Bone Lake
Comprehensive Lake Management Plan

Bone Lake Management District
June 2015

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Introduction

This comprehensive lake management plan guides the activities of the Bone Lake Management District. It was originally developed by the Lake District and approved by the Wisconsin Department of Natural Resources in 2009. This current, updated plan will be implemented over a ten year period from 2015 through 2024.

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.

1. Improve Bone Lake water clarity.
2. Maintain safe navigation in Bone Lake.
3. Protect and improve the Bone Lake fishery.
4. Maintain and enhance Bone Lake's natural beauty.
5. Protect and enhance wildlife habitat.

An aquatic plant management plan was prepared for Bone Lake in 2008 and updated in 2013. Aquatic plant management goals were developed in 2008 and reviewed with no changes made in 2013.

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.

The Bone Lake Management District

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. 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

Needs Assessment

Public Opinion Survey

The Lake District completed a property owner survey in 2013. With 243 surveys returned out of 530 mailed, the response rate was 46%. Selected survey results are included below and full survey results are found in Appendix A. When asked what recreation activities they enjoyed, respondents reported most enjoying the view, then peace and tranquility followed by swimming, open water fishing, and observing wildlife.

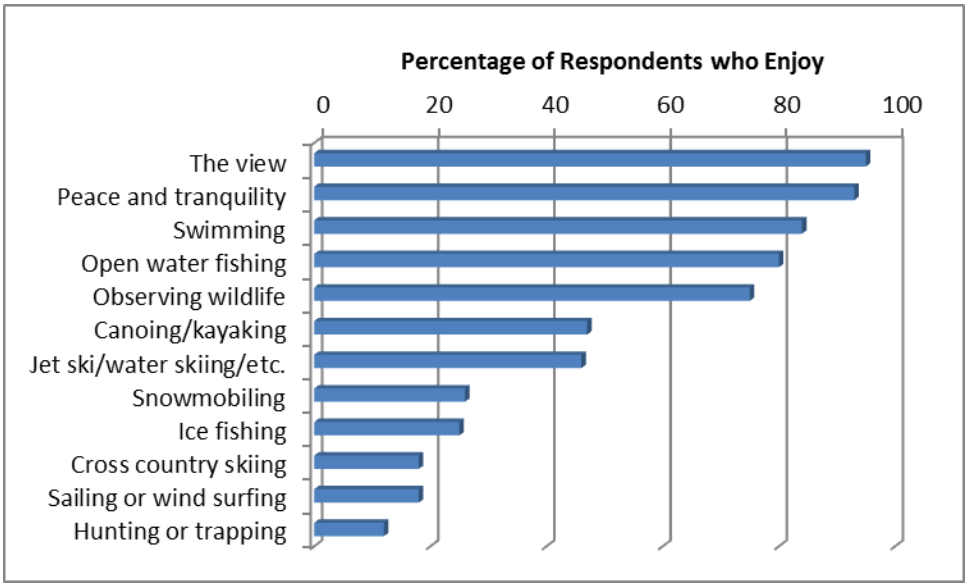


Figure 1. What recreational activities do you enjoy at Bone Lake?

Additional survey results indicate a range of concerns and priorities from lake residents. The highest degree of concern was related to new invasive species entering the lake, excessive aquatic plant growth, and lack of water clarity. The graph below combines the medium and high concern rankings for each item. Detailed results are found in Appendix A.

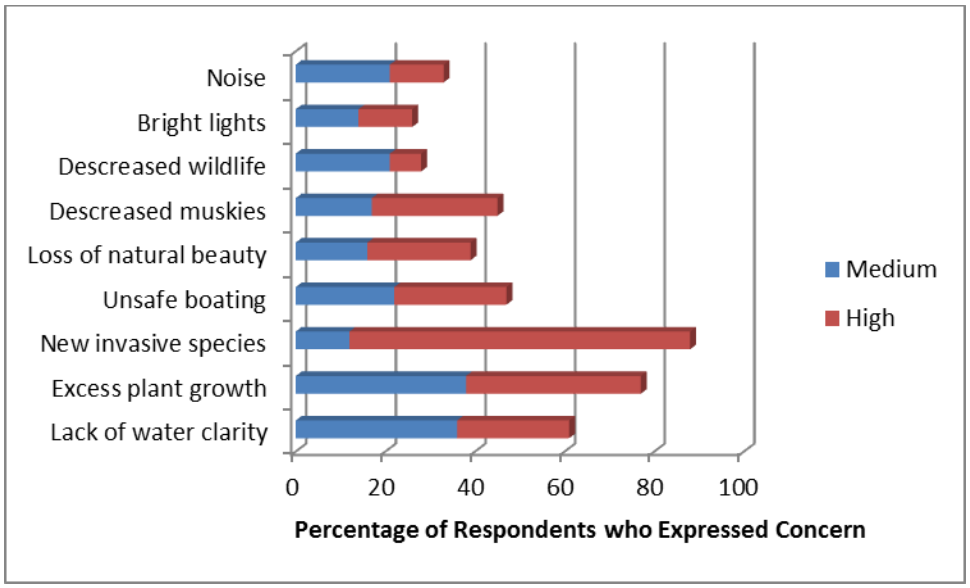


Figure 2. What is your degree of concern associated with each issue listed?

Comprehensive Plan Advisory Committee

The existing lake management committee structure was used to provide input for the update of the plan. Once this input was obtained, implementation recommendations were reviewed at a combined meeting of all committees on November 15, 2014. The comprehensive plan advisory committee for the original lake management plan met five times in 2009.

Public Review

The May 2015 Bone Lake newsletter announced the availability of the draft lake management plan for public review. The draft plan was posted on the Bone Lake web site: bonelakewi.com beginning May 15, 2015 with comments accepted through May 31, 2015. A plan summary was mailed to all lake district residents in May 2015. No public comments were received. The Bone Lake Management District Commissioners approved the plan June 20, 2015.

Population Dynamics

Bone Lake and its watersheds are located in central Polk County, Wisconsin in the towns of Georgetown and Bone Lake. Population growth is low in the area in recent years. The town of Bone Lake had a population growth of only 1.0% from 2000 to 2010 and 0.7% from 2010 to 2014. The town of Georgetown population decreased 2.7% from 2000 to 2010 and grew only 0.9% from 2010 to 2014.[2]

Population records include only permanent residents and do not reflect residential development for seasonal housing. Most seasonal housing is concentrated around waterfront. The lake property owner survey results indicated that only 12% of lake residences are occupied year round. Others owners leave during the winter (7%), use their property mainly on weekends (29%), or are here for months at a time (9%). The remainder of owners uses their property seasonally in some manner.

Records of new septic permits indicate the amount of residential construction occurring in the lake district which consists of property surrounding Bone Lake. Figure 3 illustrates this construction from 1988 through 2014. During this time period, there was an average of 3.5 homes constructed with a new septic system each year within the lake district with substantial declines since 2007.[3]

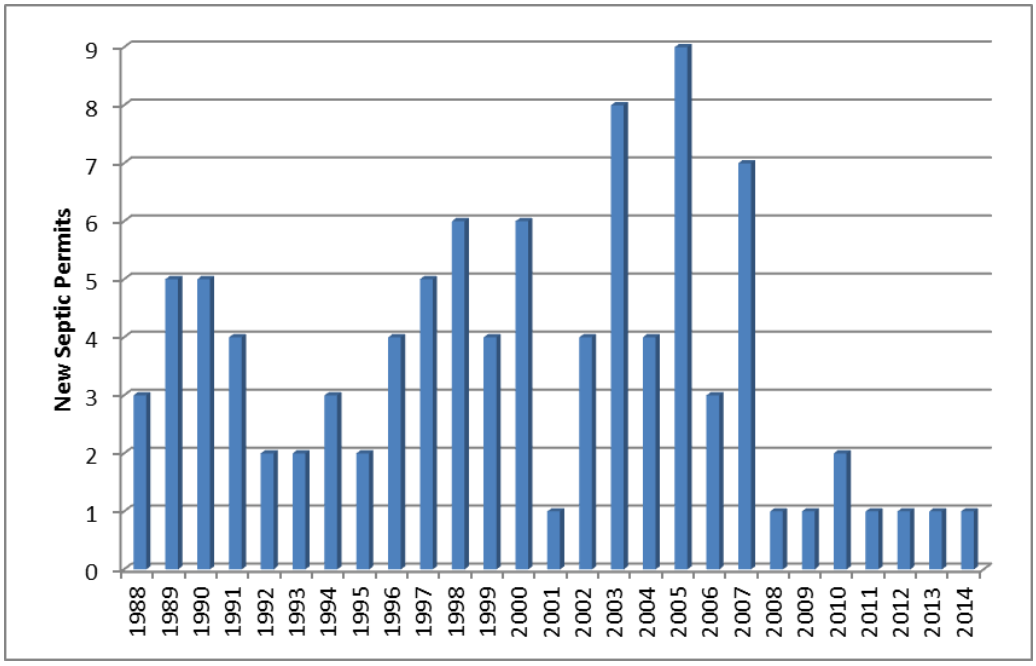


Figure 3. New Septic Permits: within the Bone Lake Management District

[1] Wisconsin Demographic Services Center. 2014.
[2] Information from Polk County Zoning records. April 2015

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 which flows to the St. Croix River. The maximum depth is 43 feet, and the mean depth is almost 22 feet.

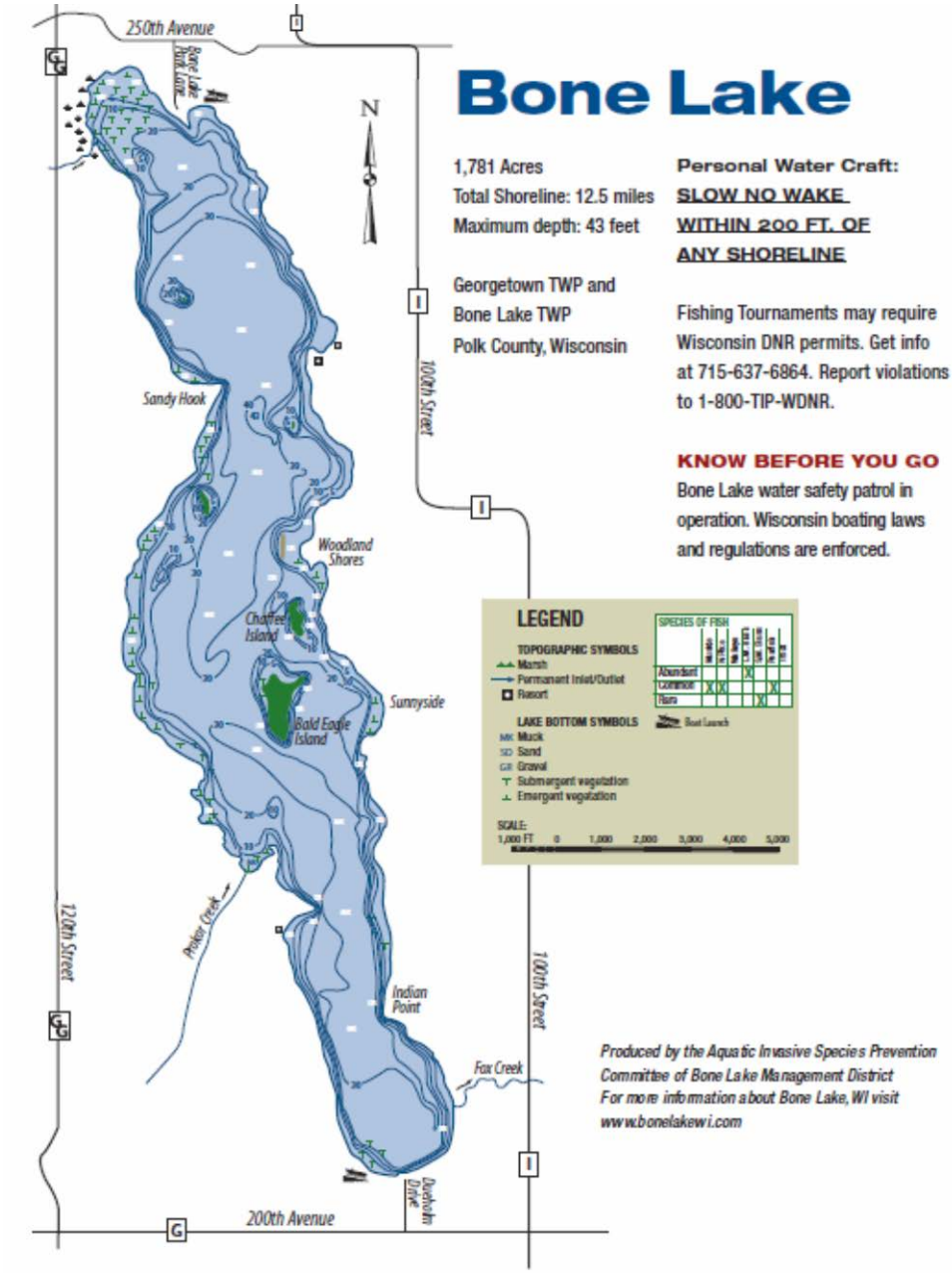


Figure 4. Bone Lake Map

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 past 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 (LWRD) and The Limnological Institute updated water quality monitoring, and Aquatic Engineering prepared a water quality technical report in 2004. Ecological Integrity Services completed a lake nutrient budget in 2008 with data collection and mapping by the Polk County LWRD. 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[3]

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 monitoring locations at the deep hole and south of the large island are shown in Figure 4 and 5. Figure 6 illustrates all sample test results using TSI (trophic status) rankings for the deep hole. Figure 7 shows how water clarity changed over the 2014 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.

