PELICAN LAKE
LITTLE PELICAN LAKE
BASS LAKE
FISH LAKE

PREPARED BY:

Emelia Thielman, PGOLID Water Resource Data Analyst

DIRECTION AND SUPERVISION BY:

Steve Henry, PGOLID Water Resource Coordinator

Pelican Group of Lakes Improvement District Board

RMB Environmental Laboratories, Inc.

ACKNOWLEDGEMENTS

REPORT COMPILATION AND DATA ANALYSES

Emelia Thielman, PGOLID Water Resource Data Analyst

SUPERVISION AND FUNDING

Pelican Group of Lakes Improvement District Past and Present Board Members

Mike Ostbye
Jeff Peltier
Lisa Wheeler
Jonal Uglem
Denny Tollefson
Nick Valentine
Vance Stueness
Gary Hart
Doug Oksendahl
Bill Zimmerman
Doug Johnson
Larry Kohler
Ed Johnson
Suzanne Lervick
Bill Kelsven
Jay Elshaug
Bert McDonough
Melody Jensen
Paul Horstmann
Erika Gilsdorf
John Kruse
Arlan Swenson
Dave Haarstad
Dave Gordon
Bob Leonard
Dave Stene
Denise Lund-Smith
John Cosgriff

WATER QUALITY DATA COLLECTION

Steve Henry, PGOLID Water Resource Coordinator (2019 - Present)
Emelia Thielman, RMB Environmental Laboratories (2022 – Present)
Ellie Kriese, RMB Environmental Laboratories (2018 - 2020)
Field Staff and Interns, RMB Environmental Laboratories (2010 - Present)
Moriya Rufer, former PGOLID Water Resource Coordinator (2006 - 2018)
Jordan Ornquist, former PGOLID Water Resource Coordinator (2004 - 2006)

PAST REPORT COMPILATION AND DATA ANALYSES

Steve McComas, Blue Water Science (2004)
Jordan Ornquist, former PGOLID Water Resource Coordinator (2006)
Moriya Rufer, former PGOLID Water Resource Coordinator (2009, 2013, 2016, 2018)
Emelia Hauck, RMB Environmental Laboratories (2016, 2018)

ORGANIZATIONAL CONTACTS AND REFERENCE SITES

PELICAN GROUP OF LAKES IMPROVEMENT DISTRICT (PGOLID)
www.pgolid.org

PGOLID WATER RESOURCE COORDINATOR
Steve Henry
c/o RMB Environmental Laboratories, Inc.
22796 County Highway 6
Detroit Lakes, MN 56501
(218) 846-1465
steve.henry@rmbel.info

PELICAN LAKE PROPERTY OWNERS ASSOCIATION (PLPOA)
PO Box 1782
Detroit Lakes, MN 56502
plpoa@pelicanlakemn.org
www.pelicanlakemn.org

WEST OTTER TAIL SOIL AND WATER CONSERVATION DISTRICT
506 Western Ave N
Fergus Falls, MN 56537
(218) 739-1308 ext.3
wotswcd@gmail.com
www.wotswcd.org

OTTER TAIL COUNTY LAND AND RESOURCE DEPARTMENT
Government Services Center
540 Fir Ave W
Fergus Falls, MN 56537
(218) 998-8095
www.ottertailcountymn.us/department/land-resource-management/

DNR FISHERIES OFFICE
1509 1st Ave N
Fergus Falls, MN 56537
(218) 739-7576
fergusfalls.fisheries@dnr.state.mn.us
www.dnr.state.mn.us/areas/fisheries/fergusfalls/index.html

REGIONAL MINNESOTA POLLUTION CONTROL AGENCY OFFICE
714 Lake Ave, Suite 220
Detroit Lakes, MN 56501
(218) 847-1519
www.pca.state.mn.us

TABLE OF CONTENTS

CHAPTER 1. EXECUTIVE SUMMARY

INTRODUCTION

The PGOLID Lake Management Plan is a comprehensive report from over two decades of data collection and effort from many organizations, including PGOLID, the Pelican Lake Property Owners Association, Blue Water Science, and RMB Environmental Laboratories. This plan's purpose is to address ongoing and emerging concerns and issues related to water quality preservation and lake management. It is intended to be a working document that will provide direction and aid in cooperative decision making for the PGOLID Board, county government, residents of the Pelican Group of Lakes, and the public at large with vested interests in establishing and maintaining high standards of water quality and sustainable use of these lakes as a natural resource for generations to come. It is a summary of water quality data, various lake projects, ongoing lake programs, and recommendations for future projects. This report is also available online and is updated biannually.

www.pgolid.org/lake-plan/

The Pelican Group of Lakes encompasses 4 lakes: Pelican, Little Pelican, Bass, and Fish. Although these lakes have somewhat different characteristics, they are all considered to have good water quality for northwest Minnesota.

PGOLID LAKE VITALS	PELICAN	LITTLE PELICAN	BASS	FISH
SURFACE AREA (ACRES)	3,961	366	51	293
MEAN DEPTH (FT)	22	10	18	27
LITTORAL AREA (%)	41%	70%	47%	43%
MAXIMUM DEPTH (FT)	55	25	33	69
VOLUME (ACRE-FT)	87,692	4,140	864	7,047
WATERSHED AREA (ACRES)	164,092	96,538	138	162,190
TROPHIC STATE INDEX (TSI)	42	50	43	40
TOTAL PHOSPHORUS MEAN (UG/L)	14.8	24.0	17.2	12.2
CHLOROPHYLL-A MEAN (UG/L)	3.5	8.1	4.1	2.6
CHLOROPHYLL-A MAXIMUM (UG/L)	13	31	17	8
SECCHI DEPTH MEAN (FT)	13.3	9.0	12.6	15.1

PGOLID GOALS

The Pelican Group of Lakes Improvement District (PGOLID) was formed to identify, quantify, study, and manage water resources as to preserve quality. Goals that have led to this report were outlined by PGOLID early in 2002. The overall scope can be broken into tasks by subject.

1. **WATER QUALITY PRESERVATION**
   - Interpretation and analysis of existing lake data
   - Identification of all potential sources of lake water pollution, e.g. septic, chemical, runoff, etc.
   - Development and implementation of a comprehensive plan to eliminate water pollution
   - Collection of new lake water quality data for research
   - Evaluation of wetlands for wildlife and water quality services
   - Characterization of lake sediments to evaluate potential for nuisance growth of aquatic invasive plants
2. **INVASIVE SPECIES MANAGEMENT**
   - Prevention of invasive species through education and watercraft inspection programs
   - Control of invasive plants through mechanical methods and chemical treatment
   - Promote re-establishment and protection of native plants for quality habitat
3. **PEST CONTROL**
   - Management of mosquitoes with pesticides to prevent the spread of mosquito-borne illnesses and promote enjoyment of the lake
   - Annual spring monitoring for tent caterpillars and funding available for pesticide treatment if necessary
4. **SHORELINE RESTORATION**
   - Evaluate shoreland conditions
   - Promote shoreline restoration and stewardship
   - Recommend ways to improve natural areas
5. **ON-SITE WASTE TREATMENT SYSTEMS**
   - Maintain septic system records of lake properties to monitor the age of systems and possible impacts to the lake
   - Encourage residents to properly maintain septic systems and holding tanks
   - Explore options for future waste treatment scenarios
6. **LAKE USE AND RECREATION**
   - Monitor crowding potential
   - Placement of buoys for boating safety
7. **INFORMATION AND EDUCATION**
   - Keep residents informed of PGOLID projects
   - Inform residents of new rules, regulations, legislation, and other changes

PGOLID PROGRAMS

WATER QUALITY PRESERVATION

SHORELAND INVENTORY	A shoreland inventory conducted in 2004 by Blue Water Science showed that 40% of properties had a strip of natural vegetation at least 15 feet deep on at least 50% of their shoreline.
SHORELINE HABITAT RESTORATION GRANT	PGOLID was awarded 3 different grants from the DNR to restore shorelines. Through this program we have completed 15 projects since 2009. This program is no longer offered through the DNR, so residents are now directed to the Otter Tail County Shoreline Specialist for shoreline projects.
TREE PROGRAM	In 2016, PGOLID implemented a tree planting program where residents can buy trees and have them planted along the shoreline.
RECOMMENDATIONS	Continue the voluntary tree program, converting to a free spring seedling distribution. Conserve undeveloped parcels to preserve water quality. Participate in local water planning and protection discussions including One Watershed One Plan activities, Soil & Water Conservation District Board Meetings, County Commissioner Meetings, Coalition of Lake Association meetings, and statewide lake group events.

