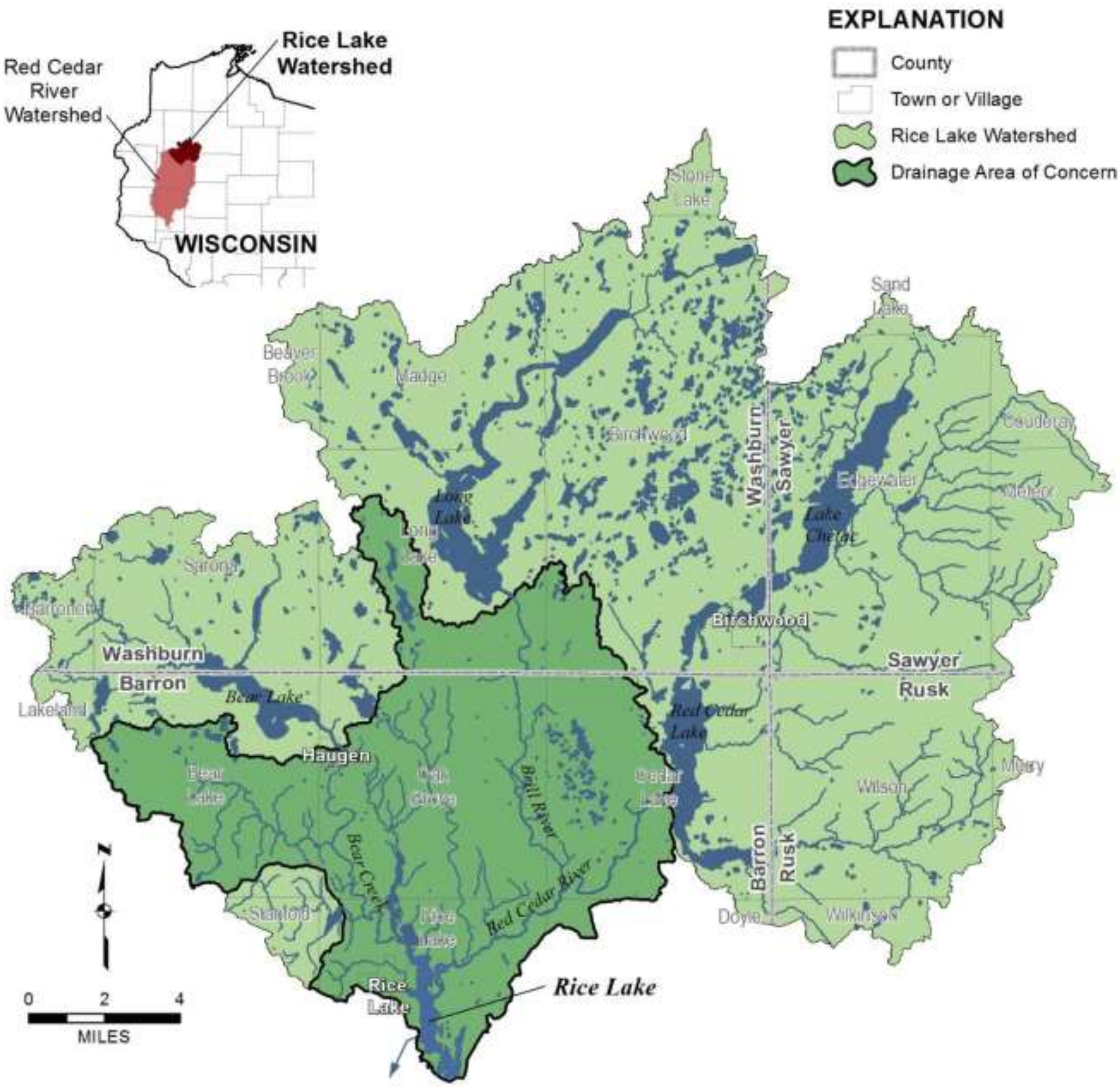
Rice Lake Comprehensive Management Plan

Barron County, Wisconsin

DNR No. SPL-304-13
SEH No. RICLI 123040

January 5, 2015



Rice Lake Comprehensive Management Plan

Barron County, Wisconsin

Prepared for:
Rice Lake Protection and Rehabilitation District
Rice Lake, Wisconsin

Prepared by:

Dave Blumer, Lake Educator
Lake Education and Planning Services, LLC

Jacob A. Macholl, Water Resources Scientist
Short Elliott Hendrickson Inc.

With:

Sara M. Hatleli
Aquatic Plant and Habitat Services LLC

Distribution List

No. of Copies	Sent to
4	Dan Genereau, Chairman Rice Lake Protection and Rehabilitation District Rice Lake, WI 54868

Executive Summary

INTRODUCTION

Rice Lake (WBIC 2103900) is a 940-acre impoundment of the Red Cedar River located in Barron County in northwestern Wisconsin. The watershed for Rice is about 386.3 square miles with the majority of the land use comprised of forests followed by farm lands. The drainage area of concern for the Rice Lake Protection and Rehabilitation District covers 100.4 square miles, about one-third of the watershed. The drainage area of concern is comprised land drained by the Brill River upstream to the Long Lake Dam in Washburn County, the land drained by the Red Cedar River upstream to the dam on Red Cedar Lake in Barron County, and the land drained by Bear and Little Bear Creeks upstream to the dam on Bear Creek in Haugen of Barron County.

A survey of lake district residents found that the top four uses of Rice Lake are: (1) fishing; (2) walking and biking along the lakeshore; (3) rest and relaxation; and (4) wildlife viewing. The main concerns of respondents were nuisance aquatic plant growth and poor water quality. Respondents felt that public use of the lake would increase if there were fewer nuisance plants and better water quality.

The purpose of this Comprehensive Lake Management Plan is to identify lake improvement projects throughout the watershed area of concern, establish and maintain a willingness to participate in the implementation of these projects by the agricultural, residential, and urban community, and assess the cost and feasibility of multiple projects aimed at improving or enhancing water quality and lake use. The management goals and activities described in this plan focus on agricultural and near-shore best management practices, and were developed to reflect the lake stewardship goals of the Rice Lake Protection and Rehabilitation District.

WATER QUALITY TARGETS

Changes to lake water quality following changes in external nutrient loading were evaluated as part of the 2001 U.S. Army Corps of Engineers study of Rice Lake. In Rice Lake during the summer, nuisance algal blooms (viable chlorophyll a concentrations greater than 30 mg/m^3) currently occur approximately 23% of the time, total phosphorus averages about 43 µg/L and Secchi depth averages about 4 feet.

Reducing the phosphorus load from the watershed by 25% is a reasonable target based on the urban and farm land best management practices that can be implemented within the drainage area of concern. This equates to the external load from the Red Cedar River and Bear Creek being reduced from 13,746 to 10,310 pounds per year (a reduction of 3,436 pounds).

A 25 % reduction in the external phosphorus load will result in a decrease in nuisance algal bloom frequency to about 10% of the time. Total phosphorus levels will decrease to about 38 µg/L, which is below the NR 102 water quality standard of 40 µg/L for impoundments, and water clarity will increase from about 4 feet to 5.3 feet.

IMPLEMENTATION ROADMAP

Problem Statement

Cultural eutrophication is causing an increase in algal blooms and nuisance aquatic plant growth in Rice Lake. If mitigation of nutrient loading is not undertaken, more intensive agricultural practices and continued urban development in the watershed will further degrade the water quality of Rice Lake, negatively impacting the lake ecosystem and lake users.

Executive Summary (Continued)

The management goals for Rice Lake were developed as a collaborative effort between the District and lake managers from SEH. The goals were developed to be inspirational, believable and actionable and are derived from the values of the Rice Lake community and mission of the District. The goals of this plan are to:

- Decrease the phosphorous and sediment load to the lake from the watershed.
- Decrease internal phosphorus load to the lake.
- Promote sustainable and multi-use recreational opportunities
- Manage and improve the fishery and wildlife habitat
- Continue implementing the management activities of the Aquatic Plant Management Plan.
- Support activities of other management and stewardship groups in the Rice Lake Watershed
- Implement, update and maintain this management plan

A six-year timeline for implementation and a listing of potential funding sources has also been developed as part of this plan. This plan should serve as a guide for achieving these objectives in a technically sound and community-supported manner

Table of Contents

List of Tables

List of Figures

List of Appendices

Rice Lake Comprehensive Management Plan

Prepared for the Rice Lake Protection and Rehabilitation District

1.0 Introduction

Rice Lake (WBIC 2103900) is located in Barron County in northwestern Wisconsin (Figure 1). The lake is an impoundment of the Red Cedar River covering approximately 940 acres. The water level in the lake is controlled by a dam operated by Barron County. The lake narrows at the Sawyer Street (County Road C) Bridge creating two basins, each with its own distinct set of characteristics. The maximum depth of the larger north basin (locally referred to as Upper Rice Lake) is 15 feet and it receives inflow from the Red Cedar River and Bear Creek, the primary tributaries to the lake. The smaller south basin (Lower Rice Lake) has a maximum depth of 19 feet and has a number of bays including Clear Water Bay which has a high diversity of aquatic plant life.

Curly-leaf pondweed, a non-native, aquatic invasive plant species, is present throughout the lake. Curly-leaf is controlled through and integrated management approach that utilizes mechanical harvesting and spring herbicide applications. Other native plant species are harvested throughout the open water season to maintain navigation and recreation channels.

The City of Rice Lake is adjacent to the lake and both are substantially impacted by each other. The lakeshore is nearly fully developed. Downtown Rice Lake is along the west shore and a significant portion of the urban storm sewer from the city drains directly to the lake. Numerous public boat launch facilities exist around the lake, with the most frequented launch facilities at Veterans Memorial Park and at the downtown launch site at the Lumbering Hall of Fame Park off Stein Street. There are a number of businesses located on the lake including hotels, resorts, bars, and restaurants, as well as manufacturing facilities. Several private residences on the lakes are operated as vacation rental units. Tourist and locals use the lake for boating, fishing, waterfowl hunting, water skiing, cross country skiing, wildlife watching, and general recreation. The main attraction to Rice Lake is the fishing, including trophy muskellunge.

Rice Lake is listed as a Wisconsin 303(d) impaired water. The Lake is listed for impaired recreational use due to excess algal growth from excess total phosphorus. Rice Lake, falls within the limits of the Phosphorus Total Maximum Daily Load Plan for Tainter and Menomin Lakes, two hyper-eutrophic impoundments located near the bottom of the Red Cedar River watershed in central Dunn County, Wis.

The purpose of this Comprehensive Lake Management Plan is to identify lake improvement projects throughout the watershed area of concern, establish and maintain a willingness to participate in the implementation of these projects by the agricultural, residential, and urban community, and assess the cost and feasibility of multiple projects aimed at improving or enhancing water quality and lake use. The management goals and activities described in this plan focus on agricultural and near-shore best management practices, and were developed to reflect the lake stewardship goals of the Rice Lake Protection and Rehabilitation District.

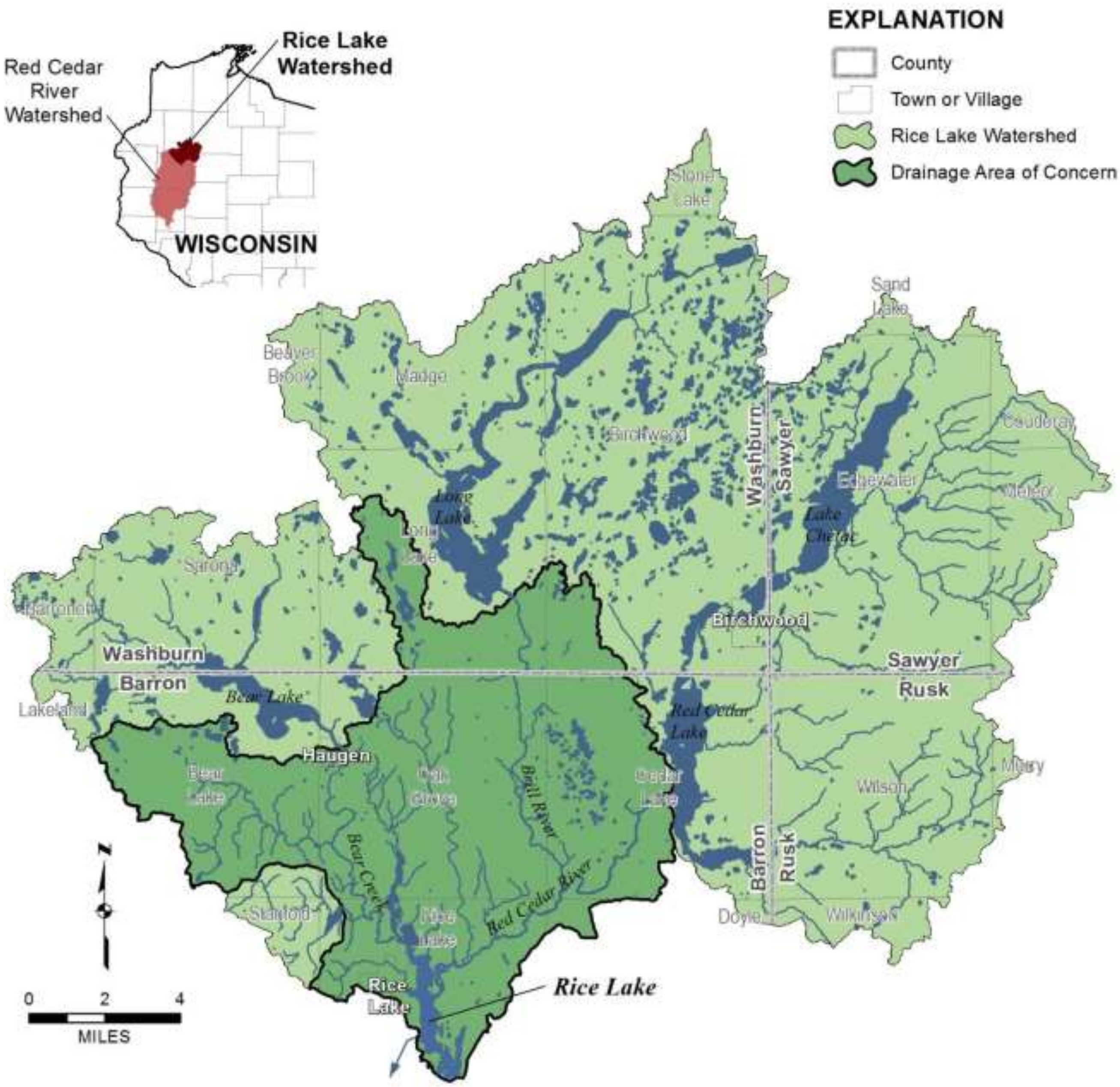


Figure 1 – Location of Rice Lake, Its Watershed, and Drainage Area of Concern

1.1 Project History

The Rice Lake Protection and Rehabilitation District (District) was established in 1977 to include the municipal boundaries of the City of Rice Lake and a large portion of Rice Lake Township. The mission of the District is to represent and protect the interests of the residents and property owners of the Town and City of Rice Lake. The District seeks to protect the ecology of the lake, enhance the natural scenic beauty, control invasive species, and promote responsible boating, swimming, fishing, and recreational opportunities that Rice Lake offers to residents and visitors.

All properties within the city limits of Rice Lake and that portion of the Town of Rice Lake that extends east from the city limits to CTH M-22 Street and north to STH 48 (Appendix A) are included in the lake district boundaries. Lake districts are special purpose units of government whose purpose it is to maintain, protect, and improve the quality of a lake and its watershed for the mutual good of the members and the lake environment.

Lake districts are established by town, county or village boards, or city councils, and usually based on a formal petition of lake area owners. Lake district formation and operations must comply with Chapter 33 of the Wisconsin Statutes. The boundaries of a lake district usually include the property of all riparian owners and can include off-lake property that benefits from the lake or affects the lake's watershed. The district may include all or part of a lake or more than one lake. A city or village must give its approval to be included in a district.

Lake districts are governmental bodies with elected or appointed leaders and annual budgets funded from tax levies or special assessments. Districts also have some capabilities to regulate lake use, such as local boating ordinances and sewage management. Within a lake district, all property owners share in the cost of management activities undertaken by the district. Residents who live in the district and are eligible voters and all property owners have a vote in the affairs of the district.

The District has been managing aquatic plants in the lake since the early 1980's (Figure 2). A Lake Management Plan was developed in 1993, finalized in 1994, and an updated Aquatic Plant Management Plan was completed in 2010. More details on the history of management for Rice Lake are available in the 2010 Aquatic Plant Management Plan. This Comprehensive Lake Management Plan complements the 2010 Aquatic Plant Management Plan with focus on recommendations for improved water quality, littoral zone habitat management, and riparian zone habitat management. A full summary of management activities undertaken by the District since its inception, compiled to aid with development of this plan, is available in Appendix B.

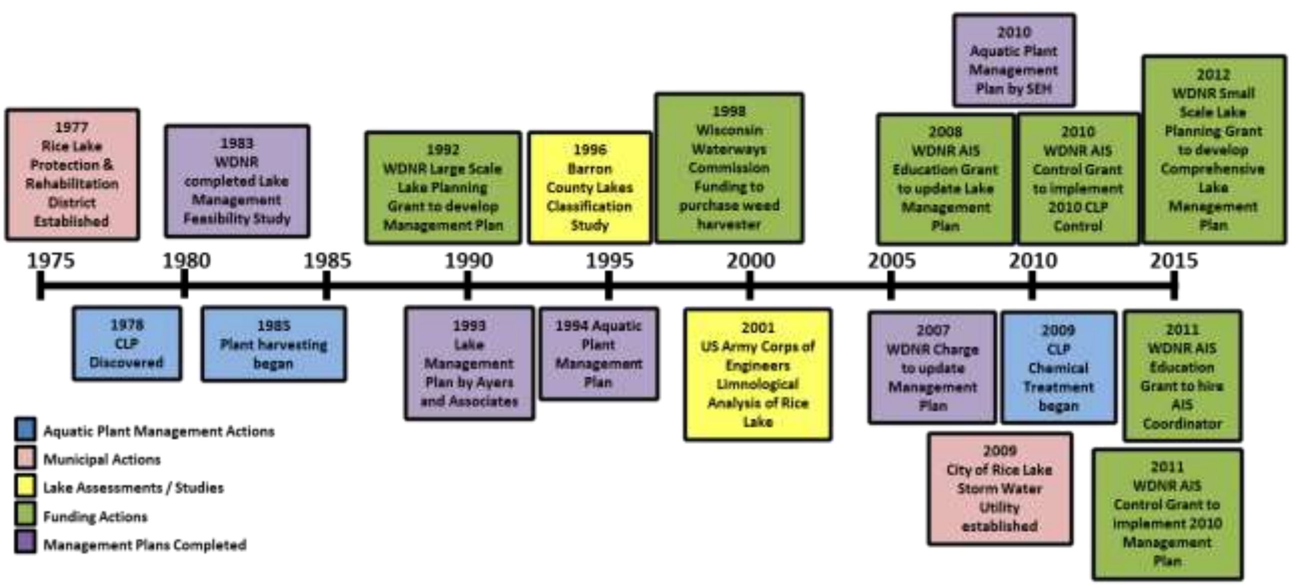


Figure 2 – Management History of Rice Lake from 1977 through 2012

1.2 Management Funding

The District utilizes tax levy funds for management activities along with WNDR lake grant funds. The District will continue to seek grant aid to implement many of the activities outlined in the Comprehensive Lake Management Plan.

A number of studies and management activities have been completed utilizing Lake Grant program funds, including this plan (Table 1). In 2011, the District received an Aquatic Invasive Species Grant to fund an Aquatic Invasive Species Coordinator position, support the watercraft inspection program, and conduct aquatic plant and best management practices outreach, education, and monitoring. The District received an Aquatic Invasive Species grant in 2010 to implement activities outlined in the Aquatic Plant Management Plan with emphasis on curly-leaf pondweed monitoring and treatment. Additional Aquatic Invasive Species Grant funding was awarded in 2011 to continue management efforts from 2011 through 2013.

In 2008, the District received funding to complete a management plan with an emphasis on aquatic plants but also including a watershed assessment, water quality and plant conditions, coordinate community involvement, and an education program. The District received a WDNR grant in 1992 to evaluate aquatic plant control techniques, inventory land use practices, and prepare a Lake Management Plan.

Table 1
Summary Matrix of WDNR Funding Granted to the Rice Lake Protection and Rehabilitation District

	CBCW	User Survey	Plant Survey/ Monitor	AIS Survey/ Monitoring/ Control	Shoreline Survey/ BMPs	Lake Mgmt Plan	Watershed Assessment	Storm Sewer	Ed. Program	CHD	Water Quality	Restoration
1992 LSLP			X	X		X	X					
2008 AIS ED	X	X	X	X	X		X	X	X	X	X	
2010 AIS Control			X	X					X		X	X
2011 AIS Control	X			X								
2011 AIS ED	X			X	X				X		X	
2012 SSLP		X				X	X				X	

CBCW = Clean Boats, Clean Waters. LSLP = Large Scale Lake Planning. AIS = Aquatic Invasive Species. ED = Education. SSLP = Small Scale Lake Planning. CHD = Critical Habitat Designation. BMP = Best Management Practices.

1.3 Other Management Plans

Management of Rice Lake to improve water quality, fish and wildlife resources, and recreational uses is included in several local management plans. Several of the goals, and many of the objectives included in the Barron County 2011 Land and Water Resource Management Plan relate directly to management goals and objectives in the District Plan. The Town of Rice Lake 2009-2030 Comprehensive Plan also mentions the protection of surface waters and other natural resources. The 2001 State of the Lower Chippewa Basin also mentions reducing sediment and phosphorus loads to waters in the basin, including Rice Lake. The City of Rice Lake has recently adopted an Outdoor Recreation Plan and has a Comprehensive Plan as well. Both mention protecting the lake and other water resources.

