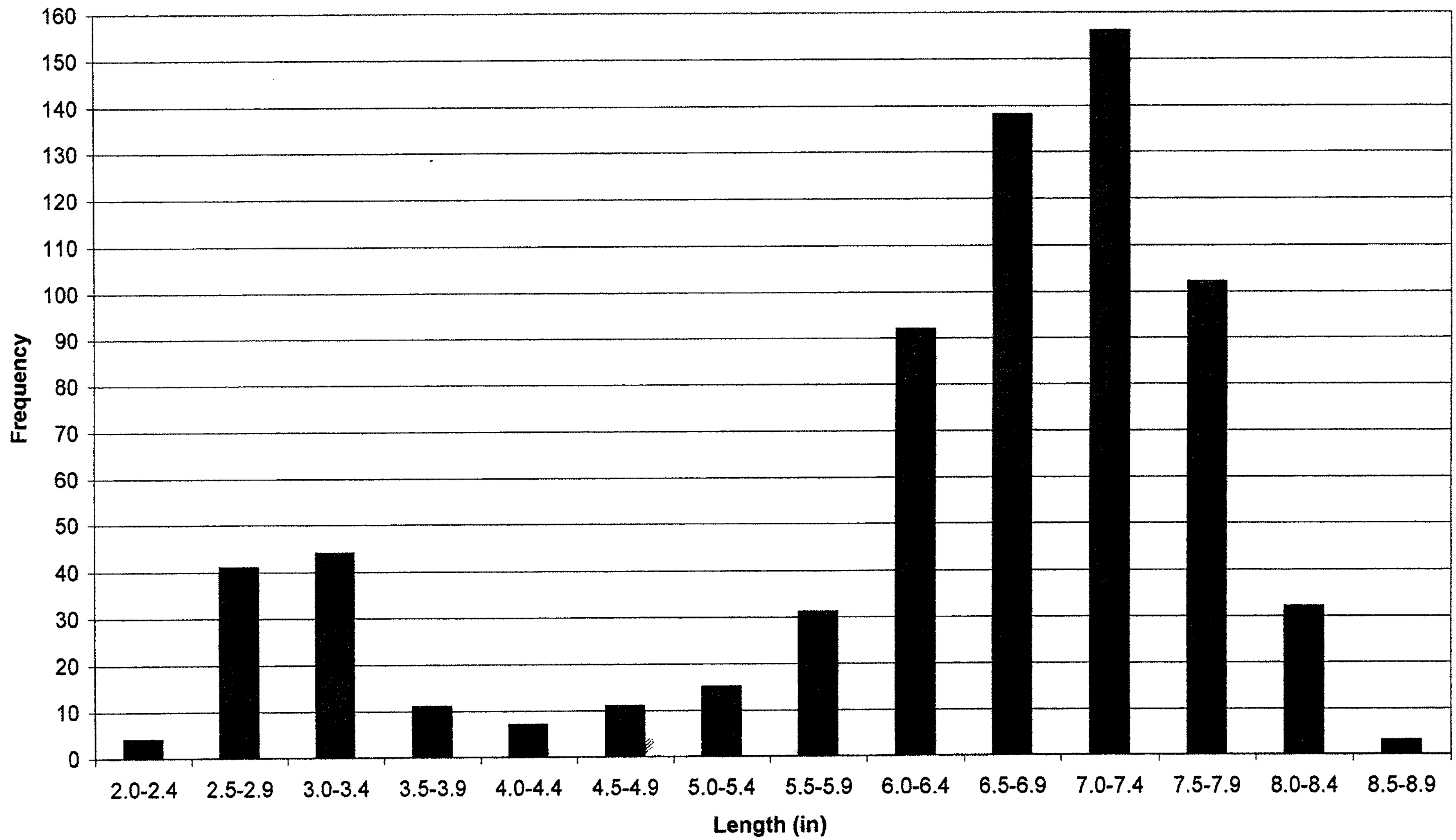
Bluegill (1994-2001)

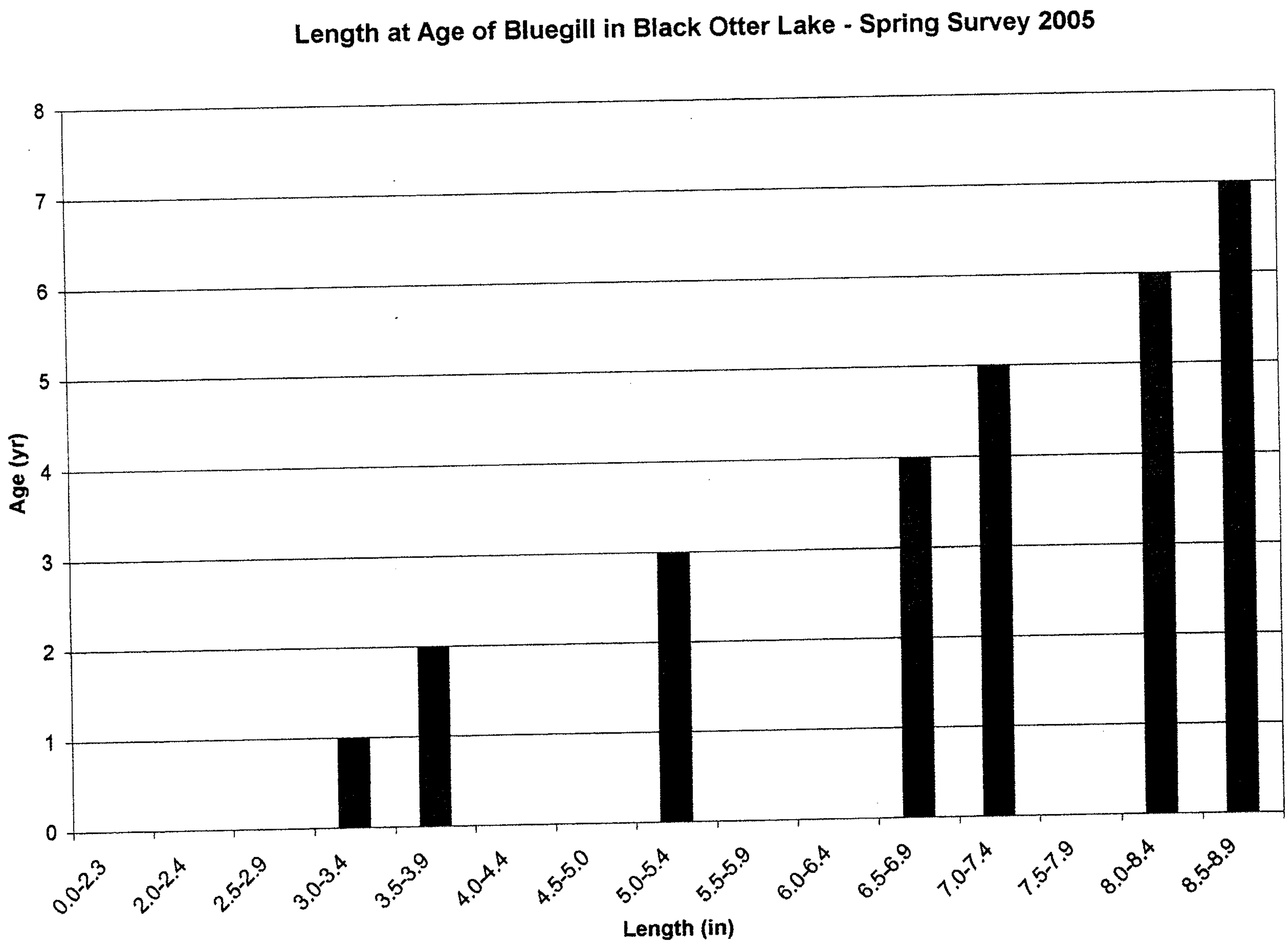




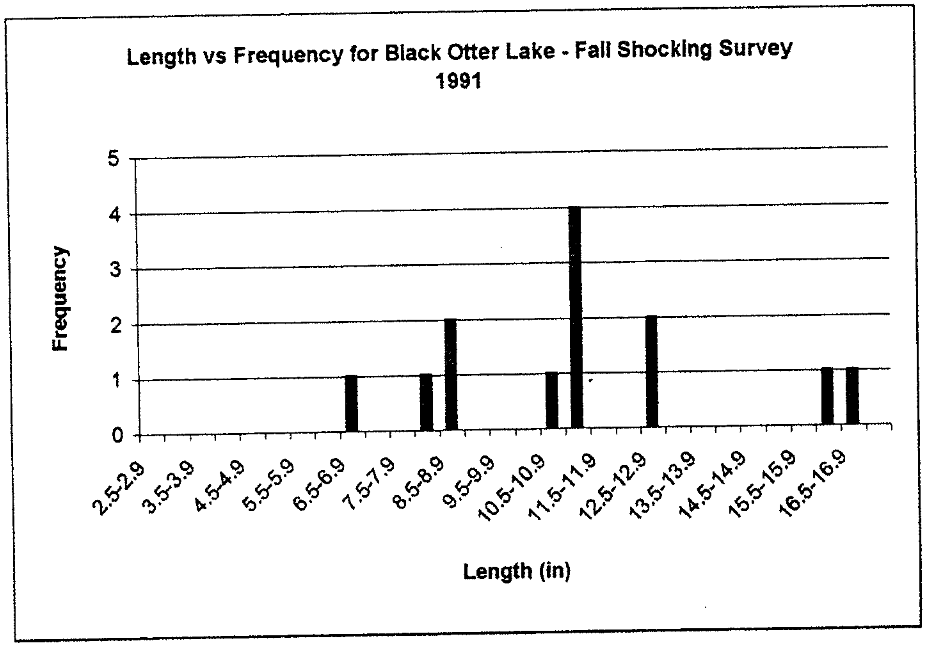
Length vs. Frequency for Bluegills in Black Otter Lake

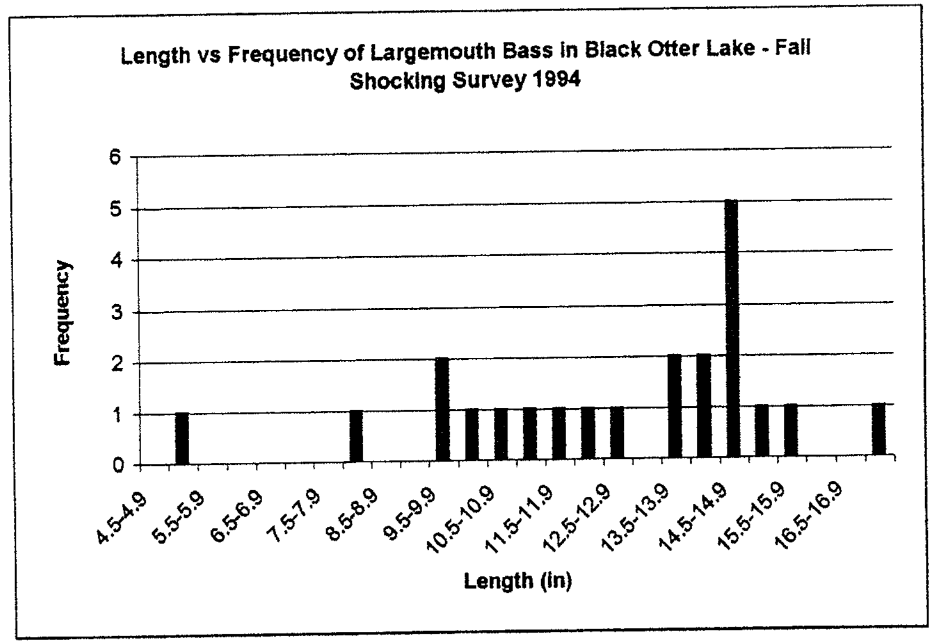
Spring Shocking and Netting Survey 2005

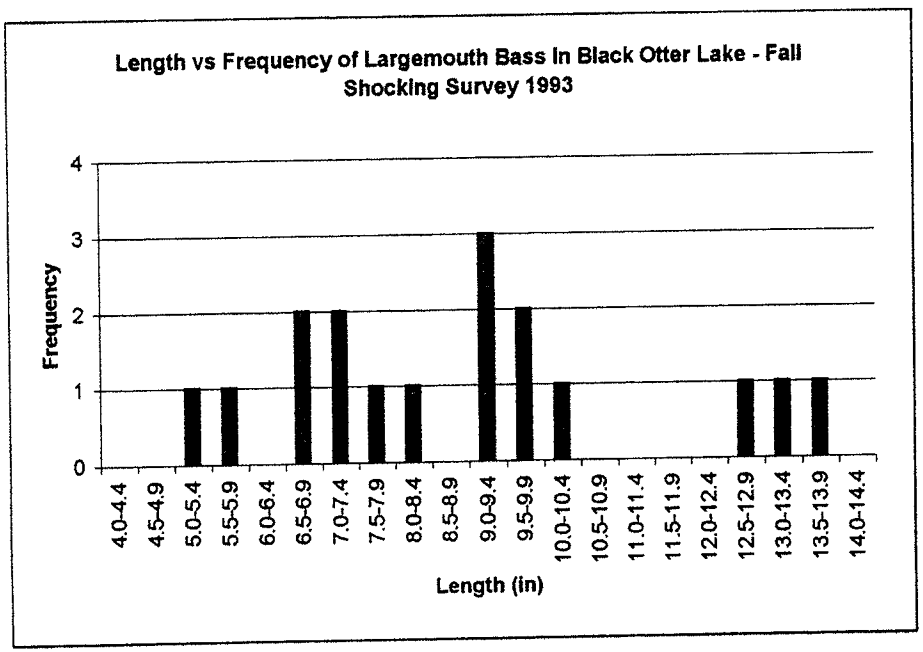


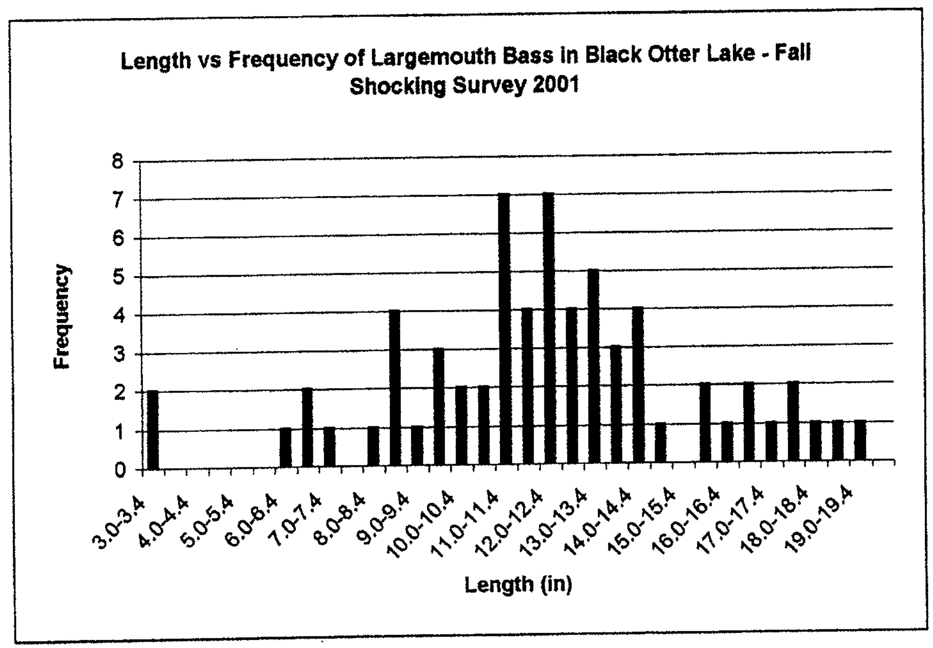

Length at Age of Bluegill in Black Otter Lake - Spring Survey 2005
Age (yr)
0
1
2
3
4
5
6
7
8
0.0-2.3
2.0-2.4
2.5-2.9
3.0-3.4
3.5-3.9
4.0-4.4
4.5-5.0
5.0-5.4
5.5-5.9
6.0-6.4
6.5-6.9
7.0-7.4
7.5-7.9
8.0-8.4
8.5-8.9
Length (in)

