SPL-105-05

Progress Report:
Aquatic Plant Management in Black Otter Lake, Outagamie County, Wisconsin

Prepared for:

Black Otter Lake District
c/o Jim Poweleit
207 Lakeshore Drive
Hortonville, WI 54944

Prepared by:

Wisconsin Lake & Pond Resource LLC

P.O. Box 109
Berlin, WI 54923-0109
920-361-4088

Introduction

Black Otter Lake is a shallow 75-acre impoundment located in the village of Hortonville (**Figure 1**). 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 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. The Black Otter Lake District was formed in 1976 to help restore and protect the lake.

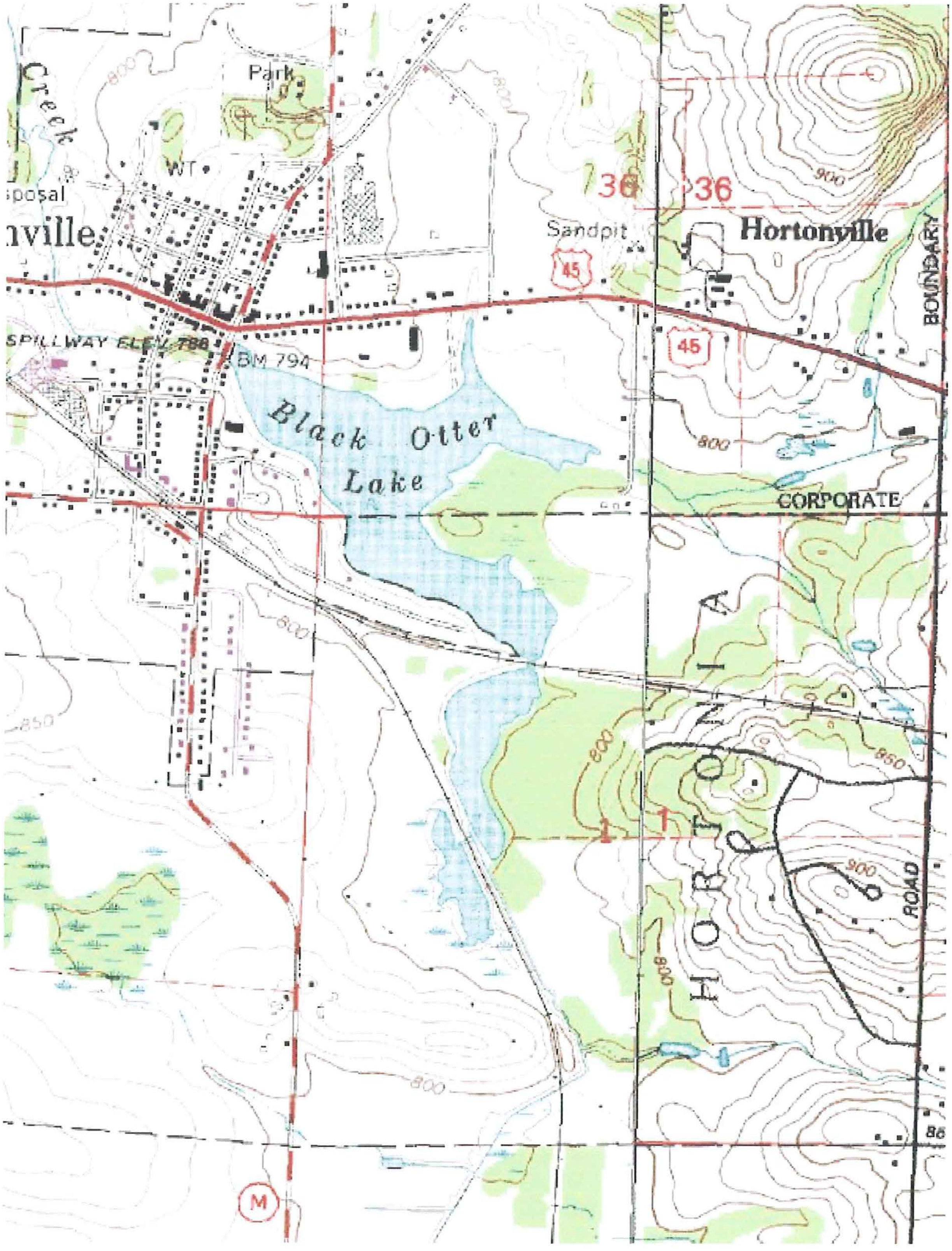
Due to its shallowness and nutrient inputs from the watershed, Black Otter Lake has a history of nuisance aquatic plants, water quality, and sedimentation problems. In January, 2003 a comprehensive lake management study was completed. This study found that high nutrient inputs continued to enter the 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 to prevent winter and summer fish kills in order to maintain a viable fishery. The system has generally been successful in accomplishing this task.

