Lily Lake Comprehensive Lake Management Plan

Watershed Land Use and Water Quality Study

Town of Eaton, Brown County, Wisconsin

Funding for this study was provided in part by the Wisconsin Department of Natural Resources through a Large-Scale Lake Planning Grant.

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Lily Lake Watershed Land Use and Water Quality Study

Prepared for the Town of Eaton by the Brown County Planning Commission with funding provided through a Large-Scale Lake Planning Grant from the Wisconsin Department of Natural Resources.

The Brown County Planning Commission would like to gratefully acknowledge the assistance of Mr. Jim Reyburn with the Wisconsin Department of Natural Resources, and Mr. Doug Hartman with the Brown County Facility and Park Management Department in preparing the study.

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CHAPTER 1

Introduction

Introduction

Lake management is a process in which local municipalities, homeowners, citizen groups, and county, state, and federal agencies collaborate to develop a long-term protection and improvement strategy for a specific surface water resource. During the early stages of lake management planning, an inventory of the natural environmental setting and the human influences that affect the water quality is compiled. In later stages goals are defined and prioritized, and alternative restoration and protection methods are evaluated and eventually selected to reach those goals.

The Lily Lake Comprehensive Management Plan has been complied as the final component in the planning process for the Lily Lake, Middle Lake, and Third Lake watersheds. Since Lily Lake is the most predominantly utilized lake, the majority of the report focuses on data gathered on Lily Lake itself. Both Middle Lake and Third Lakes have limited access as they are surrounded by an expansive wetland. Third Lake is predominantly held within private ownership.

As each chapter was completed, drafts were sent to organizations that had a specific interest in the subject matter. Once the editorial comments were incorporated, the text was added and watershed residents, Town of Eaton citizens, and Brown County residents were invited to public information meetings to provide further input.

It is expected that the resulting data and analyses contained within the report will be utilized by the Town of Eaton and Brown County specifically to implement measures to ensure the Lily Lake system remains a healthy and vital component of the Town of Eaton's landscape and the Brown County Park System.

Study Area and Background

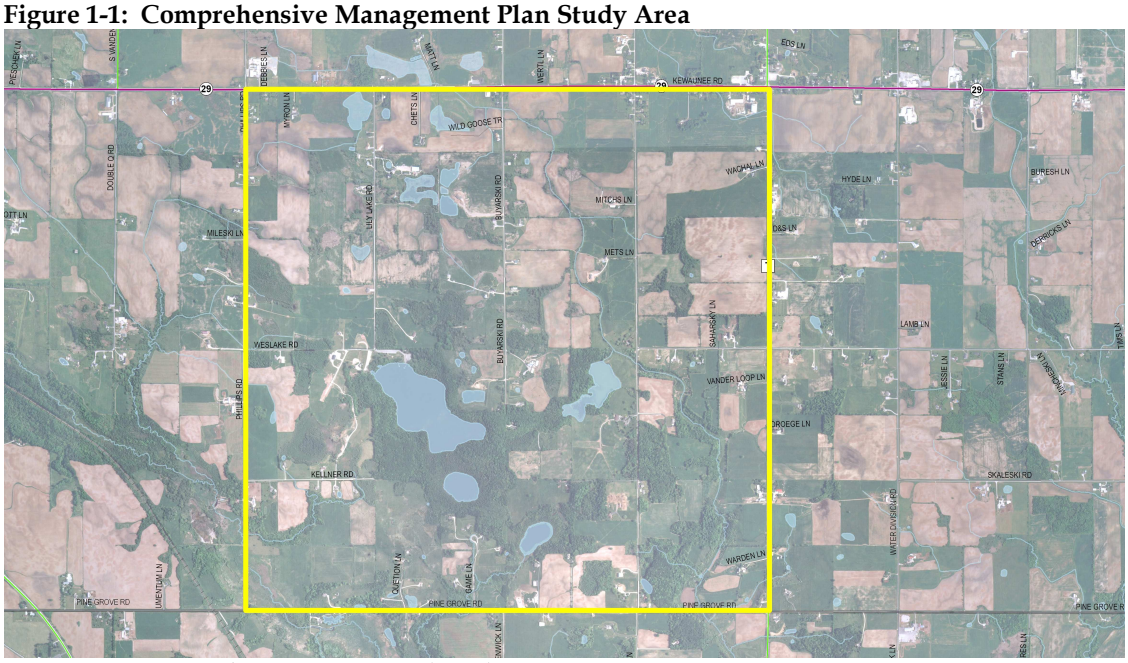
The project area includes Lily Lake in the southwestern part of the Town of Eaton Brown County, Wisconsin. Lily Lake and the smaller Middle and Third Lakes (Lily Lake System) are the only natural lakes within Brown County. Lily Lake is approximately 43 acres in area with a maximum depth of 21 feet. The entire shoreline is buffered by woodlands and wetlands and contains a county park at its northern end. Lily Lake is described as mesotrophic with a mean summer Secchi reading of about 14 feet. Due to the generally shallow nature of the lake, periodic winterkills of fish have occurred. An aerator is now utilized to increase dissolved oxygen levels during the winter months.

Located about ten miles southeast of the City of Green Bay, Lily Lake receives significant usage for fishing and passive outdoor recreation. Facilities at Lily Lake County Park include picnic areas, two fishing docks (one ADA accessible), a boat launch, an open air

shelter, and parking. The lake is popular for day fishing trips either from the fishing docks or from non-motorized (except electric trolling motors) watercraft.

Although the previous phase of this ongoing study focused on the entire Lily Lake watershed, this study is restricted to Lily Lake. See Figure 1-1 for an aerial photograph of Lily Lake. All sampling and monitoring were conducted in Lily Lake between May and November 2008.

Figure 1-1: Comprehensive Management Plan Study Area



Source: Brown County Planning Commission (BCPC), 2005

Purpose and Intent

The Lily Lake Comprehensive Management Plan is intended to inventory and analyze Lily Lake from a watershed perspective in order to ascertain the overall water quality of the lake and identify any variables which are adversely affecting the lake. Studies throughout this document examined several important physical, chemical, and biological parameters to analyze all important components of a lake. This study analyzed the historic land use changes, existing legal mechanisms, water chemistry, lake vegetation, fisheries, and park facilities. All factors were investigated to establish a baseline "health" status of Lily Lake.

The lake management plan is the culmination of three years of study in the Lily Lake Basin. Two previous reports were completed to compile this report. The Phase I report examined the historic land use and inventoried existing ordinances (BCPC, 2007). These topics will be briefly discussed and interpreted. Phase II examined water chemistry data gathered in 2008 and provided preliminary trophic classification (BCPC, 2008a). This phase expands on water chemistry data gathered in the winter of 2008 and spring

and summer of 2009. The findings are detailed in the following chapters. This report will be used by both the Town of Eaton and Brown County to protect the long-term health and vitality of Lily Lake as a valuable natural resource.

Study Area

The study area consists of Lily Lake, Middle Lake, Third Lake, and an area bounded by STH 29 (Kewaunee Road), Phillips Road, Pine Grove Road, and Allen Road as identified in Figure 1-1. The study area contains a mixture of rural uses including wetlands, upland woodlands, streams, agriculture, park/recreation, and rural residential development. The study area contains three square miles of land or approximately 1,919 acres.

Surface Water Features

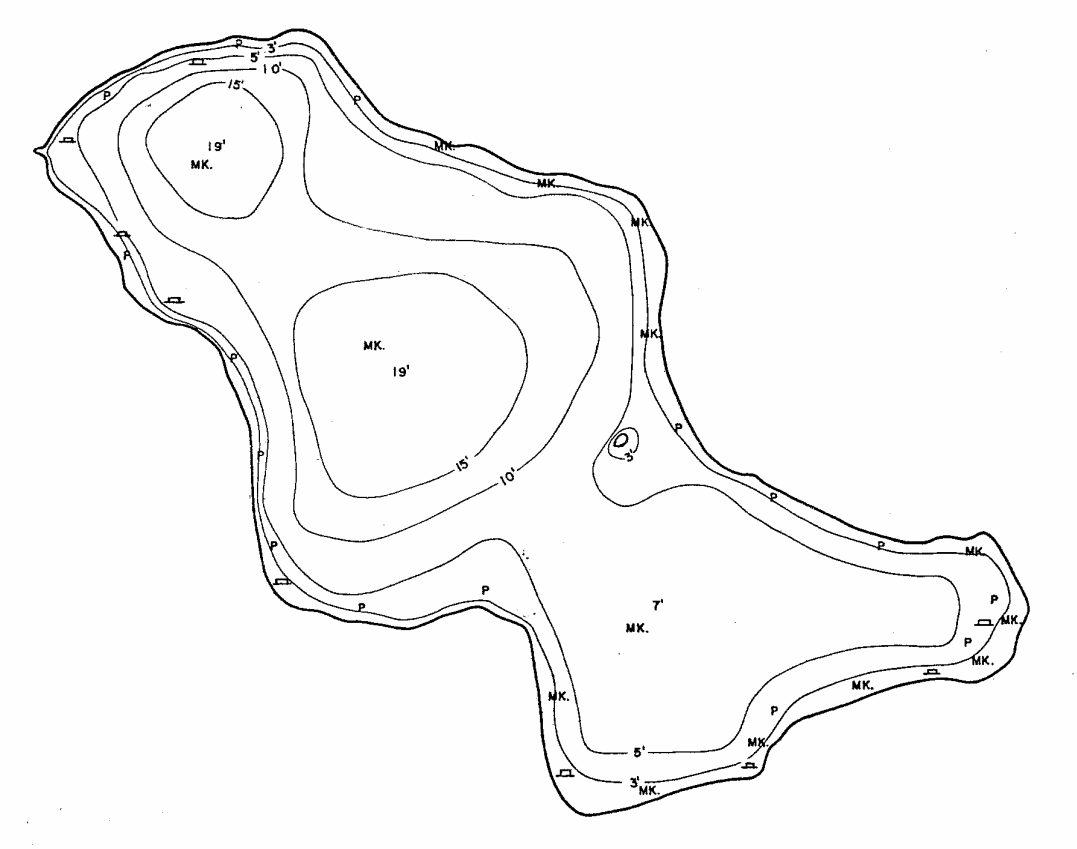
Surface water is one of the most important natural resources within a community. Lakes, rivers, and streams offer enjoyment, peace, and solitude. Surface waters provide recreational opportunities to anglers, boaters, hunters, water skiers, swimmers, sailors, and casual observers alike. Surface waters provide an end source for drainage after heavy rains, provide habitat for countless plants, fish, and animals, are a source of drinking water for many communities, and are a source of process water for industry and agriculture. Lands immediately adjacent to such waters have an abundance of cultural and archeological significance because they were often the location of Native American and early European settlements. For all these reasons and more, surface waters are typically the most important natural resource contained within a community.

Because of this importance, numerous federal, state, and local laws and regulations have been created to protect surface waters. They range from the commerce clause of the United States Constitution to county shoreland and floodplain zoning regulations. The most heavily regulated waters are those that are determined to be natural and "navigable." Using the direction provided in DeGayner v. DNR 70 Wis. 2d 936 (1975), a waterway within the State of Wisconsin is determined to be navigable in-fact if it is navigable by a canoe or skiff on a recurring bases (i.e. annually during freshets) and has a discernable bed and banks. The Wisconsin Department of Natural Resources (WDNR) determines whether or not a stream is navigable within the State of Wisconsin.

Lily Lake

Lily Lake is a 43 acre seepage lake that is up to 21 feet in depth at its deepest point (Figure 1-2). The entire shoreline is buffered by woodlands and wetlands and contains a county park at its northern end. Facilities at Lily Lake County Park include picnic areas, a two fishing docks (one ADA accessible), boat launch (no motors), open air shelter, and parking. Due to the generally shallow nature of the lake, periodic winterkills of fish have occurred. An aerator is now utilized to increase dissolved oxygen levels during the winter months. According to the Wisconsin Lakes Book, the lake contains northern pike, large mouth bass, and pan fish. The lake is popular for day fishing trips either from the fishing docks or from a non-motorized (except electric trolling motor) watercraft.

Figure 1-2: Lily Lake



Middle Lake

Middle Lake is a seven acre seepage lake located immediately south of Lily Lake, separated by approximately 450 feet of wooded wetlands. The northern shoreline is within the boundaries of Lily Lake County Park, while the southern shoreline is parceled into two separate residential lots. The entire shoreline of Middle Lake, including the privately-held lands, is heavily wooded due to the wetlands that surround it. Since wetlands surround Middle Lake, there is currently no improved public access to the lake. The maximum depth of Middle Lake is seven feet.

Third Lake

Third Lake is a six acre seepage lake and is the southern most lake in the Lily Lake System, lying approximately 1,200 feet to the southwest of Middle Lake. All of the shoreline of Third Lake is in private ownership, however, as with Middle Lake, Third Lake is surrounded by a heavily wooded wetland, providing a buffer to impacts from neighboring residential and agricultural activities. Third Lake has an intermittent tributary that drains the lake from its southern end, eventually reaching the Neshota River. The maximum depth of Third Lake is 15 feet.

Topography and Soils

The Lily Lake System lies in a shallow glacial depression that was created during the retreat of the last glacier. There is no inlet to any of the three lakes, and only an intermittent outlet drains Third Lake. In this manner, the Lily Lake System is similar in nature to the "kettle lakes" associated with the interlobal glacial area of the Kettle Moraine State Forest in southeastern and east central Wisconsin. These lakes also are remnants of the last glacial period, sustained by groundwater, without a continuous inlet or outlet. The topography is generally rolling with small ravines along the stream corridors and upland agricultural lands interspersed with pockets of wetlands.

According to the Brown County Soil Survey, the Lily Lake System is completely surrounded by soils classified as Carbondale Muck (Ca). These soils are found in old glacial lake basins and along stream valleys, have high organic content, and typically are associated with high water tables. Figure 1-3 displays the soils in the Lily Lake Study Area.

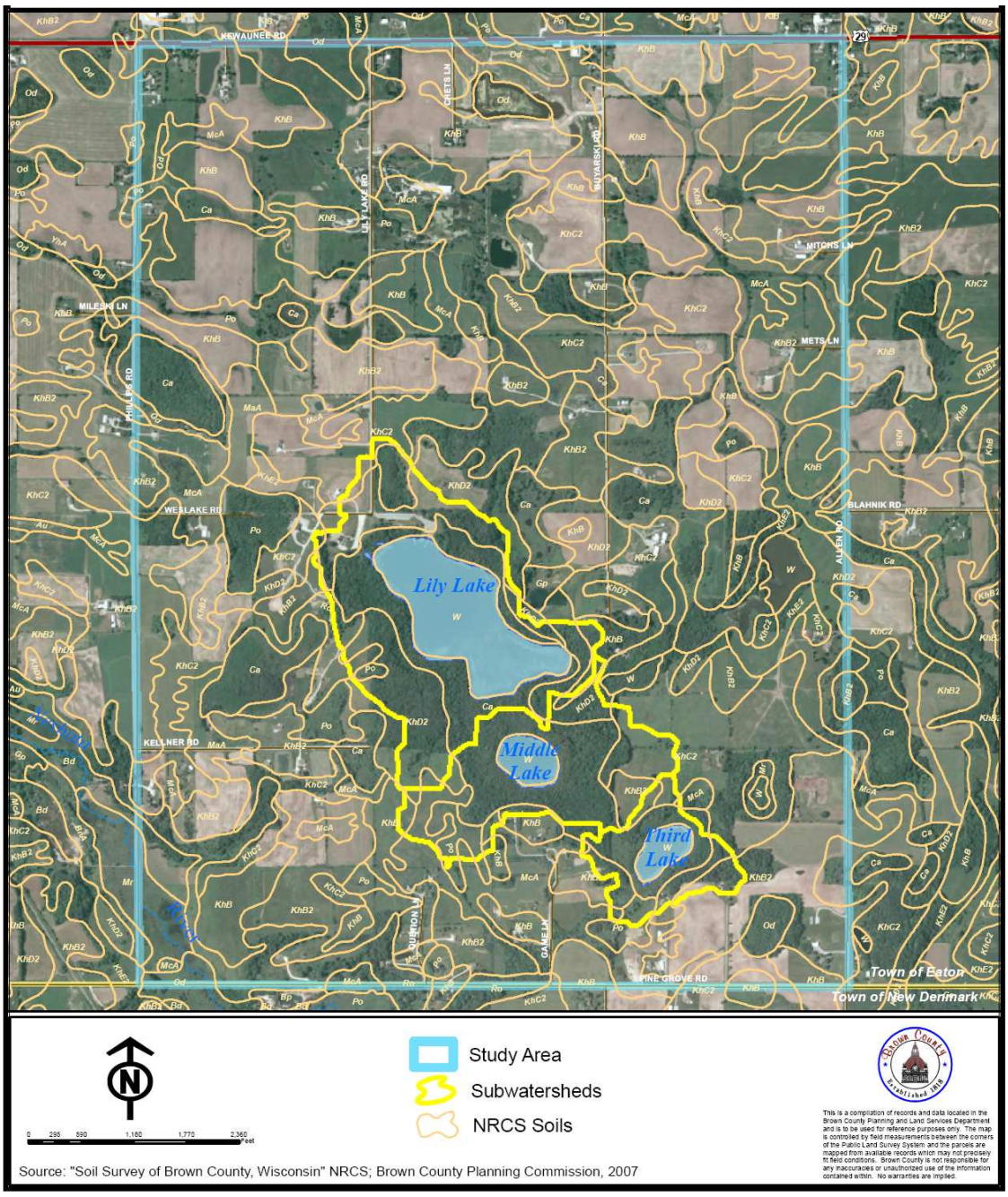
Wetlands

There are several wetlands within the Lily Lake watershed and surrounding area (Figure 1-4). Wetlands are characterized by water at or near the ground level, by soils exhibiting physical or chemical characteristics of waterlogging, or by the presence of wetland-adapted vegetation. Wetlands are significant natural resources that have several important functions. They enhance water quality by absorbing excess nutrients within the roots, stems, and leaves of plants and by slowing the flow of water to let suspended pollutants settle out. Wetlands help regulate storm runoff, which minimizes floods, and periods of low flow, provide essential habitat for many types of wildlife, and offer recreational, educational, and aesthetic opportunities to the community.

The primary threat to wetlands is filling from development. Although an array of federal, state, and local regulations help protect them, wetlands (especially smaller ones) are still lost to road construction and other development activities. The draining of wetlands can also occur through tilling and rerouting of surface water. Some agricultural areas are actually former wetlands that would likely revert back to wetland character if left alone for a period of time.

Even if wetlands are not directly filled, drained, or developed, they still can be impacted by adjacent uses. Siltation from erosion or pollutants entering via stormwater runoff can destroy the wetland. Previously healthy and diverse wetlands can be reduced to degraded "muck holes" where only the hardiest plants like cattails can survive. Invasive plant species, such as phragmites, have seriously compromised the ecological integrity of many wetlands.

Figure 1-3: Soil Types



Impervious Surfaces

Impervious surfaces are those surfaces which do not allow for the infiltration of precipitation into the ground. Typical impervious surfaces include driveways, rooftops, patios, and roads. Since precipitation is not allowed to slowly percolate into the ground and recharge the groundwater, it is forced to runoff from these impervious surfaces directly into a storm sewer system or nearby water features without a chance for any

pollutants that the stormwater may carry to settle out prior to reaching the surface water. Stormwater that originates from impervious surfaces oftentimes carries with it a host of pollutants, including sediments, grease, oil, and salt from roads and driveways. Stormwater from impervious surfaces also contributes to "flashy" flows in creeks and rivers resulting in increased flow velocities and therefore increased streambank erosion and sedimentation during storm events. Figure 1-5 identifies impervious surfaces within the Lily Lake System watershed.

Figure 1-4: Wetlands

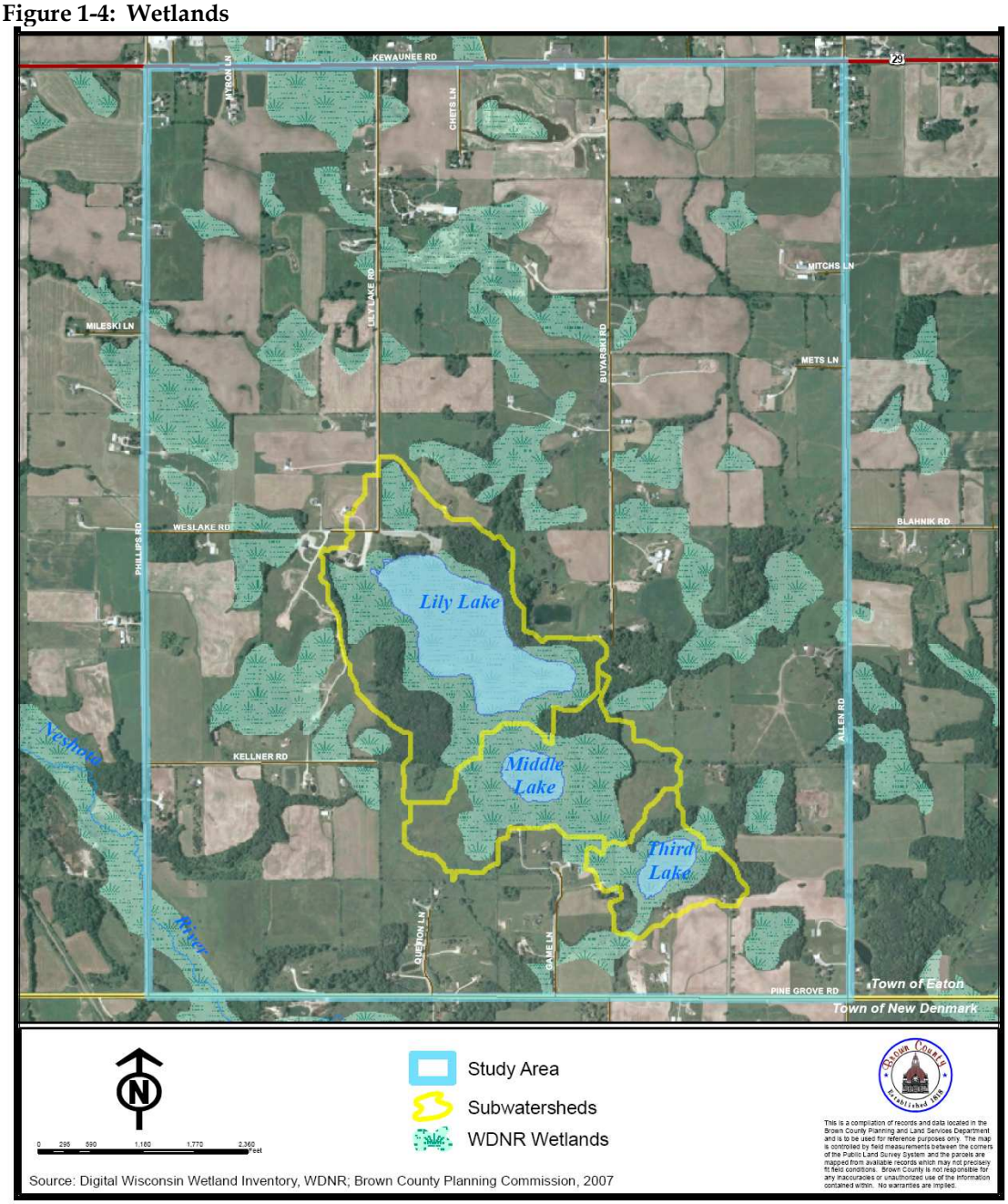
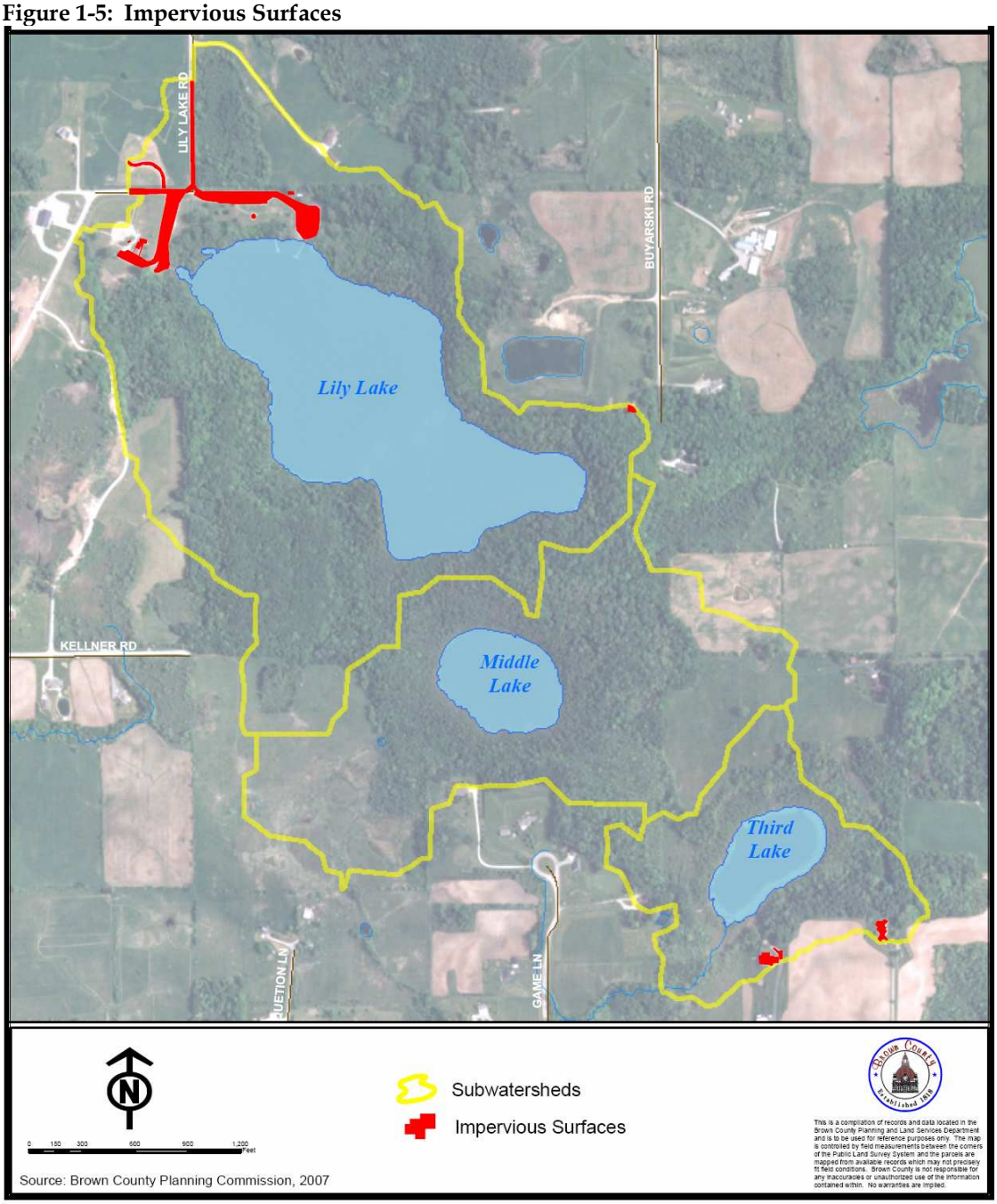


Figure 1-5: Impervious Surfaces



A number of scientific studies indicate that fish habitat and diversity begin to decline rapidly once a watershed exceeds ten percent impervious surfaces. To determine the impervious surfaces present within the Lily Lake, Middle Lake, and Third Lake basins an inventory of impervious surfaces within watershed was completed utilizing Brown County's 2005 six-inch resolution aerial orthophotos. Impervious surfaces within the Lily Lake System basins, including roads, driveways, and rooftops, totaled 3.56 acres of land. However, the total Lily Lake System basin area covers 261.5 acres. Therefore only

1.36 percent of the total system basin area is considered to be impervious surfaces. It is critical that as development continues around the fringes of the Lily Lake System watershed, that extensive erosion control measures are used during construction and that serious consideration be given to pervious surfaces such as interlocking pavers rather than asphalt or concrete for driveways. Additionally, existing development could utilize stormwater management techniques such as rain barrels or rain gardens to minimize stormwater runoff and encourage percolation into the groundwater.

Although there is a very limited amount of impervious surface within the drainage basins, the Lily Lake parking lot and boat ramp drain directly into the boat launch area without any filtration or treatment. Brown County should consider the installation of a catch basin or other stormwater treatment system to prevent sediments, grease, oil, and other pollutants that are commonly found on parking lots from discharging directly into Lily Lake during the first flush of a rain or snowmelt event. Since phosphorus, as one of the primary nutrients that promote excessive weed and algae growth, is generally attached to particles of sediments, trapping these particles prior to them entering Lily Lake would also assist in keeping additional phosphorus from entering the lake.

Chapter 2

Historic Land Use Changes

Introduction

The Lily Lake System, as previously noted is generally a closed watershed. Except for an intermittent stream draining Third Lake, all rainwater, stormwater runoff, and pollutants that enter the Lily Lake System remain there without the "flushing" that typically occurs in lakes that contain a regular inlet and outlet. Therefore, land use activities within the Lily Lake System watershed have a direct impact upon the water quality and long-term ecological health of the system. The following chapter inventories land use changes within the study area and more specifically, within the three distinct watersheds that drain directly into the lakes.

The land uses were interpreted from historic aerial photos maintained by the Brown County Planning and Land Services Department for the years of 1938, 1960, 1992, and 2006 (BCPC, 2007). Land uses were analyzed between STH 29, Allen Road, Pine Grove Road and Phillips Road (Figure 1-1). The land uses were digitized into a geographic information system platform, which was then utilized to map the land uses for a visual representation of change over time and calculate acreages by land use for each year. An aerial photo, land use map, and study area/watershed area acreages by land use are provided for 1938 and 2006 to compare the cumulative change.

1938 Land Use Inventory

As displayed in Figure 2-1 the land use within the study area in 1938 is primarily agricultural with small farms being the only developed land use. Agricultural lands totaled 1,312 acres of land, or 67.6 percent of the total study area. Woodlands and natural areas comprise the next largest categories of land uses and were primarily located along the lakeshores, wet depressions, and the larger drainageways in the study area. The absence of more woodlands and natural areas is likely due to the practice of draining and tiling of wetlands to produce tillable acreage, which was commonplace at the time.

Woodlands and natural areas comprised a total of 482 acres of land, or 24.87 percent of the total study area. Residential and agricultural buildings accounted for a total of 28.2 acres of the total study area or 1.45 percent of the total study area. Specifically within the Lily Lake System watersheds, there were small areas of agricultural lands on the fringes of the watersheds; however, the actual waterbodies were well buffered by large areas of woodlands and wetlands.

2006 Land Use Inventory

The 2006 land use inventory (Figure 2-2) displays a continuation of the trend toward residential development first noted in the 1992 land use inventory. The years between

1992 and 2006 witnessed significant numbers of new, primarily single-family homes developed within the Lily Lake Study Area. The homes are typically on large lots in former agricultural lands. Residential development has also begun close to the boundaries of Lily Lake County Park, likely drawn to the area because the park land will not be developed. Many of the former agricultural fields that were transitioning into wetlands in previous years show up as wooded wetlands in 2006.

Figure 2-1: 1938 Land Uses

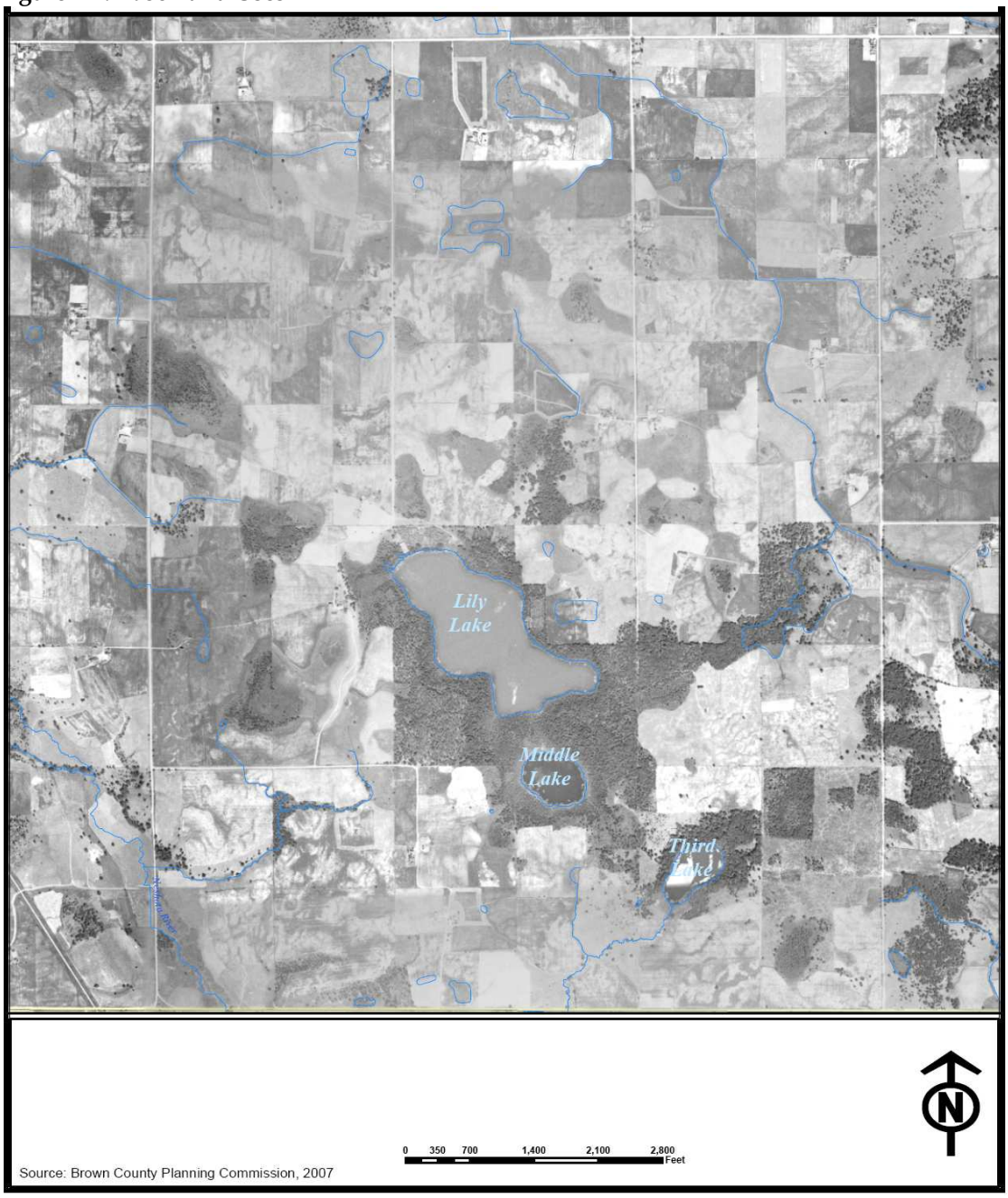
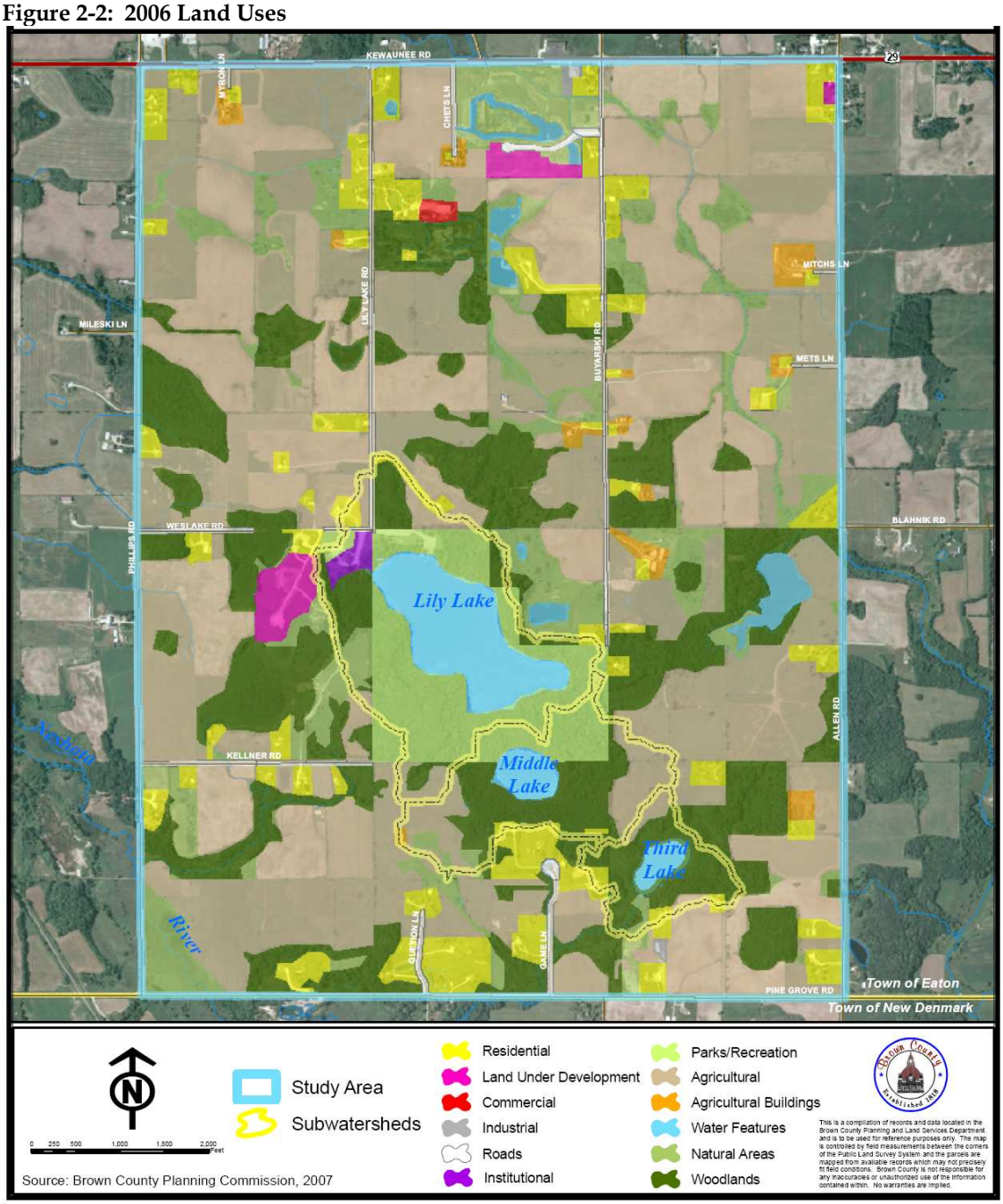


Figure 2-2: 2006 Land Uses



In 2006, developed uses (Residential, commercial, and agricultural structures and other miscellaneous uses) accounted for 256.0 acres of land or 13.20 percent of the total study area. Agricultural use continued to decrease to 973.8 acres (50.21 percent), while woodlands and natural areas continued to increase to 633.3 acres (32.65 percent). Lily Lake, Middle Lake, Third Lake, and a few other small bodies of water accounted for 76.4 acres, or 3.94 percent of the total study area. Table 2-1 identifies the land use categories and acreages for each year inventoried.

Table 2-1: Changes in Lily Lake Study Area Land Uses, 1938-2006

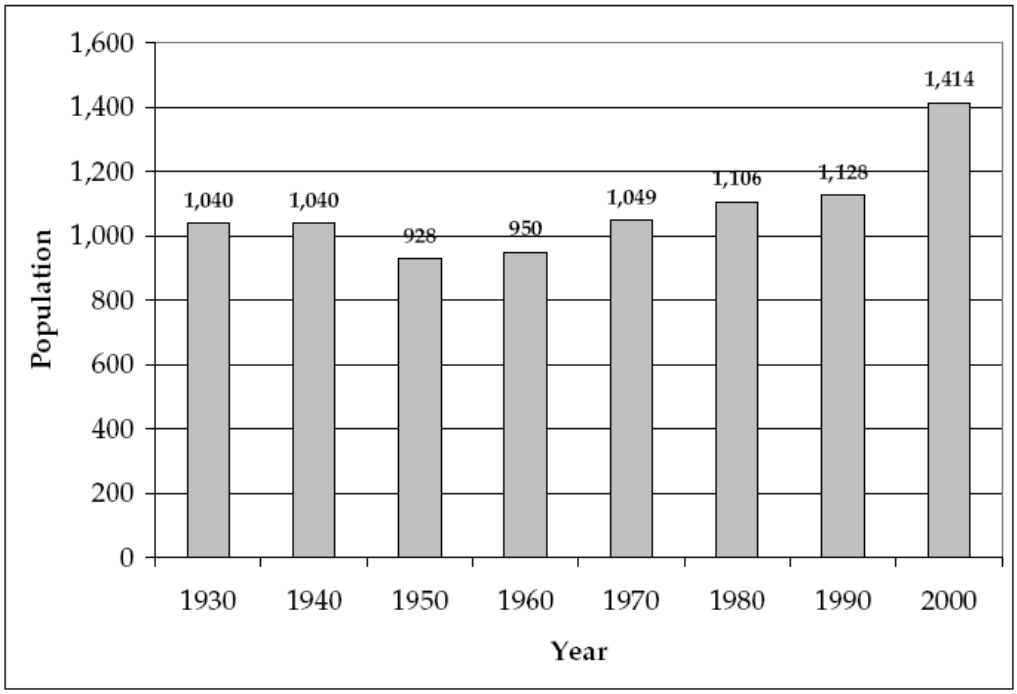
Change in Land Uses, 1938-2006								
Land Use	1938	Percent	1960	Percent	1992	Percent	2006	Percent
Residential	11.7	0.60%	12.6	0.65%	79.8	4.11%	145.2	7.49%
Land Under Developmen	0.0	0.00%	0.0	0.00%	0.8	0.04%	19.3	0.99%
Commercial	0.0	0.00%	0.0	0.00%	2.3	0.12%	2.3	0.12%
Quarry	0.0	0.00%	5.8	0.30%	4.4	0.22%	0.0	0.00%
Storage	0.0	0.00%	0.0	0.00%	0.0	0.00%	2.2	0.11%
Roads	60.3	3.11%	60.3	3.11%	60.3	3.11%	62.6	3.23%
Institutional	0.0	0.00%	5.1	0.26%	4.0	0.21%	4.0	0.21%
Farm Buildings	16.5	0.85%	18.5	0.95%	18.9	0.97%	20.4	1.05%
Agriculture	1,311.7	67.63%	1,318.1	67.96%	1,090.2	56.21%	973.8	50.21%
Lakes	57.1	2.95%	57.6	2.97%	65.5	3.38%	76.4	3.94%
Natural Areas	165.4	8.53%	82.2	4.24%	193.8	9.99%	177.9	9.17%
Woodlands	316.8	16.34%	379.3	19.56%	419.6	21.63%	455.4	23.48%
Total Acreage	1,939.5		1,939.5		1,939.5		1,939.5	

Source: Brown County Planning Commission, 2007

Town of Eaton Population Changes, 1938-2006

As is evidenced in Figure 2-3, during the time period of 1930-2000, the Town of Eaton population grew from 1,040 residents in 1930 to 1,414 residents in 2000, which is an increase of approximately 36 percent over 70 years. Additionally, the 2007 Wisconsin Department of Administration preliminary population estimates place the Town of Eaton's population at 1,581 residents, which is an 11.8 percent increase from the 2000 Census.

Figure 2-3: Town of Eaton Population Trend, 1930-2000



Source: U.S. Bureau of the Census, 1930-2000

In the context of land use as previously identified in Table 2-1, from 1938 to 2006, just within the Lily Lake Study Area, residential land use increased from 11.7 acres in 1938 to 145.2 acres in 2006, resulting in residential lands as a percentage of the total study area increasing from 0.60 percent in 1938 to 7.49 percent in 2006. It is evident from these numbers that even though population in Eaton as a whole is generally slowly increasing, the change in residential land uses within the study area has increased significantly. This has likely increased the usage of Lily Lake for recreation activities and potentially increased its susceptibility to negative impacts such as additional stormwater runoff and the introduction of invasive species.

In addition, the development to support higher populations with additional homes and businesses increased the impervious surfaces. Impervious surfaces such as driveways, parking lots, and roof tops increase stormwater runoff by preventing the infiltration of nutrient-laden water into the ground. This may lead to a decrease in water quality as detailed in Chapter 5.

Town of Eaton Population Changes, 1938-2006

Brown County and the Town of Eaton have experienced relatively high growth over the past decade. The trend to convert agricultural land and woodland to new developed uses is likely to continue. The primary land use goal for the Lily Lake Study Area is to assure that development can occur in an environmentally friendly fashion which emphasizes stormwater management.

Objective 1: Monitor land use changes and assess how they will affect surface water quality in the Lily Lake watershed.

Lily Lake is a wonderful natural amenity located minutes from the Green Bay metropolitan area. The fact that almost its entire shoreline is protected from development by virtue of it being within Lily Lake County Park means that it will be protected from development into the future. However, based upon the land use and population research contained in this report, it is obvious that development is beginning to slowly reach the boundaries of the park, and will likely continue to increase for the foreseeable future. With increased development will come, for better or worse, increased demands upon Lily Lake and Lily Lake County Park for fishing, canoeing, kayaking, hunting, picnicking, and other recreation opportunities.

1A. Brown County, the Town of Eaton, or a "friends group" should apply for funding once every five to 10 years to replicate the water quality study in this report.

1B. Utilize the periodic funding to assess how the overall water quality has changed and assess how strategies implemented to help curtail eutrophication have fared.

Objective 2: Monitor land use changes and assess how they will affect groundwater quality in the Lily Lake watershed.

Development and other land use changes will have significant impacts on groundwater quality as well. Stormwater runoff infiltrates into the ground. As it seeps through soil and enters the water table some contaminants can be carried along. Since Lily Lake is a seepage lake, it is directly fed by ground water. In many cases, the groundwater recharge areas for a lake are significantly different in location and size to the surface watershed (ACPD, 2007). Care must be taken throughout the Town of Eaton to protect water quality.