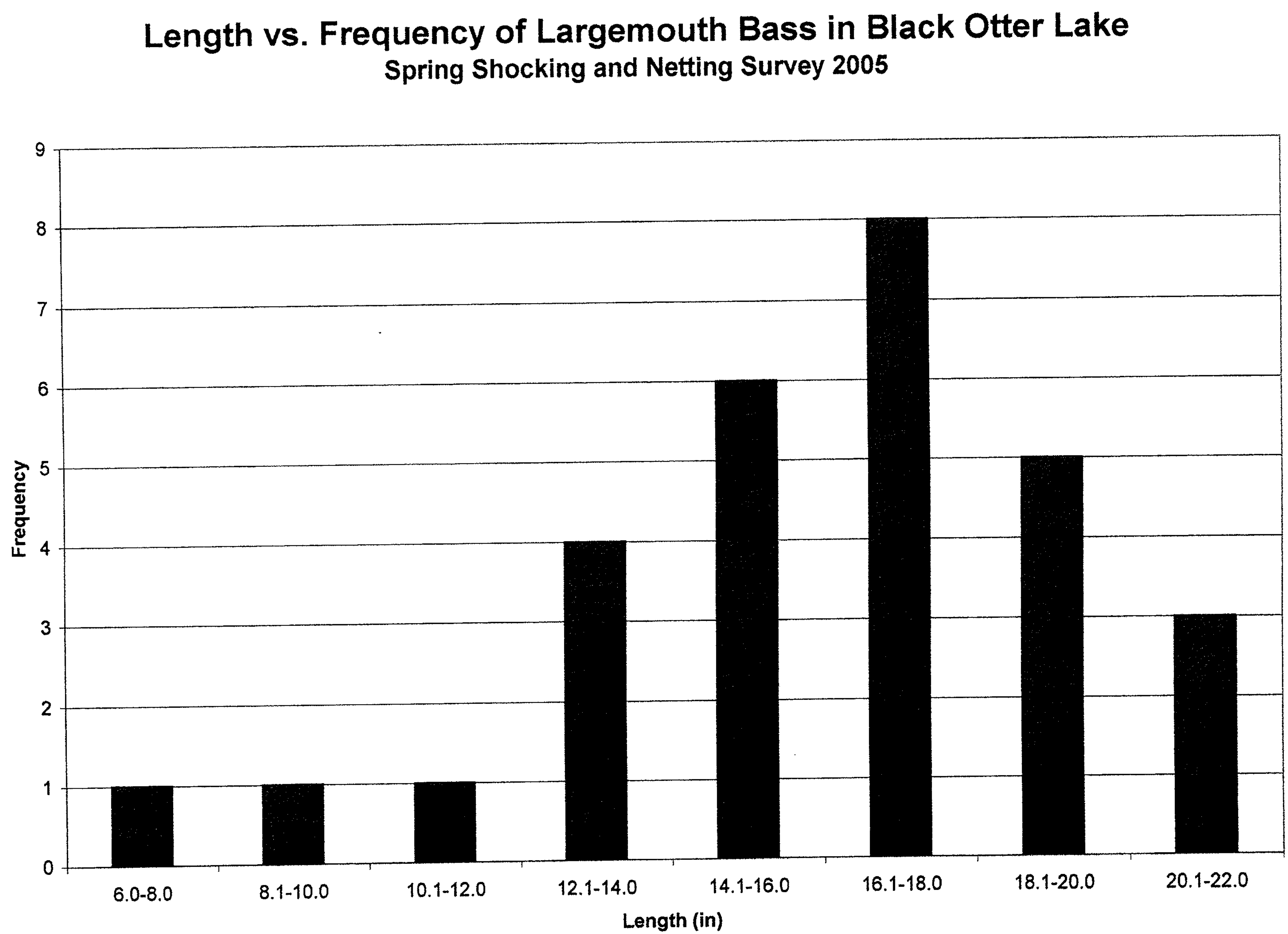
Largemouth Bass (1991-2001)

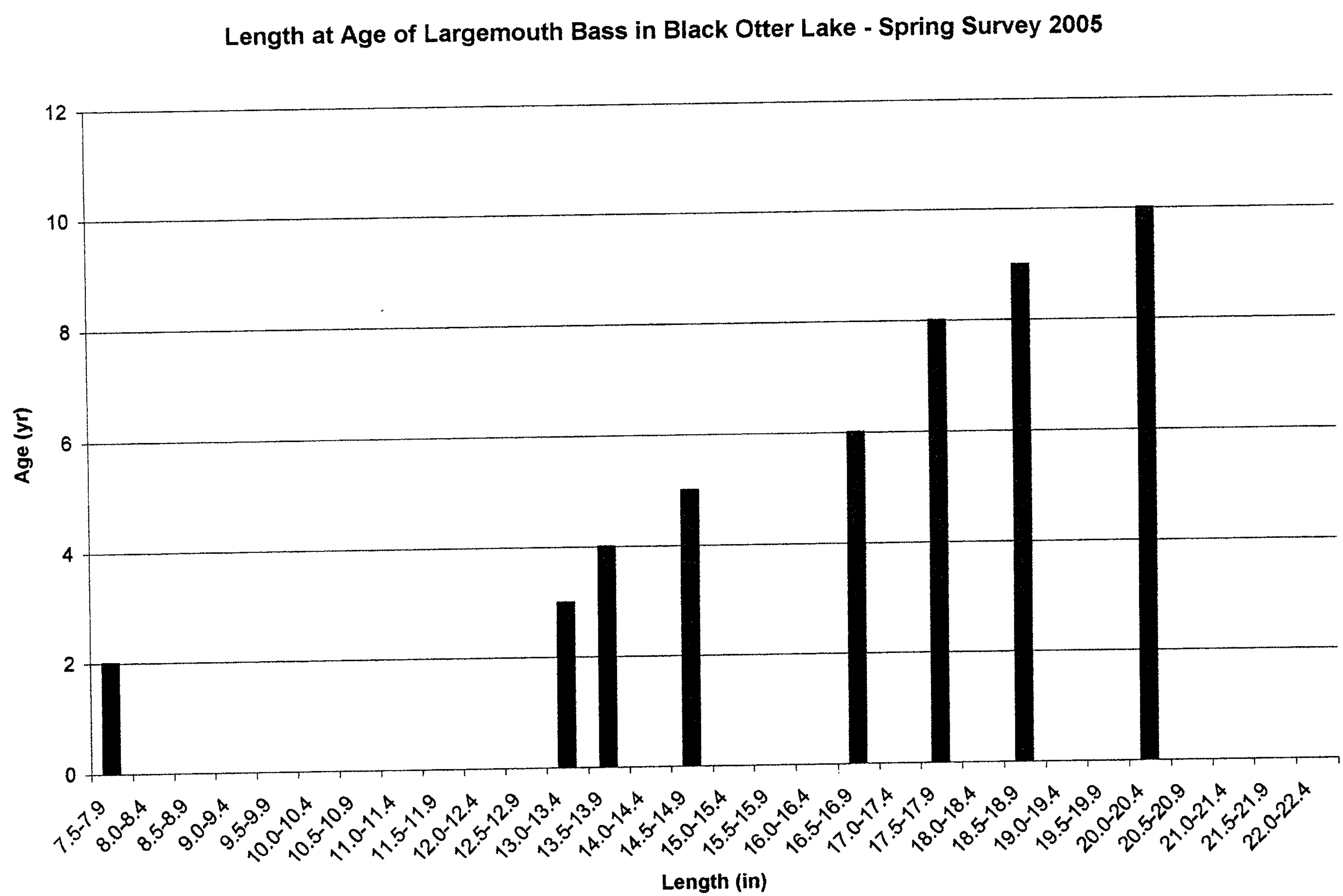






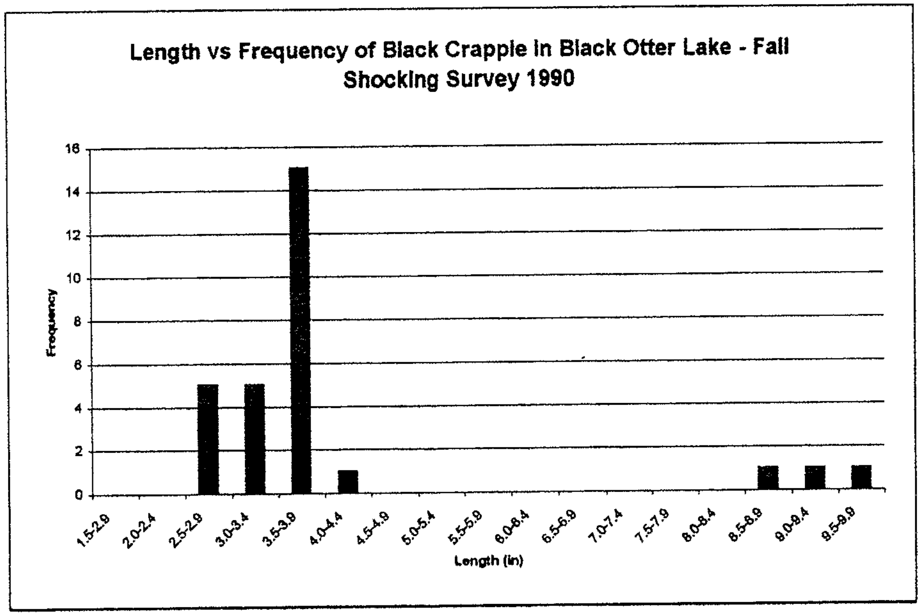


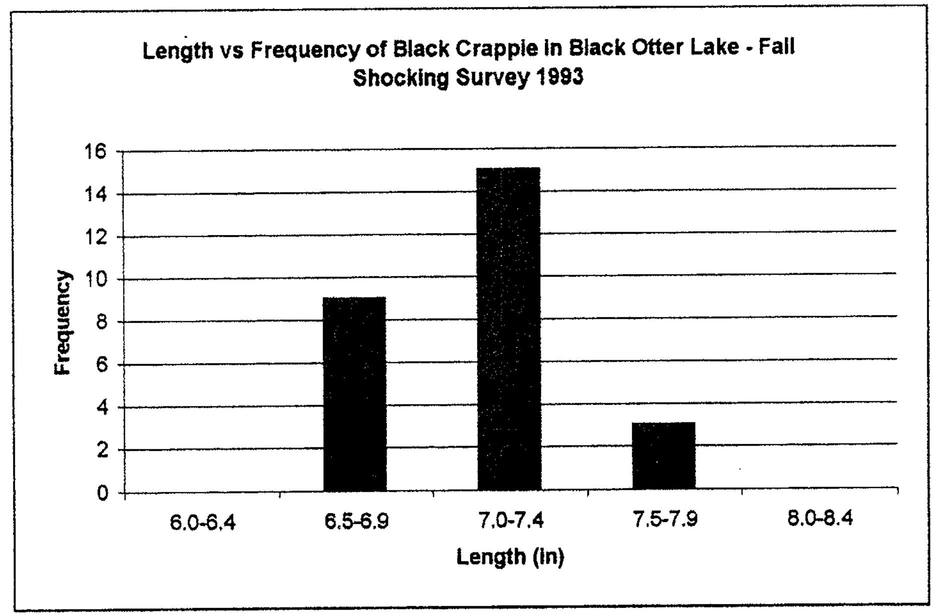

Length vs. Frequency of Largemouth Bass in Black Otter Lake
Spring Shocking and Netting Survey 2005
Frequency
0
1
2
3
4
5
6
7
8
9
6.0-8.0
8.1-10.0
10.1-12.0
12.1-14.0
14.1-16.0
16.1-18.0
18.1-20.0
20.1-22.0
Length (in)

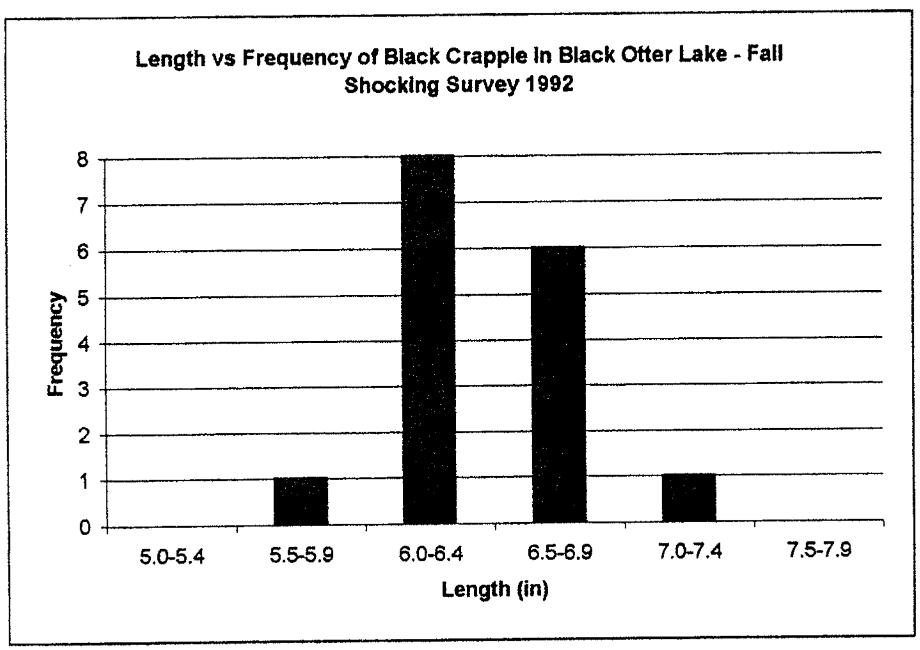


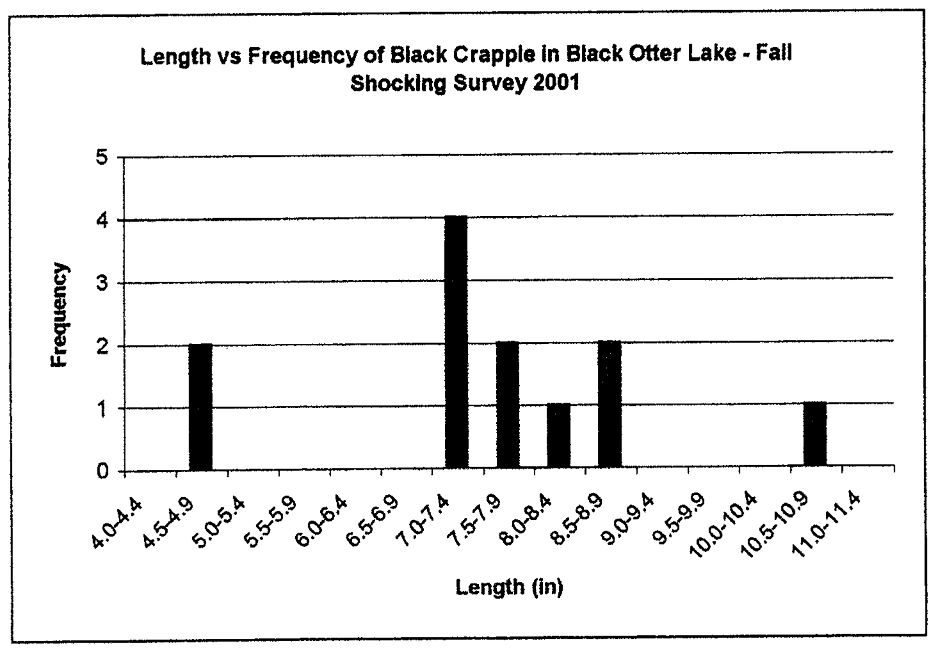
Length at Age of Largemouth Bass in Black Otter Lake - Spring Survey 2005
Age (yr)
0
2
4
6
8
10
12
7.5-7.9
8.0-8.4
8.5-8.9
9.0-9.4
9.5-9.9
10.0-10.4
10.5-10.9
11.0-11.4
11.5-11.9
12.0-12.4
12.5-12.9
13.0-13.4
13.5-13.9
14.0-14.4
14.5-14.9
15.0-15.4
15.5-15.9
16.0-16.4
16.5-16.9
17.0-17.4
17.5-17.9
18.0-18.4
18.5-18.9
19.0-19.4
19.5-19.9
20.0-20.4
20.5-20.9
21.0-21.4
21.5-21.9
22.0-22.4
Length (in)

Black Crappie (1990-2001)