LAKE MONITORING

BASELINE WATER QUALITY MONITORING	Collect water samples at designated lake sites once a month from May to September and evaluate for total phosphorus, chlorophyll a. Secchi disk monitoring once a month from May to September. Dissolved oxygen and temperature profiles taken once a month from May to September.
EXTRA WATER QUALITY MONITORING PROJECTS	In 2008-2010 hypolimnion water samples collected to evaluate internal phosphorus loading. In 2009-2010, additional water quality parameters collected including ortho-phosphorus, total nitrogen, chloride, alkalinity, color, conductivity, and total suspended solids. In 2007-2008, collected water samples in Echo Bay to evaluate conditions. In 2015-2016, collect water samples in Echo Bay to see if there are any changes since 2008.
SPECIAL LAKE PROJECTS	In 2004 lake sediment samples were taken from all four lakes to characterize the muck content and nutrient enrichment. Aquatic insect biomonitoring survey (2008) and zooplankton community monitoring (2015). Starting in 2020 and continuing to date nearshore (End of Dock) water quality samples have been taken to categorize the nutrient enrichment condition of the Pelican Group of Lakes. In 2021 lake sediment samples were taken from a portion of the 2004 sites as a repeat of that sampling. In 2022 an automated water level monitor was installed at the Pelican Yacht Club with a wireless link to the PGOLID website.
RECOMMENDATIONS	Repeat the lake sediment sampling to determine what changes have occurred in the past 15 years. Continue baseline monitoring, adding additional analyses that have become pertinent to lake health and water quality.

WATERSHED / STREAM MONITORING

BASELINE WATER QUALITY MONITORING	Collect water samples at designated stream inlets monthly (total phosphorus, total suspended solids, water flow, dissolved oxygen, temperature, conductivity), as well as additional samples after storm events (>1 inch rain).
EXTRA WATER QUALITY MONITORING PROJECTS	Collect extra water samples during spring thaw to track the snow melt runoff into streams. Collect E.coli samples at Bob Creek and Burton Lake Outlet during baseline monitoring and storm event monitoring to evaluate any health risks from upstream cattle operation. Deploy a flow data logger to establish a rating curve for Pelican River (2015-2016).
SPECIAL STREAM PROJECTS	Aquatic insect biomonitoring survey (2008). Intensive monitoring of the Spring Creek drainage started in 2021 and continues to date including additional analyses and varied sample timings monthly, seasonally, and post rain events.
RECOMMENDATIONS	Add additional monitoring of Spring Creek for Total and Dissolved Phosphorous to determine if the wetland sediments or legacy pollution are acting as a phosphorous source. Sites include Cormorant, Sherbrooke, below the pond past Sherbrooke (above Ida ditch), and inlet to Pelican Lake.

INVASIVE SPECIES PROJECTS

CHEMICAL TREATMENT OF INVASIVE PLANTS	PGOLID started a Curly-leaf pondweed (CLP) treatment program in 2005. This project has shown a great reduction in CLP and is an ongoing project.
MECHANICAL TREATMENT OF INVASIVE PLANTS	From 2007-present, flowering rush surveys are conducted from Buck's Mill to Little Pelican lake. Any flowering rush that is found is hand-pulled to limit growth. This project is ongoing, as flowering rush is continuing to spread down the Pelican River. From 2015-present, hand pulling of the flowering rush located in Bass Lake. This patch has continued to increase in size. Chemical treatment will be considered as options are identified.
SURVEYS	From 2006-present, inspect areas around public accesses for Eurasian watermilfoil. From 2015-present, inspect areas around public accesses for Starry Stonewort. The Coordinator and RMB Field Staff respond to and investigate resident's concerns and reports. Reports are made to the resident and PGOLID Board.
DNR & OTTER TAIL COUNTY WATERCRAFT INSPECTION PROGRAM	From 2006-present, PGOLID has participated in the Watercraft Inspection Program. This program inspects boats for invasive species and survey boaters entering and exiting the two Pelican Lake accesses.
ZEBRA MUSSEL MONITORING	Monitor Zebra mussel veliger density throughout the summer, 2012-2021. Monitor Zebra mussel adult density and distribution, 2013- 2015.
RECOMMENDATIONS	Develop and implement Rapid Response Plans for the eradication or control of potential invasive species. detection, assessment, decision for action, action implementation, and communications Continue all programs as currently designed.

MOSQUITO TREATMENT

MOSQUITO TREATMENT	PGOLID hires an independent contractor to treat the perimeter of the lake for mosquitoes weekly throughout the summer.
RECOMMENDATIONS	Continue program as designed.

AQUATIC PLANT PROJECTS

AQUATIC PLANT SURVEYS	In 2003, Blue Water Science was hired to survey aquatic plants in the PGOLID lakes. In 2010-2011, PGOLID completed a point intercept survey for all four lakes as a follow-up to the 2003 survey. In 2015, a point intercept plant survey was completed on Echo Bay to document the native plant community.
RECOMMENDATIONS	Complete an aquatic plant survey in 2023 to document changes in the plant community since the 2010-2011 MN DNR and PGOLID surveys that could be indicative of trophic changes in the Pelican Group of Lakes.

ON-SITE WASTE TREATMENT SYSTEMS

COUNTY RECORDS SURVEY, 2004	Obtained county records for on-site waste treatment systems and evaluated the status and age of systems.
VOLUNTEER SURVEY, 2006	Invited lake residents to volunteer for a screening of their on-site waste treatment system.
COUNTY INSPECTIONS AND ABATEMENTS	In 2007-2009, Otter Tail County inspected on-site waste treatment systems that were 20 years old or older. They abated the properties that did not meet requirements.
COUNTY RECORDS SURVEY, 2012	Obtained county records for on-site waste treatment systems and evaluated the status and age of systems. Compared to 2004 survey.
OUTREACH, 2013	Sent a letter to all residents with septic systems or holding tanks over 20 years old recommending they have it checked. Sent out an anonymous voluntary survey to homeowners asking about how they maintain their system, while educating them on proper maintenance.
RECOMMENDATIONS	Continue to education residents about waste treatment and water quality. Explore options for future waste treatment scenarios.

LAKE USE AND RECREATION

BUOY PROGRAM	PGOLID hires an independent contractor to install 42 buoys in the Pelican Group of Lakes to mark hazard areas, no wake zones, and channels.
RECOMMENDATIONS	Consider adding additional funding for post storm buoy repositioning.

INFORMATION AND EDUCATION

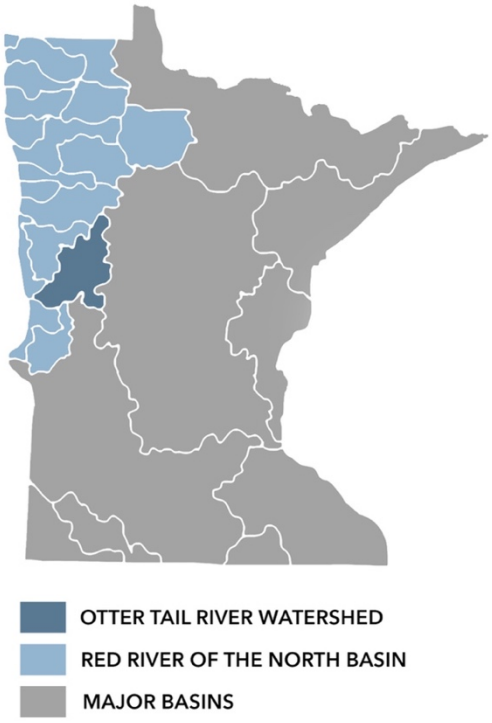
EDUCATIONAL SEMINARS AND PRESENTATIONS	Educational seminars for lake residents in the summer. Educational presentations at PGOLID and PLPOA meetings.
DISSEMINATION OF EDUCATIONAL INFORMATION	Articles in the Pelican Brief (Pelican Lake Property Owners Association [PLPOA] Newsletter). Refrigerator magnets with AIS prevention and boat safety messages were distributed in 2021.
NEW REGULATIONS	Keep abreast of new state/county/local government lake regulations and disseminate the information in an understandable way to PGOLID residents.
COMMUNITY	Work with upstream landowners, farmers, ranchers, and other lake associations to act in a proactive manner in the protection of the water quality that flows into the PGOLID.
RECOMMENDATIONS	Cultivate partnerships with potential local, regional, and statewide partners. Continue all programs as currently designed.