To date, Black Otter Lake uses a variety of lake management practices. Some important existing management tools include an aeration system, exotic species control, and enforcement 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 1982, 55 acres within Black Otter Lake was dredged. 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 have followed up on recommendations proposed from past management plans.

In April 2003, a large-scale treatment for curly-leaf pondweed (*Potamogeton crispus*) totaling 25 acres was conducted using the herbicide Aquathol K® (liquid endothall). This treatment was duplicated in April 2004. This treatment 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 Aquathol K® and Weedar 64® (liquid 2,4-D).

Figure 1. Black Otter Lake and the surrounding area, Outagamie County, WI



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 plants species, determining the level of success in the plant restoration project, and assessing the ongoing lake management activities. This report presents the results of this study, identifies lake management needs and provides further recommendations for future management of Black Otter Lake.

Methods for Field Studies

Submergent Aquatic Plant Mapping

On April 21, 2005 a mapping effort was made to briefly assess the submergent aquatic plant community as a whole. Numerous areas of Black Otter Lake were surveyed using surface observations from a boat and with rake tows. The plant species found in these areas including exotic species were identified and ranked according to their abundance. This mapping was conducted prior to the herbicide treatment of curly-leaf pondweed. Consequently, the results of this mapping effort reflect pre-treatment conditions.

In addition, on July 1, 2005, the location and extent of exotic plant beds were identified using surface observations and rake tows. This mapping effort specifically focused on Eurasian watermilfoil and curly-leaf pondweed. The dimensions of the beds, minimum and maximum depths, and distances from shore were measured and recorded on a contour map. The map drawings were superimposed upon an acreage grid to determine the area of the beds.

Water Quality Assessment

At the time of the exotic species mapping, baseline water quality data were also collected for the following parameters:

- Water transparency (Secchi depth)
- Dissolved oxygen profile
- Temperature profile
- pH

These samples were taken at the lake's deepest point near the dam. The information gathered was used to gain a better understanding of conditions in the lake at the time of sampling and factors which may contribute to the further spread of exotic plant species.

Assessment of Plant Restoration

Assessing the aquatic plant restoration efforts in Black Otter Lake consisted of surveying the estimated 5.1 acres of the lake planted with native macrophytes in May 2004. This assessment included determining the survival of each species by estimating the stem count and extent of growth. Two visits were made to Black Otter Lake for this assessment. The first was on October 2004, five months after the planting effort. The second was in July 2005, 14 months after planting.

Results

Submergent Aquatic Plant Mapping

Figure 2 presents the results of the submergent aquatic plant community assessment performed on April 21, 2005. Both Eurasian watermilfoil and curly-leaf pondweed were located in nearly every area surveyed. However, in general low numbers of curly-leaf pondweed were found in the lake. Native submergent aquatic plants were also plentiful in Black Otter Lake. The natives were dominated by coontail (*Ceratophyllum demersum*), elodea (*Elodea canadensis*), and musk grass (*Chara* spp.). The deepest portions of the lake fall outside those areas identified in **Figure 2**. In depths greater than eight feet, coontail was consistently the only species found.