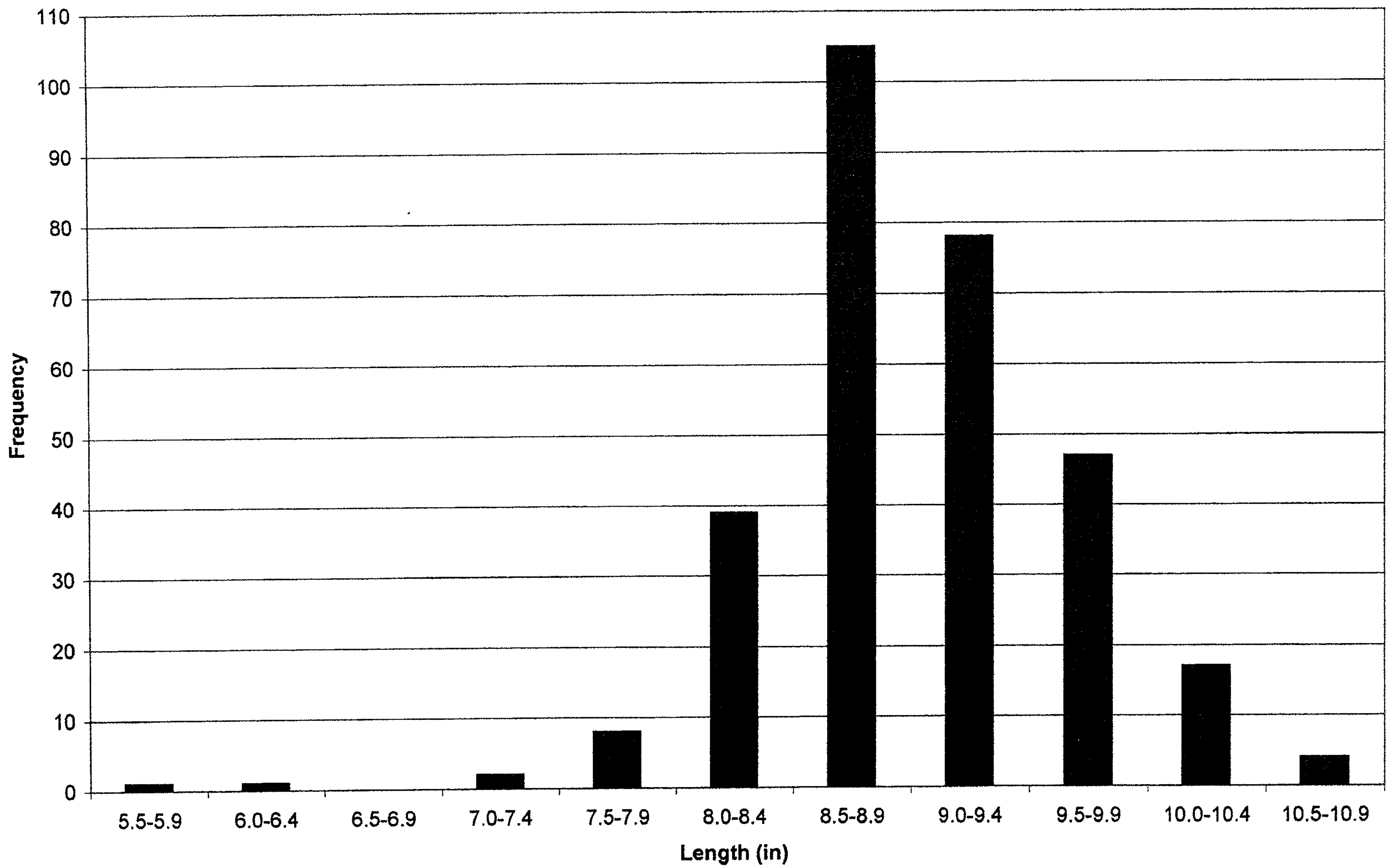


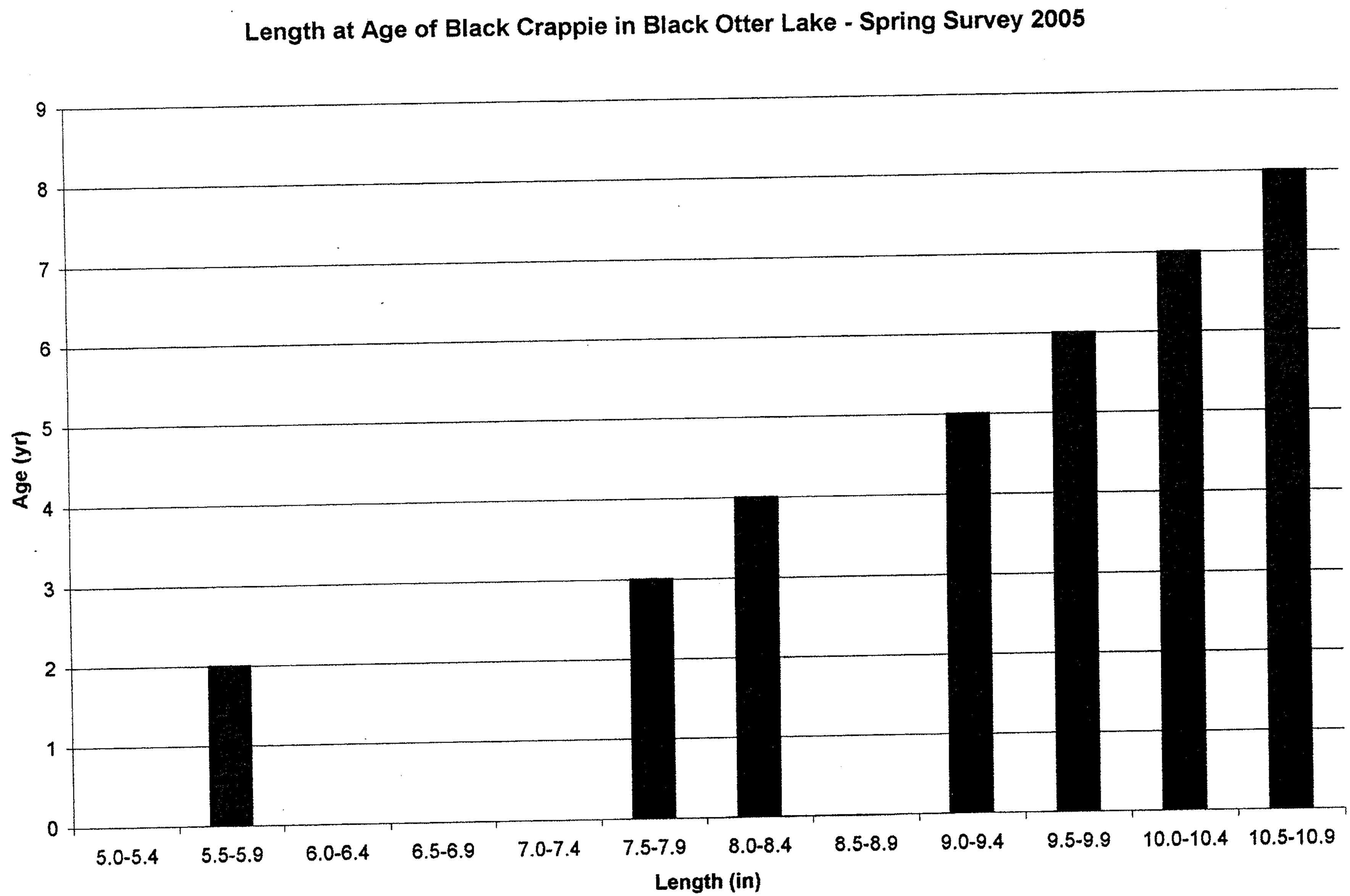




Length vs. Frequency of Black Crappie in Black Otter Lake

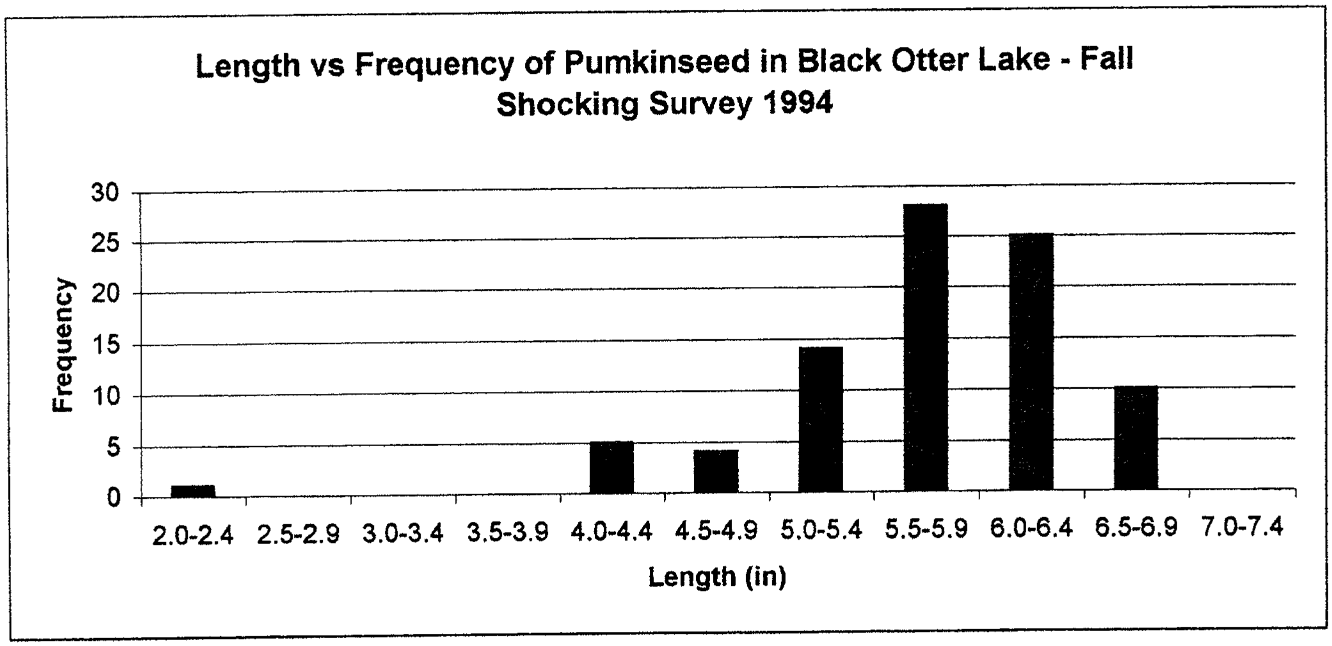
Spring Shocking and Netting Survey 2005





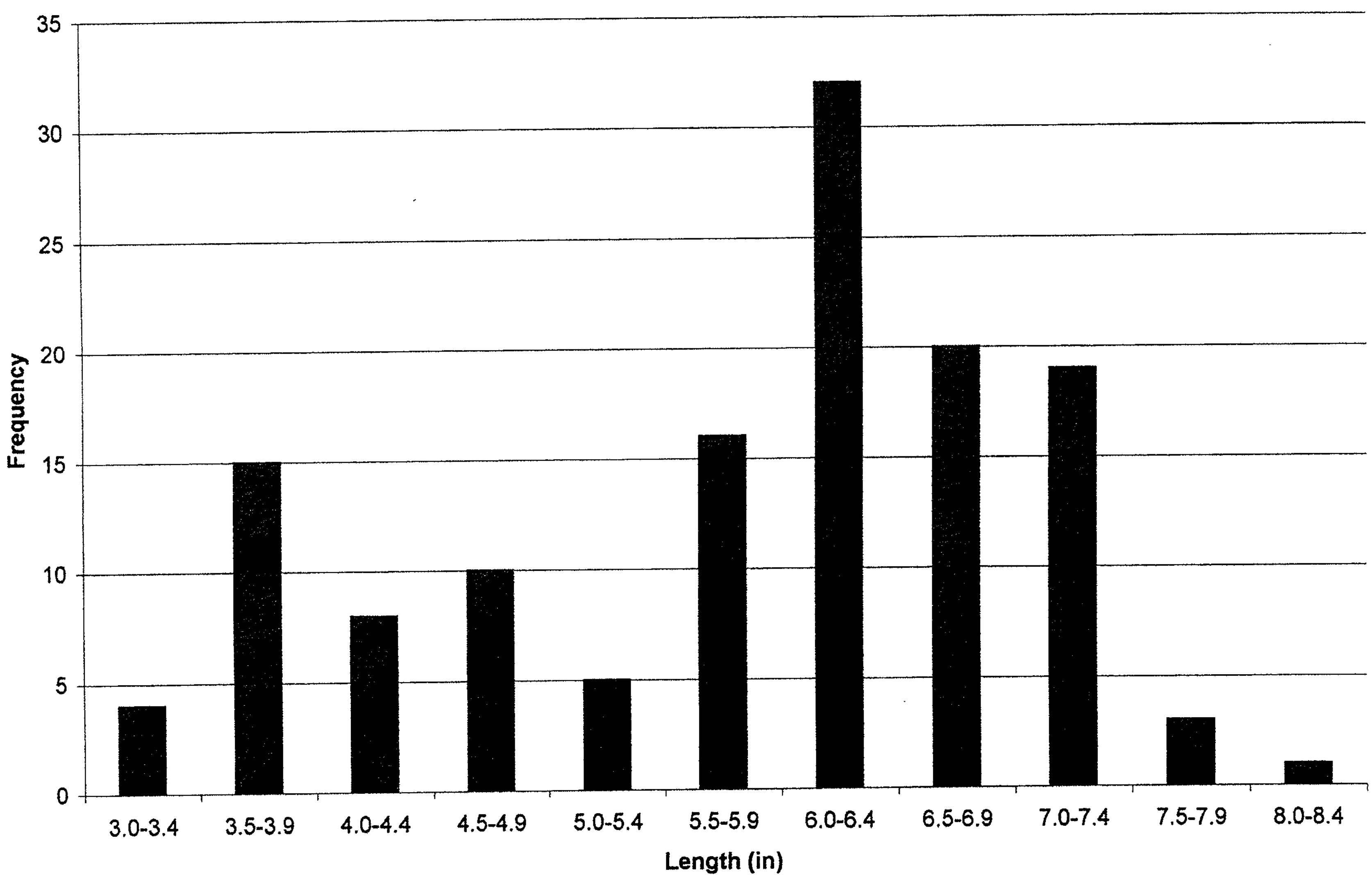
Length at Age of Black Crappie in Black Otter Lake - Spring Survey 2005
Age (yr)
9
8
7
6
5
4
3
2
1
0
5.0-5.4
5.5-5.9
6.0-6.4
6.5-6.9
7.0-7.4
7.5-7.9
8.0-8.4
8.5-8.9
9.0-9.4
9.5-9.9
10.0-10.4
10.5-10.9
Length (in)

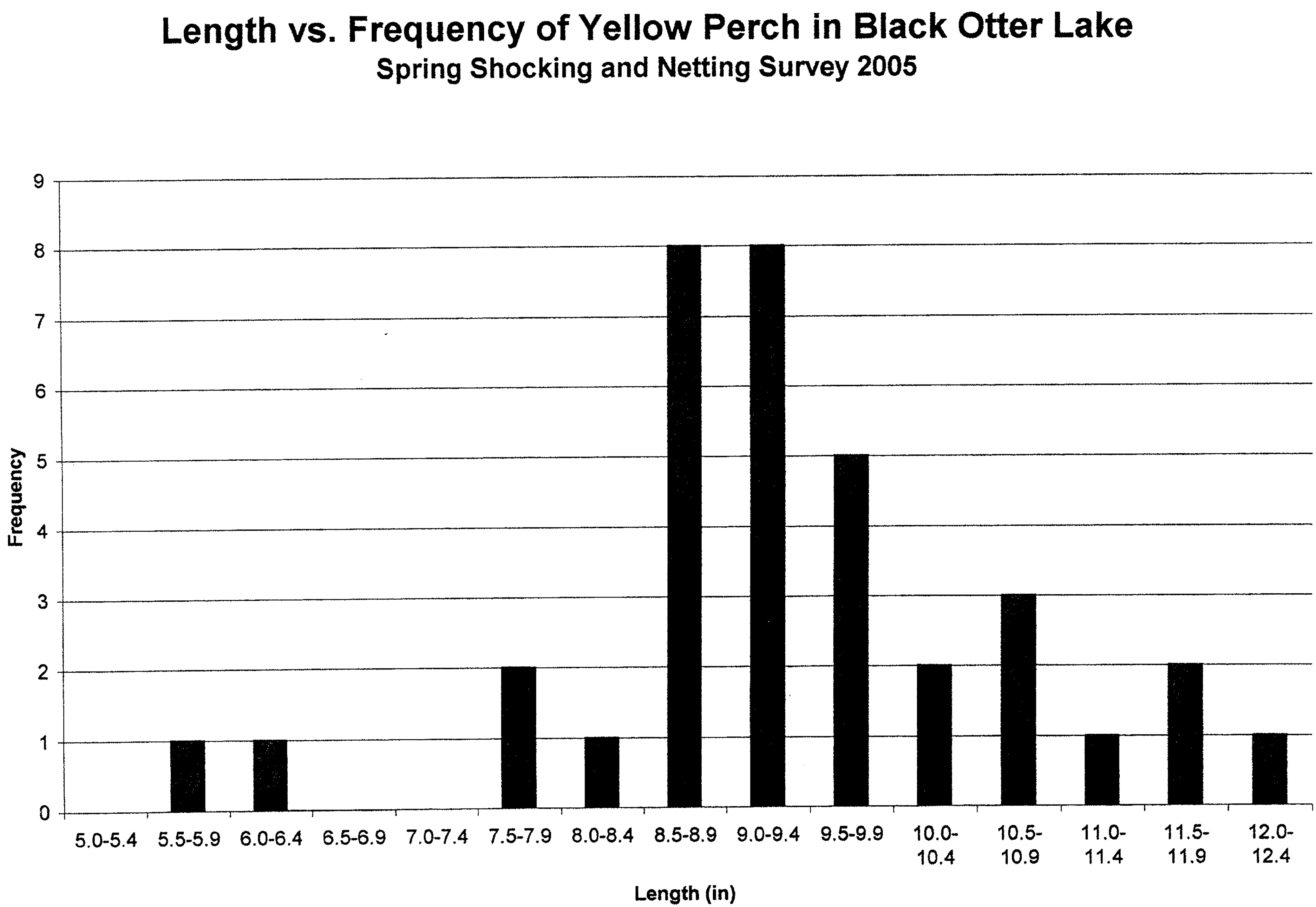
Pumpkinseed (1994)

