State of the Long Lake Watershed 2004

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Executive Summary

Long Lake is located in Washburn County at the southern end of a 38,000 acre watershed. The watershed represents the landscape where rain and snowmelt runs off of the land and flows through streams, wetlands, and other lakes before passing through the Long Lake dam. From the dam, this water becomes the headwaters of the Brill River and eventually flows into the Red Cedar River, the Chippewa River, and finally the Mississippi to the Gulf of Mexico.

As a headwaters area, the Long Lake watershed is characterized by abundant and high quality ground and surface waters. Originally formed by glaciers, the lakes and streams in the area are replenished annually by precipitation. As rain and snowmelt moves across the landscape, they carry along sediments and chemicals that are eventually transported to Long Lake. The accelerating volume of nutrients and sediments coming into the surface waters of the area pose a major threat to the water quality of the area's lakes. Already there is evidence that the lake's water quality is not meeting goals set in the 1997 Long Lake Management Plan.

Today's challenge is to ensure that the changes taking place in the watershed- changes driven by the high quality of the environment and natural resources found there- do not seriously degrade the value of the community's natural assets. This report summarizes the quality of that environment in 2004- the State of the Watershed- and outlines the strategies that are available to preserve and protect Long Lake, its watersheds and ecosystems.

Measuring Watershed Health

One of the most prominent indicators of watershed health is the water quality found in the lakes. Lakes are not only an important resource that people enjoy, they also function as "sinks" that land use activities throughout the watershed drain to and potentially impact. This is especially true for Long Lake, which sits at the bottom-most point of the watershed.

One way to assess water quality is to measure how clear it is. A clean lake has fewer floating particles and algae, allowing sunlight to penetrate deeper into the water. Secchi disks are used to standardize water clarity measurements and are reported as the deepest depth that the disk can still be seen when submerged in the lake. In the Long Lake area, water clarity is most commonly rated as "fair". Average summer Secchi disk measurements ranged from 6 to 8 feet in 2003. The Secchi readings for Wisconsin's clearest lakes typically range from 10 to 32 feet.

Measuring the amount of phosphorous in lake water provides another indicator of watershed health. Phosphorous is the key nutrient limiting plant growth in the area's lakes. Adding more phosphorous from erosion and runoff is guaranteed to increase algae and plant growth. High levels of phosphorous in lakes are associated with algae blooms and green, turbid water. Excess algae growth can lead to low-oxygen situations in lakes, harming fish and reducing the aesthetics of the lake. Phosphorous measurements in the watershed range from 12 to 76 micrograms-per-liter (ug/l), with the highest levels found in Mud Lake and lowest levels found in Bass and Harmon Lakes. The table below summarizes recent phosphorous measurements in Long Lake.

Basin	Goal	1994 summer average	1998-2001 summer average	2002-2003 summer average
A	16 ug/L	16 ug/L	22 ug/L	21.5 ug/L
B	17 ug/L	17 ug/L	20 ug/L	NA
C	19 ug/L	19 ug/L	19 ug/L	NA
D	18 ug/L	18 ug/L	20 ug/L	NA
E	17 ug/L	17 ug/L	19 ug/L	NA
F (between A and B)	NA	NA	20 ug/L	25 ug/L

Summer total phosphorous goals from Lake Management Plan and actual averages for sampling stations in Long Lake.

While the water quality in the lakes is a fairly common way to measure the health of the watershed's natural resources, it may take years for upstream environmental changes to have an impact in the lake. A preventative approach to maintaining the quality of the watershed's resources involves monitoring environmental indicators found farther upstream such as the health of the forests, wetlands, and tributary streams in the watershed.

Like the lakes and shoreland areas, the forests and wetlands in the Long Lake watershed are under pressure for development and land use change. This is not the first time that the land resources around Long Lake have been stressed. From the late 1800s through the 1940s, the forests were cut and the wetlands drained to harvest timber and establish farms. Today's landscape represents a recovered ecosystem, testament to nature's resilience and a reminder that human and natural timescales are of very different magnitudes. There are numerous signs that the land resource in the watershed is in good health. Indicators of good ecological health in the watershed include:

> * ***Increasing timber stands***. The total volume of standing timber is greater today than anytime since the great cutover. These forested areas help slow rainwater and snowmelt and yield less runoff and nutrients into the lakes, wetlands and streams compared to open or developed land.
>
> * ***Slowed wetland loss***. The pace of wetland loss to development and agriculture is slowing dramatically. Wetland protection rules and incentives for wetland restoration have combined to reduce the amount of wetlands lost each year.

* ***Healthy wildlife and habitats***. The plant and animal communities and their associated habitats are flourishing in the Long Lake watershed. Eagles, ospreys, loons and sandhill cranes are fairly common around the lakes while deer, bears, and otters share the land with an occasional timber wolf.

* ***Public ownership of critical lands***. Much of the watershed is in public ownership as County Forest. Another 2,500 acres of forest and open space and eight miles of sparsely developed shoreline can be found at the Tomahawk Scout Reserve on Long Lake's eastern shores.

Altogether, the Long Lake watershed is an ecological gem where land and water resources support a diverse wildlife community. However, not all the news is good. Changes driven by the area's popularity are combining to place pressure on the natural resource assets.

The 1997 Long Lake Management Plan warned that development in the Long Lake watershed could potentially transform Long Lake into a eutrophic lake with high levels of phosphorous and poor water clarity. Such widespread development would have impacts beyond the lake. It would replace the natural landscape of the watershed with a suburban environment. This type of change is not unimaginable, as growth and change radiates at an increasing pace from the Twin Cities in Minnesota and the Eau Claire area to the south. But such change is also not inevitable. Local decisions and actions can play a major role in shaping the future of the watershed. As change occurs, a number of issues must be addressed to protect the ecology of the watershed in the face of pressure and change.

Issues for the Near Future

Many of the issues in the watershed stem from the area's popularity with tourists, recreational homeowners and retirees. As more and more people come and stay in the watershed, they place stress on the very natural systems that make the area so attractive. Addressing these issues requires a delicate balance between the wants and desires of people and the capacity and integrity of the watershed's natural resources.

* ***Shoreland Development***: More development near the shore of lakes and rivers means more runoff; this runoff can greatly impact water quality.

* ***Polluted Runoff***: The problem of polluted runoff isn't limited to shoreland development. Roads, construction sites and agricultural operations throughout the watershed can degrade water resources. As impervious and developed pervious areas increase, so does total runoff and phosphorous loading to the watershed's lakes.

* ***Forest Health and Habitat***: The Long Lake watershed's public and private forests are valuable social and natural assets that must be protected in the long-term.

* ***Invasive Species***: The popularity of the Long Lake watershed ensures a steady stream of visitors from distant locations. These visitors can accidentally bring with them uninvited guests such as Eurasian water milfoil, gypsy moths, oak wilt, and other invasive, exotic species.

Potential Strategies for Protecting the Long Lake Watershed

The overarching challenge facing the Long Lake Preservation Association and anyone concerned with the area's future is to develop proactive, preventative strategies to maintain and the health of the watershed. Waiting until it's too late is a recipe for failure. Four broad types of strategies are outlined in this report:

- *Education, Communication and Outreach*
- *Monitoring*
- *Resource Restoration and Improvement*
- *Protection and Policies*

Of these strategies, watershed protection and policies holds the greatest promise. Because the area is currently in relatively good ecological health, the most straightforward tactic is to prevent the sort of things that will likely degrade resources. This can be accomplished through the concerted efforts of local and state governments to review and regulate new development and land uses. The key concern is the amount of runoff that such development will bring about. Decision makers need to make sure that construction and land use change in the watershed does not add to the existing runoff reaching the lake.

Monitoring and improving resources and educating stakeholders are complementary to the proactive protection measures described in this report. The different groups and individuals who are concerned with the lake and the watershed are encouraged to draw from this report and use the data and ideas listed to help guide their activities. This will help ensure that groups like the Long Lake Preservation Association, the local towns of Madge, Birchwood and Long Lake, Washburn County, the Wisconsin DNR, and others are all on the same page and working in the same direction: towards the long term ecological health of the watershed.

Conclusion

It will be no accident if 100 years from now Long Lake is still the valuable and unique resource that it is today. To make that future a reality, proactive decisions that protect the landscape- especially its most sensitive components- are needed. Wetlands and natural drainage pathways will need to be restored. The public, lawmakers, and government staff will need to understand the long-term, cumulative impact of hundreds of seemingly small changes to the watershed. Consistent and regular monitoring will be required to ensure that lake and watershed health are maintained. Most importantly, hundreds if not thousands of people will need to stand up and speak on behalf of the lake and its watershed, advocating that the right choices are made whenever a threat is posed to water quality or ecology.

I. Introduction and Overview

A. What is the Long Lake Watershed?

Located at the headwaters of the Brill River in northwest Wisconsin, Long Lake is a unique and important natural resource. Covering 3,290 acres and surrounded by nearly 40 miles of shoreline, Long Lake is the largest lake in Washburn County. Its water comes from precipitation on the lake, groundwater springs, and surface water runoff from a 38,000-acre watershed. The lake is a headwaters region of the Red Cedar River, which is a tributary of the Chippewa and Mississippi Rivers.

As rainwater and snowmelt moves through the Long Lake watershed it carries nutrients, sediment, and other chemicals that affect the water quality of the lake. This runoff would naturally transport some nutrients and even low levels of sediment to the lake. Development and land use changes in the watershed can dramatically increase rates of runoff and the quantity of nutrients, sediment, and other chemicals moved to the lake. The runoff can then be considered a form of pollution referred to as *non-point source* pollution. It enters the lake in many locations and originates throughout the watershed.

Non-point source pollution is one of the principal threats to the long-term health of the lake. It impacts water quality, aquatic life, recreational pursuits, and property values. Information collected on Long Lake suggests it is a water resource that is truly *on the edge*. It is vulnerable to water quality problems such as algae blooms and oxygen depletion as a consequence of increasing demands for residential, recreational and economic development on shorelands and throughout the Long Lake watershed.

This report includes a snapshot of the health and status of the Long Lake watershed in 2004. It describes ecological trends, water quality measurements, and other indicators that reflect water quality in the lake and its tributaries. The report also identifies threats to the ecology, water quality, aquatic habitat and related water recreation. Finally, the report identifies potential strategies available to local groups for addressing those threats.

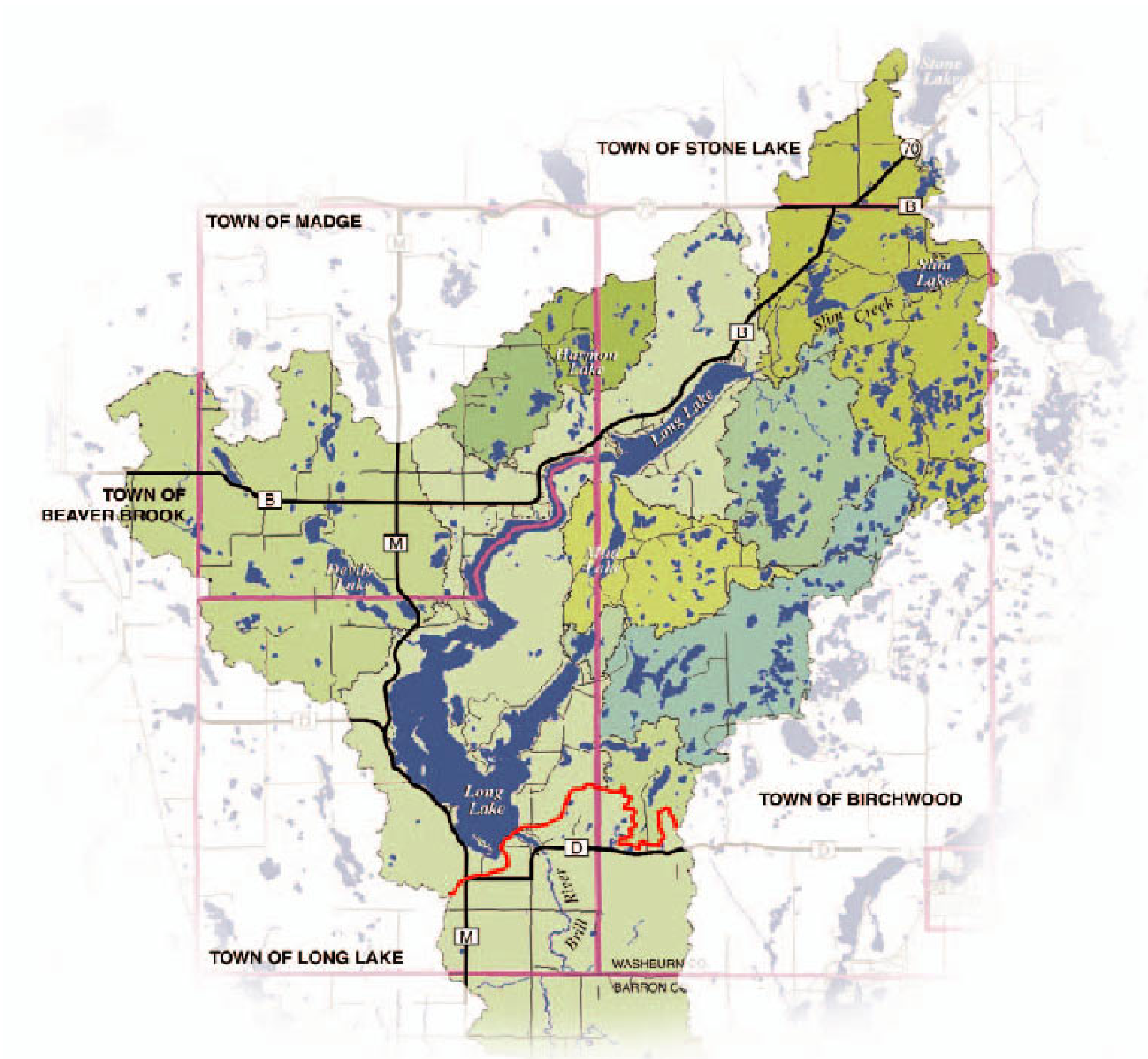


Figure 1-1. Map of the Long Lake watershed.

B. Organization of Report

The watershed concept brings together two distinct resources- land and water- and highlights their interrelationships. Chapter II looks more closely at the status and trends of the water resource in the Long Lake watershed and analyzes water issues and opportunities from the point that it enters the watershed as precipitation to its endpoint in Long Lake.

Chapter III explores the land resource in the watershed. The landscape around Long Lake has experienced tremendous change over the last 150 years. The land resource is characterized by physical features such as topography and soils, the plants and animals it supports, as well as by human activities and development. Chapter III provides inventories of land cover and land use and presents land resource trends to identify issues and opportunities for management of the Long Lake watershed.

After analyzing water and land resources in the watershed, this report turns to the other resources critical to sound watershed management: the communities, agencies, organizations and individuals who are charged with or choose to be involved in related decision-making. Chapter IV documents the programs and partners involved in resource management in the Long Lake watershed, including the US Department of Agriculture, the Wisconsin DNR, county and local agencies as well as the Long Lake Preservation Association and other volunteer non-profit groups. It also discusses opportunities for cooperation and greater efficiency in the stewardship of this important regional and state resource.

Chapter V presents a prioritized summary of the issues identified in Chapters II, III and IV and summarizes a strategy for long-term management of the Long Lake watershed. An appendix at the end of the document provides references and supplemental material related to the main body of the report. Readers who are unfamiliar with watershed and limnology may wish to review some of the definitions and explanations provided at the beginning of the appendix.

Taken as a whole, this report attempts to provide the reader with information to understand the current condition of natural resources in the watershed, understand the natural and human forces that shape them, and develop meaningful strategies to protect the watershed.

II. Water Resources in the Long Lake Watershed

A. Water Quality Overview

The water resources of the Long Lake Watershed include its lakes, streams, wetlands and groundwater. These are important resources, providing water for drinking and household uses, opportunities for recreation and aesthetic enjoyment, and economic benefits for many area residents. The water resources are directly linked to the land resources of the region through runoff and groundwater flows. In this hydrologic "headwater" region, it is primarily the annual precipitation in the area that eventually becomes stream flow in the Brill, Couderay, Namekagon and Trego Rivers. As it passes through the watershed, this precipitation becomes the groundwater, streams, wetlands and lake water in the watershed.

The quality of water in the Long Lake watershed is generally excellent, but there are increasing signs that the water quality is declining. The last several years have seen more frequent and intense algae blooms on Long Lake. Nutrient levels in the lake are increasing. Phosphorous levels exceed the goals that were set in the 1997 Lake Management Plan. Based on water quality samples the DNR has recently classified Long Lake as a eutrophic lake.

This chapter of the State of the Watershed report summarizes the current knowledge of water resources in the Long Lake watershed. The discussion begins with precipitation- the main source of water within the watershed- followed with an examination of principal water resources: groundwater, wetlands, streams and rivers, lakes and impoundments and dams. Finally, biological aquatic resources are discussed.

Included within each discussion is a summary of the forces that have shaped the current condition of the resource in the watershed and observations about how these resources may change in the future. Much of the data in this chapter is directly related to Long Lake itself. Long Lake is the final destination for nearly all of the surface water within the watershed before it leaves out the Brill River. Long Lake can be seen as an indicator of what's going on throughout the watershed. Long Lake has also been extensively studied in the recent past, largely through the efforts and initiative of the Long Lake Preservation Association.

B. Precipitation and Runoff

Inventory and Status

As a headwater region, precipitation is the primary source of water for groundwater, stream flow, lakes and wetlands in the Long Lake watershed. The amount of precipitation that falls in the region and the path it takes as it moves through the watershed are important determinants of water quantity and quality in the watershed. Water entering the watershed as precipitation eventually leaves in one of three ways: flowing out the Long Lake dam, groundwater flow away from the lake, and evapotranspiration. The annual precipitation for the area is kept in records maintained by Agricultural Research Station gauging stations located in nearby Rice Lake and Spooner. These records are shown in table 2-1.

	Annual Precipitation (in inches)		
Station	**Average (Period)**	**Minimum**	**Maximum**
Spooner	30.06	9.83	45.28
Rice Lake	32.03	17.41	46.91

Table 2-1. Precipitation records for Rice Lake and Spooner Wisconsin
(Source: Midwest Regional Climate Center http://mcc.sws.uiuc.edu)

Annual precipitation is critical to the water resources of the region. Some of it falls directly onto streams, wetlands, and lakes, but most of it falls on land. How much of that precipitation eventually makes it to surface waters and the path that it takes to get there determines what will be carried into lakes and streams. For example, land with high infiltration rates, such as forested areas, will generally have low surface runoff and water will become groundwater prior to entering lakes and streams. Areas with low infiltration rates, such as paved surfaces or compacted soils, will have higher amounts of precipitation directly run off as overland flow which can move directly to surface waters.

Table 2-2 illustrates the water budget for Long Lake. The watershed receives approximately 31 inches of precipitation each year. Of this amount, approximately 12 inches becomes groundwater, stream flow or the water in wetlands and lakes; the rest is lost through evaporation, plant uptake and transpiration (“evapotranspiration”).

Component	Annual Volume
Precipitation	35 billion gallons
Drainage at Long Lake Outlet	12 billion gallons
Evaporation and Evapotranspiration	21 billion gallons

Table 2-2. Annual watershed budget for Long Lake watershed

At any given time, only a small fraction of the water in the Long Lake watershed- about five percent- is found within the streams, wetlands and lakes. The remaining ninety-five percent of the water is moving through the ground. The relatively slow transport and filtering that occurs in the ground results in a groundwater resource relatively free of impurities.

As a hydrologic headwater region, only a very small quantity of water likely enters the watershed through groundwater from outside the watershed. Water is continually entering the groundwater aquifers when it infiltrates into the soil and moves down beyond the root zone of plants. The groundwater also emerges as surface and subsurface springs to feed lakes, rivers and streams in the Long Lake watershed, replenishing water that leaves through the Long Lake outlet and surface evaporation.

The composition of precipitation reflects its origins as water that evaporates from distant sources and then condenses in the local atmosphere. It contains very low concentrations of dissolved minerals. Analysis of precipitation provided by the National Deposition Program indicated that the precipitation has a relatively low pH (4-6) and is low in dissolved solids (mineral and dissolved metals such as iron and calcium).

In addition to precipitation, atmospheric deposition brings dust and particulates to watershed surface waters. These materials are generally more local in origin than the water found in precipitation. They include wind blown soil, pollen, dust and even particulates from burning yard and household waste. These atmospheric contributions can be significant sources of phosphorus and other materials in lakes with small drainage areas.

Air pollution can be a concern for rural areas near large urban centers. The nearest ozone monitoring station to the Long Lake watershed is located in Somerset, Wisconsin in St. Croix County. From 1993 to 2003, this monitoring station recorded no exceedances of the maximum EPA standard for ozone.

Trends

Precipitation and temperature records are available for weather stations near the watershed. Those records provide long-term averages and show the variability from year to year in climate. Actual records of storm events recorded at the Spooner Agricultural Research Station indicate that the frequency of large storm events in the region is not increasing. Figure 2-1 illustrates the timing of precipitation events greater than one inch from 1980 to 2001. No clear trend is evident in the number or intensity of such events over this twenty-year period. This suggests that intensity of precipitation events is not increasing over time.

The DNR is also collecting and analyzing data on the effects of climate change on coldwater fisheries. At this point there has been no conclusive evidence that the global climate change has disrupted coldwater fisheries habitat within this watershed or Wisconsin. This is another area to monitor in the future, since stream water temperatures could be impacted by overall temperature increases.

Another challenging change in precipitation is the addition of mercury into the atmosphere. In the short term, it is likely that mercury from regional coal burning and other sources will continue to be present in the region’s rain and snowfall. Over time, this could have negative consequences for the area’s ecology.

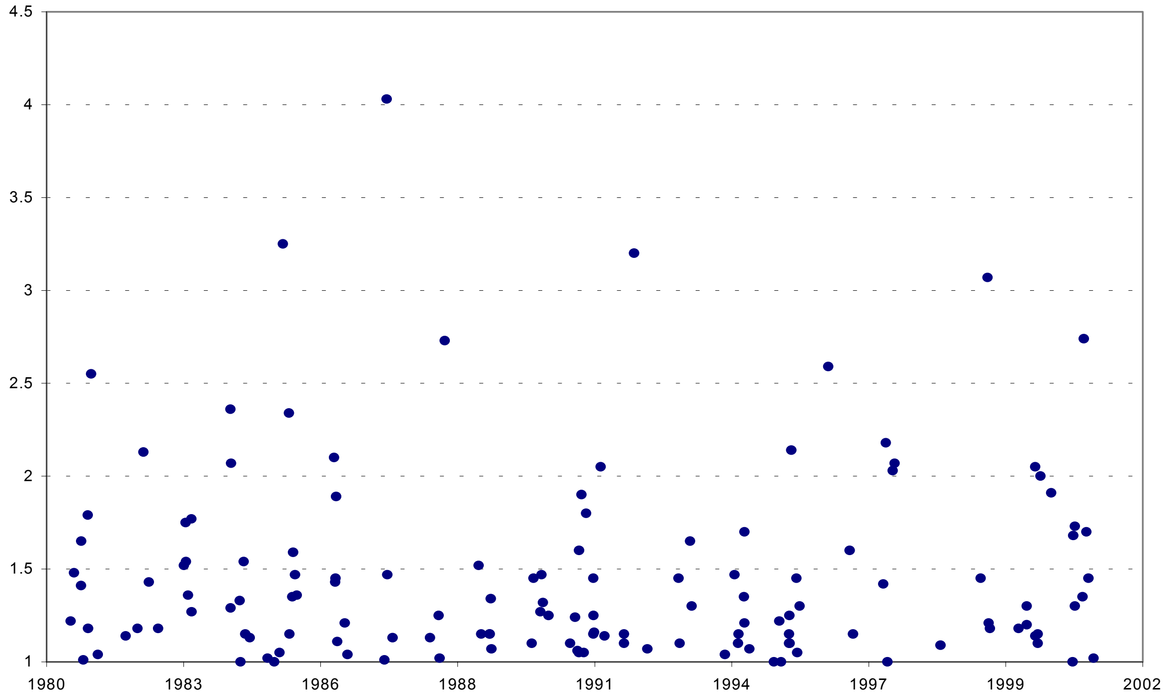


Figure 2-1. Precipitation events greater than 1” from 1980 to 2001 (Source: National Atmospheric Deposition Program)

Threats and Opportunities

Changes in Climate and Precipitation Quality

Climate change and its potential impact on water resources of the Long Lake watershed are important considerations in evaluating the role of precipitation. Changes to the quantity and quality of precipitation as well as its distribution during the year over could impact water levels and runoff patterns in the long-term. Groundwater levels and groundwater discharge to wetlands, streams and lakes will also be influenced by precipitation distribution, although those impacts are buffered by the size and relatively long travel times in the groundwater aquifers.

Climate and precipitation are important aspects of the watershed, but they are the aspects over which society has the least control. This is particularly true for local and regional stakeholders who have limited ability to influence things like global carbon dioxide production or mercury deposition. While people should pay attention to these issues and play their part in developing long-term solutions, this report focuses more on practicable issues that can be addressed closer to home.

Runoff

While precipitation may be stable, its effects on the watershed are not. Large amounts of water from precipitation pass through and out of the watershed annually. This movement of water is important for maintaining groundwater levels, stream baseflow and transfers nutrients and other elements from land to water. However, reductions in infiltration and increases in overland runoff can reduce groundwater levels and stream baseflow. Increases in impervious surfaces can also increase the transfer of sediment and nutrients to surface waters. There are opportunities to promote the reduction of impervious surfaces throughout the watershed. Efforts to reduce or minimize impervious surfaces are most important near and around surface waters and wetlands where the transport of nutrients is likely to have an immediate effect on water quality. This issue is addressed in greater detail in Chapter III where land uses are discussed.

Air Pollution and Toxic Particulates

With respect to air quality and pollutants in precipitation, the primary threat is the fact that most sources of air pollution are non-local. Mercury from distant power plants and other pollutants from the Twin Cities are the most likely sources of future air pollutants. Recently, rural Door County in northeast Wisconsin has experienced dramatic declines in air quality due to ozone pollution from sources as distant as Milwaukee and Chicago. Local sources of pollution such as burn barrels represent an opportunity since local measures and education can have an impact on the amount and types of materials incinerated within the watershed.

C. Groundwater

Inventory and Status

In the three towns that make up the Long Lake watershed there is far more water in groundwater than in all the lakes and streams combined. The groundwater supply in the three towns is constantly in motion. Water enters the groundwater from precipitation and leaves by discharging to streams, wetlands and lakes. It flows from areas of high pressure to areas of low pressure, sometimes moving “up” to springs around lakes, streams and wetlands. Long Lake is the final groundwater discharge point in the watershed.

The surface topography in some areas of the watershed prevents surface water drainage from some areas directly to Long Lake, but groundwater flow is not limited by such topographical boundaries. As a result, the groundwater drainage area (groundwater watershed) that ultimately emerges in Long Lake and the Brill River is larger than the surface watershed.

Groundwater is the primary source of drinking water for households in the area. It is also used for irrigation and commercial applications. There are over 1,000 private wells in the Long Lake watershed, mostly associated with residential structures. In addition, there are about 70 commercial and public wells in the watershed that are regularly utilized by someone other than the well owner; nearly 40 of these wells are located at the Tomahawk Scout Reserve.

In most years, nearly one-third of the annual precipitation in the watershed seeps into the water table, replacing that water which is pumped for human use or drained to streams and lakes through springs. This balance between the amount of groundwater recharge through precipitation and groundwater drainage to streams and lakes yields stable long-term groundwater levels. However, dramatic increases or decreases in the amount of precipitation entering the groundwater supply (e.g., drought or wet years) can have a noticeable effect on groundwater levels, and ultimately stream-flow at the watershed’s outlet.

Local land use changes can also affect the recharge of groundwater. Impervious surfaces can convey water directly to surface waters, and reduce the amount of water re-supplying groundwater. Deforestation can temporarily increase the recharge of groundwater by reducing evapotranspiration if precipitation infiltrates and does not directly runoff.

Little information has been collected on the chemical properties of the groundwater within the watershed. Based on existing data sources, the water in the watershed is known to be *moderately hard* to *hard*, reflecting calcium concentrations between 20-30 mg/l and magnesium concentrations between 6 and 12 mg/l. Most groundwater in the region is likely to contain low natural concentrations of sodium and potassium; the county averages for sodium and potassium are 11 and less than 2 mg/l, respectively. Like much of Wisconsin’s groundwater, it is probably dominated by calcium, magnesium and bicarbonate alkalinity.

The type of groundwater found within the Long Lake watershed is able to neutralize some of the acidity naturally occurring in precipitation recharge, making the drinking water less corrosive and improving the quality of the water for human consumption. Natural buffers within the water allow most of the seepage lakes within the Long Lake watershed to buffer small amount of acid rain without drastically impacting the overall water quality.

Like all water resources, groundwater is vulnerable to contamination. Unlike surface waters, however, it can be difficult to determine how groundwater is being polluted and even more difficult to clean once it is polluted. There are numerous ways in which the area's groundwater could become contaminated. Some of these include:

- volatile organic compounds from subsurface leaking underground storage tanks (LUSTs);
- bacteria and nitrates from private septic system drain field discharges;
- surface spills of toxic chemicals that infiltrate through the soil;
- abandoned wells that have not been properly sealed;
- contamination from accumulated fertilizers, pesticides, herbicides and road salts;
- surface mining including sand and gravel extraction and other excavation projects.

Recent groundwater contamination at several locations in the Long Lake watershed confirms the vulnerability of this resource. Most of the groundwater testing performed to date in the watershed is at locations where groundwater is used as a drinking water supply. As a result, the testing has focused on compounds such as chloride or nitrate or on bacteria that could impact human health.

Nitrate is one of the most commonly examined groundwater pollutants tested. Both chloride and nitrate are easily dissolved in water and are often applied to the land surface in relatively high concentrations (i.e., fertilizers, pesticides, animal waste). As rainfall and snowmelt infiltrate into groundwater aquifers, they can readily dissolve these compounds and transport them into the groundwater.

Nitrate is a form of nitrogen that is commonly derived from fertilizers and from septic system effluent. The nitrate concentrations found in well water in the Long Lake area are shown in table 2-3 below.

Parameter	Number of Wells
Wells sampled for nitrates	345
Found to be greater than 5 mg/l *	126 (37%)
Found to be greater than 10 mg/l **	14 (4%)
Wells sampled for pesticides	277
pesticide detections	7 (3%)

Table 2-3. Nitrates and pesticides in wells located in the Red Cedar Basin
(Source: The State of the Lower Chippewa River Basin)

* >5mg/l for NO_3 is the Wisconsin preventative action limit for groundwater, which indicates no action needs to be taken but monitoring should be conducted more frequently.
** 10mg/l for NO_3-N is the Federal and State maximum water contaminant level, which public water systems cannot exceed. Private water supplies do not have to comply with these standards, but this is a health-based advisory level that private wells should adhere to.

Most nitrate concentrations in waters tested were less than 5 mg/l, but higher nitrate concentrations levels were found in several locations. Excessive concentrations of nitrates in drinking water are a particular problem for human infants. They are susceptible to methemoglobinemia (blue baby syndrome) from consuming water with elevated nitrate. The locations of elevated nitrates are mapped in figure 2-2. There is no clear pattern to suggest a systematic source of elevated nitrates. The relatively shallow depth to groundwater and the porous nature of area soils makes groundwater contamination from soluble compounds like nitrate very likely.

Trends

Precipitation and stream-flow information available for the Long Lake watershed indicate considerable quantities of groundwater continue to enter and move through the watershed. Current groundwater information is not sufficient to establish trends in its quantity or quality. Consistent samples from the same well would be needed to demonstrate trends in nitrate and other pollutant concentrations, and still those trends may only be representative of a small portion of the aquifer.

There is evidence that land use and human activities are impacting groundwater quality. Although there has not been extensive testing of groundwater in the watershed, the results available do show elevated nitrate and chloride concentrations in several locations. Interpreting these results requires that the groundwater flow, location of the wells and the depth at which the wells withdraw water be considered. Groundwater quality will vary both horizontally and vertically in the aquifers of the Long Lake watershed. Deeper groundwater typically originates farther from and shallow groundwater closer to the sampling location.

Threats and Opportunities

High Groundwater Quality

Overall, groundwater in the Long Lake area is plentiful and in many places of a relatively high quality. Once degraded, groundwater can be very difficult to improve. This represents an opportunity to maintain and protect this valuable resource from degradation or contamination.

Groundwater Contamination

Although we have insufficient data on groundwater quality to link geologic features (e.g., sandy soils over a shallow groundwater table or bedrock cracks and crevices), or land use (e.g., high densities of septic systems or land application of nitrogen fertilizers) unambiguously with groundwater quality problems, enough is known about the physical features and hydrology, and the quantities of pollutants which can be released by these activities to suggest that groundwater impacts are likely to increase. County-level maps indicate that much of the Long Lake watershed is highly susceptible to groundwater contamination, but more detailed analysis would be needed to guide land use decisions or regulations. Work should be done to clearly delineate areas where groundwater contamination is most likely to occur.

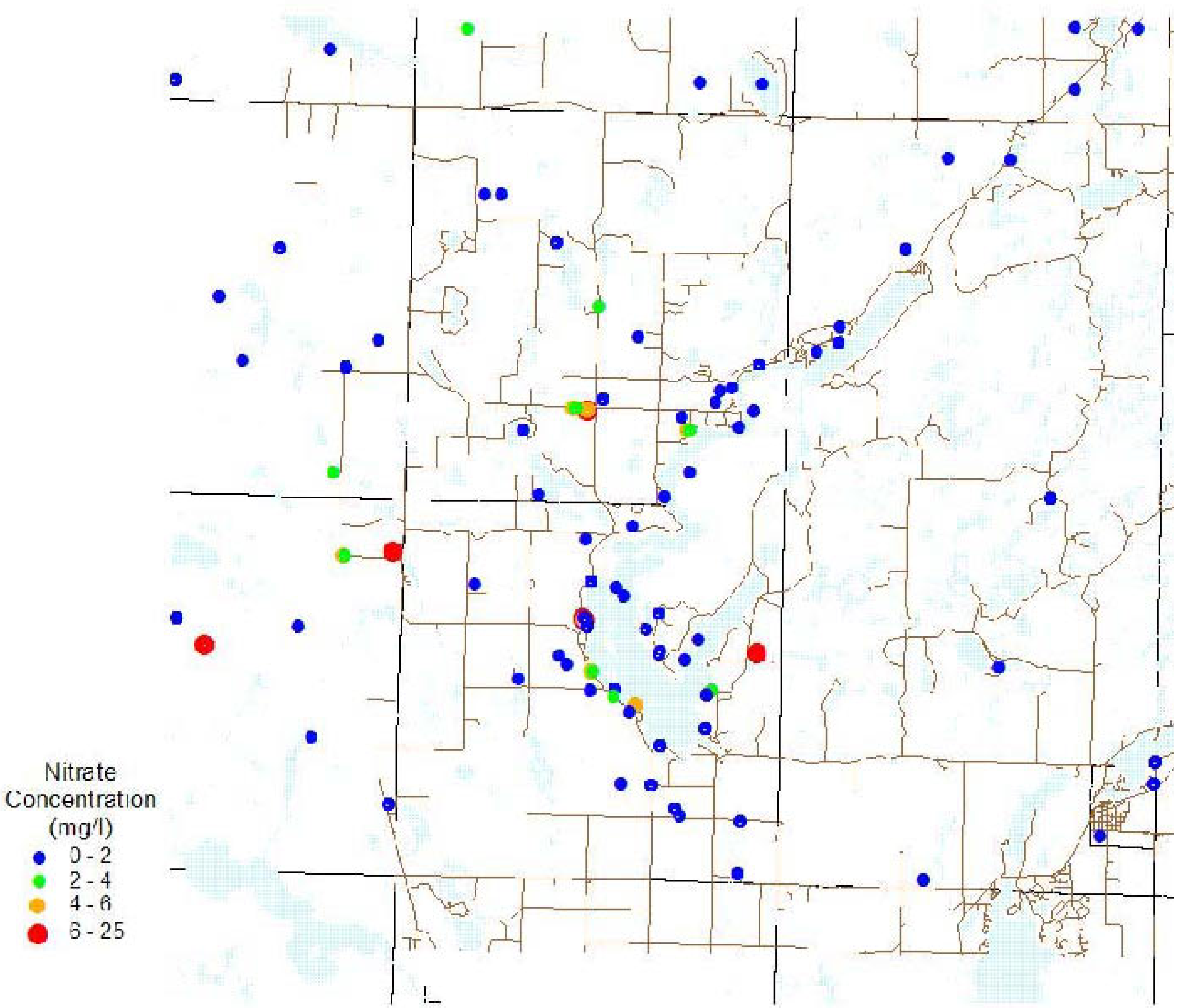


Figure 2-2. Map of the Long Lake area showing nitrate concentrations for select wells
(Source: DNR Groundwater Retrieval Network and Central Wisconsin Groundwater Center)

In both residential and agricultural areas there remains a rising risk of elevated nitrate concentrations and pesticides leaching into groundwater. Sources include agricultural and domestic fertilizers and pesticides and septic systems. The extent to which these will impact water supplies depends on the location of related activities, groundwater flow paths, and well locations.

Education

Groundwater is a fairly complex component of the Long Lake watershed, and its "unseen" nature makes it more challenging for the public to appreciate and understand. Education can help people understand current water quality and encourage implementation of practices to reduce groundwater contamination. People are often unaware of the danger that chemicals can pose for groundwater supplies. Promoting groundwater-friendly nutrient and pesticide management should be a high priority.

Prevention

Prevention of groundwater contamination can focus on relatively simple activities such as properly abandoning unused wells.

Toxic Substances

Buried petroleum, waste oil, and chemical tanks may potentially leak directly into groundwater. Holding tanks for household waste can also leak and pollute groundwater. The public should be made more aware of this potential contamination problem. The county is currently implementing a program to monitor the rate of tank pumping in Washburn County towns. This information will help identify holding tanks that are not properly functioning. There are also programs administered by the DNR to identify and remove leaking underground storage tanks. Currently in the Long Lake watershed there is no information on the number or location of LUST sites. It is likely that there are some old tanks that are leaking but going unreported.

Waste Disposal Sites

Currently there are five closed municipal waste disposal sites in the watershed towns, all of which have not been active since the early 1970's. The location of these sites is illustrated in the map in figure 2-3.

Requirements for inactive waste disposal sites include a relatively impermeable cap, vegetation management, and groundwater monitoring. No contamination has been detected in all five town monitoring well locations near these facilities; however, some groundwater contamination has been detected at a regional facility in the area. Comprehensive planning presents an opportunity to foster long-term partnerships for meeting the community's shared interest in groundwater protection.

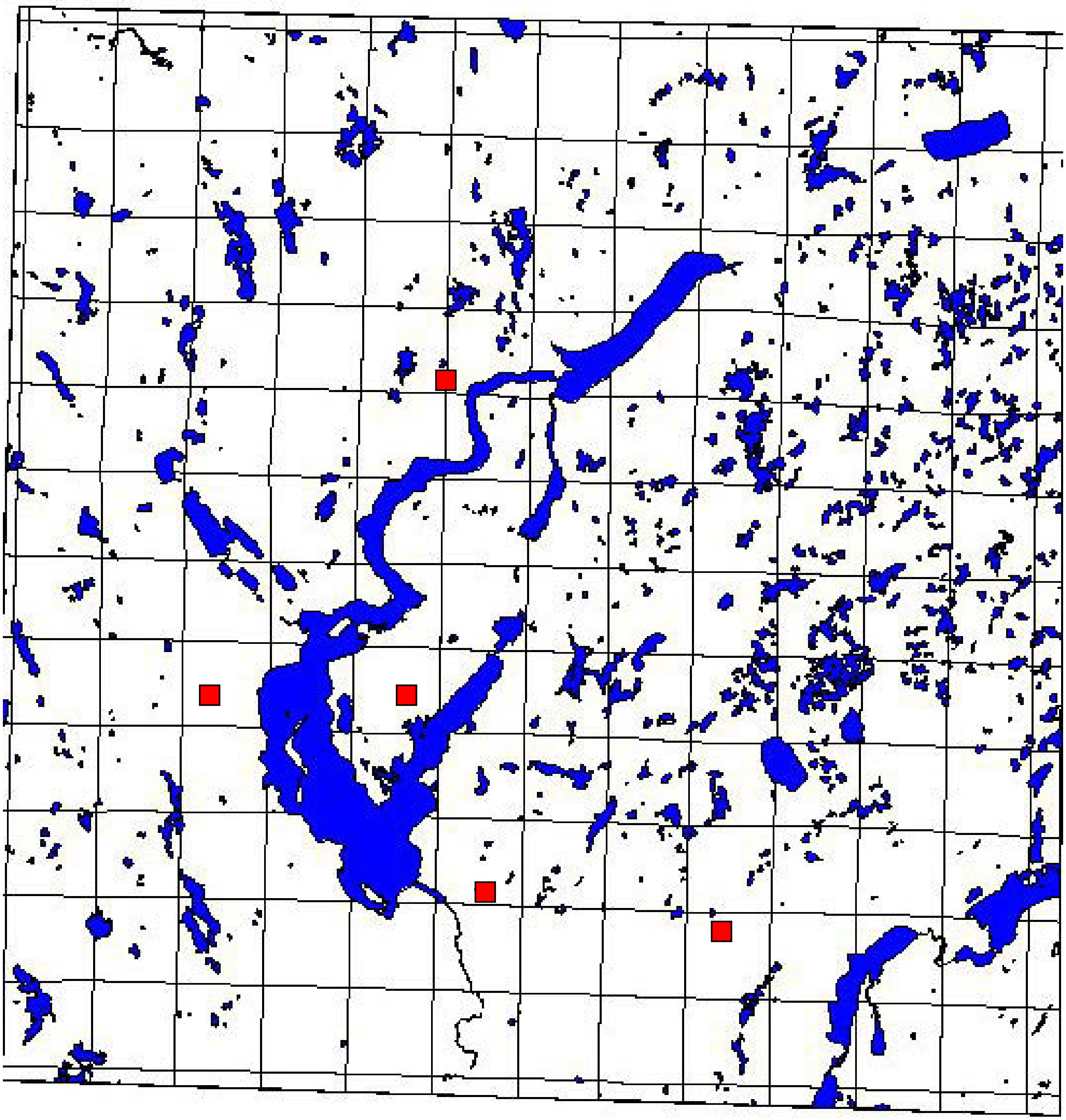


Figure 2-3. Approximate Location of Closed Landfills in Madge, Birchwood and Long Lake (Source: WI DNR)

D. Wetlands

Inventory and Status

Wetlands represent one of the most unique and ecologically diverse elements of the Long Lake watershed. Wetlands were once referred to as swamps and considered to have little value. Prior to European and American settlement, nearly a third of Wisconsin's land area was wetland. Since settlement, nearly half of the original wetlands have been drained and tiled for farmland or filled for real-estate development. The remaining wetlands support a number of native wildlife and plant species along with numerous threatened and endangered species.