1.4 Management Units

Along with the District, there are a number of other lake stewardship groups within the Rice Lake watershed. Groups with lake management plans include the Bear Lake Association along headwaters of Bear Creek, the Long Lake Preservation Association at the headwaters of the Brill River, the Red Cedar Lakes Association and Big Chetac Chain Lake Association at the headwaters of the Red Cedar River, and the Desair Lake Association along a tributary to Bear Creek (Figure 3). Because these groups are actively managing their lakes and watersheds, the District focuses its efforts on the portion of the watershed downstream from these waterbodies. The drainage area of concern for the District (shown in Figure 1 and Figure 3) is primarily agricultural, covers 100.4 square miles (64,240 acres) and includes a heavily developed portion of the City of Rice Lake. The drainage area of concern is the focus of this management plan. It is important that the District maintain open lines of communication with other groups in the watershed to coordinate management efforts, particularly regarding water level management as most are impoundments upstream of Rice Lake

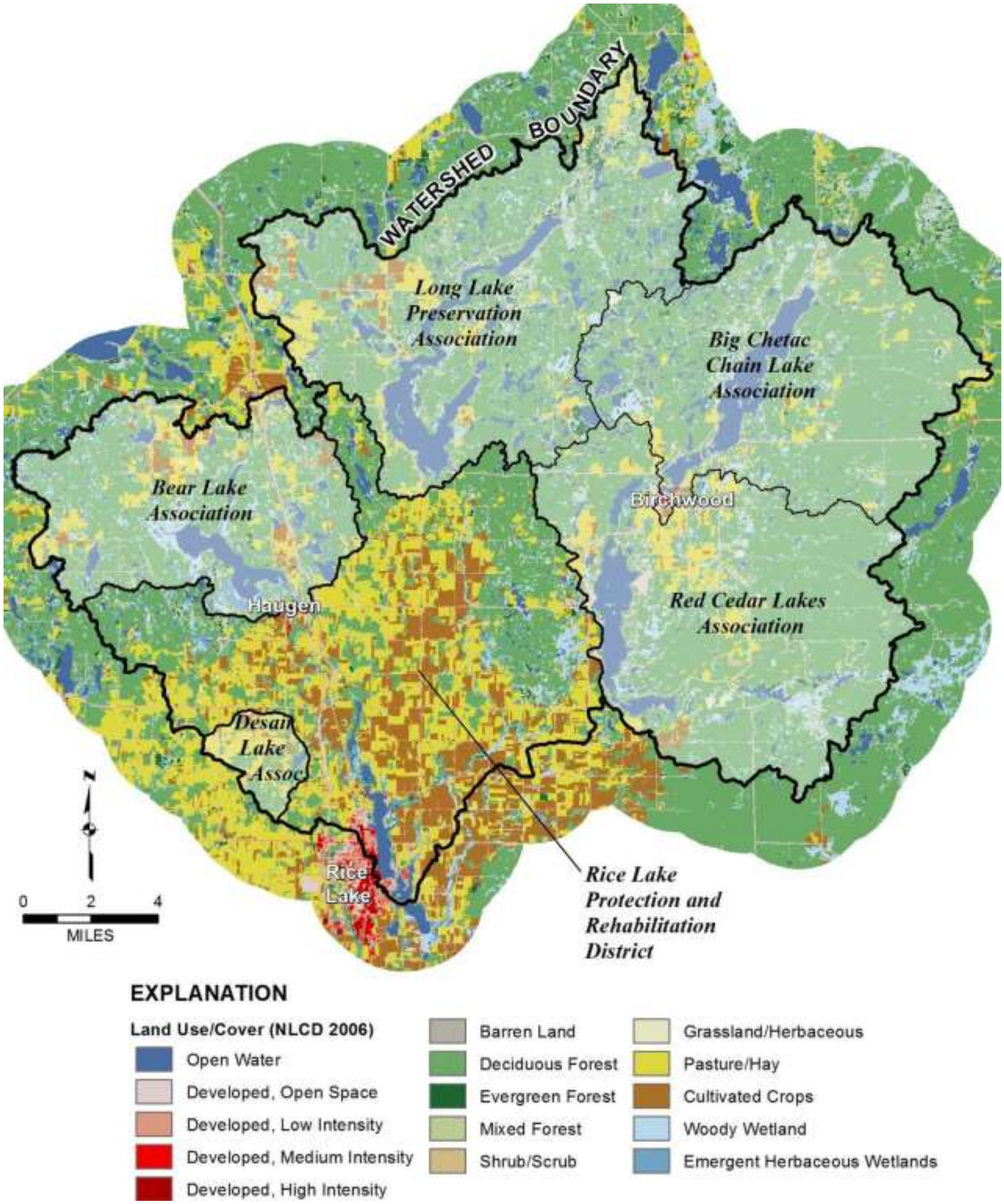


Figure 3 – Drainage Area of Concern for the Rice Lake P & R District.

2.0 Management Goals and Activities

The management goals for Rice Lake were developed as a collaborative effort between the District and lake managers from SEH. The goals were developed to be inspirational, believable and actionable and are derived from the values of the Rice Lake community and mission of the District.

Problem Statement
Cultural eutrophication is causing an increase in algal blooms and nuisance aquatic plant growth in Rice Lake. If mitigation of nutrient loading is not undertaken, more intensive agricultural practices and continued urban development in the watershed will further degrade the water quality of Rice Lake, negatively impacting the lake ecosystem and lake users.

2.1 Goal 1: Decrease the phosphorous and sediment load to the lake from the watershed.

Objective: Reduce the total phosphorous load from the Bear Creek and Red Cedar River watersheds by 25% (reduce annual load from 13,746 to 10,310 pounds—a reduction of 3,436 pounds). The largest nutrient load reductions will be realized via farmland best management practices.

Action Steps:

- Partner with Barron County Soil and Water Conservation Department (SWCD) to install grassed waterways at sites identified throughout the watershed.
- Provide financial support to fix livestock fences along tributaries that are in disrepair. Sites in need of repair were identified during the Bear Creek and Red Cedar River shoreline surveys (Appendix B) and others are likely located throughout the watershed.
- Utilize DOT mitigation funds from Bear Creek sedimentation event as match for lake protection grant funds to implement these and other agricultural best management practices identified as priorities by the Barron County SWCD in the watershed.
- Encourage agricultural community participation in best management practices (including nutrient management planning, cover cropping, no- and low-till agriculture) via direct contact, public meetings, mailings, and by supporting efforts of the Barron County SWCD.
- Showcase best management practice projects, both agricultural and shoreland, which have been implemented on the District webpage and through press releases.
- Publicize management activities and spur discussion by holding an open-house field day at a farm implementing soil and water management practices. Invite farmers, lake advocates, the general public, scientist, educators and government officials.

Objective: Reduce the total phosphorus load from the near-shore area and the City of Rice Lake by 30%.

Action Steps:

- Provide financial support for installation of riparian best management practices.
- Support the efforts of the City of Rice Lake during MS4 permit implementation, particularly those that relate to education and outreach.
- Develop and implement a District policy for demolition site discharge management.
- Work the City of Rice Lake to reclaim the old beach and beach house.
- Develop a runoff reduction plan for the Barron County Fairgrounds
- Work with land owner to remove large trash pile along the Bear Creek shoreline (located during the shoreline survey, Appendix B).
- Identify responsible party to repair erosion along the southwest corner of the Highway 48 Bridge between Stump Lake and Rice Lake, and develop and implement a repair plan.
- Encourage prompt repair of areas of erosion along ditches and roadsides by the City, Towns, County, and property owners.

Objective: Monitor loads (collect nutrient samples and monitor streamflow) on Bear Creek (1), Little Bear Creek (1), Tuscobia Creek (1), the Brill River (2), Unnamed Tributary on the north shore (1), on the Central Wash (1), and on the Red Cedar River (1) to determine changes to external loading.

Action Steps:

- Collect TP, DRP, TKN, Nitrates/Nitrites, Ammonia, and Total Suspended Solids monthly and during spring snow melt and other significant runoff events annually.

2.2 Goal 2: Decrease internal phosphorus load to the lake.

Objective: Control curly-leaf pondweed to reduce growing season internal load from early summer curly-leaf die-back by at least 50%.

Action Steps:

- Follow guidelines in the current Aquatic Plant Management Plan for harvesting and herbicide application to reduce the distribution of curly-leaf pondweed in the lake.

Objective: Complete a feasibility study of in-lake improvement options for Lower Rice Lake (south basin). Locking up phosphorus in the South Basin could reduce phosphorus loading by more than 800 lbs. annually.

Action Steps:

- Select resource professionals (consulting firm, university, government agency) to complete a feasibility analysis that evaluates expected costs and benefits of in-lake improvement options including alum dosing and aeration.

2.3 Goal 3: Promote sustainable and multi-use recreational opportunities

Objective: Support a safe and multifaceted recreational environment in the lake.

Action Steps:

- Assist the City of Rice Lake with maintenance and development of public swim beaches and public access areas.
- Timely place and maintain navigation buoys.
- Monitor patterns of recreational use in the lake to guide management activities and education efforts.

2.4 Goal 4: Manage and improve the fishery and wildlife habitat.

Objective: Improve riparian and littoral zone habitat.

Action Steps:

- Survey coarse woody structure in the lake using GPS.
- Develop management goals for coarse woody structure, potentially based on undeveloped lakes or estimates of pre-settlement conditions.
- Continue to develop the Aquatic Plant Management goal of creating a residential and riparian owner best management practice program.
- Work with landowners, Barron County, the WDNR to control buckthorn growth along the Red Cedar River upstream of Rice Lake using approved physical removal (for example, hand pull plants less than 3/8 inch in diameter) and chemical control methods (for example, cut and spray or paint stems with the herbicide glyphosate or other approved herbicide).
- Map riparian environmental corridor lands throughout the Rice Lake drainage area of concern and develop management goals to protect and enhance the environmental, economic, and recreational benefits provided by environmental corridors.
- Create a new bathymetric map of the lake using state of the art GPS and GIS methods to identify important habitat features, aid in nuisance aquatic plant and invasive species control, and evaluate impacts of sedimentation.

Objective: Minimize negative impacts to fishery caused by lake management activities

Action Steps:

- Work closely with WDNR fisheries staff to identify and mitigate effects of activities that may be detrimental to the fishery (e.g. harvesting, alum dosing).

Objective: Manage resident urban Canada geese population using an integrated approach.

Action Steps:

- Determine times of year when problems occur, available control options, probable effectiveness of control techniques, community support, cost, and legality of control measures.
- Educate riparian property owners about the habitat preferred by geese—large unobstructed lawn areas close to open water—and support appropriate landscape modifications (for example, native plantings of trees, shrubs and herbaceous ground cover).

2.5 Goal 5: Continue implementing the management activities of the Aquatic Plant Management Plan.

The current Aquatic Plant Management Plan supports sustainable practices to protect, maintain and improve the native aquatic plant community, the fishery, and the recreational and aesthetic values of the lake. The goals of the Aquatic Plant Management Plan are:

1. Reduce the total amount of curly-leaf pondweed in Rice Lake by combining the use of aquatic herbicides and large-scale mechanical harvesting;
2. Prevent the spread and establishment of aquatic invasive species already present along the shores of and in the wetlands adjacent to Rice Lake;
3. Maintain a Eurasian watermilfoil rapid response plan;
4. Provide native aquatic plant management that protects and enhances native plant growth and diversity in Rice Lake;
5. Improve record keeping, monitoring, and assessment for all plant management activities;
6. Provide the general public with a means to contact the District to request information, voice concern over aquatic plant and other issues, and request appropriate service;
7. Create a residential and riparian owner best management practices program;
8. Increase public awareness of and involvement in the District by improving public outreach, exposure, and image and provide greater land owner and lake user education;
9. Implement the activities associated with the APM Plan through a combination of District and State of Wisconsin grant funding; and,
10. Complete annual project summaries and a final project evaluation.

2.6 Goal 6: Support activities of other management and stewardship groups in the Rice Lake Watershed

Objective: Maintain open lines of communication to coordinate management efforts.

Action Steps:

- Identify contacts for the various lake management and stewardship groups in the Rice Lake Watershed.
- Host annual watershed meeting with representatives from each group to showcase project successes and failures, identify opportunities for collaboration, discuss water level management, and discuss future activities.
- Continue to participate in the Red Cedar River Total Maximum Daily Load project implementation.
- Expedite data acquisition and lower costs by entering into a formal data-sharing agreement with Barron County to share county land information data including GIS data as it relates to the District.
- Continue District involvement with the Rice Lake Aquafest to increase exposure.

Objective: Partner with the Barron County Soil and Water Conservation Department to promote and implement agricultural and riparian BMPs

Action Steps:

- Maintain an open dialogue with Barron County Representatives for possible collaboration on BMP projects.
- Promote and uupport Barron County BMP programs including nutrient management planning, local resource/habitat protection, protection of forested areas and wildlife habitat, no-till packets, and others.

2.7 Goal 7: Implement, update and maintain this management plan.

Objective: Follow and adaptive management approach.

Action Steps:

- Draft annual reports that include summaries of management activities, water quality conditions, and future directions and needs.
- Integrate new information and planning elements into the plan as they become known.

Because of the various management activities currently, and to be undertaken, it is important to continue monitoring lake water quality through Citizen Lake Monitoring Network. The water quality of Rice Lake provides a useful barometer of conditions in the watershed. Further developing a long-term dataset can be used to identify both problems and improvements in the lake and to the watershed and to evaluate the effectiveness of management efforts.

Secchi depth, total phosphorous, chlorophyll *a*, temperature, and dissolved oxygen monitoring should be completed on regular basis during the open water season at the three primary monitoring sites. The District should continue to recruit and support volunteers collecting water quality data.

Objective: Secure funding to support implementation of management activities.

Action Steps:

- Finance implementation of management activities through District funds and by seeking WDNR Lake Protection grant funds.
- Identify other potential funding sources and grant programs for implementation of management activities.

3.0 Needs Assessment and Public Input

Public input has been gathered to balance the needs of the different lake users. The City of Rice Lake has the largest population in Barron County (U.S. Census, 2013) and Rice Lake itself is the fifth largest lake in the county (WDNR, 2013). The lake helps generate seasonal tourism in the area and is thus an important economic resource to the local municipalities and to Barron County. There are five city parks along the lake shore and a public beach (LRPRD, 1994). Aquafest is an annual celebration coordinated by the City of Rice Lake and held on the shores of the lake and includes Men's Club Kids Fishing Day, and Rice Lake Protection and Rehabilitation District displays and educational demonstrations.

3.1 Public Meetings and Plan Review

The District holds public meetings throughout the year during which time further public input regarding lake management activities and concerns are addressed. Recent concerns and issues raised include conflicts with the resident Canada goose population, the status of swim beach renovation at Lake Shore Drive and the potential of a new beach at Narrows Park on County Road C/Sawyer Street, the CTH V and Highway 53 interchange project north of the lake, ice racing during weekends in the winter, and safety buoy placement.

A completed draft of the Rice Lake Comprehensive Lake Management Plan was distributed to members of the Lake District Board for review and comment in mid-December 2013 through March 2014. Following District approval on April 16, 2014, the plan was posted online at www.rllakedistrict.org and placed in the Rice Lake Public Library for a 30 day public review and comment period. Public notices announcing the availability of the plan were posted in the Rice Lake Chronotype the week of April 23, 2014. The 30 day review period lasted until May 24, 2014. Public comment was also accepted at District board meetings in April, May, June, and July. Despite the public posting, no public comment was made.

3.2 2008 Lake User Survey

A lake user survey was developed and distributed in 2008 in order to gather information on how Rice Lake is currently being used, lake-related issues and concerns, public opinion of aquatic plants in the lake, familiarity with non-native invasive species, and gauge support and understanding of aquatic plant management. Approximately 1,200 surveys were distributed in the community, 1,000 of which were mailed to randomly selected residents within the Rice Lake Protection and Rehabilitation District. More than 330 responded to the survey, which is a relatively high response rate of 28%. The majority of respondents (94%) were District residents, of which the majority (68%) did not live along the lakeshore.

Survey results reveal the top four uses of Rice Lake are: (1) fishing; (2) walking and biking along the lakeshore; (3) rest and relaxation; and (4) wildlife viewing. The main concerns of respondents were nuisance aquatic plant growth and poor water quality. Respondents felt that public use of the lake would increase if there were fewer nuisance plants and better water quality. Public opinion of macrophytes in the lake reveal that 87% of respondents believed the aquatic plant issue to be moderate or large and that swimming and fishing were most affected by vegetation. Familiarity with non-native invasive species, specifically curly- leaf pondweed, was low. Most (83%) respondents indicated they could not identify curly-leaf pondweed. Survey results reveal that over 80% of respondents believe aquatic plant management is necessary. More detailed survey results are available in the 2010 Aquatic Plant Management Plan.

3.3 Increased Use of the Lake

The lake user survey asked if it is important to have a City beach. The responses were nearly split 50/50 yes and no. Comments throughout the survey indicated that a beach with better swimming conditions than previously experienced, including higher water quality, less goose feces, and no worries related to swimmers itch, would get more use and be more important overall. When asked what one thing would increase respondents use of the lake, responses varied, but several things stood out (Figure 4). Controlling weed growth and improving water quality were at the top of the comments, followed by having a public swimming beach. Improving swimming conditions in the lake as a whole and at the City beach also came up a lot. Approximately 7% of the general comments in the survey had to do with developing the lake front to include walking and biking trails, lakeside restaurants and bars, and even a shopping center.

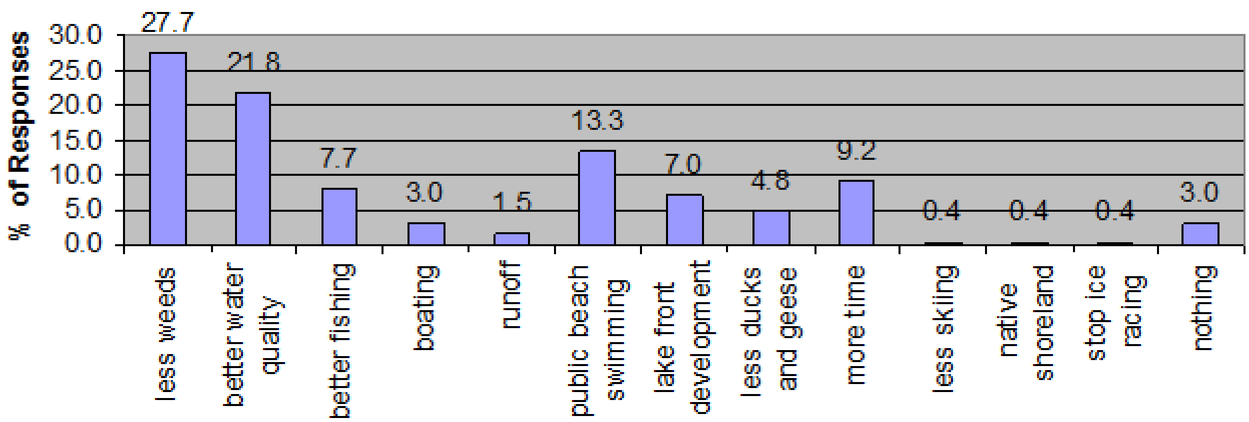


Figure 4 – Changes to the Lake with the Potential to Increase Public Lake Use

3.4 A New City Beach

Appendix I – Water Quality and Nutrient Loading Summary of the 2010 APM Plan recommended the following:

Complete a Public Beach Study to determine if the current beach can be improved or moved to provide more public access to swimming in Rice Lake. Part of this study would be to determine if sources of Swimmers Itch could be identified and then controlled.

In September 2013, the City of Rice Lake proposed a new city beach site at the Narrows Park based on comments from the Lake District and discussion had related to re-opening the old beach site. Figure 5 and Figure 6 below show the location and design proposal. A Recreational Facilities grant was applied for by the City of Rice Lake in 2013 and was awarded in 2014. The total beach project is estimated to cost about $250,000.00. Half of this sum was awarded in the Recreational Facilities grant award. The remaining sum will be collected through partners, donations, and other fund raising opportunities. The District will likely be one of these partners.

Figure 5 – Proposed New Beach Site at Narrows Park

Figure 6 – Conceptual Drawing of New Public Beach at Narrows Park

4.0 Lake Characteristics

Rice Lake is a 940-acre impoundment of the Red Cedar River located in Barron County, Wisconsin. That lake controlled to within a few inches of normal pool elevation by an 18-foot dam with a 12-foot hydraulic head. Rice Lake is separated into two distinct basins, north and south, separated by the County Highway C Bridge (Figure 7). The north basin (Upper Rice Lake) is shallower with a maximum depth of 15 feet while the maximum depth of the south basin (Lower Rice Lake) is 19 feet. Prior to the impoundment of the Red Cedar River, the portion of Upper Rice Lake south of where the river enters existed as a lake and the remainder was primarily wetlands, described in the original land survey in the 1850s as tamarack swamp and marshy lake. Presently, nearly the entire shoreline is developed consisting of year-round residences, rental cabins, hotels, resorts, bars, restaurants, and manufacturing facilities. The physical characteristic of Rice Lake can be found in Table 2.

Table 2
Physical Characteristics of Rice Lake, Barron County, Wis.

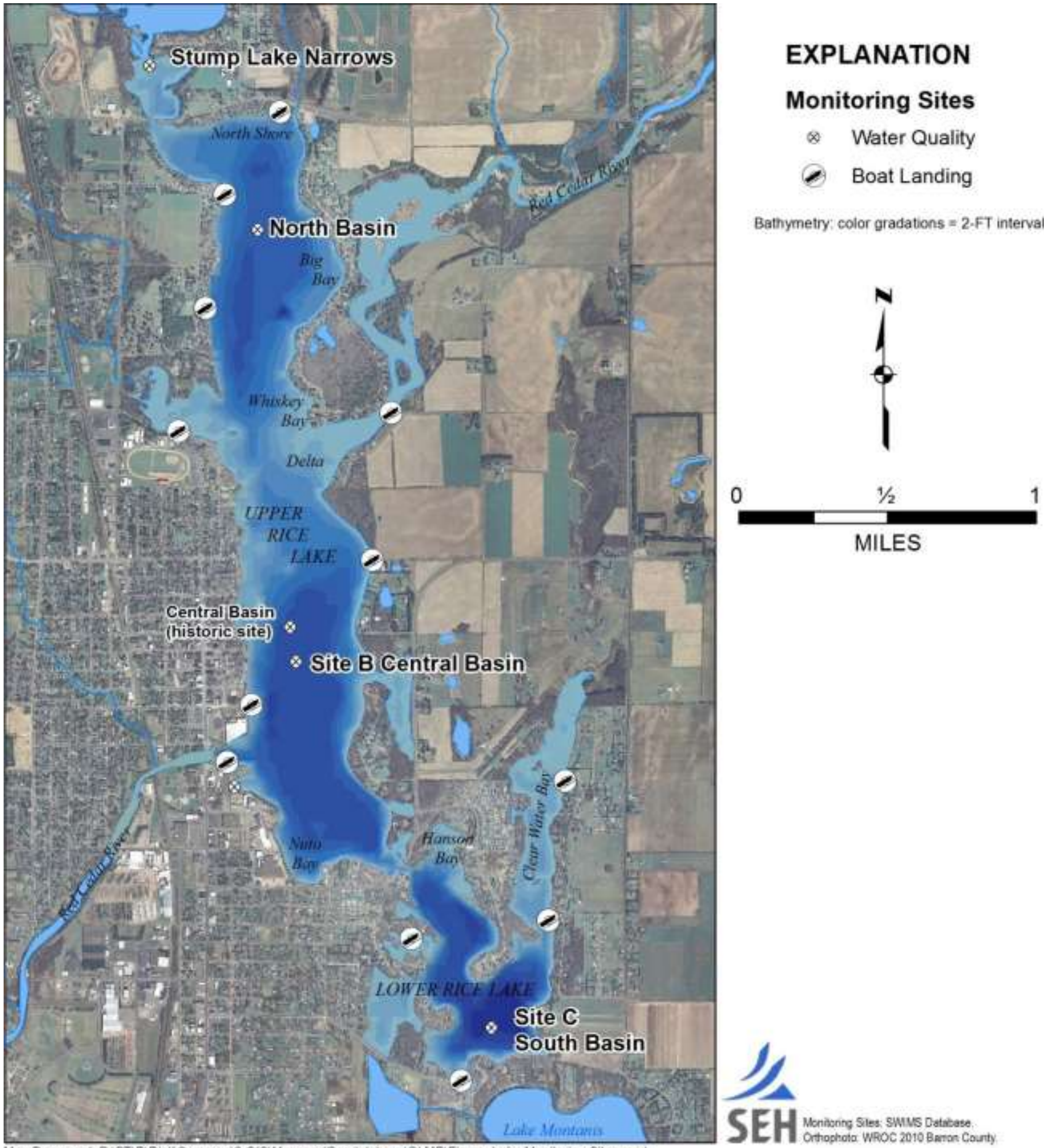
Lake Area (acres)	940
Watershed Area (square miles)	386.3
Watershed to Lake Ratio	262:1
Maximum Depth (feet)	19
Mean Depth (feet)	8.5
Volume (acre-feet)	7,953
Miles of Shoreline (excluding islands)	18.5
Lake Type	Drainage/Impoundment
Source: Barron County Soil & Water Conservation Dept., Wisconsin Dept. of Natural Resources.	

