Bone Lake

Comprehensive Lake Management Plan

Bone Lake Management District

August 2009

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Introduction

The Lake District Charter: Inland Lake Protection and Rehabilitation Districts

The Bone Lake Management District (the District) was formed in 1977. A Bone Lake Association had been in place prior to lake district formation since approximately 1965. A public inland lake protection and rehabilitation district is a special unit of government formed under Chapter 33 Wisconsin State Statutes to address lake management issues. Property owners living within the district boundaries may be assessed fees as part of the property tax levy. The lake district is not a general purpose unit of government like a town or county that must deal with a broad range of issues from fire protection to road repairs. A lake district is empowered to operate on its own initiative, independent of its creating entity and the state, but subject to local ordinances and state law. Lake districts can act together with other municipalities and agencies to undertake lake protection and rehabilitation projects.

Lake District General Management Powers

Lake districts can perform a wide variety of lake management activities such as:

- evaluate lake management issues
- carry out lake management activities such as lake aeration, dredging, and aquatic plant management
- develop long range lake management plans
- undertake projects to enhance recreation
- monitor water quality
- cooperate with non-profit organizations on projects
- operate water safety patrols
- form a sanitary sewer district

Plan Mission Statement

Bone Lake is a precious resource and one of the premier recreational lakes in this area. The overall mission of this comprehensive lake management plan is to maintain the health of Bone Lake to support clean water, natural beauty, recreation, and sport fishing for decades to come.

Bone Lake Management Goals

The following goals will guide the Lake District management efforts for Bone Lake.

Improve Bone Lake water clarity.

Maintain and enhance Bone Lake's natural beauty.

Protect and enhance wildlife habitat.

Protect and improve the Bone Lake fishery.

Maintain safe, effective navigation in Bone Lake.

An aquatic plant management plan was prepared for Bone Lake in 2008. Aquatic plant management goals are shown below.

Bone Lake Aquatic Plant Management Goals

Goal 1. Maintain recreational uses important to lake residents and users including swimming, fishing, and boating while balancing the need to preserve important native aquatic plant functions and their values.

Goal 2. Prevent the introduction of Eurasian water milfoil and other invasive aquatic plants.

Goal 3. Manage curly leaf pondweed to minimize navigation problems, prevent its spread, and protect native plant populations.

Goal 4. Protect the natural functions of diverse native plants including fish and waterfowl habitat, sediment stabilization, protection against invasion by non-native species, and natural aesthetics.

Goal 5. Educate lake residents and visitors about the role of aquatic plants in the lake, the management strategies found in the plan, and appropriate plant management actions.

Needs Assessment

Concerns of District Members

Concerns of district members were gathered in a variety of ways. The most important were a public opinion survey and participation of the comprehensive plan advisory committee.

Public Opinion Survey

A lake property owner survey was distributed in October 2007. As of January 3, 2008, 264 out of 487 surveys were completed and returned, a return rate of 54%. The results of the survey are discussed below and are found in Appendix A.

Popular lake activities are summarized in Figure 1 below.

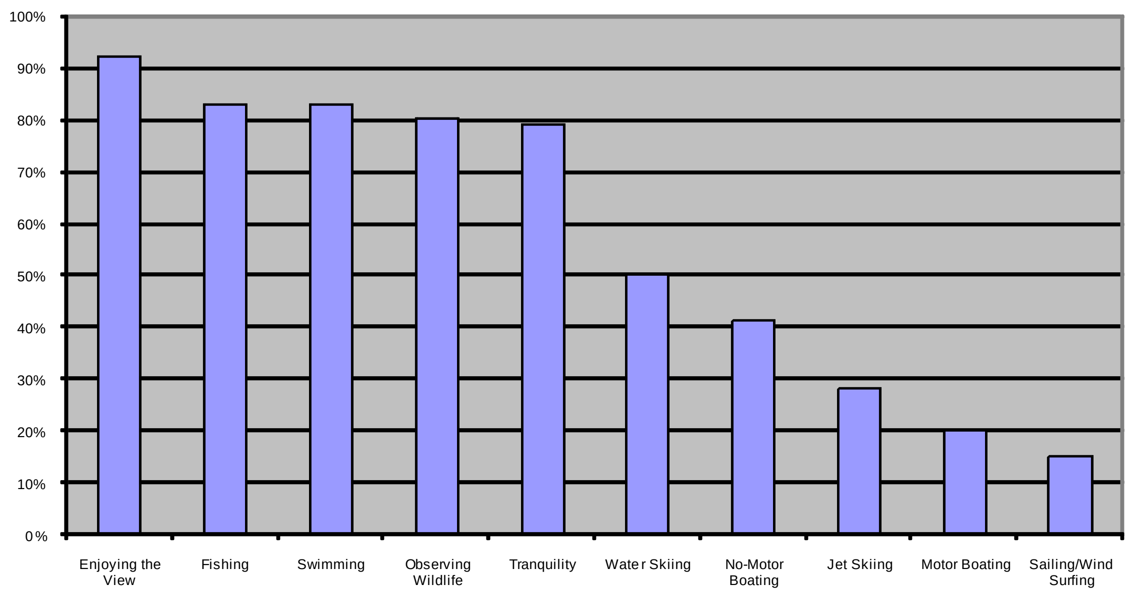


Figure 1. Survey Response: What recreational activities do you enjoy at the lake?

Additional survey results indicate a range of concerns and priorities from lake residents. The top concerns identified in the survey are property taxes, protecting the lake environment, and water clarity at the end of an owner's dock. In terms of negative impacts on use and enjoyment of the lake, invasive aquatic plant growth and algae growth were the top two, and native plant growth ranked third.

Comprehensive Plan Advisory Committee

The Comprehensive Plan Advisory Committee is the same group of people who helped develop the Bone Lake Aquatic Plant Management Plan in 2007 and 2008. The Committee met five times, beginning in November 2008, to identify lake management concerns, learn more about lake water quality, and to develop a lake management action plan.

The Comprehensive Plan Advisory Committee expressed a variety of concerns that are reflected in the goals and objectives in this plan. The committee considered the survey results and identified the following concerns in priority order. The number following each concern reflects a weighted ranking by the committee.

Water Quality (27)

Natural Scenery (12)

Fish Management (7)

Sediment Accumulation (6)

User Conflicts (3)

Aquatic Plant Management (3)

Visual impacts of residential development – building standards (3)

Wildlife Habitat (0)

Public Review

Public concerns and comments regarding lake management were solicited at the Bone Lake District Annual Meeting in August 2008. The draft plan was made available for public comment on the Bone Lake web site: bonelakewi.com beginning April 20, 2009 with comments accepted through June 1, 2009.

Population Dynamics

Bone Lake and its watersheds are located in central Polk County, Wisconsin in the Towns of Georgetown and Bone Lake. This area has experienced steady population growth since 1970 as illustrated in Figure 2.

From 2000 to 2008 Georgetown had a growth rate of 10 percent while the Town of Bone Lake had a growth rate of 14 percent. These rates are comparable to the overall Polk County growth rate of 11 percent in the same period.

Population records include only permanent residents and do not reflect increases in residential development for seasonal housing. Most seasonal housing is concentrated around waterfront. Bone Lake has about 500 residences, and of these residences, about 75 percent are occupied only seasonally.[2] This percentage is quite high throughout the watershed, with seasonally occupied housing at 64% of the total housing units in the Town of Georgetown and 36% in the Town of Bone Lake. Countywide, about 20 % of the housing units are occupied seasonally for recreational or occasional use.[3]

Records of new septic permits indicate the amount of residential development occurring in the watershed. Figure 3 illustrates this growth from 2000 through 2008 in towns included in the watershed. During this time period, there was an average of 23 homes constructed with a new septic system each year in the Towns of Georgetown and Bone Lake. Some of the construction was outside of the Bone Lake watershed area.

[2] Based upon voter registration records for the Towns of Georgetown and Bone Lake.
[3] U.S. Census. 2000.

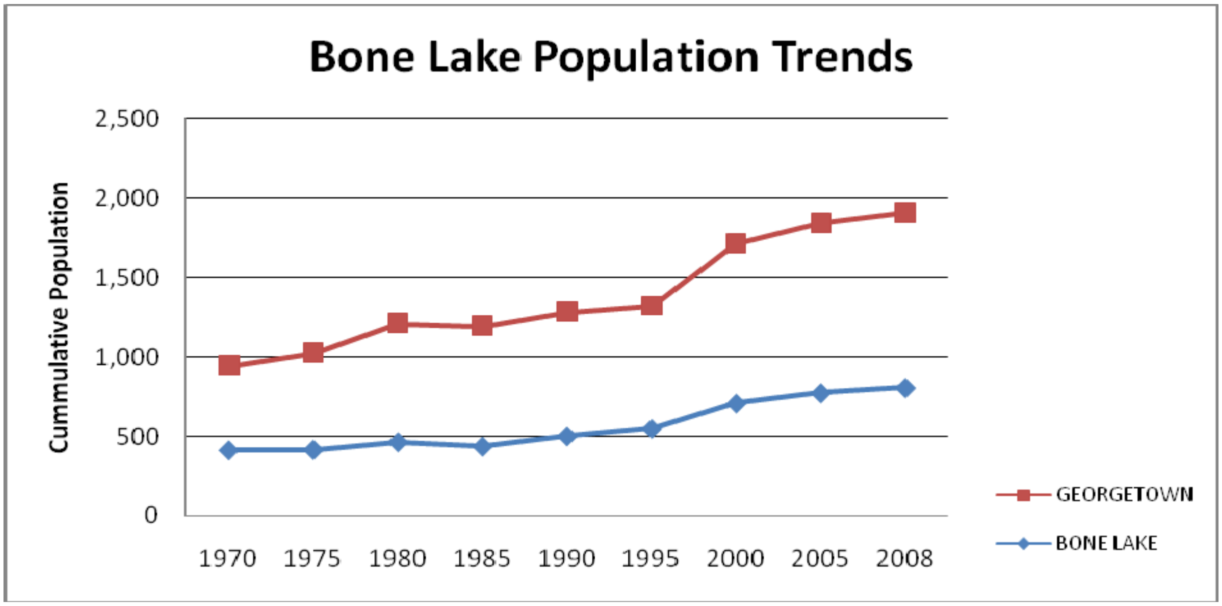


Figure 2. Bone Lake Area Population Trends[4]

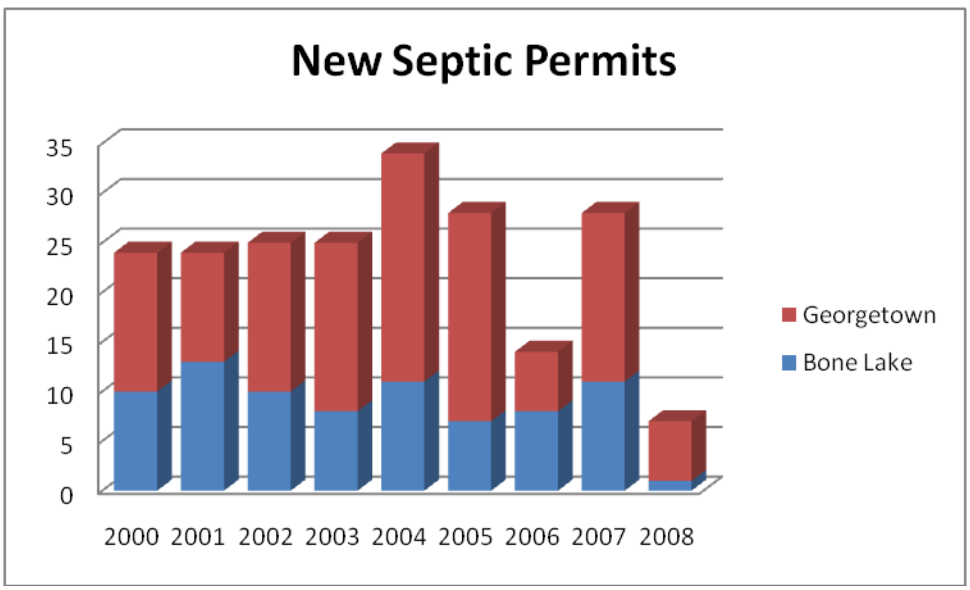


Figure 3. New Septic Permits: Towns within the Bone Lake Watershed

[4] Note that the population values in this figure are cumulative: the Georgetown line reflects a total of both Bone Lake and Georgetown population. Population figures include land outside of the Bone Lake watershed as well as land within the watershed.

Bone Lake Overview

The Lake

Bone Lake is a 1,781 acre lake located in Polk County, Wisconsin in the Town of Georgetown (T35N, R16W, S5, 6, 7, 8, 17, 18, and 20) and the Town of Bone Lake (T36N, R16W, S 31); WBIC: 2628100. It is a drainage lake. Prokop Creek and three intermittent streams flow into the lake while Fox Creek flows out of the lake. Fox Creek eventually reaches the Apple River. The maximum depth is 43 feet, and the mean depth is almost 22 feet.

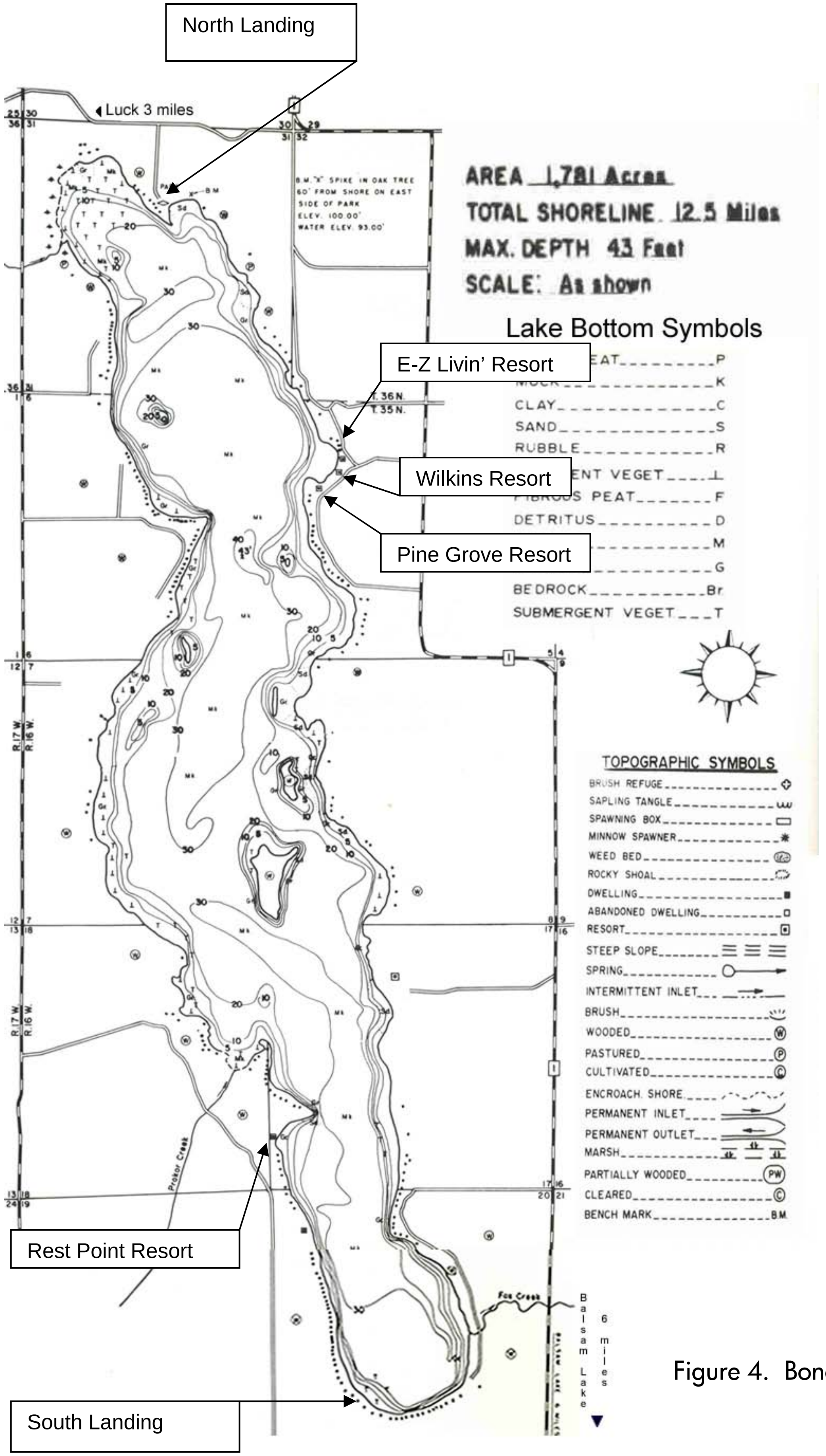


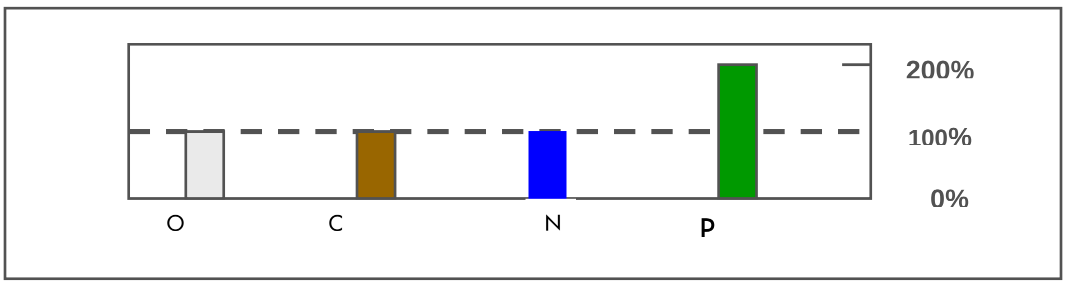
Figure 4. Bone Lake Map

Basic Limnology – Understanding Lake Information

To help understand the water quality study results in this plan, a basic introduction of limnology - the study of lakes - follows.

Importance of Phosphorus

The two nutrients of greatest interest in lakes are nitrogen and phosphorus. Both are required for plant and algae growth, but phosphorus is the most common limiting nutrient in lakes. "Limiting" means that of all nutrients available, phosphorus will be the first to run out and therefore limit plant growth. Therefore, increasing phosphorus can result in increases in plant and algae growth. Because algae absorb phosphorus directly from the water column, they will often respond most dramatically to increases in phosphorus availability.



This graph shows the resultant algae growth by adding 0.05 micrograms per liter (ppb) of each nutrient in an unproductive (low nutrient) lake[4]. As can be observed in the graph, raising the phosphorus by 0.05 micrograms per liter can double the algae growth while there is no increase with addition of the other nutrients. In a lake setting, increasing phosphorus content by l lb can result in 500 lbs of algae growth.

Aquatic plants will also respond to increases in phosphorus, but many are rooted and absorb the phosphorus from the sediment. As a result, they may not reflect increases in phosphorus concentrations in the water as quickly (except for plants such as coontail which doesn't need to root).

Forms of Phosphorus

Phosphorus usually exists in the form of phosphate (PO_4^{-3}). Phosphate can exist in various forms: organic, inorganic, soluble, and insoluble. The first important form is referred to as soluble reactive phosphorus (SRP) - a common form of phosphorus in fertilizers. This form is dissolved readily in the water and is immediately available for plant and algae growth.

The second important form is total phosphorus (TP). This is the measurement of all forms of phosphorus in the water. Total phosphorus is important because it reflects the

[4] From Water on the Web. University of Minnesota. 2008.

amount of phosphorus potentially available to plant and algae growth. Phosphorus has a propensity to bind to sediments. If an increased amount of sediment is introduced in a lake, the TP will most likely rise as well. Phosphorus can also be contained in the tissue of microorganisms and algae. This, too, would be reflected in TP. A high TP value does not necessarily indicate immediate algae growth since some or much of the total phosphorus may not be in the usable, SRP form.

If a large amount of the TP in runoff to the lake is SRP, it is mostly likely coming from sources such as sewage, fertilizers, and manure. If the TP has very little SRP in it, then most of the phosphorus is in other forms such as those tied to sediment or present in plant tissue. Phosphorus in an unusable form must be converted by biological or chemical reactions before it is available as SRP.

Sources of Phosphorus

Phosphorus can come from many sources. Any tissue or waste from living or once living organisms can be a source of phosphorus. Therefore, any human or animal waste (from septic systems and manure) contains concentrations of phosphorus. Any leaves or grass clippings can also contain phosphorus. Decomposition of dead plants and animals releases phosphorus.

As mentioned earlier, phosphates tend to bind to sediment. Whether sediment runs directly from the land into the water, or is carried in streams to the lake, it is a source of phosphorus. High levels of erosion can create significant phosphorus loads.

Phosphorus is also concentrated in raindrops. Raindrops pick up dust and other particulate matter in the air and deposit the phosphorus into the lake as precipitation. In many lakes, this can be a significant source of phosphorus, especially in more pristine lakes that receive little phosphorus from other sources.

As precipitation hits the land around the lake (the watershed), some of the rain will infiltrate into the soil and some will run-off. As the water runs off of the land, it can pick up sediments, dead and living matter, and dissolved forms of phosphorus. When this water reaches the lake, it brings the phosphorus with it. The amount of rain, the soil types, the topography, and the degree of vegetative cover will affect the concentration of phosphorus carried in runoff water. When the land is covered with forest, the soil is more stable. The raindrops dissipate and infiltrate into the soil, and therefore, the runoff volume and phosphorus content will be low. On the contrary, a row crop field such as a cornfield will not dissipate the raindrops, and the exposed soil will be much less stable. This results in increased erosion and runoff volume and therefore, higher phosphorus concentration and higher phosphorus loads into the lake.

The last source of phosphorus in a lake is the release from the lake bottom sediments. As decomposers break down the dead organic matter in the lake bottom sediment, phosphorus is released. Much of the sediment in lakes will bind phosphorus just as on land. The major contributor to this binding is iron. When iron is in high enough oxygen conditions, it has a +3 charge and therefore binds the phosphate (which has a -3 charge) forming an insoluble floc particle and remaining in the sediment. When the oxygen content decreases, the iron is reduced to a +2 charge, becomes soluble, and tends to release the phosphate ions. As a result, the sediment can release very large amounts of phosphorus into the water column. Phosphorus release occurs at a threshold of low dissolved oxygen – referred to as anoxia - of 1 mg/l or less. The length of time the sediment is anoxic and the size of the area that goes anoxic determines the amount of phosphorus released. Release of phosphorus from lake bottom sediment is one component of the lake's internal load.

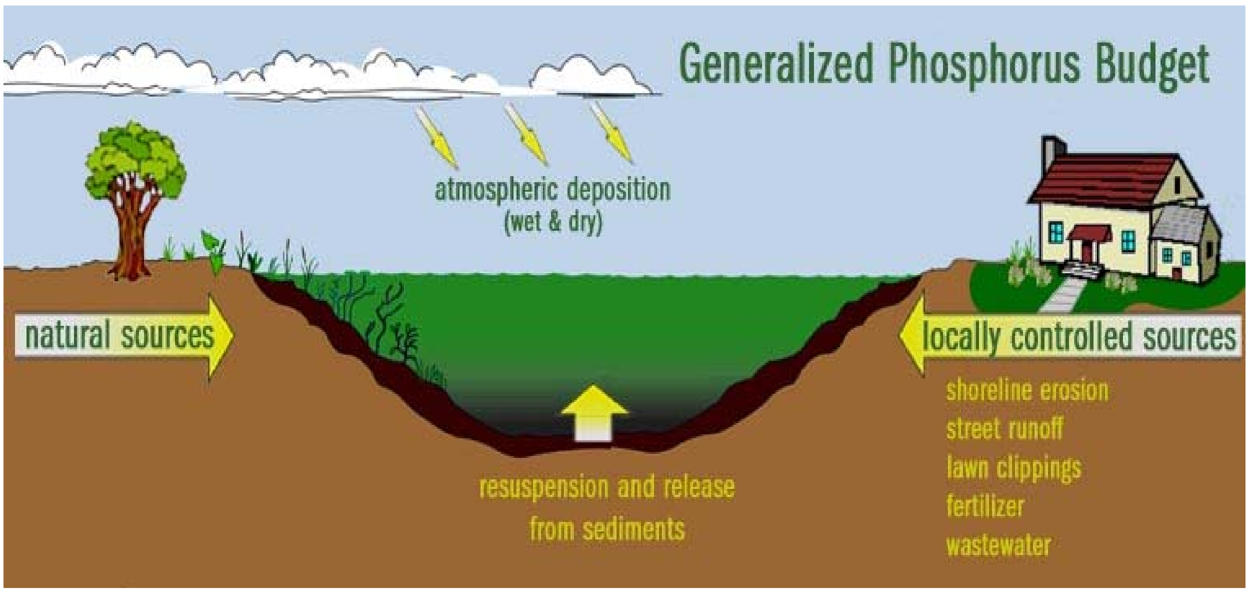
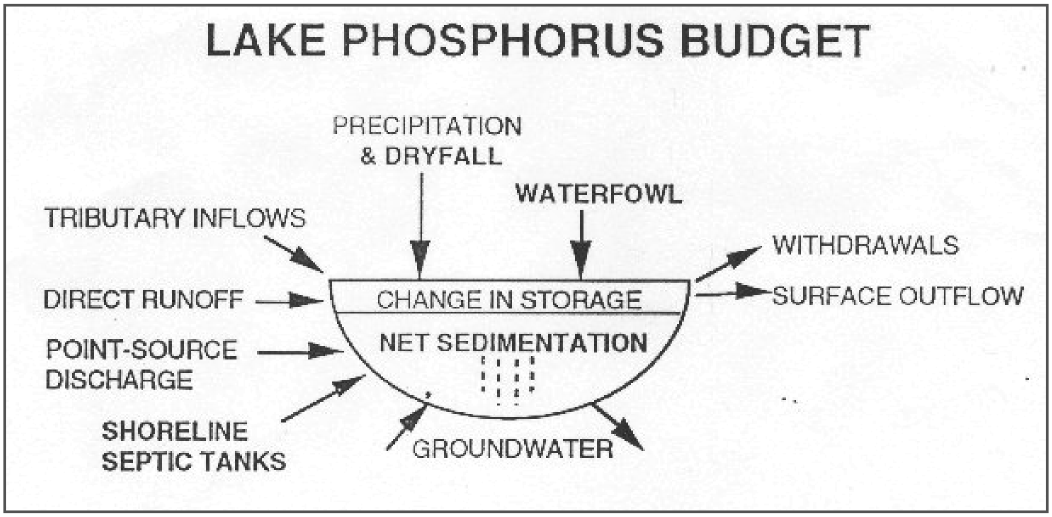


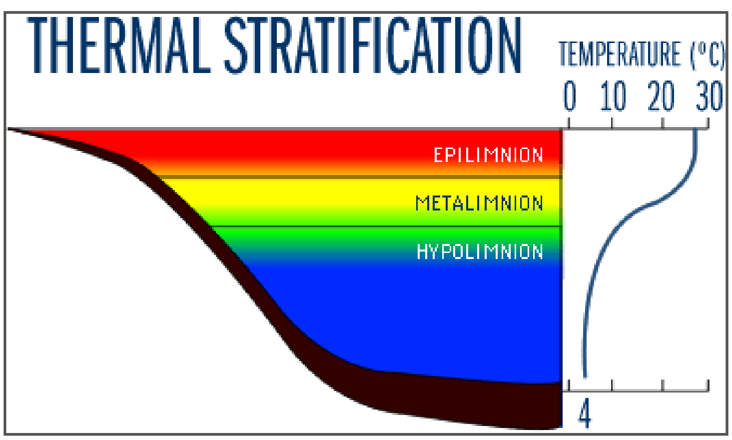
Figure obtained from "Water on the Web" (www.waterontheweb.org) an educational website at the University of Minnesota.

A summary of the phosphorus sources and losses are outlined in the diagram below.[5]



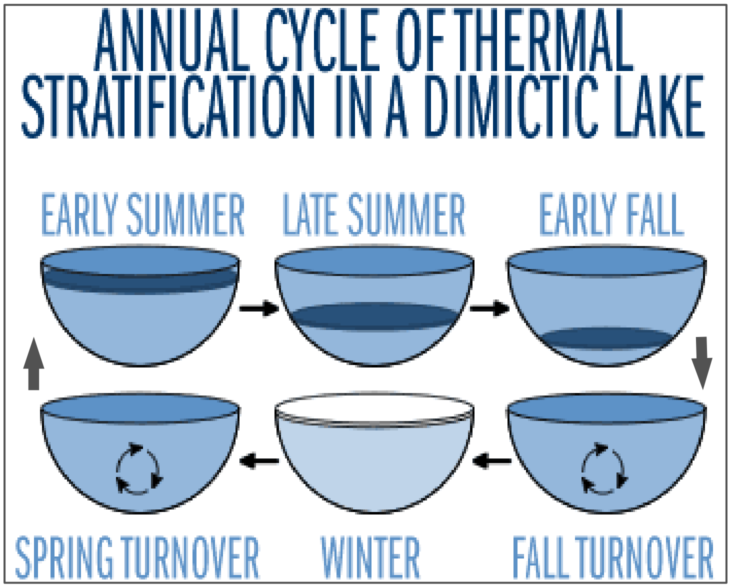
In many cases, a lake will stratify during the summer months. When a lake stratifies, the colder water stays on the bottom (hypolimnion) of the lake while the warmer water remains on the surface (epilimnion). Since this is a very stable situation, the lake water does not mix. The phosphorus released from the bottom sediment (where low oxygen levels occur) remains in the hypolimnion until the lake turns over in the fall. If a lake does not completely stratify but becomes anoxic in portions of the lake, the lake may mix prior to the fall turnover, injecting the phosphorus into the water column where it is available for uptake by algae.

Photosynthesis and wave action are major contributors of oxygen to a lake. When a lake stratifies, however, there is no opportunity for oxygen to get to the bottom of the deep portions of the lake. On the bottom, microorganisms will use the oxygen for respiration, depleting the oxygen. If the lake doesn't mix and has no photosynthesis, the lake will tend to reach anoxic conditions. The rate of stratification and the rate of respiration (from breaking down organic matter) will determine how early in the summer the lake will go into anoxia on the bottom.

