Lake Management Plan for Lake Koronis and Rice Lake

Stearns County, Minnesota

Visioning: July 2010
Revised: July 2014

Healthy Lakes & Rivers Partnership Committee
Koronis Lake Association
Rice Lake Association

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INTRODUCTION

In February 2010 the Rice Lake Association (RLA) and Koronis Lakes Association (KLA) were invited to participate in the Initiative Foundation's Healthy Lakes and Rivers Partnership program along with seven other Lake Associations in Stearns County. Under the coordination of Greg Berg (Stearns County Soil & Water Conservation District) and Susan McGuire (Stearns County Environmental Services), representatives attended two days of training on strategic planning, communication, and nonprofit group leadership.

Representatives of many state and local agencies, as well as nonprofit organizations also attended the training sessions in order to offer their assistance to each group in developing a strategic Lake Management Plan. The RLA and KLA were represented at the Healthy Lakes & Rivers training sessions by: three members from RLA and five members from KLA.

Following the training sessions, the two lake associations held an inclusive community planning/visioning session designed to identify key community concerns, assets, opportunities, and priorities. The KLA and RLA held this planning session July 17, 2010, facilitated by John Sumption. Approximately 80 people were in attendance. Details of the public input received at this session are provided within this plan.

This document is intended to create a record of historic and existing conditions and influences on Lake Koronis and Rice Lake, and to identify the goals of the lake community served by Koronis and Rice. Ultimately it is meant to help prioritize goals, and guide citizen action and engagement in the priority action areas. Clearly state agencies and local units of government have a vital role and responsibility in managing surface waters and other natural resources, but above all else this Lake Management Plan is intended to be an assessment of what we as citizens can influence, what our desired outcomes are and how we will participate in shaping our own destiny.

This Lake Management Plan is also intended to be a *living document*. As new or better information becomes available and as we accomplish our goals or discover that alternative strategies are needed, it is our intent to update this plan so that it continues to serve as a useful guide to future leaders.

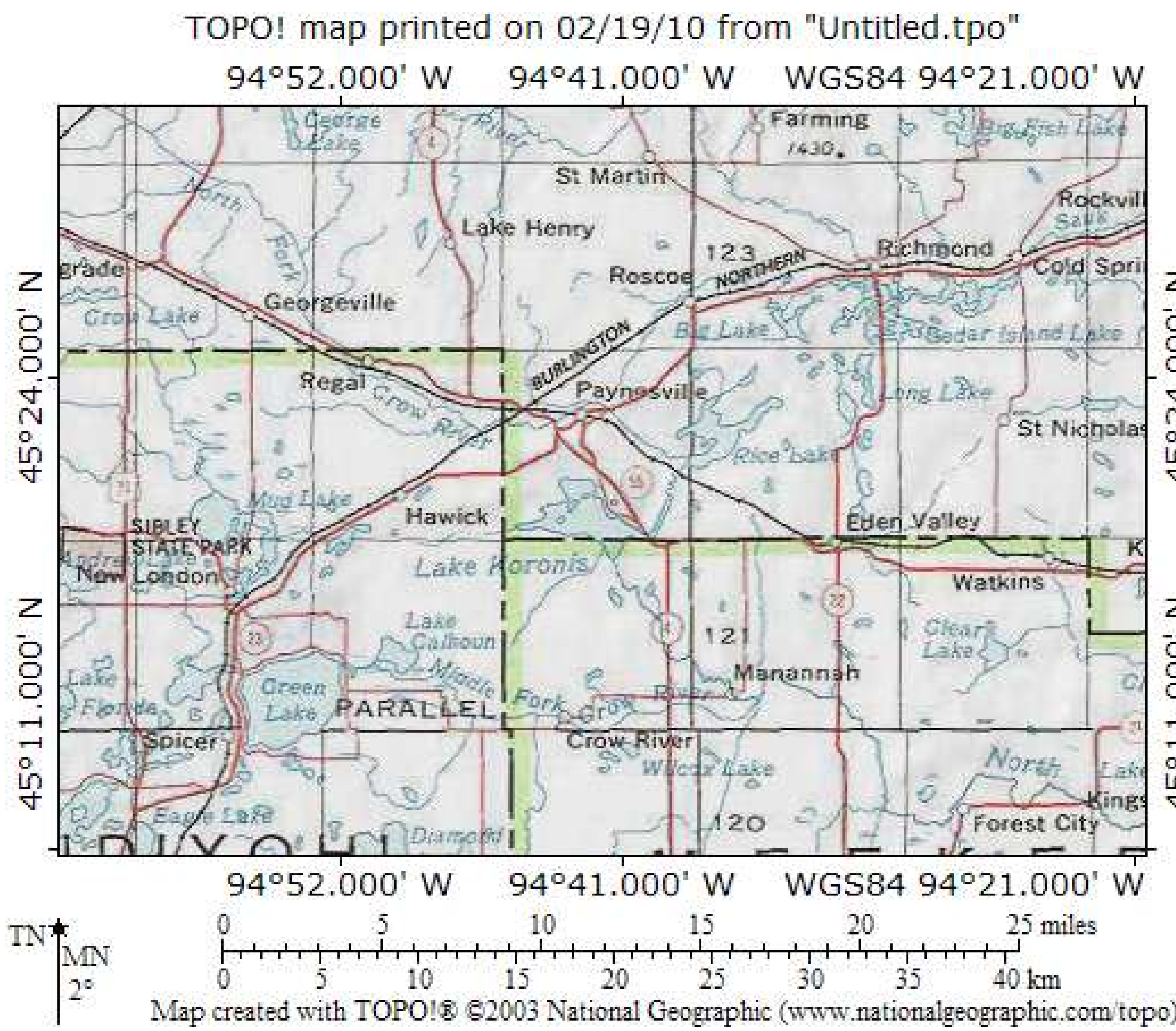
In discussing lake management issues, it is impossible to avoid all scientific or technical terms. We have tried to express our goals, measures of success and other themes as simply and clearly as possible but have included a glossary of common limnological terms at the end of the plan to assist the reader. Limnology is the state of lake conditions and behavior.

Finally, we would like to thank the funders of the Healthy Lakes & Rivers Partnership program for Stearns County, including the McKnight Foundation, Minnesota Power, Xcel Energy, U.S. Environmental Protection Agency, McDowall Company, the Cass County Water Plan, Lake Hubert Conservation Association, Portage-Crooked Lakes Association, Sibley Lake Association of Stearns County, Ann Lake Sportsmen's Club of Kanabec County, various staff from the Initiative Foundation and over thirty generous individuals.

PHYSICAL CHARACTERISTICS AND LOCATION OF LAKE KORONIS AND RICE LAKE

Lake Koronis (#74-0200) and Rice Lake (#73-0196) are located south southeast of the city of Paynesville. Lake Koronis has a surface area of 3,014 acres and maximum depth of 132 feet. Rice Lake has a surface area of 1,509.35 acres, and a maximum depth of 41 feet. Approximately 1,176 acres (39 percent) of Lake Koronis is within the littoral zone (having a depth of less than 15 feet); at Rice Lake 958 acres (63 percent) is littoral. Water clarity at Koronis averages 5.2 feet; Rice Lake the average clarity is about 3.5 feet.

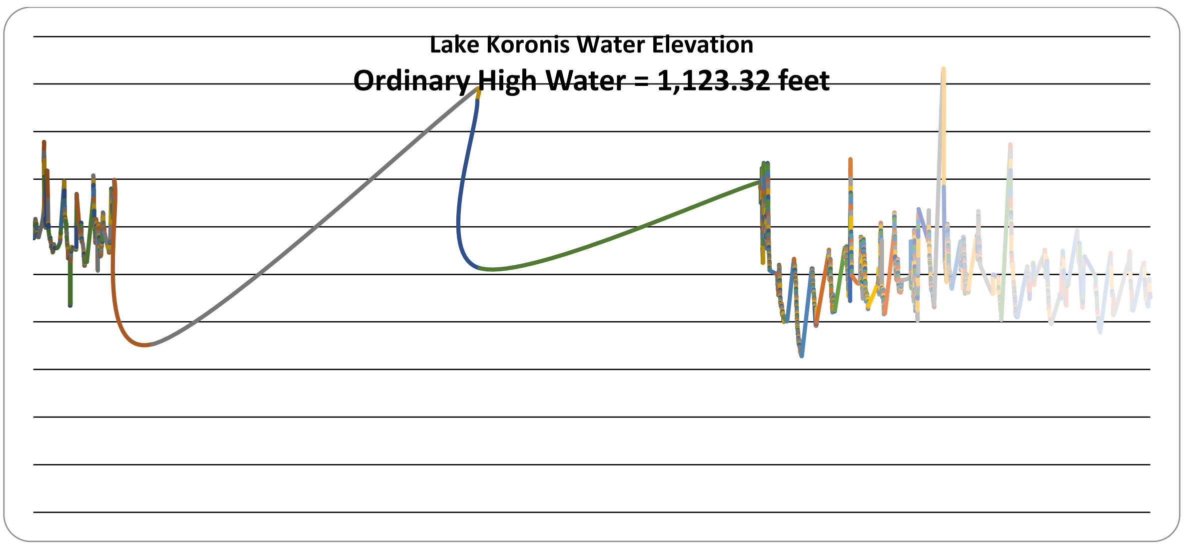
The largest inlet is the North Fork of the Crow River, which enters Lake Koronis along the east shore and outlets near the southeast corner.

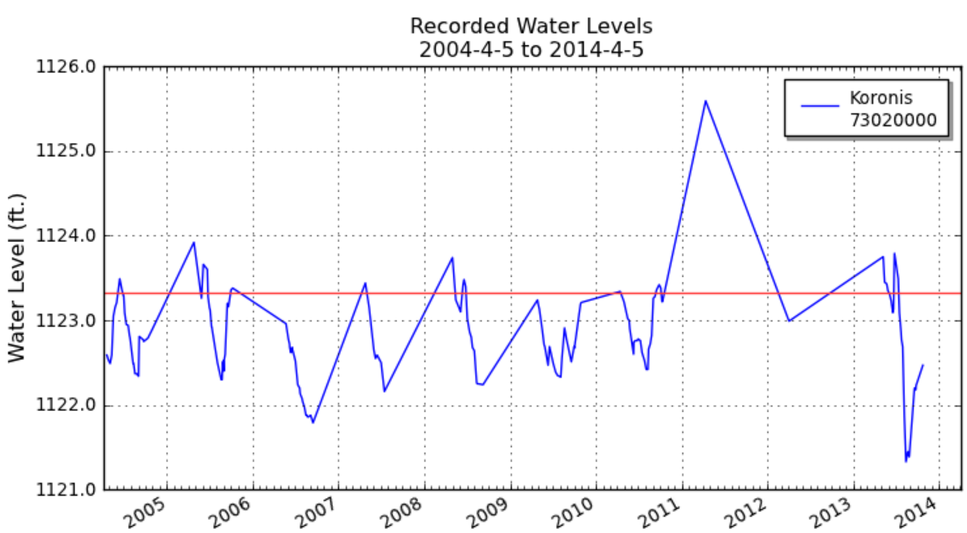


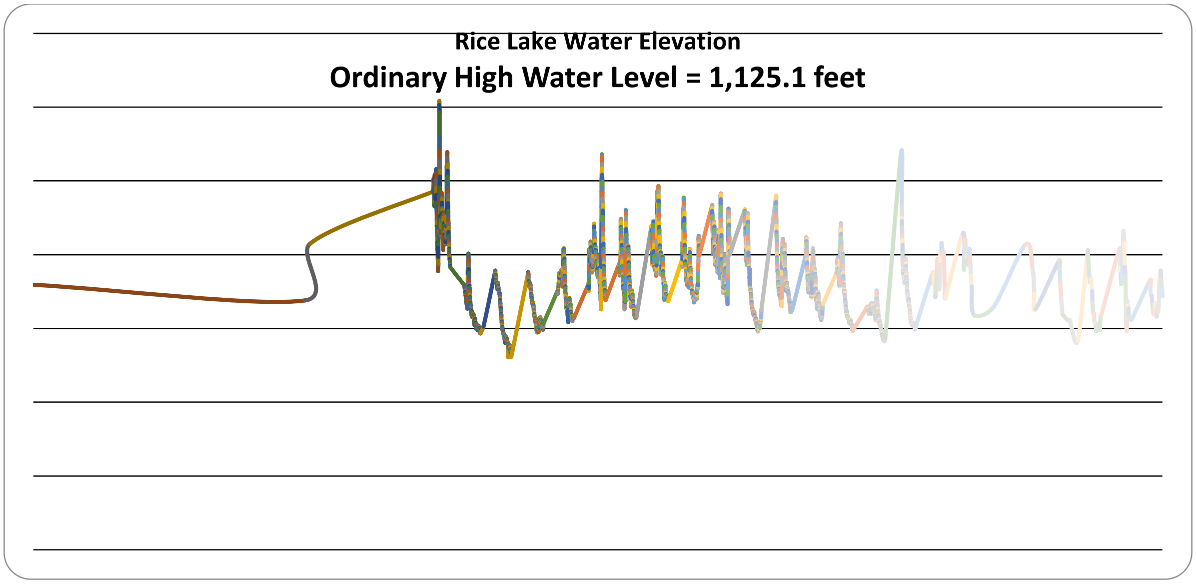
Water Level

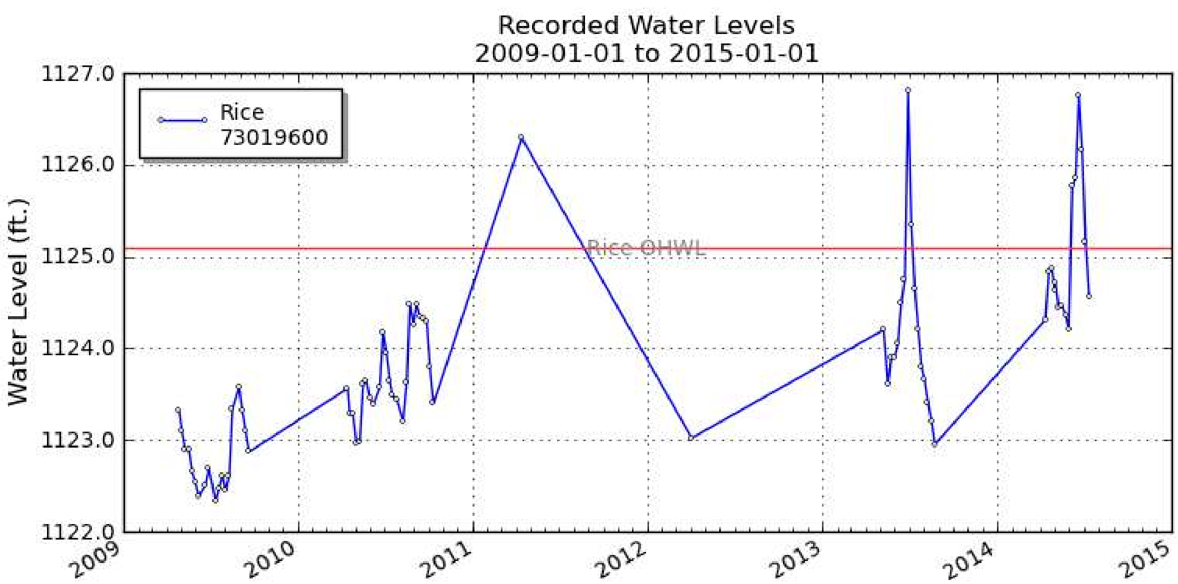
The Minnesota Department of Natural Resources, Division of Waters has monitored Koronis Lake levels in cooperation with volunteer readers since 1942. During the period of record the lake level has varied 6.0 feet based on 2,777 readings (through September 2009). In general, water levels decline from May through September, with the exception of a slight increase in mid-July in response to several storms.

	Highest Recorded (feet/date)	Lowest Recorded (feet/date)	Ordinary High Water (feet)
Koronis	1,127.28 ft (April 9, 1997)	1,121.28 ft (October 8, 1988)	1,123.32 ft.
Rice	1128.16 ft (June 24, 1986)	1,121.22 ft (September 9, 1988)	1,125.1 ft.



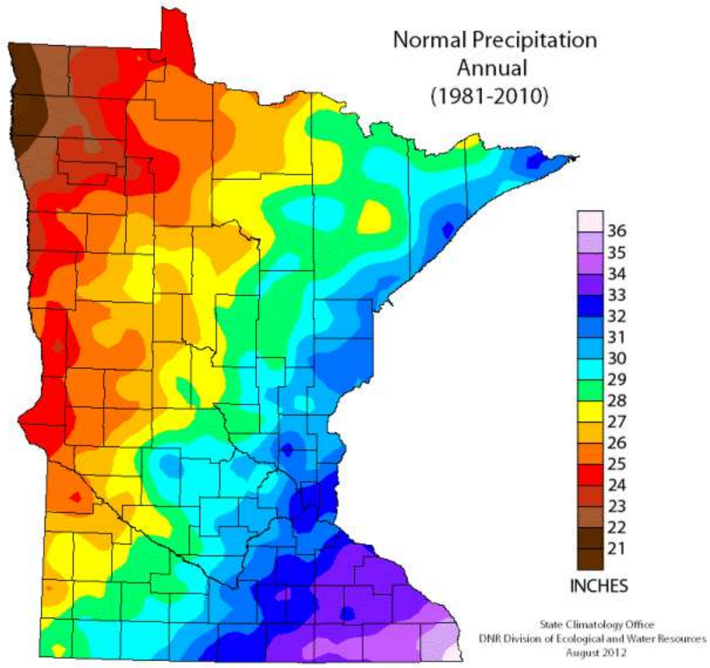






Precipitation

The Minnesota Pollution Control Agency conducted many Lake Assessment Program (LAP) studies in Stearns County and reports that in this part of the state average annual precipitation ranges around 28 inches and evaporation averages around 36 inches. Summer (May to September) precipitation averages about 18 inches.



Land Use

The 2010 Lake Management Plan presented estimates of existing land cover within the watershed (prepared by Minnesota Planning). The table below compares these to typical ranges for the entire ecoregion (presented in the Two Rivers Lake – MPCA Lake Assessment Program report, 2003) showing that 21 years ago the watershed was less urbanized (residential), more agricultural, less forested, and with fewer surviving wetlands that most of the rest of the region.

Land Use Type	Rice-Koronis Watershed Land Cover 1989			Typical Range for North Central Hardwoods Eco-region
	Acres	Percentage		Percentage
Residential	**5,051**	**2.5%**		**2-9%**
Agricultural	**133,889**	**67.2%**		**22-50%**
Prairie – Pasture/grasslands	**32,709**	**16.4%**		**11-25%**
Forest	**15,444**	**7.8%**		**6-25%**
Lake (Water)	**6,726**	**3.4%**		**Water & Marsh (Lake and Wetland): 14-30%**
Wetland (Marsh)	**5,247**	**2.6%**		
Total	**199,178 acres**			**122,228 acres**

LAKE HISTORY FROM THE 2003 LAKE MANAGEMENT PLAN

In 2002, the Rice Lake Association and the Koronis Lake Association both sent teams of citizen leaders to the Initiative Foundation's Healthy Lakes & Rivers Partnership program to develop a Lake Management Plan. This effort was supplemented by assistance from the Stearns County Soil & Water Conservation District (SWCD) which also provided funding through the MN Board of Water & Soil Resources (BWSR) to coordinate planning and support projects which lead to tangible, measureable outcomes. The resulting 2003 Lake Management Plan (for both lakes) is a primary source of the history presented below, and is also still available online at the SWCD website: **http://www.stearnscountyswcd.net/Rice-Koronis%20Lakeshed%20Management%20Plan/ricekoronis_lake_management_plan.htm**

The Rice and Koronis Lakes area is rich with cultural and natural history accounts and events. Over the past 100 or so years, there have been numerous events in and around the lakes that have affected their character and use. The following table summarizes some of the more important events:

YEAR	EVENT
1856	First attempt by settlers to form a community in the Paynesville area.
1857	The town site that would eventually become the City of Paynesville was established. Settlers began moving into the area that year.
1960	A total of 14 resorts were operating on Lake Koronis. By1987, only four resorts remained operating on Koronis, and three on Rice Lake.
1967	There were 180 seasonal and 96 permanent dwellings (276 total) on Lake Koronis and 116 seasonal and 30 permanent dwellings (146 total) on Rice Lake.
1971	The Koronis Lake Association (KLA) was formed.
1975	The Rice Lake Association (RLA) was formed.
1979	A spillway project and a walleye-rearing pond were constructed with support from RLA. The pond was used for three years.
1979	RLA had 183 members that paid $5/annual membership dues.
1982	Since 1967, the number of dwellings on Lake Koronis increased by 79 percent to 293 seasonal and 202 permanent homes (495 total). The number of dwellings on Rice Lake increased by 86 percent to 201 seasonal and 87 permanent homes (288 total) over the same 15 year period.
1983	RLA and KLA work together to pursue efforts to address issues on a watershed basis.
1984	Petition filed with the Minnesota Water Resources Board to create a watershed district.
1985	The MWRB established the North Fork Crow River Watershed District (NFCRWD).
1987	The first overall Watershed Plan was completed and adopted for the NFCRWD.

YEAR	EVENT
2001	The two lake association jointly received grants from the Initiative Foundation for the HRLP program and from BWSR through the Challenge Grant program.

SUMMARY OF COMPLETED LAKE ASSOCIATION PROJECTS (REVISED JULY 2014):

YEAR	PROJECT/DESCRIPTION
1979	Water quality study – John Barten completed a nutrient and hydrologic budget study of Lake Koronis for this at St. Cloud State University. He presented the study to the Koronis Lake Association in1979.
1982	Water diversion study – A report on ways to restore Lake Koronis was prepared by Hickok & Associates for the KLA. One of the recommendations from the study proposed the diversion of water from the North Fork Crow River around Lake Koronis.
1989	RLA contributes $700 for the construction of an earthen dam project on the east end of the lake and $575 towards a retention pond project constructed by the Paynesville Sportsman's Club.
1995	Diagnostic Feasibility Study – a diagnostic feasibility study for the two lakes was completed as part of the Clean Water Partnership grant (Phase I). The Phase II or implementation portion of the CWP grant began the following year and continued for several years.
1997	Several water quality projects were completed in 1997 including: Septic system upgrades – 47 systems were upgraded with loans from the Revolving Loan Fund project on the two lakes ($290,000) One livestock exclusion project ($1,000) Four sediment control projects ($88,000) Six stabilization projects installed, including two on the North Fork Crow River and four on the two lakes ($48,500) Three manure management projects ($159,000).
1998	Crestridge Road project completed.
1998	Aldon Heights project.
1998	Paynesville Township drainage system repairs completed.
2004	Larson I Project: built a damn and tiling to create a wetland.