4.1 Water Budget

Approximately 69% of water flowing into the impoundment comes from the Red Cedar River and the remaining 31% is from Bear Creek (James, 2001). Other intermittent streams flow into Rice Lake but their contribution to lake volume is negligible. Flow is typically not observable between the two lake basins, but a significant amount of drainage enters the southern basin via ditches and stormwater outlets.

The lake water has an average residence time of 15 days before flowing out of the basin. This residence time is variable depending on periods of high or low flow and can range from 5 days to 30 days (James, 2001). Red Cedar River contributes greater than 60% of the sediment and nutrients from May through September (James, 2001) while the remainder is contributed by Bear Creek. Much of the urban storm sewer water drains from downtown Rice Lake directly into the lake system (RLPRD, 2013).

Approximately 33% of the City of Rice Lake surface water drainage flows into Rice Lake while the remainder flows into the Red Cedar River or the Meadows Creek Drainage (Lake Montanis and Moon Lake) (WDNR NR216 Evaluation). The WDNR required the City to apply for a Municipal Separate Storm Sewer System (MS4) permit to address urban runoff and prevent discharge of pollutants from the City storm sewers. Efforts to establish a Storm Water Utility began in 2009 with the intent to maintain stormwater infrastructure, install best management practices, and perform various maintenance practices such as street sweeping.



Map Document: P:\PT\R\Ricli\Common\0-GIS\MapsandGeodatabase\CLMP\Figure_Lake Monitoring Sites.mxd

Figure 7 – Monitoring Sites on Rice Lake, Barron County, Wis.

4.2 Water Quality

Water quality monitoring data are available from 1995 to present with a more complete dataset beginning in 2008 following development of the Aquatic Plant Management Plan. A detailed limnological analysis was completed by the U.S. Army Corps of Engineers in 2001. The study determined that external nutrient loading sources to Rice Lake are much more significant than internal loading sources (James, 2001); therefore, efforts to improve water quality and decrease algae blooms should focus on land use in the watershed. Rice Lake is a eutrophic system with some dissolved oxygen depletion in the bottom waters during the growing season.

The 2008 Lake User Survey found that poor water quality is one of the main concerns of residents and lake users, second only to aquatic plant growth. Phosphorus and chlorophyll sampling in 2012 exceeded the Wisconsin Consolidated Assessment and Listing Methodology (WisCALM) criteria for recreational use. As a result, Rice Lake is proposed for and listed as an impaired waterbody in accordance with the Clean Water Act Section 303(d) in 2013.

There are a number of monitoring sites on Rice Lake that are monitored by citizen volunteers since the early 1990s including 12 boat launches and three in-lake water quality monitoring sites (Figure 7). The primary in-lake monitoring sites, those with the most extensive datasets, are Site B Central Basin and Site C South Basin and are discussed in greater detail below. Water clarity data have also been collected consistently from the North Basin site and data have been collected from various sites in the lake since 1995.

4.2.1 Temperature and Dissolved Oxygen

The northern basin of Rice Lake develops weak thermal stratification but the water column mixes due to wave action and flow. The southern basin is dimictic, meaning the lake thermally stratifies during the summer and under the ice in the winter and is fully mixed for short periods during the spring and fall. During the summer months, the thermocline develops at about 15 feet below the lake surface which isolates the lake bottom from interactions with the water column. Dissolved oxygen levels below the thermocline approach zero and above the thermocline dissolved oxygen levels are closer to saturation.

4.2.2 Water Clarity

Water clarity is measured by lowering a black and white Secchi disk into the water and recording the depth of disappearance. The disk is then lowered slightly more and slowly raised until it reappears. The Secchi depth is the mid-point between the depth of disappearance and the depth of reappearance. Because light penetration is usually associated with algae growth, a lake is considered eutrophic when Secchi depths are less than 6.5 feet. Secchi depths vary throughout the year, with shallower readings in summer when algae become dense and limit light penetration and deeper readings in spring and late fall when algae growth is limited.

Water clarity measurements were taken consistently at the three primary monitoring sites from 2007 through 2012 (Figure 8). At the North Basin site, mean summer Secchi depths range from 3 feet to 5 feet with an overall average of 3.9 feet. Mean summer Secchi depths range from 2.3 feet to 5.75 feet with an overall average of 4.4 feet at the Site B Central Basin site and at the South Basin site mean summer Secchi depths range from3 feet to 9 feet with an overall average of 6 feet. The south basin monitoring station has less chlorophyll *a*, less total phosphorus, and higher water clarity than any stations in the central and north portions of Rice Lake. Mean summer water clarity values classify Rice Lake as a eutrophic system. Water quality modeling suggests that a 50% reduction in phosphorus loading would lead to a 24% increase in Secchi depth (James, 2001).

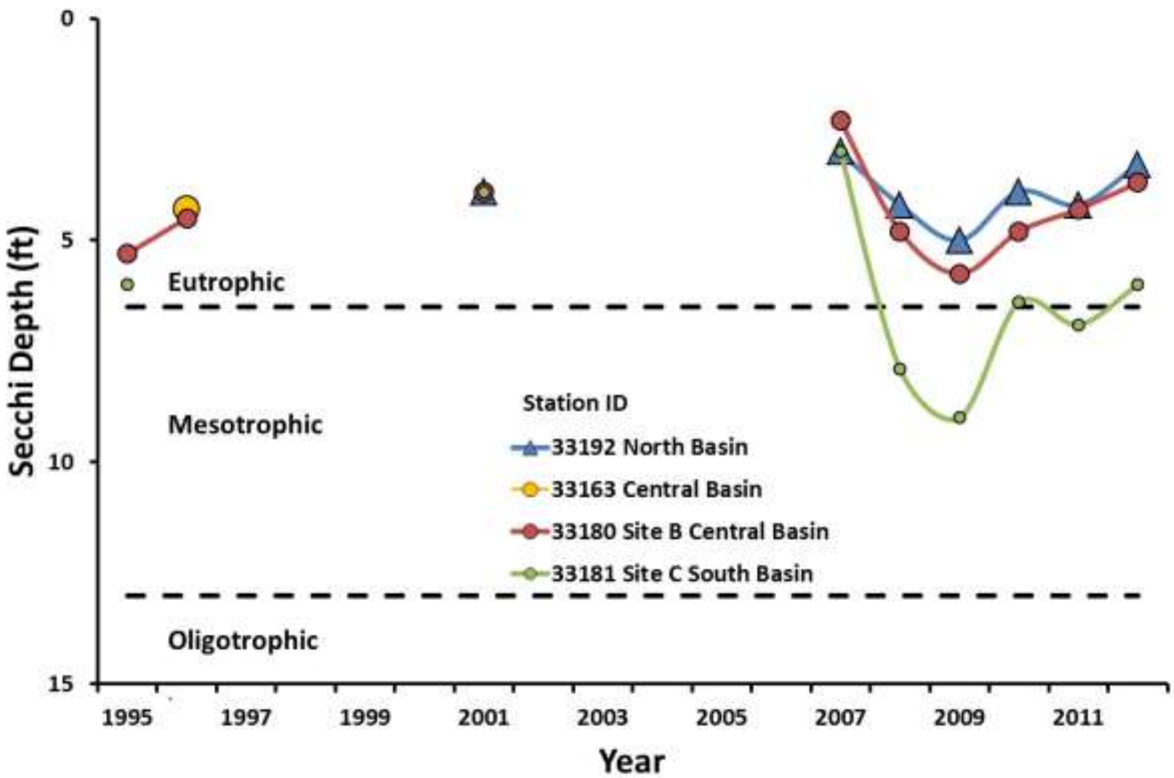


Figure 8 – Mean summer (June – August) water clarity in Rice Lake, Barron County, Wis.

4.2.3 Total Phosphorus

Phosphorus is an important nutrient for plant growth and is commonly the nutrient limiting plant production in Wisconsin lakes. When phosphorus is limiting production, small additions of the nutrient to a lake can cause dramatic increases in plant and algae growth. Phosphorus can become biologically available to aquatic plants and algae through external or internal means of nutrient loading. Internal loading of phosphorus is made possible when the water- sediment interface becomes anoxic (no oxygen) or when the water-sediment interface is oxic (oxygen present) and the pH is high.

Laboratory simulations of internal phosphorus loading revealed that the average daily load from May through September is 0.4 mg/m2 while the average daily external phosphorus loading rate is 9.4 mg/m2 (James, 2001). Water quality modeling of Rice Lake suggests that a 50% decrease of external phosphorus loading would result in a 58% reduction of chlorophyll (i.e. algae). Conversely, increasing external phosphorus loading by 50% would result in a 62% increase in chlorophyll (James, 2001). These results suggest that efforts to control phosphorus loading into Rice Lake should focus on mitigating external sources.

Another source of external phosphorus loading is the City of Rice Lake. Fifteen of the 18 subbasins within City limits drain directly into Rice Lake via the storm sewer system. Total phosphorus loading into Rice Lake from this 1,052-acre area within the City is estimated at 1,365 lbs/year (SEH 2010).

Total phosphorus data is available for five monitoring stations in Rice Lake from 2008 through 2012 and at one site in 1996 with continuous data available for the Central Basin and South Basin from 2008 through 2012 (Figure 9). The Central Basin site had mean summer surface water values ranging from 37 µg/L to 58 µg/L and an average for all those years of 42 µg/L. The South Basin site had mean summer surface water values ranging from 19 µg/L to 31 µg/L and an average for all those years of 24 µg/L. The south basin monitoring station has less chlorophyll-a, less total phosphorus, and higher water clarity than any stations in the central and north portions of Rice Lake. The overall mean near-surface summer average for the four monitoring sites is 45 µg/L which classifies Rice Lake as a eutrophic system. Station 10031154 in Stump Lake, a tributary of Rice Lake, had a mean summer value of 84 µg/L in 2010.

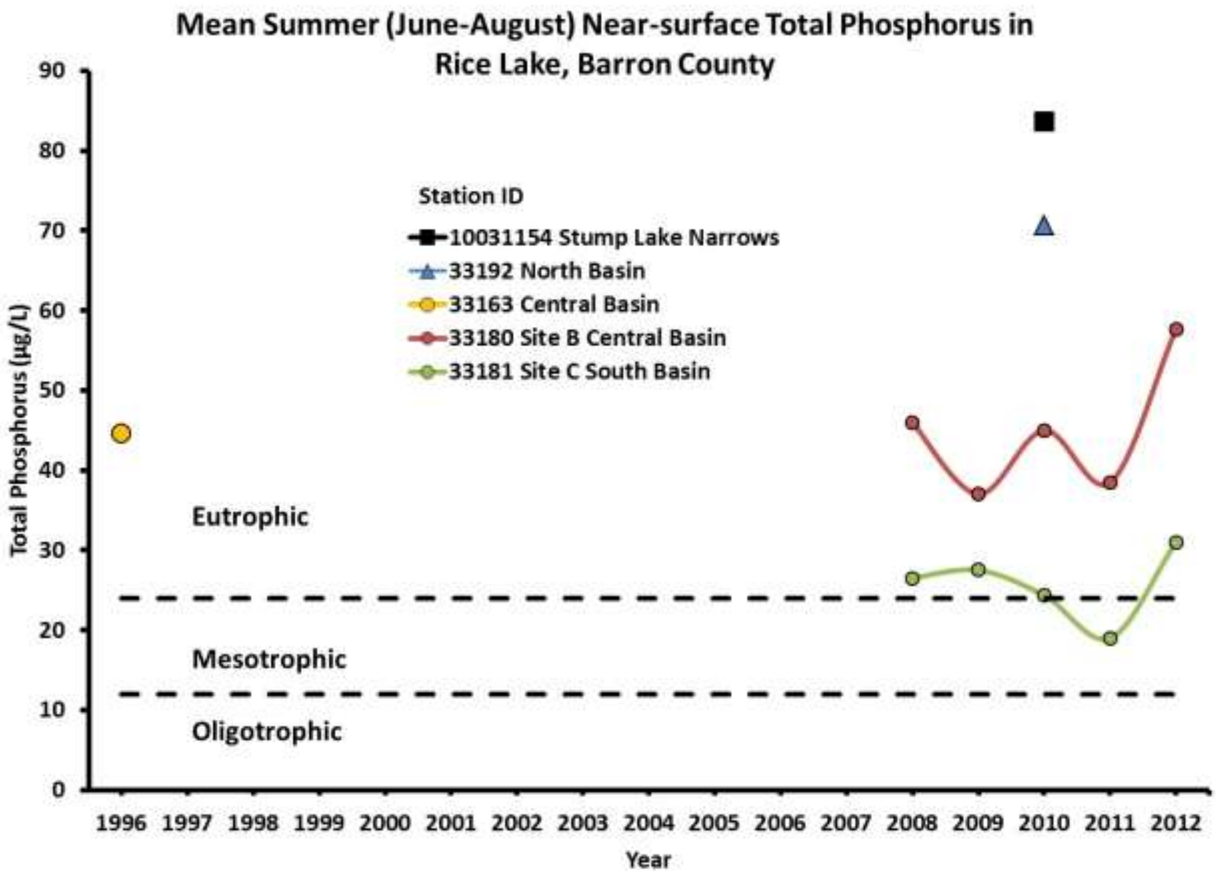


Figure 9 – Mean summer near-surface (0 to 6 feet deep) total phosphorus in Rice Lake, Barron County, Wis.

4.2.4 Chlorophyll *a*

Chlorophyll *a* is a measurement of algae in the water. The concentration varies throughout the year, generally peaking in late summer. A detailed limnological analysis of Rice Lake in 2001 found a peak chlorophyll *a* concentration in mid-July and a secondary peak in early September (James, 2001). The preferred method of determining the trophic status of a lake is by converting the measured concentration to the chlorophyll *a* trophic state index.

Chlorophyll-*a* data is available for Rice Lake at four monitoring stations with the South and Central Basin sites having continuous data from 2008 through 2012 (Figure 10). Mean summer trophic state index (TSI) values between 1996 and 2012 ranged from 48 to 66 (chlorophyll *a* concentrations of 6 µg/L to 36 µg/L). The highest mean summer chlorophyll *a* was 66, measured in 1996 and the Central Basin site. Overall summer mean values at the Central and South basin sites from 2008 through 2012 were 60 and 53, respectively (chlorophyll *a* concentrations of 20 µg/L and 10 µg/L). The overall mean summer average chlorophyll *a* for all monitoring stations was 19.4 µg/L, a TSI value of 60, which classifies Rice Lake as a eutrophic system.

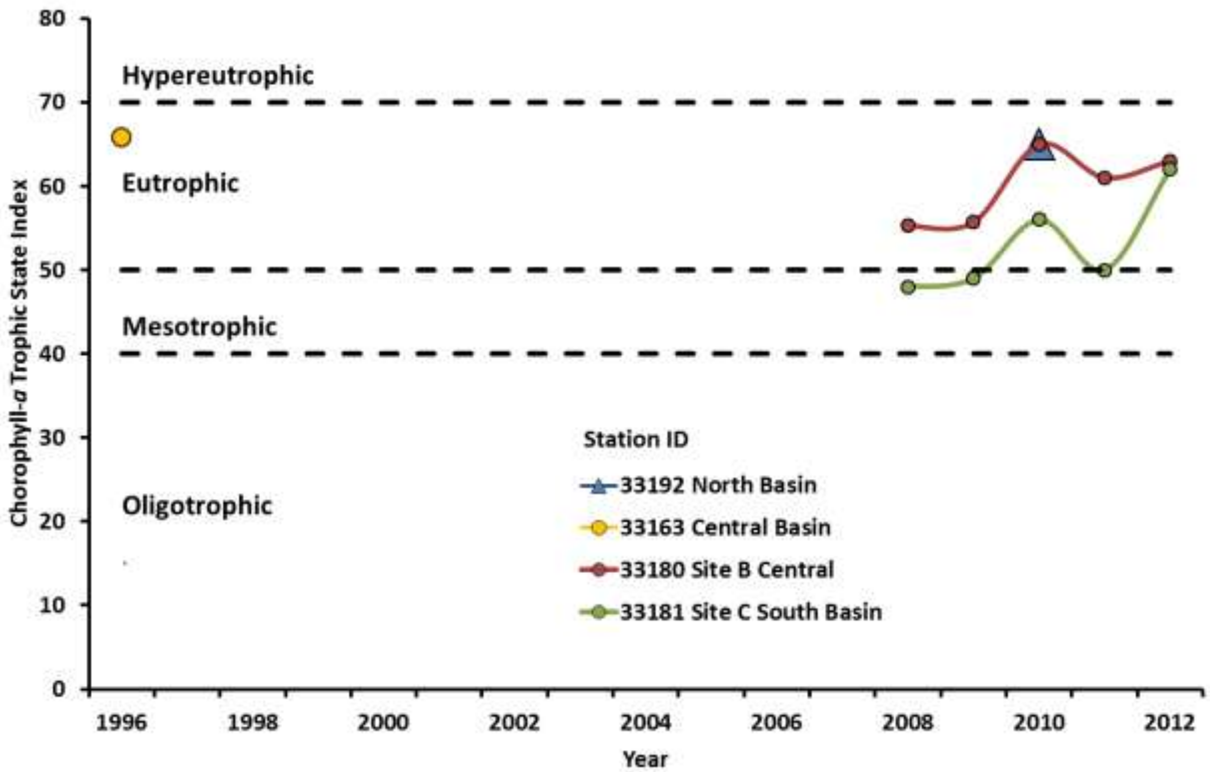


Figure 10 – Mean summer chlorophyll *a* trophic state index for Rice Lake, Barron County, Wis.

4.3 Aquatic Plants

Aquatic plants play a vital role in lakes. They anchor sediments, buffer wave action, oxygenate water, and provide valuable habitat for aquatic animals. The amount and type of plants in a lake can greatly affect nutrient cycling, water clarity, and food web interactions. Furthermore, plants are very important for fish reproduction, survival, and growth, and can greatly impact the type and size of fish in a lake.

Healthy aquatic plant communities can be degraded by poor water clarity blocking light and limiting growth, excessive plant control activities, and the invasion of non-native nuisance plants. These disruptive forces alter the diversity and abundance of aquatic plants in lakes and can lead to undesirable changes in many other aspects of a lake's ecology (Figure 11). Consequently, it is very important that lake managers find a balance between controlling nuisance plant growth and maintaining a healthy, diverse plant community.

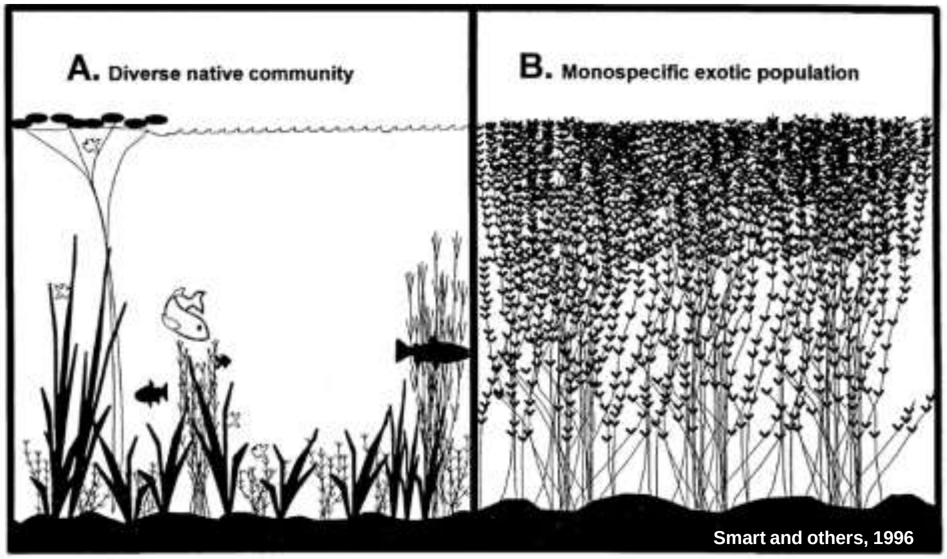


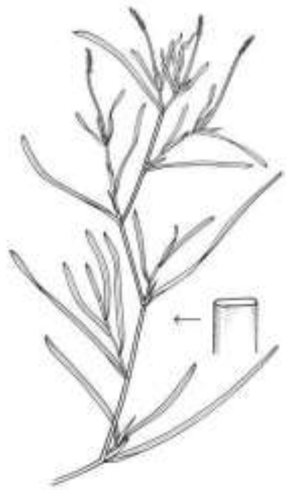
Figure 11 – Submersed Aquatic Plant Communities

A whole-lake aquatic plant point intercept survey was done on Rice Lake in the summer of 2008. Data for this survey are available in the 2010 Aquatic Plant Management Plan. During the survey, a total of 55 aquatic plant species were identified including two the non-native plants curly-leaf pondweed and aquatic forget-me-nots. This species richness is much higher than the state median of 13 native species and the North Central Hardwood Forests ecoregion median of 14 native species. The Floristic Quality Index of 39.9 is also much higher than the state median (22.2) and the ecoregion median (20.8).

The littoral zone, or the maximum depth of plant growth, was to water depths up to16.2 feet with most plant growth occurring in water less than 12 feet deep. Although a high diversity of plants was found, the distribution was limited to a few areas, primarily within the shallow bays identified as Critical Habitat. Large portions of the lake were dominated by coontail, flat-stem pondweed, and elodea, the three most commonly encountered plants in the lake. Other common aquatic plants include forked duckweed, wild celery and Robbins' pondweed.