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

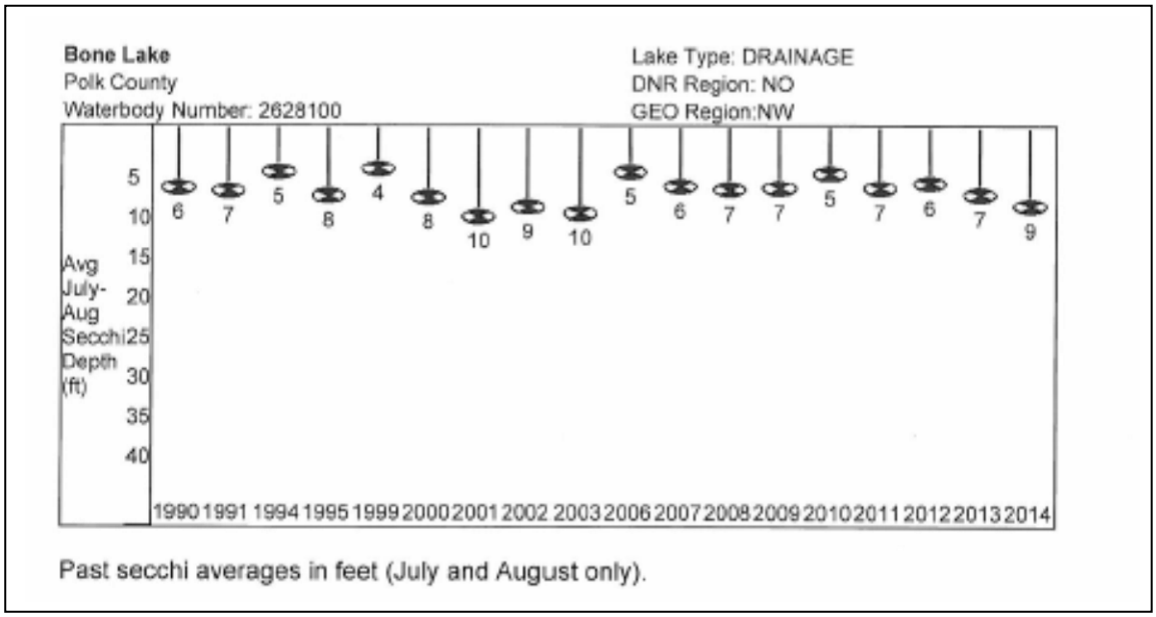


Figure 5. Bone Lake Deep Hole Secchi Depths 1990-2014

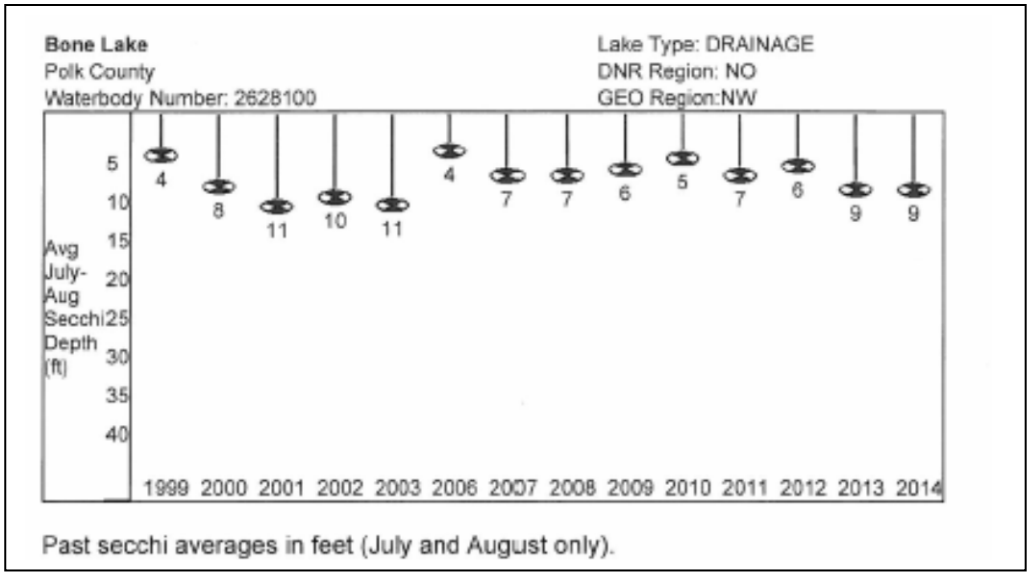


Figure 6. Bone Lake South of Island Secchi Depths 1999-2014

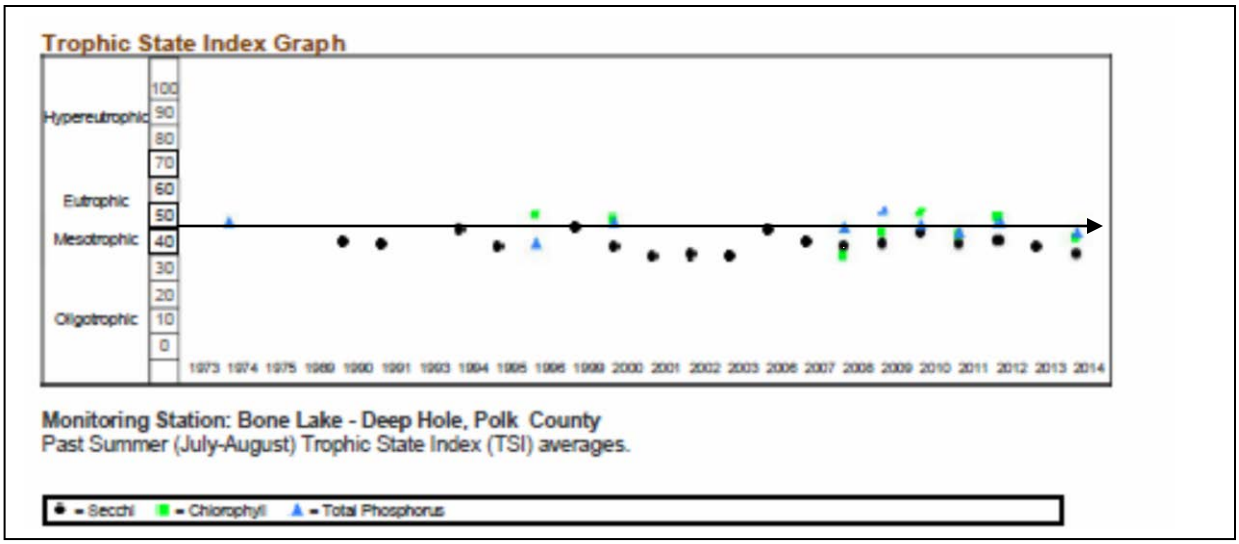
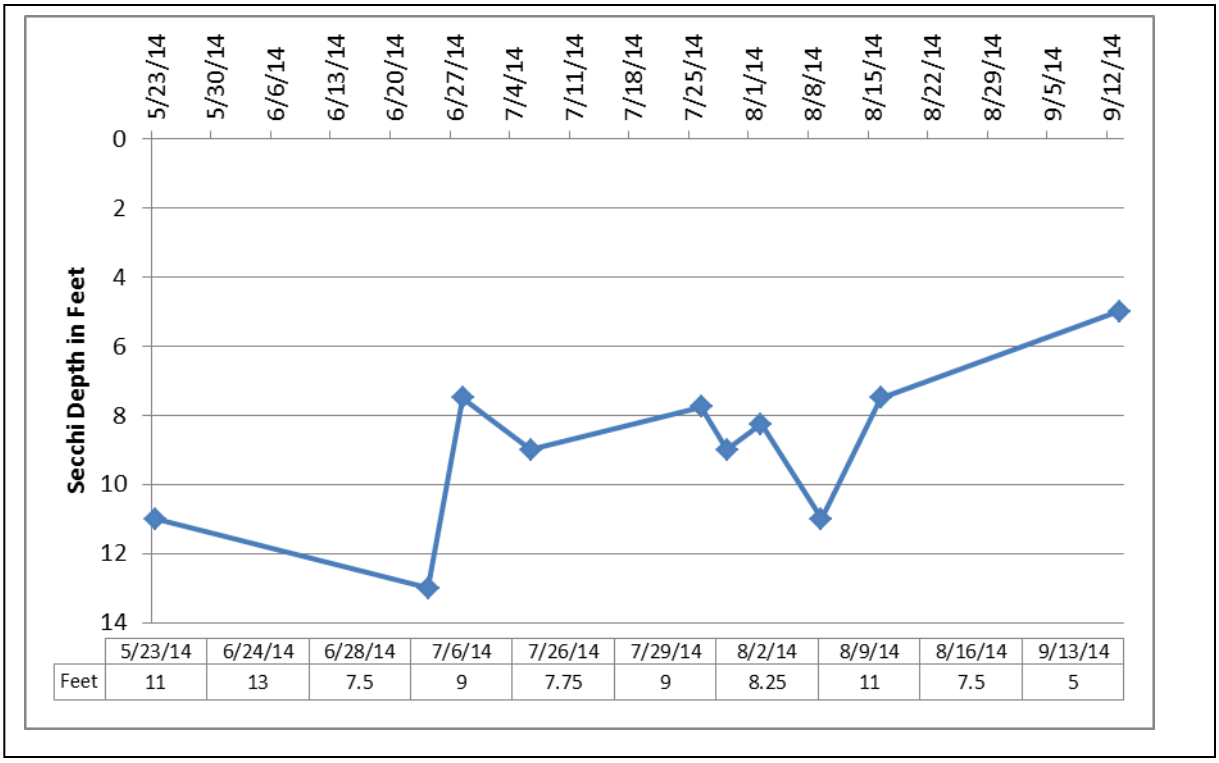


Figure 7. Trophic Status Index Bone Lake Deep Hole 1973-2014



	5/23/14	6/24/14	6/28/14	7/6/14	7/26/14	7/29/14	8/2/14	8/9/14	8/16/14	9/13/14
Feet	11	13	7.5	9	7.75	9	8.25	11	7.5	5

Figure 8. Secchi Depths Bone Lake Deep Hole 2014

Historical Water Quality

The Lake District commissioned a study of Bone Lake sediments in the fall of 2014. The purpose of the study was to assess historical water quality and sediment accumulation from the watershed. Sediments from a 1.95 meter core were dated, and diatoms, sediment accumulation rates, and other factors were examined for this study.

Diatoms are types of algae. By examining the types of algae present, it is possible to "reconstruct" historical phosphorus levels in the lake. The diatom remains show that Bone Lake was a rather nutrient rich lake even back in the early 1800's before development occurred. However, nutrient levels increased, and algae composition shifted in the 1930s and 1940s with highest nutrient levels and lowest water quality from the 1920's to the 1990's. Water quality improvements are evident beginning in the mid-1990s.

The analysis of inorganic sediment accumulation from the watershed showed an increase after 1900 with sedimentation rates doubling by the late 1940s. In recent years sedimentation rates from the watershed have decreased, but not back to predevelopment levels.

The report recommends continued watershed management efforts to minimize sediment and nutrient loading along with an analysis of algae pigments. This analysis (which is planned for early 2015) will indicate whether blue-green algae blooms and potential algae toxin formation are only recent occurrences, or if they happened historically. (Edlund, Ramstack Hobbs, and Williamson 2015)

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 acres are 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[4]

The land use was assessed 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. 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.

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

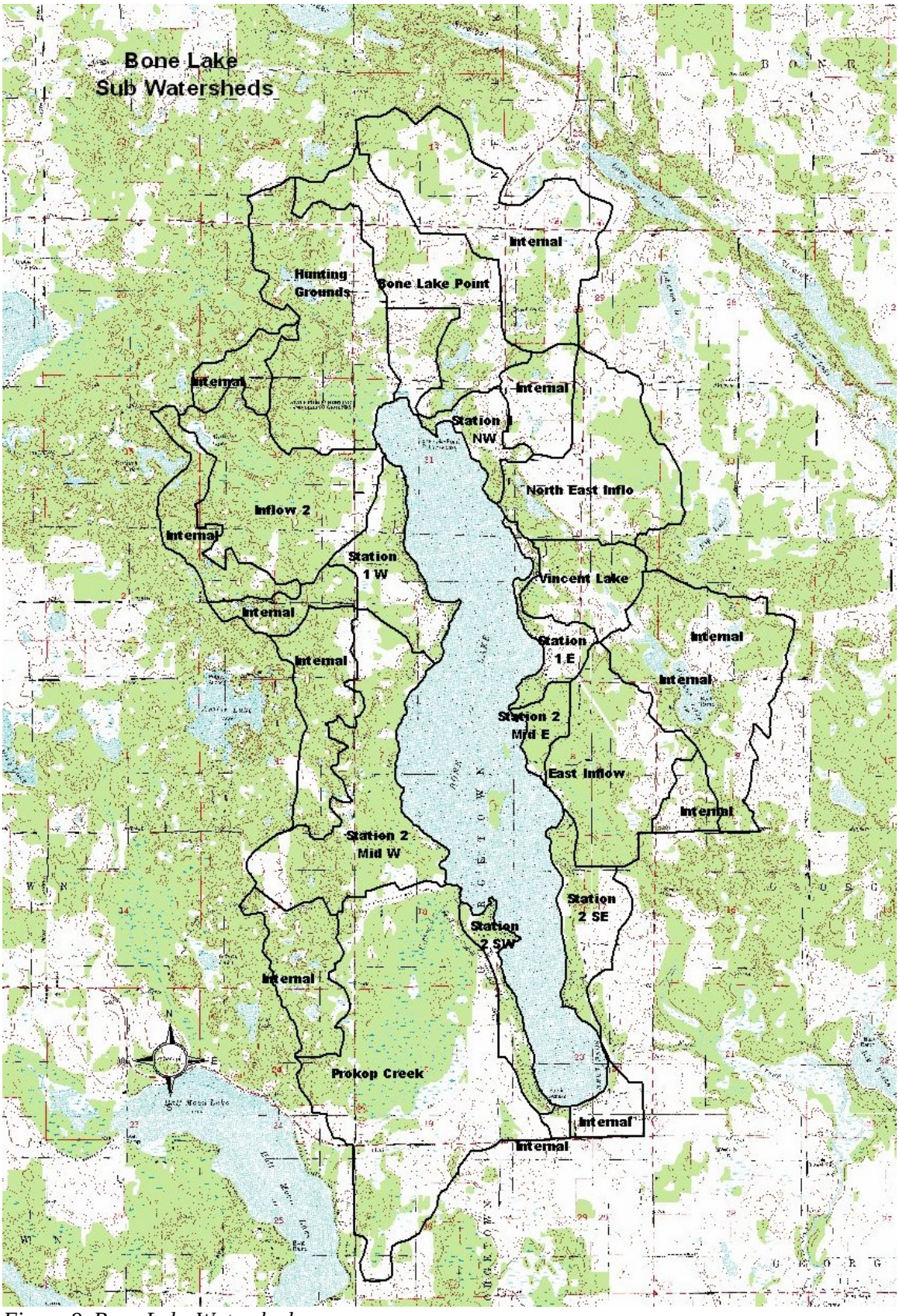


Figure 9. Bone Lake Watersheds

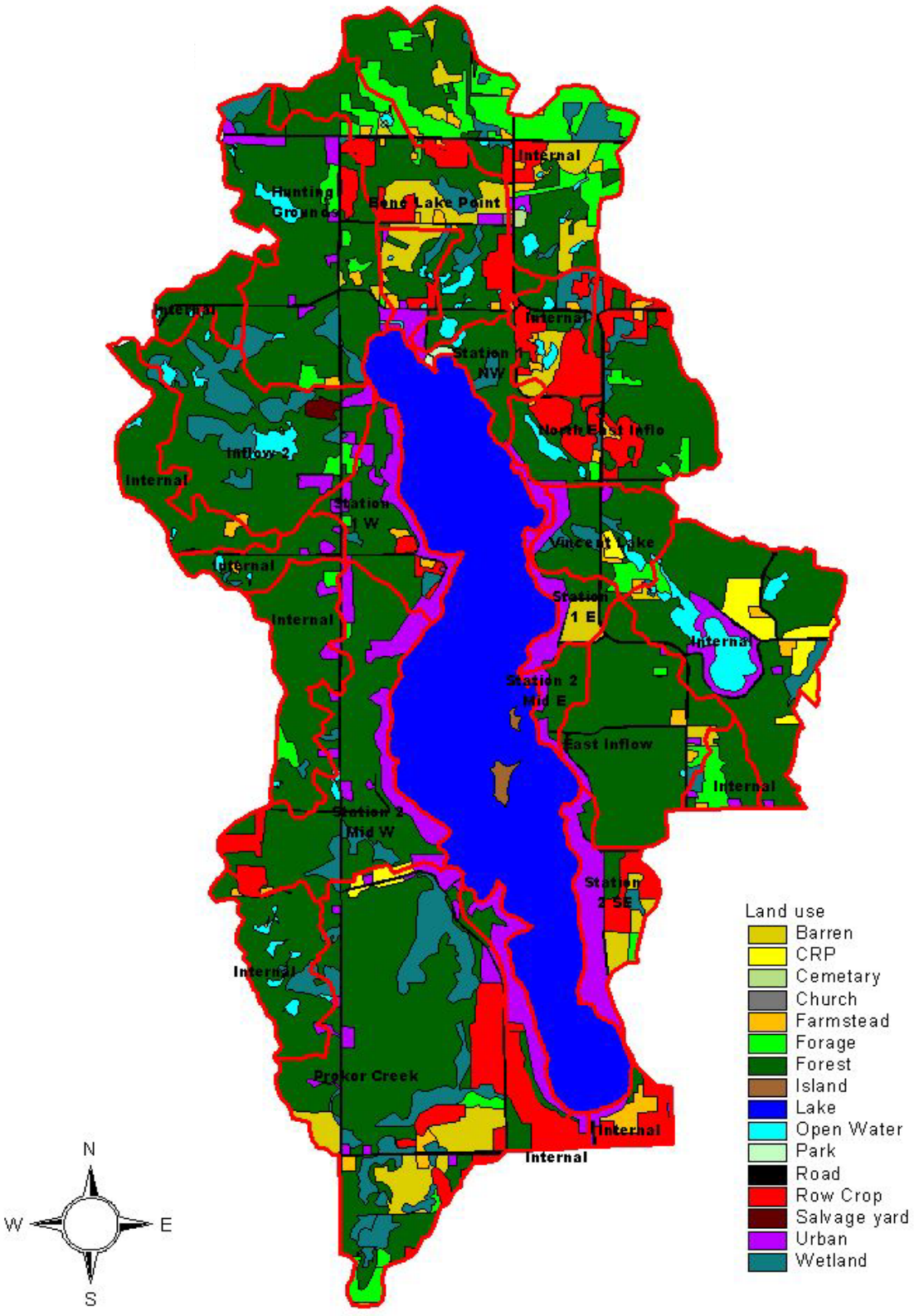


Figure 10. Land Use in Bone Lake Watershed

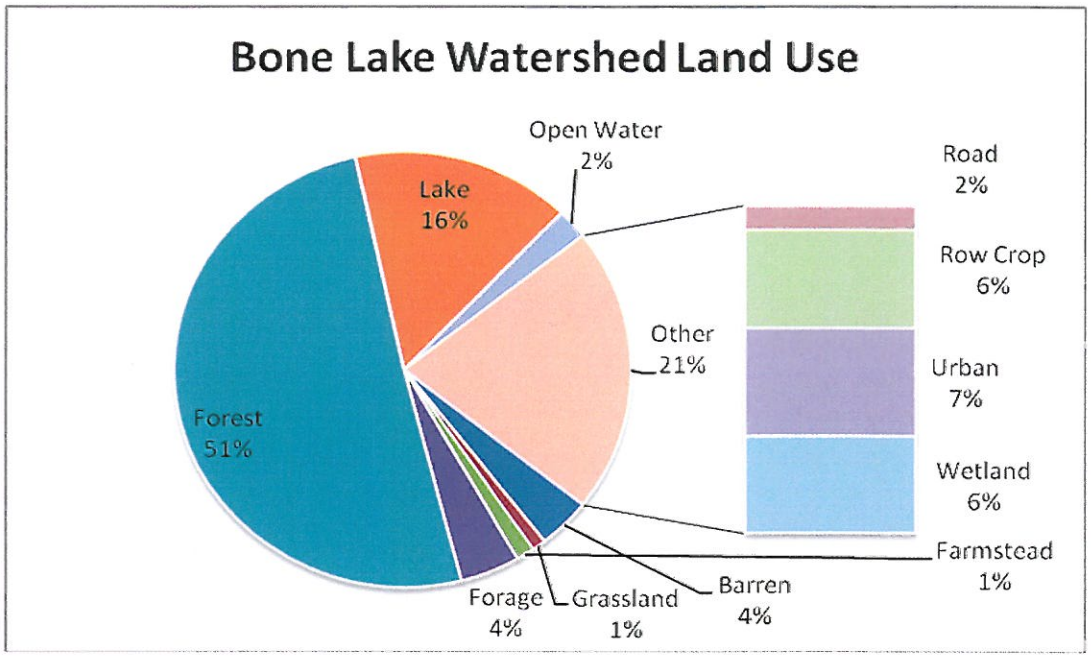


Figure 11. Composition of Bone Lake Watershed Land Use

Watershed Loading

With land use information, it is possible to estimate phosphorus loading from various areas within the watershed. Forest makes up just over half of the land use. 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.