RECOMMENDATIONS SUMMARY

These recommendations were provided by the PGOLID Water Resource Coordinator after evaluating the status of past and present projects and the resulting data. These recommendations were written in August of 2022.

1. **WATER QUALITY PRESERVATION**
   Partner with local and upstream citizens, governments, and agencies to achieve the nutrient load reductions identified by the State of Minnesota in the Phosphorous Sensitivity Significance analysis. Implementing the projects identified in the Pelican Group of Lakes Clean Water Roadmap and Otter Tail River One Watershed One Plan.
2. **LAKE AND STREAM MONITORING**
   Repeat the lake sediment survey to document changing conditions. Intensively monitor Spring Creek for dissolved phosphorous to determine if the wetland sediments are acting as a legacy nutrient source. Continue current baseline lake and stream monitoring programs adding additional analyses such as chloride, conductivity, dissolved organic matter, and others that have become pertinent in lake health measurement. Add extra monitoring and special projects when deemed necessary by the PGOLID Water Resource Coordinator, PGOLID Data Analyst, and PGOLID Board.
3. **INVASIVE SPECIES**
   Continue all current programs including Curly-leaf pondweed treatment, Eurasian flowering rush surveys and removal, and Access AIS monitoring. Reinvigorate the public access inspection program by interacting with MN DNR and Otter Tail County AIS. Consider distributing materials to engage residents and visitors in lake preservation.
4. **INFORMATION AND EDUCATION**
   Continue current educational programs including articles for the website, educational seminars and presentations at meetings, communication with neighboring districts and landowners, and new regulation information. Promote smart responsible low-impact development practices. Utilize innovative outreach methods such as refrigerator magnets, direct mailing, yard signs, billboards, boat towels, and sponsorships.
5. **LAND CONSERVATION**
   Promote the conservation of all undeveloped land and limit the opportunities for future high-impact developments via conservation easements by partnering with groups like Minnesota Land Trust to obtain funding from the Lessard Outdoor Heritage Council established through the 2008 Legacy Amendment. Considerations include the potential for a future regional trail linking Detroit Lakes, Pelican Lakes, and Maplewood Park, future park areas, and areas for cluster treatment systems.
6. **AQUATIC PLANT SURVEYS**
   Complete a new aquatic plant survey every 10 years to monitor plant diversity and the presence of any new invasive species. The most recent aquatic plant surveys were in 2010 and 2011. An aquatic plant survey should be conducted in 2023.
7. **ON-SITE WASTE TREATMENT SYSTEMS**
   Continue educating PGOLID residents through various means including surveys, the Pelican Brief, and e-communications. Explore options for future waste management scenarios around the PGOLID lakes.

CHAPTER 2. WATERSHED CHARACTERISTICS

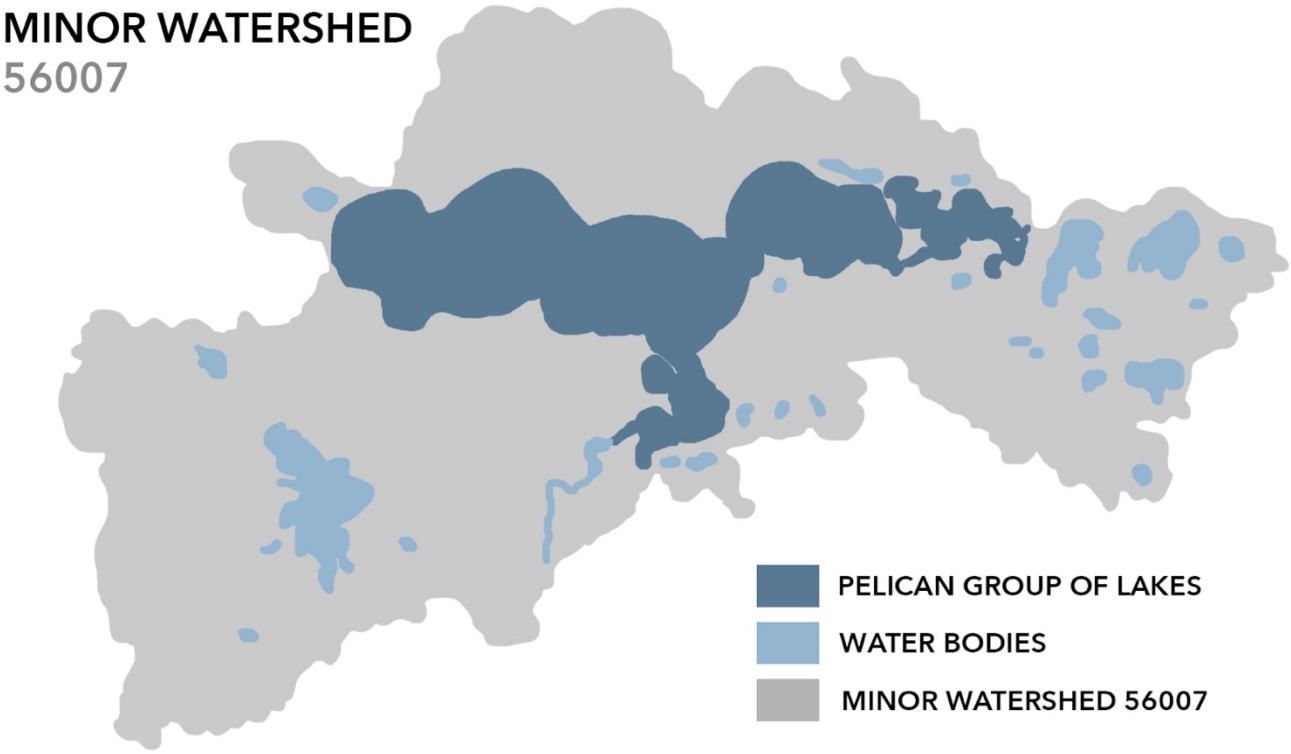


Understanding a watershed requires an understanding of basic hydrology. A watershed is the area of land that drains into a surface water body such as a stream, river, or lake and contributes to the recharge of groundwater. There are three categories of watersheds: 1) basins, 2) major watersheds, and 3) minor watersheds. This watershed hierarchy can be further subdivided into catchments, which are commonly referred to as lakesheds.

The Pelican Group of Lakes is located within the Red River of the North Basin, which includes the Otter Tail River Major Watershed as one of its twenty five major watersheds. The Otter Tail River Major Watershed consists of 108 minor watersheds.

The lakes are located in minor watershed 56007, falling within two catchments: catchment 5600702 includes Little Pelican Lake, and catchment 5600703 includes Pelican, Bass, and Fish lakes.

Land use and human activities in the watershed have direct impacts on water quality and ecosystem health. Conservation measures and best management practices in the watershed and on the lakeshore are necessary to ensure the maintenance of good water quality.