A total of 11.5 acres of Eurasian watermilfoil were identified in Black Otter Lake on July 1, 2005. **Figure 3** shows the location and size of each milfoil bed. This survey did not locate any curly-leaf pondweed in the 37.4-acre treatment area and only sparse occurrences in the rest of the lake.

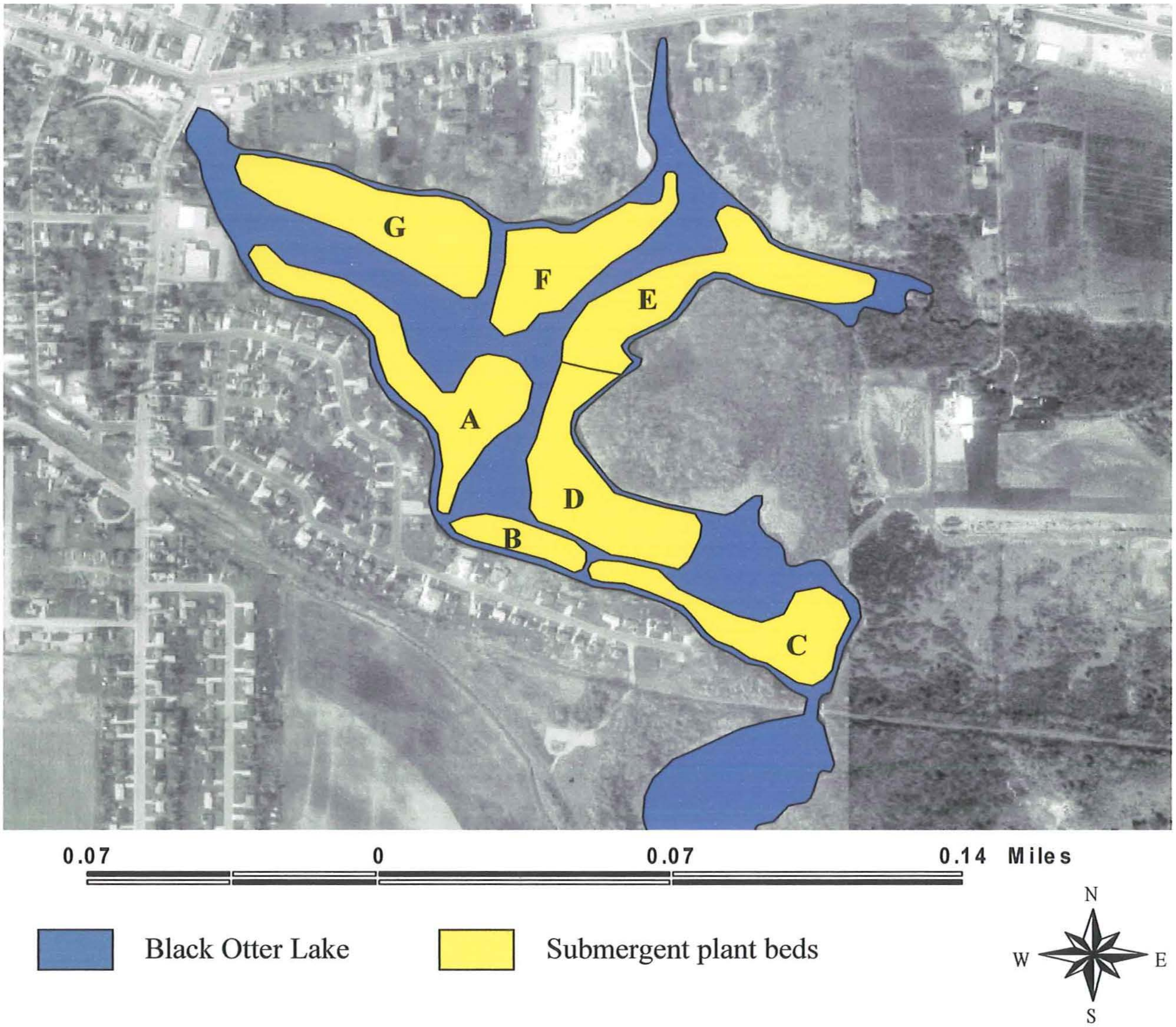
Water quality

Dissolved Oxygen and Temperature

Oxygen concentration is one of the greatest limiting factors in aquatic ecosystems. Because water is capable of holding relatively 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. Even with numerous sources of available oxygen, very productive lakes may experience periods of oxygen depletion.