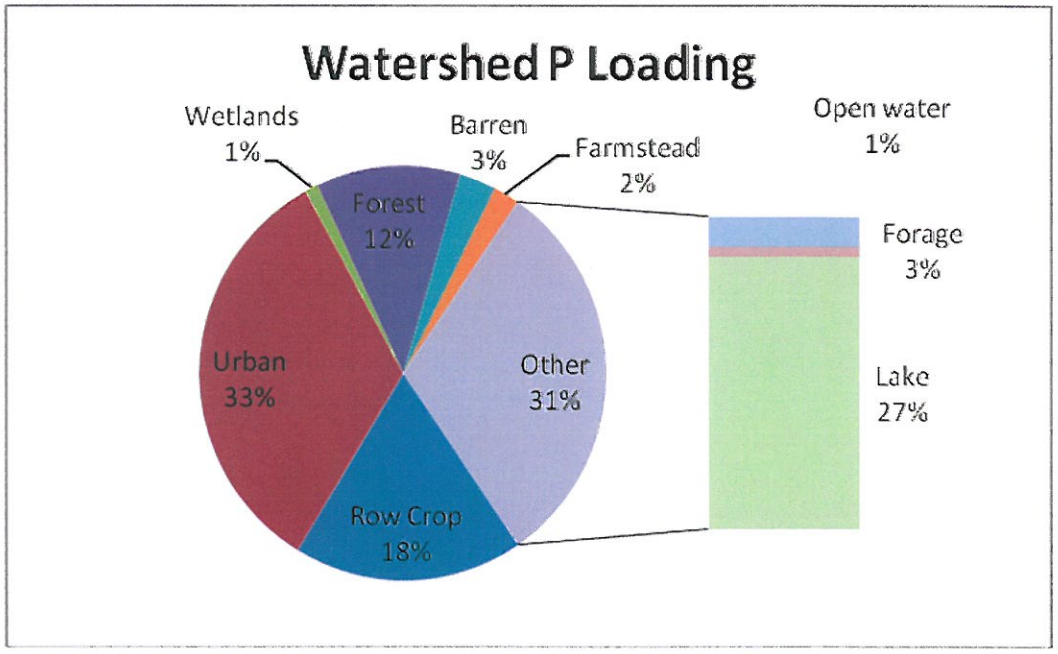


Figure 12. Watershed Phosphorus Loading by Land Use

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.

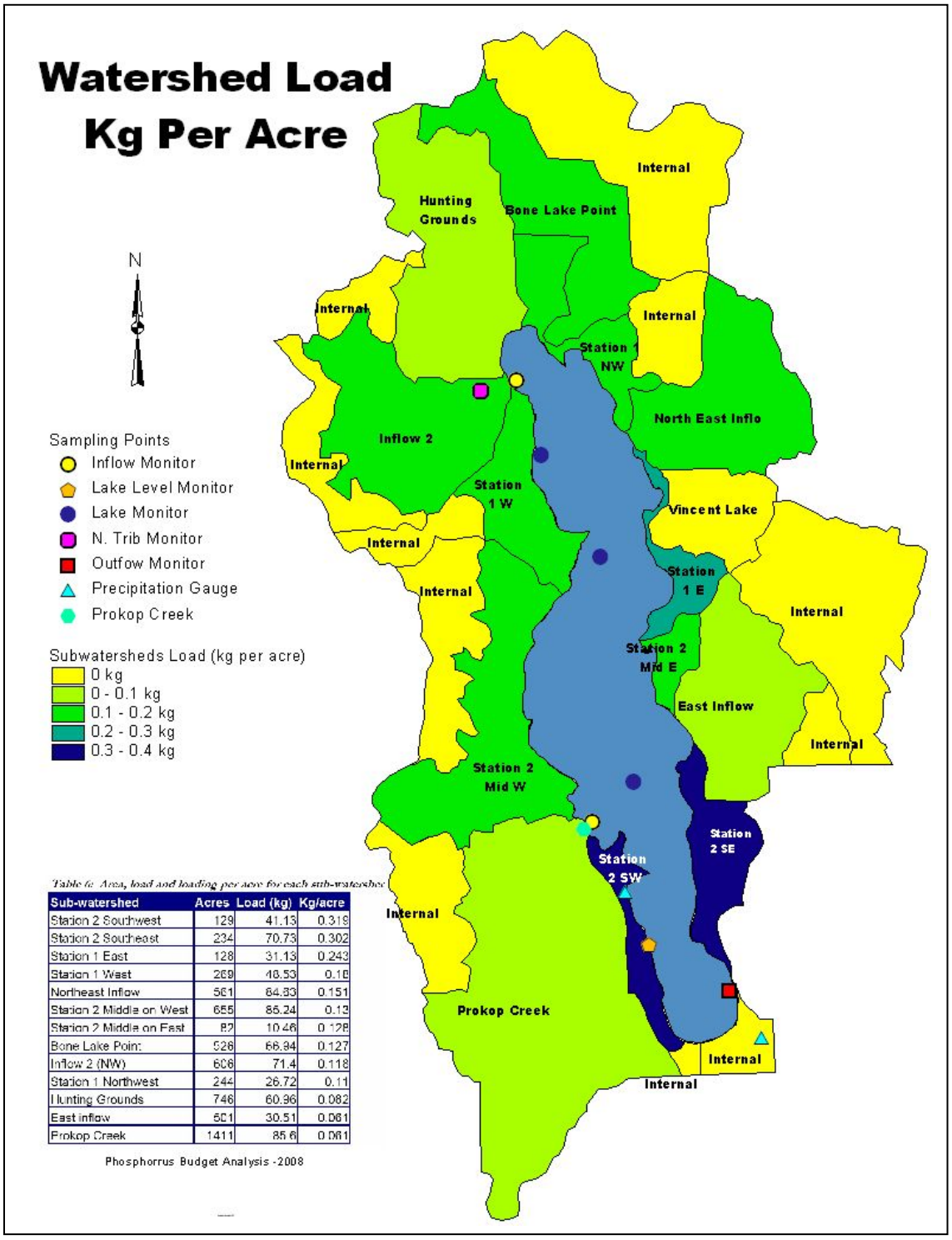


Table 6: Area, load and loading per acre for each sub-watershed

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	86.24	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 Load by Subwatershed

Phosphorus Loading to Bone Lake

Phosphorus comes from both outside (external) and within the lake (internal) including the following major sources:

- Watershed runoff including waterfront properties (external)
- Precipitation on the lake (external)
- Water flow from two tributary streams (external)
- Die back of curly leaf pondweed (internal)
- Release from lake bottom sediments (internal)

Estimates of watershed load are described in the previous section. Septic system loads are estimated from the number of systems and amount of use. Tributary loads were measured with actual samples and flow rates. Above values were available in the original plan. Additional values were available in 2010 following a study of release of phosphorus from lake sediments in 2009 and 2010 and a study of release from dieback of curly leaf pondweed (CLP) in 2010. The updated 2010 estimates based on these studies are included below.

Table 1. Sources of Phosphorus to Bone Lake

Source	Kg/Year	Percent of P Load
Septic Systems	67	5
Prokop Creek	124.8	10
NW Tributary	122.7	10
Watershed	557	45
Lake Surface Precipitation	143	12
Lake Sediments	192	15
CLP	40	3
Total	**1246.5**	

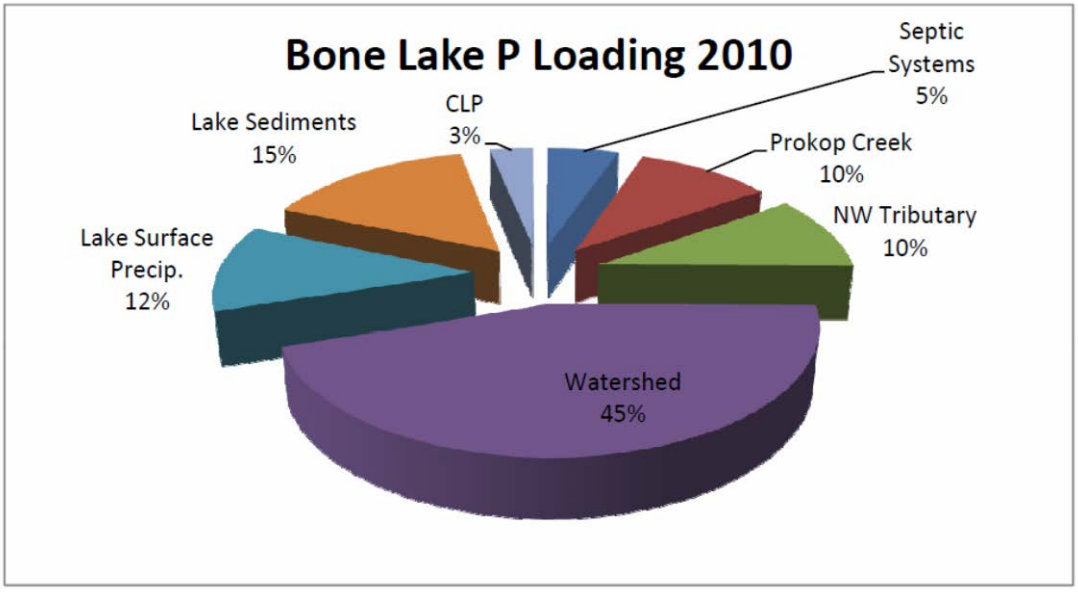


Figure 14. Bone Lake Phosphorus Loading 2010

This is the best estimate that we currently have for managing phosphorus to reduce nuisance algae growth in Bone Lake. It shows a higher tributary load than the 2008 estimate. This is simply because there was more precipitation in 2010 than in 2008. Precipitation was close to normal in 2010. It was low in 2008. Watershed and lake surface loads decreased in importance as the internal sediment and CLP loads were added.

Internal Loading

Like precipitation and resulting tributary loading, in-lake sediment loading of phosphorus can vary from year to year in Bone Lake. Sediment loading of phosphorus is caused from phosphorus release when there is no oxygen at the bottom of the lake. Bone Lake may be more likely to mix throughout the summer because of its long, narrow shape and orientation in line with prevailing winds. During some summers, this released phosphorus stays at the lake bottom because the water stratifies into temperature layers. In other years, phosphorus is released from the bottom and phosphorus is brought to the surface when the lake mixes. In fact, in 2008 the lake was mixed nearly throughout the entire growing season and total phosphorus averaged 38 ppb. In 2009, the lake also mixed with total phosphorus averaging 47 ppb. In 2010 and 2011 when temperature stratification was stronger, lower in-lake phosphorus concentrations were present with averages of 36 and 33 ppb respectively. In a given year, whether the lake stays stratified or mixes may have the greatest impact on phosphorus levels and algae growth. Water clarity improvements from reductions in external loading would be evident when the lake does stratify.

The north deep hole is mixed in the spring and tends to hold stratification throughout the growing season. The south hole is mixed in the spring and mixes more readily throughout the growing season. Prior to fall turnovers, mixing in the south hole may affect the total phosphorus levels in the entire lake. Total phosphorus is generally higher when the lake is mixed or partially mixed, but mixing/stratification alone does not predict in-lake mean total phosphorus in a given year.[5]

A study is underway from 2015-2017 to better assess the phosphorus contribution from internal loading. A second component will be to assess the cost and potential effectiveness of available management measures to control the phosphorus load from lake sediments (internal loading).

Targeting Phosphorus Reduction[6]

Current phosphorus loading estimates help to focus management efforts to improve Bone Lake water quality. Some sources of phosphorus are outside of immediate human control, so the Lake District focuses on those sources which can be managed. These include watershed, tributary, septic, and CLP. Internal sediment loads are much more difficult and expensive to manage, especially when there is periodic mixing of the lake during the summer.

[5] Conclusions based on citizen lake monitoring data 2009-2014.
[6] Modeling results from Steve Schieffer, Ecological Integrity Services.

The WILMS water quality model was used to predict the impacts of changes in land management with the updated figures.

Updated numbers used in the WILMs model show the following result:

- Reducing 25% of residential P loading by 50% [32 kg] predicts a 2.5 % reduction in summer in-lake total phosphorus.

- Watershed projects which remove 6% of watershed phosphorus from non-residential areas [33 kg] will result in a 2.5% reduction in summer in-lake total phosphorus.

- These projects combined will lead to a 5% reduction in summer in-lake total phosphorus.

- Reducing the NW tributary load by 50% [61 kg] predicts a 5% reduction in summer in-lake total phosphorus. The NW tributary is targeted because pollutant concentrations are twice as high as those of Prokop Creek.

Projects that currently appear realistic would bring a 13% reduction in total P loading. The WiLMS model predicts a 12.5% improvement in in-lake total P as a result. This would bring the growing season mean (GSM) total phosphorus to 31.5 ppm, a value which correlates to an 8 foot secchi depth in Bone Lake (based on past Bone Lake data). This is about a 1.5 foot increase in secchi depth. Without the Northwest Tributary reduction, a 7.5% reduction in in-lake phosphorus is predicted (to 33 ppm) along with a 1.2 foot increase in secchi depth.

Lake modeling is an inexact process, and the results above are from only one lake model. Bathtub, another lake water quality model, was also used to predict in-lake total P reductions. That model predicts an 8% improvement in in-lake total P resulting from 13% reduction in total P loading. This would bring the GSM total P to 33 ppb, a value which correlates to a 1.2 foot increase in secchi depth. Additional in-lake phosphorus reductions might be possible through internal load management.

Waterfront Property Reductions

With approximately 530 properties around the lake, 25% participation represents 132 properties. Early work (from 2010 to 2014) to mitigate runoff from waterfront property around the lake has resulted in projects such as rain gardens, shoreland buffers, native plantings, or rock infiltration systems installed at 19 properties – only about 14% of the project goal. Participation in waterfront projects will need to increase dramatically to meet the residential reduction objective.

Multiple property owner contacts were made for the owners with properties rated with a high or medium impact to the lake. This included 280 properties with one or more of the following characteristics:

- Moderate or steep slope to the lake
- Roads with direct access to lake
- Obvious erosion
- Structures close to the lake
- Lack of natural vegetation

The waterfront runoff mitigation program was also promoted at annual meetings and through the Bone Lake Newsletter.

Table 2. Waterfront Runoff Mitigation Progress to Date (2010 to 2014)

Technical assistance site visits	75
Designs completed	35
Projects installed (more involved)	18
Simple projects installed (10X30s)	10
Septic system upgrades	17

Septic Systems

Septic systems were estimated to load 67 kg of phosphorus to Bone Lake. This would mean that each system would contribute an average of 0.15 kg to the lake. A failing system might contribute twice the phosphorus of a functioning system. Therefore, 50 systems would need to be upgraded to meet the target of a 15 kg reduction in septic system loading. A total of 17 systems were upgraded from 2010 – 2014.[7] This reaches 34% of project goal.

Watershed Reduction

Priorities for reductions from watershed flow were developed by testing water in culverts that flow to Bone Lake. Volunteers tested flow and grabbed samples from eight culverts. Samples were analyzed for total phosphorus, dissolved phosphorus, and total suspended solids. Testing and flow measurements were taken following storm events of at least 1 inch. This amounted to 5 times in 2010: once in March, once in May, twice in July, and once in August.

[7] Dick Mackie, Personal Communication. October 2, 2014.

The objective of the culvert monitoring was to compare the relative contributions of phosphorus from culverts entering Bone Lake. Results were intended to be used to establish priorities for watershed practices. With limited data and flow collected, they were not intended to provide updated loading amounts for the watersheds.

The results of the 2010 culvert study were used to identify priorities for watershed practices. Projects were installed in some of these priority areas. In others the presence of wetlands or lack of owner interest precluded installation of practices. A follow-up watershed monitoring study is underway in 2015 to evaluate the effectiveness of installed practices and to potentially identify new areas for projects.

Installed Projects

250th Avenue Projects/ Culvert 5

This is the only portion of the Station 1 NW watershed that flows to the Lagoon. High flows were reported by residents, and streambank erosion was evident below this culvert prior to project installation.

The existing 30" culvert under 250th Avenue was replaced with a 42" culvert in cooperation with the Town of Bone Lake. The streambank on private property south of 250th was stabilized by removing debris, shrubs, and small trees then re-sloping. A rock plunge pool was constructed directly below the culvert, and the remaining streambank (100 feet) was re-vegetated with grasses.

Water and sediment control basins were installed within the intermittent stream on two private properties to the north of 250th Avenue in the fall of 2014. These basins were created with earthen dams across the channel to hold and slow runoff water to allow the sediment load to drop out.

Sunnyside Lane/ Culvert 1

A culvert in this area appeared to create flooding in a wooded area of the watershed. This flooding was assumed to result in relatively high phosphorus loading from this area. The culvert was repositioned so that water flow was not impeded. Wetlands preclude additional practice installation in this location.

240th Avenue

This project was identified prior to the culvert study. It involved creating a small holding pond to allow sediments to settle and installing a culvert under a private road.

Reductions from Curly Leaf Pondweed

A target phosphorus reduction of 20 kg/year assumes that there are 46 acres of CLP and half of that acreage is removed through an early season treatment. There are currently about 30 acres treated each year, with increased success in recent years. Success is measured through a decrease of frequency of curly leaf pondweed following treatment and a decrease of turion density in lake sediments from year to year.

However, although plants are smaller than if treated at full extent of growth, some amount of phosphorus is also released with herbicide treatment annually. Ultimate reductions from CLP release will not occur until the total acres of CLP beds have declined.

If consistent successful treatment occurs, it may be prudent to expand treatment acreage. However, treatment areas must be selected carefully because site characteristics are important to treatment success. Areas with steep drop-offs are particularly difficult to treat successfully because concentration of herbicide may not be maintained above the plants.

Table 3. Curly Leaf Pondweed Treatment History (2010 to 2014)

Year	Acres Treated	Frequency decrease pre to post treatment	Total Acres Mapped
2010	15	38%	46
2011	13	19%	56
2012	13	72%	68
2013	31	78%	48
2014	30	64%	NA*

* Curly leaf pondweed did not grow close to the surface, and therefore, beds could not be mapped in 2014.