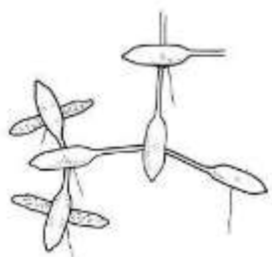
4.3.1 Common Plants in Rice Lake

Coontail
Ceratophyllum demersum

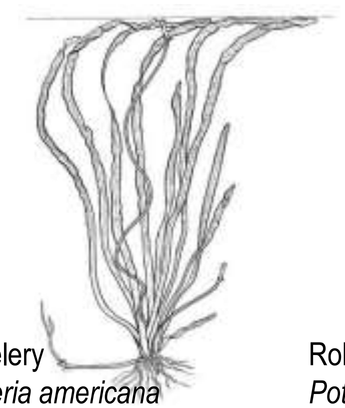


Flat-Stem Pondweed
Potamogeton zosteriformis

Elodea
Elodea canadensis



Forked Duckweed
Lemna trisulca



Wild Celery
Vallisneria americana

Robbins' Pondweed
Potamogeton robbinsii

4.3.2 Aquatic Invasive Plant Species in Rice Lake

Curly-leaf Pondweed
Potamogeton crispus

USDA-NRCS PLANTS Database

Purple Loosestrife
Lythrum salicaria

USDA-NRCS PLANTS Database

Japanese Knotweed
Polygonum cuspidatum

Unless otherwise noted, images from Nichols, S.A., 1999. *Distribution and habitat descriptions of Wisconsin Lake Plants*. WGNHS Bulletin 96.

4.3.3 Aquatic Plant Management

The 2008 Lake User Survey found that "weed growth" is the main concern of respondents and over 80% felt that plant management was necessary. At that time, 83% admitted they could not identify curly-leaf pondweed and education and outreach regarding aquatic plants accompanied ongoing lake management efforts. Based on survey respondent comments, overall satisfaction with plant management in 2008 seemed to be low, although direct questioning on this topic was not in the survey. The first Aquatic Plant Management Plan was developed in 1994 and an update was completed in 2010. The 2010 plan includes eleven goals with detailed and timely objectives and actions covering a four-year period. A point intercept aquatic plant survey of Rice Lake was done in 2008 to assist with plan development. Although aquatic plants were surveyed before 2008, this was the most comprehensive work done to date and provided a baseline for any future aquatic plant management. Detailed information from the 2008 survey is available in the 2010 Aquatic Plant Management Plan.

Curly-leaf pondweed was discovered in Rice Lake in 1978 but likely existing in the lake since the 50's and 60's. It has been a significant problem in the lake for decades. Curly-leaf is problematic for various reasons which are detailed in the 2010 Aquatic Plant Management Plan. Curly-leaf senescence, or die-back, in early summer contributes an estimated 375 to 568 pounds of phosphorus to the lake, a release that occurs at an opportune time to fuel algae growth. Curly-leaf pondweed is distributed throughout the lake, covering approximately 22% of the entire lake area and 48% of the littoral zone.

Mechanical harvesting and herbicide applications are used to control curly-leaf pondweed. Large-scale harvesting has been completed since 1985 and is also used to control native plant species. Harvesting of native plant species is done throughout the open water season to maintain navigation and recreational thoroughfares. A summary of mechanical harvesting efforts is presented in Table 3.

Chemical treatment using the herbicide endothall began on Rice Lake in May of 2009 in a 20-acre area near the city beach where public use was concentrated. In 2011, chemical treatment was done on four beds of curly-leaf totaling 41.56 acres and included a native plant and turion (curly-leaf winter buds) analysis. A total of 180 acres of curly-leaf was removed in 2011, which is approximately 85% of the 211 acres of total curly-leaf coverage established during the 2008 aquatic plant survey. The 2012 chemical treatment was done on the same four curly-leaf beds with a slightly higher treatment area of 46.65 acres. Generally speaking, using chemical treatment for curly-leaf pondweed control has been successful since it was started in 2009.

Table 3
Rice Lake Protection and Rehabilitation District Reports for Tons of Aquatic Plants Removed From Rice Lake

Year	Tons	Species
1992*	316-1560 (dry weight)	ND
1993*	516-1932 (dry weight)	ND
2005-2008	Approx. 1018 total	ND
2011	139	Curly-leaf pondweed
2011	326	Wild celery, coontail, elodea
2012	138	Curly-leaf pondweed
2012	272	Wild celery, coontail, elodea
2013	65	Curly-leaf pondweed
2013	203	Wild celery, coontail, elodea
*1993 Lake Mgmt Plan reports the lower tonnage harvested while the 1994 Aquatic Plant Mgmt Plan reports the higher tonnage harvested		
ND = not documented.		

Because Eurasian watermilfoil has not been discovered in Rice Lake, a Rapid Response plan for it and other aquatic invasive species was developed as part of the 2010 Aquatic Plant Management Plan. According to past reports and citizen monitoring data, other invasive species that have been found in Rice Lake include purple loosestrife, Japanese mystery snail, Chinese mystery snail, and rusty crayfish (Table 4).

Table 4
Aquatic Invasive Species Monitoring in Rice Lake, Barron County, Wis.

Aquatic Invasive Species	Year(s) monitored	Year Found
Curly-leaf pondweed	2008-2012	1978
Japanese mystery snail	2007	2007
Chinese mystery snail	2007	2007
Purple Loosestrife	2008	unknown
Rusty Crayfish	2008	unknown
Eurasian watermilfoil	2008	Not found
Zebra mussels	2008	Not found
Spiny water flea	2008	Not found

4.4 Fishery

A survey of Rice Lake Protection and Rehabilitation District residents in 2008 revealed fishing to be the main recreational use of Rice Lake. However,

Complex interactions among fish are at play in lakes with abundant structural habitat. Aquatic plants, or macrophytes, provide important structural habitat to fish and their food sources. Rice Lake is abundant in macrophyte growth, thereby supporting complex interactions among fish species. For example, as macrophyte complexity increases, prey capture tends to decrease (Savino and Stein, 1982) but predacious fish are attracted to underwater shade to better see approaching prey and to remain hidden (Helfman, 1981 and Engel, 1990).

Theoretically, an intermediate abundance of macrophyte cover provides forage areas and hiding spaces for prey fish (such as bluegills) but does not impede the mobility of predacious fish (for example, bass, northern pike, and muskellunge). The ongoing efforts to decrease curly-leaf pondweed abundance may also support a fishery with less stunted panfish. However, it is worth noting that many of the studies exploring predator-prey interactions among macrophytes are supported by independent studies that have not yet yielded consistent results (Heck and Crowder, 1991).

4.4.1 Historic Fishery Management

Muskellunge, largemouth bass, and northern pike are common in Rice Lake. Walleye, smallmouth bass, and panfish (crappies, bluegill, rock bass, sunfish) are present as are bullheads and various minnow species (WDNR 2013, RLPRD, 1994). According to the 2008 Lake User Survey, Rice Lake is mainly used for fishing, including trophy musky fishing (RLPRD, 2013). Many respondents voiced concerns that the panfish population was stunted. Spring and summer surveys were completed by the WDNR in 2008 and the results are shown in Table 5. Historic fish stocking records are shown in Table 6.

Table 5
WDNR Fish Survey Results from 2008

	Species	Abundance
May 1-8, 2008 Early Spring Walleye & Muskellunge Survey Fyke Net	Northern Pike	63
	Smallmouth Bass	45
	Muskellunge	44
	Largemouth Bass	26
	Walleye	9
May 19-20, 2008 Late Spring Bass and Panfish Survey Boom Shocker	Bluegill	489
	Black Crappie	36
	Rock Bass	27
	Largemouth Bass	23
	Pumpkinseed	11
	Smallmouth Bass	8
	Yellow Perch	7
June 16-17, 2008 Summer Panfish Survey Fyke Net	Bluegill	604
	Pumpkinseed	78
	Black Crappie	8
	Rock Bass	4
	Pumpkinseed X Bluegill	2

Table 6
Fish stocking in Rice Lake

Year	Species	Age Class	Average Fish Length (in)
2011	Muskellunge	Large Fingerling	10.1
2009	Muskellunge	Large Fingerling	10.1
2007	Muskellunge	Large Fingerling	12.2
2005	Muskellunge	Large Fingerling	10.5
2003	Muskellunge	Large Fingerling	12.0
2001	Muskellunge	Large Fingerling	10.4
1999	Muskellunge	Large Fingerling	11.3
1997	Muskellunge	Large Fingerling	10.0
1995	Muskellunge	Fingerling	11.9
1993	Muskellunge	Fingerling	10.0
1991	Muskellunge	Fingerling	10.0
1990	Muskellunge	Fingerling	9.0
1989	Muskellunge	Fingerling	7.0
1988	Muskellunge	Fingerling	9.0
1987	Muskellunge	Fingerling	9.0
1984	Northern Pike	Fry	1.0

4.4.2 Fishery Habitat

Coarse woody structure (CWS) is a type of structural habitat found in the littoral zone, or near-shore region, of lakes and is contributed as trees fall from shore into lakes. Natural addition of CWS to lakes can be a very slow process. For example, the mean germination date of eastern white pine (*Pinus strobus*) sampled from the littoral zone of a lake in Ontario was 600 years ago (Guyette and Cole, 1999). Therefore, most of the CWS in the littoral zone took 600 years to grow, senesce, and eventually fall into the lake. Many studies suggest that CWS is an important component of habitat in littoral zones. Wood provides a surface for insect larvae (Bowen et al. 1998) and provides shelter for small fish from predation (Werner and Hall, 1988).

Complex interactions among fish are at play with abundant structural habitat as discussed above. Predator and prey dynamics among varying macrophyte densities may be comparable to those occurring among CWS (Sass et al.2006), especially if most of the branches and twigs are intact. Compared to macrophytes, however, CWS as structural habitat in littoral zones is scarce. For example, a survey of 13,657 square meter quadrats in 12 lakes revealed that only 6% of quadrats had CWS within one meter (Schmidt, 2010). One reason for this is shoreline development. As shoreline development increases, CWS abundance decreases (Jennings et al. 2003, Christensen et al. 1996) mainly due to riparian tree removal. Despite its rarity, CWS has very little protection in Wisconsin statutes related to lakes and lake habitat. Furthermore, an official method for measuring CWS in lakes has not yet been adopted by the state.

Although abundant structural habitat in the form of macrophytes exists in Rice Lake, it would still be beneficial to survey and develop management goals for CWS protection. Survey methods could be developed in coordination with the state. Management goals could be based on a percentage of pre-settlement conditions. For example, Christensen et al. (1996) found an average of 555 logs/km of shoreline in lakes with no development versus a range of 57-379 logs/km in lakes with development.

4.5 Critical Habitat

Every body of water has areas of aquatic vegetation or other features that offer critical or unique aquatic plant, fish and wildlife habitat. Such areas can be mapped by the WDNR and designated as Critical Habitat. Critical Habitat areas include important fish and wildlife habitat, natural shorelines, physical features important for water quality (for example, springs) and navigation thoroughfares. These areas, which can be located within or adjacent to the lake, are selected because they are particularly valuable to the ecosystem or would be significantly and negatively impacted by most human induced disturbances or development. Critical Habitat areas include both Sensitive Areas and Public Rights Features. Sensitive Areas offer critical or unique fish and wildlife habitat, are important for seasonal or life-stage requirements of various animals, or offer water quality or erosion control benefits.

The Wisconsin Department of Natural Resources designated eighteen Sensitive Areas in Rice Lake in 1997 (Figure 12). Management recommendations for these critical habitats include limiting macrophyte removal and littoral zone alterations, and minimizing sediment and nutrient inputs from lawns and septic systems. The Sensitive Areas report also recommends that coarse woody structure be left in the lake, promoting shoreline buffer zones, enforcing zoning ordinances, implementing "slow-no-wake" zones for watercraft, and encouraging the District to acquire property near sites D, L, and P for conservation purposes.

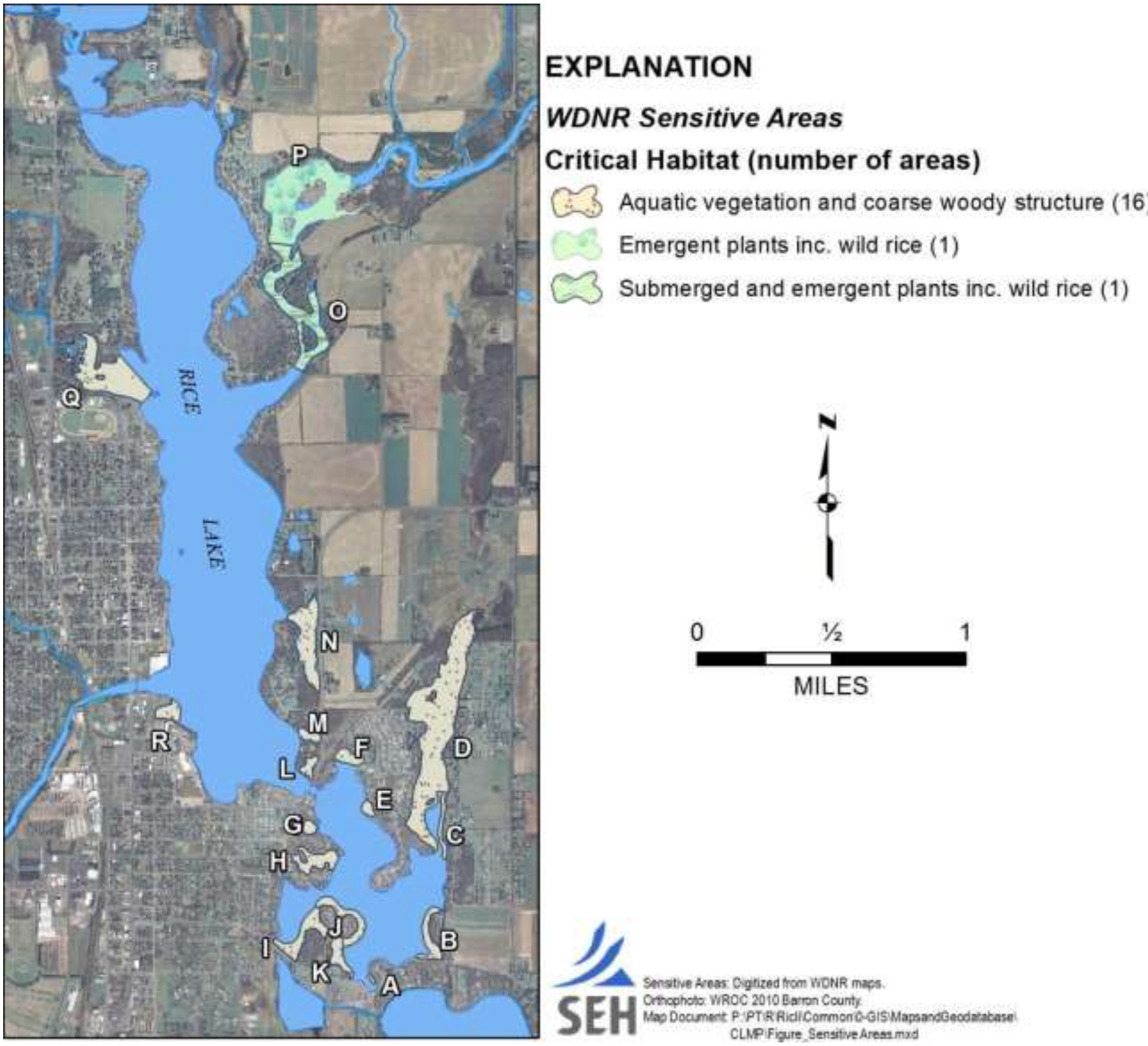


Figure 12 – Sensitive Areas in Rice Lake, Barron County

5.0 Watershed Setting

A watershed is an area of land from which water drains to a common surface water feature, such as a stream, lake, or wetland. A lake is a reflection of the topography, geology, soils, and land use in its watershed. Rice Lake is in the lower end of the larger Brill and Red Cedar Rivers Watershed (recognized by the state as LC10). This watershed covers approximately 298 square miles and is located primarily in the Forest Transition Ecological Landscape which lies along the northern border of Wisconsin's Tension Zone, through the central and western part of the state, and supports both northern forests and agricultural areas (Figure 13). The central portion of the Forest Transition Landscape is located primarily on a glacial till plain deposited by glaciation between 25,000 and 790,000 years ago. The eastern and western portions are on moraines of the Wisconsin glaciation. The growing season in this part of the state is long enough that agriculture is viable, although climatic conditions are not as favorable as in southern Wisconsin. Soils are diverse, ranging from sandy loam to loam or shallow silt loam, and from poorly drained to well drained.

The historic vegetation of the Forest Transition Landscape was primarily northern hardwood forest. These northern hardwoods were dominated by sugar maple and hemlock, and contained some yellow birch, red pine and white pine. Currently, over 60% of this Ecological Landscape is non-forested. Forested areas consist primarily of northern hardwoods and aspen, with smaller amounts of oak and lowland hardwoods. The eastern portion of the Ecological Landscape differs from the rest of the area in that it remains primarily forested (WDNR).

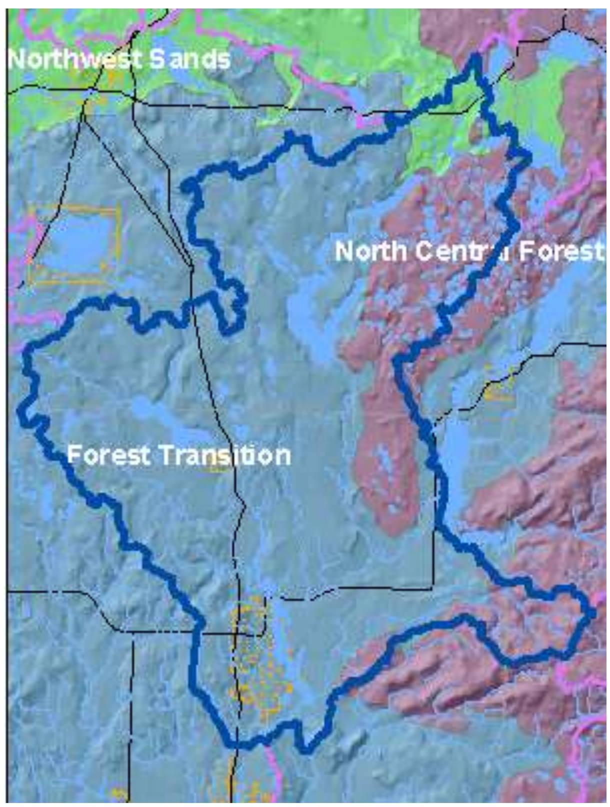


Figure 13 - Brill and Red Cedar River Watershed (LC10), WDNR

The Brill and Red Cedar Rivers Watershed is considered one of seven recognized watersheds included in a larger watershed drained by the Red Cedar River and its tributaries to Tainter and Menomin Lakes in Dunn County. Overall land use, sediment loading, and phosphorus loading from the Brill and Red Cedar River Watershed was estimated in a 1999 WDNR Report (with corrections made in 2010) that focused on determining the amount of suspended solids and total phosphorus entering the Red Cedar River from all seven of the smaller watersheds. Figure 14 shows the breakdown of land use in the more than 77,100 hectare Brill and Red Cedar Rivers Watershed; total suspended sediment from the different land uses, and total phosphorus loading attributed to the different land uses.

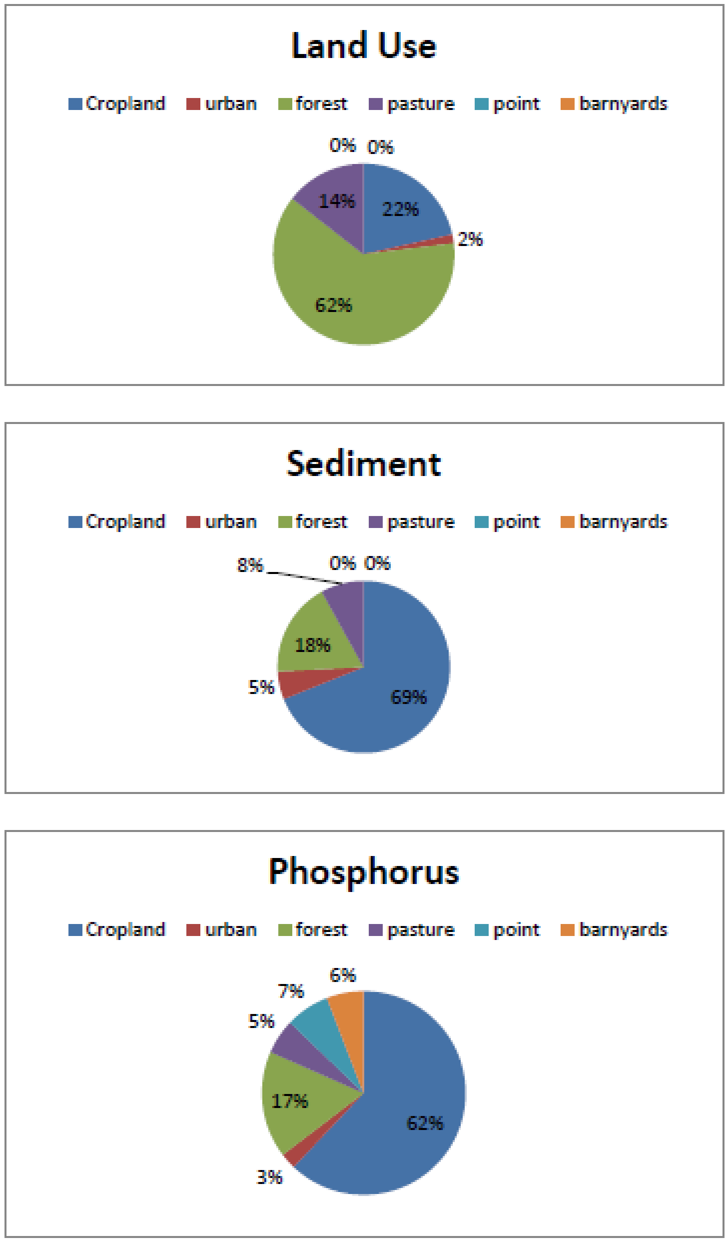


Figure 14 - Land Use, Total Suspended Solids, and Total Phosphorus Loading from the Brill and Red Cedar Rivers Watershed, WDNR Report to the Red Cedar River Basin Project, July 1999

The drainage area of concern for Rice Lake (Figure 3) covers about 100 mi², or about one-third of the entire Brill and Red Cedar River Watershed. It is comprised of land drained by the Brill River upstream to the Long Lake Dam in Washburn County, the land drained by the Red Cedar River upstream to the dam on Red Cedar Lake in Barron County, and the land drained by Bear and Little Bear Creeks upstream to the dam on Bear Creek in Haugen of Barron County. The principle land use within the drainage area of concern is agriculture. The landscape is flat and the soils consist of well- drained sandy loam making for ideal agricultural conditions. The primary agricultural land use in the watershed is row crops (corn and beans) and potatoes. There are also a number of dairy and cattle operations.). Urban development makes up a small portion of the land use in the watershed, but the majority, the City of Rice Lake, is adjacent to the lake.