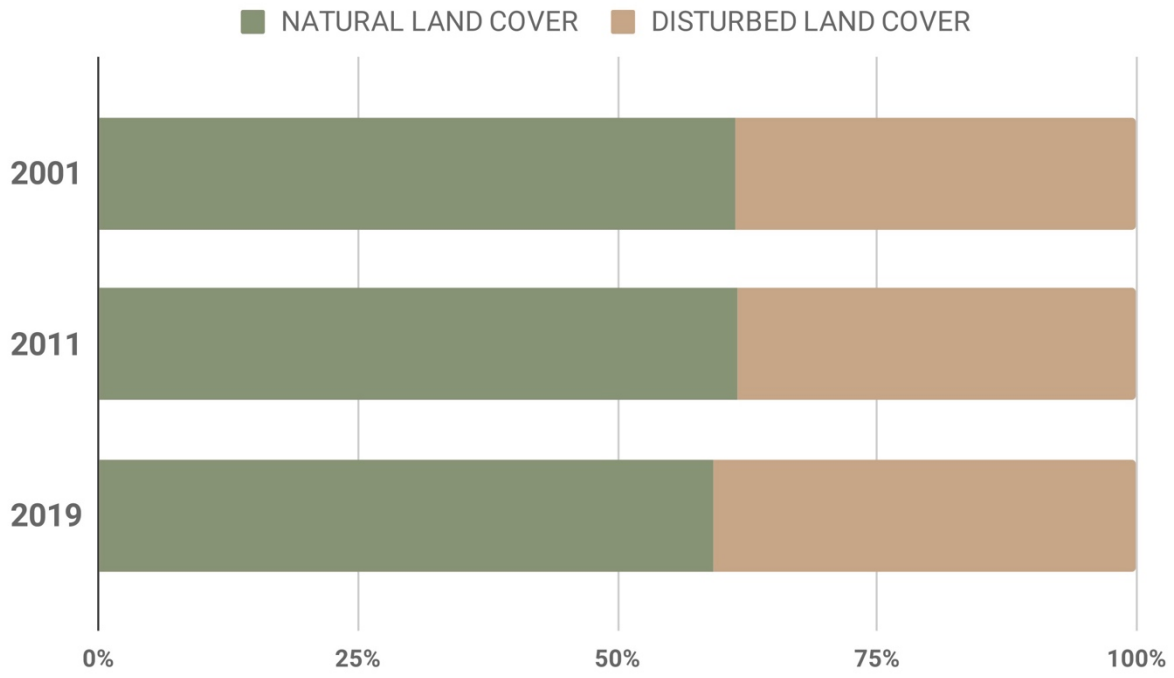


LAND COVER / LAND USE

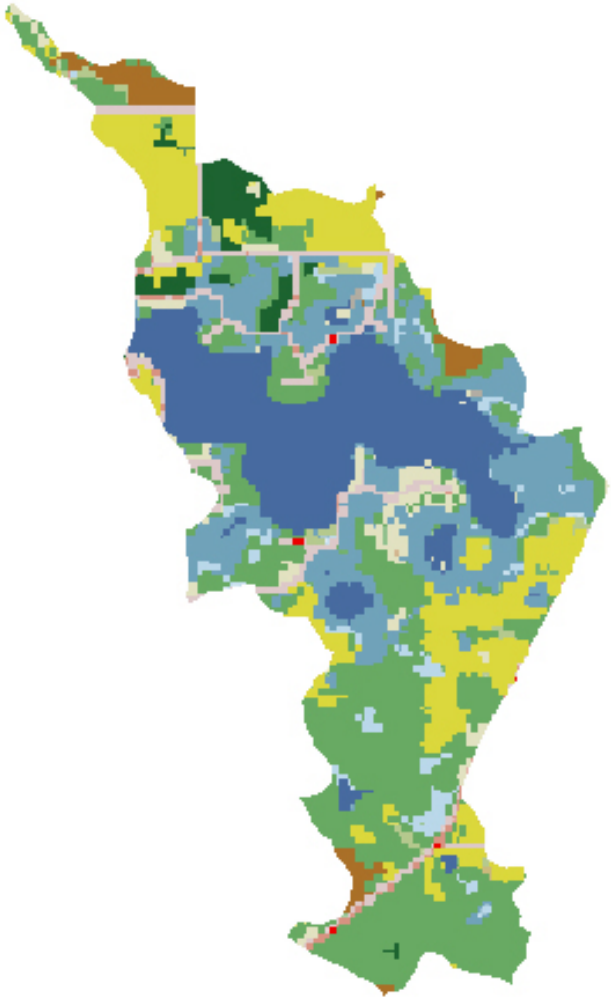
The activities that occur on the land within the lakeshed can greatly impact the lakes. Land use planning helps ensure the use of land resources in an organized fashion so that the needs of the present and future generations can be best addressed. The basic purpose of land use planning is to ensure that each area of land will be used in a manner that provides maximum benefits to humans without degradation of the land resource.

Changes in land use and land cover impact the hydrology of a lakeshed. Land cover is directly related to the lands ability to absorb and store water, rather than causing it to flow overland (gathering nutrients and sediments as it moves) towards the lowest point, which is typically the lake. Impervious intensity describes the lands inability to absorb water. The higher the percent impervious intensity, the more area that the water cannot absorb into the soils. Monitoring changes in land use can assist in future planning to address both the needs of people and the health of the lakeshed.

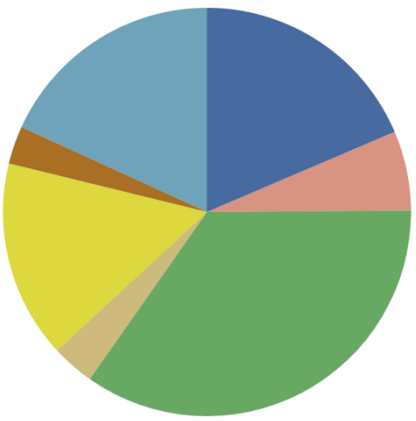
From 2001 – 2019, disturbed land cover in the PGOLID lakeshed has increased by 416 acres. Disturbed land cover includes land used for development and agriculture. When disturbed land cover increases, natural land cover decreases, resulting in increased nutrient and sediment loading into nearby lakes, streams, and wetlands. Forested land is a primary target for new development. Protecting forests and preserving natural land cover is critical for the maintenance of good water quality and ecosystem health in the PGOLID lakeshed.



LITTLE PELICAN LAKESHED 5600702

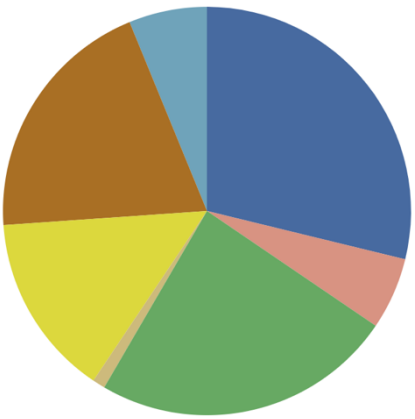


WATER	18.6%	0.55 miles^2
DEVELOPED	6.3%	0.18 miles^2
FOREST	34.9%	1.04 miles^2
SHRUB AND HERBACEUOUS	3.4%	0.10 miles^2
PASTURE AND HAY	15.7%	0.47 miles^2
CULTIVATED	3.0%	0.09 miles^2
WETLAND	18.2%	0.54 miles^2



PELICAN, BASS, & FISH LAKESHED 5600703

WATER	28.8%	7.11 miles^2
DEVELOPED	5.7%	1.41 miles^2
FOREST	23.9%	5.89 miles^2
SHRUB AND HERBACEUOUS	1.0%	0.24 miles^2
PASTURE AND HAY	14.5%	3.57 miles^2
CULTIVATED	19.9%	4.90 miles^2
WETLAND	6.2%	1.54 miles^2



LAKESHED WATER QUALITY PROTECTION STRATEGY

Each lakeshed has a different makeup of public and private lands. Looking in more detail at the makeup of these lands can provide insight on where to focus protection efforts. The protected lands (easements, wetlands, public land) are the future water quality infrastructure for the lake. Developed land and agriculture have the highest phosphorus runoff coefficients, so this land should be minimized for water quality protection.

LITTLE PELICAN LAKESHED 5600702

	PRIVATE (81.4%)					18.6%	**PUBLIC** (0%)		
	DEVELOPED	**AGRICULTURE**	**FORESTED UPLANDS**	**OTHER**	**WETLANDS**	**OPEN WATER**	**COUNTY**	**STATE**	**FEDERAL**
LAND USE (%)	6.3%	18.7%	34.9%	3.4%	18.2%	18.6%	0%	0%	0%
RUNOFF COEFFICIENT LBS OF PHOSPHORUS/ ACRE/YEAR	0.45 – 1.5	0.26 – 0.9	0.09		0.09		0.09	0.09	0.09
DESCRIPTION	Focused on Shoreland	Cropland	Focus of development and protection efforts	Open pasture, grass-land, shrub-land	Protected				
POTENTIAL PHASE 3 DISCUSSION ITEMS	Shoreline restoration	Restore wetlands, CRP	Forest stewardship planning		Protected by Wetland Conservation Act		County Tax Forfeit Lands	State Forest	National Forest

PELICAN, BASS, & FISH LAKESHED 5600703

	PRIVATE (71.2%)					28.8%	**PUBLIC** (0%)		
	DEVELOPED	**AGRICULTURE**	**FORESTED UPLANDS**	**OTHER**	**WETLANDS**	**OPEN WATER**	**COUNTY**	**STATE**	**FEDERAL**
LAND USE (%)	5.7%	34.4%	23.9%	1%	6.2%	28.8%	0%	0%	0%
RUNOFF COEFFICIENT LBS OF PHOSPHORUS/ ACRE/YEAR	0.45 – 1.5	0.26 – 0.9	0.09		0.09		0.09	0.09	0.09
DESCRIPTION	Focused on Shoreland	Cropland	Focus of development and protection efforts	Open pasture, grass-land, shrub-land	Protected				
POTENTIAL PHASE 3 DISCUSSION ITEMS	Shoreline restoration	Restore wetlands, CRP	Forest stewardship planning		Protected by Wetland Conservation Act		County Tax Forfeit Lands	State Forest	National Forest

RECOMMENDATIONS

CONSERVATION EASEMENTS

The charts on the previous page show that the lakesheds of Little Pelican, Pelican, Bass, and Fish lakes are mostly made up of private land. This means that the land is not protected from future development. Any undeveloped lots with lakeshore and those considered "second ring" development should be considered for conservation easements. With conservation easements, these lands would be protected from future development.