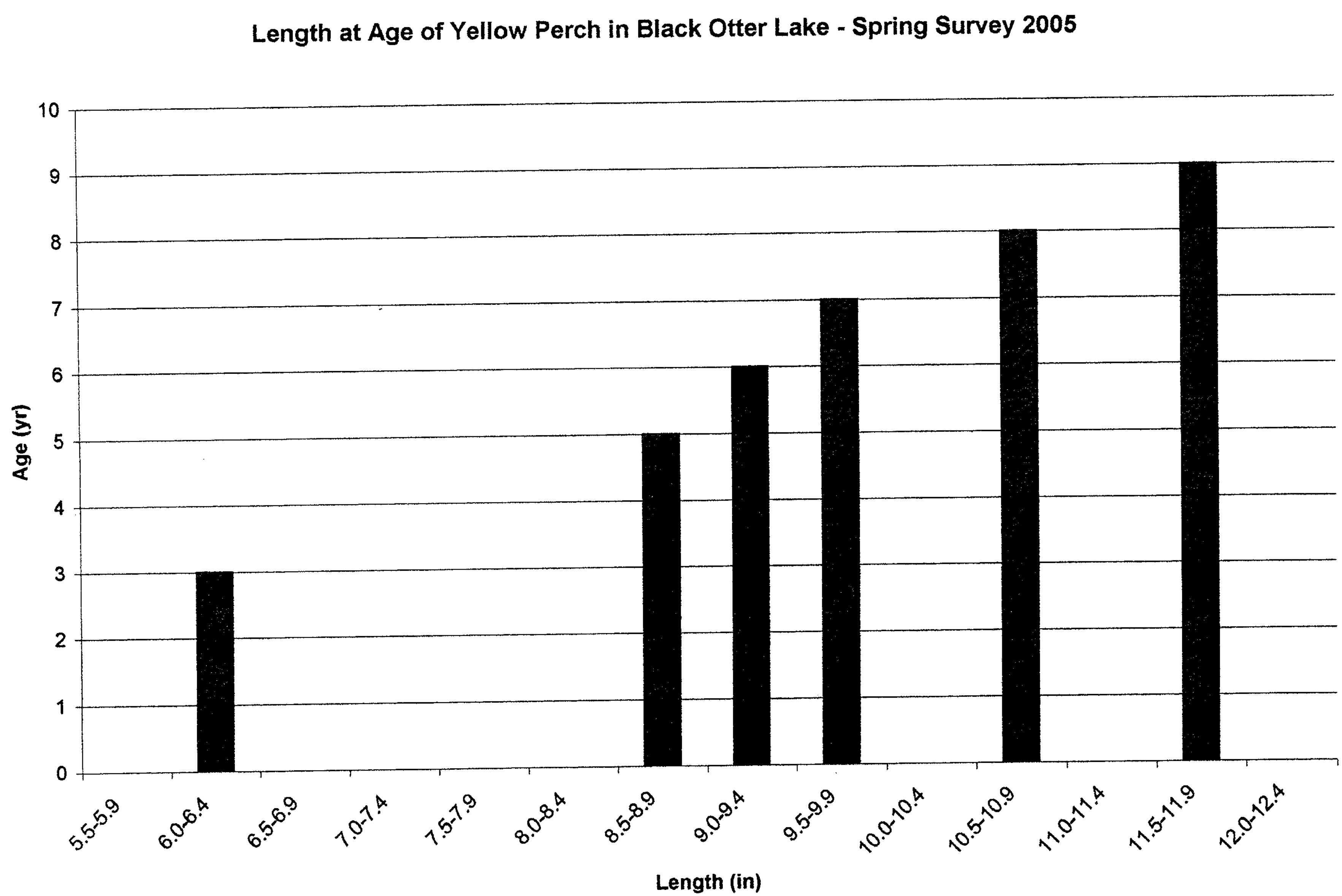


Length vs. Frequency of Pumpkinseed in Black Otter Lake

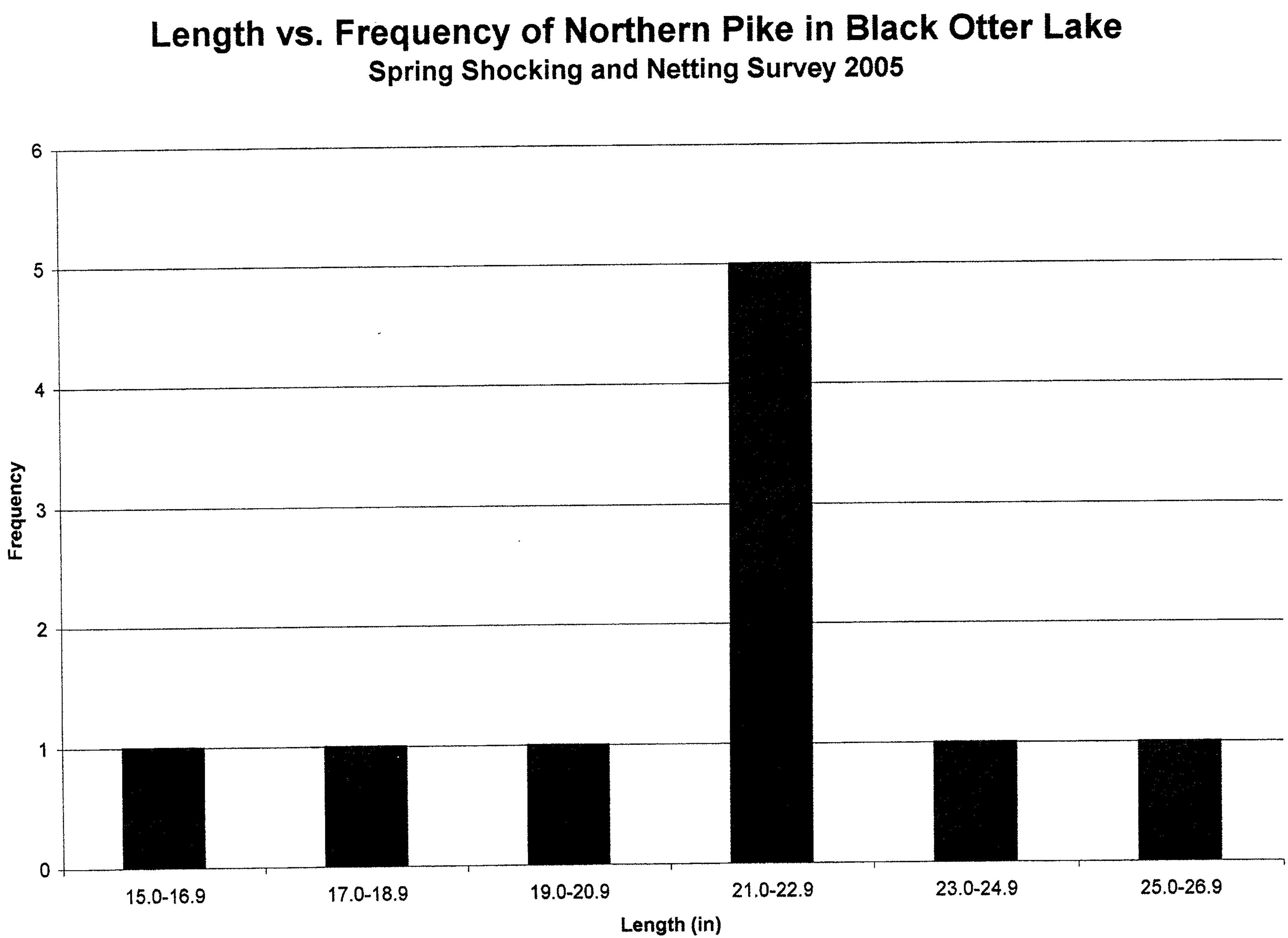
Spring Shocking and Netting Survey 2005




Length vs. Frequency of Yellow Perch in Black Otter Lake
Spring Shocking and Netting Survey 2005
Frequency
9
8
7
6
5
4
3
2
1
0
5.0-5.4
5.5-5.9
6.0-6.4
6.5-6.9
7.0-7.4
7.5-7.9
8.0-8.4
8.5-8.9
9.0-9.4
9.5-9.9
10.0-10.4
10.5-10.9
11.0-11.4
11.5-11.9
12.0-12.4
Length (in)



Length at Age of Yellow Perch in Black Otter Lake - Spring Survey 2005
Age (yr)
0
1
2
3
4
5
6
7
8
9
10
5.5-5.9
6.0-6.4
6.5-6.9
7.0-7.4
7.5-7.9
8.0-8.4
8.5-8.9
9.0-9.4
9.5-9.9
10.0-10.4
10.5-10.9
11.0-11.4
11.5-11.9
12.0-12.4
Length (in)


Length vs. Frequency of Northern Pike in Black Otter Lake
Spring Shocking and Netting Survey 2005
Frequency
0
1
2
3
4
5
6
15.0-16.9
17.0-18.9
19.0-20.9
21.0-22.9
23.0-24.9
25.0-26.9
Length (in)

Appendix B

Aquatic Plant Survey Data for Sept. 18, 2006

Entry	sampling point	Depth (ft)	Dominant sediment type (M)uck, (S)and, (R)ock	Sampled holding rake pole (P) or rake rope (R)?	*Ceratophyllum demersum* ,Coontail	*Chara* ,Muskgrasses	*Elodea canadensis* ,Common waterweed	*Lemna minor* ,Small duckweed	*Lemna trisulca* ,Forked duckweed	*Megalodonta beckii* ,Water marigold	*Myriophyllum spicatum* ,Eurasian water-milfoil	*Potamogeton crispus* ,Curly-leaf pondweed	*Potamogeton natans* ,Floating-leaf pondweed	*Potamogeton robbinsii* ,Robbins pondweed	*Stuckenia pectinata* ,Sago pondweed	*Typha latifolia* ,Broad-leaved cattail	Wolffia columbiana, Watermeal	Filamentous Algae
BLACK OTTER	1	7.8	M	R	3												1	1
OUTAGAMIE COUNTY	2	6.1	M	R	3												1	1
9/14/2006 - 9/18/2006	3	3.3	M	R	3		1										1	1
	4	7	M	R	2												1	1
ROBYN MC ALLISTER	5	8.6	M	R	2													
10/24/2006	6	6.2	M	R	3												1	
	7	4.8	M	R	3												1	1
	8	2.1	M	R	2						1						1	1
	9	5.2	M	R	3													
	10	9	M	R	1													
Species present not	11	8.3	M	R	1													
sampled:	12	6.9	M	R	1													
	13	1.7	M	R	3												1	1
	14	2.7	M	R	3						1						1	1
	15	5.7	M		3													
	16	8.2	M	R	2													
	17	8.6	M	R	2													1
	18	8.5	M	R	1													
	19	7.3	M		1													
	20	7.4	M	R	2												1	1
	21	4.4	M	R	2													1
	22	7.3	M		1													
	23	4.6	M	R	1													
	24	8.9	M		1												1	
	25	3.1	M	R	3						2						1	1
	26	3.3	M	R	2						1							1
	27	6.8	M	R	3													
	28	6.7	M	R	2						1							
	29	8.4	M	R	1													
	30	3.6	M	R	3												1	1
	31	1	M	R	2						1		1				1	1
	32	2.6	M	R	3						1							1
	33	2.7	M	R	2						1	1						1
	34	6.5	M	R	1													
	35	7	M		1													
	36	7.6	M		1													

Entry	sampling point	Depth (ft)	Dominant sediment type (M)uck, (S)and, (R)ock	Sampled holding rake pole (P) or rake rope (R)?	*Ceratophyllum demersum*, Coontail	*Chara*, Muskgrasses	*Elodea canadensis*, Common waterweed	*Lemna minor*, Small duckweed	*Lemna trisulca*, Forked duckweed	*Megalodonta beckii*, Water marigold	*Myriophyllum spicatum*, Eurasian water-milfoil	*Potamogeton crispus*, Curly-leaf pondweed	*Potamogeton natans*, Floating-leaf pondweed	*Potamogeton robbinsii*, Robbins pondweed	*Stuckenia pectinata*, Sago pondweed	*Typha latifolia*, Broad-leaved cattail	Wolffia columbiana, Watermeal	Filamentous Algae
	37	3.4	M		3												1	1
	38	1.5	M	R	2						1						1	1
	39	2.2	M	R	2						1							
	40	7.1	M	R	1		1					1						
	41	4.9	M	R	2						1							
	42	8.1	M	R	2						1							
	43	4	M	R	3													
	44	4.2	M	R	3												1	
	45	3.8	M		2												1	1
	46	2.1	M	R	1						2				1		1	1
	47	2	M	R	2		1				1				1		1	1
	48	2.5	M	R	2						1							1
	49	6.9	M	R	1													
	50	8.1	M	R	1													
	51	8.3	M	R	1													
	52	4.5	M	R	1													1
	53	7	M	R	1													1
	54	4.7	M	R	2													1
	55	1.4	M	R	3						1		1		1		1	1
	56	1.8	M	R	2		1				2						1	1
	57	2.1	M	R	2		1				2						1	1
	58	4	M	R	1													1
	59	4.8	M	R	1													
	60	8	M	R	3													
	61	11	M	R	1													
	62	4	M	R	3													1
	63	6	M	R	2		1				1							
	64	5.3	M	R	2		1											
	65	3.4	M	R	3												1	1
	66	2.9	M	R	3						1							
	67	5	M	R	3												1	
	68	0.5	M		1						1						1	1
	69	1.5	S	R	1						1						1	1
	70	2.2	M	R	2		1				2						1	
	71	4	M	R	1						1							1
	72	7.3	M	R	1													

Entry	sampling point	Depth (ft)	Dominant sediment type (M)uck, (S)and, (R)ock	Sampled holding rake pole (P) or rake rope (R)?	*Ceratophyllum demersum* ,Coontail	*Chara* ,Muskgrasses	*Elodea canadensis* ,Common waterweed	*Lemna minor* ,Small duckweed	*Lemna trisulca* ,Forked duckweed	*Megalodonta beckii* ,Water marigold	*Myriophyllum spicatum* ,Eurasian water-milfoil	*Potamogeton crispus* ,Curly-leaf pondweed	*Potamogeton natans* ,Floating-leaf pondweed	*Potamogeton robbinsii* ,Robbins pondweed	*Stuckenia pectinata* ,Sago pondweed	*Typha latifolia* ,Broad-leaved cattail	Wolffia columbiana, Watermeal	Filamentous Algae
	73	7.5	M	R	1													
	74	7.3	M		3						2							
	75	3.5	M	R	1						1							1
	76	6.7	M	R	1										1			
	77	4.9	M	R	2													
	78	4.7	M	R	2						1				1			
	79	6.8	M	R	3						1							1
	80	5.4	M	R	1													1
	81	4.3	M	R	3												1	
	82	1.2	M	R	1						2				1		1	1
	83	2.9	M	R	1						2				1		1	1
	84	2.5	M	R	1		2				2						1	1
	85	7	M	R	3						2							
	86	4.9	M	R	2						1							
	87	5.6	M	R	1													1
	88	3.9	M	R	2						1						1	1
	89	3.1	S	R	1						1							1
	90	3.3	S	R	1						1							1
	91	3.5	M	R	2													1
	92	3.3	M		2						2				1		1	
	93	6.2	M	R	3						1				1			
	94	4.3	M	R	2						1							
	95	1.8	M	R	2						2		1		1		1	
	96	2.4	M	R							1						1	1
	97	3	M	R	1						3						1	1
	98	5.4	M	R	1						2						1	1
	99	5.6	M	R	2						2						1	
	100	5.2	M	R	2						1							
	101	4.9	M	R	1													
	102	7.6	M	R	1													
	103	3.6	M		1	1					2						1	1
	104	4.6	M	R	2						1				1		1	1
	105	4.7	M		2						1						1	
	106	5.1	M	R	3						1				1		1	
	107	4.1	M		3						1							
	108	2.4	M	R	1						1						1	1

Entry	sampling point	Depth (ft)	Dominant sediment type (M)uck, (S)and, (R)ock	Sampled holding rake pole (P) or rake rope (R)?	*Ceratophyllum demersum* ,Coontail	*Chara* ,Muskgrasses	*Elodea canadensis* ,Common waterweed	*Lemna minor* ,Small duckweed	*Lemna trisulca* ,Forked duckweed	*Megalodonta beckii* ,Water marigold	*Myriophyllum spicatum* ,Eurasian water-milfoil	*Potamogeton crispus* ,Curly-leaf pondweed	*Potamogeton natans* ,Floating-leaf pondweed	*Potamogeton robbinsii* ,Robbins pondweed	*Stuckenia pectinata* ,Sago pondweed	*Typha latifolia* ,Broad-leaved cattail	Wolffia columbiana, Watermeal	Filamentous Algae
	109	1.2	S	R	1						1		1				1	
	110	1.9	M	R	2						2						1	1
	111	2.3	M	R	2						1		1				1	1
	112	3.4	M		2		1				1						1	1
	113	8.7	M		1													
	114	7.2	M	R	1													
	115	5.5	M		2													
	116	3.9	M	R	3						2						1	
	117	2.8	M	R	1	1					2						1	1
	118	4.1	M	R	3						1						1	
	119	3.4	M	R	1						2						1	
	120	5.1	M	R	1						2						1	
	121	4.3	M	R	1						1						1	
	122	3.1	M	R	1						1						1	1
	123	2	M	R	2		1				1				1		1	
	124	2.7	M	R	3						1						1	
	125	5.6	M	R	3						1						1	
	126	6.8	M	R	1		1											
	127	3.8	M	R	1						1							
	128	3.4	M	R	1						2		1		1		1	
	129	2	M	R	2						2				1			
	130	1	S								1				1		1	1
	131	1.8	M	R	1						1						1	1
	132	3	M		2						1						1	1
	133	4.7	M	R	2						1						1	
	134	4.1	M	R	1						1						1	1
	135	4.4	M	R	1													
	136	1	M	R	1			1			1						1	1
	137	1.8	M	R	1						1				1		1	
	138	2.2	M	R	2						1						1	1
	139	2.1	M	R	1												1	
	140	3.7	M	R	2						1						1	
	141	2.4	M	R	2						2		1		1		1	
	142	1	M	R	1						1		V				1	1
	143	1	M	R	1		1				1				1		1	1
	144	1.4		R	1						2						1	1