Although the land use numbers presented here are for the entire Brill and Red Cedar Rivers Watershed, almost all of the agricultural land use and much of the urban land use is in the area of concern for Rice Lake, so it is reasonable to assume that the numbers adequately reflect what is contributing to water quality issues in Rice Lake.

Land cover and land use management practices within a watershed have a strong influence on water quality and water quantity. Increases in impervious surfaces, such as roads, rooftops and compacted soils associated with residential and agricultural land uses, can reduce or prevent the infiltration of runoff. This leads to an increase in the volume and rate of stormwater runoff and pollutant loading to the lakes and their tributary streams. The removal of riparian (near-shore) vegetation causes an increase in the amount of nutrient-rich soil particles transported directly to a waterbody during rain events.

5.1 Institutional Framework Affecting Lake Management

While State and Federal agencies have primary water quality enforcement responsibilities, a variety of county and local regulations may also contribute to water quality protections, a few of the more common of which are noted here. All of the information in Section 5 is from the Water Quality Management Programs and Plans in the Red Cedar River Watershed published by the West Central Wisconsin Regional Planning Commission (WCWRPC) in March 2012.

5.1.1 Land and Water Conservation Departments

Each county in the larger Red Cedar River watershed has a land/soil and water conservation department. Though exact responsibilities and department names do vary by county, these departments are generally responsible for a variety of educational and enforcement activities to protect the farmlands, waters, and natural resources of their respective counties. Each department develops and maintains a Land and Water Resource Management Plan which identifies their resource management goals and activities. Activities often include, potentially in concert with other departments or agencies: stormwater, run-off, and erosion management, soil and nutrient management, animal waste controls, water quality programs, county farmland preservation programs, non-metallic mining regulations, recycling programs, waterway/wetland permitting, and environmental education. These departments also provide assistance to the lake districts and lake associations in their counties. Some of these departments also manage dams, dikes, and surface water improvements on behalf of the county.

Land and Water Conservation Departments in Barron, Washburn, and Sawyer Counties all cover some of the watershed impacting Rice Lake.

5.1.2 Stormwater Management Plans and Utilities

A stormwater management plan describes communitywide surface water management needs. This local tool is useful in determining actions to improve surface water quality and stormwater detention storage needs. County and local jurisdictions often incorporate stormwater management requirements as part of subdivision regulations and building codes, in part to ensure consistency with state construction site erosion controls. State law (NR 216) also requires landowners to develop an erosion control plan and obtain necessary WDNR erosion control and stormwater discharge permits for all construction sites where one or more acres of land will be disturbed. The exceptions to this are for public buildings and WisDOT projects which have special regulations. Currently, municipalities in Census-defined urbanized areas and municipalities with more than 10,000 population are required by state and federal law to develop a stormwater programs with measurable goals, required permitting, and educational efforts for municipal-owned stormwater conveyances which discharge to public waters.

Cities, villages, and towns with village powers may create a stormwater utility that is responsible for maintaining and managing the surface water management system. Stormwater utilities have the ability to charge fees to generate revenue to support these activities, and fee structures are often based on the amount of impervious surface area of a parcel or equivalent residential unit size. According to the Wisconsin Chapter of the American Public Works Association, the following communities have stormwater utilities or user charges in the Red Cedar River Watershed as of August 2008:

- City of Barron (adopted 2005)
- City of Chetek (2005)

- City of Menomonie (2008)

For several years, the City of Rice Lake has been embattled in the process whereby they either develop a stormwater utility or continue to fight against its' development. The Lake District is in favor of the formation of a Stormwater Utility in Rice Lake and would work with it to provide what resources it could to support it, but can only stand by and let the City and State settle the dispute.

5.1.3 Outdoor Recreation Plans (ORPs)

Outdoor recreation plans inventory a community's parks and outdoor recreation facilities, identify related needs, and establish goals for the acquisition, development, and improvement of such facilities. ORPs can play an important role in protecting water quality. By adopting an outdoor recreation plan which is reviewed and accepted by WDNR, a community becomes eligible to participate in the Land and Water Conservation Fund Program (LAWCON), the Stewardship Local Assistance Programs, and other related funding programs.

The City of Rice Lake adopted a new Outdoor Recreation Plan in April of 2014 for the years 2014-2019.

5.1.4 Comprehensive Planning Wis. Stats. §66.1001

Comprehensive plans are important tools for establishing community goals and guiding municipal decision-making. Beginning on January 1, 2010, if a town, village, city, or county enacts or amends an official mapping, subdivision regulation, or zoning ordinance, the enactment or amendment ordinance must be consistent with that community's comprehensive plan. Comprehensive plans must encompass nine elements and water quality issues, goals, and strategies are often addressed as part of a community's agricultural, natural, and cultural resources element. All counties in the watershed have adopted a comprehensive plan, except Washburn County. Surface and groundwater quality consistently ranked highest among the natural resources most important to residents during planning surveys. Figure 15 shows the municipal comprehensive plans that have been adopted, and submitted to the Wisconsin Department of Administration, within the watershed.

The City of Rice Lake adopted a Comprehensive Plan for the years 2003-2028.

5.1.5 Zoning Ordinances Wis. Stats. §59.69, 60.61,62.23, & 61.35

Zoning creates districts (or zones) within a community in which certain land uses are permitted outright, while other uses may be permitted with conditions. Guiding certain uses away from environmentally sensitive areas or requiring certain setbacks are two ways in which zoning may contribute to water quality protection. Any county, city, or village may establish a zoning ordinance to promote public health, safety and general welfare. All counties in the watershed have adopted a zoning ordinance, though many towns do not participate in county zoning. Most cities and villages in the watershed have adopted their own zoning ordinance. No towns in the watershed have their own zoning regulations.

A complete listing of City of Rice Lake Ordinances is available at http://ecode360.com/RI1728?needHash=true.

A complete listing of Barron County Ordinances is available at http://www.barroncountywi.gov/index.asp?Type=B_BASIC&SEC=%7B5849F663-F197-46AF-9020-7123068F82DF%7D.

5.1.6 County Shoreland Zoning Wis. Stats. §59.692

Each county is required to zone by ordinance all shorelands in its unincorporated areas. Shorelands include areas within 1,000 feet of a lake or 300 feet of a navigable stream. Shoreland zoning ordinances may be more restrictive than minimum state standards, but not less. Counties may permit only certain uses in wetlands of five acres or more within the shoreland zone.

A complete listing of Barron County Ordinances is available at http://www.barroncountywi.gov/index.asp?Type=B_BASIC&SEC=%7B5849F663-F197-46AF-9020-7123068F82DF%7D.

5.1.7 City and Village Shoreland/Wetland Zoning Wis. Stats. §61.351 & 62.231

Cities and villages are required to zone by ordinance all unfilled wetlands of five acres or more which are shown on WDNR's final wetland inventory maps located within shorelands and within the incorporated area. Ordinances adopted under Wisconsin Statutes §62.23 or §61.35 may be more restrictive than wetland protection ordinances, but not less restrictive.

A complete listing of City of Rice Lake Ordinances is available at http://ecode360.com/RI1728?needHash=true.

5.1.8 Shoreland Management Ordinances Wis. Stats. §92.17

Counties, cities, villages, and towns may enact shoreland management ordinances for the purpose of maintaining and improving surface water quality. Such ordinances cannot be enforced unless the county has a land conservation committee with an approved land and water resource management plan and the county receives state funding for land and water conservation activities. This tool is not commonly used and municipalities regulate shorelands through county or local shoreland-wetland zoning ordinances, instead of having a separate shoreland management ordinance.

A complete listing of City of Rice Lake Ordinances is available at http://ecode360.com/RI1728?needHash=true.

A complete listing of Barron County Ordinances is available at http://www.barroncountywi.gov/index.asp?Type=B_BASIC&SEC=%7B5849F663-F197-46AF-9020-7123068F82DF%7D.

5.1.9 Floodplain Ordinances Wis. Stats. §87.30 & NR116

Counties, cities, and villages are required to adopt reasonable and effective floodplain zoning ordinances within one year after hydraulic and engineering data adequate to formulate the ordinance becomes available. All counties in the watershed have adopted a floodplain ordinance which applies to all unincorporated areas in their respective county. However, not all local floodplain ordinances in the region have been updated for consistency with the latest WDNR model based on FEMA guidelines.

A complete listing of City of Rice Lake Ordinances is available at http://ecode360.com/RI1728?needHash=true.

A complete listing of Barron County Ordinances is available at http://www.barroncountywi.gov/index.asp?Type=B_BASIC&SEC=%7B5849F663-F197-46AF-9020-7123068F82DF%7D.

5.1.10 Sanitary Ordinances Wis. Stats. §59.065

As required by state statute, all counties in the watershed have adopted sanitary ordinances governing private sewage systems which apply to the entire county. The counties issue sanitary Water Quality Management Programs and Plans in the Red Cedar River Watershed 20 permits for the siting, design, installation, and/or repair, reconnection, or rejuvenation of private sewage systems and non-plumbing sanitation systems. Landowners must also sign a maintenance agreement to ensure proper upkeep and periodic inspections of their system. Sanitary ordinances may be part of a zoning ordinance or larger code of ordinances in some communities.

A complete listing of Barron County Ordinances is available at http://www.barroncountywi.gov/index.asp?Type=B_BASIC&SEC=%7B5849F663-F197-46AF-9020-7123068F82DF%7D.

5.1.11 Solid Waste Management Wis. Stats. §59.70(2), 59.07(135)(a), and 144.437(1)

Counties may establish a solid waste management board which is authorized to develop plans for a solid waste management system and operate a solid waste system. Such plans must be consistent with applicable state rules and must be reviewed by the WDNR.

A complete listing of Barron County Ordinances is available at http://www.barroncountywi.gov/index.asp?Type=B_BASIC&SEC=%7B5849F663-F197-46AF-9020-7123068F82DF%7D.

5.1.12 Recycling Ordinance Wis. Stats. §144.449(3), 59.07(133) & (135),159.17, and NR 502.05

Counties, towns, villages, and cities may enact ordinances to manage the storage of waste materials, recycling, and disposal of tires. These may be part of a larger solid waste management ordinance. Communities must meet state recycling requirements and some communities may have additional recycling programs.

A complete listing of City of Rice Lake Ordinances is available at http://ecode360.com/RI1728?needHash=true.

A complete listing of Barron County Ordinances is available at http://www.barroncountywi.gov/index.asp?Type=B_BASIC&SEC=%7B5849F663-F197-46AF-9020-7123068F82DF%7D.

5.1.13 Manure Storage and Management Ordinances Wis. Stats. §92.16 & NR 151

All counties in the watershed have adopted and administer a manure storage or animal waste management ordinance under Wisconsin Statutes §92.16 and DATCP rules. Such ordinances may be part of a larger zoning ordinance or code of ordinances. Generally, these ordinances require all new or altered manure storage facilities be liquid tight and meet NRCS standards. Under NR 151 and ATCP 50, WDNR also enforces performance standards and prohibitions related to manure management (e.g. storage facilities, runoff, and fertilizer application) which have been integrated into many county ordinances.

A complete listing of Barron County Ordinances is available at http://www.barroncountywi.gov/index.asp?Type=B_BASIC&SEC=%7B5849F663-F197-46AF-9020-7123068F82DF%7D.

5.1.14 Livestock Facility Siting Ordinances Wis. Stats. §93.90 & ATCP 51

The role of local governments in the regulation of the siting of new and expanded livestock operations changed significantly in 2006 with the adoption of Wisconsin Statutes §93.90 and Administrative Rule ATCP 51. Effective May 1, 2006, local ordinances which require permits for livestock facilities must follow state siting rules. The siting standards only apply to new and expanding livestock facilities in areas that require local permits, and then only (in most communities) if they will have 500 animal units (AU) or more and expand by at least 20 percent. For more information, refer to http://datcp.state.wi.us/arm/agriculture/landwater/ livestock_siting/siting.jsp.

5.1.15 Mining Regulations Wis. Stats. §295.13, 295.20, & NR 135

Mining regulations are in flux this sub-section may be outdated. There are many environmental and water quality concerns associated with the more recent interest in frac sand mining and processing. The WDNR is the primary state agency regulating these environmental impacts of sand mining and processing plants. See http://dnr.wi.gov/org/aw/wm/mining/nonmetallic/ for more information. Wisconsin Statutes §295.13 requires all counties to enact a nonmetallic mining reclamation ordinance that complies with state rules (NR 135). This approach establishes statewide uniform reclamation standards with permitting administered locally. County non-metallic mining ordinances apply to the entire area of the county, except for cities, villages, and towns that enact their own such ordinance which complies with state rules. Metallic mining (e.g., copper, gold, silver, iron, lead) is regulated by Wisconsin DNR under state statutes and administrative codes. As stated within the Guide to Community Planning in Wisconsin, if a metallic mining operation complies with all applicable laws, meets all protection standards, complies with local zoning regulations, and minimizes impacts to wetlands, WDNR must issue a mining permit.2

5.1.16 Drainage Districts Wis. Stats. §88

Wisconsin Statutes allow for the creation of drainage districts for the draining of land for agricultural use. A board is established for the district with the power to plan, purchase, repair, and construct drains. Only one drainage district exists in west Central Wisconsin-the Little Missouri Drainage District which covers five sections of the Town of Eau Galle in Dunn County.

5.1.17 Erosion Controls Wis. Stats. §59.974, 61.354. 62.234, & 144.266

In addition to the state regulations previously mentioned, counties are authorized to enact ordinances to control construction site erosion applicable to all its unincorporated areas. Cities and villages are authorized to enact similar ordinances. Within the watershed, such regulations are typically included as part of subdivision ordinances.

A complete listing of City of Rice Lake Ordinances is available at http://ecode360.com/RI1728?needHash=true.

A complete listing of Barron County Ordinances is available at http://www.barroncountywi.gov/index.asp?Type=B_BASIC&SEC=%7B5849F663-F197-46AF-9020-7123068F82DF%7D.

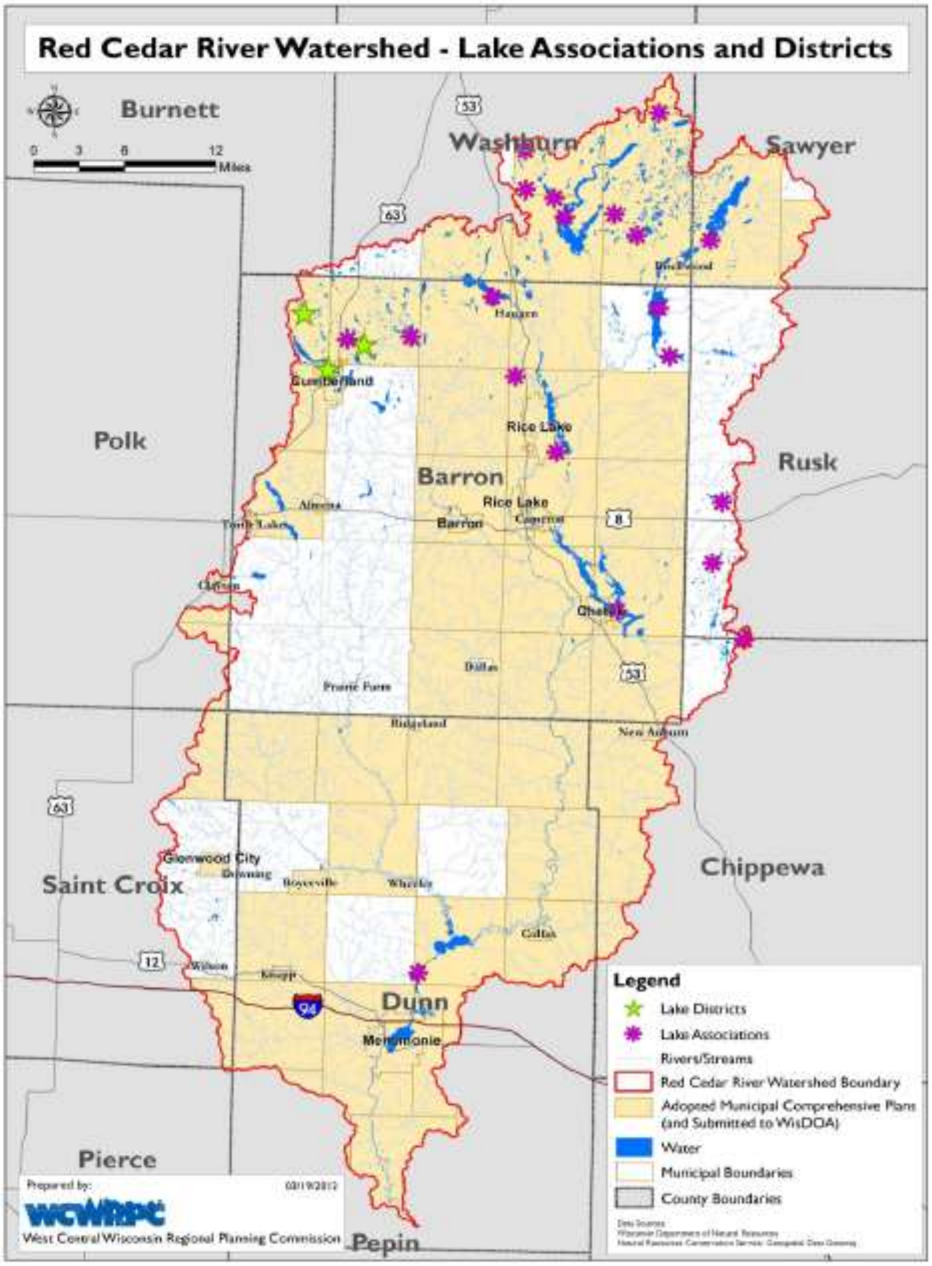


Figure 15 - Adopted Municipal Comprehensive Plans & Lake Associations and Districts –Red Cedar River Watershed

6.0 Lake and Watershed Assessment

Previous studies have found that the watershed is the primary source of nutrients to Rice Lake and internal loading (for example, sediment release of phosphorus) is only a minor source (James, 2001). Figure 13 shows an estimate of those phosphorus sources that actually can be manipulated in various ways to reduce the overall load into Rice Lake. This figure is not intended to be a full phosphorus budget, but does provide a general account of the phosphorus sources and the estimated load. The 100 square mile drainage area of concern is the target for management activities directed at reducing runoff and the sediment, nutrients, and pollutants it carries.

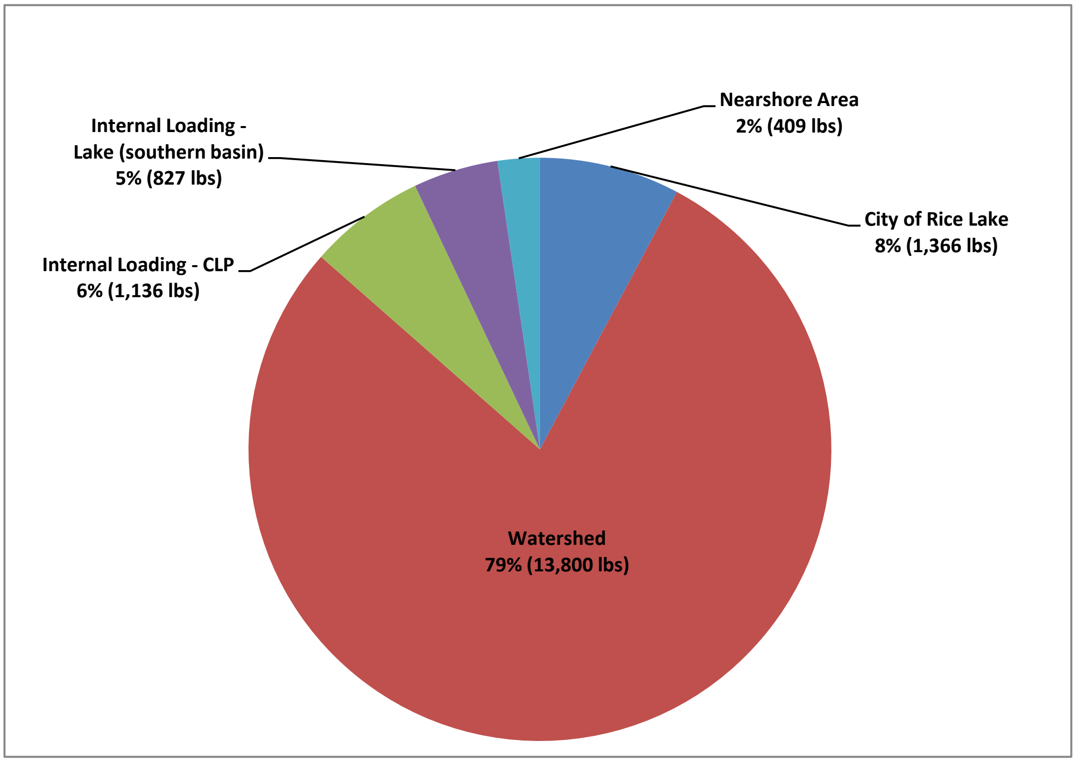


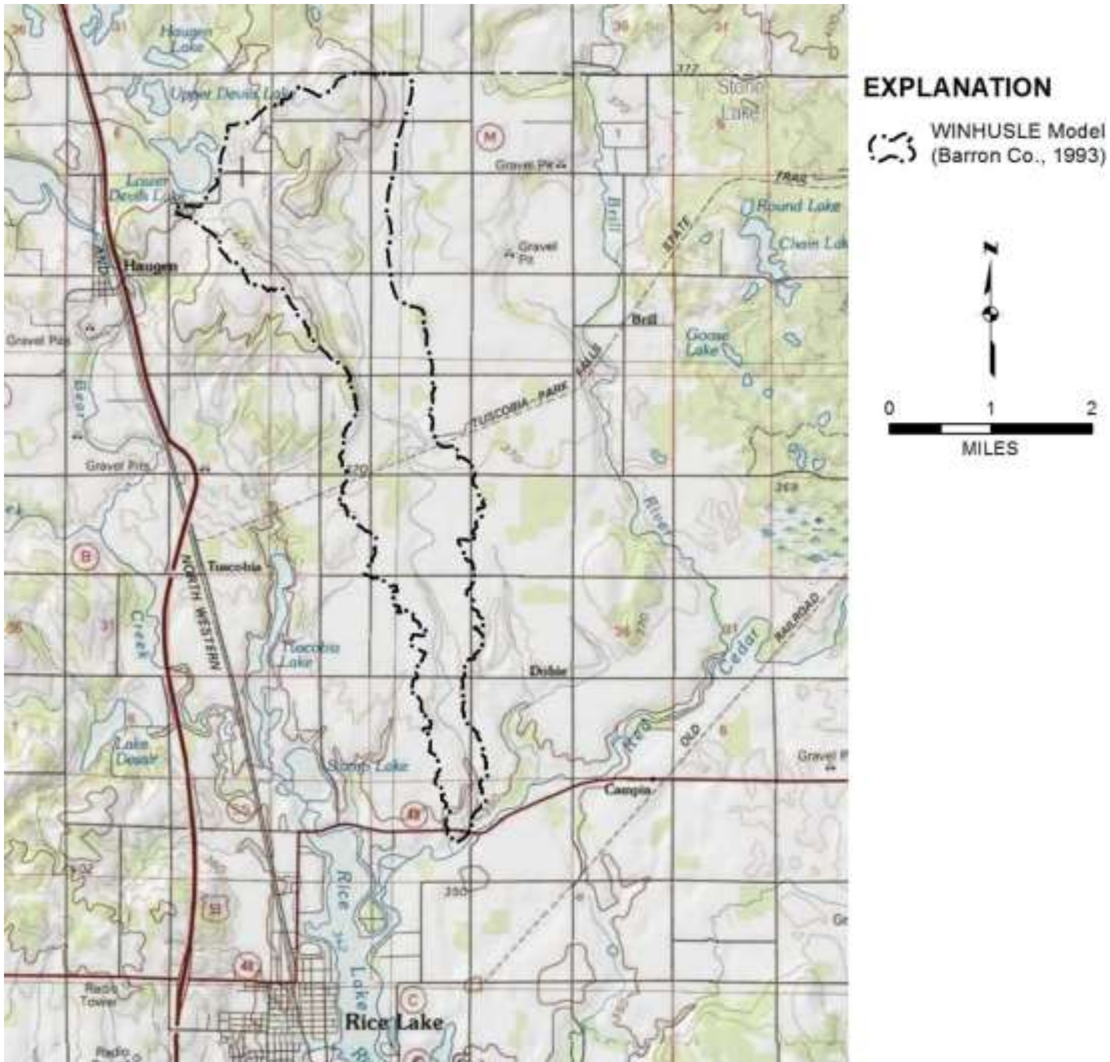
Figure 16 - Estimated Total Phosphorus Load from Sources that can be Manipulated

6.1 Watershed Sources

Several studies have been completed within the last 20 years that assess the sediment and nutrient load coming into Rice Lake from the watershed. Within the watershed, three main tributaries feed the lake: Bear Creek, the Brill River, and the Red Cedar River. In addition, there is a “super waterway” (so called for its extent across the watershed) that only carries runoff during spring snowmelt and large rain events.