2005	Roberg Diversion: A diversion structure was installed near the Roberg Farm on Co Rd 20 one quarter mile northeast of the outlet bridge in the east ditch right-of-way. This structure diverts surface water runoff in the east road ditch from going into Lake Koronis. All surface water is diverted except the heaviest of rains away from the lake and into the North Fork Crow River downstream from the lake.
2006	Doug Larson Project: Located south of Co Rd 20 and east of Co Rd 25 in Meeker County. This project re-established wetlands on land owned by Doug Larson and Tom Burr. The natural surface waterway was repaired. Once the surface water enters the wooded creek area, it is held back and slowed down by a 25 foot high, 150 foot long earthen dam. Water is released slowly back into the creek and into Lake Koronis.
2007	Randall Feedlot: Located south of Co Rd 20 in Section 6, Union Grove Township, and Meeker County. The pole building that was being used for shelter for livestock and storage for hay was removed and the manure pack was cleaned up. This facility was adjacent to a significant drainage creek flowing into Lake Koronis.
2008	Recreational Trail Bridge: A 60 foot bridge was used to span an environmentally sensitive area, including fish spawning every spring. The bridge runs parallel to Baywater Road and also has a fishing bump-out for public use.
2002-2020	Paynesville Water Festival: This one day festival in the spring of each year educates Paynesville Area Middle School fifth graders about ground water, surface water, erosion, contamination and other areas related to water quality. KLA has been a contributor each year to the program.
2006-2012	Crow River Clean-up: The Koronis Lake Association has been actively involved in the clean-up of the North Fork Crow River during September each year. We have helped the Paynesville Trail Guards haul junk and debris out of the river as it passes through the city of Paynesville.
2007-2009	Pheasants Forever/CRP: KLA has contributed over $6500 to the Stearns County Soil and Water Conservation District to help pay for one staff salary. This staffer has enlisted several farmers with land near ditches and streams in the North Fork Crow River Watershed District into CRP. A strip of land 50 feet wide adjacent to the ditch or stream on the farmers land has been enrolled into the CRP program. This reduces nutrient loading into the river and also compensates the landowner for the loss of cropland.
2008	RLA partnered with Stearns County Soil and Water Conservation District to renaturalize the shoreline at Camp Ojibway. This is an ongoing partnership with the Camp to demonstrate how attractive and beneficial a natural shoreline can be. The planting was done over Memorial weekend with 40 volunteers from both the Camp and RLA.
2008	Rice Lake was declared an "Impaired" body of water in 2008 which then mandated that a TMDL study be undertaken as part of the Federal Clean Waters Act. The North Fork Crow River Water District then hired Wenck and Associates to undertake the study.
2009-2010	RLA supported the NFCRWD as it inspected the septic systems on Rice Lake. All failing systems were brought up to code so there is no direct discharge into Rice Lake. There were 186

	systems inspected and 33 needed to be repaired or replaced. This took place over two years: 2009-2010.
2009-2012	Rice Lake water quality monitoring completed. TMDL Study completed and approved by EPA in May, 2012. Implementation Plan completed June 2012.
2012	Storm water gully stabilization on Koronis Mnistries property. Several berms were installed in the gully to slow down the storm water running down the gully. This allows settling of the silt, gravel and rocks before entering Lake Koronis.
2012	Breuer Shoreland Stabilization Project: several hundred feet of riprap were installed to prevent additional erosion and nutrient transportation on the south shore of Lake Koronis.
2012	Hoeft Streambank Stabilization Project: Riprap was placed on the eroding bank of the North Fork of the Crow River to stabilize the bank and prevent further erosion. Rock J-hooks were installed in the bed of the river to direct the water away from the highly erodible soils. This project is located in Kandiyohi County and is upstream from both Kale Koronis and Rice Lake.
2012	Loven and Winter Streambank Stabilization Project: Riprap was placed on the eroding bank of the north Fork of the Crow River to stabilize the bank and prevent further erosion. Rock J-hooks were installed in the bed of the river to direct the water away from the highly erodible soils. This project is located in Stearns County and is upstream from both Lake Koronis and Rice Lake.
2013	Herfendahl/Kalkbrenner Project: Stormwater runoff from several hundred acres of cultivated farm and wooded land was channeled into a ravine. Several berms were installed in the bottom of the ravine to slow the storm water down and to settle out the silt. The storm water passes through another sediment basin before it is carried in a pipe that runs downhill underground to Lake Koronis. This project is located in Stearns and Meeker Counties.
2013	AIS Watercraft Inspections were started at the two DNR ramps located on Rice Lake in May 2013**.** Led by NFCRWD and KLA, DNR trained inspectors were hired to enforce AIS laws at public boat ramps on the lakes in the NFCRWD.
2013	The Mueller project was completed in the summer of 2013. The project created an embankment to prevent further run-off from farm properties into the North Bay at the Klassen property. Years of run-off had carried enough soil into the lake to created peninsula and altered the shoreline. The project was funded by a grant from SWCD and contributions from NFCRWD, KLA, RLA, the Muellers and the Klassens.
2012-2015	Two Individual Septic Treatment System (ISTS) studies have been initiated: one completed and the second in progress on these two lakes. In 1996, the study largely involved the educational component. About 25% of the ISTS around both lakes were found to be out of compliance. The worst systems were required to upgrade. The latest study, started in 2007, is being completed through the NFCRWD with the cooperation of Kandiyohi, Meeker, Pope and Stearns counties. The involvement of the counties ensures that all ISTS out of compliance will be brought up to code. This study is being conducted throughout the entire watershed district and will be completed in 2015

Additional on-going activities performed by the Lake Associations include:

- Both KLA and RLA assist with water quality monitoring performed by the NFCRWD.
- KLA and RLA have recently had extensive vegetation studies performed.
- Both KLA and RLA participate in ongoing projects relating to lake quality improvement and shoreline restoration.
- KLA placed curb markers on storm sewers in Paynesville to raise awareness. What goes down our sewers ends up in our rivers and lakes.
- KLA helps to fund life guards at the public beach on Lake Koronis.
- Efforts to help clean up our lakes has been supported by the cooperation of four areas previously mentioned, Paynesville Township, City of Paynesville, Union Grove Township and the Paynesville Sportsmen's Club.
- KLA volunteers at various events year round. (Winterfest, Waterfest, etc.)

Additional history is available on the *Natural Resource Inventory* webpage maintained by the SWCD:

http://www.stearnscountyswcd.net/Rice-Koronis%20Lakeshed%20Management%20Plan/ricekoronis_lake_management_resource_inventory.htm

North Fork Crow River Watershed District (NFCRWD) is conducting a project to inspect all of the individual subsurface sewage treatment systems in the watershed. Stearns County hired an inspector to complete the inspections. Her salary is paid by NFCRWD. The systems around Rice were inspected in 2007 and around Koronis in 2008. Both now have 100% of the inspections completed and are up to code.

ASSOCIATIONS HISTORY

Koronis Lake Association

The Koronis Lake Association was formed into a group of lake residents in 1971. This group noticed other lakes were forming associations, and this seemed like a good opportunity to do something about water quality and their enjoyment of Lake Koronis. It is believed the first board members were Mary Ann Erdmann, Bill Henderson, Bob Monson, Dwight Putzke, Harold Putzke, and Virgel Vagle. Vagle became the first president of the association. Others who have served as presidents are Paul Bugbee, Peter Jacobson,Diane Rittenhouse, Ken Hess and the current president Karen Langmo.

The association's motto, written in 1971, "An association formed to promote the protection and improvement of Lake Koronis" is just as true today as it was 39 years ago.

In the 1970's and the early 1980's, two major studies were done: first, a study of the sources of nutrient loading into Lake Koronis, and second, a feasibility study which assessed whether a diversion of much of the water in the North Fork Crow River around Lake Koronis would result in a reduction of nutrient loading in the lake.

Rice Lake Association

The Rice Lake Association (RLA) was formed in 1975 as a way for those with a vested interest in the lake to protect and improve the quality of the lake. Over our 35+ years history, the RLA has been actively working with members, government organizations and area watershed districts, completing many clean water projects. RLA's mission is:

- Improve the water and recreational quality of our Lake through promotion of sound lake management practices;
- Educate our members regarding issues that affect their lakeshore;
- Advocate our members' interests before governmental bodies in matters involving our Lake;
- Promote research and appropriate standards for proper management of our Lake, the North Fork of the Crow River, and other surrounding tributaries;
- Seek enforcement of laws that affect Minnesota lakes and watersheds.

North Fork Crow River Watershed District

In the mid 1980's, the Koronis Lake Association and the Rice Lake Association were instrumental in the establishment of the North Fork Crow River Watershed District (NFCRWD). This district included all of the sub-watersheds that flow into the North Fork Crow River through Rice Lake and Lake Koronis, as well as all of the sub-watersheds flowing into both lakes.

REVIEW OF HISTORICAL AND EXISTING CONDITIONS FOR EACH OF NINE FOCUS AREAS

WATER QUALITY

Since 1974, citizen volunteers from Rice and Koronis Lakes have participated in the Minnesota Pollution Control Agency's (MPCA) Citizen Lake Monitoring Program (CLMP), recording secchi disc transparency – a measure of water clarity. For Koronis Lake, Roland Ebent, William H. Moyer, Jim Paster, Greg Berg, Harry Thielen, Garry Swenson, Mark Schmisek, and the North Fork Crow River Watershed District have been responsible for these efforts in recent years. On Rice Lake the volunteers, Al Schmidtbauer, Jim Ellickson, Dave Gay, Ed Bies, Ralph Klassen, DeWayne Eberhardt, Ray Peters, Ray Van Brunt, John Hanson, and the NFCRWD regularly collect nutrient and transparency data from May through October.

On the MPCA's web-site link, *Lake Water Quality Database*, additional water chemistry data is reported. The MPCA's *Environmental Database Access* system also provides additional water chemistry data which includes total phosphorus concentrations as well as other data.

One application of secchi disc transparency data is to convert the clarity measurements into a Carlson Trophic Status Index (TSI) score. The Carlson Trophic Status Index (TSI) is a tool used to summarize several measurements of water quality into one index value, which can be used to compare a lake to other lakes, or to historic/future data as a measure of degradation or improvement. In many ways, the index can be viewed as a measure of the potential for algal productivity. Since most people value lakes with low algae productivity, the lower the TSI value, the healthier the lake. The table below explains TSI and trophic status.

TSI Range	**Trophic Status**	**Characteristics**
0-40	Oligotrophic	Clean Lake
41-50	Mesotrophic	Temporary algae & aquatic plant problems
50-70	Eutrophic	Persistent algae & aquatic plant problems
Greater than 70	Hyper-eutrophic	Extreme algae & aquatic plant problems

Based on the limited data provided on the MPCA website, an average concentration (or depth) for the key TSI parameters can be determined, and the associated TSI score calculated.

Average TSI Measurements for Koronis Lake, 1973-2009.

Year	Chlorophyll *a* (µg/L)	Total Phosphorus (µg/L)	Secchi Depth (feet)	Average TSI
1973	---	---	6.6	50.1
1974	---	---	8.8	46.3
1975	---	---	5.3	53.2
1976	---	---	6.6	49.9
1977	---	---	5.8	51.8
1978	---	---	7.4	49.1
1980	4.0	50.0	17.4	46.9
1985	---	---	5.2	53.9
1986	---	---	6.1	52.3
1987	---	---	5.2	54.6
1988	---	---	7.3	48.9
1989	---	---	9.4	45.2
1990	---	---	8.6	47.0
1991	8.6	39.9	8.0	49.5
1992	37.0	59.8	10.3	49.9
1993	---	---	6.8	51.3
1994	---	---	8.0	48.4
1995	---	---	4.3	56.5
1999	---	---	11.7	42.8
2001	23.0	42.3	5.6	54.9
2002	29.6	60.1	10.1	46.9
2003	5.0	52.5	10.5	46.9
2004	22.3	56.5	11.1	45.4
2005	17.0	72.8	10.0	46.8
2006	8.3	28.0	8.0	49.1
2007	17.5	42.8	6.7	51.5
2008	19.0	45.3	6.8	50.8
2009	12.3	57.2	8.6	54.0

These data suggest that water quality in Lake Koronis routinely exhibits conditions in the mesotrophic range (a score above 40 but below 50) or lower eutrophic range (above 50 but below 70).

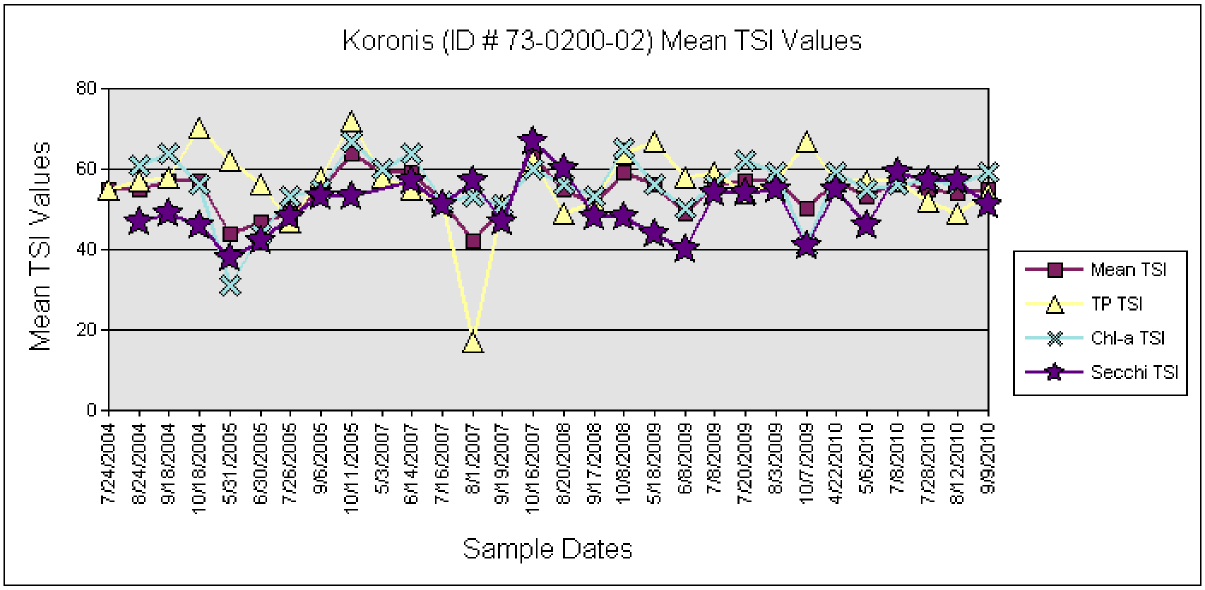
In the MPCA's *Report on the Transparency of Minnesota Lakes* (2006 edition), these data were statistically analyzed. Lake Koronis was classified as demonstrating *no trend* with respect to water clarity.

Average TSI Measurements for Rice Lake, 1947-2009.

Year	Chlorophyll *a* (µg/L)	Total Phosphorus (µg/L)	Secchi Depth (feet)	Average TSI
1947	---	34.0	---	55.0
1958	---	---	2.0	67.1
1976	---	---	5.0	54.9
1977	---	---	5.2	56.2
1979	---	85.3	5.6	56.6
1980	4.0	77.0	4.0	61.5
1981	---	69.5	4.6	57.7
1982	---	---	5.4	56.5
1983	---	---	5.9	53.8
1989	---	---	2.4	65.2
1990	---	---	5.0	57.8
1991	9.7	57.4	6.2	54.4
1992	57.7	77.9	6.0	58.3
1993	---	---	6.5	52.3
1994	---	---	6.4	54.1
1995	---	---	4.6	57.7
1996	---	---	5.1	57.7
1997	---	---	5.9	54.5
1998	---	---	5.4	54.8
1999	---	---	5.5	55.2
2000	---	---	5.9	54.3
2001	28.0	76.4	6.2	53.4
2002	29.0	78.9	6.9	52.9
2003	34.0	72.3	7.3	54.0
2004	44.3	63.8	7.4	51.4
2005	32.6	86.4	8.2	50.6
2006	14.8	37.7	5.0	57.2
2007	42.1	64.4	3.8	61.0
2008	39.3	67.0	4.2	58.9
2009	35.3	84.3	7.5	59.3

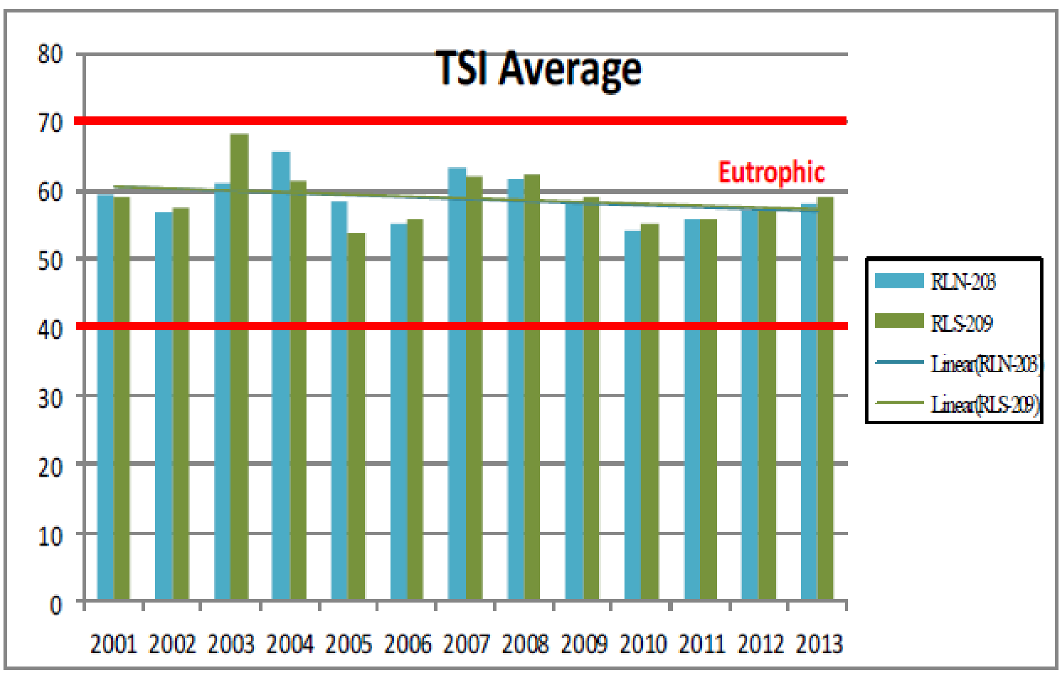
This data suggests that water quality in Rice Lake routinely exhibits conditions in the upper eutrophic range (a score above 50 but below 70).

In the MPCA's *Report on the Transparency of Minnesota Lakes* (2006 edition), these data were statistically analyzed Rice Lake was classified as demonstrating *no clear water clarity trend.*



The graph above shows the long-term trend in Trophic Status Index values the years for which data are available for Koronis Lake. The variation observed within a single year reflects naturally occurring impacts of temperature, precipitation and water level; the important *take home message* of this graph is that the data suggests range in mesotrophic or lower eutrophic conditions since data were first collected in 1973.

Rice Lake TSI Readings



The goal for Ricek Lake is a TSI Average of 40 or below. As can be seen by the chart below the TSI seems to slowly be improving but we have a ways to go.

Summary of average TSI across from data collected for each year.
A second method of assessing water quality and determining whether your water body is the best that it can be is to compare it to other lakes of similar morphology, geology and land uses. The table below is adapted from the Minnesota Pollution Control Agency (MPCA) *Environmental Data Access* database. It compares observed surface water results in Lake Koronis and Rice Lake to common water quality ranges

Parameter	Typical Range: Central Hardwood Forest Eco-region (25^{th}-75^{th} Percentile)	Koronis Lake (#73-0200)	Rice Lake (#73-0196)
Total Phosphorus (µg/L)	23 – 50	59.2 + 51.2	112.9 + 203.4
Chlorophyll a (µg/L) mean	5-22	18.2 + 20.95	32.7+ 24.3
Chlorophyll a (µg/L) maximum	7 – 37	147	129
Secchi disc (feet)	4.9 – 10.5	8.01 + 4.10	5.6 + 3.9
Total Kjeldahl Nitrogen (mg/L)	< 0.60 – 1.2	1.24 + 0.25	1.4 + 0.3
Nitrite + Nitrate Nitrogen (mg/L)	<0.01	0.43 + 0.34	0.42 + 0.50
Alkalinity (mg/L)	75-150	202.9 + 23.9	195.2 + 39.8
Color (Pt-Color units)	10 – 20	15 + 0	19.3 + 7.0
pH	8.6 – 8.8	8.2 + 0.3	8.3 + 0.5
Chloride (mg/L)	4 – 10	12.5 + 2.0	11.2 + 6.0
Total Suspended Solids (mg/L)	2 – 6	4.7 + 2.8	7.3 + 4.1
Conductivity (µmhos/cm)	300 – 400	292.3 + 56.2	417.2 + 82.4

for lakes within the Central Hardwood Forest Eco-region.

A third application of these data is to compare phosphorus concentrations to the MPCA water quality criterion for swimming and other recreational contact. For the Central Hardwood Forest Ecoregion phosphorus criteria level of 40 micrograms per liter (µg/L) serves as the upper threshold for full-support for swimmable use.

Phosphorus concentration (µg/L)	Trophic Status Index range	Regulatory Status	Common conditions
40	57 or lower	Full support for swimmable use	
40-45	57-59	Partial-support	Increased frequency of nuisance algal blooms results in high percentage of the summer (26-50 percent) perceived as impaired swimming.
45	59 or higher	Non-support	Mild algal blooms occur over 80 percent of the summer, nuisance blooms about 40 percent of the summer, and severe nuisance blooms about 15 percent of the summer.

The MPCA also uses a summary based on available summer (June through September) data in STORET. STORET is the national water quality data repository developed by the United States Environmental Protection Agency to calculate achievement in this area. All water quality data collected by MPCA or received from external groups between 1987 and 2009 is placed in STORET. The following summary is presented on the MPCA website:

Name	Mean Total Phosphorus (µg/l)	Carlson's Trophic Stratus Index (phosphorus)	MPCA Swimming Criterion
Lake Koronis	42.0	58	Partial-Support
Rice Lake	60.0	63	Non-Support

Based on the phosphorus data presented above, Rice Lake does not support "fishable/swimmable" standards, and Koronis Lake only provides partial support for recreational use and contact.

The North Fork-Crow River Watershed District (NFCRWD) is also a primary partner in protecting and restoring water quality in the Rice-Koronis Basin. Created on May 10, 1985 by citizen petition, the district administered a budget of $663,000 in 2007 for monitoring, permitting, projects, ditch maintenance and repair, and education. The District's address is: 100 Prairie Avenue North, PO Box 40, Brooten, MN 56314, (320) 346-2869, **nfcrwsd@tds.net**. The MPCA will complete a total maximum daily load (TMDL) study of Rice Lake in June, 2011. The study is administered through the NFCRWD.

FISHERIES

Lake Koronis Fishery Survey

The Minnesota Department of Natural Resources (DNR) provides the following report of fishery on Lake Koronis as of 07/23/2012.

A population assessment of Lake Koronis was conducted in late July of 2012. Koronis is a large, deep, and productive lake located primarily in Stearns County. Koronis is a popular fishery for walleye, northern pike, smallmouth bass, black crappie, tullibee and bluegill. Koronis receives moderate recreational use during the summer months. There are five public access sites on Koronis. The lake is highly developed with approximately 498 homes and cabins, and seven resorts/bible camp/campgrounds. In addition, the city of Paynesville is within two miles of the lake. The immediate watershed is composed primarily of agricultural row crops, hardwood areas, and residential development. Nutrient runoff enters Koronis via 45 inlets/tiles (mostly small inlets) from agricultural, city storm sewer, and lake residential sources. The largest inlet is the North Fork of the Crow River, which enters Koronis along the east shore and outlets near the southeast corner. The greatest volume of nutrient loading is delivered to Koronis via the North Fork of the Crow River. Nutrient levels (total phosphorus=0.030 ppm, chlorophyll a=24.0 ppb) were moderate in June of 2007 for Koronis. Aquatic vegetation densities are variable yearly in the lake. Curly-leaf pondweed can often become dense in the east end and outlet bay of Koronis. Submergent vegetation densities were low to moderate in 2012. Water clarity was good (6.2 feet) on July 24, 2012 in Koronis. Water clarity (coffee colored) was poor during the 2012 fall and 2012-13 winter months. Water levels were high to normal early in 2012, but low by mid-summer.

A minor summerkill of large sized tullibee (cisco) was noted during late July - early August of 2010. A major summerkill of tullibee occurred in Koronis during 2011, but only a minor kill occurred in Green Lake during the 2011 summer. Drought conditions and extremely high air temperatures were the norm for the area during July and early August of 2012. There were no apparent summerkills in Green or Koronis during 2012, but adult numbers were so low that summerkill events may not have been recognizable, especially due to the large numbers of pelicans living on Lake Koronis islands. A narrow band (1-3 feet) of marginal temperatures (<23.5 C) and dissolved oxygen levels (1-3 ppm) was present at depths of 18-25 feet in Koronis during mid-July and early August of 2012. Tullibee summerkill conditions on Koronis were suitable when dissolved oxygen levels were less than 1 ppm at a depth of 20 feet with a water temperature of 24.2 C on July 24, 2012, but no summerkill events were observed in 2012. Partial summerkills of tullibee and white sucker are common in Koronis during hot summers.

Rice Lake is upstream and connects to Lake Koronis via the North Fork of the Crow River. Walleye from both Rice and Koronis spawn in the North Fork of the Crow River upstream of Rice Lake. Walleye also spawn adjacent to the east shores of the three islands in Koronis and the east point of Rice. Both Rice and Koronis are periodic walleye egg take sites for the statewide walleye propagation program. Historic spawning sites for walleye in both Koronis and Rice have been degraded in recent years with increased sedimentation, algal and periphyton growth. Northern pike spawning areas are located along the north (Spaeth) and west (Hendrickson) shores of Koronis.

Best management practices (buffers, storm sewer settling ponds, better wastewater management practices, better shore land practices) have been enacted or encouraged by local governments, the North Fork Crow River Watershed District, homeowners, lake associations, and Paynesville Sportsman's Club. Koronis is managed primarily for walleye and northern pike, in addition to secondary species such as bluegill, yellow perch, tullibee, bass, and black crappie.

Black crappie numbers were moderately abundant in 2012 (1.60 fish/gillnet) compared to the normal ranges for Koronis and similar lakes, but below the 2010 gillnet catch (7.50 fish/gillnet). The Koronis black crappie historical average catch rate is 1.13 fish/gillnet. The 2012 black crappie average size was moderate (0.47 pounds and 8.53 inches) from gillnets. The black crappie historical average length is 8.22 inches from gillnets. The 2012 catch rate of preferred size (10.00 inches) and larger black crappie was low (0.60 fish/gillnet). Black crappie fishing has been excellent the last few years from shore adjacent to the Highway 55 access during the spring.

Bluegill numbers were low to moderate in 2012 (5.33 fish/trapnet) compared to the normal ranges for Koronis and similar lakes. The Koronis bluegill historical average catch rate is 8.65 fish/trapnet. The 2012 bluegill average size was small (0.16 pounds and 5.66 inches) from the trapnets. The bluegill historical average length is 5.09 inches from trapnets. The 2012 catch rate of quality size (6.00 inches) and larger bluegill was low (1.60 fish/trapnet).