2A. Conduct a groundwater flow study to identify the recharge areas for Lily, Middle, and Third Lakes.
2B. Monitor land uses within the identified groundwater recharge areas to ensure that fertilizer usage is limited to assure long-term water quality.

Chapter 3

Inventory and Analysis of Existing Ordinances and Plans

Introduction

Plans and ordinances are the tools by which local, county, regional, and state units of government identify a vision for the future and the means to put plans into action. Within the Lily Lake Study Area, there are three units of government with plans or ordinances that govern how land may be used. The Town of Eaton, Brown County, and the State of Wisconsin all have various plans, ordinances, and in the case of the state, statutes and administrative codes that are applicable to the study area. Phase I of this study provided a detailed analysis the primary plans and ordinances that apply to Lily Lake and the lands and waters surrounding it (BCPC, 2007). The Comprehensive Lake Management Plan summarizes these ordinances as a reference.

Town of Eaton

Town of Eaton Comprehensive Plan

A comprehensive plan is an official public document adopted by ordinance on April 5, 2003, by the Town of Eaton that sets forth its major policies concerning the future physical development of the community. The primary purposes of this plan are to generate goals for attaining a desirable development pattern, devise strategies and recommendations the town can follow to achieve its desired development pattern, and meet the requirements of the State of Wisconsin Comprehensive Planning Law. The Future Land Use Map, which depicts the overall intent and ultimate goal of the comprehensive plan, is shown in Figure 3-1. The recommendations of the plan reflect the 14 local comprehensive planning goals prescribed in state statute. The plan is used by town officials when revising and administering its Zoning Ordinance, Subdivision Ordinance, and official map. The plan is the basis for reviewing potential developments, and provides a guiding vision so that there is a consistent policy to follow and a clear goal for the future for the residents of the Town of Eaton. The future land use plan depicts what areas of the town are expected to grow, areas that are environmentally sensitive, and other proposed future facilities. A land use plan can be used to identify areas where stormwater management is critical to protecting critical environmentally sensitive areas (ESAs).

Zoning Ordinance

The Town of Eaton Zoning Ordinance was last updated in October 2003 shortly after adoption of the town's comprehensive plan. There are five zoning districts within the town: Residential, Agricultural, Exclusive Agricultural, Community Business, and Industrial. Each zoning district specifies building criteria for all structures and uses. Utilizing the Zoning Ordinance to limit development around Lily Lake can be an effective tool in protecting overall water quality. As displayed on Figure 3-2, lands

Figure 3-1: Town of Eaton Future Land Use Map

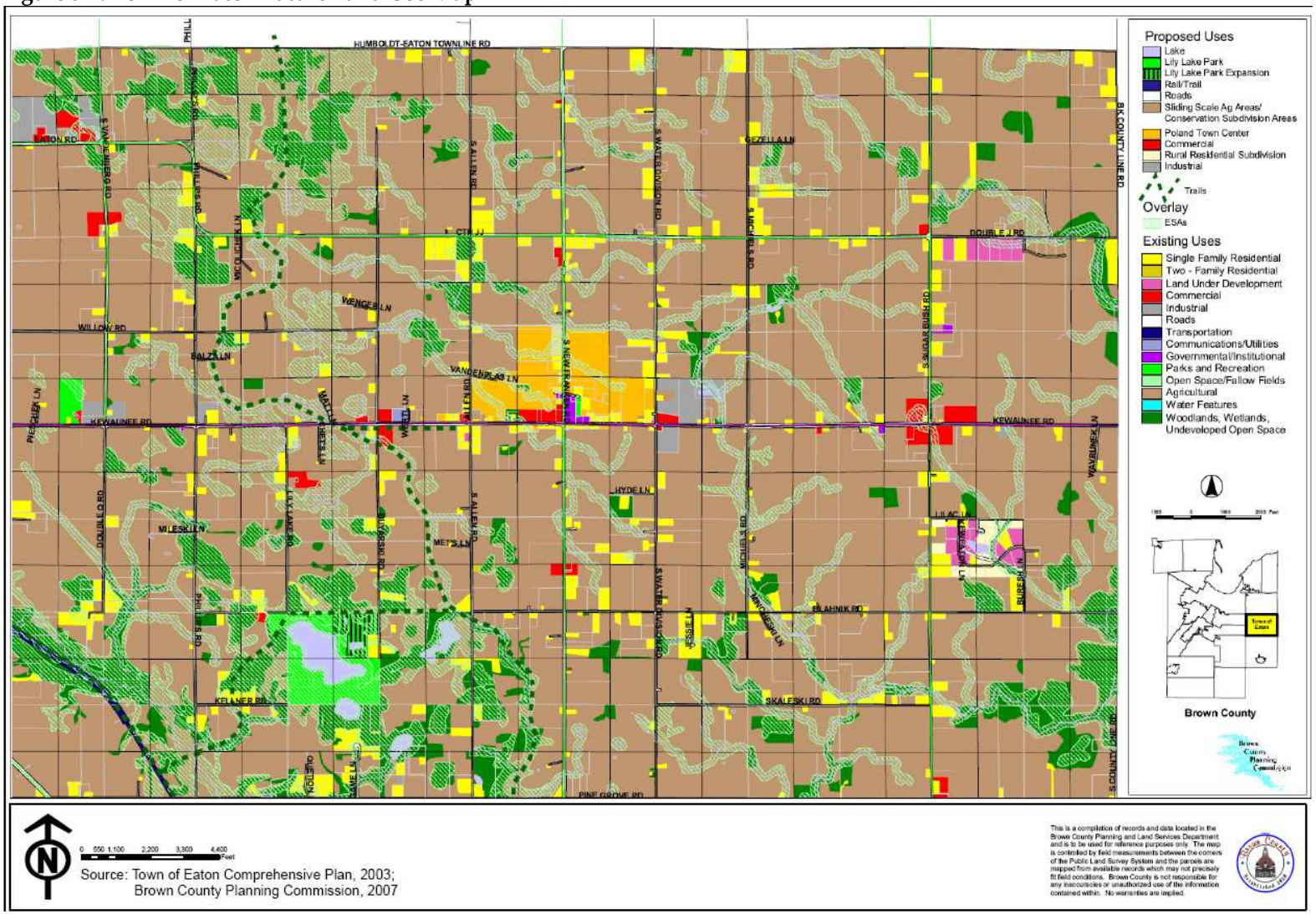
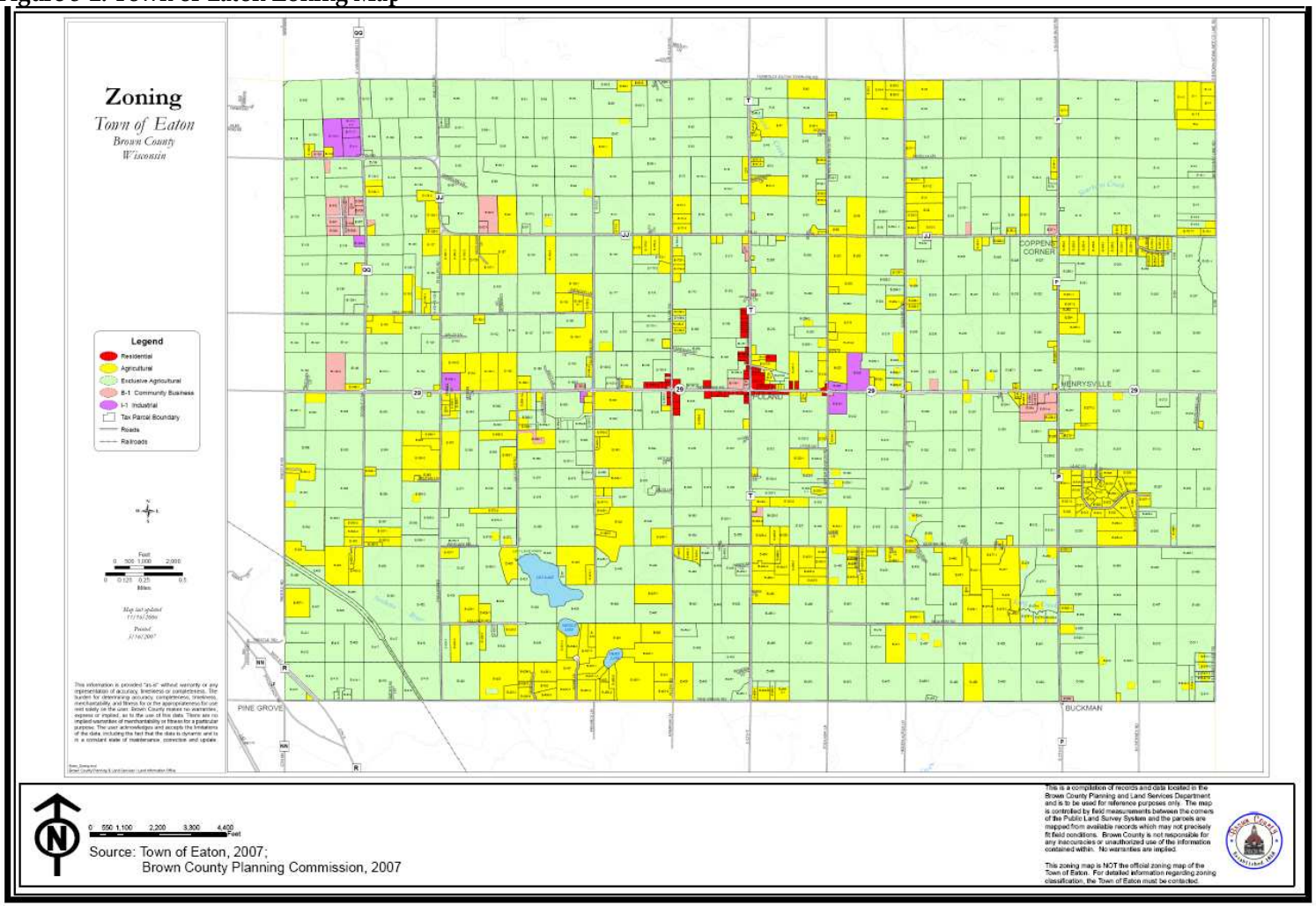


Figure 3-2: Town of Eaton Zoning Map



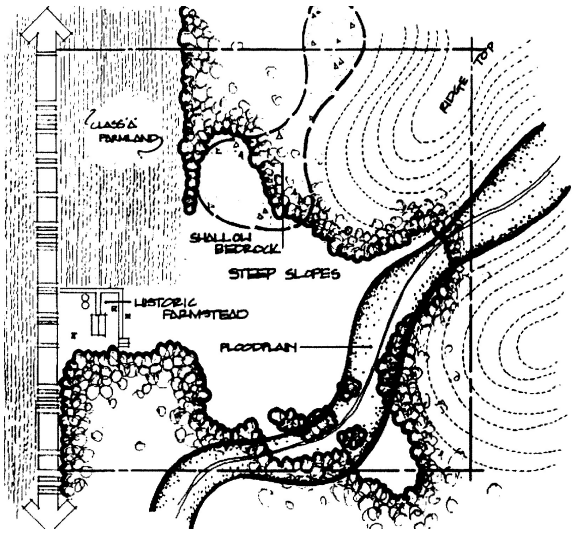
within the Lily Lake Study Area lands are predominantly zoned either Exclusive Agricultural or Agricultural, although there are a few very small parcels zoned residential for homes on smaller lots, community business for an excavation business, and industrial for mini warehouses.

As identified on the zoning map, the majority of lands in the Lily Lake Study Area are zoned Exclusive Agricultural. However, all of the land around Third Lake and the half of Middle Lake that is outside of the park boundaries are zoned Agricultural, which permits single and two-family residences by right, so long as there is a maximum two acre parcel to build upon. There are only two very small areas adjacent to Lily Lake that are not zoned Exclusive Agricultural. Not coincidentally, these are also the only parcels that are not part of Lily Lake County Park. As this is an unofficial copy of the Town of Eaton Zoning Map, any inquiries related to the current zoning of any parcels in the Town of Eaton should be directed to the Town of Eaton Zoning Administrator.

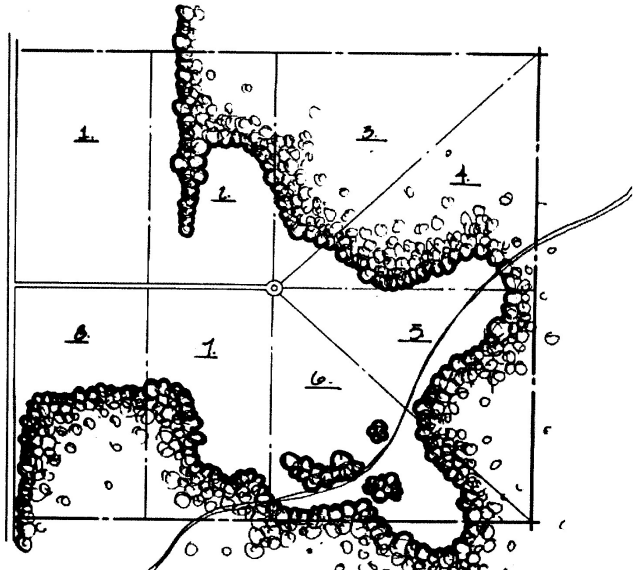
Conservation by design subdivision development is an innovative development method that focuses on maintaining open space and conserving significant natural and cultural features. In the Town of Eaton, conservation by design subdivisions is a permitted use under the Agricultural zone, whereas conventional subdivisions are a conditional use. The town promotes the preservation of open space and conservation of natural and cultural features by preserving a significant portion of a development site as undivided open space with the remaining land uses for the house lots and necessary roads. The open space is permanently preserved through conservation easements. It is important to note that conservation by design subdivision provides the landowner with the same number of lots as could be accomplished through a conventional subdivision.

The following conservation by design example uses the same number of house lots from the conventional layout but completely alters the design by simply reducing the lot size and being sensitive to the environmental features in order to preserve natural and open areas. The following sketches are from "A Model Ordinance for a Conservation Subdivision" prepared by the University of Wisconsin Extension. These sketches (steps 1-3) are hypothetical situations and the lot sizes utilized in the sketches do not reflect the existing town zoning requirements.

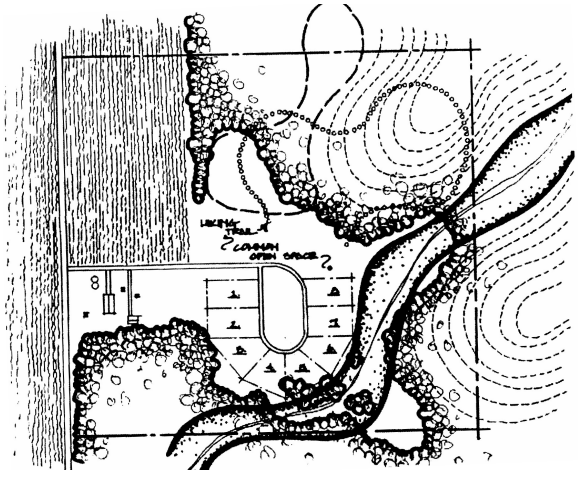
Step 1: Inventory and mapping of existing resources for a hypothetical 40 acre site.



Step 2: Development yield as permitted under existing ordinances (zoning, etc.) for the 40 acre site and assuming a five acre minimum lot size zoning standard. Eight lots would be permitted under this scenario.



Step 3: Concept map of the conservation subdivision showing the eight lots that would be permitted, plus the historic farmhouse, which would be preserved, for a total of nine dwelling units.



The conservation by design subdivisions offers a preferable alternative to typical subdivisions with large house lots blanketing entire tracts of land.

Brown County

In addition to the Town of Eaton Comprehensive Plan and Zoning Ordinance, Brown County maintains a number of land use plans and ordinances that apply to the Lily Lake Study Area. The ordinances govern activities as diverse as land divisions to nutrient management. The following section will inventory and analyze those ordinances that apply either to the Lily Lake System or to those lands surrounding it.

Brown County Subdivision and Platting Regulations

All villages and towns within Brown County are covered under the Brown County Subdivision and Platting Regulations, including the Town of Eaton. Many communities also have their own more specific subdivision and platting regulations, however, the Town of Eaton has not yet adopted its own ordinance governing the division of land. Within the Lily Lake Study Area, all land divisions that create at least one parcel of land ten acres or less in size is subject to the Brown County Subdivision and Platting Regulations.

Environmentally sensitive areas (ESAs) are required to be delineated on the face of any certified survey map or subdivision plat for it to be approved and recorded by Brown County. In order to define the ESA, Brown County typically requires WDNR-approved wetland delineation for any lands that are proposed to be divided that contain likely wetlands. Additionally, where a stream may be navigable and therefore an ESA, Brown County may require WDNR navigability determination to evaluate the distance a structure must be setback. When a subdivision plat is submitted for review, if there is not one already completed, Brown County requires a stormwater management plan be completed and erosion control measures are in place to ensure adequate drainage and treatment of stormwater during and after development.

Shorelands and Wetlands Ordinance

Chapter 22 of the Brown County Code of Ordinances, pursuant to state statute and Administrative Code NR 115 regulates activities within the shorelands of Brown County. The shoreland zone consists of the lands within 1,000 feet of the ordinary high-water mark or any lake, pond or flowage and lands within 300 feet of the ordinary high-water mark of navigable rivers or streams or to the landward side of the floodplain, whichever distance is greater. The Brown County ordinance applies to all unincorporated areas in Brown County, including the Lily Lake Study Area. Cities and villages must maintain their own shoreland regulations or contract with the Brown County Zoning Department to administer their local ordinance on the community's behalf.

Within the shoreland zone, a permit is required to be obtained from the Brown County Zoning Department prior to any filling, grading, excavating or general development activity on the site. Additional requirements govern the cutting and removal of shoreland vegetation, building setbacks, and erosion control measures.

A second component of this chapter of the Brown County Code of Ordinances is the definition of the shoreland-wetland district. The shoreland-wetland district is a separate zoning overlay district contained within the Shoreland Zoning Ordinance. The shoreland-wetland district restricts the uses of properties on lands that are identified as wetlands on the Brown County Wetlands Zoning Maps that are two acres or greater in area. Uses within the shoreland-wetland zone are primarily limited to passive recreation, agricultural uses and other non-intensive limited activities.

The Shorelands and Wetlands Ordinance for Brown County provides another layer of protection for the surface water features of Brown County, including Lily Lake, Middle Lake, and Third Lake. All three named lakes' shorelines are part of a 1,000 foot shoreland zone, within which a permit is required prior to beginning any development

activity. When development takes place, erosion control measures, in compliance with the permit, must be in place and functioning in their intended manner.

Private Sewage System Ordinance

Chapter 11 of the Brown County Code of Ordinances governs the installation, maintenance, and removal of private on-site wastewater treatment systems (POWTS) within Brown County and is administered by the Brown County Zoning Department. All POWTS installed after January 17, 1990 are required to have their sludge or scum pumped a minimum of once every three years with certification provided to the Zoning Department. All POWTS installed on or after July 1, 2000 are also required to be maintained and serviced in accordance with an approved management plan on file with the Zoning Department. Additionally, any land divisions subject to Brown County review involving any existing POWTS are required to be inspected prior to approval by Brown County. As the Town of Eaton does not provide public sanitary sewer service, all homes and businesses within Lily Lake Study Area are on POWTS and subject to the requirements set forth in Chapter 11 of the Brown County Code of Ordinances.

Agricultural Shoreland Management

Chapter 10 of the Brown County Code of Ordinances requires the installation of vegetative buffers or "equally effective erosion control practice" within the agricultural shoreland corridor. The agricultural shoreland corridor is defined as agricultural lands extending 20 feet from the top of the bank on each side of a perennial river or stream, the centerline of an intermittent stream, or the ordinary high water mark of any lake or pond, shown on a USGS quadrangle map with a scale of 1:24,000.

The Agricultural Shoreland Management Ordinance is administered through the Brown County Land Conservation Department which provides a cost-sharing program for landowners to install the buffers and utilize best management practices for the land owners that are subject to the ordinance.

Animal Waste Management

The Brown County Land Conservation Department also administers Chapter 26 of the Brown County Code, which regulates design, construction, abandonment, and maintenance of animal waste storage facilities, animal feedlots, and nutrient management plans. The primary component of this ordinance that impacts the Lily Lake Study Area is the section dealing with nutrient management. Any landowner that has a permitted animal waste storage facility is required to develop a nutrient management (590) plan that "balances the nutrient needs of a crop with the nutrients available from legume crops, manure, fertilizer, or other sources." Management includes the rate, method, and timing of the application of all sources of nutrients to minimize the amount of nutrients entering surface and groundwater, as established in Wisconsin Administrative Code ATCP 50.04(3). A nutrient management plan must be updated and submitted to the Brown County Land Conservation Department annually until the permitted animal waste storage facility is no longer in use and has been properly abandoned. The Brown County Land Conservation Department has published general maps and guidelines to aid landowners in developing the nutrient management plans.

Brown County Open Space and Outdoor Recreation Plan

The Brown County Open Space and Outdoor Recreation Plan (recreation plan) was updated in August 2008. The recreation plan identifies long-range goals and short-term projects to enhance the opportunities for outdoor recreation in Brown County. Specific to the Lily Lake Study Area, the recreation plan identifies approximately 75 acres of land for acquisition by Brown County to expand Lily Lake Park to the east, south, and west. The plan further recommends the development of walking trails, playground equipment, and a restroom.

Brown County Comprehensive Plan

The Brown County Comprehensive Plan was adopted in October 2004 and amended in June 2007 by the Brown County Board of Supervisors. Brown County's Comprehensive Plan is a compilation of the locally developed and adopted comprehensive plans. Therefore, the recommendations and future land uses contained within the Town of Eaton Comprehensive Plan are reflected in the composite future land use map for Brown County. Recommendations include the purchase of a 27.9 acre parcel just to the east of Lily Lake by Brown County as an addition to Lily Lake County Park. Brown County's future land use map also identifies the environmentally sensitive areas in the Lily Lake Study Area, similar to those identified in the Town of Eaton Comprehensive Plan.

Brown County Land and Water Resources Plan

The Brown County Land and Water Resources Plan was developed by the Brown County Land Conservation Department to assess water quality and soil erosion conditions within the county. The focus of the plan is on the reduction of sediment and phosphorus delivery caused by agricultural non-point sources. Additional information and analysis on stream corridors and field parcels not meeting erosion standards and animal waste management was also compiled for the plan.

State of Wisconsin

The State of Wisconsin has a number of plans, statutes, and administrative codes in place that apply to the Lily Lake Study Area. However, many of these, particularly navigable waters, wetlands, floodplains, and shorelands, have previously been addressed within this report.

2005-2010 Wisconsin Statewide Comprehensive Outdoor Recreation Plan

The Wisconsin Statewide Comprehensive Outdoor Recreation Plan (SCORP) is developed by the Wisconsin Department of Administration and updated on a five-year cycle to provide eligibility to the state for Federal Land and Water Conservation Program acquisition and development assistance. The program is administered by the WDNR and provides grants to state and local agencies for land purchases, facility development and facility rehabilitation. The plan provides state regional baseline population trends and analysis to forecast the outdoor recreation needs of Wisconsin residents and then uses those trends to identify recommendations for eight regions of the state.

Chapter 4

Stakeholder Participation

Introduction

Public participation was an integral part of completing this lake management plan. If stakeholders do not understand the value of the ecosystem they utilize, the will not strive to protect or enhance it. Stakeholder participation was initiated in several ways including public informational meetings, newsletter publication, a Lily Lake watershed landowner survey, and a survey for general Lily Lake users.

Public Informational Meetings

Several public informational meetings were held throughout the creation of this lake management plan. These information meetings were publicized in both the *Green Bay Press-Gazette* and the *Denmark News*.

Since this study was completed in three distinct phases, meetings were held after the completion of the first two phases in 2008 and 2009. The results for Phase I (BCPC, 2007) and Phase II (BCPC, 2008) were presented to the Eaton Town Board and the Brown County Planning Commission Board of Directors at each agency's monthly meetings. Public input was sought from Town of Eaton officials, Brown County planning commissioners, and citizens of Brown County at these meetings.

Public input was directly sought at two informational meetings in April 2009. Each informational meeting consisted of presentations regarding the status of the Lily Lake fishery and existing water quality obtained in Phase II. One meeting was held at the Brown County Central Library and one at the Eaton Town Hall. These locations were chosen to maximize the number of individuals that could attend. Verbal suggestions were taken from meeting attendees.

Survey Participation

Two distinct stakeholder self-administered surveys were completed in 2009. The first targeted Lily Lake watershed landowners. The primary purpose of this survey was to assess potential properties which could contribute to phosphorous loading in Lily Lake. In addition, the survey elicited responses regarding existing water quality, existing fishing conditions, and desired management outcomes for the aforementioned areas. The second survey was intended to allow general Lily Lake users to provide public input. The primary purpose of this survey was to ascertain how the general population felt about both the existing water quality and fishery at Lily Lake. In addition, questions were included to determine desired management outcomes for these subjects.

The watershed landowner survey was conducted in spring 2009. A modified Salant and Dillman (1994) survey mailing approach was utilized. This protocol involved three separate mailings (Dillman, 2000). The procedure is formally known as the Tailored Design method. The survey was mailed with an accompanying cover letter which detailed the purpose and the importance of the survey (Appendix A). Survey questionnaires were mailed with self-addressed stamped return envelopes. Approximately one month from the initial survey, a second copy of the questionnaire along with a personalized follow-up cover letter restating the purpose of the survey was sent to all non-respondents. The cover letter explained the importance of the survey.

The date each important mailing was sent out was recorded. The original survey was mailed on May 11, 2009. The follow-up survey was mailed on June 5, 2009.

A general Lily Lake user survey was conducted utilizing the Brown County Planning Commission (BCPC) web site (Appendix B). The survey period began on July 1, 2009, and continued until September 1, 2009. Placards advertising the survey were posted on the kiosk at the boat ramp at Lily Lake and on each of the portable restrooms. The placard included the web site link and a brief description of the survey purpose and intent. The placard was posted during the entire survey period. Each newspaper article also indicated that the BCPC was conducting surveys and included the web site information.

Survey Response Rates

The tailored design method was chosen for several reasons. First, surveys that have utilized this methodology have yielded a higher response rate than other survey methods (Dillman, 2000). The use of several mailings provided the opportunity to repeatedly remind participants about the importance of the comprehensive lake management plan. Past surveys utilizing this methodology have typically yielded response rates exceeding 60 percent (Eubanks etal, 1999; Eubanks etal, 2000). This far exceeds lower response rates that are obtained through other survey methods (Dillman, 2000; Sallant and Dillman, 1994). Second, the tailored design method assigns a unique number to each survey. Each survey had a hand-written identification number on the upper right hand corner of the survey. This number was explained to participants in the survey cover letter as a means to track response rates to maximize the usefulness of the data collected. This forthrightness helps increase response rates (Dillman, 2000; Sallant and Dillman, 1994). Third, several personal touches are incorporated to help improve response rates. Each letter and post card was individually hand signed in blue ink by BCPC staff. Individual address labels were printed using mail merge features. The return envelope postage was paid in recognizable postage stamps instead of a bulk rate meter.

A survey response rate of 79 percent was obtained for the watershed resident survey. This far exceeds the average 30–35 percent response rates for recent surveys conducted by the BCPC. A response rate is unavailable for the general user internet survey as it

was conducted to be open continuously to the open public. Only three persons responded.

Survey Data

All survey data is presented in the appendices. The watershed landowner survey data is presented in Appendix C. The data for the general user internet survey is presented in Appendix D. Where appropriate, the data will be discussed throughout the text of the document.

Future Public Participation

Brown County Facility and Park Management and Brown County Planning Commission anticipate that several of the recommendations included in the lake management plan will be implemented. Brown County residents will be given opportunity to participate at informational meetings. The public will be notified when this arises. The Park Department will continue to alert the public through its media distribution list and maintain up-to-date postings on its web site.

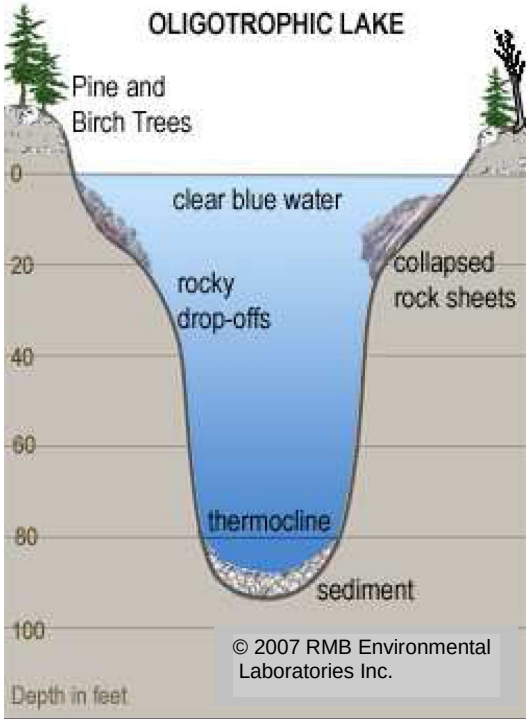
Chapter 5

Water Chemistry

Limnology

Limnology is the division of hydrology that studies fresh water. Limnology covers lakes, ponds, reservoirs, streams, rivers, wetlands, and estuaries. Limnologists recognize that lakes are complex ecological systems physically and chemically connected with its surroundings. Scientists use biological, physical, chemical, and geological characteristics of the surface water to determine a lake's overall "health."

Trophic Status

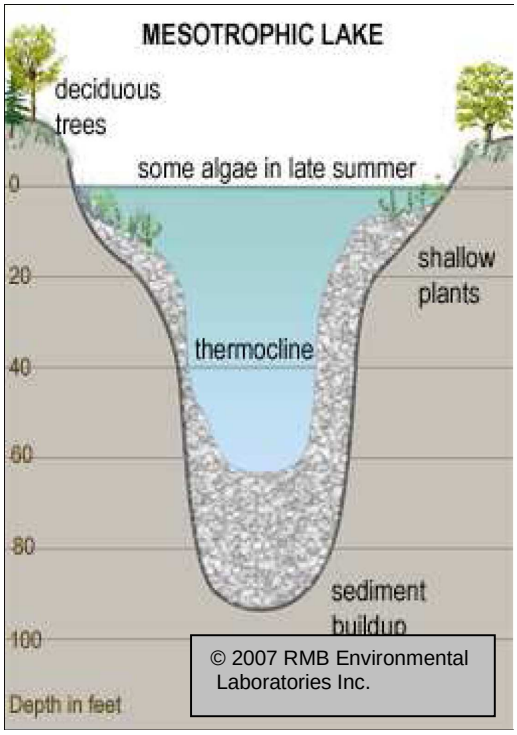


Lakes are classified according to their "trophic status" depending on the amount of nutrients present in the lake. Lakes are classified as either oligotrophic, mesotrophic, or eutrophic.

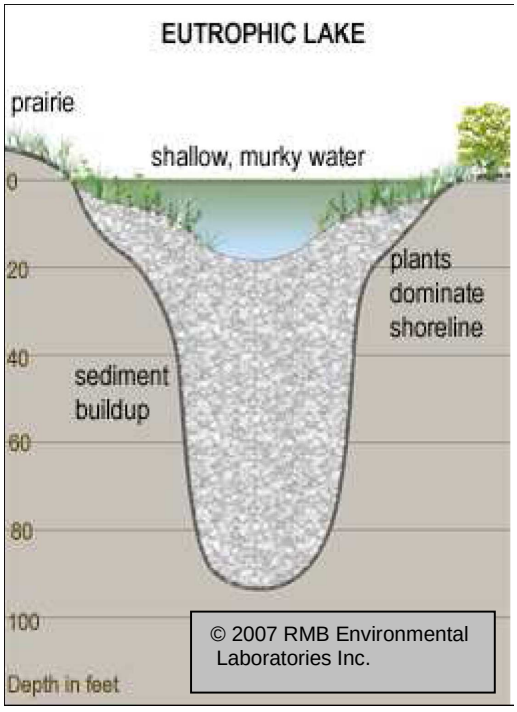
Oligotrophic lakes have little or few nutrients. They are generally deep lakes within generally U-shaped basins. Temperatures are often cold, and oxygen levels are high throughout the water column. Since cold water can hold more oxygen, they often hold healthy trout populations.

Eutrophic lakes have highly enriched nutrient levels. Such lakes are often shallow V-shaped bottoms. The bottoms are often mucky and soft-bottomed. Deeper portions of the lakes are often anoxic, or devoid of oxygen, during a large part of the year. In very shallow lakes, the entire lake may become anoxic. The high nutrient concentrations allow high plant and algae growth. In less eutrophic lakes, game fish populations such as bass, pan fish, and northern pike thrive. In more eutrophic lakes, rough fish such as carp and catfish survive.

Mesotrophic lakes have an intermediate nutrient concentration. Mesotrophic lakes support higher fish diversities than either oligotrophic or eutrophic lakes. As a result, they often support excellent fisheries. Mesotrophic lakes are unique because they display stratification, or layering of water. As the sun warms the surface layers, water temperatures rise and the density decreases. Since sunlight may not penetrate to the bottom, deeper water becomes colder and denser than surface waters. This differentiation between water causes noticeable layering. Since the layers do not mix, oxygen levels deplete as algae and other organisms die, settle to the bottom, and decay. Most lakes throughout Wisconsin are mesotrophic.



A natural aging process occurs in all lakes causing them to change from oligotrophic to eutrophic over time. Each year plants uproot in the fall and sink to the bottom. Although some of the material decomposes, lakes will eventually start to fill in. People can accelerate the eutrophication process by allowing nutrient rich runoff to enter lakes from lawns, agricultural fields, septic systems, or urban storm drains.

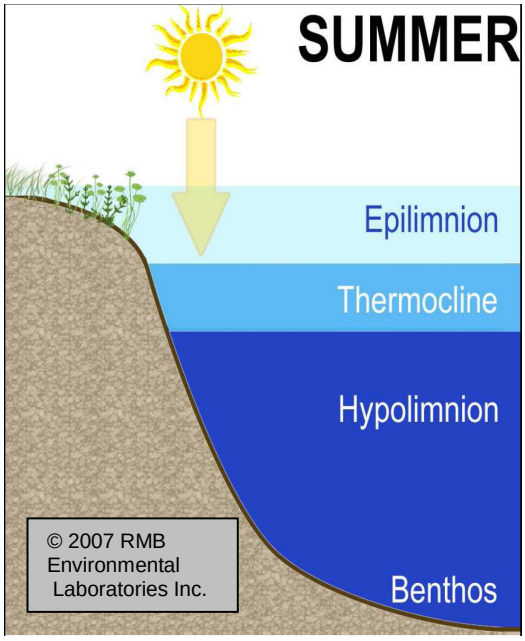


One drawback of defining trophic states within the trophic state index is that lakes vary. The trophic state of a particular lake depends on numerous factors including depth, surface area, watershed size, adjacent land use, and climate. There is some overlap between the trophic classifications. Trophic states should be considered a general definition of lakes condition.

Lake Cycles

Most inland lakes undergo an annual cycle as seen in Figure 5-1. The cycle begins at the spring thaw and repeats itself annually. The length of each stage in the cycle can change the lake's chemical and physical properties throughout the year. During summer, lakes more than 20 feet deep usually experience stratification, or layering. A lakes water quality and ability to support fish are affected by the extent to which the water mixes.

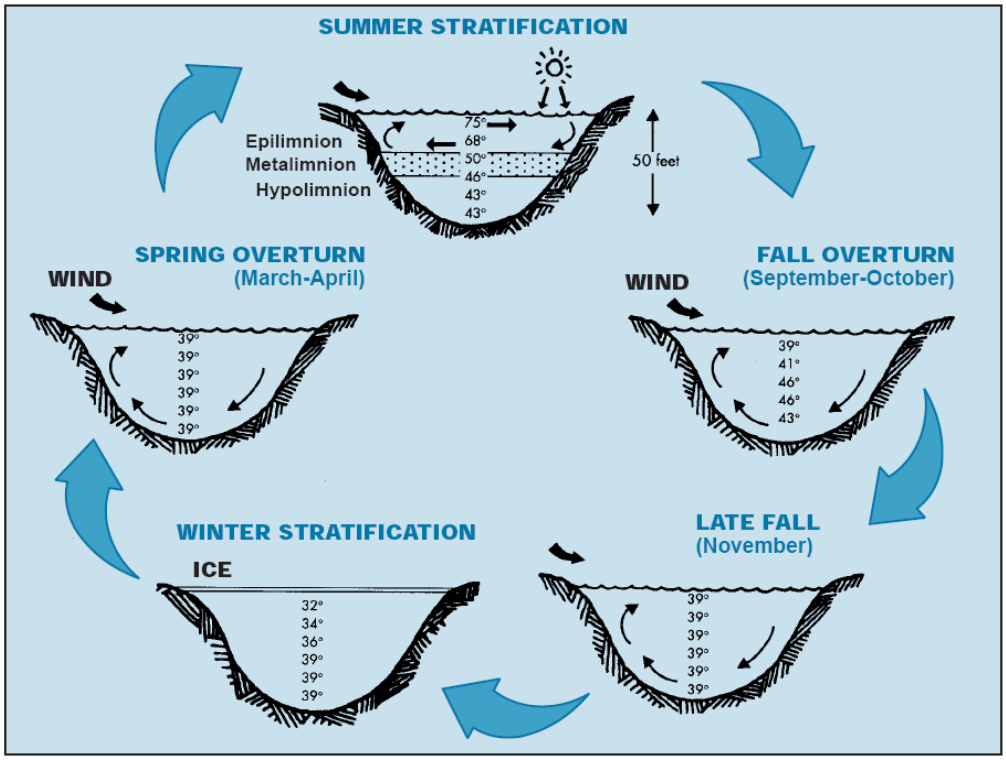
The mixing is caused by the evening of water temperatures throughout the water column. When a lake mixes, cold bottom water is brought to the surface and the warmer surface water is mixed downward.



Stratification is influenced by lake depth and lake orientation. Shallow lakes can be mixed all year by wind or waves. In larger lakes, the wind may continuously mix the water to a depth of 30 feet. Lake shallows do not form layers, though deeper areas may stratify. Winds will sweep over the water surface causing mixing. Lakes with numerous bays may not be thoroughly mixed.

Water density is highest at 39°F (4°C). It is lighter at both warmer and colder temperatures. When ice melts in early spring, the temperature and density of lake water will be almost uniform from the surface to the bottom. The uniform density allows the lake to mix completely, recharging the bottom with oxygen and bringing nutrients to the surface. The mixing is called the spring overturn. Natural mixing can occur to depths of 30 feet.

Figure 5-1: Annual Lake Cycles and Stratification



Source: Wisconsin Department of Natural Resources, 2007

As the summer lengthens, the sun warms the upper layers. Typically the warming is observed to the depth at which sunlight penetrates. As the surface water temperature is warmed, three distinct layers form: the epilimnion (warm surface layer), the metalimnion (transition zone), and hypolimnion (cold bottom water). The metalimnion also known as the thermocline is a zone of rapid change. The temperature usually drops several degrees within a few feet. In some lakes, the metalimnion may be extremely thin preventing mixing of water between the upper and bottom layers.

The circulation of nutrients, food, and other components in stratified lakes are restricted to within a single layer. The bottom layers of productive lakes (those with significant plant growth) become oxygen depleted as temperatures water rise and bacterial respiration increases. With insufficient oxygen, fish kills can occur. In the fall, surface waters cool until the temperature evens out from top to bottom. The evening temperatures allow a second mixing to take place. Nutrients such as phosphorous are re-distributed through the lake. As a result, some lakes may experience a fall algal bloom. There is little variation in temperature and dissolve oxygen after mixing is completed.

Stratification is less noticeable during the winter. Temperature variations only reach 7°F. Ice cover will prevent water from mixing and temperatures will be uniform throughout the winter months. If insufficient oxygen is re-circulated or algal blooms result in increased bacterial decomposition before the water freezes, dissolved oxygen levels will be lower. Fish kills can also occur when ice cover prevents mixing of dissolved oxygen.

Water Quality Testing

Researchers use various methods to calculate the trophic status of lakes. Common characteristics used to make a determination are total phosphorous concentration, chlorophyll a concentration, Secchi disc readings, temperature, dissolved oxygen readings, and color. Other tests such as specific conductivity and pH give clues on the overall chemical composition of a lake.

Total Phosphorous Concentration

Phosphorous is the main nutrient which plants and algae need to grow. Phosphorous occurs in several forms. Not all forms are available for biological activity; the total amount available is dependent on several chemical and physical parameters.

Phosphorous is measured in micrograms per liter (µg/L) which is equivalent to parts per billion (ppb). Typical total phosphorous concentrations for each trophic index are found in Table 5-1. Lakes that have phosphorous concentrations higher than 20 µg/L are susceptible to periodic algal blooms.

Chlorophyll a Concentration

Chlorophyll is the pigment that makes algae and other plants green. At least four types of chlorophylls are known. Chlorophyll a is the most common and is present in all plants. It is the primary photosynthetic pigment and receives light energy from most other pigments.

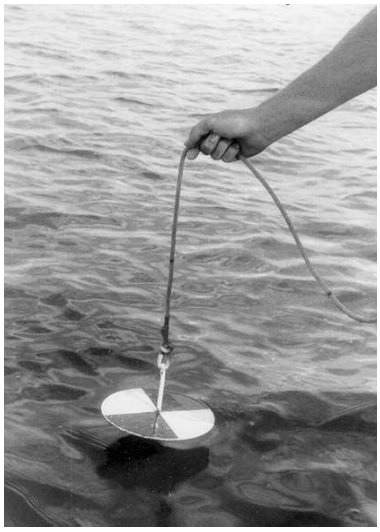
Chemical instrumentation was used to quantify how much algae is in the water. A chlorophyll reading of less than 5 g/L is very good or excellent. A chlorophyll reading of greater than 30 g/L is very poor. Chlorophyll concentrations for the trophic indexes are found in Table 5-1.

Table 5-1: Water Quality Parameters by Trophic Classification

Water Quality Parameter	Oligotrophic	Mesotrophic	Eutrophic
Secchi (feet)	> 16.4	6.5 - 16.4	< 6.5
Total Phosphorus (µg/L)	< 10	10 - 30	> 30
Chlorophyll a (µg/L)	< 2	2 -5	> 5

Source: Mackie, 2001

Secchi Disc Readings



The Secchi disc is arguably the most useful and easy device that is used to perform test in water quality analysis. The instrument is a 20 cm disc with black and white quadrants. An eye bolt is fastened to the center of the disc and a rope is attached to it. The rope is marked in one foot increments. The Secchi disc is lowered into the water until the white quadrants disappear from view. The depth at which the disc disappears is referred to as the Secchi depth.

Secchi readings measure the relative depth of light penetration. It is a relative measurement because readings vary from individual to individual or moment to moment. Factors such as algae concentrations, turbidity, water color, cloud cover, or the amount of shade cast by the boat affect the reading. Algae absorb sunlight and reduce the depth to which it will penetrate. Suspended sediment stirred up by wind or boat motors will cloud the water. "Stained" water may result if tannic acids or other naturally occurring chemicals are present in the water. Secchi data for the trophic index is located in Table 5-1.

Temperature and Dissolved Oxygen

Measuring the temperature of a lake at different depths will determine the influence it has on the physical, biological, and chemical aspects of the lake. Lake temperature can affect the rate of decomposition, nutrient recycling, lake stratification, and dissolved oxygen contents near the bottom. Temperature

changes can also affect the distribution of fish species throughout a lake. The dissolved oxygen content of lake water is vital in determining the fishery present.

Dissolved oxygen also has a strong influence on the chemical and physical conditions of a lake. The amount of dissolved oxygen is dependent on the water temperature, atmospheric pressure, and biological activity. Oxygen levels are increased by aquatic plant production but reduced by bacterial consumption for decomposition and respiration of fish and aquatic invertebrates.

The amount of dissolved oxygen available in a lake, particularly in the deeper parts of a lake, is critical to overall health. Colder water holds more oxygen than warm water. Thus shallower lakes have the tendency to hold less dissolved oxygen.

Both temperature and dissolved oxygen data are collected simultaneously with specialized probes at the end of a 25 foot cord. Readings are taken at the deepest point of the lake. Measurements were taken at the surface and at two foot intervals until the dissolved oxygen content reached 0°C. Measurements were recorded at one foot intervals near the thermocline. The purpose behind collecting profile data is to show how water characteristics change with depth. The profile is taken at the deepest point of the lake because it is the best indicator of lake health.

Color

The color of a lake bottom often affects our perception of the water color. In general bluish or black lakes indicate oligotrophic lakes. The lack of nutrients creates clear water. Brownish lakes indicate mesotrophic or eutrophic lakes. Greenish lakes are typically eutrophic; the green color is a direct result of large concentration of algae and other microscopic plant material.

Specific Conductivity

Electric conductivity is a measure of water's ability to conduct electricity, and therefore a measure of the water's ionic activity. Increasing conductivity is a direct result of higher dissolved ion concentrations. Conductivity is affected by the temperature.

Specific conductance (SC) is a measure using two probes one squared centimeter in area separated by one centimeter. The probes measure the electrical current created by ions in the water. SC is measured in µS/cm.

pH

The pH of a lake indicates whether it is an acidic or basic environment. The pH scale ranges from 0 to 14. A pH value of seven is neutral. As the pH decreases (closer to 0), the water is more acidic; as the pH increases (closer to 14), the water becomes more basic.

A wide range of pH values is encountered in different lakes. The pH is influenced by the geology of the underlying soils and the resulting ions that are dissolved in the water. The pH can regulate various chemical cycles that occur in lakes and directly influence the plant and fish communities present. Furthermore, the temporal and vertical patterns

of pH in lakes mediates through the overall dynamics of photosynthetic consumption and respiratory/decomposition production of carbon dioxide (CO2). Photosynthesis by algae and other plants will increase the pH, while decomposition and respiration make the pH more acidic.