Dissolved oxygen and temperature data for Black Otter Lake were used to develop a profile graph for April 21, 2005 (**Table 1, Figure 4**). Very high levels of oxygen were found at the surface of the lake. This is a condition referred to as supersaturation caused as a result of wind, wave, and certain biological activities. In lakes with high levels of production, daily cycles in the level of dissolved oxygen can occur. During the day, large amounts of oxygen are produced through photosynthesis causing levels to reach over 100% saturation. With nightfall, and the cessation of photosynthesis, levels can drop dramatically. Oxygen levels remained consistently high in the upper five feet of water. Low oxygen levels, insufficient to support most game fish (less than 5 ppm), were found below five feet of depth. These results should raise concern regarding the productivity of Black Otter Lake and the effect it has on the availability of oxygen.

Figure 2. Assessment of the submergent aquatic plant community in Black Otter Lake, Outagamie County on April 21, 2005.



	Submergent Plant Beds						
	A	*B*	*C*	*D*	*E*	*F*	*G*
Species present (ranked in order of abundance) *	CLPW CT EWM	EWM CT	CT CLPW	CLPW EWM CT	CT CLPW EWM ELO MG	EWM CLPW CT MG	CLPW CT EWM

* CLPW = curly-leaf pondweed (Potamogeton crispus)
CT = coontail (Ceratophyllum demersum)
ELO = elodea (Elodea canadensis)
EWM = Eurasian watermilfoil (Myriophyllum spicatum)
MG = musk grass (Chara spp.)

Figure 3. Eurasian watermilfoil distribution in Black Otter Lake, Outagamie County on July 1, 2005.