Northern pike numbers were low in 2012 (1.60 fish/gillnet) compared to the normal ranges for Koronis and similar lakes. The Koronis northern pike historical average catch rate is 2.67 fish/gillnet. The 2012 northern pike average size was large (6.83 pounds and 29.41 inches) from gillnets. The northern pike historical average length is 24.20 inches from gillnets. The 2012 catch rate of preferred size (28.00 inches) and larger northern pike was moderate to high (0.80 fish/gillnet). Northern pike growth rates in Koronis were generally above the Spicer Area normal ranges for ages 1-6. The 2009 year class comprised about 36% of the 2012 northern pike assessment catch. The largest northern pike captured was 40.4 inches in the 2012 assessment. Northern pike angling (2012 summer) and spearing (2011-12 winter) was excellent for moderate/large sized fish, but fair for total numbers. Poor water clarity resulted in minimal spearing pressure during the 2012-13 winter.

Smallmouth bass numbers were abundant in 2012 (2.20 fish/gillnet) compared to the normal ranges for Koronis and similar lakes. The smallmouth bass historical average catch rate is 0.87 fish/gillnet from Koronis. The 2012 smallmouth bass average size was moderate (1.07 pounds and 12.05 inches) from gillnets. The smallmouth bass historical average length is 12.80 inches from gillnets. The 2012 catch rate of preferred size (14.00 inches) and larger smallmouth bass was moderate to high (0.80 fish/gillnet) compared to the historical average (0.51 fish/gillnet). The largest smallmouth bass captured was 19.1 inches in the 2012 assessment. Smallmouth bass growth rates were within the Spicer Area normal ranges for ages 1-3 and above the normal ranges for ages 4-8. The 2010 year class comprised 47% of the 2012 smallmouth gillnet and trapnet catch.

Tullibee "cisco" numbers were not present in the 2012 summer gillnets. The tullibee historical summer average catch rate is 1.20 fish/gillnet for Koronis. The tullibee summer historical average length is 12.30 inches from gillnets.

Tullibee abundance was moderate (23.8 fish/gillnet, 15.28 inches average length) in the 2010 fall gillnet special assessment, but low in 2012 (5.33 fish/gillnet). The 2012 fall tullibee average size was moderate (1.41 pounds and 14.91 inches) for Koronis. The fall tullibee historical average catch rate and average length are 31.6 fish/gillnet and 15.16 inches for Koronis. Fall tullibee catch rate in nearby Green Lake was also low in 2012 (8.33 fish/gillnet, 13.61 inches average length). The 2012 fall tullibee condition factor (1.180) was below the normal range for Koronis. Tullibee growth rates were at or below the Koronis normal ranges for ages 1-7. The 2006 year class comprised 34% of the 2012 fall tullibee catch in Koronis. The 2008 and 2007 year classes each comprised 22% of the total 2012 fall catch. A major summerkill of tullibee occurred in Koronis during 2011. Hopefully, cool summers will occur during the next several years, which may result in a good hatch and survival of tullibee in Koronis if adequate brood stock numbers are still present. Tullibee are an important forage species for both large northern pike and walleye.

Yellow perch numbers were low to moderate in 2012 (18.40 fish/gillnet) compared to the normal ranges for Koronis and similar lakes. The yellow perch historical average catch rate is 59.09 fish/gillnet for Koronis. The 2012 yellow perch average size was small to moderate (0.13 pounds and 6.84 inches) from gillnets. The yellow perch historical average length is 7.01 inches from gillnets. The 2012 catch rate of quality size (8.00 inches) and larger yellow perch was low (0.40 fish/gillnet). Yellow perch growth rates were within the Spicer Area normal ranges for ages 1-4. The 2010 year class comprised 96% of the 2012 gillnet catch.

Walleye numbers were abundant in 2012 (19.60 fish/gillnet) compared to the normal ranges for Koronis and similar lakes. The walleye historical average catch rate is 9.96 fish/gillnet for Koronis. The 2012 walleye average size was small (0.89 pounds and 12.82 inches) from gillnets. The walleye historical average length is 13.84 inches from gillnets. The 2012 catch rate of quality size (15.00 inches) and larger walleye (6.00 fish/gillnet) was high compared to the historical average (3.77 fish/gillnet) for Koronis. Walleye growth rates were generally below the Spicer Area normal ranges for ages 2-7, but within the normal ranges for ages 1 and 8. The 2011 year class (fry stocked and natural reproduction) comprised 44% of the 2012 walleye gillnet and trapnet catch. Oxytetracycline "OTC" marked fish (fry stocked) comprised 77% of the 2011 year class captured in the 2012 summer gillnets. The 2010 year class (fry stocked, fingerling stocked, natural reproduction) comprised 19% of the 2012 walleye gillnet and trapnet catch. The 2008 year class (fry stocked, natural reproduction) comprised 17% of the 2012 walleye gillnet and trapnet catch.

Walleye natural reproduction in Koronis was generally both frequent and adequate to sustain walleye numbers based on previous fall and summer surveys from 1993-2002. YOY Walleye numbers were low (<11.0 YOY/hour) from 2003-2006 in Koronis. There were moderate to low numbers of YOY walleye from fry stocking and natural reproduction in the 2007 (44.00 YOY/hour, 7.29 inches) and 2008 (22.94 YOY/hour, 5.93 inches) fall electrofishing surveys. Approximately 40% of the YOY walleye sampled in the 2007 fall electrofishing survey were from an OTC marked fry stocking. No fall electrofishing survey was conducted for Koronis in 2009, but low walleye numbers (1.30 fish/hour, 7.60 inches average size) of the 2009 year class were captured in a 2010 spring electrofishing survey. Low numbers of YOY walleye (6.43 YOY/hour, 7.27 inches) were captured in the 2010 fall electrofishing survey. Approximately 55% of the 2010 fall electrofishing YOY catch had white light characteristics on otoliths (unmarked fry stocking). Abundant numbers of YOY walleye (205.50 YOY/hour, 6.50 inches) were captured in the 2011 fall electrofishing survey. Approximately 80% (164.40 YOY/hour) were OTC marked fish in the 2011 fall electrofishing survey. Moderate YOY walleye numbers (32.83 YOY/hour, 6.97 inches) were captured in the 2012 fall electrofishing survey. Approximately 92% of the 2012 year class fish captured in the 2012 fall electrofishing survey were OTC marked (fry stocked). The fall electrofishing YOY walleye historical average catch rate is 37.26 YOY/hour for Koronis.

Walleye fry (0.5-2.0 million/year) were stocked during 1996 and 2001-2012 as a 10% return of walleye eggs taken for the DNR statewide walleye hatching program. Walleye fingerlings were recently stocked in 2004 (2,409 pounds, 48,180 fish), a combination of ages (2,355 pounds, 45,685 fish) were stocked in 2006, and a combination of yearlings and fingerlings (867 pounds, 4,887 fish) were stocked in the 2010.

Rock bass numbers were moderately abundant in 2012 (3.20 fish/gillnet) compared to the normal ranges for Koronis and similar lakes. The rock bass historical average catch rate is 1.75 fish/gillnet for Koronis. The 2012 rock bass average size was moderate (0.32 pounds and 7.32 inches) from gillnets. The rock bass historical average length is 7.10 inches from gillnets.

Other species of interest captured in 2012 included moderate/low numbers of black bullhead (7.40 fish/gillnet, 0.07 fish/trapnet), carp (0.40 fish/gillnet, 0.13 fish/trapnet), white sucker (6.00 fish/gillnet), largemouth bass (0.40 fish/gillnet) and shorthead redhorse (0.80 fish/gillnet). Yellow bullhead abundance (14.00 fish/gillnet, 10.31 inches average length) was above the normal range for Koronis in 2012.

Invasive goldfish were sampled in a 2012 Index of Biotic Integrity "IBI" survey. Invasive goldfish were documented in a private pond that connects to Koronis during 2011. The pond was drained and reclaimed, but goldfish probably entered Koronis prior to 2011 over the pond's dam boards during high flows. Lake shore residents reported seeing goldfish in the outlet stream of the pond next to the lake during 2011.

Current fish management activities on Koronis include protecting the important aquatic vegetation such as bulrush through the permit process, participating in local watershed projects, assisting aquatic plant management and enforcement personnel in educating boaters and monitoring access sites for potential invasive species introductions, stocking various species as needed, and stocking walleye fingerlings after two consecutive years of poor natural reproduction as documented by fall night electrofishing surveys. The Koronis fishery will be surveyed again for YOY walleye in the 2013 fall and 2014 for a population assessment.

Rice Lake Fishery Survey

The Minnesota Department of Natural Resources (DNR) provides the following report of fishery on Rice Lake as of 07/16/2012.

A population assessment of Rice Lake was conducted in mid-July of 2012. Rice is a large, moderately deep, and productive lake located in Stearns County. Rice is a popular lake for angling (walleye, bass, bluegill, black crappie) and spearing (northern pike). There are two public access sites on Rice. Rice receives moderate recreational use during the summer months. The lake is highly developed with approximately 288 homes and cabins. In addition, the city of Paynesville is within four miles of the lake. The immediate shoreline area is a mixture of hardwoods and residential development with lesser amounts of wetlands, grassland, and pasture areas. The surrounding watershed is a mixture of rolling hardwood and row crop areas, feedlots/pastures, wetlands, and residential development. The largest inlet and nutrient contributor is the North Fork of the Crow River, which enters Rice along the southwest corner and outlets about 100 yards south of where it enters the lake. Nutrient runoff enters Rice from agricultural row crops, feedlots/pasture areas, city storm sewer, and lake residential sources. Water clarity was poor during mid-July of 2012 (secchi=3.0 feet). Dissolved oxygen levels were less 1 ppm below 18 feet deep during the survey. Low water levels due to drought conditions and high summer air temperatures were the norm during the 2012 summer. Nutrient levels (total phosphorus=0.049 ppm, chlorophyll a=36.3 ppm) were moderately high during June of 2007. Aquatic vegetation densities are variable in the lake on a yearly basis. Curly-leaf pondweed can often become dense in the bay and near shore littoral areas of Rice Lake. Curly-leaf pondweed can provide important cover for young and adult fish species during early summer, especially in shallow lakes/bays lacking native submergent vegetation cover. However, the release of phosphorus and nitrogen from dead/decaying curly-leaf pondweed during mid-July may exasperate conditions for more intense blue-green algae occurrences in Rice. Severe blue-green algae blooms are a common occurrence on Rice during mid to late summer. Emergent vegetation stands (cattails) are limited within the lake (outlet area, north bay).

Rice Lake is upstream and connects to Lake Koronis via the North Fork of the Crow River. Walleye from both Rice and Koronis spawn in the North Fork of the Crow River upstream of Rice Lake. Walleye also spawn adjacent to an east shore point area in Rice. Both Rice and Koronis are periodic walleye egg take sites for the statewide walleye propagation program. Historic spawning sites for walleye in Rice Lake (i.e. east shore point) have been degraded in recent years with increased sedimentation, algal and periphyton growth. A northern pike spawning area is located along the northwest shore of the northeast bay. Rice is managed primarily for walleye with northern pike, black crappie, bluegill, largemouth bass, smallmouth bass and yellow perch as secondary species.

An Index of Biotic Integrity "IBI" survey was conducted from July 3-9, 2012 on Rice Lake. Seine hauls were conducted with a bag seine of 50 foot width and 1/8 inch bar mesh in depths of 3.5 feet or less. Near shore electrofishing was conducted with a back-pack unit in water depths less than 2 feet deep. There are 16 stations that were spaced equally apart around the entire shoreline of the lake in a variety of near shore habitats and each station was approximately 100 feet long, but not all stations were sampled with both seining and electrofishing gears due to water levels, emergent vegetation, or unsuitable substrates for walking. Two electrofishing runs were conducted with the initial run of 100 feet near the shore-water interface in depths of < 1 foot and the second run of 100 feet long about 10-20 feet from shore in depths up to 2 feet. Approximately 32 known and 1 unknown fish species (24 species from electrofishing, 23 species from seining) were captured from electrofishing and seining combined. Fish species captured included gamefish (i.e. smallmouth bass, walleye, and largemouth bass), panfish (bluegill, black crappie, yellow perch, rock bass, pumpkinseed sunfish, green sunfish, hybrid sunfish and unknown sunfish species), large non-gamefish (white sucker, shorthead redhorse, yellow bullhead, bowfin, black bullhead and brown bullhead) and small non-gamefish (Iowa darter, johnny darter, blackside darter, logperch, tadpole madtom, hornyhead chub, brook silverside, banded killifish, common shiner, golden shiner, spottail shiner, blacknose shiner, blackchin shiner, bluntnose minnow, central mudminnow, and fathead minnow). The various species captured in Rice is indicative of species present in most Spicer Area lakes.

Black crappie numbers were abundant in 2012 (10.53 fish/trapnet) compared to the normal ranges for Rice and similar lakes. The black crappie historical average catch rate is 6.68 fish/trapnet. Abundant numbers of black crappie were also captured in the 2012 gillnets (22.40 fish/gillnet, 6.98 inches average length). The 2012 black crappie size was moderate to small (0.33 pounds and 8.07 inches) from trapnets. The black crappie historical average length is 8.26 inches from trapnets. The catch rate of quality size (8.00 inches) and larger black crappie was high (5.30 fish/trapnet) in the 2012 assessment. Black crappie growth rates were within the Spicer Area normal ranges for ages 1-7. The 2010 and 2009 black crappie year classes comprised 38% and 27% respectively of the 2012 black crappie gillnet and trapnet catch in Rice.

Bluegill numbers were moderate in 2012 (13.27 fish/trapnet) compared to the normal ranges for Rice and similar lakes. Abundant numbers of bluegill were captured in the 2012 gillnets (12.4 fish/gillnet, 6.76 inches average length). The bluegill historical average catch rate is 14.73 fish/trapnet for Rice. The 2012 bluegill average size was small (0.18 pounds and 5.95 inches) from the trapnets. The bluegill historical

average length is 5.33 inches from trapnets. The 2012 catch rate of quality size (6.00 inches) and larger bluegill was high (5.49 fish/trapnet) compared to the historical average (2.18 fish/trapnet).
Northern pike numbers were abundant in 2012 (10.40 fish/gillnet) compared to the normal ranges for Rice and similar lakes. The northern pike historical average catch rate is 3.96 fish/gillnet. The 2012 northern pike average size was small (2.77 pounds and 21.92 inches) from gillnets. The northern pike historical average length is 22.45 inches from gillnets. The 2012 catch rate of quality size (21.00 inches) and larger northern pike was high (5.60 fish/gillnet). The 2012 catch rate of preferred size (28.00 inches) and larger northern pike was also high (1.00 fish/gillnet). Northern pike growth rates in Rice were below the Spicer Area normal ranges for ages 1-2, but within the normal ranges for ages 3-8. The 2010 year class comprised 32% of the 2012 gillnet and trapnet catch. The largest northern pike captured in the 2012 assessment was 35.83 inches. Local residents reported good spearing success during the 2012-13 winter.

Smallmouth bass numbers were abundant in 2012 (1.20 fish/gillnet) compared to the normal ranges for Rice and similar lakes. The smallmouth bass historical average catch rate is 0.26 fish/gillnet. The 2012 smallmouth bass average size was large (1.92 pounds and 14.67 inches) from gillnets. The smallmouth bass historical average length is 15.07 inches from gillnets. Smallmouth bass growth rates were below the Spicer Area normal range for age 1, within the normal range for age 2 and generally above the normal ranges for ages 3-6. The 2009 year class comprised 50% of the 2012 smallmouth bass gillnet catch. The largest smallmouth bass captured was 17.72 inches in the 2012 assessment.

Largemouth bass numbers were abundant in 2012 (1.20 fish/gillnet) compared to the normal ranges of Rice and similar lakes. The largemouth bass historical average catch rate is 0.30 fish/gillnet. The 2012 largemouth bass average size was small (0.76 pounds and 10.72 inches) from gillnets. Local anglers have reported higher bass catches in recent years for Rice Lake. Anglers often seek both smallmouth bass and largemouth bass in shallow basins like the north bay or nearby Mud Lake located downstream of Rice Lake via the North Fork of the Crow River during the early summer months.

Yellow perch numbers were abundant in 2012 (54.00 fish/gillnet) compared to the normal ranges for Rice and similar lakes. The yellow perch historical average catch rate is 29.58 fish/gillnet for Rice. The 2012 yellow perch average size was moderate (0.16 pounds and 7.13 inches) from gillnets. The yellow perch historical average length is 7.01 inches from gillnets. The 2012 catch rate of quality size (8.00 inches) and larger yellow perch was moderate (6.42 fish/gillnet).

Walleye numbers were abundant in 2012 (20.40 fish/gillnet) compared to the normal ranges for Rice and similar lakes. The walleye historical average catch rate is 9.97 fish/gillnet for Rice. The 2012 walleye average size was moderate (1.26 pounds and 14.66 inches) from gillnets. The walleye historical average length is 15.83 inches from gillnets. The 2012 catch rate of quality size (15.00 inches) and larger walleye was high (8.00 fish/gillnet). The 2012 catch rate of preferred size (20.00 inches) and larger walleye was moderate (1.40 fish/gillnet). Walleye growth rates were within the Spicer Area normal ranges for ages 1-5, but above the normal ranges for ages 6-8. The 2010 year class (fry and fingerling stockings) comprised 47% of the 2012 gillnet and trapnet catch. The 2009 year class (fry stocking and natural reproduction) comprised 13% of the 2012 gillnet and trapnet catch.

Walleye natural reproduction in Rice was generally both frequent and adequate to sustain walleye numbers based on previous fall and summer surveys from 1993-2004. However, poor natural reproduction or fry stocking success occurred from 2005-2010 in Rice. Thus, various combinations of walleye fingerlings, yearlings and adults were stocked in Rice during 2007 (25,310 fish, 2,556 pounds), 2008 (417 fish, 330 pounds) and 2010 (15,281, 1,923 pounds). Walleye fry (1-2 million each year) were stocked during 2001-2012 as a 10% return of walleye eggs taken for the DNR statewide walleye hatching program. Generally, low young of year "YOY" walleye numbers have been captured in fall night electrofishing surveys since 2005. The 2012 fall electrofishing survey also documented low numbers of YOY walleye (4.00 YOY/hour, 5.77 inches average). Moderate/good YOY walleye year classes due either to natural reproduction or fry stocking were documented in 2003 (42.00 YOY/hour, 6.46 inches average), 2004 (55.50 YOY/hour, 6.74 inches average) and 2011 (150.00 YOY/hour, 6.27 inches average). Approximately 62% of the YOY walleye captured in the 2011 fall electrofishing survey were OTC marked fish from a 2011 fry stocking. The fall electrofishing YOY walleye historical average catch rate is 48.16 YOY/hour for Rice. The yearling walleye catch rate was moderate in 2012 (6.00 fish/hour, 9.20 inches average).

Black bullhead numbers were low in 2012 (2.00 fish/gillnet) compared to the normal range for Rice. The black bullhead historical average catch rate is 25.66 fish/gillnet. The 2012 black bullhead average weight (1.35 pounds) was large and above the Rice historical average (0.68 pounds).

Yellow bullhead numbers were moderate in 2012 (2.20 fish/gillnet) compared to the normal range for Rice and similar lakes. The yellow bullhead historical average catch rate is 1.89 fish/gillnet for Rice. The 2012 yellow bullhead average weight (0.73 pounds) was moderate and similar to the Rice historical average (0.69 pounds).

Other species of interest captured in 2012 included high numbers of shorthead redhorse (8.40 fish/gillnet) and white sucker (6.80 fish/gillnet), and low numbers of carp (0.47 fish/trapnet) from Rice. The Rice historical average catch rates for shorthead redhorse, white sucker, and carp were 6.58 fish/gillnet, 5.32 fish/gillnet and 2.60 fish/trapnet respectively. The 2012 average size was 2.38 pounds for shorthead redhorse, 1.73 pounds for white sucker, and 8.29 pounds for carp.

Current fish management activities on Rice include protecting important aquatic vegetation through the permit process, participating in local watershed projects, assisting aquatic plant management and enforcement personnel in educating boaters and monitoring access sites for potential invasive species introductions, considering potential curly-leaf pondweed management options, operating the northern pike spawning area as needed, and stocking walleye fry or fingerlings as required or needed. The Rice Lake fishery will be surveyed during the 2013 fall for YOY walleye numbers and 2014 for a population assessment.

For southern Stearns County the DNR contact is Bruce Gilbertson, Spicer Area Fisheries Supervisor, 10590 Co Rd 8 NE, Spicer, MN 56288, (320) 796-2161, e-mail: www.bruce.gilbertson@state.mn.us. Gilbertson and his colleagues have prepared a fisheries management plan for Rice and Koronis Lakes.

DNR Lake Koronis Fishery Management Plan

The fisheries management goal of the DNR plan for Koronis Lake is to manage, "…primarily for walleye and secondarily for a variety of other gamefish species. Although walleye natural reproduction occurs during most years as measured by annual fall electrofishing, supplemental fingerling stocking has periodically been needed after consecutive years of poor natural reproduction to sustain survey catches to meet long-range goals.

The DNR plan also notes the following limiting factors for Lake Koronis:

- Continual loss of emergent vegetation due to shoreline development has progressively occurred and has undoubtedly limited spawning/rearing habitat, particularly for Centrarchids. Water quality benefits from emergent vegetation have been reduced.
- Lake Koronis receives consistently moderate-heavy angling pressure which can limit certain species, particularly walleye, quality-sized panfish and large northern pike. There is a lack of quality creel information for Koronis and Rice Lake. Periodic creel surveys are needed to better monitor the fishery (at least once per decade), evaluate the fishery (develop creel based long-range goals) and will be useful if changes in management occur (e.g., experimental regulations).
- Water levels tend to fluctuate relatively rapidly given the large watershed that drains into Lake Koronis which exacerbates shoreline erosion and variable habitat conditions.
- Summerkill, particularly of tullibee, periodically occur. Under periods of stable summer thermoclines, anoxic conditions persist in the hypolimnion.
- Population abundances of yellow perch, bluegill, and black bullhead fluctuate widely.
- The popularity of automatic untended aquatic plant control devices is increasing.

DNR Rice Lake Fishery Management Plan

The DNR management goal for Rice Lake notes that the lake, "…supports a primary walleye fishery and a secondary fishery for a variety of other gamefish species, most notably northern pike and black crappie. Although walleye natural reproduction occurs during most years as measure by annual fall electrofishing, supplemental fingerling stocking may periodically be needed to maintain survey catches within long-range goals."

The limiting factors for fisheries in Rice Lake are similar to those of Koronis:

- Continual loss of emergent vegetation due to shoreline development has progressively occurred and has undoubtedly limited pawning/rearing habitat, particularly for Centrarchids. Water quality benefits from emergent vegetation have been reduced.
- Rice Lake periodically receives heavy angling pressure which can limit certain species, particularly walleye and black crappie, quality-sized panfish and large northern pike. There is a lack of quality creel information for Koronis and Rice Lakes. Periodic creel surveys are needed to better monitor the fishery (at least once per decade), evaluate the fishery (develop creel based long-range goals) and will be useful if changes in management occur (e.g., experimental regulations).

- Water levels tend to fluctuate relatively rapidly given the large watershed that drains into Rice Lake which exacerbates shoreline erosion and variable habitat conditions.
- Population abundances of most species tend to fluctuate widely. This is related to the variable habitat/water quality conditions that exist in Rice Lake
- The popularity of automatic untended aquatic plant control devices is increasing. The recent increase in submerged vegetation densities on Rice Lake has also increased interest in aquatic plant control efforts.
- Partial Summerkill, primarily white sucker, occurs periodically.
- Curled Pondweed (an invasive exotic) is periodically abundant. Mid-summer die-offs exacerbate algal booms.
- Poor water clarity periodically limits winter spearing success for northern pike.

The entire DNR Fisheries Management Plan Koronis Lake (Appendix I) and Rice Lake (Appendix II) are presented at the end of this Lake Management Plan.

AQUATIC VEGETATION

In all discussions we distinguish between beneficial vegetation (wildlife or fish habitat, vegetative buffer zones, native species) and nuisance (impediments to recreation) or exotic/invasive (biological "threats" such as Eurasian milfoil, purple loosestrife, curlyleaf pondweed). It is important to remember that control of the nuisance kind of vegetation may have adverse impacts on fishery and wildlife. By Minnesota Rule, aesthetics *are not* part of the definition of nuisances. Recreational impairment is the standard used to define nuisance conditions related to aquatic plants.

Both lake associations have access to Garden Clubs as site-specific assets, such as Lake Demonstration sites on the lake.

See Appendix III for most current information.

WILDLIFE

Developing a Lake Management Plan by the Interagency Lake Coordinating Committee, (p. 18) notes, "Minnesota's lakes are home to many species of wildlife. From our famous loons and bald eagles to muskrats, otters, and frogs, wildlife is an important part of our relationship with lakes. In fact, Minnesota's abundant wildlife can be attributed largely to our wealth of surface water. From small marshes to large lakes, these waters are essential to the survival of wildlife.