FORESTRY

Property owners who own large forested lots should consider forest stewardship planning. This planning will allow proper protection and management of the forested land. The DNR forestry program is available for private forest landowners including corporations whose stocks are not publicly traded and own between 20 – 1,000 acres of land. At least 20 acres of the land must have or will have trees. For more information, visit: https://www.dnr.state.mn.us/foreststewardship.

DEVELOPED LAND

In the developed area around the lake, the most significant impact to the lake comes from runoff from grass lawns and impervious surface. To minimize this runoff, trees, shrubs, and native vegetation should be planted along the shoreline. A secondary impact from developed land comes from improperly maintained septic systems. All septic systems should be inspected and maintained regularly to protect the lake from excess nutrients.

AGRICULTURE

Agricultural areas tend to have a high concentration of nutrients from fertilizers. Proper agricultural practices near lakes should minimize these impacts. Conservation practices could include Conservation Reserve Program land and wetland restoration. The local Soil and Water Conservation District can help with both of these practices.

LAKESHED VITALS	LITTLE PELICAN	PELICAN, BASS, & FISH
MILES OF SHORELINE	7.2	22.9
Miles of shoreline describes the distance around the lake shore. Lakes with more miles of shoreline have more area for potential shoreline impacts to occur.		
MILES OF STREAM	1.0	0.4
Streams provide valuable habitat for aquatic and riparian organisms including fish, aquatic invertebrates (insects, crayfish, mussels), waterfowl, muskrats, and otters. Small streams are also highly productive systems, owing to their relationships with adjacent upland habitats. On the other hand, streams are also major sources of nutrients and suspended solids to lakes. It is important that lake residents keep riparian areas natural with vegetated buffers in order to protect the lake and the stream.		
MILES OF ROAD	7.0	39.3
Roads are considered impervious surface; they fragment the landscape for wildlife habitat and lead to increased development.		
WATER RESIDENCE TIME	< 1 year	1.4 years
Water residence time is a measure of the average time a molecule of water spends in a reservoir. For lakes having longer residence times (a year or more), long-term average pollutant loadings become more important to overall lake water quality. Lakes that have a residence time of more than 5 years have a capacity of retaining about 60% of the phosphorus loading that occurs and is not lost via outflow. This characteristic requires that the longer the water residence time, the longer the time frame needed for in-lake observations to detect any response to loading reduction.		
MUNICIPALITIES	None	None
Municipalities adjacent to a lake are areas of dense population and impervious surface. Stormwater runoff from streets, parking lots, roofs and storm gutters can contribute nutrient and pollutant loading to a lake. In addition, road salt used in the winter can increase the salinity and conductivity in a lake.		
SEWAGE MANAGEMENT	Individual waste treatment systems (septic systems and holding tanks). County does lake wide inspections every 15 - 20 years.	
Properly maintained septic systems and holding tanks are effective in treating human waste. Education of property owners is the best way to get this message across in a positive manner.		
PUBLIC DRAINAGE DITCHES	None	None
Public drainage ditches can contribute nutrient enriched runoff to lakes during heavy rain events and spring thaw. Channelized streams or constructed ditches effectively increase the slope of the watershed and reduce the time it takes water to reach the lake.		
FORESTRY PRACTICES	None	None
Properly planned and managed forestry will have little impact on lake water quality; however, clear-cutting along a tributary or in the lakeshed can accelerate erosion and runoff.		
DEVELOPMENT CLASSIFICATION	Recreational Development	General Development
Recreational Development Lakes usually have between 60 and 225 acres of water per mile of shoreline, between 3 and 25 dwellings per mile of shoreline, and are more than 15 feet deep. General Development Lakes usually have more than 225 acres of water per mile of shoreline and 25 dwellings per mile of shoreline, and are more than 15 feet deep. These different classifications have different setback requirements.		

SHORELINE DEVELOPMENT INDEX	2.7	2.5

The shoreline development index is the ratio of the length of shoreline to the circumference of a circle with an area equal to the lake area. As the index value increases from 1, it indicates a more irregularly shaped shoreline. An index value of 1 is the smallest possible value and indicates a lake that is perfectly circular. Lakes with an index value of approximately 2 are more elliptical in form, while elongated or dendritic-shaped lakes can have values greater than 4. The shoreline development index is an important morphological parameter to consider because it can give an idea of a lake's susceptibility to the impacts of shoreline development. Lakes with high index values are more susceptible to the impacts of development because there is more shoreline to be developed compared to a more regularly shaped (round) lake with a similar surface area. (Wetzel 2001)

LAKESHED TO LAKE AREA RATIO	5.2 : 1	3.7 : 1

The lakeshed to lake area ratio shows how much land area drains into the lake compared to the size of the lake. If this ratio is greater than 2, the land has more potential impact on the lake.

PUBLIC LAND : PRIVATE LAND	0 : 1	0 : 1

Public land is protected, and therefore additional development cannot occur in those areas. Private land that is undeveloped has the potential to be developed unless there are wetlands present that are protected by the Wetland Conservation Act.

WETLAND COVERAGE	5%	3%

Wetland protection is a critical component for the long-term protection of water quality and recharge of groundwater. Historically, wetlands were drained for various land-use practices. Today, environmental awareness and increased stewardship has lead practices to restoration. All wetlands in the National Wetlands Inventory are protected by the Wetland Conservation Act and cannot be developed. The more land tied up in protected wetlands around a lake, the less development and impact there will be on the lake water quality. Wetlands in agricultural areas around the lake could be restored for better water storage in periods of high precipitation.

INVASIVE SPECIES	Zebra mussels, curly-leaf pondweed	Zebra mussels, curly-leaf pondweed

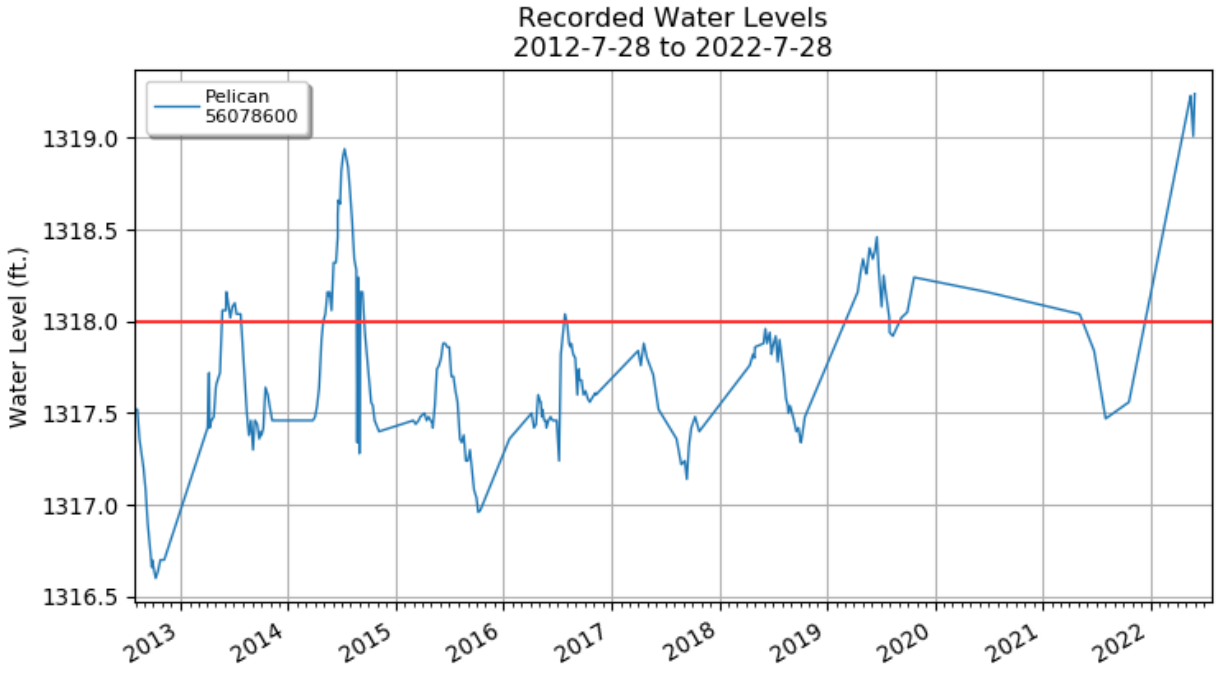
Curly-leaf pondweed is under control in the Pelican Group of Lakes by chemical herbicide application. Zebra mussels are a problem with no solution for removal.