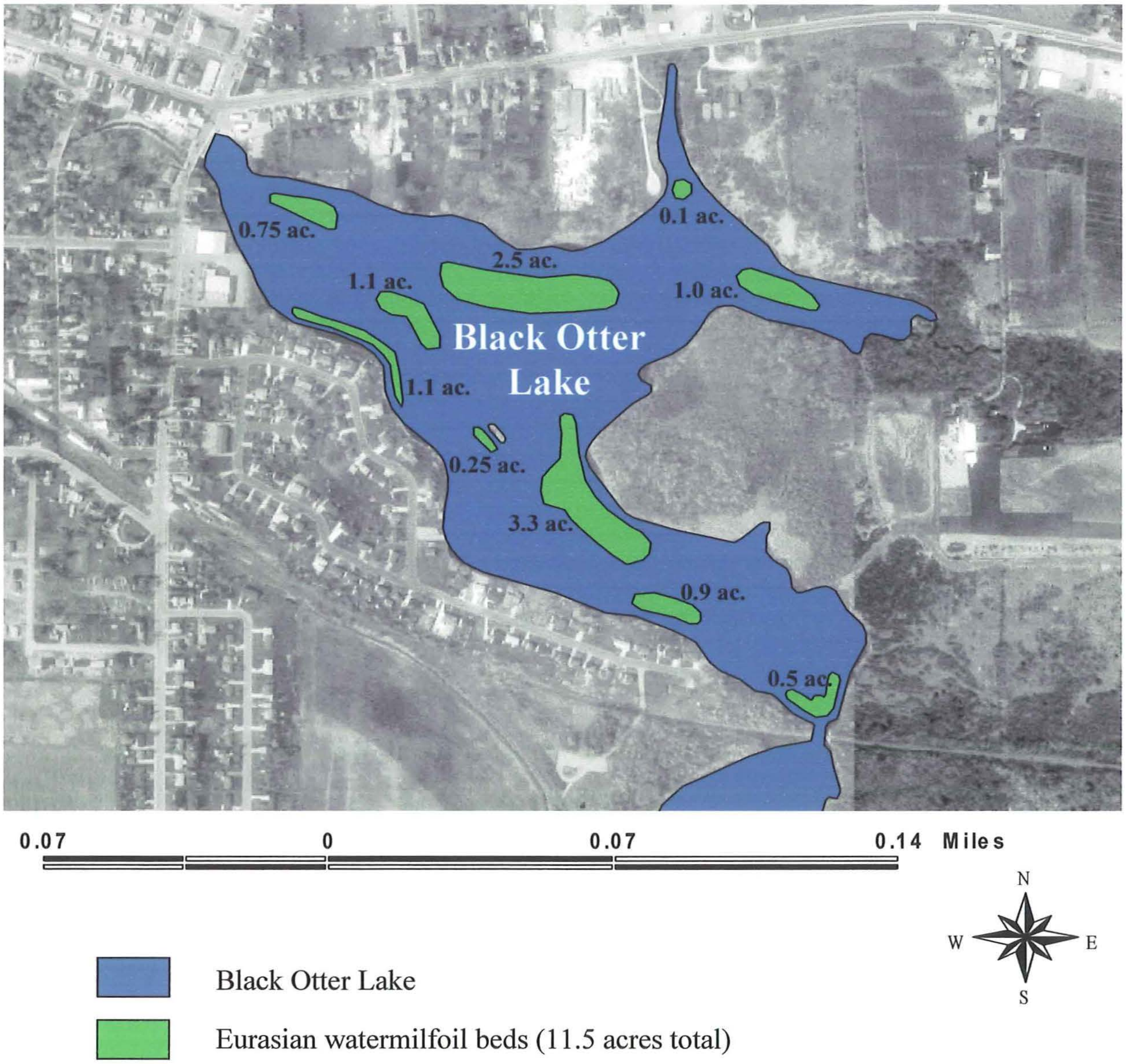


Figure 4. Black Otter Lake dissolved oxygen and temperature profiles for April 21, 2005.