The most important wildlife habitat begins at the shoreline. The more natural the shoreline, with trees, shrubs and herbaceous vegetation, the more likely that wildlife will be there. Just as important is the shallow water zone close to shore. Cattail, bulrush, and wild rice along the shoreline provide both feeding and nesting areas for wildlife. Loons, black terns and red-necked grebes are important Minnesota birds that are particularly affected by destruction of this vegetation. Underwater vegetation is also important to wildlife for many portions of their life cycle, including breeding and rearing of their young."

The primary agency charged with the management of Minnesota's wildlife is the Department of Natural Resources, Division of Fish and Wildlife, Wildlife Section.

Of special interest is the nesting of eagles on Third Island on Lake Koronis. Loon nesting is also confirmed.

The Minnesota County Biological Survey has completed the survey for Stearns County. At the north end of Rice Lake is shown with the symbol indicating that a federally or state listed animal has been identified in a Dry Prairie – Hill subtype area and in the Koronis Lakeshed on the western shores a similar designation has been attributed to an Oak Forest, Mesic subtype area.

Dry Prairie - hill subtype - Dry to dry-mesic prairies on well-drained soils on slopes andhilltops in glacial till. Dominant grasses are little bluestem, side-oats grama (*Boutelouacurtipendula*), and prairie dropseed (*Sporobolus heterolepis*); associated graminoids include plains muhly (*Muhlenbergia cuspidata*), porcupine grass, big bluestem, and Mead's sedge (Carex meadii). Typical forbs include standing milk-vetch (*Astragalus adsurgens*), buffalo- bean (*Astragalus crassicarpus*), purple prairie clover (*Petalostemon purpureum*), silky aster (*Aster sericeus*), heath aster (*Aster ericoides*), dotted blazing star (*Liatris punctata*), and pasque-flower (*Anemone patens*). Lead-plant (*Amorpha canescens*) and wolfberry (*Symphoricarpos occidentalis*) are common low shrubs.

Oak Forest - mesic subtype - Mesic forests primarily on well-drained glacial till on level to strongly rolling topography in northern and eastern Stearns County. Canopy typically dominated by red oak (*Quercus rubra*); common associated or codominant canopy trees in-
clude basswood (*Tilia americana*) , northern pin oak (*Quercus ellipsoidalis*), white oak (*Quercus alba*), bur oak (*Quercus macrocarpa*), paper birch (*Betula papyrifera*) , and redmaple (*Acer rubrum*). Sugarmaple (*Acer saccharum*) and big-toothed aspen (*Populus grandidentata*) are occasional in the canopy of some stands. Subcanopy consists mostly of shade-tolerant pecies including sugar maple and ironwood (*Ostrya virginiana*). Shrub-layer species include American hazelnut (*Corylus americana*), prickly gooseberry (*Ribes cynosbati*), downyarrowwood (*Viburnum rafinesquianum*), and frequently, dense patches of sugar maple. Ground
layer dominated by summer-blooming species such as wild sarsaparilla (*Aralia nudicaulis*),
common false Solomon's-seal (*Smilacina racemosa*), wild geranium (*Geranium maculatum*),
sweet cicely (*Osmorhiza claytonii*), pointed-leaved tick-trefoil (*Desmodium glutinosum*), and
black-fruited rice-grass (*Oryzopsis racemosa*).

EXOTIC SPECIES

No specific surveys for sampling invasive species have been done on Lake Koronis or Rice Lake. However, DNR watercraft inspectors monitor accesses across the state as well as Lake Koronis and Rice Lake. The NFCRWD, in cooperation with KLA, RLA, DNR, Meeker County and several LGU's, implemented an AIS Inspection program for the lakes within the watershed, including Koronis and Rice in the spring of 2013. On-going inspections are public ramps occurs from May into September..

When Fisheries crews work on area lakes, they detect invasive species. They also respond to reports from the public about unusual plants with concern that they may be invasive species. Lake Koronis does not have a Lake Vegetation Management Plan (LVMP). That is a plan our invasive species specialist would work with the lake association to develop if KLA establishes that as a goal.

Nathan Olson is now the DNR's Invasive Species Specialist, 1509 1st Avenue North
Fergus Falls, MN 56537, 218-739-7576 x259 phone, **nathan.olson@state.mn.us**.

Bruce Gilbertson, previously listed, is also knowledgeable in this area.

Background

Exotic species -- organisms introduced into habitats where they are not native -- are severe worldwide agents of habitat alteration and degradation. A major cause of biological diversity loss throughout the world, they are considered *biological pollutants*.

Introducing species accidentally or intentionally from one habitat into another is risky. Freed from the predators, parasites, pathogens and competitors that have kept their numbers in check, species introduced into new habitats often overrun their new home and crowd out native species. In the presence of enough food and favorable environment, their numbers will explode. Once established, exotics rarely can be eliminated.

Most species introductions are the work of humans. Some introductions, such as carp and purple loosestrife are intentional and do unexpected damage. But many exotic introductions are accidental. The species are carried in on animals, vehicles, ships, commercial goods, produce and even clothing. Some exotic introductions are ecologically harmless and some are beneficial. But other exotic introductions are harmful to recreation and ecosystems. They have caused the extinction of native species, especially those of confined habitats such as islands and aquatic ecosystems.

The recent development of fast ocean freighters has greatly increased the risk of new exotics in the Great Lakes region. Ships take on ballast water in Europe for stability during the ocean crossing. This water is pumped out when the ships pick up their loads in Great Lakes ports. Because the ships make the crossing so much faster now, and harbors are often less polluted, more exotic species are likely to survive the journey and thrive in the new waters.

Many plants and animals described in this guide arrived in the Great Lakes this way. But they are now being spread throughout the continent's interior attached to boats and other recreational watercraft and equipment. This guide is designed to help water recreationists recognize these exotics and help stop their further spread.

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

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

A key factor in the plant's success is its ability to reproduce through stem fragmentation and runners. A single segment of stem and leaves can take root and form a new colony. Fragments clinging to boats and trailers can spread the plant from lake to lake. The mechanical clearing of aquatic plants for beaches, docks, and landings creates thousands of new stem fragments. Removing native vegetation creates perfect habitat for invading Eurasian watermilfoil.

Eurasian watermilfoil has difficulty becoming established in lakes with well established populations of native plants. In some lakes the plant appears to coexist with native flora and has little impact on fish and other aquatic animals.

Likely means of spread: Milfoil may become entangled in boat propellers, or may attach to keels and rudders of sailboats. Stems can become lodged among any watercraft apparatus or sports equipment that moves through the water, especially boat trailers.

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

Purple loosestrife invades marshes and lakeshores, replacing cattails and other wetland plants. The plant can form dense, impenetrable stands which are unsuitable as cover, food or nesting sites for a wide range of native wetland animals including ducks, geese, rails, bitterns, muskrats, frogs, toads and turtles. Many rare and endangered wetland plants and animals are also at risk.

Purple loosestrife thrives on disturbed, moist soils, often invading after some type of construction activity. Eradicating an established stand is difficult because of an enormous number of seeds in the soil. One adult plant can disperse 2 million seeds annually. The plant is able to resprout from roots and broken stems that fall to the ground or into the water.

A major reason for purple loosestrife's expansion is a lack of effective predators in North America. Several European insects that only attack purple loosestrife are being tested as a possible long-term biological control of purple loosestrife in North America.

Likely means of spread: seeds escape from gardens and nurseries into wetlands, lakes, and rivers. Once in an aquatic system, moving water and wetland animals easily spread the seeds.

<u>Other Midwestern Aquatic Exotics</u>

Curly-leaf pondweed (*Potamogeton crispus*) is an exotic plant that forms surface mats that interfere with aquatic recreation. The plant usually drops to the lake bottom by early July. Curly-leaf pondweed was the most severe nuisance aquatic plant in the Midwest until Eurasian watermilfoil appeared. It was accidentally introduced along with the common carp.

Flowering rush (*Botumus umbellatus*) is a perennial plant from Europe and Asia that was introduced in the Midwest as an ornamental plant. It grows in shallow areas of lakes as an emergent and as a submerged form in water up to 10 feet deep. Its dense stands crowd out native species like bulrush. The emergent form has pink, umbellate-shaped flowers and is 3 feet tall with triangular-shaped stems.

Round goby (*Neogobius melanostomus*) is a bottom-dwelling fish, native to Eastern Europe that entered the eastern Great Lakes in ballast water. They can spawn several times per year, grow to about 10 inches, are aggressive and compete with native bottom-dwellers like sculpins and log perch. They are expected to be harmful to Great Lakes and inland fisheries.

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

White perch (*Morone americana*) are native to Atlantic coastal regions and invaded the Great Lakes through the Erie and Welland canals. Prolific competitors of native fish species, white perch have the potential to cause declines of Great Lakes walleye populations.

Zebra Mussel (*Dreissena polymorpha*) is a freshwater mussel – small fingernail sized – native to the Caspian Sea region of Asia. They are believed to have been transported to the Great lakes via ballast water, taken on in a freshwater European port and discharged into Lake St. Clair where the mussel was discovered in 1988. They have spread rapidly to all the Great Lakes and lakes in many Minnesota.

LAND USE AND ZONING

The water quality of a lake or river is ultimately a reflection of the land uses within its watershed. While the specific impacts to a lake from various land uses vary as a function of local soils, topography, vegetation, precipitation and other factors, it is ultimately the land uses to which citizens have the most control that impact water quality.

Many zoning regulations are based upon the Shoreland Management Act and/or the Minnesota Department of Natural Resources (DNR) classification of a given lake. The DNR has classified all lakes within Minnesota as General Development (GD), Recreational Development (RD), or Natural Environmental (NE) lakes, and assigned a unique identification number to the lake for ease of reference. Counties in turn have used these classifications as a tool to establish minimum lot area (width and setbacks) that is intended to protect and preserve the character reflected in the classification. Clearly any local municipal jurisdiction may have additional (and usually more restrictive) standards as well.

On any shoreland the permissible density and setbacks for virtually all new uses are determined by the lake or river classification standards established by the Department of Natural Resources. Lake Koronis (DNR Lake ID #73-0200) is a General Development (GD) lake, and Rice Lake (#73-0196) is classified as Recreational Development (RD).

Natural Environment lakes are generally small, often shallow lakes with limited capacities for assimilating the impacts of development and recreational use. They often have adjacent lands with substantial constraints for development such as high water tables, exposed bedrock, and unsuitable soils. These lakes, particularly in rural areas, usually do not have much existing development or recreational use. In Stearns County, a NE management district is "established to preserve and enhance high quality waters by protecting them from pollution and to protect shorelands of waters which are unsuitable for development; to maintain a low density of development; and to maintain high standards of quality for permitted development."

Recreational Development lakes are generally medium-sized lakes of varying depths and shapes with a variety of landform, soil, and ground water situations on the lands around them. They often are characterized by moderate levels of recreational use and existing development. Development consists mainly of seasonal and year-round residences and recreationally-oriented commercial uses. Many of these lakes have capacities for accommodating additional development and use. In Stearns County the RD management district is established to "manage proposed development reasonably consistent with existing development and use; to provide for the beneficial use of public waters by the general public, as well as the riparian owners; to provide for multiplicity of lake uses; and to protect areas unsuitable for residential and commercial uses from development."

General Development lakes are generally large, deep lakes or lakes of varying sizes and depths with high levels and mixes of existing development. These lakes often are extensively used for recreation and, except for the very large lakes, are heavily developed around the shore. Second and third tiers of development are fairly common. The larger examples in this class can accommodate additional development and use. Stearns County's Shoreland Ordinance notes that "the GD management district is established to provide minimum regulations in areas presently developed as high density, multiple use areas; and to provide guidance for future growth of commercial and industrial establishments which require locations on protected waters."

The Stearns County zoning standards for lakes for each of the respective classifications are:

Standards:	General Development	Recreational Development	Natural Environment	River – Agriculture
Structure setback from OHWL[1]	75 feet	100 feet	200 feet	100 feet
Structure setback from Bluff Height	30 feet	30 feet	30 feet	30 feet
Lot Size	20,000 sq ft	40,000 sq ft	80,000 sq ft	40,000 sq ft
Lot Width	100 ft	150 ft	200 ft	150 feet
Height (other than water oriented accessory structure)	30 ft	30 ft	30 ft	30 ft
Elevation of lowest floor above highest known water level	3 feet	3 feet	3 feet	3 feet
Water Oriented Accessory Structure setback from OHWL	10 feet	10 feet	25 feet	10 feet

[1] **OHWL = Ordinary High Water Level**

Paynesville Township has an ordinance requiring a 75 foot setback for any new out buildings or placements of fish houses after removing from the ice.

Most lakes have numerous properties that are "grandfathered," or developed prior to the establishment of these restrictions. In general, these pre-existing uses are allowed to remain unless they are identified as a threat to human health or environment or are destroyed by natural, accidental causes or in association with significant renovation.

The Stearns County web-site provides a link to the Planning and Zoning ordinances for the county: **http://www.co.stearns.mn.us/Government/CountyOrdinances/PlanningandZoningOrdinances**. On any shoreland the permissible density and setbacks for virtually all new use are determined by the lake or river classification standards established by the Department of Natural Resources. Stearns County has a web site which offers helpful contact information regarding planning and zoning matters: http://co.stearns.mn.us/Government/CountyDepartments/EnvironmentalServices/LandUseDivision

Details on shoreland standards and restrictions and answers to *frequently asked questions* regarding best management practices, resources of education or information and additional assistance are provided through the Environmental Services Department, Stearns County Environmental Services, 705 Courthouse Square, Administration Center Room 343, St. Cloud, MN 56303, Phone: 320/656-3613, E-mail: **dave.nett@co.stearns.mn.us**

There have been some trends from seasonal to year round occupancy on Lake Koronis. Rice Lake has had new construction occurring on empty lots over the years.

Veterans Park has a new shelter for picnic use with a kitchen. This facility may be rented.

Community Park has a newly developed camping area for everyone's enjoyment with several camp sites and a few small cabins for rent. A newly constructed storm shelter and new playground were also added. There is a tornado warning siren now in place to warn campers and residents of any impending storm.

MANAGING WATER SURFACE USE CONFLICTS

The goal of lake management is to ensure that the lake can continue to provide the benefits that attract homeowners and users. However, conflicts among uses invariably arise. Successful resolution of conflicts lies in the ability of the users to work collaboratively to arrive at acceptable compromises.

The primary agency responsible for managing surface water use conflicts is the Minnesota Department of Natural Resources, Bureau of Information and Education. The Boat and Water Safety Section within the Bureau oversees surface water use and is in charge of administering the Water Surface Use Management (WSUM) program. The goal of this program is to enhance the recreation use, safety and enjoyment of the water surfaces in Minnesota and to preserve these water resources in a way that reflects the state's concern for the protection of its natural resources.

Within this context, any governmental unit may formulate, amend or delete controls for water surface use by adopting an ordinance. Submit the ordinance for approval by the MDNR Boat and Water Safety Coordinator by calling 1 (800) 766-6000 or (651) 296-3336. To gain approval the ordinance must:

- Accommodate all compatible recreational uses, where practical and feasible
- Minimize adverse impacts on natural resources
- Minimize conflicts between users in a way that provides for maximum use, safety and enjoyment
- Conform to the standards set in WSUM Rules

PUBLIC WATER ACCESS

Research has shown that Minnesotans rely heavily upon public access sites to enter lakes and rivers. A 1988 boater survey conducted by the University of Minnesota showed that three-fourths of the state's boat owners launch a boat at a public water access site at least once a year. In addition, over 80 percent of boat owners report using public water access sites for recreation activities other than boating.

The primary agency responsible for pubic water accesses in Minnesota is the Minnesota Department of Natural Resources, Trails and Waterways Unit. They are responsible for the acquisition, development and management of public water access sites. The DNR either manages them as individual units or enters into cooperative agreements with county, state and federal agencies as well as local units of government such as townships and municipalities. The DNR's efforts to establish and manage public water access sites are guided by Minnesota statutes and established written DNR policy. The goal of the public water access program is free and adequate public access to all of Minnesota's lake and river resources consistent with recreational demand and resource capabilities to provide recreation opportunities.

According to the 2003 Minnesota Department of Natural Resources Fisheries Survey, there are five public access on Koronis Lake, and four more on Rice, as shown below:

Koronis Lake Public Access

OWNERSHIP	TYPE	DESCRIPTION
Minnesota DNR	**Concrete**	Norman Dahlman Access is a large access located in the inlet bay (east side of lake) southwest of Highway 55.
Minnesota DNR	**Gravel**	Putzke Access is a small access on north side of the north bay off County Road #181.
Township	**Concrete**	Tim Adams Access is a small access on the west side of the lake east of the Tri-County Road (County Roads #20 & #39).
DNR	**Concrete**	Community Park Access is on the south side of the lake in the Tri-County Regional Park.
City	**Concrete**	Veteran's Park Access on the east side of the north bay, across the road from the park. Cooperative access with the DNR and Paynesville.

Rice Lake Public Access

OWNERSHIP	TYPE	DESCRIPTION
Private Property	**Other**	Access is located at Morning Star Campground on the northeast side of lake.
Private Property	**Concrete**	Fishers Resort
DNR	**Concrete**	Access is located along the southwest corner of Rice (south of the Crow River Inlet/Outlet).
DNR	**Concrete**	Access is located in Schaumann's Bay (northwest portion of lake).

ORGANIZATIONAL DEVELOPMENT AND COMMUNICATION KORONIS LAKE ASSOCIATION

Koronis Lake Association

We are investigating educational opportunities on invasive species at high volume times of the year: fishing opener, Memorial Day, 4th of July, and Labor Day weekends. This will include inspections and educational handouts. We are interested in fishing contests held throughout the year. We need more information on where and when contests are held as well as where boaters have recently been with their boat and trailer.

KLA was established in 1971, approximately 40 years ago. Our mission statement was and still reads: An association formed to promote the protection and improvement of Lake Koronis. We all wish to improve the water quality of our lake for the enjoyment of everyone for years to come.

Concerns impacting our water quality are the North Fork Crow River, local watershed drainage and water runoff from lake property and surrounding farms. Our goal is to limit nutrient loading from these sources in the next 5 years.

Our communication tools are:

- KLA newsletter (published 3 times per year) sent to all lake association members and interested persons in our area
- articles published in our local newspaper
- KLA website
- KLA board and annual meetings where findings from attended workshops can be discussed

We will communicate progress on our goals to our residents and community constituents. Keeping informed is a high priority for us. We hope to increase more participation toward our future goals.

Rice Lake Association

The Rice Lake Association (RLA) was formed in 1975 as a way for those with a vested interest in the lake to protect and improve the quality of the lake. Having been designated an “impaired” lake in 2008, we are focusing our efforts on working in conjunction of state and local government agencies to implement the steps identified in our TMDL Implementation Plan, date June 2012.

We are focused on working both with the NFCRWD to implement measures to reduce the significant amount of nutrients being deposited in Rice Lake by the Crow River, and with property owners within the Rice Lake local watershed to reduce nutrients entering Rice Lake directly. Realizing that it has taken well over 50 years for Rice Lake to become impaired, our goal is to reduce the average annual TSI to below 50 in 10 years, and to reach our long-term goal of an average annual TSI below 40 within 20 years.

Our communication tools to our lakeshore property owners are:

- RLA newsletter (published 2-3 times per year) sent to all lakeshore property owners and interested persons
- Other mailings throughout the year
- RLA website
- RLA Facebook page
- RLA monthly Board meetings held April through October
- RLA Annual Meeting held in August each year
- Occasional articles in local newspapers

RLA will continue to communication goals and plans to our membership through all of these means. We also solicit membership input through meetings, surveys and other communications.

Recognizing the need to work with other lake associations within Stearns County, to address water quality and lakeshore issues, RLA was one of the founding members of the Stearns County Coalition of Lake Associations.

SUMMARY OF VISIONING/PLANNING SESSION

KLA and RLA held a joint visioning session at Ron and Judy's Restaurant in Paynesville on July 17th, 2010. We had a good turnout with over 80 in attendance. We had goals listed in several areas:

- Water quality
- Land use
- Zoning
- Aquatic Species

Group discussions were held in order to list priorities for lake improvement in the years to come.

Our visioning facilitator was John Sumption.

The following pages provide the goal, objectives and implementation strategies that make up the Lake Management Plan for Lake Koronis and Rice Lake.

SUMMARY OF KORONIS LAKE ASSOCIATION VISIONING AND PLANNING GOALS

WATER QUALITY IMPROVEMENTS – Lake Koronis

GOAL 1 – Reduce subwatershed nutrient loading around Lake Koronis				
Objectives	**Implementation**	**Supporting Agencies**	**Year**	**Estimated Cost**
Lakeshore Improvement Project: Assist in establishing 50 new lakeshore improvements over the next 6 years	-use KLA newsletter for education and solicit properties for consideration -encourage word of mouth education -hold Field Days where SWCD reps visit potential project sites -assist property owners with their 25% of cost (invite NFCRWD, KLA, Sportsmens Club to help with costs)	KLA, NFCRWD, Meeker and Stearns SWCD's	2014 - 2020	$250,000
Wetland Restoration: Assist in restoring wetlands wherever possible upstream from Lake Koronis and in surrounding subwatersheds	-approach individual landowners to help	DNR SPORTMAN'S CLUB DUCK'S UNLIMITED NFCRWD KLA	2014 - 2020	$100,000
Shoreline/Restoration/ Stormwater Management Grant: (Peterson Point and north/east shorelines)	-facilitate in project initiation and completion	NFCRWD SWCD KLA MPCA	2017	TBD

GOAL 1 – Reduce subwatershed nutrient loading around Lake Koronis				
Objectives	**Implementation**	**Supporting Agencies**	**Year**	**Estimated Cost**
Larson II Project (Meeker): establish water retention buffer strips and sediment basins to reduce nutrient loading on northwest quarter of Section 4, Union Grove Township, Meeker County. This is another subwatershed that has a lot of nutrient loading into Lake Koronis.	-confirm cooperation of principal landowners, Doug and Velda Larson -confirm cooperation of Stearns and Meeker SWCD's -entertain building duck ponds on this property -restore a wetland in upper (southern) end of waterway	KLA, NFCRWD, Meeker SWCD	2020	$20,000
Larson II Project (Stearns): minimize nutrient loading into Lake Koronis	-repair/redesign tile (after water flows under Co Rd 20, it is not contained in the culvert)	KLA, NFCRWD, Stearns SWCD	2020	$15,000
Birch Beach Subwatershed: located in the NE quarter of section 4, Union Grove Township, Meeker County. Reduce nutrient loading. (2 ravines)	-reduce run off using water retention basins, streambank buffers, and sediment basins	KLA, NFCRWD, Meeker SWCD	2020	$25,000
Randall Project: (to be proposed) develop cattle exclusion practices from the creek that runs through property.	-confirm cooperation from landowner --advise as necessary	KLA, NFCRWD Meeker and Stearns SWCD	2020	$20,000

GOAL 2 – Water Testing Awareness

Objectives	Implementation	Supporting Agencies	Year	Estimated Cost
Obtain more information from the NFCRWD on water testing	**-collect information from NFCRWD and testing lab -place information in newsletter and local newspaper**	**KLA, NFCRWD**	**ongoing**	**-**
Yearly water quality testing -to establish baseline information	**-samples taken at various places throughout the summer on lake via boat (see appendix III)**	**KLA, ST. CLOUD STATE**	**ongoing**	**$2500**

LAND USE AND ZONING - Lake Koronis

GOAL 3 – Awareness and Action

Objectives	Implementation	Supporting Agencies	Year	Estimated Cost
Become more involved in land use, on-going planning and decision making	**-participate in discussions of land use and conditional use permits given by counties to individuals -participate in ongoing planning and decision making**	**KLA**	**On-going**	**$0**
Preventative storm safety measures for residents	**-encourage local government agencies to install storm shelters and warning sirens at strategic points around Lake Koronis**	**KLA, Paynesville City, Paynesville and Union Grove Townships**	**2015**	**TBD**
Education on Lake Living	**-ask Stearns and Meeker county Planning and Zoning boards to notify the KLA of hearings relating to changes in land use -update the Living with Lake Koronis book, submitting articles to educate homeowners on proper land use -distribute books to new residents**	**KLA NFCRWD**	**On-going**	**TBD**
Web site development	**www.koronislakeassociation.org**	**KLA**	**ongoing**	**$200 per year**

AQUATIC VEGETATION - Lake Koronis

GOAL 4 – To keep Lake Koronis free of invasive species and to promote education/awareness of healthy weeds

Objectives	Implementation	Supporting Agencies	Year	Estimated Cost
To decrease or eliminate chemical use to control weeds	-educate and re-educate by newsletter and reports at the annual meeting	KLA NFCRWD	2014-2020	?
To keep exotic species from entering Lake Koronis	–posting informational signs at landings -paid and volunteer workers at landings on high traffic days to distribute educational brochures, inspect lake entering boats, and create awareness -channel 8 publicity -see appendix IV	KLA NFCRWD SWCD DNR	2014-2020	$25,000
To educate all on being environmentally friendly	-Lake Koronis booklet and newsletter -channel 8 -promote the good things weeds do for our lake environment -promote public beaches for swimming -annual meetings	KLA NFCRWD	2014-2020	$500

* Other sources of support for efforts to prevent/control invasive species are the DNR http://www.dnr.state.mn.us/grants/aquatic_invasive/index.html and Minnesota Waters http://www.minnesotawaters.org/

SUMMARY OF RICE LAKE ASSOCIATION VISIONING AND PLANNING GOALS

Rice Lake Association (RLA) worked with the NFCRWD and Wenck and Associates to complete a Total Maximum Daily Load (TMDL) Study, through the Minnesota Pollution Control Agency (MPCA). With that as a context, our visioning and planning goals will focus on water quality measures we think will be validated in this study. The consensus of those attending our visioning meeting centered on the following goals:

- Water quality: Decrease runoff from both lakeshore and agricultural areas near and adjacent to Rice Lake.
- Aquatic vegetation: Promote a healthy balance of weeds including a decrease in curly leaf pondweed and algae growth.