Sampling Methodology

Bathymetry

Bathymetry is the study of underwater depth. The double-headed rake utilized in the plant survey discussed in Chapter 6 was marked at one foot intervals. The depth at each of the 155 sampling points was noted. The depths were entered into ArcView 9.2, and a contour map was created. The ArcView software was also utilized to create a three-dimensional model of Lily Lake.

Temperature and Dissolved Oxygen

Temperature and dissolved oxygen profiles were obtained monthly at the deepest part of Lily Lake. A Hydrolab Quanta probe was lowered through the water column. Temperature, dissolved oxygen, specific conductivity, and pH were measured at the surface and at two foot intervals until the probe hit the bottom of the lake or the dissolved oxygen content reached zero. Measurements were also recorded at one foot intervals at the thermocline.

Per Wisconsin Department of Natural Resources Citizen Lake Monitoring Network requirements, three temperature/dissolved oxygen profiles were to be collected during the growing season (July 15 – September 15). To better understand the annual cycle of Lily Lake, profiles were collected each month. In addition, monthly temperature/dissolved oxygen profiles were collected monthly during the winter to analyze the efficiency of the aerator used by Brown County Park and Facility Management. Winter profiles were collected only as safety conditions warranted.

Chemical Instrumentation

Water samples were collected by hand at the deepest part of Lily Lake. Plastic bottles obtained from the Wisconsin State Lab of Hygiene (SLOH) were rinsed three times with lake water. The bottles were inserted upside-down and extended to an arm's length depth below the water surface. The bottle was inverted and filled to the neck. The bottle was capped, labeled with a unique identifying number, and treated with chemical preservatives where appropriate. All water samples were stored in individual ziploc bags in a refrigerator until shipping. Water samples were shipped on ice to the SLOH in Madison for analysis. The sampling schedule for Lily Lake water quality monitoring is summarized in Table 5-2.

Secchi Readings

Secchi readings were taken during the summer months of 2007 through 2009. Where possible, Secchi readings were also taken in both the fall of 2008 and 2009. Only four readings were taken in 2007 due to needed boat repairs. During 2008 and 2009, Secchi

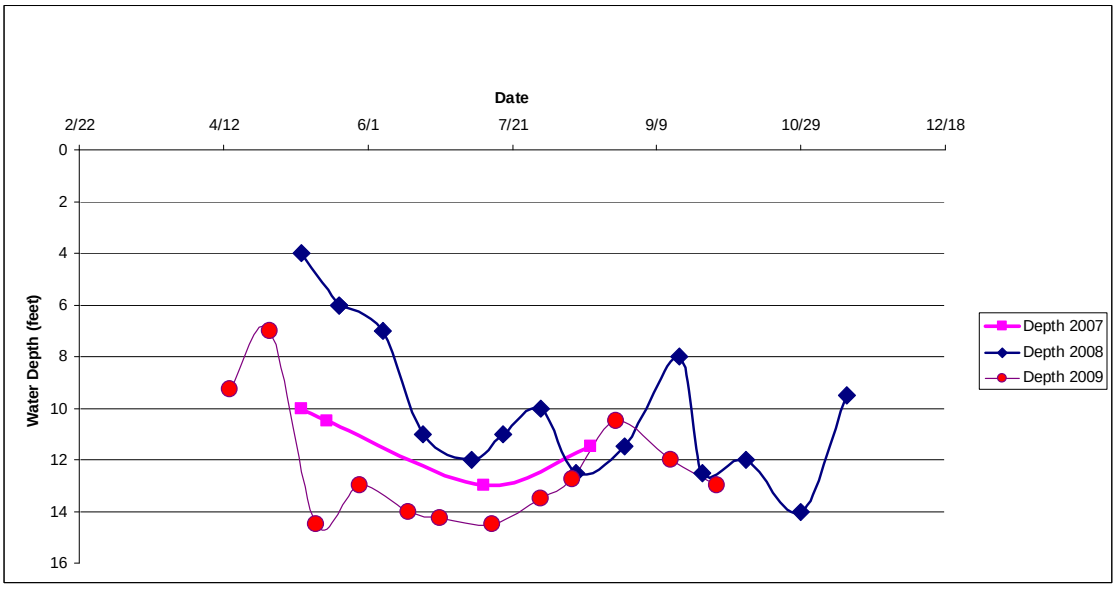
readings were taken twice a month during months when there was no ice on the lake. Figure 5-2 details the Secchi sampling for this study.

Table 5-2: Water Quality Sampling Schedule – 2008 & 2009

Parameter	May	June	July	August	September
Nutrients					
Total Phosphorous, all levels	X		X	X	X
Total Kjeldahl Nitrogen				X	
Nitrate plus Nitrite-N				X	
Wet Chemistry					
Automated conductivity			X	X	X
pH			X	X	X
Alkalinity			X	X	X
Chlorophyll a			X	X	X
True color				X	
Metals					
Calcium, total				X	
Magnesium, total				X	

Source: Wisconsin State Lab of Hygiene

Figure 5-2: Current Secchi Depths at Lily Lake



Source: Brown County Planning Commission (BCPC), 2007-2009

Historic Comparisons

Limited data on historic water quality sampling performed in 1995 and 1996 was available for Lily Lake in the SWIMS Database. The data was used to re-create and graphically display the aforementioned information. Historical comparisons were made for Secchi readings; temperature and dissolved oxygen profiles, and chemical analyses

(total phosphorous and chlorophyll a). The historical data is able to develop some long-term trends.

Results

Bathymetry

The deepest recorded depth within Lily Lake is 21 feet. This is two feet deeper than listed in the Wisconsin of Department of Natural Resources bathymetrical maps indicated. There are two deep holes in which this depth occurs. Both a two-dimensional and three-dimensional view of Lily Lake is located in Figure 5-3.

All sampling for this study was completed in the deepest hole in the center of the lake. Sampling within the center of the lake minimizes the affects that the chemical cycles which occur in the littoral areas (shorelines) of the lake. Minimizing these affects provides the most reliable picture of water chemistry.

Phosphorous

Water samples were collected in May, July, August, and September 2008 and 2009. The specific dates are listed in Table 5-3 and Figure 5-4. Individual water samples were sent to the Wisconsin State Lab of Hygiene (SLOH) for analysis.

Table 5-3: Phosphorous Concentrations

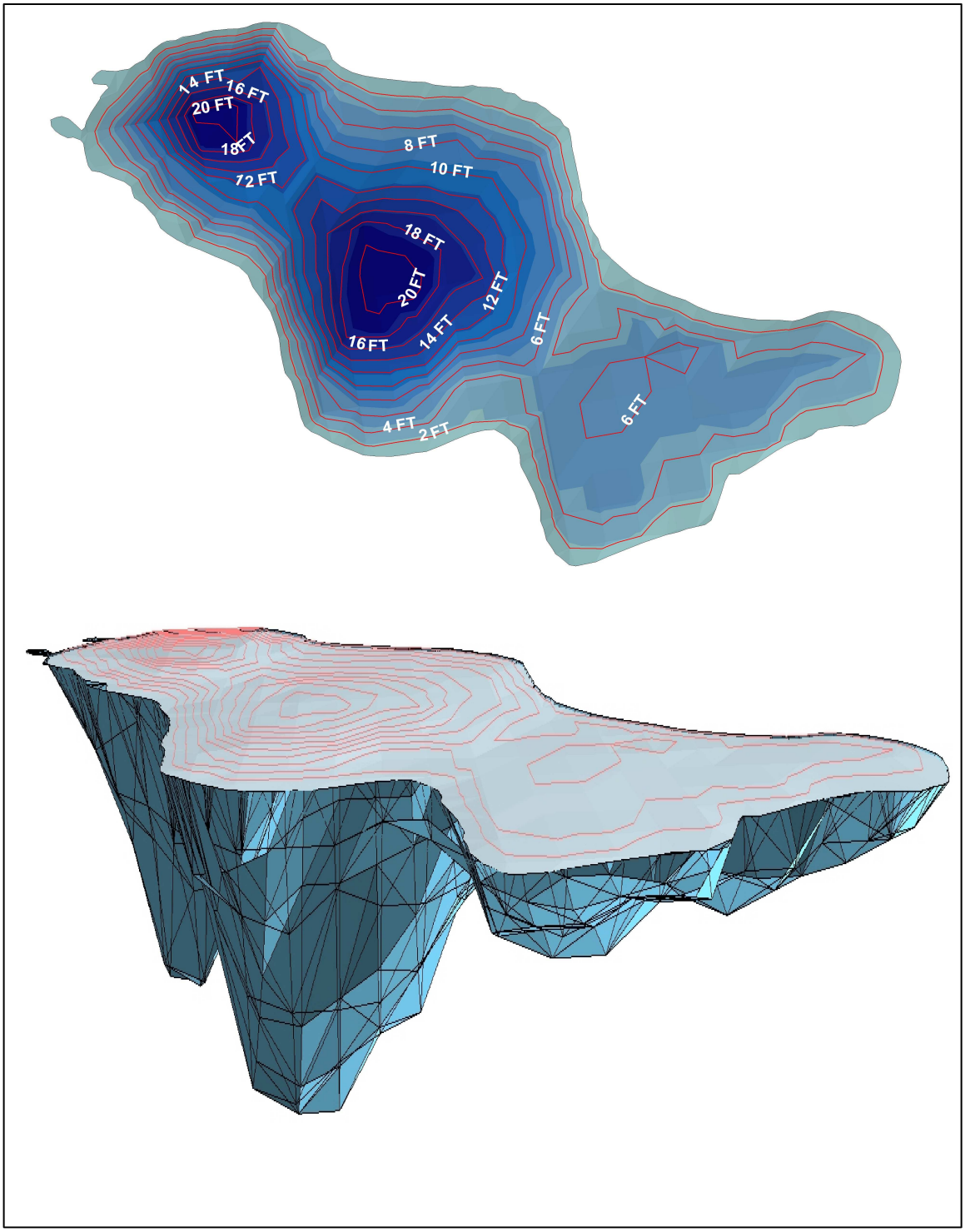
Date		Concentration (µg/L)
2008	5/22	20
	7/18	20
	8/29	20
	9/25	11
2009	4/14	26
	6/14	18
	7/13	18
	8/11	18
	9/14	15

Source: SLOH 2008 & 2009

Chlorophyll a

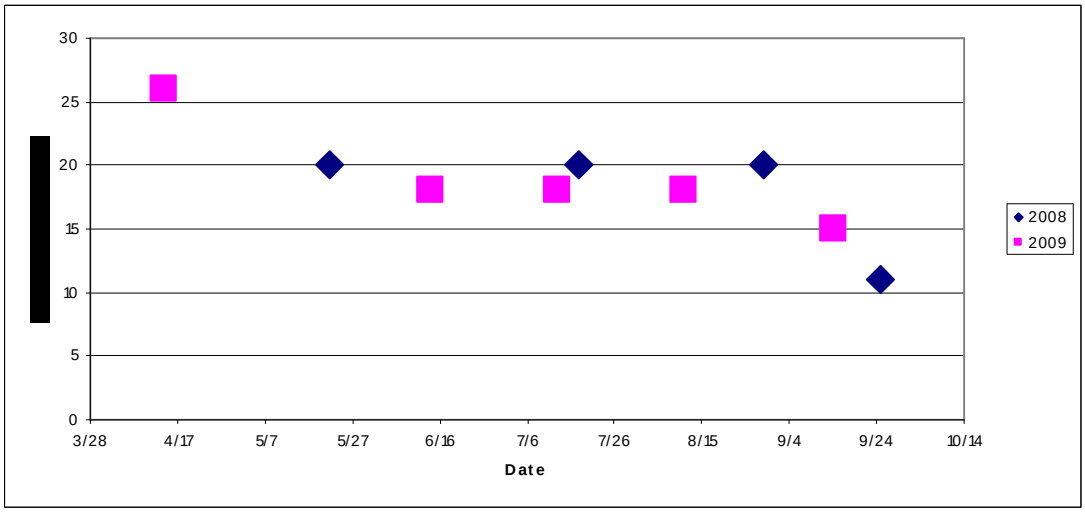
Water samples were collected in July, August, and September 2008 and 2009. The specific dates are listed in Table 5-4 and Figure 5-5. Results were unable to be processed in July in both years. Individual water samples were sent to the SLOH for analysis.

Figure 5-3: Lily Lake Contour Map and Bathymetry



Source: BCPC, 2008

Figure 5-4: Phosphorous Concentrations



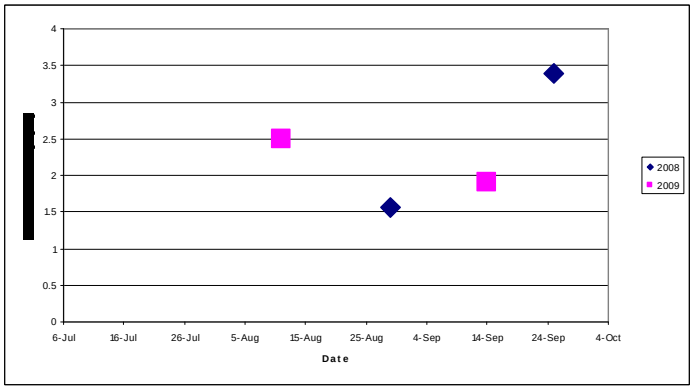
Source: SLOH, 2008 & 2009

Table 5-4: Chlorophyll *a* Concentrations

Date		Concentration (µg/L)
2008	7/18	-
	8/29	1.57
	9/25	3.39
2009	7/13	-
	8/11	2.49
	9/14	1.90

Source: SLOH, 2008 & 2009

Figure 5-5: Chlorophyll a Concentrations



Source: SLOH, 2008 & 2009

Dissolved Oxygen and Temperature

Monthly dissolved oxygen (DO) and temperature (Temp) profiles were collected between May 2008 and September 2009 when safety conditions permitted. Profiles were not collected in November 2008 and March 2009 due to unsafe ice conditions.

Individual monthly profiles can be viewed in Appendix E. The profiles demonstrate that Lily Lake undergoes an annual stratification cycle as discussed in the introduction of this chapter. The warmer, less dense water is separated into a single layer, an epilimnion, at the surface of the lake. The colder waters have settled below this layer to form another distinct layer, the hypolimnion. Each lake also has a region in which the temperature dropped rapidly; this phenomenon is called the thermocline. The thermocline occurs in the metalimnion. As summer progressed, the top layers warmed significantly. The bottom layers showed signs of anoxia (oxygen depletion) as early as June.

Chemical Instrumentation

Although phosphorous is the primary nutrient which contributes to plant growth, other elements can affect the overall plant growth. Nitrogen can be a growth-limiting factor to plants in some aquatic systems, especially those that are extremely oligotrophic or extremely eutrophic. Mineral abundances can also affect the overall pH of a lake. The pH, in turn, has a significant impact on the type of plants that can grow.

All water samples were collected in bottles provided by the SLOH as discussed earlier in this chapter. Specific tests performed were indicated in Wisconsin Citizen Lake Monitoring Manual. All samples were analyzed by the SLOH.

Nitrogen

Nitrogen is a secondary nutrient in limiting plant growth. Two tests were completed to analyze nitrogen content in the water. They were the Kjeldahl Nitrogen and Total Nitrogen (Nitrate + Nitrite) Tests. The Kjeldahl Nitrogen (TKN) determines the overall organic nitrogen and ammonia concentrations within a lake. Total nitrogen examines the dissolved inorganic nitrogen as the presence of nitrates and nitrites. Results for both analyses are located in Table 5-5 and Figure 5-6.

Table 5-5: Lily Lake Nitrogen Analyses

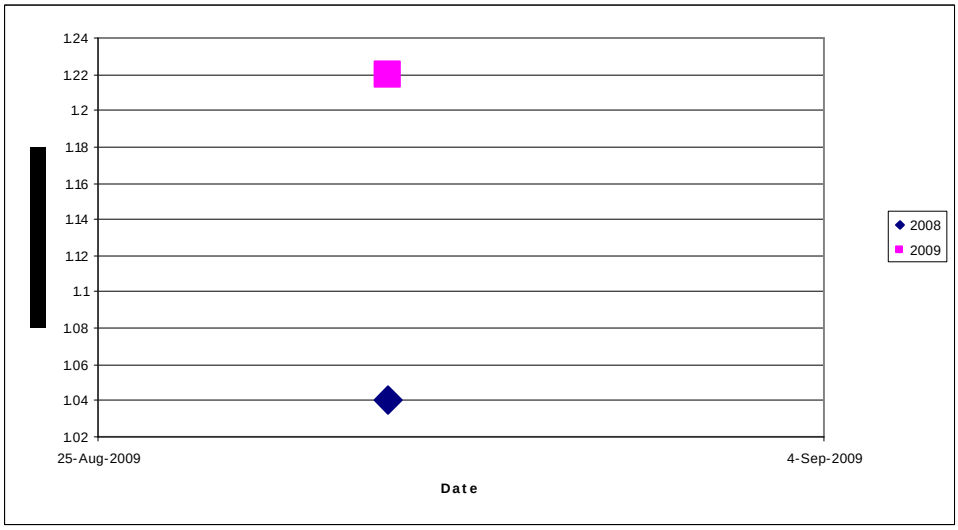
Date	Nitrogen Kjeldahl	Nitrogen (Nitrate + Nitrite)
	Concentration (mg/L)	
8/29/2008	1.04	*
8/11/2009	1.22	*

*Not detectable
Source: SLOH, 2008 and 2009

Water Hardness

The overall water hardness is determined by the amount of dissolved minerals such as calcium, magnesium, and to some extent iron present in surface water. The overall concentration of metal concentrations was analyzed by chemical instrumentation methods. Results are listed in Table 5-6 and Figure 5-7.

Figure 5-6: Organic and Inorganic Nitrogen Concentrations



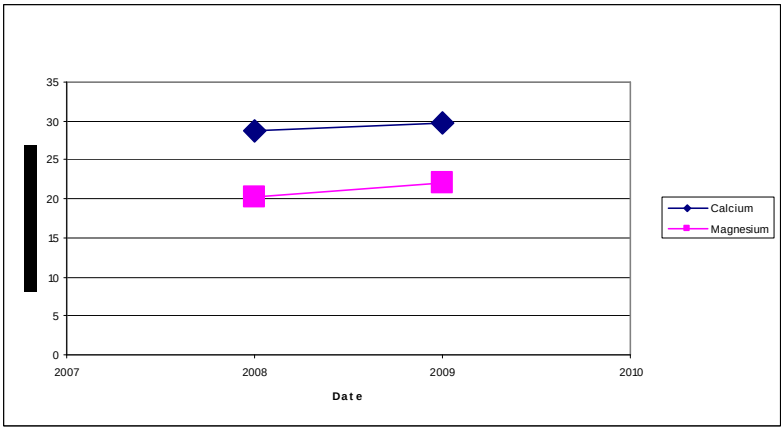
Source: SLOH, 2008 and 2009

Table 5-6 Lily Lake Water Hardness

Metals	Concentration (mg/L)	
	2008	2009
Calcium	28.8	29.8
Magnesium	20.3	22.0

Source: SLOH, 2008 & 2009

Figure 5-7: Lily Lake Water Hardness



Source: SLOH, 2008 and 2009

Alkalinity

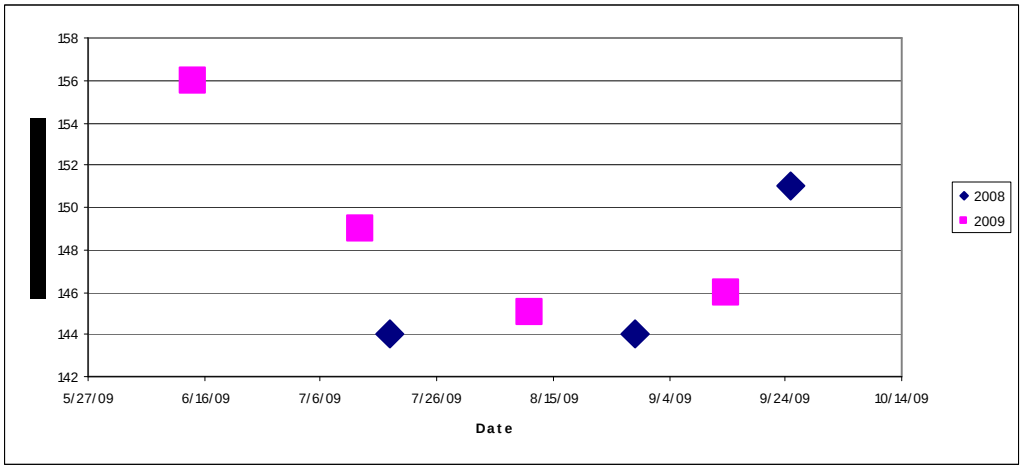
Alkalinity is a measure of the ability of water to resist a change in pH. Water resists changes in pH due to the presence of anions of carbonates, bicarbonates, and hydroxides. The total alkalinity is the sum of the concentrations of these anions. Alkalinity is summarized in Table 5-7 and Figure 5-8. Alkalinity is expressed in terms of equivalents of calcium carbonated ($CaCO_3$) per liter of water.

Table: 5-7: Alkalinity Total $CaCO_3$

Date		Concentration (µg/L)
2008	7/18	144
	8/29	144
	9/25	151
2009	6/14	156
	7/13	149
	8/11	145
	9/14	146

Source: SLOH, 2008 and 200

Figure 5-8: Lily Lake Alkalinity



Source: SLOH, 2008 and 2009

Specific Conductivity

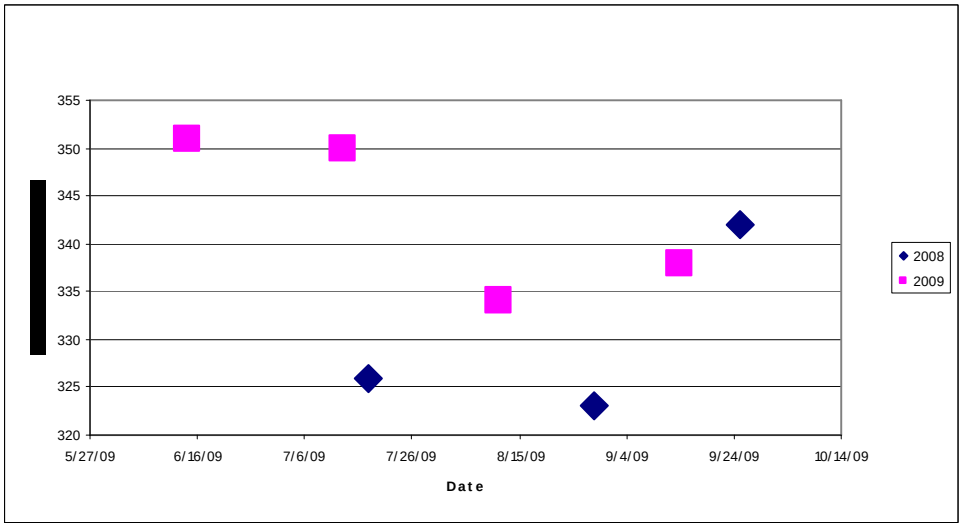
Specific conductivity is a measure of the overall dissolved ion concentration. Elements whose ionic forms can contribute to the overall SC measure include calcium (Ca^{2+}), magnesium (Mg^{2+}), sodium (Na^{+}), and potassium (K^{+}). Other ions which contribute include bicarbonate (HCO_3^{-}), sulfate (SO_4^{2-}), and chloride (Cl^{-}). Conductivity was measured both at the SLOH and by Brown County staff. The conductivity was measured by a pair of probes on the dissolved oxygen/temperature probe. Results from the SLOH are found in Table 5-8 and Figure 5-9. Results obtained by Brown County staff are in Appendix E.

Table 5-8: Specific Conductivity

Date		Conductivity (µs/cm)
2008	7/18	326
	8/29	323
	9/25	342
2009	6/14	351
	7/13	350
	8/11	334
	9/14	338

Source: SLOH, 2008 and 2009

Figure 5-9: Specific Conductivity



Source: SLOH, 2008 and 2009

pH

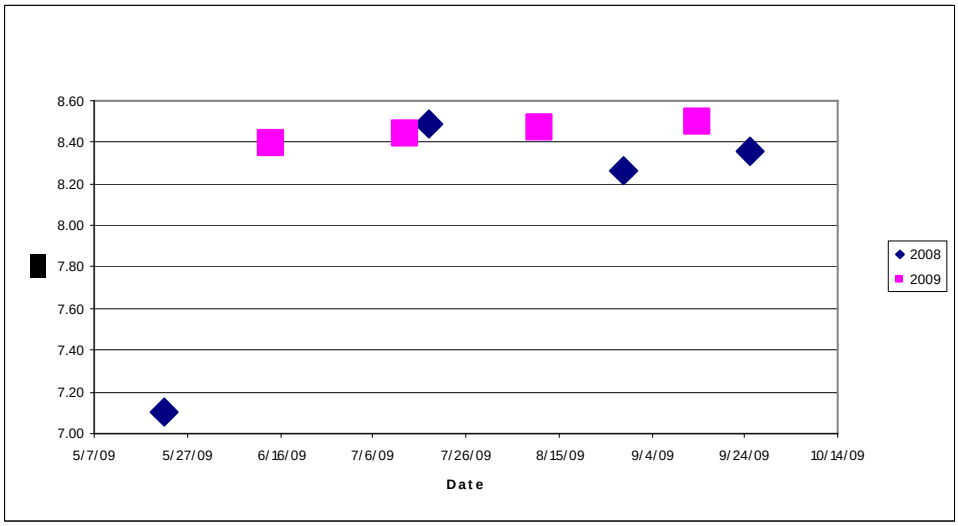
The pH scale measures the overall acidity or causticity of liquids. Both the SLOH and Brown County staff measured pH. The pH levels were measured monthly by a probe on the dissolved oxygen/temperature meter. With the exception of May and October, all pH readings in the epilimnion exceeded 8.2. Results from the SLOH are found in Table 5-9 and Figure 5-10. Brown County results are listed in Appendix E

Table 5-9: pH Concentrations

Date		pH
2008	5/22	7.10
	7/18	8.49
	8/29	8.26
	9/25	8.36
2009	6/14	8.39
	7/13	8.44
	8/11	8.47
	9/14	8.50

Source: SLOH, 2008 and 2009

Figure 5-10: pH Values



Source: SLOH, 2008 and 2009

Discussion and Interpretation

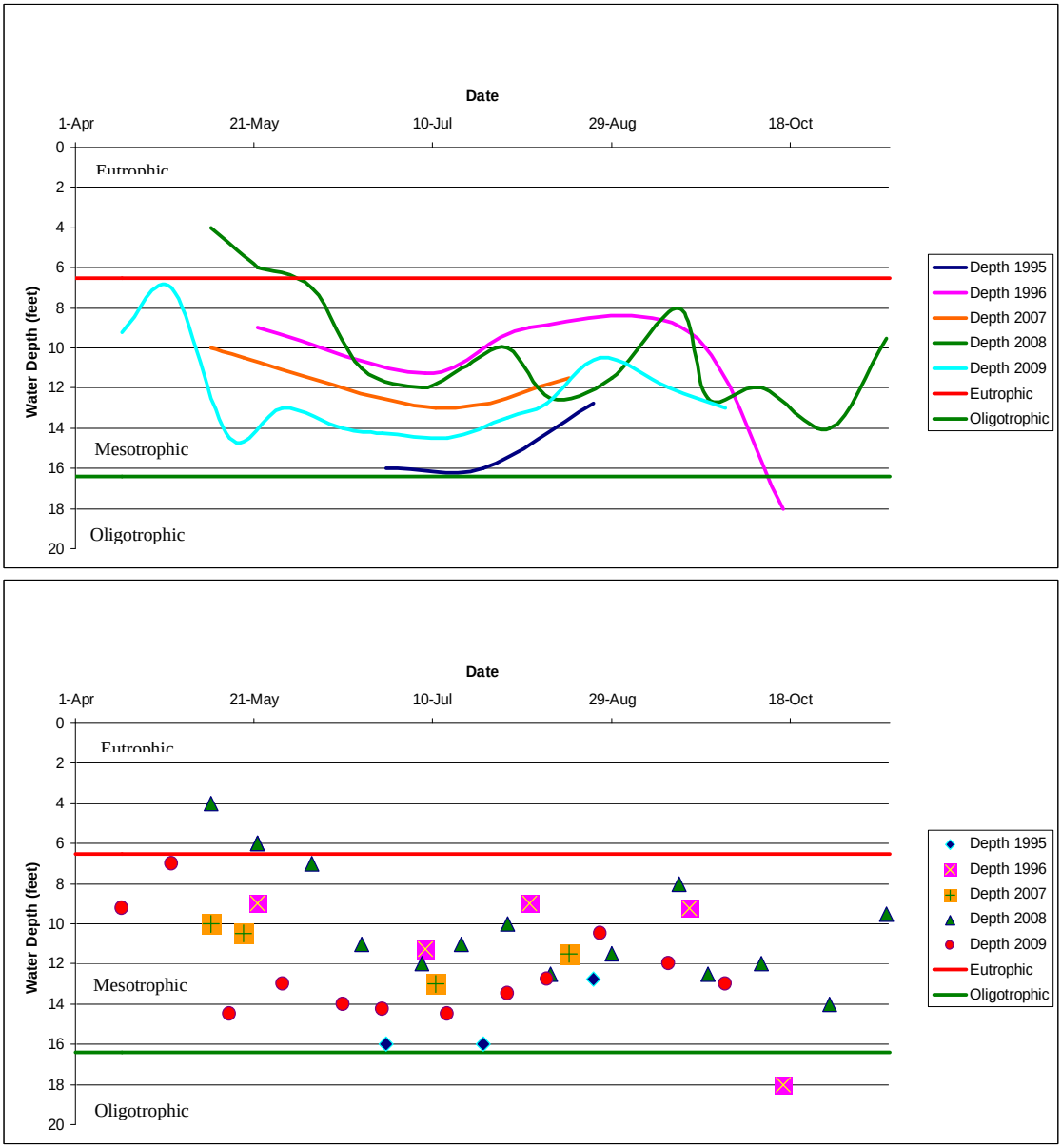
Secchi Readings

Figure 5-11 displays all Secchi readings available in the SWIMS database. Depths are displayed as both continuous lines (top) and points (bottom) to better represent the overall trends and individual readings. Historical observations were completed in 1995 and 1996, although limited historical information is available, several trends can be seen. Over time, the overall Secchi depth, and thus, water clarity have decreased.

The variation in readings observed gives a snapshot of how the water quality of a lake is affected by outside pollution sources and the natural cycle of turnovers and stratification. Readings tended to be lower at turnover due to the increase of sediment and algae which was recycled to the surface. Water clarity increased during the summer as sediment settled and was trapped in lower layers of the lake. Several "spikes" in

decreased water quality were observed during 2008. These readings were taken less than two days after significant storm events. The direct input of water and runoff from adjacent uplands mixes with the lake water at the surface. The mixing redistributes algae within the epilimnion resulting in reduced water clarity.

Figure 5-11: Historical Secchi Depth Comparisons at Lily Lake



Source: WDNR, 1995-1996. BCPC, 2007, 2008, and 2009

Water clarity was the lowest shortly after ice out in May. The water column became increasingly clear as the growing season progressed. Water clarity began to decrease in November. Several episodes of decreased water clarity occurred throughout the summer. These readings were taken within a day or two after significant rainfalls during the summer.

Since 1995, the water clarity of Lily Lake has decreased. The average Secchi depth has decreased from 12.75 to 10.5. Maximum Secchi depths have also decreased during this same time frame. Secchi depths were 16 feet in 1995 and 14.5 in 2009. Overall Secchi depths have decreased throughout the spring and summer months.

Secchi readings cannot be averaged over an entire year. Instead, readings between June and August are averaged as this is the growing season and predominant period for algal blooms. Secchi readings are not typically taken after a lake has frozen. Snow cover and the overall "cloudiness" of the ice significantly impact light penetration into a lake. Thus, winter Secchi readings do not properly indicate overall water clarity or quality.

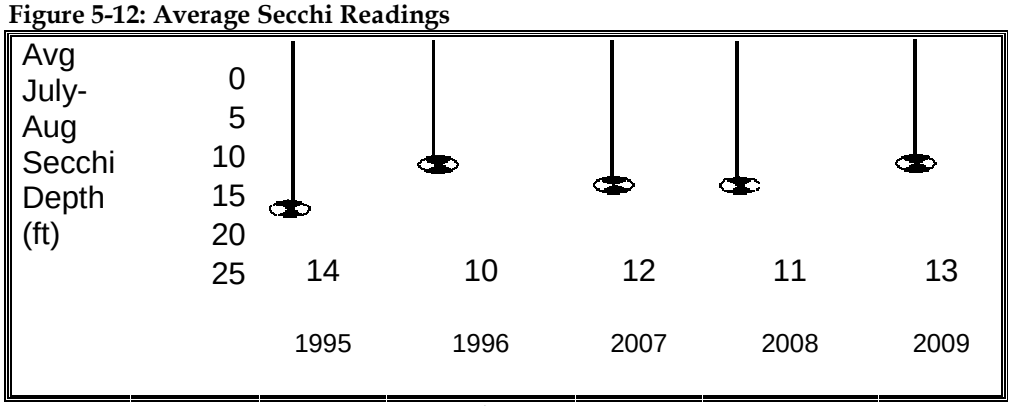
Table 5-10 and Figure 5-12 detail the average Secchi reading during the growing season between July and August for Lily Lake. Water clarity has shown dramatic annual change in each year observed. Between 2007 and 2008, the average Secchi depth decreased by one foot. This indicates an approximately eight percent decrease in water clarity. Between 2008 and 2009, water clarity increased by over 15 percent.

Table 5-10: Average Historical Secchi Depths

Year	Mean Depth (ft)	Min. Depth (ft)	Max. Depth (ft)	Number of Readings
1995	14.4	12.75	16	2
1996	10.1	9	11.25	2
2007	12.3	11.5	13	2
2008	11.4	10	12.5	5
2009	12.8	10.5	14.5	4

Source: WDNR 1995 and 1996. BCPC, 2007, 2008, and 2009

Figure 5-12: Average Secchi Readings



Source: WDNR, 1995-1996, BCPC, 2007, 2008, and 2009

The significant annual changes and historic long-term change indicate that there are one or more environmental factors which considerably impact water quality. The overall change in Secchi readings is directly correlated to a change in algae concentrations which, in turn, is directly correlated to phosphorous inputs. Phosphorous (PO_3^-) can come from two main sources. First, phosphorous can be reintroduced from suspended

sediments. This occurs at the fall, and more predominantly, the spring lake turnover. The other common source is inputs from upland sources which enter the lake through soil erosion and water runoff. The most likely source is discussed in the next section.

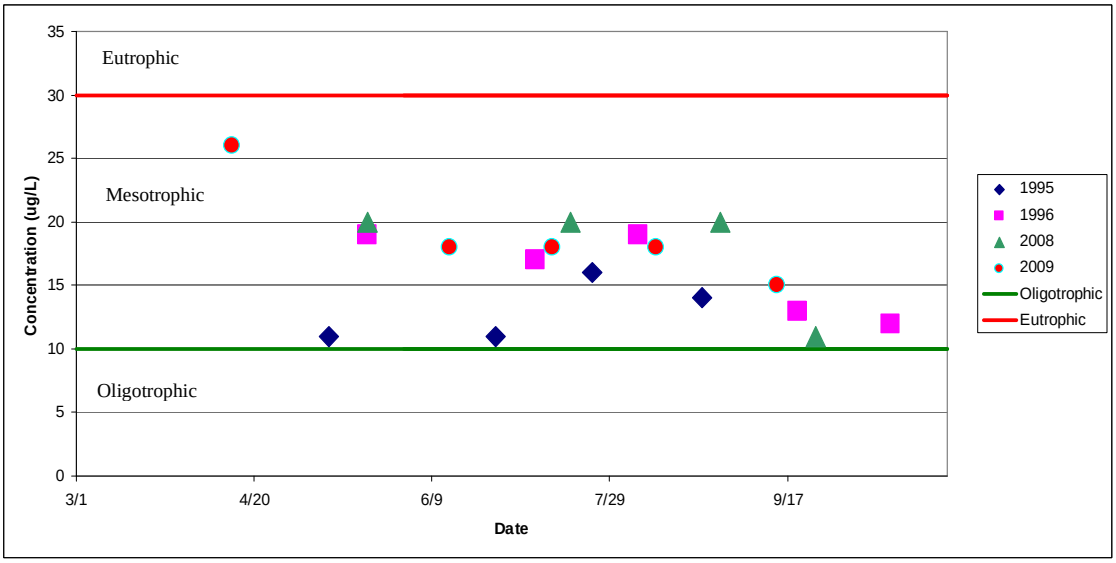
Phosphorous

In more than 80 percent of Wisconsin's lakes, phosphorous is the key nutrient affecting aquatic plant and algae growth. There are both naturally occurring and anthropogenic (man-made) sources of phosphorous occur. Very few sources of phosphorous such as soil and bedrock are naturally occurring. Man-made sources of phosphorous are quite varied and include septic systems; detergents; animal waste; farmland and storm sewer runoff; soil erosion; and fertilizers for lawns, gardens, and agriculture.

Once in a lake system, phosphorous levels are difficult to reduce, so limiting phosphorous input is essential. Phosphorous levels above 30 µg/L can lead to increased plant growth or foster the growth of nuisance exotic plants. Historically, phosphorous levels have ranged from 10 to 20 µg/L as show in Figure 5-13. These values indicate Lily Lake is mesotrophic.

Current phosphorous levels indicate that Lily Lake is mesotrophic as previously seen in Table 5-1. However, it is important to note that phosphorous concentrations have, on average, doubled since 1995 (Figure 5-13). This indicates that eutrophication is currently occurring within Lily Lake.

Figure 5-13: Historic Phosphorous Concentrations in Lily Lake



Source: WDNR, 1995-1996; BCPC, 2007 - 2009

The soils within the Lily Lake basin are predominantly Carbondale muck. Although it is high in organic material, its phosphorous content is very low. This means that a fair portion of all phosphorous inputs into Lily Lake will be manmade under oligotrophic or mesotrophic conditions. Phosphorous may also be mobilized from sources within the lake such as dead plant material and the underlying bedrock. Under the anoxic (oxygen

depleted) conditions during the summer stratification, the rate of phosphorous release will increase. Hence, phosphorus mobilization increases as lakes become more eutrophic. Normally occurring lake cycles may increase phosphorous concentrations and the eutrophication rate.

Manmade phosphorous inputs will be limited to the developed areas around Lily Lake. Lawn fertilizers applied at either Lily Lake County Park or the Polish League of American Veteran Park would contribute to increasing phosphorous levels. In addition, additional phosphorous runoff may be contributed to runoff from the parking lots. Immediate action can be taken to limit the amount of direct runoff from impervious surfaces at Lily Lake County Park. A stormwater facility such as a large rain garden could be constructed to divert water from running directly into the lake and allow for increased rates of natural infiltration.

A major concern expressed by Lily Lake users is predominant algal blooms in the summer and fall. Algal blooms can occur throughout the water column. Although algae produce oxygen, the increase may be short lived. As the algal die and fall to the bottom, bacterial decomposition will consume oxygen and produce excess carbon dioxide. In addition, zooplanktons (microscopic animals) consume oxygen throughout the entire summer; they respire carbon dioxide as a waste product. As a result, oxygen levels fell below the saturation level as oxygen is displaced by carbon dioxide.

Nitrogen

Nitrogen, like many other nutrients, is continually recycled by plants and animals within a lake. This recycling of nitrogen through the environment is called the "nitrogen cycle." Most organisms cannot utilize nitrogen in its gaseous form for biological activities. Instead, plants and animals rely on several other forms of nitrogen including ammonium, nitrite, and nitrate. In the nitrogen cycle, bacteria will convert gaseous nitrogen to biologically usable forms through a process called "fixation." Plants utilize either ammonium or nitrate in several biological processes to form proteins. As plants and animals die, they are decomposed by bacteria. Most decomposition processes produce ammonia. Ammonia is then converted to nitrite and subsequently to nitrate by bacteria. This "nitrification" is essential for living organisms.

The nitrogen cycle is dependent on the oxygen content of a lake. Anaerobic (denitrification) processes occur in the hypolimnion of lakes where oxygen content is low. Nitrification occurs in the epilimnion where oxygen contents remain higher. Although nitrogen fixation is an anaerobic process, most occurs in the hypolimnion near the surface.

Since Lily Lake is a closed hydrological system, the various forms of nitrogen are available from two main sources: recycled organic material within the lake and environmental sources from outside the lake. Environmental sources of nitrogen include precipitation, atmospheric fallout, sewage, and overland runoff. Environmental sources can contribute up to 90 percent of the biologically active nitrogen input of a lake (Mackie, 2001).

Researchers are concerned with two primary forms of nitrogen: inorganic and organic. Nitrates (NO3-) are the most common form of inorganic nitrogen in aquatic system. Nitrites (NO2-) exist to a lesser degree. Nitrate is highly soluble in water and is stable over a high range of environmental conditions. Nitrates feed plankton, aquatic plants, and algae. These in turn are eaten by fish. Nitrite is relatively short lived as it is continuously converted by bacteria to nitrates. Excessive nitrate concentrations can lead to increased eutrophication within a lake. Excess nitrogen can lead to algal blooms which ultimately decrease water quality.

Nitrates are also commonly found in upland environments. Lawn fertilizers, agricultural fertilizers, and animal manure add to the nitrate concentration of topsoil. Nitrates not utilized by plants are either leached into the groundwater or dissolve in overland runoff. Either way, nitrates can enter lakes increasing the overall nitrate concentration.

Organic nitrogen is most commonly found in living material. All animal and plant matter contains proteins which are composed of nitrogen in part. Decomposition changes the proteins into ammonia.

In order to assess the overall nitrogen content of the lake, both inorganic and organic nitrogen must be tested. Total nitrogen tests for both nitrates and nitrites. The Kjeldahl procedure is used to routinely measure the overall content of free ammonia and organic nitrogen. When both tests are performed, the overall nitrogen content of a lake can be determined and used to examine lake health.

Typically nitrogen concentrations of 10 mg/L or less are considered "healthy." Total nitrogen concentrations in both 2008 and 2009 were just over 1.0 mg/L. The continued low concentrations indicate that nitrogen concentrations are not a concern.

Because nitrates and ammonia are used by plants, the best time to measure total nitrogen is during spring turnover. Spring readings give the maximum nitrogen concentrations. WDNR protocol requires measuring nitrogen concentration in the growing season. Summer nitrate concentrations are typically less than 0.15mg/L (Mackie, 2001). The observed results are not abnormal. The overall nitrogen content is at a level where the existing plant life is using it for biological production.

The ratios of nitrogen and phosphorous allow researchers to determine which nutrient is more important in controlling the growth of plants within a lake. If the ration of phosphorus to nitrogen is greater than 15:1, algal production within a lake is limited by the amount of phosphorous present. If the ratio is less than 15:1, algal production is controlled by nitrogen. In 2008, this ratio was 19:1. In 2009, the ration was 15:1. This indicates Brown County staff should be most concerned in controlling phosphorous application in the Lily Lake watershed.

Chlorophyll a

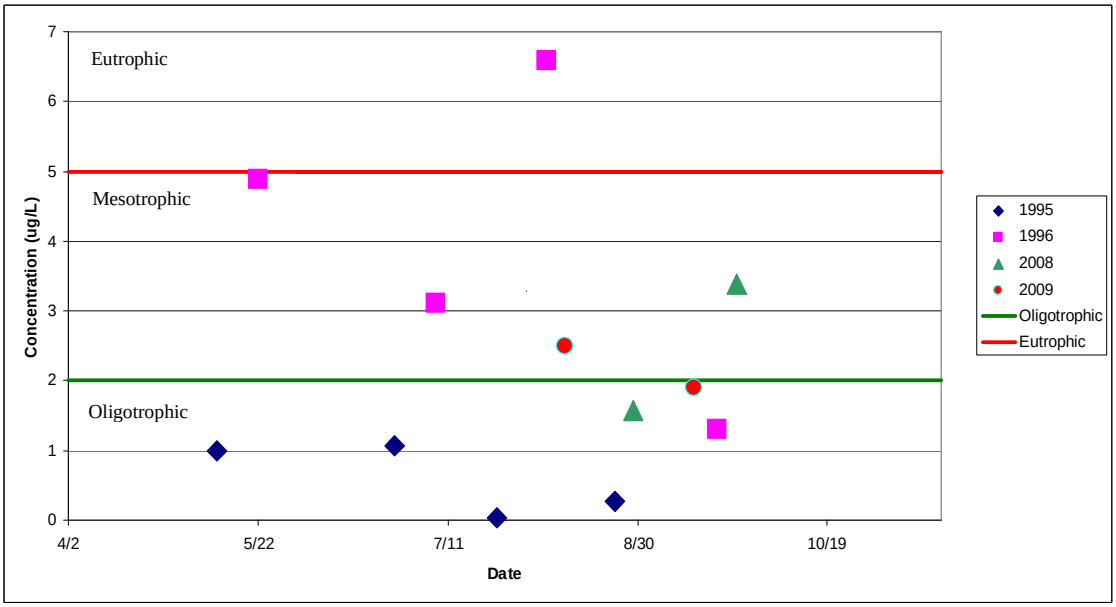
Chlorophylls are the greenish pigments which give plants there characteristic color. Chlorophyll a is the primary substance which is responsible for photosynthesis, the

process of converting sunlight into food. The amount of chlorophyll a is correlated with the amount of green plant material in the water. The higher the chlorophyll a concentration, the more active plant material that is present. With lakes, chlorophyll a is typically present in algae.

Chlorophyll a is the primary indicator for nutrient pollution in lake systems. Excess nutrients result in increased algal growth. Chlorophyll a analyses reveal that it has been as high as 7 µg/L as seen in Figure 5-14.

Currently chlorophyll levels indicate that Lily Lake is a mesotrophic lake as previously seen in Table 5-1. However, since 1995, the overall chlorophyll a concentrations have been increasing in Lily Lake. This indicates that algae content of Lily Lake is increasing. This indicates that nutrient enrichment can and is occurring within the watershed. Chlorophyll a readings as high as 7 µg/L indicates that Lily Lake experiences periodic algal blooms. Steps should be taken to minimize and eliminate sources of additional phosphorous inputs into Lily Lake.