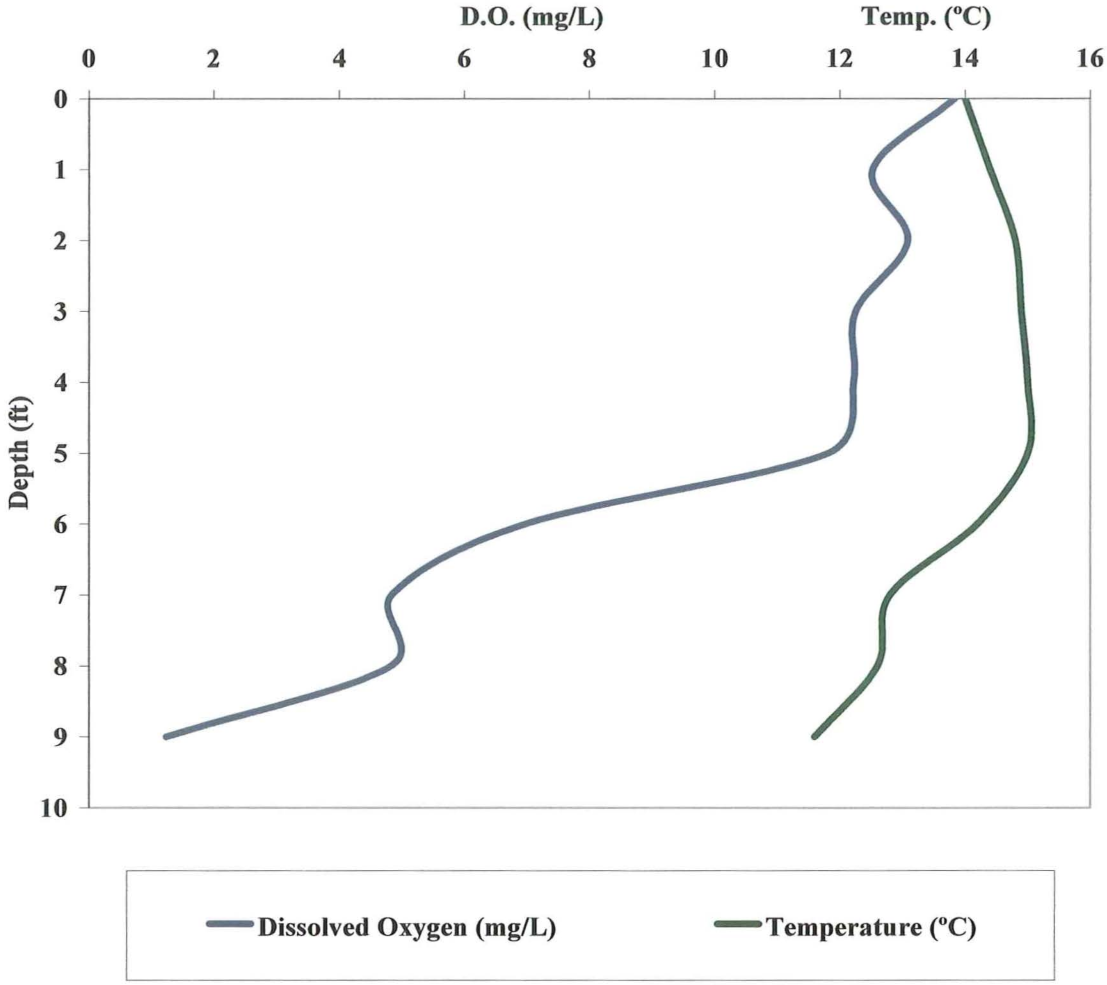


Table 1. Black Otter Lake water quality data for April 21, 2005

Dissolved Oxygen and Temperature Data:

	April 21, 2005	
Depth (ft)	Temp (°C)	D.O. (mg/L)
0	14.0	13.83
1	14.4	12.52
2	14.8	13.08
3	14.9	12.25
4	15.0	12.22
5	15.0	11.81
6	14.2	6.98
7	12.8	4.84
8	12.6	4.83
9	11.6	1.24

Water transparency (Secchi depth):	**2.4 ft**
pH:	**8.5**

Secchi Disc Depth and Trophic State

In addition to measuring the water clarity of a lake, Secchi discs 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 disc is visible. Secchi readings can be used to determine the trophic state or productivity of a lake; another 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 is large amounts of algae – a result of a high productivity or trophic level in a lake. Lakes can be categorized into three trophic levels:

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

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.

A lake's trophic state is a measure of its ability to support living things. Lakes can naturally become more eutrophic with time, however trophic state is more influenced by nutrient inputs than by time. 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 and odor is more typically considered poor water quality.

During the time of sampling, a Secchi disc was visible 2.4 feet (0.79 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.

pH Levels

pH is the measure of a lake's acidity level. A pH of 7 is neutral. Values below 7 are considered acidity while those above 7 are considered alkaline. Low pH values are much more detrimental to a lake system than higher pH levels. The pH value recorded for Black Otter Lake in April was 8.5. pH levels of this type are common for hard water, high productivity lakes throughout Wisconsin. These levels are often attributed to increases in plant metabolism and/or geologic conditions.

Assessment of Plant Restoration

Table 2 presents the results of the assessment of plant restoration in Black Otter Lake both five months (October 2004) and 14 months (July 2005) after planting. During the October 2004 assessment a number of species were either not found (river bulrush and wild celery) or difficult to assess due to the effects of frost (common arrowhead, pickerelweed, and water plantain). During the summer of 2004, Black Otter Lake experienced record flooding conditions. It was expected that large numbers of plants would have been lost. By October 2004, the overall survival rate was approximately 22%. This number dropped to just above 10% by July 2005. The greatest success in restoration was with white water lily and the spatterdock both of which had a greater than 100% success rate. Survival rates for water plantain, common arrowhead and hardstem and softstem bulrushes were above the average but less than 30%. The remaining five species had very low, if any, survival.

Table 2. Restoration success of aquatic plants planted on May 8, 2004 in Black Otter Lake.