Shoreland Owner Survey

In the spring of 2011 RLA mailed out a survey about people's attitudes toward shoreland restoration. Two hundred thirty surveys were mailed out, and one hundred seventeen property owners responded. The survey consisted of eighteen questions related to shoreland restoration.
75% of the responses indicated they would be willing to make changes to their shoreline to improve water quality and protect their investment.

The question: "What do you use your shoreline for?" was asked and here are the results:

Quiet enjoyment - 70
Beach activities - 52
Fishing - 63
Swimming - 49
Lake access - 82
Water activities - 56
Socializing – 60

This shows the wide range of shoreline uses.

WATER QUALITY IMPROVEMENT – Rice Lake

GOAL 1: Decrease runoff from lakeshore and agricultural land near and adjacent to Rice Lake				
Objective	**Implementation**	**Supporting Agency**	**Year**	**Estimated cost**
Reduce nutrient runoff draining into the Crow River above Rice Lake	**begin discussion with farmers, with fields that drain into Rice Lake,to define problem and potential solutions - identify projects to reduce or slow water runoff from agricultural land - monitor nutrient load by collecting runoff samples -work with Enforcement and Regulatory Agencies to ensure proper manure and application, based on regulations, to limit runoff -maintain tiling and ditches**	**Stearns County Environmental Services MPCA NFCRWD**	**Ongoing**	**TBD based on scope of solution; estimate of $75,000**
Reduce surface water nutrient loading coming from the CrowRiver	**- -identify wetlands within the watershed for protection and restoration -create holding ponds to slow water flow during high water times and allow settling out of nutrients**	**NFCRWD Soil and Water Conservation District (SWCD);**	**Ongoing**	**TBD based on scope of solution; estimate of $75,000**
Educate effects of runoff and benefits of shoreland restoration	**- develop education plan targeted to lakeshore property owners**			

GOAL 1: Decrease runoff from lakeshore and agricultural land near and adjacent to Rice Lake

Objective	Implementation	Supporting Agency	Year	Estimated cost
	-work with SWCD to develop long-range plan - provide shoreland owners with information and assistance installing rain gardens and native plantings - create a demonstration project on a residential shoreland property - educate shoreland property owners about proper lawn care practices	University of Minnesota Extension Service; SWCD, RLA	Ongoing	$500 for educational materials
Determine City of Paynesville storm water effect on Rice Lake and potential beneficial interventions	- - Get an update on the City of Paynesville plan for water runoff retention plans	City of Paynesville; North Fork Crow River Watershed District (NFCRWD)	2014	TBD dependent on results affecting North Fork Crow River and Rice Lake
Wetland Restoration: Assist in restoring wetlands wherever possible upstream from Rice Lake and in surrounding subwatersheds	- Approach individual landowners to help	DNR SPORTMAN'S CLUB DUCK'S UNLIMITED NFCRWD KLA RLA	2014 - 2020	$10,000

GOAL 1: Decrease runoff from lakeshore and agricultural land near and adjacent to Rice Lake				
Objective	**Implementation**	**Supporting Agency**	**Year**	**Estimated cost**
Shoreline Restoration: Properties located between Morning Star Resort and Fisher's Resort	**-Approach individual landowners to undertake restoration projects - Assist Stearns SWCD with communication of restoration plans for grants covering property between Morning Star Resort and Fisher's Resort**	**SWCD RLA**	**2014-2015**	**TBD**

GOAL 2: Monitor Water Quality				
Objective	**Implementation**	**Supporting Agency**	**Year**	**Estimated cost**
Continue water quality monitoring on Rice Lake	**- continue monthly water sample collection and Secchi disk readings**	**NFCRWD RLA**	**On-going**	**$250 annually**
Monitor water quality of Crow River above Rice Lake inlet	**- collect water samples from Crow River above Rice Lake Inlet**	**NFCRWD**	**On-going**	**$250 annually**
Monitor water quality of other inlets	**-identify other direct inlets that where water samples should be collected for analysis**	**NFCRWD RLA**		

AQUATIC VEGETATION IMPROVEMENT – Rice Lake

GOAL 3: Promote a healthy balance of weeds including a decrease in curly leaf pondweed and algae growth				
Objective	**Implementation**	**Supporting Agency**	**Year**	**Estimated cost**
Complete aquatic plant inventory	**work with NFCRWD to have Vegetation Study completed** **-determine frequency required to understand vegetation diversity and populations** **-**	**NFCRWD** **RLA**	**2014 2020**	**Est. $2500**
Develop vegetation management plan	**work with DNR to determine if treatment of invasive or native species required**	**DNR** **NFCRWD** **RLA**	**2015 -2020**	**TBD based on Vegetation Study**
To keep exotic species from entering Rice Lake	–posting informational signs at landings -paid and volunteer workers at landings on high traffic days to distribute educational brochures, inspect lake entering boats, and create awareness	**NFCRWD** **SWCD** **DNR** **KLA** **RLA**	**2014-2020**	**$25,000**
To educate property owners and public on being environmentally friendly	-promote the good things weeds do for our lake environment -hand out educational brochures and discuss at annual meeting	**RLA** **NFCRWD** **SWCD** **DNR**	**2014-2020**	**$500**

APPENDIX I - DNR FISHERIES MANAGEMENT PLAN - KORONIS LAKE

LAKE MANAGEMENT PLAN (DIVISION OF FISHERIES)

Region	Area	DOW Number	County	Lake Name	Acres	Littoral Acres	Lake Class
South	Spicer	73-0200	Stearns/Meeker	Koronis	3,014	1,175	22

Long Range Goals

Walleye (10-15/GN, 25-40% ≥ 15", 15-25%$_{TSB}$, min. 20+/hr. YOY$_{FEF}$) *Status ('10) – 16.3/GN, 44% ≥ 15", 18.5%$_{TSB}$, 6/hr. YOY$_{FEF}$*
N. Pike (2-4/GN, 6-12%$_{TSB}$) *Status (2010) – 3.3/GN, 11.0%$_{TSB}$*
SM Bass (1-2/GN, 1-3%$_{TSB}$) *Status (2010) – 2.3/GN, 3.5%$_{TSB}$*
Yellow Perch (15-40/GN, 5-10%$_{TSB}$) *Status (2010) – 56.5/GN, 7.2%$_{TSB}$*
Bluegill (10+ per TN, stock if consecutive surveys <0.25/TN) *Status (2010) – 5.1/TN*
Black Crappie (2+ per TN or GN) *(2010 Status – 7.5/GN, 2.3/TN, both above or near historical highs)*
Maintain Carp at less than 10%$_{TSB}$ *Status (2010) – 8.4%$_{TSB}$* / Maintain Cisco ≥ 25 in fall gillnets *Status (2010) – 38.2/GN*
Note – High water levels (1-2 ft above average) during 2011 summer/fall. Minor summerkill of Cisco in 2011.

Operational Plan

1) Population Assessment 2012, Full Survey 2014, Population Assessment 2017, (Area Schedule).
2) Annual fall electrofishing (FEF) survey of young-of-year walleye (YOY$_{FEF}$). If walleye egg-take operations are conducted, stock a minimum of 10% return with OTC marked fry to monitor natural reproduction success.
3) Propose 'contingent' walleye fingerling stocking after a poor year of natural reproduction (e.g., <20 YOY per hour). If fall electrofishing is poor the 2nd fall in a row, stock up to 2,350 pounds of walleye fingerlings (minimum 35,250 fish).
4) If surplus walleye available, consider stocking at 1/lb. per littoral acre if LR Goals not being exceeded and latest information warrants (e.g., latest fall electrofishing catches low-moderate, relative low numbers of small walleye in latest survey, growth/condition of existing small walleye adequate, etc.). Do not stock prior to FEF or if contingent stocking occurred the previous year.
5) Conduct spring electrofishing for largemouth bass during Full Surveys.
6) Conduct a full special assessment of cisco (6 experimental fall gillnet sets) every 2-3 years (next in fall 2012 and 2014).
7) Suspend operating Spaeth NPSA if latest N.Pike indices are above LMP goals and yellow perch indices low. Continue the operation of Spaeth NPSA through 2012.
8) Consider stocking up to 1,175 pounds of bluegill (<6" from removal lakes) up to twice between surveys if latest survey catches are extremely low (i.e., < 0.25/TN and 0/GN).

Mid Range Objective

Continue monitoring the fishery with surveys 1 of 2-3 years and utilizing annual fall electrofishing to determine walleye stocking needs and NPSA operations. Continue participation in ongoing cooperative watershed, habitat and water quality improvement, protection and education efforts. Update Lake Management Plan as needed utilizing stakeholder input.

Potential Plan

• Increase shore fishing access opportunities.	**$10-25K**
• Acquire 'critical' habitat through the AMA acquisition process.	**$10-300K**
• Participate in developing shoreland management demonstration site(s).	**$1-10K**
• Creel Survey in conjunction with Rice Lake once every 10 years (develop LMP creel based fishery goals in addition to current survey related fishery goals). Include Mud L. connection.	**$20K ea.**

Primary Species Management	Secondary Species Management
Walleye	N.Pike, Bluegill, Y. Perch, S.Bass, L.Bass, Cisco

Area Supervisor's Signature **Date** __ __/__ __/__ __ Month Day Year

Regional Supervisor's Signature **Date** __ __/__ __/__ __ Month Day Year

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Entry Date __ __/__ __/__ __ Year Resurvey __ __

Stock Species – Size – Number per Acre
Pr./Sec.

Schedule | Year Beginning

Population Manipulation ___ YES ___ NO Year __ __
Development ___ YES ___ NO Year __ __
Creel or Use Survey ___ YES ___ NO Year __ __
Other

Narrative :

(Historical perspectives – various surveys ; management ; social considerations ; present limiting factors ; survey needs ;

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land acquisition ; habitat development and protection ;
commercial fishery ; stocking plans ; other management tools ;
and evaluation plans)

Various Surveys

Historical Fish Survey/Assessments – Survey Netting, Spring LMB Electrofishing, Fish Growth Summary, Fall YOY Walleye Electrofishing, Age-Class Distributions/Stocking Evaluations, Fish House Counts
MN-DNR Website Links – Lake Survey Report, Lake Map, Lake Water Levels, Fish Consumtion Advisory, Lake Water Quality, Lake Water Clarity, Satellite Lake Water Clarity, Lake Location, Area Topo Map
Historical Fish Stocking and NPSA Production
Historical Fish Removal

Management

Lake Koronis is managed primarily for walleye and secondarily for a variety of other gamefish species. Although walleye natural reproduction occurs during most years as measured by annual fall electrofishing, supplemental fingerling stocking has periodically been needed after consecutive years of poor natural reproduction to sustain survey catches to meet long-range goals. Secondary species in Lake Koronis also offer excellent angling opportunities. Bluegill and black crappie populations tend to be cyclic; however, larger bluegill and black crappie are periodically available. Black crappie angling success has been excellent during winter and open water seasons during 2009-2011. Periodic bluegill stocking (fish <6" coming from lakes with slow-growing populations) has also occurred during periods of very low bluegill abundance. Smallmouth bass have provided a quality, secondary angling opportunity with trophy potential. Reports of excellent largemouth bass angling also occurs. Historically, Lake Koronis has been one of the most popular northern pike darkhouse spearing lakes in the Spicer area in addition to periodic good angling for larger yellow perch and tullibee (generally late season).

Summer survey catches during 2010 exceeded current LMP goals for walleye with yellow perch catches also above LMP goals. Walleye angling success was good in 2010 (12-14 inch fish), but poor in 2011. Stocked (OTC marked fry and fingerlings) in addition to natural year classes have made significant contributions to abundant walleye numbers in Koronis during recent years. Poor walleye YOY/Yearlings numbers were documented for 2009 and 2010 year classes by electrofishing. Black crappie gillnet and trapnet catches were at or near all-time highs with the majority of fish coming from the 2009 (4-5 inches) and 2005 year-classes (9.5-10.5 inches in late July 2010). Bluegill numbers were low to moderate in the 2010 survey and moderate in size (6 inches). Local anglers had good success catching large bluegill and moderate sized black crappie during spring/early summer of 2011 near the Highway 55 access area. Northern pike gillnet catches met LMP goals, however local anglers have reported low catches of northern pike in 2010 and 2011 probably due to the high abundance of yellow perch forage. Northern pike numbers in 2010 were significantly down from the previous 2007 survey. Spearers have reported poor success for northern pike numbers, but good success for large fish > 30 inches during the last few winters. Although spring bass electrofishing was not conducted in 2010, there have been many reports of numerous largemouth bass being caught. Abundant numbers of large (14 inch plus) smallmouth bass were captured in the 2010 summer survey. Black bullhead and carp survey catches were below average during the 2010 survey. Other species that were abundant in the 2010 summer survey included rock bass, white sucker, northern redhorse, and cisco in both summer and fall nets.

Compared to other Spicer area lakes, growth rates for walleye were slightly below average; black crappie, northern pike, bluegill and yellow perch are typically average-to-slightly above average and largemouth bass are typically above average.

Social Considerations

- Maintenance/improvement in water quality is a major concern for many on Lake Koronis. In addition to heavy lakeshore/immediate watershed development, Rice and Koronis lakes are the initial receiving lakes for the primarily agricultural upper North Fork of the Crow River watershed. Variable yearly/seasonally water levels are common occurrences for Koronis and Rice due to the large agricultural dominated watershed. Algal blooms periodically occur as does nuisance levels of filamentous algae. Submerged vegetation densities appear to be quite variable from year-to-year, periodically producing nuisance conditions (i.e. curly-leaf pondweed, water celery, etc.) in certain locations. The North Fork of the Crow River watershed district is the lead agency for the cooperative watershed sampling and improvement projects that are occurring. The Koronis Lake Association has been active in promoting best management practices and has a close working relationship with the Rice Lake Association. A joint Rice-Koronis Lake Management Plan has been adopted to serve as a "blueprint" to guide lakeshore property owners.

- Given the regional/statewide popularity of Lake Koronis and frequent permitted/non-permitted fishing tournaments that attract non-resident anglers, the introduction of Eurasian water milfoil and zebra mussels are a primary concern.
- Koronis and Rice lakes are vitally important to the local Paynesville, MN economy and are centerpieces of the community.
- The Paynesville Sportsman's Club has actively supported various DNR and watershed/lake association groups' efforts in fish stocking, watershed projects, AMA acquisition and educational endeavors to improve water quality in Koronis and Rice lakes.
- Historically, cisco netting was popular on Lake Koronis (as many as 250 nets). Criticism concerning the number of gamefish netted was prominent. Cisco netting was closed during the late 1980's following severe summerkills. Periodic partial summerkills continue to occur, but the surviving cisco populations continue to maintain adequate reproduction and recruitment.

Present Limiting Factors

- The continual loss of emergent vegetation due to shoreline development has progressively occurred and has undoubtedly limited spawning/rearing habitat, particularly for Centrarchids. Water quality benefits from emergent vegetation have been reduced.
- Lake Koronis receives consistently moderate-heavy angling pressure which can limit certain species, particularly walleye, quality-sized panfish and large northern pike. There is a lack of quality creel information for Koronis and Rice lakes. Periodic creel survey's are needed to better monitor the fishery (at least once per decade), evaluate the fishery (develop creel based long-range goals) and will be useful if changes in management occur (e.g., experimental regulations).
- Water levels tend to fluctuate relatively rapidly given the large watershed that drains into Lake Koronis which exacerbates shoreline erosion and variable habitat conditions.
- Summerkill, particularly of tullibee, periodically occur. Under periods of stable summer thermoclines, anoxic conditions persist in the hypolimnion.
- An abundance of siltation, periphyton and dead algae/diatoms on in-lake walleye spawning substrates has been observed in recent years coinciding with poor walleye natural year classes.
- Curled Pondweed (*exotic*) is periodically abundant. Mid-summer die-offs exacerbate algal blooms.
- Population abundances of yellow perch, bluegill and black bullhead fluctuate widely.
- The popularity of automatic untended aquatic plant control devices is increasing.

Survey Needs

- Use of GIS technology to enhance habitat sampling, watershed analysis, etc. will continue to be incorporated in future surveys.
- As previously mentioned, periodic creel surveys are a necessity to properly manage and evaluate this important fishery.

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• The utilization of 'OTC' marking to evaluate stocking contribution would aid in evaluating the effectiveness of the current walleye management strategy. Walleye fry stocked in 2001 (424,568 fish, 10% return from egg-take) were 'OTC' marked. An estimated 21% of the total YOY walleye sampled in fall electrofishing in 2001 came from that fry stocking. Walleye fry stocked in 2007 and 2008 from egg-take operations were also OTC marked and will be evaluated. In 2007, an estimated 40% of all YOY walleye sampled in 2007 were from the fry stocking.

Land Acquisition

• Currently, there are several opportunities for the acquisition of 'critical' shoreline habitat through the AMA program. Spaeth NPSA is highest area priority for acquisition. Recent AMA acquisitions include property across the south shore road in Meeker County adjacent to the Hendrickson NPSA inlet marsh.

Habitat Development and Protection

• Ongoing environmental protection efforts include the DOW review process, APM permitting process, various education initiatives, periodic meetings with various stakeholders, cooperation in watershed initiatives, etc. Efforts to find new, more effective ways to monitor and protect habitat should be identified and initiated.
• Efforts to maximize shore fishing opportunities should be a focus for the next decade.
• Continued participation with other agencies and local groups in TDML studies and implementation projects.
• Landowners willing to participate in shoreline restoration demonstration projects need to be identified. More projects need to be initiated, especially for highly developed, prominent lakes such as Koronis.
• Continued effort to obtain and protect critical habitats through the AMA acquisition process.

Commercial Fishery (Includes Fish Removal Summary)

• MNDNR Fisheries has set trapnets to collect walleye eggs to meet statewide stocking quotas annually since 2001 (see historical fish removal). Walleye fry have been stocked in each of those years at a minimum rate of 10% of the egg-take to compensate for losses.
• An outlet trap has been operated below the Koronis dam for many years. In recent years, the Paynesville Sportsman's Club has removed 19,000 lbs. of carp in 2010, 37,000 lbs in 2009, 38,000 lbs. of carp in 2007 and 21,000 lbs. in 2005.
• Historically, a commercial hoopnet fishery (targeting bullhead primarily) periodically operated in Lake Koronis. Commercial fish removal interest has declined since the late 1990's.

Stocking (Includes Fish Stocking Summary)

• Lake Koronis was regularly stocked (usually biennial) with walleye fingerlings until 1993 at rates ranging between 1-3/L.A. Since 1994, walleye stocking depended on the absence of natural reproduction success as measured by fall electrofishing. Walleye stocking was not conducted because of periodic good years of natural reproduction coupled with relatively high survey gillnet catches in the mid-1990's. Regular walleye fry stockings (10% of the egg-take as fry which is usually 0.5 – 1.2 million) resumed in 2001 as a result of egg collections from trapnet caught walleye. Recent walleye fingerling/yearling/adult stockings occurred in 2004 (48,180 fish), 2006 (45,685 fish) and 2010 (4,867fish) prompted by consecutive years of poor natural reproduction as measured by walleye fall electrofishing during this same time period except for 2007 (44 YOY/hr) and 2008 (23YOY/hr). With the advent of '*Accelerated Walleye Management*', walleye abundance goals for the lake increased to 10-15/GN (above the 75th percentile for Lake Class 22). A more aggressive stocking strategy is called for in this plan to meet those objectives; however, walleye stocking will not take place on top of an already strong natural year-class, in situations of poor forage levels (i.e., poor growth and condition of young walleye) or in cases of walleye abundance levels far exceeding current LMP goals.
• Spaeth Northern Pike Spawning Area (NPSA) has been stocked with brood stock northern pike during most

years while Hendrickson NPSA has been operated more as a 'natural' run situation because of lack of water-level control, drain ability, constant water-flow, etc. NPSA operations had been suspended from 2007-2010 because of an abundant northern pike population. Spaeth NPSA was operated in 2011 (2,141 fingerlings, 2.0 inches average size) with marginal success due to extreme spring weather conditions. Accurate production estimates can be difficult on Spaeth NPSA due to continual flow over the dam boards from upstream springs.

• In the mid-1990's, bluegill survey catches were low. Relatively heavy supplemental stockings of slow-growing bluegill from area sources occurred (1,141 lbs. in '98; 1,064 lbs. in '97; 1,250 lbs. in '96). Bluegill survey catches increased in the 1999 and 2003 surveys accompanied by reports of improved angling. This management action may be utilized in the future if similar circumstances occur

• No other stocking is anticipated at this time.

Other Management Tools

• The utilization of 'OTC' marking to evaluate stocking contribution would aid in evaluating the effectiveness of the current walleye management strategy.

• There does not appear to be a current impetus for experimental regulations. The potential exists in the future if current statewide regulations are ineffective at periodically meeting long-range fishery goals.

• More stakeholder input is needed in future lake management planning efforts.

Evaluation Plans

The current sampling schedule of alternating full surveys (includes habitat and water quality sampling, shoreline seining, spring electrofishing, comprehensive age and growth analysis, etc) and assessments every 2-3 years (including fall cisco netting) coupled with annual fall electrofishing will attempt to evaluate the parameters of this LMP. The use of 'OTC' marking (or similar technique) may be needed to evaluate the current walleye stocking strategy. As stated previously, periodic creel information is needed to monitor/evaluate this important fishery.

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APPENDIX II - DNR FISHERIES MANAGEMENT PLAN - RICE LAKE

LAKE MANAGEMENT PLAN (DIVISION OF FISHERIES)

Region	Area	DOW Number	County	Lake Name	Acres	Littoral Acres	Lake Class
South	Spicer	73-0196	Stearns	Rice	1,639	958	25

Long Range Goals

Walleye (10-15/GN, 40-60% ≥ 15", 15-20%$_{TSB}$, min. 20+/hr. YOY$_{FEF}$) *Status (2010) – 11.9/GN, 66% ≥ 15", 21.4%* $_{TSB}$*, 7/hr. YOY*$_{FEF}$
N. Pike (2-4/GN, 5-10%$_{TSB}$) *Status (2010) –3.0/GN, 6.8%*$_{TSB}$
Yellow Perch (15-40/GN, 3-5%$_{TSB}$) *Status (2010) – 43.4/GN, 4.0%*$_{TSB}$
Bluegill (10+ per TN with fish 8"+ represented) *Status (2010) – 26.1/TN, 9 fish were 8"+*
Black Crappie (5+ per TN or GN with fish 12"+ represented) *Status (2010) – 20.0/GN, 17.3/TN, 0 fish were 12"+*
Maintain Carp and Black Bullhead at less than 10%$_{TSB}$ *Status (2010) – Carp 6.8%*$_{TSB}$*, Black Bullhead 1.6%*$_{TSB}$

Operational Plan

1) Population Assessment 2012, Full Survey 2014, Population Assessment 2017(Area Schedule).
2) Annual fall electrofishing (FEF) survey of young-of-year walleye (YOY$_{FEF}$). If walleye egg-take operations are conducted, stock a minimum of 10% return with OTC marked fry to monitor natural reproduction success.
3) Propose 'contingent' walleye fingerling stocking after a poor year of natural reproduction (e.g., <20 YOY per hour). If fall electrofishing is poor the 2nd fall in a row, stock up to 1,916 pounds of walleye fingerlings. If larger yearlings/adults utilized for stocking, increase total poundage stocked not to exceed 2,874 pounds (3 lbs. per littoral acre).
4) If surplus walleye available, consider stocking at 1/lb. per littoral acre if LR Goals not being exceeded and latest information warrants (e.g., latest fall electrofishing catches low-moderate, relative low numbers of small walleye in latest survey, growth/condition of existing small walleye adequate, etc.). Do not stock prior to FEF or if contingent stocking occurred the previous year.
5) Conduct spring electrofishing for largemouth bass during Full Surveys.
6) Temporarily suspend operating Rice NPSA if latest N. Pike indices are above LMP goals and yellow perch indices low.

Mid Range Objective

Continue monitoring the fishery with surveys 1 of 2-3 years and utilizing annual fall electrofishing to determine walleye stocking needs. Continue participation in ongoing cooperative watershed, habitat and water quality improvement, protection and education efforts. Update Lake Management Plan as needed utilizing stakeholder input.