LAKE WATER LEVEL REPORT

MN DNR: https://www.dnr.state.mn.us/lakefind/showlevel.html?downum=56078600

WATER LEVEL DATA

LAKE	Pelican - 56078600
PERIOD OF RECORD	03/24/1938 – 05/31/2022
NUMBER OF READINGS	1770
HIGHEST RECORDED	1319.72 ft (08/25/1993)
LOWEST RECORDED	1314.78 ft (03/24/1938)
RECORDED RANGE	4.94 ft
LAST READING	1319.24 ft (05/31/2022)
ORDINARY HIGH WATER LEVEL ELEVATION	1318 ft
DATUM	MSL 1912 (ft)



BENCHMARKS

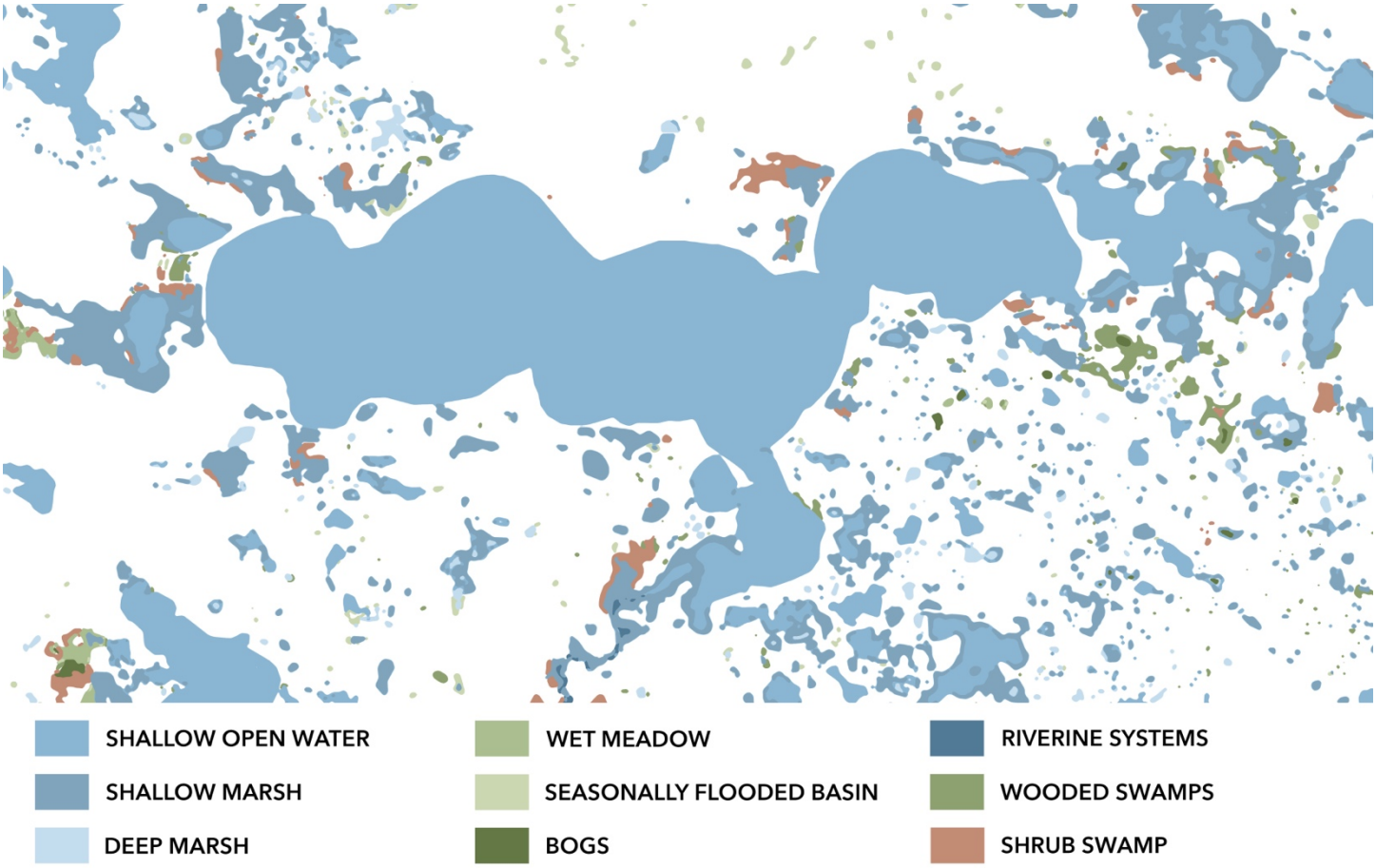
ELEVATION	1319.19 ft	**DATUM**	MSL 1912 (ft)	**DESCRIPTION:** Top left upstream corner of left abutment on "old dam" - also called "association dam" on Fish Lake (56-768).
DATE SET	01/07/1998	**LOCATION**	T137R42S17	
ELEVATION	1322.25 ft	**DATUM**	MSL 1912 (ft)	**DESCRIPTION:** Bent 60d spk in notched NW root of a 12" maple, 95' SE of Pelican Lk dam on Fish Lake (56-768).
DATE SET	07/28/1978	**LOCATION**	T137R42S20	
ELEVATION	1323.19 ft	**DATUM**	MSL 1912 (ft)	**DESCRIPTION:** Set bent 3/8" x 8" spike 0.9' above ground in west side of 1.1' maple, 132' S-SE of dam, 28' SE of mowed trail to dam on Fish Lake.
DATE SET	09/23/2009	**LOCATION**	T137R42S20	
ELEVATION	1327.76 ft	**DATUM**	MSL 1912 (ft)	**DESCRIPTION:** MHD disk in S end of E conc wheelguard of bridge for CSAH 31 crossing on narrows between Little Pelican and Pelican Lakes.
DATE SET	03/24/1976	**LOCATION**	T137R42S2	

WETLANDS

"Wetlands" is a broad term that describes marshes, swamps, bogs, and similar areas. There are many types of wetlands throughout Minnesota, each with their own unique characteristics. Wetlands are found in flat vegetated areas, in depressions on the landscape, and between water and dry land along streams, rivers, lakes, and coastlines.