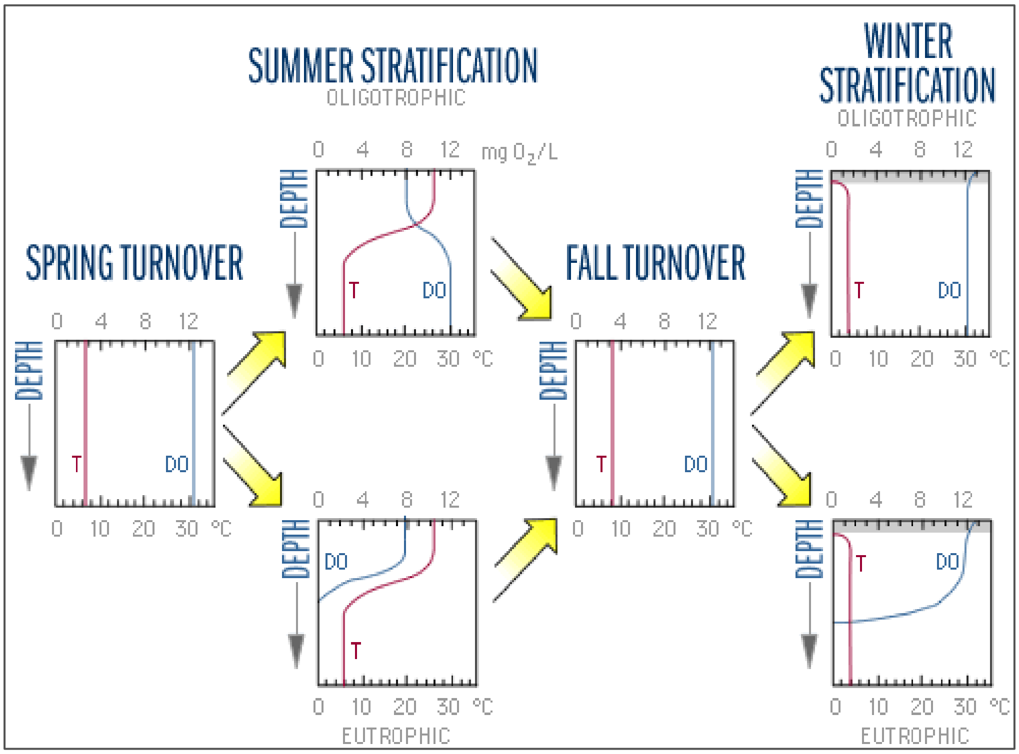


[5] From Water on the Web. University of Minnesota. 2008.

As the water cools in the fall, that water becomes denser and sinks, mixing the lake. This process is called fall turnover. When the lake freezes, the ice floats. In the spring when the ice melts, the cold water sinks, again mixing the lake (spring turnover). If anoxic conditions occurred during the summer months, a phosphorus load will usually be released in the water column in the fall turnover.



The figure on the following page includes idealized versions of temperature and oxygen profiles (each measured at increasing depth intervals). During turnover periods in spring and fall the temperature and dissolved oxygen will be consistent from top to bottom. During stratification in the summer the temperature will decline immensely at the thermocline (the depth where temperature gets significantly colder). In productive lakes (nutrient-rich or eutrophic lakes) the bottom will be at or near anoxia, and in less productive lakes the dissolved oxygen will still be quite high. In the winter, productive lakes will tend to have anoxia again while less productive lakes will have oxygen on the bottom throughout the winter.



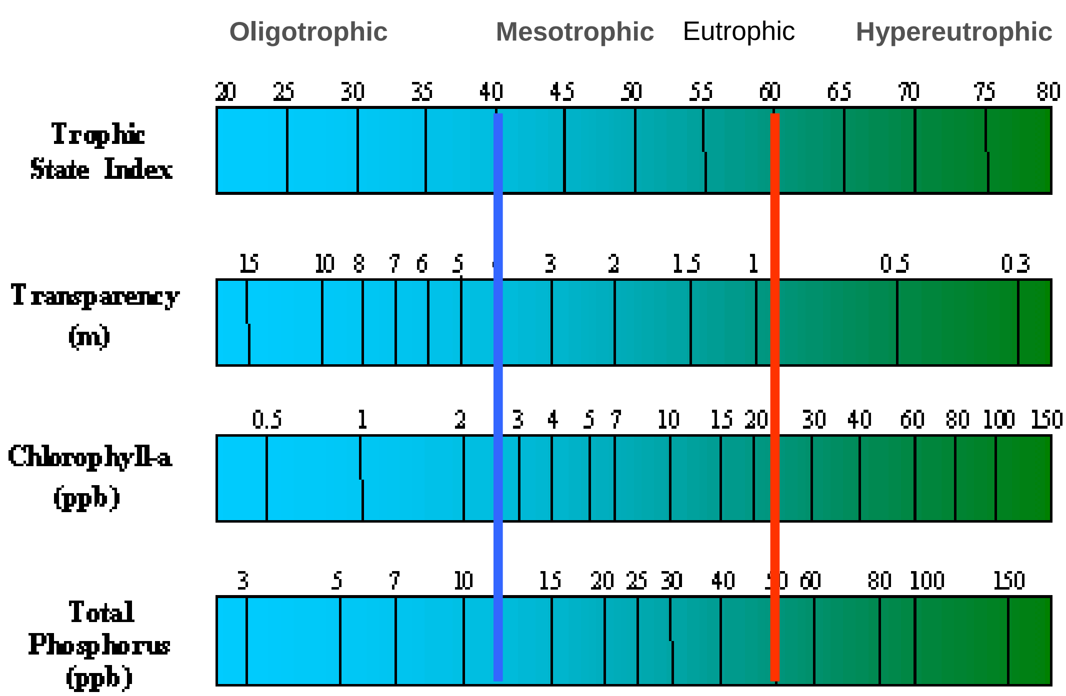
Bone Lake appears to be a partially stratified lake. It has few areas where oxygen levels drop below one ppm in the summer, and the temperature thermocline is not evident in the deep areas of the lake throughout the summer. While the lack of complete stratification limits the release of phosphorus from sediments, phosphorus may be released when low oxygen levels exist. The phosphorus may be brought to the surface during the summer months instead of in the fall. Bone Lake may be more likely to mix throughout the summer because of its long, narrow shape and orientation in line with prevailing winds.

Trophic Status

Trophic status describes the productivity of a lake. The least productive are oligotrophic lakes. The most productive lakes are referred to as eutrophic. Those in the middle are called mesotrophic. The more nutrients available in a lake, the more productive the lake will be. Therefore, if a watershed with little runoff and phosphorus loading surrounds a lake, the water will tend to have low phosphorus levels. This will result in limited plant and algae growth, causing it to be classified as an oligotrophic lake.

Trophic status can be measured and the lake given a trophic status value (the Carlson Trophic Status Index). This value can be based upon three measurements: total phosphorus, Secchi depth, and chlorophyll a. If the phosphorus is high, the algae will grow more, resulting in high chlorophyll a and reduced water clarity. Water clarity is measured by the Secchi disk reading. If there is limited phosphorus, the water will have little algae growth, therefore low chlorophyll a readings and high Secchi depths.
This table shows the Carlson Trophic Status value in the left column and the characteristics of each lake type in the right column.

<40	Oligotrophic; clear water; high hypolimnetic O_2 year-round but possible anoxia in the deeper hypolimnion part of year
40-50	Mesotrophic; moderately clear water; possible hypolimnetic anoxia in summer and/or under ice. Fully supportive of all swimmable /aesthetic uses; possible cold-water fishery
50-60	Mildly eutrophic; decreased secchi; anoxic hypolimnion; possible macrophyte “problems”; warm-water fishery; supportive of all swimmable /aesthetic uses but “threatened”
60-70	Blue-green algal dominance with scums possible; extensive macrophyte problems; not supportive of all beneficial uses
>70	Heavy blooms and scums in summer likely; dense “weed” beds; hypereutrophic; possible fish kills; fewer plant beds due to high algae; not supportive of many beneficial uses



Management of Phosphorus

Managing some sources of phosphorus can be very effective, while other sources can't be managed. Atmospheric deposition is not manageable since it is carried from other locations and deposited via rain. However, when sources of phosphorus are from the watershed, various management options are available. Any practice that can reduce runoff and retain the water or infiltrate the water into the soil is very beneficial. Because phosphorus is tied to sediment, phosphorus loading can be reduced by preventing water with sediment and dissolved phosphorus from making its way into the lake. If the water is infiltrated, it will return to the water table, and the soil it filters through will remove the phosphorus. Land cover with significant vegetation will slow the runoff of water and help reduce phosphorus loading.

For these reasons, restoring areas that contain exposed soil, have vegetation with very shallow root structure, or are prone to erosion and the release of sediment can significantly reduce phosphorus loading. Many agricultural and lawn care practices involve fertilizing with soluble phosphorus. As a result, these areas can greatly increase phosphorus loading. However, if the water runoff can be reduced by planting buffers or changing agricultural practices to grow crops such as grasses, the phosphorus can be retained and not reach the lake as readily.

Impervious surfaces are those that do not allow water to soak in and result in increased runoff. Roads, driveways, roofs, sidewalks and parking lots are all examples of impervious surfaces. Large amounts of sediment, and therefore phosphorus, are carried to the lake when significant impervious surfaces are present. If that water can be slowed, or better yet, infiltrated into the soil, the loading can be significantly reduced.

In this photo, a sediment plume is very evident. Notice the degree of development and the large amount of impervious surfaces.

Septic system malfunctioning can also cause loading of phosphorus. A typical septic system relies on the soil's ability to retain the nutrients from human waste by infiltrating the water in a drain field. If the system is not functioning properly and lacks the infiltration and ultimate phosphorus removal, the nutrients can reach the lake. Holding tanks that don't leak and are routinely pumped can reduce failure and therefore phosphorus inputs. Some lakes have installed public sewer systems in order to eliminate the possibility of septic system failures.

Management of internal loading is also a possibility, but it can be very difficult and expensive. Alum (aluminum sulfate) can be added to the lake. Alum contains an aluminum ion that behaves like iron to bind phosphate ions. However, unlike the iron ion, aluminum can bind phosphates in anoxic conditions. There have been both successful and unsuccessful alum treatments. Even when successful, the time of effectiveness is limited, and the alum application eventually must be repeated to remain effective. Aeration is another tool that is sometimes used to reduce internal loading. Aeration is used to mix the lake and reduce anoxic conditions. As described previously, oxygen allows iron to remain bound in an insoluble form with phosphate. Both alum treatment and aeration can be very expensive. However, if the internal loading is a very significant portion of the entire phosphorus load, it can be cost-effective to manage this source of phosphorus.

Bone Lake Water Quality Information

Trophic Status

Bone Lake is a mesotrohpic to eutrophic lake with clear water in early summer that deteriorates with frequent algae blooms in mid to late summer. The south basin generally has greater water clarity than the north basin. Phosphorus concentrations control the level of water clarity in Bone Lake because increased phosphorus levels increase algae growth. Lake sediments release phosphorus when the lake water temperatures stratify in the summer and oxygen levels decrease at the lake bottom. The lake may periodically mix with high summer winds so that phosphorus-rich bottom waters are brought to the surface and increase algae growth. Phosphorus input to Bone Lake also comes from the watershed, direct rainfall, groundwater, and septic systems.

Previous Lake Studies

The Bone Lake Management District requested and/or funded a variety of studies to increase understanding of the water quality and plant community of Bone Lake. The Wisconsin Department of Natural Resources Office of Inland Lake Renewal completed a lake feasibility study with management alternatives in 1980. Barr Engineering completed a lake management plan that included a water quality study (1997), hydrologic and phosphorus budgets (1997), and additional water quality monitoring and management recommendations (1999). The Polk County Land and Water Resources Department and The Limnological Institute updated water quality monitoring, and Aquatic Engineering prepared a water quality technical report in 2004. Lake resident volunteers have collected Secchi disc self-help monitoring data since 1989 (although not every year). Summaries of previous studies are included in Appendix B.

Lake Self-Help Monitoring Results[6]

Secchi depths are the most commonly collected self-help lake monitoring data reported. Secchi depths measure water clarity. The Secchi depth reported is the depth at which the black and white Secchi disk is no longer visible when it is lowered into the water. Greater Secchi depths occur with greater water clarity. Results of average July and August Secchi depth readings for the Deep Hole of Bone Lake are shown in Figure 5 below. Figure 6 illustrates all sample test results using TSI (trophic status) rankings. Figure 7 shows how water clarity changed over the 2008 growing season with increasing algae growth and decreasing water clarity as the summer progresses. Results available for a second sampling point south of the large island show similar results for all reports.

[6] Wisconsin Department of Natural Resources Self Help Monitoring results.

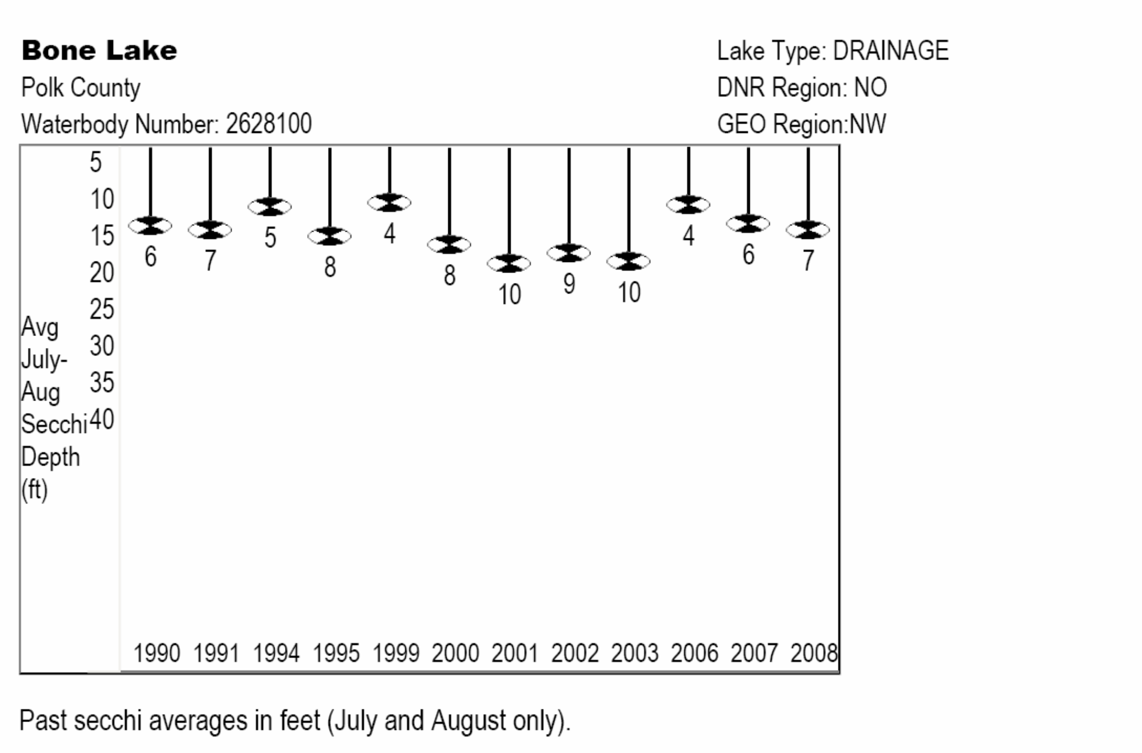


Figure 5. Bone Lake Deep Hole Summer Secchi Depth Averages

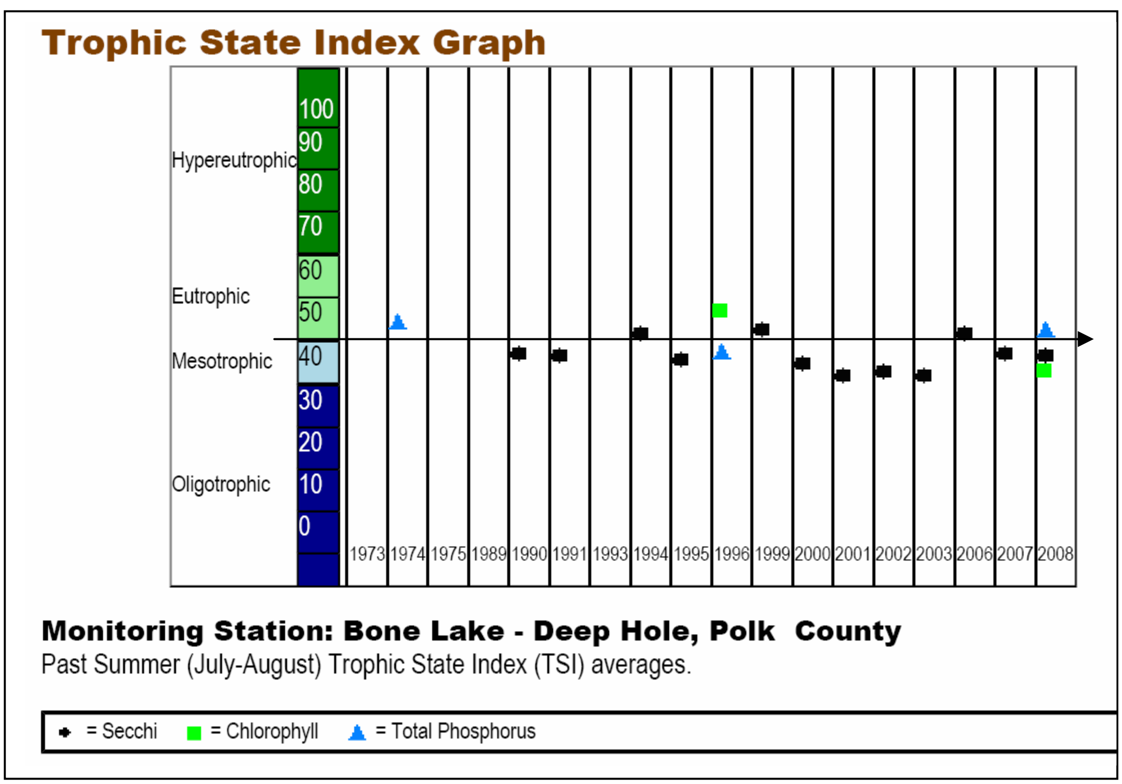
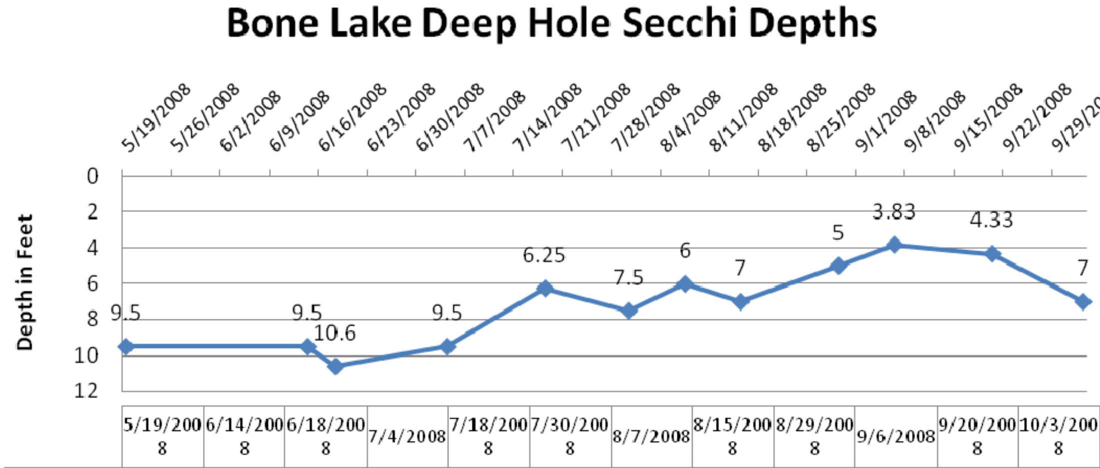


Figure 6. Bone Lake Deep Hole Trophic Status Index



	5/19/2008	6/14/2008	6/18/2008	7/4/2008	7/18/2008	7/30/2008	8/7/2008	8/15/2008	8/29/2008	9/6/2008	9/20/2008	10/3/2008
Secchi (Feet)	9.5	9.5	10.6	9.5	6.25	7.5	6	7	5	3.83	4.33	7

Figure 7. Bone Lake Deep Hole 2008 Secchi Depths

2008 Lake Nutrient Analysis

A lake nutrient analysis was prepared in preparation for the development of this plan. The purpose of the analysis was to identify sources of phosphorus loading to Bone Lake and the areas that could be managed to reduce nutrient inputs. A full copy of the report is included as Appendix C. A summary of the study results follows.

The phosphorus budget from external sources (not from within the lake) was analyzed during the growing season from April 2008 until October 2008. To calculate the loading of phosphorus, the flow of two tributaries (Prokop Creek and an un-named northwest tributary) were measured. Volunteers also collected water samples which were analyzed for total phosphorus, soluble reactive phosphorus, and suspended solids. In addition, the land use in the watershed was updated. Finally, a water quality model (WILMS) was used to estimate the remaining phosphorus loading.

Tributaries

The total loading of phosphorus and sediments from the two tributaries are quite similar, although the volume of water carried in Prokop Creek is almost twice the volume of the northwest tributary. Table 1 summarizes the tributary loading results.

Table 1. Tributary Loading to Bone Lake

Tributary	Volume (m^3/yr)	TP Load (kg/yr)	SRP loading (kg/yr)	TSS loading (kg/yr)
Prokop Creek	1,126,670	85.6	20.4	2,145
Northwest Tributary	590,129	71.4	16.7	2,793

The soluble reactive phosphorus made up only 23-24% of the total phosphorus in both tributaries. This indicates that the source of phosphorus is not likely in highly soluble forms such as fertilizers, manure, sewage, etc. The total suspended solids load was much higher in the northwest tributary, so this tributary will contribute more sedimentation into Bone Lake. TSS values did increase (especially with the northwest tributary) with increased flow, as expected.

It should be mentioned that the latter half of the 2008 growing season was rather dry, reducing flow in both tributaries. Prokop Creek was dry during several weeks in August and September. The northwest tributary had flow during the entire sampling period.

Watershed

The Bone Lake watershed is part of the Upper Apple River watershed in the St. Croix River Basin. The entire watershed (excluding the lake surface) is 9,173 acres. Of this acreage, 3,088 is internally drained, flowing to ponding areas within the larger watershed. Therefore, the area that drains directly to Bone Lake is about 6,085 acres. The watershed area is illustrated in Figure 8.

Watershed Land Use[7]

The land use was determined through an analysis of 2006 digital ortho aerial photos. In addition, the entire watershed and subwatersheds developed for the Barr Engineering study in 1996 were adjusted following field checks of the topography and culvert locations. The resulting watershed map is illustrated in Figure 8 below. The total acres of each subwatershed are included in Appendix C. Figure 9 illustrates the land use in the Bone Lake watershed. Land uses are important to understanding nutrient loading because they influence the amount of runoff generated and the nutrients carried to the lake.

[7] Dave Peterson, Polk County Land and Water Resources Department, completed this analysis.

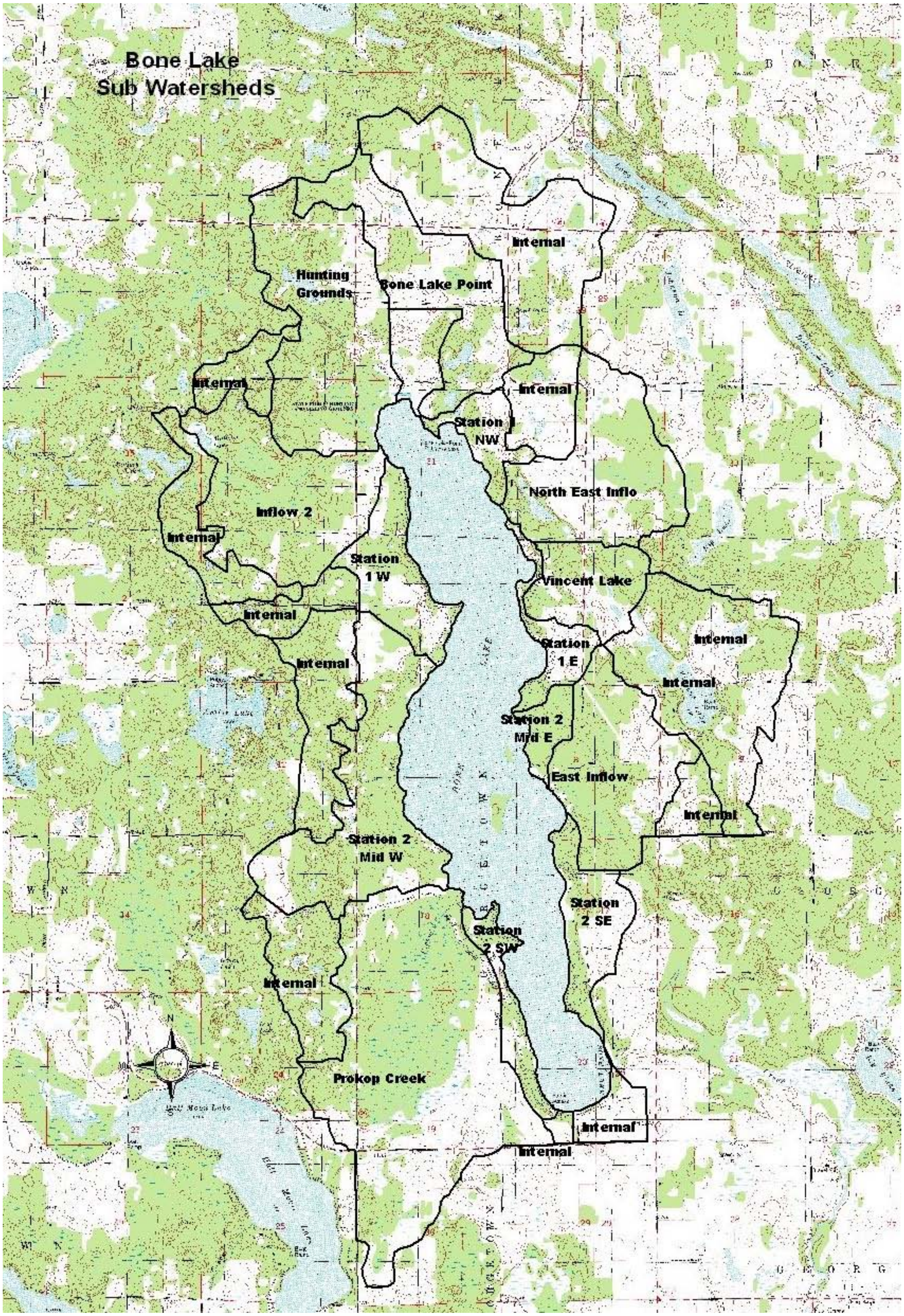


Figure 8. Bone Lake Subwatersheds

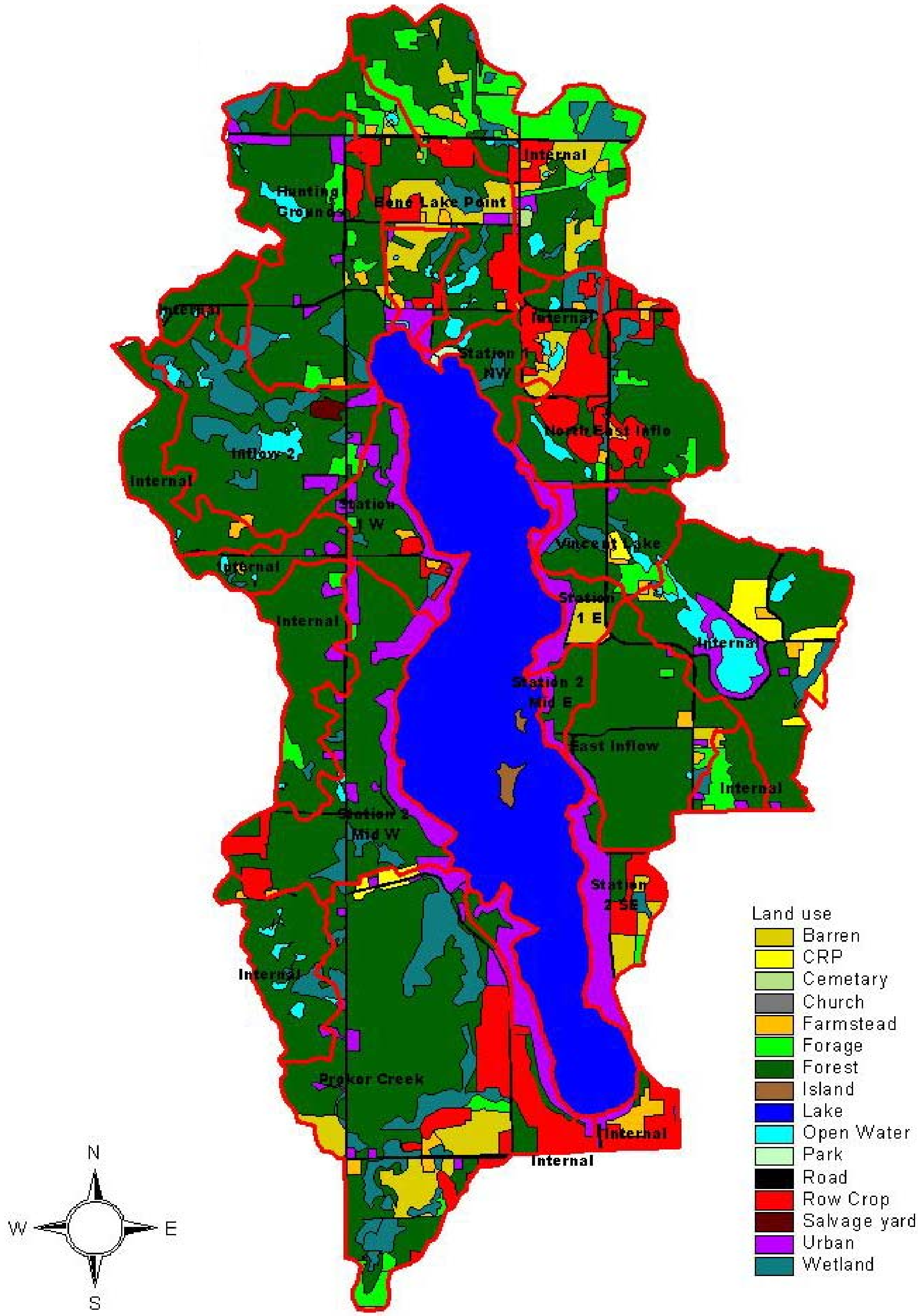


Figure 9. Land Use of Bone Lake Watershed.