Wetland environments provide additional benefits to the Long Lake watershed such as:

- natural water filters, removing nutrients, and chemicals from runoff;
- natural flood control through the interception and detention of water, reducing flood risk to local communities;
- groundwater recharge areas;

The United States Army Corps of Engineers, the DNR, US Natural Resource Conservation Service (NRCS), and local zoning codes regulate the use of wetlands. Section 404 of the Clean Water Act establishes a program to regulate the discharge of dredged material and soils into waters of the state, including wetlands. This also acts as the primary Federal regulatory program for wetlands protection.

The legislature established the Wisconsin established the Wetland Inventory in 1978 as part of the state's effort to protect wetland resources. The initial statewide inventory was completed in 1984. Wetlands of 5 acres or larger were outlined, classified and mapped for public review and use. Recently the DNR has begun re-mapping wetlands to include wetlands two acres and larger as well.

The inventory classifies wetlands according to vegetative type, hydrology, human influence, and other wetland characteristics. Legends on each map explain the classification system. The maps are very useful for governments and private parties as they clearly show where the state's larger wetlands are located. The five-acre maps are not suitable for site planning as the rules governing wetland protection include smaller wetlands that may not be shown on the maps. Figure 2-3 below shows the five-acre inventory of wetlands located in the Long Lake watershed.

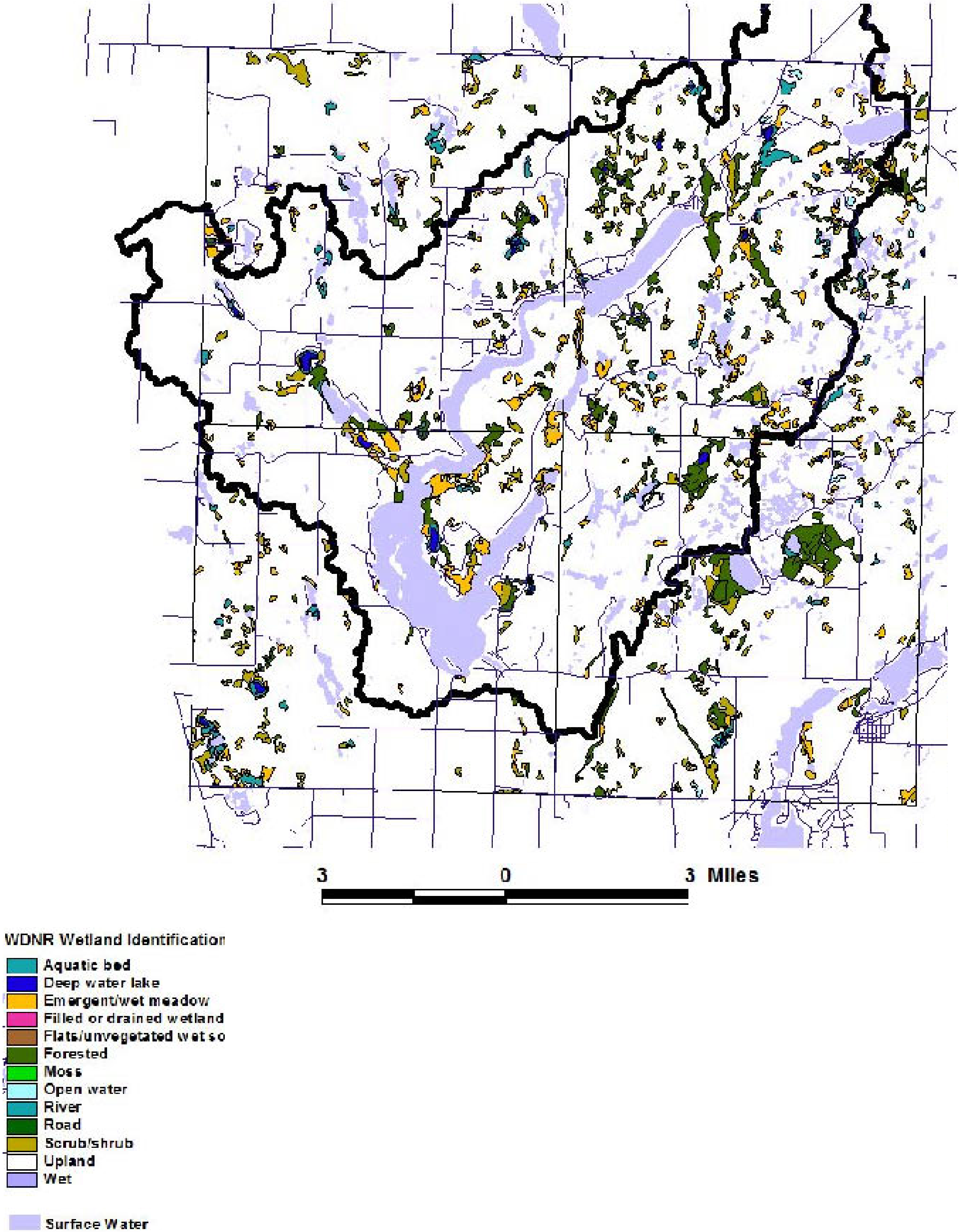


Figure 2-4. Wetlands Inventory Map for Birchwood, Long Lake and Madge

Washburn County covers 518,236 surface acres, of which 79,140 acres are wetlands. Based on DNR data, the Towns of Birchwood, Madge and Long Lake have approximately 7,807 acres of wetlands (wetlands five acres and larger). Of this amount, over 4,500 acres are located within the Long Lake watershed. Table 2-4 below shows the distribution of these wetlands in the watershed by wetland type.

Wetland Type	Approximate **Acres**
Forested	2,056
Scrub/Shrub	1,240
Emergent/Wet Meadow	1,189
Approximate Total	4,485

Table 2-4: Wetlands Types, Long Lake Watershed

As shown in table 2-4, the majority of wetland areas in the Long Lake watershed are classified as either *Scrub/Shrub, Emergent/wet meadow, or forested* wetlands. The Scrub/Shrub communities include bogs and alder thickets. They are characterized by the presence of woody shrubs and small trees such as tag alder, bog birch, willow, and dogwoods. Emergent/wet meadow wetlands have saturated soils, rather than standing water. Sedges, grasses, and reeds are dominant species in emergent/wet meadow wetlands. Species such as blue flag iris, marsh milkweed, sneezeweed, mint and several species of goldenrod and aster may also be present. Forested wetlands include bogs and forested floodplain complexes and are characterized by trees 20 feet or more in height. Common trees include tamarack, white cedar, black spruce, elm, black ash, green ash and silver maple.

One of the most common types of plant communities in and around Long Lake is the *Aquatic Bed.* This type of plant community comprises of vegetation growing entirely on or in a lake or stream at a depth no greater than 6'. Plant species present may include: pondweed, duckweed, lotus and water lilies.

Trends

A current trend in the Long Lake watershed is the filling in of wetlands for development and road construction. Most of the wetlands being created to mitigate for loss and destruction are located outside of the watershed, creating a net-loss of wetlands for the Long Lake watershed. In addition to wetland loss, some wetlands are being degraded from sedimentation and changes in their hydrology. Currently, no system exists for tracking the changes in wetland quality over time.

Threats and Opportunities

Wetlands Inventory

An overriding challenge for wetland protection is the lack of a detailed inventory of wetlands. Wetland maps for the Long Lakes watershed currently only include wetlands 5 acres or greater in size. As a result, many wetlands do not show up on commonly used GIS or paper maps. There are opportunities to have wetlands 2 acres in size or greater mapped for the towns that encompass the watershed.

Lose of Wetlands
Wetlands provide many critical functions for a healthy watershed and their loss and degradation represents a major threat to the streams and lakes of the region. Particularly at risk are those wetlands nearest the lakes, as these areas are subject to higher levels of development pressure.

Highway development accounts for the greatest loss of wetlands in the watershed. The need for new and improved highways cannot always be fulfilled without wetland loss. The Wisconsin Department of Transportation (DOT) and DNR have the authority to require mitigation for destroyed wetlands. These mitigation requirements are somewhat effective for reducing the overall net loss of wetland acreage. The quality of wetlands restored or created through the mitigation process can be fair to good, but is rarely as good as the original wetlands destroyed. As mentioned earlier, mitigation requirements are not applied at the geographic level of the Long Lake watershed. As a result, the watershed can still experience a net-loss of wetlands when mitigation occurs elsewhere.

In recent years, subdivision and rural home construction in the Long Lake area has been increasing. Some developments are directly associated with the filling and removal of wetlands or small ponds. Stormwater runoff from developed land often discharges directly to wetlands, impacting the water cycles of wetlands. In many cases, land is graded and filled up to the wetland's edge. The altered hydrology and surrounding habitat can severely reduce the quality, location and type of these wetlands.

Wetland Restoration
Local groups should work to locate suitable restoration sites within the watershed to ensure that wetland acreage is maintained, or, where possible, increased. Whenever possible, these efforts would emphasize replacing the type of wetland that was lost. For example if a forested wetland were destroyed for a road project, another forested wetland would be need to be created or preserved as mitigation. In many cases, farmland in the Long Lake watershed was at one time a wetland but was drained and tiled for cropland. Using aerial photos and soils analysis, idle agricultural lands could be systematically assessed for their potential for wetland restoration.

Conservation Programs
There are numerous resources available for wetland restoration projects. The Wetland Reserve Program (WRP), Conservation Reserve Program (CRP), Conservation Reserve Enhancement Program (CREP), and Conservation Reserve Buffers are all Federal conservation programs administered by the NRCS through local partners. These programs provide incentives to local landowners to preserve and maintain wetlands. The US Fish & Wildlife Service also has significant programs for outright purchase of wetland areas as Waterfowl Production Areas, as well as a program to fund, design, and build drained wetland restorations. DNR Wildlife Managers work with these federal agencies in an advisory capacity and use programs funded by duck stamp and pheasant stamp revenue to restore drained wetlands and establish quality habitat around the wetlands.

The NRCS works to restore wetlands through the Wetland Reserve Program. This program offers three options to protect, restore, and enhance wetlands and associated uplands; permanent easements, 30-year easements, or 10-year restoration cost-share agreements. Landowners retain ownership and access to the land. NRCS provides cost-share money in order to restore wetlands. To date 2,165 acres have been restored by the NRCS in the Lower Chippewa River Basin.

The DNR also has wetland restoration programs that help reduce the cost to local parties and promote wetland planning. In one program, the DNR provides for 100% of the costs (with a total cost limit) for wetland restoration projects identified in a local comprehensive plan.

Polluted runoff
Runoff represents another threat to wetlands. Eroding croplands continue to impact wetlands in the basin, as does runoff from construction sites and roads. The state is continually improving on its polluted runoff control programs, but a local constituency for wetland protection is often needed to ensure proper enforcement. Wetlands suffer because of inadequate staff to administer regulatory programs designed to protect them. Laws that regulate wetland activities are controversial and jurisdiction to regulate and protect wetlands is not strong. A powerful local voice favoring wetland protection can go a long way towards ensuring that healthy wetlands remain in the Long Lake watershed.

Education
Continuing education and outreach for private landowners and developers with respect to wetland functions and values is necessary. Through education and information sharing, a greater appreciation of the importance of healthy wetlands can be cultivated. By educating developers and construction workers about the rules and regulations regarding wetlands, the plea to ignorance can be eliminated from the list of reasons why wetlands are lost or damaged. Local groups can partner with state and local governments to sponsor educational requirements for contractors and construction workers.

E. Streams and Rivers

Inventory and Status
Streams and rivers are intimately linked to the area's wetlands and groundwater. Numerous small streams in the watershed begin with a spring- a point where the groundwater emerges to the surface. Changes in groundwater volume and quality are likely to be seen in streams and rivers before they are observed in downstream lakes and impoundments. Water quality in the streams and rivers in the Long Lake watershed can be evaluated using a variety of indicators including:

- suitability for fishing;
- measurements of dissolved nutrients
- measurements of clarity/turbidity
- invertebrate (insect) sampling
- serial measures of water volume/flow

Most of these indicators have not been recorded for the tributaries that feed into Long Lake. There are two "major" streams that connect water bodies in the watershed: Slim Creek, connecting Slim Lake to the Slim Creek flowage and the flowage to Long Lake; and Pepper Creek, connecting Lower Twin Lake to Long beneath Audubon Road and

County Highway M. In addition to these navigable streams are countless small drainages that emerge from springs or wetlands surrounding the lake.

For much of its run, Slim Creek is surrounded by Washburn County Forest land. This is true for the stretch between Slim Creek Flowage and for the portion immediately upstream of the flowage. The portion of the creek between Slim Lake and Slim Creek Flowage is mostly in private ownership. This area may experience pressure for development in the future.

Pepper Creek is a fairly short stretch of water that runs largely through private lands. The source of the stream is located within the Hunt Hill Audubon Sanctuary and is populated with warm water forage fish and inhabited by several beaver colonies. After crossing Audubon Road, the stream passes through a handful of private properties. One of these properties is a small hobby farm with sheep and miniature horses, and there is visible evidence that animal grazing is contributing to erosion into the creek.

Of the numerous small drainages entering the lake, the LLPA has monitored water quality for only a small handful. Two of these streams- at the Dennison property in the Town of Birchwood (section 20) and at the Bailey property in the Town of Long Lake (section 14)- have yielded significantly elevated measurements of phosphorous.

Trends

Without historic records on streams, trends are difficult to assess. There is evidence that many of the stream outlets on the lake have experienced increased levels of sedimentation in recent years. This would be consistent with an increased level of erosion on upland sites. For example, Slim Creek passes through a particular sandy area in the watershed where the Birchwood Fire Lane crosses the creek; there is visible evidence of long-term erosion in this area and a high likelihood that sediments are transported to the creek and downstream into Long Lake.

Another trend present throughout the region is an increased level of development pressure on and near streams and rivers. As lake properties become more scarce and expensive, homebuyers seeking water features are drawn to streams and rivers. Slim Creek runs through private land that could be developed in the future. Increased levels of erosion and more variable runoff volumes as well as habitat loss could accompany such development.

Threats and Opportunities

Information Gathering

Streams and rivers are the most visibly obvious connection between the lake and its watershed: in these riparian areas, it is fairly easy to argue that whatever takes place will affect Long Lake, sooner rather than later. Long-term data on water quality in streams, volume and flow, and stream-related erosion is needed to better understand how the streams impact Long Lake and the watershed.

Improvement/Restoration Projects

Once the tributaries of the lake are assessed, a prioritized list of protection and improvement projects could be developed. These should focus on areas where sedimentation, nutrient loading and habitat loss are either already taking place or are likely to occur in the near future. This would include areas not already in public ownership and stream areas near or crossed by roads.

There are also opportunities for restoration projects on these tributaries. The portion of Slim Creek between the Slim Creek Flowage and Long Lake represents one area where sedimentation has likely degraded the stream's viability as fish spawning habitat. There is a portion of the creek upstream from the Birchwood Fire Lane that could potentially be rehabilitated for walleye spawning, and the portion near the outlet to Long Lake provides opportunities to improve northern pike spawning habitat.

Managing Stream Side Development Pressure
Another threat comes from the potential for increased development pressure around the watershed's smaller streams. Development at any scale near streams is a potential threat to water quality. Land erosion from construction can have an immediate impact on a stream, altering stream flow, increasing stream temperature, and decreasing the clarity of the water in the stream. The DNR oversees erosion control plans and implementation on construction sites. All too often, staffing shortages at the state and local level means that there is inadequate enforcement of erosion control requirements. As the number of construction sites requiring stormwater BMPs increases there will be a real need to provide education and information to homeowners, contractors, and construction workers.

Water Quality/Quantity
Another threat to stream water quality is the common practices of fertilizing and waste spreading on agricultural lands. For example, frequently septic tank waste in the watershed is ultimately disposed of through field application. A recent permit for turkey manure management in Barron and Washburn counties could lead to increased manure applications in the Long Lake watershed. Done properly, such land spreading can be an effective means of fertilizing agricultural crops. However, over-application and spreading during winter months can effectively transfer wastes into the stream and lake network. Any resulting increase in nutrient runoff would first be evident in the stream and river network feeding into the lake; this system could be viewed as an "early warning" network for Long Lake.

F. Lakes

Inventory and Status
The lake resources of the Long Lake watershed distinguish the area and provide its unique northern Wisconsin character. The Long Lake watershed has 39 lakes larger than 10 acres in size. These larger lakes comprise over 69% of the entire surface waters found within the watershed. There are also 3 named and numerous unnamed lakes less than 10 acres in size.

Many of these lakes are a result of the glacial history of the basin. Long Lake itself is a combination of several lakes with their water levels elevated by the dam on the south end of the lake. The lake's internal basins show characteristics of both lakes and flowages. North of Long Lake is the Slim Creek flowage, another impoundment water body. Table

2-5 below summarizes some of the characteristics of the larger lakes in the watershed. A more complete table of lakes can be found in the Appendix.

	Surface Area (acres)	Mean and Maximum Depth (feet)	Average Total P (ppb)*	Number of P Samples	P class**	2003 Trophic State Index	2003 Secchi (feet)
Bass Lake	129.5	13/ 66	12	1	1A	49	NA
Big Devil Lake	162.2	27 / 75	24	1	1A	45	NA
Harmon Lake	95.8	9 / 33	18	5	1C	NA	NA
Lazy Island Lake	60.1	19 / 52	NA	-	1C	NA	NA
Little Devil Lake	55.6	14 / 34	NA	-	1C	NA	NA
Long Lake	3,289.7	26 / 74	19	21	1A	53 - 55	6 - 8
Loyhead Lake	74.5	11 / 35	NA	-	1C	NA	NA
MacRae Lake	124.2	NA / 45	NA	-	1C	NA	NA
Mud Lake	102.7	7 / 13	71	6	2C	NA	NA
Nick Lake	55.7	21 / 79	NA	-	1C	NA	NA
Slim Creek Flowage	101.1	6 / 27	26	6	1C	NA	NA
Slim Lake	223.5	22 / 42	NA	-	1C	46	9

Table 2-5. Characteristics for lakes > 50 acres in the Long Lake watershed

* data obtained from USEPA STORET site in March, 2003
** Phosphorous sensitivity classifies lakes according to their relative sensitivity to phosphorus loading and existing trophic condition.
1A: Lakes sensitive to increased phosphorus loading; existing water quality fair to excellent; potentially most sensitive to increased phosphorus loading.
1C: Lakes sensitive to increased phosphorus loading; data inadequate or insufficient to assess trophic condition; classification monitoring recommended.
2C: Lakes less responsive to changes in phosphorus loading; data inadequate or insufficient to assess trophic condition; classification monitoring recommended.

Water quality in lakes is influenced by the complex interaction of many watershed and lake characteristics. These include the ratio of the sub-watershed size to the size of the lake; land uses within the lake's watershed; the volume of water in the lake in relation to the lake's surface area; the topography and geology of the watershed; and the sources of water that flow into and out of the lake.

Lakes are a defining feature in the towns of Birchwood, Long Lake and Madge. They provide focal points for recreational, commercial and residential activities. Shoreline property yields substantial tax base for the county and the towns. Healthy lakes depend on clean water moving through their watersheds. Land uses and other practices that negatively impact water quality or quantity throughout a watershed will ultimately impact the lakes.

There is only limited descriptive information available for the many smaller lakes found in the towns surrounding Long Lake. Lakes in the watershed generally have small watersheds relative to the lake's size. Water flow into many lakes is dominated by groundwater inflow. Because of the low level of current development in many areas, these lakes often have good water quality, but because they have small watersheds they may be particularly sensitive to land use activities that take place near the lake. There is substantially more information available to characterize the larger lakes in the watershed, and Long Lake has been the subject of a number of detailed studies. The following section draws on these studies to summarize the water quality issues in the area.

Lake Water Quality

Lake water quality is measured using a number of parameters including total nutrient, chlorophyll (algae) concentrations, dissolved oxygen, and water clarity. The amount of algae growth that occurs within a lake is directly determined by available nutrients, water temperature, and the amount of decomposition occurring in the lake. Waters low in nutrients with little decomposition occurring usually have little algae growth taking place and higher degrees of water clarity. Based on water quality, lakes are broadly classified as oligotrophic, mesotrophic and eutrophic. Table 2-6 below shows how these categories relate to lake water quality measurements such as total phosphorous.

Variable	Oligotrophic	Mesotrophic	Eutrophic
Total Phosphorus (ug/l)	Less than 10	Between 10 – 20	Greater than 20
Secchi-disk depth (meters)	Greater than 4	Between 2 – 4	Less than 2
Chlorophyll A (ug/l)	Less than 4	Between 4 – 10	Greater than 10

Table 2-6. Trophic state classification scales.

These water quality parameters can be combined to calculate a *Trophic State Index (TSI)* for monitored lakes. Table 2-7 below lists the descriptions for different TSI measurements. Water quality in lakes and flowages in the Long Lake watershed varies widely. The TSI for lakes and flowages ranges from 58 (eutrophic/poor) in Red Lake, to 43 for Moody Lake (mesotrophic/good). The TSI for some of the clearer lakes in the watershed such as Harmon Lake has not been calculated. As shown in table 2-5 above, the larger lakes in the watershed for which TSI is available range from 45 to near 50. These lakes are mesotrophic today but close to becoming eutrophic.

The existing TSI on many lakes may be at or near the lakes' highest water quality potential given characteristic regional geology and land uses. Red Lake, for example, is completely undeveloped and surrounded by County Forest, yet it rates poorly in TSI (58). This reflects the lake's natural productive state more than the impact of particular land uses within its watershed. Overall the majority of the lakes within the watershed are meeting or exceeding their water quality potential.

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

Table 2-7. Trophic State Index (TSI) key.

Water Clarity

Water clarity is an indicator of the amount of algae, sediment and other visible chemicals that are in the water column. Nutrients, sediment, organic matter, and water temperature all have different impacts on water clarity. Waters with high quantities of nutrients experience more algae growth, and subsequently have lower water clarity. The most critical nutrient with respect to the water clarity in Wisconsin lakes is usually phosphorus.

Clarity is often measured with a Secchi disk, a visual device lowered into the lake. A person taking a Secchi disk reading records the depth at which the disk can no longer be seen. This distance decreases with water quality. Tables 2-8 and 2-9 show the results of self-help monitoring for Secchi disks from 2000 to 2003 on Long Lake's northern basin and Slim Lake. These results show how clarity typically decreases over the course of the summer as temperatures and algae growth increase. They also indicate that there can be substantial variation from year to year.

	2000	2001	2002	2003
June	3.2	1.8	1.8	3.5
July	2.1	1.8	3.4	2.0
August	2.2	1.4	2.1	1.7
Average	2.5	1.7	2.4	2.4

Table 2-8. Secchi Disk Readings at Long Lake's Northern Basin (Site A), 2000-2003, meters

	2000	2001	2002	2003
June	3.2	2.4	2.7	2.8
July	3.1	2.1	2.9	2.8
August	3.5	1.8	1.7	2.4
Average	3.2	2.1	2.4	2.7

Table 2-9. Secchi Disk Readings at Slim Lake, 2000-2003, meters

Phosphorous and Nutrients

Increased concentrations of phosphorous can increase the total amount algae and other biological growth occurring in the lake. A consequence of this increased productivity is greater oxygen depletion, particularly late in the summer in lakes that stratify, or at night in very productive shallow lakes. Anoxic (oxygen-poor) conditions can negatively impact fish and other lake dwellers, and can result in unpleasant bacteria growth.

Total phosphorus is the form most often used in correlation with water clarity, biological productivity, and/or chlorophyll. The range in total phosphorus concentrations in Long Lake watershed lakes is more than three-fold, with average concentrations ranging from 6-15 ug/l on the majority of the lakes to concentration as high as 46 ug/l in Mud Lake. As mentioned above, phosphorous can have numerous negative consequences for a lake. The ability to control these phosphorus concentrations and determine how excessive phosphorus concentrations can be avoided is an important issue.

The phosphorus concentration in a lake reflects the volume of phosphorus entering the lake over time and how that phosphorus moves through and is recycled within the lake. In general, if the amount of phosphorus entering the lake is increased, the phosphorus concentration in the lake will increase. There is always going to be some phosphorus entering a lake from:

- atmospheric deposition;
- stream and groundwater flow into the lake;
- soil erosion;
- plants and leaf debris from trees.

Activities that increase the amount of direct runoff into the lake increase the amount of phosphorus delivered to the water. Most often this is attributed to an increased volume and velocity of the runoff, which in turn carries a greater amount of sediment and plant material into a water body. Phosphorous tends to bind to soil particles and is delivered to the lake with the sediment.

Mercury

Harmon Lake, located in the Long Lake watershed is currently on the state's list of impaired water bodies due to elevated levels of mercury found in some of the lake's fish. Some water contaminants such as mercury build up in the body over time and may pose reproductive risks, as well as impaired brain development and function in children and adults. Mercury is distributed throughout a fish's muscle/fatty tissue (the part that is eaten), rather than in the bones or skin. The only way to reduce mercury intake is to reduce the amount of contaminated fish consumed.

Numerous lakes in Wisconsin contain fish with elevated levels of mercury. Fish consumption advisories are issued semi-annually for lakes with fish mercury levels of 0.5 ppm or greater. Generally, predator fish from soft water, poorly buffered, low pH lakes have the highest concentrations of mercury. Since 2001, Wisconsin has provided statewide mercury consumption advisory that applies to most of Wisconsin's inland waters, in addition to the specific 303(d) listed waterbodies like Harmon Lake.

The mercury advisory for Harmon Lake does not imply that the water quality in the lake is poor. Some of the reasons for elevated mercury in fish include: low buffering capacity of the water; very slow growth in fish; no inlet/outlet (seepage lake, for all the water to be replaced within the lake takes several years); and slow replacement of the lake’s water.

Land Use and Water Quality

The importance of land use to water quality was explored in a study prepared by Barr Engineering for the Long Lake Preservation Association in the 1990s. That study examined several lakes in the watershed and identified how land use was impacting water quality. Projections of how future land use might impact water quality were also made. The following paragraphs briefly describe some of the findings of this study. More detail can be obtained from the original reports (Barr Engineering, 1993, 1994 and 1995).

The Barr study focused on phosphorus because its role as the limiting nutrient for productivity in the Long Lake watershed. The report showed that Long Lake in the 1990s had a phosphorus concentration of intermediate productivity (“mesotrophic”). The study also showed that the concentration of phosphorus in the lake was consistent with the various land uses in the watershed and internal recycling of phosphorus already in the lake. That is to say that the levels of phosphorous were about what would be expected given the lake’s characteristics and the land uses present in the watershed.

Phosphorus Concentrations and Water Quality in Long Lake

Research examining phosphorus concentrations in different parts of Wisconsin has established some relationships between different land use and annual loss of phosphorus. These general estimates can be used to estimate phosphorus loss for a watershed based on the different land uses. Table 2-10 shows some example annual phosphorus losses from different land uses.

Land Use	**Annual Phosphorus Export (lb/acre/year)**
Forest	0.07 – 0.12
Cropland	1.13 – 1.16
Pasture	0.15 – 0.58

Table 2-10. Annual “typical” phosphorus export rates for land use categories
(Source: Barr Report)

Phosphorus transport from land to water is usually linked to the volume of runoff, a reflection of the reactivity of phosphorus and its attachment to sediment. The difference between varying land uses is a reflection of both the amount of water which directly runs off and the amount of phosphorus in that water. For example, land uses which results in precipitation on exposed soil can lead to more runoff, high sediment loss, and greater phosphorus export. Both the increased runoff and the increased sediment content of that water are reflected in these average phosphorus loss rates.

Land uses, however, can change over time. Substitution of alternative land uses into a simulation model for the lake showed how such changes could impact phosphorus concentrations. Figure 2-5 below shows how development in the watershed would be expected to impact total phosphorous in Long Lake's different basins. The location of the basins referred to in figure 2-5 are illustrated in the map in figure 2-6.

That study concluded that the water quality of Long Lake is highly susceptible to increasing development within the direct watershed and that complete medium-density residential development of the watershed would be catastrophic for water quality. The reasons for this are twofold: one, the lake is already on the borderline between a mesotrophic and eutrophic state; secondly, the impact of development would certainly add phosphorous to the lake, pushing the trophic state into the eutrophic category faster than one would expect to happen naturally.

The Barr study explored other options for development to find ways that the lake water quality would not be degraded. They concluded that a minimum lot size for non-lakeshore development of 5 acres and on the lake of 40,000 square feet could slow the eutrophication of the lake. This is in contrast to the existing 30,000 square foot minimum for lakeshore lots on Long Lake and the lack of an effective minimum lot size on second tier shoreland lots and throughout the watershed. The Barr report also recommended widespread adoption of runoff management BMPs.

Trends

Effect of Seasonal Variation on Trend Evaluation

Developing trends that can reliably conclude that the water quality within the Long Lake watershed is declining or improving is quite difficult with the data that has been currently collected. The best time to get an accurate water quality reading is during the spring and fall turnover events. (This allows the samples taken to portray an accurate interpretation of what's occurring throughout the entire lake profile.) With various samples taken at different times of the year, and not consistently taken in the same location, developing trends is almost impossible.

Below are several figures showing the limitations of the data on phosphorus in Long Lake (refer to Figure 2-6 for approximate site locations). The records at site A are consistent with the other four testing sites located on Long Lake. The figures below represent data that was collected by the Environmental Task Force (ETF) Lab University of Wisconsin Stevens Point, during the time frame of 1993 – 2002.

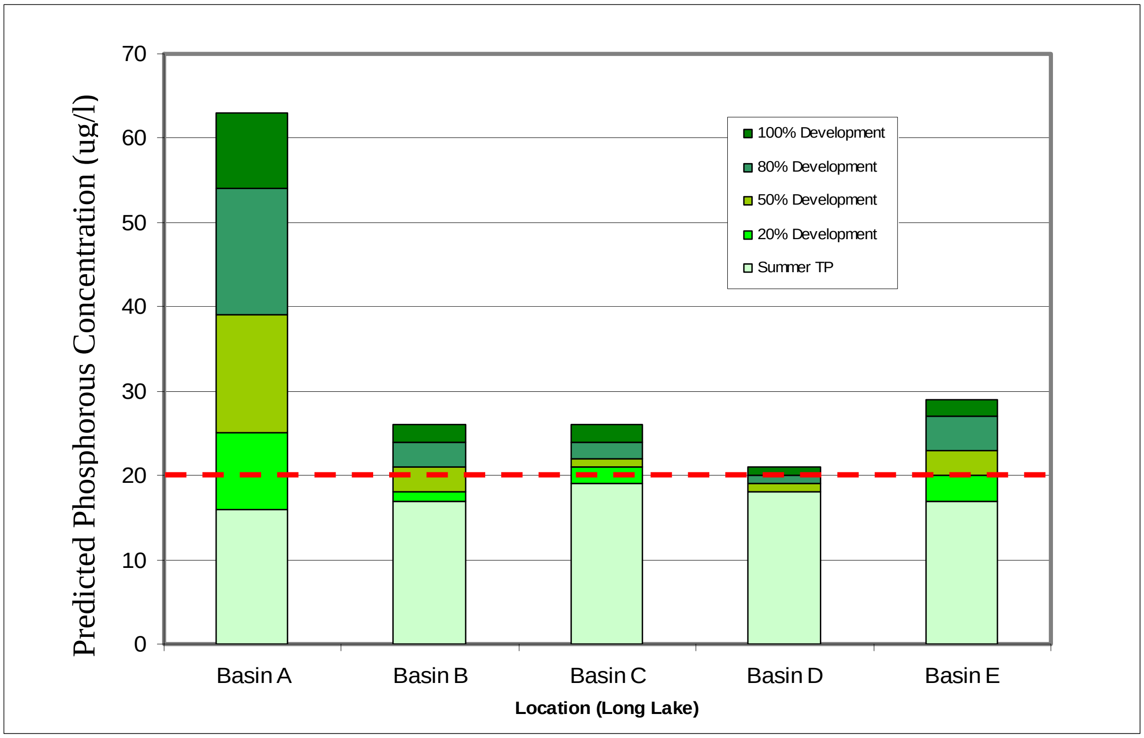


Figure 2-5. Effect of watershed development on total phosphorous in Long Lake (source: Barr Report data)

Note: Summer TP levels represent 1994 actual phosphorous levels as well as target goal levels for the lake. Generally, levels above 20 ug/l indicate eutrophic lake conditions.

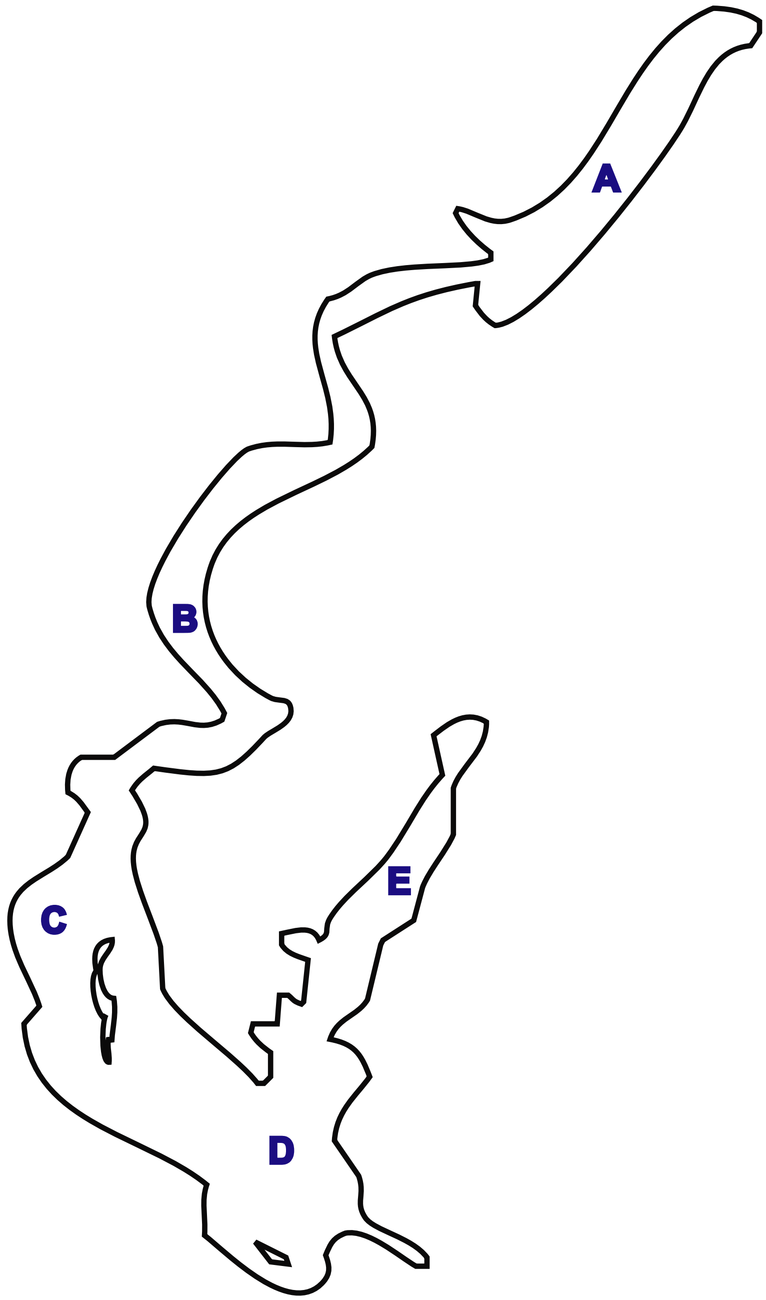


Figure 2-6. Approximate location of water quality sampling sites within Long Lake

Figure 2-7 would appear to indicate a steady increase in phosphorous in recent years. However, this is somewhat an artifact of the time of year when samples were taken. In recent years, more samples have been taken in the spring and fall months.

Figure 2-8 shows the phosphorous measurements organized by the month in which the sample was taken. One can see that spring and fall samples are considerably higher in phosphorus than those from summer months. Factors that contribute to this variation within the year include increased lake mixing in spring and fall (bringing phosphorus from decaying vegetation and lake sediments back into the water) and higher rates of phosphorus settling in the lake during the summer.

If one focuses only on summer readings taken in July and August, the data shows that the lake is consistently on the edge of a eutrophic state, where phosphorous levels are at or above 20mg/l of phosphorus ($\geq$20 is entering the ***eutrophic stage).*** However, what is not evident in these samples is any consistent trend upward or downward. This can be seen in Figure 2-9, showing the changes in phosphorous readings at Site A for only the summer months of July and August.

In one sense, the nearly 10 years of sampling is still too brief to determine the rate that water quality might be changing in the lake. Casual observations made by people long familiar with the lake suggest that the water quality is in fact declining, but without historical water quality data one cannot say much about the *rate* of decline.

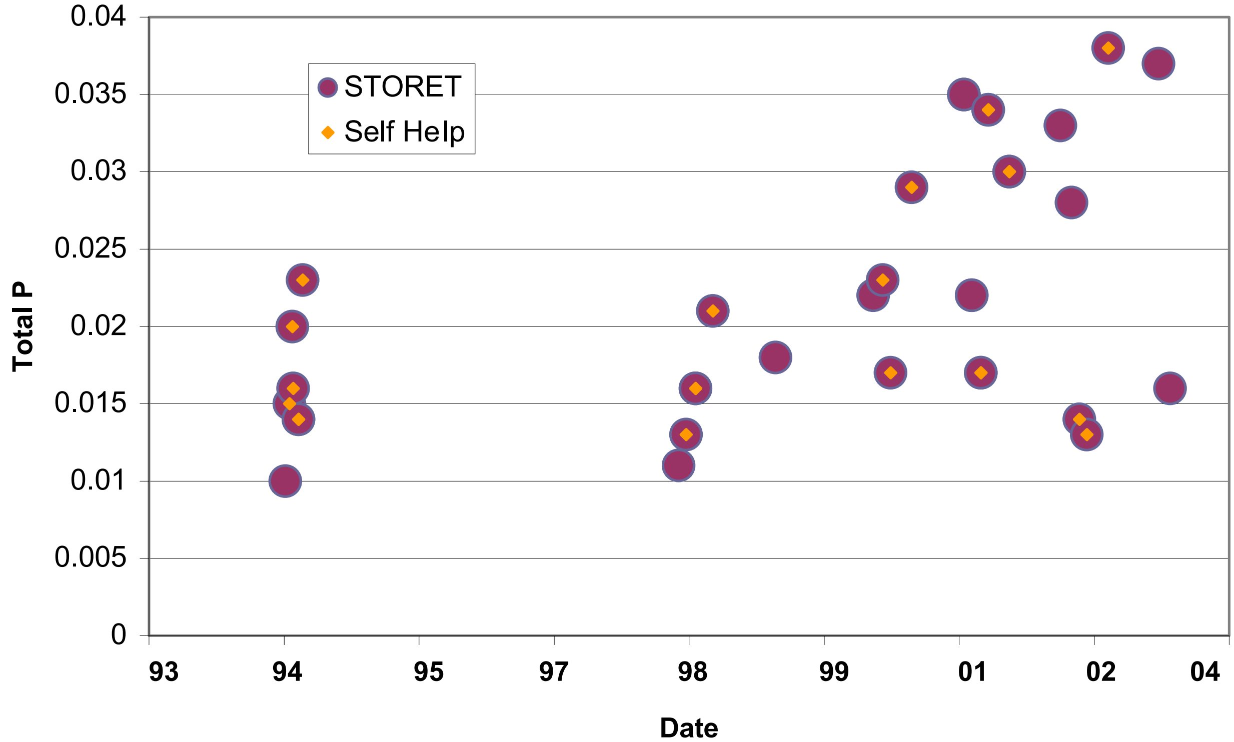


Figure 2-7. Phosphorus readings at Long Lake Site A, 1993-2002
(source: Storet Data obtain by the ETF Lab, UWSP, 1993-2002)

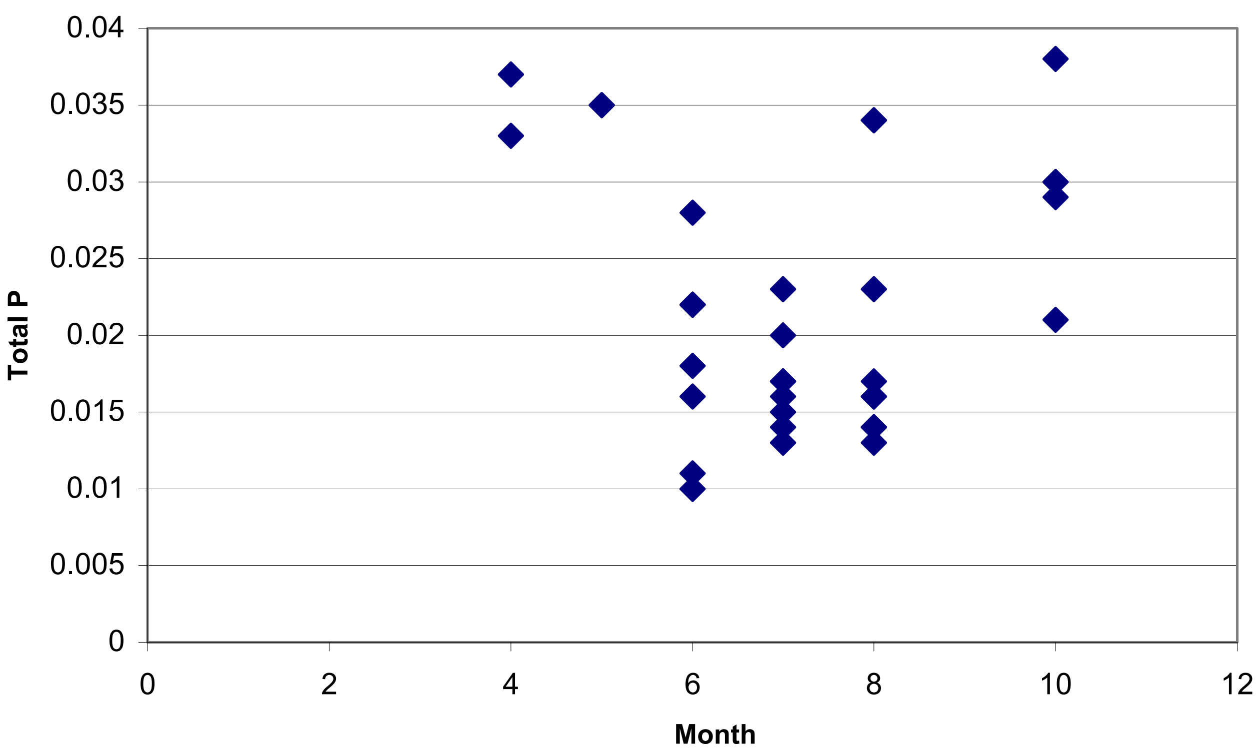


Figure 2-8. Phosphorous readings at Site A according to month of sample
(source: Storet Data obtain by the ETF Lab, UWSP, 1993-2002)

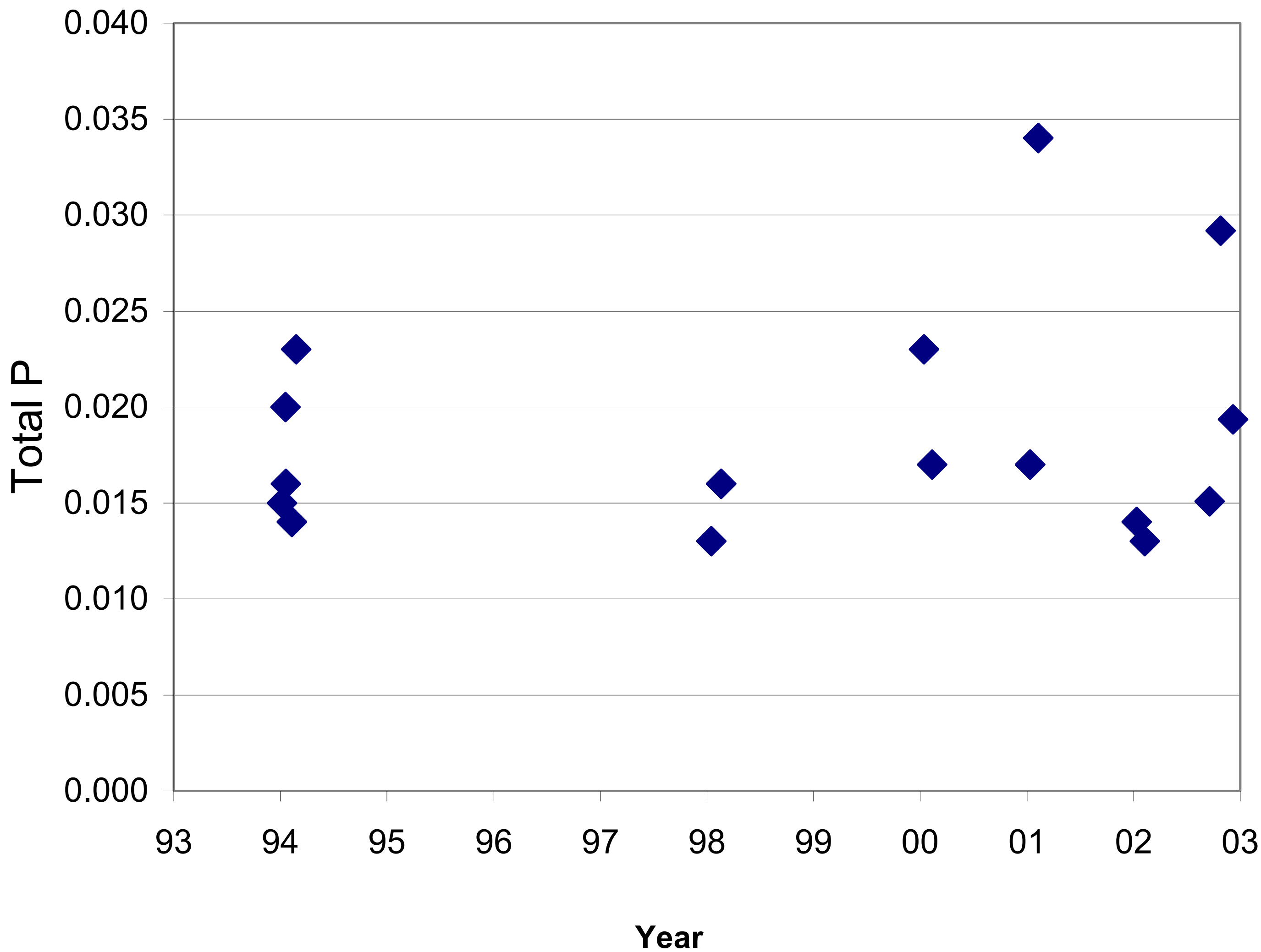


Figure 2-9. Summer phosphorous readings at Long Lake sampling site A (source: Storet Data obtain by the ETF Lab, UWSP, 1993-2003)

Threats and Opportunities

Nutrients and Sediment Loading

Polluted runoff from land use practices within a watershed can have severe impacts on surface waters. Runoff from development and agricultural practices affects water quality and aquatic habitat conditions. It also results in amplifying nutrient inputs into surface and groundwater sources by increasing the amount of runoff generated on the shoreland. Several waterbodies in the Long Lake watershed suffer poor water quality due to these pollutant loads. Over time, these nutrients and sediments are likely to accumulate in Long Lake and contribute to its eutrophication.