Figure 5-14: Historic Chlorophyll a Concentrations in Lily Lake



Source: WDNR, 1995-1996, 2007; BCPC, 2008

Dissolved Gases – Oxygen and Carbon Dioxide

The important gases of in freshwater ecosystems are oxygen, carbon dioxide, and nitrogen. All three play vital roles in the functioning of a freshwater lake. The concentration of each is determined by a series of complex chemical reactions. Dalton's Law states that the pressure of each component of gas in a mixture is proportional to the concentration in the mixture. The total pressure of all gases being equal to the sum of its components. The three gases exist in equilibrium with one another. As the concentration of one decreases, one (or both) will increase.

Nitrogen is the least stable gas in aquatic systems. Gaseous nitrogen is readily converted to nitrate through a series of complex chemical reactions generically called nitrogen fixation. Most nitrogen fixation occurs in the epilimnion.

Carbon dioxide is the most abundant gas in freshwater ecosystems. Carbon dioxide comes from several sources. The most common is atmospheric deposition. Other sources include bacterial decomposition of animal and plant material. This typically occurs in the hypolimnion in anoxic (low oxygen) environments. Animal respiration also accounts for the presence of carbon dioxide.

Dissolved oxygen is essential to the well being of most aquatic organisms. The overall dissolved content determines the aquatic life which can survive in a freshwater lake. The overall content is dependent on the water temperature, depth, and presence of other gases.

There are two primary sources of oxygen in aquatic systems: the atmosphere and photosynthetic production. In most aquatic systems, oxygen is predominantly created by the photosynthetic activities of plants. Plants utilize carbon dioxide in the water and convert it to sugars; oxygen is given off as a waste by-product.

Oxygen is introduced into water from the atmosphere in several ways. First it can diffuse across the air-water interface. This is a slow process. Other physical factors such as mixing accelerate the atmospheric deposition of oxygen. Oxygen mixes more rapidly into rough, or choppy, water than calm water because waves and ripples create additional surface area for interactions. Fast moving streams tend to be the most oxygenated systems because the turbulent waters are naturally aerated. Since Lily Lake is a predominantly "calm" lake, atmospheric oxygen is slowly diffused from the air into the water.

The amount of oxygen in the water is also influenced by the temperature and air pressure. As temperatures increase, the solubility of oxygen decreases. Molecules in a solution such as water are "held together" by small intermolecular forces. Higher temperatures provide additional energy to the individual molecules. As the energy levels increase, it becomes easier for gases to escape into the atmosphere. An open bottle of soda provides an excellent example. When left at room temperature, soda will go "flat" faster than if left refrigerated because the carbon dioxide bubbles escape faster. In addition, gases naturally expand as the temperature increases. This expansion will cause oxygen to leave the water as temperatures increase.

Lakes that have high saturation values in the epilimnion and low values in the hypolimnion exhibit clinograde oxygen profiles. Both eutrophic and mesotrophic lakes exhibit such patterns. Lily Lake is no exception. Typically mesotrophic lakes have 25 to 75 percent oxygen saturation in the epilimnion. Lily Lake is at over 80 percent. This is reasonable as Lily Lake is a highly productive lake with a significant amount of vegetation. Although Lily Lake has a higher dissolved oxygen content compared with other mesotrophic lakes, levels have declined since 1996.

Lily Lake undergoes stratification as discussed in earlier in this chapter. The surface layers had temperatures which were significantly higher than the bottom layers. This held true between May and September. Temperatures were constant after the fall turnover in October as seen in Figure 4-5. A temperature increased was observed in the hypolimion.

The water column displayed a clinograde profile as seen Appendix E. Oxygen levels in the epilimnion (surface layer) near complete saturation and are greatly reduced in the hypolimnion (lower layers). Clinograde profiles show a curve which descends and curves to the left. This pattern was observed each month from May until the fall turnover in October.

Carbon dioxide concentrations increase as water temperatures decrease. As such, carbon dioxide profiles will mirror dissolved oxygen profiles. When the concentration of carbon dioxide is higher, dissolved oxygen will be lower.

Historical trends of the overall dissolved oxygen levels within Lily Lake were examined. Historical data was available in June, July, and August 1995 as well as May, July, August, September, and October 1996. A month by month comparison indicated 2008 dissolved oxygen levels were lower than historical levels in all months.

Since oxygen concentrations vary according to the temperature of the water, it is also necessary to examine the saturation levels present. Percent saturation indicates the amount of oxygen that is dissolved in water compared to the maximum amount. The percent saturation can give key to various chemical and biological processes that may be occurring within a lake system.

Percent saturation levels were compared at a depth of six feet as seen in Table 5-11. In 1995 and 1996, Lily Lake oxygen levels were completely saturated at 100 percent. In 2008, percent saturation was normally below 90 percent. The percent saturation was also less than 90 percent in the growing season of 2009. This means that biological and chemical processes within Lily Lake are consuming oxygen necessary to support fish and other life. Oxygen levels are at acceptable levels though. Mesotrophic lakes typically display percent saturation levels between 50 and 75 percent (Mackie, 2001.)

Table 5-11: Percent Saturation Levels for DO in Lily Lake

Percent Saturation	Year			
Month	1995	1996	2008	2009
May		100	87	81
June	100		98	96
July	100	100	87	93
August	100	100	84	73
September		92	80	81
October		100	77	

Source: BCPC, 2008

Finally, data gathered indicate that an anoxic layer in Lily Lake is present throughout the year. Anoxia is the complete removal of oxygen from a portion of the water column. The anoxic layer is most likely present due to increased bacteria decomposition from increased phosphorous loading throughout the year. An alternative hypothesis is that the spring and fall mixing in Lily Lake are limited to less than 20 feet due to the size of Lily Lake. Although this phenomenon is usually restricted to extremely deep lakes, it may occur in shallower lakes (Wüest etal, 1992).

Oxygen levels must be continually monitored within a lake. If a lake's dissolved oxygen levels decrease significantly, fish kills may occur or fish species composition may shift to those with lower oxygen needs.

Methodologies utilized for this study varied slightly from CLMN protocol for temperature and dissolved oxygen. The CLMN protocol called for measurements at three foot intervals. Brown County staff felt better data could be obtained by increasing the sampling frequency. The varying scales utilized in the 1990s and 2000s will not affect the overall analysis as both sampling methods provided profiles with enough detail to analyze changes in the water column.

Alkalinity, Water Hardness, pH, Specific Conductivity, and the Effect on Dissolved Gases

The pH of a lake affects many chemical parameters in a lake; pH levels control the solubility (amount that can be dissolved in water) and the biological availability (amount that can be used by aquatic life) of nutrients such as phosphorous and nitrogen. Aquatic life functions best at a pH between 6.0 and 9.0. A complex series of chemical reactions in lakes within this pH range converts carbon dioxide to carbonic acid, bicarbonates, and monocarbonate ions. Each reaction occurs in equilibrium with one another. Since the pH of Lily Lake is approximately 8.0, most of the carbon dioxide is present in the form of bicarbonate ions. As plants and algae consume carbon dioxide for photosynthesis, the bicarbonates are converted into carbon dioxide. This ongoing series of chemical reactions will produce an almost endless supply of carbon dioxide within Lily Lake.

Bicarbonates react with calcium to produce calcium carbonate and carbon dioxide. The calcium carbonate precipitates as a solid white substance called marl. Marl is readily visible on the plants throughout Lily Lake. Since the bicarbonate concentration (measure as alkalinity) is rather high in Lily Lake, plants have a nearly inexhaustible source of carbon dioxide for photosynthesis. As a result, Lily Lake will continue to be productive with high levels of macrophyte (plant) growth and periodic algal blooms.

Calcium, magnesium, and iron are the three major elements which cause hard water. Iron accounts for less than one percent of all dissolved minerals in "hard water" lakes. Thus, it is typically not analyzed by analytical laboratories.

The concept of water hardness originated because the salts form complexes with soaps which can be seen on various hard surfaces such as watercraft and bathroom surfaces. Since magnesium and calcium form similar salts, they are expressed as one unit,

milligram $CaCO_3$ per liter ($CaCO_3$ mg/L). Hard water is classified as 120–240 mg $CaCO_3$/L. Lily Lake is classified as hard water.

Alkalinity is a measure of the buffering capacity of water. A buffer is a solution to which an acid can be added without changing the overall pH of the solution. In most natural water bodies, the buffering system is comprised of carbonate (CO_3^{2-}) and bicarbonate ions (HCO_3^-). In addition, several other negatively charge ions contribute to the overall alkalinity of water. Since calcium carbonate is present in the highest concentration, it is used as the overall measuring unit.

Water bodies with high metal carbonate concentrations are less susceptible to rapid pH changes. This is important as it protects fish and other aquatic life. For protection of aquatic life, the buffering capacity should be at least 20 mg/L. Analyses completed by the SLOH indicated that Lily Lake had at least a 144 mg/L buffering capacity, well above the minimum threshold.

Specific conductivity is important because it can indicate the overall concentration of total dissolved solids (TDS) in a lake. The exact ions present can affect the overall pH, and thus, fish habitat suitability of the water. In addition, the specific ions present can indicate how healthy the lake is, as some are increased by manmade sources. As discussed in previous water hardness and alkalinity sections, there are high concentrations of basic ions present in Lily Lake which leads to noticeable levels of conductivity.

Considering the chemical composition of Lily Lake, the higher values seem to reflect the naturally occurring chemical makeup of the lake. Conductivity was constant throughout the summer averaging approximately 320–330 µs/cm. Lily Lake is highly mineralized, especially when compared with rain water (50 µs/cm) (NWFWMD, 2006). Values increased as the summer progressed. As lake levels decreased, the concentrations rose due to a decrease in the overall volume of water. Deeper depths ($\geq$ 16 feet) had noticeably higher levels. No explanation is hypothesized for this phenomenon.

Fortunately, lake water is complex. A complex array of chemical reactions simultaneously occurs. The basic ions such as carbonate, calcium, magnesium, and other form a buffer solution. Small or localized changes in pH will be quickly neutralized by the high buffering capacity in Lily Lake.

Trophic Status Index

Phosphorous, Chlorophyll a, and Secchi depth are interrelated measurements. When additional phosphorous is introduced into a lake, it provides a food source for algae. The increased algal blooms result in an increase in chlorophyll a concentrations. The increased algae content, in turn, results, in lower water clarity. The interactions between these parameters are a complex and dynamic process. As an alternate to analyzing each parameter separately, the trophic state index (TSI) can be calculated for each parameter.

The trophic state index was developed by Carlson (1977) to alleviate the difficulties in communicating the overall health of a lake system utilizing the traditional oligotrophic, mesotrophic, and eutrophic classification system.

Since not all lakes with the same trophic classification are identical, TSI quantitatively describes the trophic status with a numerical range from 0–110 (see Table 5-12). Shallow Secchi measurements correspond to higher TSI numbers. Higher TSI numbers indicate more eutrophic lakes. An increase of ten on the TSI scale correlates to a doubling of lake algal biomass and halving of water clarity (Carlson, 1997).

Chlorophyll a and total phosphorous concentration may also be used to calculate TSI. Both can be used to measure overall lake productivity. Higher chlorophyll a and total phosphorous concentrations translate into higher TSI values.

The Wisconsin Department of Natural Resources has developed its own TSI scale based upon chlorophyll a concentrations. Since chlorophyll a is directly correlated to the overall biomass present, it is a better indicator than Secchi depth.

Table 5-12: TSI Index

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

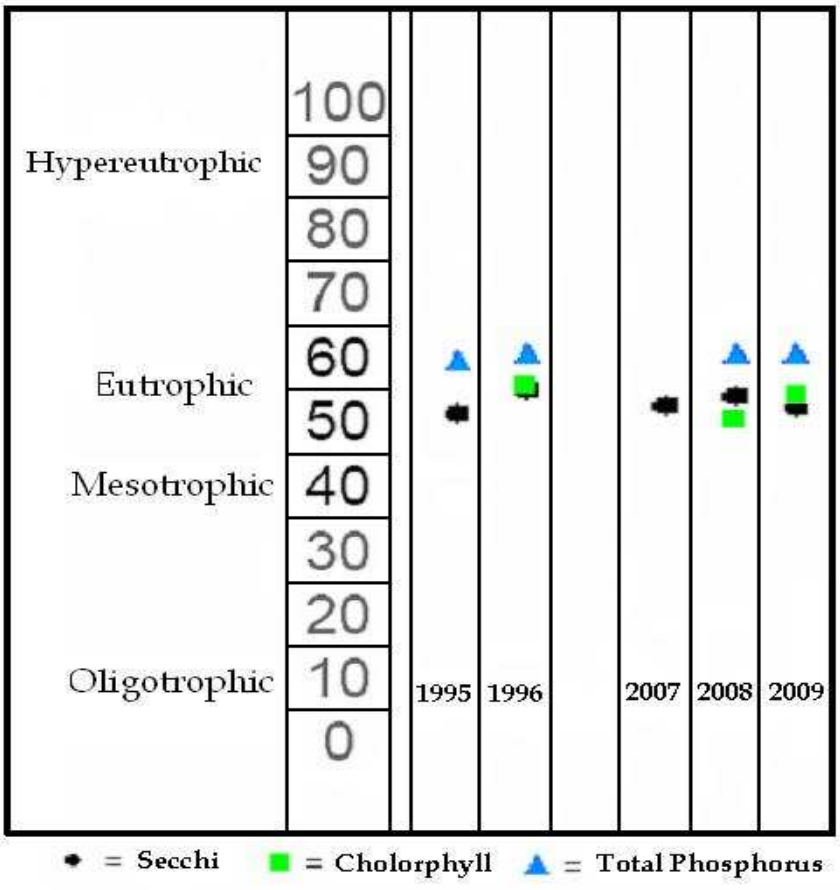
Source: WDNR, 2008

The SWIMS database calculates TSI indices for all available parameters as seen in Figure 5-15. Currently, the TSI for chlorophyll a is in the high 50's. Since 1995, the TSI for chlorophyll a has increased by 10 units indicating a doubling in plant biomass present. TSI indices for phosphorous have remained relatively stable in the mid-60's; TSI Secchi readings have increased slightly to the high 50's. Overall, the TSI indices reveal that Lily Lake is becoming more nutrient rich.

All lakes undergo a natural eutrophication process. During this process, sediment and plant material accumulate at the bottom. The additional plant material leads to not only a decrease in overall depth, but the biological oxygen demand also increases. While these changes may be naturally slow, human intervention can accelerate the eutrophication process. Lily Lake is no exception.

Over the past 12 years, Lily Lake has been classified as a mesotrophic lake. Much of the recorded data such as Secchi readings, phosphorous concentrations, and chlorophyll a levels indicate that Lily Lake is still considered a mesotrophic lake. However, the TSI indicates that more biomass (plant life) is accumulating in Lily Lake. The TSI for chlorophyll increased between 2008 and 2009. Unlike observed chemical parameters, the increased biomass classifies Lily Lake as a eutrophic lake.

Figure 5-15: TSI Indices



Source: WDNR, 1995-1996, 2007-2009; BCPC, 2007-2009

Management Concerns

Lily Lake watershed residents and Brown County residents expressed concerns during two surveys that existing water quality at Lily Lake affected their decision to use the lake. Approximately three-quarters of respondents indicated that existing water quality

prompted a decision to use Lily Lake. Of these respondents, the usage of Lily Lake has decreased as a result of a perception of decreasing water quality. Respondents cited an increase in macrophyte growth, an increase in the occurrence of algal blooms, and decreased water quality as the primary reasons for decreasing Lily Lake usage (See Appendices C and D).

Although many survey respondents indicated that their use of Lily Lake has decreased due to perceived water quality issues, Lily Lake is still an excellent resource. All chemical testing indicated that Lily Lake is mesotrophic. However evidence of accelerated eutrophication is obvious. Increased sedimentation was observed around the edges of the lake. Several Secchi readings indicated that decreased water clarity is problematic at certain times of the year. Brown County staff recognizes that Lily Lake provides an "up north" experience for a large population. As such, Brown County staff promotes the continued health of Lily Lake.

The primary water quality goal for the Lily Lake Comprehensive Management Plan is to maintain or improve existing water quality through continued in-watershed projects and in-lake monitoring so that Brown County residents can continue to enjoy a healthy lake resource.

The following management objectives and strategies will be used to achieve this goal:

Objective 1: Monitor long-term water quality trends at regular intervals.

As indicated by the two years of water quality, specific water quality parameters are highly variable from one year to the next. A long-term database is required to determine the overall extent of cultural eutrophication within Lily Lake. The following action items will help.

1A. Brown County, the Town of Eaton, or a "friends group" should apply for funding once every five to ten years to replicate the water quality study in this report.
1B. Utilize the periodic funding to assess how the overall water quality has changed and assess how strategies implement to help curtail eutrophication have fared.

Objective 2: Reduce potential sources of phosphorous and nitrogen loading by reducing overland runoff into Lily, Middle, and Third Lakes.

All of Middle Lake and most all of Lily Lake are surrounded by either upland forests or wooded wetlands. Forest lands provide the greatest infiltration potential and reduce erosion and runoff to the greatest extent of any land cover type. Direct runoff is currently restricted to the boat launches at Lily Lake County Park and the Polish Legion of American Veterans property. Stormwater management facilities should be designed to reduce direct runoff from impervious surfaces at these facilities directly into Lily Lake. Since Third Lake is privately owned, educational programs should focus on the water quality benefits of establishing Shoreland vegetation.

2A. Eliminate fertilizer usage within Lily Lake Park and the PLAV property, or when it must be applied, utilize phosphorus-free fertilizers only.
2B. Design and install stormwater management facilities such as rain gardens at Lily Lake to promote direct infiltration of stormwater at Lily Lake County Park.
2C. Apply for grant funding to design and implement stormwater infiltration facilities at Lily Lake. Sources may include, but are not limited to, the Wisconsin Department of Natural Resources and the Wisconsin Environmental Education Board.
2D. Partner with the Denmark School District to create an educational curriculum regarding stormwater management and outdoor education at Lily Lake County Park.

Objective 3: Educate landowners within the study area regarding how proper maintenance of private on-site wastewater treatment systems (POWTS) can ensure the health of Lily Lake.

Lily, Middle, and Third Lakes are fed by groundwater seepage. Any nitrogen and phosphorous present in sewage can dissolve in groundwater and be transported to the watershed over time.

3A. Continue the Brown County POWTS maintenance system.
3B. Assist landowners who are eligible for state funding programs to apply for funding to replace their failing POWTS.
3C. Support Brown County's regulations related to surface water protection through the Brown County Land Conservation Department and Brown County Planning Commission.

Objective 4: Limiting phosphorous and nitrogen use is critical in protecting water quality throughout Brown County. Runoff from all developed land uses can have a cumulative impact on water quality throughout Brown County. Continued education is pertinent to assure that local surface and groundwater supplies remain a sustainable and usable natural resource.

4A. Eliminate fertilizer usage within Lily Lake Park and the PLAV property, or when it must be applied, utilize phosphorus-free fertilizers only.
4B. Create an educational kiosk regarding how lawn care and other practices affect the water quality at Lily Lake.
4C. Create an education kiosk to demonstrate how the proposed rain garden in action items 2A and 2B help protect water quality and explain the ease of constructing rain gardens.
4D. Provide information for the Northeast Wisconsin Stormwater Consortium on an educational kiosk to readily provide a wide array of practices Lily Lake visitors can do at home or work to help protect and improve water quality.
4E. When development is proposed around Lily Lake, encourage conservation subdivisions to minimize stormwater runoff.

Chapter 6

Aquatic Vegetation Survey

Introduction

Aquatic vegetation is an important indicator in the overall health of a lake. Since phosphorous is the primary "food" source for plants, high nutrient concentrations can lead to an abundance of plant growth or algal blooms. In addition, the chemical parameters of a lake can limit what species of plants can grow.

Freshwater plant monitoring is completed by natural resource agencies to track aquatic plant community changes over time. In addition, these programs help identify whether invasive species have been introduced into a lake.

Invasive species are non-native plants that have been introduced to Wisconsin either accidentally or on purpose by humans. Many invasive plants were originally used in either the aquarium industry or landscaping. Invasive species typically originated in foreign countries. Once introduced, they live in an environment which lacks natural predators such as plant-eating insects or disease that normally keeps their growth in check. The lack of natural controls, combined with the plants high reproductive rates, allows the plants to thrive and out-compete desired native species.

Aquatic Vegetation Survey

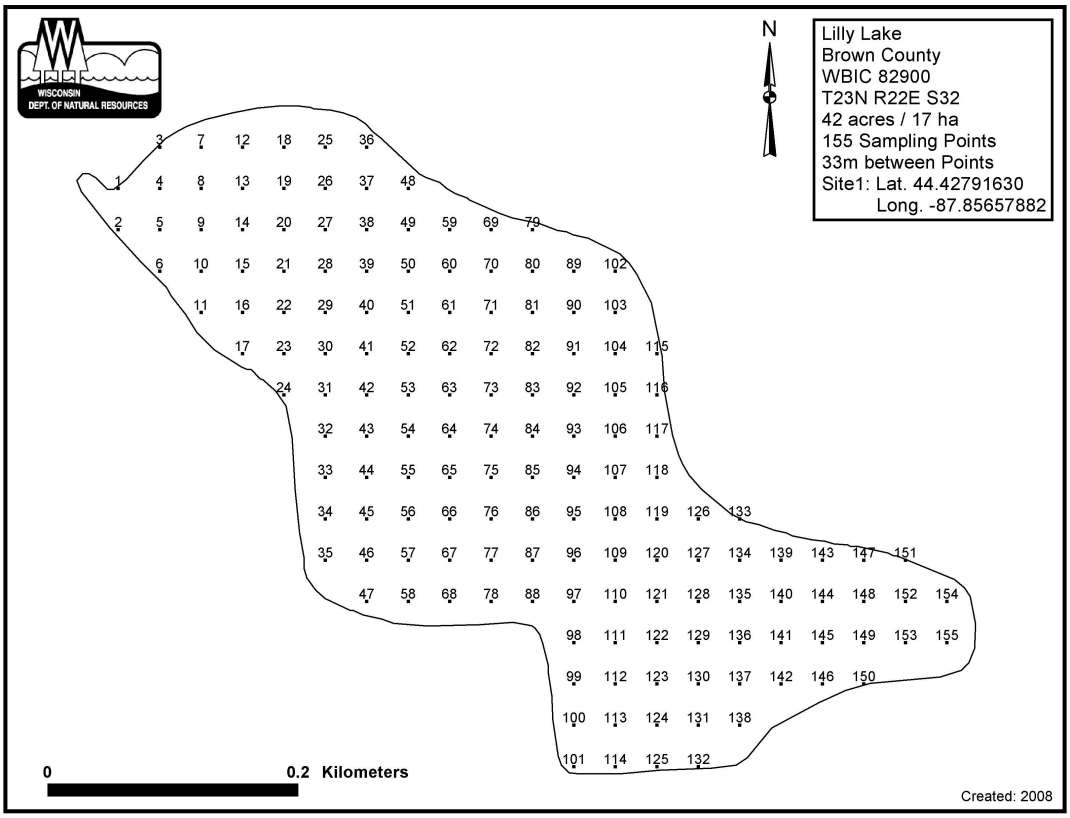
A point-intercept vegetation survey of Lily Lake was conducted between July 23, 2008, and July 31, 2008, following the methodology described by Madsen (1999). Sample points were established across Lily Lake by using a 33 meter by 33 meter grid. This resulted in a total of 155 sample points as seen in Figure 6-1. Specific GPS coordinates for the points is located in Appendix F.

A Garmin GPSMAP 60CX GPS unit was used to navigate the boat to each sample point. One side of the boat was designated as the sampling area. At each site, water depth was recorded using a measured weighted rope. A double-headed, weighted garden rake, attached to a rope was lowered into the water. At depths less than eight feet, the rake was spun in two complete circles to entwine plant material; at depths greater than eight feet, the rake was swung like a pendulum to tangle plant material. Emergent vegetation surrounding the lake not identified at the sampling points were noted and identified to species where possible. Sample points that fell on land were noted in the field and not included in the overall analysis.

All vegetation was identified to a species level where possible utilizing dichotomous keys utilizing nomenclature by Vosters (1972). When necessary, plants were identified to their genus.

Data was entered into an Access database and frequency of occurrence was calculated for each species as the number of sites in which a species occurred as a percentage of the total sites sampled. Water depths for each observed species were identified and distribution maps for each species were created.

Figure 6-1: Lily Lake Point-Intercept Sampling Map



Source: WDNR, 2008

Aquatic Vegetation

Two aquatic vegetation surveys were completed on Lily Lake in 2008. Brown County staff completed a survey in late July, and the Wisconsin Department of Natural Resources (WDNR) staff completed a survey in September 2009.

A total of 18 native species and one non-native plant species were recorded by Brown County staff in Lily Lake; a total of 16 species were found by WDNR staff. All species identified by the WDNR were native species. The survey focused on in-lake vegetation, and the majority (68 percent) of the species found was submerged. Submergent species accounted for 87 percent of all vegetation found as seen in Table 6-1.

The plant community is dominated by macrophytes. Macrophytes are large aquatic plants commonly referred to as "weeds" or "seaweed." Two of the most commonly observed macrophytes included were white-stemmed pondweed (*Potamogeton praelongeous*) and Coon's tail (*Ceratophyllum demersum*). White-stemmed pondweed was

Table 6-1: Aquatic Vegetation Surveys in Lily Lake

Scientific	Common	Brown County	Wisconsin DNR	Number of Sites Observed (Brown County/ WDNR)	Visual Observations
Ceratophyllum demersum	Coon's-tail	X	X	36 / 39	
Chara spp.	Muskgrass	X	X	18 / 47	
Elodea canadensis	Canadian waterweed	X	X	5 / 1	
Heteranthera dubia	Water star-grass		X	0 / 3	X
Lemna minor	Common duckweed	X		1 / 0	
Myriophylum sibiricum	Common water-milfoil	X	X	21 / 9	
Najas flexis	Northern water-mint	X	X	17 / 11	
Nymphea odorata	American white water-lily	X	X	26 / 14	
Potamogeton amplifolius	Large-leaf pondweed		X	2 / 2	
Potamogeton amplifolis x P. praelongus?			X	0 / 11	
Potamogeton crispus	Curly-leaved pondweed	X		68 / 0	
Potamogeton illinoensis	Illinois pondweed	X		8 / 0	
Potamogeton natans	Floating leaved pondweed	X		2 / 0	
Potamogeton praelongeous	White-stemmed pondweed	X	X	39 / 56	
Potamogeton richardsonii	Richardson's pondweed	X		12 / 0	
Potamogeton robbinsii	Robbin's pondweed	X	X	42 / 36	
Potamogeton zosteriformis	Flat-stemmed pondweed	X	X	12 / 33	
Spirodela polyrhiza	Greater duckweed	X		1 / 0	
Stuckenia pectinata	Sago pondweed	X	X	46 / 9	
Vallisneria americana	Water-celery	X	X	37 / 31	
Eupatorium maculatum	Joe-pye-weed	X			X
Filamentous algae		X	X	0 /1	X
Nuphar variegata	bull-head pond-lily	X	X	0 / 1	X
Typha latifolia	Broad-leaved cattail	X			X

Source: BCPC & WDNR, 2008

found in 44 percent of all sample points. Other common submersed species included water-celery (*Vallisernus americanus*), unidentified Chara species, Robbin's pondweed *(Potamogeton robbinsii*) and flat-stemmed pondweed (*Potamogeton zosteriformis*).

Emergent species accounted for less than one percent of all vegetation. Although not sampled in the point-intercept survey broadleaf cattails (*Typha latifolia*) and Joe-Pye weed (*Eupatorium maculatum*) were common along the edges of the shallow bays.

Floating leaf species made up approximately 13 percent of the plant community. The most common species was American white water lily (*Nymphea odorata*). Free-floating pondweed (*Potamogeton natans*) was found at one location and bull-head pond lily (*Nuphar variegata*) was observed at several points on the lake which were not included as sampling points. Free-floating vegetation was found at only one sample point. Two species of duckweed were observed.

Aquatic vegetation was sampled at 137 of the 155 (97 percent) sample points as seen in Table 6-2. Six of the predetermined points were on land; the remaining points lacked vegetation. Vegetation was found to a depth of 18.5 feet.

Species richness or the number of species present in a lake is a commonly used parameter to quantify the overall "healthiness" of a lake. Typically, the higher the diversity of aquatic plants, the healthier the lake is. The aquatic vegetation survey indicated that 19 species of plants were present in Lily Lake. An average of 2.85 species was found at each site; of these, 2.47 were native species. Species richness was greatest in shallower water as seen in Table 4-1. The southeastern portions of Lily Lake had the highest species richness where as many as six species were found at a single sample point. A brief discussion of the most prevalent species follows below.

Only one invasive species of plant was located. Curly-leaf pondweed was identified at 44 percent of sites on Lily Lake. Due to the observed proliferation of Curly-leafed pondweed, proactive steps must be taken to create an eradication and management program for the invasive plant.

Curly-leafed pondweed (CLP) was identified only by Brown County staff. Two reasons can account for this explanation. First, CLP completes its life cycle in late July or early August. By mid-August, most CLP plants have fallen to the lake bed. The timing of the Wisconsin Department of Natural Resources survey occurred well after the time frame in which CLP would be observed. Second, aquatic vegetation identification can be difficult due to minute differences between similar species. Brown County staff may have misidentified another similar species as CLP.

In order to determine if CLP was misidentified, Brown County staff completed minimal plant surveys on the days Secchi readings and other water quality measurements were recorded in May 2009. May was chosen as CLP should be the only plant growing. Native species begin growing in late May or early June. (See discussion below.) No evidence of CLP was found during the two trips to Lily Lake. Aquatic vegetation surveys in May 2009 were brief due to staff time constraints and unusually choppy

water conditions on Lily Lake. Additional surveys should be completed in 2010 to ensure that CLP is not present in Lily Lake.

Table 6-2: Aquatic Vegetation Species Richness Analysis

Summary Statistics	Brown County	Wisconsin DNR
Total number of sample points	155	143
Total number of points sampled	150	130
Total number of sites with vegetation	137	134
Frequency of occurrence of sites shallower than maximum depth of plants	137	97.01
Simpson Diversity Index	*	0.89
Maximum depth of plants (ft)	18.5	17.0
Average number of all species per site (veg. sites only)	2.85	2.36
Average number of native species per site (shallower than max depth)	2.47	2.27
Average number of native species per site (veg. sites only)		3.21
Species Richness	16	16
Species Richness (including visuals)	19	16
Number of native species	18	16

*Brown County did not calculate due to the lack of area or abundance calculations for each sample site.
Source: BCPC and WDNR, 2008

Species diversity is probably the most misused value in ecology because it is often confused with species richness. Although the two measurements are interrelated, species diversity accounts for the overall number of species as well as the relative abundance of each species. Species diversity is calculated by identifying both the plant species present and the overall area they cover. Lakes with high species diversity are much more stable and more resistant to environmental changes. A lake dominated by one or two species is considered to be less diverse than one in which several different species have similar abundance. Lily Lake has a Simpson's Diversity Index (SDI) of 0.89 as determined by the WDNR. Since overall diversity increases as the SDI decreases to zero, this indicates that Lily Lake is not tremendously diverse.

Macrophytes Discussion

Although viewed as "weeds" and a nuisance by humans, macrophytes are essential in maintaining a beneficial healthy lake ecosystem. Macrophytes provide cover for fish and food for aquatic invertebrates. They also produce oxygen which is essential for most aquatic life. A lack of macrophytes may indicate water quality problems such as excess water turbidity, high nutrient concentration, or herbicide pollutions. Below is a discussion of the macrophytes present in the lake. Curly-leaf pondweed (*Potamogeton crispus*) has been included due to the potential it is present in Lily Lake.

Coon's tail (Ceratophyllum demersum)

Coon's tail is a brittle, rootless, and entirely submerged perennial. The leaves are needlelike and found in whorls around a common stem. The leaves possess two "forks" giving the illusion that each leaf is comprised of four tiny leaflets. The flat leaves which curl are densely packed around the stem giving an overall shape and appearance similar to a raccoon's tail. Individual coon's tail plants can exceed three feet in length.

Since the plant is rootless, it is free-floating. Since the plant is adapted to relatively low light intensities, it can be seen at depths exceeding 15 feet. In many cases, it was the only plant observed in deeper water in Lily Lake. Coon's tail is common in alkaline lakes throughout the United States and Canada.

The plant produces large quantities of oxygen for aquatic animal life. Its dense leaf pattern provides ideal habitat for aquatic invertebrates such as insects, plankton, and newly hatched fish. The plant also produces an alkaloid which inhibits the growth of blue-green algae, the species associated with "toxic" algal growth in highly eutrophic environments.

Muskgrass

Most members of the genus Chara are commonly called "muskgrass". Although these common lake inhabitants look similar to many underwater plants, they are actually related to algae. Muskgrass species are green or gray-green and grow completely submersed in shallow water. Individuals can very greatly in size from a few inches to over three feet in length. The main "stem" of the stonewort bears whorls of branchlets, clustered at regularly spaced joints. When growing in hard water such as Lily Lake, they sometimes become coated with lime giving them a gritty feel.

Water Celery (Vallisneria Americana)

Water celery is an attractive plant. It has long ribbon-like leaves that grow from a root-stock anchored in the lake bottom. The leaves can grow up to six feet in length. There is a prominent red mid-vein which runs the entire length of the plant. The plant is usually submersed, but leaves will float on the surface in shallow waters. The plant reproduces by extending a small flower to the water surface on a cork screw stem. Male plants produce a stomach-shaped tuber. In the fall after reproduction is complete, the plant rises to the surface and floats to shore in large mats. Water celery provides important cover for fish, and the tubers and leaves that are a delicacy for waterfowl.

Pondweeds (Potamogeton spp.)

Pondweeds are a large family of widely distributed aquatic vegetation. Over 30 species are found in Wisconsin. Plants are mostly perennial and typically produce rhizomes (undergrounds running roots). Many species also produce over-wintering buds called turions. In many species, the thin leaves are submersed and float easily within the current. Those species with floating leaves tend to be more leathery.

Curly-leaf Pondweed (Potamogeton Crispus)

Curly-leafed pondweed is an invasive perennial that is native to Eurasia, Africa, and Australia. It was accidentally introduced to United States waters in the mid-1880s by the aquarium industry. The approximately three inch long leaves are reddish-green, oblong, and have distinct wavy edges that are finely toothed. The stem of the plant is flat, reddish-brown and grows up to three feet long.

In Wisconsin, curly-leaf pondweed usually is fully grown by the end of July. The summering bud (called a turion) breaks off from the plant, falls to the bottom of the lake, and lies submerged and dormant. The turions begin to sprout in fall, responding to the shortening day length and cooling water temperatures. The new plantlets continue to grow throughout the winter. The

early growing start allows the plant to crowd out other more desirable native species. Curly-leafed pondweed is one of the predominant species within Lily Lake.

Turions and plant fragments can be carried on boats, trailers and fishing gear from one water body to another. Since its introduction into Lily Lake, it has spread rapidly. Control methods for this species are varied and the best options will be explored further in the lake management study.

Management Concerns

The Brown County Facility and Park Management have received numerous complaints that Lily Lake is a "weedy" lake (Hartman, 2008, Personal Communication). There is a common perception that aquatic macrophytes are a nuisance to the recreational use of a lake. However, these plants are an essential element in a healthy and functioning lake ecosystem. Diverse aquatic vegetation provides food and habitat for a number of animals including fish, insects, amphibians, waterfowl, and mammals. Shoreline vegetation filters upland nutrients from entering Lily Lake and littoral (near shore) vegetation provides erosion control eliminating re-suspension of nutrients through wave action. Increased education will be needed to inform Lily Lake users of the benefits of the existing vegetation at Lily Lake.

The goal for the Lily Lake Vegetation Survey is to monitor and assess macrophyte and plankton populations and communities for continued biodiversity within Lily Lake.

The following management objectives and strategies will be used to achieve this goal:
Objective 1: Monitor long-term plant populations to determine long-term population and biodiversity trends.

Plant communities can change in abundance and diversity over time due to a variety of environmental conditions. Land use trends and recreational activities can greatly affect macrophyte populations. The lake management plan provides a snapshot of the Lily Lake ecosystem. Additional information is required.

1A. Develop and implement voluntary programs for either an academic institution or the general public to perform aquatic vegetation surveys at regular five year intervals.
1B. Perform a survey of the algal and plankton communities within Lily Lake.

Objective 2: Develop a system for early response to eradicate or contain aquatic invasive species (AIS) before species can become permanently established.

Once invasive species have arrived there is often a window of opportunity to eradicate small pioneering populations before they become a nuisance, yet species are not detected until nuisance populations are formed. By initiating detection and monitoring programs, Brown County will be able to discover and manage small infestations at a point where the species can be eradicated in a cost effective manner.

2A. Install a boat wash at Lily Lake.
2B. Create an invasive species management plan for Lily Lake and all of Brown County which includes early and rapid response protocol for all aquatic invasive species.
2C. Continue to monitor Lily Lake for the introduction of new aquatic invasive species.
2D. Hire a dedicated staff person in the Land Conservation Department as Invasive Species Management Coordinator.
2E. Collaborate with the Wisconsin Department of Natural Resources, University of Wisconsin Extension, United States Fish and Wildlife Service, and other appropriate state and federal agencies to identify and eradicate new infestations.
2F. Apply for Wisconsin Department of Natural Resources grant programs which allow for the creation of an invasive species management plan, funding staff positions, or creating educational materials as stated above.

Objective 3: Educate the public on the value of healthy ecosystems and encourage advocacy on maintaining a variety of scientifically sound lake management.

Although many people perceive macrophytes as "weeds," they are integral components of a healthy lake. The chemical and physical parameters of a lake are the best indicators of the overall best use of a Lily Lake. For example, Lily Lake is not well suited for swimming as most of the lake bottom is compromised of naturally occurring mucky sediments.

3A. Develop and erect a kiosk detailing the species of macrophytes present in Lily Lake and their importance for fish and wildlife habitat.
3B. Organize a bio-blitz to determine the overall biodiversity of Lily Lake and Lily Lake County Park.

Objective 4: When feasible, control and eradicate established AIS that have significant impacts in Lily Lake. Reduce the harmful effects resulting from AIS infestations by managing those that cannot be eradicated.

Established invasive species populations create the most noticeable impacts, yet are often impossible to eradicate or control. Management activities are most effective when they are focused on populations of established species where there is a clear and significant impact on native species, and where the control or eradication of specific populations is feasible both economically and technically.

4A. Continue to annually monitor Lily Lake for the presence of curly-leafed pondweed in early spring between "ice out" and mid-May.
4B. Monitor all areas within and adjacent to Lily Lake County Park for invasive species to ensure they do not enter the park.
4C. Establish a boat washing program at all Brown County Park facilities to limit the spread of invasive species between water bodies throughout Brown County.

Chapter 7

Aquatic Invasive Species Management

Introduction

Freshwater plant monitoring is completed by natural resource agencies to track aquatic plant community changes over time. In addition, these programs help identify whether invasive species have been introduced into a lake.

Invasive species are non-native plants that have been introduced to Wisconsin either accidentally or on purpose by humans. Invasive species typically originated in foreign countries. Once introduced, they live in an environment which lacks natural predators such as plant-eating insects or disease that normally keeps their growth in check. The lack of natural controls, combined with the plants high reproductive rates, allows the plants to thrive and out-compete desired native species. Both plant and animal species can be considered invasive if they readily adapt to their new environs and out-compete the native inhabitants.

Over 180 aquatic invasive species (AIS) have been introduced into the Great Lakes ecosystem. Unfortunately, many AIS were discovered after the problem became too large to solve. Since all waters within Brown County flow directly into the Lake Michigan watershed, special attention should be given to long-term monitoring of the plant and animal communities within Lily Lake.

Aquatic Invasive Species

Aquatic invasive species (AIS) are species that impact aquatic ecosystems. They are non-native species that threaten the diversity or abundance of native species, the ecological stability of infested waters, human health and safety, or commercial, agricultural, aquaculture, or recreational activities dependent on such waters. Humans have created conditions where plants and animals can aggressively invade and dominate natural areas and water bodies. Aquatic invasive species are spread to new areas by various methods such as: moving watercrafts from water body to water body without removing AIS, ships releasing ballast water containing AIS, carrying seeds of AIS on footwear or pet's fur, mowing along roadsides, and driving or biking with AIS seeds or fragments in tire treads.

The spread of AIS can cause significant economic and ecological problems. AIS can interfere with water uses (drinking water, water intakes, recreation), affect the ability of lakes and streams to support native fish and wildlife, lower water quality, and alter riparian (streamside and shoreline) conditions. Once AIS are introduced, there may be no natural controls, such as pathogens, parasites, and predators. Lack of natural controls may allow a population increase at an exponential rate. AIS can cause the disruption of

native species in the ecosystem as the AIS may prey upon, out compete, or transmit disease to the native species.

Study Area

Brown County is unique as it serves as the focal point of two major watersheds. The Fox-Wolf Rivers watershed bisects the county and encompasses approximately one-half on the land area. It traverses Brown County in a southwesterly – northeasterly fashion from its mouth at the southern end of Green Bay to the southwestern corner of the county. The Lake Michigan watershed encompasses the remainder of the county. The Lake Michigan water shed includes the Bay of Green Bay, several tributary watersheds along the west shore of Green Bay, and the headwaters of several tributary watersheds to Lake Michigan.

Similarly, the Town of Eaton is unique that it hosts the headwaters of several sub-watersheds of Lake Michigan. The Neshota River watershed headwaters are located in the Lily Lake area. The Neshota River generally flows southeasterly. Flowing in a northeast-easterly direction, the Kewaunee River watershed is located approximately three miles east of Lily Lake. The headwaters of the Baird Creek watershed is located less than one mile north.

The close proximity of Lily Lake to the other watersheds makes an aquatic invasive species infestation highly probable. The wide variety of surface water resources presents an opportunity for Brown County residents and visitors to regularly utilize both water sheds. It is reasonable to assume that an angler residing in the Town of Eaton will target yellow perch on Green Bay one day and fish for bluegills on Lily Lake the next. This leads to a high probability of transferring invasive species from Green Bay to Lily Lake.

Infestation Vectors

The introduction of AIS is not a new phenomenon. A myriad of species have been introduced to the Great Lakes ecosystem both intentionally and accidentally. Species such as rainbow smelt (*Osmerus mordax*) and several salmon were introduced to replace native herring species and lake trout which were commercially over-fished in the 1800s. Others such as the round goby (*Neogobius melanostomus*) and Eurasian ruffe (*Gymnocephalus cernuus*) have been accidental.

Invasive species can be introduced in a variety of ways. Landscaping and nurseries have introduced a variety of invasive species. These vectors include the landscaping industry, recreational watercraft, sport and commercial fisheries, the intentional release of wild animals, the aquarium industry, and oceanic shipping.

As the original settlers imported plants from their home countries, some escaped cultivations. As new varieties of plants are used in commercial and residential landscaping, the number of potential AIS increases. The most prominent AIS from

nurseries is purple loosestrife (*Lythrum salicaria*). Although its sale is illegal in Wisconsin, it now infests vast areas of riparian and lacustrine habitats.

Humans have readily and unknowingly spread several AIS through recreational watercraft. AIS plant fragments that adhere to boats are transported between water bodies, the fragments are released in the new water body. The fragments are able to quickly colonize resulting in another infested lake. The most common species transferred by recreational watercraft include Eurasian water milfoil (*Myriophyllum spicatum*) and curly leaf-pondweed (*Potamogeton crispus*). Animal species such as zebra mussels (*Dreissna polymorpha*) and some snail species have spread in this fashion as they cling to the plant material.

Commercial and sports fishermen spread invasive species. Live bait left over from a fishing trip that is dumped into the water directly introduces a potential invasive species. Not only may the bait be exotic, but there may also be fragments of invasive plants adhering to the fish. Furthermore, the fish may be infected with invasive viruses such as *viral hemorrhagic septicemia* (VHS).

Many invasive species plants were originally used in either the aquarium industry. Releasing unwanted plants or animals from aquariums and water gardens are a source of invasive species.

Oceanic vessels utilized in the shipping industry have been responsible for the introduction of a majority of the species in the Great Lakes ecosystem. Ballast water discharge is a common introduction vector around the world. Ballast water is pumped from the sea (or the Great Lakes) in the hulls of large ships to maintain stability during transit. As the cargo is loaded or unloaded at a foreign (or trans-Great Lakes) port, ballast water is exchanged at a new location. The continual exchange of ballast water at new ports accelerates the spread of AIS to new locations.

Potential AIS in Lily Lake

The following species are present and established in Wisconsin and have the potential to spread. Proactive monitoring can prevent the introduction of invasive species altogether. If any invasive species are present, these species can be managed through actions that involve mitigation of impact, control of population size, and prevention of dispersal to other water bodies. This list is not comprehensive but is provided to illustrate species that potentially threaten inland lakes such as Lily Lake.

Invasive Aquatic Plants

Curly-leaf Pondweed (Potamogeton crispus)

Curly-leaf pondweed is an invasive perennial that is native to Eurasia, Africa, and Australia. It was accidentally introduced to United States waters in the mid-1880s by the aquarium industry. The approximately three inch long leaves are reddish-green,

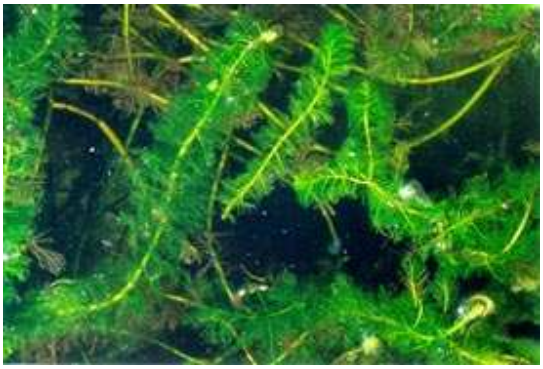
oblong, and have distinct wavy edges that are finely toothed. The stem of the plant is flat, reddish-brown and grows up to three feet long.