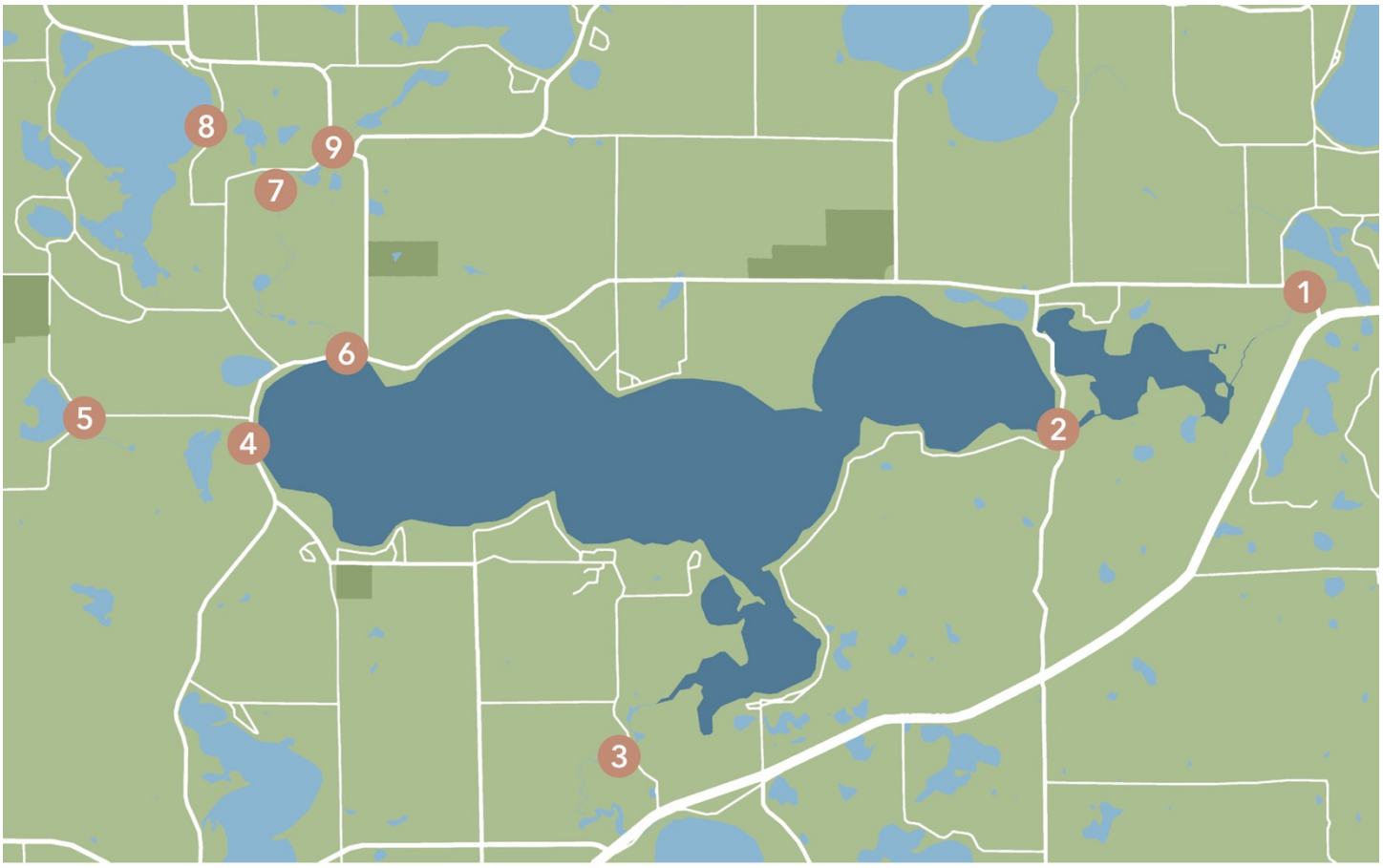
Wetlands prevent erosion by reducing wave damage on shorelines. They also slow and retain water from runoff, which helps maintain water levels and limit flooding. Some wetlands recharge groundwater, while others act as groundwater discharge areas. Wetlands protect the water quality of nearby lakes and streams by filtering pollutants. They provide habitat for wildlife, including rare and threatened species.

It's estimated that Minnesota has lost about 50 percent of its original wetland acreage. When wetland areas are filled in, essential water storage space is lost, which can cause lake levels to rise. Protecting and preserving these areas will help maintain water levels and water quality in the Pelican Group of Lakes.



CHAPTER 3. STREAM ASSESSMENTS

Streams and rivers have a direct impact on lake water quality. The Pelican Group of Lakes has 4 impacting streams, which are sampled in several locations to better pinpoint sources of pollution. PGOLID monitors 9 stream sites, as shown on the map below. Samples are collected on a monthly basis with additional monitoring following heavy precipitation. Sampling after a storm event provides a relation as to how the watershed's runoff is impacting water quality in a "worst case scenario." Storm event samples are included with other samples during data analysis to more accurately represent the true average.



1 HWY 20 CULVERT, PELICAN RIVER
S007-749

2 STROM'S BRIDGE, PELICAN RIVER
S007-750

3 PELICAN RIVER OUTLET
S007-751

4 BOB CREEK INLET
S007-752

5 BURTON LAKE OUTLET
S007-753

6 SPRING CREEK INLET
S007-754

7 SHERBROOKE ROAD, SPRING CREEK
S007-755

8 LAKE IDA OUTLET
S007-757

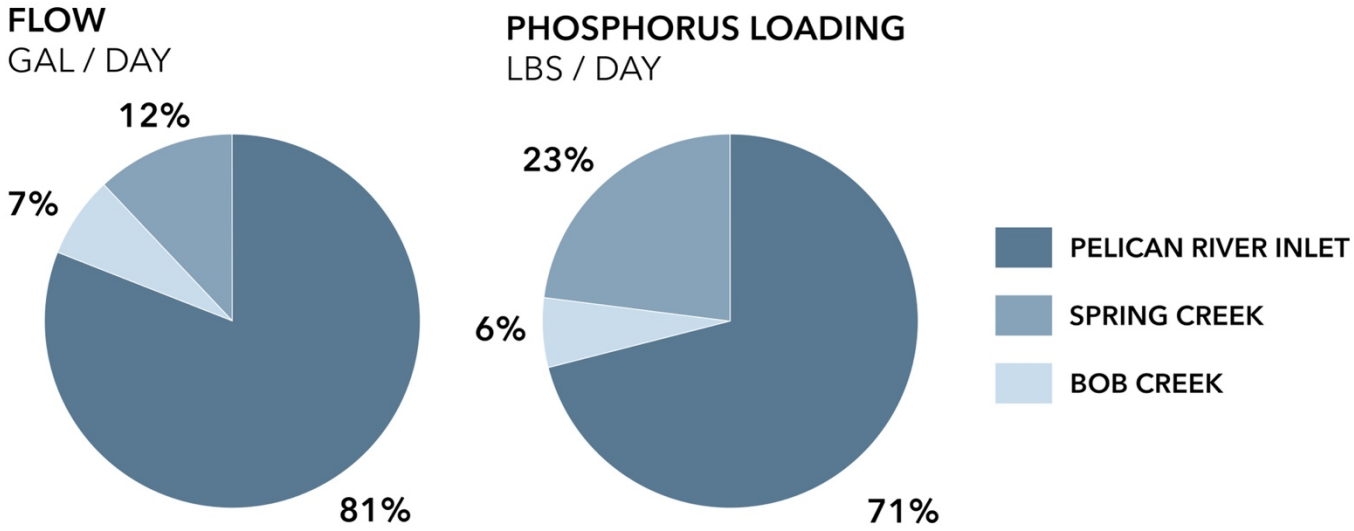
9 CORMORANT LAKE OUTLET
S009-521

FLOW & PHOSPHORUS LOADING HISTORICAL DATA

Total phosphorus loading is calculated by considering both the phosphorus concentration in the water and the volume of flow passing through a certain area. In streams, phosphorus loading is a better indicator for water quality than phosphorus concentration. A stream with high phosphorus concentration that is just a trickle of water could be depositing less phosphorus into a lake than a stream with low phosphorus concentration and high flow.

The combined flow from the inlets mirrors the outlet flow. This means that most of the water that is flowing into the PGOLID lakes is flowing back out as expected.

The combined phosphorus loading from the inlets mirrors the phosphorus loading at the outlet. As pulses of phosphorus enter the PGOLID lakes, much of that phosphorus exits back out of the system. A portion of the phosphorus stays in the lake and gets taken up by plants and algae. If all the phosphorus remained in the lake without flowing back out, it would contribute to increased algae concentration and aquatic plant growth.



In comparing the flow between the different inlets, the Pelican River accounts for the majority (81%) of the water flowing into the PGOLID lakes. It also accounts for the majority (71%) of the total phosphorus entering Pelican Lake. Despite only contributing to 12% of the water flow, Spring Creek is responsible for 23% of the daily phosphorus load into Pelican Lake. This could be due to land use and human activities upstream that increase nutrient runoff into Spring Creek.

INLET / OUTLET LOADING	AVERAGE ENTERING	AVERAGE EXITING
CHLOROPHYLL-A	3.03 lbs. / day	1.99 lbs. / day
TOTAL SUSPENDED SOLIDS	1188 lbs. / day	652 lbs. / day
FECAL COLIFORM BACTERIA	48,615 colonies / day	50,234 colonies / day
TOTAL PHOSPHORUS	13.63 lbs. / day	8.81 lbs. / day
ORTHO PHOSPHORUS	9.80 lbs. / day	7.91 lbs. / day
FLOW	63,644,236 GPD	66,628,510 GPD

CHAPTER 4. LAKE ASSESSMENTS

The Pelican Group of Lakes encompasses 4 lakes: Pelican, Little Pelican, Bass, and Fish. Although these lakes have somewhat different characteristics, they are all considered to have good water quality for northwest Minnesota.