Potential Plan

• Increase shore fishing access opportunities.	**$10-40K**
• Acquire 'critical' habitat through the AMA acquisition process.	**$10-300K**
• Participate in developing shoreland management demonstration site(s).	**$1-10K**
• Creel Survey in conjunction with Lake Koronis once every 10 years (develop LMP creel based fishery goals in addition to current survey related fishery goals)	**$20K ea.**

Primary Species Management	Secondary Species Management
Walleye	N.Pike, B. Crappie, Bluegill, Y. Perch, LM Bass

Area Supervisor's Signature **Date**

__ __ / __ __ / __ __
Month Day Year

Regional Supervisor's Signature **Date**

__ __ / __ __ / __ __
Month Day Year

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Entry Date __ __ / __ __ / __ __ Year Resurvey __ __

Stock Species – Size – Number per Acre

Pr./Sec.

Schedule Year Beginning

Population Manipulation ___ YES ___ NO Year __ __

Development ___ YES ___ NO Year __ __

Creel or Use Survey ___ YES ___ NO Year __ __

Other

Narrative :

(Historical perspectives – various surveys ; management ; social considerations ; present limiting factors ; survey needs ;

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land acquisition ; habitat development and protection ;
commercial fishery ; stocking plans ; other management tools ;
and evaluation plans)

Various Surveys

Historical Fish Survey/Assessments – Survey Netting, Spring LMB Electrofishing, Fish Growth Summary, Fall YOY Walleye Electrofishing, Age-Class Distributions/Stocking Evaluations, Fish House Counts
MN-DNR Website Links – Lake Survey Report, Lake Map, Lake Water Levels, Fish Consumtion Advisory, Lake Water Quality, Lake Water Clarity, Satellite Lake Water Clarity, Lake Location, Area Topo Map
Historical Fish Stocking and NPSA Production
Historical Fish Removal

Management

Rice Lake supports a primary walleye fishery and a secondary fishery for a variety of other gamefish species, most notably northern pike and black crappie. Although walleye natural reproduction was frequent during most years prior to 2006 as measured by annual fall electrofishing, supplemental fingerling stocking may periodically be needed to maintain survey catches within long-range goals. Under the 'A*ccelerated Walleye Management'* initiative, Rice Lake will be placed on the 'contingent' stocking list after a poor year of natural reproduction (as measured by fall electrofishing, e.g., <20 YOY walleye per hour) and will be stocked if consecutive poor fall electrofishing catches of YOY walleye occur. Rice Lake was last stocked in 2010 (15,281 fish, 1,923 pounds) after poor 2007-2010 fall electrofishing catches. In addition, under periods of surplus walleye production, Rice Lake may be stocked if specific conditions exist (see Operational Plan).

Secondary species in Rice Lake can offer excellent angling opportunities. Winter angling for black crappie has been extremely popular. Darkhouse spearing for large northern pike can also be popular; however, poor water clarities sometimes limit visibility. Largemouth bass and bluegill angling success has been more cyclic and smallmouth bass have provided a secondary fishery in recent years.

General Survey Summary

The 2010 survey did meet current LMP goals for walleye (11.9/GN) with 59% of those fish larger than 15 inches. The previous four surveys dating back to 1997 sampled walleye from 8.3-16.1 per gillnet. The Rice historical gillnet average catch rate for walleye is 9.2/GN. The 2007 and 2008 year classes (fry or fingerling stocked years) were moderately abundant in the 2010 gillnet sets. Fall YOY walleye electrofishing catches were low during 2005-2010 prompting stocking of walleye fingerlings/yearlings/adults in 2007, 2008 and 2010. Fall YOY electrofishing catches from 2000-2004 were excellent. Growth rates for Rice Lake compared to other Spicer area lakes are average to slightly above average. Overall, walleye angling has been excellent on Rice Lake for over a decade; however, angling pressure has also been high. Walleye angling success has been fair during recent years of 2010-2011 according to local anglers.

Northern pike 2010 gillnet catch rate (3.0/GN) was slightly below the historical average (3.5/GN) with the majority of those fish less than 24 inches with the 2008 year-class being the most dominant. The Rice Lake NPSA was not operated from 2007-2009. Production estimates have been low since 1993 including 2011 (1,630 fish, 3.5 inches). Northern pike growth rates for Rice Lake compared to other Spicer area lakes are generally average/slightly below average. Several large northern pike (20-27 lbs.) fish were speared during the 2009-10 winter.

Black crappie gillnet catch rate in 2010 was at an all-time high (20.0/GN) and the trapnet catch rate (17.3/TN) was above the historical lake average (4.8/GN, 6.4/TN). The majority of black crappie size ranges captured were 4-5 and 8-10 inches with few fish over 10.0 inches. The 2005 and 2009 year-classes dominated the catch.

Winter anglers had good success catching black crappie during the 2010-11 winter.

Yellow perch 2010 gillnet catch rate increased (43.4/GN) substantially compared to the previous 2007 survey (10.6/GN). The historical lake average is 27.7/GN. Growth rates in 2010 were slightly below average compared to Spicer area lakes. The average size was small (6.6 inches) in 2010 gillnets. There were only 3 fish greater than 9 inches long in 2010 survey nets.

Bluegill trapnet catch rate in 2010 (26.1/TN) was the second highest historically sampled in Rice Lake; however, only 10% of the fish sampled in trapnets were at least 7 inches long.

Black bullhead catch rate in 2010 was the second historical lowest (1.4/GN in 2010, 27.5/GN historical average). Carp abundance was also low in 2010 (0.3/TN).

Social Considerations

- Maintenance/improvement in water quality is a major concern for many on Rice Lake. In addition to heavy lakeshore/immediate watershed development, Rice and Koronis lakes are the initial receiving lakes for the primarily agricultural upper North Fork of the Crow River watershed. Blue-green algae blooms are common during the summer months. Submerged vegetation densities appear to be quite variable from year-to-year, periodically producing nuisance conditions in certain locations (e.g., the north bay). The North Fork of the Crow River watershed district is the lead agency for the cooperative watershed sampling and improvement projects that are occurring. The Rice Lake Association has been active in promoting best management practices and has a close working relationship with the Koronis Lake Association.
- Given the regional/statewide popularity of Rice and Koronis lakes and frequent permitted/non-permitted fishing tournaments that attract non-resident anglers, the introduction of Eurasian water milfoil and Zebra mussels are a primary concern.
- Rice and Koronis lakes are vitally important to the local Paynesville, MN economy and are centerpieces of the community.
- High levels of fecal coli form bacteria were sampled during 2003.
- High water levels (1-2 ft above average) occurred throughout the 2011 summer and fall due to high precipitation events within the watershed. A no wake zone on the lake was enacted for part of July 2011.

Present Limiting Factors

- The continual loss of emergent vegetation due to shoreline development has progressively occurred on nearly all area lakes which decreases spawning/rearing habitat, particularly for Centrarchids. Water quality benefits of emergent vegetation have also been reduced.
- Rice Lake periodically receives heavy angling pressure which can limit certain species, particularly walleye and black crappie, quality-sized panfish and large northern pike. There is a lack of quality creel information for Koronis and Rice lakes. Periodic creel survey's will be called for to monitor the fishery (once per decade), evaluate the fishery (develop creel based long-range goals) and will be useful if changes in management occur (e.g., experimental regulations).
- Water levels tend to fluctuate relatively rapidly given the large watershed that drains into Rice Lake which exacerbates shoreline erosion.
- Population abundances of most all species tend to fluctuate widely. This is related to the variable habitat/water quality conditions that exist in Rice Lake.
- The popularity of automatic untended aquatic plant control devices is increasing in all area lakes. The recent increase in submerged vegetation densities on Rice Lake has also increased interest in aquatic plant control

efforts.
• Partial summerkill, primarily of white sucker, occurs periodically.
• Curled Pondweed (*exotic*) is periodically abundant. Mid-summer die-offs exacerbate algal blooms.
• Poor water clarity periodically limits winter spearing success for northern pike.
• An abundance of siltation, periphyton and dead algae/diatoms on in-lake walleye spawning substrates has been observed in recent years coinciding with poor walleye natural year classes.

Survey Needs

• Continual incorporation of GIS technology to enhance habitat sampling, watershed analysis, etc. is needed and forthcoming.
• Periodic creel surveys are a necessity to properly manage and evaluate this important fishery.
• The utilization of 'OTC' marking to evaluate stocking contribution would aid in evaluating the effectiveness of the current walleye management strategy. Walleye fry stocked in 2001 (314,760 fish, 10% return from egg-take) were 'OTC' marked. An estimated 9.4% of the total YOY walleye sampled in fall electrofishing in 2001 came from that fry stocking. Walleye fry in 2007 were also OTC marked (1,000,418 fish). During 2007 fall electrofishing, 71 percent (5 of 7) of all YOY walleye captured were OTC marked.

Land Acquisition

• There is a potential site for acquisition adjoining the Rice Northern Pike Spawning Area. This parcel is 35 acres with approximately 2,500 feet of shoreline.

Habitat Development and Protection

• Ongoing environmental protection efforts include the DOW review process, APM permitting process, various education initiatives, periodic meetings with various stakeholders, cooperation in watershed initiatives, etc. Efforts to find new, more effective ways to monitor and protect habitat should be identified and initiated.
• Efforts to maximize shorefishing opportunities should be a focus for the next decade.
• Continued participation with other agencies and local groups in TDML studies and implementation projects.
• Landowners willing to participate in shoreline restoration demonstration projects need to be identified. More projects need to be initiated, especially for highly developed, prominent lakes such as Rice.
• A cooperative bulrush re-establishment project (DNR Fisheries/Rice Lake Association) was attempted in the early 1990's, but failed because of rapidly rising water levels and heavy winds immediately after planting.

Commercial Fishery (Includes Fish Removal Summary)

• MDNR Fisheries has set trapnets to collect walleye eggs to meet statewide stocking quotas on a regular basis in recent years. Walleye fry have been stocked in each of those years at a minimum rate of 10% of the egg-take to compensate.
• Commercial "B" permits have historically been issued to the Roscoe Sportsman's Club to operate temporary traps at the inlet/inlet bay area; however, there has been no activity reported since the mid 1990's. In addition, Rice Lake has historically been commercially fished with hoopnets/seines both during winter and open water with recent minimal activity occurring during 2001 and 2004.

Stocking (Includes Fish Stocking Summary)

• Rice Lake was regularly stocked (10% of the egg-take as fry) with walleye fry through 1992 because of the operation of the Rice Lake inlet walleye egg-take station (not operated since '92). Rice Lake periodically received walleye fingerling/yearling stocking at rates ranging between 1-2 lbs. /LA. Regular walleye fry stockings (10% of the egg-take as fry which is usually 1 – 2 million) resumed in 2001 as a result of egg

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collections from trapnet caught walleye. Since 1992, walleye fingerling stocking has depended on the absence of natural reproduction success as measured by fall electrofishing. Walleye (fingerling/yearling/adult) stocking was not conducted from 1992-2006 because of many moderate-good years of natural reproduction coupled with high survey gillnet catches from 1997-2003. Walleye fingerling/yearling/adult stockings occurred in 2007 (25,310 fish), 2008 (2,441 fish), and 2010 (15,281 fish) prompted by consecutive years of poor natural reproduction as measured by fall electrofishing during this same time period. With the advent of '*accelerated walleye management*' in the mid-to-late 1990's, walleye abundance goals for the lake increased to 10-15/GN. An aggressive stocking strategy is called for in this plan to meet that objective (this includes potential for periodic surplus walleye stockings); however, walleye stocking will not take place on top of an already strong natural year-class, in situations of poor forage levels, or in cases of walleye abundance levels far exceeding current LMP goals.

- Rice Northern Pike Spawning Area (NPSA) has been routinely operated for several years. NPSA operations were temporarily suspended from 2007-2010 based on high 2007 northern pike survey catches. Rice NPSA produced 1,630 large (3.5") northern pike fingerlings in 2011.
- In 1990, 1,452 lbs. of slow-growing bluegill from area sources were stocked into Rice Lake. If bluegill survey catches drop below target levels for an extended time period, additional stocking may be proposed.
- No other stocking is anticipated at this time.

Other Management Tools

- With the possible increase in walleye fingerling stocking for Rice Lake, the utilization of 'OTC' marking to evaluate stocking contribution would aid in evaluating the effectiveness of the current walleye management strategy.
- As mentioned previously, there does not appear to be a current impetus for experimental regulations. The potential exists in the future if current statewide regulations are ineffective at periodically meeting long-range fishery goals.
- More stakeholder input is needed in future lake management planning efforts.

Evaluation Plans

The current sampling schedule of alternating full surveys (includes habitat and water quality sampling, shoreline seining, spring electrofishing, comprehensive age and growth analysis, etc) and assessments every 2-3 years coupled with annual fall electrofishing will attempt to evaluate the parameters of this LMP. The use of 'OTC' marking (or similar technique) will be utilized as much as possible to evaluate the current walleye stocking strategy. As stated previously, periodic creel information is needed to monitor/evaluate this important fishery. Implementation of new initiatives that more effectively sample, monitor and protect habitat is also needed.

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APPENDIX III - AQUATIC VEGETATION OF LAKE KORONIS, STEARNS COUNTY, MINNESOTA

AQUATIC VEGETATION OF LAKE KORONIS

STEARNS COUNTY, MINNESOTA

(July 10, 11, 22, 26, 2013)
(Lake ID 7302002)

(Lake Koronis 2013)

Ben Austing

ACKNOWLEDGMENTS

Report by: Ben Austing
St. Cloud State University
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Lake Sampling: Ben Austing, Field Ecology/ Natural resources graduate 2012 SCSU

Jordan Moberg, biology graduate 2013 SCSU, DNR intern 1012

Funding: Provided by the Lake Koronis Association.

Equipment: Boat, cabin, life jackets, gas, provided by Karen Langmo. Double headed sampling rake, and rope provided by Koronis lake Association. GPS, computer, Arc Gis Software provided by Ben Austing.

INTRODUCTION

LAKE DESCRIPTION

Lake Koronis is located within the North Fork Crow River Watershed in Stearns and Meeker County Minnesota, just minutes south of Paynesville Minnesota. The lake is approximately 3,014 acres, with a littoral area of 1,176 acres, and has a maximum depth of 132 feet. Mud lake flows into the lake on the south eastern side of the lake and the main outflow of the water body is located in the southern most bay. The lake has seven accesses including two owned by the DNR, two by the county, two by the township and one by the city. In recent years the Carlson Trophic Status Index (TSI) score of Lake Koronis has been on the rise. With a score of 54 (2009), its trophic status is considered on the low end of the Eutrophic s tatus (table 1), which puts it in a category of lakes which often see problems related to persistent algae blooms and other aquatic plant issues. However, on average the TSI lies within the mesotrophic range which generally only exhibit occasional problematic plant and algae blooms (MN DNR).

Figure 1. Lake Koronis contour map and aerial image

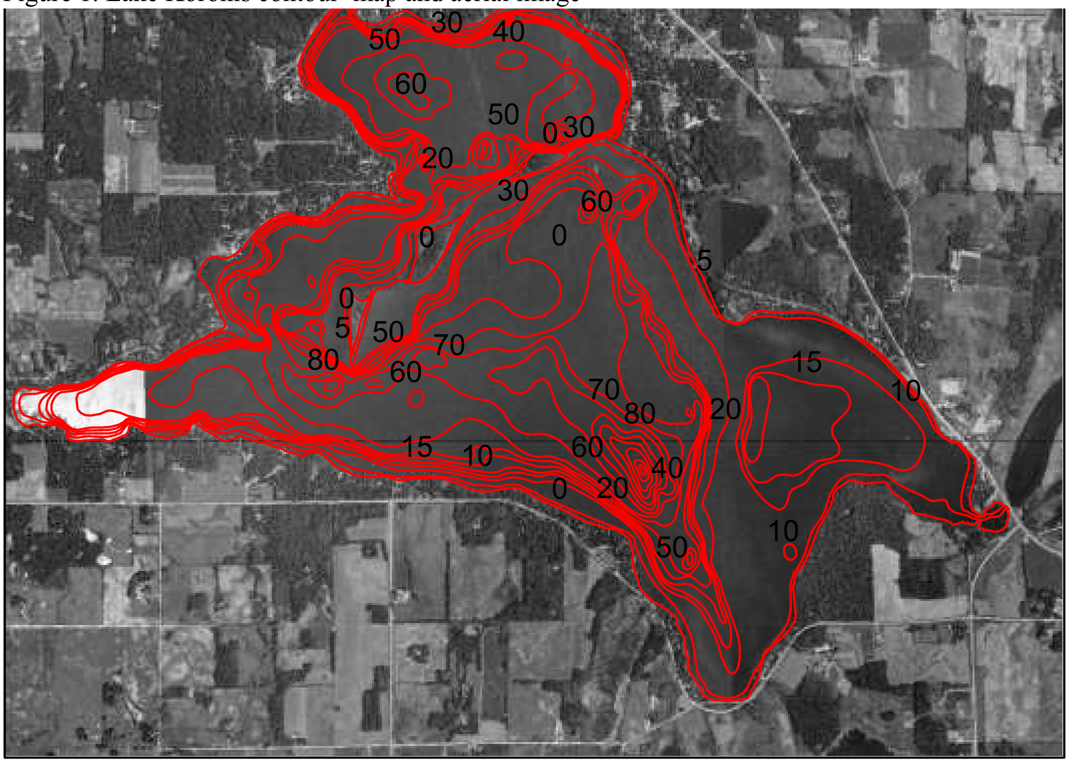


Table 1. Trophic Status Index ranges

TSI Range	Trophic Status	Characteristics
0-40	Oligotrophic	Clean lake
41-50	Mesotrophic	Temporary algae and plant blooms
50-70	Eutrophic	Persistent algae and plant blooms
Greater than 70	Hyper-Eutrophic	Extreme algae and plant blooms

LAKE VEGETATION SURVEY OBJECTIVES

The purpose of this vegetation survey is to describe and analyze the populations of aquatic species within Lake Koronis summer of 2013. The specific objectives for the survey included:

1) Estimate the maximum depth of rooted vegetation.
2) Record all aquatic plant species present within the lakes littoral zone.
3) Estimate percent of littoral zone occupied by rooted vegetation.
4) Collect quantitative estimates of species abundance (frequency) for each species observed during the survey.
5) Develop distribution maps/graphs for the most common species.
6) Survey for the presence or absence of invasive species (if present, distribution maps will be created).
7) Produce a final report for the survey.

METHODS

The survey was conducted mid-July 3013. A point intercept grid method was used for the survey. The first step in the survey was to create a point intercept grid of sampling points using Arc Gis software (figure 2). The grid was created for the littoral zone only (the area between 0 feet and approximately

Figure 2. All 329 Sample sites 2013

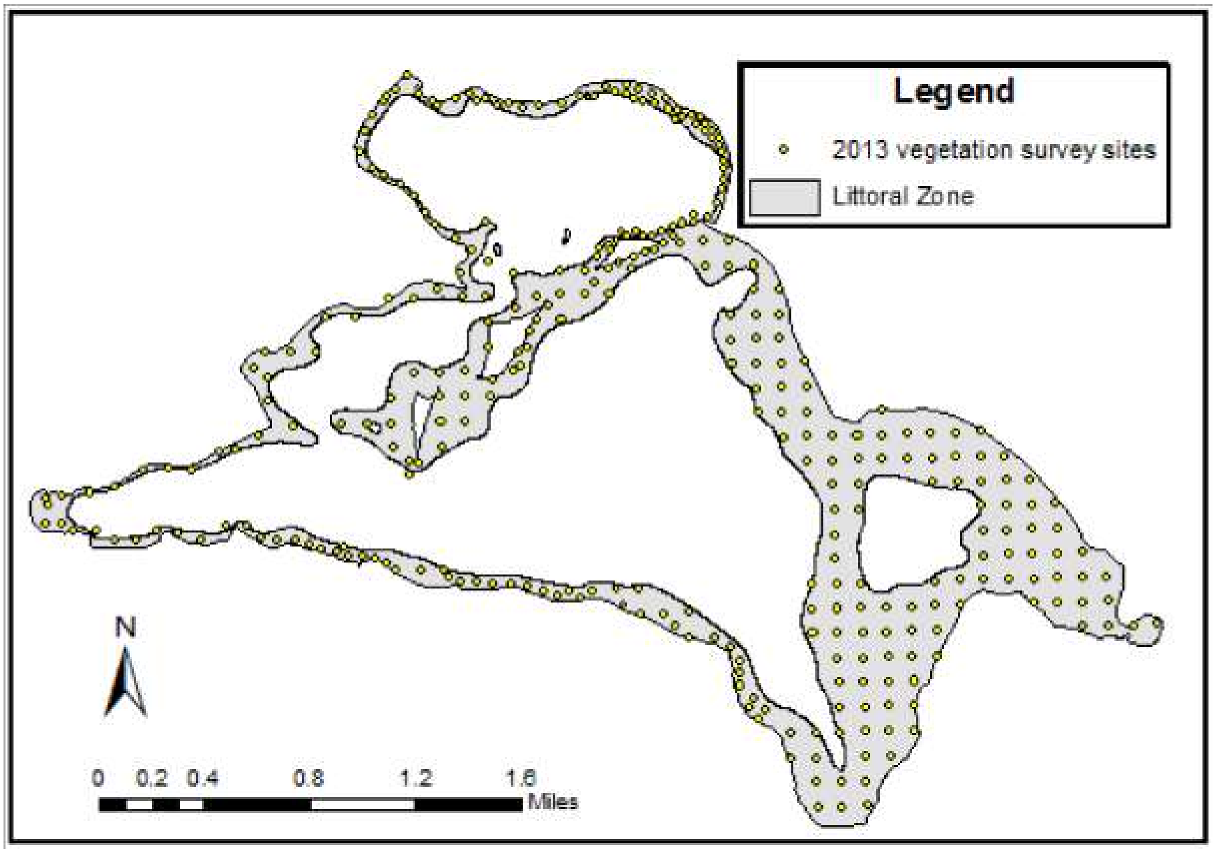


Figure 3. Double headed survey rake

18 feet in depth). The grid was created using software and then uploaded to a Garmin GPS unit. The GPS was then used to navigate to each of the 329 sample points that were created. Sampling was conducted by boat (supplied by Karen Langmo). One side of the boat was designated as the sampling side of the boat. When each survey site was reached, the double headed garden rake attached to a rope was thrown from the edge of the boat (figure 3), dragged approximately one meter, and then retrieved. The plant taxa collected from the rake were then separated, and each species was assigned a density rating of 1-4 depending on relative density (1 being most sparse, 4 being most dense) within the collected sample. The data was collected on spreadsheets for further analysis. Frequencies for each species were calculated (table 2.), and distribution maps for the most common and exotic species were created to observe trends

in distribution. Frequency of occurrence was calculated for each species as the number of sites in which a certain species occurred then divided by the total number of sample sites.

Example: Frequency: In Lake Koronis there were a total of 329 sample points in the littoral zone. Sago Pondweed occurred in 148 sample sites. The frequency of Sago Pondweed is calculated as 148/329 which equals 45%.

Depths were also recorded using an electronic depth finder to determine the maximum depth of rooted vegetation. The nomenclature used followed Crow and Hellquist (2000)

RESULTS

MAXIMUM VEGETATION DEPTH

In Lake Koronis, vegetation was present to a depth of 17 feet. However, the vast majority of vegetation that was sampled was seen from 0 to 10 feet in depth. The limiting factor in determining the maximum depth that vegetation can grow is sunlight. The turbidity (the measure of water clarity and how many suspended solids are present in the water column) of the water determines how deep the sunlight can penetrate into the water column. Suspended solids present in the water column can include mud, algae, and detritus. The more turbid the water, the less likely the sun can penetrate to deeper depths, causing a decrease in photosynthesis, which reduces the ability of rooted vegetation to grow. Many factors can contribute to high turbidity, but some include boats driving over the littoral zone, elevated nutrient inputs due to local agricultural runoff, waste discharge from urban runoff, algae blooms, and bottom feeders stirring up the bottom of the lake.

TYPES OF AQUATIC PLANTS FOUND

There were eighteen species found in total during the vegetation survey. Of the eighteen, seventeen species were native, which included one emergent, one floating, two free floating, and thirteen submerged species. One non-native submerged species was also found in the lake (table 2.).