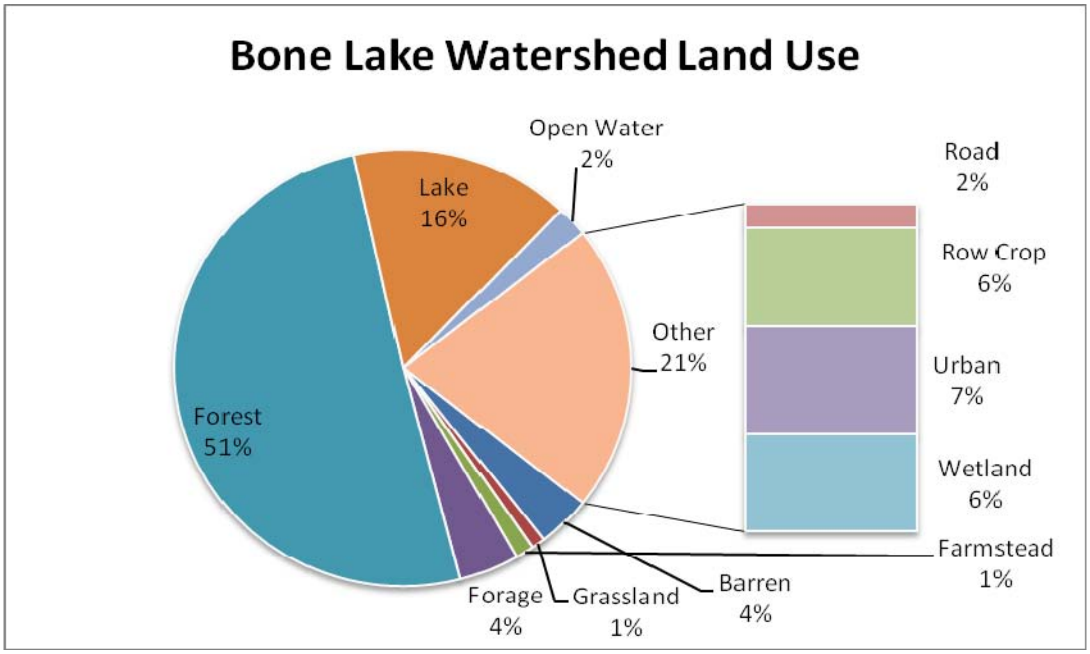


Figure 10. Composition of Bone Lake Watershed Land Use

Forest makes up just over half of the land use types. This forest cover helps to maintain good water quality in Bone Lake with low rates of runoff and pollutant loading. While row crops and urban land use make up only 6.33% and 6.97% of the watershed respectively, they have high phosphorus loading rates, and greater proportional impact than other land uses. Therefore, management of these land uses may significantly reduce phosphorus loading.

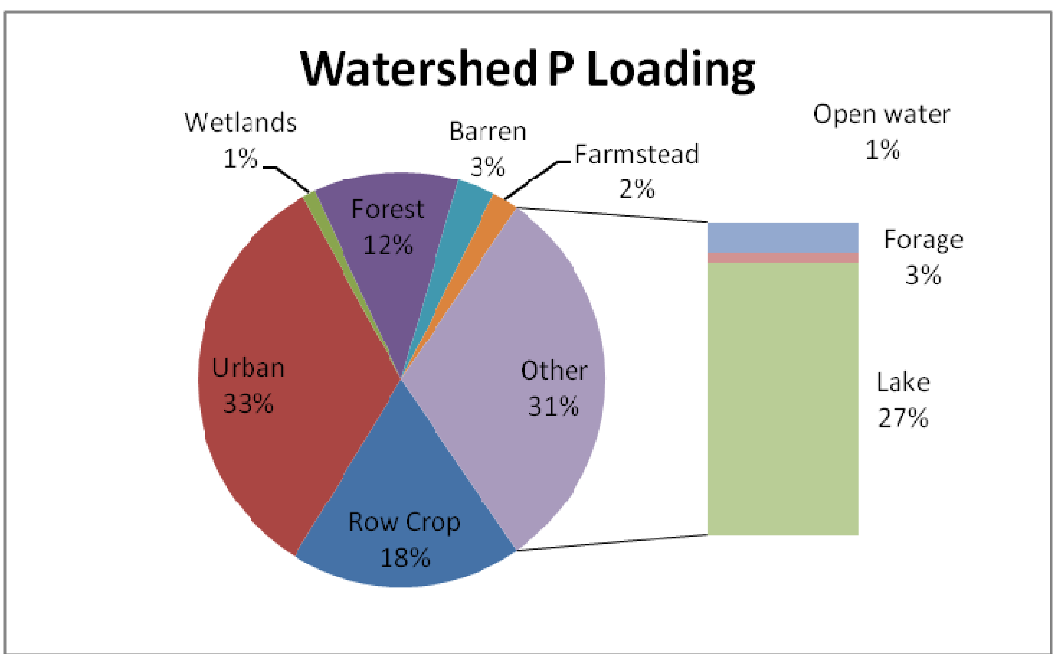


Figure 11. Phosphorus Loading by Land Use

Watershed Loading

With land use information, it is possible to estimate phosphorus loading from various areas within the watershed. The phosphorus load from the final source - septic systems – was also estimated. All estimates of phosphorus sources are included in Table 2 and Figure 12 below.

Table 2. Sources of Phosphorus to Bone Lake

Source	**Kg/Year**	**Percent of P Load**
Watershed	557.1	**56**
Septic Systems	67.6	**7**
Tributaries	157	**16**
Lake Surface	206.8	**21**
TOTAL	988.5	**100**

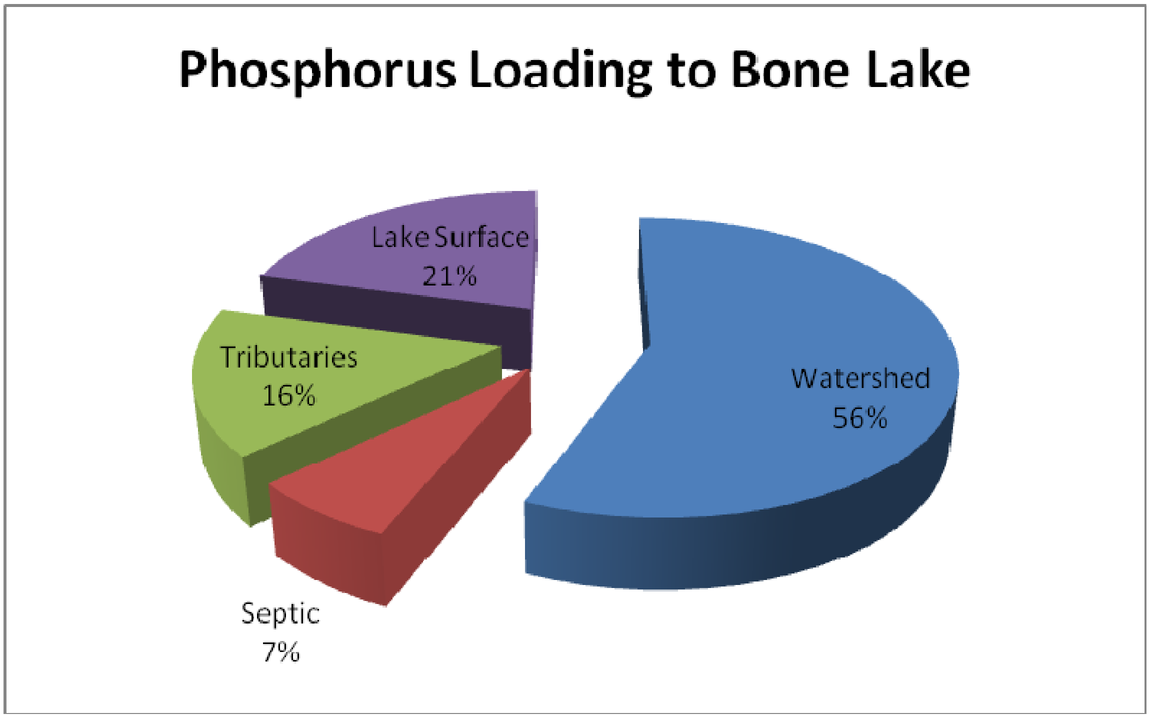


Figure 12. Phosphorus Sources to Bone Lake

The subwatersheds have a wide range of nutrient loading impacts. For management purposes, it is convenient to compare the contribution of each subwatershed based upon the area and loading, expressed in kg/acre. Figure 13 shows the loading per acre for each subwatershed.

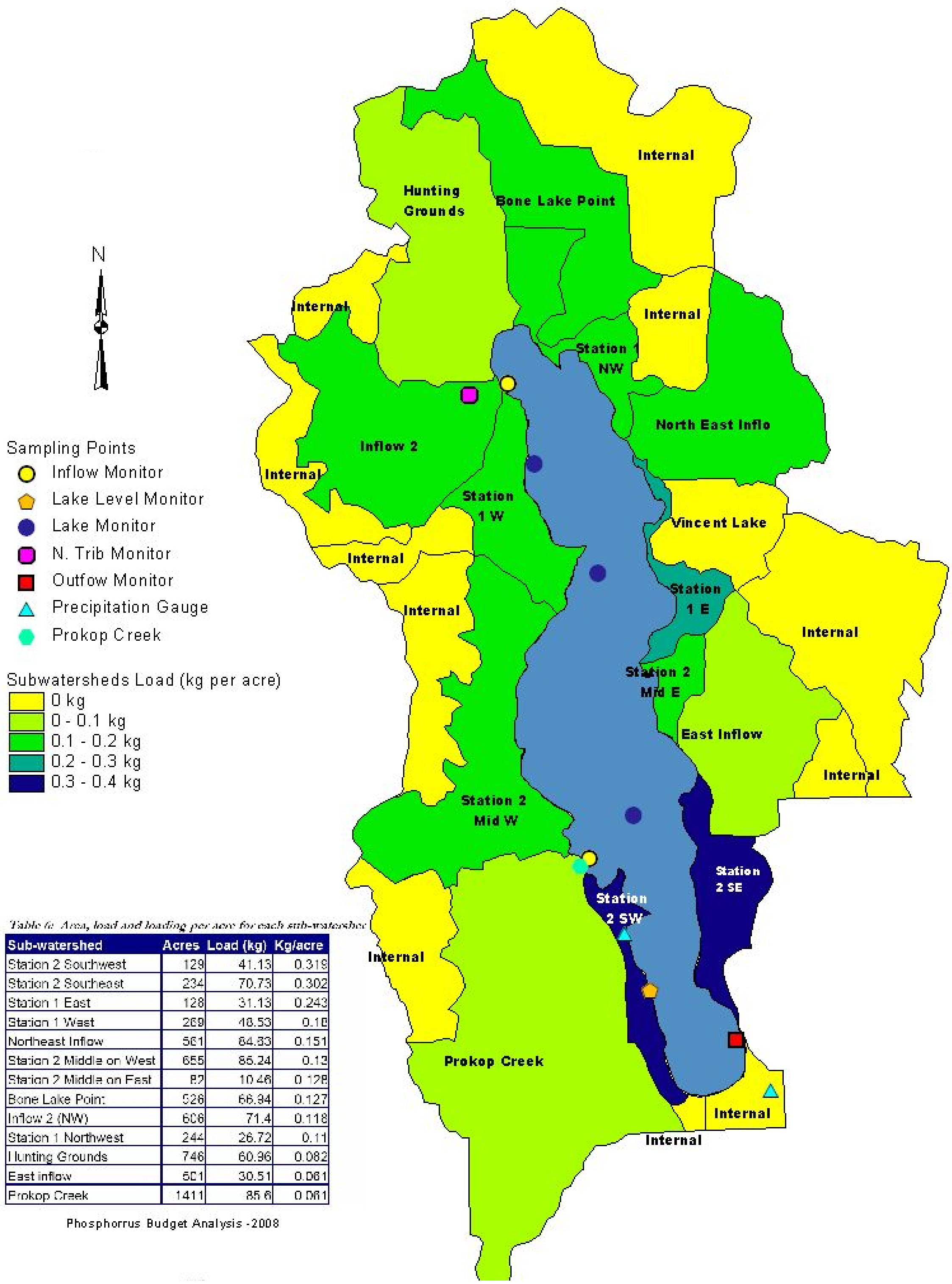


Table 6: Area, load and loading per acre for each sub-watershed

Sub-watershed	Acres	Load (kg)	Kg/acre
Station 2 Southwest	129	41.13	0.319
Station 2 Southeast	234	70.73	0.302
Station 1 East	128	31.13	0.243
Station 1 West	269	48.53	0.18
Northeast Inflow	561	84.83	0.151
Station 2 Middle on West	655	85.24	0.13
Station 2 Middle on East	82	10.46	0.128
Bone Lake Point	526	66.94	0.127
Inflow 2 (NW)	606	71.4	0.118
Station 1 Northwest	244	26.72	0.11
Hunting Grounds	746	60.96	0.082
East inflow	501	30.51	0.061
Prokop Creek	1411	85.6	0.061

Phosphorrus Budget Analysis -2008

Figure 13. Phosphorus Loading by Subwatershed

Internal Loading

Additional sources of phosphorus come from within the lake. Two of these in-lake sources are 1) the release of phosphorus from bottom sediments and 2) the release of phosphorus from plant growth and subsequent decay.

Lake Sediments

Internal loading from lake sediments was not analyzed in this study. Release from Bone Lake sediments appears to be limited because there are few times and areas where the lake stratifies in layers of water temperature and few areas where oxygen levels at lake bottom drop below 1 ppm in the summer. While the lack of complete stratification limits the release of phosphorus from sediments, phosphorus may be released when low oxygen levels occur. The phosphorus may be brought to the surface during the summer months instead of in the fall. Bone Lake may be more likely to mix throughout the summer because of its long, narrow shape and orientation in line with prevailing winds. Further study is needed to assess the importance of phosphorus sediment release to the Bone Lake nutrient budget.

Curly Leaf Pondweed Dieback

Previous studies have pointed to dieback of the non-native plant, curly leaf pondweed (*Potamageton crispus*) as a source of increasing lake phosphorus levels and therefore algae growth during the growing season. The potential for significant in-lake phosphorus increases from curly leaf pondweed (CLP) was assessed using a range of data from the literature and maps of curly leaf pondweed growth. Literature values provided density measurements of CLP and the phosphorus content of CLP tissue samples. In 2007 there were 87 acres of curly leaf pondweed in beds with a density of at least 50%. The phosphorus content of the curly leaf pondweed used from the literature is 0.5%. A density of 190 g/m^2 yields the lower value in the graphs below, and a density of 530 g/m^2 yields the higher value. The proportion of CLP loading is approximately 2 – 7 percent when compared with other sources of phosphorus in the lake. In the graphs below, the results are compared with calculated watershed and tributary loading values.

Effective management methods for CLP are currently under investigation as part of implementation of the aquatic plant management plan. This plan includes early season herbicide treatment of designated CLP beds along with an evaluation of treatment effectiveness. Remapping of CLP beds is planned for 2010. A recommendation from this plan is to analyze tissue samples of the CLP for phosphorus content and record density of CLP growth in each bed. This will allow a more accurate assessment of the CLP impact. By this time, evaluation of CLP herbicide effectiveness will also be available.

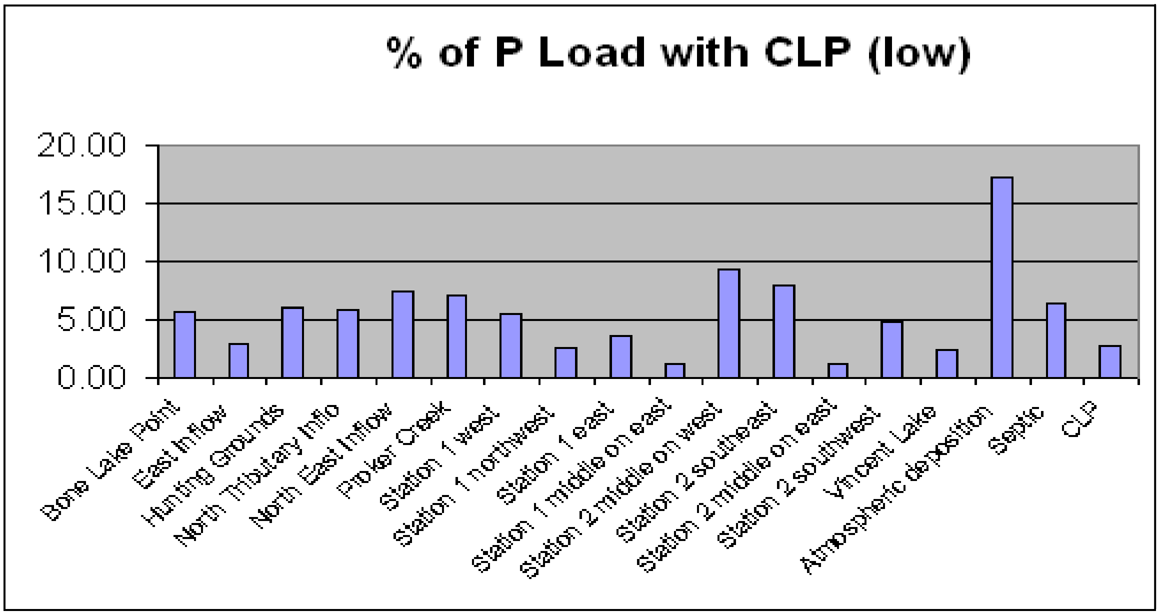


Figure 14. Potential (Low) CLP Phosphorus Loading Compared to Other Sources

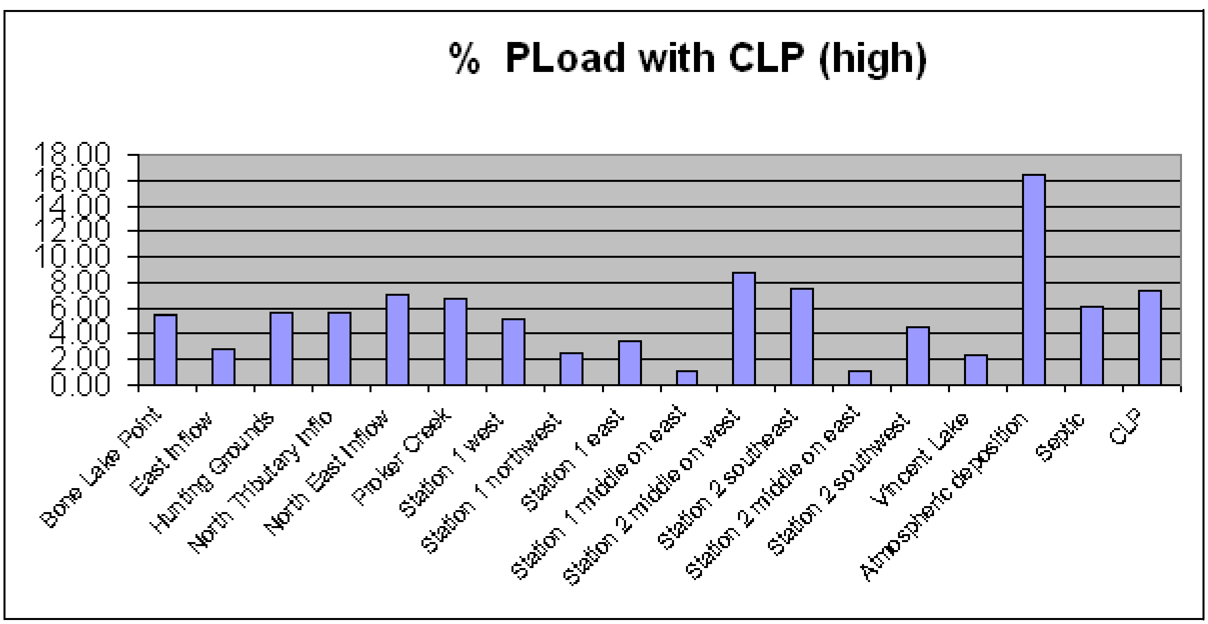


Figure 15. Potential (High) CLP Phosphorus Loading Compared to Other Sources

Shoreland Habitat Assessment

Volunteers completed a shoreland habitat assessment in October 2008 as part of this project. The purpose of the assessment was to assess the shoreline and buffer zone composition, to identify habitat characteristics around the lake, and to assess the potential for runoff from waterfront lots.

Volunteers either walked along the water's edge or boated to complete the assessment. Digital aerial photos were used to measure large stretches of natural areas. Shoreline characteristics were recorded in feet and shoreland buffer characteristics in square feet.

The assessment looked at the characteristics of the immediate shoreline at ordinary high water mark and the shoreland buffer zone. The ordinary high water mark is the level water reaches during periods of high water.[8] The shoreland buffer zone begins at the ordinary high water mark and extends 35 feet inland.

Results were entered by parcel and recorded in a spreadsheet for analysis. Examples of each description are found in Appendix D. Results are illustrated in Figures 16 and 17 below.

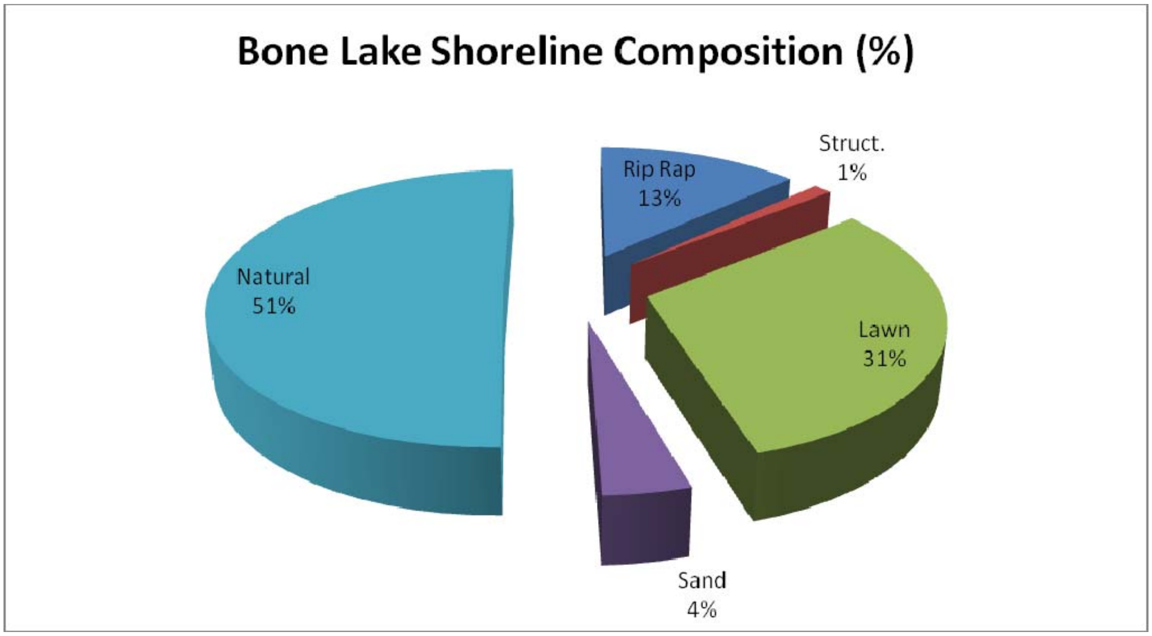


Figure 16. Shoreline Composition at the Ordinary High Water Mark

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[8] In 1914, the Wisconsin Supreme Court defined the OHWM as "the point on the bank or shore up to which the presence and action of the water is so continuous as to leave a distinct mark either by erosion, destruction of terrestrial vegetation or other easily recognized characteristic."

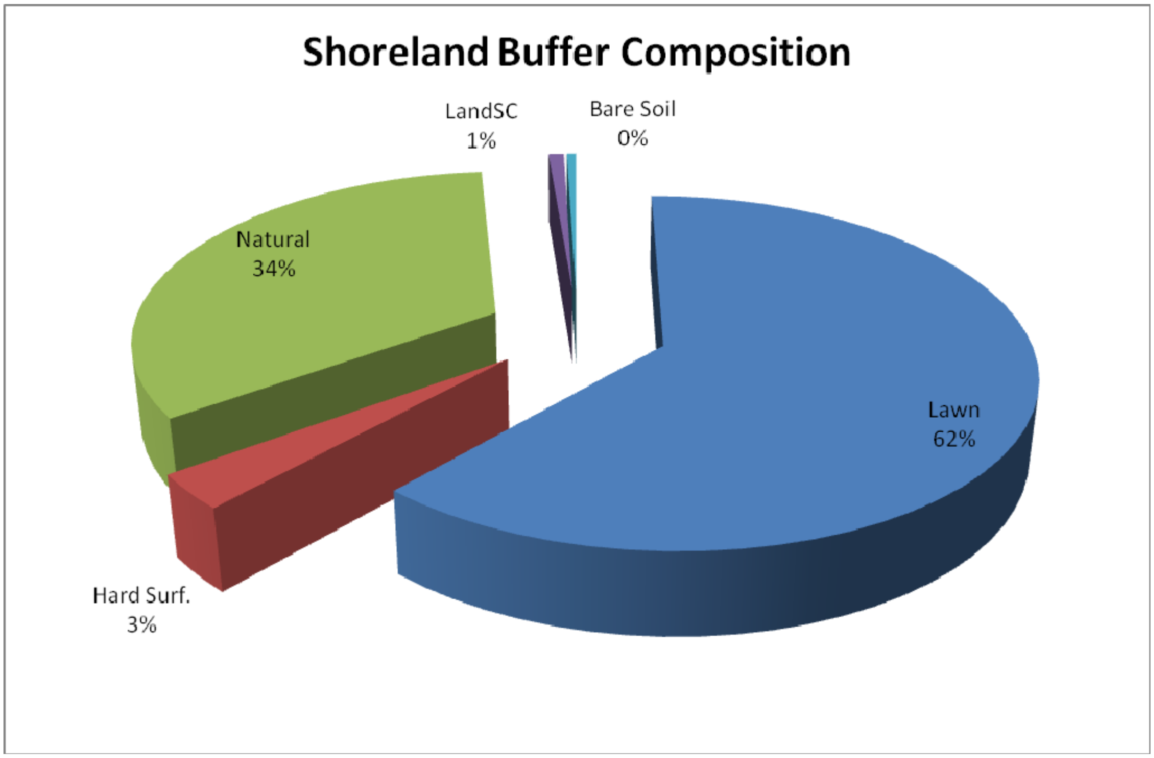

Figure 17. Shoreland Buffer Composition

Over half of the Bone Lake shoreline was found to have natural vegetation at the water's edge. This vegetation, along with vegetation in the water, can prevent erosion and sedimentation into the lake. Rock rip rap, found along 13% of the Bone Lake shoreline also stabilizes the bank, but may be detrimental to lake habitat.

The shoreland buffer composition is far from meeting state standards and recommendations. A minimum recommendation is for the buffer zone to extend 35 feet inland from the ordinary high water mark on at least 70% of developed parcels. Only 34% of the shoreland buffer of Bone Lake consisted of natural vegetation with much of this on undeveloped parcels.

Woody debris, such as fallen trees in the water, is important for fish and wildlife habitat structure. The habitat survey found only thirteen locations where woody debris was present. Although more may have occurred where there were large stretches of natural areas.

Rare and Endangered Species Habitat

Bone Lake is in the Town of Georgetown (T35N, R16W) and the Town of Bone Lake (T36N, R16W). Rare species are noted in this area. However, records of species present are not available to the public, so there is no indication of what species are actually present or if they are located within or surrounding Bone Lake. There were no state or federally listed threatened, endangered, rare or special concern plant species found in any lake plant surveys.

Scientific Name	**Common Name**	**State Status**[9]	**T35N R16W**	**T36N R16**
HALIAEETUS LEUCOCEPHALUS	BALD EAGLE	SC/FL	YES	YES
PANDION HALIAETUS	OSPREY	THR		YES
WILSONIA CANADENSIS	CANADA WARBLER	SC/M		YES
DENDROICA CAERULESCENS	BLACK-THROATED BLUE WARBLER	SC/M		YES
COCCYZUS AMERICNUS	YELLOW-BILLED CUCKOO	SC/M		YES
DENDROICA CERULEA	CERULEAN WARBLER	THR		YES
CYGNUS BUCCINATOR	TRUMPETER SWAM	END		YES
OPHIOGOMPHUS SMITHI	SAND SNAKETAIL	SC/N		YES
FUNDULUS DIAPHANUS	BANDED KILLIFISH	SC/N	YES	YES
HEMIDACTYLIUM SCUTATUM	FOUR-TOED SALAMANDER	SC/H		YES
ELEOCHARIS ROBBINSII	ROBBINS SPIKERUSH	SC		YES

The following communities are also listed in the database for Georgetown:
Northern dry-mesic forest
Northern wet-mesic forest

The following communities are also listed in the database for the Town of Bone Lake:
Open bog
Northern wet forest
Northern dry-mesic forest
Northern wet-mesic forest
Lake – soft bog
Ephemeral pond
Southern dry-mesic forest
Tamarack (poor) swamp

[9] THR = Threatened, END = endangered, SC/FL = Special Concern (federally protected as endangered or threatened), SC/N = Special Concern (no laws regulating use, possessions, or harvesting), and SC/H = Special Concern (take regulated by establishment of open closed seasons).

Bone Lake Fishery

The Wisconsin Lakes Book indicates that northern pike, largemouth bass, panfish and muskellunge are common in Bone Lake. Musky fishing is especially popular; and stocking efforts and bag limits have increased average sizes of muskies caught in the lake.

In 2006 the adult muskellunge population estimate was 0.55 fish/acre. This is lower than a 1995 estimate of 0.99 fish/acre. Even though the overall density of muskellunge is lower, the population estimate for 40 inch and larger muskellunge has remained similar between the two sampling periods at 0.11 fish/acre. This is one of the highest reported muskellunge densities for muskellunge 40 inches and larger in Wisconsin on a per acre basis. In addition, five muskellunge between 45 to 47.5 inches were sampled in Bone Lake in 2006 and 2007.