Summary

Current information suggests that a 25% reduction in phosphorus loading to Bone Lake is probably not currently a reasonable objective. Goals of perhaps 12.5% or 7.5% phosphorus loading reduction are more realistic to reach 31 to 33 ppb. Even at the lower levels of reduction, an extensive, combined effort in reductions from waterfront, watershed, tributary, and CLP and septic sources would be needed. The predicted in-lake impact of such a reduction ranges from 0.6 to 1.5 foot increases in secchi depth from previous years. The impact would be seen most dramatically when the lake remains stratified all summer. In years when the lake mixes and phosphorus from sediments and deep water is brought to the surface, these results may be less evident.

<u>Recommended areas for ongoing work include the following (with current funding source):</u>

- Installation of waterfront mitigation practices at medium and high priority sites *(Lake Protection Grant)*
- Incentives for upgrades of failing septic systems *(Lake District Funding)*
- Ongoing monitoring to assess, target, and install watershed practices *(Lake Planning and Lake Protection Grants)*
- Continuation of CLP treatment *(Aquatic Invasive Species Control Grant)*
- Further investigation into options for Northwest Tributary treatment options *(Lake Protection Grant)*
- Increase understanding of internal load from lake sediments and costs associated with sediment load management *(Lake Planning and Lake Protection Grants)*

Several of these recommendations are funded through Wisconsin Department of Natural Resources grants. These grants are matched at a rate of 25% to 50% funding by the Lake District.

Shoreland Habitat Assessment

Volunteers completed a shoreland habitat assessment in October 2008. 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 of the 2009 plan. Results are illustrated in Figures 14 and 15 below.

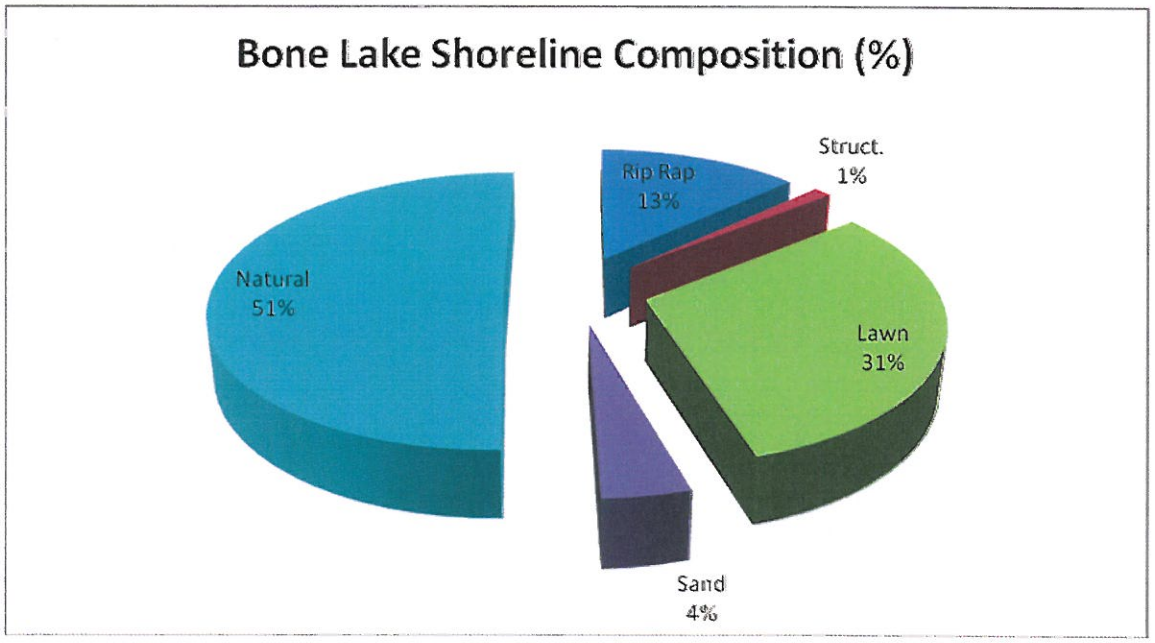


Figure 15. Shoreline Composition at the Ordinary High Water Mark

[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."

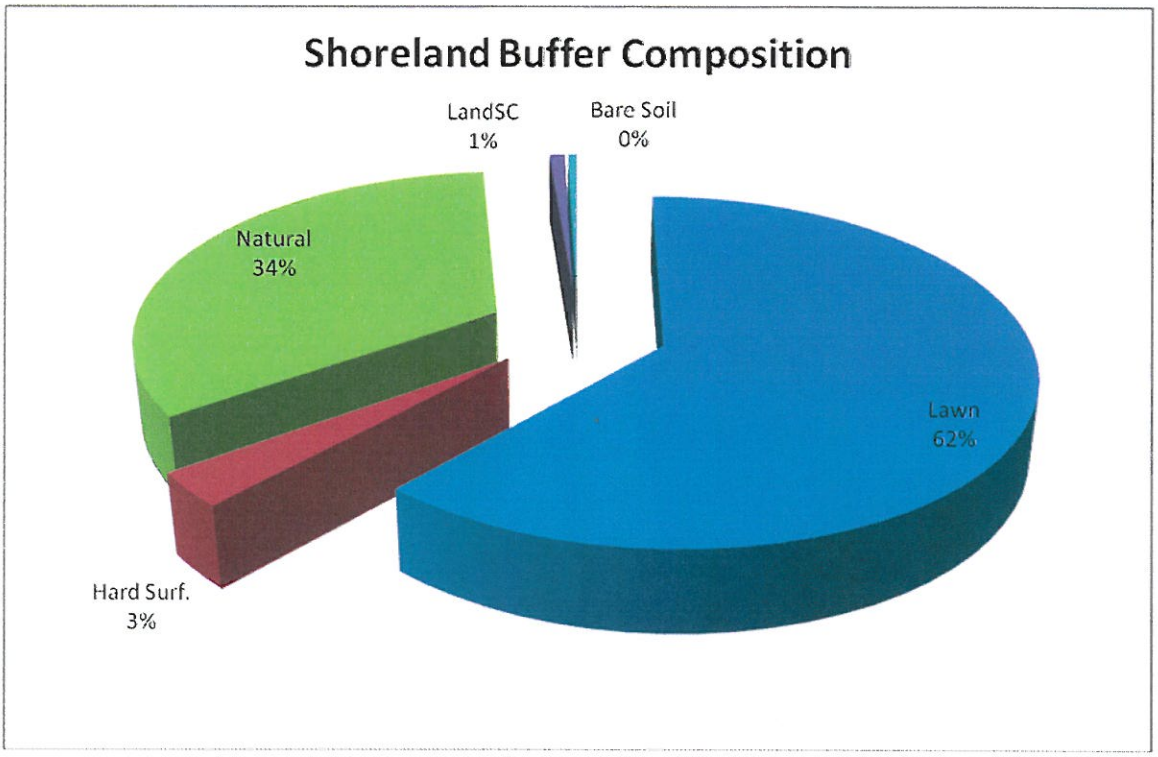


Figure 16. Shoreland Buffer Composition

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.

Woody debris for fish habitat increased through implementation of the 2009 lake management plan recommendations. The fisheries committee oversaw installation of three fish stick complexes consisting of over 100 trees. Additional woody habitat consisting of 80 half log structures was also installed.

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. Some sensitive species are not shown on the data base available to the public. No state or federally listed threatened, endangered, rare or special concern plant species were found in any lake plant surveys.

Table 4. Bone Lake and Georgetown Natural Heritage Inventory Sensitive Species[9]

Scientific Name	**Common Name**	**State Status**[10]	**T35N R16W**	**T36N R16**
BUTEO LINEATUS	RED SHOULDERED HAWK	THR		YES
DENDROICA CERULEA	CERULEAN WARBLER	THR	YES	YES
CYGNUS BUCCINATOR	TRUMPETER SWAN	END		YES
OPHIOGOMPHUS SMITHI	SAND SNAKETAIL	SC/N		YES
AGABETES ACUDUCTUS	WATER SKAVENGER BEETLE	SC/N		YES
HELOPHORUS LATEPENSI	WATER SKAVENGER BEETLE	SC/N		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] Dnr.wi.gov/topic/NHI/Data April 2015
[10] 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[11]

The fish community in Bone Lake consists of muskellunge, largemouth bass, bluegill, pumpkinseed, black crappie, yellow perch, northern pike, smallmouth bass, walleye, white sucker, bullheads, and golden shiner. All fish present in Bone Lake depend (to some degree) upon aquatic vegetation for survival and life processes. Stands of aquatic vegetation provide cover from predatory fish as well as forage areas for fish to feed on small organisms.

Bone Lake is well known for its muskellunge fishery. The Wisconsin DNR currently stocks 2,500 large fingerling muskellunge every other year, and the lake is now managed as a trophy lake for muskellunge with a 50-in minimum length limit regulation. The abundance and size structure of muskellunge has decreased in recent years according to WDNR muskellunge surveys. The abundance of adult muskellunge was at an all-time high in 1999 when it was 0.99 fish/acre, but due to concerns of intra-specific competition and poor condition, stocking was reduced and the lake has been managed as a lower-density fishery since then. As a result, the population density in 2005 was only 0.55 adult fish/acre, and has continued to decrease during the most recent survey in 2011, when it was 0.42 adult fish/acre. The current population level is the lowest it has been since 1964, but is still within the target density level (0.4-0.6 adult fish/acre) for Bone Lake. The relative weight (a measure of fish condition) of muskellunge has improved following the reduction in stocking after the 1999 assessment. Muskellunge relative weight has increased from 96 in 1995, to 104 in 2006, to 111 in 2011 (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. Pan fish were generally small when compared to other Polk County lakes, but an expanding yellow perch fishery is present and has provided good results for ice fishing.

The Bone Lake Management District has a very active Fishery Committee that has been engaged in several projects over the last three years. They have installed “fish stick” complexes at three different locations on Bone Lake. Fish sticks are essentially a complex of approximately 16 to 60 whole trees that are acquired from an upland source, cabled together, and secured to the shoreline. The intent of these projects was to replicate wood that was historically present in the near shore littoral zone before lakeshore development and logging activities at the turn of the century “cleaned up” much of the shorelines. The installation of over 100 trees has provided valuable cover for fish, wildlife, and a host of other aquatic organisms. Additional fish stick complexes are not being planned for installation at this time because: 1) Bone Lake has limited shoreline that is protected from spring ice-out movement (which causes damage and shifting of the fish stick complexes); 2) much of the shoreline is developed into residential lots that do not have space available for complexes; 3) the water is too shallow for proper placement

[11] Information provided by Aaron Cole, DNR Fisheries Biologist. April 2015.

in most potential sites; and 4) wakes from excessive boat traffic cause a shifting of the complexes. However, natural recruitment of woody habitat is very important, and lake residents are encouraged to leave trees that fall naturally into the water. In some locations hinge trees, those that could be cut and dropped into the water to provide cover, will be considered for additional wood habitat.

The Fishery Committee also installed 80 half log structures throughout the lake. Half logs consist of a hardwood log 6-8' long and 8-12" in diameter that is split lengthwise. The log is anchored to cinder blocks on the underside so that when placed into the lake there is a space between the lake bottom and the half log structure. The half logs are intended to provide cover for spawning fish and add additional structure for the fish community. Funding for the wood habitat projects has come from a WDNR lake protection grant and from district funds. An additional 80 half log cribs will be installed by the Bone Lake Fishery Committee over the next three years.

The Bone Lake Management District provided funds for a smallmouth bass stocking program in Bone Lake. The Fishery Committee stocked 12,500 smallmouth bass in the last three years under the guidance of the WDNR. The goal of these stockings was to establish a fishable population of smallmouth bass in Bone Lake. The Fishery Committee will work with the WDNR to evaluate the success of this project, and also monitor natural recruitment of smallmouth bass in the future. The WDNR fisheries crew should be able to assess the smallmouth bass population and begin to gauge any natural recruitment during the next comprehensive lake survey scheduled for 2017. In addition, to better estimate the success of the smallmouth bass stockings, the Bone Lake Fishery Committee will be interviewing bass tournament anglers to collect data on the number and size of smallmouth bass that were caught.

In recent years, there has been an increase in black crappies that have a condition with large open raised sores on the skin of the fish. This condition has been termed "black crappie sarcoma." Although the exact mechanism of transfer is unknown, it is suspected that it is from fish to fish contact. Black crappie sarcoma does not seem to be lethal, as it appears to be more prevalent in larger and older fish. In general, diseases of fish in Wisconsin do not infect people because the human body temperature is too warm. However, since it is a tumor, the current recommendation is not to eat fish that have lesions or that look abnormal as the tumor goes deep into the muscle and is not just a surface lesion. Anglers that catch infected fish are encouraged to keep and discard them, but anglers should realize infected crappies still count towards their daily bag limit. In an attempt to learn more about black crappie sarcoma, the Bone Lake Fishery Committee networked with and assisted the WDNR Black Crappie Sarcoma study during the winter of 2014-2015. Samples from infected fish have been sent to several laboratories across the country. To better understand the prevalence of black crappie sarcoma in Bone Lake and track trends over years, the Bone Lake Fishery Committee will collect and record crappie fishermen's overall catch as well as the number (and percentage) of those which appear to show symptoms of black crappie sarcoma.. This information will be shared with the WDNR.

Tribal Fishing[12]

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.

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

Wildlife

The Bone Lake Wildlife and Natural Beauty Committee guided bird and frog and toad studies around Bone Lake. (Collins, 2011) (Collins & Berg, 2012) These projects were supported by Small Scale Lake Planning grants from the Wisconsin Department of Natural Resources. All lake residents received a high quality illustrated map created with study results and additional information. The map shown as Figure 17 is available for the cost of shipping and handling on Bonelakewi.com.

Bird Survey Results

Bone Lake is a biologically diverse, valuable mosaic of high quality terrestrial and aquatic habitats. Eighty-five species of birds were found during the 2011 shoreline survey. Bird habitat was divided in to the following classes: residential woodlot, second growth deciduous forest, transitional habitats, and tamarack lowland. Several recommendations to improving and maintaining bird populations were included in the report.

Recommendations

- Allow standing dead wood to remain for habitat for red-headed woodpeckers and other cavity nesting birds.
- Maintain (and potentially expand) large parcels of second growth forest to support red-shouldered hawk, least flycatcher, ovenbird, rose-breasted grosbeak, scarlet tanager, and veery. (Planting trees adjacent to second-growth parcels will be encouraged as part of the 2015 WNDR Lake Protection Grant project.)
- Create a no-wake zone surrounding the DNR-owned tamarack swamp along the northwest corner of the lake to support common loons, sandhill cranes, and golden-winged warbler. (A no-wake zone will be pursued as part of the 2015 WNDR Lake Protection Grant project.)
- Decrease use of lead sinkers to protect bald eagle, trumpeter swan, and common loon. (A non-toxic tackle awareness campaign is part of a 2015 WDNR Lake Planning Grant Project.)
- Install nest boxes for a variety of species including purple martin and chimney swift.
- Pursue opportunities for citizen-based monitoring. (The lake district will be participating in a purple martin study as part of a 2015 WDNR Lake Planning Grant Project.)

Frogs and Toad Study Results

Bone Lake is home to seven frog and toad species. True frogs present include the green frog, leopard frog, and wood frog. Tree frogs present include the gray tree frog, spring peeper, and western chorus frog. The American toad is also present. Descriptions of each species and the habitat which supports it are included for each along with a map of where the frogs and toads were detected.

Recommendations

- Maintain a wide buffer of natural shoreline vegetation for green frogs
- Protect forested wetlands and small, temporary pools for tree frogs and toads
- Protect identified sensitive areas in Bone Lake especially beds of hardstem bulrush for green frogs and leopard frogs
- Maintain quality of Bone Lake's oxygen-rich feeder streams for green frogs and leopard frogs

Figure 17. Green Frog (Rana clamitans) Photo by Brian M. Collins

Other 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.[13]

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

Figure 18. Wildlife and Habitat around Bone Lake Map

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.

Bone Lake Management District committees have distributed information using a variety of methods including:

- Web site
- Newsletter
- Annual meetings
- Workshops and training sessions
- Packets of information for new homeowners
- Brochures
- Email announcements
- Social media (Facebook)

According to the 2013 Bone Lake Property Owner Survey, the most preferred method for receiving information from the BLMD is the newsletter (82%), followed by email (41%), websites (20%), and the annual meeting (16%). Ninety-five percent of respondents receive the newsletter, 52% are aware of the BLMD website, 40% have attended at least one annual meeting in the past five years, and 18% receive Bone Lake email announcements.

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.

The Bone Lake Management District developed or participated in the development of several key educational materials to overcome identified barriers including: the *Bone Lake Wildlife and Habitat Map, Top Ten Shrubs for Wildlife brochure, 10X30 Planting Information, Promotional Materials for Waterfront Runoff Mitigation Visits, and Waterfront Runoff Interactive Checklist.*

Conservation Practices

Conservation practices, frequently called best management practices, are installed to reduce pollutant runoff. 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 require significant funding for design and installation. Some lake organizations, including Bone Lake, provide direct financial and technical assistance. Bone Lake has received DNR Lake Protection Grants for both small and large-scale practices. Conservation practices for Bone Lake focus on reducing runoff and pollutant loading from waterfront property and properties further back in the watershed.

Waterfront Runoff Practices

Waterfront runoff practices include rock pits or trenches, rain gardens, and shoreline buffers. The Bone Lake Management District offers site visits to analyze runoff from property, propose potential projects to address runoff, develop project designs, and cost share project installation.

Recommendations for Residential Lands

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 the 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 18 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 are 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.