Entry	sampling point	Depth (ft)	Dominant sediment type (M)uck, (S)and, (R)ock	Sampled holding rake pole (P) or rake rope (R)?	*Ceratophyllum demersum* ,Coontail	*Chara* ,Muskgrasses	*Elodea canadensis* ,Common waterweed	*Lemna minor* ,Small duckweed	*Lemna trisulca* ,Forked duckweed	*Megalodonta beckii* ,Water marigold	*Myriophyllum spicatum* ,Eurasian water-milfoil	*Potamogeton crispus* ,Curly-leaf pondweed	*Potamogeton natans* ,Floating-leaf pondweed	*Potamogeton robbinsii* ,Robbins pondweed	*Stuckenia pectinata* ,Sago pondweed	*Typha latifolia* ,Broad-leaved cattail	Wolffia columbiana, Watermeal	Filamentous Algae
	145	2.5		R	3						2						1	1
	146	3.7		R	3						1							1
	147	5.1		R	3						2							1
	148	4.1		R	3						1						1	1
	149	1.8	M	R	1			1			1						1	1
	150	4.7	M	R	1		1				1						1	
	151	6.5	M	R	1													
	152	4	M	R	3						2		1	1			1	1
	153	2.1	M	R	2		1				1		1	1			1	1
	154	2	M	R		1					1		1	1	1		1	
	155	1.7	M	R	1						1						1	1
	156	3		R	1						2				1	1	1	1
	157	3		R	2						1							1
	158	5.3		R	2						2						1	1
	159	4.3		R	2						1						1	1
	160	1.1	M	R	2		1									1	1	
	161	1	M	R	1		1	1	1							1	1	1
	162	2.6	M	R	1		1	1	1								1	1
	163	3.6	M	R														
	164	3.4	M		1		1											
	165	6.3	M	R	3		1										1	
	166	7.7	M	R	2		1				2						1	1
	167	2.2	M	R	3						1		1	1			1	
	168	2	M	R	2			1			1				1		1	1
	169	2.4	M	R	1						2		1				1	1
	170	2.7	M	R	2						1		1				1	1
	171	2.8	M	R	2						2		1					1
	172	3.1	M	R	1												1	1
	173	1	M	R	2			1			1						1	1
	174	1	M	R	2		1				1						1	1
	175	1	M	R	2		1	1			1						V	1
	176	3.4	M	R	3			1									1	1
	177	3.9	M	R	3			1			1						1	1
	178	4.1	M	R	3			1			1						1	1
	179	4.2	M	R	3						1						1	
	180	2.8	M	R	2						1		1				1	1

Entry	sampling point	Depth (ft)	Dominant sediment type (M)uck, (S)and, (R)ock	Sampled holding rake pole (P) or rake rope (R)?	*Ceratophyllum demersum* ,Coontail	*Chara* ,Muskgrasses	*Elodea canadensis* ,Common waterweed	*Lemna minor* ,Small duckweed	*Lemna trisulca* ,Forked duckweed	*Megalodonta beckii* ,Water marigold	*Myriophyllum spicatum* ,Eurasian water-milfoil	*Potamogeton crispus* ,Curly-leaf pondweed	*Potamogeton natans* ,Floating-leaf pondweed	*Potamogeton robbinsii* ,Robbins pondweed	*Stuckenia pectinata* ,Sago pondweed	*Typha latifolia* ,Broad-leaved cattail	Wolffia columbiana, Watermeal	Filamentous Algae
	181	2.7	M	R	2						2						1	1
	182	1.7	M	R	3						2						1	1
	183	2.4	M	R	1			1			1					1	1	1
	184	3.3	M	R	2			1			2		1				1	1
	185	4.2	M	R	1						1							1
	186	5.1	M	R	2			1			1		1				1	1
	187	2.9	M	R	1			1									1	1
	188	1.2	M	R	2			1			1						1	1
	189	1.1	M	R	1		1	1			1						1	1
	190	1	M	R	1			1			1		1		1		V	1
	191	1.1	M	R	2		1	1			1						V	1
	192	1.3	M	R	1			1			1						1	1
Not navigable	193																	
Not navigable	194																	
Not navigable	195																	
	196	1.9	M	R	3						2						1	1
	197	1.9	M	R	3		1				1						1	
	198	2.4	M	R	2						1						1	
	199	2	M		2						1		1				1	1
	200	2.3	M	R	2						1		1		1		1	1
	201	5.8	M	R	3						1							
	202	8.5	M	R	1													
	203	4.6	M	R	2						1							
	204	2.3	M	R	1			1									1	
	205	1.9	M	R	3			1			1						1	1
	206	1.8	M	R	3			1			1						1	1
	207	1.1	M	R	3		1			1	1						1	1
	208	1.5	M	R	2		1	1		1	1						1	1
	209	1	M		3			1		1	1				1		1	1
	210	1.1	M	R	1		1	1		1	1				1		1	1
Not navigable	211																	
Not navigable	212																	
Not navigable	213																	
Not navigable	214																	
Not navigable	215																	
	216	2	M	R	3						1						1	

Entry	sampling point	Depth (ft)	Dominant sediment type (M)uck, (S)and, (R)ock	Sampled holding rake pole (P) or rake rope (R)?	*Ceratophyllum demersum* ,Coontail	*Chara* ,Muskgrasses	*Elodea canadensis* ,Common waterweed	*Lemna minor* ,Small duckweed	*Lemna trisulca* ,Forked duckweed	*Megalodonta beckii* ,Water marigold	*Myriophyllum spicatum* ,Eurasian water-milfoil	*Potamogeton crispus* ,Curly-leaf pondweed	*Potamogeton natans* ,Floating-leaf pondweed	*Potamogeton robbinsii* ,Robbins pondweed	*Stuckenia pectinata* ,Sago pondweed	*Typha latifolia* ,Broad-leaved cattail	Wolffia columbiana, Watermeal	Filamentous Algae
	217	3.3	M	R	3						1						1	1
	218	1.7	M		3						1		1		1		1	
	219	2.1	M		2						1		1				1	1
	220	7.9	M		1													
	221	7.7	M	R	1													1
	222	6.3	M	R	2			1			1							
	223	3.3	M	R	2			1			1				1		1	1
	224	1.4	M	R	3			1			1						1	1
	225	1.9	M	R	2		1	1			1						1	1
	226	1.4	M	R	1						1						1	1
	227	1.2	M	R	3		1										1	1
	228	1.4	M		1		1	1		1	1						1	1
	229	1	M	R	1		1	1			1						1	1
Not navigable	230																	
Not navigable	231																	
Not navigable	232																	
Not navigable	233																	
	234	1.7	M	R	2						1						1	1
	235	3.2	M	R	3						1		1				1	
	236	1.4	M	R	2						1						1	1
	237	1.8	M	R	1			1			1				1		1	1
	238	2.2	M	R	2						1		1				1	1
	239	2.6	M	R	1						1		1		1		1	1
	240	3.7	M	R	1			1			1							1
	241	3.9	M	R	2			1			1				1		1	1
	242	2	M	R	3										1		1	1
	243	1.2	M	R	2			1									1	1
	244	1.2	M	R	1			1			1						1	1
	245	2.2	M	R	3			1									1	1
	246	2	M	R	2			1			1						1	1
	247	2.1	M	R	2			1									1	1
Not navigable	248																	
Not navigable	249																	
Not navigable	250																	
	251	3.2	M	R	3		1				1						1	1
	252	3.1	M	R	3						1		1				1	

Entry	sampling point	Depth (ft)	Dominant sediment type (M)uck, (S)and, (R)ock	Sampled holding rake pole (P) or rake rope (R)?	*Ceratophyllum demersum* ,Coontail	*Chara* ,Muskgrasses	*Elodea canadensis* ,Common waterweed	*Lemna minor* ,Small duckweed	*Lemna trisulca* ,Forked duckweed	*Megalodonta beckii* ,Water marigold	*Myriophyllum spicatum* ,Eurasian water-milfoil	*Potamogeton crispus* ,Curly-leaf pondweed	*Potamogeton natans* ,Floating-leaf pondweed	*Potamogeton robbinsii* ,Robbins pondweed	*Stuckenia pectinata* ,Sago pondweed	*Typha latifolia* ,Broad-leaved cattail	Wolffia columbiana, Watermeal	Filamentous Algae
	253	2.6	M	R				1			1						1	1
	254	3.7	M	R	2						1						1	1
	255	2.2	M	R	3			1			1						1	1
	256	3.8	M	R	3												1	1
	257	1.6	M	R	3			1			1						1	1
	258	1.2	M	R	1			1					1				V	1
	259	2	M	R	1			1			1						1	1
	260	3.1	M	R	1			1			1						1	1
	261	1	M	R	3			1			1						1	1
	262	1.5	M	R	1		1				1						1	1
	263	2.9	M		3						1				1		1	1
	264	2.7	M	R	3						1						1	1
	265	1.8	M	R	1			1			1						1	
	266	5.7	M	R	1						1						1	
	267	4.5	M	R	2						1							1
	268	5	M	R	1			1			1						1	1
	269	1.5	M	R	2			1									1	1
	270	3.1	M	R	1													1
	271	2.1	M	R	2			1			1						1	
	272	1.6	M	R	2			1			1						1	
	273	1.1	M	R	1		1	1			1						1	1
	274	1.1		R	3			1			1						1	1
	275	1.4		R	3			1			1						1	1
	276	1		R	3			1			1						1	1
	277	2	M	R	2						1						1	1
	278	2.1	M	R	1						1							1
	279	2.7	M	R	1			1			1							1
	280	4.5	M	R	2			1			1							
Not navigable	281			R														
Not navigable	282			R														
Not navigable	283			R														
Not navigable	284			R														

Appendix C

The Importance of Aquatic Plants

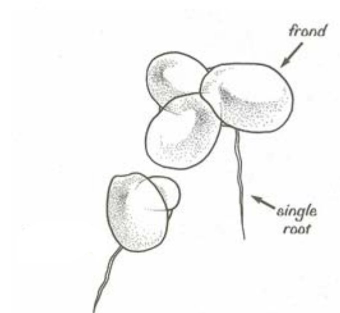
The Importance of Aquatic Plants

Plant information was gathered from Borman et al. (1997), Eggers and Reed (1997), Fasset (1940), Fink (1994), Nichols and Vennie (1991), and Whitley et al. (1999). Images obtained from Schmidt and Kannenberg (1998) and Borman et al. (1997).

The following are descriptions of the most commonly found native aquatic plants found in Black Otter Lake at the time of the survey.

Coontail *(Ceratophyllum demersum)* produces whorls of narrow, toothed leaves on a long trailing stem that often resembles the tail of a raccoon. The leaves tend to be more crowded toward the tip. Coontail blankets the bottom, which helps to stabilize bottom sediments. Tolerant to nutrient rich environments, coontail filters a high amount of phosphorus out of the water column. Coontail provides a home for invertebrates and juvenile fish. Seeds are consumed by waterfowl, but are not of high preference.

Duckweeds are is among the world's smallest vascular plants. Individual plants are tiny, round, and bright green disks, with or without roots. In lakes, they are found scattered among emergent plants or massed together in floating mats. Duckweeds are also commonly found in stagnant waters. Duckweed can occur as single plants or multiple plants may be connected. They provide food for fish and waterfowl and habitat for aquatic invertebrates.



Common waterweed (*Elodea canadensis*) is made up of slender stems with small, lance-shaped leaves that attach directly to the stem. Leaves are found in whorls of two or three and are more crowded toward the stem tip. The branching stems of elodea provide valuable cover for fish and are home for many insects that fish feed upon. Elodea also provides food for muskrats and waterfowl.

Sago Pondweed (*Potamogeton pectinatus*) is a perennial herb that emerges from a slender rhizome that contains many starchy tubers. Leaves are sharp, thin, and resemble a pine needle. Reddish nutlets (seeds) that resemble beads on a string rise to the water surface in mid-summer. Sago pondweed produces a large crop of seeds and tubers that are valued by waterfowl. Juvenile fish and invertebrates utilize sago pondweed for cover.

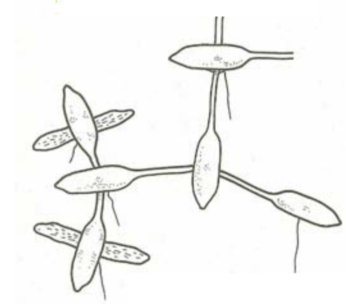
Floating Leaf Pondweed (*Potamogeton natans*) is a perennial that emerges from a red-spotted rhizome. Leaves that rest at the waters surface are heart shaped. Submerged leaves tend to be longer and skinnier than floating leaves. Fish find this pondweed to be useful for foraging opportunities and shelter. Growing upright in the water column, floating leaf pondweed attracts many aquatic invertebrates. Muskrats, ducks, and geese all graze on the plant.

Robbins Pondweed (*Potamogeton robbinsii*), also known as **fern pondweed**, is a stiff, robust plant that produces only underwater leaves. It is usually dark-green with flat closely spaced leaves pointing away from the stem on two sides, thereby giving it the appearance of a fern. Leaf bases form a sheath around the stems and may have stipules present on new leaves. Fern pondweed is also able to stabilize bottom sediments. Fern pondweed is known to provide habitat for small aquatic animals used as food by predator fishes, especially northern pike. Seeds and vegetation provide food for aquatic animals and waterfowl.

Broad-Leaved Cattail (*Typha latifolia*) emerges from a robust spreading rhizome. This perennial herb has pale green, sword-like leaves that grow up to 9 ft. tall. The male and female flowers grow on the same spike and there's no gap between them. Cattails provide cover and or food for a variety of wildlife including muskrats, black birds, marsh wrens, and waterfowl. Deer and pheasants also seek cattail stands for winter cover. Cattails serve as a home to many invertebrates and are an important spawning habitat for fish. With a network of large rhizomes, cattails also are sturdy shoreline stabilizers.

Musk grass (*Chara* spp.) is a complex algae that resembles a higher plant. It's identified by its pungent, skunk-like odor and whorls of toothed branched leaves. Ecologically, musk grass provides shelter for juvenile fish and is associated with black crappie spawning sites. Waterfowl love to feast on musk grass when the plant bears its seed-like oogonia. This species serves an important role in stabilizing bottom sediments, tying up nutrients in the water column, and maintaining water clarity.

Star Duckweed (*Lemna trisulca*) individuals are called fronds. Each frond consists of a small, green, floating body with a single root that extends into the water from the undersurface, but is not rooted to the soil. Star duckweed can grow rapidly, reproducing not by seeds, but by simple division of a frond to produce new "daughter" fronds. The developing daughter fronds remain attached to the "mother" frond for a short time as shown above, but eventually break apart. Star duckweed is a good food sources for waterfowl. Large amounts of star duckweed can provide cover and habitat for fish and invertebrates.



Emergent Aquatic Plants

The following are descriptions of the emergent plant species recommended for planting/restoration purposes in Black Otter Lake.

Common Arrowhead (*Sagittaria latifolia*) also known as duck potato is a perennial herb that is a very common shoreline plant. As its' name implies, leaves are shaped like an arrowhead. The leaves vary greatly in size and shape. Common arrowhead produces small white flowers made up of three rounded petals. Ecologically, duck potato is considered one of the highest valued aquatic plants for wildlife. The high-energy tubers and seeds are relished by a variety of wildlife, including several species of waterfowl. Arrowhead stands provide rearing habitat for fish and help aid in shoreline stabilization.

Common Bur-reed (*Sparganium eurycarpum*) is a perennial herb that tends to grow in shallow waters. This emergent has sword-like leaves that resemble a compressed triangle in cross section and grow 2-4 feet. Bur-reed produces a large seed crop that is consumed by a variety of waterfowl. Like bulrush, bur-reed provides excellent habitat for nesting birds and important habitat for fish. Common bur-reed also anchors bottom sediment and offers nutrient filtering capabilities.

Softstem Bulrush (*Schoenoplectus tabernaemontani*), and **River Bulrush** (*Bolboschoenus fluviatilis*) are common perennial pond and lake colonizers that can grow in water up to 5 feet. Softstem bulrush supports long cylindrical leaves that grow 3-8 feet high. Bulrushes provide important spawning, nursery, and foraging habitat for fish and waterfowl. Bulrush species are also very effective at taking up nutrients and stabilizing shorelines.

Pickerel Plant (*Pontederia cordata*) is an ornamental perennial that can grow in water up to 3 feet deep. Pickerel plant is made up of glossy, heart shaped leaves and a showy violet blue flower spike. The colorful flower stalk serves as a nectar source and home for many beneficial insects. Pickerel plant also offers exceptional habitat for both adult and juvenile fish. The robust leaves and rhizomes play a key role in shoreline stabilization and help buffer wave action.

Yellow Water Lily (*Nuphar variegata*) also known as spatterdock is a perennial herb that produces yellow, rounded flowers. Large (4-10 inches) long, heart-shaped leaves float at the waters surface. Spatterdock prefers soft sediment and can grow in water up to 6 feet deep. With large buried rhizomes, spatterdock helps stabilize bottom sediment. The large leaves also help buffer the impact of wave action on the shoreline. Spatterdock offers excellent fish habitat. Seeds are eaten by waterfowl; leaves, rhizomes, and flowers are relished by beaver, moose, and deer.