Despite the efforts of the LLPA and others, the lake itself is perched precariously on the brink between a mesotrophic and eutrophic status due primarily to increased phosphorous. Algal blooms within the past four years and standardized measures of water quality all indicate that lake conditions are not improving. Table 2-11 below indicates the differences between water quality goals for summer total phosphorous established in the Phase III Lake Management Plan for Long Lake (1997).

Basin	Goal	1994 summer average	1998-2001 summer average	2002-2003 summer average
A	16 ug/L	16 ug/L	22 ug/L	21.5 ug/L
B	17 ug/L	17 ug/L	20 ug/L	NA
C	19 ug/L	19 ug/L	19 ug/L	NA
D	18 ug/L	18 ug/L	20 ug/L	NA
E	17 ug/L	17 ug/L	19 ug/L	NA
F (between A and B)	NA	NA	20 ug/L	25 ug/L

Table 2-11. Summer total phosphorous goals from Lake Management Plan and actual averages for sampling stations in Long Lake.

The measures of water quality recorded on the lake, summarized as trophic state indices (TSI) of 55 and 53, indicate that Long Lake may already be transitioning to a eutrophic status. Work is needed immediately to begin managing and reducing phosphorous sources for the lake.

With so little of the watershed in agricultural use (less than 10%) and no direct discharge sources of phosphorous, efforts to manage phosphorous must be targeted to non-point sources found throughout the Long Lake area. Earlier studies- including the Long Lake Management Plan- indicate that 40% of the phosphorous reaching the lake is coming from direct surface runoff. The balance of phosphorous is coming from direct atmospheric deposition (16%), groundwater (15%) and internal loading (24%). Of these phosphorous sources, surface runoff is the only one that can be readily managed in the long term through readily available and relatively inexpensive practices.

Watershed analyses of the lake in the management plan indicate that implementation of best management practices (BMPs) for runoff control and management could yield significant reductions in phosphorous loading. Table 2-12 below shows the predicted increase in total phosphorous associated with 50% development of the watershed both with and without BMPs.

Basin	50% no BMPs	50% with BMPs	difference
A	+ 23 ug/L	+ 6 ug/L	- 17 ug/L
B	+ 4 ug/L	+ 0 ug/L	- 4 ug/L
C	+ 3 ug/L	+ 1 ug/L	- 2 ug/L
D	+ 1ug/L	+ 0 ug/L	- 1 ug/L
E	+ 6 ug/L	+ 1 ug/L	- 5 ug/L

Table 2-12. Predicted increase in total phosphorous from 50% watershed development for Long Lake basins, with and without BMPs.

The BMPs assumed in the above analysis are specified in the plan as wet detention ponds capable of removing 60% of the phosphorous contribution associated with development throughout the watershed (on and off shore). Among the specific structural BMP's recommended for implementation in the Long Lake Management Plan are:

- *Landscape requirements to reduce connected impervious areas*
- *Infiltration basins and trenches*
- *Grassed waterways*

The watershed plan concludes that implementation of BMPs could yield a 30% to 90% reduction in watershed phosphorous export. ***Widespread implementation of these practices is necessary to ensure that water quality goals can again be met in the lake.***

Near Shore Development

In addition to impacting water quality through runoff, development is a major factor affecting the quality and quantity of shoreline habitat. The degradation of shoreline habitat affects the natural transition from terrestrial to aquatic habitat, and in turn the quality of shallow water habitat. Shoreline modifications can also decrease the landscape's ability to filter nutrients, sediments and other runoff pollutants (for more information on aquatic habitat and locations refer to section G).

Mercury Deposition and Acidification

Other sources of problems in the watershed include air borne mercury and acid precipitation. Most lakes in the watershed are likely to have natural buffering against rapid changes in pH from acidic precipitation because groundwater contains alkalinity. Groundwater alkalinity in the Long Lake watershed averaged 109 mg/l as $CaCO_3$ in 56 samples in the Central Wisconsin Groundwater Center database (minimum of 56). Twenty-five mg/l is typically used as a lower limit for lakes that are not very vulnerable. However, some seepage lakes with small groundwater drainage areas may be vulnerable to pH changes.

Mercury can be a serious problem for large game fish due to long-term bioaccumulation. At present one mercury advisory exists within the Long Lake Watershed, Harmon Lake. The DNR has developed statewide consumption guidelines for special populations that may be at risk by even low levels of mercury consumption. Before consuming fish harvested on area lakes consumers should check these advisories for their own personal guidelines.

Recreational Use

Recreational users continue to put increasing pressure on Long Lake watershed lake resources, at times causing conflicts between various users. Recreational boating can have detrimental water quality impacts in shallow areas. Continual boat traffic in an area can increase suspended organic matter, making phosphorous more available and decreasing water clarity. Invasive exotic vegetation and animals can spread when transported by boats from lakes outside the basin.

G. Aquatic Ecology (fish, insects, plants)

Inventory and Status

Surface water ecosystems are complex communities of organisms. At the base of these communities are the primary producers such as algae, which use photosynthesis and nutrients to create energy and organic matter. Microscopic animals feed on the algae and in turn are consumed by larger animals, thus creating a food chain. While many of these activities operate at levels that humans cannot easily see, we do observe (and are often quite concerned about) the top predators in these systems, the fish. Much like terrestrial ecosystems, fish and the aquatic food chain will be impacted by the full set of activities taking place in and around their environment. A healthy fishery cannot exist without healthy lakes, streams and wetlands.

Fisheries

Largemouth bass and panfish is the predominant fishery within the watershed's abundant small to midsize lakes. Major panfish species include bluegill, black crappie and yellow perch. Northern pike provide the second-most abundant fishery. While most lakes in the Long Lake watershed contain bass/panfish and northern pike, a few of the fisheries contain moderate walleye populations. Many small, shallow lakes are subject to winterkill conditions and cannot establish a healthy population of top predators.

Walleye fingerlings (1.5-3.0 inches in length) have been stocked in Long Lake since the late 1970's to help sustain the natural walleye spawning population that exists within the lake. Prior to the year 2000, on average 50,000 – 60,000 walleye fingerlings were stocked each year. At the start the survival rate of those fingerlings was very poor. Some assumptions for the poor survival rate could be due to predation from a large abundance of crappies within the lake at that time, and lack of food due to competition with the crappie. With the building of the DNR Spooner Fish Hatchery and support from the St. Croix Indian Tribe, on a biannual basis Long Lake is stocked with more than 200,000 walleye fingerlings (stocked Mid to Late Summer, 150,000/WIDNR and 50,000/St. Croix Tribe) and on a yearly basis between 2,000 – 5,000 walleye yearlings (stocked Late Fall, by the Chamber of Commerce, *if available*). Current survival rate of the walleye being stocked within Long Lake is relatively poor.

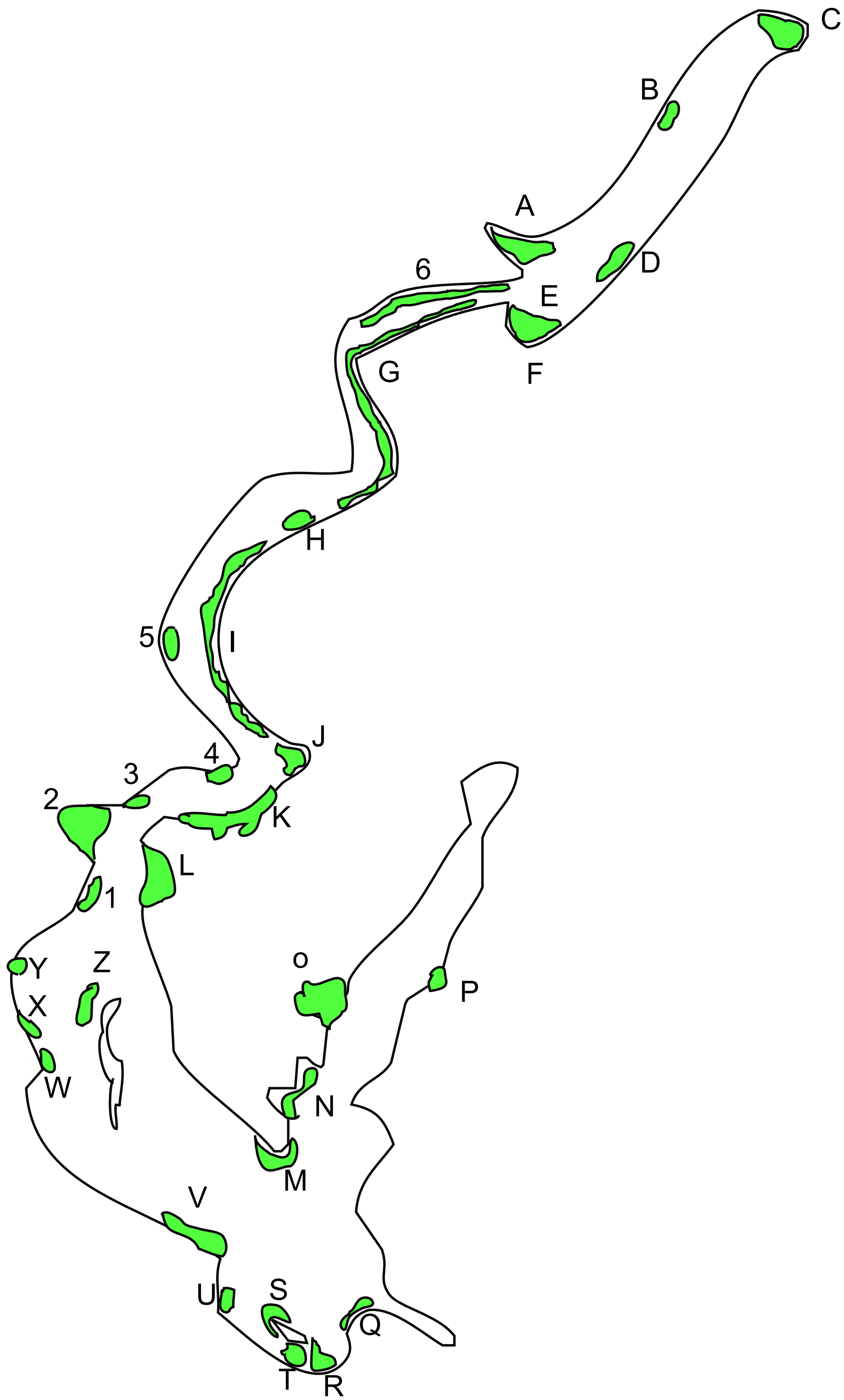


Figure 2-10 Sensitive Areas Within Long Lake (Source: WI DNR Long Lake Sensitive Areas Study)

Aquatic Habitat

Land use and shoreland development has had significant impacts on shoreland and in-lake habitat. Shoreland development and agricultural land uses have reduced or eliminated native vegetative buffers surrounding lakes, yielding higher rates of runoff and sedimentation. Shoreland development has degraded near shore habitat on almost all lakes in the Long Lake watershed, excluding those lakes that are surrounded by public land. Developed shorelines can be characterized by loss of natural vegetation and removal of trees (both standing and fallen), all of which provide critical lake habitat.

The DNR conducted a Sensitive Areas Study in Long Lake in 1998 to inventory and map aquatic bed communities important for the lake's ecology. The findings of this survey are summarized in the map shown in figure 2-10. The Sensitive Areas Study identifies 32 locations in and around the lake that should be protected to preserve Long Lake's aquatic habitat and ecology.

Several wetlands complexes and emergent plant beds adjacent to Long Lake provide critical spawning and nursery habitat for bass, panfish and forage fish (i.e. young of the year, minnows). These sites are indicated on the map in figure 2-9 as sites A,B,C,E,F,G,H,I,J,K,L,N,O,P,R, T,U,W,X,Y as well as sites 1,2,3,4,5,6. Native aquatic vegetation dominates many of these areas along with wild rice beds that hold an important niche within the lake ecosystem. These sites need to be protected from the removal of vegetation and excessive disturbance from boat traffic.

In addition, five sites in Long Lake are important spawning habitat for walleye, a popular game fish. In figure 2-9 these sites are marked as M,Q,S,V and Z. Spawning sites are characterized by an abundance of coarse gravel and rubble with little to no fine sediments and are usually located along sharp drop-offs adjacent to shore. No alterations of the gravel or rock substrate should occur at these locations.

Aquatic vegetation studies elsewhere have demonstrated that aquatic plant communities were degraded in front of developed shorelands. Recent research found that certain critical habitats are eliminated and/or degraded for aquatic and terrestrial species at currently acceptable shoreland development densities.

Plant surveys conducted elsewhere within the Chippewa River Basin reflect the differences between lakes as well as the impacts from human activities. The maximum depth at which rooted aquatic vegetation occurs in the lakes in the Lower Chippewa Basin ranges from 5.3 to 30 feet. This indicates a wide range of conditions that control light penetration.

There is also a wide range of the number of plant species that can be found within a given lake in a watershed. The diversity of plant species in individual lakes represents the abundance and distribution of those species in relation to one another. A diverse plant community will support a more diverse fish and wildlife community. The plant diversity in natural lakes of the Lower Chippewa Basin ranges from fair to excellent, with four lakes having excellent diversity. No assessment of plant diversity in Long Lake has been conducted.

Major factors impacting plant diversity within the lakes of the Long Lake watershed include various activities occurring in or near the lake, such as: recreational use, shoreline and near-shore development, fluctuating water levels, methods employed to manage the aquatic plant community, and introduction of exotic species. Impacts from development, exotic species, indirect management of exotic species and agricultural land use are the most likely causes for the disturbance in native aquatic plant communities within the Long Lake watershed. In Long Lake itself, the management of water levels at the dam can have an impact on aquatic communities; this is discussed in further detail in Section H below.

Trends

Increasing nutrient delivery to lakes enhances their biological productivity leading to increased fish and plant growth. This may increase the total weight of fish produced in the lake. Unfortunately, increased productivity also leads to greater amounts of organic matter, which are decomposed in the lake sediments. Decomposition of plant and animal matter in a lake consumes oxygen and leads to faster onset of low oxygen conditions in deep portions of stratified lakes, and oxygen depletion in winter and at night in shallow lakes.

Creel surveys of anglers are indicative of some of the trends in game fish for Long Lake. Table 2-13 shows the creel survey results for 1994 and 2001. The most notable trend is the increase in angler efforts directed at smallmouth bass and black crappie. This trend coincides with a decrease in effort for northern and bluegills. Though the time anglers reported fishing for bluegills decreased substantially, both the total reported catch and the number of fish kept remained steady.

Residential development along lakes and flowages in the watershed continues to alter the natural shoreline and shallow water habitat. Changes attributable to development include: increased runoff from construction, soil compaction and surfaces such as roofs and driveways; increased sediment loss from land and deposition within the lake; plant removal; reduction in fallen trees and other larger natural debris. Woody cover and aquatic plant beds are being lost in spawning, nursery and feeding areas that support fish populations.

Many of the smaller lakes found within the watershed still retain good to excellent shoreline and shallow water habitat due to a lack of development and low recreational use. In addition, the large peninsula in Long Lake has remained in relatively natural state, providing substantial fish habitat along the shore of the Boy Scout camp and along the private lands to the north. However, some water bodies in the watershed may soon become over-fertile from additional runoff pollution in the watershed, increasing the chances that they will experience low-oxygen conditions in the summer months.

	Year	Directed Effort (Hours)	%	Total Catch	Total Harvest	Mean Length
Walleye	1994	53075	23.70%	6562	2295	19
	2001	47106	22.74%	5067	1235	18
Northern Pike	1994	42923	19.17%	14224	3824	23
	2001	23449	11.32%	14592	2800	25
Smallmouth Bass	1994	4883	2.18%	4665	596	16
	2001	32349	15.61%	19937	1256	16
Largemouth Bass	1994	38700	17.28%	23205	1595	15
	2001	42173	20.36%	43494	2294	16
Bluegill	1994	62344	27.84%	127375	41490	7
	2001	29117	14.05%	123151	41683	7
Warmouth	1994	60	0.03%	412	202	8
	2001	0	0.00%	0	0	na
Pumpkinseed	1994	427	0.19%	82	1292	7
	2001	750	0.36%	2682	82	7
Black Crappie	1994	19279	8.61%	19399	36947	10
	2001	31052	14.99%	54296	14279	10
Yellow Perch	1994	1054	0.47%	7801	423	8
	2001	704	0.34%	5141	856	9
Rock Bass	1994	876	0.39%	11124	13682	8
	2001	446	0.22%	13682	2804	9
Bullhead	1994	0	0.00%	32	32	12
	2001	0	0.00%	0	0	na
Whitefish	1994	284	0.13%	317	108	12
	2001	17	0.01%	142	292	15
Green Sunfish	1994	0	0.00%	0	0	na
	2001	15	0.01%	104	78	6

Table 2-13. Creel survey results for Long Lake, 1994 and 2001
(Source: DNR Records)

Threats and Opportunities

Meeting Fishery Resource Demands

The demand for quality and quantity in Long Lake area fisheries is high. With degradation of spawning habitat there's increasing reliance placed on artificial stocking to maintain certain fisheries. The area's DNR fisheries specialists are continually refining their understanding of the lake's ecology. The DNR is also working with local partnerships such as the LLPA and the Long Lake Chamber of Commerce to improve the health and recreational value of the fishery. In 2004, these partners worked with Walleyes for Tomorrow to operate a small portable fish hatchery on the lake.

Polluted Runoff

Runoff from urban and agricultural land uses is a threat to habitat because it carries excessive quantities of nutrients, can be warmer than groundwater inflow, and may be flashy rather than steady. Increases in water temperature, weak spring flow and flooding all contribute to reduced habitat quality in the region's wetlands, streams, rivers and lakes. In addition, many small lakes experience low dissolved oxygen levels in winter and without some form of aeration, they are limited in the aquatic life they can sustain.

Stream Sediment Loads

Over 150 years of soil erosion has lead to heavy deposition of fine sediment in many small warm and coldwater streambeds. Excessive bank erosion in wooded or heavily pastured areas continues to remain a serious problem today. This has resulted in the loss of deep-water fish habitat, spawning habitat and stream productivity. Measures such as bank restoration, rotational grazing, fencing and buffer strips must be taken to reduce active bank erosion and reduce the impact of fine sediment on our small stream resources.

Protecting Sensitive Areas

Those portions of the lake and watershed identified by the DNR as Sensitive Areas are particularly of concern. These areas are key to maintaining healthy lake ecology. Though located within Long Lake, Sensitive Areas are commonly associated with and dependent upon adjacent wetlands. As these wetlands are lost, the Sensitive Areas may lose some of their habitat function.

The Sensitive Areas report also provides the following recommendations that would apply to associated wetlands:

- develop a Purple Loosestrife eradication plan for Long Lake;
- create shoreland buffers in excess of 35 feet where no such buffer currently exists;
- prevent soil erosion during all construction activities along the near shore areas;
- eliminate nutrient inputs to the lake;
- control exotic species in the lake and shore areas.

The Sensitive Areas Study for Long Lake analyzed the near-shore habitat and provided several recommendations for habitat protection, including:

- limit vegetation removal to navigational channels no wider than 25 feet;
- develop protection strategies for wild rice beds;
- deny permits for rock riprap were healthy native vegetation exists, promoting vegetative erosion control as an alternative; and,
- protect coarse woody debris within the near shore areas from removal.

Preventing Introduction of Invasive Exotic Species

At present, there are no significant populations of invasive exotic species in any of the Long Lake watershed waterbodies. The popularity of the region with visitors and seasonal residences assures a steady stream of boats and other traffic from outside the watershed, and it is very likely that species such as Eurasian milfoil or zebra mussel will be introduced. Table 2-14 below lists the area lakes that are already infested with Eurasian milfoil.

Lake	County	Year Detected
Beaver Dam Lake	Barron	1991
Kidney Lake	Barron	2001
Sand Lake	Barron	2002
Clear Lake	Sawyer	1999
Connors Lake	Sawyer	2002
Lake Chippewa (Chippewa Flowage)	Sawyer	1991
Little Round Lake	Sawyer	1999
Round Lake (Big Round)	Sawyer	1993
Minong Flowage	Washburn	2002
Nancy Lake	Washburn	1991
Shallow Lake	Washburn	2003

Table 2-15. Lakes infested with Eurasian water milfoil near the Long Lake watershed

H. Impoundments and Dams

Inventory and Status

Records show two large dams existing in the Long Lake watershed. Large dams are defined as having a structural height of over 6 feet and impounding more than 50 acre-feet or having a structural height of over 25 feet and impounding more than 15 acre-feet. Since 1986, SS Ch. 31.19 requires the DNR to inspect large dams on navigable waterways once every 10 years.

The largest dam within the Long Lake watershed is the Long Lake Dam. Earliest records indicate that this dam was constructed in 1884 for logging purposes under Wisconsin General Dam Act, Ch. 318, Section 1; Section 1777, of Ch. 86, along with SS Ch. 222, Section 1 and Ch. 223 (statutes of 1878). The only justification needed to build a dam at that time was that no one individual property was to be completely destroyed or flooded from the dam construction. By 1914, logging had been largely abandoned in the area and Long Lake Dam was converted to a hydropower plant.

The water level orders for the Long Lake dam were issued on January 30th of 1915 and reordered on March 13th of 1918. The orders state that water levels could not change more than 2.2 feet during the summer months (between the gauge heights of 7.2 – 5.0). Drawdown events can occur during all other times of the year and can be no more than 3.7 feet (or a gauge reading of $\geq$3.5). The order also states that during the spring months there shall be no spilling of water until the water level reading is at or above the 5.0-gauge mark. This order still remains in effect today, and a literal interpretation of the order could mean that the Brill River would be dry for short periods of time depending on weather and lake levels during the spring months.

The Long Lake dam retains over 3,289 acres of water and has a dam head of 15 feet. Renovations on the dam were completed in 1995 through local support funding, along with state and federal grants. Currently Washburn County is in charge of operating and maintaining the Long Lake dam and the area around it and has delegated the responsibility to the County Highway Department. Water level records since 1915 indicate water levels fluctuate very little during the summer months and the lake is subject to an early winter drawdown and is not refilled until after ice out.

Threats and Opportunities

Winter Drawdowns

The drawdown practice is done at Long Lake for a number reasons. The main reason for the winter drawdown is to prevent ice pushes and heaves from damaging or destroying boathouses, permanent docks, and rip rapped areas. Another impact includes the cleaning off of rocky walleye spawning reefs that if not controlled would be choked out by algae and fungi. The drawdowns likely have adverse effects on many of the aquatic plant, invertebrates and fish species living within and around the lake.

DNR fisheries biologists have noted that the bottom structure of the lake (steep drop offs adjacent to the shore) means that a very small portion of the lake is actually drained during the 1.5 – 2.0 foot winter drawdown. One of the concerns that the DNR fisheries biologists have is that the drawdown is often conducted too late into the fall. As a result, amphibians and aquatic insects that find refuge in the near shore substrate of the lake beginning in autumn and into the winter months are sometime frozen out and/or killed when their hibernation spot is exposed from the drawdown.

III. Land Resources in the Watershed

A. Land Resources Overview

Though distinguished by its water resources, most of the Long Lake watershed is covered by land. The land's characteristics affect the quality of surface and ground water in many ways. For example, heavy clay soils are less porous and allow less water to infiltrate into the ground. Sandy soils are not only more porous than clay soils, they also do not bind chemicals in the water and allow them to readily infiltrate into the groundwater. The fundamental characteristics of the watershed's land resources are determined by the underlying soils and geology.

Soils are the long-term product of an area's geology and climate. In the Long Lake watershed, a good example of this is the most-recent glaciation of 15,000 years ago. During the last ice age, massive ice sheets built up and moved across northern Wisconsin. Existing soils were removed in the process and replaced with sediments carried by the glaciers. In addition, the topography of the region was reconfigured to its present rolling and gently rolling state. The Blue Hills area located just to the southeast of Long Lake represents the remnants of what once was a mountain range of 20,000 foot peaks. It has only been through millions of years of repeated glaciation that the existing landscape has come to be what it is today.

The subsoil in most of the Long Lake watershed is largely composed of unconsolidated till: a mixture of sand, gravel, and rocks deposited by the terminal moraine of the last glacier. In some places this layer is hundreds of feet deep and through most of the watershed it is covered by a thin layer of silty topsoil. At the far northern portion of the watershed is a deposit of well-sorted sandy material associated with the Pine Barrens ecotypes. The relatively recent retreat of the glaciers has not allowed much time for minerals to break down and organic matter to accumulate. As a result, the topsoil in most of the watershed is significantly shallower and less fertile than that found only a few miles to the south where the most recent glacier had a lesser impact.

The seasonal climate in the region still provides annual reminders that the glaciers are not long in the past. This cool, continental climate continues to interact with the soils to influence the types of plants and animals that populate the area. Prior to the 19th century, the Long Lake watershed was heavily forested with a mixture of conifers and deciduous trees. The forest featured large stands of hundreds-year-old white pine trees. It is thought that northern Wisconsin's pineries flourished after the dispersal and decline of Native Americans between the 15th and 17th century. There is evidence that indigenous residents of the area practiced forest clearing and may have maintained a more open landscape using intentionally-set fires. Rapid population loss brought on by introduced diseases would have reduced their influence and allowed the pine forests to thrive.

At the time when European and American explorers and settlers arrived in the Long Lake watershed, the pine forest was reaching a mature stage. Public land ownership was established through treaties with Native American tribes. The Federal government sold land in a rapid manner, ostensibly to promote settlement of the region and utilization of the natural resources. The harvesting of the pine forests in the watershed began in earnest at the middle of the 19th Century and continued nearly until the century's end. To facilitate the moving of pine logs to mills at the southern end of Long Lake and further south in Rice Lake, several dams were built in the watershed. The dam at the southern outlet of Long Lake into the Brill River raised the levels of what had been a series of lakes to form the current lake. The felling of the pines was followed by the introduction of roads and rail lines and the clearing of remnant hardwoods. Though not as significant as the most recent glaciers, the deforestation of the watershed 100 years ago was a major modification to the Long Lake ecosystem.

Government and landowners promoted farming and settlement after the timber harvest and they divided large land blocks into smaller parcels for these purposes. Pioneering settlers established primitive recreational resorts in old logging camps, hosting vacationers from as far away as Rockford, Illinois. Numerous farms were started, though the more hilly and lake-pocked portions of the watershed were largely avoided. In time, farmers found that the soils in much of the area were inferior to those found further south. Many farmers left and their operations were discontinued or absorbed into larger farms. One can still find a small number of farms scattered in the watershed and further south in the more fertile soils of the Brill River's outwash plain.

Some of the cutover land was replanted with trees, but in most other areas the forests naturally regenerated as fields were abandoned and fires suppressed. The result is the landscape as it stands at the beginning of the 21st Century: a combination of forests, remnant agricultural operations, and recreational homes. The most recent change has been the growth of year-round housing for retirees and persons working in Washburn, Barron and Sawyer counties. The growth in housing has come from both new construction and the conversion of seasonal cottages and cabins into year-round homes.

The Long Lake watershed's transition from a rural farming, forestry, and recreation area to an exurban retirement community portends significant change for the ecosystem and the lake. The following sections explore how historic, present and future land use change impacts the watershed. The discussion focuses on four major land uses: forests and natural areas, agricultural areas, residential and commercial areas, and lands used for transportation and other infrastructure networks.

B. Forests and Natural Areas

Inventory and Status

Forest cover is the most predominant landscape feature in the watershed. According to aerial photo interpretations prepared by the Northwest Regional Planning Commission, over 85% of the land in the towns of Long Lake, Madge and Birchwood- totaling almost 70,000 acres- is forested. The Wisconsin DNR conducts land cover inventories based on aerial photos and shares this information through the Wisconsin Initiative for Statewide Cooperation on Landscape Analysis and Data (WISCLAND). WISCLAND data for the Long Lake watershed indicates that mixed hardwoods- red and white oak, aspen and paper birch- are the most common forest cover type. There are a number of small red pine plantations in the area as well. There are numerous large stands of even-aged red oak in the watershed, a legacy of the harvesting and fire suppression in the 20th Century.

	Acres	Percent
Birchwood	36,509.9	93.38%
Long Lake	16,485.4	80.70%
Madge	16,603	87.47%
Total	69,598.3	87.47%

Table 3-1. Forest Land Use in Long Lake Watershed Towns
(Source: NWRPC land use analysis)

Public and Institutional Forest Areas
Numerous very large tracts of forestland- over 2,000 acres in size- are owned by Washburn County or institutional landowners such as the Indianhead Boy Scout Camp on the eastern end of Long Lake. Washburn County's public forests are managed for a variety of purposes, including recreation, wildlife habitat, and timber production. The 3,500-plus acre Scout Camp is managed primarily for recreational use with minimal timber harvest. The wildlife sanctuary at the Hunt Hill Audubon Preserve represents an additional 400-plus acres of forestland that is maintained in a largely natural state.

The Washburn County Department of Forestry manages several distinct forest units in the watershed, including:

- Stauffer Lake Unit; 2,635 acres
- Nordic Unit; 4,030 acres
- Birchwood Canoe Unit; 4,305 acres
- Wolf Lake Unit; 5,443 acres
- Long Lake Unit; 6,635 acres

The county forest units in the watershed are not as intensely managed as units in other portions of the county. The Birchwood Canoe and Nordic Units, for example, are managed to provide unique recreational experiences such as quiet water sports and cross-country skiing. In these areas, as well as in numerous aesthetic management zones in the watershed, aesthetic considerations influence the timber harvesting techniques when harvests or other forest management activities are carried out. These considerations reduce the negative impact of forest management on the environment. The aesthetic zones encompass several lakes in the watershed as well as along roads such as County Road B and the Birchwood Fire Lane.

In addition to special recreational and aesthetic management, the Birchwood Lakes Unit has been identified through the Wisconsin Natural Heritage Inventory and the Wisconsin

Lands Legacy report as an area of special concern worthy of conservation and protection. The lakes (14 named, 47 unnamed) and wetlands in the unit are for the most part entirely surrounded by county forest land. The lakes and groundwater in the western portion of the Birchwood Lakes Unit- located within the Long Lake watershed- contributes to the pure ground and surface water coming into Long Lake.

The Indianhead Council of the Boy Scouts of America operates the Tomahawk Scout Camp on the eastern shores of Long Lake. This site is over 3,500 acres in size and includes forestlands and open pasture, as well as a significant amount of shoreline on the lake itself. Since 1953 the camp has been managed for recreational programs developed by the Boy Scouts. This includes a number of developed camping areas and other facilities to accommodate thousands of campers each summer. Forest lands on the camp are not intensively managed for timber production, but are maintained in a largely natural state.

East of Long Lake is another camp encompassing over 500 acres of forests and fields. The Hunt Hill Audubon Sanctuary was once operated by the Audubon Society and is now run by a private non-profit, the Friends of Hunt Hill. In addition to large tracts of forest land, the sanctuary encompasses Upper and Lower Twin Lakes and a more shallow lake located east of County Road M. The Twin lakes drain to Pepper Creek, beneath Audubon Road and County M directly into Long Lake.

The forests at Hunt Hill are managed for wilderness conditions with minimal cutting or clearing. A portion of the main property and a wetland area east of County M (Dory's Bog) were designated State Natural Areas (SNA) in 1974. The SNA at Hunt Hill is one of only four in the county and is the only one located on private property. These portions have limitations on management options that ensure that they will remain in a natural state for years to come.

Other Private Non-Industrial Forest Lands

Private parties own several large tracts of forestland in the watershed. Some of this land is used for private recreation, and some is held for speculative land development. One such parcel is located north of the Boy Scout camp and features several miles of shoreline as well as over 500 acres of undeveloped forestland. Together, these undeveloped forested areas yield clean rainwater and snowmelt runoff as well as numerous other ecological and social benefits.

In addition to large forest tracts, there are dozens of smaller wooded parcels held by individuals. Owners of these forest tracts- generally less than 200 acres in size- manage their land for a wide variety of purposes including recreational opportunities and revenue through timber sales. Approximately fifty forested parcels in the three towns are enrolled in the State's Managed Forest Law (MFL) program totaling about 5,000 acres. As with county forest land, MFL lands are subject to the state's forestry best management practices (BMPs) for water quality.

<u>Trends</u>

Four forestry-related trends currently affect the Long Lake watershed:

- A century-long trend towards more land area placed in forest cover and greater volumes of standing timber;
- A more recent trend of increased subdivision of forested parcels for recreational and residential uses- particularly parcels with shoreland, water access and water views;
- Another recent trend of increased participation in the state's MFL program as owners of forest lands seek the related tax relief;
- A steady and healthy demand for forest products and services in the region.

Increased Amount of Forestland

The first trend reflects the post-cutover reality in the Long Lake area. The soils and climate of the region are more suitable for forest cover than for farming. As farming in the area has declined over the past 60 or 70 years, the once and future forest land has either been actively planted into forest cover or is slowly returning to trees from natural propagation. Federal, state and local governments have encouraged farmers to plant more trees to prevent erosion, restore habitat and retire farmland through numerous conservation programs.

While many trees are being added to the watershed through planting and natural regeneration, comparatively fewer trees are dying or being removed for timber or to accommodate other land uses. The Washburn County Forestry Department and some landowners manage their land for timber production and harvest, but most land owners do not actively engage in intensive forestry practices. The post-cutover trees in the region are relatively young and healthy. As a result, the average age and size of the trees in the forest is growing and the total volume and size of the forest increases with each passing year.

Like most of the region, the Long Lake watershed is subject to occasional poor timber harvest practices that place short-term profits ahead of the health of the resource. "Oak mining" and "high grading" refer to forest harvests that remove all the most valuable trees and do not adequately ensure that a desirable forest cover type will regenerate. In some cases, unscrupulous forestry operations convince unwitting landowners that such practices are in the landowner's best interest, sometimes going as far to suggest that without such harvests the trees will die from disease or infestation.

Forest Parcelization

As the forest grows, the size of forest *parcels* in the watershed is getting smaller. Large parcels of privately held land are being subdivided for a number of reasons. Forestland on and near the shores of the lakes in the watershed has been subdivided most intensely, negatively affecting the forest in the riparian area in two ways. First, there are fewer and fewer long, linear riparian areas in contiguous forest cover. Second, there are fewer riparian areas that are connected to larger forest tracts away from the shore.

In the short term, the results of forest parcelization may be impossible to see: an 80 acre forest will look no different when it is initially subdivided into 5 or 10 acre lots. Over time, however, the effect on a forest can be substantial. Once subdivided, the forested lots are likely to be owned by a variety of people with different goals that may or may not be completely compatible. One owner may wish to use the land for hunting, while a neighboring owner wishes to build a home and live among nature.

Forest parcelization can have a broader effect on forest management. Some forest management practices are most efficiently and effectively carried out on a large scale. Examples include forest thinning, pest management, habitat restoration and fire prevention. In theory, owners of small wooded parcels could collaboratively carry out such management practices, but in reality such collaboration and coordination is nearly impossible. One result of parcelization is forest fragmentation, creating a mosaic of different forest management that over time can place forests at greater risk to fires, pest outbreaks, and other problems. Forest fragmentation also impacts habitat and biodiversity, as it favors species that do well along the “edge” of different types of forest cover at the expense of plants and animals that thrive in large contiguous cover types.

Increase in MFL Enrollment

The forces behind forest parcelization are largely economic and market driven. There is a steadily growing demand for forested parcels for recreation or housing use. This demand has yielded substantially higher market prices for what was sixty years ago surplus, unwanted land. As land values have rapidly grown, property taxes have shifted to these idle lands. One result has been a growing interest in the state’s Managed Forest Law program, a worthy program that provides landowners with property tax relief as a means to help defray the long-term costs associated with sustainable forest management. Another response has been the sale and division of forestlands.

Growth in the popularity of MFL can be seen in figure 3-1. This chart illustrates the amount of land in the three watershed towns placed in MFL from 1987 to 2003. Higher land values, coupled with the state’s implied shift of revenue from the income to the property tax, suggests that enrollment in the MFL program will continue to increase in the near future. In most cases, these lands are entered into 25-year management contracts. Early withdrawal from the program carries substantial financial penalties, but withdrawal at the end of contracts might be anticipated.

Increasing Total Demand for Forestland

When forestlands become essentially large wooded housing lots they are valued even greater in the marketplace, pushing prices for forestland even higher. This is parallel to what has already occurred in the market for lakeshore property, though the values have not reached similar heights. As undeveloped lakeshore lands become ever more scarce, it is believed that forestlands will be in even higher demand. Forest lands with additional amenities such as proximity to a lake (second-tier lakeshore) or public lands are even more likely to experience value growth and pressure for subdivision.