Watershed 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. Bone Lake watershed best management practices have included constructing sediment basins, replacing improperly sized or installed culverts, and stabilizing streambanks.

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 property 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.

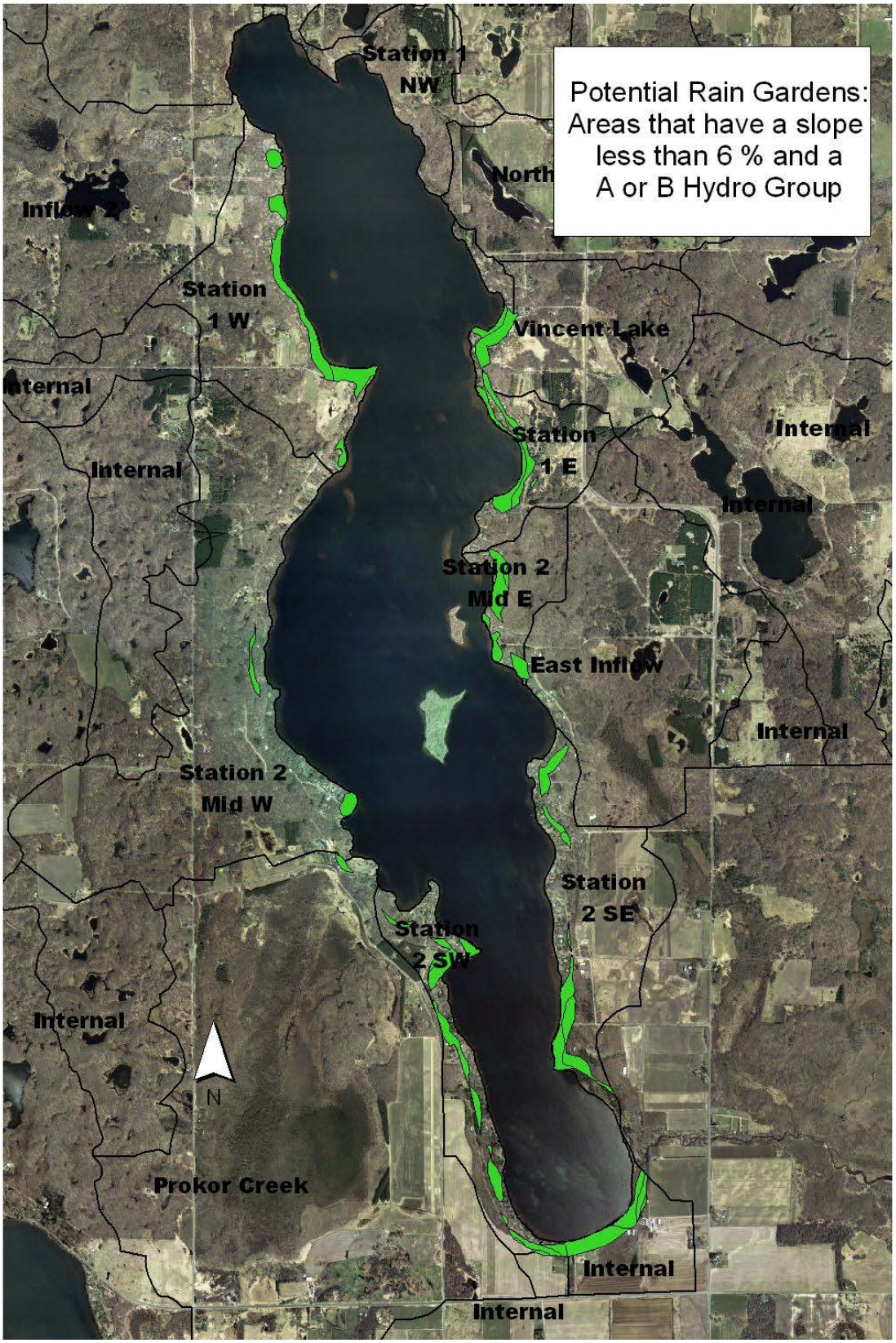


Figure 19. Potentially Suitable Locations for Rain Gardens

In-Lake Management

Options for in-lake management include aeration, dredging, and alum treatment among others. 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 was in operation through 2012. An internal loading study to better estimate phosphorus loading from lake sediments and evaluate options for managing this load in Bone Lake is underway beginning in 2015.

Lake Studies/Evaluation

Several studies were completed to prepare the original lake plan and to update the plan. Additional studies are underway to better understand the lake and watersheds. 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 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. Survey respondents were asked if seven different activities should be continued by the Lake District to improve Bone Lake. For each of the activities over half of respondents felt that the activity should be continued. Over three-quarters of respondents feel that the Lake District should continue to implement programs to deter new aquatic invasive species (95%), continue to treat for curly leaf pondweed (88%), and implement incentives to upgrade non-conforming septic systems (85%).

In general, very few respondents felt that activities should not be continued (1-16%). However, approximately one quarter of respondents were unsure if the lake district should continue lake fairs to share information (32%), programs to reduce waterfront runoff from properties (25%), programs to reduce water runoff from the watershed (25%), and improvements to the north boat landing (24%).

Survey respondents were also asked if the BLMD should consider increasing the acreage of curly leaf pondweed herbicide treatment, increasing jet ski regulation enforcement, and increasing boating regulation enforcement. Approximately two thirds of respondents agree that the BLMD should increase the acreage of curly leaf pondweed herbicide treatment (67%), and around one quarter are unsure (28%). The remaining 6% of respondents do not think the BLMD should increase the acreage of treatment. Over half of respondents feel that the BLMD should increase jet ski enforcement (54%), over one quarter feel that the BLMD should *not* increase jet ski enforcement (28%), and the remaining 18% are unsure. Less than half of respondents feel the BLMD should increase boating regulation enforcement (43%), around a third feel the BLMD should *not* increase boating regulation (32%), and the remaining quarter of respondents are unsure (24%).

Familiarity with Practices to Reduce Waterfront Runoff

In general survey respondents are familiar with landscaping practices designed to reduce runoff from their property. However, with the exception of a few practices, respondents have not installed or are not planning to install these practices. Less than 3% of respondents are planning on installing any given practice. Over half of respondents are familiar with, but have not installed the following practices: rain barrels (79%), rain gardens (71%), 10x30 shoreline plantings offered by the BLMD (60%), and larger shoreline plantings (56%).

The landscaping practices most often installed by respondents include not fertilizing/using zero phosphorus fertilizer (83%) and native plants on property (46%). The practices that survey respondents are generally unfamiliar with include: infiltration pits or trenches (48%), water diversions (37%), 10x30 shoreline plantings offered by the BLMD (31%), and larger shoreline plantings (27%).

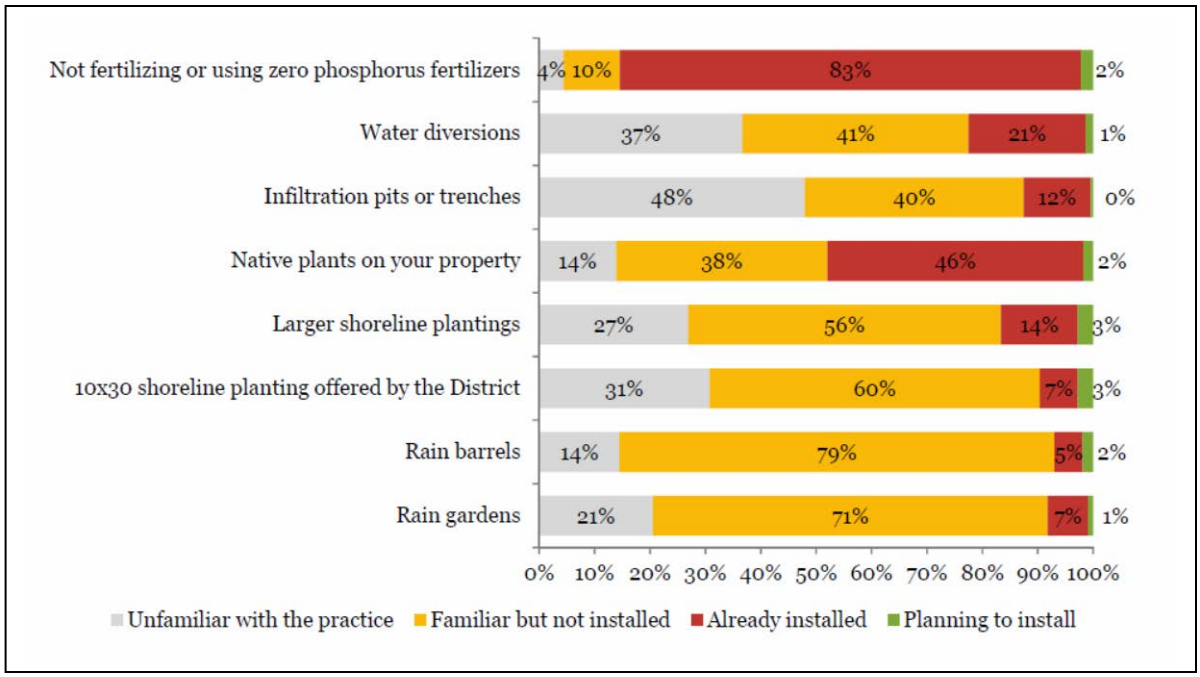


Figure 20. Familiarity with Practices to Reduce Waterfront Runoff

Factors Preventing the Installation of Practices to Reduce Waterfront Runoff

Nearly one third of respondents haven't installed practices to reduce waterfront runoff on their property because they believe their property doesn't impact the lake (31%). Approximately one quarter of respondents haven't installed practices because they are cost prohibitive (24%) or they are unsure how to install a practice (21%). Reasons preventing fewer respondents from installing a practice include: lack of space on their lot (12%), the belief that practices won't help improve water clarity (7%), the time necessary to install a practice (4%), and concerns with neighbors not liking the practice (3%).

Factors Motivating the Installation of Practices to Reduce Waterfront Runoff

Survey respondents were also asked which factors would help motivate or convince them to install a practice to reduce waterfront runoff on their property. The factors which are most likely to convince respondents to install a practice include: improving the water quality of Bone Lake (51%) and improving the water quality around their property's shoreline (42%). Factors such as providing habitat for fish (39%), providing better habitat for birds and wildlife (34%), and increasing natural beauty of property (31%) would motivate around a third of respondents to install a practice to reduce waterfront runoff. Around a quarter would be motivated to install a practice by how-to information (30%), financial assistance (29%), and no cost technical assistance (23%). Approximately a quarter of respondents have no interest in installing water quality practices on their property (23%).

Table 5. Factors Motivating Installation of Practices to Reduce Waterfront Runoff

Factors motivating or convincing respondents to install a practice to reduce waterfront runoff on their property	Percent
Improving the water quality of Bone Lake	51%
Improving the water quality around your property's shoreline	42%
Providing better habitat for fish	39%
Providing better habitat for birds and wildlife	34%
Increasing the natural beauty of your property	31%
More how-to information about landscaping for water quality practices	30%
Financial assistance that pays a portion of the cost of installation	29%
No cost technical assistance that would identify appropriate practices to install	23%
I have no interest in installing water quality practice on my property	23%
Setting an example for other lake residents	20%
Training to learn how to install a practice	13%
Less lawn mowing time	10%

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.

Comprehensive Land Use Planning

The Polk County Comprehensive Land Use Plan was adopted in 2009. 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. Plan information is available online at http://www.co.polk.wi.us/landinfo/PlanningCompPlan.asp

Town, City and Village Comprehensive Plans are available at:
http://www.co.polk.wi.us/landinfo/PlanningCompPlans.asp

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 added "Energy and Sustainability"

Polk County Comprehensive Land Use Ordinance

The Polk County Comprehensive Land Use Ordinance**,** more commonly known as the Zoning Ordinance, is currently being updated due to the passage of the Comprehensive Plan. 17 of Polk County's 24 Towns have adopted county zoning, including: the Towns of Alden, Apple River, Beaver, Black Brook, Clam Falls, Clayton, Clear Lake, Eureka, Georgetown, Johnstown, Lincoln, Lorain, Luck, McKinley, Milltown, Osceola, and West Sweden. The Towns of Farmington, Garfield, and St .Croix Falls have adopted Town Zoning and the Towns of Balsam Lake, Bone Lake, Laketown, and Sterling have no town or county zoning other than the state-mandated shoreland zoning. Land use regulations

in the zoning ordinance include building height requirements, lot sizes, permitted uses, and setbacks among other provisions. The current Comprehensive Zoning Ordinance is available at:
http://www.co.polk.wi.us/landinfo/pdfs/Ordinances/ComprehensiveLandUse.pdf

Shoreland Protection Zoning Ordinance

The State of Wisconsin's Administrative Rule NR 115 dictates that counties must regulate lands within 1,000 feet of a lake, pond or flowage and 300 feet of a river or stream. The Shoreland Protection Zoning Ordinance is also currently being rewritten due to the Comprehensive Plan and the State of Wisconsin passing a new version of NR 115 in 2010. Polk County passed an update of the current Shoreland Ordinance in 2002 and again in 2008. These updates put in place standards for impervious surfaces, a phosphorus fertilizer ban for shoreland property, and lakes classification and setback standards. The current ordinance is available online at:
http://www.co.polk.wi.us/landinfo/pdfs/Ordinances/ShorelandOrdinance.pdf
Updates to the Shoreland Protection Ordinance and the Comprehensive Land Use Ordinance are still underway in 2015. The old and new version of the ordinances will be available at: http://www.co.polk.wi.us/landinfo/ordinances.asp

Subdivision Ordinance

The subdivision ordinance, adopted in 1996 and updated in 2005, 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://www.co.polk.wi.us/landinfo/PDFs/Ordinances/Subdivision%20Ordinance%202005-07-01.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 countywide compliance with the ordinance 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

Polk County Land and Water Resources Management Plan

The Polk County Land and Water Resources Management Plan describes the strategy the Land and Water Resources Department (LWRD) will employ from 2010-2018 to address agriculture and non-agriculture runoff management, stormwater discharge, shoreline management, soil conservation, invasive species and other environmental degradation that affects the natural resources of Polk County. The plan specifies how the LWRD will implement NR 151 (Runoff Management). It involves identifying critical sites, offering cost-share and other programs, identifying BMP's monitoring and evaluating projects for compliance, conducting enforcement activities, tracking progress, and providing information and education.

Polk County has local shoreland protection, zoning, subdivision, animal waste, and non-metallic mining ordinances. Enforcing these rules and assisting other agencies with programs are part of LWRD's ongoing activities. Other activities to implement the NR 151 Standards include information and education strategies, write nutrient management plans, provide technical assistance to landowners and lakeshore owners, perform lake

studies, collaborate with other agencies, work on a rivers classification system, set up demonstration sites of proper BMP's, control invasive species, and revise ordinances to offer better protection of resources.

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

Boating Regulations

The Department of Natural Resources regulates boating in the state of Wisconsin.[14] 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 shore or 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.[15] Local ordinances may now extend the slow-no-wake zone to within 200 feet of shore with passage of WI Act 31.

Dredging Regulations (Sec 30.20 Wis. Stats.)[16]

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

Bone Lake Management Implementation Plan

Plan Timeframe

The plan will be implemented over a ten year period from 2015 through 2024.

Implementation Plan Work Plan and Updates

A more detailed work plan is found in the following section. The work plan details how action steps from the implementation plan will be carried out over the next three year period. This work plan will be updated on a regular basis (every one or two 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

1. **Improve Bone Lake water clarity.**
2. **Maintain safe navigation on Bone Lake**
3. **Protect and improve the Bone Lake fishery.**
4. **Maintain and enhance Bone Lake's natural beauty.**
5. **Protect and enhance wildlife habitat.**

Goal

1. Improve Bone Lake water clarity.

Objectives

A. Achieve an in-lake average summer phosphorus concentration of 30 ppb. (21% reduction)

B. Reduce phosphorus (P) loading from external sources to Bone Lake (watershed, waterfront, tributary) by 13% or more.

- Reduce P loading from urban sources by lowering runoff from 25% of residential lots by 50%
- Reduce tributary loading of phosphorus by 10%
- Implement watershed projects to reduce phosphorus loading
- Use monitoring to justify and prioritize watershed activities
- Control curly leaf pondweed to prevent phosphorus release
- Reduce phosphorus loading from septic systems

C. Evaluate in-lake sources of phosphorus.

Lake bottom sediments

Investigate options for control of in-lake phosphorus

Actions

Waterfront Runoff

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

- Update 10X35 designs

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

- Increase cost sharing rate to 75%
- Survey to self-report installations; request photos of self-installed projects and provide incentive for completion

Provide financial incentives to encourage upgrades of nonconforming septic systems. (OBJ A AND B)

Provide education for lake residents. (OBJ A AND B)
Target education based upon an understanding of the barriers to implementing practices.

Messages

- Impacts of waterfront runoff to lake water quality
- Explain why property is identified as high or medium impact
- How waterfront runoff practices protect water quality
- Bone Lake is on the threshold of being a high nutrient lake with frequent blue-green algae blooms. List nearby lakes with this problem. We need to reduce runoff of phosphorus so we don't cross this line.
- It is urgent that we take action now!
- Focus on impacts from construction sites and best management practices to prevent these impacts.
- Deter geese with a 10X35 planting. Use testimonials and photos.
- Native vegetation is critical for wildlife habitat
- Do not blow grass and leaves into the lake
- Impacts of failing septic systems on lake water quality
- Maintain your septic system properly (provide direction on how to do this)
- Long-term stewardship focus, tie to sediment core results
- Deer Lake case study including participation of waterfront owners and water quality improvements
- Native plants can be used in more formal landscaping
- Owners can choose how they wish to landscape with native plants
- Combine waterfront with natural beauty messages
- More do-it-yourself focus
- Discourage fertilizing lawns.
- If you fertilize your lawn, use zero phosphorus fertilizer.