In Wisconsin, curly-leaf pondweed usually is fully grown by the end of July. The summering bud (called a turion) breaks off from the plant, falls to the bottom of the lake, and lies submerged and dormant. The turions begin to sprout in fall, responding to the shortening day length and cooling water temperatures. The new plantlets continue to grow throughout the winter. The early growing start allows the plant to crowd out other more desirable native species. Curly-leafed pondweed may be present within Lily Lake. This will need to be verified.

Turions and plant fragments can be carried on boats, trailers and fishing gear from one water body to another. Since its introduction into Lily Lake, it has spread rapidly. Control methods for this species are varied and the best options will be explored further in another section.

Eurasian Water Milfoil (Myriophyllum spicatum)

Eurasian water milfoil (EWM) is a submersed aquatic plant native to Europe. It is the only non-native milfoil in Wisconsin. EWM has slender stems whorled by submersed feathery leaves and tiny flowers produced above the water surface. It can be readily distinguished from native milfoils because it has over twenty pairs of leaflets on each leaf; native species have less than 13 pairs.



Eurasian water milfoil is capable of growing under a wide range of conditions. Typically, it grows in shallow water but can inhabit water up to 30 feet deep. Eurasian water milfoil can take root from a single segment of stem and leaves. Fragments of the plant clinging to boats and trailers can spread the plant from lake to lake. EWM grows best in fertile, fine-textured, inorganic sediments. Since it grows less productively in lakes, it is restricted to area of nutrient rich sediments or areas receiving nitrogen and phosphorous laden runoff. Local water temperatures can promote multiple periods of flowering and fragmentation.

Purple Loosestrife (Lythrum salicaria)

Purple loosestrife is a perennial, aquatic plant. It is native to Europe and Asia and was introduced to the United States in the 1800s as a garden perennial. Purple loosestrife is easily identified by its bright purple flowers which bloom from July to September. Individual plants typically grow in dense bush-like clusters which can reach three to seven feet tall. Individual clumps can have up to 50 stems.

Purple loosestrife is a very adaptive plant that invades marshes, lakeshores, and disturbed habitats such as roadside ditches. It readily out-competes native aquatic vegetation as individual plants produce several million seeds. Animals and wind carry the seeds over long distances allowing purple loosestrife to colonize in several new areas.

Phragmites (Phragmites australis)

Phragmites, also know as common reed, is a tall grass that inhabits shorelines, riverbanks, marshes, and ditches. Plants exceed 13 feet in height. Its stalks support broad sheath-type leaves that are one-half to two inches wide at the base, tapering to a point near the ends. Large, purple (or white), feathery cluster appear by late June. The plant turns tan in the fall. Most leaves drop off leaving only the plume-topped shoot.

Found throughout temperate regions of North America, Phragmites is abundant through northeast Wisconsin. It is found in a high percentage of roadside ditches in alarmingly close proximity to Lily Lake County Park. It can quickly displace native plants such as cattails, wild rice, and native wetland orchids. Its high biomass can block light to other native plants. The extensive root system also occupies all of the growing space below ground choking out native species. New plants grow from the rhizomes running below ground and stolons, above ground runners. Once established, Phragmites requires several years of manual intensive treatment to be eradicated.

Invasive Aquatic Animals

Round Goby (Neogobius melanostomus)

The round goby is a bottom dwelling fish with a large head resembling a tadpole. Females and immature males are mottled slate gray and brown. Spawning males turn almost solid black. The round goby has a large, rounded head with protruding eyes. The belly is slightly flattened. There is a predominant black spot on the dorsal fin. Round gobies look similar to native sculpins but can be distinguished by a single scallop-shaped pelvic fin. The round goby can grow to ten inches long.

Native to the Black and Caspian Seas, the round goby most likely entered the Great Lakes through ballast water. Round gobies are aggressive feeders and can forage in total darkness. They feed mostly on bivalves, crustaceans, small fish, and fish eggs. The round goby also takes over prime spawning sites traditionally used by native species. It has been recently discovered that gobies may be infected with *Viral Hemorrhagic Septicemia* (VHS) and may cause the spread of this viral disease to native species.

Eurasian Ruffe (Gymnocephalus cernuus)

Eurasian ruffe are a small perch-like fish native to Eurasia. The ruffe reaches up to six inches in length, and resembles a walleye. Unlike the yellow perch, the ruffe has a joined dorsal fin. The mouth is slightly turned down, and the head lacks scales.

Eurasian ruffe were introduced to the Great Lakes in the 1980s through ballast water of oceangoing vessels. Currently, ruffe have established a significant population in western Lake Superior. Although the ruffe prefers slower moving waters, it is a highly adaptable species. It can tolerate a wide temperature range. Unlike other perch species, ruffe are more tolerant of murky, nutrient-rich conditions.

The Eurasian ruffe has demonstrated that it can destroy the delicate predator-prey relationship in Lake Superior. Since the ruffe feeds on small insects and larvae, it will eliminate species through direct competition. Ruffe compete with native fish for the limited food and habitat sources. Their sheer numbers out-compete native perch and the fry of sport fish. Furthermore, their spiny dorsal fins discourage predation by other fish giving populations the potential to increase rapidly.

Quagga Mussel (Dreissena rostriformis bugensis)

The quagga mussel is a small freshwater bivalve related to the zebra mussel. The quagga mussel has a rounded angle, or carina, between the ventral and dorsal surfaces. The quagga also has a convex ventral side. Color patterns can vary widely with black, cream, or white bands. They usually have dark concentric rings on the shell and are paler in color near the hinge. It is believed that the specific coloration patterns are determined by the local environmental surroundings. The quagga is significantly larger than its cousin the zebra mussel reaching sizes up to four centimeters.

The quagga mussel prefers cold, deep water. They have been found to depths of 45 feet. Quagga mussels are prolific filter feeders siphoning large quantities of water each day. Lake Michigan water clarity has improved significantly due to their presence. However, their negative side effects have included reducing biodiversity and damage the base of the food web by removing phytoplankton. Quagga mussels are so aggressive that they've displaced zebra mussels in several areas throughout the Great Lakes.

The quagga mussel has only been found in Green Bay to date. Since they thrive on all types of lake bottoms, they have the same inland invasion potential as the zebra mussel has already demonstrated. Zebra mussels are unlikely to invade Lily Lake as they require a hard substrate bottom such as sand or rock. Both species of mussels can be transported on plant fragments, or the veliger, the infant stage, can be transported in bilge water.

AIS Control Strategies

Aquatic Invasive Species can be controlled by a variety of means. The specific method chosen depends on the specific species, the extent of the infestation, and the individual lake. The control methods for AIS can be classified according to three general categories: mechanical, chemical, and biological. Within each category several control strategies can exist. Each method has its advantages, disadvantages, and limitations. The appropriate method to utilize should be determined by both fiscal measurements and by consultation with the WDNR.

Mechanical

Mechanical control involves physical removal of the plant from a water body. Plants can be removed by hand or through utilization of equipment. A variety of mechanical harvesting techniques can be utilized including rakes, cutting blades, or industrial harvesters. All plants which are mechanically controlled must be removed from the lake. A disposal source is required.

Mechanical removal offers immediate control for small areas of infestation. By removing plant material from the water, dissolved oxygen levels are maintained as decomposing plant material will not remove oxygen from the water column. Mechanical control allows for continued use of the lake; many chemical treatments restrict human usage of the water body for a specific time period following application.

Mechanical controls offer several disadvantages. Mechanical control measures are costly averaging over $10,000 per treatment. Furthermore, mechanical controls such as harvesting must be periodically repeated over several years. It is impossible to remove all plant fragments or reproductive structures in one treatment. Control efforts can also be time consuming. Hand-picking individual plant requires extensive labor, and the most efficient mechanical harvests can only treat approximately ten acres per day. Harvesting may actually introduce new infestations elsewhere in the water body. Depending on the mechanical method chosen, the treatment may disrupt the benthic (bottom dwelling) community of a lake. This disturbance may allow an AIS to re-root more quickly than a native plant.

Chemical

Chemical control involves the application of either pesticide or herbicidal treatments to the water body. Herbicides can be either selective (target a single species) or general. The specific herbicide to be used will depend on the target species, the time of application, the temperature of the lake, and several other factors.

Chemical treatments are preferred when an invasive species are unlikely to be controlled by mechanical means or when mechanical efforts would likely increase the spread of the invasive species. They are extremely effective when performed by knowledgeable licensed professionals. Caution must be exercised to time applications to minimize any adverse impacts on desirable native species.

Herbicide treatments are strictly regulated by the WDNR. Typically chemical applications mandate that use restrictions are placed on the water body for a period of time to avoid human contact. Chemical applications can be costly. Most herbicides can be harmful to human health. Individuals handling herbicides must wear appropriate safety equipment, properly transport, and safely dispose of all unused herbicides.

Prior to herbicidal treatments, the negative effects chemical treatments have on the environment must be out-weighed against the negative impacts that no action will have on a lake. For all practical purposes, some invasive species cannot be controlled without the use of herbicides.

Biological

Biological control involves the use of another living organisms to control the AIS. Typically, a known predator from the region of origin of the individual invasive species is selected to be released.

Extreme caution must be exercised when utilizing biological control. This method involves the intentional release of a non-native species to a water body. Many predators

are generalists and able to feed on several species. Potential exists that the biological agent will damage the desired native species within the lake. Organisms can also escape to other water bodies; the end result would be the creation of a second invasive species. Scientists thoroughly study a variety of biological control agents to assure they will associate only with the targeted invasive species. Biological controls do not always completely eliminate an invasive species outbreak. Furthermore, it may take several years for the biological agent to work. Biological control releases are strictly monitored by the Wisconsin DNR.

Although biological control efforts have limitations, some efforts have demonstrated a great deal of success. Purple loosestrife has been successfully controlled using a predatory beetle. The beetle selectively eats purple loosestrife plants. In addition, these beetles are killed by the onset of colder temperatures associated with Wisconsin winters.

Current AIS Status in Lily Lake

Curly-leafed pondweed (CLP) is the only invasive species that may be present in Lily Lake. There is a moderate to high probability that this plant is present in Lily Lake. A June 2008 plant inventory by Brown County Planning Commission staff potentially identified the presence at several sites a plant inventory completed by the Wisconsin Department of Natural Resources (WDNR) Inventory did not reveal the presence of CLP. Since CLP completes its annual life cycle prior to the WNDR survey, it may have been missed.

Brown County Planning Commission completed limited surveying of Lily Lake this spring for the presence of CLP. CLP begins its annual growth cycle prior to "ice out." Additional surveys should be completed in May 2010 to validate the presence of CLP.

New introductions of AIS are a continuing threat to any inland lake. The number of aquatic invasive species within the Great Lakes region exceeds 200. In order to infest Lily Lake, a particular species must be able to make the "jump" from either Green Bay and its tributaries or another nearby infested inland lake. Humans are likely vectors to transport new AIS to Lily Lake. The species discussed in this chapter are the most likely species which may be encountered in Lily Lake.

Several physical and chemical parameters will limit the likelihood of the introduction of some species. All plants listed above are likely invaders to Lily Lake. In addition, an introduced species must be able to survive within the chemical parameters of Lily Lake. The common occurrence of invasive plants in inland lakes across Wisconsin demonstrates the ease of introduction for plants. The physical separation of Lily Lake from other Lake Michigan sub watersheds may temporarily halt the introduction of invasive animal species. For example, round gobies have been found as far upstream as the first dam in Baird Creek, it is unlikely the goby could survive a journey from its present location to Lily Lake even in a 500-year flood. This does not prevent introductions. Spiny water fleas (*Bythotrephes cederstroemi*) have been transported from Lake Superior to two nearby inland lakes. It is believed that the spiny water fleas were

transported on fishing lines. This new infestation represented "jumps" of less than 25 miles for the spiny water flea (WDNR, 2009a).

Preventative Steps

The best control strategy for AIS is prevention. If specific species have not been found in a lake, the best way to prevent an infestation is to minimize opportunities for AIS to be transferred into Lily Lake. New introductions of plants are found near public access sites and heavily used entryways. Therefore, prevention levels should be focused on access points.

The most likely introduction source of any invasive species to Lily Lake is boaters. Since there are only two public access points to Lily Lake, a concentrate effort can be made on public education, Brown County and the Town of Eaton can readily focus attention on public education. Public education can be completed in several passive and active methodologies described below. A combination of several of the strategies listed below may be most effective in AIS education.

Education Kiosk

A kiosk is currently located at Lily Lake near the boat ramp. Several educational and informational materials including fishing regulations, county park rules, and an advisory for CLP notify Lily Lake users of important information. Several educational kiosks have been developed by volunteer groups for lakes throughout Wisconsin. These materials could be posted on new kiosks to inform Lily Lake users about the potential dangers of AIS. Education kiosks frequently provide pictures of the most significant invaders, identify specific areas of boats and fishing equipment which become contaminated, and offer simple strategies to remove these "hitchhikers."

In addition, the materials will have the ability to prevent the spread of new AIS infestations elsewhere in Brown County and Wisconsin. To be most effective two sets of kiosks would need to be erected at both the county park boat launch and the Polish League of American Veterans access area.

Clean Boats, Clean Waters

"Clean Boats, Clean Waters," (CBCW) is a Wisconsin Department of Natural Resources program which stresses public education through individualized contact at local boat launches. The effort is completed through a combination of paid staff and volunteers. Volunteers perform boat and trailers checks at local lake access points with consent of anglers. In addition, boat inspectors disseminate informational brochures and educate boaters on how to prevent the spread of AIS. Since the programs inception, over 54,000 boats have been inspected and over 113,000 individuals have been informed of the hazards of AIS. Volunteer participation and time has steadily increased since 2004 (WDNR, 2009b). The program has been successful as a majority (57 percent) of respondents indicated they have used one or more of the preventative measurements discussed in this chapter.

Training seminars for new boat inspectors are held by University of Wisconsin Extension (UWEX) staff. In addition, UWEX coordinates volunteer efforts at specific lakes. Train boat inspectors are able to organize and conduct localized boater education programs. Most important, CBCW volunteers serve as an early detection sources as they are required to report any new infestations. Additional information can found at the UWEX CBCW website at http://www.uwsp.edu/cnr/uwexlakes/CBCW/default.asp.

High Pressure Wash Station

High pressure wash stations allow boaters and anglers the opportunity to "clean" their watercraft prior to launching. By spraying the entire boat hull and trailer with highly pressurized water, the plants which may have been inadvertently transferred can be removed. Wash stations have been installed at several lakes throughout Wisconsin. In some cases, local communities combine a boat inspection program such as Clean Boats, Clean Waters with pressure washing. High-temperature washes also have the ability to be more effective in reducing the likelihood of transferring Quagga mussel veligers.

AIS Coordinator / Friends Group

An Aquatic Invasive Species Coordinator is a hired technical staff person whose primary responsibilities include organizing and supervising programs involving AIS education and control. AIS coordinators are typically an employee within the county's Land Conservation Department or are University of Wisconsin Extension staff. The job duties include developing stakeholder groups and partnerships; creating relevant public education programs; and supervising work programs dedicated to AIS identification, prevention, and control. Several sources such as the WDNR operate grant programs to fund AIS coordinators. Alternatively, many counties assign AIS control activities to a current staff member.

"Friends" groups, or lake groups, are typically a dedicated group of local residents, lake users, local businesses, and other interested stakeholders which organize to protect and enhance the quality of a specific lake. Lake groups take many forms in Wisconsin including simple friends groups, lake districts, or lake association. Many groups form a constitution, work plan, goals, and objectives for managing a lake long-term. The friends group may perform long-term water quality monitoring, assist in public education programs, perform service projects to protect the land, and conduct other vital functions necessary to protecting water quality.

AIS Management Goals

The goal for the Lily Lake Aquatic Invasive Species Management Plan is to minimize the harmful ecological, economic, and human health impacts of AIS through the prevention and management of their introduction, expansion, and dispersal into, within and from Lily Lake.

The following management objectives and strategies will be used to achieve this goal:
Objective 1: Detect new introduction of AIS in Lily Lake before they have a chance to become established in the ecosystem.

There are many different pathways by which new aquatic invasive species can arrive into Lily Lake. Species that provide fishing opportunities, erosion control, or aesthetic enjoyment can be intentionally introduced. Others will be inadvertently introduced through other mechanisms such as boats and trailers. Understanding these pathways is essential in reducing the likelihood of new invasions.

1A. Install a boat washing station at Lily Lake.
1B. Investigate and encourage the development of a boat inspection program at Lily Lake.

Objective 2: Develop a system for early response to eradicate or contain target species before species can become permanently established.

Once invasive species have arrived there is often a window of opportunity to eradicate small pioneering populations before they become a nuisance, yet species are not detected until nuisance populations are formed. By initiating detection and monitoring programs, Brown County will be able to discover and manage small infestations at a point where the species can be eradicated in a cost effective manner.

2A. Complete an aquatic plant survey of Lily Lake every three years.
2B. Create an invasive species management plan for Lily Lake and all of Brown County which includes early and rapid response protocol for all aquatic invasive species.
2C. Hire a dedicated staff person in the Land Conservation Department as Invasive Species Management Coordinator.
2D. Collaborate with the Wisconsin Department of Natural Resources, University of Wisconsin Extension, United States Fish and Wildlife Service, and other appropriate stated and federal agencies to identify and eradicate new infestations.
2E. Apply for Wisconsin Department of Natural Resources grant programs which allow for the creation of an invasive species management plan, funding of staff positions, or creating educational materials as stated above.

Objective 3: When feasible, control and eradicate established AIS that have significant impacts in Lily Lake. Reduce the harmful effects resulting from AIS infestations by managing those that cannot be eradicated.

Established invasive species populations create the most noticeable impacts, yet are often impossible to eradicate or control. Management activities are most effective when they are focused on populations of established species where there is a clear and significant impact on native species, and where the control or eradication of specific populations is feasible both economically and technically.

3A. Continue to annually monitor Lily Lake for the presence of curly-leaf pondweed in early spring between "ice out" and mid-May.

3B. Monitor all areas within and adjacent to Lily Lake County Park for invasive species to ensure they do not enter the park.
3C. Establish a boat washing program at all Brown County Park facilities to limit the spread of invasive species between water bodies throughout Brown County.

Objective 4: Educate the general public about AIS issues so that they do not facilitate the introduction or spread of AIS.

The lack of awareness concerning invasive species issues is one of the largest management obstacles. Few people understand the economic and ecologic threats non indigenous species pose and how their actions might introduce them. Uninformed people can introduce new invasive species through a variety of ways including dumping bait buckets, stocking a private pond, or planting water gardens. New introductions can be curtailed and eliminated through education programs to provide citizens with new information.

4A. Distribute educational materials developed by the Wisconsin Department of Natural Resources and other natural resource agencies with annual boat launch pass sales.
4B. Develop an educational kiosk at Lily Lake regarding invasive species identification and control.
4C. Develop an educational kiosk at Lily Lake illustrating the native species within Lily Lake and discuss their important to fish and wildlife populations.
4D. Continue to collaborate with state and federal natural resource agencies to create press releases regarding invasive species occurrences both at Lily Lake and within Brown County.

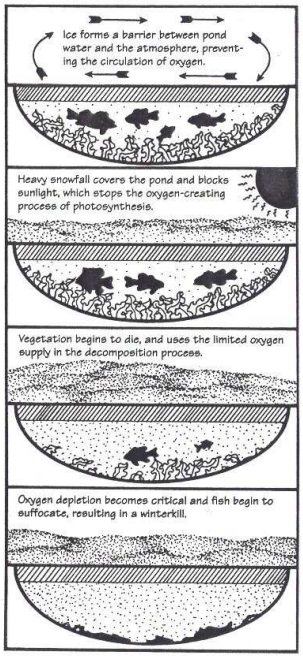
Chapter 8

Fishery

Introduction

Lily Lake is a popular fishing destination for residents in Brown County. Fishing pressure is quite profound during legal fishing seasons. Brown County staff observed heavy usage of both fishing piers while conducting water quality sampling throughout the summer months. In addition, many boats also access the lake.

Figure 8-1: Winterkills



History

Lily Lake has a complex history with respect to its fishery. The lake commonly experienced winterkills during the 1950's and 1960's and provided very little in the way of a recreational fishery. Winterkills are mass die-offs of fish due to low oxygen levels (Figure 8-1). The lake became publicly accessible in 1968 when Brown County established the Lily Lake County Park.

In 1976, the lake underwent chemical rehabilitation with rotenone, a naturally occurring fish toxicant, to remove overabundant bullheads and eliminate common carp. After the chemical treatment, the lake was stocked with various sunfish species and minnows (Table 8-1). Sometime in the early 1980's, Brown County Parks started to operate a winter aeration system to prevent the depletion of oxygen in the water that in the past had resulted in fish kills.

Table 8-1: Stocking History of Lily Lake, Brown County, WI, from 1972 -1978

Year	Species	Size	Amount
1976	Largemouth Bass	Adult	50
1976	Largemouth Bass	Fingerling	190
1976	Largemouth Bass	Yearling	135
1977	Bluegill	Adult	4,000
1977	Crappies	Adult	346
1977	Minnows unspecified	Fingerling	6,000
1978	Bluegill	Adult	4,170

The chemical rehabilitation treatment and the winter aeration have both proven beneficial to the Lily Lake fishery. The fishery has provided good action for bluegills and a decent largemouth bass fishery. Northern pike were either stocked without

record or survived the chemical rehabilitation, because there were northern pike harvests recorded during a 1998 creel survey. This creel survey reported very high amounts of angler effort per acre in both the open water and winter fisheries. Recently, the Brown County Parks Department has received complaints that the quality of the fishing has decreased. In response to the complaints, the Parks Department contacted the Wisconsin Department of Natural Resources (WDNR) to conduct another fisheries study at Lily Lake.

Sampling Methodology

WDNR fisheries biologist conducted a fishery study in fall 2008. Lily Lake was sampled twice over a period of two weeks using a direct current electrofishing boat at night and all fish observed were collected. Dip nets were 0.5 inch mesh. The sampling station encompassed one trip around the entire shoreline of the lake. The first night of the survey was September 30. Sampling was completed in 40 minutes. Game fish were measured and all fish were counted. All largemouth bass and bluegills larger than four inches were fin clipped to allow for a mark recapture population estimate. The second night of sampling was October 6, the same station was sampled and sampling was completed in 38 minutes. Fish were examined for fin clips, measured, and counted. Summary statistics were calculated.

Results

Only six species of fish were sampled during the two nights of electrofishing, largemouth bass, bluegill, yellow perch, golden shiner, green sunfish and white sucker in order of abundance (Table 8-2). Largemouth bass dominated the sample representing over 81 percent of the total catch. Bluegills were notably sparse as only 34 were caught. The lack of diversity was not unexpected because of the history of the lake being chemically treated in the 1970's and the lack of subsequent stockings. Northern pike are likely present in very low numbers, even though they were not collected in this survey. Only the largemouth bass and bluegill populations were considered for further analysis because of the very small samples of other fish species.

Table 8-2: Lily Lake Electrofishing 2008 Summary

Species	2008 Total Catch	2008 Population Estimate	1998 Total Catch	1998 Population Estimate
Largemouth Bass	239	3020 (95%CI 1227-6039)	221	1933 (95%CI 912-3719)
Bluegill	34	NA	249	4662 (95%CI 1393-8121)
Yellow Perch	8	NA	49	NA
Rock Bass	0	NA	9	NA
Black Crappie	0	NA	1	NA
White Sucker	2	NA	1	NA
Green Sunfish	2	NA	1	NA
Pumpkinseed	0	NA	1	NA
Golden Shiner	8	NA	0	NA

Largemouth Bass (Micropterus salmoides)

The largemouth bass population has increased in abundance while becoming bottlenecked in size compared to the size distribution in 1998 (Figures 8-2 and 8-3). The dashed line in these figures indicates the legal harvestable size for largemouth bass per Wisconsin fishing regulations. The population estimate for 2008 was 3,020 fish (72/acre). Only one legal fish (> 14 inches) was sampled in 2008. Most fish are sub-legal length fish and cannot be harvested. The average length was 11.1 inches, and the maximum was 14.7 inches. The proportion of fish greater than 15 inches was zero.

Figure 8-2: Largemouth Bass Length Frequencies 2008

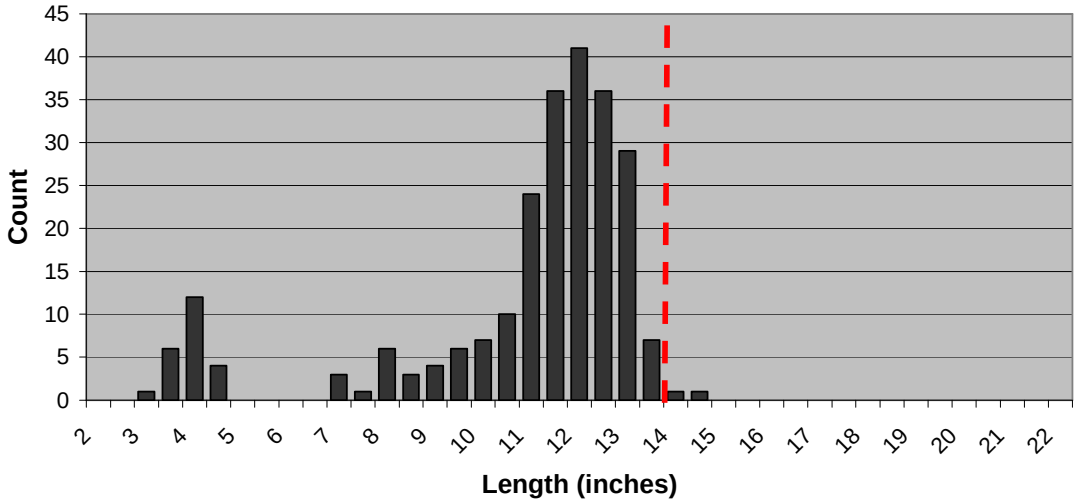
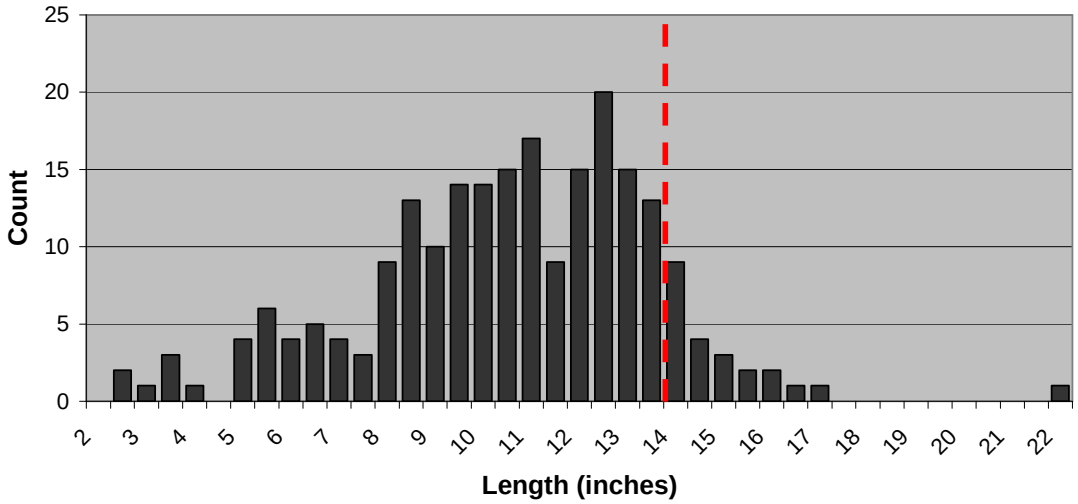


Figure 8-3: Largemouth Bass Length Frequencies 1998



When comparing the size distribution of the 2008 sample with the 1998 sample; there are fewer large fish and a majority of the fish are just below the legal minimum length of 14 inches. In 1998, the average length was 10.8 inches and the maximum was 22.2 inches

and the population estimate was 1,933 (46/acre). The percentage of fish greater than 15 inches was six percent.

Bluegill (Lepomis macrochirus)

There was a large decrease in the overall abundance of bluegill over the past ten years. A total of 34 bluegills were sampled in 2008. No population estimate was possible because of the very low sample size. The average bluegill length was 3.8 inches, and the maximum was 8.9 inches. In 1998, the average length was 4.9 inches, and the maximum was 7.6 inches. In 1998, the population was estimated at 4,662 (111/acre). There is a drastic change in bluegill size distribution between the 2008 and 1998 samples (Figures 8-4 and 8-5).

Figure 8-4: Bluegill Length Frequencies 2008

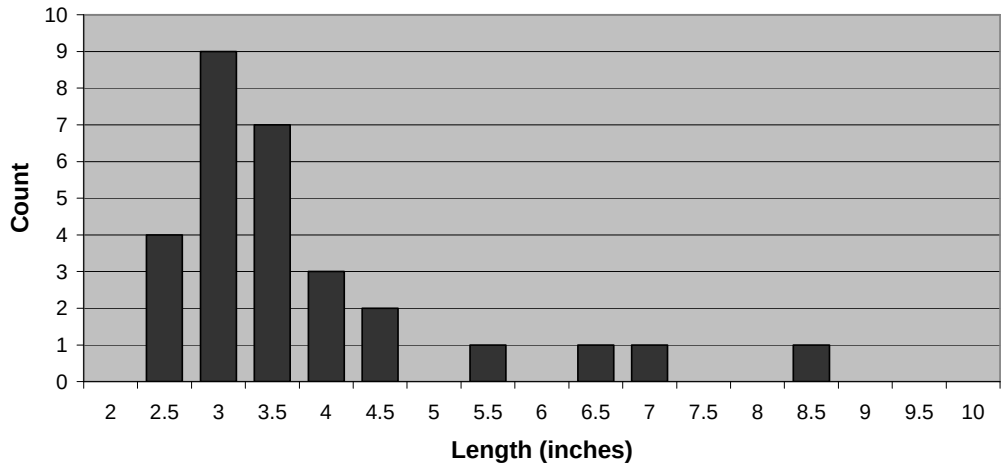
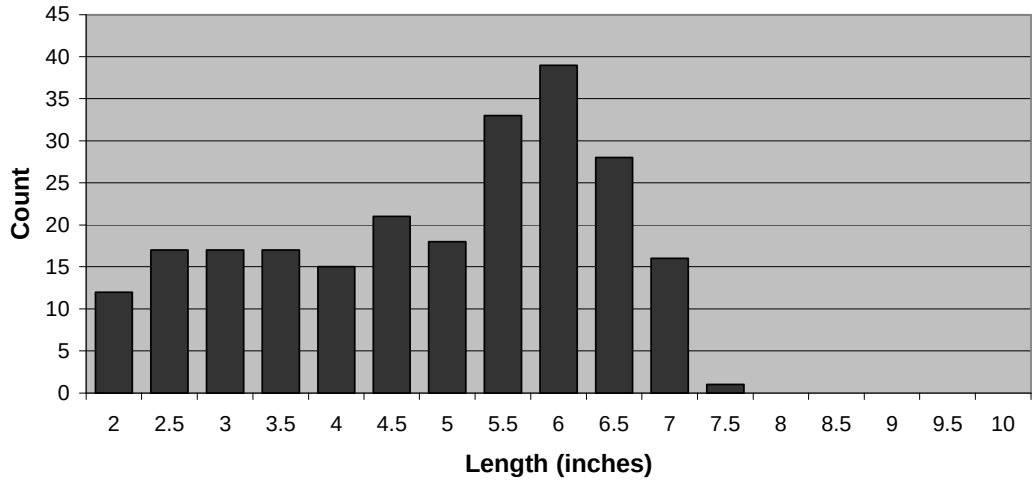


Figure 8-5: Largemouth Bass Length Frequencies 1998



Discussion

Largemouth Bass (Micropterus salmoides)

The change in size distribution is a very strong indication that there is heavy harvest pressure on bass. It is likely that bass are harvested as soon as their lengths are even close to legal size limits. The stockpiling of fish just below the legal minimum size leads to decreased growth rates and poorer condition of the fish. Due to the limited population sizes, larger bass may be eating smaller bass leading to a slower population growth.

Bluegill (Lepomis macrochirus)

In 1998, there was a drop off in the number of bluegills at around seven inches suggesting that anglers didn't harvest fish until they reached that size. In the 2008 sample, we observed a drop in the number of fish around 4 inches. Most adult bluegill have been removed from Lily Lake in the past ten years as indicated by the decreasing average size.

The drastic change is likely the result of two major causes. First, increased human harvest is likely occurring. As more fish are harvested, fewer fish grow as large because they are harvested sooner. Thus, the average size can be reduced significantly over time. As the large mouth bass population has grown, there can be a decrease in small bluegills due to natural predation. Although students on a field trip to Lily Lake caught several young bluegills during an invertebrate sampling experiment, predation from the overly abundant largemouth bass is keeping the bluegill population suppressed.

Management Recommendations

The current fishing regulations for Lily Lake are the same as the general inland regulations (Table 8-2). Daily bag limits and size limits are discussed.

Table 8-3: Current Fishing Regulations for Lily Lake

Species	Open Season	Daily Limit	Minimum Length
Panfish-bluegill, sunfish, crappie and yellow perch	Open all year	25 in total	none
Largemouth bass	1st Saturday in May-March 1	5	14 inches
Northern pike	1st Saturday in May-March 1	5	none

The WDNR has suggested several changes to the fishing regulations for Lily Lake that account for the current angling pressure and fish community composition. Over-abundant, sub-legal largemouth bass are dominating the fishery. Fishing harvest appears to be eliminating bass once they reach a size near legal length. In addition, fishing pressure has removed most adult bluegill.

To restore some balance to the fishery, the fishing mortality on panfish must be reduced. This can be done by lowering the panfish daily bag limit from 25 fish per day to ten fish per day to prevent over fishing of bluegill, black crappie and yellow perch. This strategy has been used on other lakes throughout Wisconsin with success.

In addition, it was also recommended to increase the harvest of largemouth bass. The WDNR has suggested implementing a protected slot limit from 14 to 18 inches and a daily bag limit of three largemouth bass. One fish could be over 18 inches and the remaining two would be less than 14 inches. Alternately, three fish less than 14 inches could be harvested.

The protected slot range is commonly used to create strong game fisheries in Wisconsin Lakes. This has provided quality fisheries for walleye, northern pike, and muskellunge in northern lakes and the Bay of Green Bay. This regulation would mean no possession of fish between 14 and 18 inches. However, anglers could harvest some of the smaller overabundant bass while still allowing the harvest of one trophy fish.

Protected slot limits restore balance to a lake fishery through several objectives. First, the bass abundance is reduced. A smaller bass population means the predation on panfish is directed lowered allowing more bluegills, crappie and perch to reach adult size and reproduce. With more adult panfish, overall populations will increase.

If anglers are not interested in quality bass fishing, the regulation could be switched to no size limit with a daily bag of three fish. WDNR staff caution against this regulation because of the history high harvest pressure on Lily Lake. Having no protection at all on largemouth bass may eliminate them completely. The lack of a top level predatory fish can allow panfish populations to explode (MPR, 2006). This typically will lead to a lake with a stunted panfish population.

Northern pike are not commonly caught on Lily Lake. If anglers are interested in increasing the abundance and size of northern pike in Lily Lake, WDNR staff recommended enacting a 26 inch minimum length limit and a two fish daily bag limit.

Public Input

The general public has been given several options to provide input regarding the types and qualities of the fishing experience that we will manage for on Lily Lake. Brown County Parks hosted two public meetings in April 2008 where public input was sought. The Brown County Planning Commission (BCPC) has conducted two surveys during the completion of this lake management plan. A mail survey was conducted among residents in the Lily Lake watershed. A second internet survey was hosted on the BCPC web site to allow for input from all Brown County residents and other lake users.

The public was informed of these meetings in several venues. First, public hearing announcements were distributed to the Brown County Parks media distribution list. News articles regarding the meetings and surveys appeared in both the *Green Bay Press-Gazette* and the *Denmark News*. Placard notification of the internet survey was posted on

both porta-potties and the educational kiosk at the Lily Lake boat launch. Due to the low response rate (n = 11), the data presented regarding fisheries was analyzed using a combination of the two surveys discussed in the previous paragraph. Survey participants were asked to rate their overall fishing experience at Lily Lake. Over 80 percent of survey respondents indicated current fishing conditions were poor or fair. The perceived low quality fishing experience has caused approximately half of the respondents to reduce their overall number of fishing trips to Lily Lake.

Survey respondents were asked several questions regarding various potential fishery management options for Lily Lake. Approximately half supported increasing the size limits to allow for a trophy fishery. All respondents supported decreasing daily bag limits to decrease the overall harvest from Lily Lake.

Additional public input opportunities will be provided before any regulation changes will be pursued. The BCPC and Brown County Parks will host several public meetings in late 2009 and early 2010 to discuss the overall lake management plan and the fishery study. WDNR staff has expressed a willingness to attend that meeting and describe the fishery and management recommendations. Utilizing the gathered survey data and Brown County staff opinions, the WDNR would bring any recommendations to the annual Conservation Congress meetings held annually in early April. Anglers from across Wisconsin would then have an opportunity to vote on any proposed management changes for Lily Lake. The recommendations from the Conservation Congress would then be forwarded to the Wisconsin Natural Resources Board for consideration and approval. It is estimated that no changes could occur until 2013 for the fishing regulations.

Fishery Management Goals

The goal for the Lily Lake Fishery to stabilize the population structure of all fish species in Lily Lake to provide a sustainable fishery that provides a quality fishing experience for all Brown County residents.

The following management objectives and strategies will be used to achieve this goal:

Objective 1: Assist the Wisconsin Department of Natural Resources in implementing the preferred management goals discussed in the 2008 Lily Lake Fishery Report:

The survey data collected by Brown County staff indicated that the general public is willing to implement the management changes proposed by WDNR staff. Brown County staff will communicate with the WDNR to begin the public participation process to change fishing regulations at Lily Lake.

1A. Present lake management plan at public informational meetings and Neville Public Museum Naturalist series.
1B. Organize and hold informational meetings regarding the Lily Lake fishery in association with the WDNR.

1C. Participate in the WDNR Conservation Congress proceedings to implement recommended changes in Lily Lake fishing regulations.

Chapter 9

Park Facilities

Introduction

The purpose of the Brown County Facilities and Park Management (Brown County FPM) is to enrich the quality of life in Brown County through a comprehensive system of open space and outdoor recreation facilities. The Parks Departments emphasizes natural resource preservation within the park system and the provision of a variety of recreational opportunities and outdoor education programming.

Currently the Brown County FPM owns and maintains 18 different facilities including a rifle range, campgrounds, county parks, boat launches, county fairgrounds, and recreational trails. Park activities include conservancy and wildlife management, education programs, wildlife observation areas, hiking, mountain biking, equestrian activities, snowmobile trails, picnic areas, playgrounds, pet exercise areas, a golf course, disc golf, and fishing.

Lily Lake County Park provides several important park amenities. An overhead shelter is available for picnickers and special events. This beautiful gazebo offers a picturesque background for weddings and all photo occasions. The boat launch provides access to the lake for electric motors and non-motorized watercraft. Two fishing piers provide access for disabled persons and are very popular for near shore angling.

Lily Lake Surveys

Two surveys were performed in the completion of the Lily Lake Comprehensive Management Plan as discussed in chapter four of this document. Both Lily Lake watershed residents and Brown County residents were asked to provide their input on existing park facilities and improvements and/or additions which are needed to the existing infrastructure. Results for both surveys are located in Appendices C and D.

A mail survey was completed in early 2008 during the update of the Brown County Park and Recreation Plan (BCPC, 2008b). This survey asked Brown County residents to provide input on the activities they participated in at county parks and asked for suggestions to improve on the existing facilities A 13 question survey was mailed to 1,480 residential property owners in Brown County.

An upland vegetation survey was completed by a certified forester. The forester identified all visible tree, shrub, and herbaceous species on a walk-through basis. Surveys were completed on foot by a walk around Lily Lake and via a kayak ride around the perimeter of the lake. Upland surveys were limited to those areas immediately adjacent to Lily Lake.

All four surveys provided valuable insight to the physical and natural amenities at Lily Lake. The three user surveys allowed citizens to provide input into evaluating the quality of existing amenities and assessing what amenities were needed at Lily Lake County Park. The upland vegetation survey provided a baseline snapshot of the overall composition and "health" of the upland habitats. A summary of the results and the recommended management actions at Lily Lake County Park follow.

Survey Results

The Lily Lake Comprehensive Lake Management Plan had mixed results. A mail survey was completed with landowners within the Lily Lake watershed. This survey had a 79 percent response rate. The low return rate for the internet survey resulted in statistically insignificant data since only three individuals responded. Both surveys allowed the opportunity for open-ended responses.

The 2008 Brown County Outdoor Recreation and Open Space Plan mail survey was sent to a random selection of over 1,400 Brown County residents. The survey had a 34 percent response rate. An open house was also conducted to gain public opinion. The information generated from the open house and the public opinion survey helped to guide the development of future recreational facilities at Lily Lake County Park.

Results for these three surveys were similar in that respondents indicated several improvements were needed. Most responses indicated that infrastructure improvements and additions were needed. The comments will be discussed in the following facility needs analysis.

Facilities Needs Analysis

Surveys have shown that most people enjoy open spaces and vistas of unspoiled nature at Lily Lake County Park. Respondents indicated that several infrastructure improvements would enhance the enjoyment of the natural environment. Table 9-1 lists the open-ended responses. The responses are separated into infrastructure improvements and policy suggestions. The policy suggestions are discussed in other chapters within this document.

The Brown County Outdoor Recreation and Open Space plan survey identified that 15 percent of Brown County residents in urbanized municipalities utilize Brown County parks and 28 percent of Brown County residents in rural municipalities utilize Brown County parks. In addition, approximately eight percent of respondents used Lily Lake. If the eight percent is extrapolated to the 2009 estimated population for Brown County, it can be anticipated that over 19,600 residents use Lily Lake County Park annually. As indicated in all surveys, many people use Lily Lake several times per year. The average number of trips per year as indicated by the two most recent surveys indicates the average Lily Lake user visits the park two times per year. That translates into over 39,000 visits annually.

Table 9-1: Recommended Infrastructure Improvements at Lily Lake

Infrastructure Needs	Number of Responses	Policy Issues	Number of Responses
Indoor restrooms	1	Discontinue hunting	2
Indoor shelter	1	Increase litter pick-up	1
Playground equipment	1	Increased aquatic vegetation control	1
Recreational trails around lake	2	Increase WDNR patrols	1
		Reduce daily bag limits for fish	1
		Remove upland invasive species	1

Source: BCPC, 2008-2009

Upland Vegetation Survey

Several habitats were identified in the baseline vegetation survey (Petznick, 2009, Personal Communication). The upland habitats are dominated by a climax oak-hickory forest (Table 9-2). The forest was dominated by northern red oak (*Quercus rubra*), white oak (*Quercus alba*), and bitter nut hickory (*Carya cordiformis*). Two types of wetland communities were identified (Table 9-3). The first was a mixed cedar swamp. The two predominant trees were black spruce (*Picea mariana*) and northern white cedar (*Thuja occidentalis*). The true "gem" of the park is a "northern Wisconsin" bog. This habitat is dominated by tamarack (*Larix laricina*) and black spruce (*Picea mariana*). Other "bog" species such as blueberry (*Vaccinium myrtilloides*), bog laurel (*Kalmia polifolia*), and Labrador tea (Ledum groenlandicum), comprise the majority of the herbaceous and shrub layers.

An analysis of the health of all habitats was completed. Typical attention was given to the upland and "bog" habitats.

The oak-hickory climax forest located within Lily Lake County Park is a rare "old growth" forest in Brown County. Most areas in Brown County were cleared in the 1800's for agricultural lands. As a result, most woodlands that have regenerated are "second growth" forests. Most trees have growth relatively straight and have a complete canopy closure. A predominant herbaceous ground layer is characterized by several different native species. A middle story is present, but the canopy is preventing future re-generation of the oak and hickory trees. As the oak trees die, it is unlikely that they will regenerate. The true climax forest in Wisconsin is maple community (Petznick, 2009).

The "northern Wisconsin" bog is a rare central Wisconsin gem. These habitats are associated more with the conifer dominated forests of the northern tension zone. It holds stunted tamaraks and spruce on high knolls interspersed with herbaceous plants on flat, wet areas. Brown County is unique in that it lies in the tension zone of Wisconsin. This areas hold species characteristic of both the Canadian boreal (evergreen) forests and the Midwestern prairie ecosystems. Care must be exercised to

protect this resource as bogs can take several thousand years to form. Once a bog is destroyed, it is impossible to replace or restore.