October, 2004 Survey

Species common name	**scientific name**	**Planted Quantity**	**Survey Quantity**	**Estimated % Survival**
Common Arrowhead	*Sagittaria latifolia*	400	Frost	
Common Bur-reed	*Sparganium eurycarpum*	400	272	68.0%
Hardstem and Softstem Bulrush	*Scirpus* spp.	1000	978	97.8%
Pickerelweed	*Pontederia cordata*	400	Frost	
River Bulrush	*Scirpus fluviatilis*	400	Not Detected	
Spatterdock	*Nuphar variegata*	50	70	100%
Water Plantain	*Alisma* spp.	400	Frost	
Wild Celery	*Vallisneria americana*	1500	Not Detected	
White Water Lily	*Nymphaea odorata*	50	3	6.0%
Wild Rice	*Zizania aquatica*	1500	10	0.7%
		6100	**1333**	**22.2%**

July, 2005 Survey

Species common name	**scientific name**	**Planted Quantity**	**Survey Quantity**	**Estimated % Survival**
Common Arrowhead	*Sagittaria latifolia*	400	65	16.3
Common Bur-reed	*Sparganium eurycarpum*	400	2	0.5%
Hardstem and Softstem Bulrush	*Scirpus* spp.	1000	275	27.5%
Pickerelweed	*Pontederia cordata*	400	8	2.0%
River Bulrush	*Scirpus fluviatilis*	400	5	1.3%
Spatterdock	*Nuphar variegata*	50	150	100%
Water Plantain	*Alisma* spp.	400	55	13.8%
Wild Celery	*Vallisneria americana*	1500	0	0.0%
White Water Lily	*Nymphaea odorata*	50	88	100%
Wild Rice	*Zizania aquatica*	1500	0	0.0%
		6100	**648**	**10.6%**

Conclusions and Recommendations

2005 was the third year for large-scale treatment of curly-leaf pondweed in Black Otter Lake. Although some curly-leaf remains, good control has been achieved. And although complete eradication is often the hope in these types of treatments, it is an unrealistic expectation. A much more realistic expectation has been achieved, however. Levels of curly-leaf pondweed have been reduced in Black Otter Lake to manageable sub-nuisance levels.

Although curly-leaf pondweed management has been successful, Eurasian watermilfoil continues to pose a threat to Black Otter Lake. As of July 2005, over 11 acres of milfoil remained. It is advisable to treat the remaining milfoil in the spring of 2006 with Navigate® (granular 2,4-D) at rates of 100-150 lbs/acre. The rate should depend upon the size and density of the individual bed being treated.

Education and prevention should play a large role in further control of Eurasian watermilfoil in Patrick Lake. There are a number of resources available that can be used to better educate the public of the impact of exotic species on a lake environment. Contacting your local DNR or UW-Extension office is certainly a good place to start.

District members should also take the opportunity to educate themselves and assist in identifying and mapping exotic species found in the lake. An ongoing effort should be initiated by numerous members to located and record the locations of invasive species if found in the lake. This information can then used to aid in lake management activities, and will serve as a foundation for a long-term monitoring program.

The water quality data collected in April 2005 indicate that even early in the season, poor conditions dominate Black Otter Lake. Transparency results generally indicate a highly turbid system. This may be due to high nutrient levels fueling early-season algal growth and/or high levels of suspended solids in the water. In addition, oxygen levels drop off quickly at only five feet in depth. These conditions indicate that management of Black Otter Lake's water quality must continue to be a high priority.

Although the success rate for the reintroduction of native emergent plants was low, it does reflect the nature of ecosystem restoration in aquatic settings. For reasons not completely known, aquatic environments do not respond well to projects of this type. One factor that could not be controlled and which had a significant impact to the survival rate was the flooding which occurred in 2004. Although only 10% of the plants have thus survived, eight out of the ten species can still be found growing in the restored areas, albeit often at low levels. It will take more time and perhaps additional planting events before success in this effort can be achieved. At a minimum, further monitoring should continue, as it will better shed light on the long-term success of restoration.