6.1.1 Agricultural Land Use

An analysis of nutrient and sediment loading coming from this super waterway was completed by Barron County using the WINHUSLE model (Olson and Hanson, 1993). The area modeled was an approximately 4,000-acre agricultural subwatershed east of Rice Lake (Figure 13). The model estimated that 34 tons of sediment and 205 pounds of phosphorus entered this tributary each year. When extrapolated for the entire drainage area of concern, it was estimated that more than 300 tons of sediment and 1,800 pounds of phosphorus enters Rice Lake from crop fields each year.



Source: U.S. Geological Survey 1:100K Topographic Maps

Figure 17 – 1993 WINHUSLE Model Boundary

More recent limnological investigation of Rice Lake found measured total phosphorus and sediment loads to be greater than that estimated in 1993. Through the growing season (May through September) nutrient and sediment loads to Rice Lake from the Red Cedar River and Bear Creek were calculated using flow and water quality measurements from the streams (James, 2001). The Red Cedar River was found to contribute greater than 60% of the total nutrient and sediment loads to the lake (Table 7). Particulate (suspended or sediment-bound) phosphorus dominated the load to the lake with soluble reactive (dissolved) phosphorus comprising about 20% of the total phosphorus load.

Table 7
Summary of Summer External Loads to Rice Lake

	May-September Load, in tons		
Source Water	**Total Suspended Sediment**	**Total Nitrogen**	**Total Phosphorus**
Red Cedar River	485	99	4.2
Bear Creek	276	38	2.7
Total	**761**	**137**	**6.9**
Source: James, 2001			

The sediment and nutrient load coming into the Red Cedar River via the Brill River has never been quantified, though it was included in the 2001 calculations associated with the Red Cedar River.

As part of the development of this plan, the County reassessed the status of agricultural practices in the watershed and identified a number of farmed waterways that likely provide a substantial amount of sediment and nutrients to the lake during spring runoff and extreme rain events (Figure 16). Depending on the width of the grassed waterway that could be installed (40-60 ft), these 30 sites cover 44 to 66 acres and extend 48,000 ft. or more than nine miles. Runoff from one of these waterways during the 2013 spring snowmelt is shown in Figure 17. Studies by the University of Wisconsin Discovery Farms have found that close to or more than 50% of annual sediment and nutrient losses from fields occurs during the largest rain event of the year.

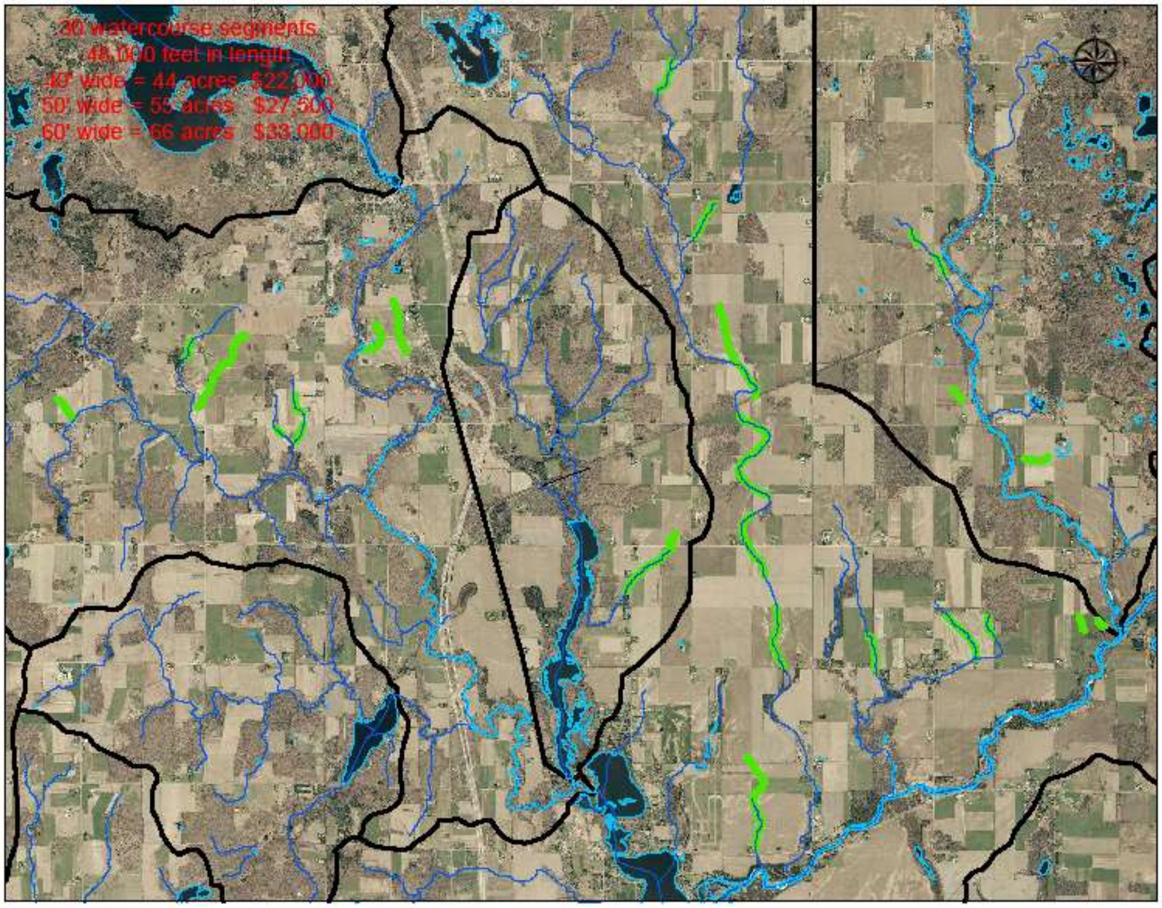


Figure 18 – Potential Grassed Waterways in the Rice Lake Drainage Area of Concern

Figure 19 – Runoff from a field in the Rice Lake watershed during the 2013 spring snowmelt

The Bear Creek, Brill River, and Red Cedar River shorelines were surveyed by boat in the summer of 2013 to ground-truth the status of best management practices, identify areas of concern, and note the presence or absence of invasive species including purple loosestrife, phragmites, and Japanese knotweed. Results of this survey can be found in Appendix B.

Areas of immediate concern along the two waterways were found to be minimal. Along the Red Cedar River, runoff from a farm at Highway 48 and 23rd Avenue appeared to have a direct path to the stream. Concerns along Bear Creek include the construction site at Haugen (discussed below), cattle fencing intended to keep cattle out of the water in disrepair, trash dumps next to the creek, and ditch erosion along the southwest corner of the Highway 48 Bridge between Stump Lake and Rice Lake. Honeysuckle and reed canary grass dominated the shores of Bear Creek.

Although there were very few immediate areas of concern along these waterways, adequate buffering as recommended by the Natural Resource Conservation Service (NRCS) is not in place along the entire stretch. The NRCS recommends a 160-ft buffer along a stream corridor through agricultural lands. Approximately 28 acres of agricultural land along Bear Creek between Haugen and Rice Lake have been identified within the recommended buffer area. These sites are present on approximately 10 different properties and range in size from just over a half acre to as much as 7.5 acres. Approximately 62 acres along the Brill River between the Long Lake Dam and the Red Cedar River where stream corridor buffers do not meet the 160-ft have been identified. These sites are present on approximately 13 different properties ranging in size from just under an acre to as much as 9.0 acres.

Converting these lands to a conservation buffer would reduce runoff into Bear Creek and the Brill River from the farmlands. The buffer could be a grassed field border, or it could be a full riparian forest cover restoration project.

The Barron County Soil and Water Conservation Department has worked closely with a number of agricultural producers in the watershed and has already installed best management practices to reduce runoff and erosion from both cattle and row crop operations in many places. Many of the problem areas identified during previous studies of the watershed had best management practices implemented via County cost-sharing programs and WDNR Targeted Runoff Management grants

6.1.2 Construction Site – Hwy 53 & V Interchange

Heavy sediment loading occurred in 2012 from a highway construction project upstream near Haugen. Multiple releases of fine silt from the construction site during rain events created a sediment plume that began at the southern end of Bear Lake and traveled nine miles into Rice Lake. A biological assessment of Bear Creek was conducted by the WDNR following the sediment and runoff releases. The degree and extent of resource impacts from the documented construction site sediment releases could not be precisely quantified due to limited background data prior to highway construction and the lack of more extensive sampling and survey work within the entire watershed following the sediment release events. Based on the evidence available, the construction site sediment discharges were not likely significant enough to cause large-scale mortality in fish given the particular circumstances, but may have negatively impacted spawning of a number of fish species. It is also likely that the sediment carried a large phosphorus load which was delivered to Rice Lake. The Wisconsin Department of Transportation has provided funds to the District for mitigation.

One of the issues that came to the forefront during the discussion of potential remediation activities was the lack of background or baseline data on Bear Creek. It was difficult to clearly define the extent of the damage to Bear Creek caused by the sediment release because there was very little baseline data that represented conditions in the creek before the release. In an effort to prevent this from being the case in the future on Bear Creek and on other tributaries in the Bear Lake and Rice Lake watersheds, it is recommended that baseline water quality data be collected from multiple sites throughout the watershed where data is lacking (Bear Creek, Little Bear Creek, Brill River, Red Cedar River, and the 7-mile Central Draw) for a period of at least two years. Water quality (nutrients, suspended sediment, metals) and biotic index (fish, invertebrates) sampling should be included for a period of at least two years.

6.2 Nearshore Land Use

According to The Lakes of Barron County (Thorson, 1996), Rice Lake has approximately 14.43 miles of shoreline. At that time there were 331 dwellings on Rice Lake, 22.9 dwellings for every mile of shoreline. There were 130 lawns mowed down to the edge of the water, and 135 shoreland protection structures in place. A shoreline survey completed in 2008 found approximately 59% or 8.5 miles of the Rice Lake shoreline was in a disturbed or unnatural state. Approximately 78% or 6.6 miles of this disturbed shoreline was mowed lawn down to the edge of the lake.

Approximately 39.5% or 5.7 miles of the total shoreline had some sort of shoreline protection structure in place. These structures ranged from rock rip rap, to concrete barriers, to wooden retaining systems. The remaining 41% or 5.9 miles of the shoreline was considered to be in a natural state where upland forests were the main type of cover at 61% or 3.5 miles of shoreline, followed by shrub cover at 32% or 1.9 miles of shoreline.

6.2.1 Impervious Surfaces

The amount of impervious (non-permeable) surface in the nearshore area of Rice Lake has not been quantified to date; however, the impacts of impervious surfaces on water quality are well known. Different land uses have different levels of impervious surface (Figure 14) (Markham, 2003). The total coverage by impervious surfaces in an area (for example, a watershed, or within a municipality) is usually expressed as a percentage of the total land area. The coverage increases with rising urbanization. In rural areas, impervious cover may be only one or two percent. In residential areas, coverage increases from about 10 percent in low-density subdivisions to over 50 percent in multi-family communities (Figure 14). In industrial and commercial areas, coverage rises above 70 percent, and in regional shopping centers and dense urban areas, it is over 90 percent.

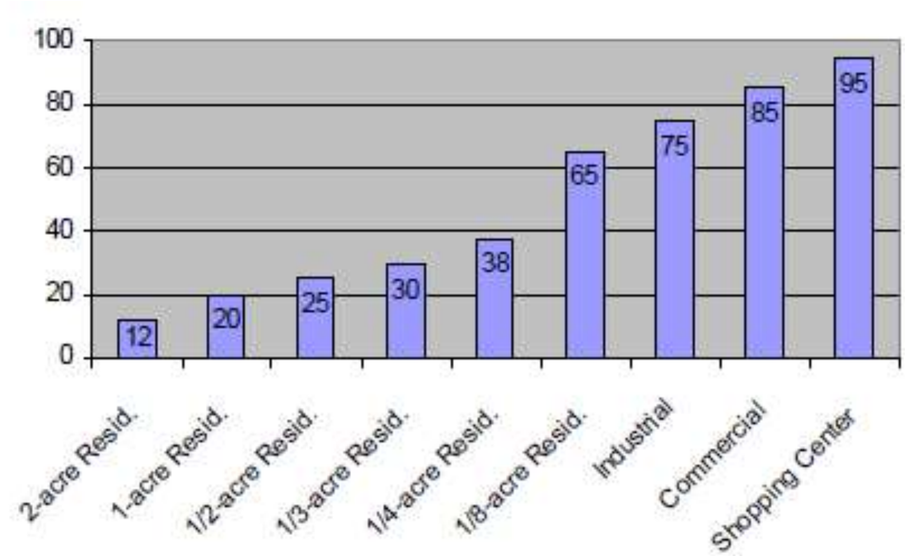


Chart adapted from Ferguson, B. K. 1998. *Introduction to Stormwater: Concept, Purpose, Design*. New York: John Wiley & Sons.

Figure 20 – Average Percentage of Impervious Cover by Land Use

Impervious surfaces closer to the water have a greater negative impact on water quality because there is less opportunity for the runoff from these areas to soak into the ground or be filtered before reaching the lake or stream. The findings from a study of 47 watersheds in southeastern Wisconsin indicated that 1 acre of impervious surface within 100 meters (~330 feet) of the stream had a negative effect on fish populations and diversity equivalent to 10 acres of impervious surface more than 100 meters from the stream (Markham, 2003).

Lawns often comprise the largest fraction of land area within low-density residential development and often have similarities with impervious surfaces. Although lawns are pervious, they have sharply different properties than the forests and farmlands they replace. Compared to forests and farmlands, residential lawns generally have more compacted soils, greater runoff and much higher input of fertilizers and pesticides (Markham, 2003). A pound of soil in a lawn has 24% less volume than forest soil and 15% less volume than pasture soils (Figure 15). The decreased volume of the lawn soil reflects decreased pore space and ability to infiltrate water, resulting in increasing runoff. Cultivated soils and lawn soils are similar to each other due to disturbance and compaction. The soil cover also affects water quality. For example, blades of turf grass are flat and easily flattened during a runoff event whereas native grasses and forbs typically have round, square or triangular stems that stay upright to slow runoff velocity and filter it during a storm (Markham, 2003).

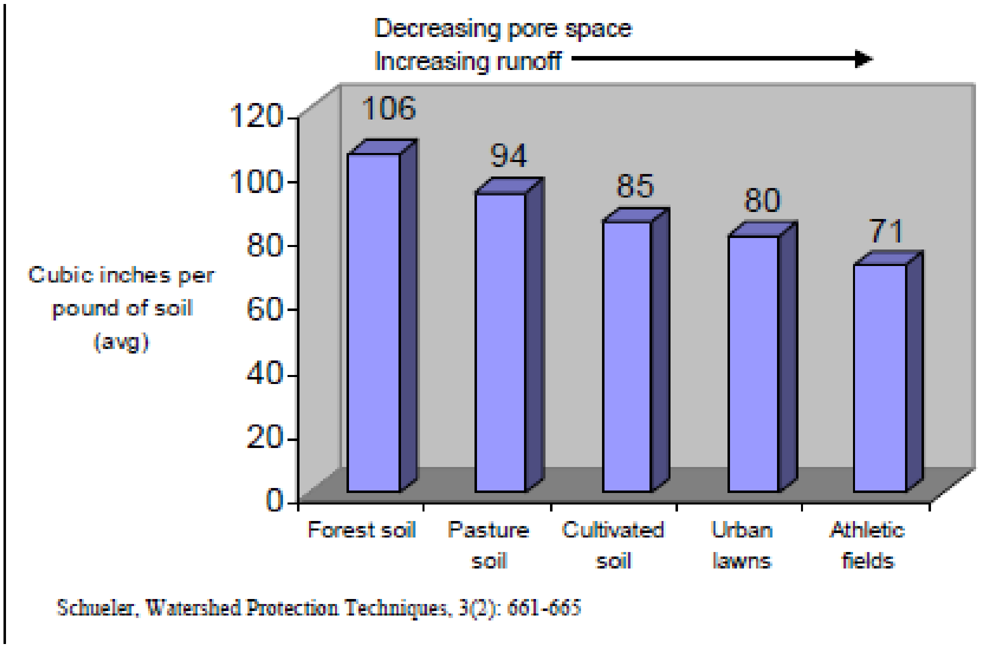


Figure 21 – Soil Compaction with Different Land Uses

Identifying and protecting the remaining natural shoreline, restoring disturbed shoreline with shoreland improvement best management practices, and reducing the amount of impervious surface and turf grass in the nearshore areas of Rice Lake and in the broader area of the City of Rice Lake would reduce the amount of runoff that carries suspended solids, phosphorus, and other pollutants into the lake. In addition, fish and wildlife habitat would be improved.

6.3 Urban Stormwater

Another significant source of nutrient loading to the lake is the City of Rice Lake municipal storm water sewer system. The bulk of the urban land use in the Brill and Red Cedar River Watershed is contained within the boundaries of the City of Rice Lake. Stormwater management planning completed in 2008 estimated that the City of Rice Lake contributes approximately 1,366 pounds of phosphorus to the lake annually, an average of 2.02 pounds per acre. The portions of the City contributing the most phosphorus are the northwest development area, the Barron County Fairgrounds, and the downtown business district.

The total impervious surface area in the City has increased at a rate greater than population growth. Approximately 25% of the total drainage area within the corporate limits of the City drains to Rice Lake and the remainder flows to the Red Cedar River below the Rice Lake dam. Most of the development in the last ten years has included on-site stormwater treatment via retention ponds and other best management practices which have minimized total impacts to some degree.

In 2011, the WDNR required the City of Rice Lake to implement a municipal separate storm sewer system (MS4) permit to reduce and limit the amount of sediment and pollutants entering surface water and groundwater from the Rice Lake storm sewer system. Under the permit, the City is required to provide public education and outreach, identify illicit discharges, map the storm sewer system, initiate a pollution prevention program, and reduce total suspended solids (TSS) in runoff initially by 20% and eventually by at least 40%. A study completed in 2012 found that approximately 27% of the annual TSS and 30% of the annual phosphorus discharges from the City are delivered directly into Rice Lake.

The City has been taking steps to reduce TSS discharged from the MS4 system including a street sweeping program designed to target streets that generate the most pollutants and have the highest probability to negatively impact receiving waters. In 2011, with funds generated by a storm water utility, the City purchased a vacuum sweeper, which is much more effective at pollutant removal than conventional mechanical sweepers. The City has also constructed four storm water detention/infiltration basins in the north industrial park to complement the existing 20 storm water ponds in the industrial park. New development and redevelopment sites in the city are required to comply with the TSS removal standards in DNR rule NR 151, which will augment the overall TSS removal in the MS4 system. The City storm sewer system currently has 10 storm sewer sumps that are cleaned regularly to supplement TSS and phosphorus removal.

The City of Rice Lake has also made some changes in their snow removal and storage procedure. The City has relocated snow storage locations to areas that minimize the pollutant delivery to Rice Lake and the Red Cedar River. One of the primary snow storage locations, near the Lumbering Hall of Fame site, includes overland sheet flow filtration and infiltration of runoff followed by routing through a recently constructed wet detention basin, before overflow into Rice Lake.

The City has applied for WDNR Urban Non-point Source grant funding assistance for on- going MS4 Permit compliance activities and capital improvements to further enhance the efficiency of the MS4 system pertaining to TSS removal. Additional funding to help implement projects associated with the MS4 Permit is gathered through a storm water utility fee. Since the storm water utility was implemented in 2011, the structure of the fee has changed several times, but it only provides revenue for on-going maintenance. New projects are now funded by other means such as borrowing. There are currently no “credits” to reduce fees associated with the storm water utility given to businesses or general property owners for implementation of best management practices that may further reduce TSS and phosphorus loading.

The Lake District will work closely with the City of Rice Lake and encourage the City to go the extra mile to reduce the TSS and other pollutant loads, and when appropriate or possible, provide funding support. One example of a project like this is improvements being planned on Humbird Street between Main Street and Lakeshore Drive near downtown Rice Lake in 2014. Currently, planning for street and storm water improvements ends at Lakeshore Drive, and is not continued to the lakes’ edge. The RLPRD has proposed to add funds to install a grit chamber at the outfall from this street to the lake.

6.3.1 Barron County Fairgrounds

Sediment- and nutrient-laden runoff into the lake from the Barron County Fairgrounds in Rice Lake has been considered a problem for some time. In 2008, 15 storm sewer sub-basins in the City of Rice Lake draining to the lake were analyzed to determine their individual phosphorus contributions to the lake (Appendix C). Sub-basin 6, which encompasses approximately 25 acres of the Barron County Fairgrounds, drains to an outfall that enters Hospital Bay near Lakeshore Drive in front of the old hospital. Sub-basin 6 has the third highest loading rate per unit area, or yield, of all 15 basins at 3.11 pounds per acre (Appendix C). The phosphorus load from sub-basin 6 comprises 5.62% of the total phosphorus load to the lake from the storm sewer system, ranking it as the fourth largest offender overall.