Water Plantain (*Alisma subcordatum*) is a common shoreline colonizer that grows well on exposed mud flats in water less than 1 foot deep. Water plantain is a perennial herb that supports broad, flat leaves that grow 1-2 feet high. Tiny white flowers are spread out on a highly branched flower stalk. Like arrowhead, water plantain has many ecological values. The sturdy flower stalk offers a popular perch for songbirds and insects. A variety of waterfowl consume both tubers and nutlets. Water plantain also provides juvenile fish rearing habitat and shoreline buffering.

Wild Rice *(Zizania aquatica)* is an annual emergent grass that grows from seed each year. Flower stalks rise up to 9 feet tall. Wild Rice can grow in waters up to 3 feet deep. Rice establishes best in clear, shallow moving waters that have a mucky substrate. Ecologically, wild rice is prized by an array of wildlife. A variety of waterfowl, shorebirds, and songbirds relish the large seeds. Muskrats use the robust stems for lodge building and as a food source. Wild rice beds also provide spawning habitat for fish and help stabilize bottom sediment.

Wild Celery (*Vallisneria americana*) also known as eel-grass has long ribbon-like leaves that emerge in clusters. Leaves have a prominate central stripe and leave tips tend to float gracefully at the water's surface. In the fall, a vegetative portion of the rhizome will break free and float to other locations. Water Celery is considered one of the best all natural waterfowl foods. The entire plant is relished by waterfowl, especially canvasbacks. Eel-grass beds serve as an important food source for sea ducks, marsh birds, and shore birds. Fish utilize water celery for cover.

Appendix D

Threat of Exotic Aquatic Species to Black Otter Lake

Exotic Species

Both Eurasian watermilfoil and curly-leaf pondweed currently infest Black Otter Lake. As a result, it is important that members of the Black Otter Lake District familiarize themselves with the threats posed by these and other invasive species. The following descriptions are given to promote awareness of exotic species.

Eurasian Watermilfoil

Eurasian watermilfoil (*Myriophyllum spicatum*) produces long spaghetti-like stems that often grow up to the water's surface. Leaves are feather-like and resemble bones on a fish. 3-5 leaves are arranged in whorls around the stem, and each leaf contains 12-21 pairs of leaflets. At mid-summer small reddish flower spikes may emerge above the water's surface. Perhaps the most distinguishing characteristic though, is the plant's ability to form dense, impenetrable beds that inhibit boating, swimming, fishing, and hunting.

Eurasian watermilfoil is native to Europe, Asia and Northern Africa. Of the eight milfoil (*Myriophyllum*) species found in Wisconsin, Eurasian watermilfoil is the only exotic. The plant was first introduced into U.S. waters in 1940. By 1960, it had reached Wisconsin's lakes. Since then, its expansion has been exponential (Brakken, 2000).

Eurasian watermilfoil begins growing earlier than native plants, giving it a competitive advantage. The dense surface mats formed by the plant block sunlight and have been found to displace nearly all native submergent plants. Over 200 studies link declines in native plants with increases in Eurasian watermilfoil (Madsen, 2001). The resultant loss of plant diversity degrades fishery habitat (Pullman, 1993), and reduces foraging opportunities for waterfowl and aquatic mammals. Eurasian watermilfoil has been found to reduce predatory success of fish such as largemouth bass (Engel, 1985), and spawning success for trout (*Salmonidae spp.*) (Newroth, 1985).

The continued spread of Eurasian watermilfoil can produce significant economic consequences. In the Truckee River Watershed below Lake Tahoe, located in western Nevada and northeastern California, economic damages caused by Eurasian watermilfoil to the recreation industry have been projected at $30 to $45 million annually (Eiswerth et al., 2003). In Tennessee Valley Authority Reservoirs, Eurasian watermilfoil was found to depress real estate values, stop recreational activities, clog municipal and industrial water intakes and increase mosquito breeding (Smith, 1971).

Eurasian watermilfoil has been found to reduce water quality in lakes by several means. Dense mats of Eurasian watermilfoil have been found to alter temperature and oxygen profiles – producing anoxic conditions in bottom water layers (Unmuth et al., 2000). These anoxic conditions can cause localized die-offs of mollusks and other invertebrates. Eurasian watermilfoil has also been found to increase phosphorus concentration in lakes through accelerated internal nutrient cycling (Smith and Adams, 1986). Increased phosphorus concentrations released by dead and dying Eurasian watermilfoil have been linked to algae blooms and reduced water clarity.

Eurasian Watermilfoil Management Options

Historically, management of Eurasian watermilfoil has included mechanical, biological, and chemical means. It is important to consider each of these control measures before management efforts on any water body are undertaken. After weighing the pros and cons of each option, the wisest course of action should be chosen.

Hand pulling

Hand pulling of Eurasian watermilfoil is a useful tool when the extent of milfoil occurs at very low frequencies. For this method to be successful care must be taken to remove the entire root mass along with the plant or else it will quickly regenerate. When a high occurrence and wide distribution of Eurasian watermilfoil occurs, this method is impractical as a lake-wide control option at this time. However, if other management options are successful in reducing Eurasian watermilfoil to a sparse distribution, this option should be reconsidered. This is still a viable option for riparian property owners. Without obtaining a permit, individuals can hand pull aquatic plants in a 30-foot strip along their property extending out as far as necessary. If *exotic* plants are singled out for hand removal, there are no restrictions on the extent of hand-pulling. If large amounts of milfoil are present, it will be labor intensive. If individuals choose to hand pull, care should be taken to properly identify Eurasian watermilfoil and minimize its fragmentation.

Mechanical harvesting

Mechanical control methods include hand cutters and boat-mounted mechanical weed harvesters (Nichols, 1974). While these methods provide temporary nuisance relief, they are rarely recommended as control methods for Eurasian watermilfoil. Eurasian watermilfoil can reproduce effectively through fragmentation (Borman et al. 1997). Free-floating plant matter left from cutting operations can spread quickly and encourage additional infestations within the lake or in neighboring lakes. When Eurasian watermilfoil is present, harvesting of native plants in areas of infestation should be suspended until additional control efforts are implemented to remove the milfoil.

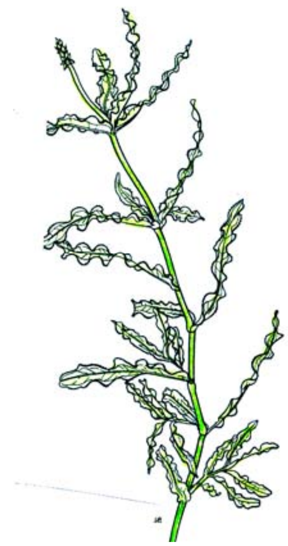
Although harvesting does remove plant matter, a source of nutrients to the lake, it is unlikely that harvesting will induce a shift back to a native plant-dominated community. It is not recommended that Eurasian watermilfoil be controlled long-term through mechanical harvesting.

Milfoil weevils

There has been considerable research on biological vectors, such as insects, and their ability to affect a decline in Eurasian watermilfoil populations. Of these, the milfoil weevil (*Euhrychiopsis lecontei*) has received the most attention. Native milfoil weevil populations have been associated with declines in Eurasian watermilfoil in natural lakes in Vermont (Creed and Sheldon, 1995), New York (Johnson et al., 2000) and Wisconsin (Lilie, 2000). While numerous lakes have attempted stocking milfoil weevils in hopes of controlling milfoil in a more natural manner, this method has not proven successful in Wisconsin. A twelve-lake study called “The Wisconsin Milfoil Weevil Project” (Jester et al. 1999) conducted by the University of Wisconsin, Stevens Point in conjunction with the Wisconsin DNR researched the efficacy of weevil stocking. This report concluded that milfoil weevil densities were not elevated, and that Eurasian watermilfoil was unaffected by weevil stocking in any of the study lakes. Recently, however, work carried out on a number of Portage County lakes has shown some promise at enhancing milfoil weevil populations. In order for weevils to be successful in reducing the extent of Eurasian watermilfoil, a number of environmental criteria are needed, including the availability of proper year-round habitat. In the event of milfoil infestation, a survey of existing weevils should be conducted to determine the likelihood of success if weevils were chosen as a management tool. Until more evidence that suggests weevil stocking is an effective control agent for Eurasian watermilfoil, this method should be discouraged as a control option for most lakes.

Herbicides
Herbicides have been the most widely used and often most successful tools for controlling Eurasian watermilfoil. The two herbicide groups most commonly employed are fluridone (Avast®, Sonar®) and 2,4-D (Aquacide®, Aquakleen®, Navigate®, and Weedar 64®). Whole-lake fluridone treatments have been conducted on several Wisconsin Lakes. While initial results were encouraging (species selectivity, 95-100% initial control), continued monitoring found that desired long-term control was not achieved (Cason, 2002). In addition, for fluridone to be most effective, a relatively long contact time is needed. 2,4-D herbicides, on the other hand, have been very effective at controlling Eurasian watermilfoil in hundreds of Wisconsin lakes. 2,4-D is a herbicide which rapidly breaks down and does not persist in the environment. When applied at labeled rates, 2,4-D has been shown to be an effective tool at selectively controlling Eurasian watermilfoil.

Curly-leaf Pondweed



Curly-leaf pondweed (*Potamogeton crispus*) has oblong leaves that are 2-4 inches long and attach to a slightly flattened stem in an alternate pattern. The most distinguishing characteristics are the curled appearance of the leaves, and the serrated leaf edges. Curly-leaf pondweed also produces a seed-like turion, which resembles a miniature pinecone. Curly-leaf pondweed produces turions in early summer allowing the plant to regenerate annually. Turion production begins when water temperatures reach into the 60's.

This exotic pondweed is a cold-water specialist. Curly-leaf pondweed can begin growing under the ice, giving it a competitive advantage over native plants, which are still lying dormant. By mid-summer when water temperatures reach the upper 70° F range, it begins to die off.

Curly-leaf pondweed has been found in the U.S. since at least 1910. A native of Europe, Asia, Africa and Australia, this plant is now found throughout much of U.S. (Baumann et al., 2000).

As with Eurasian watermilfoil, curly-leaf pondweeds aggressive early season growth allows it to out compete native species and grow to nuisance levels. Because the plant dies back during the peak of the growing season for other plants though, it is better able to coexist with native species than Eurasian watermilfoil. Perhaps the most significant problem associated with curly-leaf pondweed involves internal nutrient cycling. The die-off and decomposition of the plant during the warmest time of year often leads to a sudden nutrient release in the water. This often leads to nuisance algae blooms and poor water quality.

Curly-leaf Pondweed Management Options

Curly-leaf pondweed has primarily been managed through mechanical and chemical means.

Hand pulling
As with Eurasian watermilfoil, this method may be appropriate for riparian property owner. Hand pulling is most effective when curly-leaf pondweed is discovered in its pioneering stage. If it has existed long enough to produce turions, hand pulling may become a long-term, labor-intensive process. To be most effective, as with other curly-leaf pondweed control options, early response is recommended.

Mechanical harvesting and cutting
Both mechanical harvesting and hand cutting are commonly used to control curly-leaf pondweed. Cutting the plant provides temporary nuisance relief and may increase recreational opportunities on the lake. And although harvesting may not encourage dispersal of the plant, as it does with Eurasian watermilfoil, it is unlikely to provide any long-term control.

Herbicides
The herbicide most often used to control curly-leaf pondweed is Aquathol®. Aquathol® is an endothall salt-based herbicide which also rapidly breaks down. While endothall herbicides are effective on a broad range of aquatic monocots, early season applications made at low rates are highly species-selective for curly-leaf pondweed. While herbicides effectively kill the parent plant, the turions are resistant to herbicides, allowing curly-leaf pondweed to regenerate annually.

Studies conducted by the Army Corps of Engineers have found that conducting treatments of curly-leaf pondweed using Aquathol® when water temperatures are in the 50-60° F range will kill plants before turions form, thus providing long-term control. Researchers found that conducting two or more treatments over consecutive seasons for established curly-leaf pondweed populations will target both the standing crop of the pondweed as well as the resulting regrowth from the turions (Skogerboe and Poovey, 2002). These findings make Aquathol® the tool of choice for controlling curly-leaf pondweed in the lakes of Wisconsin.

Purple Loosestrife

Purple loosestrife (*Lythrum salicaria*) forms bright purple flowers in a spike atop stems that reach 2 to 7 feet in height. Lance-shaped leaves are arranged oppositely along the stem. Purple loosestrife can be found in a wide variety of habitats from shallow water to moist soils. Like Eurasian watermilfoil it is a very aggressive plant that can displace many native wetland plants including cattails (*Typha spp.*). Purple loosestrife plants produce hundreds of thousands of tiny seeds. When purple loosestrife is cut, seeds stick to mowing equipment and are spread to new locations. This invasive plant causes significant economic damage by clogging waterways and irrigation canals. Unlike cattails, purple loosestrife has little food or cover value for wildlife (Borman et. al. 1997).

Purple Loosestrife Management Options

Although purple loosestrife has not been introduced to Black otter Lake, the District and individual property owners should still be aware of control options to stop the spread of this exotic in the State. There are several methods that are commonly used for purple loosestrife control including digging or hand pulling, cutting, herbicide treatments and biological controls.

Manual removal
Digging and hand pulling are most effective for small infestations. Individual property owners are encouraged to use this method if they are able. Cutting involves removal and destruction of flowers and seed heads to inhibit plant propagation. Since cut plants tend to re-grow and since seeds present in the soils can sprout new plants, this method may need to be done for a number of years before desired control is achieved.

Herbicides
Herbicide treatments are the least labor intensive of methods. The preferred herbicide is glyphosate (Eagre®, Rodeo®). This compound rapidly biodegrades upon contact with soil or water. As a result, there are no water use restrictions following treatment. Because it is non-selective, each individual plant must be sprayed, as opposed to broadcast applications. Glyphosate is extremely effective in controlling purple loosestrife at a very low cost of treatment. The biggest disadvantage is that seeds in the soil will sprout new plants, requiring annual treatments for a number of years before desired control is achieved. A DNR permit is required for treatment; however the fee is waived. This option should be considered if the distribution of purple loosestrife increases significantly.

Loosestrife beetles
Two species of leaf-eating beetles (*Galerucella calmariensis* and *G. pusilla*) are currently available from the Wisconsin DNR in an effort to control purple loosestrife by biological means. Research has shown that these insects are almost exclusively dependent upon purple loosestrife and do not threaten native plants. Although, as with most biological control agents, these insects will not eradicate loosestrife, but may significantly weaken the population and allow native

species to reclaim infested areas. According to the WDNR, tests have shown significant declines in loosestrife as a result of biological control. The District should consider using biological control for loosestrife. The purple loosestrife control program established through the DNR provides a parent stock of beetles to individuals who are willing to raise the insects in a controlled environment until they are able to reproduce. Once the young have matured, they are released and are able to begin control of the purple loosestrife. As with other exotic plant control project, annual monitoring should be employed to assess the success of control measures. If significant progress is not made, alternative management options can be considered to control purple loosestrife.

Zebra Mussels

Zebra mussels (*Dreissena polymorpha*) are small (1/4" to 2") mollusks with elongated shells marked by alternating light and dark markings. They produce dense elastic strands, called byssal threads, by which they can securely attach to nearly any surface, often forming barnacle-like incrustations. Mussels spawn in the early spring when water temperatures reach 54º F. Fertilized eggs develop into microscopic free-swimming larvae called veligers. After three to four weeks, the surviving veligers settle onto firm objects where they quickly attach themselves. Within a year the young grow into adults that can live four to six years.

Zebra mussels were introduced to the Great Lakes region in the late 1980s through discharged ballast water of ships traveling the Saint Lawrence Seaway. These ships originated from European ports. Zebra mussels are native to the Ukraine and Russia near the Black and Caspian Seas. Since the 1700s zebra mussels have spread throughout European river systems.

Although zebra mussels do not cause much harm to the surrounding environment, they can negatively impact recreation and business by clogging water intake pipes, encrust boat hulls and piers, and wash up on beaches.

Zebra Mussel Management Options

Currently there is no lake-wide control option that isn't deadly to other aquatic life forms. In some areas of Europe and Lake Erie large populations of diving ducks have been shown to significantly decrease the population of zebra mussels each year. However, given the zebra mussel's high reproductive capacity, populations are able to recover each summer. In addition, diving duck populations in the Great Lakes region are low since they are only prevalent in the region during winter and summer migrations.

A number of fish species have been known to feed on zebra mussels. These include the freshwater drum, round goby, yellow perch, catfish, and carp. Certain fish species will feed on the adults while others eat the free-swimming juveniles. Although fish predation occurs, it is not significant enough to significantly decrease zebra mussel populations.

In recent years scientists have noted that native freshwater sponges in Lake Michigan appear to be increasing in number and attaching themselves to zebra mussels. In doing so, the sponges can kill the zebra mussels by cutting off the mussel's food and water supply.

Some success has been achieved by manually removing mussels from a lake. Although this method can dramatically reduce populations, it does not eradicate the mussels. In addition, it should be noted that this option is also very labor intensive.

Appendix E

Managing Sediments and Water Quality in Black Otter Lake

Protecting Lake Water Quality

Elevated nutrient inputs from human activities around Black Otter Lake can adversely affect both water clarity and water quality as well as contribute to sediment accumulation. A number of practices can be carried out to improve conditions in the lake. The most significant contributions of nutrients to Black Otter Lake are likely from direct runoff from areas closest to the lake. The following are options for water quality enhancement which both the District as a whole and individual lakefront property owners can undertake to improve Black Otter Lake.