Table 2. Aquatic Plants of Lake Koronis 2013

Table 1. Aquatic plants of Lake Koronis

Life Forms	Common Name	Scientific Name	Frequency
SUBMERGED	Sago pondweed	*Stuckenia pectinata*	45
These plants grow primarily under the water surface. Upper leaves may float near the surface and flower may extend above the surface. Plants are usually rooted or anchored to the lake bottom.	Muskgrass	*Chara sp.*	44
	Narrow-leaf pondweed	*Potamogeton sp.*	36
	Wild Celery	*Vallisneria americana*	24
	Coontail	*Ceratophyllum demersum*	22
	White-stem pondweed	*Potamogeton praelongus*	14
	Flat-stem pondweed	*Potamogeton zosteriformis*	9
	Curly-leaf pondweed	*Potamogeton crispus*	7
	Northern-watermilfoil	*Myriophyllum sibiricum*	3
	Large-leaf pondweed	*Potamogeton amplifolius*	2
	Canada water-weed	*Elodea canadensis*	2
	Illinois pondweed	*Potamogeton illinoensis*	<1
	Clasping-leaf pondweed	*Potamogeton richardsonii*	<1
	Small Duckweed	*Lemna valdiviana*	<1
FREE FLOATING	Filamentous algae	*Cladophora*	25
Algae	Blue-Green algae	*Anabaena*	present
FLOATING	White-waterlily	*Nymphaea odorata*	<1
These plants are rooted in the lake bottom and have leaves that float on the water surface. Many have colorful flowers that extend above the water.			
EMERGENT	Cattail	*Typha sp.*	present
These plants extend well above the water surface and are usually found in shallow water, near shore.			

SPECIES DISTRIBUTION

Aquatic species occurred in all depths from shore to 17 feet, however not every sample site contained vegetation. The number of species sampled at each sample site ranged from 0 to 6, with an average of 3. Approximately 92 percent of the littoral zone in Lake Koronis is occupied by rooted vegetation.

EMERGENT AND FLOATING SPECIES

The emergent species found during the vegetation survey were identified visually and were not collected in the sample sites. The only emergent species found during the survey was the common cattail, however more emergent species are likely to inhabit areas close to the shoreline which were not always represented in the survey sites. Cattail stabilizes the littoral zone close to shore by minimizing wave actions which cause turbidity in shallow waters. Emergent plants also offer aquatic insects, and fish a retreat against the elements.

Free-floating plants included Filamentous and Blue-Green Algae. Filamentous algae are single algae cells that join together to make visible algae filaments. The filaments join together to form mats. The algae begins to form at the bottom and attaches to rocks and other objects on the substrate. The mats can float to the surface which many people call “pond scum”. These mats are used as shelter for micro-invertebrates, which are food for fish and other forms of wildlife.

Floating species were sparse within the sample sites. The only observed floating species was the white water-lily. The white water-lily is a perennial plant that comes back from year to year that often colonize in dense groups. The leaves float on the waters surface and the flower arises from a separate stock. The submerged stems of the plant offer habitat for shallow-water fish and micro invertebrates.

NATIVE SUBMERGED SPECIES

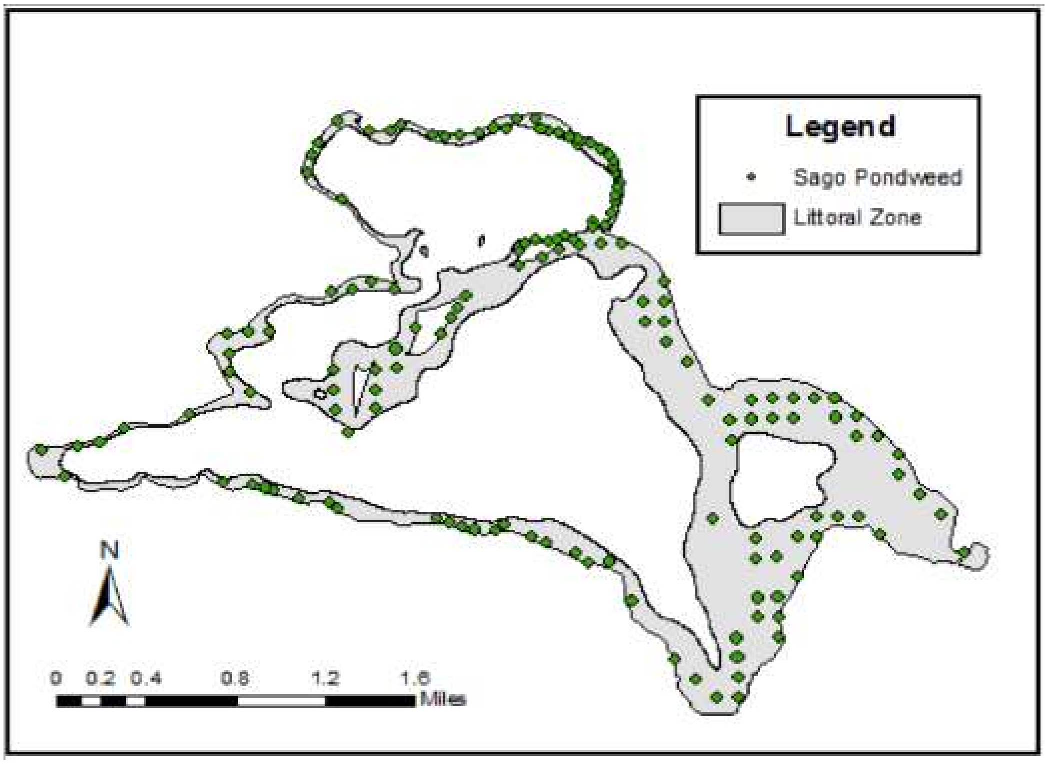
Native submerged species were the most common types of plants found during the survey. The species that occurred in 20% or more of the survey sites include Sago pondweed, Muskgrass, Narrow-leaf pondweed, Wild Celery, and Coontail.

SAGO PONDWEED

Sago pondweed was the most common plant observed during the survey (figure 4). It was found in 45% of the survey sites. It is usually completely submerged within the water column except for when its reproductive spike extends above the waters surface in June. This plant has the ability to become aggressive and displace other native varieties (Allen, 2010). The leaves are threadlike and anywhere from 2-12 cm long and between 0.2 and 1.5 cm wide. Within Lake Koronis, the distribution of Sago pondweed was fairly even throughout the lake (figure 5.). During sampling, Sago was often found in a mixture with other native plants and not found in monocultures. It can be used to suppress phytoplankton blooms by taking up phosphorus from the water (Allen, 2010). Waterfowl also rely on it as a food source.

Figure 4. Sago pondweed

Figure 5. Sample sites where Sago pondweed was present

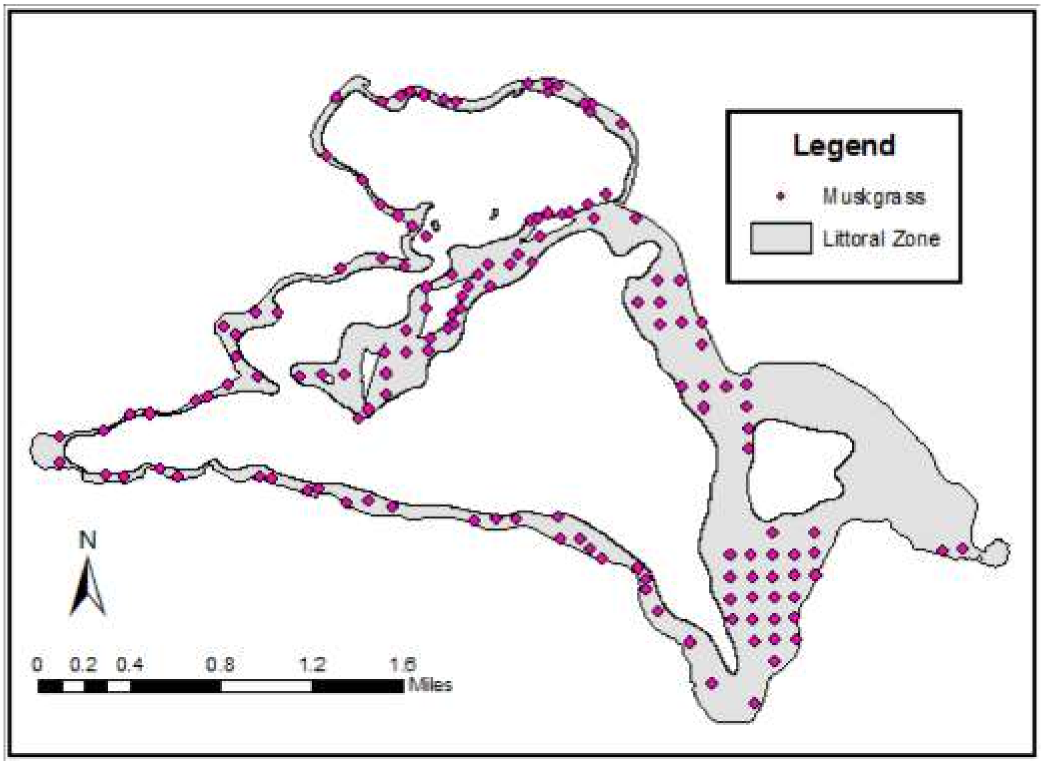


MUSKGRASS

Figure 6. Muskgrass

Muskgrass is common in clear water lakes. It is an advanced form of algae that can grow several feel long, and can look like other aquatic plants (MN DNR). It can be light grey to green in color, and has stem-like branches with forked leaves. It grows below the surface and can form dense mats on the substrate. It is gritty and bristly in appearance and its defining characteristic is its potent musky odor when pulled above the surface (MN DNR). The dense mats can help calm the lake bed and reduce erosion caused by boating traffic. Muskgrass provides shelter for baitfish and other small organisms. Within Lake Koronis, Muskgrass had an even distribution, but was sparse in areas near the "5 mile bridge" where Coontail dominates (figure.7). When sampled, it was often found in large dense mats which often completely covered the sampling rake.

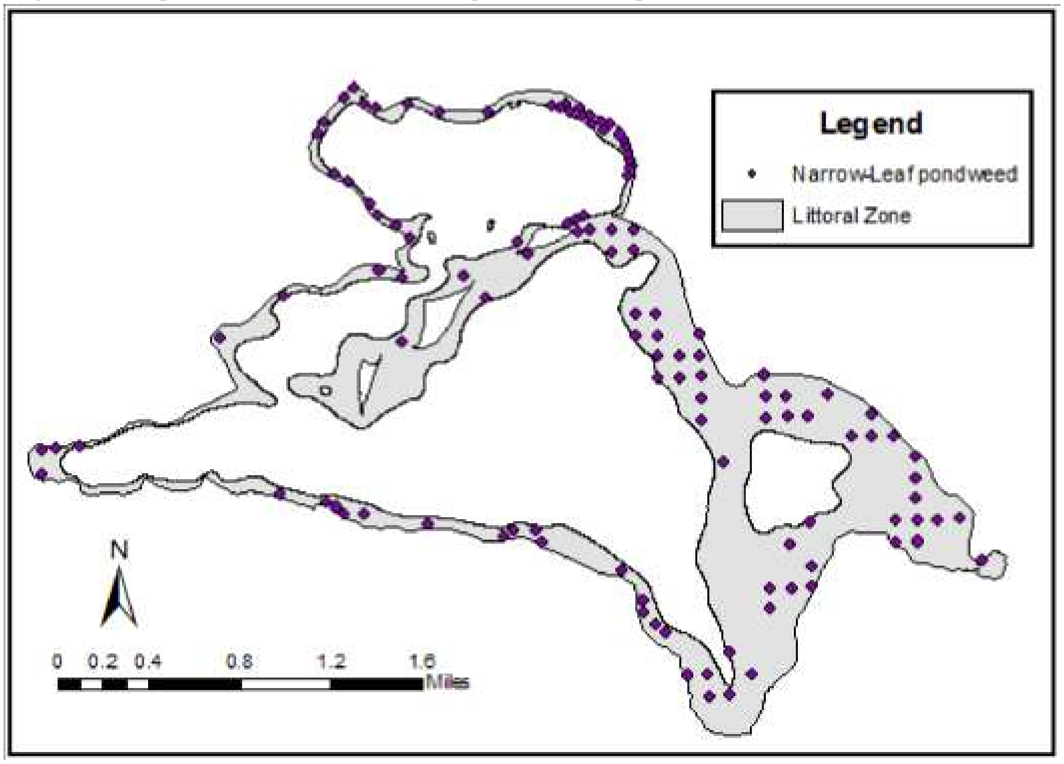
Figure 7. Sample sites where Muskgrass was present



NARROW-LEAF PONDWEED

Narrow-leaf pondweed is a perennial, submerged plant, with small thin leaves (MN DNR). It is usually present below the waters surface, but seasonally grows a flower spike that extends out of the water. The plant does provide good cover for sunfish, perch, northern pike, and bait fish. The foliage also protects aquatic insects and provides food for ducks and other waterfowl. Within Lake Koronis, the distribution was even (figure 8). When it was found, it tended to be in a mixture with other native-submerged species, but sometimes formed dense mats.

Figure 8. Sample sites where Narrow-Leaf pondweed was present



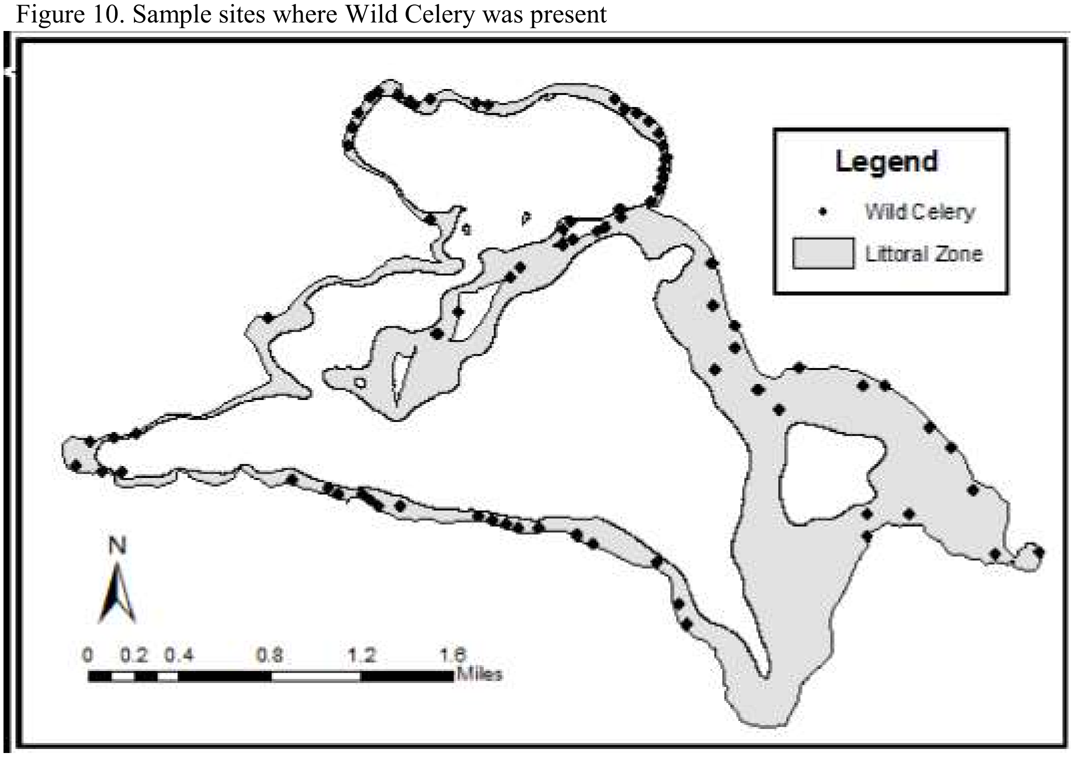
WILD CELERY

Wild Celery is found in depths of up to 15 feet. Leaves are green, thin, and ribbon like. The plant grows below the surface and roots in the mud. In late summer, the plant produces a small whitish-yellow flower (MN DNR).

The species is often found in a diverse mixture of other native aquatic plants. It provides food and shelter for baitfish, and particularly good hunting ground for diving ducks (MN DNR). Within Lake Koronis, Wild Celery was found in 24% of all sample sites (figure 10.). In the sites where it was present, it was never found in dense mats. The tendency was to find it sparsely distributed within the sample.

Figure 9. Wild Celery

Figure 10. Sample sites where Wild Celery was present

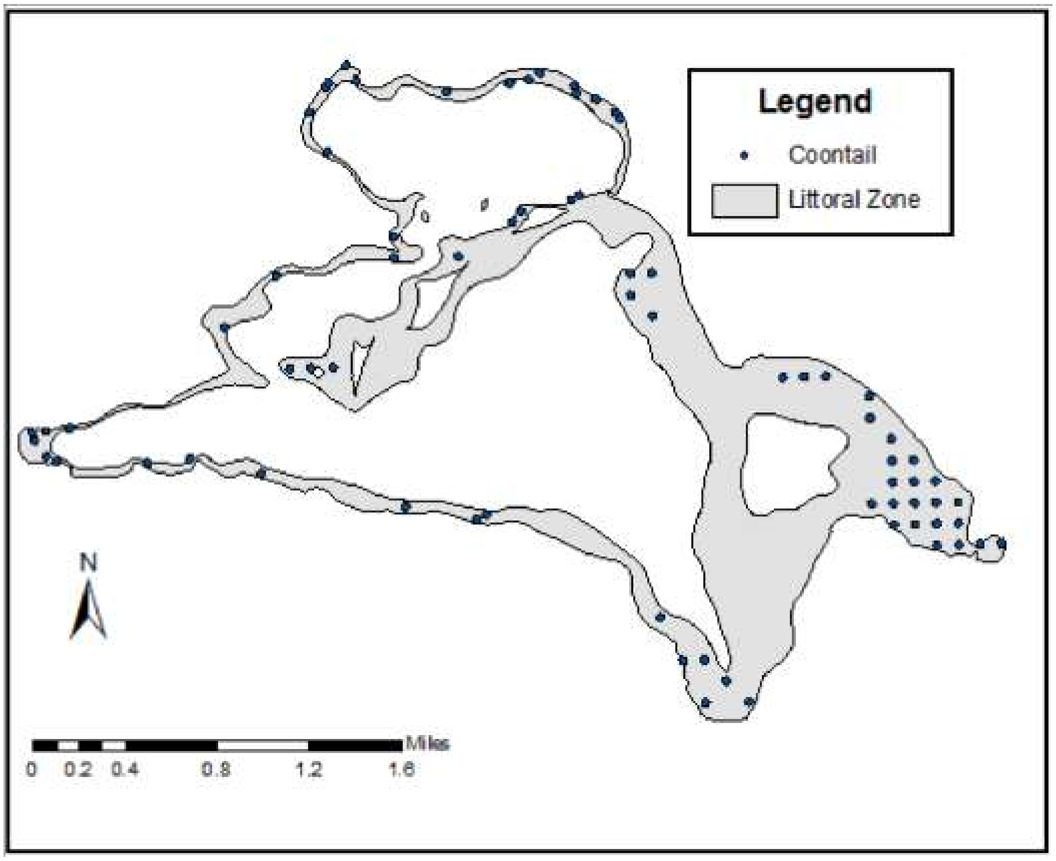


COONTAIL

Coontail was common throughout the lake. The plant grows completely submerged and is adapted to a variety of lake conditions including turbidity. It is a perennial and can over winter under the ice while remaining green, but its growth is halted. When spring returns Coontail begins to produce new growth as water conditions begin to get warmer. It is capable of forming very dense mats which cover large areas on the lake floor. The leaves are green and forked which whorl around the stem of the plant. At maturity it has a close resemblance to a coons tail which is how it got its name (Smith 2010). Coontail can be spread through fragmentation which allows it to reproduce very quickly, which in certain situations causes problems in the lake ecosystem. When Coontail is excessive, it can reduce the amount of open water in a lake which can limit recreational fishing and swimming, and can cause a scummy appearance to the waters surface (Smith 2010). Within Lake Koronis, Coontail had a clumped distribution with a large monoculture in the bay near the “5 mile bridge” on the south eastern side of the lake (figure 12). The dense mats of Coontail were common at the surface of the water, and could not be driven through with a boat. Areas where Coontail was present tended to contain a high density of plants. Coontail was present in 29% of the sample sites.

Figure 11. Coontail

Figure 12. Sample Sites where Coontail was present



NON-NATIVE SUBMERGED SPECIES

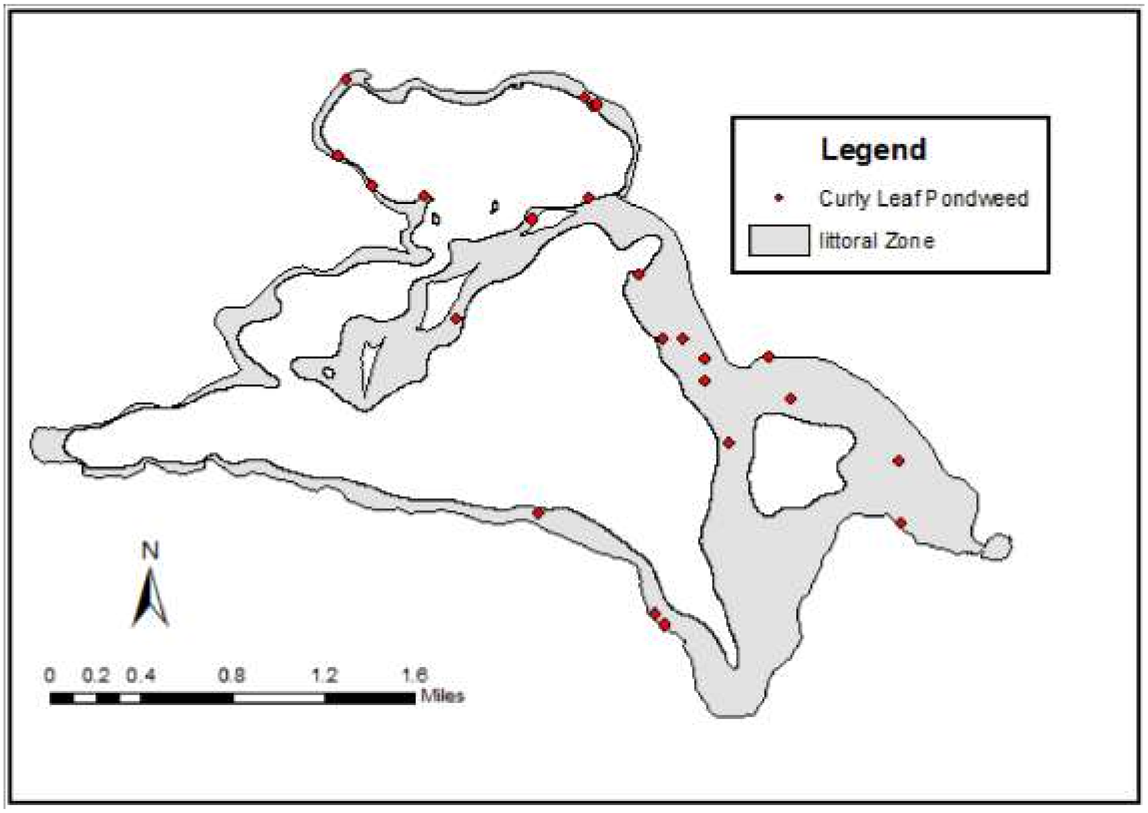
CURLY-LEAF PONDWEED

Curly-leaf pondweed is a non-native submerged species that was confirmed in

Lake Koronis. It is native to Europe, Africa, Australia, and Asia. It was introduced in the 1800s to the United States because of its popularity as Figure 13. Curly-Leaf Pondweed an aquarium plant (KDWP 2013). The stems are flattened and branched. The leaves are simple, long, narrow and connect directly to the stem. The leaf profile gives the appearance of a waved lasagna noodle. The flowers are brownish and can appear from May to October (KDWP 2013). It is closely related to the pondweeds such as flatstem, but it has a unique lifecycle which allows it to out compete many other species of aquatic plants. In the early spring it forms dense mats which can interfere with recreation and limit the growth of other aquatic plants. The plant will die back mid summer, and as the mats begin to decay it can cause the water to become more turbid. Early detection of the species is key to keeping it at bay. There are several methods for controlling the species which include mechanical control, which includes hand pulling or the use of harvesting machines. A second method for control is chemical, this would include the use of aquatic safe chemicals. Early spring treatments using contact herbicides with active ingredients of diquat or endothall have shown positive effects in reducing Curly-Leaf pondweed shoot and root biomass as well as suppressing turion (seed) production (IN DNR 2009)(figure

14.). Curly-Leaf Figure 14. Curly-Leaf turions pondweed is a nonnative species, but because of the extended time it has been established, it has partially become naturalized in many water bodies (KDWP).

Figure 15. Sample sites where Curly-Leaf pondweed was present



Within Lake Koronis the distribution of Curly Leaf pondweed is scattered and sparse. The plant was only present in 7% of sample sites (figure 15.)

FOLLOW-UP SURVEY

A follow-up survey was conducted on September 20th, 2013. The study was conducted to survey for any new species that may have populated after the initial survey. Sampling methods were random and used the same survey rake from the initial survey. Water clarity was good, so when possible sight surveys were used in the shallower areas for identification. Some seasonal die-back had begun to occur within the lake, however the vegetation was still easily identifiable. Samples were taken throughout the littoral zone at random. The most common species were Sago Pondweed, Muskgrass, and Coontail. No new species were found during the follow-up survey.