Methods

Newsletter
Web site
Workshops
Annual meeting
How-to guides
Special mailings
Email blast– link to web site checklist
Photos of installed projects on BoneLakewi.com
Posters at Wilkins Resort
Demonstrations during project installation
Neighbor-to-neighbor sharing: open houses/parties to view projects
U-tube interviews with owners linked to Bone Lake web site
Recognition signs where projects have been installed or other forms of recognition
Thank you letters to participants

Watershed and Tributary

Provide financial and technical assistance for installation of priority watershed and tributary projects. (OBJ A AND B)

Provide education for lake residents. (OBJ A AND B)
Target education based upon an understanding of the barriers to implementing practices.

Messages

- Landowners have contributed to improved water quality of Bone Lake by installing projects on their properties.
- Significant water quality benefits result from installation of these larger, watershed projects.

Methods

Tours of watershed projects – personal invitations
Newsletter articles about watershed projects – purpose, process, photos
Targeted mailings to watershed owners

Evaluation/Studies

Develop targeted monitoring program to evaluate success of watershed projects and identify new priorities. (OBJ A)

Continue WDNR Citizen Lake Monitoring program to track lake water quality trends. (OBJ A)

Complete multi (3)-year internal load study measuring lake temperature, oxygen, and total phosphorus across multiple lake profiles and laboratory study of phosphorus release from sediments. (OBJ C)

Investigate internal load management options available to Bone Lake. (OBJ C)

Goal

2. Maintain safe navigation on Bone Lake

Objectives

A. Watercraft users practice safe navigation
B. Identify shallow water areas
C. Improve snowmobile safety on the lake

Actions

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

Encourage increased boat patrol and enforcement by WDNR and Polk County Sheriff. (OBJ A)

Continue Kids Don't Float program. (OBJ A)

Provide education to lake residents

Messages

- Information about lake levels
- Describe why shallow buoys are installed and where they are located.
- Importance of reflectors on all ice houses left overnight

Methods
Newsletter
Web site
Workshops
Annual meeting

Notes

- Need to repeat messages for everyone.
- There are always new residents and visitors.

Goal

3. Protect and improve the Bone Lake fishery.

Objectives

A. Maintain desirable levels of game fish in Bone Lake.
B. Assess and improve fish habitat.
C. Encourage inclusion of winter tribal harvest of muskies in yearly safe harvest levels determined by the WNDR and GLIFWC (Great Lakes Indian Fish and Wildlife Council).

Actions

Communicate with the DNR and Tribes to improve fish management. (OBJ C)

- Encourage voluntary reporting of tribal winter harvest of musky.

Encourage and support DNR and Tribal assessment and management of game fish populations. (OBJ C)

- Encourage experimental reclassifying of lake to catch and release only for muskies– no harvesting for a period of 6 years. The goal is an increased in size of the muskies.

Assess the impact of small mouth bass stocking. (OBJ A)

- Monitor the population of small mouth bass through tournament communications and local fishermen input at the boat landings.

Add 80 more half log cribs over the next 3 years to provide more structure for spawning fish. Identify prime locations that do not require approval of residents – just the DNR (OBJ A AND B)

- Check existing cribs, straighten out and realign as needed.

Explore the option of hinge trees dropped into the lake to provide structure for fish and other wildlife. (OBJ A AND B)

Assist the WDNR in determining the cause of crappie sarcoma and possible treatment and containment of disease. (OBJ A)

Educational Message

- Don’t clean up downed trees in the lake.

Goal 4. Maintain and enhance Bone Lake's natural beauty.

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

Objectives

A. Maintain undeveloped natural areas on private and public land.
Behavior: Stop clearing trees and shrubs and forbs

B. Enhance natural beauty of developed areas.
Behavior: Add plants and change building colors to obscure buildings; reduce visual impact of structures on shore

C. Preserve and enhance the opportunity to observe the beauty of the night sky
Behavior: Install lights that reduce glare in shoreland area, which also increase safety

D. Increase understanding of noise pollution around the lake (noise from boat motors, loudspeakers on boats, fireworks, parties) by demonstrating how noise travels farther near the water.

Noise, like many other pollutants, precludes many enjoyable uses of the lake environment. 95% of property owners stated in 2013 survey that they enjoy peace and tranquility.

Behavior: Turn it down a notch, leave time for quiet

Actions

Identify potential priority lands to protect natural beauty. (OBJ A)

Consider land protection methods such as land purchase and conservation easements to preserve undeveloped lands. (OBJ A)

Provide education for lake residents. (OBJ A-D, see Wildlife Goal)

Goal

5. Protect and enhance wildlife habitat.

Objectives

A. Engage property owners in observing, recording and reporting their encounters

B. Increase understanding of ways to attract wildlife
Behavior: Preserve existing and add wildlife habitat to lakeshore property

C. Preserve wildlife habitat in public and private land around Bone Lake
Behavior: Protect and preserve near shore aquatic plant communities

D. Homeowners understand the value of native plants in lakeshore landscape, how to create beautiful and ordered low-maintenance gardens with native plants, and the threats of invasive plants in the lakeshore landscape.
Behavior: Choose native plants for landscaping over horticultural varieties, reduce area of lawn

E. Homeowners understand the importance of and identify the habitat for threatened and endangered species.
Behavior: Preserve vernal pools, ponds

Actions

Consider land protection methods such as land purchase or conservation easements to preserve undisturbed parcels of woodland. (OBJ C)

Establish no-wake zone near the northern sedge/meadow/tamarack lowland *(recommended in bird survey).* (OBJ C)

Encourage DNR and Polk County enforcement of state no-wake zone requirements. (OBJ C)

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 motorboat within 100 feet of any shoreline, swimmer, dock, raft, pier, or restricted area on any lake at greater than "slow, no wake speed."
- Operate a PWC at greater than "slow, no wake speed" within 200 feet of shoreline, and within 100 feet of swimmer, docks, raft, piers or restricted areas.

From: Wisconsin Handbook of Wisconsin Boating Laws and Responsibilities.2013.

NATURAL BEAUTY AND WILDLIFE EDUCATION STRATEGY

Reforest edges of developed properties adjacent to undeveloped forest parcels.
This would benefit sensitive forest bird species, including WI threatened Red-shouldered Hawk, Broadwinged Hawk, Cooper's Hawk, Barred Owl. Other forest birds that would benefit: Hooded Mergansers, Pileated Woodpeckers, Neotropical migrant songbirds, warblers.
Partner with Polk County tree planting program, DNR forest management programs. Offer cost share for planting.

Share your shore. Use these words for initiatives that add wildlife habitat to lakeshore properties. Point to the various benefits this brings to property owners. All committee work can use this language.

Shield lakeshore lighting. Use this message in educational efforts.

Survey property owners to help inform our work for the next five years. Gather specific information about perceptions of wildlife, natural beauty, light pollution, noise pollution to inform our work.

- Find out how property owners interact with wildlife. What's considered a nuisance? What's fun? What wildlife brings enrichment to a life on the lake?
- 95% of the 2013 survey respondents (48% response rate) say they enjoy the view, peace and tranquility. What does that view consists of and what are the threats to that enjoyment? What interferes with it?
- Get an idea of what people will actually do, what will they make time for, to improve and or change their property then overlay that with the wildlife and natural beauty objectives.

Publication: 50 Ways to preserve, protect and enhance Bone Lake.
Create a booklet for all property owners, and distribute to new property owners. Have available at meetings and events, and provide online pdf. Include information from all LMP goals and objectives.

Score your shore program shows property owners how to assess their property for habitat in the water, near shore and upland areas with a point system. Completed surveys can identify sites for awards, prioritize sites for restoration, helps set lake-wide goals. Use as alternative to runoff self-assessment, in addition to that assessment and site visit. Give awards to high scoring sites and sites that made improvements. Point to benefits to property owners.

Meets Goal 3, Objective A-E
Meets Goal 2, Objective A, B

Endangered wildlife, sensitive areas
The bird survey has many recommendations for actions we could take to protect and enhance habitat and populations of endangered wildlife including:

Distribute Purple Martin houses and other nesting boxes to interested residents.

Require photo and location of installation once complete.
Use social media, e-news and newsletter to promote this activity.
Partner with Unity School students who need 40 hours community involvement to build houses. Materials expense to District.
Meets Goal 3, Objective A, B, C, E

Promote use of non-toxic tackle**.** Newsletter article, giveaway, signage at landings. Also mention danger of fishing line breakage and similar litter. Lead tackle threatens three high profile bird species: Bald Eagle, Trumpeter Swan and Common Loon. Non-toxic tackle is hard to find in stores. Provide links to online sources and encourage property owners to ask for it where they shop. In conjunction with fisheries committee, talk with fishing tournament organizers.

Meets Goal 3, Objective C, E
Meets Goal 2, Objective A

Track wildlife forms rather than a booklet, provide forms property owners can use to record observations, or for kids to use to write, draw, and collage. Easiest and measurable distribution: download from website. With instruction methods for saving, binding single sheets into a booklet by season, by year, etc. Develop opportunity to share these booklets if interest is demonstrated by download from website.

Meets Goal 3, Objective A: Engaging property owners in observing wildlife and recording encounters

Noise reduction. Newsletter articles and include as part of "50 ways" booklet. Demonstrate lake acoustics, how noise is like other pollutants and precludes many enjoyable uses of the lake environment. 95% of property owners stated in 2013 survey that they enjoy peace and tranquility. Suggestions for voluntary noise reduction and a good neighbor policy.
Meets Goal 2, Objective D

Take part in ongoing surveys with area scientists. For instance, there's a Purple Martin study going on now. Let property owners know about these opportunities and direct them to information and ways to participate.

Meets Goal 3, Objective A

Matching game. Identify some of the problems property owners may have with their shore and match with a native plant or natural practice that would solve it — problems like ice berms, erosion, lighting issues and safety, wildlife "nuisances", steep slopes. Produce in newsletter, online, or as separate mailer.

Meets Goal 3, Objective B, C, D
Meets Goal 2, Objective A, B

Bird booklet or postcard series of Bone Lake birds and wildlife from our studies

Collectible series. Mail to property owners 2-4 times per year, or insert with newsletter. Consider letterpress printing to elevate perceived value.

Meets Goal 3, Objective A, D, E

Lake fair and picnic. In addition to the annual meeting or 4th of July activities, create a district-sponsored event for property owners to socialize, have a meal, play games. Make it kid friendly with opportunity to learn more about ongoing lake management. Provide information, handouts. Possibly revive the walk/run activity to precede the event. Re-consider the nature printing or fish printing activity. Have a guest speaker like John Haack or Chris Cold who would present info and bring critters. Location suggestions: North landing, East Balsam Baptist Church. Timing: 2016

Funding Plan Implementation

The work plan in Appendix D 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 $25,000 and small scale up to $3,000. These applications are accepted each year on December 10. DNR Lake Protection Grants for plan implementation have a maximum grant amount of $200,000. These grants are due each year by February 1. The Lake District successfully applied for the grants shown in Table 6 to implement this lake management plan.

Table 6. Grants for Plan Implementation

Grant Number	Dates	Amount	Grant %	Selected Activities
SPL-343-15	2/15/15 – 12/31/15	$2,974	67	Plan Summary
LPL-1568-15	2/15/15-12/31/17	$24,669	67	Internal Load Study Wildlife Tracking Fish Studies Watershed Assessment
LPT-475-15	4/15/15-12/31/17	$175,020	75	Waterfront Runoff Watershed Projects P Release from Sediments Fisheries Habitat No Wake Zone

Appendix A. 2013 Bone Lake Survey Summary

A Bone Lake survey was mailed to five hundred thirty (530) property owners of the Bone Lake Management District (BLMD) in late April 2013. The survey had a great response with two hundred forty three (243) responses. This survey was designed to obtain input on a variety of areas to help direct future BLMD actions. The BLMD will discuss these new actions/responses at the annual meeting on Saturday 9 a.m. August 10, 2013 at Wilkens and will also post on the website in August. This is a summary but the detailed results are also available on our website bonelakewi.com.

Property Ownership

Respondents have owned their property on Bone Lake for an average of 23 years. Half of respondents use their property on a seasonal basis (50%) and approximately half (48%) use their property year around. Forty one percent of respondents who use their property seasonally do so only on weekends, vacations, and holidays and 9% use their property seasonally for months at a time. Forty eight percent of respondents use their property year round. However, 7% of respondents who use their property year round leave for all or most of the winter and 29% use their property only on weekends, vacations, and holidays. Only 12% of respondents occupy their property as a year round residence.

Overall, respondents are highly satisfied with owning property on Bone Lake (66%) or somewhat satisfied (29%). Only 4% of respondents are somewhat dissatisfied and a mere 1% are very dissatisfied.

Recreational Use

Survey participants enjoy a variety of recreational activities at Bone Lake. The most highly enjoyed activities include: enjoying the view (95%), enjoying peace and tranquility (93%), motorized boating (87%), swimming (84%), open water fishing (80%), and observing wildlife (75%). Less than half of respondents enjoy the following recreational activities on Bone Lake: non-motorized boating (47%), jet skiing/wakeboarding/waterskiing (46%), snowmobiling (26%), ice fishing (25%), sailing/wind surfing (18%), cross county skiing (18%), and hunting/trapping (12%).

The majority of respondents want to keep having the Bone Lake sponsored fireworks around the 4th of July (80%). Of these respondents, 91% are willing to help pay for the fireworks which rely 100% on donations.

Nearly half of respondents feed birds or other wildlife (46%) and approximately one third put up nesting boxes for birds or other animals (35%).

Changes Impacting Recreational Use

Nearly half of respondents perceive that aquatic plants growth has worsened in the time they have owned their property (46%), over one third perceive no change (37%), and nine percent perceive an improvement.

Approximately one third of respondents described the quality of pan fishing as unchanged (35%) or worse (31%) than when they purchased their property. Seventeen percent of

respondents were unsure how to describe changes in the quality of pan fishing and 7% described an improvement.

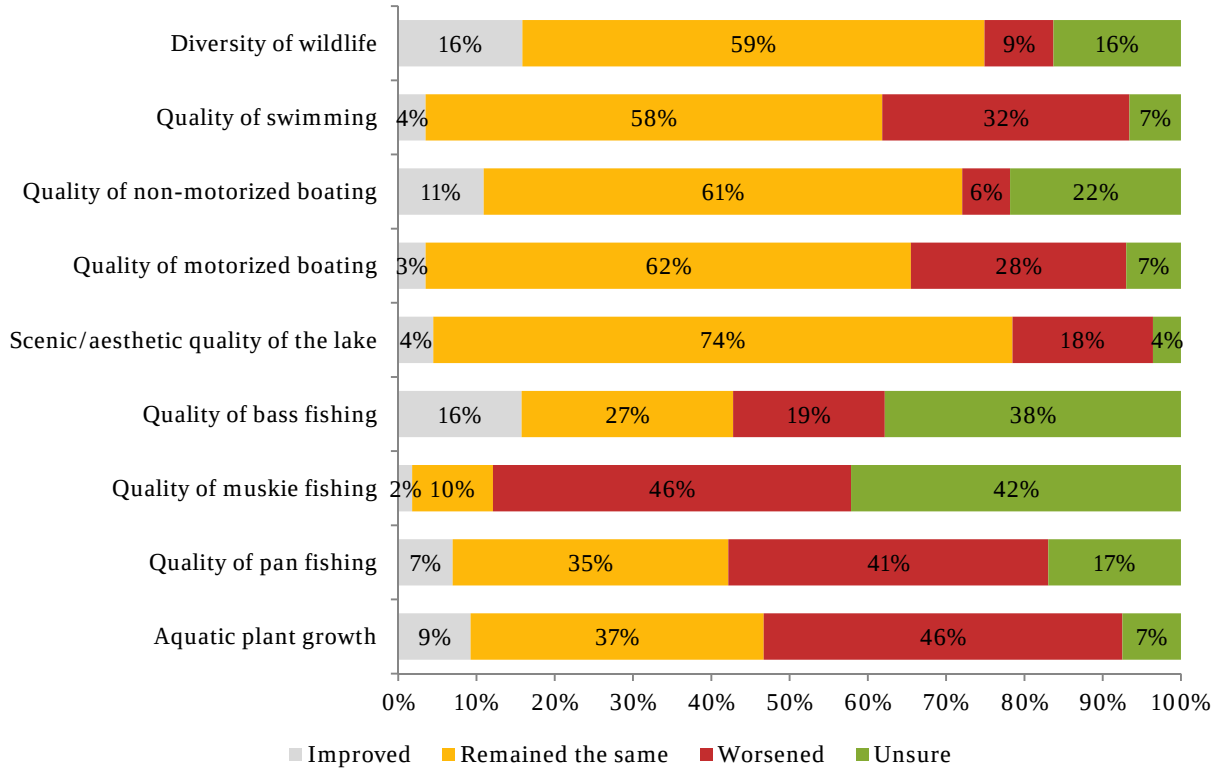
Nearly half of respondents perceive that the quality of muskie fishing has worsened (46%) in the time they have owned their property or were unsure how to describe changes (42%). Ten percent perceive that the quality of muskie fishing has remained unchanged and two percent perceived an improvement.

Respondents were generally unsure how to describe the quality of bass fishing (38%) or feel that bass fishing has remained unchanged in the time since they have owned their property (27%). The remainder of respondents were nearly equally split in describing the quality of bass fishing as having worsened (19%) or improved (16%).

Over half of respondents feel that the scenic/aesthetic quality of the lake (74%), quality of motorized boating (62%), quality of non-motorized boating (61%), diversity of wildlife (59%), and quality of swimming (58%) have remained unchanged in the time they have owned their property.