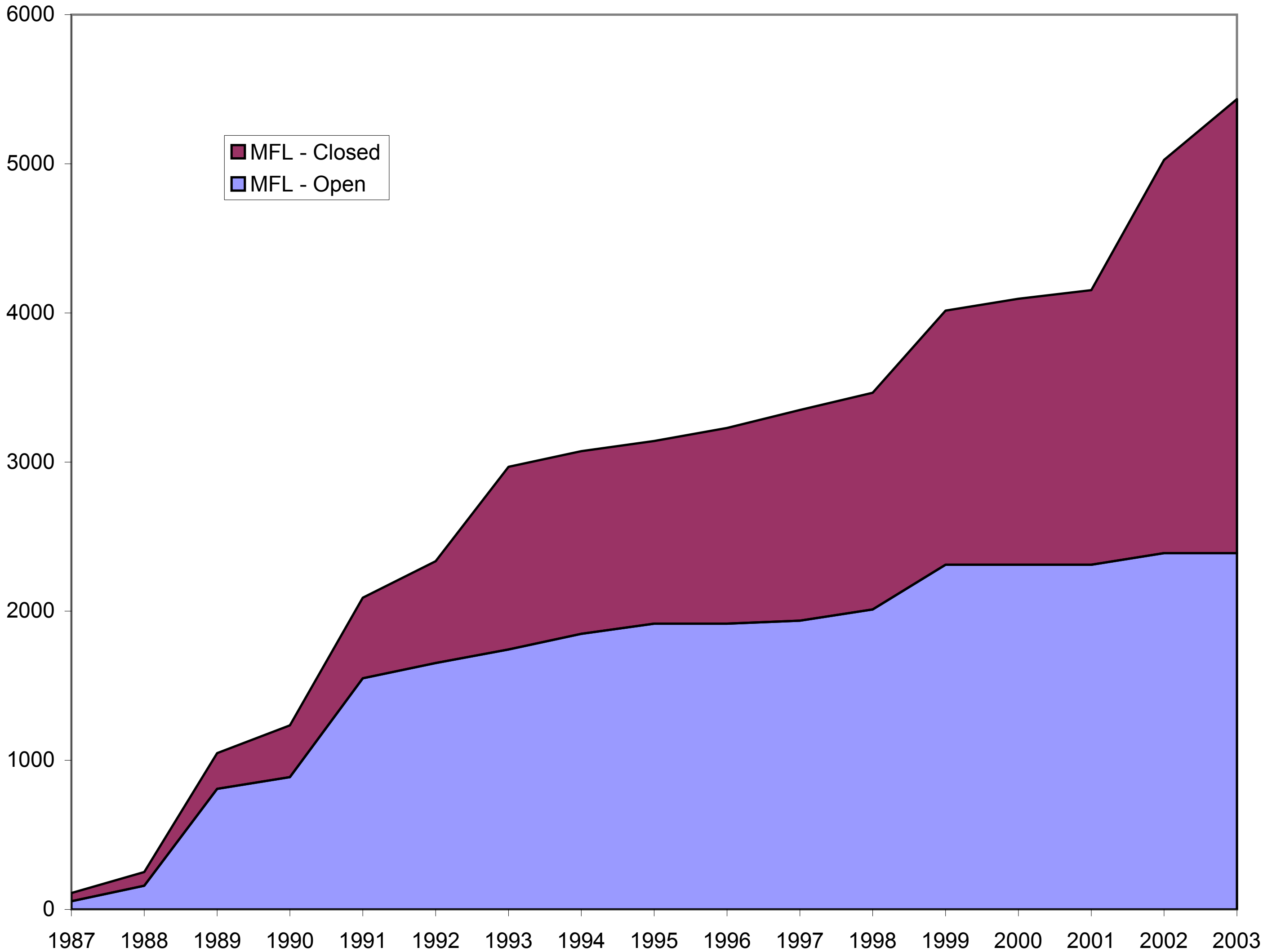


Figure 3-1.Acres enrolled in Managed Forest Law in Birchwood, Long Lake and Madge; 1987-2003
(Source: DNR records)

The market for housing is only one component of the demand for forested land in the Long Lake watershed. An overlapping dimension is the demand for recreational experiences such as hunting and trail sports such as ATV, horseback, and mountain bike riding as well as hiking and cross country skiing. For some people, purchasing woodlands for private recreational enjoyment is a realistic dream. For many others, public lands such as the county forest are increasingly their only option for their preferred recreational pursuits. Increasing pressure on public lands for recreation use is not likely to make forest management any easier. For all recreationists, the role of a healthy forest in providing habitat for numerous plants and animals cannot be understated. Without proper habitat, much of the wildlife that people enjoy would not be as abundant and some animals may disappear from the area entirely.

A third dimension of forestland demand is the market for forest products. The forest products industry is a major source of economic activity in Northwest Wisconsin. Large mills in nearby Hayward and Birchwood provide high-paying jobs and require a steady input of timber. Smaller mills and harvesting operations also provide employment and timber demand. For small and large mills, the cost of transporting raw timber creates a preference for nearby sources compared to distant forests.

Wisconsin's forest products industry is one of the largest in the nation. Parcelization of forest lands and the conversion of forestland into wooded homesites could, over time, erode the supply base that this industry depends on. At the same time, the price for timber in the region has been steady and in many cases growing. The county forest operation has seen revenue from timber sales increase substantially in the past ten years; this revenue is used to offset taxes county-wide. The Town of Long Lake recently carried out a timber sale on 40 acres of town-owned land located west of the Brill River with revenue earmarked for the development of trails and other public facilities in the town.

Threats and Opportunities

Relating Forests to Water Quality

Sustaining the health and integrity of the forests that surround the lake is important for keeping runoff volume and non-point pollution at desirable levels. A clean lake is a reflection of a healthy watershed forest. The strong demand for timber products and forest-based recreation opportunities implies that forests will continue to dominate the landscape in the watershed. However, the trends indicate that parcelization and subsequent fragmentation of forested land is a significant threat to the long-term health of the total forest resource.

Slowing Parcelization

There are significant opportunities for maintaining and improving the health and function of the forests in the watershed. One starting point is to focus efforts to limit and slow the parcelization of private forest lands that may likely be subdivided in the future. Owners of such parcels can be provided with voluntary alternatives and opportunities that help them meet their ownership goals without dividing up large forested areas. For example, the Managed Forest Law helps to make it financially feasible for a landowner to commit to a long-term forest management plan for their land. As illustrated earlier, many landowners in the watershed are enrolling in this program.

One aspect of the MFL program that some landowners find objectionable is the requirement for active management and periodic timber removal. This provision ensures that the program is used for its intended purpose: to encourage the active and sustainable management of private forest lands. The state and the DNR have an interest in ensuring that MFL lands are professionally managed and that they yield some level of timber output. Five percent of the revenue realized at when timber is sold is distributed to county government, providing a local interest in seeing that harvesting prescriptions are followed through on MFL lands.

For those landowners who do not wish to engage in forest management, another alternative is the use of conservation subdivisions and conservation easements. These would allow for the sale of land and development of housing without necessarily fragmenting large tracts of forest. Wisconsin's Nelson-Knowles Stewardship Fund and the federal Forest Legacy Program provide funds for acquiring lands or easements for public benefits and recreation.

Prioritizing Forest Protection Efforts

Resources for making available the anti-parcelization options described above will likely be limited. It may be necessary to prioritize the type of parcels that such efforts are directed at. At least three considerations should be considered simultaneously: the size of the parcel, its location and function in the forest in the watershed, and the enthusiasm and interest of the owner. Larger parcels near existing infrastructure (roads, utilities, etc.) are more likely to be subdivided and present greater opportunities to encourage management consistent with a clean watershed and lake.

Some parcels may be more important because of where they are located and other site-specific characteristics. For example, forests that encompass wetlands and streams in the Long Lake watershed provide valuable opportunities to secure surface water sources that directly contribute water to the lake. Other parcels may include significant shoreline areas on Long Lake itself.

Lastly, efforts should be directed towards owners who are interested in exploring their options and alternatives before deciding to divide their land. It's likely that some landowners will not be interested in limiting forest parcelization no matter what the potential benefit is to them or the community. Willing partners should be sought out so that some of the less common options- such conservation subdivisions or easements- can be developed without the air of skepticism that often accompanies new ideas and practices. Over time, their experiences and stories may encourage more hesitant owners to look into anti-fragmentation options.

Working with County Forests

Attention to those forestlands threatened by fragmentation should not undermine the importance of the watershed's other large forested parcels. The county forest is relatively secure in ownership, but management of this public forest reflects the priorities of the elected County Board, their Forestry Committee and voters county-wide. Advocates of a clean Long Lake and a healthy watershed should continually encourage the county to follow best management practices (BMPs) near lakes, streams and wetlands in the watershed.

The Washburn County Forest Plan is a ten-year management plan set to be revised in 2004-2005. The plan includes detailed forest stocking plans, as well as general forestry policies such as the aesthetic management zones and the recreational components of the resource. Due to the importance of the County Forest land for Long Lake and its watershed, the stakeholders in the Long Lake area have a strong reason to be active in the County's forest planning process. Area residents can stress the importance of surface and groundwater protection and advocate for forest management guidelines that do not imperil these resources. In addition, the Birchwood Lakes Unit and the Slim Creek area should continue to be given special consideration and protection in the Forest Plan.

Tomahawk Scout Camp

The Tomahawk Scout Camp represents another important watershed resource. The Lake Management Plan prepared by Barr Engineering advised the LLPA to encourage the Boy Scouts of America to make a permanent commitment to conservation land use on their Long Lake property. The reality is that the Boy Scouts, like other private landowners, are free to use their land to meet their needs, including selling land. At the same time, the Boy Scouts of America are different from other landowners due to their tax-exempt, non-profit status. This relieves them of the property-tax induced fiscal pressure to subdivide and sell that other landowners face, but it also makes tax incentives such as the MFL program or donation of development rights relatively ineffective. The opportunity exists to work with the Boy Scouts and develop a long-term commitment to watershed friendly forestry and maintaining the property as one contiguous forest.

There are also opportunities to add to the existing forest resource in the watershed. Though the watershed is already mostly covered with trees, there are fallow fields and other lands that could be placed into forest. The following discussion of agriculture and open lands in the watershed discusses the opportunities for afforestation. Consideration should always be given to the mosaic of land covers (forest, open space, transition areas) needed to maintain a diverse landscape and a healthy ecosystem.

Preventing Forest Disease and Pests

Lastly, it should be mentioned that the forest resource is subject to similar biotic problems facing the area's surface water resource. The forests in the Long Lake watershed are relatively healthy today, but this does not mean that diseases, pests and exotic species cannot establish a foothold in the area. Oak wilt, for example, is a disease that can rapidly kill large stands of even-aged oak trees. The disease has been detected as close as northern Barron County, and it has had a tremendous toll on the northern Twin Cities area. Because the fungus that causes the disease can be transported on wood from infected trees, there is a high likelihood that oak wilt can and will be introduced to the Long Lake watershed.

Gypsy moths represent another potential major forest health problem. Much of the eastern half of Wisconsin is already infested with this voracious leaf-eating insect. With the amount of non-local traffic coming through the Long Lake area, it is only a matter of time before gypsy moths become prevalent.

The Long Lake watershed has numerous areas of even-aged red oaks that would be very vulnerable to oak wilt disease and gypsy moths. In the very long term, the cycle of disease and pests can be viewed as part of the ongoing ecological changes in the forest. Already the species mix is changing as shade-tolerant species such as maple become more common in the forest understory. In the near term, however, the loss of the dominant oak trees could have untold effects on the aesthetics and ecology of the Long Lake watershed.

Slowing these diseases and pests once they comes into the area would be costly and difficult. Dealing with oak wilt or gypsy moth would also divert resources that otherwise could be focused on surface water protection. As with the surface water quality protection, the least costly approach is to prevent such problems before they can even begin. More can be done to protect the current health of the Long Lake watershed's forest resources and limit the introduction of forest pests, diseases and exotic species.

C. Agricultural Lands and Open Space

Inventory and Status

Agricultural activities represent the second most predominant land use in the Long Lake watershed. The soils in the watershed are not the best for growing crops, but they can be coaxed with fertilizers and labor. Agriculture was promoted heavily after the cutover of the forests in the 19th Century, and the many old barns in the area are testament to the enthusiasm and dedication that settlers brought to their farms. Most of these barns today go unused and untilled fields are gradually returning to forest.

Amount of Agricultural Lands

Overall, less than 2,500 acres of the watershed is in cropland. This figure represents less than 10% of the total land in the watershed and excludes an unknown number of acres that are used as pasture. Table 3-2 below shows how the farmland is distributed among the drainage basins of the Long Lake watershed. The number of dairy and other animal operations in the watershed is small with only three dairy farms and a handful of beef, sheep and horse farms.

	Acres in Cropland	Acres of Highly Erodible Soil
Slim Lake Sub-Basin	80	-
Harmon Lake Sub-Basin	176	10
Big Devils Lake Sub-Basin	1,534	203
Lower Long Lake Sub-Basin	147	89
Little Mud Lake Sub-Basin	141	-
Mud Lake Sub-Basin	346	100
Middle Long Lake Sub-Basin	-	-
Total	**2,424**	**402**

Table 3-2. Croplands in the Long Lake sub-basins
(Source: Barr Engineering land use report, 1994)

An earlier analysis of the watershed found that in the late 1990s, most agricultural lands in the watershed were placed in a rotation consisting of one year in corn, one year in seeded oats, followed by four or more years in hay cropping. Since then, market prices for commodities have encouraged farmers to increase the intensity of their cropping rotation, with repeated corn plantings becoming more common. There is also a pivot-irrigated potato field in Madge, northeast of Long Lake.

Estimated crop yield for farmable soils in the three towns ranges from 111 to 118 bushels of corn per acre or 3 tons of forage per acre. These productivity estimates may be high as they include farmland in the Brill floodplain area south of the watershed. Pasture and other non-forested lands are common in the watershed, though they do not represent a large portion of the overall land use.

Trends

Fewer Farms and Less Land in Agriculture

Agriculture is experiencing significant change both within the Long Lake watershed and in the broader American landscape. Nationwide, there are many people voicing concern over the loss of agricultural lands to development and the rapid decline of the family farm as an American institution. A century-long trend towards larger, more mechanized agricultural operations has recently been wed with a trend towards corporate ownership to place control over the country's food sources into fewer and fewer hands.

In northwest Wisconsin and the Long Lake watershed, one sees evidence of these trends as farm operations end or consolidate. Cropland is increasingly leased and some is transitioning to non-agricultural uses. A notable qualitative difference exists between the farmland being "lost" in the Long Lake watershed and land being converted to other uses in places such as southeastern Wisconsin. As discussed above, the soils and climate of the watershed are in many places marginal for productive agriculture. The sandy soil structure is less fertile and more drought-prone, the rolling and occasionally hilly terrain presents a challenge for erosion control. Additionally, the presence of many small lakes and wetlands makes large-scale operations impossible in portions of the watershed.

The relatively low quality of farmland in the watershed (and glacial northern Wisconsin in general) has played as much a part in the decline of the area's agriculture as the macroeconomic forces affecting the industry. As farming becomes more capital-intensive, operators focus on the most productive lands. For nearly 100 years, people have questioned the wisdom of promoting farming and settlement in the poorly-suited cutover. The abandonment of northern farms in the 1930s and the continuing transition of agricultural lands to other uses contribute to the fading sense of farming as a way of life in the Long Lake watershed.

Use Value Assessments

The State Constitution was amended in 1974 to allow preferential tax treatment of agricultural lands as part of an effort to slow down the conversion of farms to residential, commercial and industrial uses. Use value assessment replaces the market value of farmland (determined through appraisals) with a value based on the land's agricultural productivity. For pastureland in the watershed, use value could reduce the property taxes on a parcel by about 90%. While this will likely have the effect of keeping land in agriculture, there is evidence that some woodlot owners are using their woods as pasture to qualify for the lower tax rate. A trend towards more pasturing in woodlots would have a negative effect on the forests' ability to store and filter rain and snowmelt, with unknown effects on runoff and water quality.

Regional Poultry Production

A seemingly contradictory trend is evident in the regional agricultural economy. In Barron County, south of the Long Lake area, poultry production has been increasing in scale and intensity. Turkeys are being raised in large industrial rearing operations for use in processing facilities in the city of Barron. Over 23,000 turkeys are processed daily in these facilities. Turkey raising and processing represents one of the largest employment bases in the region, and the scale of investment in growing and processing facilities suggests that poultry will play a prominent role in the area's future. This trend, however, could be seen as generating conflict with another regional trend: increased regional population and growing concern for water resources.

Like Washburn County and the Long Lake area, the population in Barron County is increasing. Rural housing and a human affinity for lakes and streams elevates concerns over the effects of intensive agriculture on the environment. Downstream from Long Lake, south of where the Brill joins the Red Cedar River, there are a number of impoundment lakes facing severe degradation due to nutrient loads far above acceptable levels. Some of this nutrient loading is attributable to the growth in rural housing and the effects of construction erosion and fertilizing, but much of it can be traced back to turkey manure and the land-spreading disposal method.

Large-scale "factory" farms raising turkeys account for over 30,000 animal units in the region. This represents over 4.7 million turkeys annually, generating 130,000 tons (2.6 million pounds) of manure each year. Growing concern over the negative effects of turkey farms could lead to a more widespread territory in which animals are raised and their waste disposed of. Long Lake's watershed, situated within this poultry production region, could very well see an increase in turkey waste spreading and poultry rearing operations.

Threats and Opportunities

The future of agriculture in the watershed holds more questions than answers. On the one hand, use value assessment and a continuing agricultural economy- particularly in the regional sense- is helping to keep land in agricultural production. This land contributes to the rural character of the watershed and provides income to its owners. On the other hand, the land and soil in the watershed is not as suited for agriculture as lands further to the south (or lands in the southern portion of the state). The negative effects of agriculture on the watershed- whether from polluted runoff or impairment of woodlots through pasturing- suggest that, from a water quality perspective, a less intensive use of agricultural lands may be desirable. This is particularly true for parcels that are known to directly contribute polluted runoff into public surface waters.

Reducing the Intensity of Agriculture

There are opportunities for owners of agricultural land who wish to explore less intensive options. Already, a number of farming operations in the watershed are employing no-till methods of raising grain, minimizing the potential erosion from their fields. There are a number of options for farmers looking to transition out of production. The Managed Forest Law program provides tax breaks to woodlot owners and could be seen as an alternative to entering woodlots into pasture for use value benefits. Similarly, there are a number of conservation programs offered by the NRCS that encourage and reward farmers who place marginal lands into permanent conservation uses. In some cases, these programs provide funds for planting of trees and shrubs on former agricultural lands.

Limiting Non-point Pollution

Further opportunities come from the State of Wisconsin's recently enacted rules for non-point pollution prevention. These rules include specific requirements for agricultural operations known to contribute polluted runoff into a watershed. In many cases, the implementation of specific, mandatory pollution control practices must be accompanied by appropriate cost-share funding. This presents both an opportunity and a challenge, as sources for funding are not explicitly included in the program. In one clause of the non-point rules, farmers are required to develop nutrient management plans by 2005 if they are offered 70% cost share and located on or near a designated Outstanding Resource Water such as Long Lake. The enforcement of these rules is the responsibility of the county's Land and Water Conservation Department. This department will be updating its operational plan in 2005 and will need to address non-point pollution control.

D. Residential and Commercial Areas

Inventory and Status

Although residential and commercial areas occupy far less land than agriculture and forestry, these areas are the most visible and prominent land use in the Long Lake watershed. There are thousands of housing units and numerous commercial buildings in the watershed. The majority of these buildings are located on or near the shores of Long Lake or other lakes and water features. This reflects a desire for lake access for recreation as well as the aesthetic amenities such land affords.

Extent of Housing

An analysis of recent aerial photos conducted by the Northwest Regional Planning Commission estimates that commercial and residential land uses in the towns of Madge, Long Lake and Birchwood total less than 1,000 acres. This represents about 1% of the total land base in the three towns. A casual observation of the Long Lake shoreland area suggests that a large portion of this total exists on or near the lake's edge. The 600-plus units of shoreland housing on Long Lake accounts for about 40% of the total housing units in the three towns (1,575).

Commercial Land Uses

Commercial land use in the watershed is limited to small-scale operations that mostly cater to visitors and homeowners. There is one golf course located in the Town of Madge that falls within the watershed and numerous small restaurants and resorts on or near the shores of the lake. There is only a limited amount of industrial land use in the three towns (10 acres), and none in the Long Lake watershed.

Property Values

While commercial and residential lands represent a small portion of total watershed, they are among the most valuable parcels from both an economic and ecological perspective. In economic terms, values of residential lands in general and shoreland housing in particular are remarkably high. Houses on Long Lake routinely sell for over $200,000, and numerous properties are valued in the seven-figure range. Residential land values on the lake are routinely expressed in terms of price-per-linear-foot of shoreline. In 2003, the price-per-foot is typically greater than $2,000; the minimum lot width of 150 feet implies that new lots on the lake are valued at around $300,000.

These values reflect the fact that the market for Long Lake properties extends far beyond buyers in the immediate vicinity: the Twin Cities of Minnesota, located two hours from the lake, and the Chicago-Milwaukee area, located 5-6 hours away, provide much of the buying power affecting residential and recreational land prices on the lake and in the watershed. Nearby Eau Claire and Rice Lake provide additional demand. As shown in Table 3-3, the majority of these properties are for seasonal or weekend and holiday use.

	1990		2000	
Town	Total / Seasonal	Percent Seasonal	Total / Seasonal	Percent Seasonal
Birchwood	475 / 341	72%	528 / 337	64%
Long Lake	569 / 305	59%	590 / 306	52%
Madge	364 / 221	61%	410 / 208	51%
Total	1,409 / 867	62%	1,528 / 851	56%

Table 3-2. Housing units in the Long Lake watershed towns
(Source: US Census)

On Long Lake and many area lakes, much of the privately held shoreland is already developed. The majority of existing housing lots on the lake were created by subdivisions prior to the passage of Wisconsin’s shoreland zoning regulations. There are a number of significant lakeshore parcels that have not been developed. These include the Tomahawk Scout Camp and a large parcel north of the camp owned by real estate developers.

Development Regulations

The effect of shoreland development on water quality and lake ecology has been the focus of much research and policy. Development near riparian areas increases runoff volume and velocity, alters habitat in and near shores, contributes nutrients to lakes from septic systems, and can contribute sediment to the lake through erosion both during and long after construction. Wisconsin’s shoreland zoning rules came about in part because of the negative impacts of unguided development on and near lakes. Recently adopted lakes classification standards refine the shoreland zoning rules to better protect sensitive and vulnerable lakes.

The regulations apply to all lands within one thousand (1,000) feet of the ordinary high-water mark of any navigable lake, pond, or flowage and those lands within three hundred (300) feet of the ordinary high-water mark of any navigable river or stream.

All new buildings and structures in the shoreland zone are required to have a minimum setback from the ordinary high water mark of navigable waters. In the 1990s, Washburn County went through a process to tailor their shoreline regulations to the particular characteristics of the many different lakes in the county. Through lakes classification, lakes were assigned to different development categories based on their ability to withstand the impacts of development. Some lakes, due to their small size and slow water turnover, would be heavily impacted by even a small amount of development. More stringent requirements for lot sizes and setbacks are used on these lakes. The table below summarizes the effect of lakes classification regulations for different classes of water bodies in Washburn County.

In the Long Lake watershed, the following lakes were classified as “class 1” lakes, meaning that they are more capable of withstanding impacts of development:

- Big Devils Lake
- Long Lake
- Slim Lake

The following lakes were classified as “class 2”, or intermediate:

- Bass Lake
- Deep Lake
- Little Devils Lake
- Little Mud Lake
- East and West Twin Lakes
- Loyhead Lake
- Mac Rae Lake
- Mud Lake
- Nick Lake
- Slim Creek Flowage

The balance of lakes and all streams in the watershed are classified as class 3 water bodies.

Non-lakeshore property in the watershed is increasing in value as well and is becoming more attractive for development and housing. “Second tier” lands that are adjacent to lakeshore lots are desirable for the views that they provide as well as the potential for lake access through easements and “keyholes”, shared lots that provide access for multiple second tier lots. Many of the pre-1960 subdivisions included the establishment of second-tier lots. These existing lots are increasingly being built upon. In the Long Lake area, the number of existing second tier lots is small compared to shoreland lots, but the potential for future second tier lots is large.

Further from the shore, the value of wooded and open acreage is growing as more people seek land not only for recreation (as discussed earlier) but also for housing. Anecdotally, wooded acreage is seen by many as a less-expensive option for recreational and retirement housing. Farmlands are also being converted to residential purposes. Retired farmland is among the least expensive land in the county, and for some people building on this land is seen as an affordable housing option. Though there exist a number of small rural parcels with older homes, much of the recent development has occurred on larger parcels, five to ten acres or more in size. This reflects the current zoning standards.

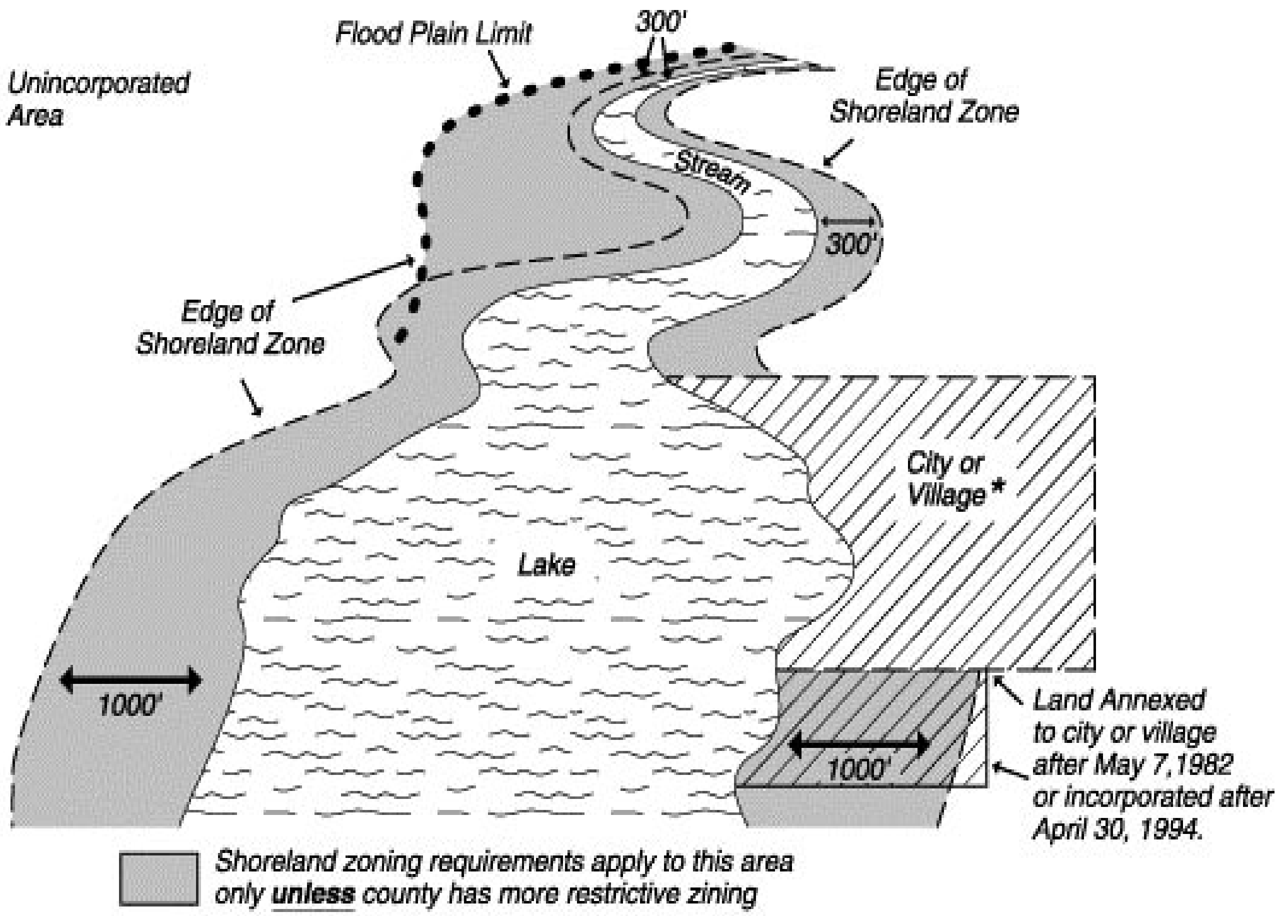


Figure 3-2. Extent of shoreland regulations in Wisconsin.
(Source: Wisconsin DNR)

Classification	Lot Width per Single Family Unit	Min. Lot Area	Min. Shore-line Setback	Vegetation Removal	Minimum Side Yard Setback	Minimum Rear Yard Setback
Class 1	150 feet	30,000 sq. ft	75 feet	30 foot limited removal corridor within 50 feet of OHWM	10 feet one side 30 feet total both sides	40 feet
Class 2	200 feet	80,000 sq. ft.	100 feet (setback averaging per Sect. 271 (1))	30 foot limited removal corridor within 75 feet of OHWM	20 feet one side 60 feet total both sides	40 feet
Class 3 Includes all lakes of less than 50 acres and all rivers and streams	300 feet	3 acres	100 feet on lakes 125 feet rivers and streams (setback averag-ing per Sect. 271 (1))	30 foot limited removal corridor within 75 feet of OHWM	30 feet one side 90 feet total both sides	40 feet
Mapped Wetlands			25 feet			
Drainage-ways and non-navigable intermittent streams			10 feet			
Planned Residential or Cluster Development	Optional in Class 3 with parcel size of 35 acres or greater Minimum lot size 30,000 sq. ft, 150 ft width 50% open space dedication (See Article XIV-A)					
Multi-unit Attached	Minimum lot size and width by class, plus 25% additional per unit					
Multi-unit Detached	Minimum lot size and width by class, plus 50% additional per unit					

Table 3-3. Lakes classification regulations for Washburn County

Trends

Property Value Increases and Associated Development

Not adjusting for inflation, total property values in the towns of Birchwood, Long Lake and Madge have increased from approximately $77 million in 1990 to over $200 million in 2001. This trend reflects both the increased development in the area (new construction and improvements) as well as the effect of strong non-local demand in the retirement and recreational housing markets. For the three towns surrounding Long Lake, property value growth from 1990 to 2000 was as follows:

- Birchwood $23M to $94M +404%
- Long Lake $34M to $95M +281%
- Madge $20M to $62M +316%

The growth in values has a secondary effect: as land becomes worth more, banks and lenders are generally more apt to provide mortgages for improvements. New construction on one property yields "neighborhood" value gains to adjacent properties, further encouraging development.

As the value of rural land and lake area housing grows, property taxes can shift to the owners of such real estate from owners of properties in less demand such as older homes in the county's small cities and villages. Many rural property owners view the selling of land for development as one of their only options for meeting this growing tax burden. Use-value assessment of farmland and the MFL program, discussed in the above sections on forestry and agriculture, are growing in popularity as means of preserving land from tax-induced development.

Overarching Drivers of Growth and Development

More broadly, macroeconomic and demographic trends have helped fuel the boom in rural housing in the Long Lake watershed. Interest rates in the early part of the decade were at their lowest levels in over thirty years. With the recent downturn in the stock market and general economy, real estate has proven to be a popular investment. The coming retirement of the Baby Boom generation will supply a steady pool of consumers for retirement and recreational properties.

Together, these trends suggest a strong demand-induced pressure for development in the coming decades. Small-area population forecasts are difficult to make and interpret, but analysts from the Midwest and Wisconsin both expect areas rich in lake resources to be among the fastest growing communities in the next 20 years. Table 3-2 above confirms this trend, as the housing stock in the towns surrounding the Long Lake watershed have grown by nearly 10% in one ten-year period.

Threats and Opportunities

Prosperity has its own price for the watershed. With increased development comes a host of negative consequences for the natural systems that maintain water quality and wildlife. Erosion from construction sites, nutrients from septic systems, forest fragmentation, introduction of lawn fertilizers and other chemicals, forest clearing for construction, shoreline habitat modifications, and a general increase in impervious surfaces- all these are likely to grow and spread throughout the watershed in the future. Together they will have negative consequences on the many aspects of the lake that people most value: the lake's pristine appearance, its clean water for swimming, and its healthy fishery. The primary mechanism through which this will occur is the net addition of phosphorous to surface waters.

These changes are hardly limited to Long Lake: they are occurring on all private lands near water in the watershed, the county, and northern Wisconsin. Because the changes associated with housing and commercial construction are relatively permanent in nature, it would seem prudent to use great caution when making decisions about the pace and scale of this development.

Increased Impervious Surface and Developed Pervious Surfaces
As the landscape is built up and developed, roads and roofs limit the amount of water that can infiltrate into the groundwater. The added volume of runoff instigates efforts to more effectively and efficiently transport storm water downhill. This is done by smoothening the landscape, eliminating puddles or other low areas, and generally directing runoff to the nearest steam or lake. This acceleration of runoff is the surest way to increase phosphorous loading to Long Lake.

There is an inverse relationship between lot size and the amount of runoff created by new development. Already there are hundreds of relatively small lots built right on the shore of the lake. This existing pattern of development surely contributes to the lake's nutrient budget. Approximately 40% of the phosphorous in the Long Lake nutrient budget comes from direct surface water runoff. There are numerous opportunities to begin installing storm water BMPs such as rain gardens, rain barrels, wet detention ponds, and other diversions.

The questions surrounding the impacts of development on lake water quality are fairly complex, as each site and project will vary in terms of on-site infiltration and potential runoff shed to lakes and streams. As part of the watershed planning project, the UWSP has produced a general model of watershed impacts of development. This model suggests that watershed-wide development on smaller lots will have significant negative impacts for water quality in Long Lake. The model can be used to roughly evaluate specific projects and determine the detail needed by project proponents for local review. As landowners seek small lots, there is an opportunity to require that BMPs be employed to effectively retain storm water and yield no new phosphorous to the lake. Town or county regulations could be created to effectively require these practices for developers. The model itself and the underlying assumptions are presented in Appendix B.

Lack of Local Control Over Change
Perhaps the greatest challenge in addressing these changes is the relative lack of control that local and regional stakeholders have with regards to development pressure. Nearly nothing can be done to affect the interest rates that encourage homebuilding, the design of the property tax system, or the total demand for properties coming from extra-local populations. Paradoxically, the more that is done to protect and enhance the area's natural amenities, the more desirable the area will be for development and the more threatened it will be by the forces of change. The institutional setting, described in more detail in the following chapter, further limits what can be accomplished to meet these challenges.

Comprehensive Planning

The comprehensive planning process underway holds great promise for ensuring that recreational and commercial development does not occur in such a way as to destroy the very characteristics that make the Long Lake area desirable in the first place. Planning and locally-developed land use regulations can effectively minimize the negative consequences of development. This does not require strictly limiting what can be done with private land, but it does mean that some guidelines are needed to better describe how different activities can be best be carried out without negatively impacting the resources.

Through planning, viable alternatives to "cookie cutter" land development can be made available for property owners who sincerely wish to preserve the natural characteristics of the landscape. Local communities can also set very real limits on the intensity of development allowed in environmentally sensitive areas. In doing so, much of what is needed to maintain a healthy watershed can be accomplished as well.

New State Regulatory Changes

Several statewide regulatory changes that will affect residential and commercial development are already underway. The new polluted runoff rules will change how erosion is controlled at construction sites; any construction site disturbing more than one-acre of land will require erosion control plans and practices consistent with best management practices (BMPs). This will reduce the amount of nutrients and sediments entering surface waters throughout the watershed. Recent changes in rules governing on-site septic systems require regular reporting of system maintenance that will, over time, ensure that all systems are properly functioning.

Other rule changes are just now being initiated. The state is reviewing its rules that govern development in the shoreland area. This effort could bring about changes in four major areas of the rules:

- minimum building setbacks and requirements for mitigating buffer restoration and maintenance
- minimal lot sizes and maximum impervious surfaces in the shoreland zone
- changes in the way that non-conforming structures and uses are addressed
- additional mitigation and restoration options to provide greater local flexibility in enforcement and implementation

Enforcement

Rules, no matter how well prepared, are only as meaningful as the enforcement attached to them. In 2003, the Washburn County Zoning Department went through a major reorganization as the long-time Zoning Administrator left and the department was reorganized into a Department of Planning, Zoning and Natural Resources. This has made the identification of shoreland zoning violations and enforcement of rules and regulations challenging in the short term. In the long run, it is expected that the reorganization of the Zoning Department will lead to a more effective administration of the ordinance.

E. Transportation and Infrastructure

Inventory and Status

Without a transportation and infrastructure network, much of the human activity in the Long Lake watershed would not be possible. Roads and utilities, however, can create issues when it comes to water quality and polluted runoff.

According to the Northwest Regional Planning Commission's analysis, county and town roads in the three towns encompassing the watershed cover over 1300 acres. While relatively small (just over 1.5% of the total land base of the three towns), this amount is actually larger than the amount of land estimated to be covered by housing and commercial development. Roads contribute to the overall total of impervious surfaces in the watershed, accelerating runoff and adding to sedimentation of waterways. In addition, roads serve as conduits of chemicals associated with cars and trucks. Unintentional spills on roadways can readily be transported by rain and snowmelt into nearby surface waters.

As of 2003, the road network in the watershed has no sediment or polluted runoff control structures beyond ditches and curbs. In numerous locations, the road system is designed to rapidly deliver runoff directly into the lake.

Roadways are commonly laid out with little respect for drainage patterns. Where streams are encountered, they are channeled through culverts. This often has the effect of increasing the rate at which surface water moves towards the lake, increasing its ability to transport sediment and other pollution. Culverts themselves require quality installation and regular maintenance, and when not properly maintained they can "blow out" in a heavy storm, unleashing major quantities of sediment into the stream and eventually Long Lake.

Trends

Road construction often accompanies the development of homes. As more roads are constructed, more land becomes available for development. As more land is developed, more roads are needed. As both occur, more streams are crossed and culverts installed. The cost to the taxpayer and the environment grows with each additional mile.

Slow Growth in Road Miles

The Long Lake watershed has sufficient state, town and county roads to handle current and future traffic. There has been very little new roads added in the last twenty years compared to the existing road system. In a sense, the area has been "road rich" for some time. The layout of town and county roads following section lines is testament to the confidence of earlier generations that the area would support numerous farms. Many of the local roads serve a very small number of households and see very little traffic.

Increase in Paved Roads

While few new miles are being added to the roads system, there is a trend in the watershed to pave existing roads for safety and to lower yearly maintenance expenses. Towns in the watershed typically allocate a significant portion of each year's budget to pave a particular stretch of road, usually about a mile long. There is also a trend towards requiring developers to pave new roads prior to town acceptance of the road as a public road. This is done in order to ensure that the wider population does not subsidize a particular development or subdivision. While the intent is worthy, this could have the effect of further increasing the amount of paved, impervious surfaces in the watershed.

Threats and Opportunities

While roads may not pose the most significant threat to the watershed, they are among the most visible. In addition, because they are mostly publicly owned and operated, they are theoretically subject to the public will and oversight. Projects that visibly enhance the way that road projects relate to surface waters could provide very real and prominent gains in watershed protection.

Planning to Recognize the Expense of Road and Infrastructure

Unfortunately, road and infrastructure projects present a relatively expensive area for developing water quality strategies. One opportunity that could actually save money would entail using the comprehensive planning process as a basis for developing future road plans that are both economically and ecologically sound. This could follow up on the principle described above wherein developers are required to create new roads associated with new development according to some basic standards. Those standards could be extended to include adequate surface water protection and runoff treatment.

Controlling Road-related Runoff

With regards to the existing transportation infrastructure, there are opportunities to include runoff treatment practices at the time when roads are improved. The state's non-point pollution rules include standards for runoff control during construction, but only provide limited cost-share money for implementing long-term solutions to runoff problems. These grants should be pursued when and where road projects could include watershed protection strategies.

F. Terrestrial Ecology and Wildlife

Inventory and Status

Ecologically speaking, shoreland areas are valuable for the services that they provide to the environment. The riparian zone, where the water meets the land, is critical habitat for plants and wildlife. This is particularly true for the lake's fishery. Spawning areas and food sources are mostly located within a few feet of the shore. For terrestrial wildlife, the lakes, rivers, and wetlands are important sources of food, water, and habitat. Many birds and waterfowl depend almost entirely on the shoreland area. Streams and wetlands serve as habitat corridors that link large tracts of undeveloped land, both within the watershed and in the wider region.

The inventorying and monitoring of wildlife in the watershed is fairly incomplete and unsystematic, particularly compared to the fisheries and aquatic ecosystems. Still, there are some indicators of the health of the area's ecosystems that are regularly or periodically recorded. From these records one can get a sense of where these ecosystems stand today.

White-Tailed Deer

Game animals such as white-tailed deer, bear, waterfowl, and a number of other species are managed by the DNR and monitored for population health. The status of these animals in the Long Lake area is a combination of the quantity and quality of their habitat and the pressures placed on the population by hunting. Of all these game animals, few receive the attention and pressure as the white-tail deer herd. Public and private lands in the Long Lake watershed provide ample deer habitat. The watershed falls almost entirely in Unit 17 of the DNR's Deer Management Unit system. In 2002, the DNR estimated that there were 16 deer per square-mile in Unit 17. The densities in surrounding units range from 24 to 32 deer per square mile. During the 2002 season, hunters successfully took 1,729 deer in Unit 17, or 7 deer per square mile.

Game and Non-Game Birds
The DNR annually tracks ruffed grouse and North American woodcock numbers in the Harmon Lake area northwest of Long Lake. In 2003, the DNR surveyor recorded two woodcock peentings and four ruffed grouse drummings along the route. Other birds have been noted in the Hunt Hill SNA, including: crested flycatcher, eastern wood pewee, red-eyed vireo, rose-breasted grosbeak, black-billed cuckoo, hermit thrush, veery, common yellowthroat, white-throated sparrow, and Nashville warbler.

The DNR also maintains records of American bald eagle and osprey nesting sites, two birds that are of interest for breeding and reintroduction programs in the United States. Both eagles and ospreys are particular about their breeding habitat, preferring a large number of clear-water lakes and streams for gathering fish and a fairly low level of human disturbance. These birds of prey are known to have successful nesting sites at several locations in the Long Lake watershed. Long Lake itself has five known bald eagle nesting sites, three of which were established in the last ten years. Osprey nests are found on the numerous lakes in the northern portion of the Birchwood lakes area and along Slim Creek, as well as in and around the county forestland northwest of Long Lake.

Trends
The overarching trend for terrestrial ecology and wildlife can be expressed as the sum of all trends described above in forestry, agriculture, and development as well as the trends in the water resources. The net effect of these trends is reflected in the habitat and ecology of the watershed. At present, this trend is relatively unclear as some components are improving while others are worsening. On the positive side, the amount of forested habitat in the watershed is as high as it has been in the last 100 years. Trees are larger and more diverse than they have been in recent past.

Growing Human Impact
On the other hand, many wetlands and shore areas are drastically changed from their undeveloped character, and pressure to modify and develop these areas is only increasing. Countless acres of wetlands are gone entirely. In addition, there is more total human activity in the watershed now than there has been since the period of unfettered clearcuts in the 19th century. Unlike the clearcuts, the traffic and landscape modifications of housing development are permanent in nature. Once in place, homes and roads rarely disappear from the watershed.

Cyclical Population Trends
Recent bird counts show population changes that are somewhat dramatic in the short run, but are seen to be stable over a longer period of time. The woodcock and ruffed grouse counts, for example, experience cyclical changes that reflect the natural population

dynamics of the community. Figures 3-3 and 3-4 illustrate how these cycles might look over time. Ruffed grouse populations, estimated through drumming surveys, follow a ten-year cycle as shown in figure 3-3. This cycle is driven in part by the population of grouse predators; over the next several years, grouse numbers would be anticipated to climb again and peak near 2010.