The reduction in muskellunge abundance was not a surprise since stocking densities were reduced over the past 10 years. Stocking densities were reduced to avoid outstripping the available forage base and decreasing the overall fish condition, which could occur if the muskellunge abundance was too high in Bone Lake. The stocking reduction made ten years ago appears successful because muskellunge relative weight values (a measure of fish condition) has increased from 96 in 1995 to 104 in 2006 (100 is considered normal).

In 2006 a moderate density largemouth bass population of 5.9 fish/acre or 10,508 bass larger than 8 inches was present with a respectable number of larger bass in the 18-20 inch range. Northern pike were also present with many individuals in the 24-30 inch size range, and the fish were in excellent condition. Panfish were generally small when compared to other large lakes in Polk County, but an expanding yellow perch fishery is present and has provided good results for ice fishing.

Table 3. Fish Species of Bone Lake

Common Name	Scientific Name	Abundance
Northern pike	*Esox lucius*	Common
Largemouth bass	*Micropterus salmoides*	Common
Panfish	*various*	Common
Muskellunge	*Esox masquinongy*	Common

Tribal Fishing[10]

Lake residents have recently raised concerns regarding the impact of tribal fishing on Bone Lake fish populations. A review of tribal fishing rights and tribal fishing on Bone Lake is included to better understand this issue.

Tribal fishing rights are accorded as a matter of federal treaty. Prior to the arrival of Europeans in North America, Indian tribes were independent, sovereign nations. Although the Chippewa tribes ceded their land in the northern one-third of Wisconsin to the United States government in the Treaties of 1837 and 1842, they reserved their off-reservation rights to hunt, fish, and gather within the Ceded Territory. The maintenance of these rights is comparable to a conservation easement or the retention of mineral rights by someone selling real estate.

In 1983, in what is commonly referred to as the Voigt case, the United States Court of Appeals for the Seventh Circuit affirmed that the off-reservation hunting, fishing, and gathering rights are part of the sovereign rights that the Chippewa Tribes of Wisconsin have always had and that they have never been voluntarily given up nor terminated by the federal government. The courts defined the scope of these rights between 1985 and 1991. As a result, the Chippewa tribes of Wisconsin are allowed to legally harvest walleyes and muskellunge using a variety of high efficiency methods, including spearing and gillnetting, on lakes within the Ceded Territory.

Tribal Harvest

The six Chippewa tribes of Wisconsin are legally able to harvest walleyes using a variety of high efficiency methods, but spring spearing is the most frequently used method. In spring each tribe declares how many walleyes and muskellunge they intend to harvest from each lake. Harvest begins shortly after ice-out, with nightly fishing permits issued to individual tribal spearers. Each permit allows a specific number of fish to be harvested, including one walleye between 20 and 24 inches and one additional walleye of any size. All fish that are taken are documented each night with a tribal clerk or warden present at each boat landing used in a given lake. Once the declared harvest is reached in a given lake, no more permits are issued for that lake and spearfishing ceases.

[10] http://www.dnr.state.wi.us/fish/ceded

Wildlife

The wildlife around Bone Lake is very plentiful. Animals ranging from the abundant whitetail deer (*Odocoileus virginianus)* to the majestic bald eagle (*Haliaeetus leucocephalus*) can be found in the area.

Some of the common species present in the area are: wild turkeys, ring-neck pheasants, grouse, woodcock, mallards, wood ducks, geese, coyotes, fox, black bear, raccoon, beavers, otters, fishers, mink, muskrats, various song birds, snakes, frogs, and turtles to name a few.

One reason for the wildlife diversity around Bone Lake and its watersheds is the habitat diversity. This geographic area contains various types of wetlands, open grasslands, upland and lowland woodlands, and agricultural areas - key habitats to the wildlife in the area.[11]

[11] Provided by Eric Mark, DNR Wildlife Biologist, Balsam Lake. January 5, 2006.

Lake Management

Lake Management Activities

A range of management activities are available to address water quality and habitat concerns. Categories for consideration include the following:

- Education/Incentives
- Conservation Practices
- Land Preservation
- Enforcement/Land Use Planning
- Lake Studies/Evaluation
- In-Lake Management

Education/Incentives

Providing education and information to lake residents and visitors is an important component of any lake management program. There is an abundance of printed and web information to help explain lake ecology and management methods. Incentives such as payments, tax credits, and recognition can also encourage adoption of desired lake management behaviors.

Information can be distributed using a variety of methods including

- Packets of information for new homeowners
- Notebooks with pertinent information
- Brochures
- Web sites
- Newsletters
- Newspapers
- Workshops and training sessions

Bone Lake residents report that they prefer to get information in the following ways: newsletter (88%), web site (18%), annual meeting (11%), email (6%), signs (3%), and newspaper (2%). Distributing information can certainly increase knowledge. A key consideration is that sometimes people have the knowledge of lake concerns, but still don't make desired behavioral changes. It is important to identify the barriers to behavioral change and to design programs that overcome these barriers.

Conservation Practices

Conservation practices, frequently called best management practices, are installed to reduce pollutants. For lake management, conservation practices tend to focus on reducing erosion, slowing water flow, and encouraging infiltration. Many times these practices use native vegetation to accomplish pollutant reduction objectives. For the most effective installation of conservation practices, target the most likely participants where significant sources of pollution can be addressed.

Installation of conservation practices is likely to require some form of technical assistance. For simple practices, this might be in the form of a guidebook. Many practices will require on-site visits with designs prepared by technicians. More complicated practices may require design by professional engineers.

Large scale practices and multiple small scale practices are likely to require significant funding for design and installation. Some lake organizations provide direct financial and technical assistance. It is more common for lake organizations to work together with a county and/or another nonprofit organization. DNR Lake Protection Grants are available for both small and large-scale practices with comprehensive lake management plan approval.

Conservation practices for Bone Lake are likely to focus on reducing runoff and pollutant loading from waterfront property and/or reducing erosion and runoff from agricultural crop fields.

Waterfront Runoff Practices

Waterfront runoff practices include rock pits or trenches, rain gardens, and shoreline buffers. It may be appropriate for Bone Lake to consider offering design assistance and cost sharing for these practices. Nearby Deer Lake, Balsam Lake, and Burnett County offer programs and education materials to encourage waterfront runoff practices. These programs could be used as examples.

Agricultural Best Management Practices

Large-scale best management practices are likely to be more expensive and must be targeted carefully by the significance of the pollutant source. Best management practices might involve conversion of a crop field to a more permanent vegetative cover, restoring wetlands, constructing sediment basins, or implementing nutrient management plans.

A nutrient management plan consists of a conservation plan to insure that crop rotations and tillage methods are within the range of tolerable soil loss (T). It helps to manage the amount, source, placement, form, and timing of the application of nutrients and soil amendments. All nutrient sources, including soil reserves, commercial fertilizer, manure, organic byproducts, legume crops, and crop residues are accounted for and properly utilized. These criteria are intended to minimize nutrient entry into surface water, groundwater, and atmospheric resources while maintaining and improving the physical, chemical, and biological condition of the soil.

Land Preservation

Land preservation involves purchasing land or putting land in conservation easements to preserve natural areas or to ensure that conservation practices will remain in place. There are several nearby examples of land preservation purchases and easements. To ensure that conservation practices remain in place, the Deer Lake Conservancy has easements or owns land where the practices are installed. The Half Moon Lake Conservancy accepted donation of forty acres of natural area along Harder Creek, the largest tributary flowing into the lake. The Balsam Lake District purchased twelve acres on the north side of the lake to preserve and prevent development of an important wildlife area.

Enforcement / Planning

Lake District involvement in enforcement of state and local regulations and planning activities can help to protect lakes. Lake District members can report potential violations of regulations and ordinances to assist with appropriate enforcement. However, it is important to note that the Lake District cannot establish or enforce laws (except for boating laws under certain circumstances). Involvement in planning activities can help to ensure that land uses that protect the lake are in place in the watershed. Plans might be developed at the town, county, or state level.

In-Lake Management

There are many options for in-lake management. Aeration, dredging, and alum treatment are just a few. These techniques generally require in-depth study, detailed permits, and significant funding. Nearby examples include Lake Wapogasset and Bear Trap Lake where an alum treatment was completed in 2001 and Cedar Lake where an aeration system is in place.

Lake Studies/Evaluation

The water quality study completed in preparation for this plan is one example of a lake study. It is common for studies to identify further work that is needed to better understand the lake. It is important to understand why data is being collected before taking the time and spending the money to do it. Recommendations for ongoing study and evaluation are included in the water quality subcommittee recommendations and implementation plan.

Choosing Management Options

To choose from the many management options that are available, it is important to do the following:

- Set clear goals and objectives
- Understand potential results
- Prioritize activities
- Consider social and political feasibility
- Investigate funding possibilities
- Seek available assistance

The goals, objectives, and action items in the implementation plan seek to incorporate the above considerations.

Public Survey Results

Selected public survey results can assist in choosing management options. Lake residents supported monitoring lake water quality (77%), educating residents about lake issues (64%), programs to prevent runoff from farms (63%) and programs to prevent runoff from residents (49%). See Appendix A for additional results. The survey results can also help to guide the development of a program for preventing runoff from residences. Many residents were familiar with not fertilizing or using zero phosphorus fertilizer (76%), but fewer were familiar with shoreline buffer zones (59%), or rain gardens (21%). There is also little awareness of the negative impact of runoff from residential property or the effectiveness of shoreline buffer zones in survey results as shown in Figure 18 below. The figure numbers are in percentage of total response.

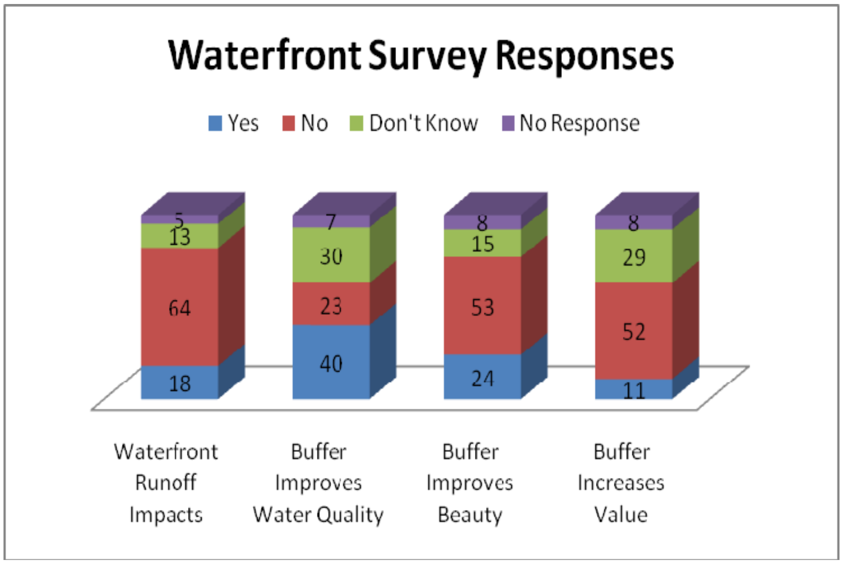

Figure 18. Selected Survey Responses Related to Waterfront Runoff Practices

The survey can further help understanding of the potential motivation for installation of waterfront practices. Improving lake water quality is the biggest reported motivator for project installation.

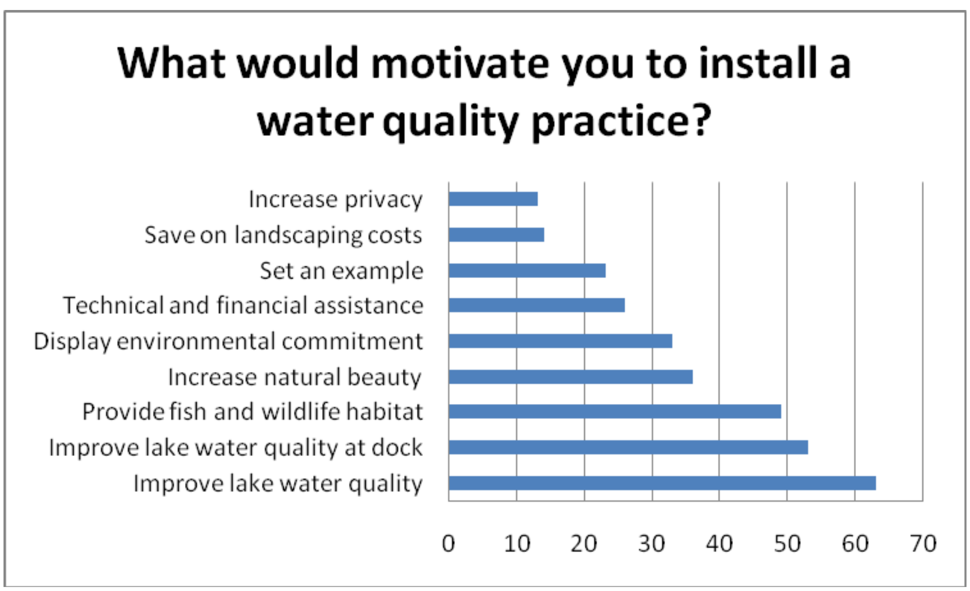

Figure 19. Motivation for Waterfront Practice Installation

Residents report that they would be most encouraged to seek assistance for controlling runoff because of a property tax rebate (52%), technical assistance to evaluate property (30%), and technical assistance to identify practices (28%).

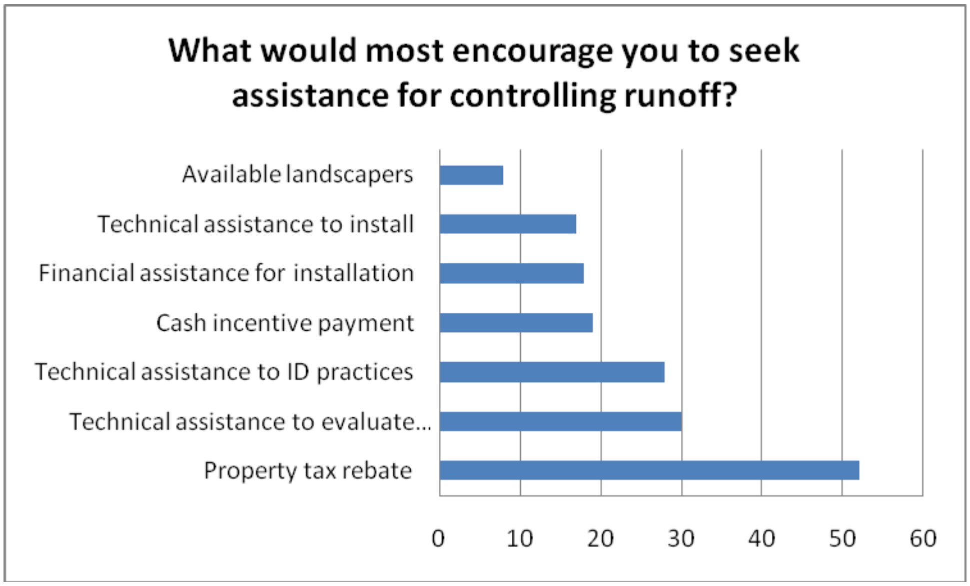

Figure 20. Reasons to Seek Assistance for Controlling Runoff

And finally, practices of most interest are described as runoff reduction practices and native flower plantings. This question tests the reaction to terminology in addition to interest in the practice because some of the answers have the same or very similar definitions. For example native flower plantings, buffer zones, and natural shoreline resotration could all be the same practice.

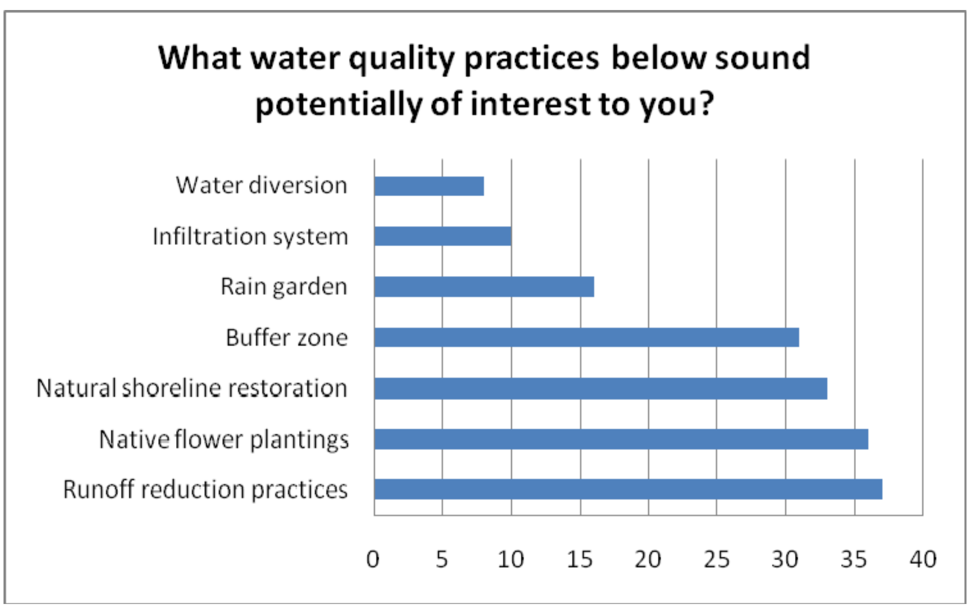

Figure 21. Water Quality Practices of Interest

Comprehensive Lake Management Plan Committee Input

Committee members were also asked to provide guidance for waterfront resident education. They did so by responding to the two questions below.[12]

<u>What keeps Bone Lake residents (you?) from implementing residential water quality practices like shoreland buffer zones and rain gardens?</u>

Don't believe benefit (my lot doesn't contribute) (6)

Don't understand benefit (3)

It won't look good (weeds) (3)

Don't tell me what to do (2)

Costs too much (2)

Grandkids can't play by the shore (1)

Can't see my grandkids playing by the shore

Too much effort

My neighbors won't like the way it looks

<u>What would encourage you to install a practice?</u>

A plan that provides a design (5)

Nothing (5)

A plan that identifies benefits (4)

Financial incentive (cost sharing) (2)

Recognition (2)

A plan that addresses the concerns I have (e.g., grandkids) (1)

No covenant (1)

Tax break (0)

Financial incentive (payment for completing) (0)

[12] Each committee participant was asked to choose 2 top choices for each question. Numbers are tallied and put in priority order. There were 10 committee members in attendance.

Related Plans, Regulations, and Ordinances

As described previously, knowledge of and involvement in development and implementation of local plans and ordinances can assist the Bone Lake Management District in achieving the goals of this comprehensive lake management plan.

Polk County Land and Water Management Plan

The land and water management plan guides the activities of the Polk County Land and Water Resources Department from 2005 to 2009. The department will partner with local, state, and federal agencies and organizations to conserve soil and water resources, reduce soil erosion, prevent nonpoint source pollution, and enhance water quality. Activities include technical assistance with enforcement, technical and financial assistance, and education. Local plans and ordinances are described in the document. The land and water management plan includes an implementation strategy for state agricultural performance standards. Farmers are required to meet these standards when the county offers cost sharing. The plan will be revised in 2009.

WI Agricultural Performance Standards (NR 151)

For farmers who grow agricultural crops

- Meet “T” on cropped fields
- Starting in 2005 for high priority areas such as impaired or exceptional waters, and 2008 for all other areas, follow a nutrient management plan designed to limit entry of nutrients into waters of the state

For farmers who raise, feed, or house livestock

- No direct runoff from feedlots or stored manure into state waters
- No unlimited livestock access to waters of the state where high concentrations of animals prevent the maintenance of adequate or self sustaining sod cover
- Starting in 2005 for high priority areas, and 2008 for all other areas, follow a nutrient management plan when applying or contracting to apply manure to limit entry of nutrients into waters of the state

For farmers who have or plan to build a manure storage structure

- Maintain a structure to prevent overflow, leakage, and structural failure
- Repair or upgrade a failing or leaking structure that poses an imminent health threat or violates groundwater standards
- Close a structure according to accepted standards
- Meet technical standards for a newly constructed or substantially-altered structure

For farmers with land in a water quality management area (defined as 300 feet from a stream, or 1,000 feet from a lake or areas susceptible to groundwater contamination)

- Do not stack manure in unconfined piles
- Divert clean water away from feedlots, manure storage areas, and barnyards located within this area

Polk County Comprehensive Land Use Plan

The Polk County Comprehensive Land Use Plan was adopted in 2002. The plan includes an analysis of population, economy, housing, transportation, recreation, and land use trends. It also reports the physical features of Polk County. The purpose of the land use plan is to provide general guidance to achieve the desired future development of the county and direction for development decisions. The lakes classification outlines restriction on development according to lake features. Planning areas are recommended in the plan. The plan is available online at http://co.polk.wi.us/landinfo/comprehensive_plan.htm.

Polk County Comprehensive Land Use Ordinance

The Polk County Comprehensive Land Use Ordinance, more commonly known as the Zoning Ordinance was last updated effective June 1, 2007. Georgetown adopted this ordinance, but the Town of Bone Lake has not. Land use regulations in the zoning ordinance include building height requirements, lot sizes, permitted uses, and setbacks among other provisions.

Smart Growth

Smart growth is a state mandated planning requirement to guide land use decisions and facilitate communication between municipalities. Wisconsin's Comprehensive Planning Law (Statute 66.1001, Wis. Stats.) was passed as part of the 1999 Budget Act. The law requires that if a local government engages in zoning, subdivision regulations, or official mapping, those local land use regulations must be consistent with that unit of local government's comprehensive plan beginning on January 1, 2010. The law defines a comprehensive plan as having at least the following nine elements:

- Issues and opportunities
- Housing
- Transportation
- Utilities and community facilities
- Agricultural, natural, and cultural resources
- Economic development
- Intergovernmental cooperation
- Land use
- Implementation

Polk County was awarded a 2007 Comprehensive Planning Grant from the Wisconsin Department of Administration. This multi-jurisdictional grant is being used by the participating municipalities to establish local comprehensive plans as well as amendments to the county's 2003 Land Use Plan.

Shoreland Protection Zoning Ordinance

Polk County passed an update of the Shoreland Ordinance in 2002. The updates put in place standards for impervious surfaces, a phosphorus fertilizer ban for shoreland property, and lakes classification and setback standards. The shoreland protection ordinance applies to all land within 1,000 feet of a lake and 300 feet of a river or stream in Polk County. The ordinance is available online at http://www.polkshore.com.

Subdivision Ordinance

The subdivision ordinance, adopted in 1996, requires a recorded certified survey map for any parcel less than 19 acres. The ordinance requires most new plats to incorporate storm water management practices with no net increase in runoff from development. The ordinance is available online at http://co.polk.wi.us/landinfo/PDFs/subdivisionordinance.pdf.

Animal Waste

The Polk County Manure and Water Quality Management Ordinance was revised in January 2000. A policy manual established minimum standards and specifications for animal waste storage facilities, feedlots, degraded pastures, and active livestock operations greater than 300 animal units for livestock producers regulated by the ordinances. The Land and Water Resource Department's objective was to have compliance with the ordinance countywide by 2006. The ordinance is available online at http://www.co.polk.wi.us/landwater/MANUR21A.htm.

Storm Water and Erosion Control

The ordinance, passed in December 2005, establishes planning and permitting requirements for erosion control on disturbed sites greater than 3,000 square feet, where more than 400 cubic yards of material is cut or filled, or where channels are used for 300 feet more of utility installation with some exceptions. Storm water plans and implementation of best management practices are required for subdivisions, survey plats, and roads where more than ½ acre of impervious surface will result. The Polk County Land and Water Resources Department administers the ordinance. The ordinance is a local mechanism to implement the Wisconsin Non-agricultural Runoff Performance Standards found in NR 151.

WI Non-Agricultural Performance Standards (NR 151)

Construction Sites >1 acre – must control 80% of sediment load from sites

Storm water management plans (>1 acre)
- Total Suspended Solids
- Peak Discharge Rate
- Infiltration
- Buffers around water

Developed urban areas (>1000 persons/square mile)
- Public education
- Yard waste management
- Nutrient management
- Reduction of suspended solids

Boating Regulations

The Department of Natural Resources regulates boating in the state of Wisconsin.[13] Wisconsin conservation wardens enforce boating regulations. A few highlights of boating regulations are found below.

- ✓ Personal watercrafts (PWCs) may not operate from sunset to sunrise.
- ✓ PWC operators must be at least 12 years old.
- ✓ There are 100-foot restrictions between boats or PWCs and water skiers, towropes, and boats towing skiers.
- ✓ It is unlawful to operate within 100 feet of any dock, raft, pier, or buoyed restricted area at a speed in excess of "slow-no-wake."
- ✓ Boats have specific lighting requirements after dark.
- ✓ Speed must be reasonable and prudent under existing conditions to avoid colliding with any object or person.

A town or village may delegate the authority to adopt lake use regulations to a lake district. These may include regulation of boating equipment, use, or operation, aircraft, and travel on ice-bound lakes.[14]

Dredging Regulations (Sec 30.20 Wis. Stats.)[15]

A general permit or an individual permit is required to dredge material from the bed of a navigable waterway. Bone Lake is designated as an "Area of Special Natural Resource Interest" and Sensitive Areas on the lake, including the northern most bay, are designated as "Public Rights Features." Because of these designations, an individual permit is required for in-lake dredging. This permit requires submitting the proposed dredge area and shoreline cross sections, where spoils will be deposited, and floodplain and wetland boundaries. The cross sections must include the normal water level and a profile of the existing bottom and proposed dredged bottom. Sediment testing for hazardous materials may be required. Permit review may take three months or longer. Local zoning permits and U.S. Army Corps of Engineers permits may also be required. The depth and navigability of the entrance to the lagoon at the northern end of the lake was raised as an issue of concern both by lake residents and the advisory committee.

District Involvement in Planning and Zoning

The Bone Lake Management District has two seats on the board of directors for representatives appointed by the Polk County Board of Supervisors and the Town of Georgetown. These individuals help to bring concerns related to local planning and zoning to the Lake District board. As concerns are identified, commissioners may attend related meetings and hearings to express concerns and gather information.

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[13] Boating regulations may be found online at www.dnr.wi.us/org/es/enforcement/docs/boating regs.pdf.
[14] Chapter 33. Wisconsin State Statutes.
[15] Information from http://dnr.wi.gov.org/water/fhp/waterway/dredging

Water Quality Subcommittee Recommendations

The water quality subcommittee examined consultant recommendations and analyzed available information to make recommendations regarding ways to improve the water quality of Bone Lake. Specific land uses and areas of concern were also identified. These include crop fields that drain directly to the lake and residential lands surrounding the lake. Potential management activities and their impact were considered in the development of the recommendations that follow.

Recommendations for Crop Fields

Options are available to convert crop fields to more permanent cover, thereby reducing runoff to the lake. The Lake District might also consider purchasing a crop field and/or portions of fields and converting them to permanent vegetative cover.

The District might also encourage a change in cropping practices to leave more residue on the field and reduce erosion. Fertilizer applications that meet but do not exceed crop needs could also be beneficial to lake water quality. Nutrient management planning and associated conservation practices can lead to these desired changes.

Nutrient Management Planning

Changes in tillage practices can reduce phosphorus loading by 30-90 percent, depending upon the current and final practice. As the cropland becomes a cash grain operation with more years of row crops (corn-soybean rotations), high residue management and no-till are needed to reduce soil erosion to a tolerable amount (commonly referred to as “T”). Using characteristics of fields in the Bone Lake watershed, if all fields were in a corn-soybean rotation and moldboard plowed, the soil loss would be estimated at 11 tons per acre of soil loss. This soil loss would have a P delivery of approximately 9 pounds per acre to the field edge. With conservation tillage, this average would be reduced to a soil loss of 6 tons per acre and to a P delivery of approximately 6 pounds per acre to the field edge. No-till would result in less than 1 ton of soil loss and less than 1 pound P delivery to the field edge. State agencies have recommended a soil loss of “T”, and a P index of less than 6. Any buffering between the field and the lake or retention of runoff water will reduce the load that actually reaches the lake.

Polk County recently was selected to receive cost share funding under a Supplemental Educational Grant (SEG) for Nutrient Management. This funding (only $12,000 for 2009) will be used to fund Nutrient Management Planning throughout the county. A limited amount of funding may be used to support conservation practices to reduce soil loss. However, a Nutrient Management Plan must be implemented to receive any residue management cost sharing.

Conservation Reserve Program

The USDA Conservation Reserve Program (CRP) makes payments to agricultural producers to temporarily take crop land out of production. Currently there are only two fields (<10 acres) that are in USDA Conservation Reserve Program (CRP) in the Bone Lake watershed. The farm bill has authorized CRP but no sign ups have been offered in 2008.

Recommendations for Residential Lands

The main recommendation for residential land (classified as urban in the lake modeling analysis) is to install conservation practices to reduce runoff from waterfront lots. These practices include rain gardens and rock trenches to infiltrate water and shoreland buffer zones to slow runoff and improve habitat around the lake.

Because there are many cases of wet, saturated soils, soil types around the lake were examined to see if they were appropriate for infiltration practices. Steep slopes may also make infiltration practices difficult to install, while these sites are also most likely to contribute pollutants to lake without adequate vegetative cover. A shoreland buffer zone is a good choice to reduce pollutant loading to the lake on such steeply sloped sites.

The map in Figure 22 shows that although there are areas with limitations because of slope and soil, many areas around the lake are suitable for rain gardens. Potential rain garden areas amount to 29 percent of all land within 300 feet of Bone Lake. Note that not all of the areas indicated as appropriate for rain gardens occur on developed waterfront lots.

Many additional areas are appropriate for native plantings in shoreland buffer zones. In fact, steeply sloped areas are excellent candidates for shoreland buffer installation not only for runoff reduction but also to reduce the effort of maintaining a waterfront lot. Steeply sloped areas should be priorities for shoreland buffer zone installation. The Shoreland Habitat Survey indicated that only 34% of the potential shoreland buffer area (within 35 feet of the lake) was in natural vegetation. A minimum of 70% is recommended.