More respondents perceived that the following characteristics have worsened as compared to improved: quality of swimming (32% versus 4%), quality of motorized boating (28% versus 3%), and scenic/aesthetic quality of the lake (18% versus 4%).

More respondents perceived that the following characteristics have improved as compared to worsened: diversity of wildlife (16% versus 9%) and quality of non-motorized boating (11% versus 6%).



Concerns for Bone Lake

Survey respondents were asked to rank their degree of concern with nine different issues. [1] The issue of greatest concern was new invasive species entering the lake, followed by excessive aquatic plant growth, and lack of water clarity.

Issue	Degree of concern value
New invasive species entering the lake	835
Excessive aquatic plant growth	692
Lack of water clarity	583
Unsafe boat or personal water craft safety	546
Decreased Muskie population	542
Loss of natural scenery/beauty	469
Noise level on the lake	459
Decreased wildlife population	421
Bright shoreline lighting	401

Bone Lake Management Activities

Survey respondents were asked if seven different activities should be continued by the BLMD to improve Bone Lake. For each of the activities over half of respondents felt that the activity should be continued. Over three-quarters of respondents feel that the BLMD should continue to implement programs to deter new aquatic invasive species (95%), continue to treat for curly leaf pondweed (88%), and implement incentives to upgrade non-conforming septic systems (85%).

In general, very few respondents felt that activities should not be continued (1-16%). However, approximately one quarter of respondents were unsure if the BLMD should continue lake fairs to share information (32%), programs to reduce waterfront runoff from properties (25%), programs to reduce water runoff from the watershed (25%), and improvements to the north boat landing (24%).

	Yes	No	Unsure
Continue to treat curly leaf pondweed	88%	4%	9%
Programs to encourage rain gardens and waterfront plantings to reduce waterfront runoff from properties	70%	5%	25%
Programs to control stream bank stabilization to reduce harmful water runoff from the watershed	74%	2%	25%
Programs such as boat inspections and lake monitoring to help deter new aquatic invasive species	95%	1%	3%
Lake fairs to share information on activities	59%	9%	32%
Improve boat north landing	61%	16%	24%
Incentives to upgrade non-conforming septic systems	85%	6%	9%

[1] The following values were assigned to each degree of concern: issue doesn't exist = 0, exists but not a concern = 1, low concern = 2, medium concern = 3 or high concern = 4. Values were summed to determine a total for each issue.

Survey respondents were also asked if the BLMD should consider increasing the acreage of curly leaf pondweed herbicide treatment, increasing jet ski regulation enforcement, and increasing boating regulation enforcement.

Approximately two thirds of respondents agree that the BLMD should increase the acreage of curly leaf pondweed herbicide treatment (67%), and around one quarter are unsure (28%). The remaining 6% of respondents do not think the BLMD should increase the acreage of treatment.

Over half of respondents feel that the BLMD should increase jet ski enforcement (54%), over one quarter feel that the BLMD should *not* increase jet ski enforcement (28%), and the remaining 18% are unsure.

Less than half of respondents feel the BLMD should increase boating regulation enforcement (43%), around a third feel the BLMD should *not* increase boating regulation (32%), and the remaining quarter of respondents are unsure (24%).

	Yes	No	Unsure
Increase acreage of curly leaf pondweed herbicide treatment	67%	6%	28%
Increase boating regulation enforcement	43%	32%	24%
Increase jet ski regulation enforcement	54%	28%	18%

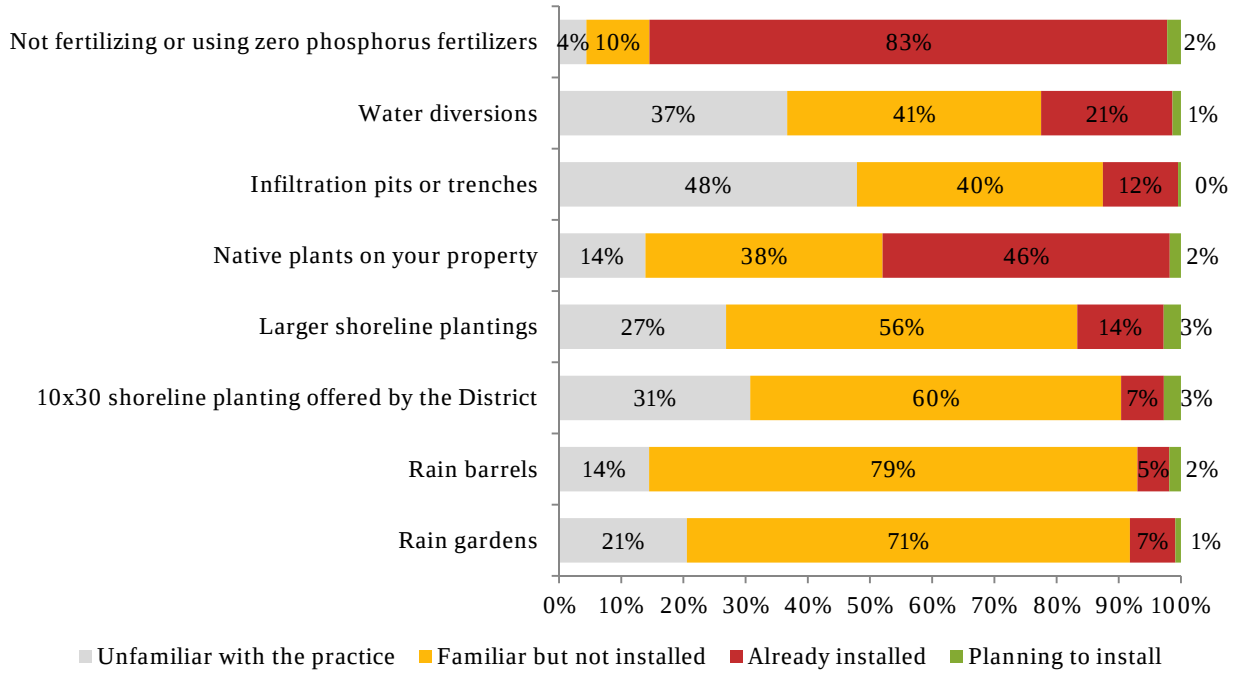
Familiarity with Practices to Reduce Waterfront Runoff

In general survey respondents are familiar with landscaping practices designed to reduce runoff from their property. However, with the exception of a few practices, respondents have not installed or are not planning to install these practices. Less than 3% of respondents are planning on installing any given practice.

Over half of respondents are familiar with, but have not installed the following practices: rain barrels (79%), rain gardens (71%), 10x30 shoreline plantings offered by the BLMD (60%), and larger shoreline plantings (56%).

The landscaping practices most often installed by respondents include not fertilizing/using zero phosphorus fertilizer (83%) and native plants on property (46%).

The practices that survey respondents are generally unfamiliar with include: infiltration pits or trenches (48%), water diversions (37%), 10x30 shoreline plantings offered by the BLMD (31%), and larger shoreline plantings (27%).



Factors Preventing the Installation of Practices to Reduce Waterfront Runoff
Nearly one third of respondents haven't installed practices to reduce waterfront runoff on their property because they believe their property doesn't impact the lake (31%). Approximately one quarter of respondents haven't installed practices because they are cost prohibitive (24%) or they are unsure how to install a practice (21%).

Reasons preventing fewer respondents from installing a practice include: lack of space on their lot (12%), the belief that practices won't help improve water clarity (7%), the time necessary to install a practice (4%), and concerns with neighbors not liking the practice (3%).

Factors Motivating the Installation of Practices to Reduce Waterfront Runoff
Survey respondents were also asked which factors would help motivate or convince them to install a practice to reduce waterfront runoff on their property. The factors which are most likely to convince respondents to install a practice include: improving the water quality of Bone Lake (51%) and improving the water quality around their property's shoreline (42%).

Factors such as providing habitat for fish (39%), providing better habitat for birds and wildlife (34%), and increasing natural beauty of property (31%) would motivate around a third of respondents to install a practice to reduce waterfront runoff.

Around a quarter would be motivated to install a practice by how-to information (30%), financial assistance (29%), and no cost technical assistance (23%).

Approximately a quarter of respondents have no interest in installing water quality practices on their property (23%).

Over two thirds of respondents (68%) are aware that the BLMD offers free no obligation site visits by their consultant to help members identify practices on their property which would reduce runoff and help improve Bone Lake's water clarity.

Factors motivating or convincing respondents to install a practice to reduce waterfront runoff on their property	Percent
Improving the water quality of Bone Lake	51%
Improving the water quality around your property's shoreline	42%
Providing better habitat for fish	39%
Providing better habitat for birds and wildlife	34%
Increasing the natural beauty of your property	31%
More how-to information about landscaping for water quality practices	30%
Financial assistance that pays a portion of the cost of installation	29%
No cost technical assistance that would identify appropriate practices to install	23%
I have no interest in installing water quality practice on my property	23%
Setting an example for other lake residents	20%
Training to learn how to install a practice	13%
Less lawn mowing time	10%

Shoreline Perceptions

Survey respondents were asked what they considered the most desirable shoreline to own and what they considered the most desirable shoreline to see what looking across the lake. Although the survey directed respondents to check only one choice, many respondents picked more than one choice for these two questions.

Close to half of respondents prefer to own shoreline that is either managed natural vegetation (43%) or trees and shrubs with cabins/lake homes that blend into environment (42%). Fewer respondents prefer to own shoreline that is mowed/manicured lawn (34%) and unmanaged natural vegetation (10%).

When looking across the lake, over half of respondents would prefer to see trees and shrubs with cabins/lake homes that blend into environment (58%) and approximately one third of respondents prefer to see managed natural vegetation (33%) or mowed/manicured lawn (31%). Fewer respondents would like to see unmanaged natural vegetation (14%).

Communication Outlets

The most preferred method for receiving information from the BLMD is the newsletter (82%), followed by email (41%), websites (20%), and the annual meeting (16%).

Ninety-five percent of respondents receive the newsletter, 52% are aware of the BLMD website, 40% have attended at least one annual meeting in the past five years, and 18% receive Bone Lake email announcements.

Newsletter

The newsletter is the most preferred method of receiving information and is read in its entirety

by the vast majority of recipients (91%). Respondents rated the newsletter articles as either very interesting (59%) or somewhat interesting (40%).

Over half of respondents would like to see Bone Lake history/photos (87%) and property value improvement articles (68%) included in the newsletter. Fewer respondents would like to see fishing tips (48%), lakeside cooking/recipes (41%), photos or drawings by residents (29%), guest columns (19%), children's columns (13%), and teen columns (8%) included.

Email Announcements

The BLMD publishes timely email announcements at bonelakewi.com to subscribers. Although 41% of respondents prefer to receive information by email, less than one third of respondents are aware of the email announcements (28%) and less than a quarter have subscribed to the email list (18%). Combined, nearly three quarters of respondents that were unaware of the email announcements indicated that they would subscribe now that they are aware of the list (73%).

Website

Over half of respondents are aware of the BLMD website (52%) and in the past year have visited the website an average of four times. Most respondents agree that the website is easy to use (100%), easy to find information on (96%), contains useful information (95%), contains interesting information (94%), contains high quality information (87%), and is up to date (67%).

Approximately one third of respondents that are aware of the website have read and/or downloaded informative brochures and articles from the website (31%). The topics that were of most interest to visitors include the Bone Lake Management Plan (65%), the Bone Lake Aquatic Plant Management Plan (60%), native plant brochures (53%), bird survey results (48%), and the Bone Lake Newsletter (45%).

Fewer respondents were interested in sensitive area surveys (38%), BLMD budgets and minutes (35%), lighting and light pollution reprints (18%), and wildlife and wildlife management reprints (18%).

Annual Meeting

The majority of respondents have not attended the BLMD Annual Meeting in the past five years (59%). Fourteen percent of respondents have attended a few of the meetings, 9% have attended some, 12% have attended most, and 5% have attended all of the meetings. The most common factors preventing respondents from attending the Annual Meeting are conflicts with the date and time (64%), forgetting the date/time/location (25%), and being too busy (25%).

Fewer respondents have conflicts with the location of the meeting (11%), feel that the meeting isn't beneficial (5%), find it difficult to hear the speakers (3%), and feel that the meeting isn't worth their time (2%).

Eighteen percent of respondents indicated that none of the above would encourage them to come to the meeting.

The meeting would be improved/respondents would be encouraged to come if they received a reminder post card containing the meeting date and proposed agenda (51%) or if the meeting was shorter (38%). Fewer respondents indicated the meeting would be improved/they would be encouraged to come if the meeting included guest speakers (21%), a free lunch (12%), raffles/door prizes (10%), or activities for children (4%).

Willingness to Volunteer

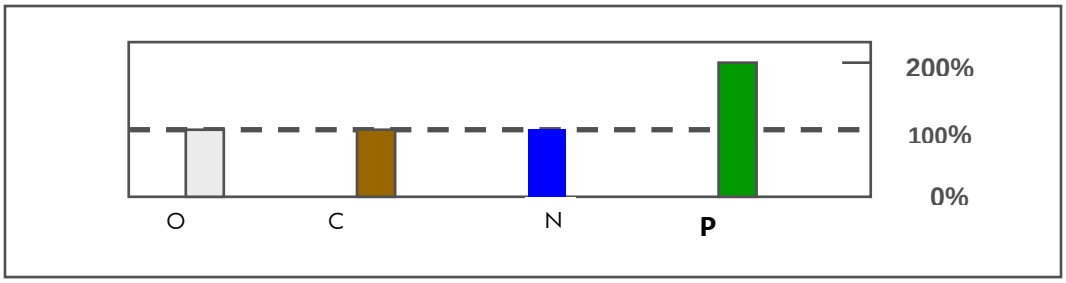
Approximately one third of respondents would like to learn more about available volunteer activities (38%).

Appendix B. 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[17]. 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 amount of phosphorus potentially available to plant and algae growth. Phosphorus has a

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

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.

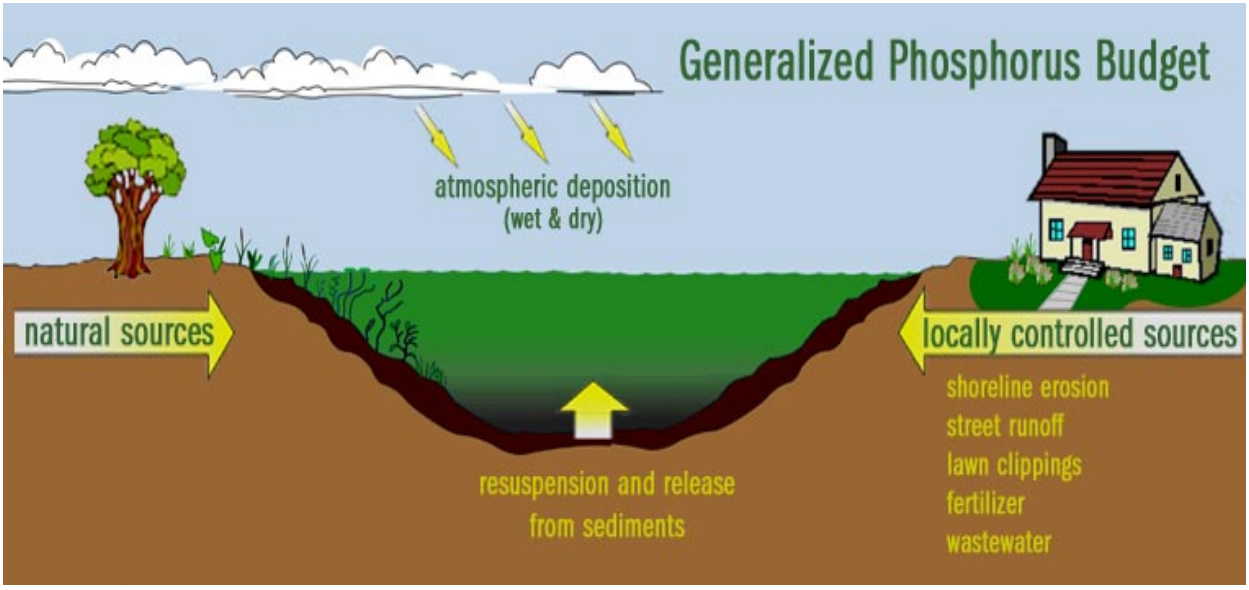
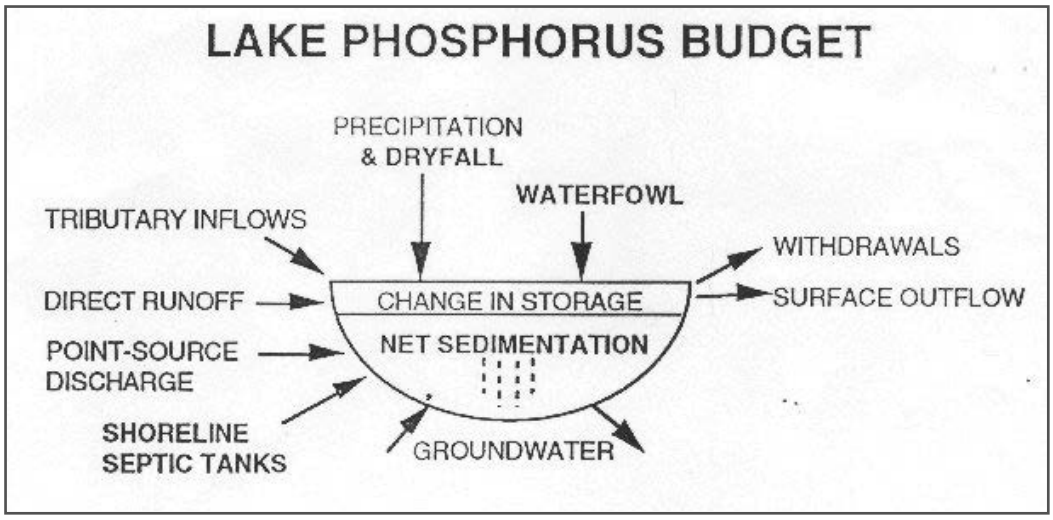


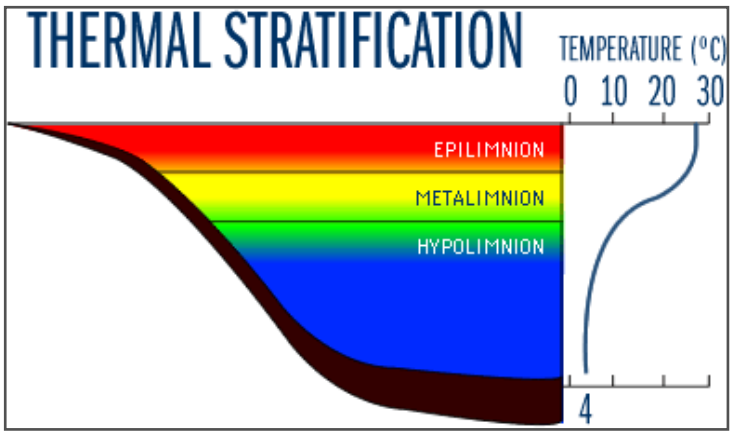
Figure obtained from "Water on the Web" (www.waterontheweb.org) an educational website at the University of Minnesota.