DISCUSSION

Lake Koronis contains a high diversity of native aquatic plant species. Curly-Leaf pondweed was the only non-native species found during the vegetation survey. Its distribution was random and sparse. Curly-Leaf has the potential to become invasive, so even though the current Curly-leaf population is low, it is important to maintain good management practices. One factor that may contribute to the relatively low Curly-Leaf pondweed community is a more abundant and diverse native plant community. Coontail density in several locations in Lake Koronis was high, it created dense matted populations near the surface causing boat navigation to become difficult and swimming to become dangerous (particularly near the "5 mile bridge" on the south and east side of the lake). In general, most sample sites contained a diverse mix of vegetation with minimal non-native populations. With a healthy aquatic plant community in Lake Koronis, it is important to continue to use safe practices when it comes to cleaning boats, pulling the plug and draining live-wells of recreational boats to stop the spread of invasive species. Using buffer zones in agricultural areas, limiting the amount of fertilizer being used on lake- shore lawns, and keeping lawn cuttings and fallen leaves out of the water are simple ways everyone can help reduce nutrient runoff/loading. It is important to have contributions (as previously stated) from local residents when it comes to maintaining the diverse, aquatic plant populations of Lake Koronis.

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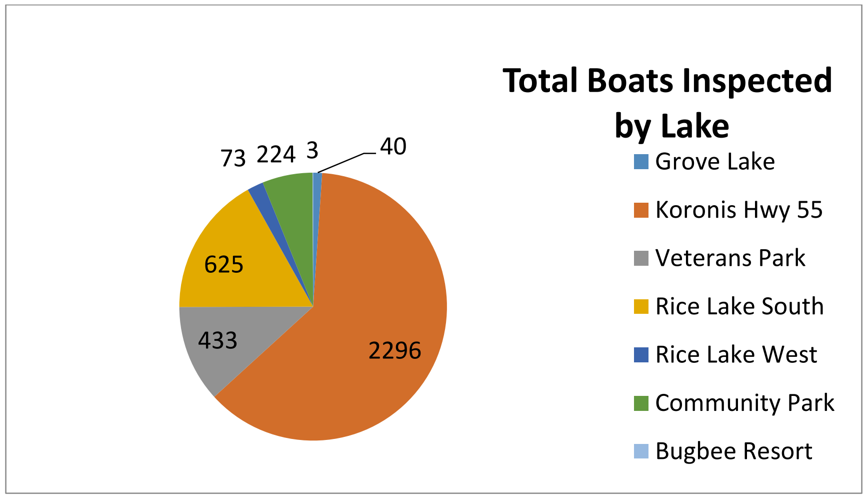
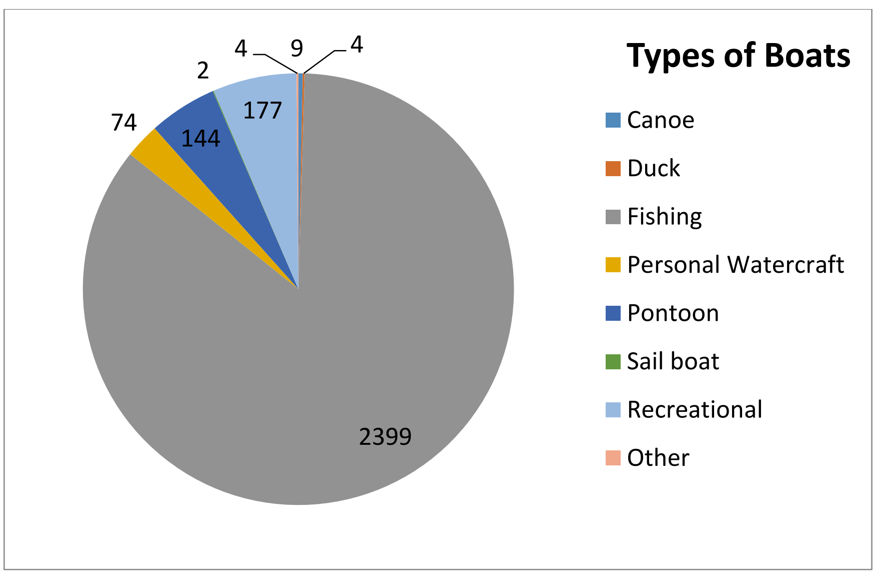
APPENDIX IV - 2013 AIS BOAT INSPECTION RECAP FROM NFCRWD AND KORONIS LAKE ASSOCIATION – TOTAL SUMMARY DATA

2013 AIS BOAT INSPECTION RECAP FROM NFCRWD AND KORONIS LAKE ASSOCIATION – TOTAL SUMMARY DATA

The North Fork Crow River Watershed District (NFCRWD) and the Koronis Lake Association employed 4 level 1 watercraft inspectors and 3 inspectors through the WaterGuards during 2013. The inspectors were trained by the MN DNR to inspect boats entering and exiting public boat accesses on the District's recreational lakes. Contributors to the project included the Koronis Lake Association, MN DNR, Paynesville Township, Meeker County, NFCRWD, City of Paynesville, Union Grove Township, Rice Lake Association, and Grove Lake Association.

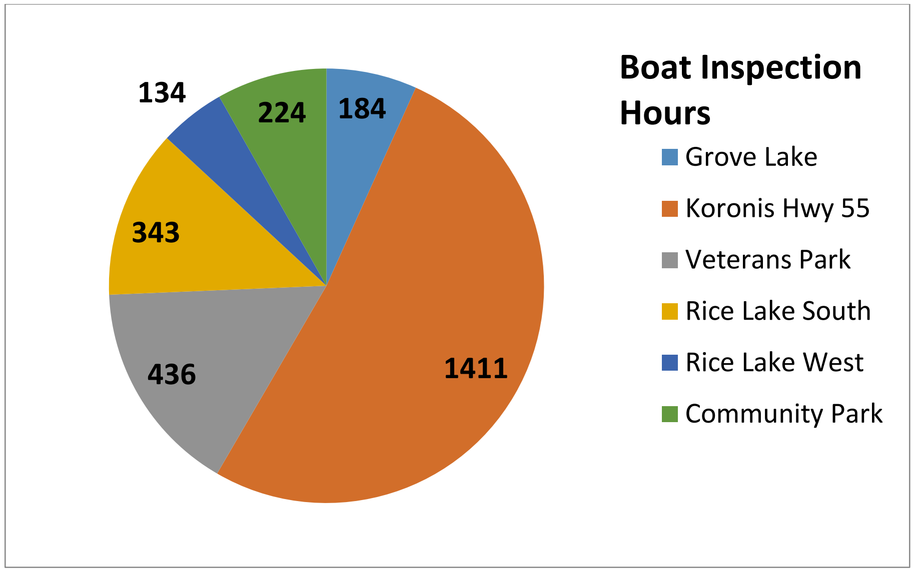


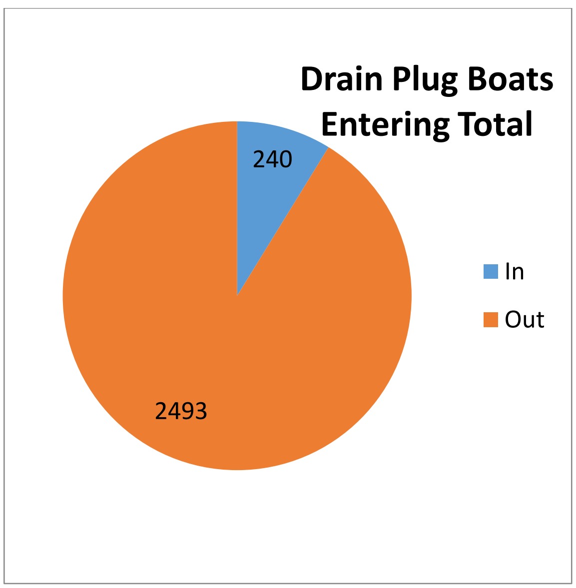


By far the largest number of transient boats was fishing boats. Inspections/surveys went very well taking only about 5 minutes each unless there was an issue. i.e. weeds on the boat, plug in the boat, water in the live-well. The inspectors also did basic AIS training with each boater. Most boaters were very cooperative with the inspection and survey. Some reluctance existed on revealing previous lake entered.

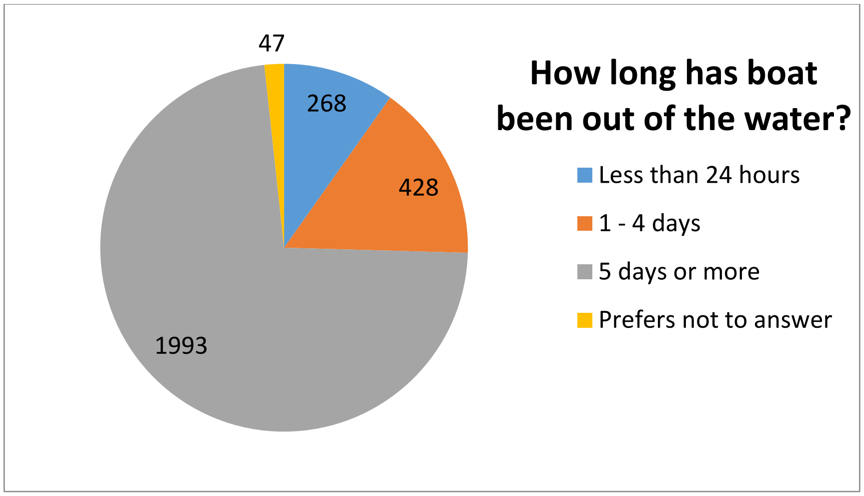
The graphs in this report are a combination of the Watershed / DNR data and the WaterGuards data obtained from the surveys.

The hours at each launch site within the watershed were not split up equally. Initially it was estimated which launches would be the busiest and based on that, hours were assigned. The busiest launch then had the watershed Level I trained inspectors assigned as they had the most authority.
During each watercraft inspection, the inspectors completed a DNR survey, discussed MN AIS laws and completed a visual and physical inspection of boats entering or exiting the waterways. Completing these processes with boaters increases the knowledge of AIS and self-inspection techniques, reducing the AIS risk for the District's waters.





It is documented that transient boats present the greatest risk for the transfer of aquatic invasive species from lake to lake. Several key factors determine the risk and when controlled can substantially reduce the risk. These are dependent on the biological factors of the invasive. In the case of Eurasian milfoil, small fragments that still have the ability to grow are all that are needed to be put into a lake to start the invasive population and pending ecological change. Zebra Mussels are transferred when attached to boats, trailers or other equipment that are placed in water. The juvenile mussels can be transferred from lake to lake in a very small amount of water, such as the bottom of a boat, a live-well, or a ballast tank. Failing to completely drain a boat can greatly increase the spread of zebra mussels. Zebra Mussels can also survive out of a lake on boats for 21 days, depending on weather conditions. A boat that is not dry for 21 days coming from a contaminated lake or has not been decontaminated (high pressure wash with 140°F water) can spread zebra mussels.



As previously noted the length of time a boat is out of the water can also indicate the risk of transfer of AIS. A question on the survey was asked to try and determine how great of a risk this presented. The scientific data all indicates it takes 21 days of drying for zebra mussels to become dead on a boat.

The surveys also gathered data on what lake the transient boats had last been launched into as a way of determining travel patterns and risk to the watershed. Included is a table to demonstrate travel patterns.

Incoming boats, lake last visited:

Prefers not to answer	644	Koronis	847	Rice	247	Green	41	Horseshoe Chain	37
Clearwater	33	Out of state	21	Mille Lacs	27	Long Lake	25	Minnetonka	24
Diamond	20	Big Lake	17	Sylvia	21	Osakis	13	Clear	19
Minnewaska	13	Leech Lake	15						

Green - lakes known to have Milfoil   Red – lakes known to have milfoil and Zebra mussels

When did boats typically arrive at the lakes in the Watershed?

Saturday was the busiest with about 40% of the boats arriving.
Sunday had about 25% of the boats arriving.
Thursday and Friday roughly had the same number of boats entering on each day or a total of 25% of the boats

Koronis Lake Association would like to **Thank** our partners in supporting our efforts to protect the watershed from Aquatic Invasive Species.
Grant Funds and Contributions for 2013 Inspections :
Koronis Lake Association $ 15,080.00
DNR grant $7,750.00
Paynesville Township $6,000
Meeker County $3,500
NFCRWD $ 2,993.00
City of Paynesville: $1,670.00
Union Grove Township $1,500
Rice Lake Association $500.00
Grove Lake Association $300.00
NFCRWD In-kind Hours ~80hrs
AND a special THANKS to the NFCRWD for their willingness to sign the DNR Delegation Agreement and manage the inspection hours.

Lakes that were last visited before entry into the NFCRWD – (many of these lakes are infested with Milfoil, Zebra mussels and/or other AIS)

5th Crow Wing
Hubbard Cty
Allie
Andrew (2)
Bass Lake
Bass, Cook Cty
Beret Lake
Beebe (2)
Bell Lake
Betsey
Big Birch Lake
Big Elk Sherburne
Big Marine
Big Sauk
Big Stone
Big Swan
Birch Lake
Brainerd
Bone Lake
Wisconsin (2)
Boy Lake
Briggs Chain
Sherburne
County
Browns Lake
Stearns (2)
Buffalo Lake (2)
Carnelian
Carver
Cass
Cedar
Collinwood (2)
Coon Lake
Crystal, Dakota
Cty
Curry
Dean Lake
Demontreville
Dunn Lake
Meeker
Eagle Lake (3)
Eden Lake (3)
Elizabeth
Erie
First Crow Wing
Fish Lake (4)
Flint
Foot Lake
Freeborn
Games Lake (2)
Goose lardy
Grand (3)
Granite Lake
Green lake Isanti
Cty
Green Leaf
Meeker (2)
Grindstone Lake
Pine Cty
Grove Lake
Gull Lake
Hoffman
Howard Lake
Ida
Independence
Iowa
John Lake
Knife Lake
Lake Andrew (2)
Lake Ella
Lake Erie
Lake Florida
Lake Hanska
Lake John
Lake Marion
Lake Martha
Lake Mary (3)
Lake Michigan
Lake Maria
Lake of the
Woods
Lake Schnook
Lake Salmon
Lake Superior
Lake of the
Woods
Litchfield
Little Mad Lake
Little Trout Lake
Long Lake
Stevens Cty
Loon Lake
Madison
Marie (2)
Marion
Martha (2)
Mazaska
McCarron
Miller
Miltona Lake
Minnebelle (4)
Mississippi River
(3)
Mtn. Creek New
Ulm
Mud Lake
Ness Kandiyohi
(2)
New Ulm Lake
O-Brien (2)
O'dowd
Omega
Osakis Douglas
County
Otter Tail River
Ottertail
Pelican
Pleasant (2)
Prior Scott Cty
Rainy River (2)
Red Cedar lake
Wisconsin (2)
Red Wood
Reno Lake Pope
Ripley (2)
Rue Richardson
Meeker Cty
Lake Shetek
Spectacle Lake
Spunk Lake
Stella Meeker Cty
Sugar (2)
Swann
Twin Lakes
Upper Red Lake
Upper Spunk
Valentine Blue
Earth Cty
Vermilion
Waconia Carver
Watab (2)
West Norway
(Kandiyohi)
Woman Lake

GLOSSARY

Aerobic: Aquatic life or chemical processes that require the presence of oxygen.

Algal bloom: An unusual or excessive abundance of algae.

Alkalinity: Capacity of a lake to neutralize acid.

Anoxic: The absence of oxygen in a water column or lake; can occur near the bottom of eutrophic lakes in the summer or under the ice in the winter.

Benthic: The bottom zone of a lake, or bottom-dwelling life forms.

Best Management Practices: A practice determined by a state agency or other authority as the most effective, practicable means of preventing or reducing pollution.

Bioaccumulation: Build-up of toxic substances in fish (or other living organism) flesh. Toxic effects may be passed on to humans eating the fish.

Biological Oxygen Demand: The amount of oxygen required by aerobic microorganisms to decompose the organic matter in a sample of water. Used as a measure of the degree of water pollution.

Buffer Zone: Undisturbed vegetation that can serve to slow down and/or retain surface water runoff, and assimilate nutrients.

Chlorophyll *a*: The green pigment in plants that is essential to photosynthesis.

Clean Water Partnership (CWP) Program: A program created by the legislature in 1990 to protect and improve ground water and surface water in Minnesota by providing financial and technical assistance to local units of government interested in controlling nonpoint source pollution.

Conservation Easement: A perpetual conservation easement is a legally binding condition placed on a deed to restrict the types of development that can occur on the subject property.

Cultural eutrophication: Accelerated "aging" of a lake as a result of human activities.

Epilimnion: Deeper lakes form three distinct layers of water during summertime weather. The epilimnion is the upper layer and is characterized by warmer and lighter water.

Eutrophication: The aging process by which lakes are fertilized with nutrients.

Eutrophic Lake: A nutrient-rich lake – usually shallow, "green" and with limited oxygen in the

bottom layer of water.

Exotic Species: Any non-native species that can cause displacement of or otherwise threaten native communities.

Fall Turnover: In the autumn as surface water loses temperature they are "turned under" (sink to lower depths) by winds and changes in water density until the lake has a relatively uniform distribution of temperature.

Feedlot: A lot or building or a group of lots or buildings used for the confined feeding, breeding or holding of animals. This definition includes areas specifically designed for confinement in which manure may accumulate or any area where the concentration of animals is such that a vegetative cover cannot be maintained. Lots used to feed and raise poultry are considered to be feedlots. Pastures are not animal feedlots.

Groundwater: water found beneath the soil surface (literally between the soil particles); groundwater is often a primary source of recharge to lakes.

Hardwater: Describes a lake with relatively high levels of dissolved minerals such as calcium and magnesium.

Hypolimnion: The bottom layer of lake water during the summer months. The water in the hypolimnion is denser and much colder than the water in the upper two layers.

Impervious Surface: Pavement, asphalt, roofing materials or other surfaces through which water cannot drain. The presence of impervious surfaces can increase the rates and speed of runoff from an area, and prevents groundwater recharge.

Internal Loading: Nutrients or pollutants entering a body of water from its sediments.

Lake Management: The process of study, assessment of problems, and decisions affecting the maintenance of lakes as thriving ecosystems.

Littoral zone: The shallow areas (less than 15 feet in depth) around a lake's shoreline, usually dominated by aquatic plants. These plants produce oxygen and provide food, shelter and reproduction areas for fish & animal life.

Local Unit of Government: A unit of government at the township, city or county level.

Mesotrophic Lake: A lake that is midway in nutrient concentrations (between a eutrophic and oligotrophic lake). Characterized by periodic problems with algae blooms or problem aquatic vegetation.

Native Species: An animal or plant species that is naturally present and reproducing.

Nonpoint source: Polluted runoff – nutrients or pollution sources not discharged from a single point. Common examples include runoff from feedlots, fertilized lawns, and agricultural fields.

Nutrient: A substance that provides food or nourishment, such as usable proteins, vitamins, minerals or carbohydrates. Fertilizers, particularly phosphorus and nitrogen, are the most common nutrients that contribute to lake eutrophication and nonpoint source pollution.

Oligotrophic Lake: A relatively nutrient-poor lake, characterized by outstanding water clarity and high levels of oxygen in the deeper waters.

Nutrient: A substance that provides food or nourishment, such as usable proteins, vitamins, minerals or carbohydrates. Fertilizers, particularly phosphorus and nitrogen, are the most common nutrients that contribute to lake eutrophication and non-point source pollution.

pH: The scale by which the relative acidity or basic nature of waters are accessed,

Photosynthesis: The process by which green plants produce oxygen from sunlight, water and carbon dioxide.

Phytoplankton: Algae – the base of the lake's food chain, also produces oxygen.

Point Sources: Specific sources of nutrient or pollution discharge to a water body, i.e., a stormwater discharge pipe.

Riparian: The natural ecosystem or community associated with river or lake shoreline.

Secchi Disc: A device measuring the depth of light penetration in water.

Sedimentation: The addition of soils to lakes, which can accelerate the "aging" process by destroying fisheries habitat, introducing soil-bound nutrients, and filling in the lake.

Spring turnover: After ice melts in the spring, warming surface water sinks to mix with deeper, colder water. At this time of year all water is the same temperature.

Thermocline: During summertime deeper lakes stratify by temperature to form three discrete layers; the middle layer of lake water in known as the thermocline.

Trophic Status: The level of growth or productivity of a lake as measured by phosphorus, content, algae abundance, and depth of light penetration.

Watershed: The surrounding land area that drains into a lake, river, or river system.

Zooplankton: Microscopic animals.

COMMON BIOLOGICAL OR CHEMICAL ABBREVIATIONS

BOD	**Biological Oxygen Demand**
°C	**degree(s) Celsius**
cfs	**cubic feet per second (a common measure of rate of flow)**
cfu	**colony forming units (a common measure of bacterial concentrations)**
chl *a*	**Chlorophyll *a***
cm	**centimeter**
COD	**Chemical Oxygen Demand**
Cond	**conductivity**
DO	**dissolved oxygen**
FC	**fecal coliform (bacteria)**
ft	**feet**
IR	**infrared**
l	**liter**
m	**meter**
mg	**milligram**
ml	**milliliter**
NH_3-N	**nitrogen as ammonia**
NO_2-NO_3	**nitrate-nitrogen**
NTU	**Nephelometric Turbidity Units, standard measure of turbidity**
OP	**Ortho-phosphorus**
ppb	**parts per billion**
ppm	**parts per million**
SD	**Standard Deviation (statistical variance)**
TDS	**total dissolved solids**
TN	**total nitrogen**
TP	**total phosphorus**
TSI	**trophic status index**
TSI (C)	**trophic status index (based on chlorophyll *a*)**
TSI (P)	**trophic status index (based on total phosphorus)**
TSI (S)	**trophic status index (based on secchi disc transparency)**
TSS	**total suspended solids**
µg/l	**micrograms per liter**
µmhos/cm	**micromhos per centimeter, the standard measure of conductivity**
UV	**Ultraviolet**

GUIDE TO COMMON ACRONYMS

STATE AND FEDERAL AGENCIES

BWSR	**Board of Soil & Water**
COE	**U.S. Army Corps of Engineers**
CRP	**Conservation Reserve Program - A federal government conservation program**
DNR	**Department of Natural Resources**
DOJ	**United States Department of Justice**
DOT	**Department of Transportation**
DTED	**Department of Trade and Economic Development**
EPA	**U.S. Environmental Protection Agency**
EQB	**MN Environmental Quality Board**
LCCMR	**Legislative-Citizen Commission on Minnesota Resources**
MDH	**Minnesota Department of Health**
MPCA	**Minnesota Pollution Control Agency**
OEA	**MN Office of Environmental Assistance**
OSHA	**Occupational Safety and Health Administration**
RIM	**Reinvest In Minnesota - a State of Minnesota Conservation Program**
SCS	**Soil Conservation Service**
SWCD	**Soil & Water Conservation District**
USDA	**United States Department of Agriculture**
USGS	**United States Geological Survey**
USFWS	**United States Fish & Wildlife Service**

REGIONAL, WATERSHED, COMMUNITY DEVELOPMENT, TRADE AND ADVOCACY GROUPS

AMC	**Association of Minnesota Counties**
APA	**American Planning Association**
COLA	**Coalition of Lake Associations**
IF	**Initiative Foundation**
KLA	**Koronis Lake Association**
LMC	**League of Minnesota Cities**
MAT	**Minnesota Association of Townships**
MCIT	**Minnesota Counties Insurance Trust**
MSBA	**Minnesota School Board Association**
Mid-MnMA	**Mid-Minnesota Association of Builders**
MnSCU	**Minnesota State Colleges and Universities**
MW	**Minnesota Waters**

RLA	**Rice Lake Association**
TIF	**Tax Increment Financing**

CODES AND REGULATIONS

110B	**The Minnesota law that regulates non-metro county water plans**
ADA	**American Disabilities Act**
B & B	**Bed and Breakfast**
BOA	**Board of Adjustment**
Chapter 70/80	**Individual Sewage Treatment Standards**
CIC Plat	**Common Interest Community Plat**
Class V	**Class Five "Injection" well; any well which receives discharge**
CSAH	**County State Aid Highway**
CUP	**Conditional Use Permit**
CWA	**Clean Water Act**
EAW	**Environmental Assessment Worksheet**
EIS	**Environmental Impact Statement**
EOA	**Equal Opportunity Act**
FOIA	**Freedom of Information Act**
GD	**General Development (lake)**
GLAR	**Greater Lakes Area Association of Realtors**
IAQ	**Indoor Air Quality**
ISTS	**Individual Sewage Treatment System**
LMP	**Lake Management Plan**
LQG	**Large Quantity Generator (of hazardous waste)**
MAP	**Minnesota Assistance Program**
OHW	**Ordinary High Water**
PUD	**Planned Unit Development**
RD	**Recreational Development (lake)**
ROD	**Record of Decision**
ROW	**Right-of-Way**
SBC	**State Building Code**
SDWA	**Safe Drinking Water Act**
SF	**Square feet**
SIZ	**Shoreland Impact Zone**
SQG	**Small Quantity Generator (of hazardous waste)**
SWMP	**Stormwater Management Plan**
UBC	**Universal Building Code**