Installing rain gardens and shoreland buffer zones can result in a 50-90+% reduction in phosphorus runoff from residential lands.

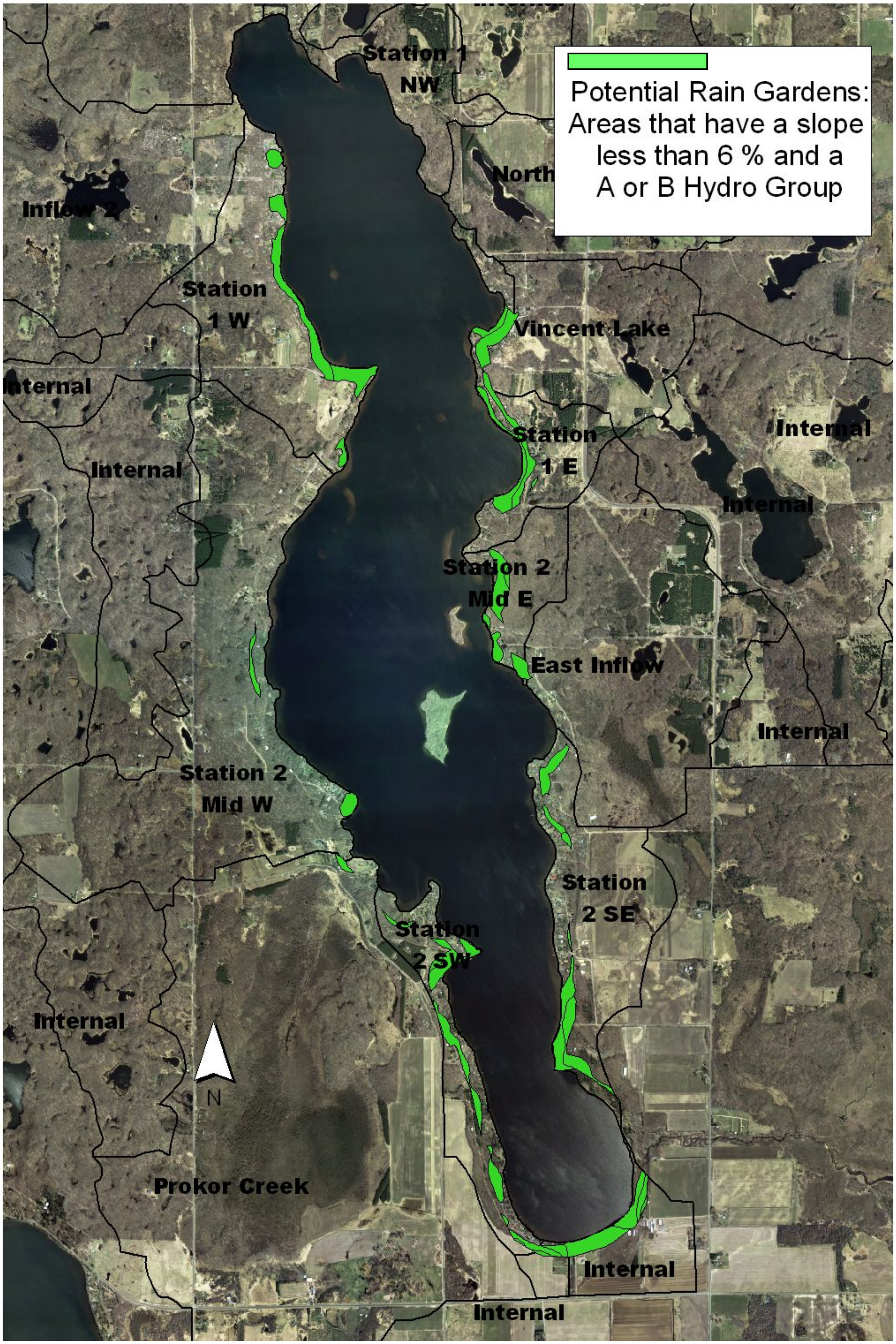


Figure 22. Suitable Rain Garden Locations

Water Quality Model Results[16]

The water quality model can be used to predict the impacts of changes in land management. The 2008 in-lake total phosphorus growing season average was 38 ppm which is consistent with model predictions. A tentative goal is to reach 30 micrograms per liter (equivalent to 30 parts per billion or 30 ppb). With overall watershed reduction of 20%, a result of 31.5 ppb is predicted. With overall watershed reduction of 30%, 29.5 ppb is predicted.

Additional predictions from the water quality model are described in the bulleted list below.

- Reducing 70 acres of crop field P loading by 80% predicts 37 ppb, a 2.6% reduction in summer in-lake total phosphorus.

- Reducing 25% of residential P loading by 50% predicts 36 ppb, a 5.2% reduction in summer in-lake total phosphorus.

- A combination of the two predicts 34 ppb, an 11% reduction in summer in-lake total phosphorus.

- Additional phosphorus reduction could come from management actions on the tributaries – especially on the northwest tributary where actual phosphorus loading was higher than predicted.

- Curly leaf pondweed management might help to attain the remaining desired reduction of in-lake phosphorus. More information is needed on the composition of curly leaf pondweed in the lake and the effectiveness of herbicide treatment.

- Changing 25% of forested land to residential land predicts 44 ppb, a 16% increase in summer in-lake total phosphorus.

Future Study Needs Identified

<u>Spring runoff samples from various areas (TP, SRP, TSS)</u>

- NE inflow (24” culvert) – sample both above and below pond
- Dueholm Drive (concern re: winter spread septic)
- Prokop Creek
- North Tributary (Inflow #2)
- Other areas of channelized flow identified by residents (request this information via email to AIS volunteers and committee)

[16] Information from Steve Schieffer, Ecological Integrity Services.

Northwest tributary inflow

- Sample Volatile Organic Carbons and heavy metals because of potential pollutants from salvage yard upstream (move sample location closer to salvage yard)
- Take samples during spring runoff and following three large storm events

In-lake P loading

- Lake temperature and oxygen profiles (twice monthly)
- Further study of curly leaf pondweed bed locations, density, and phosphorus in plant tissues.

Implementation Plan

Plan Timeframe

The plan will be implemented over a ten year period. With this schedule, plan review and update will begin in 2018.

Implementation Plan Updates

An implementation plan is found in the following section. The implementation plan or workplan details how action steps will be carried out over the next four year period. This implementation plan will be updated on a regular basis (every two to three years) to keep actions up-to-date.

Mission Statement

Bone Lake is a precious resource and one of the premier recreational lakes in this area. The overall mission of this comprehensive lake management plan is to maintain and enhance the health of Bone Lake to support clean water, natural beauty, recreation, and sport fishing for decades to come.

Goals

Improve Bone Lake water clarity.

Maintain and enhance Bone Lake's natural beauty.

Protect and enhance wildlife habitat.

Protect and improve the Bone Lake fishery.

Maintain safe, effective navigation in Bone Lake.

Goal

Improve Bone Lake water clarity.

Objectives

Achieve an in-lake average summer phosphorus concentration of 30 ppb or less.

Reduce watershed phosphorus (P) loading by 25% or more.

- Reduce P loading from urban sources by lowering runoff from 25% of residential lots by 50%.
- Reduce P loading from cropland sources by reducing loading from 50 acres of row crop by 80%.
- Reduce tributary loading of phosphorus by 25%.

Further evaluate phosphorus loading from the watershed.

Evaluate in-lake sources of phosphorus.

Curly leaf pondweed (2010)

Lake bottom sediments (2009)

Reassess in-lake and watershed objectives in 2011. Objectives may need to be adjusted with better understanding from tributary monitoring and in-lake source evaluation.

Actions

Crop Fields

Test runoff where cropland runoff potentially flows to Bone Lake to clarify which crop fields are significant contributors of phosphorus.

Investigate options for reducing nutrient loading.

Open dialogue with landowners with the assistance of Polk County LWRD.

Encourage implementation of practices that reduce runoff and erosion from cropland.

Reducing runoff and erosion from cropland generally involves changing the crop that is planted, modifying tillage methods, or converting cropland to permanent vegetative cover. Federal, state, and local incentives may be available to encourage these changes. The Lake District could choose to support these incentive programs.

Consider purchasing a portion(s) of a crop field(s) that contributes significant nutrients to the lake.

Waterfront Runoff

Provide on-site technical assistance to property owners to encourage implementation of practices that reduce runoff from waterfront property. *Technical assistance must be no-strings attached and non-regulatory.*

Provide financial incentives (cost-sharing) to encourage installation of waterfront runoff practices.

Provide education for lake residents.
Target education based upon an understanding of the barriers to implementing practices.

Messages
Impacts of waterfront runoff to lake water quality.
How waterfront runoff practices protect water quality.
Native vegetation is critical for wildlife habitat.
Discourage fertilizing lawns.
If you fertilize your lawn, use zero phosphorus fertilizer.
Maintain your septic system properly (provide direction on how to do this).
Do not blow grass and leaves into the lake

Methods
Newsletter
Web Site
Workshops
Annual meeting

Evaluation/Studies

Monitor spring runoff (TP, SRP, TSS) from tributaries and other areas of potential runoff concern.

Assess if there are volatile organic carbons and heavy metals potentially entering the lake by collecting samples from the northwest tributary.

Complete internal load study measuring lake temperature, oxygen, and total phosphorus across three lake profiles.

Assess phosphorus loading from curly leaf pondweed.

Goal

Maintain and enhance Bone Lake's natural beauty.

Definition includes wildlife, plants, trees, clear water, quiet solitude, a variety of scenery, views of the lake. Where development occurs, it is preferable to have minimal views of buildings.

Objectives

Maintain undeveloped, natural areas where feasible.
Enhance natural beauty of developed areas.

Actions

Identify potential priority lands to protect natural beauty.

Consider land protection methods such as land purchase and conservation easements to preserve undeveloped lands.

Provide education for lake residents.

Messages
- Become less visible to your neighbors.
- Encourage natural vegetation.
- Restore native vegetation in developed areas.
- Describe ways to be more courteous to neighbors
- Consider removing your old boat house.

Methods
- Newsletter
- Web Site
- Handouts

Goal

Protect and enhance wildlife habitat.

Objectives

Protect existing natural areas with native vegetation along the lake shoreline and in the watershed.

Increase resident understanding of ways to attract wildlife to their property.

Actions

Encourage zoning regulations in the Towns of Bone Lake and Georgetown. *Georgetown has adopted Polk County Zoning regulations, but the Town of Bone Lake has not.*

> Zoning regulations establish permitted uses and building requirements. A zoning map establishes where various land use classes are located.

Identify potential priority lands for protection of wildlife habitat.

Consider land protection methods such as land purchase or conservation easements to preserve undeveloped lands.

Encourage DNR and Polk County enforcement of state no-wake zone requirements.

> Slow, no wake speed means a speed at which a vessel moves as slowly as possible while still maintaining steerage control.
>
> It is illegal in Wisconsin to:
>
> - Operate a vessel within 100 feet of any dock, raft, pier, or restricted area on any lake at greater than "slow, no wake speed."
> - Operate a vessel at greater than "slow, no wake speed" within 100 feet of a swimmer, unless the vessel is assisting the swimmer.
>
> *From: Wisconsin Handbook of Wisconsin boating laws and responsibilities.2009.*
>
> New requirements may be added in 2009. Senate Bill 12 would require slow, no wake within 100 feet of the shoreline.

> Provide education for lake residents and visitors.
>
> Messages
> No-wake zone requirements.
> Travel at no-wake speed in wildlife areas.
> How to attract wildlife to your property.
> Un-mown vegetation next the water's edge attracts wildlife (but not geese).
> Protect loon and eagle nesting areas.
> Install loon nesting platforms.
> Describe shoreline inventory results (amount of disturbed shoreline).
>
> Methods
> Newsletter
> Web site
> Workshops
> Annual meeting

Goal

Protect and improve the Bone Lake fishery.

Objectives

Maintain desirable levels of game fish in Bone Lake.

Assess and improve fish habitat.

Balance fish populations to encourage zooplankton (algae eaters).

Actions

Communicate with the DNR and Tribes to improve fish management.

Encourage voluntary reporting of tribal winter harvest of musky.

Encourage and support DNR and Tribal assessment and management of game fish populations.

Support increasing minimum size limits on game fish.

Monetarily support fish stocking.

Goal

Maintain safe, effective navigation in Bone Lake

Objective

Maintain navigation channels to allow access.

Identify shallow water areas

Action

Investigate actions and permits needed to maintain boating access to the lagoon.

Follow aquatic plant management plan to manage vegetation in a manner that maintains designated navigation channels. (This includes investigating the purchase of a harvester.)

Maintain buoys in approved locations on shallow water reefs and points. (31 buoys are currently approved for installation).

Provide education to lake residents

Messages

Information about lake levels

Describe why shallow buoys are installed and where they are located.

Methods

Newsletter
Web site
Workshops
Annual meeting

Funding Plan Implementation

The work plan in Appendix E describes potential funding sources for plan implementation. The main sources of implementation funds are Bone Lake Management District tax revenues and Department of Natural Resources grants. The DNR Lake Management grant program has two major types of grants: planning and lake protection grants. Lake planning grants are available at two scales – large scale up to $10,000 and small scale up to $3,000. These applications are accepted twice each year on February 1 and August 1. DNR Lake Protection Grants for plan implementation have a maximum grant amount of $200,000. These grants are due each year by May 1. Plan activities will be eligible for Lake Protection Grant funds following approval by the DNR.

<u>DNR Lake Planning Grants</u>

Large scale – up to $10,000
Small scale – up to $3,000

Applications due February 1 and August 1
These grant applications could proceed without final plan approval.

<u>DNR Lake Protection Grants</u>

Up to $200,000
Requires DNR approval of tasks in the comprehensive plan (allow 60 days)

Applications due May 1

Appendix A. Public Opinion Survey Results

Bone Lake Property Owner Survey

RESULTS 264 RETURNED OUT OF 487 DELIVERED = 54% RETURN

Preliminary results 01/03/2008

Please complete and return in the enclosed self-addressed stamped envelope to:

Harmony Environmental
516 Keller Avenue S
Amery, WI 54001

Do you currently own property on Bone Lake? (Circle one)

Yes **215** No **3** No Response **46**

Comments:

- If you stopped all the people from driving their boats too close to the shoreline, we could & would all have better shoreline...TOO FAST, TOO CLOSE - ERODES OUR SHORELINE
- We are located on opposite side of Road of Bone Lake. We call it a back lot!
- A Bone Lake back lot property + cabin
- Weeds have been well documented by past & present engr. firms.
- Completed by: Jeanne Vighot 2263 Woodland Shores 1-715-857-5848
- The fireworks the south owner put on the best yet. Why waste the money. Parade ok.

1. What recreational activities do you enjoy at the lake?

(Check all that apply and circle the one that is most important.)

(The first numerical value is a weighted response with the circled item counted twice and others once. The percentage is the percentage of respondents who checked this item with no weighting given to circled item.)

254 Enjoying the View (92%)

239 Fishing (83%)

242 Swimming (83%)

227 Observing Wildlife (80%)

229 Appreciating Peace and Tranquility (79%)

138 Water Skiing (50%)

113 Non-motorized boating (canoe, kayak, paddleboat) (41%)

77 Jet Skiing (28%)

58 Other (list)Motor boating/Pontoon[1] (20%)

40 Sailing or Wind Surfing (15%)

9 Scuba Diving or Snorkeling (.03%)

[1] Motor boating was inadvertently missing from the list in the original survey.

Comments:
- I won't allow my family to use Jet skis, boats come too close to docks
- Peace & tranquility rare on weekends
- I tried to scuba dive once - almost got killed because boats didn't respect the diving glag & drove over us.
- Duck Hunting
- NO! Jet Skiing
- Most hated: Jet Skiing!
- Your list is not complete
- Boat Fishermen not respecting safe distance to swimmers, throwing lures around them. Jet skiers coming too close to docks & boats & skiers & swimmers
- Eagles and loons
- By Jet Skiing wrote "yuk"
- Water volleyball.

2. What issues regarding owning waterfront property concern you the most?
(Rank each H = high concern, M = medium concern, L = low concern, 0 = no concern)

675 Paying property taxes
660 Protecting the lake environment
618 Water clarity at the end of my dock
607 Excessive aquatic plant growth in the lake
601 Maintaining the investment value of my property
481 Water clarity in the middle of the lake
12 Other Noise Level
11 Other Low Water Levels
10 Other Jet skis
9 Other Water Level
6 Other high electric cost per mo w/o using it
6 Other high taxes that increase a lot every year
6 Other Algae Bloom in summer
6 Other Thick Weeds
6 Other Boats not resp. swimmers
3 Other Non Res.Boat Traffic
3 Other Fireworks beyond July 4
3 Other Quality of Fishing
2 Other Private Enjoyment
1 Other High cost fishing license by non-resident
1 Other Over Development

Comments:
- Prop. Taxes have increased 4x the amt I paid 12 years ago.
- Controlling aquatic growth in front of my property.
- Excessive aquatic plant growth is a VERY big concern!!!!
- Water level maintained

- Maintaining overall health of lake
- Weeds so thick I have a hard time using the lake
- Dangerous, Inconsiderate boat traffic
- Protecting our lake from AIS
- Loss of frogs, turtles, toads, snakes, etc
- Safety & security of area on and off the lake
- Why was the neighbor next door to us allowed to put in a boathouse 8 feet from the lake and use red-dyed mulch which floats in lake (Pat Lyons) - but other neighbor cannot put porch on street side of cabin? We have a huge concern with this type of lakeshore mismanagement. - the Konigsons
- Paying taxes for no services offered
- Shoreline preservation. Too much mowing.
- And losing our property to high taxes!!
- Shore erosions (muskrats boring under the shoreline)
- Being able to have a SWIMMABLE beach. Having enough dock space for association.
- Except invasive species & algae bloom due to high W levels
- Re: Protecting the lake environment: The County & State are already overdoing this.
- 3- not respecting swimmers
- Inappropriate use of jet skis.
- Navigable channel (North End). Silt & Muck (3-4' deep) end of dock or in channel in general (North End).
- Fishing too close to dock. Keep Lake Water Level to level of today 10/24/2007 UP!!
- Non-phosphorus fertilizer
- People throwing cans & garbage on our property from their pontoons while swimming on/off our shore.

3. Rank the degree each concern negatively impacts your use or enjoyment of the lake.
(Rank each H = high impact, M = medium impact, L = low impact, 0 = no impact

654 Invasive species aquatic plant (weed) growth

602 Algae growth

489 Native aquatic plant (weed) growth

477 Lake level too low

454 Loss of wildlife habitat

436 Boat/traffic congestion

415 Noise

394 Loss of natural scenery around the lake

325 Small fish size

307 Not enough fish

309 Sediment prevents navigation

174 Lake level too high

12 Other Irresponsible Jet Ski Operation

12 Other Boats speeding close to shore on my point. I'm losing lots of my shore that is washed away!!

6 Other Low Water Level

3 Other theft of dock section

3 Other neighbors wood pile

3 Other neighbors noise & junk in yard

3 Other No Walleyes

3_____Other Trailer Camps

3_____Other Too Many Boats

3_____Other Jet skis

3_____Other hunters

3_____Other Swimmers Itch

1_____Other Farm runoff

Comments:

- I interpret this to mean if the items below were a problem, what degree would they negatively impact my enjoyment.
- Damn fool chemical treatments to kill weeds or algae
- weed/plant growth immediately at shore by the dock
- How about hours on the noisy and disturbing jet skis? (Offensive noise)
- Rude people on jet skies & fast boats passing people fishing
- Why allow boathouses on lake to block views of other cabin owners?
- Noise (Jet Skis)
- "!" by Noise
- Lake Level, native (weed) growth, invasive (weed) growth = Not sure if they're native or not!
- Stop having the tournaments - boats go too fast
- Too many trailer camps & too many boats from trailer camps.
- Install something at entrance to Fox Creek to maintain a constant water level during droughts like we've had the last two years.
- Shoreland lighting that's too bright
- Tubers driving in circles
- Taxes
- Weeds
- Too many muskie & Too many Fishing Tournaments
- Jet skis chasing loon on east side
- Re: fish & water level statements, I haven't found any of these to be a reality.
-? On sed.
- Muck on shoreline, decomposing weeds
- (Boat congestion some weekends)
- Increased rude & dangerous behavior of Jet Ski drivers
- Lack of weed control

4. The lake management district should consider the following actions to improve Bone Lake.
(Check all that apply) (% Checked out of 264 surveys returned)

80% Monitor for aquatic invasive species introduction
77% Monitor lake water quality
74% Prevent aquatic invasive species introduction
64% Educate residents about lake issues
63% Programs to prevent nutrient runoff from farms
61% Spray aquatic plants (lake weeds)
49% Program to prevent runoff from residences
48% Test septic systems
42% Protect sensitive habitat areas
41% Stock fish
41% Be involved in local planning and zoning
40% Harvest aquatic plants (lake weeds)
28% Offer financial incentives to residents for lake water quality practices
26% Improve boat landings
23% Expand "slow no-wake" times and locations
20% Increase boating regulation enforcement
20% Acquire property for watershed and lake protection
.01% Other Control Water Level
.01% Other Control Alum treatment
.003% Other Dredge shallow area @ north end to channel for navigation
.003% Other fisherman/resident privacy issues
.003% Other Educate landowners
.003% Other Limit/eliminate Fishing Contests

Comments:

- I don't know the implications of many of these, so hard to answer. Educate ignorant owners like myself. I am willing to do my part; I just don't know what needs to be done.
- Re: spray - who knows the ultimate affect on humans and the lake? Yes, some sept seep into the lake; offer education; some disregard the no wake completely; south landing has some improvements
- Stock fish but NOT Muskie
- Re: "slow no-wake"...I'm on Sandy Hork Pt. Boats come around point at high speeds, an accident in the making & also erosion problem
- Stock Walleye
- Spray if Invasive
- Let the DNR (Educate, stock fish, monitor water quality, invasive, improve boat landings) & County (test septic,) do their jobs
- Dam outlet creek
- NO to acquire property
- Especially south end boat landing
- South end boat landing
- Apply tax incentives to property owners
- Re: Boat regs. How about clearly mark, then inform, and then enforce
- Don't allow boathouses so close to lakeshore while preventing decks & patio at cabins.
- Improve boat landing at north end
- Limit fireworks

- Listen to the lake property owners concerns. Do not accept the DNR says we have to do this and not question why with a good explanation.
- Never harvest lake weeds
- Re: Stock fish means other than muskie
- Spray only if it is safe for the environment.
- Encourage shore restoration
- No spray. Loon Island Signs!!
- Spraying is a very bad idea. Septic & nutrient runoff: I believe these two approaches are the only real, long lasting methods to get the weeds and algae under control.
- South end of the lake
- All of these.
- You already improved boat landings and it's great!
- In fishing for musky this year there was a good variety of growth on east side from big island south. Need to keep the good stuff!
- Increase boat regs on 7/4. Concern: NO mosquito control West Nile. We need to mow our lawns.
- Dredge channel & "lagoon" at North end.
- Tax non-home-owners for lake use + programs (boat launch fees for non-tax payers).
- Stock small mouth bass and walleye. NO! to acquire property...

5. **How would you describe Bone Lake's aquatic plant (lake weed) growth overall?** (Circle one)

Too few plants	Healthy amount	Too many plants	Not sure	No response
3%	**36%**	**44%**	**13%**	**4%**

6. **Which best describes the amount of rooted vegetation near the shore (in the water)?** (Circle one)

Too much	About right	Too little	Don't know	No response
38%	**41%**	**6%**	**9%**	**6%**

Comments:
- By our cabin
- Different at different areas of lake
- Too much by my dock, don't know over all
- Cattails should be declared an invasive weed or plant
- Depends on where you are.

7. **Which best describes the overall level of aquatic plant (weed) growth in Bone Lake?** (Circle one)

Light Growth	Moderate Growth	Heavy Growth	Choked with Growth	No resp.
3%	**57%**	**29%**	**5%**	**6%**

Comments:
- It not controlled
- Need to promote weed growth in depths greater than 18'.

8. **Should the Lake Management District encourage more aquatic plant (weed) removal in Bone Lake?** (Circle one)

Yes	Yes, but only invasive plants	Maybe	No	Don't know	No resp.
33%	**40%**	**12%**	**6%**	**6%**	**3%**

9. Should the Lake Management District harvest aquatic plants (weeds) in the lake?
(Circle one)

Yes	Yes, but only invasive plants	Maybe	No	Don't know	No resp.
23%	**27%**	**18%**	**18%**	**9%**	**5%**

Comments:

- Harvesting just adds more weeds.
- Fishing sucked this year because of the spraying

10. Should the Lake Management District use pesticides to control aquatic plants (weeds) in the lake? (Circle one)

Yes	Yes, but only invasive plants	Maybe	No	Don't know	No resp.
27%	**26%**	**16%**	**19%**	**9%**	**3%**

Comments:

- Pesticides kill pests not plants (scary mistake)
- Control overgrowth due to eutrophy
- DO NOT USE - our family is highly allergic to pesticides
- If possible
- Only if they are environmentally safe and don't promote more future growth.
- Herbicides?
- But consider toxicity do fish, animals, and humans.
- Depends on what is best for the lake
- Pesticides don't control weeds![2]

= Herbicides?

11. Have you had aquatic plants (weeds) sprayed in front of your property within the last five years?
(Circle one) Yes **30%** No **62%** **No response 8%**

Comments:

- DON'T WANT & you better not!
- Not that we know of, owned our property for 1 yr.
- Don't know
- Not sure
- Don't know
- By Bone Lake /DNR Plan
- Don't know. We do have few weeds in front of our property.
- Unknown. First year on lake.
- Too costly
- I do pull weeds for swimming but would not consider that as "maintaining an opening" to navigate a boat per se.

[2] In fact, an herbicide is one type of pesticide.

12. Do you rake or hand pull aquatic plants (weeds) to maintain an opening in the water in front of your property?

(Circle one) Yes **34%** No **59%** **No response 7%**

Comments:

- Done by association?
- Try but not very successful
- But not very often
- Where kids play in the water

13. Which of the following water quality landscaping practices are you familiar with?

(Check all that apply) (% Responses checked out of 264 surveys returned)

76% Not fertilizing or using zero phosphorus fertilizer

59% Shoreline buffer zones

21% Rain gardens

12% Infiltration pits or trenches

14% Water diversions

.003% Other spraying pesticides

Comments:

- County ordinance requirements in affect.
- None
- All were installed with the development of my new house 2129 Maier Ct.
- Shoreline Buffer Zones are a bad idea. West Nile is increasing. Mosquitoes are awful now.

14. Do you think the water that runs off from your property impacts Bone Lake?

(Circle one) Yes **18%** No **64%** Don't Know **13%** **No response 5%**

Comments:

- Use no fertilizers, have minimally changed natural landscape
- Minimally-little fertilization and leave grass longer at lake

15. Do you believe that establishing or maintaining native vegetation (a buffer zone)along your shoreline improves the water quality of the lake?

(Circle one) Yes **40%** No **23%** Don't Know **30%** **No response 7%**

Comments:

- Yes, but not enough impact to outweigh adverse affects
- We have level lot
- I don't want any buffer zones
- Possible

16. Do you believe that establishing or maintaining native vegetation (a buffer zone) along your shoreline enhances the beauty of the property?

(Circle one) Yes **24%** No **53%** Don't Know **15%** **No response 8%**

Comments:

- Yes, if well planned
- Do it because it improves H2O
- Depends what it is. Rip Rap yes.

17. Do you believe that establishing or maintaining native vegetation (a buffer zone) along your shoreline increases its economic value?

(Circle one) Yes **11%** No **52%** Don't Know **29%** **No response 8%**

Comments:

- Only if it helps to maintain the quality of the lake
- Yes riprap
- It can if done right

18. What would motivate you to install a water quality practice on your property?
(Check all that apply) (% Responses checked out of 264 surveys returned)

63% Improving lake water quality

53% Improving water quality around my dock

49% Proving better habitat for fish and wildlife

36% Increasing the natural beauty of my property

33% Displaying a commitment to the environment

26% Available financial and technical assistance

23% Setting an example for other lake residents

14% Savings on landscaping/maintenance costs

13% Increasing my privacy

.004% Other: education

Comments:

- I would not!
- Leave our property alone. It has been just fine for 19 years.
- Lower lakeshore taxes
- Already have in place.
- Improve shoreline for availability to not have muck on lake bottom
- Nothing would.
- None. We do NOT want those ugly buffer zones of native plants. And again, why allow a boat house (it is only 2 years old) right at the water with floating dyed mulch.
- What do you mean? If it is buffer zones, nothing, no motivation what so ever for this practice
- in return for money
- Nothing would motivate us. We have been on Bone Lake for 35 years. The lake is fine. Leave it alone and the Assoc. should turn its resources to lowering property taxes. What good is a weedless, no fish, sprayed out lake if you can't sell it or afford to live there!!
- I already have on the land our house is on. The lake access lot is shared so I don't have much control over that.
- We do this already
- I do pull weeds for swimming, but would not consider that as "maintaining and opening" to navigate a boat per se.
- We already have one
- Probably all to a degree
- Farm Runoff is the problem. I have been on the lake many years. I don't see anyone around me fertilizing. We cut grass only when needed. I suppose you want all the trees on the lake cut down so the leaves don't float down into the water.
- Stupid question
- None
- Nothing - I have great water quality with natural vegetation along the shore.

19. What would most encourage you to seek assistance for controlling runoff from your Bone Lake property? (Choose **2**) (% Responses checked out of 264 surveys returned)

52% A property tax rebate

30% Technical assistance that would evaluate my property for water quality concerns

28% Technical assistance that would identify appropriate practices to install

19% A cash incentive payment

18% Financial assistance that pays a portion of practice installation costs

17% Technical assistance that would explain how to install practices

8% Landscapers available for practice installation

.007% None

Comments:

- Re: A Cash incentive payment "? Bullshit"
- Don't know about the problem. Need education.
- I do not believe there should be any financial, tax rebates or cash incentives to encourage people. Water Quality is a team effort of which we all reap the benefits. It's like recycling garbage, we all win. Due to this, I believe education is the key. Technical assistance will help people who want to help improve water quality but does not know how. Also fertilizers should not be allowed within so many feet of shoreline.
- Already do this
- What do you want our property to flood during the rainy season?
- Already have in place.
- Need more info
- Nothing
- None, if it means adding ugly vegetation
- What do you mean by or how be specific with these questions!
- If really is needed.
- Relating to existing ordinance.
- The land my house sits on is over 1000' from the lake and has been inspected and passed erosion control standards and is 99.9% wooded and undisturbed. I am in no way interested in anyone nosing around my property and will vigorously prevent anyone from doing so (within legal limits, of course).
- Also concerned about runoff from Township and County
- We have very limited run of from our property
- I bag my grass.
- Nothing
- Make it BIG $
- Where would the money for these come from? The Taxpayer!!!