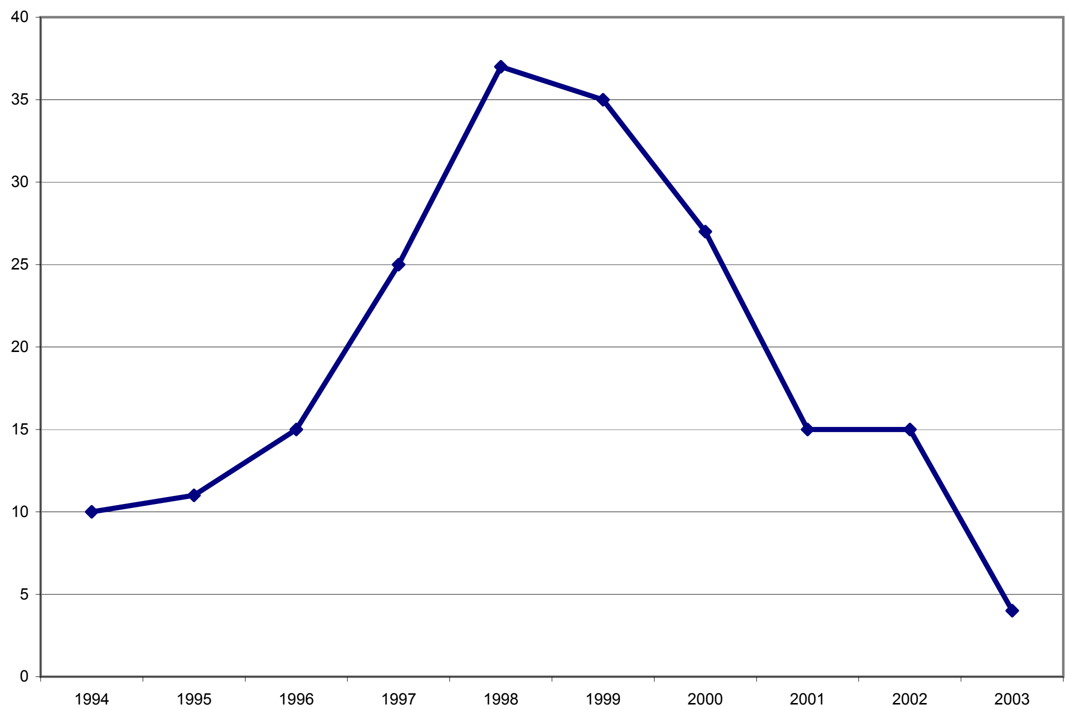


Figure 3-3. Ruffed Grouse surveys near Harmon Lake 1994-2003
(source: DNR records)

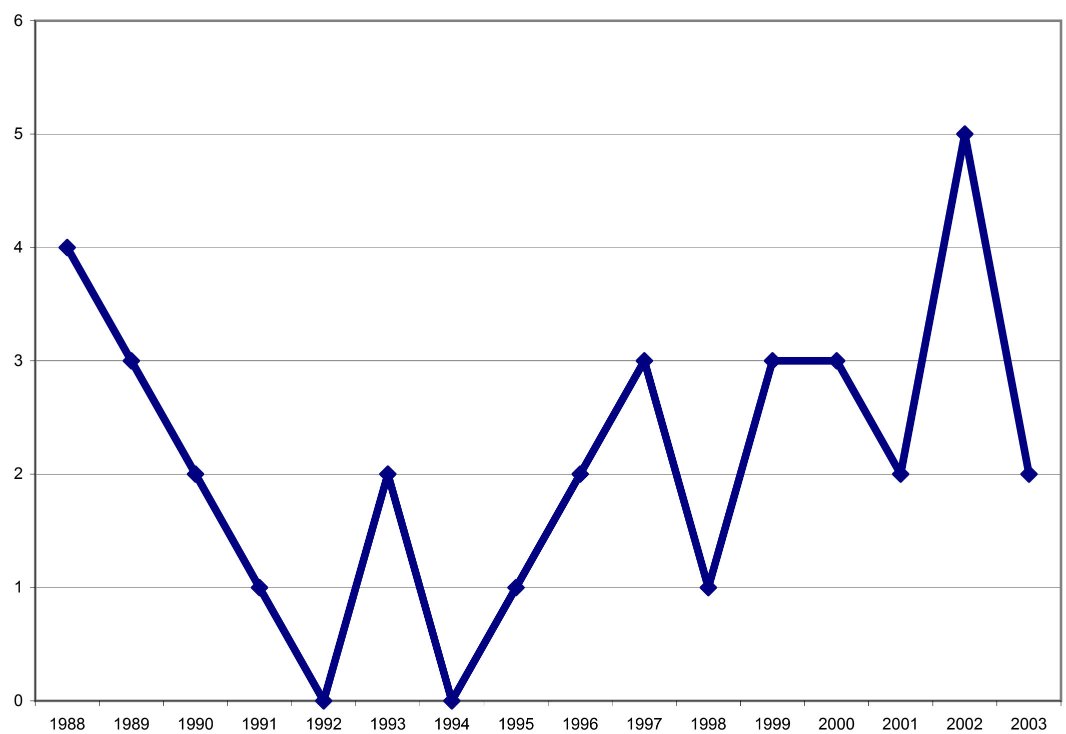


Figure 3-4. Woodcock surveys near Harmon Lake 1988-2003
(source: DNR records)

Managed Populations

For some animals, the number found in the watershed is more a function of natural resource management and hunting pressure than any natural processes. Deer, for example, are managed for a "goal" population size; goals reflect the carrying capacity of a particular deer management zone. The Long Lake watershed is in Deer Management Unit 17. As mentioned earlier, the DNR has established a density goal of 15 deer per square mile for this unit. As of winter 2002, the estimated deer density was 16 per square mile. Figure 3-4 illustrates how annual deer hunts have helped the Unit obtain this density. Through bonus tags and T-zone hunts, the number of doe has been reduced in the past five years. This has a long-term effect of reducing the size of deer herds in the area.

While the trends in animal populations are unclear, the trend for habitat is rather certain. There will be more roads, development, traffic, noise, and habitat fragmentation. This does not bode well for the ecology of the watershed.

Threats and Opportunities

Permanent Habitat Loss

The permanence of the changes in the Long Lake watershed and the rate at which these changes are occurring both suggest that the current ecology of the region is, in the long run, seriously imperiled. The effect of these changes will not likely be seen in the next five, ten, perhaps even twenty years- indeed, they may be so subtle that few people will ever realize that where once there was a diverse community of plants, animals and people, there is but another suburban landscape of tract homes, boat lifts and Kentucky bluegrass.

In this long-term sense, the trends toward more development and greater amounts of human activity can be expected to have a negative impact on most wildlife. There are a number of plants and animals that depend on relatively undisturbed habitat for reproduction and health. Other plants and animals depend on a very high level of water quality. Still others require large, uninterrupted land parcels. As development accelerates, all of these characteristics of the land and water resource are likely to diminish, resulting in a less diverse, more human-tolerant mix of wildlife species. That is to say that the effects of suburbanization and exurbanization in the Long Lake watershed will be first evident in the type and numbers of plants and animals that are found there.

Monitoring Effects of Development on Wildlife

Monitoring the populations of plants and animals in the watershed is a central way of detecting these changes in their early stages. Such monitoring efforts could be focused on those plants and animals most sensitive to ecological degradation and habitat loss. These would include some of the more uncommon birds found in the watershed today. Frogs and toads are also animals sensitive to habitat change and readily monitored through aural surveys. Changes in their presence and numbers could be early cues to wetland degradation. Other more common animals could be tracked as well to establish a record of the types and numbers of fauna that populate the watershed; phenological journals could be maintained throughout the watershed for this purpose.

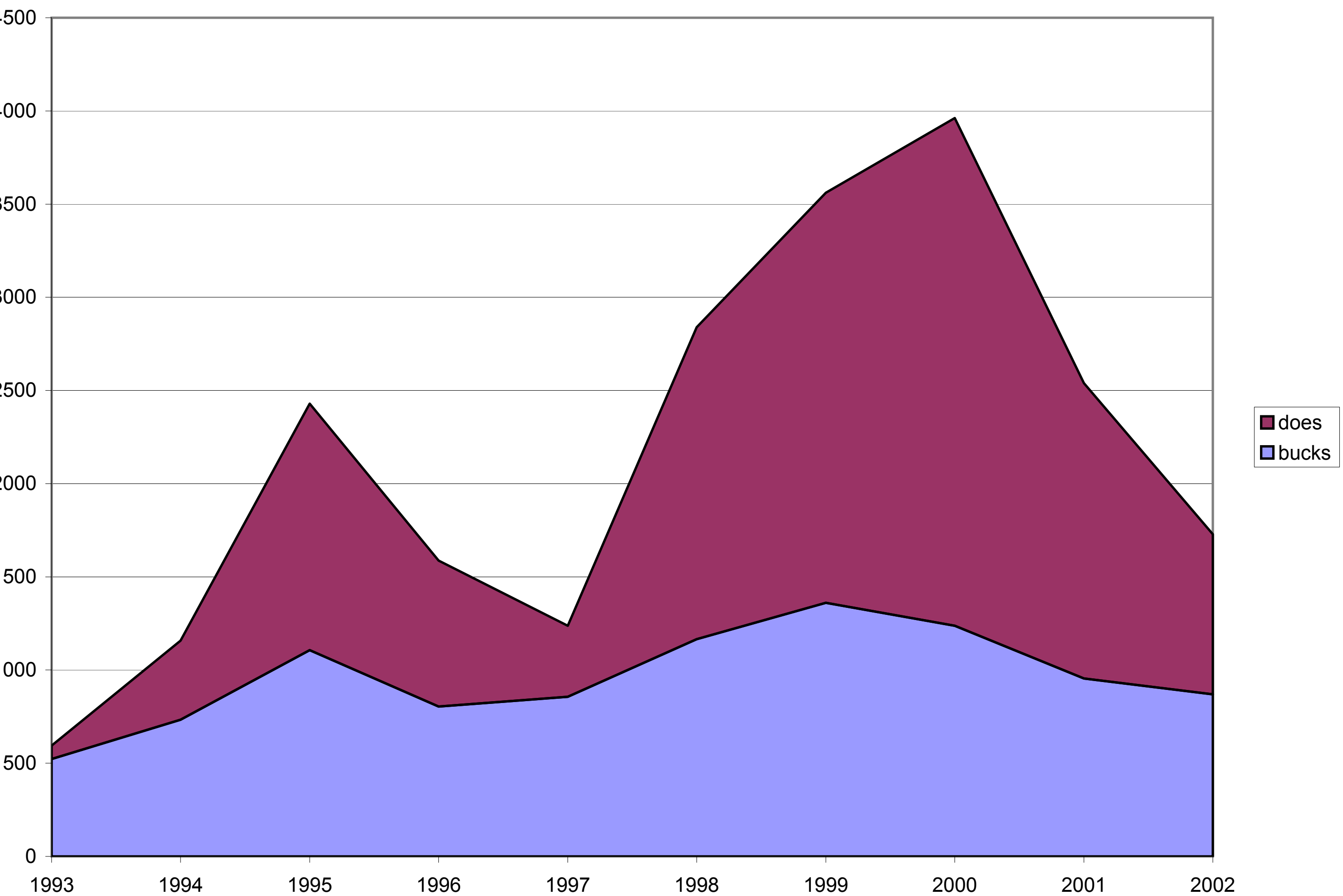


Figure 3-5. Annual deer harvests in Unit 17 (Long Lake area) 1993-2002 (source: DNR records)

A more intense form of monitoring could be instigated through detailed ecological surveys. Such surveys have taken place on county forest lands in nearby Chippewa County. Local partners such as the LLPA could work with the DNR and the county to obtain funding to conduct surveys of the public lands in the watershed. These could be extended to include the two camps in the area as well. Such surveys would provide detailed information on habitat quality and the presence of rare and endangered plants and animals. The information could be used as a basis for improving management plans for protecting these plants and animals.

Proactively Preserving Habitat

A more proactive opportunity involves protecting the “gems” of habitat that already exist in the watershed. First and foremost, these include the county forest lands, the Scout Camp, and the Hunt Hill Sanctuary. They also include the largely tracts of privately held land located north of the Scout Camp where a rare opportunity exists to protect a large expanse of shoreline from development. Proposals to subdivide or develop these properties should be thoroughly assessed and evaluated for impacts on plant and animal communities before being approved.

Restoring Habitat

Another proactive strategy would include working with landowners to encourage habitat restoration. Already there are incentives to encourage property owners to restore degraded shrorelands to more hospitable mixtures of trees, shrubs and groundcover. Habitat projects could be extended throughout the watershed to restore and rehabilitate wetlands, prairie openings, and diverse forest areas.

Habitat Corridors and Linkages

There are also opportunities to “link up” existing habitat areas through linear corridors. Portions of Pepper Creek and Slim Creek, for example, could be better maintained to better accommodate wildlife travel along the riparian zone. The county could be encouraged to continue “blocking” their county forest holdings in the area to reduce the habitat fragmentation within county forest parcels.

IV. Intergovernmental Cooperation: Institutional Arrangements for Protection of Water Quality

Protecting water quality might seem to be an uncontroversial, universally acceptable goal. After all, who isn’t interested in maintaining clean drinking and surface water? Experience has demonstrated that simply agreeing that water should be protected is not enough to ensure that it will be. In the last 50 years, a number of regulatory and incentive programs have been developed at the federal, state and local levels to prohibit or limit activities that negatively impact water quality and promote those that improve water.

Richly endowed with water resources, The State of Wisconsin has been on the leading edge of many water protection movements. Water quality threats from sewage and waste discharge have been dramatically reduced through the coordination of federal laws such as the Clean Water Act, state resources such as the DNR, and cooperation from local and private actors including local governments and industry. Today’s most pressing water quality threat is not from direct sewage and waste discharge, but from non-point sources such as polluted runoff from roads, yards and agricultural lands.

The problem of polluted runoff is directly related to the need for a watershed approach to water quality protection and enhancement. Polluted runoff can come from nearly anywhere within the watershed. Construction sites eroding sediments from hilltops can be as much a problem as nutrients coming from lowland pastures near streams and wetlands. The implication is that *everyone in general and no one in particular is responsible for limiting or stopping polluted runoff*. The existing groups such as the DNR, EPA, local governments and volunteer organizations constitute an *institutional framework* for organizing strategies that ensure pollution is prevented and water quality protected.

The following discussion highlights the different roles that these groups play in the framework through the programs they carry out. This is not an exhaustive list of all of the programs and projects in the state and the Long Lake watershed; rather, it is an overview of some of the more prominent programs and actors that exist at this point in time. Of overriding importance is the need for cooperation and coordination among the groups to effectively implement water protection strategies.

A. Federal Government

Programs

Federal laws, agencies, and programs provide a legal and financial foundation for water quality protection in the United States. The 1972 Clean Water Act (CWA) serves as the basis for many federal, state and local actions. The Environmental Protection Agency (EPA) has developed a number of strategies for implementing the CWA and ensuring its effectiveness. In Wisconsin, the EPA has delegated much of the implementation of the CWA to the state's DNR. The resulting role for the EPA is to monitor compliance and provide technical support to state and Tribal agencies. In addition, the EPA is empowered to carry out investigations of non-compliance and pursue enforcement actions.

There are other federal agencies that directly influence water quality protection, including the Department of Agriculture. The Natural Resource Conservation Service (NRCS) is a division within the Department of Agriculture that provides National leadership in a partnership effort to help people conserve, maintain, and improve America's natural resources and environment. This agency provides technical assistance and information to individuals; communities; tribal governments; Federal, State and local agencies; and others. The NRCS staff partners with staff of the local conservation district and state agencies and with volunteers. NRCS also offers financial assistance, surveys the Nation's soils, inventories natural resources conditions and use, provides water supply forecasts for Western States, and develops technical guidance for conservation planning.

Other federal programs provide similar support and partnership roles: the U.S. Geological Survey, organized in the Department of the Interior, maps and analyzes water and land resources. The U.S. Fish and Wildlife Service, also within Interior, establishes partnerships and provides funding and technical assistance for habitat protection and water quality projects such as wetland restoration.

Overall, federal programs are designed as cooperative ventures that provide technical and financial assistance to state and local groups. These programs are generally incentive-based and rely on willing partners in the public and private sectors. Federal laws and the courts provide a sound constitutional basis for implementation and enforcement of rules.

Local Partners in the Long Lake Watershed

The Department of Agriculture and its NRCS are the most visible actors working for water quality protection in the Long Lake watershed. The NRCS has two programs active in Washburn County: the Soil Survey project and the Service Center. The Soil Survey is completing the Washburn County soils map; Washburn County is one of the last counties in the state to have its soils map completed. The Service Center is home to the District Conservationist, a Soil Conservation Technician and a Civil Engineering Technician

Resources

The local NRCS actors partner with state, county and private groups to access technical and financial resources for designing and implementing natural resource conservation programs and projects. One such program is the Wetland Reserve Program (WRP), a voluntary program to restore and protect wetlands on private property. It is an opportunity for landowners to receive financial incentives to enhance wetlands in exchange for restoring wetlands that have been drained for agriculture. Landowners who choose to participate in WRP may sell a conservation easement or enter into a cost-share restoration agreement with USDA to restore and protect wetlands. The landowner voluntarily limits future use of the land, yet retains private ownership. The landowner and NRCS develop a plan for the restoration and maintenance of the wetland.

The Conservation Reserve Program (CRP) is similar to the WRP, but is more often implemented on upland areas prone to erosion. Local NRCS staff also work with farmers and landowners to develop nutrient management and water quality plans. They cooperate with the Farm Service Agency (also in the Department of Agriculture) and the County Land and Water Conservation Office (described below) to carry out these programs.

B. State Government

Programs

The State of Wisconsin has a much more visible position in the water quality framework in the Long Lake watershed. As mentioned above, the Wisconsin DNR is charged with implementing the federal Clean Water Act. The DNR is also entrusted to carry out the Public Trust Doctrine in the state. This doctrine is based in the Wisconsin Constitution and establishes the legal basis for public ownership of the states' waters. The DNR is in essence contracted by the public to manage and protect the public's shared wealth in water. Another role for the DNR, similar its role in the Public Trust Doctrine, is its responsibility for the protection and management of wildlife and the state's ecosystems. Conservation wardens are among the most visible of the DNR's staff people charged with carrying out these programs.

The DNR is the most powerful actor in this framework, but they are also supported by and actively partner with a number of other state agencies including the Department of Agriculture, Trade and Consumer Protection (DATCP), the University of Wisconsin (UW), and regional planning commissions such as the Northwest Regional Planning Commission (NWRPC).

The DNR currently operates with two complementary principles. One is that the natural resources of the state are best understood, managed and protected as *ecosystems*-complex, interrelated and interdependent networks of plants, animals and resources. The other is a watershed-based geographical orientation. The state is divided into Geographical Management Units (GMUs), generally following watershed boundaries.

This approach recognizes that working with the natural structure and function of resources, as opposed to strictly political or social boundaries, will provide more successful results. The following excerpt is from the US EPA document: "What Watersheds?":

> *Because watersheds are defined by natural hydrology, they represent the most logical basis for managing water resources. The resource becomes the focal point, and managers are able to gain a more complete understanding of overall conditions in an area and the stressors which affect those conditions. Traditionally, water quality improvements have focused on specific sources of pollution, such as sewage discharges, or specific water resources, such as a river segment or wetland. While this approach may be successful in addressing specific*

> *problems, it often fails to address the more subtle and chronic problems that contribute to a watershed's decline. For example, pollution from a sewage treatment plant might be reduced significantly after a new technology is installed, and yet the local river may still suffer if other factors in the watershed, such as habitat destruction or polluted runoff, go unaddressed. Watershed management can offer a stronger foundation for uncovering the many stressors that affect a watershed. The result is management better equipped to determine what actions are needed to protect or restore the resource.*

It is this very same watershed approach that is sought to protect and maintain water quality in the Long Lake area. The DNR's approach recognizes that no single agency is or can be responsible for all natural resource stewardship at the river basin scale. The DNR maintains formal and informal partnerships with other government agencies and private groups and landowners to plan, design and implement protection and restoration programs.

For example, the State Legislature recently passed legislation to address the problem of polluted runoff. The responsibility for implementing the new law is shared between the DNR's Bureau of Watershed Management, DATCP's Division of Agricultural Resource Management and the local Land and Water Conservation Departments. Partnering in this way presents both challenges and opportunities: the opportunities arise from shared resources and diverse perspectives, while differing goals, management structures and rules within organizations create challenges.

The UW works to assist government and private groups in their cooperative efforts through its campuses and Extension. Through research, UW provides answers to shared questions and problems. Through outreach and education, UW works to build awareness and capacity throughout the state. The UW Stevens Point Center for Watershed Science and Education, for example, seeks to build local capacity and improved watershed management through education, outreach, and application of cutting edge technologies.

UW Extension's Basin Initiative is another example of cooperation between UW, the DNR and other groups. This program divides the state into watershed basins roughly (though not exactly) equivalent to the DNR's arrangement. Each basin is staffed with a Basin Educator, a resource specialist who brings together numerous environmental education programs throughout a basin. Basins also have "Partner Teams" with local members from both government agencies and private groups. These teams make recommendations as the DNR implements natural resources programs. In addition there are local work groups and other organizations active within each basin.

Northwest Regional Planning Commission is another resource available for networking and partnerships. In the past, NWRPC has worked with the DNR and multiple counties on projects such as the Northwest Sands Plain Ecosystem Plan. NWRPC is currently contracted with Washburn County and most of the local units of government in a comprehensive planning process.

Local Partners in the Long Lake Watershed

Long Lake's physical location presents some interesting jurisdictional challenges. Most of Washburn County is located in the St. Croix River Basin, but the extreme southeast corner of the county where Long Lake is located drains into the Chippewa River. In the DNR's GMU arrangement, Long Lake falls into the Upper Chippewa River GMU. The Upper Chippewa GMU Water Team Leader is based in Park Falls in Price County.

Not all DNR programs can be neatly organized under the GMU divisions. Many programs operate at the county level. For example, Washburn County has DNR forestry positions assigned to the county who are based in the DNR offices in Spooner. There are a number of other DNR programs and contacts that affect the Long Lake watershed but are based out of the Spooner offices rather than Park Falls.

The UW Basin Educator program presents still more geographical peculiarities for Long Lake. Under UW's Basin Initiative, the Long Lake watershed is located at the intersection of the Lower Chippewa Basin, the Upper Chippewa Basin, and the St. Croix Basin. The Lower Chippewa Basin Educator, based out of Eau Claire, is technically responsible for the Long Lake watershed, but the St. Croix Basin Educator, based out of Spooner, is closer to the watershed and has worked on numerous projects in the Long Lake area in the past.

UW has other programs organized at the county level. UW Extension's Agriculture agent is based in Spooner and is responsible for programs in both Washburn and Burnett County. The County's Extension Community Resource Development (CRD) agent is also based in Spooner.

Northwest Regional Planning Commission is also based in Spooner. They represent a middle-ground between state and local institutions as their territory includes a number of counties in the region. The NWRPC is currently working with the towns in the watershed and the county to develop their comprehensive plans. This has involved a significant amount of interaction between the staff planners and community members who are serving on the planning committees. The NWRPC's role is primarily advisory and consultative, as they have minimal authority over local actions.

Resources

With regards to watershed management and natural resource protection, the DNR brings tremendous resources to the Long Lake watershed. As a regulator, the DNR works with the county to ensure that rules such as shoreland zoning are properly implemented and enforced. As a cooperating partner, the DNR shares its technical and archival knowledge on natural resources. DNR staff bring their own skills and passions to resource management in the watershed, carrying out their work not only as bureaucrats, but also as community members. Finally, the DNR manages a number of grant programs that help local governments and other groups to leverage their resources and achieve water quality protection.

Section 30 permits are an area where the DNR has direct authority over watershed activities. These permits are required when landowners wish to carry out certain activities in or near a lake, river or stream. Regulated activities include dredging, installing rip-rap, and large-scale grading. Grading permits from the DNR are required for projects that disturb more than 10,000 square feet on the bank of a navigable waterway. The bank is legally defined as any area that slopes and drains to the waterway (either before or after grading). This means the bank area may include land hundreds or thousands of feet from the waterway.

Shoreland zoning is an example of a program administered by the DNR but jointly implemented with the counties. Counties are responsible for ensuring that their zoning ordinances comply with state standards and they also are charged with enforcing the ordinance. The DNR is responsible for monitoring county implementation and modifying state standards as needed. The DNR also has enforcement capabilities with respect to shoreland zoning violations.

The DNR, DATCP and the county Land and Water Conservation Department are also responsible for designing and implementing programs to reduce polluted runoff under the state's recently enacted non-point pollution laws. NR 151 is the set of rules used by the DNR to implement polluted runoff control statewide. In the Long Lake watershed, responsibility for implementing these rules falls under the Runoff Management Program in the Bureau of Watershed Management. This program has determined that the runoff rules for agricultural lands should be implemented by county land conservation committees and directors, using their land and water resource management plans as a basis for decision making.

Erosion control at construction sites also falls under the Runoff Management Program. The construction site rules currently apply to sites with 5 acres of land disturbance or larger, but it is anticipated that they will soon affect sites as small as one acre. This change will occur as soon as NR 216, the administrative rules on the matter, are approved. The DNR has scheduled public hearings on NR 216 in summer of 2003. Construction sites affected by these rules must prepare and adhere to erosion control plans that include best management practices outlined by the state. Note that projects permitted through the State Department of Commerce and the State Department of Transportation may not require additional permits from the DNR.

The DNR's regulatory and partnership programs are complemented by an array of grant programs. These programs offer assistance to local governments and private non-profit organizations to design and implement watershed protection strategies. The lake management and protection programs, for example, allocates gasoline taxes paid by boaters towards lake monitoring, protection and enhancement efforts. The state also leverages its own resources through federal grants from the EPA and other agencies.

Other noteworthy grant programs include the Targeted Runoff Management (TRM) grants. These grants are competitive financial awards to support small-scale, short-term projects that are completed by local governmental units within 24 months of the start of the grant period. Up to 70% of a project can be funded through a TRM grant, to a maximum of $150,000 in state funding. Project selection is based on geographical water quality priorities, local support for the project, the ability of the project to control non-point pollution and other factors. Applications for 2005 TRM grants are due in April of 2004.

The Nelson-Knowles Stewardship Program is a state funding source for land acquisition and protection. Lands acquired through these grants must be open to the public for recreational enjoyment, but the program also prioritizes environmentally sensitive areas under development pressure. Applications can originate from local governments or from non-profit conservation organizations. The Stewardship Program only provides up to 50% of the total project costs, so local matches for high-value projects can be substantial. Stewardship grants are typically due May 1 of each year.

The UW resources in the region include the Basin Educators program, the County Extension Agricultural and Community Resource Development (CRD) Agents, as well as the connections that these offices provide to the entire UW System. Their roles are primarily educational and facilitative. UW staff can help design and implement educational programs related to water quality and watershed protection. They also help form and sustain local networks of non-governmental groups who are also focusing on natural resource issues. The Basin Educators do this through their Basin Partners Teams, bringing together state, county and federal agency personnel with citizen stakeholders.

Program	Location
St. Croix Basin Educator	Spooner
Lower Chippewa Basin Educator	Eau Claire
Washburn County Extension Agricultural Agent	Spooner
Washburn County CRD Agent	Spooner

Table 4-1. UW Extension Resources in the Long Lake Watershed

UW Campuses such as Stevens Point can also engage in watershed programs in the Long Lake area. The current watershed project brings the UW Stevens Point Center for Watershed Science and Education and the Center for Land Use Education together with the Long Lake Preservation Association in an effort to integrate watershed strategies into locally developed comprehensive plans. Generating this State of the Watershed report for Long Lake is one step in that process.

NWRPC also brings resources to watershed protection. They maintain a robust set of geographic information system (GIS) files in their computer database, as well as a number of historic documents and reports on the watershed in their library. They are currently working with Washburn County to develop a map of potential environmental and habitat corridors in the county. NWRPC also works to prepare grants for lake and watershed protection. Another project that they are preparing is a landowner’s guide to shoreland development and protection. The RPC is also the contracted consultant for the comprehensive planning process underway in the watershed and the county.

C. Local Government

Programs

At the county and local level there are several more programs designed to ensure that natural resources are well managed and protected. Local offices are commonly the implementing agency for state and federal programs. An example provided earlier was the new non-point rules for agricultural lands developed by the DNR and DATCP and subsequently delegated to local land and water conservation offices for incorporation in their own plans. Other county programs operating in the watershed include Forestry, Highway and Zoning.

These programs operate under supervision of the County Board and its committees. There are also a number of close partnerships with the state. For example, the DNR provides a liaison forester to the County Forestry Department to assist in forest planning and implementation. County departments also operate under the framework of state laws and rules. County zoning in shorelands and floodplains, for example, must comply with state statute and DNR rules.

Another set of programs can be found at the municipal level, though they are rarely recognized as programs per-se. Through their Town Boards, local citizens and their elected representatives deliberate and decide on matters that affect how resources are used in the watershed. These decisions, from road building to zoning approvals, can and often do have effects on water quality.

The recent passage of comprehensive planning legislation has motivated a number of towns, including those in the Long Lake watershed, to develop their own plans for the future of their communities. Citizens in these communities are working with the NWRPC to draft these plans and the towns in the Long Lake watershed anticipate completing and approving their plans in Summer 2004. Properly implemented, these plans will provide a reasonable set of guidelines for town and county boards to follow when making decisions that affect land use.

Natural resource protection and the needs of the Long Lake watershed should be duly recognized in these plans. Specific watershed protection actions and strategies are more likely to be successfully implemented when they are integrated in a community-wide planning framework. When these actions and strategies are eligible for state or federal grants, grant applications are likely to fare better if the program is enumerated in a comprehensive plan. For example, a recently created portion of the DNR’s Lakes Protection Grant provides funds for up to 100% of the cost of locally implemented wetland restoration projects if the project is explicitly identified in a local comprehensive plan.

Local Partners in the Long Lake Watershed

The Washburn County zoning office is one of the most visible county departments operating in the Long Lake watershed. In addition to implementing regulations on a site-by-site basis, they have been heavily involved in county-wide water protection efforts such as the recently completed Lakes Classification project. The Zoning Administrator has been a key player in successfully completing lakes classification and updating the county’s shoreland zoning ordinance to implement this system, and was involved in initiating the comprehensive planning processes underway in the county and the Long Lake watershed. Unfortunately, the long-time Zoning Administrator recently resigned for a position in neighboring Burnett County.

The county has also reorganized the zoning responsibilities under a new Planning, Zoning and Natural Resource department. This department is headed by the Washburn County Land and Water Conservationist and is another agency responsible for local implementation of state and federal programs. In addition to facilitating and managing grant programs, the County Conservationist must prepare and maintain the County's Land and Water Conservation Plan. In addition to the conservationist, this office includes an administrative assistant and a conservation specialist.

The Washburn County Forestry Department manages the county's forestland in and around the Long Lake watershed. The Forest Administrator oversees the department's operations and supervises a staff of six full-time positions. In 2003, Mike Peterson held the position of Washburn County Forest Administrator.

These county programs are overseen by the County Board of Supervisors and their committees. There are 21 Supervisor districts; five of them include part of the Long Lake watershed: Districts 15, 7, 14, 12, and 10.

Many land use-related decisions in the Long Lake watershed do not involve areas governed by shoreland and floodplain zoning. Private land owners and town boards are key decision makers in these areas. It is the intent of the comprehensive planning legislation to provide town boards with locally generated plans and guidelines for structuring local land use decisions. In addition, the legislation calls for the creation of local planning commissions to recommend plans and plan amendments to the board. As of 2004, the town of Long Lake and Birchwood have formed plan commissions to finalize and recommend their town's comprehensive plan. Madge's volunteer planning committee continues to work on the elements of their plan in anticipation of a planning commission being formed in Summer 2004.

Resources

At the local level, it is the County that brings the greatest amount of resources to the issues of water quality management in the Long Lake watershed. This is common in rural areas where municipal government is limited fiscally and administratively. County departments, in turn, rely on partnerships and voluntary compliance from towns, private individuals, and organizations. Blatant violations of laws and regulations that require enforcement actions are somewhat rare, and there is little interest on anyone's part for zealously implementing unpopular regulations. Educational efforts and incentive programs have been heavily relied upon to encourage and promote proper resource stewardship and water quality protection.

County departments are effectively working with state and federal partners to bring their resources to bear on local issues. For example, the County Conservationist is implementing a state lakes grant that helps pay for the distribution of educational material to new riparian landowners in the county. The Land and Water Conservation Department also provides cost-share money and technical assistance to individuals wishing to restore shoreland buffers. Recently, the Land and Water Conservation Department cooperated with the Highway Department and the Long Lake Preservation Association to restore and redesign the parking area and shoreland at the Long Lake dam.

These local departments are also accessible for anyone seeking technical assistance on particular projects. They provide a great deal of local knowledge to water resource issues and ground their suggestions in the context of a particular jurisdiction, something that state and federal partners are sometimes challenged to do.

Towns and other municipalities also bring knowledge to bear on watershed issues, but they are more constrained than the county with respect to their organizational and fiscal resources. Most town resources are directed to the maintenance of town roads, and staffing is generally limited to the people who work on the roads and the town clerk and treasurer.

Even under these constraints, however, town boards can influence water quality in the watershed, particularly as it relates to sediments and polluted runoff related to roads. Towns can be proactive in maintaining and properly installing culverts, minimizing the number of blow-outs that send sediment into streams and lakes. Towns can be conservative in their approach to road building, perhaps limiting the amount of impervious surfaces in the watershed. Through the implementation of comprehensive plans and their guidance on land use in the watershed, town boards can have still more influence on water quality. More than time or money, town boards need to provide prudence and wisdom to the decision making process.

D. Non-Governmental Organizations

Programs

Outside of government, there are a number of organizations actively pursuing watershed protection. Like government, these non-governmental organizations (NGOs) operate at the federal, state and local levels. Because they often work closely with the government, these groups mirror the organizations described above in many ways. However, because they represent a particular group of stakeholders, NGOs tend to advocate their positions more strongly and are able to take actions on behalf of their constituents that government-responsible to the majority of voters and their elected representatives- either can't or will not take.

Groups like the North American Lake Management Society (NALMS) and the Center for Watershed Protection operate at the national level. They lobby for legislative changes to protect lakes, rivers and watersheds. They also sponsor and conduct research on watersheds. They also work to create and implement educational programs that stress the value of the watershed approach. In Wisconsin, the Wisconsin Association of Lakes (WAL) and the River Alliance are two major organizations that advocate water protection. Numerous other natural resource protection NGOs operate in the state, many of which embrace the organization of resource management according to watershed boundaries. Examples include the Sierra Club, Midwest Environmental Advocates, and 1,000 Friends of Wisconsin.

Locally, the Long Lake Preservation Association (LLPA) is the most actively engaged NGO in the watershed for fairly obvious reasons. They work with and are supported by the Washburn County Lakes and Rivers Association (WCLRA) and the Long Lake Chamber of Commerce as well as more specialized NGOs such as the Western

Wisconsin Land Trust, the Boy Scouts of America and the Friends of the Hunt Hill Audubon Sanctuary.

Local Partners in the Long Lake Watershed

The LLPA has been active in the Long Lake area for just over ten years. They operate with no staff and are administered by an eleven-member Board of Directors. The mission of the Association is to maintain, protect, and enhance the quality of the lake and its surroundings for the collective interests of the members and the general public, to carry out the educational programs of the Association, and to make representations on behalf of its members. LLPA members volunteer their time and energy to carry out LLPA sponsored projects such as shoreland restoration and water quality monitoring. These projects are organized by committees of the LLPA, including a water quality committee, a development and marketing committee and a special projects committee.

Slim Lake, at the very northern end of the watershed, has formed a lake association as well and recently received self-help funding from the DNR to conduct lab tests on lake water samples. Resident and landowners on Devil's lake, located west of Long Lake, recently began forming a lake association as well and could be more active in the future.

WCLRA was started in 1999 as a joint initiative between local lake stakeholders and Washburn County's UW Extension Community Resource Development Agent. Like the LLPA, they operate with no staff and a voluntary board of directors. Their mission is to promote the environmental protection and responsible use of Washburn County surface waters and their attendant wetlands, shorelands and wildlife resources; to share ideas and information through education and active participation for the benefit of individual property owners, lake and river districts and associations, local government, the general public, future generations, and the waters themselves. They implement this mission in two primary ways: to effectively networking existing lakes organizations like LLPA across the county, and providing a resource to interested stakeholders whose favored lake or lakes may not have an existing lake organization.

The Long Lake Chamber of Commerce functions as a booster organization for area businesses. They hold the trademark to the title "Walleye Capital of Wisconsin" for Long Lake. They are actively engaged in walleye stocking in the lake and organize a number of events on and near the lake. They too are a voluntary organization with no staff.

The Boy Scouts of America and the Friends of the Hunt Hill Audubon Sanctuary are more specialized NGOs. The Boy Scouts own and operate the Tomahawk Scout Preserve on the eastern shores of Long Lake. The purpose of the Boy Scouts of America, incorporated on February 8, 1910, and chartered by Congress in 1916, is to provide an educational program for boys and young adults to build character, to train in the responsibilities of participating citizenship, and to develop personal fitness. The Tomahawk Scout Preserve has a full-time Director; the most recent Director also recently served as the President of the LLPA.

The Boy Scouts' camp programs have long been a staple part of their overall purpose. Encompassing more than 2,500 acres of woodland area and over eight miles of shoreline, Long Lake's Tomahawk Preserve has for fifty years been home to the Indianhead

Council's summer Boy Scout and Webelos resident camps. Forty campsites within three Boy Scout sub-camps are host to over 5,500 boys and 1,500 leaders each summer. Troops camp for a full week (from Saturday to Saturday) during one of the nine summer sessions. Over 1,500 2nd-year Webelos and parents attend Navajo camp for four days and three nights. While at camp, scouts are involved in a number of volunteer protection and restoration projects.

Like the Boy Scouts, the Friends of Hunt Hill are similarly organized around a camp, but their educational and outreach programs are more community oriented. The Hunt Hill Nature Center and Sanctuary are situated on 500 acres of land in the Long Lake watershed. The group’s mission- to promote appreciation of nature and the environment- is broader as well. Hunt Hill has a full time director as well as support and education staff. Each year they offer a wide array of educational and experiential programs to participants from near and far.

The Western Wisconsin Land Trust is a regional NGO that focuses specifically on protecting unique lands through purchase and conservation easements. The LLPA has been working with WWLT for a number of years to involve them in several potential land protection projects in the watershed. WWLT is unique in that its non-profit status allows it to hold title to land. In 2004 WWLT was in the process of opening an office in Washburn County and the organization is poised to be more active in local land and lake protection efforts.

Resources

Compared to the government groups discussed earlier, NGO organizations in the Long Lake watershed bring a distinct set of resources to watershed issues. Chief among their resources is the interest, energy and enthusiasm of their members and supporters. NGOs such as the Long Lake Preservation Organization exist because enough people voluntarily agree to work together, advocate lake protection and ensure that it happens.

NGOs also bring their members’ skills, knowledge and experience to the resource protection table. WCLRA has become involved as a stakeholder in decisions made at the County Zoning Committee and the Board of Adjustment, drawing on their members’ knowledge of the applicable zoning laws and rules. The LLPA has recently invited the Western Wisconsin Land Trust to the Long Lake area to discuss long-term land conservation strategies and assist in their efforts to protect key parcels from development.

Western Wisconsin Land Trust also brings unique capabilities to the watershed. They are legally structured to hold title to lands and conservation easements as a non-profit. As such, landowners can donate their property or easements on their property to the Trust and realize significant tax savings. The Trust can provide expert advice to landowners interested in donations to help them maximize the financial benefits and tailor easements to meet the landowner’s long-term conservation goals. They also have staff to routinely manage lands that the Trust owns and monitor easements.

NGOs provide education in both formal and informal ways. Hunt Hill, for example, implements numerous educational programs throughout the year utilizing their members as both audience and educators. Their ability to design and carry out education programs at the local level is a tremendous asset that has yet to be fully realized by other local groups. LLPA provides lake-related information to their members and neighbors through their newsletter and website.

Members of these local groups also engage in informal education whenever they communicate the importance of lake and watershed protection with their friends and family. “Word of mouth” is often the most effective means for communicating watershed protection information. In a sense, every community member is a potential advocate of a healthy watershed.

Groups like the LLPA, and more commonly the Wisconsin Association of Lakes and Midwest Environmental Advocates, also play instrumental watchdog roles. For all the programs and activities of the governmental organizations described earlier, there is still a very real possibility that well-intended programs will fail to achieve the goal of maintaining clean water. The Public Trust Doctrine relies upon citizens and non-governmental groups to invoke the legal system when necessary to ensure that the public asset we all share is protected not only in theory, but in practice as well. For example, the Wisconsin Association of Lakes recently filed a legal notice in Oneida County to indicate their willingness to challenge a county zoning change that could weaken water protection. While the legal system is often the last resort, it is a valuable option open to NGOs willing to stand up for their beliefs and values.

E. Citizens and Community Members

Another important group of partners in lake and watershed protection is comprised of the citizens and community members who live or own property in the Long Lake watershed. One of the biggest challenges of reducing polluted runoff is its diffuse source: polluted runoff results from the accumulated acts of hundreds or thousands of individuals who may not even be aware of the effects of their actions. Lawn care chemicals and fertilizers, for example, are a common source of excess nutrients that find their way into runoff and surface waters, yet people fertilizing their lawns do not likely see themselves as polluters. Education and information can raise awareness of consequences, but in many cases people won’t change their behaviors until they want to change. And people may not want to change until the consequences affect them personally or close to home.

One aspect of water quality that seemingly everyone can agree on is the need for groundwater protection. Even if you never swim in, fish from, or look at the lakes in the watershed, citizens in the watershed are vitally connected to the lakes and each other through the groundwater. The groundwater and surface water systems in the area are closely interconnected: what happens to the surface water will likely influence groundwater, and what happens in the groundwater will inevitably affect the lakes. Stressing the value and importance of groundwater could be a powerful means of encouraging water protection to people throughout the watershed. In this way, a more diverse base of support for water protection can be developed.

V. Issues Summary

Long Lake and its watershed are rapidly approaching a crossroads. The lake itself has recently shown signs of greater phosphorous concentrations, leading to algae blooms and anoxic conditions. The watershed faces growing pressure for development, forest fragmentation, and habitat loss. A balance needs to be established between the needs and desires of the people in the watershed and the capacity and function of the ecosystems that they enjoy and depend on.