A summary of the phosphorus sources and losses are outlined in the diagram below. [18]



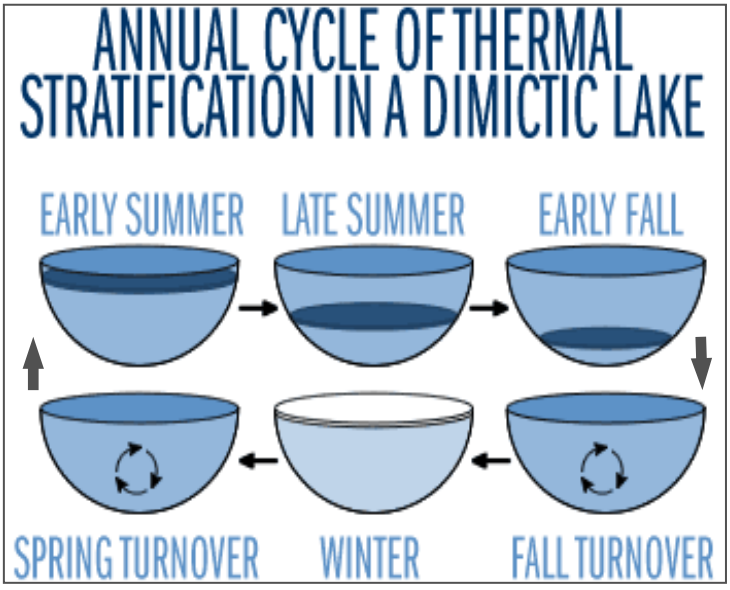
In many cases, a lake will stratify during the summer months. When a lake stratifies, the colder water stays on the bottom (hypolimnion) of the lake while the warmer water remains on the surface (epilimnion). Since this is a very stable situation, the lake water does not mix. The phosphorus released 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.

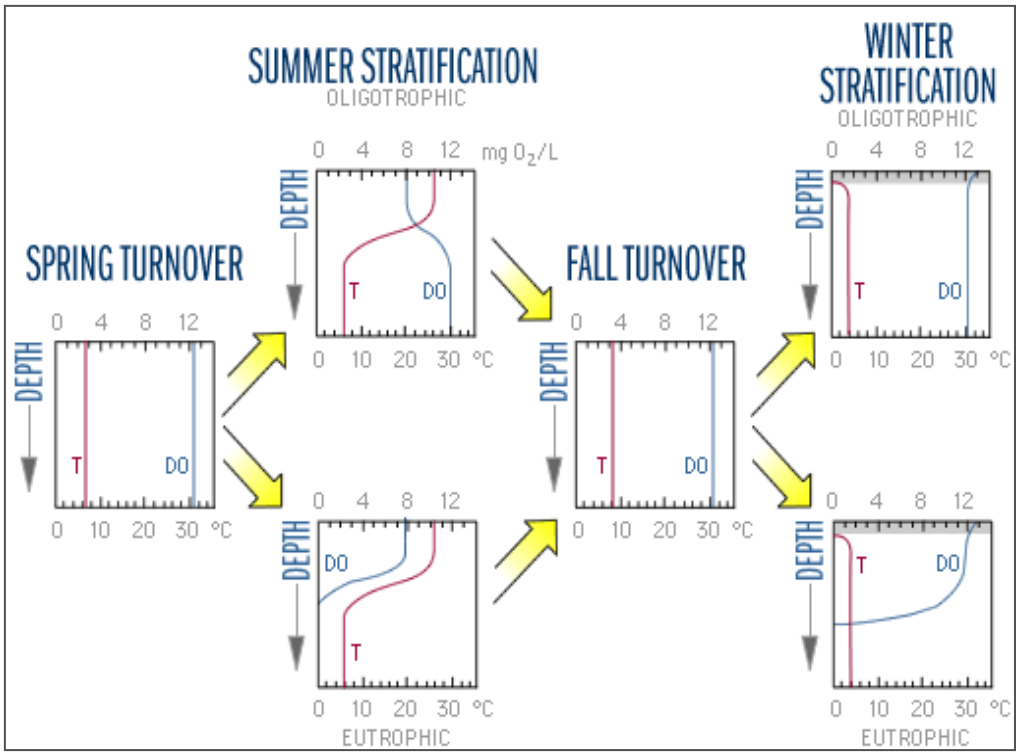


[18] From Water on the Web. University of Minnesota. 2008.

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.



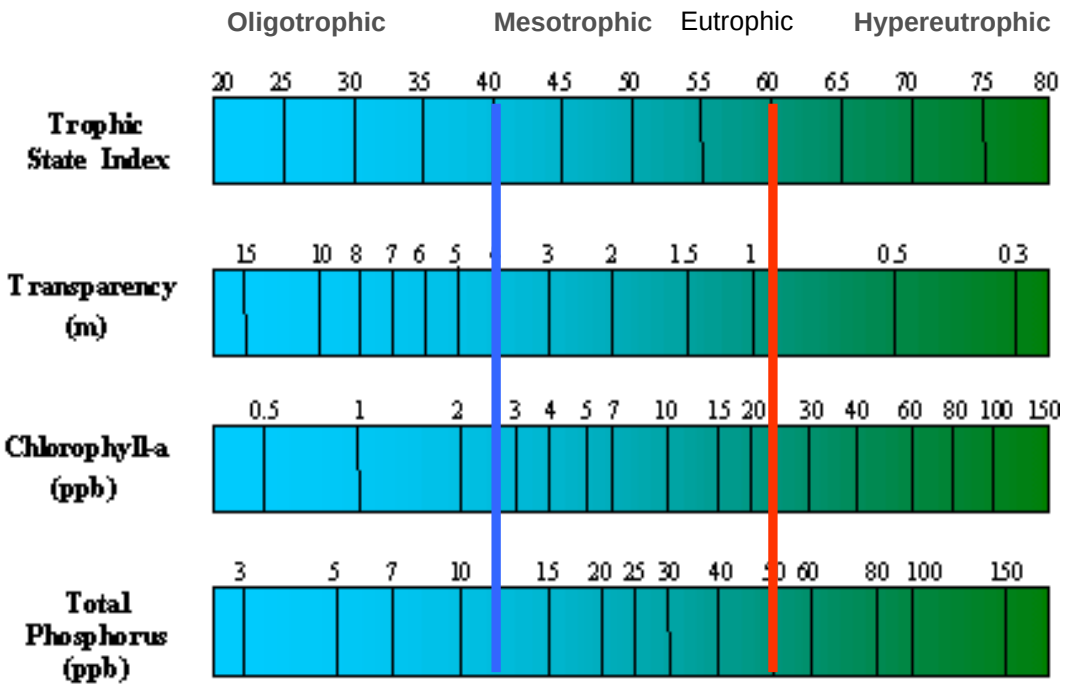
Bone Lake appears to be a partially stratified lake. It has few areas where oxygen levels drop below one ppm in the summer, and the temperature thermocline is not evident in the deep areas of the lake throughout the summer. While the lack of complete stratification limits the release of phosphorus from 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 State

Trophic state 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 state can be measured and the lake given a trophic state value (the Carlson Trophic State 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, and therefore low chlorophyll a readings and high Secchi depths. This table shows the Carlson Trophic State value in the left column and the characteristics of each lake type in the right column.

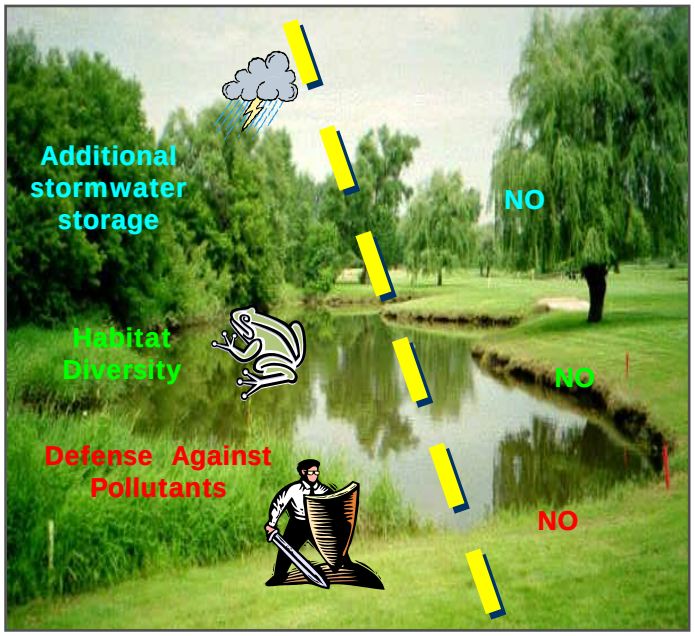
<40	Oligotrophic; clear water; high hypolimnetic O_2 year-round but possible anoxia in the deeper hypolimnion part of year
40-50	Mesotrophic; moderately clear water; possible hypolimnetic anoxia in summer and/or under ice. Fully supportive of all swimmable /aesthetic uses; possible cold-water fishery
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.

Appendix C. 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 2008, this report presented 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

2008 Phosphorus Budget Analysis

A lake nutrient analysis was prepared in preparation for the development of the 2009 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. The full report is found in Appendix C of the 2009 plan.

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 was quite similar, although the volume of water carried in Prokop Creek was 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.

Appendix D. Implementation Plan (2015 – 2017)

Goal 1. Improve Bone Lake water clarity

Action Items[1]	Timeline	10/1/14 – 9/30/15		10/1/15 – 9/30/16		10/1/16 – 9/30/17		Assigned To	Funding
		Cost	VOL Hours	Cost	VOL Hours	Cost	VOL Hours		
WATERFRONT								WATERFRONT COMMITTEE	
Provide on-site technical assistance: site visits	Ongoing Annual target: 20	$3,000		$3,000		$3,000		Harmony Environmental	Lake Protection Grant
Provide on-site technical assistance: designs and oversight	Ongoing Annual target: 10	$6,500		$6,500		$6,500		Harmony Environmental	Lake Protection Grant
Provide cost sharing: rain gardens, infiltration projects	Ongoing Annual target: 5	$18,000		$18,000		$18,000			Lake Protection Grant
Provide cost sharing: 10X35 plantings	Ongoing Annual target: 3-4	$4,000		$3,000		$3,000			Lake Protection Grant
Provide cost sharing: septic upgrades	Ongoing Annual target: 5	$5,000		$5,000		$5,000			Lake District
Committee support, outreach to encourage visits and installs	Ongoing	$3,334	200	$3,334	200	$3,334	200	Harmony Environmental	Lake Protection Grant
Print, mail, educational supplies	Ongoing	$1,595	100	$1,595	100	$1,595	100		Lake Protection Grant
WATERSHED								WATERSHED COMMITTEE	
Provide technical assistance: design	Ongoing	$4,000	200	$4,000	200	$3,000	200	Polk LWRD	Lake Protection Grant Lake Planning Grant
Provide cost sharing:	Ongoing	$14,000		$14,000		$14,000			Lake Protection

[1] See Bone Lake Implementation Plan for action item detail.

Action Items[1]	Timeline	10/1/14 – 9/30/15		10/1/15 – 9/30/16		10/1/16 – 9/30/17		Assigned To	Funding
		Cost	VOL Hours	Cost	VOL Hours	Cost	VOL Hours		
medium scale projects									Grant
EVALUATION AND STUDIES[2]								EVALUATION AND STUDIES COMMITTEE	
Internal load analysis: sediment study	2015-2016			$10,485				Eval/Studies UW-Stout	Lake Protection Grant
Internal load: lake study	2015-2017	$4,991	42	$4,991	42	$4,991	42	Ecological Integrity Service	Lake Planning Grant
Update internal load strategy	2017					$1,000	30		Lake Planning Grant
Sediment core: algal pigments	2015	$1,700						Science Museum of MN, Polk LWRD	Lake Planning Grant
Watershed/culvert monitoring	2015	$3,423	20					Ecological Integrity Service	Lake Planning Grant
Update watershed strategy	2016			$1,000	30				Lake Planning Grant
Citizen Lake Monitoring	Ongoing								DNR

[2] Project budgets include sample analysis costs

Goal 2. Maintain safe navigation on Bone Lake

Action Items[3]	Timeline	10/1/14 – 9/30/15		10/1/15 – 9/30/16		10/1/16 – 9/30/17		Assigned To	Funding
		Cost	VOL Hours	Cost	VOL Hours	Cost	VOL Hours		
Maintain buoys	Annually	$1,200	20	$1,200	20	$1,200	20		Lake District
Encourage increased boat patrol and enforcement		$2,500	30	$2,500	30	$2,500	30		Lake District
Kid's Don't Float Program	Ongoing		20		20		20		Lake District/DNR
Provide safety messages in newsletter, web site, workshops, annual meeting	Ongoing		25		25		25	COMMUNICATIONS COMMITTEE	Lake District

Goal 3. Protect and improve the Bone Lake fishery

Action Items[4]	Timeline	10/1/14 – 9/30/15		10/1/15 – 9/30/16		10/1/16 – 9/30/17		Assigned To	Funding
		Cost	VOL Hours	Cost	VOL Hours	Cost	VOL Hours		
FISHERIES								FISHERIES COMMITTEE	
Half log installs and repair	Ongoing	$4,000	120	$4,000	120	$4,000	120		Lake Protection Grant
Communication with DNR and Tribes	Ongoing		20		20		20		Lake Protection Grant
Assess small mouth bass populations	2015	$120	108						Lake Planning Grant
Study black crappie sarcoma	2015	$150	258						DNR/Lake Planning Grant
Explore option of hinge trees	Ongoing		33		33		33		

[3] See Bone Lake Implementation Plan for action item detail.
[4] See Bone Lake Implementation Plan for action item detail.

Goal 4. Maintain and enhance Bone Lake's natural beauty

Action Items[5]	Timeline	10/1/14 – 9/30/15		10/1/15 – 9/30/16		10/1/16 – 9/30/17		Assigned To	Funding
		Cost	VOL Hours	Cost	VOL Hours	Cost	VOL Hours		
NATURAL BEAUTY								WILDLIFE AND NATURAL BEAUTY	
Identify potential lands for protection	2015	$500	40						Lake Protection Grant
Consider land protection methods (also for wildlife)	2016			$500	40				Lake Protection Grant
Outreach to lake residents regarding natural areas, beauty of night sky, avoiding noise pollution	Ongoing-combined with wildlife							WILDLIFE AND NATURAL BEAUTY AND COMMUNICATIONS	Lake Protection Grant

[5] See Bone Lake Implementation Plan for action item detail.

Goal 5. Protect and enhance wildlife habitat

Action Items[6]	Timeline	10/1/14 – 9/30/15		10/1/15 – 9/30/16		10/1/16 – 9/30/17		Assigned To	Funding
		Cost	VOL Hours	Cost	VOL Hours	Cost	VOL Hours		
WILDLIFE								WILDLIFE AND NATURAL BEAUTY COMMITTEE	
Establish no-wake zone	2015-16	$1,300	53	$1,300	52				Lake Protection Grant
Purple martin study	2015	$150	45						Lake Planning Grant
Wildlife tracking forms	Ongoing	$600	35	$500	30	$500	30		Lake Planning Grant
Non-toxic tackle outreach	Ongoing	$0	0	$725	30	$725	29	WILDLIFE AND NATURAL BEAUTY AND FISHERIES	Lake Planning Grant
Additional wildlife outreach: see plan narrative	Ongoing	$3,400	40	$3,200	30	$3,200	30		Lake Protection Grant

Additional plan support

Action Items[7]	Timeline	10/1/14 – 9/30/15		10/1/15 – 9/30/16		10/1/16 – 9/30/17		Assigned To	Funding
		Cost	VOL Hours	Cost	VOL Hours	Cost	VOL Hours		
Plan communication	Ongoing	$3,333	80	$3,333	80	$3,333	80	Plan Chair	Lake Protection Grant
Volunteer recognition	Annually	$500	20	$500	20	$500	20	Plan Chair	Lake Protection Grant

[6] See Bone Lake Implementation Plan for action item detail.
[7] See Bone Lake Implementation Plan for action item detail.

Appendix E. References

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