20. What water quality practices below sound potentially of interest to you?
(Check all that are of interest) (% Responses checked out of 264 surveys returned)

37% Runoff reduction practices

36% Native flower plantings

33% Natural shoreline restoration

31% Buffer zone

16% Rain garden

10% Infiltration system

8% Water diversions

6% Infiltration pit or trench

.007% None

Comments:

= Don't know what they are.
- Would like more information; don't know what some are
- I don't know what many of these are.
- I want a beautiful lawn & beautiful lakefront!
- I am unaware of these practices (ignorant)
- Can't answer. Need more education in some areas.
- Let the weeds grow. They are native and good for our fish.
- I am not sure what any of these practices are!
- We are set; have buffer, natural shoreline & infiltration system
- Already have in place.
- Not knowledgeable on any
- Need more info
- Not sure what some of these are
- Nothing
- Don’t know
- We are not certain what these various practices entail.
- Leave the lake alone!
- Re: Runoff reduction practices - By the Township - County. Too much silt/soil running into Bone Lake.
- Explain rain garden
-? No explanation what each one is.
- Too much GOVERNMENT. This is a perfect example.
- Rip Rap Shoreline

21. Are you familiar with recent (2007) revisions to the Polk County Shoreland Ordinance? (Circle one)

Yes **16%** No **78%** No Answer **7%**

Comments:

- Next time you have a hearing do it in the summer. Instead of trying to sneak an agenda through when no one is around to vote on it.

22. How do you prefer to get information from the Bone Lake Management District? (Check one)
(% Responses checked out of 264 surveys returned)

88% Newsletter

18% Web site

11% Annual meeting

6% Other - Email

3% Signs

2% Newspaper

.003% Other - More meetings

Comments:

- More than one meeting per year.
- We think Mr. Murphy, and others like Mary Diliregherty are doing a lot to help keep the lake property owners & residents up to date with all of the issues around our beautiful Bone Lake. Thank you all!
- Otters (we've seen them) are raising havoc on our property (large area. Smashed our flowers & greenery – also some erosion. Their droppings cause dead spots & stink really bad. Nobody seems to have a solution. Can you advise? Is there a repellant? We've found none. Al & Vera Kolgerg 953/890-7669
- Mkjohnson1921@comcast.net
- Overall comment: I had spray service this year (again) but, the weed around & beyond my dock were the worst ever, interfering with boating and fishing
- The only thing I do is fish. I would like to see Jetskis & water skiers have a time they can do these sports. From early morning to well after sunset some water skiers & Jet skis are on 'n about never giving a break to fish in peace (10AM-6PM maybe).
- Answers on this survey are based on the fact that Curley Leaf Paid Weed IS an invasive weed according to the DNR agent I spoke with.
- "Urban Building Codes" - what happened to enforce these. Maybe Bone Lake Mgt. Should look into this. How about trying to stop all the building of garages that house people so that the people paying taxes can feel that it is fair. We have way too many people that have a shit load of people come up on weekends & Holidays that tear up our shorelines with thier jet boats & speed boats because their family built a garage that is really another house!!This needs to stop!
- What is the website?
- Newsletter is best of available options. All communications lack useful information on lake mgmt + protection issues. Website is poorly designed + content is limited. All communications need improvement.
- Why don't you put a summary of changes in a newsletter?
- Special mailings
- If kept current (referring to website)
- Bone Lake was sprayed out years ago and became a Dead Sea to the fisherman. It is JUST starting to come back to where you can catch a fish. We DO NOT want any more spraying of the Lake! Joe & Kathy Tschida.
- Email- Alan@wernke.com or Dorene@wernke.com
- Signs at landing stating no power loading of boats: power landing destroys the landing and pollutes the land
- Email updates would be great.
- Concerned about abundance of snail shells-so many, not walk able w/o shoes. Also causes swimmers itch; use to be able to swim in front of property when we bought our lot 20+ year ago but not anymore because of increased weeds
- Please keep Phil foster group. Doing great job maintaining the lake- keep it up!
- Note: the newsletter only comes to one of us
- Is there a web site?

Appendix B. Summaries of Previous Water Quality Studies

Highlights of the 1980 DNR Study

The study examined nutrient and phosphorus budgets, fisheries, and watershed characteristics. It also recommended management practices. Because nutrient levels were higher than those predicted by estimated watershed and septic loading, in-lake nutrient sources such as aquatic plants and lake sediments were examined as potential sources of additional phosphorus. Management recommendations included harvest of aquatic plants, aeration, and alum treatment of lake sediments. Prevention of the negative impacts of urbanization including increased impervious surfaces, fertilizing, and construction site erosion were discussed.

1980 Study Recommendations:

- Consider in-lake treatment
  - Aeration
  - Aquatic plant harvesting
  - Alum treatment
- Prevent negative impacts of watershed development
  - Construction site erosion control
  - Minimize impervious surfaces
  - Avoid phosphorus fertilizer

Highlights of the Barr Engineering Plans (1997 – 1999)

Prior to the 2008, this report presents the most recent previous analysis for nutrient loading on Bone Lake. In this analysis two tributaries were monitored with somewhat limited data and the remainder of the watershed was modeled using WILMS (as best can be determined from the report) to estimate the phosphorus loading into Bone Lake. In addition, sediment release rates were conducted in the lab and used to estimate internal loading.

Phosphorus and water budgets developed from 1995-6 data in 1997 were revised with new watershed information in 1999. The final management plan made recommendations for lake and watershed management based upon the new modeling results.

Conclusions from the 1999 report include the following:

- Bone Lake water quality is excellent in early summer and deteriorates as summer proceeds.
- Excess phosphorus concentration in upper layers of the lake result in lake water quality problems with higher than expected algae concentrations given the amount of phosphorus present.
- About two-thirds of the total phosphorus load comes from surface runoff.
- Internal loading from the lake sediments contributes about 14 percent of the phosphorus load.

Barr Engineering Lake Management Plan Recommendations

Recommended goals

- An average annual in-lake total phosphorus goal of 18 micrograms per liter is recommended (compared to summer levels of 29 in the north basin and 27 in the south basin in 1996 and 24.1 in the north basin and 21.4 in the south basin in 2004.).
- Prevent degradation of existing water quality.

Recommended management actions

- Treat the lake with alum to reduce 90 percent of the lake sediment internal loading.
- Implement structural best management practices such as sediment retention ponds with any new development in the watershed. To ensure that these practices are put in place; a county stormwater ordinance, shoreland ordinance, and septic system ordinance are recommended. The minimum buffer width recommended for the shoreland ordinance is 100 feet.
- Educate residents to refrain from using phosphorus fertilizer.

A long-term water quality monitoring program is also recommended.

Highlights of the 2004 Aquatic Engineering Water Quality Report

Water clarity improved from the results reported in the 1997 and 1999 reports. These changes could be due simply to variations in temperature and precipitation rather than a true water quality trend.

Recommendations from the Aquatic Engineering Report

- Create and enforce land use and zoning regulations
- Continue long term monitoring
- Manage curly leaf pondweed populations to control summer phosphorus loading from plant die off
- Restore shoreline vegetation to reduce runoff from waterfront lots

Appendix C. 2008 Phosphorus Budget Analysis

Phosphorus Budget Analysis

Bone Lake, Polk County Wisconsin
2008

Sponsored by: Bone Lake Management District and
Wisconsin Dept of Natural Resources

Prepared by: Ecological Integrity Service, LLC

Introduction

This phosphorus analysis was prepared in preparation for the development of a Comprehensive Lake Management Plan developed by the Bone Management District. The purpose of the analysis was to identify sources of phosphorus loading to Bone Lake and the areas that could be managed to reduce nutrient inputs.

The external phosphorus budget was analyzed during the growing season from April 2008 until October 2008. To calculate the loading of phosphorus two tributaries (Prokop Creek and an un-named tributary on the northwest portion of the lake) were measured for flow and water samples were analyzed for phosphorus and suspended solids. In addition, the land-use was updated for 2008 and WILMS was used to model (estimate) the remaining phosphorus loading. No internal loading calculations were done in this model, but the predicted WILMS internal calculator was used to calibrate the model.

The most recent previous analysis for nutrient loading on Bone Lake was in 1996. In that analysis two tributaries were monitored with somewhat limited data and the remainder of the watershed was modeled using WILMS (as best can be determined from the report) to estimate the phosphorus loading into Bone Lake. In addition, sediment release rates were conducted in the lab and used to estimate internal loading.

Methods

The loading of the two tributaries was determined by installing two gage data loggers. The data loggers measured the water level to the nearest 0.001 feet every hour of every day they were installed. The flow was determined on 8 different dates by measuring the stream cross section and measuring the rate of flow with a flow rate meter. These flow values were then correlated to the gage height reading and a flow curve rating was calculated. In addition, two water samples were obtained each month and during 4 different rainfall events that were in excess of 1 inch in 24 hours. Each sample was analyzed for total phosphorus (TP), soluble reactive phosphorus (SRP) and for total suspended solids (TSS) These measurements were then used to determine the nutrient loading through either averaging or flow weighted loading, depending on the nutrient results (averaging was done for Prokop Creek while the flow weighted method was used for the un-named tributary since the nutrient values correlated well will flow levels). In the averaging method, the average value for each test was used for each flow period (one hour). These values were then totaled to get a total load for that component. In the case of the flow weighted, the flows above the base flow threshold were weighted using the average for a particular nutrient test at high flow levels. Those at or below the base flow measurement used the average for the particular nutrient test at base flow levels. These weighted values were then totaled to get a total load for each nutrient test.

To estimate the phosphorus loads from the remaining portion of the watersheds, the WILMS lake-modeling suite was utilized. The land-use categories were imputed into WILMS from the updated land-use analysis provided by the Polk County Land and Water

Resources Department. Export coefficients recommended for this region were utilized. These coefficients were adjusted to better fit the model based upon the field data from the tributaries, recommendations from the Polk County Land and Water Resources Department, and soil types. In addition, the septic loading was estimated using estimated capita data provided by the Town of Bone Lake and Town of Georgetown voting registration records.

Results

<u>Tributaries</u>

The following table summarizes the tributary loading results.

Table 1: Tributary loading of Total Phosphorus, Soluble Reactive Phosphorus and TSS.

Tributary	Volume (m^3/yr)	TP Load (kg/yr)	SRP loading (kg/yr)	TSS loading (kg/yr)
Prokop Creek	1,126,670	85.6	20.4	2145
Northwest Tributary	590,129	71.4	16.7	2793

The WILMS model predicted about 50% less loading for the un-named north tributary and about twice as much loading from Prokop Creek (100% more). The large amount of wetland that occurs in the headwaters of Prokop Creek may cause a reduction in phosphorus concentration in the creek and could account for the difference. The difference for the un-named tributary is interesting as the main landuse is forest and would not tend to contribute higher phosphorus input into the lake.

The SRP made up only 23-24% of the total phosphorus in both tributaries. This indicates that the source of phosphorus is not likely in highly soluble forms such as fertilizers, manure, sewage, etc. The TSS was much higher in the un-named tributary and will contribute more sedimentation into Bone Lake. Neither tributary had huge TSS values but did increase (especially with the un-named tributary) with increased flow, as expected.

It should be mentioned that the growing season of 2008 was rather dry in the latter half of the summer, reducing flow in both tributaries. Prokop Creek went dry during several weeks in August and September. The un-named tributary had flow the entire sampling period. In both tributaries the flow and gage height correlation was very good (r^2=0.85 for Prokop and 0.98 for the unnamed trib) which makes the field data valid and a good reflection of the hydrologic load.

<u>Landuse</u>

The landuse was determined through an analysis of satellite imagery and some field checks of the topography and culvert locations. In addition, the entire watershed was divided into sub-watersheds. The following is a synopsis of those land-use determinations and a map of the land-use in the watershed as well as the sub-watershed boundaries.

Figure 1: Map of sub-waterhsheds of Bone Lake

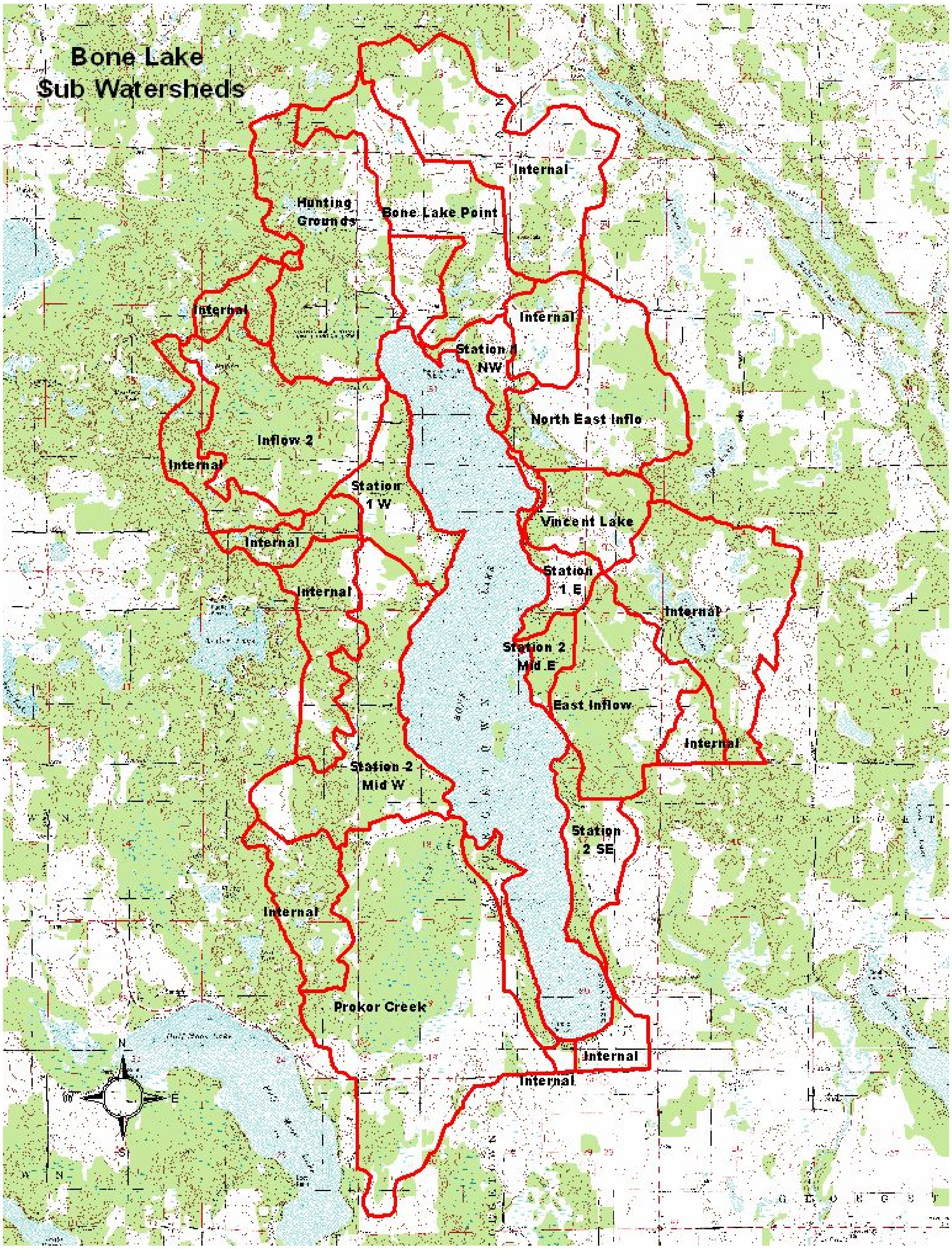


Table 2: Total acres and % of watershed for each sub-watershed.

Total acres by Sub-watershed		
Sub-watershed	%	Acres
Bone Lake Point	4.83	526
East Inflow	4.61	501
Hunting Grounds	6.86	746
Inflow 2	5.57	606
Internal	26.15	2847
North East Inflo	5.15	560
Prokop Creek	12.96	1411
Station 1	5.95	647
Station 2	10.06	1095
Vincent Lake	2.22	241
Lake	15.66	1704
Total	100.0	10887

These highlighted areas were not used in modeling as do not directly drain to the lake.

Setting up sub-watersheds allows for the designation of high impact areas and makes for easier management determinations.

Figure 2: Landuse map of Bone Lake watershed.

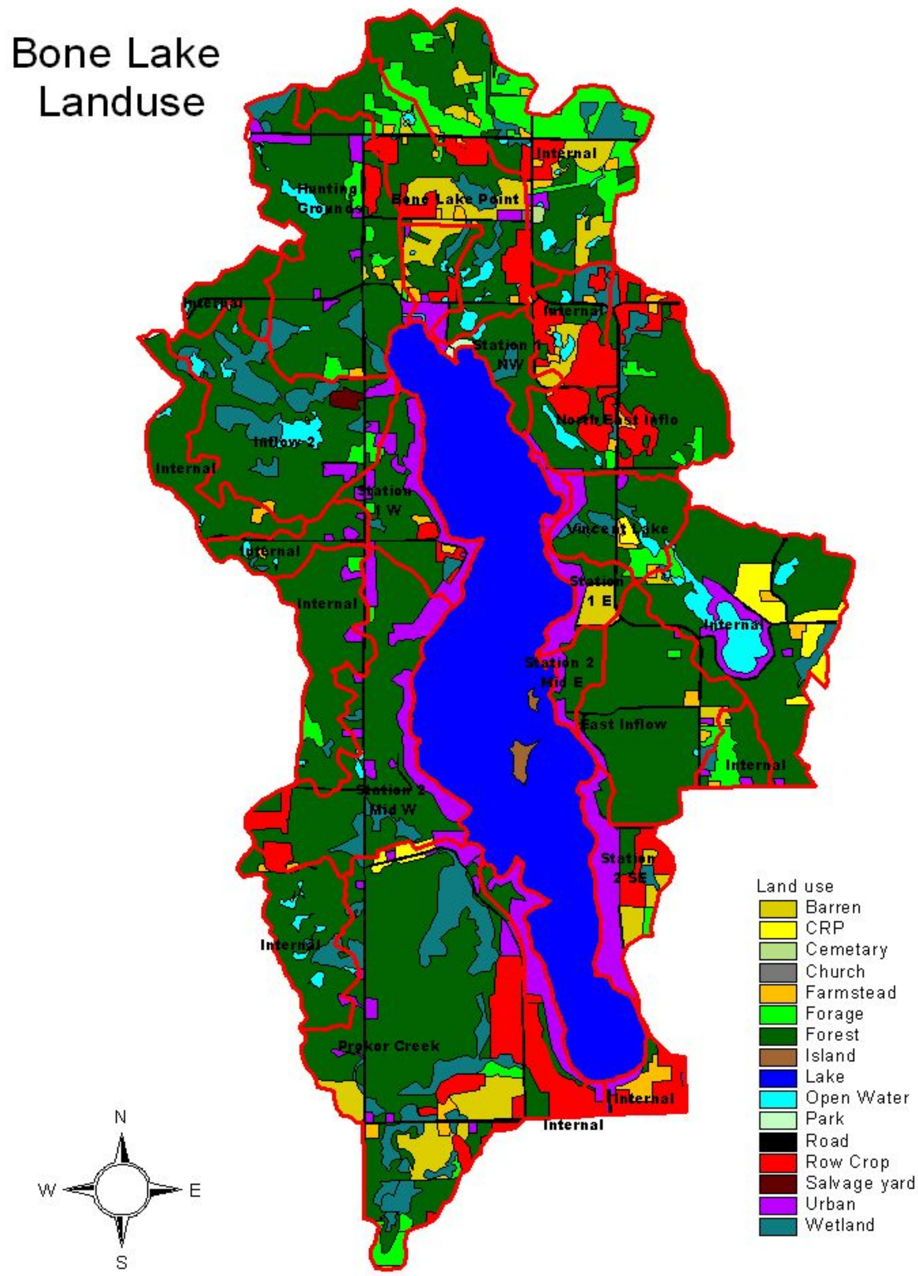


Table 3: Land-use by acres and % of total watershed.

Land-use	%	Acres
Barren	3.79	413
CRP	0.98	106
Cemetary	0.04	4
Church	0.02	2
Farmstead	1.32	143
Forage	4.25	463
Forest	50.50	5498
Island	0.15	16
Lake	15.66	1704
Open Water	2.20	239
Park	0.06	6
Road	1.55	169
Row Crop	6.33	689
Salvage yard	0.11	12
Urban	6.97	759
Wetland	6.28	684

As can be observed, forest makes up just over half of the land-use types. This is a good thing as this land-use has a very low export coefficient (a number used to calculate phosphorus loading), which means very little phosphorus comes from this land into the lake as compared to the other landuses. Although row crops and urban make up only 6.33% and 6.97% respectively, they have high export coefficients which would indicate high phosphorus loading into the lake from these areas. Therefore, management of these landuses can have a large impact on phosphorus loading reductions.

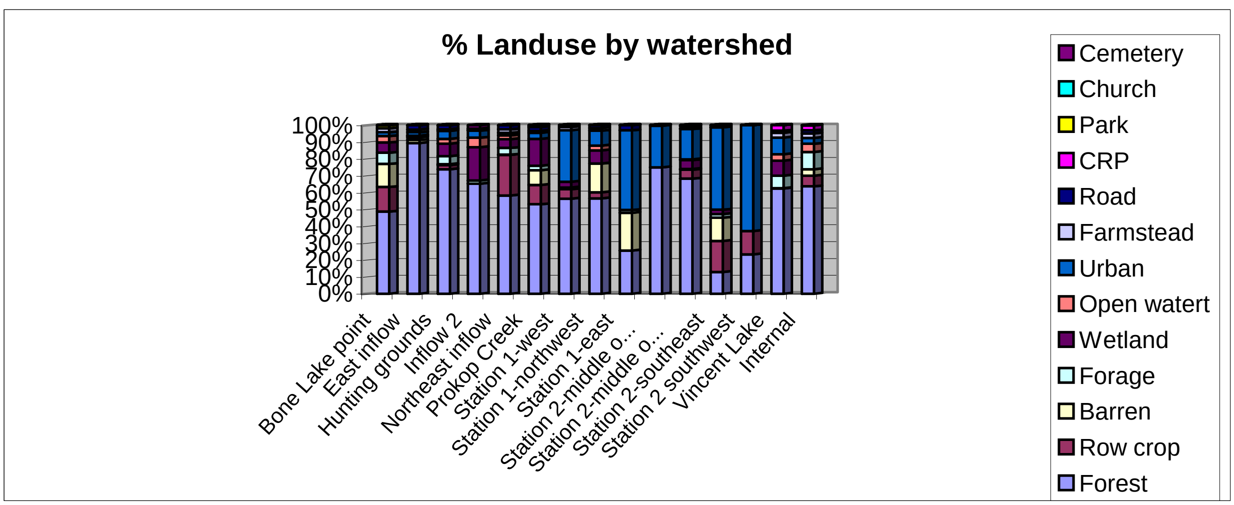
Table 4 lists each sub-watershed by land-use. This is helpful to see those sub-watersheds that have low loading land-use such as forest and grassland as well as high loading landuses such as urban. Figure 3 shows a graphic to compare the landuse within each sub-watershed.

Table 4: Land-use list for each sub-watershed.

Sub-watershed acreage	Forest	Row crop	Barren	Forage	Wetland	Open watert	Urban	Farmstead	Road	CRP	Park	Church	Cemetery
Bone Lake point	256	77	72	35	32	20	12	12	0	0	9	1	0
East inflow	449	0	9	8	4	1	10	8	13	0	0	0	0
Hunting grounds	552	18	4	36	55	21	36	7	18	0	0	0	0
Inflow 2	396	0	0	12	120	34	25	3	5	0	0	0	12
Northeast inflow	327	135	0.4	22	29	13	8	12	14	0	0	0	0
Prokop Creek	749	163	122	38	225	0	51	16	32	16	0	0	0
Station 1-west	151	15	0	3	9	0	82	5	3	0	0	0	0
Station 1-northwest	139	9	42	0.3	19	7	22	4	4	0	0	0	0
Station 1-east	33	0	29	2	0	0	61	0	4	0	0	0	0
Station 2-middle on east	61	0	0	0	0	0	20	0	0.3	0	0	0	0
Station 2-middle on west	447	35	0	3	34	3	118	2	10	3	0	0	0
Station 2-southeast	30	43	32	5	6	0	114	0	3	0	0	0	0
Station 2 southwest	30	18	0	0	0	0	81	0	0	0	0	0	0
Vincent Lake	152	0	0.2	18	22	9	24	7	3	8	0	0	0
Internal	1727	174	103	278	0	131	97	69	50	79	0	1	4

Not used as not direct drained into lake.

Figure 3: Percent landuse type for each sub-watershed.



Watershed loading

The land-use listed was used as input data for WILMS. In WILMS the export coefficients were adjusted to meet the field data, based upon soil types and finally to calibrate the model. The WILMS predictions need to be close to the actual the growing season mean (GSM) for the total phosphorus measured in the lake. The export coefficients used are in Table 5.

Table 5: Land-use export coefficients used in WILMS

Land-use	Export coefficient (kg/ha/yr)
Barren	0.3
Cemetery	0.3
Church	0.3
CRP	0.3
Farmstead	0.8
Forage	0.3
Forest	0.09
Island	0.09
Open water	0.3
Park	0.3
Road	1.0
Row crop	1.0
Salvage yard	0.3
Urban	1.0
Wetland	0.1

In addition to the landuse, the septic loading was estimated in WILMS. The septic capita-year was estimated at 67.6 kg is based upon rather limited information available.

The results of the most likely phosphorus loading predicted by WILMS are listed below.

Loading from watershed directly drained into lake estimate =**557.1 kg/yr**
Septic system loading estimate= **67.6 kg/yr**[1] **(6.8% of total load)**
Loading from monitored tributaries (field data not estimated)=**157 kg/yr**
Estimated total load (including lake surface)=988.6 kg/yr

Various sub-watersheds have a wide range of nutrient loading impacts. For management purposes, it is convenient to compare the contribution each sub-watershed has based upon the area and loading, expressed in kg/acre. Table 6 shows the loading per acre for each sub-watershed.

[1] This is based upon rather incomplete capita-year data. An attempt for more precise data is being made which could result in a more valid calculation.

Table 6: Area, load and loading per acre for each sub-watershed.

Sub-watershed	Acres	Load (kg)	Kg/acre
Station 2 Southwest	129	41.13	0.319
Station 2 Southeast	234	70.73	0.302
Station 1 East	128	31.13	0.243
Station 1 West	269	48.53	0.18
Northeast Inflow	561	84.63	0.151
Station 2 Middle on West	655	85.24	0.13
Station 2 Middle on East	82	10.46	0.128
Bone Lake Point	526	66.94	0.127
Inflow 2 (NW)	606	71.4	0.118
Station 1 Northwest	244	26.72	0.11
Hunting Grounds	746	60.96	0.082
East inflow	501	30.51	0.061
Prokop Creek	1411	85.6	0.061

Figure 4: Graph of percent load by sub-waterhsed.