The following issue categories summarize the issues explored in chapters 2, 3 and 4 of this report. In some places, distinct issues are synthesized to illustrate how they are interrelated.

A. Polluted Runoff

Excessive sedimentation to surface waters and the addition of nutrients from non-point sources into the Long Lake watershed is degrading the surface and groundwater resources. The erosion of sediment and addition of nutrients are closely related: In addition to clouding waters, sediment carries with it phosphorous, the limiting nutrient for plant and algae growth. In addition to erosion, the simple increase in runoff volume associated with development is increasing the amount of phosphorous transported to the lake.

As phosphorous levels increase, so too does algae, and water clarity is lost. In 2004, Long Lake is on the brink between a mesotrophic state and a less desirable eutrophic state. Once the water quality is lost, it is difficult or impossible to restore. Most strategies for recovering water quality are expensive. A preventative approach that emphasizes maintaining current water quality is the most cost effective strategy. The key to protecting water quality is limiting the future contribution of phosphorous to the lake.

There is growing recognition of the polluted runoff problem. State laws and regulations are increasingly focusing on this diffuse pollution source. There is a better understanding of how riparian development leads to increased nutrient loads in runoff: the predominant mechanism is simply increased runoff volume and velocity. An increase in impervious surfaces coupled with more extensive land disturbing activities and the lack of natural plant cover (trees, shrubs, understory) lead to increased nutrient and pollutant mobility and transport.

This suggests two complementary water quality protection strategies: controlling the sources of nutrients and limiting the volume of storm water that carries nutrients and sediments to surface and groundwaters. This is accomplished by protecting and improving tree and plant cover, controlling sediment runoff through BMPs, minimizing or reducing the amount of impervious surfaces and creating structural solutions such as wet detention basins, rain gardens, rain barrels and other diversions that reduce storm water volume.

Runoff associated with agriculture is an issue in the Long Lake watershed, but not to the extent that it is in more intensively farmed portions of Wisconsin. The state has recently enacted rules to both encourage and require agricultural operations to reduce or eliminate runoff problems. A major challenge is meeting the public cost-share requirement for best-management-practices to be mandatory.

B. Development

Rural landscapes and associated natural communities are being transformed into rural residential areas, compromising the biological integrity of the landscape and threatening water quality. Regional growth and development of business and industry combine with non-local demand for housing and recreational development to accelerate land use changes in the area. Increases in impervious surface and removal of riparian vegetation accelerate run-off related sediment and nutrient input into the area's surface waters.

The demand for land and associated development shows no sign of abating. Land values in the watershed continue to climb, increasing the pressure on owners to subdivide their parcels for future development. This pressure extends from the lakeshore to forest and open lands where land prices commonly exceed $2,000 per acre.

In addition to the creation of new parcels, the demand for recreational and retirement housing has led to substantial increases in the intensity of development on existing parcels. Additions, remodeling, and complete replacement of homes are adding to the amount of impervious surface in the area directly surrounding lakes. The conversion of seasonal homes to year-round residences has more subtle effects on the resource: for instance, more wintertime septic use can lead to increased volumes of pumped waste in need of disposal in winter months.

Shoreline development also has negative impacts on riparian habitats. Plant cover is lost, and coarse woody debris is often removed from the shallow areas of the lakes and streams. Together, these impacts degrade the popular recreational fishery in the area. By modifying the lake's ecology, they can also have long-term negative impacts on water quality.

Development throughout the watershed is having a gradual but permanent impact on the wildlife and natural ecosystems in the Long Lake watershed. By physically breaking up forest tracts with roads, utility corridors and structures, forest fragmentation negatively affects those plants and animals that require large tracts of contiguous forest to thrive. In addition, smaller pieces of land are associated with greater percentages of impervious surface and more runoff.

A simple (if not simplistic) means of reducing this impact is to carefully manage land division through zoning and subdivision ordinances. In the short term these policies could discourage development and in the long term such ordinances could stipulate storm water management plans and other actions necessary to balance development with social and environmental concerns.

C. Recreation

Access to privately owned lands for outdoor recreation, hunting and fishing is diminishing as land uses change and conflicts develop between recreational user groups. Long Lake itself is poised to see higher levels of intensive fishing and boating recreation in the future.

Land recreation is also placing pressure on the natural resource base of the watershed. Public land management- particularly on the county forests surrounding Long Lake- is set to become more conflict-ridden as user groups stake their claims on the resource. The desirability of owning one's own recreational forests further fuels forest parcelization and fragmentation.

D. Education

Changing resource issues and needs in the Long Lake watershed requires an integrated, dynamic educational strategy to address the public need for resource information. Steady in-migration into the watershed implies an ongoing need for public education. Successful resource management depends on a well-informed public that understands resource problems and potential solutions.

The Long Lake area is fortunate to have a substantial system in place for delivering educational material and programs. The UW-Extension programs in the area are robust and provide a means of networking between Washburn County, the DNR and local groups like the LLPA. In addition, the Hunt Hill Sanctuary provides a local venue and program structure for developing new educational opportunities that meet the needs outlined in this report.

E. Habitat Degradation

Loss, impairment, and fragmentation of native habitats have jeopardized the ecosystem function of sustaining balanced communities of aquatic and terrestrial animal and plant populations. In addition to parcelization and fragmentation, development brings new species and diseases into an area. Invasive exotics can have negative impacts both in the water and on the land.

F. Drinking Water and Groundwater

Agricultural as well as urban/rural development can threaten the high quality and plentiful groundwater resource in the Long Lake watershed. This resource is perhaps the most under-valued and under-protected asset in the area. Similar to runoff, threates to groundwater can originate anywhere in the watershed. Without clean and plentiful groundwater, much of what makes the Long Lake area desirable would be lost. Once gone, groundwater quality is difficult and expensive to recover.

G. Inventory and Monitoring

Efficient and effective resource management depends on knowledge of the current condition of each resource and whether the resource is stable, improving or declining.

Basic inventory and monitoring data collection is somewhat incomplete and current information will always be needed for sound resource management decisions.

Inventorying and monitoring resources can be expensive and time consuming. There is a growing trend towards recognizing and encouraging the work of volunteers to track ecological health in local communities. Already the LLPA has been active in collecting water quality data for over a decade. The basic infrastructure is in place to invite volunteers to become more active in citizen environmental monitoring, and these efforts can be directed at early indicators of undesirable change.

H. Institutional Concerns

The need and demand for resource management services is increasing, but available staff and funding in the government sector have not kept pace. Integrated resource management requires coordination and cooperation between and within programs and agencies at different levels of government as well as with community groups and citizens. Facilitating such cooperation is a daunting challenge. The Wisconsin DNR, as one of the key agencies influencing the watershed, is notable for its own internal integration of resource management and environmental protection. However, the coordination of activities such as road building and public campground regulations is far from complete.

This current watershed planning project is seen as one strategy for bringing groups together to develop joint solutions to community issues. It remains to be seen how the Long Lake Preservation Association and their many current and potential partners can effectively translate knowledge into action. The final section of this report presents a wide variety of available strategies and actions that should be considered by the numerous stakeholders in the watershed. It should be considered a shared and open resource, a list of applicable actions that can be implemented by one group or collaboratively among groups. The list is long but may not be exhaustive, and there needs to be periodic assessments of the list to determine what has been accomplished and what remains to be done.

VI. Strategies Summary

A. Strategy Overview

Chapters 2, 3 and 4 of this State of the Watershed report included numerous discreet issues facing the Long Lake watershed. This final chapter presents a compilation of strategies and actions that can and should be employed to address those issues and protect the watershed. They are grouped into four different categories:

- Monitoring and Analysis Strategies
- Education Strategies
- Resource Enhancement and Protection Strategies
- Policy Strategies

When all of the strategies are brought together under these categories, some overlap and redundancy becomes noticeable. Further refinement of the strategies and the development of more detailed action plans are best accomplished by the several stakeholders in the watershed through their own prioritization process and work planning.

There are a number of ways to approach prioritization and no “right” way. The Long Lake Preservation Association, for example, will need to prioritize according to its mission and capabilities: not all of these strategies can be simultaneously pursued given their limited financial and volunteer resources. The DNR, Washburn County, UW Stevens Point, and others can suggest to the LLPA those strategies that are most readily implemented and most likely to have a positive impact on the watershed. In doing so, they too take on some ownership of the strategies and can incorporate them into their own workplans.

Strategies that are best carried out by local governmental units like the towns in the watershed and the county need to be conveyed to the planning committees and others working on the local comprehensive plans. Many of the tasks and policies that will protect the watershed can only be accomplished through the local governments, and those governments will soon be required to make decisions in accordance with their plans. Where these strategies involve changes in public policy, they will need to be widely discussed and agreed upon by the citizens of the towns or the county. The comprehensive planning process includes public forums for conducting such discussion and reaching agreement. In this way, the strategies will be constantly sorted by local governments according to there political feasibility.

Some strategies may be taken up and implemented by local state and county agencies. DNR staff, for example, may choose to include some of these actions in their annual work plans. It is recommended that agency staff work closely with local partners such as the LLPA and other appropriate groups to ensure coordination and consistency among the different groups.

B. Monitoring Strategies for the Long Lake Watershed

Groundwater Monitoring and Analysis Strategies

- Establish several sites throughout the watershed where well water samples can be collected and analyzed over a long period of time.
- Provide financial assistance to well owners at long-term monitoring sites to offset the cost of annual or biannual water testing.
- Conduct a study to determine the level of groundwater withdrawal that would be sufficient to negatively impact overall streamflow in the watershed.
- Develop a citizen's groundwater quality database to publicly share groundwater-testing results and allow for trend analysis of same-well water quality.
- The LLPA should monitor stream and spring flow volumes in the watershed over time to detect changes in groundwater volume.
- Conduct a watershed-wide assessment of septic system compliance with the state plumbing codes (Comm. 81,82,93). (See Post Lake example in Langlade County.)
- Monitor groundwater use at a sampling of lakeshore properties (volume, seasonality, etc.)
- Monitor any future non-metallic mining operations in the watershed to ensure that they adequately prevent groundwater pollution

Stream Monitoring and Analysis Strategies

- Monitor water quality parameters at stream inlets to Long Lake and track changes in quality and quantity over time.
- Inventory and map all culverts and stream crossings in the watershed; monitor their status and functionality on an annual basis; track the date (year) of new culvert installations.
- Develop a stream classification scheme based on stream flow, sensitivity to stream modifications and proximity to potential pollution sources to allow prioritization of stream protection and enhancement efforts
- Expand citizen volunteer and agency monitoring to provide stream water quality and biotic assessment data on a five-year basis

Wetlands Monitoring Strategies

- Work with DNR's *Wisconsin Wetland Inventory* to have wetlands smaller than 5 acres in size mapped in the three towns encompassing the watershed.
- Highlight those wetlands that the DNR classifies as highly susceptible to degradation and assess the development threats they face.
- Develop a process for integrating new/restored wetland delineations into existing wetland databases and governmental maps, plans and records.

- Develop a monitoring program to document wetlands lost to development and those restored by mitigation or through public programs.
- Use Wetland Inventory data and citizen monitoring information to assess trends affecting wetlands and effectiveness of public policies.
- Periodic (annual, bi-annual) surveys of the watershed wetlands should be conducted to detect purple loosestrife before it can gain foothold in the area.
- Frog and toad surveys at area wetlands should be done annually as a measure of wetland ecological health. A route should be established with cooperation of DNR wildlife specialists.

Lake Water Monitoring Strategies

- All lakes in the watershed should cooperate on water monitoring programs and share resources as feasible.
- Long Lake, Devils Lake and Slim Lake should coordinate annual monitoring of oxygen depletion and lake groups in the watershed should work with UW Stevens Point and DNR to analyze results.
- A DNR Self-Help monitoring site should be established on Devil's Lake.
- "Adopt-a-Lake" or 4H programs should be initiated in the watershed to involve youth in lake monitoring and analysis projects.
- A system is needed for monitoring water quality in lakes located in the county forest and other smaller lakes in the watershed with few property owners.
- A comprehensive system for storing and analyzing lake water quality data is needed.
- Sediment cores should be collected and analyzed in the Long Lake watershed to establish long-term (100 year-plus) trends in water quality. Two or more cores may be needed from Long Lake, given its size and multiple basin nature. A core at Mud Lake would also indicate whether that lake has always been as productive as it is today.

Lake Ecology Monitoring Strategies

- A survey of the invertebrates and plankton in the watershed lakes is needed to assess the health of the watershed's food chain.
- A survey of Long Lake's aquatic plants is needed to establish the diversity of the macrophytes in the lake. Long term monitoring sites should be established to track changes in aquatic plants over time.
- A route should be established for monitoring sites where Eurasian water milfoil is likely to gain foothold; the route should be checked annually.
- A monitoring protocol for rusty crayfish detection in the Brill River is needed.
- Sensitive Areas Studies should be conducted throughout the watershed to build upon and expand the existing analysis of critical fish habitat in Long Lake; Devils Lake, Slim Lake, and Slim Lake Flowage should be priorities for such studies.
- "Anglers roundtable" meetings could be held annually to discuss and report the state of the area's fishery and supplement DNR inventory data.
- Develop a local guide/manual for resource monitoring protocols to ensure a degree of consistency over time and across different monitoring volunteers in the watershed.

Shoreline Monitoring Strategies

- Conduct an informal inventory of shoreland buffers on watershed lakes, classifying properties as deficient, adequate or superior; periodically re-evaluate shorelines to monitor changes over time.

- Require detailed tree inventories to accompany building permit requests for new shoreland area construction.
- Maintain maps showing the sites of shoreland restoration projects in the watershed.

Upland Ecology Monitoring Strategies
- Establish monitoring transects for indicator or sensitive species in the wetlands and other habitat types of the Long Lake watershed; conduct the surveys along transects three times annually to monitor plant and wildlife populations.
- Recruit volunteers to maintain journals of wildlife observations from their homes at several points throughout the watershed.
- Conduct detailed ecological surveys of public lands and large institutional tracts of land in the watershed to establish their value as habitat.
- Evaluate the connectivity of critical core habitats and identify barriers to wildlife movement.

Forest Monitoring Strategies
- Analyze and report on the health of the total forest resource in the watershed and county, noting age, extent, species mix, and forest pests and diseases.
- Following the establishment of a GIS layer for land parcels, develop an index of forest parcelization and monitor the rate that forest lands are divided.
- Establish "citizen forest health monitors" who can detect and report forest diseases and invasive exotics and report them to the county and DNR.

Watershed-Scale Monitoring Strategies
- Establish a "State of the Watershed" database or similar information clearinghouse should as a repository of the monitoring data. This could be made accessible on-line to both citizen monitors for data entry and for anyone interested in reviewing the data.
- Establish a schedule for periodic assessments of the watershed's ecological indicators (akin to the State of the Watershed Report). The report should summarize the status of the watershed, develop trends from earlier reports and identify any additional data requirements needed for future assessments.
- Develop a volunteer guide for resource monitoring protocols to ensure a degree of consistency over time and across different monitoring volunteers.

C. Education, Communication and Outreach Strategies

Groundwater Education Strategies
- Use town property-tax mailings to remind homeowners of the local source of groundwater and the common threats to groundwater quality.
- Work with Basin Educators and the Wisconsin Groundwater Guardians to develop and deliver relevant educational programs about groundwater vulnerability.
- Promote residential well water testing throughout the watershed by providing well testing kits at public events such as Town Annual Meetings and LLPA events.
- Provide educational materials to help homeowners understand well water test results.
- Stress the importance of proper septic system maintenance and use since most private wells recharge at least partially from nearby drainfields.
- Ensure that information regarding proper septic system use and maintenance are included in information packets provided to new homeowners.
- Promote the availability of cost-share money for well abandonment expenses.

Runoff Education Strategies

- Inform homeowners and developers on the importance of runoff and infiltration to reduce storm water runoff quantities and quality using newsletters, websites and other communications.
- Provide practical solutions and timely advice to help property owners reduce runoff and promote infiltration (e.g., rain gardens, use of pervious pavement, directing rooftop runoff to infiltration swales, rain barrels).
- Use public facilities (town halls, garages, etc.) to develop demonstration sites that illustrate practices that promote infiltration and detention to minimize runoff.
- Develop educational programs and events in conjunction with demonstration site installations, encouraging property owners to actively participate in demo site establishment.

Wetland Education Strategies

- Develop educational programs for contractors and construction workers who operate near wetlands to ensure that rules and regulations are known and understood.
- Establish wetland demonstration/ spotlight sites with informational signage to explain how wetlands function and their importance in the watershed.
- Develop and offer educational programs and events for watershed landowners who wish to restore or enhance their wetlands.
- Develop and distribute a publication describing wetland functions in the Long Lake watershed and list the local and state programs that assist in wetland protection and restoration.

Land Use and Stewardship Education

- Produce local educational events such as watershed fairs to highlight the importance of protecting water quality through land stewardship.
- Develop and distribute a "Washburn County Stewardship Manual" in the form of an attractive wall calendar. Use the calendar to educate landowners about stewardship practices that can improve lake water quality.
- Use newsletters and webpages to communicate the connection between land uses and lake water quality.
- Compile ecology information into plant and animal habitat maps for the watershed, illustrating where existing conditions support rare, endangered or special plant and animal populations.
- Promote "Best Management Practices" for everyday household chores and activities: septic system maintenance, yard waste disposal, gardening and landscaping, etc.
- Encourage homeowners to allow woody debris to remain in the water as fish habitat.
- Promote the use of native vegetation in landscaping and discourage the use of invasive exotics in watershed landscaping projects- particularly glossy European buckthorn
- Establish an annual "Orchids and Onions" award to recognize best, most improved and most problematic public and private sector individuals/agencies for their contributions or detraction from Long Lake watershed resources.
- Install "You are now entering the Long Lake Watershed" signs at key points where roads cross into the watershed.
- Promote the Long Lake compost site for annual tree leaf disposal.

- Share "success stories" of landowners in the watershed who are proactively involved in stewardship efforts- people enrolled in MFL, restoring shorelands, or otherwise working to improve the ecological function of their land. Use web pages, newsletters and press releases to share these experiences.

General Lake Education

- Install "adopt-a-lake" signs at watershed lakes where students are collecting lake quality data.
- Regularly communicate the state of the watershed's lakes and water quality to residents and others through newsletters, websites and other methods.
- Include useful lake information on landing kiosks (no wake zones, sensitive areas, recent water quality tests, etc.).

Shoreland Buffer and Riparian Education

- Work to ensure that people understand the impacts of riparian development on total runoff and phosphorous loading into the lakes.
- Promote restoration of shoreland buffers as an effective means of managing runoff from riparian lots and improving lake water quality.
- Develop demonstration sites throughout the watershed to provide examples of quality buffer restorations.
- Provide awards and positive reinforcement each year to recognize quality shoreland restoration projects.
- Create a shoreland buffer restoration-training program in the watershed or at the county level.
- Communicate the role of a functional lake food chain for maintaining water quality
- Stress the importance of natural shoreland areas for healthy in-lake ecosystems.
- Encourage all riparian homeowners to allow woody debris to remain in the water as fish habitat.
- Design and distribute pamphlets especially prepared for landowners who adjoin or own Sensitive Areas identified by the DNR (critical fish habitat areas). Use DNR Sensitive Area guidelines as a basis for pamphlets.
- Sponsor roundtables to discuss the need to update the dam order on Long Lake.
- Identify parties likely to be impacted by higher winter water levels and inlcude their concerns in updated dam orders.
- Provide information on the types of docks and structures can be removed to prevent damage occurring during ice pushes.
- Create a fully realized demonstration site at the Long Lake dam with informative signage to explain buffer restoration goals and strategies.
- Inform shoreland owners of the concepts related to non-conforming structures.

Invasive Species Education

- Create kiosks at boat launches in the watershed and include informative material describing how exotic plants/animals are spread and important steps for protecting lakes; post maps showing where exotics are found in the region.
- Provide event-oriented information regarding exotics during events where boats are going to be coming from outside the watershed (i.e. fishing tournaments).
- Sponsor public service announcements reminding boaters of their role in preventing the spread of exotic species.

- Utilize existing tourist-oriented communications (brochures, maps, etc.) to inform visitors of the importance of invasive species prevention.
- Conduct site visits to nearby lakes affected by invasive exotics to learn from their experience and hear what they are doing to limit further spread.
- Investigate potential areas for raising of beetles for use as a biological control of purple loosestrife

Forest Management Education

- Develop a mailing list of landowners in the watershed who would qualify for MFL enrollment or are suitable for conservation easements or subdivisions
- Contact property owners with large forest tracts to ensure that they are aware of the available management programs.
- Prioritize contact efforts to emphasize large parcels of land with special watershed impact (shorelines, wetlands, and lands likely to develop in the near future).
- Identify conservation subdivision projects in the region that can be used as examples and draw from their experiences to facilitate implementation.
- Identify willing landowners who are likely to develop and are open to the conservation subdivision idea.
- Share "success stories" of landowners in the watershed who are enrolled in MFL or have donated/sold conservation easements
- Communicate the importance of BMPs for forest management to landowners involved in timber harvesting in the watershed.
- Educate property owners about the danger of oak wilt and actions they can take to keep it out of the watershed (discourage firewood transport from infected areas, educate about proper pruning and cutting times).
- Educate visitors and landowners about gypsy moth and the importance of inspecting for egg masses when transporting vehicles and wood from infested areas into the area.
- Promote the use of native vegetation and discourage the use of invasive exotics in watershed landscaping projects- particularly glossy European buckthorn.
- Highlight forest habitat restoration projects on public lands such as the Town of Long Lake's and County lands.
- Overall forest health information in the watershed and in the county and should be shared with the public through newsletters, press releases or web pages.
- Sponsor annual presentations on land protection options with the Western Wisconsin Land Trust.

Agricultural Practices Education

- Share the stories of farmers who have successfully employed no-till and other less intensive cropping practices.
- Continue promoting programs that encourage and reward land and soil conservation like the Wetlands Incentives Program and Conservation Reserve Program.
- Develop a prairie restoration demonstration site in the watershed using retired farmland.

Local Governments and Officials Education

- Regularly provide information regarding watershed protection to area regulatory groups (county zoning, DNR, town boards, etc.).
- Explore the potential of requiring a certain level of training and awareness of natural resource issues for appointed officials (zoning committee, board of adjustment).

- Work with UW Extension to provide training for road construction personnel related to runoff and erosion control best management practices (BMPs).
- Implement culvert installation training in Washburn County to ensure that county, town and contract staff installs culverts correctly.
- Invite County resource agency staff, Board members and corporation counsel to tour watershed and Long Lake, pointing out key natural resource, land use compliance problems and enforcement issues.
- Regularly update and widely distribute the State of the Watershed report for the Long Lake watershed.
- Continue to monitor activities and decisions of the County Zoning Committee and Board of Adjustment; use newsletters and web pages forums for discussing regulatory and policy issues.
- Create a “Non-point Education for Rural Officials (NERO)” program similar to the existing “Non-point Education for Municipal Officials (NEMO)” program already being implemented in urban areas in Wisconsin and elsewhere. Modify NEMO program materials to reflect rural context and implement at the Town and County scale in the Long Lake watershed.

D. Resource Restoration and Improvement Strategies

Wetland Restoration and Improvement Strategies

- Work with local landowners who wish to restore wetlands on their property.
- Identify viable wetland restoration projects in the relevant local comprehensive plans.
- Develop a wetland restoration site inventory and map in cooperation with and recognized by DNR, the County and the Regional Planning Commission and prioritize sites using criteria including: technical feasibility and cost of restoration; type and degree of functional value (flood attenuation, water quality, habitat, etc.) of the wetland; location within the watershed; availability of the site; eligibility for leveraging additional wetland restoration funds; etc.
- Secure funding for wetland restoration projects from the DNR
- Ensure that restoration projects are accompanied by long-term maintenance commitments.
- Work with land trusts such as the Western Wisconsin Land Trust to establish conservation easements or trust ownership of designated important and threatened wetlands.

Stream Restoration and Improvement Strategies

- Identify sites where stream stabilization or stream habitat improvement projects would benefit the watershed.
- Secure funding for river and stream restoration projects from the DNR, Washburn County or US Fish and Wildlife Service.
- Ensure that restoration projects are accompanied by long-term maintenance commitments.

Lake Ecology Restoration and Improvement Strategies

- Focus restoration efforts on degraded aquatic plant communities in and adjacent to DNR designated Sensitive Areas.
- Secure cost-share money for landowners who voluntarily reestablish in-lake plant communities.

Shoreland and Riparian Area Restoration and Improvement Strategies
- Public agencies that own riparian land (DNR, county and towns) should begin improving their shoreland buffers at public boat landings, roads, and other public lands on or near lakes and rivers.
- Continue providing cost-share money to landowners who voluntarily restore shoreland buffers.

Upland Habitat Restoration and Improvement Strategies
- Work to remove or mitigate barriers to wildlife movement along natural corridors through acquisition or easements or through structural solutions such as removal of old fencing across streams and installing subsurface corridors at road crossings.
- Organize local plant, tree and shrub sales to encourage the use of native plants in landscaping and restoration projects.
- Develop a volunteer tree and shrub planting crew to assist elderly and disabled homeowners with restoration projects.

Storm Water Management and Improvement Strategies
- DNR, county and towns should work together to improve storm water infiltration at public boat landings and other public lands on or near lakes.
- Prioritize runoff control projects to emphasize those with greatest positive impact on surface waters and wetlands.
- Eliminate direct road runoff into surface waters through structural modifications to town and county roads.
- Install structural and/or natural means of filtering road runoff (settling basins, grass swales, etc.) near wetlands, lakes and streams where no such filtering currently exists.
- Install structural storm water detention mechanisms (rain barrels, rain gardens) at Town Halls and other public buildings in the watershed.
- Provide cost-share monies to building owners who voluntarily install storm water detention and infiltration BMPs (rain barrels, rain gardens, wet detention basins) on their properties.
- Eliminate unnecessary impervious surfaces throughout the watershed.

E. Watershed Protection Strategies

Groundwater Protection Strategies
- Continue efforts to locate all unsealed, abandoned wells in the watershed and properly close them to prevent pollution of groundwater.
- Provide additional financial resources to landowners if and when prohibitive costs are preventing proper well closure.
- Ensure that the County is actively documenting proper well abandonment as a condition of recording title transfers when properties are sold.
- Develop criteria for designating and mapping critical areas where groundwater resources are particularly susceptible to contamination.
- Ensure that large commercial, industrial and agricultural operations are given appropriate site and environmental review prior to authorization.
- County staff and DNR groundwater specialists need to share information with the public about any new sites of groundwater contamination.

- Encourage the County and the DNR to develop an emergency response plan in anticipation of likely groundwater contamination scenarios.
- Limit the overall amount of impervious surfaces created in the watershed through development (roads, buildings, etc.) to allow for continual and perpetual replenishing of the groundwater supply.

Wetland Protection Strategies

- Washburn County Highway Department and other groups that are permitted to remove wetlands need to develop practical alternatives to wetland modification in future road construction projects.
- Establish buffer areas around existing wetlands, particularly those classified by the DNR as highly susceptible and located outside of shoreland zones and floodplains.
- Promote rapid and complete implementation of Wisconsin's polluted runoff rules to protect wetlands from degradation.
- Work with the DNR and County to ensure that all future wetland losses are mitigated within the watershed consistent with provisions of the agreed upon priority site map.

Stream Protection Strategies

- Encourage the towns and the County to require erosion control BMPs for any land disturbance within the 125-foot stream buffer.
- Washburn County needs to strictly adhere to the lot size requirements for development along streams and rivers.
- County regulations should extend the minimum setback from 10 feet to 25 feet for intermittent streams and drainage ways determined to be critical for downstream water quality or sensitive to development and modifications.
- Prevent stream "overloading" by requiring storm water management plans for development projects that drain into streams, intermittent streams and existing drainage ways.
- Work with land trusts such as the Western Wisconsin Land Trust to establish conservation easements or trust ownership for lands along Slim Creek not already in public ownership.

Lake Protection Strategies

- Support a feasibility study for developing a hypolimnic draw for the Long Lake dam.
- Utilize native Long Lake population genetics in any fish stocking programs on the lake.
- Support initiatives to modify catch and size limits on Long Lake to improve age-class structure and species mix in the lake.
- Use the Long Lake Sensitive Areas Study as a basis for prioritizing in-lake habitat protection efforts.
- Work with land trusts such as the Western Wisconsin Land Trust to establish conservation easements for lands adjacent to Sensitive Areas that are not already in public ownership.
- Develop a Long Lake watershed "fisheries management plan" to guide stocking efforts and fishing regulations; expand native stocking efforts throughout the watershed to distribute fishing pressure more evenly.
- Identify slow-no-wake zones around in-lake Sensitive Areas.
- Develop town ordinances to implement slow-no-wake zones and other boating regulations required to protect Sensitive Areas and lake habitat.

- Secure funding to finance an enforcement officer during key times of the year to enforce lake boating rules and regulations.
- County and towns need to prepare sufficiently detailed engineering and erosion control plans for any road repair or construction in the shoreland zone or near wetlands to ensure that runoff does not impact water quality.
- Require a fairly strict timeline for operating the Long Lake dam; begin winter drawdown after Labor Day, follow a more consistent operating schedule.
- Develop a more formal dam operation process that defines who is in charge of operations of the Long Lake dam and what is expected of them.
- Amend and update the dam orders to modernize them and reflect current concerns; develop a working dam operation agreement between the DNR and the Washburn County.
- Consider elimination of the winter drawdowns that occur on Long Lake.

Upland Habitat and Storm Water Infiltration Areas Protection Strategies
- Regular meetings should take place with Washburn County, local towns, DNR, the Boy Scouts camp, the LLPA, Western Wisconsin Land Trust (WWLT), and others to develop detailed criteria for designation of threatened sensitive lands, a map describing those lands, and a system for ensuring their long-term protection.
- When appropriate, conservation groups, local government and WWLT should cooperatively prepare grant applications to appropriate funding sources to finance acquisition and easements of threatened sensitive lands.
- Conservation groups and local government should cooperate with WWLT to establish a long-term system for holding and assuring compliance with easements.
- County Forest management plans should require practices do not threaten important habitat areas, particularly riparian areas.
- The County Forest system should continue “blocking” their holdings to maintain or expand the present amount of public forest in the watershed.
- Ensure that the unique qualities of the Birchwood Lakes Unit are adequately recognized and protected in the County Forest Plan.
- New roads and road reconstruction projects need to include long-term storm water management considerations. New roads need to include storm water retention areas that ensure no net addition of runoff to nearby water bodies.
- As a general principle, local governments should work with landowners to focus new development along existing transportation network, minimizing the need for additional roads.
- Require future subdivisions to maintain storm water on-site (no net addition to a site’s runoff).
- Limit the size of new residential lots that can be created to no smaller than five acres *unless* storm water management plans (based on BMPs) are designed and implemented to ensure no net increase in runoff.
- Integrate storm water management inspections with other on-site inspections (buffer maintenance, erosion control, septic system, building, etc.) conducted during and at the end of permitted construction projects; prioritize inspection frequency based on the potential for runoff problems (based on slope, proximity to water or wetlands, amount of grading, etc.).

- Develop a land division or subdivision ordinance (at the town or county level) to codify lot size and storm water management requirements; allow for conservation subdivision designs to be used where such developments can better protect water quality.
- Identify and secure funding sources for the creation of nutrient management plans for farms in the watershed, ensuring that all watershed farms have such plans by 2005.

Appendix A. Key Concepts for The Long Lake Watershed

The terminology of watershed management can be daunting to those unfamiliar with it. The following glossary of key watershed management terms provides a guide for residents, visitors and government or agency decision makers to increase their understanding of Long Lake and its watershed.

Watersheds

- A ***watershed*** is an area of land where water drains toward a common water body. It is also called a drainage basin. Since runoff from all lands in a watershed potentially affect water quality in the receiving water body, the scope of water quality investigations and management strategies should consider the entire watershed.

- ***Wetlands*** are areas where water is near, at or above the land surface often enough to form soils that have unique structural and chemical characteristics. Wetlands commonly support plants recognized as wetland species. These species are important wildlife habitat and food sources and also function in pollution control. Wetlands store runoff helping to prevent downstream flooding and to control pollution. Many Wisconsin wetlands receive groundwater and slowly release it to streams and lakes. This helps maintain dry season stream flows and lake levels.

- ***Lakes*** are bodies of water surrounded by land. Lakes receive water from direct precipitation on the lake and drainage from their watershed. Sunlight and nutrients within the lake result in the formation of organic matter by photosynthesizing organisms. This internal production of organic matter forms the base of the lake food chain.

- ***Streams*** are surface waters characterized by their flow, usually in one direction. The base of the food chain in small streams may be provided by organic matter derived from adjacent lands (e.g., leaves), although larger streams may also support the internal generation of organic matter by algae and aquatic plants within the stream.

- ***Groundwater*** is water that flows or seeps downward through upper soil layers and fills the spaces in soil or porous rock deeper in the ground. The top of the deeper, saturated zone is called the water table. This deeper groundwater moves horizontally and vertically through the watershed from high-pressure areas where precipitation infiltrates into the soil to low-pressure areas such as wetlands, streams or lakes. Groundwater supplies water for wells and springs, and contributes water to streams, wetlands, and lakes, also provides dry season base flow in streams.

- An ***aquifer*** is the geological formation through which the groundwater moves. Some aquifers are very permeable making them important sources of drinking or irrigation water. Because groundwater moves very slowly (from less than an inch to more than a foot per day), contamination may take years to detect and many more years and dollars to clean up.

- ***Infiltration*—**is the movement of precipitation from the land surface into the ground. Infiltrated water can move deeper and reach the water table where it becomes part of the groundwater or it can be taken up by plants and moved back into the atmosphere.

- ***Permeability*** is the rate at which a geological formation or surface materials pass water. Permeable materials, such as gravel and sand, allow groundwater to move relatively quickly, while impermeable materials, such as clay or dense rock, permit only slow movement. Covering a significant portion of a watershed (12-15%) with ***impervious surfaces*** such as buildings, roadways and compacted soils greatly increases surface runoff by reducing infiltration. This surface runoff can have high concentrations of nutrients and pollutants, and can carry them directly to surface waters.

- ***Hydrologic cycle*** or more commonly the ***water cycle*** is the natural circuit of water movement from groundwater to surface waters and wetlands and from surface waters and the land surface to the atmosphere by evaporation or transpiration and the return of water from the atmosphere as precipitation. . The natural pathway water follows as it changes between liquid, solid, and gaseous states.

- ***Evapotranspiration*** is the transfer of water from land to air by converting liquid water to the vapor form. This transfer can occur through plants ***("transpiration"***) and directly from the surface of lakes and moist soil ***("evaporation")***

- A ***Water budget*** is an accounting of the sources and fate of water. For example, a water budget for a lake would describe the amount and proportion of water, which enters from tributaries, runoff, direct precipitation and groundwater and leaves as stream flow, infiltration to groundwater, and evaporation to the atmosphere or diversion for human use.

- ***Nutrient budgets*** are an accounting for the major sources of nutrients to surface waters. In Wisconsin, these are typically developed for phosphorus because that is the nutrient most directly linked to eutrophication. A phosphorus budget for a lake might include contributions from the atmosphere, tributary streams, groundwater, shoreland areas and internal recycling of phosphorus from sediments. Once in the lake, the phosphorus is cycled between bacteria, algae and microscopic animals, or leaves the lake through water flow or by settling into the sediment.

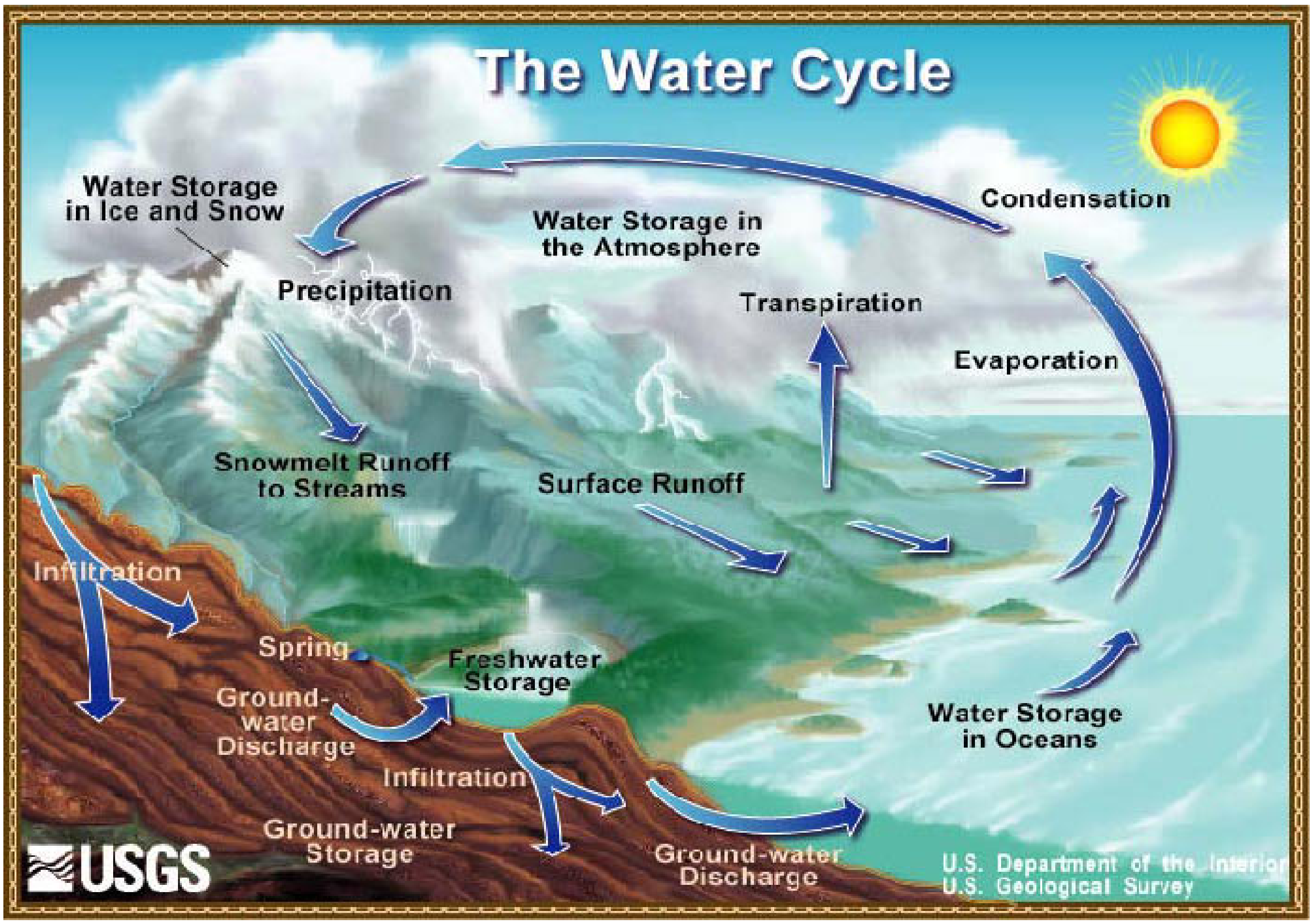


Figure A-1. The water cycle

Ecological Threats

- ***Erosion*** is the process in which soil and rock are worn away by movement of water (stream flow, runoff, wave action, ice movement, raindrop impact) or air. Phosphorus and pollutants bond to eroded materials and travel with them by runoff to surface waters.

- ***Fragmentation*** occurs when roads, utility corridors or other human development divide large, continuous tracts of land into smaller units. Resulting smaller parcels may not be economically suitable for agriculture or forestry. Some wildlife require large contiguous parcels of unfragmented habitat for their life cycle, while others thrive on the "edge" areas that are created between different land uses or cover types. Edge species become more common as fragmentation increases.

- ***Runoff*** is flow of water from storms or snowmelt through the watershed that carries nutrients and pollutants from *nonpoint sources.* Although runoff can take a variety of pathways through the watershed, most can be generalized as either surface runoff or groundwater runoff. ***Surface runoff*** or overland flow is the movement of water across the land surface. Surface runoff can carry sediment and nutrients at relatively high concentrations and transport them directly to surface waters. ***Groundwater runoff*** is the movement of water within the saturated subsurface zone to surface waters. Groundwater runoff usually carries much lower concentrations of sediment and nutrients, and takes longer to reach surface waters.

  There are several physical and biological characteristics of a watershed that affects runoff:

  Land use – Developed areas with many buildings, roads, parking and other impervious surfaces cause higher rates of surface runoff, by reducing infiltration and more rapidly conveying water.

  Vegetation – Areas of dense vegetation anchor soils, intercept raindrop impact, have higher infiltration rates, and generally slow runoff, which reduces erosion. They move water from soils to the atmosphere by transpiration and may cool runoff in shaded areas.

  Soil type – Permeable soils reduce surface runoff through greater infiltration and allowing more rapid infiltration to groundwater.

  Drainage area – The water quality of large drainage areas is generally more difficult to manage because they intercept more storms/precipitation causing more runoff and generally have more pollution sources such as development and land disturbing activities.

  Elevation – Basins at higher elevations that are *headwaters* do not receive polluted runoff and stream flow from basins upstream.

Slope – Greater slopes increase surface runoff. Greater slope decreases the time available for infiltration. Steeper slopes also increase stream velocity, which increases erosive power and ability to carry more and larger sediment particles and associated nutrients and pollutants.

Topography – Variable topography including lakes, ponds, reservoirs, sinks, and wetlands provides more opportunity for runoff detention and infiltration before transported pollutants reach surface waters.

Basin shape and direction of orientation – Runoff patterns differ with basin shape, size and orientation because patterns of precipitation and travel time of the moisture to outlet vary. For example, precipitation and runoff could be minimized for narrow basins oriented perpendicular to prevailing winds because storms pass relatively quickly, or small, round watersheds may show runoff peaks which are rapid and intense because water from throughout the watershed can appear together at the outlet.

Drainage network patterns – A dense network of stream channels is in relatively close contact with potential pollution sources throughout the basin.

- ***Nonpoint source pollution (NPS)—***is pollution transported by runoff from numerous activities/origins and locations in a watershed. Examples include eroded soil and nutrients from agricultural fields, soil from construction sites and parking lot runoff. It is distinguished from ***point source pollution*** that originates at a single source such as an industrial discharge or wastewater treatment plant. Point sources are generally regarded as easier to detect and remedy because pollution discharges are often obvious and concentrated.