Table 9-2: Upland Plant Species in Lily Lake County Park

Trees		Shrubs	
Common Name	Scientific Name	Common Name	Scientific Name
Norway maple*	*Acer platanoides*	Autumn olive*	*Elaeagnus umbellata*
Red maple	*Acer rubrum*	Winter berry	*Ilex verticillata*
Sugar maple	*Acer saccharum*	Tartarian honeysuckle*	*Lonicera tatarica*
White birch	*Betula pendula*	Black cherry	*Prunus serotina*
Ironwood	*Carpinus betulus*	Staghorn sumac	*Rhus hirta*
Bitternut hickory	*Carya cordiformis*	Prickly ash*	*Zanthoxylum americanum*
Hawthorne sp.	*Crataegus spp.*		
Beech	*Fagus grandifolia*		
White ash	*Fraxinus americana*		
Apple	*Malus pumila*		
White mulberry	*Morus alba*		
White pine	*Pinus strobus*		
Cottonwood	*Populs deltoides*		
Trembling aspen	*Populs tremuloides*		
White oak	*Quercus alba*		
Northern red oak	*Quercus rubra*		
Basswood	*Tilia americana*		
Herbaceous			
Common Name	Scientific Name		
Ferns (unidentified species)	–		
White baneberry	*Actaea pachypoda*		
Hog peanut	*Amphicarpaea bracteata*		
Spreading dogbane	*Apocynum androsaemifolium*		
Large-leaved aster	*Aster macrophyllus*		
Asters (unidentified species)	*Aster spp.*		
Solomon's plume*	*Maianthemum racemosum*		
Virginia creeper	*Parthenocissus quinquefolia*		
Twisted stalk	*Streptopus amplexiflolius*		
Wild grape	*Vitis spp.*		*Indicates invasive species

Source: BCPC, 2009

Table 9-3: Wetland Plant Species in Lily Lake County Park

Trees		Shrubs	
Common Name	Scientific Name	Common Name	Scientific Name
Box elder	*Acer negundo*	Speckled alder	*Alnus incana*
Yellow birch	*Betula alleghaniensis*	Red osier dogwood	*Cornus stolonifera*
Paper birch	*Betula papyrifera*	Blueberry	*Vaccinium myrtilloides*
Black ash	*Fraxinus nigra*		
Tamarack	*Larix laricina*		
Black spruce	*Picea mariana*		
Black willow	*Salix nigra*		
Northern white cedar	*Thuja occidentalis*		
Herbaceous			
Common Name	Scientific Name		
Water arum	*Calla palustris*		
Jewelweed	*Impatensis canadensis*		
Bog laurel	*Kalmia polifolia*		
Labrador tea	*Ledum groenlandicum*		
Broad-leaved cattail	*Typha latifolia*		

Source: BCPC, 2009

*Indicates invasive species

Bird Surveys

Bird surveys were performed while at field studies were being conducted (Petznick, 2009). Brown County staff recorded all bird species heard or seen at Lily Lake County Park. Some species such as the common loon (*Gavia immer*) and the osprey (*Pandion haliaetus*) were only for a few days during the spring and fall migrations or a brief flyover. Other species such as the red-shouldered hawk (Buteo lineatus) and white-breasted nuthatch (*Sitta carolinensis*) are regular breeding species. In total, 120 different species were observed within Lily Lake County Park. A list of observed species and a checklist of most birds which occur in Wisconsin are located in Appendix G.

All observations were made at the boat launch, on the lake, or along Buyarski Road. A detailed study of the "bog" and other areas south of Lily Lake during the breeding season (June and early July) may reveal that other species are utilizing the park environs. The unique wetland habitats may yield a species of concern or threatened/ endangered species.

Management Concerns

The primary park management goal is to achieve a balance between the recreational use and the protection and interpretation of the natural and scenic resources of Lily Lake County Park. Development plans need to be analyzed carefully to ensure this balance remains intact.

If deemed appropriate, new programs should target people of all ages and abilities. While reviewing new development options, the county should also be aware of the need to renovate, repair, and upgrade existing parks and recreational facilities.

Objective 1: Identify boater trends to ensure that existing facilities are meeting user expectations.

Brown County staff performed angler counts while examining water quality at Lily Lake. Lily Lake receives high fishing pressure as up to 20 shore anglers and eight anglers in boats were observed at one time. Extra emphasis should be given to Lily Lake to ensure a quality fishing and boating experience.

1A. Periodically perform angler censuses at Lily Lake and maintain a long-term log book to analyze trends. This can be completed by Parks Department staff as they perform routine landscaping or other duties while at Lily Lake County Park.
1B. Perform periodic fish surveys and use this information to set regulations that provide a viable sport fishery.
1C. Identify and mitigate detrimental effects to waterways by boating activity. Boaters can be a main source for invasive species introduction into a waterway. Parks Department staff should continually be vigilant to assure problems are resolved as efficiently as possible.
1D. Maintain existing infrastructure and plan capital upgrades. The WDNR offers the Recreational Boating Facility program. Grants are available to improve public boating facilities through-out Wisconsin. The Parks Department should explore the opportunities to improve launch facilities at Lily Lake and other county facilities. More information is available at http://dnr.wi.gov/org/caer/cfa/Grants/Forms/RBFGuide06.pdf.

Objective 2: Identify physical infrastructure which is needed at Lily Lake County Park and create a Capital Improvements Plan to increase user amenities.

Lily Lake can classify as a predominantly unimproved park. Minimal facility infrastructures exist. Several needed improvements were identified by the planning processes in both the Outdoor Recreation and Open Space Plan and the Comprehensive Lake Management Plan. The following program and facility improvements are recommended.

2A. Trail expansion and connections. Trail Connections - Lily Lake should be included in the development of a county wide parkway and trail system.

Providing safe access to the park through non-motorized transportation would expand the types of user and recreational activities available at the park. It is further envisioned that, should such local assistance extend to financial or other similar considerations, the local community would then assume a larger and more active role in determining the type, size, and location of the proposed site or facility. Such local/county coordination is particularly anticipated where local acquisition or development has already occurred, such as within the Baird Creek-Lily Lake Parkway/Trail, the East River Parkway/Trail, and the Fox River Parkway/Trail.

2B. Aerator analysis. Brown County aerates Lily Lake to ensure oxygen levels are sufficient during the winter months in order to prevent fish kills. The aerator system being used today draws a significant amount of power and is quite cumbersome to put in and take out of the lake each year and is not providing adequate oxygen. A new aeration system should be evaluated that would increase energy efficiency while maintaining the necessary amount of dissolved oxygen in order to prevent loss of fish and provide habitat for aquatic habitats.

2C. Establish playground. Playground equipment at Lily Lake was present at one time, but was removed because the equipment did not meet safety and accessibility guidelines. Installation of a playground unit would be an amenity for the picnic area users.

2D. Indoor shelter. The shelter at Lily Lake is an open air gazebo. The nearest indoor heated shelters are located at Neshota Park. An indoor shelter would increase the usability of the park for large scale gatherings such as family reunions or birthday parties.

2E. Public restrooms. Currently, two portable toilets serve as restroom facilities at Lily Lake County Park. Survey respondents indicated that "better restrooms" were needed. Since indoor plumbing would need to be served by a private onsite wastewater treatment system, a soils analysis will need to be completed to determine the suitability of the park grounds for a new septic system. The restroom facilities could be incorporated into the proposed indoor shelter.

Objective 3: Identify opportunities for land acquisitions to provide a wider variety of activities at Lily Lake and to better protect water quality.

The Brown County Outdoor Park and Outdoor Recreation Plan identified the need to continually expand the park system to meet a growing population. The Parks Department has several interesting options at Lily Lake County Park.

3A. Land acquisition of the adjoining Polish League of American Veterans (PLAV). Should the PLAV property ever be placed on the market, Brown County Park and Facility Management, in cooperation with the Town of Eaton, should attempt to purchase it. Acquisition of this property would place the entire shoreline of the lake in public ownership.

3B. Adjoining land acquisition around Middle and Third Lakes. The properties on the south side of the lake, near Middle and Third Lakes, would also be a

logical expansion of the park and would then place the only three natural lakes in Brown County into public ownership. Acquiring properties around Third Lake may be more difficult as all land adjacent to the lake is divided into smaller parcels with multiple ownerships.

3C. Stewardship funds. Park expansions can be difficult due to the cost-prohibitive nature of land acquisitions. To ease the burden, Brown County and local staff should be vigilant to identify all sources of grant funding programs which allow for land acquisitions. The two most prominent include the Knowles-Nelson Stewardship Fund and the North American Wetland Conservation Act (NAWCA). The Knowles-Nelson Stewardship Fund is run by the WDNR and provides $105 million annually to nonprofits and municipal governments for land acquisition and infrastructure improvements. More information can be found at http://www.dnr.state.wi.us/org/caer/cfa/LR/stewardship/stewardship.html. NAWCA provides with matching grants to the same agencies that have developed partnerships to carry out wetland conservation projects for the benefit of wetland-associated migratory birds and other wildlife. More information can be found at http://www.fws.gov/birdhabitat/Grants/NAWCA/index.shtm.

Objective 4: Maintain the viability of the active uses of Lily Lake while providing infrastructure that protects and enhances the water quality of Lily Lake.

Since Lily Lake has such a small watershed, even small changes within the watershed can have major impacts on the quality of the lake. Therefore, as the only developed areas within the watershed, how Lily Lake County Park and the Polish Legion of American Veterans (PLAV) lands are utilized in the future will have a major impact on Lily Lake. The following recommendations will provide a starting point for the responsible governmental agencies to prepare and ensure that Lily Lake remains a tranquil, natural retreat in a rapidly developing part of Wisconsin.

4A. Develop a catch basin or bio-retention system at the Lily Lake boat launch to capture stormwater runoff that may be laden with fertilizers, sediments, pesticides, grease, and oil from the parking lot rather than allowing it to directly enter Lily Lake.

4B. Plant native grasses and shrubbery to create a buffer between Lily Lake and the grassed picnic area to filter out sediments prior to reaching Lily Lake's shoreline.

4C. Work with the PLAV to plant native vegetations at their lake access point to create a buffer for sediments carried by stormwater to filter out prior to reaching the lake.

4D. Create an educational kiosk regarding how lawn care and other practices affect the water quality at Lily Lake.

4E. Create an education kiosk or interpretative signage that demonstrates how the proposed "rain garden" actions in items 4A to 4C help protect water quality and also emphasizes the ease and practicality of constructing rain gardens.

4F. Post information for the Northeast Wisconsin Stormwater Consortium on an educational kiosk to readily provide a wide array of practices Lily Lake visitors can do at home or work to help protect and improve water quality.

Objective 5: Maintain the biodiversity of all ecosystems within Lily Lake County Park.

Lily Lake County Park is rich with diversity. Several different wetland and upland vegetation types are located within the park boundaries.

5A. Perform periodic park-wide vegetation surveys. Maintaining the biodiversity and health of all upland and wetland habitats is as important as maintaining the health of the lake. The wide mixture of habitats is a unique characteristic not typically associated with privately owned land. Periodic inventories will help assess the overall long-term health of Lily Lake.

5B. Arrange a "bio-blitz" for Lily Lake County Park. A bio-blitz is an organized field study where a group of scientists and volunteers conduct an intensive biological inventory which attempts to identify and record all species of within a given area. The area is often limited to a specific urban park or nature reserve. Bio-blitzes involve experts in a wide array of disciplines and provide a wonderful learning opportunity for the general public. The Baird Creek Parkway Foundation has held several successful bio-blitzes to identify the species present over a several year period.

5C. Create an Invasive Species Management Plan for Lily Lake County Park. Several invasive species were identified in the baseline survey. One was in the parking lot flower bed. As discussed in the Aquatic Invasive Species Management Chapter, early detection is the best management strategy. Due to convenience of scales, a single plan for all county facilities may also be appropriate.

5D. Bird census. Perform a bird survey at pre-determined areas throughout all areas of Lily Lake County Park to establish a list of breeding birds. Several proven scientific surveys could be used.

5E. Plant only native species for beautification projects. Planting native species can help immediately improve the overall biodiversity of the park. Specifically selecting new trees, shrubs, flowers, or grasses will not only enhance the beauty of the park, it will help ensure its long-term health. This is already practiced at a small scale. There are Black-eyed Susans and a mulberry tree in the parking lot area.

Chapter 10

Implementation

Introduction

The completion of the Comprehensive Lily Lake Management Plan (CLMP) should be celebrated as a significant milestone in providing guidance for the future development within the Lily Lake watershed. The key to the success of a lake management plan however, lies in its implementation. Without the implementation of the recommendations in the plan, the plan is just another document. There are several land use regulatory tools, as well as administrative mechanisms and techniques, which can be utilized as implementation tools for the CLMP.

While the Implementation Chapter does not include all of the recommendations of the CLMP, it does summarize the various implementation tools and related action steps towards its implementation. These tools are typically either regulatory in nature or are found in various planning documents which are pertinent to land use decisions in both the Town of Eaton and Brown County.

Comprehensive Plans

Both the Town of Eaton and Brown County have adopted comprehensive plans under Wisconsin Statutes 66.1001. Comprehensive planning laws set forth in these statutes require periodic updates to be completed on the comprehensive plan. Both the Town of Eaton and Brown County should be proactive in incorporating the goals and visions set forth in this document. This can be done through citing the plan directly or by incorporating specific actions items.

Open Space and Recreation Plans

Brown County adopted its Open Space and Recreation Plan in 2008. This document detailed several facility upgrades which needed to be completed at Lily Lake County Park. This CLMP further detailed several more actions which need to be completed within Lily Lake to protect and enhance water quality.

To be eligible for recreational funding programs through the Wisconsin Department of Natural Resources, the recreation plan must be updated every five years. The recommended strategies should be incorporated into the Brown County Open Space and Recreation Plan. In addition, the Town of Eaton should adopt an Open Space and Recreation Plan to address its recreational needs at municipal, private, and county facilities within the Town of Eaton.

Zoning

Zoning is the most common regulatory device used by municipalities to implement plan recommendations. The major components include a zoning ordinance and a zoning district map. The zoning ordinance includes specific language for the administration of these regulations. Included in the text are definitions, district use requirements, administrative procedures, and other elements. The companion zoning district map defines the legal boundaries of each district of the zoning ordinance.

Erosion and Stormwater Control Ordinances

Communities can adopt erosion and stormwater control ordinances to control the impact of development on runoff, groundwater recharge, and overall water quality. The ordinance should include standards for compliance and guidelines to assist developers in choosing appropriate management techniques. The ordinance should also identify that a town stormwater management plan will soon be completed and identify how more innovative and efficient management practices can be designed to be compatible with the overall plan. The erosion control ordinance primarily addresses the reduction sediment runoff associated with construction.

Public Lake Management Organizations

Public lake management organizations (PLMOs) include special districts such as lake associations, town sanitary districts, and commission formed by local governments. The governmental structures, responsibilities, abilities, and authorities or each vary. Chapter 33 of the Wisconsin Statutes outlines formation, structure, and operation of PLMOs.

PLMOs are established by orders or resolutions from local or county governments. PLMOs provide an organized administrative board to oversee the protection and rehabilitation of an inland lake. Some PLMOs are quasi-governmental bodies with elected or appointed leaders. They adopt annual budgets, may levy taxes, special assessments, or other charges to support their operations. Normal operation of PLMos include assessing and monitoring water quality, designing projects to enhance existing water quality, overseeing aquatic invasive species management, and other similar topics. Since PLMOs do not have governmental board regulatory authority, they must rely on the cooperation of local and county governments to address many of the jurisdictional issues that affect water quality in local lakes.

Each PLMO has strictly defined boundaries. Wisconsin Statutes provide little guidance on the creation of boundaries. PLMO boundaries may include a portion of a lake or several lakes. In every case, an accurate legal description of the boundary of the proposed district is required.

Potential Funding Sources

Some of the recommendations in the plan may be implemented with the help of various sources of funds besides local property taxes. There are a number of grant programs administered by state and federal agencies, including the Wisconsin Department of Administration, Wisconsin Department of Commerce, Wisconsin Department of Natural Resources, and Wisconsin Department of Transportation. At the federal level, the Environmental Protection Agency, Department of Agriculture – Rural Development, and the (U.S.) Department of Commerce – Economic Development Agency all provide sources of funding. These programs are detailed in the Town of Eaton and Brown County comprehensive plans.

Management Concerns

The primary goal of the Implementation Chapter is to utilize the existing tools within the Town of Eaton and Brown County Codes of Ordinances and other similar regulatory tools to maintain the longevity of Lily Lake County Park as a primary recreation destination in Brown County.

Objective 1: Utilize the existing regulatory framework and land use planning documents to ensure the implementation of the Lily Lake Comprehensive Management Plan is a success.

Many existing ordinances and plans have already been adopted by Brown County and the Town of Eaton which would allow for the protection and enhancement of Lily Lake and the surrounding environs. In most cases, the following action items were included as a portion of the Town of Eaton or Brown County Comprehensive Plan(s). Other implementation action items may require slight modifications to existing ordinances. Either way, the protection of a unique resource is important and can readily be accomplished through intergovernmental cooperation.

1A. Consider implementing the land use recommendations from the CLMP into the Brown County and Town of Eaton comprehensive plans.
1B. Eaton should create an Open Space and Recreation Plan for the provision of recreational opportunities including activities at Lily Lake to its residents.
1C. Consider revising the town's zoning ordinance to include a special zoning district for those properties within the Lily Lake, Middle Lake, and Third Lake watersheds. This district should include concepts such as reduced front yard setbacks, maximum development percentages for overall land area, and incorporation of conservation by design landscaping principles.
1D. The town zoning ordinance should be revised to expand and establish design requirements for all commercial and industrial development in the town.
1E. The town zoning ordinance should be revised to develop design requirements for residential development. The ordinance should also be revised to eliminate barriers to conservation by design subdivisions.
1F. Explore the feasibility of creating a public lake management organization to oversee all lake protection and enhancement projects at Lily Lake.

Objective 2: Both the Town of Eaton and Brown County should explore state and federal recreation grant opportunities to add recreation options for its residents and protect environmental quality at Lily Lake County Park.

Typically, grant programs require a local match. The local match can usually include a combination of tax dollars, in-kind services, and/or private donations. Each grant program has its own set of guidelines regarding eligible projects, as well as financing mechanisms, and should be reviewed before applying.

2A. Identify the funding sources from the CLMP and the Brown County and Town of Eaton comprehensive plans which will allow local and county staff to implement the ideas forward in this comprehensive lake management plan.
2B. Continually seek new sources of funding to assist in the implementation of specific action items of this plan.
2C. Continually seek to establish a "Friends of Lily Lake" group or identify community organizations which can provide in-kind services to provide the local match for needed grant work.
2D. Where appropriate, prepare a Capital Improvements Program (CIP) for either the Town of Eaton or Brown County to allocate either matching funds or direct expenditures to implement specific action items in this plan.

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APPENDIX A

Lily Lake Watershed Resident Survey

Figure A-1: Watershed Resident Cover Letter

Lily Lake Watershed & Recreational User Survey

Dear «Title» «First_Name» «Surname»:

The Brown County Planning Commission, the Brown County Parks Department, and the Town of Eaton are facilitating the completion of a lake management study of Lily Lake. The process began in the spring of 2006 with a land use study. The project has continued through today with water quality monitoring, an aquatic vegetation survey, and a fish study. The reports can be viewed online at the Brown County Planning Commission web site.

Both local and county officials are seeking public input in creating recreational and lake management goals for Lily Lake County Park for the next 5-20 years. In order to assist local and county officials with this task, you are invited to complete the following survey in order to provide your thoughts and opinions on various issues related to recreational amenities and opportunities at Lily Lake.

Please mail the completed survey to the Brown County Planning Commission **by June 1, 2009**. Surveys can be dropped off or mailed to the Brown County Planning Commission at the following address:

Brown County Planning Commission
Planning and Land Services Department
ATTN: Jon Motquin
305 E. Walnut St., Room 320
P.O. Box 23600
Green Bay, WI 54305-3600

The survey results will help to formulate the goals and objectives of the lake management plan and will be used as a basis for some of the recommendations of the plan. It is vitally important that you complete the survey and send the information back to the Brown County Planning Commission so your voice can be heard.

For additional information regarding the Lily Lake Management Plan, contact Brown County Senior Planner Jon Motquin at (920) 448-6480.

Thank you for completing the survey. Your time and assistance is greatly appreciated and is important for the development of the overall report.

Sincerely,

Jon Motquin

Figure A-2: Watershed Resident Survey

Lily Lake Watershed & Recreational User Survey

The following questions will focus on your recreational use of Lily Lake and your opinions regarding Lily Lake.

1. Have you used Lily Lake County Park in the last year?
   - ☐ Yes
   - ☐ No

2. How many years have you used Lily Lake?
   - ☐ 0 years
   - ☐ < 1 year
   - ☐ 1 – 5 years
   - ☐ 5 – 10 years
   - ☐ 10 – 15 years
   - ☐ 15 – 20 years
   - ☐ > 20 years

3. In a typical year, how many times do you use/visit Lily Lake?
   - ☐ 0 times
   - ☐ 1 – 3 times
   - ☐ 3 – 6 times
   - ☐ 6 – 9 times
   - ☐ 9 – 12 times
   - ☐ > 12 times

4. What activities do you participate in at Lily Lake? Check all that apply.
   - ☐ Fishing
   - ☐ Observing wildlife
   - ☐ Swimming
   - ☐ Scenic beauty
   - ☐ Canoeing/kayaking
   - ☐ Waterfowl hunting
   - ☐ Deer hunting
   - ☐ Ice fishing
   - ☐ Relaxing
   - ☐ Other:_____
   - ☐ None

5. What type of watercraft do you use on Lily Lake?
   - ☐ Canoe
   - ☐ Kayak
   - ☐ Rowboat
   - ☐ Motorboat (w/ trolling motor)
   - ☐ Other: _____
   - ☐ None

6. How would you rate the current water quality at Lily Lake?
   - ☐ Poor
   - ☐ Fair
   - ☐ Average
   - ☐ Above average
   - ☐ Excellent
   - ☐ No opinion

7. What factor(s) contribute most to your perception of water quality at Lily Lake? Check all that apply.
   - ☐ Algal blooms
   - ☐ Large amount of aquatic vegetation (weeds)
   - ☐ Reduced water clarity
   - ☐ All of the above
   - ☐ None of the above
   - ☐ No opinion

8. Has the water quality changed since you first began to use Lily Lake?
   - ☐ Improved
   - ☐ Decreased
   - ☐ Remained the same
   - ☐ No opinion

9. Has the water quality of Lily Lake affected your decision to use Lily Lake?
   - ☐ Yes
   - ☐ No
   - ☐ No opinion

10. How would you rate current fishing conditions within Lily Lake?
    - ☐ Poor
    - ☐ Fair
    - ☐ Good
    - ☐ Excellent
    - ☐ No opinion

11. What type of fish do you catch at Lily Lake?

12. What type of fish would you like to catch at Lily Lake?
    - ☐ Panfish (Bluegill, crappie, sunfish, etc.)
    - ☐ Largemouth bass
    - ☐ Northern Pike
    - ☐ Other: _____

13. Based on your opinion of fishing conditions, has the number of times you visited Lily Lake:
    - ☐ Decreased
    - ☐ Stayed the same
    - ☐ Increased

14. Would you like to see a fish stocking program at Lily Lake?
    - ☐ Yes
    - ☐ No

15. If yes, how much would you be willing to pay for the fish stocking program at Lily Lake?
    - ☐ $0
    - ☐ $0 - $50
    - ☐ $50 - $100
    - ☐ Over $100
    - ☐ No opinion

16. Would you support a temporary catch-and-release only fishery to allow fish to grow larger?
    - ☐ Yes
    - ☐ No
    - ☐ No opinion

17. Would you support larger limits on fish at Lily Lake to allow for fish to grow larger?
    - ☐ Yes
    - ☐ No
    - ☐ No opinion

18. Would you support smaller daily bag limits on fish at Lily Lake to allow for fish to grow larger?
    - ☐ Yes
    - ☐ No
    - ☐ No opinion

19. What facility improvements are needed at Lily Lake County Park?
    - ☐ Playground equipment
    - ☐ Fishing shelter
    - ☐ Extended trails
    - ☐ Fish cleaning stations
    - ☐ Other

20. What factor(s) below would improve your likelihood of using Lily Lake?
    - ☐ Provide water quality suitable for maintaining fish and other aquatic life
    - ☐ Reduce the severity of nuisance plant growth
    - ☐ Improve water quality for conditions for swimming
    - ☐ Improve wildlife habitat
    - ☐ Other: _____
    - ☐ All of the above
    - ☐ None of the above

21. What changes would you make to Lily Lake and Lily Lake County Park?

The following questions will focus on the nature of your property near Lily Lake County Park. Please indicate what type of property you own, general landscaping you perform, and other property uses.

22. What best describes your property use?
    - ☐ Residential
    - ☐ Commercial
    - ☐ Industrial
    - ☐ Farmstead
    - ☐ Agricultural land

23. Do you apply fertilizers or lawn care chemicals to your lawn?
    - ☐ Yes
    - ☐ No (Skip to 25)

24. When do you apply fertilizers or chemicals to your lawn?
    - ☐ Spring
    - ☐ Fall
    - ☐ Both

25. If you are currently farming, do you (or a renter) land apply manure or other fertilizers to your fields?
    - ☐ Yes
    - ☐ No
    - ☐ Not Applicable (Skip to 28)

26. When do you land apply manure or other fertilizers to your fields?
    - ☐ Spring
    - ☐ Fall
    - ☐ Both

27. Do you follow a Wisconsin Department of Natural Resources or Brown County Land Conservation Department nutrient management/application program?
    - ☐ Yes
    - ☐ No
    - ☐ Not applicable

28. Do you have a compost pile for yard waste, food, and other biodegradable items?
    - ☐ Yes
    - ☐ No

29. How old are you?

30. Are you:
    - ☐ Male
    - ☐ Female

Figure A-3: Watershed Resident Survey Re-send Cover Letter

Lily Lake Watershed & Recreational User Survey

Dear «Title» «First_Name» «Surname»:

Approximately one month ago, the Brown County Planning Commission, the Brown County Parks Department, and the Town of Eaton mailed a questionnaire soliciting your input regarding your usage of Lily Lake Park and your opinions regarding the Lily Lake County Park. Your input is highly valued as we are formulating a long-term management plan for Lily Lake and the county park facilities. Specific information is being asked regarding your experience and opinions with fishing and water quality of Lily Lake and the overall facilities.

Since a limited number of people are being surveyed, your input is highly valued. The comments from people who have already responded include a wide variety of experiences with the usage of Lily Lake. We think these will help to formulate the goals and objectives of the lake management plan and will be used as a basis for some of the recommendations of the plan.

We are writing again because it is vitally important that you complete the survey and send the information back to the Brown County Planning Commission so your voice can be heard. Please mail the completed survey to the Brown County Planning Commission **by June 19, 2009**. Surveys can be dropped off or mailed to the Brown County Planning Commission at the following address:

Brown County Planning Commission
Planning and Land Services Department
ATTN: Jon Motquin
305 E. Walnut St., Room 320
P.O. Box 23600
Green Bay, WI 54305-3600

For additional information regarding the Lily Lake Management Plan, contact Brown County Senior Planner Jon Motquin at (920) 448-6480.

Thank you for completing the survey. Your time and assistance is greatly appreciated and is important for the development of the overall report. If you do not wish to participate or do not have time to complete the survey, please return the blank survey in the pre-paid postage envelope with the words "I do not wish to participate in this survey."

Sincerely,

Jon Motquin

APPENDIX B

Lily Lake General User Internet Survey

Figure B-1: Internet Survey Introduction

Lily Lake Watershed & Recreational User Survey

Brown County and the Town of Eaton are currently preparing a lake management study of Lily Lake. This will help ensure that we continue to meet the recreational goals of our citizens over the next 20 years. We are assessing existing water quality, aquatic vegetation, and fish populations.

In order to better manage Lily Lake, we are seeking your opinions on water quality and fishing conditions at Lily Lake. We will also ask you questions regarding facility improvements you feel should be made at Lily Lake County Park. Please feel free to provide comments on any other issues you feel should be addressed at this time.

The survey results will be used to establish short-term and long-term goals and objectives to improve Lily Lake County Park for Brown County residents.

Brown County staff has already completed two preliminary reports discussing land use and existing water quality. You can view the reports on the Brown County web site:

http://www.co.brown.wi.us/planning_and_land_services/planning/county_web//natural_res.html

Your participation in this survey is vitally important. Your feedback will provide Brown County and the Town of Eaton with valuable information to protect the scenic beauty of Lily Lake and better manage the facilities for a higher quality recreational experience.

Thank you for completing the survey. Your time and assistance is greatly appreciated.

Figure B-2: Internet Survey

Lily Lake Recreational User Survey

The following questions will focus on your recreational use of Lily Lake and your opinions regarding Lily Lake.

31. Are you a Brown County resident?
    - ☐ Yes
    - ☐ No

32. Have you used Lily Lake County Park in the last year?
    - ☐ Yes
    - ☐ No

33. How many years have you used Lily Lake?
    - ☐ 0 years
    - ☐ < 1 year
    - ☐ 1 – 5 years
    - ☐ 5 – 10 years
    - ☐ 10 – 15 years
    - ☐ 15 – 20 years
    - ☐ > 20 years

34. In a typical year, how many times do you use/visit Lily Lake?
    - ☐ 0 times
    - ☐ 1 – 3 times
    - ☐ 3 – 6 times
    - ☐ 6 – 9 times
    - ☐ 9 – 12 times
    - ☐ > 12 times

35. What activities do you participate in at Lily Lake? Check all that apply.
    - ☐ Fishing
    - ☐ Observing wildlife
    - ☐ Swimming
    - ☐ Scenic beauty
    - ☐ Canoeing/kayaking
    - ☐ Waterfowl hunting
    - ☐ Deer hunting
    - ☐ Ice fishing
    - ☐ Relaxing
    - ☐ Other:_____
    - ☐ None

36. What type of watercraft do you use on Lily Lake?
    - ☐ Canoe
    - ☐ Kayak
    - ☐ Rowboat
    - ☐ Motorboat (w/ trolling motor)
    - ☐ Other: _____
    - ☐ None

37. How would you rate the current water quality at Lily Lake?
    - ☐ Poor
    - ☐ Fair
    - ☐ Average
    - ☐ Above average
    - ☐ Excellent
    - ☐ No opinion

38. What factor(s) contribute most to your perception of water quality at Lily Lake? Check all that apply.
    - ☐ Algal blooms
    - ☐ Large amount of aquatic vegetation (weeds)
    - ☐ Reduced water clarity
    - ☐ All of the above
    - ☐ None of the above
    - ☐ No opinion

39. Has the water quality changed since you first began to use Lily Lake?
    - ☐ Improved
    - ☐ Decreased
    - ☐ Remained the same
    - ☐ No opinion

40. Has the water quality of Lily Lake affected your decision to use Lily Lake?
    - ☐ Yes
    - ☐ No
    - ☐ No opinion

41. How would you rate current fishing conditions within Lily Lake?
    - ☐ Poor
    - ☐ Fair
    - ☐ Good
    - ☐ Excellent
    - ☐ No opinion

42. What type of fish do you catch at Lily Lake?

43. What type of fish would you like to catch at Lily Lake?
    - ☐ Panfish (Bluegill, crappie, sunfish, etc.)
    - ☐ Largemouth bass
    - ☐ Northern Pike
    - ☐ Other: _____

44. Based on your opinion of fishing conditions, has the number of times you visited Lily Lake:
    - ☐ Decreased
    - ☐ Stayed the same
    - ☐ Increased

45. Would you like to see a fish stocking program at Lily Lake?
    - ☐ Yes
    - ☐ No

46. If yes, how much would you be willing to pay for the fish stocking program at Lily Lake?
    - ☐ $0
    - ☐ $0 - $50
    - ☐ $50 - $100
    - ☐ Over $100
    - ☐ No opinion

47. Would you support a temporary catch-and-release only fishery to allow fish to grow larger?
    - □ Yes
    - □ No
    - □ No opinion

48. Would you support larger limits on fish at Lily Lake to allow for fish to grow larger?
    - □ Yes
    - □ No
    - □ No opinion

49. Would you support smaller daily bag limits on fish at Lily Lake to allow for fish to grow larger?
    - □ Yes
    - □ No
    - □ No opinion

50. What facility improvements are needed at Lily Lake County Park?
    - □ Playground equipment
    - □ Fishing shelter
    - □ Extended trails
    - □ Fish cleaning stations
    - □ Other

51. What factor(s) below would improve your likelihood of using Lily Lake?
    - □ Provide water quality suitable for maintaining fish and other aquatic life
    - □ Reduce the severity of nuisance plant growth
    - □ Improve water quality for conditions for swimming
    - □ Improve wildlife habitat
    - □ Other: _____
    - □ All of the above
    - □ None of the above

52. What changes would you make to Lily Lake and Lily Lake County Park?

53. How old are you?

54. Are you:
    - □ Male
    - □ Female

APPENDIX C

Lily Lake Watershed Residents Survey Results

INTRODUCTION

The following survey results are a compilation of information based upon a 30 question survey that was submitted to property owners located within the Lily Lake watershed. A total of 19 surveys were distributed and 15 surveys were returned, resulting in an overall response rate of 79 percent. The respondent filling out the survey was asked to respond to the questions on behalf of all members of his or her household, unless otherwise specified.

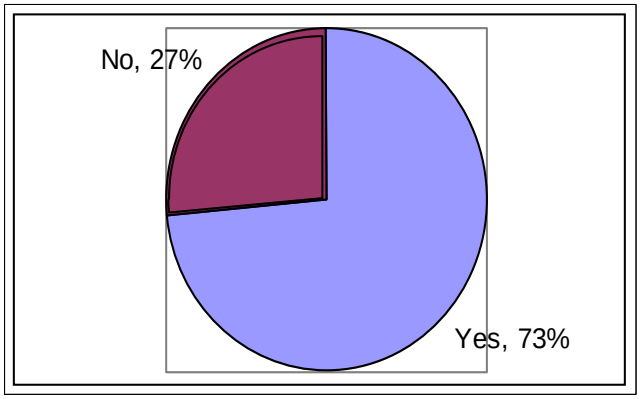
Surveys were distributed to all property owners within the watershed of Lily Lake. The watershed of Lily Lake is located in the municipality of Eaton. Surveys were distributed to this specific geographic area to determine specific land use practices which could directly affect water quality within Lily Lake.

The majority of the subject information is based upon the residents' current knowledge of Lily Lake. The information should be used as a tool to make educated decisions while developing the management plan for Lily Lake. The information should not be used as the only source for public needs and wants, because dynamic new trends in park and recreation may exist that the general public is not aware of. This is not a scientific survey.

USE OF LILY LAKE

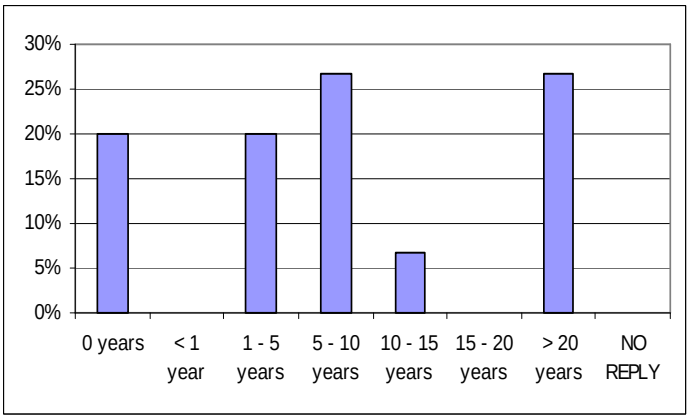
1. Have you used Lily Lake in the Last year?

Yes	11
No	4
NO REPLY	0
TOTAL	15



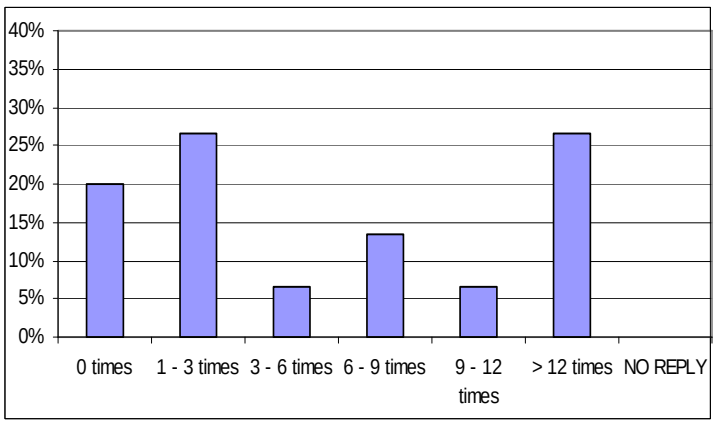
- 73% of watershed residents have used Lily Lake in the last year.

2. How many years have you used Lily Lake?	
0 years	3
< 1 year	0
1 - 5 years	3
5 - 10 years	4
10 - 15 years	1
15 - 20 years	0
> 20 years	4
NO REPLY	0
TOTAL	15



- 20% have never used Lily Lake.
- 20% have used Lily Lake for 1 – 5 years.
- 54% have used Lily Lake more than 5 years.

3. *In a typical year, how many times do you use/visit Lily Lake?*	
0 times	3
1 - 3 times	4
3 - 6 times	1
6 - 9 times	2
9 - 12 times	1
> 12 times	4
NO REPLY	0
TOTAL	15

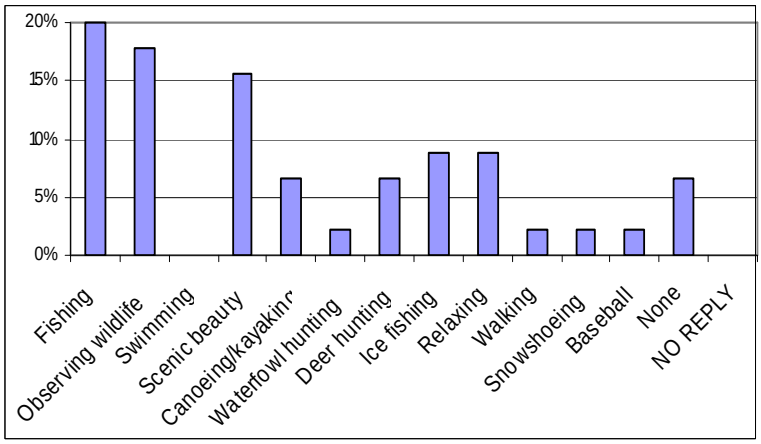


- 27% of watershed residents used Lily Lake at least once in the last year.
- 34% used Lily Lake at least 9 times.

ACTIVITIES AT LILY LAKE

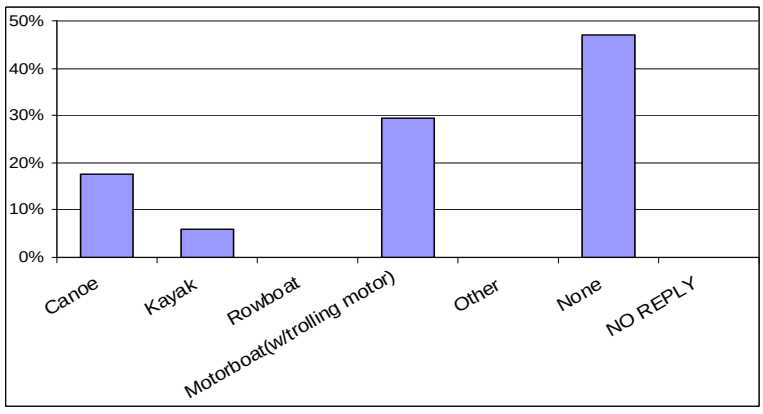
The respondents were questioned what they do in terms of recreation at Lily Lake. The following information may assist Brown County in improving the current condition of Lily Lake Park. Respondents were given the option to reply to more than one category, unless the chart represents a simple "yes/no" question.

4. What activities do you participate in at Lily Lake?	
Fishing	9
Observing wildlife	8
Swimming	0
Scenic beauty	7
Canoeing/kayaking	3
Waterfowl hunting	1
Deer hunting	3
Ice fishing	4
Relaxing	4
Walking	1
Snowshoeing	1
Baseball	1
None	3
NO REPLY	0
TOTAL	45



- The most prominent use of Lily Lake is fishing (20%).
- Nearly as many people observe wildlife (18%) or enjoy the scenic beauty (16%).

5. What type of watercraft do you use on Lily Lake?	
Canoe	3
Kayak	1
Rowboat	0
Motorboat (w/ trolling motor)	5
Other	0
None	8
NO REPLY	0
TOTAL	17

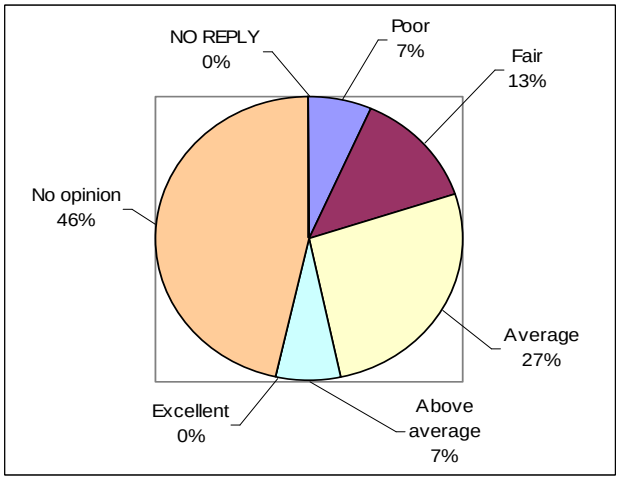


- Almost half of respondents (47%) have not used a watercraft on Lily Lake.
- Motorboats with trolling motors are used almost as equally as canoes/ kayaks (24%).

WATER QUALITY

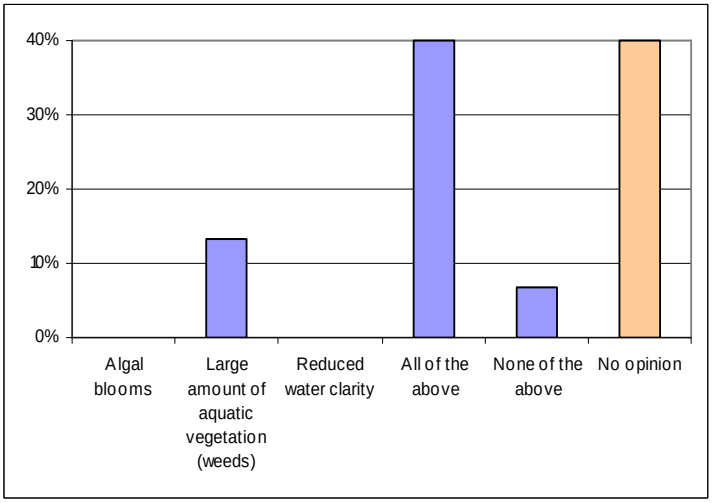
The respondents were questioned about their perceptions of water quality at Lily Lake. The following information may assist Brown County in identifying what actions need to be taken to improve the overall perceived water quality of Lily Lake Park. Respondents were given the option to reply to more than one category, unless the chart represents a simple "yes/no" question.

6. How would you rate the current water quality at Lily Lake?	
Poor	1
Fair	2
Average	4
Above average	1
Excellent	0
No opinion	7
NO REPLY	0
TOTAL	15



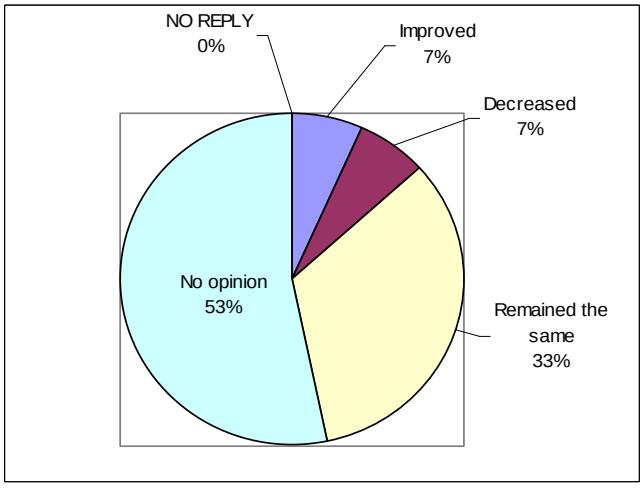
- 40% of the respondents felt water quality was fair to average.
- An equal amount (7%) disagreed on the water quality as either poor or above average.
- Almost half of respondents (47%) did not respond to the question. There may be ambiguity in the question.

7. *What factor(s) contribute most to your perception of water quality at Lily Lake?*	
Algal blooms	0
Large amount of aquatic vegetation (weeds)	2
Reduced water clarity	0
All of the above	6
None of the above	1
No opinion	6
NO REPLY	0
TOTAL	15



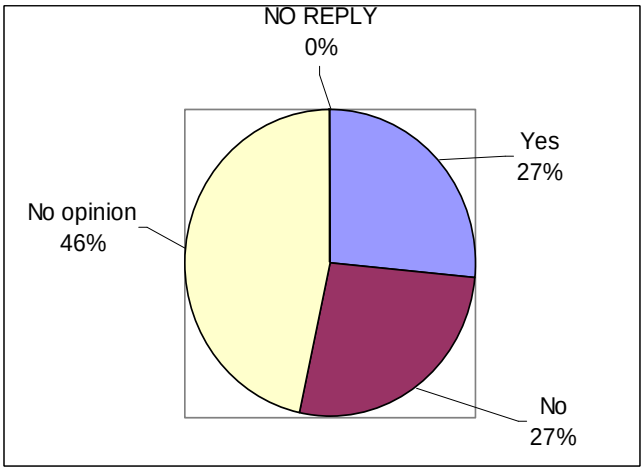
- 40% of the respondents indicated that algal blooms, abundant vegetation, and reduced water clarity contributed to declining water quality.
- Only abundant aquatic vegetation was singled out as a factor of declining water quality.
- 40% did not respond to the question. There may be ambiguity in the question.

8. Has the water quality changed since you first began to use Lily Lake?	
Improved	1
Decreased	1
Remained the same	5
No opinion	8
NO REPLY	0
TOTAL	15



- 53% did not respond to the question. There may be ambiguity in the question.
- 33% of respondents indicated that water quality has remained the same.

9. *Has the water quality of Lily Lake affected your decision to use Lily Lake?*	
Yes	4
No	4
No opinion	7
NO REPLY	0
TOTAL	15

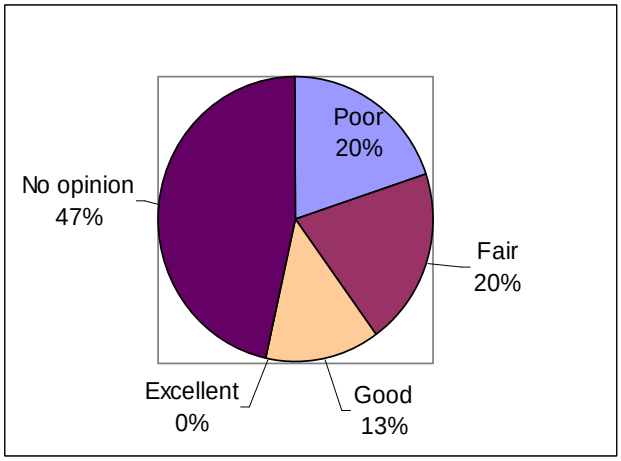


- 47% of respondents indicated their usage of Lily Lake was not dependent on water quality.
- The remaining respondents were evenly affected on their decision to continue to use or not use Lily Lake due to water quality.