Although a major phosphorus contributor to the lake, sub-basin 6 is a private storm sewer line and is therefore a low priority target for improvements by the City of Rice Lake. The City of Rice Lake, the District and the owner should determine roles (finding, design, and implementation) in moving forward with addressing this outlet.

There are several catch basins along the northern edge of the fairgrounds and a large catch basin at the east end of the track. There are also several waterways that carry runoff from rooftops and the roadway to the catch basins. Although there are two holding tanks built specifically for handling manure and other waste during times when animals are at the fair, runoff from the larger area still carries pollutants and sediments from the site to the lake. The City of Rice Lake continuously gets calls about stormwater from this outfall turning the lake brown in Hospital Bay.

The Barron County Fair Board has taken considerable measures to reduce the runoff from the fairgrounds to the lake in the last few years; however, it appears most of these measures are temporary and may not be having that great an impact. A site visit by a stormwater engineer working for the City of Rice Lake identified several projects that could be completed, including:

- A number of potential sites for a bio-engineered grassed waterways and retention areas.
- Improvements to the catch basin on the east side of the track to make it safer and more efficient, and
- The installation of storm sewer sumps in several of the existing catch basins to trap more suspended solids before emptying to the lake.

There are several issues that complicate possible fairgrounds projects, including the possibility that the existing clay track may be removed from the fairgrounds. A full engineering study of the fairgrounds area and the development of a site plan identifying multiple projects that would improve the area are recommended. The estimated cost for an engineering study of the site is $10,000. It is recommended that the District work with the Barron County Fair Board and other stakeholders to complete a detailed analysis of the fairgrounds area to determine what best management practices would provide the greatest reduction in pollutants entering the lake from this sub-basin. Dredging may be required to restore the bay to an ecologically healthy shallow water system once the pollutant source is eliminated. The District should evaluate the need and feasibility of dredging the area near the outlet and should take sediment samples for analyses of pollutants to determine the proper method of disposal of the dredge spoils.

6.3.2 Old City Beach

As mentioned previously in this report, a proposal has been approved to design and build a new public beach at the Narrows Park, which the District intends to support in concept, by providing beach maintenance, and possibly with financial assistance. There is a concern about the fate of the old beach at Lakeshore Drive. The old changing rooms will need to be removed and the site restored to a more natural state. The District supports a full shoreland restoration at this site and wishes to use it as a demonstration for shoreland restoration on the lake and to showcase restoration potential. It is recommended that the District collaborate with area stakeholders near the old beach site, the City of Rice Lake, a shoreland consultant, and local organizations like the Rice Lake Men’s Club, the School District, Master Gardeners, and the Rotary Club to develop a plan for restoring the site, followed immediately by implementation of the plan.

6.4 Internal Loading

During storm inflow periods, the hydraulic residence time of the lake complex (Rice and Stump Lakes) is < 10 days. During extended periods of lower flow, lake hydraulic residence times are much higher, ranging between 12 and > 30 days. Overall, average flows for the Red Cedar River (7.6 cms) were 2.2 times greater than average flows for Bear Creek (3.4 cms) during the summer. The average lake hydraulic residence time of the lake complex was 15 days in 2001.

The estimated lakewide rate of external phosphorus loading was 9.4 mg m-2d-1 for the period May through September. The estimated lakewide rate of phosphorus release from sediment for the same summer period was only 0.4 mg m-2d-1. Thus, external phosphorus loadings appeared to dominate phosphorus dynamics in the lake complex, based on budgetary comparison of measured external and internal phosphorus loadings (James, 2001).

Although external phosphorus loading dominates the phosphorus dynamics in Rice Lake, internal loading rates from sediments under anoxic conditions was found to be higher than those from other eutrophic lakes (James, 2001). As an example, the more isolated southern lobe of Rice Lake exhibited an extended period of thermal stratification between mid-June and early August. Associated with stratification in this region of the lake complex was the occurrence of dissolved oxygen depletion and development of anoxia in the bottom waters below about 4 meters of 15-ft. Coincident with hypolimnetic anoxia was the development of elevated concentrations of phosphorus in the bottom waters, indicating some internal loading of phosphorus from the sediments at this location. An estimate of the amount of phosphorus released into the southern basin from the sediments is about 827 lbs, about 5% of the total load calculated for this plan.

Other stations in Rice Lake, located closer to the influences of the Red Cedar River and Bear Creek, exhibited only very brief periods of stratification and bottom water anoxia due, presumably, to the flushing influences of the tributary inflows. Phosphorus increases in the bottom waters were much less at these stations.

External phosphorus loads are much more important in regulating algal productivity in the lake complex than internal phosphorus loads. Despite this, and given that Lower Rice Lake (the southern basin) is short-circuited from much of the watershed and remains stratified with anoxic conditions throughout the summer months, in-lake improvement options such as aluminum sulfate (alum) application or artificial circulation (for example, hypolimnetic aeration) may be feasible alternatives for improving water quality. A feasibility analysis for controlling internal phosphorus loads in Lower Rice Lake should be prepared to evaluate expected costs and benefits.

Curly-leaf pondweed dies in early summer each year, releasing phosphorus and other nutrients into the water column which can fuel algae growth. The current Aquatic Plant Management Plan estimates that harvesting and early season herbicide control substantially reduces the potential phosphorus load from curly-leaf, from an estimated 1,136 pounds per year to 568 pounds per year. The internal loading of Rice Lake should continue to be reduced through curly-leaf control activities.

Reducing the watershed phosphorus load would have an indirect benefit of reducing dissolved oxygen depletion in bottom waters and therefore reduce sediment phosphorus release as well.

7.0 Water Quality Targets

Changes to lake water quality following changes in external nutrient loading were evaluated as part of the 2001 U.S. Army Corps of Engineers study of Rice Lake. In Rice Lake during the summer, nuisance algal blooms (viable chlorophyll a concentrations greater than 30 mg/m³) currently occur approximately 23% of the time, total phosphorus averages about 43 µg/L and Secchi depth averages about 4 feet. Modeling suggests that the lake could respond dramatically to changes in phosphorus loading. For example, a 50% reduction in the external phosphorus load would result in nuisance algal blooms occurring only 2% of the time in the summer (Figure 18), decrease total phosphorus to about 26 µg/L, and increase water clarity to over 6 feet (James, 2001).

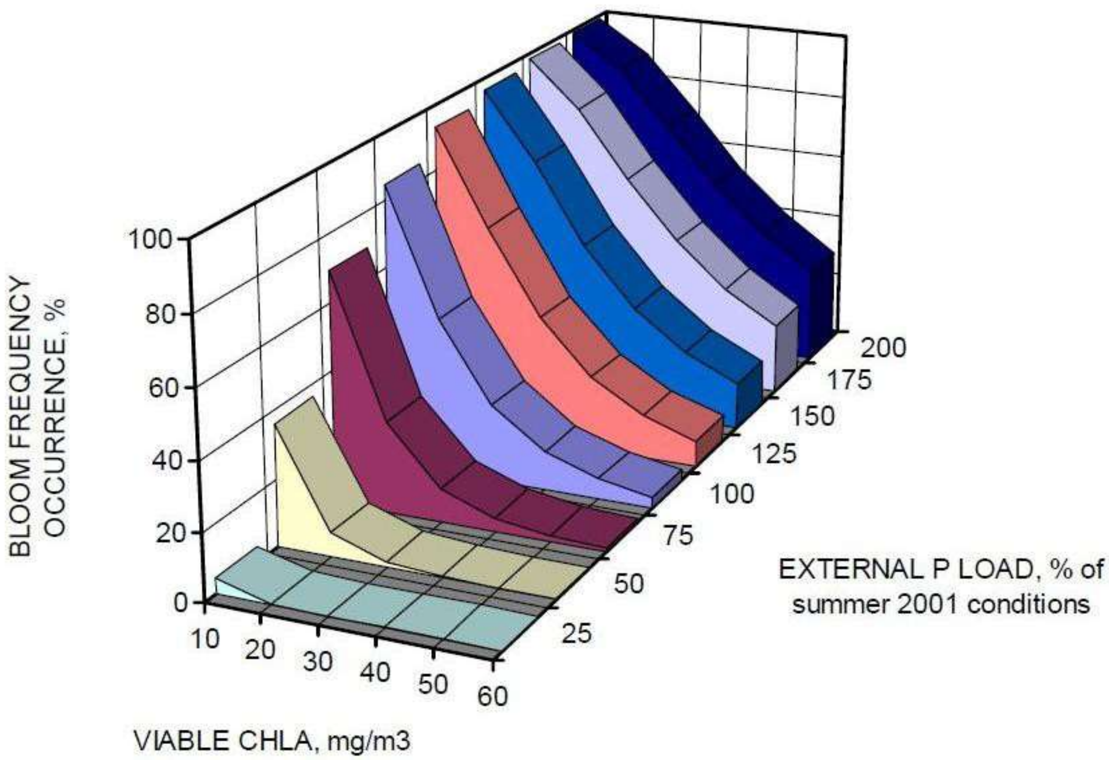


Figure 22 – Estimated changes in algal bloom frequency in Rice Lake due to changes in external loading

Reducing the phosphorus load from the watershed by 25% is a reasonable target based on the urban and agricultural best management practices that can be implemented within the Rice Lake drainage area of concern. This equates to the external load from the Red Cedar River and Bear Creek being reduced from 13,746 to 10,310 pounds per year, or a reduction of 3,436 pounds per year. The largest reductions will be realized via considerable outreach to the agricultural community and through the implementation of nutrient management plans, cover crops, conservation tillage, grassed waterways, designed filter areas, and riparian buffers.

A 25 % reduction in the external phosphorus load will result in a decrease in nuisance algal bloom frequency to about 10% of the time. Total phosphorus levels will decrease to about 38 µg/L, which is below the NR 102 water quality standard of 40 µg/L for impoundments, and water clarity will increase from about 4 feet to 5.3 feet.

8.0 Management Practices to Reduce Phosphorus Loading

It is important to distinguish between the forms of phosphorus (particulate or dissolved) as their modes of transport to the lake are different. Particulate phosphorus is associated with soil and vegetative material eroded during runoff and is commonly the most dominant form of phosphorus. Dissolved phosphorus in runoff originates from the soil surface and from vegetative material that interacts with rainfall. Desorption, dissolution, and extraction of phosphorus from the soil, plant residues (crops and lawns), animal waste (pets and livestock) or surface-applied fertilizer lead to dissolved phosphorus movement in runoff.

Best management practices for the dissolved and particulate forms of phosphorus are different. Particulate phosphorus is controlled primarily by reducing overland flow and stream/lake shore erosion (infiltration ponds, buffers, grassed waterways, no-till agriculture, etc.) whereas dissolved phosphorus control focuses on nutrient management (zero-P lawn fertilizers, cropland nutrient management plans, manure management, etc.). Both particulate and dissolved phosphorus lead to eutrophication and are available to algae; therefore, the loading of each must be reduced to improve the water quality of Rice Lake.

The following sections lay out what BMPs will be encouraged to reduce external and internal phosphorus loading to Rice Lake. Where possible, an estimate of how much phosphorus reduction could be attained is made.

8.1 Agricultural Best Management Practices

No-Till

Many different agricultural best management practices can be used to reduce both particulate and dissolved forms of phosphorus entering the lake. Converting current cropping practices to no-till has been estimated to reduce both sediment and phosphorus loading by 70% or more (Huggins & Reganold, 2008). Based on the cropland estimated at nearly 17,000 hectares in the Brill and Red Cedar Rivers Watershed, and then estimated down to just the area of concern affecting Rice Lake, there is approximately 12,500 acres of cropland (corn, soybeans, and potatoes). Using a low value related to the amount of phosphorus coming off a hectare of cropland annually (0.5 kg/hectare/year, (Kramer et al., 2006) and coordinating values with the 2001 ACOE report, converting all that cropland to no till would reduce the phosphorus load by more than 9,000 lbs. Converting 25% of that cropland to no till would reduce the load by approximately 2,200 lbs annually.

Grassed Waterways

Barron County identified locations for grassed waterways that cover between 40 and 60 acres depending on the width of the waterway. If all of these areas were taken out of row crop production, it would be possible to reduce the phosphorus load carried to the lake through these waterways by as much as 180 lbs annually.

Streambank Buffers

As much as 90 acres of streambank along Bear Creek and the Brill River has been identified as not meeting NRCS suggested 160-ft wide buffers. If all of these areas could be restored to the 160-ft, it is possible to reduce the phosphorus load from these area by about 240 lbs.

Other Agricultural BMPs

There are many more BMPs that could be implemented by the agricultural producers in the Rice Lake area of concern that could reduce both dissolved and particulate phosphorus loading. Nutrient management planning, manure management, rate and timing of manure application to fields, cover crops, other forms of conservation tillage, grazing management, field borders, critical area planting, wetland restoration, water diversions, and proper manure storage are all examples of BMPs that will be encouraged throughout the watershed. To promote these and other BMPs, the Lake District will work with Barron County and other resources to provide outreach and education, possibly providing incentive programs to get local farmers to participate.

8.2 Construction Site Best Management Practices

Several construction sites within the watershed have been identified as contributing unnecessary amounts of phosphorus and sediment to Rice Lake and the tributaries that feed it. The biggest offender in the last couple of years was the construction site at the new Highway 53 and County Highway V interchange near Haugen, WI. Because of issues in 2012 and 2013, the WDOT made funds totaling $70,000.00 available to the Bear Lake Association and Rice Lake-Lake Protection and Rehabilitation District to implement BMPs in the watersheds of Bear Lake and Rice Lake. These funds are currently being utilized to support BMPs, and are expected to be used as sponsor match for a lake protection grant to be applied for by the Lake District in early 2015.

Even though a great deal was done at the Hwy 53 & V construction site to remedy heavy runoff from the site into Bear Creek, there are still problems at the site. The Lake District will continue to watch this site and work with local residents, the WDNR, Barron County and others to reduce future phosphorus and sediment laden runoff from the site.

Another major source of phosphorus and sediment laden runoff into Rice Lake is coming from the new industrial park on the northwest edge of the city. Although businesses locating in the industrial park are required to have engineered runoff control measures in place, and there is an existing complex of holding areas and ditching, more can be done to reduce loading from this site. The Lake District will continue to work with the City to support runoff reduction projects in this area.

There have been and continues to be multiple smaller construction sites throughout the watershed and within the Rice Lake city limits. Ensuring that proper and appropriate runoff control measures are in place, erosion site repair, and other BMPs are implemented as needed, will help to reduce runoff from these sources.

8.3 Nearshore and Urban Runoff

The nearshore area of the Rice Lake contributes an estimated 2% of the total phosphorus load to the lake. With an estimated 24.3 hectares of mowed lawn to the edge of the lake, installing a 35-ft buffer nets a reduction of about 25%; a 50-ft buffer strip would decrease the phosphorus load by nearly 70%, or from 33 to 286 lbs annually. It is not realistic to assume that all properties mowed to the edge of lake can be buffered, so other BMPs will also be included. Installation of residential rain gardens will aide in the reduction of phosphorus and suspended sediments. While it is difficult to directly quantify their benefit or to determine the number of rain gardens needed, recent research indicates that when installed properly, a rain garden can reduce surface water runoff out of the garden by up to 48%. Total phosphorus can be reduced by up to 75%, and total suspended solids reduced by up to 92% (MN PCA, 2005).

The Rice Lake-Lake Protection and Rehabilitation District made up to $20,000.00 available to property owners and renters within the Boundaries of the Lake District for planning and implementation of nearshore and urban best management practices. The Lake District will continue to make up to $20,000.00 available annually throughout the implementation of this plan. The Lake District has retained the services of a local shoreland improvement consultant to provide evaluation and planning services for property owners and renters with in the Lake District boundaries, and will provide as much as 50% cost-sharing in actual projects. It has also partnered with a local proponent of rain gardens who has a goal of installing 1000 rain gardens throughout the Red Cedar River Watershed in 10 years.

It has been estimated that the total phosphorus load to Rice Lake from those portions of the City that drain to Rice Lake is about 1366 lbs annually. As a part of Rice Lakes MS4 designation, the City would be required to reduce phosphorus loading from the City by 20 to 40%. This would be accomplished by incorporating more and better street sweeping, yard waste collection, installing new holding ponds and retention basins, supporting the installation of rain gardens, curb cuts, and other urban BMPs, and repairing erosion sites along the lakeshore. It is also important for the City to incorporate appropriate runoff control measures in any new development in the City. The City of Rice Lake will be soliciting funding from various sources to help meet this goal. The Lake District will do its part with available funding and public education to support the City's efforts. The Lake District has already been working with the City to do shoreland improvement/restoration projects, and to promote larger engineered BMPs to handle runoff. One such example is the installation of a vortex grit chamber at the lake end of Humbird Street in downtown Rice Lake scheduled to be completed in 2015.

There are several areas of greater concern within the Rice Lake city limits. Of all the sub-basins contributing phosphorus to the lake, the sub-basin that is made up primarily of the Barron County Fairgrounds is the worst offender. The Lake District, City of Rice Lake, and Barron County must work with one another to determine how best to change the current makeup of the fairgrounds. One way of doing this is to contract with the City Engineer to assess the entire fairgrounds area for possible projects, large and small, that would reduce runoff from the site into the lake. Another such site is the old City Beach. If plans continue as they are now, the City will invest in the development of a new beach area on the lake. When and if that happens, what to do with the old site will need to be discussed. It would be a great opportunity to remove impervious surfaces caused by the old beach site and beach house immediately adjacent to the lake. Restoring this area to a natural state would contribute to the reduction of phosphorus to the lake and be a very public place to showcase appropriate shoreland restoration efforts.

If the city is successful at reducing its phosphorus loading by 20-40% over the next few years, then another 273 to 546 lbs. of phosphorus will be prevented from entering the lake.

8.4 Internal Loading

As mentioned previously, studies done on the Rice Lake indicate that external phosphorus loads are the primary source of excess phosphorus to the lake and should be addressed first. Internal loading from the sediments and from the presence of CLP contributes about 11% of the total. The current Aquatic Plant Management Plan targets at least a 50% removal of the total CLP biomass in the lake annually. If done successfully, then it is possible to reduce phosphorus inputs to the lake by another 500 plus lbs. Although calculations were not made to estimate the total internal loading from the north and central basins of Rice Lake, loading from these areas is likely much less than that which comes from the southern basin. The South Basin of Rice Lake stratifies by mid-June and remains so through mid-September. Approximately 5% of the calculated phosphorus load to the lake comes from the South Basin when bottom waters become anoxic or devoid of oxygen.

If efforts were made to lock up the available phosphorus in the sediments of the South Basin through the application of alum, another 500 lbs of phosphorus could be controlled.

8.5 Phosphorus Reductions

Section 7.0 suggests that a 25% reduction in the overall phosphorus loading would improve water clarity by more than a foot, and reduce TSI values for total phosphorus and chlorophyll a to below levels identified in NR 102 (water quality standards) necessary to maintain appropriate lake use in impounds like Rice Lake. With the actions described here it is possible to reduce the external phosphorus load by more than 25% (Table 8). Many of these actions will require continued promotion by the Lake District and other stakeholders throughout the time period in which this Comprehensive Plan will be implemented.

They will also require follow-up through the Lake District and other stakeholders to insure the BMPs installed and implemented are maintained and stay in place. BMPs planned and implemented as a part of this plan will require a written and signed agreement between the property owner or renter acknowledging participation and expectations. Tracking of participation and required operation and maintenance will be completed by Lake District and County personnel.

Table 8 Possible Phosphorus Loading Reduction Totals for Rice Lake

Phosphorus Source	*Estimated Annual Phosphorus Loading (lbs)	Percent of Load	Source of Data	Target Reduction	lbs of Reduction
City of Rice Lake	1366	7.8	Appendix 1 - 2008 Rice Lake Aquatic Plant Management Plan (data generated by SEH Inc)	30%	410
Watershed-Agriculture, Construction Site Erosioin	13,800	78.7	2001 Limnological Analysis of Rice Lake, Wisconsin (data generated by the USACOE)	25%	3450
Internal Loading - CLP	1136	6.5	2008 Rice Lake Aquatic Plant Management Plan (data generated by SEH Inc)	50%	568
Internal Loading - Lake (south basin)	827	4.7	2001 Limnological Analysis of Rice Lake, Wisconsin (data generated by the USACOE) and 2014 LEAPS	NA	NA
Nearshore Area	409	2.3	2008 Shoreline Survey (data generated by SEH Inc), and 2014 LEAPS	50%	204.5
Atmospheric	not calculated	NA	NA	NA	NA
Groundwater	not calculated	NA	NA	NA	NA
	17538				4632.5

9.0 Implementation and Evaluation

This plan is intended to be a tool for use by the RLPRD to move forward with comprehensive lake management actions that will improve issues of concern as they pertain to Rice Lake. However this plan is not intended to be a static document, but rather it is a living document that will be evaluated on an annual basis and updated as necessary to ensure goals and community expectations are being met. This plan is also not intended to be put up on a shelf and ignored. Implementation of the actions in this plan is highly recommended. An Implementation and Funding Matrix is provided in Appendix D.

10.0 Bibliography

Engel, S. 1990. Ecological impacts of harvesting macrophytes in Halverson Lake, Wisconsin. Journal of Aquatic Plant Management 28: 41-45.

Bowen, K.L., N.K. Kaushik, and A.M. Gordon. 1988. Macroinvertebrate communities and biofilm chlorophyll on woody debris in two Canadian oligotrophic lakes. Archives of Hydrobiology 141: 257-281.

Christensen, D.L., B.R. Herwig, D.E. Schindler, and S.R. Carpenter. 1996. Impacts of lakeshore residential development on coarse woody debris in north temperate lakes. Ecological Applications 6: 1143-1149.

Guyette, R.P. and W.G. Cole. 1999. Age characteristics of woody debris (*Pinus strobus*) in a lake littoral zone. Canadian Journal of Fisheries and Aquatic Sciences 39:257-263.

Heck K.L. and L.B. Crowder. 1991. Habitat structure and predator-prey interactions in vegetated aquatic systems. Pages 281-199 *in* S.S. Bell, E.D. McCoy and H.R. Mushinsky, *eds.* Habitat Structure. Chapman and Hall, London.

Helfman, G.S. 1981. The advantages to fishes hovering in shade. Copeia 2: 392-400.

Huggins D.R.and Reganold, J.P. 2008. No-Till: the Quiet Revolution. Scientific American, Inc.: pp 70-77.

James, W.F. 2001. Limnological Analysis of Rice Lake, Wisconsin. Engineer Research and Development Center, Eau Galle Aquatic Ecology Laboratory. Spring Valley, Wisconsin.

Jennings, M.J., E.E. Emmons, G.R. Hatzenbeler, C. Edwards, and M.A. Bozek. 2003. Is littoral habitat affected by residential development and land use in watersheds of Wisconsin lakes? Lake and Reservoir Management 19: 272-279.

Kramer, D.B., Polasky, S., Starfield, A., Palik, b., Westphal, L., Snyder, S., and Gustafson, E. 2006. A Comparison of Alternative Strategies for Cost-Effective Water Quality Management in Lakes. Environmental Management Vol. 38, No. 3: 411-425.