- ***Eutrophication*** is the increase in biologic production within a lake. This has been described as a natural result of lake “aging”, but it can be accelerated by increases in the nutrient addition to lakes. The resulting over abundance of algae and aquatic plant growth in eutrophic waters impedes navigation and water sports. It also alters habitat and ecological processes, making waters aesthetically displeasing. Changes in species composition of fisheries from quality game species to rough fish (tolerant of periodic low oxygen levels) could result. Natural rates of eutrophication are usually expressed in geological time, happening over hundreds if not thousands of years, depending on the lake and watershed. Development and other human activities in a watershed can accelerate the rate of eutrophication primarily by increasing nutrient loading through increased runoff and non-point source pollution.

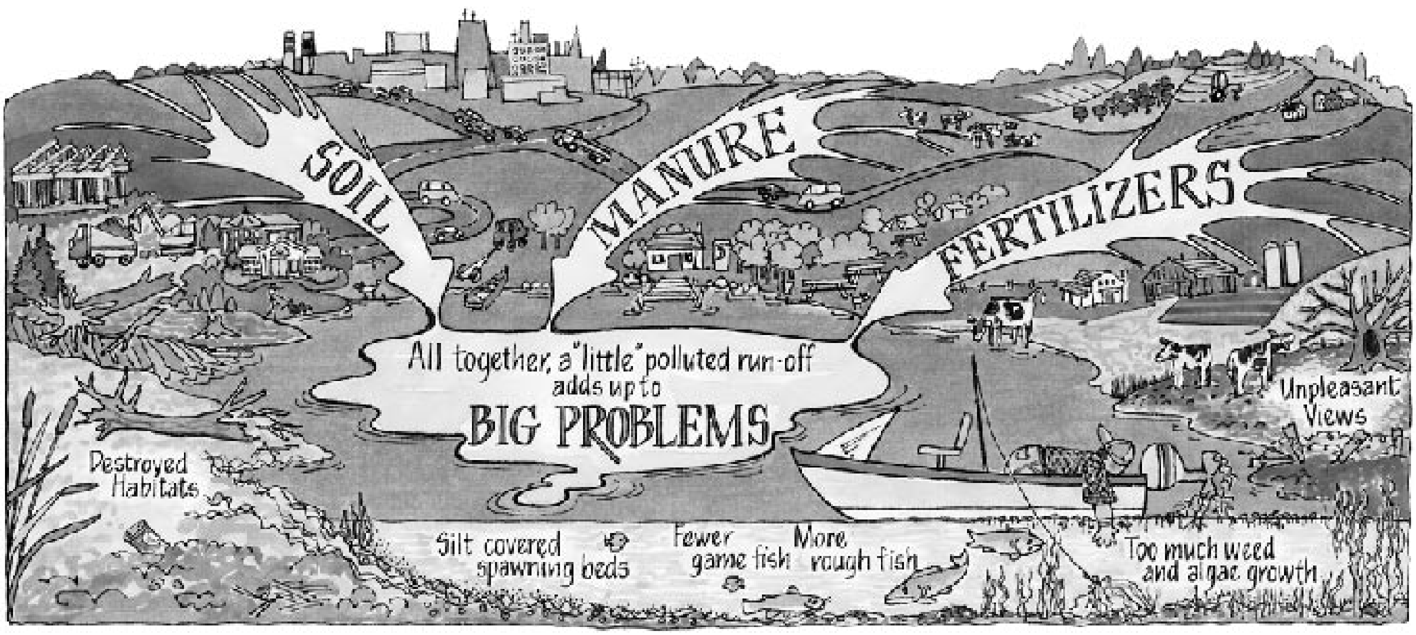


Figure A-2. Nonpoint source pollution (polluted runoff).

- ***Phosphorus*** is an essential element for aquatic and terrestrial plant life. It is a natural component of Wisconsin soils and one of three found in plant fertilizers (N = nitrogen, P = phosphorus and K = potassium). Phosphorus is a ***limiting nutrient*** in most Wisconsin surface waters because the other two elements needed for plant growth (N & K) are generally present in relative abundance. The addition of P to surface waters by runoff or other means causes increased rates of *eutrophication*. Many water quality management strategies focus on control of the amount of P transported to surface waters.

- ***Nitrogen***, in the forms of nitrate, nitrite, or ammonium, is a nutrient needed for plant growth. It is abundant naturally in the environment; about 78% of the air that we breathe is composed of nitrogen gas. It is also introduced through private septic systems, animal manure and chemical fertilizers. Excess nitrogen can cause ecological and economic affects similar to overabundant phosphorus in those few areas where N is in short supply in aquatic systems. Too much nitrate in drinking water can be harmful to young infants or young livestock. In some areas of the United States, particularly the northeast, certain forms of nitrogen are commonly deposited as acid rain that causes ecological and economic damage.

Watershed Ecology

- ***Food chain*** or ***trophic pyramid—***refers to the movement of energy in plant and animal matter as it is consumed by one trophic level of organisms that is in turn consumed by the next higher level. In most ecosystems, plants constitute the broad base of a pyramid that supports fewer and fewer species with movement up the pyramid to levels represented by meat eaters. This concept, in part, describes the ecological interdependence of species including humans.

- ***Species diversity, biological diversity***, or ***biodiversity*** refers to the variety of the world's organisms, often including genetic diversity among individuals of the same species. The term represents the natural biological wealth of the planet. Diversity allows species to evolve in response to changing conditions and serves as a repository of genetic material for new agricultural crop strains, pharmaceuticals and other plant and animal products useful to humans. The term also implies interdependence among species.

- An ***ecosystem*** consists of populations of species that interact with each other and their common environment. Humans are part of local and worldwide ecosystems on which they are dependent for food, water, oxygen and materials required for culture and commerce.

- ***Exotic species*** are plants or animals not native to an area. ***Invasive exotics*** may have a temporary or long-term competitive advantage over native species because they have no local diseases or predators to keep their numbers in check. As a result, they may overwhelm local species or ecological processes and displace native ecological components.

- ***Endangered/threatened species*** are species that is in imminent danger of becoming extinct.

- Freshwater ***macro-invertebrates*** include aquatic insects, worms, clams, snails, and crustaceans. They provide an important link in the food chain by converting plant material to animal matter and by recycling dead animal matter. Because of their abundance, wide distribution and sensitivity to environmental changes, they are commonly used to monitor water quality.

- ***Micro-invertebrates*** include microscopic insects, phytoplankton, zooplankton and parasites that provide an important link in the food chain through production of plant material by photosynthesis, predation or nutrient recycling.

Limnology

- ***Lake overturn or turnover*** refers to the mixing of lake waters caused principally by seasonal surface water temperature changes. Turnover generally occurs in the spring when water begins to warm after ice out and again in the fall as it cools. When surface water reaches 39 degrees in spring, it becomes heavier than the water immediately below it and therefore sinks. The downward movement of surface water forces water in the deeper parts of the lake upward. The resulting circulation of water is called spring turnover. Spring turnover may last several weeks until the water reaches about 50 degrees, it begins to stratify or develop temperature layers. In the fall the same process occurs until ice starts to form.

- ***The littoral zone*** is the near shore area of a lake. This area is very productive for fish and aquatic life and often very important for recreation. The littoral zone can be heavily used but also susceptible to damage from development or other human activities.

- ***Lake sediments*** is a general term often applied to the material found at the bottom of a lake. Organic matter and nutrients from the watershed can accumulate in the sediments, particularly in deep portions of a lake. Decomposition of this material can deplete the oxygen. Nutrients in the sediment can also reenter the water and contribute to algal blooms. This internal source of nutrients can be more important in shallow lakes when wind mixing moves sediments into the water, and in deeper, ***eutrophic*** lakes where a lack of oxygen in deeper water contributes to phosphorus release from the sediment.

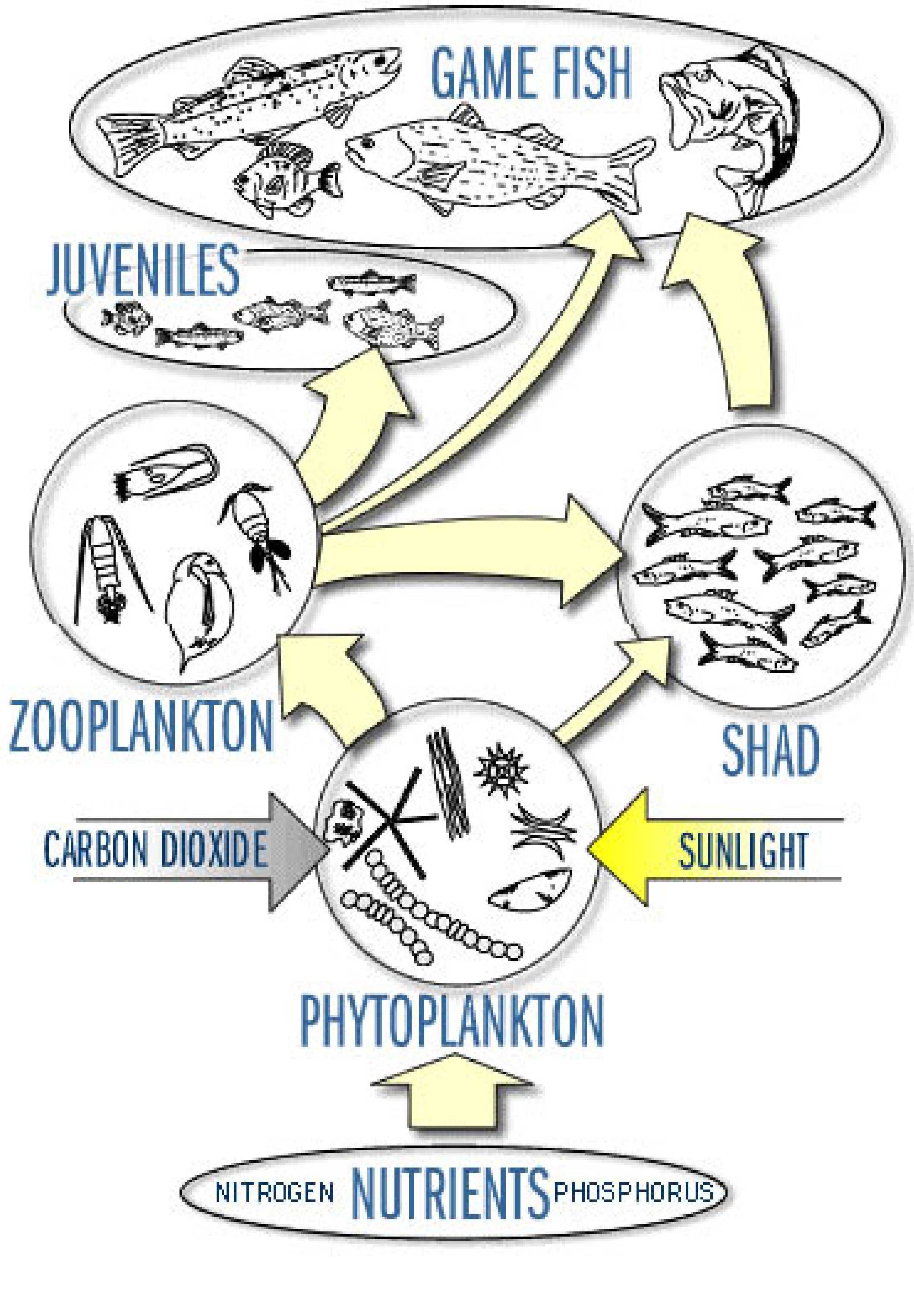


Figure A-3. The aquatic food chain.

- ***Lake stratification –*** or ***summer stratification*** is the separation of the lake into distinct layers, which have different temperatures. This occurs because the density of water changes with temperature. During the summer, cooler waters are denser and sink in the lake. Warmer waters are less dense and stay mixed at the surface. This generally occurs in lakes or portions of lakes with water depths over about 20-30 feet. Shallow lakes can be mixed throughout by wind action and may not strongly stratify, and even stratified lakes can be partially mixed at times during the summer. There are many implications of stratification for aquatic biology. Deeper waters can become depleted of oxygen when there is sufficient organic matter decomposition and an absence of mixing with the surface. This can become particularly significant in eutrophic lakes because of the large quantities of organic matter they produce. The stratification of lakes is commonly described using different temperature regions:
    - ***The epilimnion –***is the upper water layer that is a warmer (lighter), well-mixed and oxygenated zone where most aquatic life resides.
    - Below the epilimnion is a transitional zone where water temperatures rapidly change called the ***metalimnion***.
    - Within the metalimnion a ***thermocline*****—**is a plane or narrow band of greatest water temperature/density change. It is very resistant to wind mixing.
    - Beneath the metalimnion and extending to the lake bottom is the colder (heavier), and relatively undisturbed ***hypolimnion***. In lakes where prolific algal and plant growth sink to the bottom and consume oxygen during their decomposition, aquatic life in the hypolimnion will be limited to organisms that can tolerate very low oxygen levels.

- The ***trophic status*** of waters refers to their nutrient richness:

    Oligotrophic lakes have clear cold water, many different algal species but not in overabundance, oxygen throughout the year in bottom water, and oxygen-sensitive fish species in deep lakes (lake trout or cisco). Low nutrient levels may hamper plant and fish growth but water quality is generally considered to be excellent.

    Mesotrophic lakes have moderately clear water, generally offer good warm water sport fisheries but may have low dissolved oxygen in deep water during the summer.

    Eutrophic lakes are nutrient rich with abundant algal and aquatic plant growth. These conditions may impede navigation and water sports, change habitat and ecological processes, make waters aesthetically displeasing and can change species composition of fisheries from sight feeding game species to rough fish tolerant of periodic low oxygen levels.

    The process of ***eutrophication***, described above, changes lakes from one category to another.

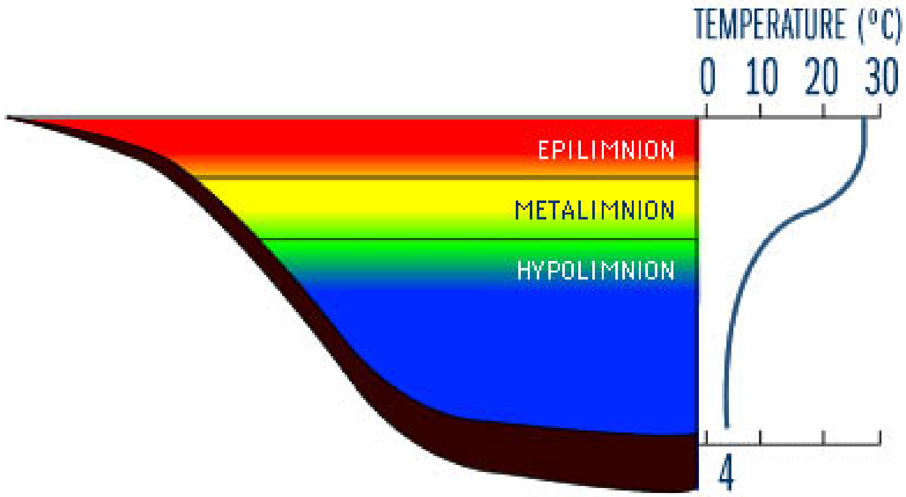


Figure A-4. Thermal stratification in a lake.

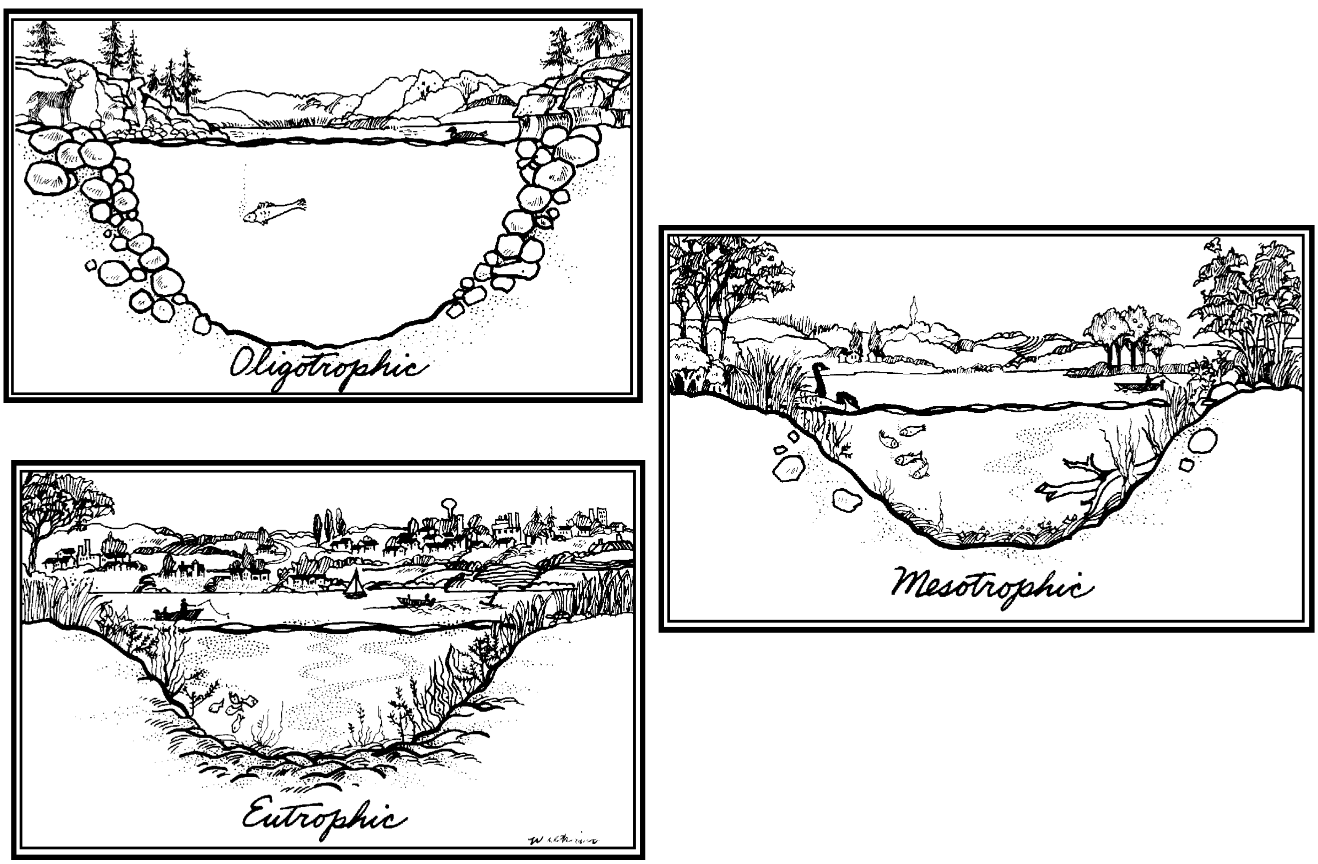


Figure A-5. Trophic status of lakes.

Agencies and Programs

Army Corps of Engineers refers to an agency of the U.S. Department of Defense that, among other duties, regulates the discharge of fill materials to wetlands under standards adopted by EPA and Section 404 of the federal Clean Water Act.

Construction site erosion control refers to requirements for management practices designed to control transport of sediment from construction sites that are administered by local units of government.

Comprehensive planning refers to local government processes that collectively prepare for future changes in the community. Under Wisconsin law, local government actions or decisions that impact how land is used must be made in accordance with a comprehensive plan as defined in SS 66.01.

DNR refers to the Wisconsin Department of Natural Resources, the lead state agency for natural resources management and regulation.

EPA refers to the U.S. Environmental Protection Agency, the federal agency that provides nationwide environmental standards and related technical and financial assistance.

Floodplain zoning refers to development standards designed to protect development and public safety that are administered by counties under a state mandate in flood prone areas.

NPDES (National Pollution Discharge Elimination System) & ***WPDES*** (Wisconsin version) refer to the federal and state programs (delegated by EPA) that regulate the discharge of water pollutants from point sources such as industry or municipal waste water treatment plants.

NRCS refers to the U.S. Department of Agriculture's Natural Resource Conservation Service, a federal agency that provides technical and financial assistance for resource management generally as it relates to agricultural production.

Shoreland zoning refers to development standards designed to protect navigable waters that are administered by counties under a state mandate in areas adjacent to waters.

State Chapter 30 regulations refer to regulations that apply to construction activities in and near state waters administered by DNR.

Stormwater management refers to standards for control of runoff that are designed to protect water quality and administered by local units of government.

Appendix B: A Baseline Approach to Control Phosphorus Delivery to Lakes

Why phosphorus?

The impact of phosphorus on lakes has been studied for more than seventy-five years . Monitoring results show reduced lake water clarity using Secchi disks and increases in algae chlorophyll concentrations can follow increases in phosphorus concentrations. Guidelines have been developed suggesting phosphorus concentrations between 10 and 20 ug/l (10-20 ppb) lead to lakes with intermediate biological productivity, and additional phosphorus leads to an increased likelihood of nuisance algal booms. Lakes with higher levels of phosphorus are termed eutrophic ("nutrient rich").

How can land development alter phosphorus transfer?

Changes to land that increase the amount of surface runoff generally increase the phosphorus transferred from land to water. Developing land often increases surface runoff for several reasons. These include: 1) less infiltration with the increase in impervious surface area; 2) less infiltration with increased compaction; 3) less infiltration after grading to facilitate water movement; and, 4) tree removal increases the amount and intensity of rain reaching the ground and can increase the amount of water available for runoff. The surface runoff generated can have relatively high concentrations of phosphorus because phosphorus is relatively abundant in most soils and plant material. Phosphorus is reactive, and will be held by the soil and recycled by vegetation, but when surface runoff travels over the land, it does not allow time or opportunities for reaction with soil, the phosphorus can be transferred to the lake. Concentrations of phosphorus in runoff from urban and agricultural areas can exceed 1000 ug/l.

A simple comparison of concentrations suggests this runoff can have undesired impacts on lakes, but that comparison oversimplifies the problem. The concentration in the runoff is important, but it is more important to understand the total quantify of phosphorus transferred. That amount is determined by the concentration and the total volume of runoff generated. Impervious surfaces, such as rooftops or paved areas, result in most of the precipitation becoming runoff. Some of the runoff can be retained in depressions within the pavement for example, but once those are filled, additional water runs off the surface. It is the combination of high phosphorus concentrations in surface runoff and increased flow rates of water that can have substantial impacts on lake water quality.

What is a baseline approach?

The baseline approach uses a target phosphorus transfer rate to evaluate land changes. This approach is a recognition that some phosphorus transfer from land to water is natural and even necessary, but that excessive phosphorus transfer can damage the aquatic ecology and water quality in lakes. The baseline approach compares future land use changes with a desired transfer rate to guide modifications to site design or relocation to meet the desired transfer rate.

How can a baseline be selected?

A baseline could be established in different ways. For example, previous research has established approximate annual phosphorus transfer rates associated with different types of land use. The most likely values for different uses described in a recent Wisconsin publication are shown in Table 1. An alternative approach could use the sensitivity of the lake to phosphorus. For example, studies in the 1970's showed that in many cases, the concentration of phosphorus in a lake is related to the amount of phosphorus and water that enters the lake every year. A variety of models were developed to predict the lake phosphorus with knowledge of phosphorus transfer and water flow. Figure 1 shows the application of one such model along with several simplifying assumptions.

Both Table 1 and Figure 1 suggest a phosphorus transfer baseline will depend on a balancing of land use and water quality. For example, if mesotrophic lake conditions are the target (e.g., phosphorus concentration of 15 ug/l), a watershed transfer rate of 0.1 to 0.2 lb/acre/year might be a reasonable target. That rate is considerably below the average of urban and row crop agriculture, suggesting such land uses would need to be aggressively managed to control phosphorus loss if they were to meet the target, or would need to be balanced with other land that has lower transfer rate.

Table 1. Most Likely Phosphorus Transfer Rates*	
Land Use	**Phosphorus Transfer (pound/acre/year)**
Urban (~ ½ acre lots)	0.46 (0.36-0.78)
Agricultural (more than 50% of watershed)	0.50 (0.14-2.1)
Agriculture (more than 95% of watershed)	0.92 (0.16-2.7)
Forest	0.08 (0.04-0.16)

*Most likely based on median of studies reviewed. Range shown represents approximately 10th and 90th percentile of studies reviewed, except urban and forest where entire range is shown. Source: Panuska and Lillie, 1995.

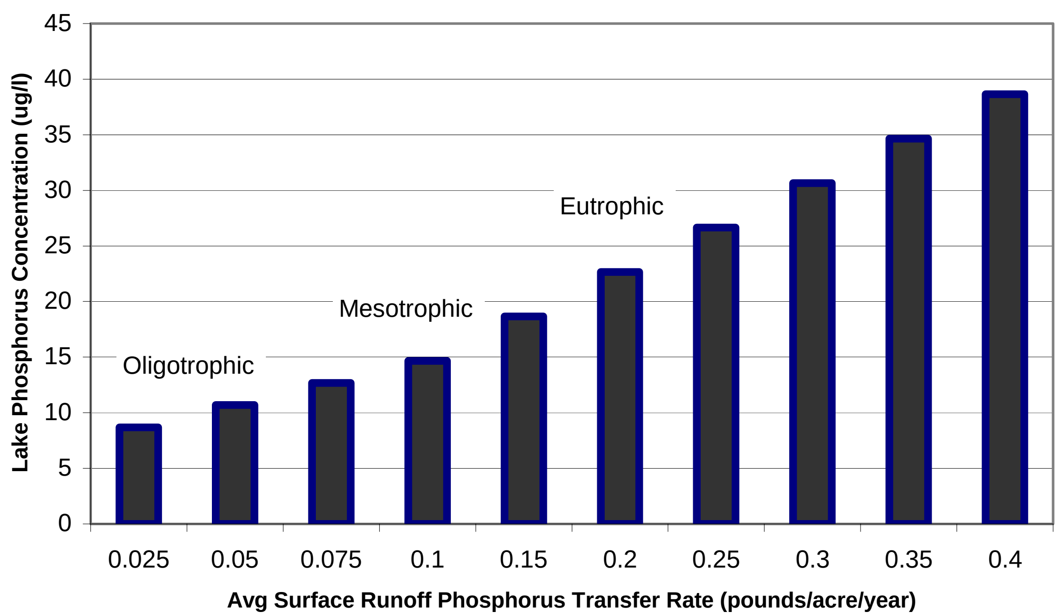


Figure 1. Example of the relationship between lake phosphorus concentration and average watershed phosphorus transfer rate using rather typical characteristics of many Wisconsin lakes (assumptions: Reckhow natural lake model, watershed/lake area ratio of 10, total watershed runoff of 0.7 cfs/square mile, atmospheric P deposition of 0.3 lb/acre-lake surface/year, groundwater P concentration 0.025 mg/l, no additional internal load assumed, precipitation on lake equal evaporation).

How can future development meet the baseline?

Meeting baseline phosphorus transfer rates below those typically found for a particular land use will require attention to runoff management. Preventing runoff from leaving a site is one way to reduce phosphorus transfer. Pervious areas that allow water to infiltrate will redirect potential runoff into the ground. This is similar to what occurs naturally in undisturbed, forested areas. Once the water infiltrates, it can either become groundwater or be taken up by plants and eventually transpired. Either way, it does not generate surface runoff. The amount of water that infiltrates depends on the soil characteristics (sand vs. silt or wet vs. dry), slope, vegetative cover and factors that relate to the storm (intensity, total amount of rain, previous soil moisture conditions). The infiltration rate of pervious areas can also be influenced by development if that results in soil compaction and grading that reduces infiltration and encourages runoff. From a phosphorus perspective, these changes would also increase the transfer rate.

Another important consideration near lakes is the fate of water from the impervious areas that is allowed to move onto more pervious areas. That transfer does provide an opportunity for the water to infiltrate; however, the amount of impervious runoff that infiltrates on the pervious areas depends on the infiltration characteristics of the pervious soils and the way in which the water is distributed. Water runoff onto small areas of pervious soil from relatively large impervious areas is likely to move as a small stream or channel. In that case, the water does not spend sufficient time nor is it allowed adequate opportunity for infiltration. In effect, such impervious areas can act as if they are directly connected with the lake.

Increased interest in protecting water resources coupled with high rates of potential development has led many communities to explore coupling development with reductions in the transfer rate. A variety of tools have been employed, and some of these approaches have been grouped under the term Low Impact Development (LID). LID is a general term that encompasses management practices and goals that will protect a natural resource. In the case of an inland Wisconsin lake for which phosphorus loading has been identified as a problem, LID practices could focus on meeting the baseline phosphorus transfer rate.

Not all LID concepts may be sufficient to meet a baseline phosphorus transfer rate. For example, disconnecting impervious areas from a drainage system will lower the overall runoff volume and reduce the peak flow from storms, but if those techniques allow runoff from larger storms to enter the lake or just delay water movement, development could still increase the phosphorus transfer rate beyond the baseline. In cases where the baseline is relatively low (e.g., 0.1 to 0.2 lb/acre/yr), meeting the baseline would likely require infiltration of large storms in addition to small ones.

Currently, there are several projects nationally exploring the influence of LID practices on phosphorus export. An ongoing monitoring program at the Somerset Subdivision in Maryland is an example. This study is comparing two developed small urban watersheds, one built with conventional curb, gutter and pipe stormwater conveyance, and the other with LID grassed swales and on-site water retention areas. Both of these developments have approximately 35% impervious area and 3 to 4 homes per acre. The LID site did produce less runoff volume than the conventional site, but still more than 25% of the rainfall was converted to runoff. Results described in a summary report, showed the LID site had a greater phosphorus transfer rate (2.45 lb/acre/yr) than the conventional design (1.2 lb/acre/yr). In this case, the LID practices provide some benefits, such as attenuating peak flows and providing some reduction in runoff volume, but they would not be sufficient to meet a relatively low phosphorus export baseline.

Another example of the challenges that simultaneous development and water resource protection face is shown in efforts to protect streams in the Pacific northwest. Tumwater, WA for example, has developed a “Zero Impact Development” drainage ordinance. To comply with this ordinance they suggest adherence to a “65/0” or 65% forested and 0% effective impervious (effective impervious refers to impervious that is hydraulically connected to the receiving water).

Can development patterns influence the phosphorus transfer rate?

The phosphorus transfer rate is significantly influenced by runoff volume and runoff concentration. Reductions in runoff volume that result when it is infiltrated instead of being directed through surface pathways decreases the phosphorus transfer rate. In general, as the fraction of the land that is developed increases, the phosphorus transfer rate is going to increase because there will be less infiltration and more runoff. Development can create more impervious area, increase runoff by grading to drain water, remove vegetation that intercepts rainfall and would otherwise reduce storm intensity, and removes leaf litter and surface accumulations that promote water retention. The extent to which these changes influence phosphorus transfer relate to the fraction of the land that is developed. Often, higher density development increases the fraction of that land that is altered.

Can we predict the phosphorus transfer rate?

Several methods are available to estimate runoff volumes and phosphorus concentrations. These are all approximations, and necessarily require assumptions be made, but they are useful for comparing the impact of different land uses on phosphorus transfer. In general, these methods must estimate runoff volumes and then associate a phosphorus concentration with it. The methods range in complexity. The simplest approach uses an estimated phosphorous transfer rate (e.g., Table 1), while more complex models may describe very specific steps in the transfer process, such as phosphorus uptake and release by plants and soil.

Does lot size influence likely phosphorus transfer rate?

To the extent that lot size changes the fraction of the land that is impervious, the connection between impervious and the lake, and the amount of land that remains forested, lot size also influences the phosphorus transfer rate. To simulate the impact of lot size on phosphorus transfer, a simple estimating approach was developed relating runoff volume to characteristics of the lot. Lots were assumed to have a percentage impervious and percentage developed pervious (e.g., lawns, gardens etc) that changed with lot size. A fraction of the impervious area was assumed to be directly connected to the lake, the other portion of the impervious area was assumed to drain uniformly across the pervious area. The assumptions regarding lot characteristics are shown in Table 2.

Increased land slope increases runoff volume because the water can move across the land more quickly and reduce the time for infiltration. Increased slope also may increase the connection between impervious areas and downstream surface water because of reduced infiltration during transfer. To provide an approximate adjustment for differences in slope, two adjustments were made: 1) the fraction of impervious connection was increased for steeper slopes; and 2) the runoff curve number was increased for steeper slopes (Williams, 1995). Developed pervious curve numbers were based on the NRCS TR-55 assuming they are vegetated but to be conservative, it assumes incomplete vegetation coverage (“poor” condition).

This estimation method is meant to be a simple, instructive tool to consider some possible impacts of development. Assumptions can be readily adjusted to consider alternatives. Care must be exercised in using the results of this lot size/phosphorus transfer rate prediction. To make these estimates, it was necessary to estimate the impervious fraction of the lot and the extent to which this impervious is connected to the lake. We have some experimental data to justify these assumptions, particularly at higher development densities, but at lower densities, little experimental data is available and estimates were made of connectedness.

Therefore, large lots are always better for water quality?

Yes, and no because it also depends on the alternatives. Before generalizing the usefulness of lot size as a way to maintain water quality, several related aspects should also be considered: 1) site design features could overcome some of the deleterious consequences suggested (but see LID discussion above), and 2) large lots are relatively inefficient in terms of the number of people that can be accommodated on the same land area. On a per person basis, the amount of runoff may be high on large lots because a relatively high percentage of land is devoted to transportation (e.g., roads). Clustered development and areas of undisturbed land in a watershed may have environmental benefits (University of Georgia, School of Environmental Design, 1997), particularly when examined in terms of the influence per-person on a water resource. These considerations are important, but were not part of the analysis here. This study specifically investigated the influence of development density on phosphorus transfer rates using a baseline approach for lake nutrient loading, and does not contrast alternatives for providing equal amounts of development potential.

Table 2. Uniform Lot Characteristics

Lot Size (acre)	Development Characteristics		
	Impervious (House, driveway)	Developed Pervious (Lawns, gardens)	Undeveloped (forested)
0.25	34%	67%	0%
0.5	23%	77%	0%
1	16%	84%	0%
2	12%	50%	38%
5	7%	20%	73%
10	5%	10%	85%
40	2.5%	2.5%	95%

Notes on Table 2:

1) Impervious percentage based on exponential fit to data in NRCS TR-55 and Capiella et al. (shown in Background to Three Component Urban Runoff Model).
2) Developed pervious percentage based on assuming up to 1 acre (if available) would be developed pervious.
3) Undeveloped assumed to be remainder of lot after impervious and developed pervious estimated.

Table 3a. Connection and Curve Number Adjustments Based on Slope for A Soil						
Lot Size (acre)	5% Slope		10% Slope		20% Slope	
	% Connection	Developed Pervious CN	% Connection	Developed Pervious CN	% Connection	Developed Pervious CN
0.25	100%	68	100%	74	100%	78
0.5	90%	68	100%	74	100%	78
1	80%	68	90%	74	100%	78
2	70%	68	80%	74	90%	78
5	60%	68	70%	74	80%	78
10	50%	68	60%	74	70%	78
40	40%	68	50%	74	60%	78

Table 3b. Connection and Curve Number Adjustments Based on Slope for B Soil						
Lot Size (acre)	5% Slope		10% Slope		20% Slope	
	% Connection	Developed Pervious CN	% Connection	Developed Pervious CN	% Connection	Developed Pervious CN
0.25	100%	79	100%	84	100%	88
0.5	90%	79	100%	84	100%	88
1	80%	79	90%	84	100%	88
2	70%	79	80%	84	90%	88
5	60%	79	70%	84	80%	88
10	50%	79	60%	84	70%	88
40	40%	79	50%	84	60%	88

Table 3c. Connection and Curve Number Adjustments Based on Slope for C Soil						
Lot Size (acre)	5% Slope		10% Slope		20% Slope	
	% Connection	Developed Pervious CN	% Connection	Developed Pervious CN	% Connection	Developed Pervious CN
0.25	100%	86	100%	90	100%	93
0.5	90%	86	100%	90	100%	93
1	80%	86	90%	90	100%	93
2	70%	86	80%	90	90%	93
5	60%	86	70%	90	80%	93
10	50%	86	60%	90	70%	93
40	40%	86	50%	90	60%	93

NOTES on Table 3:

1) CN (curve number) based on NRCS, 1986, Urban Hydrology for Small Watersheds, TR-55. USDA, Natural Resources Conservation Service, Chapter 2, Estimating Runoff and Table 2-2a. Pervious CN based on "open space" in poor condition. Slope adjustment based on Williams, J.R. 1995 equation as described in the Soil Water Assessment Tools User's Manual Version 2000 by S.L. Neitsch, J.G. Arnold, J.R. Kiniry and J.R. Williams, April, 2001.

2) % Connection describes the fraction of the runoff generated on impervious surfaces that is directed to the surface water. % Connection assumed close to 100% for small lot sizes based on research in Madison Wisconsin (USGS Water Resources Investigations Report 99-4021, Sources of phosphorus in stormwater and street dirt from two urban residential basins in Madison, Wisconsin, 1994-95, R.J. Waschbusch, W.R. Selbig, and R.T. Bannerman). Connection values for larger lot sizes can be adjusted if additional data is available. Connection assumed to increase with increasing slope based on increased likelihood for higher flow velocity and concentrated flow.

RESULTING SOIL AND SLOPE TABLES FOR P EXPORT

Table 4a. PHOSPHORUS EXPORT ON A SOILS

Lot Size (acre)	5% Slope		10% Slope		20% Slope	
	Runoff Volume (ft^3/acre/yr)	P Loss (lb/acre/yr)	Runoff Volume (ft^3/acre/yr)	P Loss (lb/acre/yr)	Runoff Volume (ft^3/acre/yr)	P Loss (lb/acre/yr)
0.25	21024	.52	21566	.54	22454	.56
0.5	13349	.33	15382	.38	16402	.41
1	8413	.21	10117	.25	12166	.30
2	5534	.14	6720	.17	8128	.20
5	2783	.07	3393	.08	4100	.10
10	1678	.04	2078	.05	2526	.06
40	706	.02	883	.02	1074	.03

Table 4b. PHOSPHORUS EXPORT ON B SOILS

Lot Size (acre)	5% Slope		10% Slope		20% Slope	
	Runoff Volume (ft^3/acre/yr)	P Loss (lb/acre/yr)	Runoff Volume (ft^3/acre/yr)	P Loss (lb/acre/yr)	Runoff Volume (ft^3/acre/yr)	P Loss (lb/acre/yr)
0.25	23371	.58	25789	.64	29284	.73
0.5	15529	.39	19588	.49	23664	.59
1	10843	.27	14886	.37	20089	.50
2	6991	.17	9603	.24	12942	.32
5	3349	.08	4536	.11	6030	.15
10	1959	.05	2647	.07	3793	.09
40	774	.02	1024	.03	1313	.03

Table 4c. PHOSPHORUS EXPORT ON C SOILS

Lot Size (acre)	5% Slope		10% Slope		20% Slope	
	Runoff Volume (ft^3/acre/yr)	P Loss (lb/acre/yr)	Runoff Volume (ft^3/acre/yr)	P Loss (lb/acre/yr)	Runoff Volume (ft^3/acre/yr)	P Loss (lb/acre/yr)
0.25	26780	.67	31379	.78	37571	.94
0.5	20365	.51	26660	.67	33777	.84
1	16188	.40	22784	.57	31120	.78
2	10187	.25	14351	.36	19600	.49
5	4606	.11	6425	.16	8697	.22
10	2583	.06	3590	.09	4826	.12
40	927	.02	1257	.03	1645	.04

NOTES on Table 4:
1) Runoff volume based on a three component model (impervious (CN=98), developed pervious (CN from Table 3), and undeveloped pervious (CN=60)) using assumptions shown in Table 3.
2) P (Phosphorus) Loss based on runoff volume calculated and assuming a phosphorus concentration of 0.4 mg/l (based on flow weighted mean phosphorus concentration for Harper Basin in Madison (USGS Water Resources Investigations Report 99-4021, Sources of phosphorus in stormwater and street dirt from two urban residential basins in Madison, Wisconsin, 1994-95, R.J. Waschbusch, W.R. Selbig, and R.T. Bannerman).

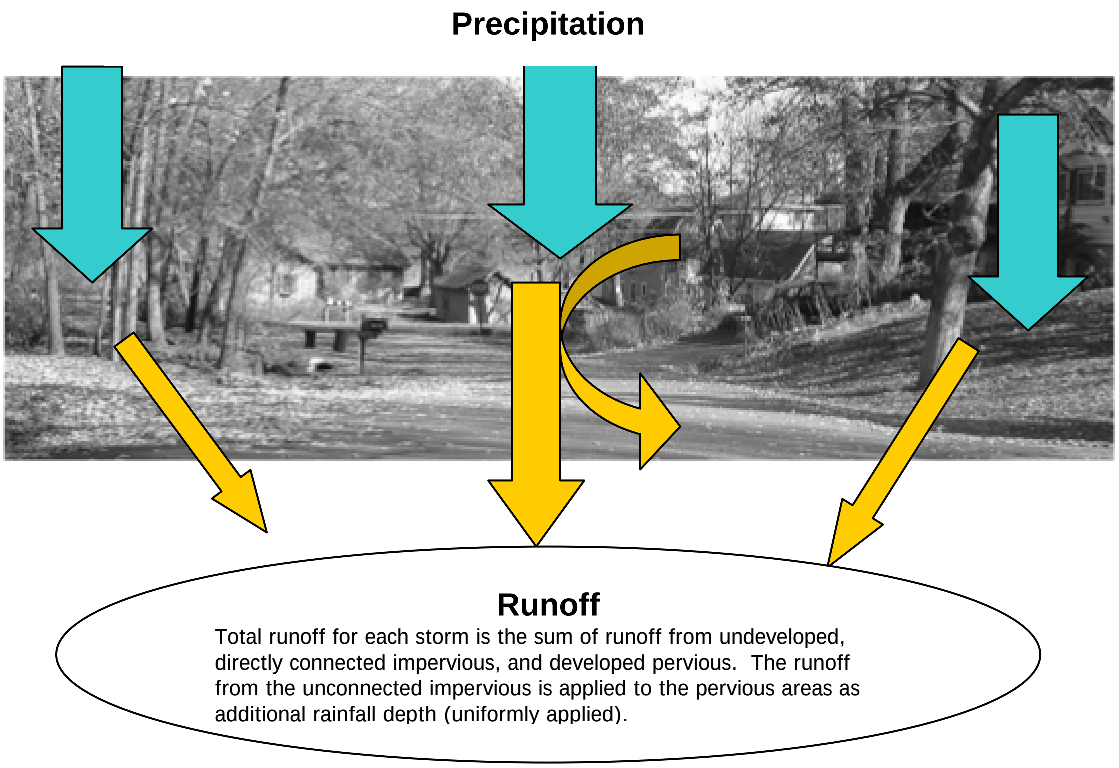
ATTACHMENT
Background on the Three Component Runoff Model

To evaluate the impact of development density on phosphorus transfer rate, a relatively simple simulation tool was employed. This tool was designed to provide a relatively transparent estimate of runoff volume from development. This tool is not meant to replace more sophisticated approaches to estimating individual site behavior, but to aid visualizing how several development characteristics impact phosphorus transfer. The approach does not include site specific variations nor does it separately evaluate snow melting and reductions in infiltration that might occur when the ground is frozen, although these can be important to phosphorus transfer.