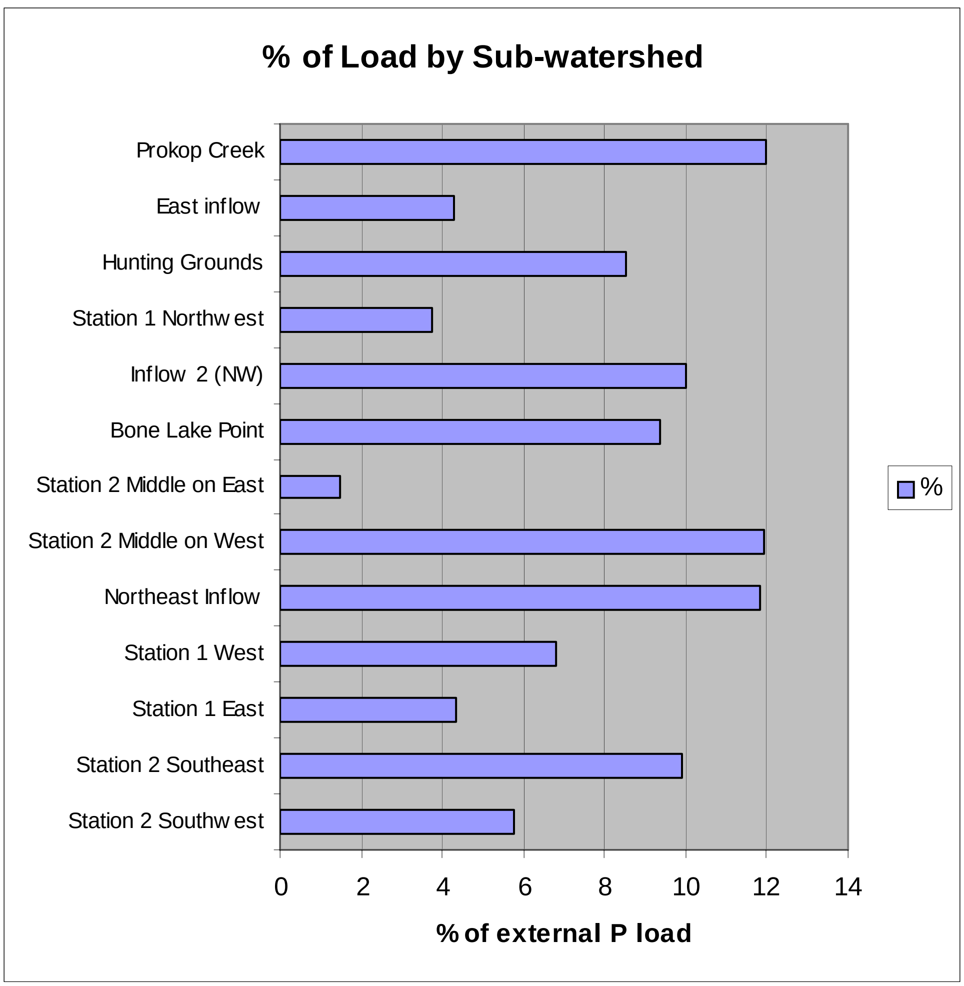
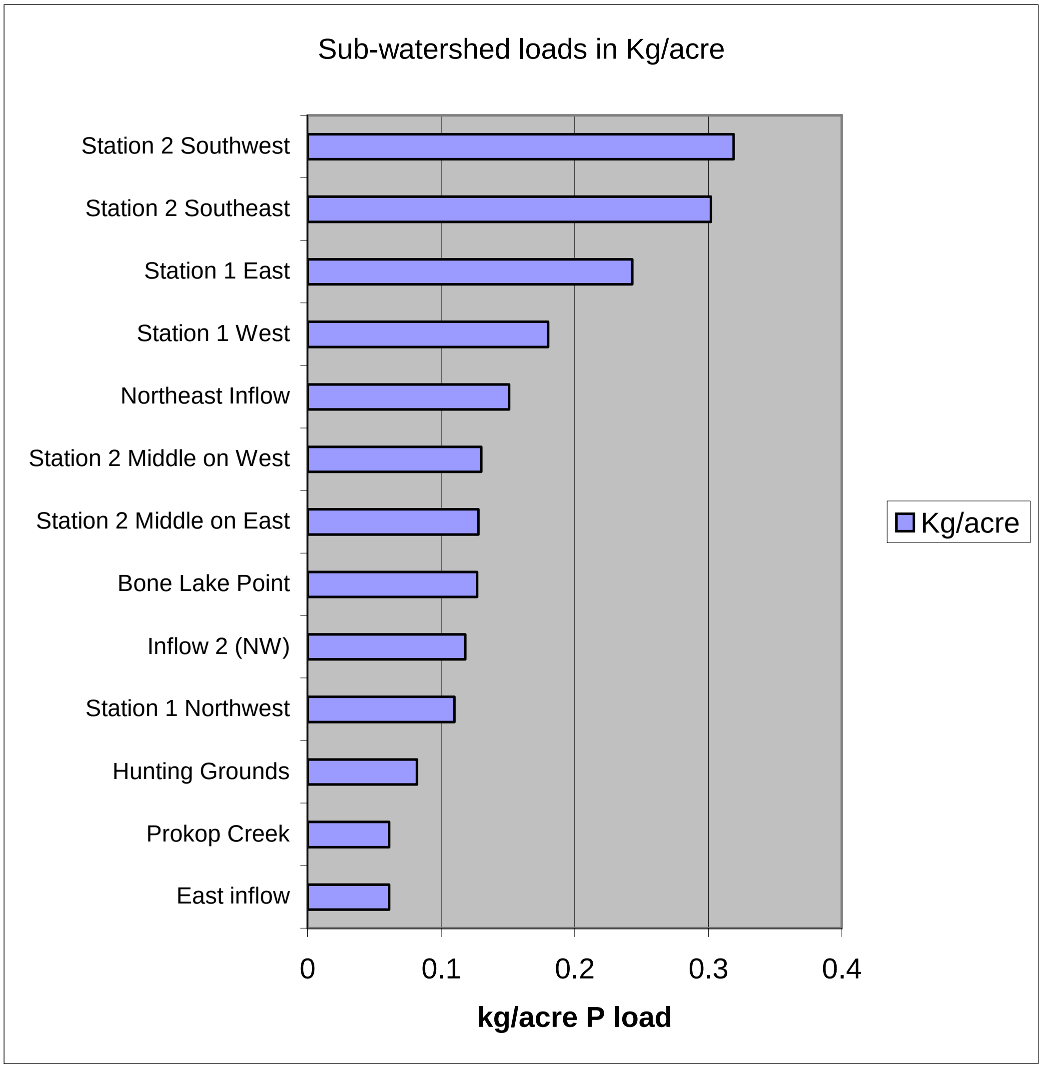
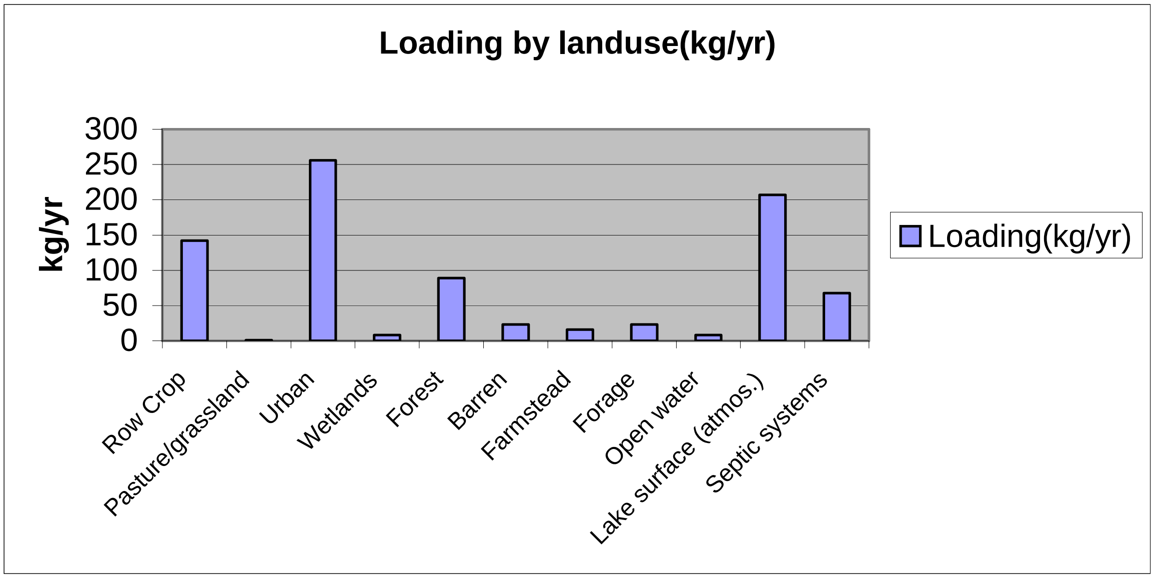


Figure 5: Graph of load of each sub-watershed in kg/acre.



The type of landuse can determine the amount of loading into the lake. As can be observed, row crops and urban development make up a large portion of the total external load in Bone Lake. Both of these landuses can have their impact reduced through management practices, which could result in a reduction in whole-lake phosphorus concentration.

Figure 6: Graph of loading of each landuse in Bone Lake watershed in kg/yr.



Internal loading

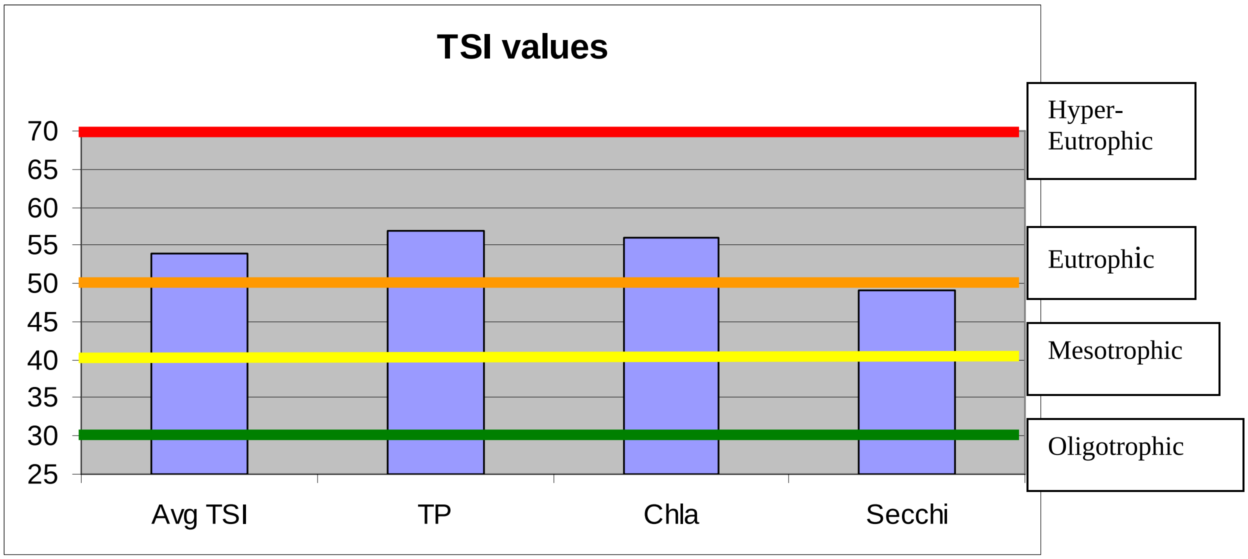
Internal loading was not analyzed in this study. Barr Engineering did an analysis of internal loading in 1996. In the Barr study, it was determined that the internal loading of Bone Lake was 201 kg/yr. This calculation was based upon laboratory studies of sediment release rates of phosphorus. This is a valid way to determine internal loading when combined with in the area and length of time anoxic conditions occur. However, recent data from the Self-Help Monitoring program does not suggest the lake is undergoing anoxic conditions for any length of time. The Barr report shows anoxic conditions but the actual data and the area that is anoxic in the lake is not contained (or at least located) in the report. For this reason, a more recent determination of internal loading should be conducted. If the Barr calculation were accurate, then the internal load would be very significant as compared to the external loading.

Another concern is loading from the senescence of curly leaf pondweed (CLP) in July. Bone Lake has over 80 acres of dense CLP coverage. When this plant dies in July, the decomposition that occurs can be quite rapid in warm water conditions. When decomposition occurs, a significant release of phosphorus may be possible. Research is ongoing within the Wisconsin DNR to try and determine how significant this loading can be. Present data suggest it could be a large contributor. Bone Lake may consider this source of phosphorus as a internal contributor.

Trophic status

The Carlson Trophic Status Index uses chlorophyll a, total phosphorus and Secchi depth to calculate a value that represents the degree of production in the lake. As can be observed, Bone Lake fell within the eutrophic (lower values for eutrophic) in all parameters.

Figure 7: Trophic status of Bone Lake in 2008[2]



The average TSI for Bone Lake in 2008 was just below 55, which is above the eutrophic level, but not by very much. The Secchi depth shows tha the water clarity remained quiet good (just up to eutrophic level) even though all other values were in the eutrophic level.

Discussion

The watershed around Bone Lake is quite diverse, ranging from forested areas to agriculture and numerous urban or residential areas. Just over half of the watershed is forested, which tends to have low phosphorus loading. However, some key areas have large amounts of row crop agriculture lands and urban areas. As a result, these areas contribute large amounts of phosphorus as compared to other sub-watersheds.

The highest contributing watersheds are Station 2 southwest, Station2 southeast, Station 1 east and Station 1 west. This is due to the landuse within the boundaries of these watersheds. Through management practices it may be possible to reduce the impacts these areas have on Bone Lake. Urban runoff can be reduced through planting native plants near the shoreline or installation of infiltration practices such as rain gardens. Cropland runoff can be reduced by changing practices or even converting cropland to native or grass vegetation. A modest reduction in runoff and therefore phosphorus in these areas could reduce whole-lake phosphorus significantly. Very small reductions in whole lake phosphorus can result in very large changes in water clarity and the aesthetic nature of the lake.

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[2] Data from Self Help data set provided by the Wisconsin DNR.

The field data on the two monitored tributaries reflect interesting results. The Prokop Creek watershed is a very large sub-wathershed, yet contributes very low amounts of phosphorus per acre. The wetland area from which the creek flow originates may be holding much of that nutrients. In a high water year, it is possible this wetland could flush, resulting in a much higher phosphorus load. The un-named tributary is flowing from the Inflow 2 subwatershed. The field data reflected a much higher phosphorus load compared to what the model predicted based upon landuse. There are a few high export landuses, but very little in the total acreage. There is a salvage yard, but it is not known if anything is present in the salvage yard to warrant high phosphorus loads. There is also a possibility that this salvage yard could release other chemicals (petroleum based) into the tributary and therefore the lake. No monitoring of such chemicals was conducted and is therefore not known. There may also be erosion along the stream channel near the monitoring station.

The septic loading in Bone Lake is estimated at just under 7%. This is similar to the report from a previous study. At this level, the biggest improvement would be to try and reduce the number of old, failing systems and have them replaced with holding tanks or good functioning systems. The number of old and failing systems were not known for this estimate calculation and therefore the impact of newer systems is unknown.

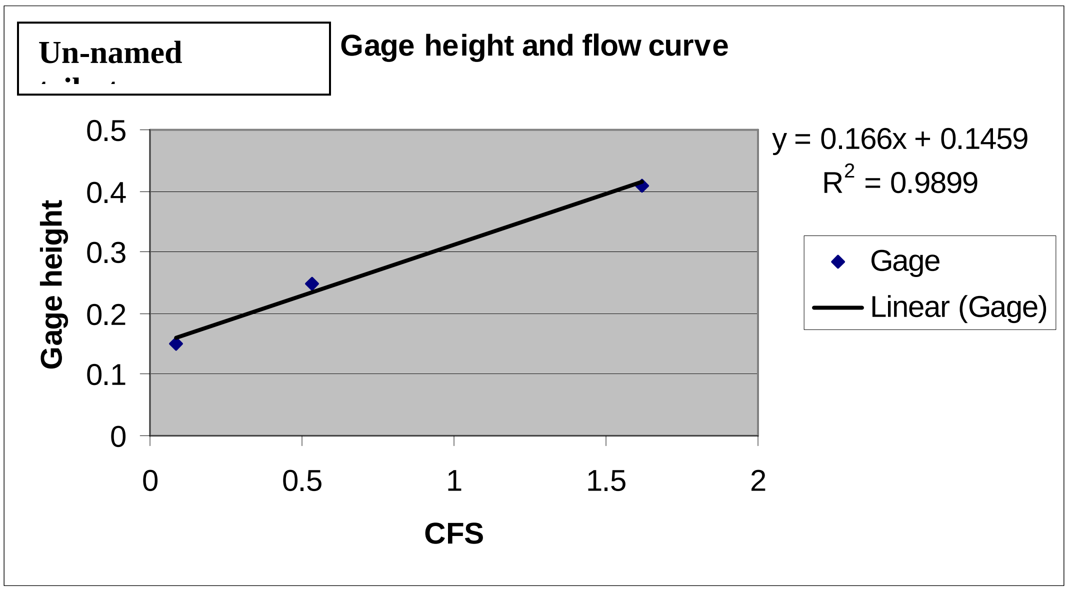
Barr Engineering reported a rather high internal load in 1996. In order for a large internal load to occur, the sediment must go anoxic for a length of time and over a rather wide area. The data that is available from self-help monitoring over recent years does not reflect periods of anoxic conditions and therefore the internal load wouldn't be large. This issue should be resolved with an updated internal load calculator. If it is significant, it would reduce the impact the external budget has on the lake by comparison. If the internal load isn't significant, then the external load reduction is much more signficant.

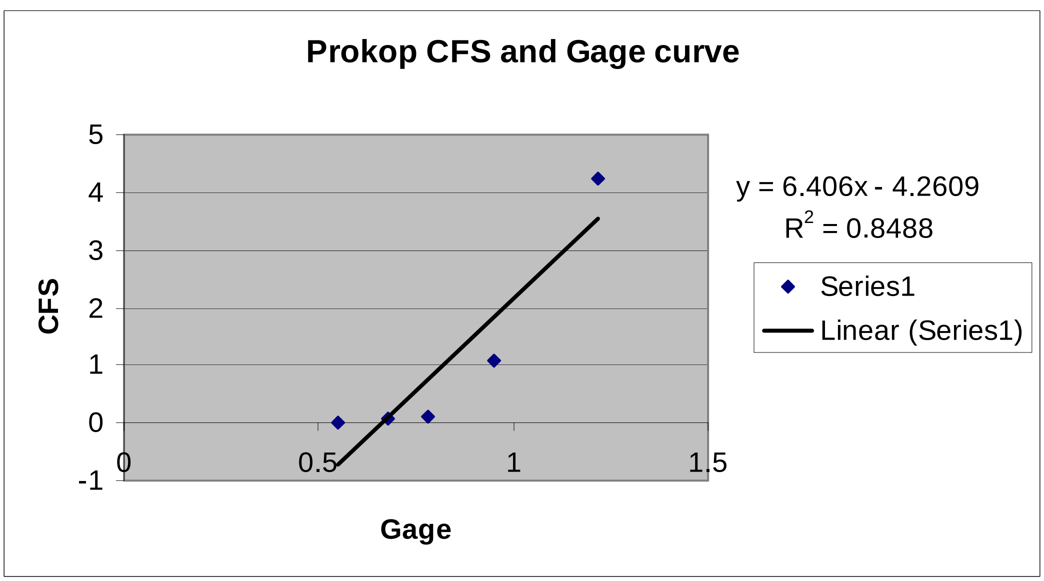
The growing season mean for total phosphorus in Bone Lake was 38.1 micrograms per liter (ppb). This is in the eutrophic zone for trophic status. The WILMS model watershed outputs predicted this same GSM, showing the model results may be a good estimate of the loading that occurs from the watershed. Reducing non-point phosphorus loads through best management practices could reduce the GSM by several micrograms per liter. Even small GSM changes can result in large improvements in water clarity.

Data for Bone Lake Phosphorus Analysis

Tributary data:

Tributary(Monitored 4/18-11/5, 2008)	Mean CFS	Max CFS	Min CFS	Total Flow M3
Prokop Creek	1.251	5.476	0	1126669
Unnamed Tributary	0.655	3.64	0.006	590129





Date	Prokop CrTP (mg/L)	Prokop Cr SRP (mg/L)	Prokop Cr TSS (mg/L)	NW trib TP (mg/L)	NW trib SRP (mg/L)	NW trib TSS(mg/L)
4/18/2008	0.042	0.015	1	0.088	0.077	1
6/23/2008	0.067	0.011	3	0.158	0.072	10
6/28/2008	0.067	0.017	3.9	0.18	0.06	15
7/8/2008	0.11	0.045	3.9	0.16	0.073	6
7/12/2008	0.085	0.077	4.9	0.189	0.055	13
7/22/2008	0.082	0.039	8	0.134	0.033	19
8/4/2008	0.075	0.038	0	0.101	0.037	3
8/18/2008	0.065	0.021	3.9	0.085	0.032	3.9
9/3/2008	0.088	0.028	2	0.07	0.025	3.9
9/14/2008	no sample/no flow	no sample/no flow	no sample/no flow	0.084	0.025	2.4
10/3/2008	no sample/no flow	no sample/no flow	no sample/no flow	0.082	0.026	6
Mean	0.076	0.032	3.400	0.121	0.047	7.564

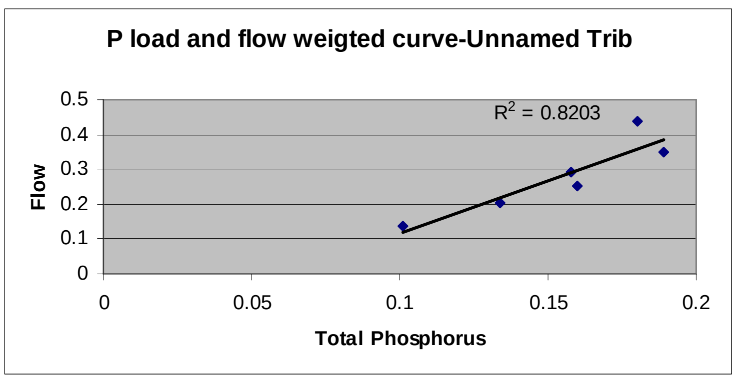
High flow mean=0.1443mg/L

Low flow mean=0.0803mg/L

TP=total phosphorus

SRP=soluble reactive phosphorus

TSS=total suspended solids



Lake Data:

WILMS Model results

Date: 12/28/2008   Scenario: Final

Lake Id: Bone

Watershed Id: 0

Hydrologic and Morphometric Data

Tributary Drainage Area: 4053.8 acre
Total Unit Runoff: 8.00 in.
Annual Runoff Volume: 2702.5 acre-ft
Lake Surface Area <As>: 1704.0 acre
Lake Volume <V>: 36460.0 acre-ft
Lake Mean Depth <z>: 21.4 ft
Precipitation - Evaporation: 3.3 in.
Hydraulic Loading: 4563.0 acre-ft/year
Areal Water Load <qs>: 2.7 ft/year
Lake Flushing Rate <p>: 0.13 1/year
Water Residence Time: 7.99 year
Observed spring overturn total phosphorus (SPO): 0.0 mg/m^3
Observed growing season mean phosphorus (GSM): 38.1 mg/m^3
% NPS Change: 0%
% PS Change: 0%

NON-POINT SOURCE DATA

Land Use	Acre (ac)	Low	Most Likely	High	Loading %	Low	Most Likely	High
		Loading (kg/ha-year)				Loading (kg/year)		
Row Crop AG	350.9	0.50	1.00	3.00	14.4	71	142	426
Mixed AG	0.0	0.30	0.80	1.40	0.0	0	0	0
Pasture/Grass	12.0	0.10	0.30	0.50	0.1	0	1	2
HD Urban (1/8 Ac)	632.6	0.50	1.00	1.50	25.9	128	256	384
MD Urban (1/4 Ac)	0.0	0.30	0.50	0.80	0.0	0	0	0
Rural Res (>1 Ac)	0.0	0.05	0.10	0.25	0.0	0	0	0
Wetlands	187.0	0.10	0.10	0.10	0.8	8	8	8
Forest	2453.4	0.05	0.09	0.18	9.0	50	89	179
Barren	188.1	0.10	0.30	0.50	2.3	8	23	38
Farmstead	49.0	0.30	0.80	1.40	1.6	6	16	28
Forage	115.1	0.10	0.30	0.50	1.4	5	14	23
Open water	65.7	0.10	0.30	0.50	0.8	3	8	13
	0.0	0.00	0.00	0.00	0.0	0	0	0
	0.0	0.00	0.00	0.00	0.0	0	0	0

Lake Surface	1704.0	0.10	0.30	1.00	20.9	69	207	690

POINT SOURCE DATA

Point Sources	Water Load (m^3/year)	Low (kg/year)	Most Likely (kg/year)	High (kg/year)	Loading %
North Tributary	590129.0	0.0	71.4	0.0	7.2
Procker Creek	1126670.0	0.0	85.6	0.0	8.7

SEPTIC TANK DATA

Description		Low	Most Likely	High	Loading %
Septic Tank Output (kg/capita-year)		0.30	0.50	0.80	
# capita-years	676.0				
% Phosphorus Retained by Soil		94.0	80.0	75.0	
Septic Tank Loading (kg/year)		12.17	67.60	135.20	6.8

TOTALS DATA

Description	Low	Most Likely	High	Loading %
Total Loading (lb)	790.8	2179.4	4246.0	100.0
Total Loading (kg)	358.7	988.6	1926.0	100.0
Areal Loading (lb/ac-year)	0.46	1.28	2.49	
Areal Loading (mg/m^2-year)	52.02	143.36	279.30	
Total PS Loading (lb)	0.0	346.2	0.0	15.9
Total PS Loading (kg)	0.0	157.0	0.0	15.9
Total NPS Loading (lb)	612.0	1228.1	2427.6	77.3
Total NPS Loading (kg)	277.6	557.1	1101.2	77.3

Phosphorus sample data from Self Help Monitors-2008

Bone Lake, Polk County

Date	**TP 2008 (ug/L)**	
19-May	26	**Deep hole**
19-Jun	18	
30-Jul	33	
6-Sep	83	
19-May	27	**S Island**
19-Jun	19	
30-Jul	30	
6-Sep	69	
Mean	**38.125**	

References

Barr Engineering. *Report on 1996 Lake Water Quality-Bone Lake.* December 1997.

Caraco, Deb and Ted Brown. *Managing Phosphorus Inputs Into Lakes II. Crafting an Accurate Phosphorus Budget for Your Lake*. Urban Lake Management. p. 782-790.

Cooke, Dennis G., Lombardo Paola, & Brandt Christina. 2001. *Shallow Successful Management Alternatives: Determining Successful Management Alternatives*. Lakeline.

Leith, Katherine McArthur, 1998. *Estimating Tributary Phosphorus Loads Using Flow Weighted Composite Storm Sampling.* Master of Science Thesis. Virginia Polytechnical Institute and State University.

Lin, Jeff P. 2004. *Review of Published Export Coefficient and Event Mean Concentration (EMC) Data.*

Nürnberg, Gertrud. 1987. *A Comparison of Internal Phosphorus Loads in Lakes with Anoxic Hypolimnia: Laboratory Incubation versus In Situ Hypolimnetic Phosphorus Accumulations*. Limnology and Oceanography.

Nürnberg, Gertrud. 2001. *Eutrophication and Trophic State*. Lakeline.

Osgood, Dick. *Lake and Watershed Planning and Analysis. Deer Lake Management Plan.* February 2004.

Soerens, Thomas S. and Marc H. Nelson. *Sampling Strategies for Determining Nutrient Loads in Streams.* Project Report for Arkansas Water Resources Center.

Søondergaard, Martin, Jeppesen, Erik, and Jensen Jens P. 2003. *Internal Phosphorous Loading and the Resilience of Danish Lakes.* Lakeline.

Turyk N. and J. Stelzer. 2002. *Assessment of Lake and Groundwater Chemistry, Shallow Groundwater Flow, and the Aquatic Macrophyte Community, Peppermill Lake, Adams County, Wisconsin*. Center for Watershed Science and Education, University of Wisconsin-Stevens Point Report to Wisconsin DNR.

U.S. Army Corps of Engineers. 1996. *Simplified Procedures for Eutrophication Assessment and Predictions: User Manual.*

U.S. Geological Survey, Wisconsin Department of Natural Resources. *Hydrology, Nutrient Concentrations, and Nutrient Yields in Nearshore Areas of Four lakes in Northern Wisconsin*, 1999-2001.

Wagner, Ken. 2001. *Limnology: The Science Behind Lake Management*. Lakeline.

Wilson, C. Bruce, Walker Jr., William W. 1989. *Development of Lake Assessment Methods Based Upon the Aquatic Ecoregion Concept.* Lake and Reservoir Management.

Wisconsin Department of Natural Resources. *Wisconsin Lake Modeling Suite – Program Documentation and User's Manual.* 2003.

Wisconsin Department of Natural Resources. Findings Number 23. April 1995.

Wisconsin Department of Natural Resources. Findings Number 35. May 1993.

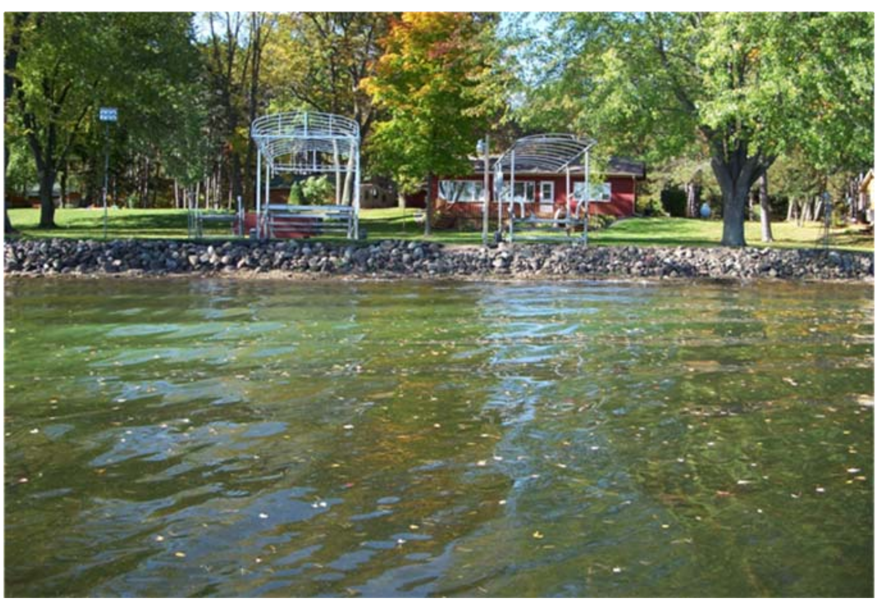
Wisconsin Department of Natural Resources. Findings Number 38. April 1995.

Appendix D. Shoreland Habitat Assessment Reference Photos.