FISHING

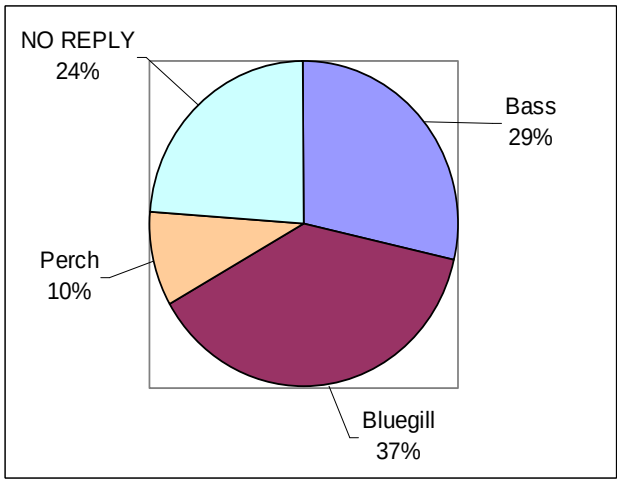
The respondents were questioned about their opinions regarding the current fishery at Lily Lake. Fishing is one of the most popular activities. As such, Brown County and the Wisconsin Department of Natural Resources are very interested in improving the fishery. The following information will assist these agencies in managing the fishery. Respondents were given the option to reply to more than one category, unless the chart represents a simple "yes/no" question.

10. *How would you rate the current fishing conditions at Lily Lake?*	
Poor	3
Fair	3
Good	2
Excellent	0
No opinion	7
NO REPLY	0
TOTAL	15



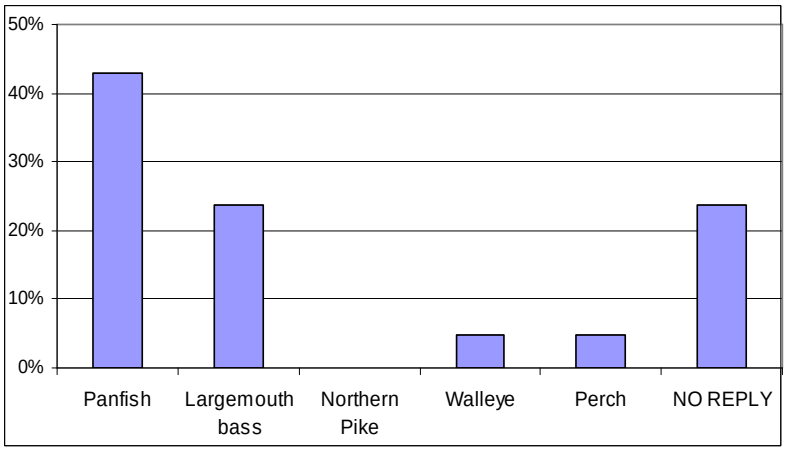
- 40% of respondents indicated that the fishery needs improvement.
- 47% of respondents did not express an opinion regarding the Lily Lake fishery.

11. *What type of fish do you catch at Lily Lake?*	
Bass	6
Bluegill	8
Perch	2
NO REPLY	5
TOTAL	21



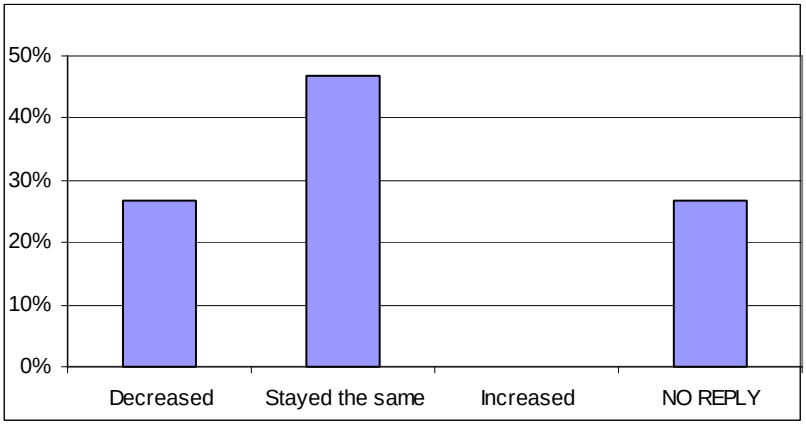
- Bluegill (38%) and Largemouth bass (29%) account for the majority of fish caught.
- Two respondents indicated they had caught perch at Lily Lake.

12. *What type of fish would you like to catch at Lily Lake?*	
Panfish (Bluegill, crappie, sunfish, etc.)	9
Largemouth bass	5
Northern Pike	0
Walleye	1
Perch	1
NO REPLY	5
TOTAL	21



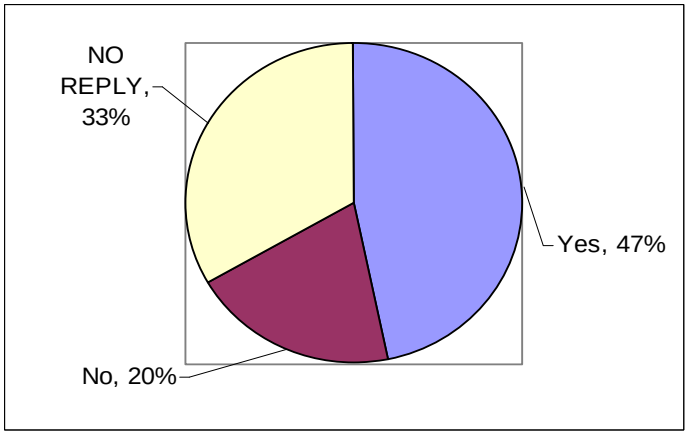
- A majority of respondents (67%) indicated they would like to continue the same species in the future.
- Two respondents indicated they were interested in catching either walleye or perch.

13. *Base on your opinion of fishing conditions, has the number of times you visited Lily Lake?*	
Decreased	4
Stayed the same	7
Increased	0
NO REPLY	4
TOTAL	15



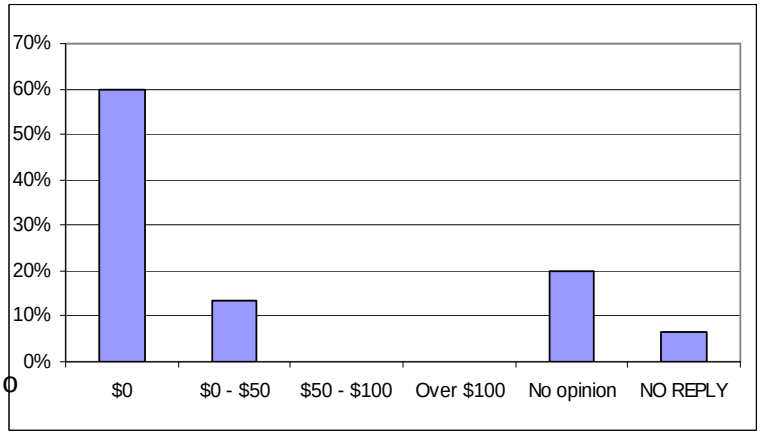
- 47%of respondents indicated that their fishing effort on Lily Lake has remained the same.
- 27% indicated fishing conditions have caused a decreased number of visits.

14. *Would you like to see a fish stocking program at Lily Lake?*	
Yes	7
No	3
NO REPLY	5
TOTAL	15



- 47% of respondents would like to see a stocking program at Lily Lake.
- 33% did not have an opinion.

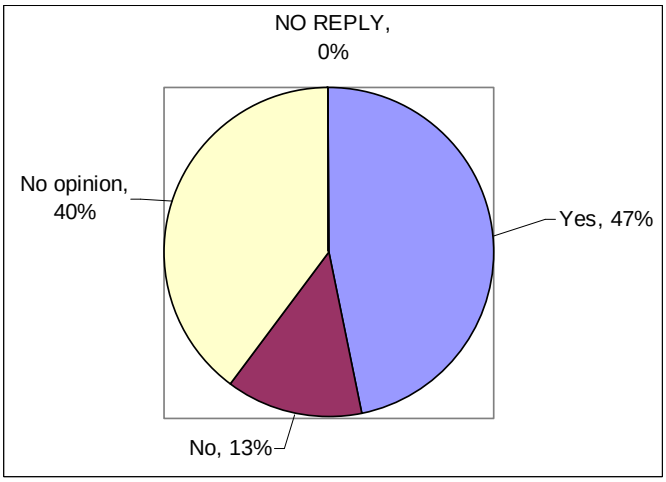
15. *If yes, how much would you be willing to pay for the fish stocking program at Lily Lake?*	
$0	9
$0 - $50	2
$50 - $100	0
Over $100	0
No opinion	3
NO REPLY	1
TOTAL	15



o

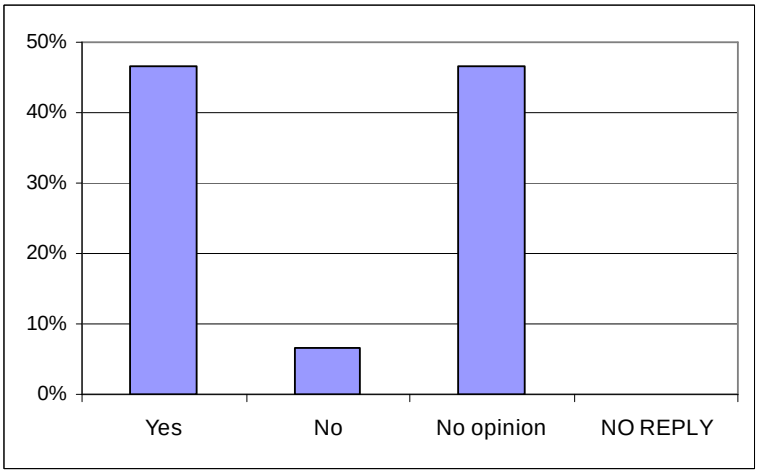
- 60%of respondents would not pay to support a stocking program.
- Only 13% indicated they would pay up to $50 for a stocking program.

16. *Would you support a temporary catch-and-release only fishery to allow fish to grow larger?*	
Yes	7
No	2
No opinion	6
NO REPLY	0
TOTAL	15



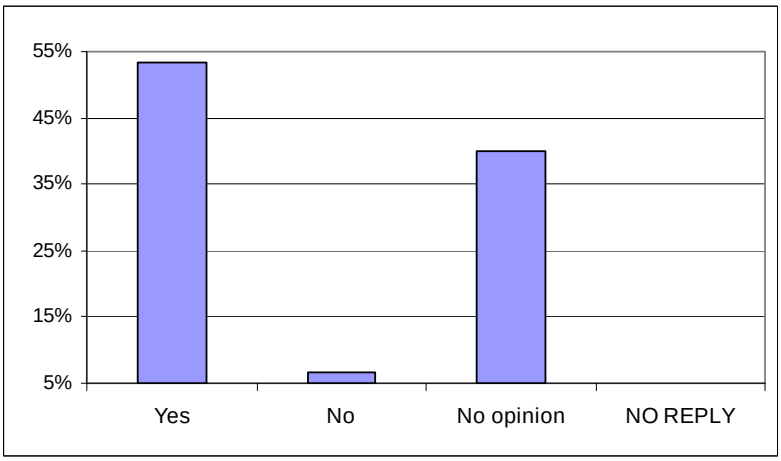
- 47%of respondents support catch-and-release regulations.
- 40% had no opinion.

17. Would you support larger limits on fish at Lily Lake to allow fish to grow larger at Lily Lake?	
Yes	7
No	1
No opinion	7
NO REPLY	0
TOTAL	15



- 47%of respondents support larger harvest limits on fish at Lily Lake.
- Almost half (47%) did not have an opinion.

18. Would you support smaller daily bag limits on fish at Lily Lake to allow for fish to grow larger?	
Yes	8
No	1
No opinion	6
NO REPLY	0
TOTAL	15

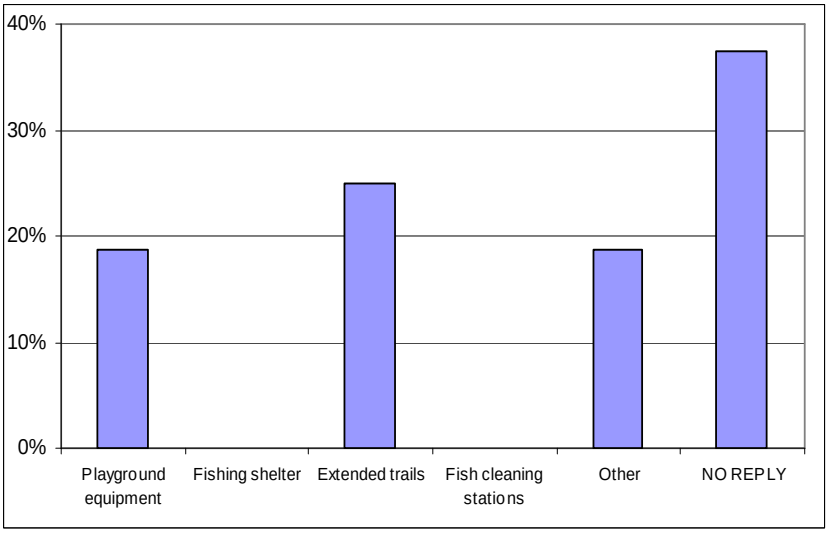


- 53%of respondents support reducing bag limits at Lily Lake.
- 40% of respondents did not have an opinion.

FACILITIES

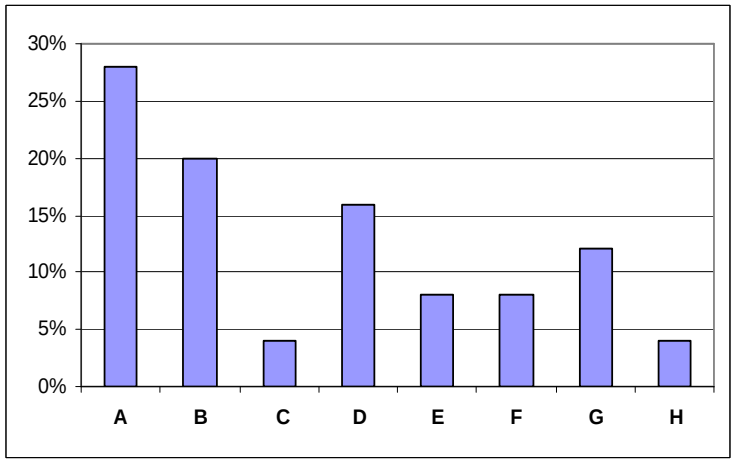
The respondents were questioned what they desire in the Brown County park system. This includes activities that may already be available, and activities that should be added to the area. One point to consider in this section of the report is that the some members of the public may have difficulty imagining new park services that are not already available in this region of Wisconsin. Thus, when developing a lake management plan, one should not remain exclusive to the choices with highest percentages. Respondents were given the option to reply to more than one category, unless the chart represents a simple "yes/no" question.

19. *What facility improvements are needed at Lily Lake County Park?*	
Playground equipment	3
Fishing shelter	0
Extended trails	4
Fish cleaning stations	0
Other	3
NO REPLY	6
TOTAL	16



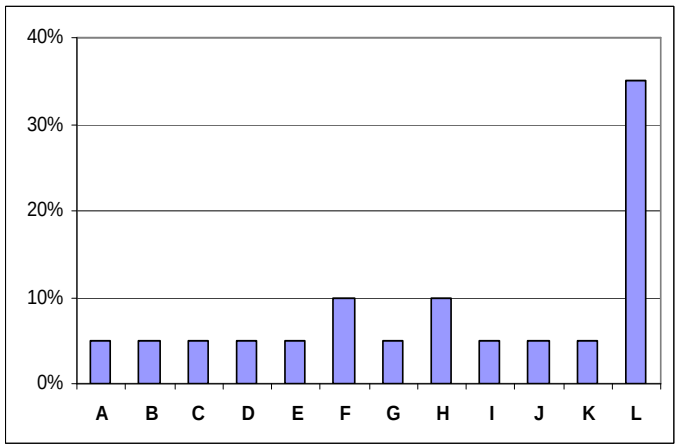
- 25% of the respondents indicated a trails system is needed.
- 19% of respondents indicated playground equipment is needed.
- 38% did not have an opinion.

20. What factor(s) below would improve your likelihood of using Lily Lake?	
A - Provide water quality suitable for maintaining fish and other aquatic life	7
B - Reduce the severity of nuisance plant growth	5
C -Improve water quality for conditions for swimming	1
D - Improve wildlife habitat	4
E - Other	2
F -All of the above	2
G - None of the above	3
H - NO REPLY	1
TOTAL	25



- 28% of the respondents indicated efforts should be made to improve fish and wildlife habitat.
- 20% of respondents expressed concerns that Lily Lake was too "weedy".
- 16% of the respondents expressed a need for swimming facilities.

21. *What changes would you make to Lily Lake and Lily Lake County Park?*	
A - Do not allow deer hunting (Bow or gun)	1
B - Weed control in the lake	1
C - Control take limits	1
D - Stock Fish	1
E - Shelter	1
F - Improved restrooms	2
G - Better access to south side of property	1
H - Trail around lake	2
I - Volunteer group to survey for and remove invasive species	1
J - Do not allow water fowl hunting	1
K - Cleaner grounds	1
L - NO REPLY	7
TOTAL	20

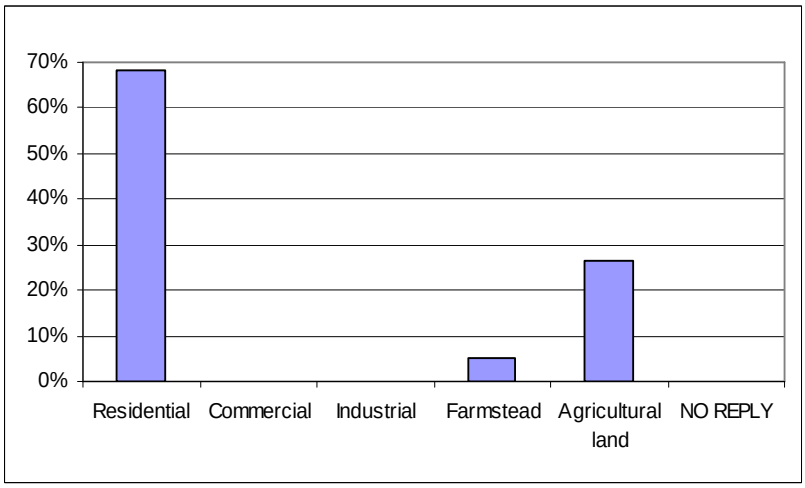


The respondents were allowed the opportunity to provide open-ended responses. Eleven suggestions were made. These recommendations reflected responses in other questions. Suggestions were given to eliminate public hunting opportunities currently available at the park and to form a group to complete an invasive species plant survey in the county park.

LAND USE

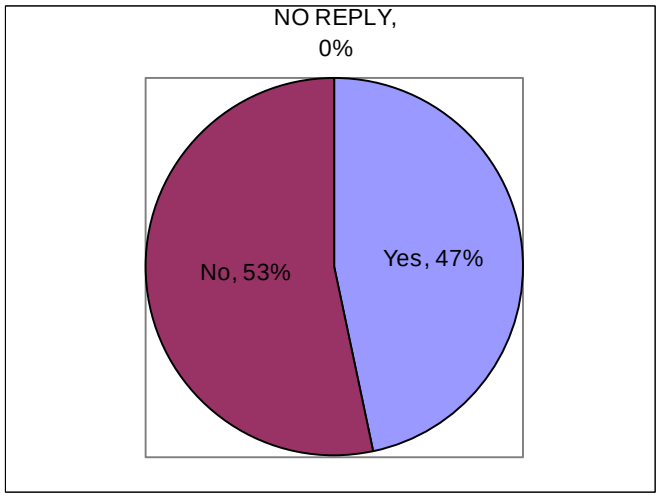
The respondents were asked to provide information on their properties. Since land use is directly correlated to water quality, identifying any sources of nutrient runoff is critical to compiling a lake management plan. Different land uses will affect water quality to various degrees. This will help Brown County staff identify any further management actions which can be taken to improve existing water quality.

22. *What best describes your property use?*	
Residential	13
Commercial	0
Industrial	0
Farmstead	1
Agricultural land	5
NO REPLY	0
TOTAL	19



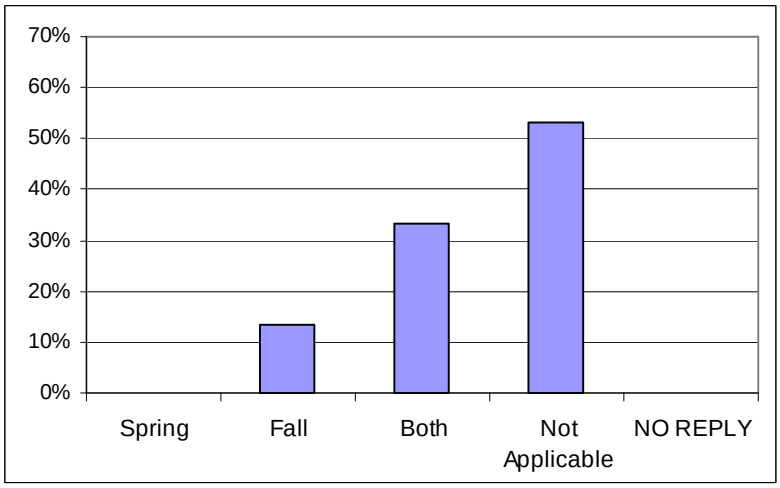
- The majority of respondents (68%) indicated they own residential property.
- 26% of properties within the watershed are agricultural in nature.
- Almost all of the properties around Lily Lake could significantly impact water quality.

23. *Do you apply fertilizers or lawn care chemicals to your lawn?*	
Yes	7
No	8
NO REPLY	0
TOTAL	15



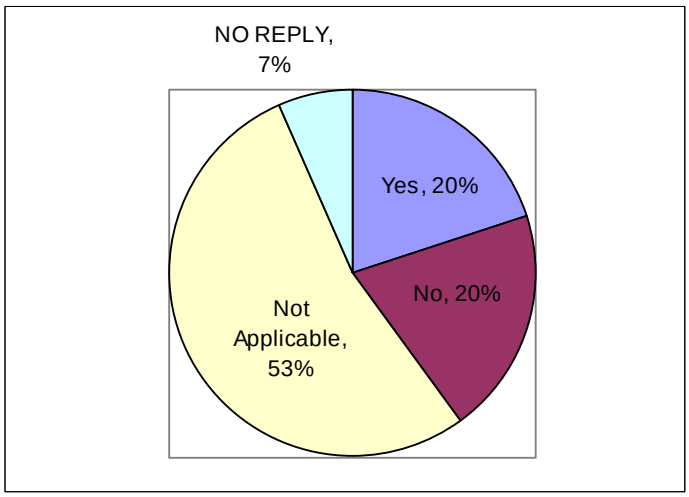
- Approximately half (47%) of respondents utilize chemical treatments.
- Many residential lawn care products contain phosphorous, the primary chemical which can have immediate impact on existing water quality.

24. *When do you apply fertilizers or lawn care chemicals to your lawn?*	
Spring	0
Fall	2
Both	5
Not Applicable	8
NO REPLY	0
TOTAL	15



- 33% of respondents treat their lawn twice a year.
- Water quality can be affected year round.

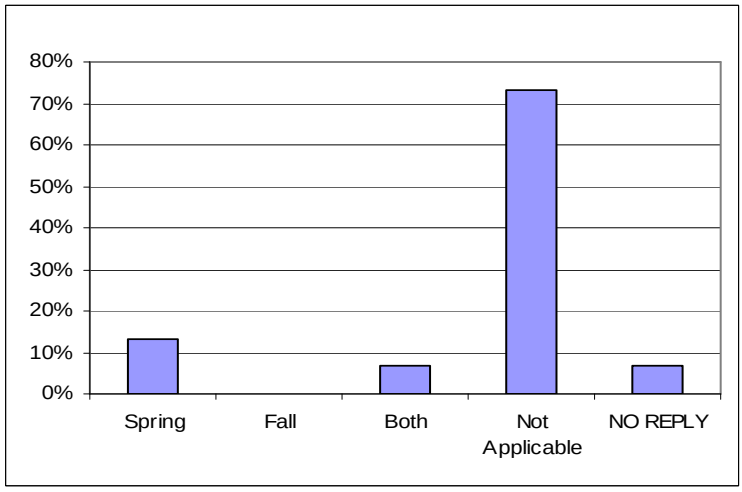
25. *If you are currently farming, do you (or a renter), land apply manure or other fertilizers to your field?*	
Yes	3
No	3
Not Applicable	8
NO REPLY	1
TOTAL	15



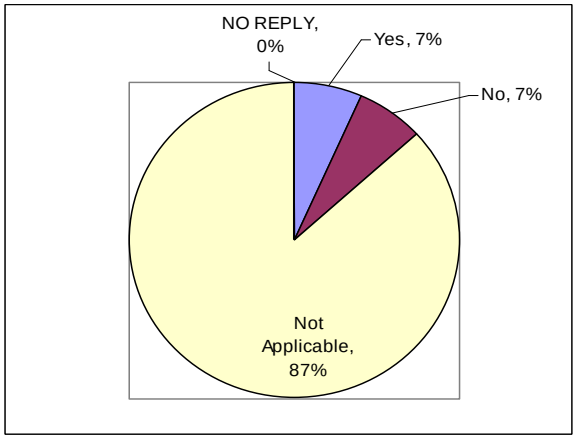
- 7% of respondents land applies manure or other fertilizer.
- This represents only three parcels surrounding Lily Lake.

26. *When do you land apply manure or other fertilizers to your field?*	
Spring	2
Fall	0
Both	1
Not Applicable	11
NO REPLY	1
TOTAL	15

- Manure is spread in both spring and fall.

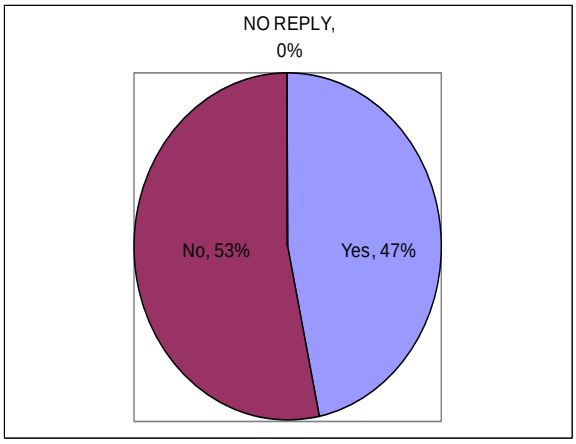


27. *Do you follow a Wisconsin Department of Natural Resources or Brown County Land Conservation Department nutrient management/application program?*	
Yes	1
No	1
Not Applicable	13
NO REPLY	0
TOTAL	15



- Only one farmer has a manure management plan.

28. *Do you have a compost pile for yard waste, food, or other biodegradable items?*	
Yes	7
No	8
NO REPLY	0
TOTAL	15



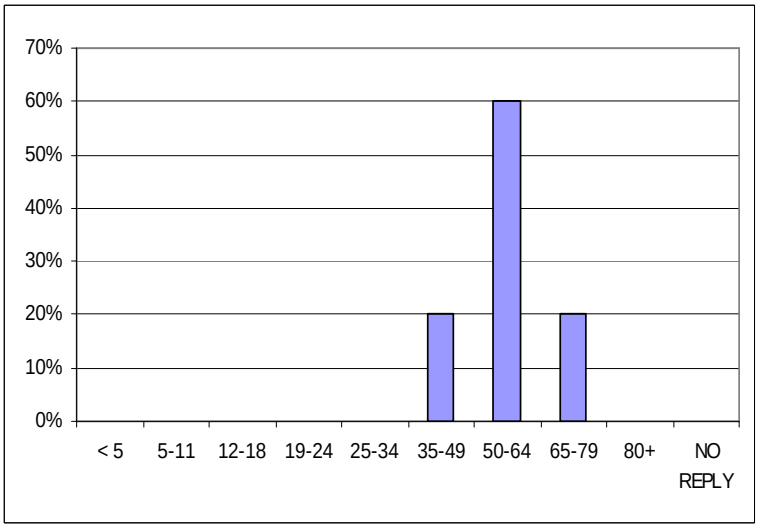
- Approximately half (47%) of respondents compost biodegradable table scraps and yard waste.
- Composting may lead to less runoff.

THE RESPONDENTS

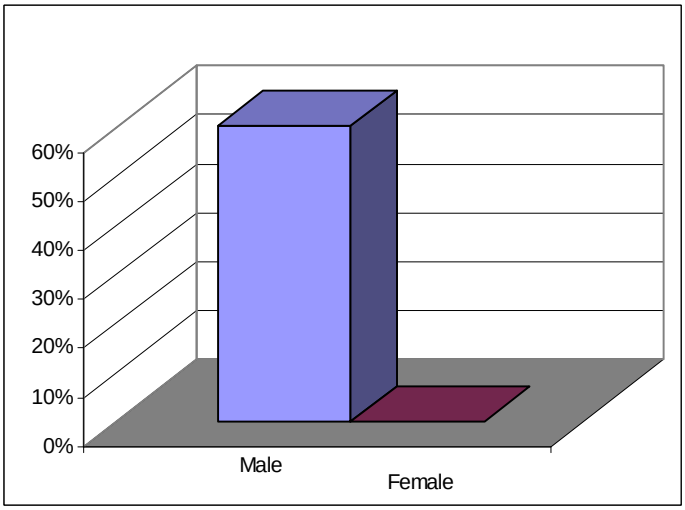
The following identifies who completed the survey, and who the survey was being completed for. The respondent was requested to complete each question on behalf of all members of the household, unless specified otherwise.

- 19 surveys were mailed and 15 surveys were returned, for a 79% response rate.
- The average age of the respondent was **56**.
- The youngest respondent was **42**, the oldest was **72**.
- **No** Surveys were completed by minors.
- All respondents were male.

29. *How old are you?*	
< 5	0
5-11	0
12-18	0
19-24	0
25-34	0
35-49	3
50-64	9
65-79	3
80+	0
NO REPLY	0
TOTAL	15



30. *What is your gender?*	
Male	14
Female	0
NO REPLY	0
TOTAL	14



APPENDIX D

Lily Lake General User Internet Survey Results

Introduction

The following survey results are a compilation of information based upon a 24 question survey that was administered to Brown County residents. The survey was conducted on the Brown County Planning Commission website.

The survey process was announced through a number of methods. Notice was given at two public informational meetings held in April 2009. A newsletter article also appeared in the Green Bay Press-Gazette and the Denmark News. Flyers were posted on the educational kiosk and restroom facilities at Lily Lake County Park from May 2009 through September 2009.

Even with the extensive publicity of this survey, response rates were extremely low. Only three individuals responded to the survey. Results for this survey are statistically insignificant. As such, no analysis was completed on the data. Several questions below have results listed because these sections were vital in the completion of the overall report.

The majority of the subject information is based upon the residents' current knowledge of Lily Lake. The information should be used as a tool to make educated decisions while developing the management plan for Lily Lake. The information should not be used as the only source for public needs and wants, because dynamic new trends in park and recreation may exist that the general public is not aware of. This is not a scientific survey.

USE OF LILY LAKE

1. Are you a Brown County resident?

Results not statistically significant

2. Have you used Lily Lake in the last year?

Results not statistically significant

3. How many years have you used Lily Lake?

Results not statistically significant

4. In a typical year, how many times do you use/visit Lily Lake?

Results not statistically significant

ACTIVITIES AT LILY LAKE

The respondents were questioned what they do in terms of recreation at Lily Lake. The following information may assist Brown County in improving the current condition of Lily Lake Park. Respondents were given the option to reply to more than one category, unless the chart represents a simple "yes/no" question.

5. What activities do you participate in at Lily Lake?	
Fishing	3
Observing wildlife	0
Swimming	0
Scenic beauty	1
Canoeing/kayaking	1
Waterfowl hunting	1
Deer hunting	1
Ice fishing	1
Relaxing	1
Walking	0
Snowshoeing	0
None	0
TOTAL	9

- Respondents participated in a variety of activities at Lily Lake.

6. What type of watercraft do you use on Lily Lake?

Results not statistically significant

WATER QUALITY

The respondents were questioned about their perceptions of water quality at Lily Lake. The following information may assist Brown County in identifying what actions need to be taken to improve the overall perceived water quality of Lily Lake Park. Respondents were given the option to reply to more than one category, unless the chart represents a simple "yes/no" question.

7. How would you rate the current water quality at Lily Lake?

Results not statistically significant

8. *What factor(s) contribute most to your perception of water quality at Lily Lake?*	
Algal blooms	1
Large amount of aquatic vegetation (weeds)	2
Reduced water clarity	1
All of the above	1
None of the above	0
TOTAL	5

9. Has the water quality changed since you first began to use Lily Lake?

Results not statistically significant

10. *Has the water quality of Lily Lake affected your decision to use Lily Lake?*	
Yes	2
No	1
No opinion	0
TOTAL	3

- Perceived water quality appears to affect the user's decision to visit the lake.

FISHING

The respondents were questioned about their opinions regarding the current fishery at Lily Lake. Fishing is one of the most popular activities. As such, Brown County and the Wisconsin Department of Natural Resources are very interested in improving the fishery. The following information will assist these agencies in managing the fishery. Respondents were given the option to reply to more than one category, unless the chart represents a simple "yes/no" question.

11. *How would you rate the current fishing conditions at Lily Lake?*

Results not statistically significant

12. *What type of fish do you catch at Lily Lake?*	
Bass	2
Bluegill	2
Perch	0
TOTAL	4

- Bluegill and Largemouth bass account for all species caught.

13. *What type of fish would you like to catch at Lily Lake?*	
Panfish (Bluegill, crappie, sunfish, etc.)	2
Largemouth bass	2
Northern Pike	0
Walleye	0
Perch	0
TOTAL	4

- All respondents indicated they would like to continue the same species in the future.

14. *Based on your opinion of fishing conditions, has the number of times you visited Lily Lake: ___?*

Results not statistically significant

15. *Would you like to see a fish stocking program at Lily Lake?*

Results not statistically significant

16. *If yes, how much would you be willing to pay for the fish stocking program at Lily Lake?*

Results not statistically significant

17. *Would you support a temporary catch-and-release only fishery to allow fish to grow larger?*

Results not statistically significant

18. Would you support larger limits on fish at Lily Lake to allow fish to grow larger at Lily Lake?	
Yes	3
No	0
No opinion	0
NO REPLY	0
TOTAL	15

- All respondents support larger harvest limits on fish at Lily Lake.

19. Would you support smaller daily bag limits on fish at Lily Lake to allow for fish to grow larger?	
Yes	3
No	0
No opinion	0
NO REPLY	0
TOTAL	15

- All respondents support reducing bag limits.

FACILITIES

The respondents were questioned what they desire in the Brown County park system. This includes activities that may already be available, and activities that should be added to the area. One point to consider in this section of the report is that the some members of the public may have difficulty imagining new park services that are not already available in this region of Wisconsin. Thus, when developing a lake management plan, one should not remain exclusive to the choices with highest percentages. Respondents were given the option to reply to more than one category, unless the chart represents a simple "yes/no" question.

20. *What facility improvements are needed at Lily Lake County Park?*	
Playground equipment	2
Fishing shelter	1
Extended trails	2
Fish cleaning stations	0
Other	0
TOTAL	5

21. What factor(s) below would improve your likelihood of using Lily Lake?	
Provide water quality suitable for maintaining fish and other aquatic life	3
Reduce the severity of nuisance plant growth	3
Improve wildlife habitat	1
TOTAL	7

22. *What changes would you make to Lily Lake and Lily Lake County Park?*	
Playground for kids	1
Retain electric motor only policy	1
Increase Wisconsin Department of Natural Resources patrol / enforcement	1
- NO REPLY	1
TOTAL	4

23. *How old are you?*

Results not statistically significant

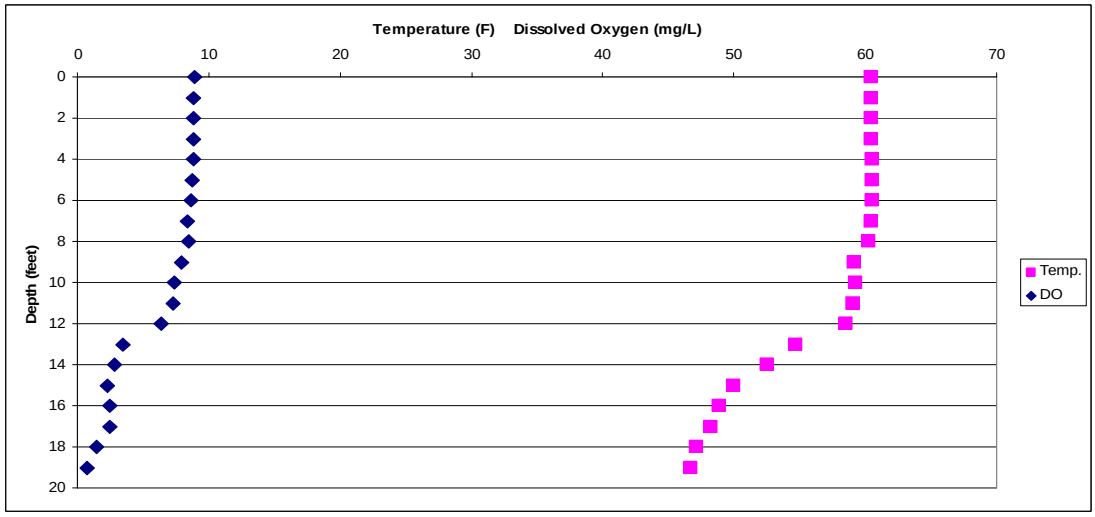
24. *Are Male/Female?*

Results not statistically significant

APPENDIX E

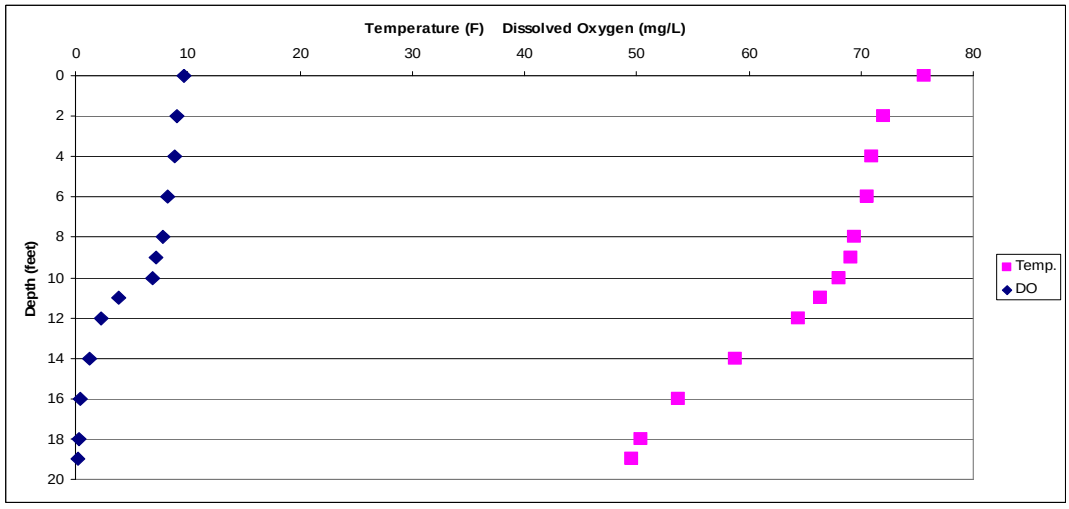
Lily Lake Water Chemistry Analysis Results

Figure E-1: Temperature and Dissolved Oxygen Profiles of Lily Lake May 22, 2008



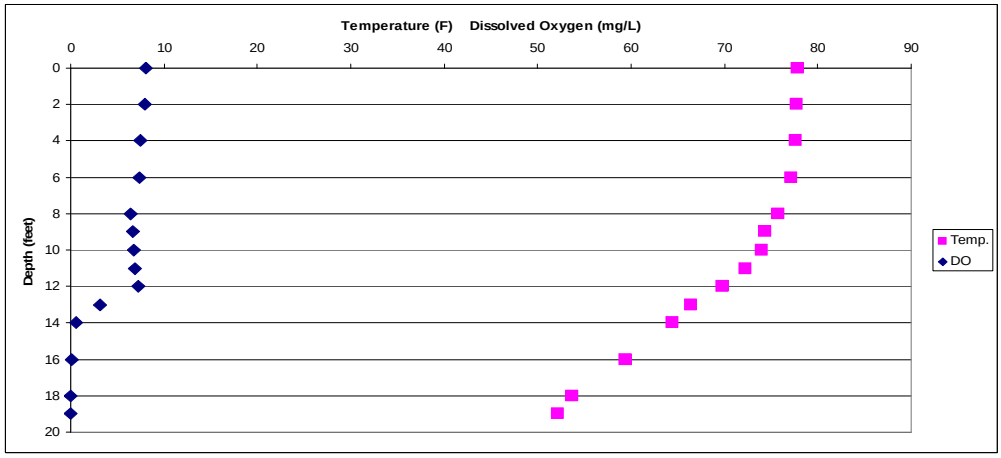
Source: BCPC, 2008

Figure E-2: Temperature and Dissolved Oxygen Profiles of Lily Lake June 20, 2008



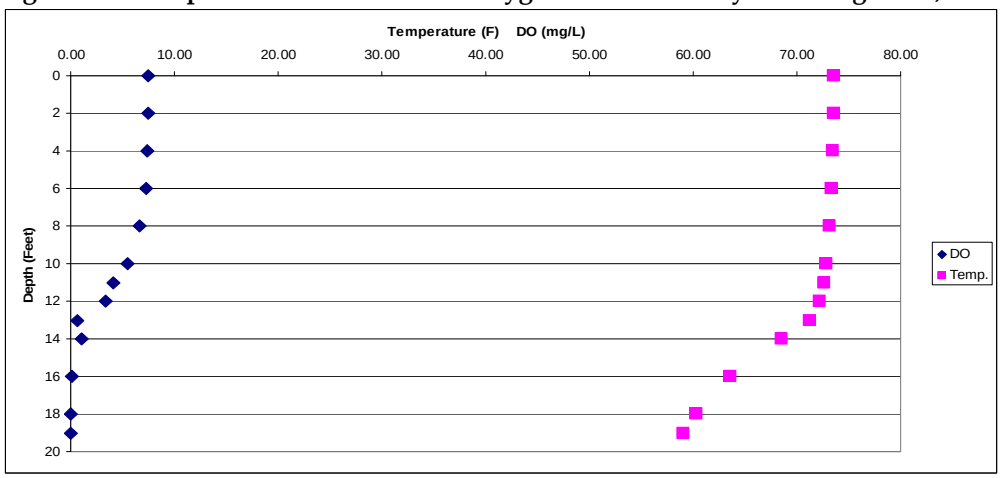
Source: BCPC, 2008

Figure E-3: Temperature and Dissolved Oxygen Profiles of Lily Lake July 18, 2008



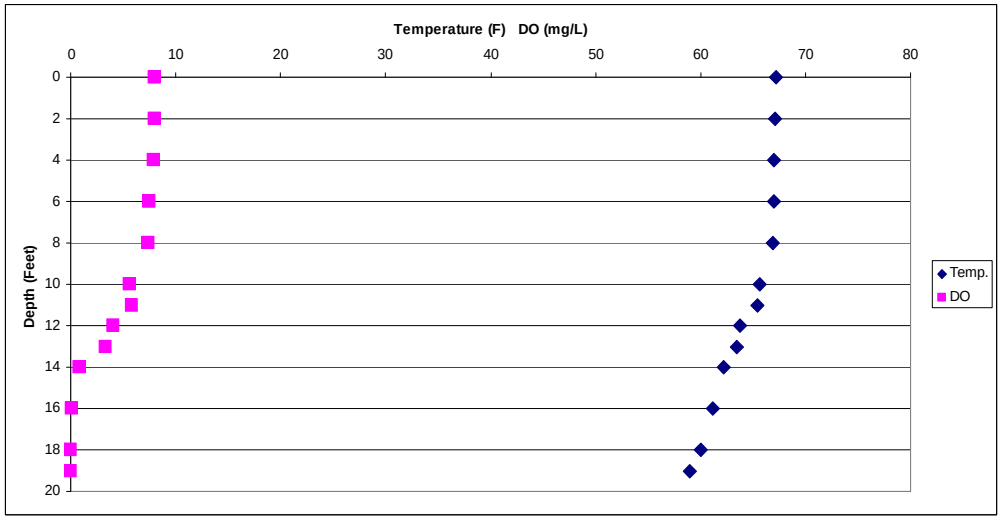
Source: BCPC, 2008

Figure E-4: Temperature and Dissolved Oxygen Profiles of Lily Lake August 29, 2008