NRCS Natural Resource Conservation Service. 2008. Rapid Watershed Assessment Red Cedar River Watershed. U.S. Department of Agriculture. 18 pp.

Nichols, S. 1999. Floristic Quality Assessment of Wisconsin Lake Plant Communities with Example Applications. Journal of Lake and Reservoir Management 15(2): 133-141.

RLPRD (Rice Lake Protection and Rehabilitation District). 1994. Aquatic Plant Management Plan for Harvesting.

RLPRD. 2013. Rice Lake Protection and Rehabilitation District, Barron County. 14 Jan. 2013. http://www.rllakedistrict.org/.

Sass, G.G., J.F. Kitchell, S.R. Carpenter, T.R. Hrabik, A.E. Marburg, and M.G. Turner. 2006. Fish community and food web responses to a whole-lake removal of coarse woody habitat. Fisheries 31: 321-330.

Savino, J.F. and R.A. Stein. 1982. Predator-prey interaction between largemouth bass and bluegills as influenced by simulated, submersed vegetation. Transactions of the American Fisheries Society 111: 255-266.

Schmidt, S.M. 2010. Development of Multi-dimensional Littoral Zone Habitat Fingerprints and Quantifying Structural Habitat in Lakes. M.S. Thesis, University of Wisconsin, Stevens Point, WI. 158 pp.

Short Elliot Hendrickson, Inc. 2008. Macrophyte Survey Analysis, Rice Lake, Barron County, WI. July 2008.

Short Elliot Hendrickson, Inc. 2010. Rice Lake Aquatic Plant Management Plan, Barron County, WI. February 2010.

Surface Water Integrated Monitoring System (SWIMS). 2013. Wisconsin Department of Natural Resources. 13 Jan. 2013. http://prodoasjava.dnr.wi.gov/swims/login.jsp.

Surface Water Data Viewer (SWDV). 2013. Wisconsin Department of Natural Resources. 13 Jan. 2013. http://dnrmaps.wi.gov/imf/imf.jsp?site=SurfaceWaterViewer.

U.S. Census Bureau. 2013. United States Census Bureau 2010 Census. 23 Jan. 2013. http://factfinder2.census.gov/faces/nav/jsf/pages/index.xhtml#none.

Werner, E.E. and D.J. Hall. 1988. Ontogenetic habitat shifts in bluegill: The foraging rate-predation risk trade-off. Ecology 69:1352-1366.

WDNR. 2013. Wisconsin Department of Natural Resources. 13 Jan. 2013. http://dnr.wi.gov/lakes/lakepages/. 23 Jan. 2013. http://dnr.wi.gov/water/impairedSearch.aspx.

Appendix A

A Brief History of the Rice Lake Protection and Rehabilitation District

can be found online at http://rllakedistrict.org/uploads/ckfiles/files/history.pdf

Appendix B

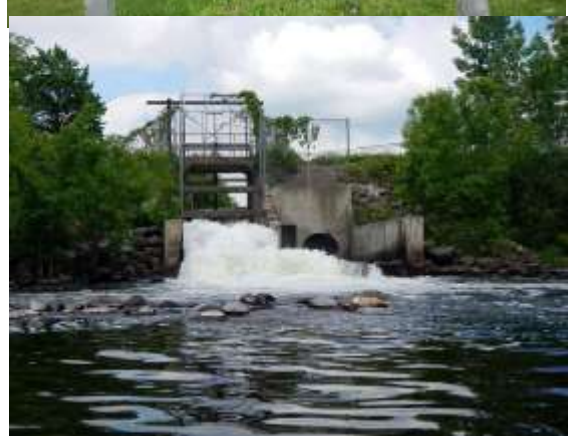
Red Cedar River and Bear Creek 2013 Shoreline Evaluation

Red Cedar River Kayak Trip from Mikana Dam to Rice Lake

June 10th and 11th, 2013

Rod Olson, MD

This section of the Red Cedar River is the official start of a beautiful watershed that actually begins as streams into Big Chetac in Sawyer County and is interupted with impoundment dams at Birchwood and Mikana creating lakes named: Big Chetac,Birch, Balsam, Hemlock and Red Cedar. A photo database and water samples have been collected on all these bodies of water and a future report will be presented at the next Red Cedar River Conference call: "The State fo the Red Cedar River 2013".



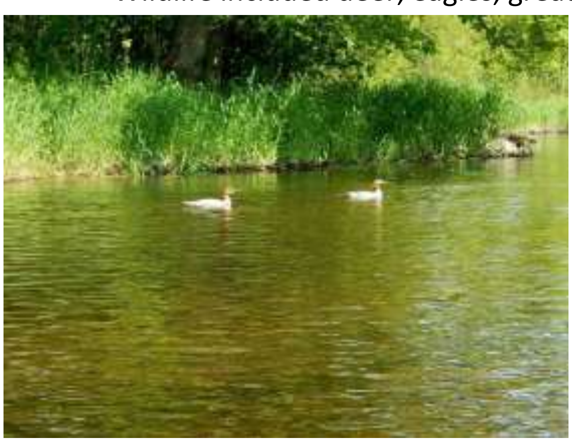
The afternoon was sunny and bright as I entered the river below the dam. This was a lovely trip over a rocky bottom with about a foot of perfectly clear fast moving water. Gravel and sand bars rarely slowed me and the river averages 100-200 feet in width. The river winds for 13 miles along wetlands and rich farmland. Very occasional home are located along this strip of river, some with mowed lawns down to the bank. The banks are low and mostly reed canary grass with groves of maple and other hardwoods on the higher banks. Old stands of white pine bring grace to the river and harken back to to pre logging days before 1880. Two farms are noticed from the water with fields beyond adequate buffers. The Willger farm on Hwy 48 near Campia has a large indoor cattle operation just across the road from the river. From my vantage point, I could not see if there is buffer for the barnyard into the dry run leading to the river.

I collected a water sample at the entrance of Brill River, an extremely lovely body of water, even clearer than Red Cedar River. From the entrance of the Brill to Rice Lake the banks of the Red Cedar was frequently thick with buckthorn. This was especially noted on a landing across from the Red Barn Theater. The buckthorn was interspersed with blooming honeysuckle. No curly pondweed was noted in the section until I entered Rice Lake.

Oxygen and temperture levels were collected at:

	Oxygen	Temperure
Below Mikana Dam	8.72	66.3
Brill River Bridge at 26th Ave	9.43	69.7
Rice Lake above the dam	9.18	69.9

Wildlife included deer, eagles, great blue herons, mallards, mergansers and red winged blackbirds . Minnows were growing in backwaters and dragonflys were not yet hatched. I did not see any people the entire trip until I reached Rice Lake.



Concerns include:

An over full outhouse that needed pumping out at Mikana Park.

The over growth of buckthorn which needs spraying to control in areas where landowners will allow. It has significantly pushed out the natural fauna typical of the river in other areas. Stop at the landing across County M from the Red Barn Theater to see a major example of what it has done. It is choking out such plants as trillium, flox, spring beauty and virgina water leaf.

Investigating runoff from the Willger farm at Hwy 48 and 23rd St. Are there buffers and possibly a detention pond?

I paddled over to Indian Mounds Park as a take out and found no provision for runoff at the Indianhead Clinic demolition less than twenty feet from a storm sewer going directly into Rice Lake. A rain will wash multiple chemicals into the lake with untold potential damage. A pathetic mitigation of covering the storm sewer grate with silt fence only caused the flow to run to the next sewer drain. A city or district policy for demolition site discharge management could be valuble to the lake and river.

Submitted by,

Rod Olson, MD

Desair Lake Restoration, Inc. and Red Cedar River Conference planner.

Bear Creek Kayak trip June 6 and 10, 2013

Rod Olson, MD

Bear Creek is a mostly wild eleven mile creek running from Bear Lake in northern Barron County, WI to Stump Lake just north of the City of Rice Lake. The upper portion of the creek averages 30 feet wide with mostly a rocky bottom. In the spring the water is fast moving, it is not a place for a canoe due to shallow flow and frequent trees across the creek. The kayak worked (barely) as I bushwhacked my way through alder branches and had to pull the kayak over several logjams. On May 3rd, a 17 inch heavy wet snow burdened all the trees in the area and several fell. Those trees leaning out over the creek were at a distinct disadvantage and quickly added to the logjams. With recent rains, the water was high enough to speed up the flow over rocks requiring me to make quick turns while ducking branches. I only capsized once,

actually I am proud of only once., when I came around a fast corner through branches into a log just above the waterline. It caught and rolled the kayak and I was wet up to my neck. It didn't take me long to pop out of the water and pull the kayak onto a sandbar. I lost my hat and some dignity but no other damage. Dumping out the kayak, I wondered for a bit just how often this would be happening to me. As a precaution, I found a strand of twine and used it to secure my glasses that I fortunately didn't lose in the capsize. The weather was cool in the 50's so fast action and a wet suit kept me warm.

The creek starts in Haugen below the Haugen Dam and wanders west of Highway 53. In June of 2012, the creek was inundated with a large dose of sediment from a construction site at County V and Hwy 53. This construction site had forty acres of raw hilly land exposed to 2.4 inches of rain. Wholly inadequate detention ponds and silt fences were quickly overwhelmed.

Several mitigating erosion control devices were now in place and I found no evidence of recent sediment discharge. There likely will be continued dissolved minerals flowing into this creek for another few seasons until the grasses along the right of away are well established. Even with the structures in place now, the creek is at risk with another heavy rain event. I did not see where further work at the

construction site is necessary but the damage from June 2012 is still impacting the creeks ecosystem.

About 4 miles down the creek it opened up and fewer logjams had to be negotiated. There were five beaver dams at different stages of repair each raising the water level about a foot. They were fun to cross at the spillways and slowed the flow into sedge ponds. Four barbed wire fences crossed the creek and had to be watched for diligently as some were camouflaged by brush and the gray cloudy skies. The wildlife were a joy to hear over the freeway noise that lessened as the flow distanced itself from the traffic. Banks were heavily draped with alder on the upper creek and reed canary grass mixed with sedge plants in the mid portion. Alder and logjams decorated the creek again near Stump Lake. One could canoe from County Rd B to Stump Lake during high water with less negotiation of logjams and branches. The fences were all above County B. Homes are rare along the creek and have little or no impact on the

streambanks. Pastureland included the creek in two cases with small areas of erosion. A trash pile next to the creek on one farm was noted. At one bend in the creek there was several old truck trailers, old cars and a pile of tires. Fields were rare close to the creek and seemed to have adequate buffering. Honeysuckle and reed canary grass were prominent exotics. I did not recognize any other exotic plants such as buckthorn which is thick along the Red Cedar River.

Wildlife was abundant, interestingly; I did not see a person along the creek for the two six hour segments it took me to run it. Wood duck, mallards, blue heron, kingfishers, orioles, warblers, redwing blackbirds and crows announced my coming to all the mammals along the way. They quickly disappeared as I rounded a bend. Deer, close to the creek crashed through the dense foliage before I could get a photo. No beaver were observed, I suspect the winter trapping reduced their population. A single wildlife followed home with me; a leech attached to my calf.

The creek has three tributaries: Little Bear Creek, Desair Lake Creek and a culvert outlet from Tuscobia Lake. I took water samples at the Haugen Dam and at the Bear's entrance into Stump Lake. Water quality appeared good throughout the trip. When I entered Stump Lake I immediately found curly pondweed growing and estimate it would soon mat the lake. I was

fortunate to finish this trip in early June. The lake is very shallow and properly named as there are several wonderfully weathered white pine stumps gracing the lake form the days of the Knapp Stout lumbering era. The trees were likely cut either

before the dam on Rice Lake was in place or cut in winter working off the ice. They are wooden islands for lichen and small plants.

The water samples at the beginning and end of Bear Creek will be analyzed later this year. Oxygen and temperatures were recorded at the following sites.

	Oxygen	Temperature
Above Haugen Dam	5.9	59.3
Below Haugen Dam	8.47	58.9
Desair Lake Creek	6.62	70.5
Hwy 48 bridge at Stump Lake	9.41	65.6

Areas of concern are minimal when we think of the degradation seen in the Red Cedar River and Rice Lake. The four fences across the creek are in poor shape and likely do not hold cattle in. One watering area erodes only one small part of the bank. Negotiations with the landowners may allow alternatives to having cattle in the creek and trash removed along the shoreline. Natural bank erosions were nonexistent. Exotics such as honeysuckle and reed canary grass are pervasive in the region and not likely to be altered. A bad area that could use restoration is the southwest corner of the Hwy 48 Bridge between Stump and Rice Lake. There is erosion along the ditch and large quantities of leaves are raked into the waterway. A small rain garden there may be the answer.

A data base of 215 photos are available for future reference.

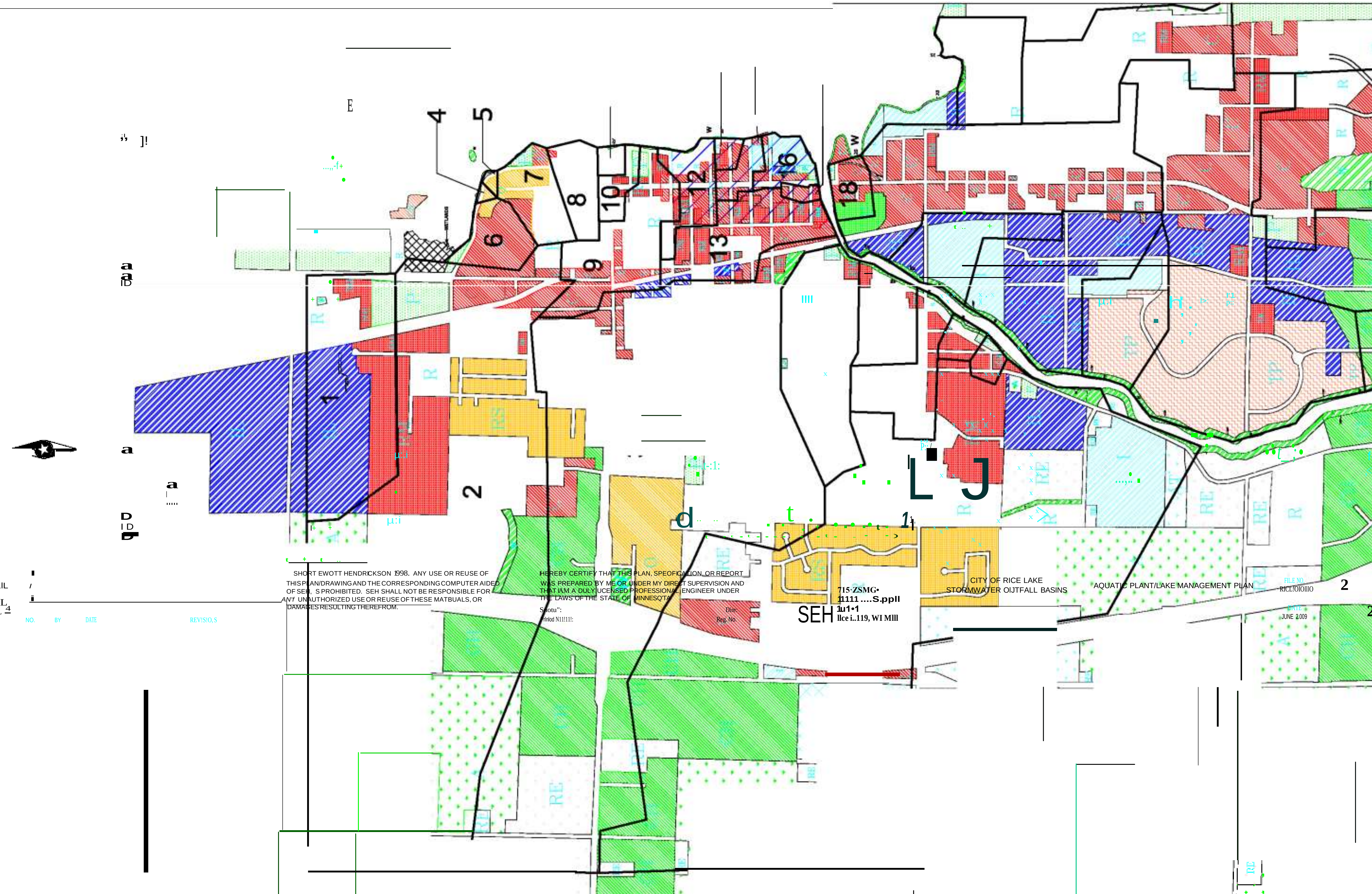
Submitted by:

Rod Olson, MD

President of the Desair Lake Restoration, Inc.

Appendix C

City of Rice Lake Stormwater Subbasins



DESIGN TEAM
DRAWN BY: ---1IL
DESIGNER: -1IL
CHECKED BY: ...!!L

NO. BY DATE REVISIONS

SHORT EWOTT HENDRICKSON 1998. ANY USE OR REUSE OF THIS PLAN/DRAWING AND THE CORRESPONDING COMPUTER AIDED OF SEH, S PROHIBITED. SEH SHALL NOT BE RESPONSIBLE FOR ANY UNAUTHORIZED USE OR REUSE OF THESE MATBUALS, OR DAMAGES RESULTING THEREFROM.

HEREBY CERTIFY THAT THIS PLAN, SPEOFICATION, OR REPORT WAS PREPARED BY ME OR UNDER MY DIRECT SUPERVISION AND THAT I AM A DULY UCENSED PROFESSIONAL ENGINEER UNDER THE LAWS OF THE STATE OF MINNESOTA.

Signature: Date:
Printed Name: Reg. No.

SEH 715·ZSMG• 11111 ....S.ppll 1u1•1 llce i..119, WI Mlll

CITY OF RICE LAKE
STORMWATER OIJTFALL BASINS

AQUATIC PLANT/LAKE MANAGEMENT PLAN

FILE NO. RICL!OIOlllO

DATE JUNE 2009

2

2

Appendix D

Implementation and Funding Matrix

Rice Lake Comprehensive Management Plan Implementation

Plan Element	Priority Level	Responsible Parties	Estimated Cost	Sources of Funding	Year 1 2014	Year 2 2015	Year 3 2016	Year 5 2017	Year 6 2018
Goals 1 & 2 - Nutrient Load Reduction									
Reduce phosphorus and sediment laod from Bear Creek and Red Cedar River Watersheds by 25%									
Install grassed waterways at sites identified throughout watershed		SWCD, RLPRD	one time $500/acre payment + seed $100/acre	LP Grant, County, NRCS	x	x			
Repair fencing at livestock stream crossings		SWCD, RLPRD		LP Grant, County, NRCS	x	x			
Utilize WDOT 53 & V mitigation funds as match for lake protection grant funds and to implement other BMPs		RLPRD, RP, SWCD			x	x			
Encourage agricultural community participation in BMPs									
Show ase BMPs implemented by the ag community and riparian community in newsletter and on webpage		RLPRD	$800	LP Grant			x		
Open house field day at area farm showcasing best management practices		SWCD, RLPRD		LP Grant, County, NRCS	x	x	x	x	x
Reduce the total phosphorus load from the nearshore area of Rice Lake by 15%									
Develop tax levy credit for shoreland best management practices		RLPRD				x	x		
Provide financial support for installation of riparian best management practices		RLPRD		LP Grant	x	x	x	x	x
Support City of Rice Lake MS4 permit implementation		RLPRD, City		LP Grant	x	x	x	x	x
Develop policy for demolition site discharge management		RLPRD			x	x			
Support clean up of trash along tributaries to the lake									
Repair eropsion site by Hwy 48 bridge between Rice Lake and Stump Lake									
Support repair of erosion sites along ditches and roadways		RLPRD, City, Town, County		LP Grant	x	x	x	x	x
Decrease the internal phosphorus load to the lake									
Continue curly-leaf pondweed control efforts		RLPRD		AIS Grant	x	x	x	x	x
Complete feasibility study of in-lake improvement options for Lower Rice Lake		RLPRD	$25,000	LP Grant	x	x			
Determine changes to nutrient loading from Bear Creek and Red Cedar River									
Collect nutrient samples and monitor streamflow at 23rd St (Red Cedar) and CTH SS (Bear Creek)		RLPRD	$9,000	LP Grant				x	x
Calculate and compare post-BMP nutrient loading to previous loading (USACE 2001 limnological study)		RLPRD	$6,500	LP Grant				x	x
Goals 3 to 5 - Lake Use									
Support multi-use recreational opportunities									
Assist with maintenance and development of public access areas		RLPRD, City		LP Grant	x	x			
Place and maintain navigation buoys		RLPRD		LP Grant	x	x	x	x	x
Monitor recreational use patterns to guide management and outreach efforts		RLPRD			x			x	
Fish and Wildlife									
Survey coarse woody structuce in lake and develop management goals		RLPRD	$5,000	LP Grant	x	x			
Support shoreland restoration activities		RLPRD	$2 per square foot	LP Grant	x	x	x	x	x
Control buckthorn growth along the Red Cedar River		SWCD, RLPRD		County		x	x	x	x
Map environmental corridors in the watershed and develop management goals for protection and expansion		RLPRD	$18,000			x			
Create new bathymetric map of Rice Lake and Stump Lake		RLPRD	$7,000	LP Grant	x	x			
Consult with WDNR Fishery Biologist prior to undertaking management activities to evaluate potential effects on fishery		RLPRD, WDNR			x	x	x	x	x
Evaluate Canada goose control measures and develop management plan		RLPRD			x	x			
Educate public about the cost and effectiveness of Canada goose control measures		RLPRD	$1,000		x	x			x
Aquatic Plants									
Continue to implement the 2010 Aquatic Plant Management Plan and update as necessary					x	x	x	x	x
Goal 6 - Collaboration									
Create contact list for various lake management and stewardship groups in the Rice Lake Watershed, update annually		RLPRD			x	x	x	x	x
Host meeting with management groups in Rice Lake watershed		RLPRD	$250/year		x	x	x	x	x
Participate in the Red Cedar River TMDL project implementation									
Enter into data-sharing agreement with Barron County		RLPRD, County	$0		x				
Participate in Aquafest		RLPRD	$250/year		x	x	x	x	x
Goal 7 - Implementation and Program Maintenance									
Complete annual reports (summary of events/activities, suggested strategy revisions, future management plans)		RLPRD	$1200/year	LP Grant	x	x	x	x	x
Continue water quality and boat launch monitoring through the CLMN and CBCW programs		RLPRD			x	x	x	x	x
Utilize WDNR Lake Protection grants for implementation of management activities		RLPRD			x	x	x	x	x
Identify other funding sources for implementation of management activities		RLPRD			x	x	x	x	x

Abbreviations: RLPRD, Rice Lake Protection and Rehabilitation District; SWCD, Barron County Soil and Water Conservation Department; NRCS, U.S. Department of Agriculture-Natural Resources Conservation Service.

Note: Responsible parties and sources of funding are not exhaustive and could change; Lake Protection (LP) and Aquatic Invasive Species Control (AIS) Grant eligibility is subject to WDNR approval.