Nutrient Management Options

The first steps taken in managing nutrients in a lake should be to control external sources of nutrients. These can include: encouraging the use of phosphorus-free fertilizers; improving agricultural practices, reducing run-off, and restoring vegetation buffers around waterways.

Lawn care practices
Individuals can play a large part in reducing nutrient inputs and sedimentation from local sources. Mowed grass up to the water's edge is a poor choice for the well being of the lake. Studies show that a mowed lawn can cause 7 times the amount of phosphorus and 18 times the amount of sediment to enter a water body than an area of land with naturally occurring vegetation (Korth and Dudiak, 2003). Lawn grasses also tend to have shallow root systems that cannot protect the shoreline as well as deeper-rooted native vegetation (Henderson et al., 1998).

Property owners within the District should take care to keep leaves and grass clippings out of the streets and away from storm drains and the channels themselves. Storm drains should not be used to dispose of used motor oil, antifreeze, paints, etc. The use of chemicals should be minimized in yards. If chemicals are to be used, paved areas such as sidewalks and driveways should be swept, not washed to avoid flushing chemical into the storm sewer.

Landowners living in close proximity to the water, in particular, those with shoreline property, should be discouraged from using lawn fertilizers. Fertilizers contain nutrients, including phosphorus and nitrogen which can wash directly into the lake. While elevated levels of phosphorus can cause unsightly algae blooms, nitrogen inputs have been shown to increase weed growth. Increases in plant biomass will lead to further sedimentation. Landowners are encouraged to perform a soil test before fertilizing. A soil test will help determine if you need to fertilize, and give you direction on fertilizing. For assistance in having your soil tested, contact your county UW-Extension office. If there is a need to fertilize a lawn, use a fertilizer that does not include phosphorus . Most lawns in Wisconsin don't need additional phosphorus. The numbers on a bag of fertilizer are the percentages of available nitrogen, phosphorus and potassium found in the bag. Phosphorus free fertilizers will have a 0 for the middle number (e.g. 10-0-3).

To further reduce nutrient loading, avoid raking twigs, leaves, and grass clippings into the lake. They contain both nitrogen and phosphorus. The best disposal for organic matter, like leaves and grass clippings is to compost them. Composted material can then be used for gardening.

Other practices can be adopted by the Town and District to reduce the amount of materials entering the channels from the watershed. These include adopting and enforcing erosion control ordinances for construction sites, requiring storm water controls in all new developments, and increasing the frequency of spring and fall street sweeping.

Shoreline vegetation
There are beneficial alternatives to the traditional mowed lawn. The best alternative is to leave the natural shoreline undisturbed. If clearing is necessary to access and view the lake, consider very selective removal of vegetation.

Natural vegetation is one of the most important and effective erosion and nutrient control options. Shoreline plants can stabilize the bank by holding soil particles together and dampening wave action. Vegetation also acts as a buffer to trap suspended sediment and filter nutrients. To prevent continued bank erosion where vegetative cover has been removed, it is important to restore the slope of the bank and reestablish ground cover vegetation, such as native trees, shrubs, and aquatic riparian vegetation. The creation of a native vegetative buffer strip would not only be a benefit to sediment management, but also to water quality protection. This buffer also provides excellent fish and wildlife habitat, including nesting sites for birds, and spawning habitat for fish.

A recommended buffer zone consists of native vegetation that may extent from 25 – 100 feet or more feet from the water's edge onto land, and up to 50 feet into the water depending upon water depth. The buffer should cover at least 50%, and preferably 75% of the shoreline frontage (Henderson, et al., 1998). In most cases this still allows plenty of room for a dock, a

swimming area, and lawn. Buffer zones are made up of a mixture of native trees, shrubs, upland plants, and aquatic plants and are quite aesthetically pleasing.

Reduced impacts from boating

Boat traffic can cause an increase in suspended solids especially in shallow areas of lakes (Hill, 2004). Studies have shown that maximum increases in turbidity occur between 2 and 24 hours following boating activities. The full effects of heavy boating depend upon a number of factors including propeller size, boat speed, draft, and sediment characteristics (Asplund, 1996). Silty sediments tend to have the highest susceptibility to resuspension and the highest potential for the reintroduction of nutrients into the water column. Studies have also focused on algae (chlorophyll a) concentrations but found no significant changes following boating activity. This is due primarily to an indeterminate time lag which occurs between the release of nutrients and the subsequent increase in algal growth. It has also been suggested that disturbances to the native plant communities due to watercraft use can accelerate the spread of opportunistic exotic plant species such as Eurasian watermilfoil and curly leaf pondweed (Asplund and Cook, 1997).

Wisconsin statutes require boaters to maintain no-wake speeds within 100 feet of shorelines, other boats, or fixed structures, including boat docks and swimming platforms. However, it is difficult to enforce such regulations and even slow boat traffic can have a negative impact on sediments and plant communities in shallow areas. This not only has a negative impact to the lake but can also damage boats. It is recommended that the Black Otter Lake District take the opportunity to educate District members and lake users alike of the impacts boating can have on a lake.

Informational resources for property owners

The following list contains a number of valuable references that property owners and the District can utilize to further explore options for water quality and shoreline habitat improvements.

Lakescaping for Wildlife and Water Quality. This 180-page booklet contains numerous color photos and diagrams. Many consider it the bible of shoreline restoration. It is available from the Minnesota Bookstore (651-297-3000) for $19.95.

The Living Shore. This video describes buffer zone construction and gives information on selecting and establishing plants. May be available at local library, or order from the Wisconsin District of Lakes (800-542-LAKE) for $17.00.

A Fresh Look at Shoreland Restoration. A four-page pamphlet that describes shoreland restoration options. Available from UW Extension (#GWQ027) or WDNR (#DNR-FH-055).

What is a Shoreland Buffer? A pamphlet that discusses both ecological and legal issues pertaining to riparian buffer zones. Available from UW Extension (#GWQ028) or WDNR (#DNR-FH-223).

Life on the Edge…Owning Waterfront Property. A guide to maintaining shorelands for lakefront property owners. Available from UW Extension-Lakes Program, College of Natural Resources, University of Wisconsin, Stevens Point, WI 54481, for $4.50.

The Water's Edge. A guide to improving fish and wildlife habitat on your waterfront property. Available from WDNR (#PUB-FH-428-00).

Sediment Accumulation

Lake sediment accumulation is a common problem faced by many lakes in Wisconsin. Sediments build up as a result of contributions from both internal and external sources. Erosion from within the watershed transports sediments over land and deposits them in lakes and rivers. Increases in sedimentation rates are often associated with increases in internal and external contributions and excessive plant and algal growth (Kim, 2002, Garbaciak, 2003). Organic sediments can often accumulate from the annual life cycle of aquatic plants. As winter approaches, aquatic plants begin to die back and decompose. Over time this process results in a build up of organic matter. Sediments with higher organic content are more heavily influenced by this process.

Although the sediments of Black Otter Lake are not particularly thick, it is important to continue monitoring sediment thicknesses and undertake activities to prevent further sediment accumulation. One likely source of sediments to Black Otter Lake is transport through the three inlet creeks.

Sediment Reduction Options

Increased sedimentation in shallow lakes can lead to obstructions in navigation. Consequently, effective management of sediments must be carried out in both the lake and the watershed to maximize its effectiveness. This management must include practices which reduce the input of sediments, nutrients, and contaminants from external sources and the internal control of these elements within the lake. If sediment removal alone is chosen, any improvements to the lake will be short-lived and limited by the continued addition of nutrients and organic matter from external sources. To best meet the wishes of all concerned, the symptoms *and* causes of sediment accumulation must be addressed.

Management of Existing Sediments

Sediment management practices can be carried out either by reducing sediments on-site or by physically removing sediments from the lake. A limited number of options are available to reduce accumulated sediments in lakes. Of these, sediment removal (dredging) is the most common option employed. However, dredging is a costly and time consuming activity. In addition, data available on the effects of dredging on lake ecosystems is limited. By its nature, dredging causes physical changes to the lake ecosystem both in terms of the sediments and the water column. Sediment resuspension and increases in nutrient and other pollution levels are constant concerns associated with dredging operations (Marsh, 2003). Given that sediments are not posing as significant a threat to the lake as nuisance aquatic plant growth, it is recommended that dredging as a lake management tool not be pursued at this time.

Preventing Sediment Accumulation

In order to properly address sediment management in a lake, it is important to not only consider the current sediment accumulation, but to also plan for the mitigation of future sedimentation. A number of control efforts should be considered for implementation. Many efforts to control sediment accumulation will also result in benefits to water quality and wildlife habitat.

Watershed Sediment Control
Erosion is a natural process. However, human activities often accelerate rates of erosion leading to detrimental effects. In watersheds, the erosion of shorelines, riverbanks, and drainage ditches accounts for large quantities of sediments reaching lakes. This type of erosion is primarily due to the removal of shoreline vegetation for agriculture and urbanization. Consequently, control practices should be carried out for the benefit of the landowners and the health of the lake. The prevention of soil erosion in watersheds is an imperative step in the control of non-point sources of nutrients and sediments. Where possible, erosion control efforts should be used. Shoreline owners are encouraged to leave existing vegetation, which is a great shore stabilizer. Careful planning must be an integral part of landscape management. Research has shown that the placement of wire-wrapped square straw bales, coconut fiber logs, pine logs, and rock riprap are also effective in controlling wave action and trapping sand (Sistani and Mays 2001). When riprap is used it is recommended that desirable shrubs and aquatic plants be planted within the riprap. Before any shoreline stabilization project is initiated, it is recommended that property owners contact the local Wisconsin DNR office for project approval and to obtain any necessary permits.

Sediment Management Objectives

The District and individuals should focus on preventing sediment reaccumulation and the related impacts to water quality. These include improved lawn care and farming practices within the watershed, the restoration of shoreline vegetation, the installation of sedimentation basins, etc. However, depending on the extent of management, these additional options will take time and financial commitments from both the District as well as individual property owners. Again many of the sediment management efforts will also result in improvements to water quality and fisheries habitat.

Appendix F
Available Grant Opportunities for Lake Organizations

Grant Programs

State grant programs

A number of State-funded grants are available to qualified lake organizations for a variety of lake management and improvement projects. Grants which the lake organizations in Wisconsin may benefit from include: Lake Management Planning and Protection grants, Aquatic Invasive Species Control grants, and the Recreational Boating Facilities grant.

Lake Management Planning Grants
This program has been established for the purpose of assisting with lake management. Eligible applicants can apply for funding to collect and analyze information needed to protect and restore lakes and their watersheds. Small and large-scale grants are available. This program funds up to 75% of the cost of the project. Grant awards cannot exceed $10,000 per grant for large-scale projects and $3,000 per grant for small-scale projects.

Eligible projects include:

- Gathering and analysis of physical, chemical, and biological information on lakes.
- Describing present and potential land uses within lake watersheds and on shorelines.
- Reviewing jurisdictional boundaries and evaluating ordinances that relate to zoning, sanitation, or pollution control or surface use.
- Assessments of fish, aquatic life, wildlife, and their habitats. Gathering and analyzing information from lake property owners, community residents, and lake users.
- Developing, evaluating, publishing, and distributing alternative courses of action and recommendations in a lake management plan.

Lake Management Protection Grants
The Lake Management Protection Grant program awards funds up to 75 percent of project costs with a maximum grant amount of $200,000. Eligible projects include the purchase of land or conservation easements, restoration of wetlands and shorelands, development of local regulations or ordinances to protect lakes, and lake management plan implementation projects.

Recreational Boating Facilities Grants
The DNR's Waterways Commission provides grant money for a variety of projects designed to improve recreation on Wisconsin lakes. The DNR provides cost sharing of up to 50 percent for eligible costs. Organizations can apply for funds to provide safe recreational boating facilities, conduct feasibility studies, purchase aquatic weed harvesting equipment, purchase navigation aids, dredge waterways, and chemically treat Eurasian watermilfoil.

Aquatic Invasive Species (AIS) Control Grants
This grant program is designed to assist management units in the control of aquatic invasive species. The WDNR awards cost-sharing grants for up to 50% of the costs of projects to control invasive species. These grants are awarded to projects that fall within three major categories:

1. Education, Prevention and Planning
2. Early Detection and Rapid Response
3. Controlling Established Infestations

These funds are currently available only to units of government including Lake Districts.

For more details on each of these and other grant programs, visit the DNR's grant program website at http://www.dnr.state.wi.us/org/caer/cfa/grants/index.html.

Tables

Table 1 – Summary of 2002 Black Otter Lake Water Analysis Data Collected One Foot Below the Surface Over the Deepest Point of the Lake

		sample date					
parameter	unit	24-Apr-02	17-Jun-02	12-Jul-02	7-Aug-02	4-Nov-02	Average Value
alkalinity	mg/l	232					232
chloride	mg/l	31.2					31.2
chlorophyll *a*	ug/l	33	10	54.4	17	4	23.7
conductivity	um/cm	567					567
dissolved oxygen - bottom	mg/l	11.8	0.10	0.10	0.08	5.44	3.5
dissolved oxygen - surface	mg/l	12.6	11.2	5.7	5.43	13.35	9.66
ammonia as N	ug/l	34					34
Kjeldahl nitrogen	ug/l	1520					1520
nitrate + nitrite as N	ug/l	798	482	N.D.	N.D.	1480	552
total phosphorus	ug/l	60	63	89	90	31	66.6
dissolved phosphorus	ug/l	N.D.					N.D.
nitrogen / phosphorus ratio		39/1					
pH, field	s.u.	8.7	8.48	8.2	8.06	8.6	8.41
pH, lab	s.u.		8.57	7.88		8.53	8.3
secchi disc depth	ft.	3.1	3.4	3.1	2.5	6.9	3.8
temperature - bottom	C	12.2	12.3	14.2	17.7	4.7	12.22
temperature - surface	C	12.2	24.9	25.6	24	4.8	18.3
total dissolved solids	mg/l	354					354
total suspended solids	mg/l	7					7
weather conditions		rainy,windy	sunny	calm	sunny	calm	
air temperature	C		29.1	25.2	24	1.7	20
cloud cover	%	100.00	20	20	0	0	28
gauge height	ft.	2.25	2.25	2.21	2.2	3.17	2.42

N.D. = not detected, concentration below limit of detection
Gauge height = distance between bottom of iron RR bridge and water's surface.

Table 2 – A Comparison of Averaged Water Quality Parameters from Black Otter Lake Between 1978, 1991, and 2002

parameter	Location	unit	1978	1991	2002
alkalinity	lake	mg/l	204	278	232
chloride	lake	ug/l	17	30	31.2
Chlorophyll a	lake	ug/l	34	*	23.7
dissolved oxygen - surface	lake	mg/l	9.6	10.2	9.66
conductivity	lake	um/cm	590	*	567
dissolved (reactive) phosphorus	lake	ug/l	44	14	N.D.
Kjeldahl Nitrogen	lake	ug/l	*	510	1520
Nitrate + Nitrite as N	lake	ug/l	*	32	552
pH, field	lake	s.u.	9.1	7.8	8.41
secchi disc depth	lake	ft.	3.8	4	3.8
temperature - surface	lake	C	21.7	19.3	18.3
total phosphorus	lake	ug/l	70	222	66.6
total suspended solids	lake	mg/l	*	478	7
conductivity	inlet (south)	um/cm	610	*	*
dissolved (reactive) phosphorus	inlet (south)	ug/l	16	*	*
total phosphorus	inlet (south)	ug/l	52.3	*	54.2
total suspended solids	inlet (south)	mg/l	51	*	*
conductivity	outlet (dam)	um/cm	510	*	*
discharge	outlet (dam)	cfs	10.4	*	67.8
dissolved (reactive) phosphorus	outlet (dam)	ug/l	48	*	*
total phosphorus	outlet (dam)	ug/l	90.8	*	69.4
total suspended solids	outlet (dam)	mg/l	23	*	*

* = no data available
N.D. = not detected, concentration below limit of detection

Averaged values from the water quality parameters were calculated from samples within the time period of April - November. The data was compared at the most similar times allowed for each sample year.