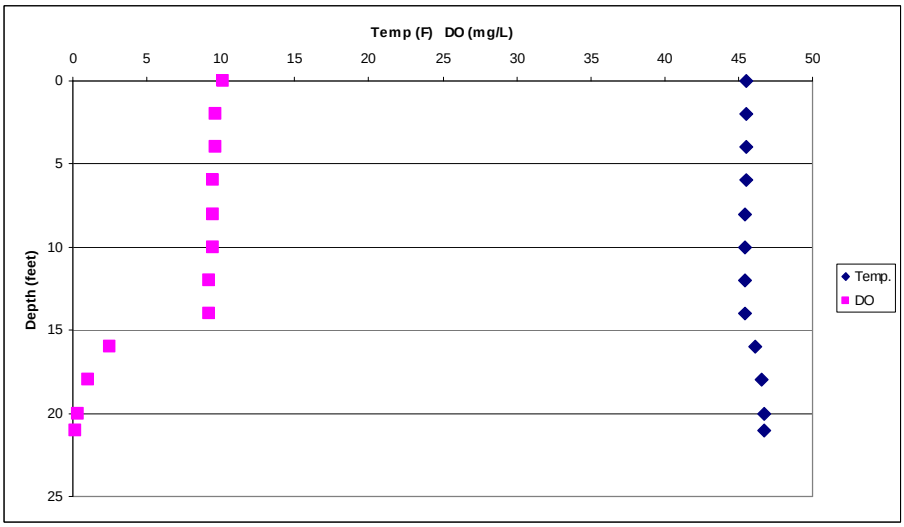
Source: BCPC, 2008

Figure E-5: Temperature and Dissolved Oxygen Profiles of Lily Lake September 24, 2008



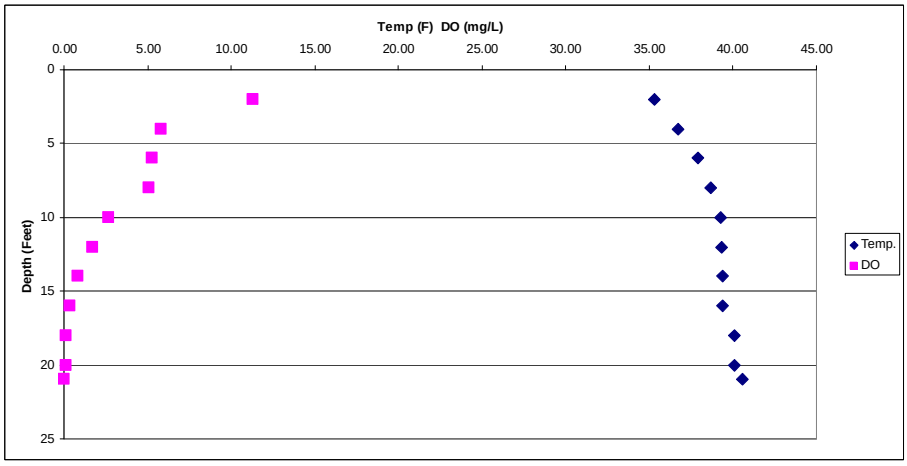
Source: BCPC, 2008

Figure E-6: Temperature and Dissolved Oxygen Profiles of Lily Lake October 29, 2008



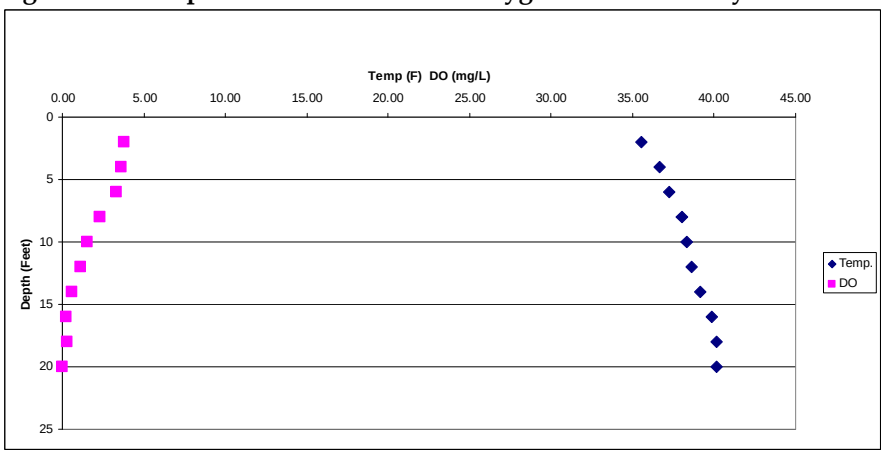
Source: BCPC, 2008

Figure E-7: Temperature and Dissolved Oxygen Profiles of Lily Lake January 21, 2009



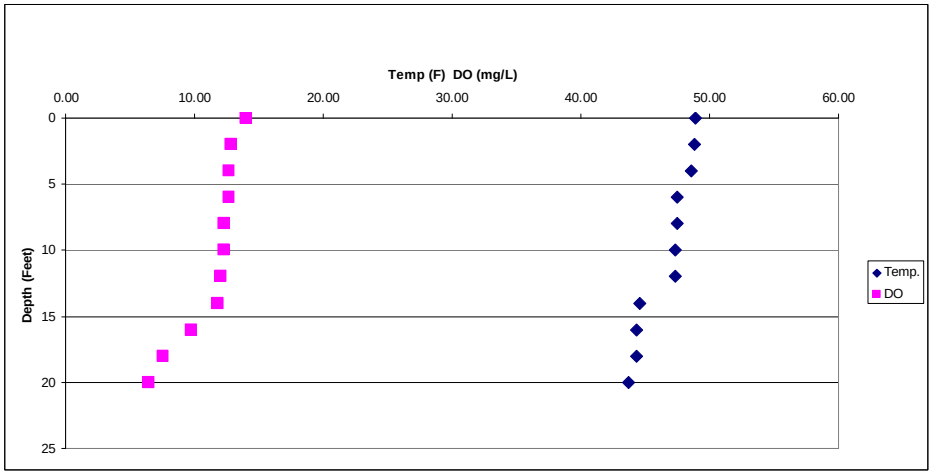
Source: BCPC, 2009

Figure E-8: Temperature and Dissolved Oxygen Profiles of Lily Lake February 6, 2009



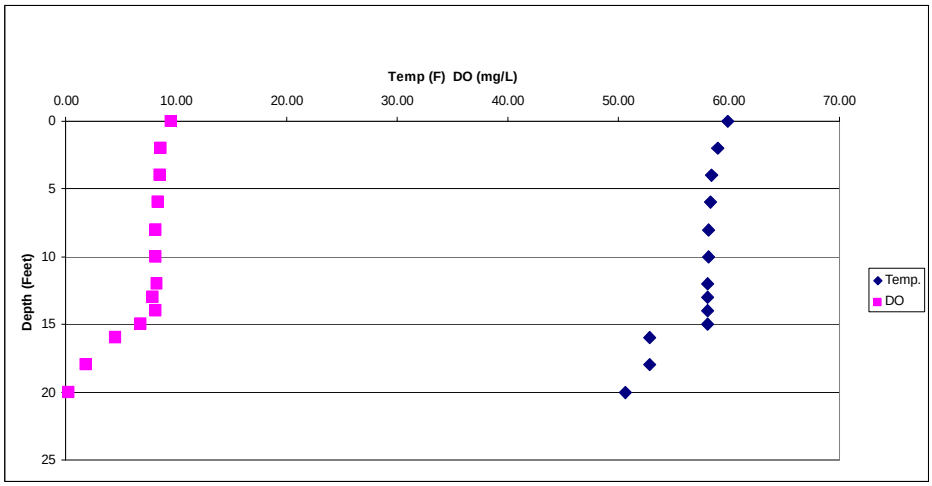
Source: BCPC, 2009

Figure E-9: Temperature and Dissolved Oxygen Profiles of Lily Lake April 14, 2009



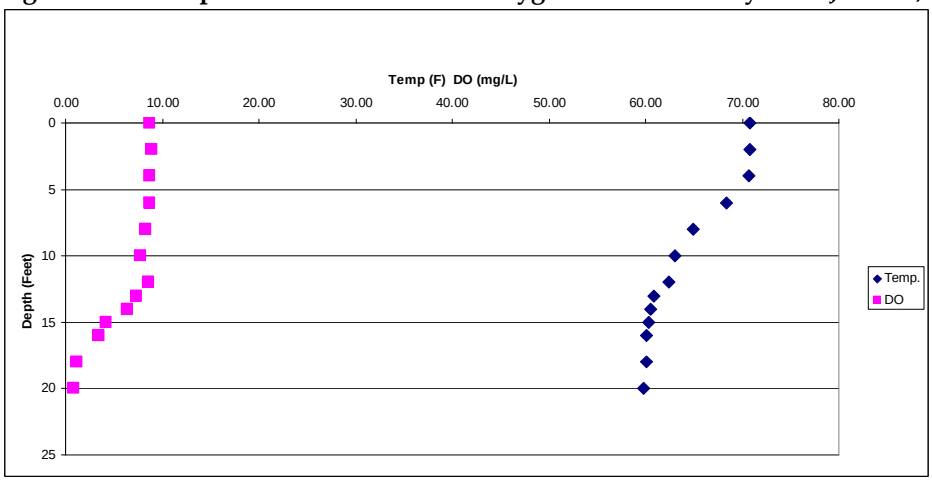
Source: BCPC, 2009

Figure E-10: Temperature and Dissolved Oxygen Profiles of Lily Lake May 14, 2009



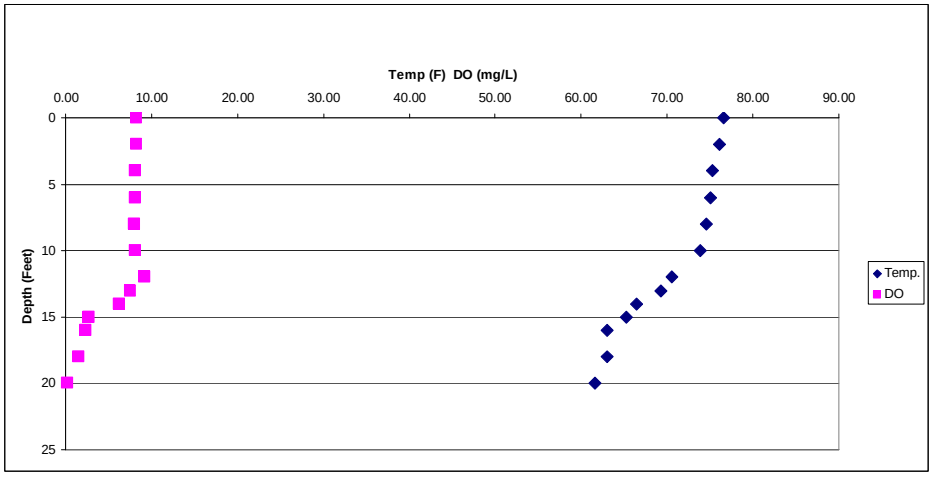
Source: BCPC, 2009

Figure E-11: Temperature and Dissolved Oxygen Profiles of Lily Lake June 15, 2009



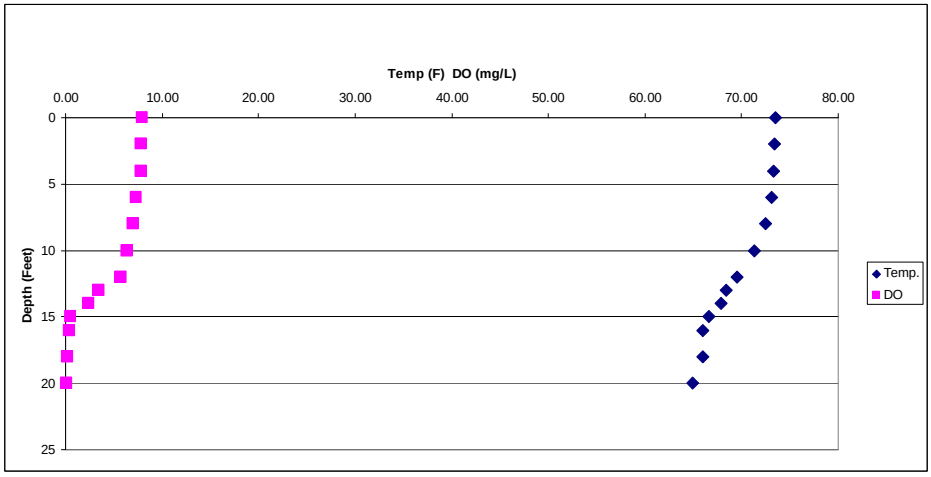
Source: BCPC, 2009

Figure E-12: Temperature and Dissolved Oxygen Profiles of Lily Lake July 14, 2009



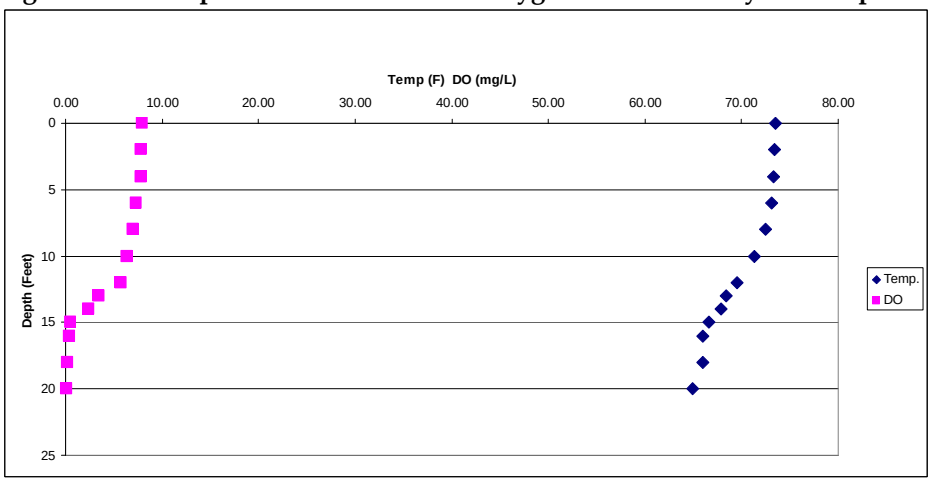
Source: BCPC, 2009

Figure E-13: Temperature and Dissolved Oxygen Profiles of Lily Lake August 26, 2009



Source: BCPC, 2009

Figure E-14: Temperature and Dissolved Oxygen Profiles of Lily Lake September 14, 2009



Source: BCPC, 2009

Table E-1: Lily Lake Specific Conductivity

Depth	2008						2009								
(Feet)	22-May	20-Jun	18-Jul	29-Aug	24-Sep	29-Oct	26-Dec	21-Jan	6-Feb	14-Apr	14-May	15-Jun	14-Jul	26-Aug	14-Sep
0	0.331	0.321	0.308	0.312	0.325	0.342				0.330	0.312	0.302	0.301	0.287	0.287
1	0.331														
2	0.331	0.320	0.308	0.312	0.325	0.342	0.376	0.375	0.386	0.328	0.312	0.303	0.301	0.287	0.286
3	0.331														
4	0.331	0.321	0.308	0.312	0.326	0.343	0.376	0.374	0.384	0.329	0.311	0.303	0.300	0.287	0.287
5	0.331														
6	0.331	0.322	0.308	0.312	0.326	0.342	0.377	0.374	0.384	0.329	0.312	0.304	0.300	0.288	0.289
7	0.336														
8	0.332	0.322	0.314	0.314	0.325	0.343	0.382	0.375	0.384	0.329	0.312	0.306	0.301	0.287	0.288
9	0.333	0.323	0.313												
10	0.333	0.324	0.314	0.317	0.327	0.342	0.387	0.379	0.388	0.330	0.312	0.306	0.301	0.289	0.288
11	0.334	0.331	0.318	0.318	0.327										
12	0.334	0.334	3.280	0.321	0.327	0.343	0.391	0.388	0.396	0.329	0.312	0.305	0.305	0.290	0.288
13	0.334		0.335	0.327	0.329						0.311	0.306	0.309	0.296	0.295
14	0.333	0.333	0.337	0.338	0.332	0.343	0.398	0.393	0.412	0.332	0.312	0.301	0.315	0.311	0.295
15	0.332										0.312	0.324	0.319	0.322	0.306
16	0.332	0.333	0.343	0.367	0.353	0.403	0.410	0.404	0.434	0.342	0.318	0.419	0.326	0.341	0.346
17	0.332														
18	0.340	0.348	0.363	0.400	0.524	0.598	0.473	0.491	0.475	0.350	0.332	0.487	0.369	0.492	0.426
19	0.343	0.354	0.385	0.403	0.578										
20						0.600	0.496	0.546	0.514	0.351	0.345	0.511	0.376	0.578	0.434
21						0.600	0.497	0.546							

Source: BCPC, 2008 & 2009

Table E-2: Lily Lake pH Levels

Depth (Feet)	2008						2009								
	22-May	20-Jun	18-Jul	29-Aug	24-Sep	29-Oct	26-Dec	21-Jan	6-Feb	14-Apr	14-May	15-Jun	14-Jul	26-Aug	14-Sep
1	8.16														
2	8.16	7.92	8.34	8.34	8.23	7.82	7.71	7.16	7.15	8.08	8.00	8.04	8.19	8.01	8.44
3	8.16														
4	8.15	7.86	8.26	8.32	8.21	7.81	7.65	7.14	7.10	8.02	8.03	8.04	8.20	8.02	8.42
5	8.15														
6	8.15	7.91	8.24	8.31	8.21	7.81	7.40	7.12	7.09	7.94	8.03	7.90	8.19	7.99	8.36
7	8.05														
8	8.06	7.81	8.00	8.22	8.20	7.80	7.27	7.08	7.07	7.91	8.03	7.85	8.13	7.89	8.34
9	7.96	7.92	8.20												
10	7.96	7.65	8.07	8.00	7.77	7.81	7.20	7.02	7.05	7.90	7.96	7.84	8.15	7.87	8.29
11	7.84	7.45	8.11	7.88	7.86										
12	7.59	7.17	7.95	7.70	7.72	7.81	7.17	7.01	7.04	7.89	7.95	8.03	8.15	7.83	8.15
13	7.15		7.34	7.36	7.53						7.95	8.03	7.98	7.53	7.98
14	7.02	7.01	7.13	7.24	7.29	7.79	7.15	7.00	7.01	7.64	7.95	7.68	7.78	7.14	7.82
15	6.90										7.97	7.46	7.37	6.87	7.61
16	6.88	6.88	6.97	6.91	7.04	6.78	7.10	6.99	6.82	7.51	7.56	7.40	7.36	6.82	7.53
17	6.75														
18	6.72	6.82	6.90	6.70	6.67	6.70	6.98	6.81	6.83	7.33	7.24	7.32	7.31	6.27	7.19
19	6.70	6.84	6.81	6.68	6.65										
20						6.69	6.73	6.48	6.83	7.32	7.23	7.32	7.01	6.21	7.04
21						6.70	6.72	6.45							

Source: BCPC, 2008 & 2009

APPENDIX F

Sample-Intercept Survey GPS Coordinates

Point	Latitude	Longitude		Point	Latitude	Longitude		Point	Latitude	Longitude
LILY001	44.42792	-87.8566		LILY040	44.42698	-87.8541		LILY079	44.42754	-87.8524
LILY002	44.42762	-87.8566		LILY041	44.42668	-87.8541		LILY080	44.42724	-87.8525
LILY003	44.42821	-87.8562		LILY042	44.42639	-87.8541		LILY081	44.42695	-87.8525
LILY004	44.42791	-87.8562		LILY043	44.42609	-87.8542		LILY082	44.42665	-87.8525
LILY005	44.42761	-87.8562		LILY044	44.42579	-87.8542		LILY083	44.42635	-87.8525
LILY006	44.42731	-87.8562		LILY045	44.42549	-87.8542		LILY084	44.42606	-87.8525
LILY007	44.4282	-87.8557		LILY046	44.4252	-87.8542		LILY085	44.42576	-87.8525
LILY008	44.4279	-87.8558		LILY047	44.4249	-87.8542		LILY086	44.42546	-87.8525
LILY009	44.4276	-87.8558		LILY048	44.42786	-87.8537		LILY087	44.42517	-87.8525
LILY010	44.42731	-87.8558		LILY049	44.42756	-87.8537		LILY088	44.42487	-87.8525
LILY011	44.42701	-87.8558		LILY050	44.42727	-87.8537		LILY089	44.42724	-87.852
LILY012	44.42819	-87.8553		LILY051	44.42697	-87.8537		LILY090	44.42694	-87.8521
LILY013	44.42789	-87.8553		LILY052	44.42667	-87.8537		LILY091	44.42664	-87.8521
LILY014	44.4276	-87.8553		LILY053	44.42638	-87.8537		LILY092	44.42635	-87.8521
LILY015	44.4273	-87.8554		LILY054	44.42608	-87.8537		LILY093	44.42605	-87.8521
LILY016	44.427	-87.8554		LILY055	44.42578	-87.8538		LILY094	44.42575	-87.8521
LILY017	44.42671	-87.8554		LILY056	44.42549	-87.8538		LILY095	44.42546	-87.8521
LILY018	44.42818	-87.8549		LILY057	44.42519	-87.8538		LILY096	44.42516	-87.8521
LILY019	44.42789	-87.8549		LILY058	44.42489	-87.8538		LILY097	44.42486	-87.8521
LILY020	44.42759	-87.8549		LILY059	44.42756	-87.8533		LILY098	44.42456	-87.8521
LILY021	44.42729	-87.8549		LILY060	44.42726	-87.8533		LILY099	44.42427	-87.8522
LILY022	44.42699	-87.855		LILY061	44.42696	-87.8533		LILY100	44.42397	-87.8522
LILY023	44.4267	-87.855		LILY062	44.42667	-87.8533		LILY101	44.42367	-87.8522
LILY024	44.4264	-87.855		LILY063	44.42637	-87.8533		LILY102	44.42723	-87.8516
LILY025	44.42817	-87.8545		LILY064	44.42607	-87.8533		LILY103	44.42693	-87.8516
LILY026	44.42788	-87.8545		LILY065	44.42578	-87.8533		LILY104	44.42664	-87.8517
LILY027	44.42758	-87.8545		LILY066	44.42548	-87.8534		LILY105	44.42634	-87.8517
LILY028	44.42728	-87.8545		LILY067	44.42518	-87.8534		LILY106	44.42604	-87.8517
LILY029	44.42699	-87.8545		LILY068	44.42489	-87.8534		LILY107	44.42574	-87.8517
LILY030	44.42669	-87.8546		LILY069	44.42755	-87.8529		LILY108	44.42545	-87.8517
LILY031	44.42639	-87.8546		LILY070	44.42725	-87.8529		LILY109	44.42515	-87.8517
LILY032	44.4261	-87.8546		LILY071	44.42696	-87.8529		LILY110	44.42485	-87.8517
LILY033	44.4258	-87.8546		LILY072	44.42666	-87.8529		LILY111	44.42456	-87.8517
LILY034	44.4255	-87.8546		LILY073	44.42636	-87.8529		LILY112	44.42426	-87.8517
LILY035	44.42521	-87.8546		LILY074	44.42606	-87.8529		LILY113	44.42396	-87.8517
LILY036	44.42817	-87.8541		LILY075	44.42577	-87.8529		LILY114	44.42367	-87.8518
LILY037	44.42787	-87.8541		LILY076	44.42547	-87.8529		LILY115	44.42663	-87.8512
LILY038	44.42757	-87.8541		LILY077	44.42517	-87.8529		LILY116	44.42633	-87.8512
LILY039	44.42728	-87.8541		LILY078	44.42488	-87.853		LILY117	44.42603	-87.8513

Source: WDNR, 2008

Sample-Intercept Survey GPS Coordinates

Point	Latitude	Longitude		Point	Latitude	Longitude		Point	Latitude	Longitude
LILY118	44.42574	-87.8513		LILY131	44.42395	-87.8509		LILY144	44.42482	-87.8496
LILY119	44.42544	-87.8513		LILY132	44.42365	-87.8509		LILY145	44.42452	-87.8497
LILY120	44.42514	-87.8513		LILY133	44.42542	-87.8505		LILY146	44.42422	-87.8497
LILY121	44.42485	-87.8513		LILY134	44.42513	-87.8505		LILY147	44.4251	-87.8492
LILY122	44.42455	-87.8513		LILY135	44.42483	-87.8505		LILY148	44.42481	-87.8492
LILY123	44.42425	-87.8513		LILY136	44.42453	-87.8505		LILY149	44.42451	-87.8492
LILY124	44.42396	-87.8513		LILY137	44.42424	-87.8505		LILY150	44.42421	-87.8493
LILY125	44.42366	-87.8513		LILY138	44.42394	-87.8505		LILY151	44.4251	-87.8488
LILY126	44.42543	-87.8509		LILY139	44.42512	-87.85		LILY152	44.4248	-87.8488
LILY127	44.42514	-87.8509		LILY140	44.42482	-87.8501		LILY153	44.4245	-87.8488
LILY128	44.42484	-87.8509		LILY141	44.42453	-87.8501		LILY154	44.42479	-87.8484
LILY129	44.42454	-87.8509		LILY142	44.42423	-87.8501		LILY155	44.42449	-87.8484
LILY130	44.42424	-87.8509		LILY143	44.42511	-87.8496				

Source: WDNR, 2008

APPENDIX G

Lily Lake Bird Survey

Table G-1: Lily Lake Bird Checklist

Species	Heard or Seen
Anhinga *Anhinga anhinga*	
Avocet, American *Recurvirostra americana*	
Bittern, American *Botaurus lentiginosus*	
Bittern, Least *Ixobrychus exilis*	
Blackbird, Brewer's *Euphagus cyanocephalus*	x
Blackbird, Red-winged *Agelaius phoeniceus*	x
Blackbird, Rusty *Euphagus carolinus*	
Blackbird, Yellow-headed *Xanthocephalus xanthocephalus*	
Bluebird, Eastern *Sialia sialis*	x
Bobolink *Dolichonyx oryzivorus*	
Bobwhite, Northern *Colinus virginianus*	
Bufflehead *Bucephala albeola*	x
Bunting, Indigo *Passerina cyanea*	x
Bunting, Snow *Plectrophenax nivalis*	x
Buzzard, Rough-legged *Buteo lagopus*	x
Canvasback *Aythya valisineria*	x
Cardinal, Northern *Cardinalis cardinalis*	x
Catbird, Grey *Dumetella carolinensis*	x
Chat, Yellow-breasted *Icteria virens*	
Chickadee, Black-capped *Poecile atricapillus*	x
Chickadee, Boreal *Poecile hudsonica*	
Chuck-will's-widow *Caprimulgus carolinensis*	
Cliff-Swallow, American *Petrochelidon pyrrhonota*	
Collared-Dove, Eurasian *Streptopelia decaocto* (escape ?)	
Coot, American *Fulica americana*	
Cormorant, Double-crested *Phalacrocorax auritus*	x
Cowbird, Brown-headed *Molothrus ater*	x
Crane, Sandhill *Grus canadensis*	x
Crane, Whooping *Grus americana*	
Creeper, Brown *Certhia americana*	x
Crossbill, Red *Loxia curvirostra*	x
Crossbill, White-winged *Loxia leucoptera*	x
Crow, American *Corvus brachyrhynchos*	x
Cuckoo, Black-billed *Coccyzus erythropthalmus*	x
Cuckoo, Yellow-billed *Coccyzus americanus*	
Curlew, Long-billed *Numenius americanus*	
Dickcissel *Spiza americana*	

Source: BCPC, 2007 - 2009

Table G-1: Lily Lake Bird Checklist (continued)

Species	Heard or Seen
Dove, Mourning *Zenaida macroura*	x
Dove, White-winged *Zenaida asiatica*	
Dowitcher, Long-billed *Limnodromus scolopaceus*	
Dowitcher, Short-billed *Limnodromus griseus*	
Duck, American Black *Anas rubripes*	
Duck, Harlequin *Histrionicus histrionicus*	
Duck, Long-tailed *Clangula hyemalis*	
Duck, Ring-necked *Aythya collaris*	
Duck, Ruddy *Oxyura jamaicensis*	
Duck, Wood *Aix sponsa*	x
Dunlin *Calidris alpina*	
Eagle, Bald *Haliaeetus leucocephalus*	x
Eagle, Golden *Aquila chrysaetos*	
Egret, Cattle *Bubulcus ibis*	
Egret, Great *Ardea alba*	x
Egret, Snowy *Egretta thula*	
Eider, Common *Somateria mollissima*	
Eider, King *Somateria spectabilis*	
Falcon, Peregrine *Falco peregrinus*	
Finch, House *Carpodacus mexicanus*	x
Finch, Purple *Carpodacus purpureus*	x
Flicker, Northern *Colaptes auratus*	x
Flycatcher, Acadian *Empidonax virescens*	
Flycatcher, Alder *Empidonax alnorum*	
Flycatcher, Great Crested *Myiarchus crinitus*	x
Flycatcher, Least *Empidonax minimus*	x
Flycatcher, Olive-sided *Contopus cooperi*	x
Flycatcher, Scissor-tailed *Tyrannus forficatus*	
Flycatcher, Willow *Empidonax traillii*	
Flycatcher, Yellow-bellied *Empidonax flaviventris*	
Frigatebird, Magnificent *Fregata magnificens*	
Gadwall *Anas strepera*	
Gallinule, Purple *Porphyrio martinica*	
Gnatcatcher, Blue-grey *Polioptila caerulea*	x
Godwit, Hudsonian *Limosa haemastica*	
Godwit, Marbled *Limosa fedoa*	
Goldeneye, Barrow's *Bucephala islandica*	
Goldeneye, Common *Bucephala clangula*	
Golden-Plover, American *Pluvialis dominica*	
Goldfinch, American *Carduelis tristis*	x
Goose, Brant *Branta bernicla*	
Goose, Cackling *Branta hutchinsii*	x

Source: BCPC, 2007 - 2009

Table G-1: Lily Lake Bird Checklist (continued)

Species	Heard or Seen
Goose, Canada *Branta canadensis*	x
Goose, Greater White-fronted *Anser albifrons*	
Goose, Ross's *Chen rossii*	
Goose, Snow *Chen caerulescens*	
Goshawk, Northern *Accipiter gentilis*	
Grackle, Common *Quiscalus quiscula*	x
Grebe, Eared *Podiceps nigricollis*	
Grebe, Clark's *Aechmophorus clarkii*	
Grebe, Horned *Podiceps auritus*	
Grebe, Pied-billed *Podilymbus podiceps*	x
Grebe, Red-necked *Podiceps grisegena*	
Grebe, Western *Aechmophorus occidentalis*	
Grosbeak, Blue *Passerina caerulea*	
Grosbeak, Evening *Coccothraustes vespertinus*	
Grosbeak, Pine *Pinicola enucleator*	
Grosbeak, Rose-breasted *Pheucticus ludovicianus*	x
Grouse, Ruffed *Bonasa umbellus*	
Gull, Bonaparte's *Chroicocephalus philadelphia*	
Gull, California *Larus californicus*	
Gull, Franklin's *Leucophaeus pipixcan*	
Gull, Glaucous *Larus hyperboreus*	
Gull, Glaucous-winged *Larus glaucescens*	
Gull, Great Black-backed *Larus marinus*	
Gull, Herring *Larus argentatus*	x
Gull, Iceland *Larus glaucoides*	
Gull, Laughing *Leucophaeus atricilla*	
Gull, Lesser Black-backed *Larus fuscus*	
Gull, Little *Hydrocoloeus minutus*	
Gull, Mew *Larus canus*	
Gull, Ring-billed *Larus delawarensis*	x
Gull, Ross's *Rhodostethia rosea*	
Gull, Sabine's *Xema sabini*	
Gull, Slaty-backed *Larus schistisagus*	
Gull, Thayer's *Larus thayeri*	
Harrier, Northern *Circus cyaneus*	
Hawk, Broad-winged *Buteo platypterus*	x
Hawk, Cooper's *Accipiter cooperii*	x
Hawk, Ferruginous *Buteo regalis*	
Hawk, Harris's *Parabuteo unicinctus*	
Hawk, Red-shouldered *Buteo lineatus*	x
Hawk, Red-tailed *Buteo jamaicensis*	
Hawk, Sharp-shinned *Accipiter striatus*	

Source: BCPC, 2007 - 2009

Table G-1: Lily Lake Bird Checklist (continued)

Species	Heard or Seen
Hawk, Swainson's *Buteo swainsoni*	
Hawk-Owl, Northern *Surnia ulula*	
Heron, Great Blue *Ardea herodias*	x
Heron, Green *Butorides virescens*	x
Heron, Little Blue *Egretta caerulea*	
Heron, Tricoloured *Egretta tricolor*	
Horned-Owl, Great *Bubo virginianus*	
Hummingbird, Ruby-throated *Archilochus colubris*	x
Hummingbird, Rufous *Selasphorus rufus*	
Ibis, American White *Eudocimus albus*	
Ibis, Glossy *Plegadis falcinellus*	
Ibis, White-faced *Plegadis chihi*	
Jay, Blue *Cyanocitta cristata*	x
Jay, Grey *Perisoreus canadensis*	
Junco, Dark-eyed *Junco hyemalis*	x
Kestrel, American *Falco sparverius*	
Killdeer *Charadrius vociferus*	
Kingbird, Eastern *Tyrannus tyrannus*	x
Kingbird, Western *Tyrannus verticalis*	
Kingfisher, Belted *Megaceryle alcyon*	x
Kinglet, Golden-crowned *Regulus satrapa*	x
Kinglet, Ruby-crowned *Regulus calendula*	x
Kite, Mississippi *Ictinia mississippiensis*	
Kite, Swallow-tailed *Elanoides forficatus*	
Kite, White-tailed *Elanus leucurus*	
Knot, Red *Calidris canutus*	
Lark, Horned *Eremophila alpestris*	
Longspur, Lapland *Calcarius lapponicus*	
Loon, Common *Gavia immer*	x
Loon, Pacific *Gavia pacifica*	
Loon, Red-throated *Gavia stellata*	
Magpie, Black-billed *Pica hudsonia*	
Mallard *Anas platyrhynchos*	x
Martin, Purple *Progne subis*	
Swallow, Bank *Riparia riparia*	
Meadowlark, Eastern *Sturnella magna*	x
Meadowlark, Western *Sturnella neglecta*	
Merganser, Common *Mergus merganser*	
Merganser, Hooded *Lophodytes cucullatus*	x
Merganser, Red-breasted *Mergus serrator*	
Merlin *Falco columbarius*	
Mockingbird, Northern *Mimus polyglottos*	

Source: BCPC, 2007 - 2009

Table G-1: Lily Lake Bird Checklist (continued)

Species	Heard or Seen
Moorhen, Common *Gallinula chloropus*	
Murrelet, Ancient *Synthliboramphus antiquus***	
Nighthawk, Common *Chordeiles minor*	x
Night-Heron, Black-crowned *Nycticorax nycticorax*	
Night-Heron, Yellow-crowned *Nyctanassa violacea*	
Nuthatch, Red-breasted *Sitta canadensis*	x
Nuthatch, White-breasted *Sitta carolinensis*	x
Oriole, Baltimore *Icterus galbula*	x
Oriole, Orchard *Icterus spurius*	
Osprey *Pandion haliaetus*	x
Ovenbird *Seiurus aurocapilla*	x
Owl, Barn *Tyto alba*	
Owl, Barred *Strix varia*	
Owl, Boreal *Aegolius funereus*	
Owl, Burrowing *Athene cunicularia*	
Owl, Great Grey *Strix nebulosa*	
Owl, Great Horned *Bubo virginianus*	x
Owl, Long-eared *Asio otus*	
Owl, Northern Saw-whet *Aegolius acadicus*	
Owl, Short-eared *Asio flammeus*	
Owl, Snowy *Bubo scandiacus*	
Partridge, Grey *Perdix perdix* (introduced)	
Parula, Northern *Parula americana*	x
Pelican, American White *Pelecanus erythrorhynchos*	
Pelican, Brown *Pelecanus occidentalis*	
Phalarope, Red *Phalaropus fulicarius*	
Phalarope, Red-necked *Phalaropus lobatus*	
Phalarope, Wilson's *Phalaropus tricolor*	
Pheasant, Common *Phasianus colchicus* (introduced)	
Phoebe, Eastern *Sayornis phoebe*	x
Phoebe, Say's *Sayornis saya*	
Pigeon, Common *Columba livia feral* (introduced)	x
Pintail, Northern *Anas acuta*	
Pipit, American *Anthus rubescens*	
Plover, Black-bellied *Pluvialis squatarola*	
Plover, Semipalmated *Charadrius semipalmatus*	
Plover, Wilson's *Charadrius wilsonia*	
Rail, King *Rallus elegans*	
Rail, Virginia *Rallus limicola*	
Rail, Yellow *Coturnicops noveboracensis*	
Raven, Common *Corvus corax*	x

Source: BCPC, 2007 - 2009

Table G-1: Lily Lake Bird Checklist (continued)

Species	Heard or Seen
Redhead *Aythya americana*	x
Redpoll, Hoary *Carduelis hornemanni*	
Redpoll, Common *Carduelis flammea*	X
Redstart, American *Setophaga ruticilla*	x
Robin, American *Turdus migratorius*	
Rosy-Finch, Grey-crowned *Leucosticte tephrocotis*	
Ruff *Philomachus pugnax*	
Sanderling *Calidris alba*	
Sandpiper, Baird's *Calidris bairdii*	
Sandpiper, Buff-breasted *Tryngites subruficollis*	
Sandpiper, Least *Calidris minutilla*	
Sandpiper, Pectoral *Calidris melanotos*	
Sandpiper, Purple *Calidris maritima*	
Sandpiper, Semipalmated *Calidris pusilla*	
Sandpiper, Solitary *Tringa solitaria*	
Sandpiper, Spotted *Actitis macularius*	
Sandpiper, Stilt *Calidris himantopus*	
Sandpiper, Upland *Bartramia longicauda*	
Sandpiper, White-rumped *Calidris fuscicollis*	
Sapsucker, Yellow-bellied *Sphyrapicus varius*	x
Scaup, Greater *Aythya marila*	
Scaup, Lesser *Aythya affinis*	
Scoter, Black *Melanitta nigra*	
Scoter, Surf *Melanitta perspicillata*	
Scoter, White-winged *Melanitta fusca*	
Screech-Owl, Eastern *Megascops asio*	x
Shoveler, Northern *Anas clypeata*	
Shrike, Great Grey *Lanius excubitor*	
Shrike, Loggerhead *Lanius ludovicianus*	
Siskin, Pine *Carduelis pinus*	
Smew *Mergellus albellus*	
Snipe, Wilson's *Gallinago delicata*	
Solitaire, Townsend's *Myadestes townsendi*	
Sora *Porzana carolina*	
Sparrow, American Tree *Spizella arborea*	x
Sparrow, Baird's *Ammodramus bairdii*	
Sparrow, Black-throated *Amphispiza bilineata*	
Sparrow, Chipping *Spizella passerina*	x
Sparrow, Clay-coloured *Spizella pallida*	
Sparrow, Eurasian Tree *Passer montanus*	
Sparrow, Field *Spizella pusilla*	

Source: BCPC, 2007 - 2009

Table G-1: Lily Lake Bird Checklist (continued)

Species	Heard or Seen
Sparrow, Fox *Passerella iliaca*	x
Sparrow, Golden-crowned *Zonotrichia atricapilla*	
Sparrow, Grasshopper *Ammodramus savannarum*	
Sparrow, Harris's *Zonotrichia querula*	
Sparrow, Henslow's *Ammodramus henslowii*	
Sparrow, House *Passer domesticus* (introduced)	x
Sparrow, Lark *Chondestes grammacus*	
Sparrow, Le Conte's *Ammodramus leconteii*	
Sparrow, Lincoln's *Melospiza lincolnii*	
Sparrow, Nelson's *Ammodramus nelsoni*	
Sparrow, Rufous-crowned *Aimophila ruficeps*	
Sparrow, Savannah *Passerculus sandwichensis*	
Sparrow, Song *Melospiza melodia*	x
Sparrow, Swamp *Melospiza georgiana*	
Sparrow, Vesper *Pooecetes gramineus*	
Sparrow, White-crowned *Zonotrichia leucophrys*	x
Sparrow, White-throated *Zonotrichia albicollis*	x
Spoonbill, Roseate *Platalea ajaja*	
Starling, Common *Sturnus vulgaris* (introduced)	
Stilt, Black-necked *Himantopus mexicanus*	
Swallow, Barn *Hirundo rustica*	
Swallow, Northern Rough-winged *Stelgidopteryx serripennis*	x
Swallow, Tree *Tachycineta bicolor*	x
Swan, Mute *Cygnus olor* (introduced)	
Swan, Trumpeter *Cygnus buccinator*	
Swan, Tundra *Cygnus columbianus*	
Swift, Chimney *Chaetura pelagica*	
Tanager, Scarlet *Piranga olivacea*	x
Tanager, Summer *Piranga rubra*	
Tanager, Western *Piranga ludoviciana*	
Teal, Blue-winged *Anas discors*	
Teal, Cinnamon *Anas cyanoptera*	
Teal, Green-winged *Anas crecca*	
Tern, Arctic *Sterna paradisaea*	
Tern, Black *Chlidonias niger*	
Tern, Caspian *Hydroprogne caspia*	
Tern, Common *Sterna hirundo*	
Tern, Forster's *Sterna forsteri*	
Tern, Least *Sternula antillarum*	
Tern, Royal *Thalasseus maximus*	

Source: BCPC, 2007 - 2009

Table G-1: Lily Lake Bird Checklist (continued)

Species	Heard or Seen
Tern, Sooty *Onychoprion fuscatus*	
Tern, White-winged *Chlidonias leucopterus*	
Thrasher, Brown *Toxostoma rufum*	x
Thrush, Grey-cheeked *Catharus minimus*	x
Thrush, Hermit *Catharus guttatus*	x
Thrush, Swainson's *Catharus ustulatus*	x
Thrush, Varied *Ixoreus naevius*	
Thrush, Wood *Hylocichla mustelina*	x
Titmouse, Tufted *Baelophus bicolor*	
Towhee, Eastern *Pipilo erythrophthalmus*	x
Towhee, Spotted *Pipilo maculatus*	
Turkey, Wild *Meleagris gallopavo* (introduced)	x
Turnstone, Ruddy *Arenaria interpres*	
Veery *Catharus fuscescens*	x
Vireo, Bell's *Vireo bellii*	
Vireo, Blue-headed *Vireo solitarius*	x
Vireo, Grey *Vireo vicinior*	
Vireo, Philadelphia *Vireo philadelphicus*	x
Vireo, Red-eyed *Vireo olivaceus*	x
Vireo, Warbling *Vireo gilvus*	x
Vireo, White-eyed *Vireo griseus*	
Vireo, Yellow-throated *Vireo flavifrons*	
Vulture, Black *Coragyps atratus*	
Vulture, Turkey *Cathartes aura*	x
Warbler, American Yellow *Dendroica petechia*	x
Warbler, Bay-breasted *Dendroica castanea*	x
Warbler, Black-and-white *Mniotilta varia*	x
Warbler, Blackburnian *Dendroica fusca*	x
Warbler, Blackpoll *Dendroica striata*	x
Warbler, Black-throated Blue *Dendroica caerulescens*	
Warbler, Black-throated Green *Dendroica virens*	x
Warbler, Black-throated Grey *Dendroica nigrescens*	
Warbler, Blue-winged *Vermivora pinus*	x
Warbler, Canada *Wilsonia canadensis*	
Warbler, Cape May *Dendroica tigrina*	x
Warbler, Cerulean *Dendroica cerulea*	
Warbler, Chestnut-sided *Dendroica pensylvanica*	x
Warbler, Connecticut *Oporornis agilis*	
Warbler, Golden-winged *Vermivora chrysoptera*	x
Warbler, Hermit *Dendroica occidentalis*	
Warbler, Hooded *Wilsonia citrina*	

Source: BCPC, 2007 - 2009

Table G-1: Lily Lake Bird Checklist (continued)

Species	Heard or Seen
Warbler, Kentucky *Oporornis formosus*	
Warbler, Kirtland's *Dendroica kirtlandii*	
Warbler, MacGillivray's *Oporornis tolmiei*	
Warbler, Magnolia *Dendroica magnolia*	x
Warbler, Mourning *Oporornis philadelphia*	x
Warbler, Nashville *Vermivora ruficapilla*	x
Warbler, Orange-crowned *Vermivora celata*	
Warbler, Palm *Dendroica palmarum*	
Warbler, Pine *Dendroica pinus*	
Warbler, Prairie *Dendroica discolor*	
Warbler, Prothonotary *Protonotaria citrea*	
Warbler, Swainson's *Limnothlypis swainsonii*	
Warbler, Tennessee *Vermivora peregrina*	x
Warbler, Townsend's *Dendroica townsendi*	
Warbler, Wilson's *Wilsonia pusilla*	x
Warbler, Worm-eating *Helmitheros vermivorum*	
Warbler, Yellow-rumped *Dendroica coronata*	x
Warbler, Yellow-throated *Dendroica dominica*	
Waterthrush, Louisiana *Seiurus motacilla*	
Waterthrush, Northern *Seiurus noveboracensis*	x
Waxwing, Bohemian *Bombycilla garrulus*	x
Waxwing, Cedar *Bombycilla cedrorum*	x
Whimbrel *Numenius phaeopus*	
Whip-poor-will *Caprimulgus vociferus*	
Wigeon, American *Anas americana*	
Wigeon, Eurasian *Anas penelope*	
Willet *Tringa semipalmatus*	
Woodcock, American *Scolopax minor*	
Woodpecker, American Three-toed *Picoides dorsalis*	
Woodpecker, Black-backed *Picoides arcticus*	
Woodpecker, Downy *Picoides pubescens*	x
Woodpecker, Hairy *Picoides villosus*	x
Woodpecker, Lewis's *Melanerpes lewis*	
Woodpecker, Pileated *Dryocopus pileatus*	x
Woodpecker, Red-bellied *Melanerpes carolinus*	x
Woodpecker, Red-headed *Melanerpes erythrocephalus*	
Wood-Pewee, Eastern *Contopus virens*	x
Wren, Bewick's *Thryomanes bewickii*	
Wren, Carolina *Thryothorus ludovicianus*	
Wren, House *Troglodytes aedon*	x
Wren, Marsh *Cistothorus palustris*	

Source: BCPC, 2007 - 2009

Table G-1: Lily Lake Bird Checklist (continued)

Wren, Sedge *Cistothorus platensis*	
Wren, Winter *Troglodytes troglodytes*	
Yellowlegs, Greater *Tringa melanoleuca*	
Yellowlegs, Lesser *Tringa flavipes*	
Yellowthroat, Common *Geothlypis trichas*	x

Source: BCPC, 2007 - 2009