This modeling approach is a “simple method” in that it computes a runoff volume and then applies a uniform concentration to estimate pollutant load. It classifies land as one of three different runoff types. Runoff is either associated with impervious (e.g., roofs, driveways), developed pervious areas (e.g., compacted/graded/vegetated, lawns), or undisturbed (forested) areas. Runoff volume is computed separately for each type. That runoff can all be directed to the outlet, or some of the runoff from the impervious can be redirected onto the pervious fraction.

Redirection of runoff from impervious areas to infiltrate on pervious areas mimics a reduction in connection between the impervious land and the outlet. Previous research provides some indication of the importance of connectivity between the impervious area and the outlet. If the runoff is directed directly towards the lake, it results in direct runoff even for low storm volumes. Previous research in urban areas has shown runoff from small storms at a watershed outlet that suggests a relatively high degree of connection. Assigning a degree of connection is not easy. In some situations, directing runoff from impervious areas to pervious areas does not always reduce the storm volume significantly. If the runoff is concentrated in channels or drainage ditches it may move too quickly over relatively small, saturated pervious areas and not be infiltrated. In that case, while the impervious connection to the lake may appear “indirect”, hydraulically, those areas can acts as though they are directly connected.

In the examples included in the attached paper, the runoff is estimated for a distribution of storms. Historical storm sizes were divided into different storm depths and the number of storms of a particular depth category per year was calculated. The runoff model was used to estimate the runoff from those different storm sizes and the resulting runoff was adjusted for the number of storms of each size. The total runoff for the year is calculated by summing the runoff volumes in each depth.

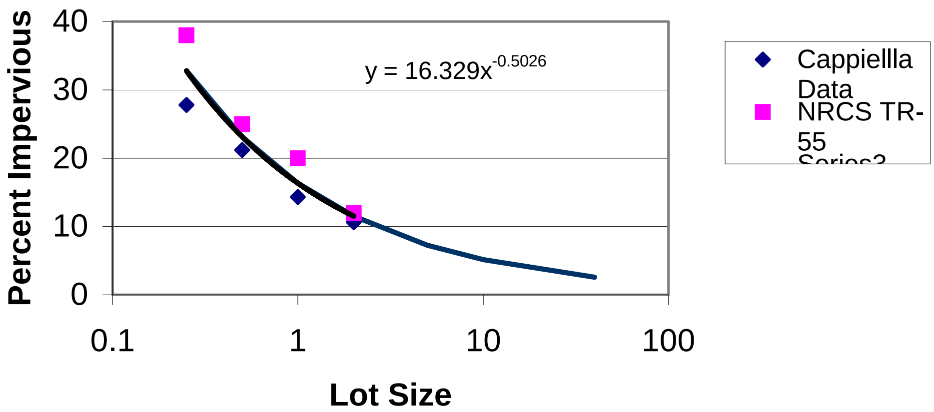


The three component model is a simple simulation tool that estimates runoff response for different storm sizes on different land uses and then combines the storms to provide an annual runoff total based on the number of storms of each depth.

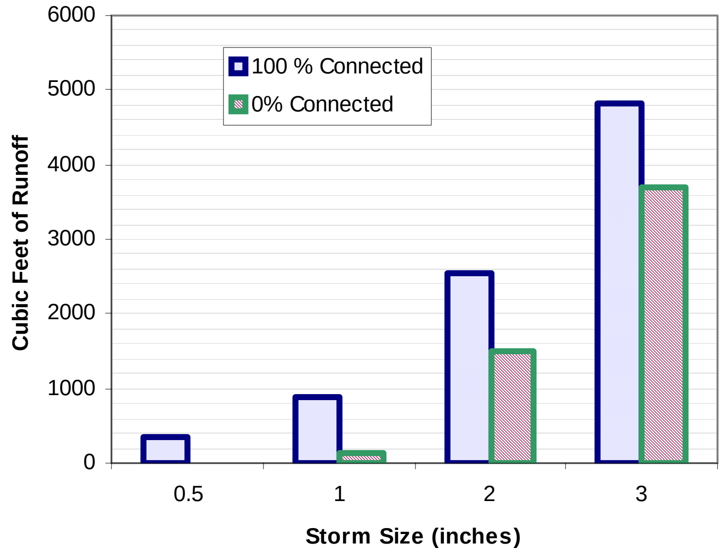
Estimating Lot Characteristics

Impervious Surface

The figure below shows the extrapolation from several studies to develop a relationship between impervious area and lot size. The developed pervious area (lawn, garden etc) was assumed to be 1 acre (or the remainder of the lot if less than 1 acre remained).



Connectivity
The connection between impervious surface and the lake is an important aspect of how runoff volume changes through development. Direct hydraulic connection between runoff generating areas and the surface water particularly influences the runoff from small storms. Because most storms are relatively small, decreasing the hydraulic connection can substantially decrease the overall runoff volume.



Importance of connectivity on runoff volume for different storm sizes assuming 35% impervious surface area and a runoff curve number of 70 for the pervious areas.

Studies of urban areas (Madison) or suburban development (Somerset) show how relatively small storms (e.g., 0.5 inches) can lead to relatively high runoff coefficients (e.g., 20-25% of the rain becomes runoff). Although both of these examples are relatively dense development (35-50% overall impervious), this does suggest a relatively strong connection between impervious area and the outlet. Development that does increase site runoff and allows for conveyance to an outlet would contribute to connectivity.

References from this section and resources for further information:

Panuska, J.C. and R.A. Lillie. 1995. Phosphorus loadings from Wisconsin watersheds: Recommended phosphorus export coefficients for agricultural and forested watersheds. Wisconsin Department of Natural Resources, Bureau of Research, Research Management Findings Number 38.

School of Environmental Design, The University of Georgia, 1997. Land Development Provisions to Protect Georgia Water Quality (available on-line).

Somerset Flow Monitoring Program. Summary report. (also see http://www.mgs.md.gov/mwmc/newsletter/pdf/somersub.pdf)

Puget Sound Action Team, 2003. Natural Approaches to Stormwater Management, Low Impact Development in Puget Sound. (available on-line: www.wa.gov/puget_sound).

Clausen, J.C., and J.K. Gilbert. 2003. Jordan Cove Urban Watershed Section 319 National Monitoring Program Project. Annual Report. Monitoring Project. University of Connecticut (http://www.canr.uconn.edu/jordancove/jcoveannual03a.pdf).

Center for Watershed Protection. An Introduction to Better Site Design. Watershed Protection Techniques 3(2):623-632.

Appendix C. Threatened and Endangered Species

The map in figure A-1 below shows the Towns of Birchwood, Madge, and Long Lake. The map illustrates the approximate locations of rare species and natural communities that have been recorded by the Wisconsin Natural Heritage Inventory (NHI).

The DNR identifies, protects and manages native plants, animals and natural communities that are threatened, endangered, or critically endangered in Wisconsin. Many of the species listed below are threatened or endangered within Wisconsin, but are not federally listed species. The DNR Endangered Resources program priorities are:

- preventing extinction;
- recovering species that are listed; and
- assist private individuals in conserving endangered species while meeting their social and economic objectives.

In many cases private lands are essential in protecting and recovering endangered species in Wisconsin. To meet this challenge, the Wisconsin DNR has started to education landowners' who are interested in maintaining their land while providing incentives to manage those lands in ways that benefit threaten/endangered species and/or resources. A variety of tools are available under the Endangered Species Act (ESA) to help States, Territories, and landowners plan and implement projects to conserve threaten/endangered species and their habitats. These types of programs make citizens aware that losing just one species/community no matter how large or small is significant. By building strong partnerships and initiating early and collaborative conservation efforts, the watershed can best achieve the purpose of the Endangered Species Act to conserve endangered and threatened species and the ecosystems upon which they depend.

The following data sets are listed under a general category, then by common name, followed by scientific name. Since the DNR will only allow NHI information to be given out at the countywide level, the following tables represent all rare species and natural communities within Washburn County.

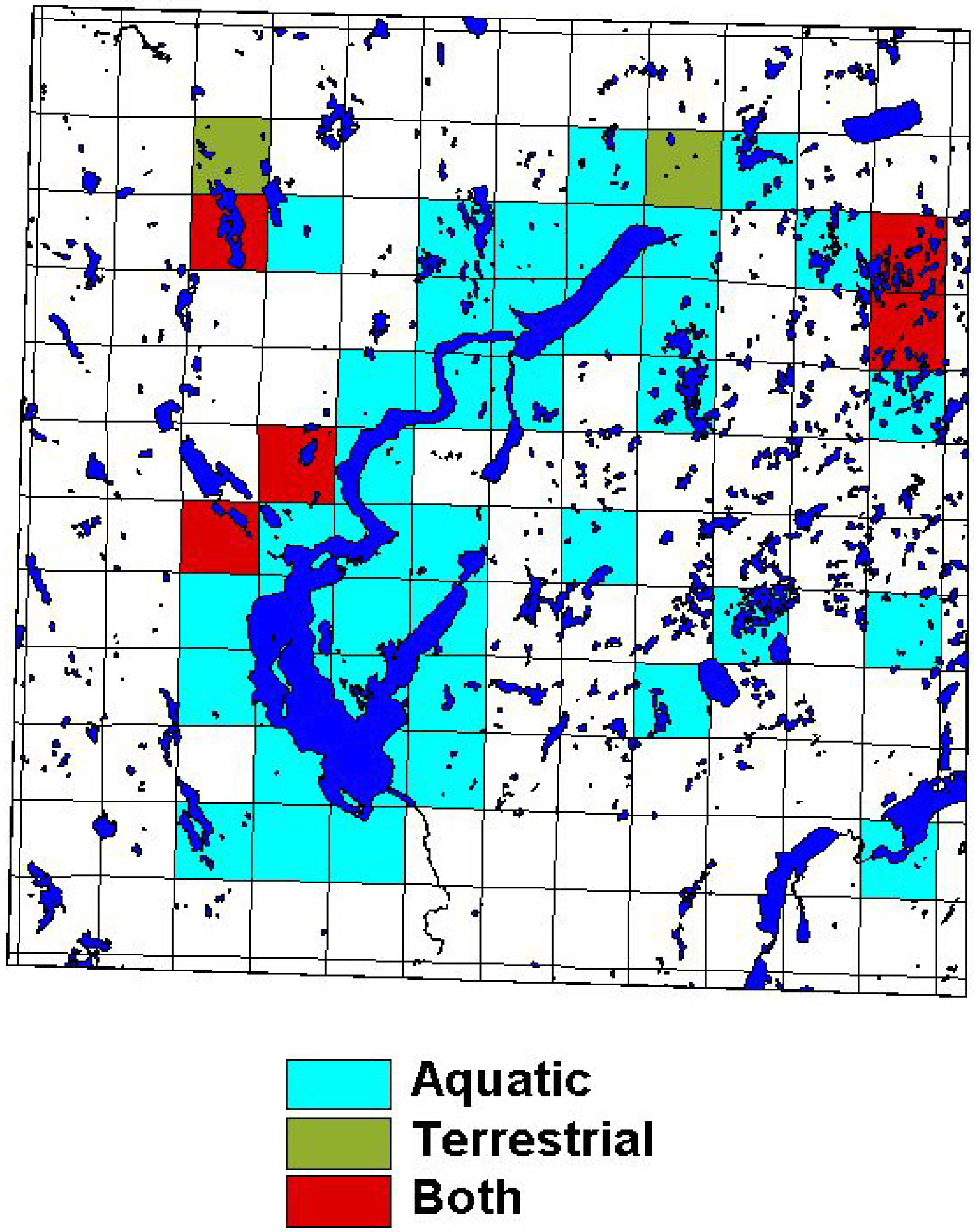


Figure C-1. Presence of Threatened and Endangered Species in Watershed
(Source: DNR Records)

Aquatic Occurrences

ANIMALS

Common Name	***Scientific Name***
Bald Eagle	*Haliaeetus Ieucocephalus*
Banded killifish	*Fundulus diaphanous*
Barrens snaketail	*Ophiogomphus sp 1 nr asperses*
Black tipped darner	*Aeshna tuberculifera*
Blanding s turtle	*Emydoidea blandingii*
Bog copper	*Lycaena epixanthe*
Bullfrog	*Rana catesbeiana*
Delicate emerald	*Somatochlora franklini*
Eastern elliptio	*Elliptio complanata*
Elktoe	*Alasmidonta marginata*
Extra striped snaketail	*Ophiogomphus anomalus*
Gilt darter	*Percina evides*
Great copper	*Lycaena dione*
Greater redhorse	*Moxostoma valenciennesi*
Green faced clubtail	*Gomphus viridifrons*
Lake herring	*Coregonus artedi*
Lake sturgeon	*Acipenser fulvescens*
Least darter	*Etheostoma microperca*
Little glassy wing	*Pompeius verna*
Osprey	*Pandion haliaetus*
Ozark minnow	*Notropis nubilus*
Pugnose shiner	*Notropis anogenus*
Purple wartyback	*Cyclonaias tuberculata*
Pygmy snaketail	*Ophiogomphus howei*
Red shouldered hawk	*Buteo lineatus*
Redside dace	*Clinostomus elongates*
Round pigtoe	*Pleurobema sintoxia*
Southern brook lamprey	*Ichthyomyzon gagei*
Splendid clubtail	*Gomphurus lineatifrons*
Stygian shadowfly	*Neurocordulia yamaskanensis*
Weed shiner	*Notropis texanus*
Wood turtle	*Clemmys insculpta*
Zebra clubtail	*Stylurus scudderi*

Aquatic Occurrences Continued

PLANTS

Common Name	Scientific Name
Assiniboine sedge	*Carex assiniboinensis*
Adder s tongue	*Ophioglossum pusillum*
Bog bluegrass	*Poa paludigena*
Leafy white orchis	*Platanthera dilatata*
Marsh ragwort	*Senecio congestus*
Round leaved orchis	*Amerorchis rotundifolia*
Showy lady s slipper	*Cypripedium reginae*
Swamp pink	*Arethusa bulbosa*
White adder s mouth	*Malaxis brachypoda*

NATURAL COMMUNITIES

Alder thicket	Lake shallow, soft, drainage	Northern wet forest
Hardwood swamp	Lake shallow, soft, seepage	Northern wet mesic forest
Lake deep, hard, drainage	Lake soft bog	Open bog
Lake deep, soft, seepage	Northern sedge meadow	Springs and spring runs, soft
		Stream slow, hard, cold

Terrestrial Occurrences

ANIMALS

Common Name	Scientific Name
Franklin ground squirrel	*Spermophilus franklinii*
A tiger beetle	*Cicindela patruela patruela*
Broad winged skipper	*Poanes viator*
Kirtland s warbler	*Dendroica kirtlandii*
Lynx	*Lynx Canadensis*
Northern goshawk	*Accipiter gentiles*

PLANTS

Common Name	Scientific Name
Flodman thistle	*Cirsium flodmanii*
Arrow headed rattle box	*Crotalaria sagittalis*
Climbing fumitory	*Adlumia fungosa*
Deam s rockcress	*Arabis missouriensis var deamii*
Dragon wormwood	*Artemisia dracunculus*
Dwarf milkweed	*Asclepias ovalifolia*
Hooker orchis	*Platanthera hookeri*
Large roundleaf orchid	*Platanthera orbiculata*
Mingan s moonwort	*Botrychium minganense*
Prairie sagebrush	*Artemisia frigida*
Purple clematis	*Clematis occidentalis*
Richardson sedge	*Carex richardsonii*
Snowy campion	*Silene nivea*

NATURAL COMMUNITIES

Northern dry mesic forest	Northern mesic forest	Southern dry mesic forest

Appendix D. Invasive Exotics

Invasive species and plants have become recognized in recent years as a major threat to the integrity of natural waterways. These species have the ability to invade natural systems and proliferate, often dominating sometimes eliminating the native species in a community. Invasive species can alter natural ecological processes by reducing the interactions of many species to the interactions of only a few species. Introduced species may compete directly with native species for nutrients, sunlight, and space, and indirectly by altering the food web or physical environment. Invasive species may also prey on or cross with existing natives. Native species with limited population size or ecological range are particularly susceptible to displacement by aggressive exotic or translocated species.

Aquatic exotics have become a major threat to the integrity of the Long Lake watershed. A key example of this is the rusty crayfish (*Orconectes rusticus*), an invader capable of eating all the native vegetation in several lakes in the Long Lake watershed. According to a 1996 report by the Nature Conservancy, exotic species have contributed to the population decline of 42 percent of threatened and endangered species in the United States.

In the Lower Chippewa Basin focus is placed towards seven exotic species that either currently affect some or all of the watershed or are of major concern for the overall integrity of the entire basin. The species that are of immediate concern are the rusty crayfish (Orconectes rusticus), Eurasian water milfoil (*Myriophyllum spicatum*), purple loosestrife (*Lythrum salicaria*), curly-leaf pondweed (Potamogeton crispus), zebra mussel (Dreissenia polymorpha), reed canary grass (*Phalaris arundinacea*), common carp (*Cyprinus carpio*). Each exotic will be described on its method of spreading, why it is a problem or could be a problem, solutions and prevention measures that can be taken or are being taken to stop the exotic from becoming a wide spread nuisance.

Exotics not only aquatic but terrestrials are affecting the Long Lake watershed and it is becoming a growing concern. Nonnative species are taking over sensitive areas at an alarming rate and prevention and control is going to play a major part in stopping the wide spread of exotics. The department has created an Aquatic Nuisance Species Program, along with a Comprehensive State Management Plan (still in draft form) that is keeping track of and studying the presence of exotic species. In the future, the Lower Chippewa basin will be keeping better track of what species aquatic and terrestrial are taking over and becoming a nuisance in each watershed. This will be done through intensive monitoring and testing of the basin waters.

rusty crayfish **(*Orconectes rusticus*)**
Rustys are native to streams in the Ohio, Kentucky and Tennessee region. Spread by anglers, who use them as bait, rusty crayfish can severely reduce lake and stream vegetation, depriving native fish of cover and food. They can also drastically reduce native crayfish populations.

Rustys are found in the most major river systems and most tributaries attached to them. They are also found in several isolated lakes and wetlands throughout the watershed. Most of the aquatic species that were introduced were either by connected waterways or spread to isolated lakes by fishermen. No solutions have been introduced to help stop or reduce the spreading of Rusty populations with out severally hurting the native species of that particular treated water body. The main concern is to stop the spread of the Rusty by educating the people, encouraging them to drain their live wells and not transporting live bait from one lake to another.

Eurasian water milfoil **(*Myriophyllum spicatum)***
Eurasian water milfoil was introduced to North America from Europe. It has spread westward into inland lakes primarily by boats and also by water birds, it reached Midwestern states between the 1950s and 1980s.

In nutrient-rich lakes it can form a thick underwater stand of tangled stems and vast mats of vegetation at the water's surface. In shallow areas the plant can interfere with water recreation. The plant's floating canopy can also crowd out important native water plants.

A key factor in the plant's success is its ability to reproduce through stem fragmentation and underground runners. A single segment of stem and leaves can take root and form a new colony. Fragments clinging to boats and trailers can spread the plant from lake to lake. The mechanical clearing of weed beds for beaches, docks, and landings creates thousands of new stem fragments. Removing native vegetation creates perfect habitat for invading Eurasian watermilfoil. One advantage of a healthy native population of vegetation is Eurasian watermilfoil has difficulty becoming established in lakes with healthy populations of native plants.

Several lakes within the Lower Chippewa Basin are currently impacted by exotic species such as curly-leaf pondweed and Eurasian water milfoil. Exotic species can have a detrimental impact on the natural plant community of a lake, particularly when their growth occurs at the expense of the lake’s native plant species. As of 2003, these exotic species were not found in the Long Lake watershed. Eurasian Water Milfoil has been confirmed in the lakes listed in table B-1 below.

Lake	County	Year Detected
Beaver Dam Lake	Barron	1991
Kidney Lake	Barron	2001
Sand Lake	Barron	2002
Clear Lake	Sawyer	1999
Connors Lake	Sawyer	2002
Lake Chippewa (Chippewa Flowage)	Sawyer	1991
Little Round Lake	Sawyer	1999
Round Lake (Big Round)	Sawyer	1993
Minong Flowage	Washburn	2002
Nancy Lake	Washburn	1991
Shallow Lake	Washburn	2003

Table D-1. Lakes with Eurasian water milfoil near the Long Lake watershed

purple loosestrife (***Lythrum salicaria***)
Purple Loosestrife is a wetland plant from Europe and Asia. It was introduced into the East Coast of North America in the 1800s. First spreading along roads, canals and drainage ditches, then later distributed as an ornamental, it is now located in 40 states and all Canadian border provinces.

The plant can form dense, impenetrable stands that are unsuitable as cover, food or nesting sites for a wide range of native wetland animals, including ducks, geese, rails, bitterns, muskrats, frogs, toads and turtles. Many rare and endangered wetland plants and animals are at risk of being forced out of their natural habitat.

Purple loosestrife thrives on disturbed, moist soils, often invading after construction activity. Eradication of an established stand is difficult because of an enormous seed bank that is stored in the soil. One adult can disperse two million seeds annually. The plant is able to regenerate from roots and broken stems that fall to the ground or into the water. A major reason for purple loosestrife's expansion is a lack of effective predators in North America. Several European insects that only attack purple loosestrife are being tested as a possible long-term biological control in North America.

curly-leaf pondweed (***Potamogeton crispus***)
Curly-leaf pondweed is a plant that forms surface mats that interfere with aquatic recreation. The plant usually drops to the lake bottom by early July. Curly-leaf pondweed was the most severe nuisance aquatic plant in the Midwest until Eurasian watermilfoil appeared. It was accidentally introduced along with the common carp. It has been here so long, most people are not aware it is an exotic.

zebra mussel (***Dreissenia polymorpha***)
Zebra mussels are small, fingernail-sized mussels native to the Caspian Sea region of Asia. Transoceanic vessels transported them to the Great Lakes. Empty oceanic going vessels would take on fresh water from European ports, then discharged the water into Lake St. Clair, near Detroit, where the mussel was discovered in 1988. Since that time, they have spread rapidly to all of the Great Lakes and waterways in many states, as well as Ontario and Quebec.

Diving ducks and freshwater drum eat zebra mussels, but not enough to control their rapidly going population. Means of spreading to inland lakes are not exactly known.

Though microscopic larvae may be carried in livewells or bilgewater, where adults can attach to boats or boating equipment that remain in the water for extended periods of time

reed canary grass **(*Phalaris arundinacea*)**
Reed Canary, a coarse grass that grows 2 to 6 feet tall, sprouting single flowers which occur in dense clusters in May to mid-June or August, seeds are shiny brown. Reed canary grass is a coarse, sod-forming, cool-season, perennial grass, native to temperate regions of Europe, Asia, and N. America, and adapted to much of the northern half of U.S. The Mediterranean region is the center of diversity for this genus. Its best growth is in and around wetlands, including marshes, wet prairies, wet meadows, fens, stream banks, and swales. It has also been planted widely through out Wisconsin for forage and for erosion control.

Reproduction occurs from seeds and vegetative stouts (creeping rhizomes). It starts growing in early spring. Growth peaks in mid-June and declines in mid-August. Seeds ripen in late June and fall off when ripe. The native reed canary grass is not thought to be aggressive, as is the Eurasian ecotype. The major concern is to marshes and natural wetlands because of its aggressive nature, and rapid growth. Native wetland and wet prairie plant species are being replaced after several years by reed canary grass. It is of particular concern because of the difficulty of selective control. There are several treatments to remove Reed Canary Grass but all of them involve several years of treatment and intensive work.

common carp **(*Cyprinus carpio)***
Common carp are domesticated ancestors of a wild carp native to the Caspian Sea region and East Asia. Carp degrade shallow lakes by causing excessive turgidity, which can lead to declines in waterfowl and important native fish species. The common carp was introduced by unintentional and intentional release in 1879 and now is located throughout most of the United States. Wisconsin state owned fish hatcheries stocked carp almost statewide until the early 1900's.

Appendix E. DNR Lake Inventory

The table on the following page provides summary information on the lakes located in the Long Lake watershed. The various columns and the terms in the columns are defined and described below.

Name of Lakes: All named lakes and some unnamed lakes over 10 acres are listed.

WI WB ID #: A (WBIC) Water Body Identification Code is used to link them to other databases.

Location Sec. T-N R-W: Township (North), range (West), and section identify location.

Surface Area (acres): This column provides information on the size of the lake surface in acres.

Max/Mean Depth (feet): The maximum depth in feet is recorded at the deepest point in a lake. The mean depth in feet is the average of all depths taken during deep study.

Miles of Shoreline: Indicates how many miles of shoreline are on each lake listed.

Public Access: This column describes if there is a public boat access on the lake or not.

- **BR -** Boat Ramp: These are sites with a defined public boat launching facility, which may or may not have parking.
- **BF -** Barrier-free Boat Ramp; These sites have a boarding dock or means of wheelchair access to boats.
- **P -** Barrier-free Pier: The piers were designed to accommodate wheelchairs.
- **T -** Walk in Trail: These access sites are partially developed, excluding a boat ramp and are entirely within public lands.
- **R** - Roadside: These sites do not include any access developments. Public roads with a marked right-of-way extending to the water provide a limited degree of access.
- **W -** Wildness in Public Ownership: A lake is in a wilderness area if there are no roads or buildings within 200 feet of the waterbody. Wilderness lakes have no defined walk-in trail to the water.
- **BW -** Barrier-free Wilderness Access: These sites have a firm surface to gain access to the water, but no special piers or ramps.
- **NW -** Navigable Water: Navigable access is provided by the presence of an inlet or outlet stream, which furnishes adequate boat access to a lake. A small stream not large enough to float a boat does is not consider a navigable access.
- **x-** Indicates there is not enough information regarding detailed accesses.

% of Private Shoreline: The over all % of shoreline at are privately owned on each lake.

Lake Name	WI WB ID #	Location Sec. T-N R-W	Surface Area	Mean/Max Depth	Miles of Shoreline	Public Access	% of Private Shoreline	Lake Type	P Sensit.	TSI	Tropic Class	Biological Use/Status	Rec. Use	LMO	Source	Impact	Monitoring A/S/D/R	Mangement A/S/D/R
Bass Lake	1833300	7-37-10	129.5	13/66	5.81	NW	49	SE	1A	49	Meso	WWSF	BT-L, FS-L, SW-L, WS-L				SH-S/R	
Berry Lake	1835000	17-37-10	42.7	UK/43	1.69		100	SE	1C			WWSF	BT-L, FS-L, SW-L, WS-L				SH-S/R	
Big Devil Lake	2107500	33-38-11	162.2	27/75	3.3	NW	100	DG	1A	45	Meso	WWSF	BT-M, FS-M, SW-M, WS-M				SH-S/R	
Camp Lake	1839000	23-38-10	10.3	010/35	0.68	BR	0	SE	1C			TSSF	BT-L, FS-M, SW-L, WS-L				DOT/O/H,WC/O/H,SH-S/R	AER/O/H,FS-ST/O/H
Casper Lake	1839600	25-38-12	18	UK/19				SE	1C			WWSF	BT-L, FS-L, SW-L, WS-L					
Chinty Lake	1840700	28-38-11	16.2	010/25	0.79		100	SE	1C				BT-L, FS-L, SW-H, WS-L					
Elbow Lake	1847000	9-37-10	36.3	UK/25	1.88	BR	29	SE	1A	45	Meso	WWSF	BT-L, FS-L, SW-L, WS-L				SH-S/R	
Eliza Lake	1847100	10-37-11	27.3	UK/46	1.08		100	SE	1C			WWSF	BT-L, FS-L, SW-L, WS-L				SH-S/R	
Elizabeth Lake	1858800	10-37-11	36.5	UK/24	1.08		100	SE	1C			WWSF	BT-L, FS-L, SW-L, WS-L				SH-S/R	
Floyd Lake	1849300	17-37-10	11	UK/33	0.74		100	SE	1C			WWSF	BT-L, FS-L, SW-L, WS-L					
Harmon Lake	1852500	13-38-11	95.8	009/33	3.8	BR	33	SE	1C			WWSF	BT-L, FS-M, SW-L, WS-L			HG	SH-S/R	
Horseshoe Lake	1854600	3-38-10	23.8	UK/5	0.86	R	100	SE	2C				BT-L, FS-L, SW-L, WS-L					
Lazy Island Lake	1859900	18-37-10	60.1	19/52	2.5		100	SE	1C			WWSF	BT-L, FS-L, SW-L, WS-L					
Little Devil Lake	2107600	29-38-11	55.6	14/34	2.16	BR	100	DN	1C			WWSF	BT-L, FS-L, SW-L, WS-L				SH-S/R	
Long Lake	2106800	15-37-10	3,289.70	26/74	38	BR	99	DN-NDL	1A	46	Meso	WWSF	BT-H, FS-H, SW-M, WS-H	ASSC			SH-C/O, VEG/C/00, FS-YOY/R/02/H	SR/R,PLAN/O,PROT/R
Loon Lake	1863100	8-37-10	48.5	14/46	2.25	R	33	SE	1C			WWSF	BT-L, FS-L, SW-L, WS-L				SH-S/R	
Loon Lake	1863200	16-37-10	45.7	14/49	2.59		100	SE	1C			WWSF	BT-L, FS-L, SW-M, WS-L				SH-S/R	
Loyhead Lake	1864200	13-38-10	74.5	011/35	4.11	BR	21	SE	1C			WWSF	BT-L, FS-L, SW-M, WS-L				SH-S/R	
MacRae Lake	1864500	28-38-10	124.2	UK/45	5.08	W	17	SE	1C			WWSF	BT-L, FS-L, SW-M, WS-L				SH-S/R	
Moody Lake	1867400	20-38-11	49.3	UK/30	2.57	BR	100	SE	1A	43	Meso	WWSF	BT-L, FS-L, SW-M, WS-L				SH-S/R	
Mud Lake	2107700	31-38-10	102.7	007/13	3.85	NW	100	DG	2C			WWSF	BT-L, FS-L, SW-M, WS-L		NPS, GW	NUT		
Nick Lake	1870500	3-37-10	55.7	21/79	3.12	W	32	SE	1C			WWSF	BT-L, FS-L, SW-M, WS-L				SH-S/R	
Ole Lake	1871500	21-38-10	42.8	UK/33	1.27	T	0	SE	1C			WWSF	BT-L, FS-M, SW-M, WS-L				SH-S/R	
Peters Lake	1873700	33-38-10	14.6	UK/12	0.78		0	SE	1C			WWSF	BT-L, FS-L, SW-L, WS-L					AER/O
Pine Island Lake	1874600	26-38-10	13.5	UK/35	0.83	W	0	SE	1C			WWSF	BT-L, FS-L, SW-L, WS-L					
Pollwog Lake	1875300	32-38-10	25.7	UK/15	1.34	W	43	SE	1C			WWSF	BT-L, FS-L, SW-L, WS-L					AER/O
Red Lake	1876500	5-37-10	41.3	23/75	1.61	BR	0	SE	1B	58	Eutr	WWSF	BT-L, FS-L, SW-L, WS-L				SH-S/R	
Ripley Lake	1877000	19-38-11	42.4	UK/25	1.69	R	100	SE	1A	45	Meso	WWSF	BT-L, FS-L, SW-L, WS-L					
Sawmill Lake	1880200	24-38-10	14.6	UK/26	0.82	BR	0	SE	1D			TSSF	BT-L, FS-M, SW-M, WS-L				DOT/O/L,SH-S/O/L	FS-ST/O/M,FS-REGS/O/M
Scoot Lake	1880300	22-38-10	21.6	UK/37	1.22	T	0	SE	1C			WWSF	BT-L, FS-L, SW-L, WS-L					
Slim Creek Flowage	2109100	10-38-10	101.1	006/27	4.3	BR	30	DG-IMP	1C			WWSF	BT-L, FS-M, SW-L, WS-L				FS-Other/P/02	
Slim Lake	2109300	1-38-10	223.5	22/42	2.63	BR	100	DG	1C	47	Meso	WWSF	BT-M, FS-M, SW-L, WS-M	ASSC			SH-S/O FS-Other.P/02	FS-ST/O
Stauffer Lake	1883900	13-38-11	42	UK/10	1.88	W	0	SE	2C			WWSF	BT-L, FS-L, SW-L, WS-L					
Stone Lake	1884000	31-38-11	38.5	UK/9	1.16		100	SE	2C			WWSF	BT-L, FS-L, SW-L, WS-L					
Superior Lake	1884700	27-38-10	37.5	UK/22	1.83		0	SE	1C			WWSF	BT-L, FS-M, SW-L, WS-L					
Twin Lake (E/W)		4-37-11	22.4	UK/44	1.08		100											
Watson Lake	2045500	23-38-11	32	UK/14				SE	2A	51	Eutr	WWSF	BT-L, FS-M, SW-L, WS-L					
West Lake	2045800	14-38-10	32.2	UK/27	1.6	T	0	SE	1C			WWSF	BT-L, FS-M, SW-L, WS-L				SH-S/R	
Wolf Lake	2046900	23-38-10	35	UK/43		BR		SE	1C			WWSF	BT-L, FS-M, SW-L, WS-L				SH-S/R	FS-REGS/O/L

<u>Lake Type</u>: Each lake type displays unique limnological characteristics based on physical and chemical properties. Production of plant and animal life generally varies in accordance with the lake type. Basic classifications and qualifying criteria are:

DG - Drainage Lake – Impoundments and natural lakes with the main water source from stream drainage. Has at least one inlet and one outlet.
SE - Seepage Lake – Landlocked. Water level maintained by groundwater table and basin seal. Intermittent outlet may be present.
SP - Spring Lake – Seldom has an inlet, but always has an outlet of substantial flow. Water supply dependent upon groundwater rather than surface drainage.
DN - Drained Lake – Natural lake with the main water source dependent on the groundwater table and seepage from adjoining wetlands. Seldom has an inlet but will have an outlet of very little flow similar to the seepage lake except for the outlet.

<u>Phos. Class</u>: Phosphorus Classification**.** This analysis classifies lakes according to their relative sensitivity to phosphorus loading and existing trophic condition. The screening identifies high quality lakes that should receive the highest priority for nutrient control. The analysis first separates lakes into two major categories: lakes sensitive to increased phosphorus loading (Class 1) and lakes less responsive to changes in phosphorus loading (Class 2). Lakes in each general classification are then subdivided into management groups based on data needs or existing water quality conditions.

Class 1: Lakes sensitive to increased phosphorus loading.

A - existing water quality fair to excellent; potentially most sensitive to increased phosphorus loading.
B - existing water quality poor to very poor; less sensitive to increased phosphorus loading than Group A.
C - data inadequate or insufficient to assess trophic condition; classification monitoring recommended.
D - stained, dystrophic lake, or aquatic plant-dominated lakes.

Class 2: Lakes less responsive to changes in phosphorus loading.

A - existing water quality fair to excellent; may not be as sensitive to phosphorus loading as Class 1 Lakes.
B - existing water quality poor to very poor; low sensitivity to increased phosphorus loading.
C - data inadequate or insufficient to assess trophic condition.
D - stained, dystrophic lake, or aquatic plant-dominated lakes.

<u>TSI Range</u>: Trophic State Index. TSI values indicate the productivity of a lake, ranging from very clear, nutrient-poor water with low TSI values (oligotrophic) to extremely productive, nutrient-rich water with high TSI values (eutrophic). The TSI range calculation uses Secchi disk readings, which measures water clarity, chlorophyll a concentrations and total phosphorus concentrations.

Trophic Class: Indicates where the lake is oligotrophic, mesotrophic, or eutrophic.

Biological Use/Statue: This column indicates the biological use that the stream or stream segment currently supports.

UNK - Existing use is unknown.
Cold (I) - High-quality stream where populations are sustained by natural reproduction.
Cold (II) - Stream has some natural reproduction but may need stocking to maintain a desirable fishery.
Cold (III) - Stream has no natural reproduction and requires annual stocking.

WWSF - Warm Water Sport Fish Communities, includes waters capable of supporting or serving as a spawning area for warm water sport fish species.

WWFF - Warm Water Forage Fish Communities, includes waters capable of supporting an abundant, diverse community of forage fish and other aquatic life.

LFF- Limited Forage Fish Communities, (intermediate surface waters); includes surface waters of limited Capacity due to low flow, naturally poor water quality or poor habitat. Capable of supporting only a limited community of tolerant forage fish and aquatic life.

LAL- Limited Aquatic Life, (marginal surface waters); includes surface waters severely limited because of low flow and naturally poor water quality or poor habitat. These waters are capable of supporting only a limited community of aquatic life.

Rec Use (Recreational Use): This category indicates the type of recreational activities known to be taking place on the lake, and the intensity of use.

BT – Boating
FS – Fishing
SW - Swimming
WS - Water Sports

LMO (Lake Management Organization): This column describes if there is a lake management District (Dist) or Association (Assn) associated with the lake.

ASSC (Lake Association) – Criteria for Lake Association status are spelled out in Section 144.253(1), Wisconsin Statutes. Generally, an Association must be at least 25 members in size, allow membership to anyone living within one mile of the lake for at least one month per year, and have lake protection and improvement as its primary purpose.

DIST (Lake District) – Criteria for Lake District status can be found in Chapter 33, Wisconsin State Statutes. A Lake District is a special purpose unit of government, which is formed through local government approval process. It has specified boundaries, and its main purpose is to improve or protect a lake and its watershed.

Rec (LMO Recommended) - It is not recommended that a LMO be developed

If blank – No lake management association exists

<u>Source</u> (cause of problem)

ACC- No or limited access
BDAM- Beaver Dam
DCH- Ditched
CM- Cranberry Marsh
DRDG- Dredging
EX- Exotic species
F- Forestry activities (logging, roads, stream crossings)
GR.PIT- Gravel Pit Washing Operation
HM- Hydrological Modification (dam, ditching wetland drainage)
IRR- Irrigation
MUN- Municipal Water Systems
NMM- Non-metallic Mining
NPS- Unspecified nonpoint sources
- **BY-** Barnyard or exercise lot runoff
- **CE-** Construction site erosion
- **CL-** Cropland erosion
- **DEV-** Intense development pressure
- **PSB-** Streambank pasturing
- **PWL-** Woodlot pasturing
- **RS-** Roadside erosion
- **SB-** Streambank erosion
- **URB-** Urban storm water runoff
- **WD-** Wind Erosion

PSM- Point source, municipal treatment plant discharge
PSI- Point source, industrial discharge
SW- Storm Sewer

<u>Impacts</u> (effects or impacts of source on a stream)

AD - Animal deformity
BAC - Bacteriological contamination
BAS - Baseflow
BEDLD - Bedload
BOD - Biochemical Oxygen Demand
CL - Chlorine toxicity
COM - Competition (i.e., encroachment by introduced species)
DO - Dissolved Oxygen
WK – Winter Kill
FLOW - Stream flow fluctuations caused by unnatural conditions.
HAB - Habitat (sedimentation, scouring, excessive removal of vegetation, etc.)
HM - Heavy metal toxicity
MAC - Undesirable rooted aquatic plant (macrophyte) or algal growth
MIG - Fish migration interference
NH_3 - Ammonia toxicity
NUT - Nutrients
ORG - Organic Chemical toxicity or bioaccumulation
PCB - PCB bioaccumulation

PH - pH (fluctuations or extreme high or low)
PST - Pesticide/herbicide toxicity
SC - Sediment contamination
SED - Sedimentation
TEMP - Temperature (fluctuations or extreme high or low)
TOX - General toxicity problems
TURB - Turbidity
303 (d) – Impaired waterbody listed on the EPA 303 (d) List
WQ – Impaired water quality

Monitoring (A) Activity/ (S) Status / (D) Date/ (R) Rank: The monitoring column includes a list of activates that have taken place on the lake in the past seven years or are recommended for the future. Monitoring activities that do not included a status, rank or dates are simply suggestions for future monitoring.

Status: This indicates the status identified for each monitoring activity.
R =Recommended, **P**=Planned, **O**=Ongoing, **C**=Complete

Date: If the monitoring activity is planned or has already been completed, the planned or completion date is included.

Rank: Each of the listed monitoring activities is also assigned a priority rank, based on the best professional judgment.
L=Low, M=Medium, H=High

Monitoring Activity Codes

DOT – The collection of dissolved oxygen and water temperature profile, generally at regular depth intervals at the deepest spot of the lake.

FS-Other – The collection of all other fisheries data that is not specifically taken to document the baseline (BASE) or comprehensive (FS-Comp) condition of fisheries resources. These monitoring activities tend to be stand-alone sampling techniques such as fish abundance (CPE), fish community health (IBI), or fish habitat condition (HAB).

SH-S (Self-Help Program – Secchi) – Collection of water clarity (Secchi depth) data by Lake Self-Help Program Volunteer Monitors.

VEG (Vegetation Surveys) – Collection of data about the aquatic plant communities by maximum rooting depth along specified transects.

WC – Water chemistry sampling includes a collection of samples for dissolved oxygen, temperature, pH, phosphorus or other parameters.

Management (A) Activity/ (S) Status / (D) Date/ (R) Rank: This column indicates if a management activities have taken place on the lake in the past seven years or are recommended for the future. Management activities that do not include a status, rank, or dates are simply suggestions for future management.

Status: This indicates the status identified for each monitoring activity.
R =Recommended, **P**=Planned, **O**=Ongoing, **C**=Complete

Date: If the monitoring activity is planned or has already been completed, the planned or completion date is included.

Rank: Each of the listed monitoring activities is also assigned a priority rank, based on the best professional judgment.
L=Low, M=Medium, H=High

Management Activity Codes

AER – Installation of an aeration system to prevent winterkill conditions

FS-Br (Fish Barrier) **–** In-lake management actions to reduce or control over abundant or nuisance fish populations. Examples include rough fish removal by commercial fishing, netting, seining, shocking or chemical treatment of waterways.

FS-Regs (Fish Regulations) – Management actions that restrict the harvest or harvest methods of sport fisheries. Examples include regulations of size and bag limits, season length, refuges, and gear and bait restrictions.

FS-ST (Stocking and Transfer) – Lake management actions to restore or enhance sport and non-game species. Examples include stocking fish raised in a hatchery or field transfer of wild stocks.

PLAN (Planning Grant) – Support of management planning through state-funded planning grants.

PROT (Protection Grant) – Support of resources protection activities through state-funded grants.

SR (Shoreline Habitat Restoration) – Protection or restoration of shoreland vegetative habitat to promote native species diversity.