Table 3 – 2002 Black Otter Lake Water Analysis Data Collected from North and South Inlets

parameter	unit	24-Apr-02	17-Jun-02	8-Jul-02	7-Aug-02	4-Nov-02	Average
				sample date			
dissolved oxygen	mg/l	8.3	14.5	5.8	2.65	14	9.05
nitrate + nitrite as N	ug/l	172	63	10	N.D.	820	213
total phosphorus	ug/l	445	126	87	96	33	157.4
pH, field	s.u.	8.54	8.82	8.3	7.76	8.59	8.4
water temperature	C	14.2	25	26.7	22.3	5.0	18.6
weather conditions		rainy,windy	sunny	humid	sunny	calm	
air temperature	C		29.1	25.2	24	1.7	20
cloud cover	%	100	20	20	0	0	28

North Inlet Data

parameter	unit	24-Apr-02	17-Jun-02	12-Jul-02	7-Aug-02	4-Nov-02	Average
				sample date			
dissolved oxygen	mg/l	13.3	11.39	0.9	0.83	17.77	8.84
nitrate + nitrite as N	ug/l	2200	2640	3100	1080	7710	3346
total phosphorus	ug/l	32	98	44	69	28	54.2
pH, field	s.u.	8.9	7.9	7.7	7.7	8.55	8.15
water temperature	C	11.4	20.7	20.1	22.1	5.4	15.94
weather conditions		rainy,windy	sunny	calm	sunny	calm	
air temperature	C		29.1	25.2	24	1.7	20
cloud cover	%	100	20	20	0	0	28

South Inlet Data

Table 4 – Black Otter Lake Water Quality Data for September 18, 2006

Depth (ft)	September 18, 2006 Temp (°F)	D.O. (mg/L)	% Sat.
0	67.7	7.79	89.1
1	67.5	7.84	89.4
2	67.0	7.88	89.1
3	67.0	7.84	88.9
4	66.9	7.83	88.6
5	66.6	7.58	85.5
6	66.4	7.37	83.1
7	66.0	6.63	74.4
8	65.5	2.55	30.1
9	65.1	1.98	21.9
10	63.7	1.31	14.5
11	62.6	0.14	1.9

Water transparency (Secchi depth):	6.2 ft

pH:	8.57

Table 5 – Soft Sediment Thicknesses and Water Depths Measured on December 10-11, 2007 on Black Otter Lake, Outagamie County

Site #	Water depth (depth to soft sediment)(ft)*	Depth to hard sediment (ft)	Soft sediment thickness (ft, in)	Soft sediment thickness (dec. ft)	Total Solids (%)	Volatile Solids (%)
1	8' 7"	9' 8"	1' 1"	1.08	14.4	15.5
16	6' 10"	9' 2"	2' 4"	2.33	13.2	31.3
19	7' 6"	9' 3"	1' 9"	1.75	7.3	13.4
32	2' 11"	5' 0"	2' 1"	2.08	39.8	5.9
35	6' 5"	8' 1"	1' 8"	1.67	3.8	18.3
55	2' 4"	4' 7"	2' 3"	2.42	17.4	9.6
58	5' 4"	7' 8"	2' 4"	2.33	27.1	7.8
61	10' 3"	11' 5"	1' 2"	1.17	53.1	4
64	6' 4"	8' 4"	2' 0"	2.00	65.1	2.2
67	5' 9"	7' 11"	2' 2"	2.17	19.1	8.2
97	1' 11"	3' 6"	1' 7"	1.58	18.5	8.7
100	6' 9"	9' 2"	2' 3"	2.25	12.6	13.9
103	4' 11"	8' 6"	3' 7"	3.58	23.6	7.7
106	5' 11"	8' 6"	2' 7"	2.58	16.2	15
136	0' 11"	2' 0"	1' 11"	1.92	32.3	7.5
139	7' 11"	10' 5"	2' 6"	2.50	38.2	7.1
142	1' 6"	3' 10'	2' 4"	2.33	39	7.5
145	1' 9"	3' 5'	1' 8"	1.67	26	9.7
148	2' 7"	4' 5"	1' 10"	1.83	12.8	12.1
178	4' 5"	7' 1"	2' 8"	2.67	22.5	10
181	2' 1"	3' 11'	1' 10"	1.83	20.8	14
183	0' 9"	1' 11"	1' 2"	1.17	25.6	13.7
186	5' 9"	7' 4'	1' 7"	1.58	9.1	11.5
189	0' 9"	3' 5"	2' 8"	2.67	12.5	20.1
192	1' 0"	4' 1"	3' 1"	3.08	9.2	17.7
195	0' 1"	5' 3"	5' 2"	5.17	17.9	17
236	1' 2"	3' 7"	2' 5"	2.42	24.5	13.1
237	0' 1"	2' 3"	2' 2"	2.17	13.4	31.1
240	5' 0"	6' 7'	1' 7"	1.58	19.3	6.2
243	1' 7"	4' 7'	3' 0"	3.00	15.2	17.6
244	1' 0"	4' 6"	3' 6"	3.50	14.2	19.7
247	0' 11"	3' 7'	2' 8"	2.67	25.6	16.5
248	0' 2"	3' 3"	3' 2"	3.17	16.2	20.8
275	1' 7"	4' 0"	2' 5"	2.42	12.4	16.9
277	0' 8"	2' 7"	1' 11"	1.92	28.5	14.6
280	1' 7"	5' 1"	3' 6"	3.50	16.8	16.3
284	1' 0"	3' 11"	2' 11"	2.92	25.2	10.1
		Average:	2' 4"	2.37		

* water depths based on fixed head of dam. Summer depths may be set 6-18 inches higher

Collectors: C. Cason
J. Nicholson

Table 6 – Shoreline Aquatic Plant Transcet Data from Black Otter Lake, June 2002

Species		Transect/Abundance Ranking								
common name	**scientific name**	**I**	**II**	**III**	**IV**	**V**	**VI**	**VII**	**VIII**	**IX**
Blue Flag Iris	*Iris versicolor*			1	1			1	2	
Bottlebrush Sedge	*Carex comosa*		1	1	1	2	2	1	1	2
Broad Leaved Arrowhead	*Sagittaria latifolia*						1			1
Broad Leaved Cattail	*Typha latifolia*				2	2	4	2		
Canada Bluejoint Grass	*Calamagrostis canadensis*				1	3				
Creeping Spikerush	*Eleocharis palustris*			1						
Curly Dock	*Rumex Crispus*								1	1
Dogwood	*Cornus spp.*									
Floating Leaf Pondweed	*Potamogeton natans*		2	3	3	4	4	3		
Hardstem Bulrush	*Scripus acutus*	1								
Jewelweed	*Impatiens capensis*		4	4				2		
Kentucky Bluegrass	*Poa pratensis*	3	4	4	4	4	2	4	4	4
Lake Sedge	*Carex lacustris*					2				
Marsh Marigold	*Caltha Palustris*							1		
Marsh Milkweed	*Asclepias incarnata*				1					
Narrow Leaved Cattail	*Typha angustifolia*					2				
Needle Rush	*Eleocharis acicularis*									
Reed Canary Grass	*Phalaris arundinacea*				2			1		
River Bulrush	*Scripus fluviatilis*				2					
Sage Willow	*Salix canadensis*									
Soft Rush	*Juncus effusus*		1	2	1	2		1	1	
Softstem Bulrush	*Scripus validus*									
Spadderdock	*Nuphar variegata*									
Stalk Grained Sedge	*Carex stipata*			1						
Tag Alder	*Alnus*							1	2	3
Tussock Sedge	*Carex*					1		1		
Water Smartweed	*Polygonum amphibium*								2	
Water Smartweed spp.	*Polygonum longistylum*								1	
Willow	*Salix spp.*							1	1	
total per transect		**4**	**12**	**17**	**18**	**22**	**13**	**19**	**15**	**11**

Relative abundance Ranking
1 Rare found along less than 5% of transect
2 Present foung along 5-25% of transect
3 Common found along 25-50% of transect
4 Abundant found along more than 50% of transect

Table 7 – Results of the Submergent Aquatic Plant Survey Conducted on Black Otter Lake During June 2002

Species common name	scientific name	Percent Frequency	Percent Composition
Curly Leaf Pondweed	*Potamogeton crispus*	74.3	22.1
Coontail	*Ceratophyllum demersum*	60.7	18.1
Horsehair algae	*Pithophora spp.*	38.6	11.5
Lesser Duckweed	*Lemna Minor*	34.3	10.2
Eurasian Watermilfoil	*Myriophyllum spicatum*	19.3	5.7
Sago Pondweed	*Potamogeton pectinatus*	15.0	4.5
Watermeal	*Wolffia columbiana*	14.3	4.3
Filamentous Green Algae	*Spirogyra spp.*	14.3	4.3
Northern Watermilfoil	*Myriophyllum sibericum*	12.9	3.8
White Water Crowfoot	*Ranunculus longirostris*	12.1	3.6
Whorled Watermilfoil	*Myriophyllum verticillatum*	10.7	3.2
Floating Leaf Pondweed	*Potamogeton natans*	9.3	2.8
Musk Grass	*Chara spp.*	7.1	2.1
Star Duckwed	*Lemna trisulca*	5.7	1.7
Water Moss	*Drepanoclaclus spp.*	2.9	0.9
Colonial BlueGreen Algae	*Oscillatoria*	1.4	0.4
Stonewort	*Nitella spp.*	1.4	0.4
Various-Leaved Watermilfoil	*Myriophyllum heterophyllum*	0.7	0.2
Filamentous Green Algae	*Cladophora spp.*	0.7	0.2
No Plants Found		0.7	

Table 8 – A Comparison of Black Otter Lake Submergent Plant Survey Data from 1978 and 2002

Species common name	scientific name	Percent Frequency 2002	1978
Curly Leaf Pondweed	*Potamogeton crispus*	74.3	
Coontail	*Ceratophyllum demersum*	60.7	88
Horsehair algae	*Pithophora spp.*	38.6	
Watermilfoil	*Myriophyllum spp.*	*	76
Lesser Duckweed	*Lemna Minor*	34.3	
Eurasian Watermilfoil	*Myriophyllum spicatum*	19.3	
Sago Pondweed	*Potamogeton pectinatus*	15.0	11
Watermeal	*Wolffia columbiana*	14.3	
Filamentous Green Algae	*Spirogyra spp.*	14.3	
Northern Watermilfoil	*Myriophyllum sibericum*	12.9	
White Water Crowfoot	*Ranunculus longirostris*	12.1	16
Whorled Watermilfoil	*Myriophyllum verticillatum*	10.7	
Floating Leaf Pondweed	*Potamogeton natans*	9.3	30
Musk Grass	*Chara spp.*	7.1	1
Star Duckwed	*Lemna trisulca*	5.7	
Spadderdock	*Nuphar variegata*	4	1
Water Moss	*Drepanoclaclus spp.*	2.9	
Colonial BlueGreen Algae	*Oscillatoria*	1.4	
Stonewort	*Nitella spp.*	1.4	
Various-Leaved Watermilfoil	*Myriophyllum heterophyllum*	0.7	
Filamentous Green Algae	*Cladophora spp.*	0.7	
No Plants Found		0.7	
Flatstem Pondweed	*Potamogeton zosteriformis*	0	75
Small Pondweed	*Potamogeton pusillus*	0	63
Elodea	*Anacharis canadensis*	0	13
Water Stargrass	*Heterathera dubia*	0	3

* sorted to genus

Table 9 - Aquatic Plant Frequency of Occurrence by Depth from 2002 Black Otter Lake Survey

Species common name	scientific name	Precent Frequency / Depth (ft.) 0-1.9	2.0-3.9	4.0-5.9	6.0-7.9	8+
Curly Leaf Pondweed	*Potamogeton crispus*	45.8	66.7	95.8	90.4	37.5
Coontail	*Ceratophyllum demersum*	95.8	62.5	79.2	44.2	37.5
Horsehair algae	*Pithophora spp.*	70.8	25.0	8.3	38.5	50.0
Lesser Duckweed	*Lemna Minor*	70.8	50.0	37.5	13.5	18.8
Eurasian Watermilfoil	*Myriophyllum spicatum*	12.5	0.0	50.0	23.1	0.0
Sago Pondweed	*Potamogeton pectinatus*	79.2	8.3	0.0	0.0	0.0
Watermeal	*Wolffia columbiana*	37.5	20.8	25.0	0.0	0.0
Filamentous Green Algae	*Spirogyra spp.*	37.5	16.7	8.3	5.8	12.5
Northern Watermilfoil	*Myriophyllum sibericum*	37.5	8.3	4.2	1.9	0.0
White Water Crowfoot	*Ranunculus longirostris*	41.7	25.0	4.2	0.0	0.0
Whorled Watermilfoil	*Myriophyllum verticillatum*	16.7	12.5	16.7	3.8	12.5
Floating Leaf Pondweed	*Potamogeton natans*	12.5	37.5	4.2	0.0	0.0
Musk Grass	*Chara spp.*	12.5	29.2	0.0	0.0	0.0
Star Duckweed	*Lemna trisulca*	20.8	16.7	0.0	3.8	6.8
Water Moss	*Drepanocladus spp.*	0.0	0.0	0.0	1.9	18.8
Colonial BlueGreen Algae	*Oscillatoria*	8.3	0.0	0.0	0.0	0.0
Stonewort	*Nitella spp.*	0.0	8.3	0.0	0.0	0.0
Various-Leaved Watermilfoil	*Myriophyllum heterophyllum*	0.0	4.2	0.0	0.0	0.0
Filamentous Green Algae	*Cladophora spp.*	0.0	0.0	4.2	0.0	0.0
No Plants Found		0.0	0.0	0.0	0.0	6.3

Table 10 – Results of the Aquatic Plant Survey Conducted on Black Otter Lake on September 18, 2006

Species common name	scientific name	Frequency	Percent Frequency	Relative Frequency
Coontail	*Ceratophyllum demersum*	249	98.8	27.7
Eurasian water milfoil	*Myriophyllum spicatum*	169	67.1	18.8
Watermeal	*Wolffia columbiana*	163	64.7	18.2
Filamentous Algae	*Pithophora, Cladophora, etc.*	153	60.7	17.0
Small duckweed	*Lemna minor*	49	19.4	5.5
Common waterweed	*Elodea canadensis*	35	13.9	3.9
Sago pondweed	*Stuckenia pectinata*	33	13.1	3.7
Floating-leaf pondweed	*Potamogeton natans*	27	10.7	3.0
Water marigold	*Megalodonta beckii*	5	2.0	0.6
Robbins pondweed	*Potamogeton robbinsii*	4	1.6	0.4
Broad-leaved cattail	*Typha latifolia*	4	1.6	0.4
Muskgrasses	*Chara*	3	1.2	0.3
Forked duckweed	*Lemna trisulca*	2	0.8	0.2
Curly-leaf pondweed	*Potamogeton crispus*	2	0.8	0.2

Table 11 – Black Otter Lake Floristic Quality Index (FQI) Analysis Table

Common Name	Scientific Name	C
Coontail	*Ceratophyllum demersum*	3
Muskgrasses	*Chara*	7
Common waterweed	*Elodea canadensis*	3
Small duckweed	*Lemna minor*	5
Forked Duckweed	*Lemna trisulca*	6
Water marigold	*Megalodonta beckii*	8
Floating-leaf	*Potamogeton natans*	5
Robbins pondweed	*Potamogeton robbinsii*	8
Sogo pondweed	*Stuckenia pectinata*	3
Broad-leaved cattail	*Typha latifolia*	1
Common watermeal	*Wolffia columbiana*	5
	N	11
	mean C	4.91
	FQI	16.28

Table 12 – Nearby Impounded Lakes Having Depths of Five Feet of Less that Sustain Fisheries.

Location	Lake Name	Surface Area (acres)	Max Depth (feet)
Calumet County			
	Hayton Pond	36	5
Waupaca County			
	Cincoe Lake	169	4
	Junction Lake	16	4
	Peterson Creek Millpond	6	4
	Waupaca Millpond	22	5
Waushara County			
	Auroraville Millpond	209	5
	Clarks Millpond	68	5
	Pine River Millpond	28	4
	Saxeville Millpond	13	4
Winnebabo County			
	Rush	3070	5

Source: *Wisconsin Lakes,* Wisconsin Department of Natural Resources, PUB-FH-800, 2001.

Table 13 – Recommended Emergent Plant Species and Planting Quantities for Black Otter Lake.

Species common name	scientific name	type	quantity	cost/plant	total cost
Common Arrowhead	*Sagittaria latifolia*	M	400	$4.00	$1,600
Common Bur-reed	*Sparganium eurycarpum*	M	800	$4.00	$3,200
Pickerelweed	*Pontederia cordata*	M	200	$4.00	$800
River Bulrush	*Bolboschoenus fluviatilis*	M	400	$4.00	$1,600
Softstem Bulrush	*Schoenoplectus tabernaemontani*	P	1000	$4.00	$4,000
Spatterdock	*Nuphar variegata*	R	100	$7.00	$700
Water Plantain	*Alisma subcordatum*	M	200	$4.00	$800
Wild Rice	*Zizania spp.*	S	200 lbs	$12.00	$2,400
Total plant material					**$15,100**
Herbivore barrier materials					**$2,000**
labor (400 volunteer hours)					**$3,200**
Total project cost					**$20,300**

M = Mature Plant

R = Rhizome

S = Seed

National Fish and Wildlife Foundation

The National Fish and Wildlife Foundation funds projects to conserve and restore fish, wildlife, and native plants through matching grant programs. The Foundation awards grants to projects that address priority actions promoting fish and wildlife conservation and the habitats on which they depend. Federal, state, and local governments, educational institutions, and nonprofit organizations can apply for the 50% matching grant throughout the year.

Pulling Together Initiative
The National Fish and Wildlife Foundation's Pulling Together Initiative (PTI) grant program provides support on a competitive basis for the development of long-term weed management projects within the scope of an integrated pest management strategy. The goals of PTI are:

- To prevent, manage, or eradicate invasive and noxious plants through a coordinated program of public/private partnerships.
- To increase public awareness of the adverse impacts of invasive and noxious plants.

PTI grants are financed by funds from federal agencies, which must be matched by cash or in-kind contributions from state, local, and private partners on at least a 1:1 basis. All proposals are reviewed by a national steering committee composed of weed management experts from government, industry, academia, and non-profit organizations.