Shoreline Composition

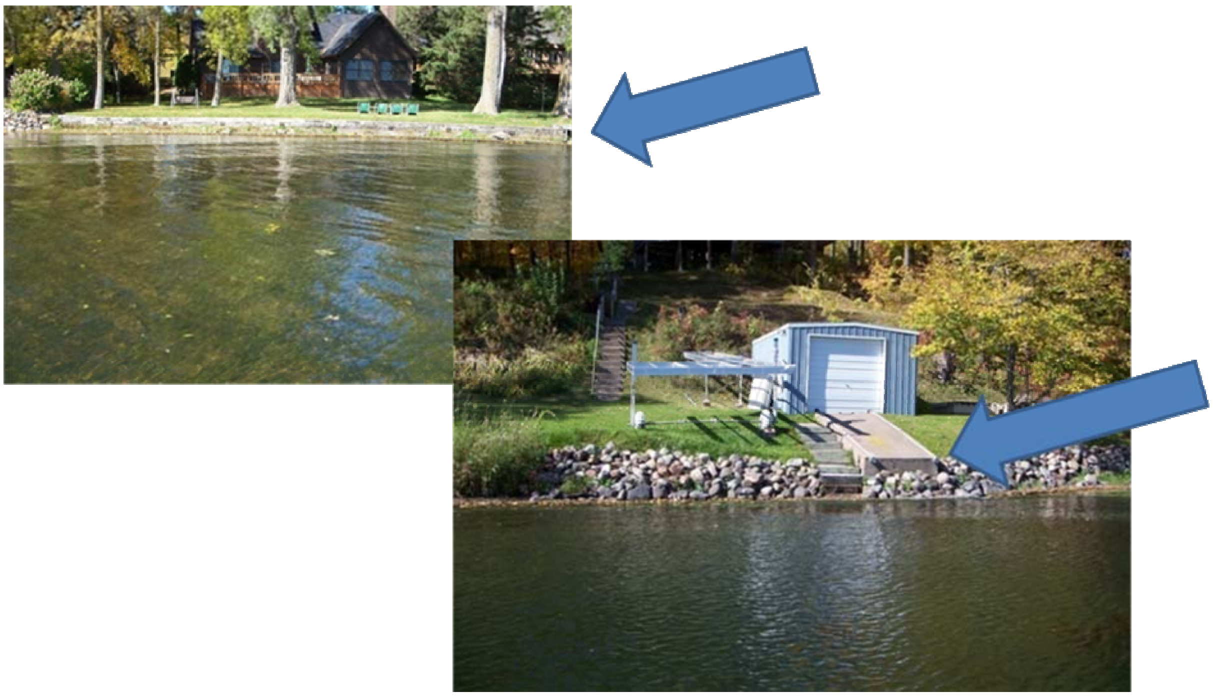
Natural

Rip Rap



Shoreline Composition

Structure



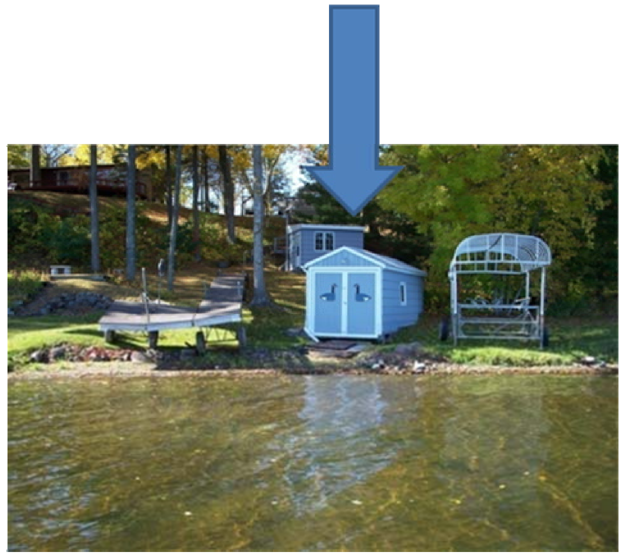
Lawn

Shoreline Composition

Sand

Shoreland Buffer Composition

Hard Surface



Natural

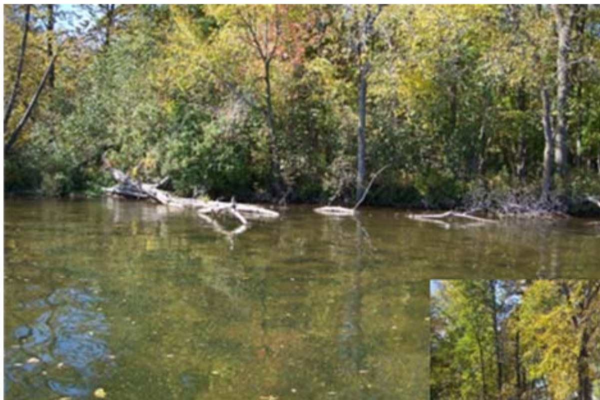
Shoreland Buffer Composition

Landscaped

Bare Soil

Lawn

Woody Debris



Appendix E. Implementation Plan or Workplan 2009-2012

Goal. Improve Bone Lake water clarity.							
Action Items[1]	**Cost 2009**	**Cost 2010**	**Cost 2011**	**Cost 2012**	**Resources/ Partners**	**Funding Sources**	**Notes**
Crop Fields					**Agriculture Committee**		
Test runoff and identify significant crop fields	40 hours (VOL) ID areas to test	40 hours (VOL) Sampling budget $2,000			LWRD Consultant	Small scale planning 8/01/09	Request LWRD assistance Consultant to analyze test results
Investigate options for reducing nutrient loading			40 hours (VOL)	40 hours (VOL)	LWRD		
Open dialog with landowners and encourage practice implementation			10 hours (VOL)	10 hours (VOL)	LWRD	NRCS DATCP	
Consider purchasing portions of crop fields and supporting incentives to reduce crop runoff			40 hours (VOL)	40 hours (VOL) $?	District Board	Lake protection grant	Implementation budgets to be determined
Waterfront Runoff					**Waterfront Runoff Committee**		
Develop waterfront runoff technical assistance and cost sharing program		50 hours (VOL)			LWRD Consultant?		Use examples of other programs
Develop and implement educational program	50 hours (VOL)	100 hours (VOL)	100 hours (VOL)	100 hours (VOL)	LWRD Consultant?		Use educational materials from

[1] See previous pages for action item detail.

Goal. Improve Bone Lake water clarity.							
Action Items[1]	**Cost 2009**	**Cost 2010**	**Cost 2011**	**Cost 2012**	**Resources/ Partners**	**Funding Sources**	**Notes**
Develop and implement educational program	50 hours (VOL) Materials $1,500	100 hours (VOL) Materials $2,000	100 hours (VOL) Materials $2,000	100 hours (VOL)	LWRD Consultant? Com. Committee		Use educational materials from other sources
Apply for DNR lake protection grant funding		$2,500			District Board Consultant	DNR Lake Protection Grant	Due May 1
Provide technical assistance and cost sharing		$20,000	$30,000	$40,000	District Board LWRD Consultant	Lake Protection Grant	Start July 1, 2010 at earliest
Evaluation/Studies					**Evaluation Committee**		
Monitor runoff from tributaries and other potential areas of concern	20 hours (VOL) Identify areas for sampling	$3,000 50 hours (VOL)			Consultant	Small scale planning 8/1/09	
Sample VOC and heavy metals from NW tributary	$1,000 10 hours (VOL)				Consultant	Lake District budget	
Complete internal load study	48 hours (VOL) $4,750	20 hours (VOL)	20 hours (VOL)	20 hours (VOL)	District Board Consultant	Small scale planning grant 2/1/09	
Assess phosphorus from Curly Leaf Pondweed – plant tissue testing and consultant analysis		$7,500 80 hours (VOL)			District Board Consultant	Planning grant 8/01/09	CLP mapping included in APM plan

Goal. Improve Bone Lake water clarity.							
Action Items[1]	**Cost 2009**	**Cost 2010**	**Cost 2011**	**Cost 2012**	**Resources/ Partners**	**Funding Sources**	**Notes**
Re-evaluate watershed reduction objectives and in-lake phosphorus goal			100 hours (VOL) $500		Comp. Plan Committee Consultant District Board		This must follow internal load study and CLP study.

Goal. Maintain and enhance Bone Lake's natural beauty.
Goal. Protect and enhance wildlife habitat.

Action Items[2]	Cost 2009	Cost 2010	Cost 2011	Cost 2012	Resources/ Partners	Funding Sources	Notes
Identify potential lands for protection			Begin	Continue	LWRD DNR		Assign committee and consider implementation
Involvement in state and local regulations and policy							
Encourage zoning in Town of Bone Lake and Georgetown	As appropriate	As appropriate	As appropriate	As appropriate	District Board Polk County Zoning Towns		Towns may opt to participate in county zoning.
Encourage DNR and Polk County enforcement of no-wake zones	Ongoing	Ongoing	Ongoing	Ongoing	District Board Polk County Sheriff DNR		
Educational activities					**Wildlife and Natural Beauty Committee** Com. Committee		Summarized in final table

[2] See previous pages for action item detail.

Goal. Protect and improve the Bone Lake fishery.							
Action Items[3]	**Cost 2009**	**Cost 2010**	**Cost 2011**	**Cost 2012**	**Resources/ Partners**	**Funding Sources**	**Notes**
Fisheries management					**Fisheries committee**		
Communicate with DNR and tribes re: fish management	100 hours (VOL)	100 hours (VOL)	100 hours (VOL)	100 hours (VOL)	DNR Tribes		
Encourage and support DNR and Tribal assessment and management of fish populations	50 hours (VOL)	50 hours (VOL)	50 hours (VOL)	50 hours (VOL)	DNR Tribes		
Support fish stocking		$?	$?		$?	District Board	What species and how much support need to be determined
Goal. Maintain safe, effective navigation in Bone Lake.							
Navigation management							
Investigate actions and permits to maintain access to lagoon	Investigate permit require-ments				District Board		Proceed with engineering study only if permit likely
Maintain shallow water buoys in approved locations.					District Board		
Manage vegetation in vegetation channels as need					APM Board Lead		See APM plan for implementation

[3] See previous pages for action item detail.

Action Items[4]	**Cost 2009**	**Cost 2010**	**Cost 2011**	**Cost 2012**	**Resources / Partners**	**Funding Sources**	**Notes**
Lake resident education (Applies to all goals)					**Communications Committee**	Small scale grants Lake protection grants	
Newsletter	100 hours (VOL) $8,000	100 hours (VOL) $8,000	100 hours (VOL) $8,000	100 hours (VOL) $8,000		District Board Grants	Consider increasing to 3X per year
Website	100 hours (VOL) $1,500	100 hours (VOL) $1,500	100 hours (VOL) $1,500	100 hours (VOL) $1,500		District Board Grants	
Workshops	$300	$1,500	$1,500	$1,500		District Board Grants	
Publications	$1,200	$1,200	$1,200	$1,200		District Board Grants	
Annual meetings	$100	$100	$100	$100		District Board Grants	

[4] See previous pages for action item detail.

Appendix F. Glossary

Aeration — To add air (oxygen) to the water supply. Generally used in lake management to reduce the release of phosphorus from lake sediments or to prevent fish kills.

Algae — Small aquatic plants without roots that contain chlorophyll and occur as single cells or multi-celled colonies. Algae form the base of the food chain in aquatic environments.

Algal bloom — Heavy growth of algae in and on a body of water resulting from high nutrient concentrations.

Alluvium — Clay, silt, sand, gravel, or similar detrital material deposited by running water.

Alkalinity — The acid combining capacity of a (carbonate) solution, also describes its buffering capacity.

Animal waste management — A group of practices including barnyard runoff management, nutrient management, and manure storage facilities designed to minimize the negative effects of animal manure on surface and groundwater resources.

Aquatic plant survey — A systematic mapping of types and location of aquatic plants in a water body, usually conducted in a boat. Survey information is presented on an aquatic plant map.

Aquifer — A water-bearing stratum of permeable rock, sand, or gravel.

BMP's (Best Management Practices) — Practices or methods used to prevent or reduce amounts of nutrients, sediments, chemicals or other pollutants from entering water bodies from human activities. BMP's have been developed for agricultural, silvicultural, construction, and urban activities.

Bathymetric map — A map showing depth contours in a water body. Bottom contours are usually presented as lines of equal depth, in meters or feet.

Benchmark — A mark of reference indicating elevation or water level.

Benthal — Bottom area of the lake

Biocontrol — Management using biological organisms, such as fish, insects or micro-organisms like fungus.

Biomass — The total organic matter present

Bottom barriers — Synthetic or natural fiber sheets of material used to cover and kill plants growing on the bottom of a water body; also called sediment covers.

Buffer strips - Strips of grass, shrubs, trees, and other vegetation between disturbed areas and a stream, lake, or wetland.

Cluster development - Grouping homes on part of a property while maintaining a large amount of open space on the remaining land.

Chlorophyll — The green pigments of plants.

Conservation easement — A legal document that restricts the use of land to farming, open space, or wildlife habitat. A landowner may sell or donate an easement to a government agency or a private land trust.

Consumers — Organisms that nourish themselves on particulate organic matter.

Contact herbicide — An herbicide that causes localized injury or death to plant tissues it contacts. Contact herbicides do not kill the entire plant.

Cost effective — A level of treatment or management with the greatest incremental benefit for the money spent.

Decomposers — Organisms, mostly bacteria or fungi, that break down complex organic material into its inorganic constituents.

Detritus — Settleable material suspended in the water. Organic detritus comes from the decomposition of the broken down remains of organisms. Inorganic detritus comes from settleable mineral materials.

Dissolved oxygen — A measure of the amount of oxygen gas dissolved in water and available for use by microorganisms and fish.

Drainage basin — The area drained by, or contributing to, a stream, lake, or other water body (see watershed).

Drawdown — Decreasing the level of standing water in a water body to expose bottom sediments and rooted plants. Water level drawdown can be accomplished by physically releasing a volume of water through a controlled outlet structure or by preventing recharge of a system from a primary external source.

Dredging — Physical methods of digging into the bottom of a water body to remove sediment, plants, or other material. Dredging can be performed using mechanical or hydraulic equipment.

Ecology — Scientific study of relationships between organisms and their surroundings (environment).

Ecosystems — The interacting system of a biological community and its nonliving surroundings.

Emergent plants — Aquatic plants that are rooted or anchored in the sediment around shorelines, but have stems and leaves extending well above the water surface. Cattails and bulrushes are examples of emergent plants.

Endothall — The active chemical ingredient of the aquatic contact herbicide Aquathol®.

Environmental Protection Agency — The federal agency responsible for enforcing federal environmental regulations. The Environmental Protection Agency delegates some of its responsibilities for water, air, and solid waste pollution control to state agencies.

Epilimnion — The uppermost, warm, well-mixed layer of a lake.

Eradication — Complete removal of a specific organism from a specified location, usually refers to a noxious, invasive species. Under most circumstances, eradication of a population is very difficult to achieve.

Erosion — The wearing away of the land surface by wind or water.

Eutrophic — Refers to a nutrient-rich lake. Large amounts of algae and weeds characterize a eutrophic lake (see also "Oligotrophic" and "Mesotrophic").

Eutrophication — The process of nutrient enrichment of a lake leading to increased production of aquatic organisms. Eutrophication can be accelerated by human activity such as agriculture and improper waste disposal.

Exotic — Refers to species of plants or animals that are not native to a particular region into which they have moved or invaded. Eurasian watermilfoil is an exotic plant invader.

Fecal coliform — A group of bacteria used to indicate the presence of other bacteria that cause disease. The number of coliform is particularly important when water is used for drinking and swimming.

Floating-leafed plant — Plants with oval or circular leaves floating on the water surface, but are rooted or attached to sediments by long, flexible stems. Waterlilies are examples of rooted floating-leafed plants.

Fluridone — The active chemical ingredient of the systemic aquatic herbicide SONAR®.

Flushing rate — Term describing rate of water volume replacement of a water body, usually expressed as basin volume per unit time needed to replace the water body volume with inflowing water. The inverse of the flushing rate is the (hydraulic) detention time. A lake with a flushing rate of one lake volume per year has a detention time of one year.

Food chain — A sequence of organisms where each uses the next as a food source.

Freely-floating plants — Plants that float on or under the water surface, unattached by roots to the bottom. Some have small root systems that simply hang beneath the plant. Water hyacinth and tiny duckweed are examples of freely-floating plants.

Glyphosate — The active chemical ingredient of the systemic herbicide RODEO®.

Ground-truthing —Close or on-the-ground observation used to test the validity of observations made at a distance as in aerial or satellite photography

Groundwater — Water which fills internal passageways of porous geologic formations (aquifers) underground. Groundwater flows in response to gravity and pressure, and is often used as the source of water for communities and industries.

Habitat — The place or type of site where a plant or animal naturally lives and grows.

Herbicide — A chemical used to suppress the growth of or to kill plants.

Habitat — The physical place where an organism lives.

Hydraulic detention time — The period of detention of water in a basin. The inverse of detention time is flushing rate. A lake with a detention time of one year has a flushing rate of one lake volume per year.

Hypolimnion — The cold, deepest layer of a lake that is removed from surface influences.

Integrated aquatic plant management — Management using a combination of plant control methods to maximize beneficial uses, minimize environmental impacts and optimize overall costs.

Limiting nutrient — Essential nutrient needed for growth of a plant organism which is the most scarce in the environment. Oftentimes, in freshwater systems, either phosphorus or nitrogen is the limiting nutrient for plant growth.

Limnology — The study of inland waters.

Littoral zone — The region of a body of water extending from shoreline outward to the greatest depth occupied by rooted aquatic plants.

Loam — A soil consisting of varying proportions of sand, clay, and silt. Generally well-suited for agriculture.

Loess — A loamy soil deposited by wind.

Macrophyte — Large, rooted or floating aquatic plants that may bear flowers and seeds. Some plants, like duckweed and coontail, are free-floating and are not attached to the bottom. Occasionally, filamentous algae like *Nitella* sp. can form large, extensive populations and be an important member of the aquatic macrophyte community.

Mesotrophic — Refers to a moderately fertile nutrient level of a lake between the oligotrophic and eutrophic levels. (See also "Eutrophic" and "Oligotrohpic.")

Milligrams per liter (mg/l) — A measure of the concentration of substance in water. For most pollution measurements this is the equivalent of "parts per million" (ppm).

Mitigation — The effort to lessen the damages from a particular project through modifying a project, providing alternatives, compensating for losses, or replacing lost values.

Morphology — Study of shape, configuration, or form.

Navigable waters — A water body with a bed and a bank that can float a watercraft at any point in the year.

Natural beauty — (as defined by Bone Lake Comprehensive Lake Management Plan Advisory Committee) Wildlife, plants, trees, clear water, quiet solitude, and a variety of scenery, views of the lake. Where development occurs, it is preferable to have minimal views of buildings.

Niche — The position or role of an organism within its community and ecosystem.

Nitrogen — A chemical constituent (nutrient) essential for life. Nitrogen is a primary nutrient necessary for plant growth.

Nonpoint source pollution (NSP) — Pollution whose sources cannot be traced to a single point such as a municipal or industrial wastewater treatment plant discharge pipe. Nonpoint sources include eroding farmland and construction sites, urban streets, and barnyards. Pollutants from these sources reach water bodies in runoff. They can best be controlled by proper land management.

Non-target species — A species not intentionally targeted for control by a pesticide or herbicide.

Nutrient — Any chemical element, ion, or compound required by an organism for the continuation of growth, reproduction, and other life processes.

Nutrient management plan — A guidance document that provides fertilizer and manure spreading recommendations for crop fields based upon soil test results and crop needs. Plans are sometimes referred to as NRCS 590 plans for the Natural Resources Conservation Service Standard that guides their preparation.

Oligotrophic — Refers to an unproductive and nutrient-poor lake. Such lakes typically have very clear water. (See also "Eutrophic" and "Mesotrophic.")

Ordinary high water mark — The point on the bank or shore up to which the water leaves a distinct mark on the shore or bank from its presence, wave action, or flow. The mark may be indicated by erosion, destruction of or change in vegetation, or another easily recognizable characteristic.

Oxidation — A chemical process that can occur with the uptake of oxygen.

pH — The negative logarithm of hydrogen ion activity. pH values range from 1-10 (low pH values are acidic and high pH levels are alkaline).

Peat — Soil material formed by partial decomposition of plant material.

Pesticide — Any chemical agent used to control specific organisms, such as insecticides, herbicides, fungicides, etc.

Phosphorus — A chemical constituent (nutrient) essential for life. Phosphorus is a primary nutrient necessary for plant growth. When phosphorus reaches lakes in excess amounts, it can lead to over-fertile conditions and algae blooms.

Photosynthesis — Production of organic matter (carbohydrate) from inorganic carbon and water in the presence of light.

Phytoplankton — Free floating microscopic plants (algae).

Point (pollutant) source — A source of pollutants or contaminants that discharges through a pipe or culvert. Point sources, such as an industrial or sewage outfall, are usually readily identified.

Pollution — The presence of materials or energy whose nature, location, or quantity produces undesired environmental effects. Pollutants can be chemicals, disease-producing organisms, silt, toxic metals, and oxygen-demanding materials, to name a few.

Primary production — The rate of formation of organic matter or sugars in plant cells from light, water, and carbon dioxide. Algae are primary producers.

Problem statement — A written description of important uses of a water body that are being affected by the presence of problem aquatic plants.

Producers — Organisms able to build up their body substance from inorganic materials.

Productivity — A measure of the amount of living matter which is supported by an environment over a specific period of time. Often described in terms of algae production for a lake.

Public awareness/outreach — Programs designed to share technical information and data on a particular topic, usually associated with activities on or around a water body.

Recruitment — The process of adding new individuals to a population.

Residence time — The average length of time that water or a chemical constituent remains in a lake.

Riparian — Belonging or relating to the bank of a lake, river, or stream.

Riprap — Broken rock, cobbles, or boulders placed on the bank of a stream to protect it against erosion.

Rotovation — A mechanical control method of tilling lake or river sediments to physically dislodge rooted plants. Also known as bottom tillage or derooting.

Runoff — Water from rain, snowmelt, or irrigation that flows over the ground surface and returns to streams and lakes. Runoff can collect pollutants from air or land and carry them to receiving waters.

Secchi depth — A measure of transparency of water (the ability of light to penetrate water) obtained by lowering a secchi disc into the water until it is no longer visible. Measured in units of meters or feet.

Secchi disc — A 20-cm (8-inch) diameter disc painted white and black in alternating quadrants. It is used to measure light transparency in lakes.

Sediment — Soil particles suspended in and carried by water as a result of erosion.

Sensitive areas — Plant communities and other elements that provide important fish and wildlife habitat as designated by the Wisconsin Department of Natural Resources.

Septic system — Sewage treatment and disposal for homes not connected to sewer lines usually with a tank and drain field. Solids settle to the bottom of the tank. Liquid percolates through the drain field.

Standing crop — The biomass present in a body of water at a particular time.

Storm sewers — A system of sewers that collect and transport rain and snow runoff. In areas that have separated sewers, such stormwater is not mixed with sanitary sewage.

Stratification — Horizontal layering of water in a lake caused by temperature-related differences in density. A thermally stratified lake is generally divided into the epilimnion (uppermost, warm, mixed layer), metalimnion (middle layer of rapid change in temperature and density) and hypolimnion (lowest, cool, least mixed layer).

Submersed plants — An aquatic plant that grows with all or most of its stems and leaves below the water surface. Submersed plants usually grow rooted in the bottom and have thin, flexible stems supported by the water. Common submersed plants are milfoil and pondweeds.

Susceptibility — The sensitivity or level of injury demonstrated by a plant to effects of an herbicide.

Suspended solids (SS) — Small particles of solid pollutants suspended in water.

Systemic herbicide — An herbicide in which the active chemicals are absorbed and translocated within the entire plant system, including roots. Depending on the active ingredient, systemic herbicides affect certain biochemical reactions in the plant and can cause plant death. SONAR® and RODEO® are systemic herbicides.

Thermal stratification — Horizontal layering of water in a lake caused by temperature-related differences in density. A thermally stratified lake is generally divided into the epilimnion (uppermost, warm, mixed layer), metalimnion (middle layer of rapid change in temperature and density), and hypolimnion (lowest, cool, least mixed layer).

Thermocline — Zone (horizontal layer) in a water body in which there is a rapid rate of temperature decrease with depth. Also called the metalimnion, it lies below the epilimnion.

Tolerable soil loss — The tolerable soil loss rate, commonly referred to as "T," is the maximum average annual rate of soil erosion for each soil type that will permit a high level of crop productivity to be sustained economically and indefinitely (ATCP 50.01(16)).

Topographic map — A map showing elevation of the landscape in contours of equal height (elevation) above sea level. This map can be used to identify boundaries of a watershed.

Total maximum daily loads — The maximum amount of a pollutant that can be discharged into a stream without causing a violation of water quality standards.

Transect lines — Straight lines extending across an area to be surveyed.

Tributaries — Rivers, streams, or other channels that flow into a water body.

Trophic state — The level of growth or productivity of a lake as measured by phosphorus content, algae abundance, and depth of light penetration. Lakes are classified as oligotrophic (low productivity, "good" water quality), mesotrophic (moderate productivity), or eutrophic (high productivity; "poor" water quality).

Turbid — Lack of water clarity. Turbidity is closely related to the amount of suspended materials in water.

Uniform dwelling code — A statewide building code specifying requirements for electrical, heating, ventilation, fire, structural, plumbing, construction site erosion, and other construction related practices.

University of Wisconsin Extension (UWEX) — A special outreach and education branch of the state university system.

Vascular plant— A vascular plant possesses specialized cells that conduct fluids and nutrients throughout the plant. The xylem conducts water and the phloem transports food.

Variance — Governmental permission for a delay or exception in the application of a given law, ordinance, or regulation. Also, see water quality standard variance.

Waste — Unwanted materials left over from manufacturing processes; refuse from places of human or animal habitation.

Water body usage map — A map of a water body showing important human use areas or zones (such as swimming, boating, fishing) and habitat areas for fish, wildlife, and waterfowl.

Water quality criteria — A measure of the physical, chemical, or biological characteristics of a water body necessary to protect and maintain different water uses (fish and aquatic life, swimming, etc.).

Water quality management area (WQMA) — The area within 1,000 feet from the ordinary high water mark of navigable waters that consists of a lake, pond or flowage; the area within 300 feet from the ordinary high water mark of navigable waters that consist of a river or stream; and a site that is susceptible to groundwater contamination, or that has the potential to be a direct conduit for contamination to reach groundwater. (NR 151.015(24))

Watershed — The entire surface landscape that contributes water to a lake or river.

Watershed management — The management of the natural resources of a drainage basin for the production and protection of water supplies and water-based resources.

Wetland — Areas that are inundated or saturated by surface or groundwater at a frequency and duration sufficient to support a variety of vegetative or aquatic life.

Wetland vegetation requires saturated or seasonally saturated soil conditions for growth and reproduction. Wetlands generally include swamps, marshes, bogs, and similar areas.

Wisconsin administrative code — The set of rules written and used by state agencies to implement state statutes. Administrative codes are subject to public hearing and have the force of law.

Zooplankton — Microscopic animal plankton in water (Gr. *zoion* animal). *Daphnia* sp. or water fleas are freshwater zooplankton.

Glossary sources: Washington State Department of Ecology; Maribeth Gibbons Jr.; Wisconsin priority watershed planning guidance.

Appendix G. References

Aquatic Engineering, Inc. *2004 Bone Lake Water Quality Technical Report.* (Preliminary Draft and Draft 2).

Barr Engineering. *Report on 1996 Lake Water Quality-Bone Lake.* December 1997.

Barr Engineering Company. *Bone Lake Management Plan. Phase I: Water Quality Study of Bone Lake. Phase II: Hydrologic and Phosphorus Budgets.* June 1997.

Barr Engineering Company. *Bone Lake Management Plan. Phase III: Lake Management Plan.* October 1999.

Beneke, Heath. Wisconsin Department of Natural Resources Fisheries Manager. Personal Communication via email. November 18, 2007.

Bone Lake Management District. *Bone Lake Property Owners Survey*. June 1993.

Caraco, Deb and Ted Brown. *Managing Phosphorus Inputs Into Lakes II. Crafting an Accurate Phosphorus Budget for Your Lake*. Urban Lake Management. p. 782-790.

Cooke, Dennis G., Lombardo Paola, & Brandt Christina. 2001. *Shallow Successful Management Alternatives: Determining Successful Management Alternatives*. Lakeline.

Leith, Katherine McArthur, 1998. *Estimating Tributary Phosphorus Loads Using Flow Weighted Composite Storm Sampling.* Master of Science Thesis. Virginia Polytechnical Institute and State University.

Lin, Jeff P. 2004. *Review of Published Export Coefficient and Event Mean Concentration (EMC) Data.*

North American Lake Management Society. *Managing Lakes and Reservoirs.* 2001.

Nürnberg, Gertrud. 1987. *A Comparison of Internal Phosphorus Loads in Lakes with Anoxic Hypolimnia: Laboratory Incubation versus In Situ Hypolimnetic Phosphorus Accumulations*. Limnology and Oceanography.

Nürnberg, Gertrud. 2001. *Eutrophication and Trophic State*. Lakelines

Osgood, Dick. *Lake and Watershed Planning and Analysis. Deer Lake Management Plan.* February 2004.

Soerens, Thomas S. and Marc H. Nelson. *Sampling Strategies for Determining Nutrient Loads in Streams.* Project Report for Arkansas Water Resources Center.

Søondergaard, Martin, Jeppesen, Erik, and Jensen Jens P. 2003. *Internal Phosphorous Loading and the Resilience of Danish Lakes.* Lakeline.

Turyk N. and J. Stelzer. 2002. *Assessment of Lake and Groundwater Chemistry, Shallow Groundwater Flow, and the Aquatic Macrophyte Community, Peppermill Lake, Adams County, Wisconsin*. Center for Watershed Science and Education, University of Wisconsin-Stevens Point Report to Wisconsin DNR.

U.S. Army Corps of Engineers. 1996. *Simplified Procedures for Eutrophication Assessment and Predictions: User Manual.*

U.S. Geological Survey, Wisconsin Department of Natural Resources. *Hydrology, Nutrient Concentrations, and Nutrient Yields in Nearshore Areas of Four lakes in Northern Wisconsin*, 1999-2001.

Wagner, Ken. 2001. *Limnology: The Science Behind Lake Management*. <u>Lakeline</u>.

Wilson, C. Bruce, Walker Jr., William W. 1989. *Development of Lake Assessment Methods Based Upon the Aquatic Ecoregion Concept.* <u>Lake and Reservoir Management</u>.

Wisconsin Department of Natural Resources. *Bone Lake Sensitive Area Assessment Summary.* July 1988 and July 1989.

Wisconsin Department of Natural Resources. Office of Inland Lake Renewal. *Bone Lake Polk County. Feasibility Study Results, Management Alternatives.* 1980.

Wisconsin Department of Natural Resources. *Wisconsin Lake Modeling Suite – Program Documentation and User's Manual.* 2003.

Wisconsin Department of Natural Resources. Findings Number 23. April 1995.

Wisconsin Department of Natural Resources. Findings Number 35. May 1993.

Wisconsin Department of Natural Resources. Findings Number 38. April 1995.

Woolf, Thomas E. and John D. Madsen. Seasonal Biomass and Carbohydrate Allocation Patterns in Southern Minnesota Curlyleaf Pondweed Populations. J. Aquatic Plant Management 41: 113-118.

Appendix H. Important Contacts

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Web Sites

Bone Lake Management District: www.bonelakewi.com/

Polk County Land and Water Resources Dept.: www.co.polk.wi.us/landwater/

WAL / Wisconsin Association of Lakes: www.wisconsinlakes.org/

Wisconsin DNR: www.dnr.state.wi.us/