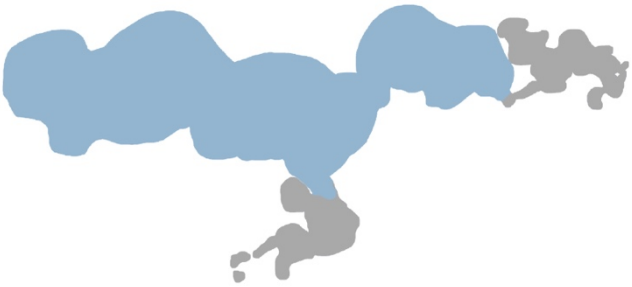
Little Pelican Lake is the first of the PGOLID lakes when considering water flow. The Pelican River drains into Little Pelican Lake on the northeast side and provides the majority of the phosphorus entering the lake. Little Pelican Lake is considered a shallow lake because the majority of the area of the lake is 15 feet deep or less, and it is ringed with emergent vegetation (bulrush, cattails, etc.). These characteristics explain why Little Pelican Lake has the highest phosphorus and lowest clarity of the PGOLID lakes. It is still considered a very healthy shallow lake, as the water quality and fishery characteristics are in the expected range for a lake of this size and depth.

Pelican, Bass, and Fish Lakes are all very similar in water quality and lake condition. In fact, they are all one large system of water. They are fairly deep (33-69 ft), have excellent fisheries, and are ideal for recreation. These characteristics make them a top tourist destination in northwest Minnesota. The Pelican River exits at the southwest end of Fish Lake.

These four lakes must be protected by preserving aquatic habitat and plants, restoring natural shoreline conditions, minimizing impervious surface, working with neighbors upstream of the Pelican River for good watershed management practices, proper maintenance of wastewater treatment systems, and education of lakeshore property owners.

PGOLID LAKE VITALS	PELICAN	LITTLE PELICAN	BASS	FISH
SURFACE AREA (ACRES)	3,961	366	51	293
MEAN DEPTH (FT)	22	10	18	27
LITTORAL AREA (%)	41%	70%	47%	43%
MAXIMUM DEPTH (FT)	55	25	33	69
VOLUME (ACRE-FT)	87,692	4,140	864	7,047
WATERSHED AREA (ACRES)	164,092	96,538	138	162,190
TROPHIC STATE INDEX (TSI)	42	50	43	40
TOTAL PHOSPHORUS MEAN (UG/L)	14.8	24.0	17.2	12.2
CHLOROPHYLL-A MEAN (UG/L)	3.5	8.1	4.1	2.6
CHLOROPHYLL-A MAXIMUM (UG/L)	13	31	17	8
SECCHI DEPTH MEAN (FT)	13.3	9.0	12.6	15.1

PELICAN LAKE 56-0786-00



Pelican Lake is the largest lake in the Pelican Group of Lakes. The Pelican River enters Pelican Lake on the east end, and Spring Creek and Bob Creek enter Pelican Lake on the west end. The Pelican River exits Pelican Lake to the south, flowing through Fish Lake until finally exiting the Pelican Group of Lakes.

Due to its size and opportunities for recreation, Pelican Lake is one of the most popular lakes for tourism in northwest Minnesota. Approximately half of the Pelican Lake visitors come from North Dakota.

In 2009, zebra mussels were found in Pelican Lake. Due to the size of the mussels and their distribution, it was concluded that they had probably been established in the lake for over a year before it was confirmed as an infested water body. Zebra mussels have changed the water quality dynamics in Pelican Lake. There is currently no treatment or fix for zebra mussels.

Current threats to Pelican Lake include changes in land use upstream from the inlets, removal of aquatic plants, unnatural shorelines and manicured lawns, new development that involves clearing vegetation, and large boat wakes in shallow areas of the lake. The west end of Pelican Lake is more susceptible to boat motor stirring because it is shallow.

Water quality data has been collected in Pelican Lake since 1997. Data shows that the lake is mesotrophic, with a mean TSI of 42.

LOCATION DATA

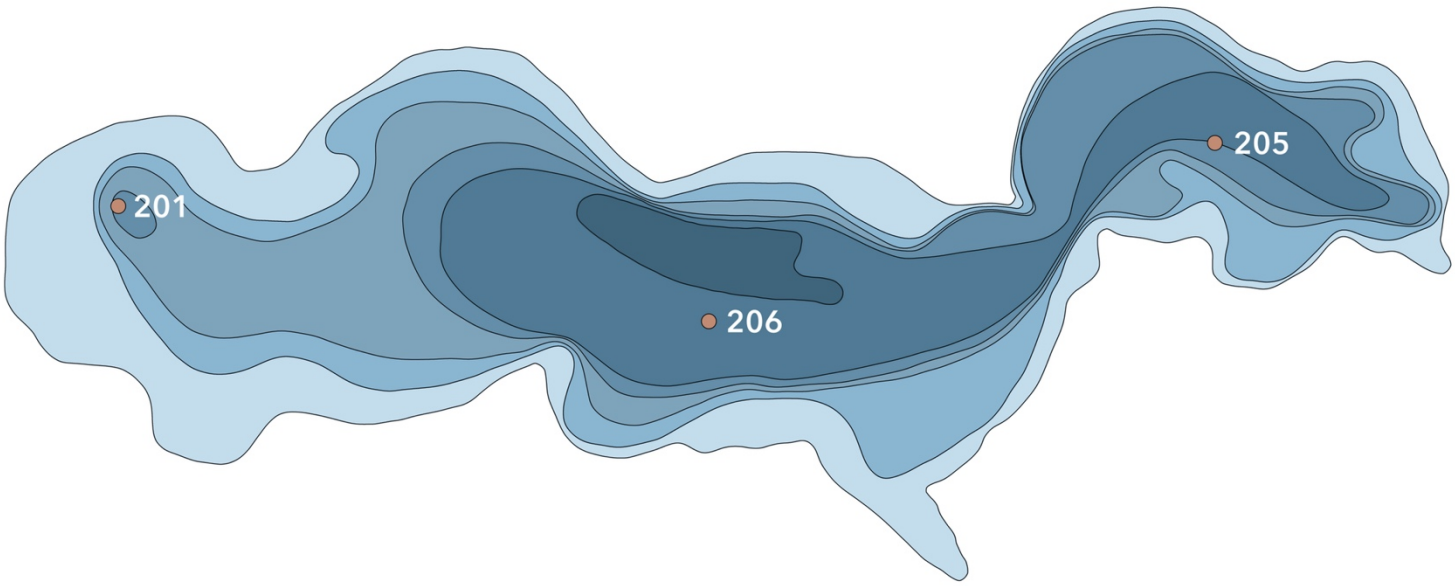
MN LAKE ID	56-0786-00
COUNTY	Otter Tail
ECOREGION	NCHF
MAJOR DRAINAGE BASIN	Red River
LATITUDE / LONGITUDE	46.7014 / -96.0281
WATER BODY TYPE	Public
PUBLIC ACCESSES	2
MONITORED SITES	206 (primary), 201, 205

PHYSICAL CHARACTERISTICS

SURFACE AREA	3,961 acres
% LITTORAL AREA	41%
MAX DEPTH	55 ft
MEAN DEPTH	22 ft
LAKESHED SIZE	15,783 acres
LAKESHED : LAKE AREA	4 : 1
INLETS	3
OUTLETS	1

DATA AVAILABILITY

TRANSPARENCY DATA	Data exists from the MPCA CLMP program from 1996 - 2002, and RMB Environmental Laboratories from 2003 - 2021.
CHEMICAL DATA	Data exists from RMB Environmental Laboratories from 2003 - 2021.
INLET / OUTLET DATA	The inlets and outlets have been monitored by RMB Environmental Laboratories from 2002 – 2021.


205
201
206

WATER QUALITY CHARACTERISTICS CHEMICAL DATA

The information below describes available chemical data for Pelican Lake from 2009 – 2021. Minnesota is divided into seven ecoregions based on land use, vegetation, precipitation, and geology. The MPCA has developed "average ranges" of water quality expected for lakes in each ecoregion. Pelican Lake is located in the North Central Hardwood Forest ecoregion.

PARAMETERS	MEAN	ECOREGION RANGE	INTERPRETATION
TOTAL PHOSPHORUS (UG/L)	14.8	23 – 50	Better Than Expected Range
CHLOROPHYLL-A (UG/L)	3.5	5 – 22	Better Than Expected Range
CHLOROPHYLL-A MAX (UG/L)	13	7 – 37	Within Expected Range
SECCHI DEPTH (FT)	13.3	4.9 – 10.5	Better Than Expected Range
DISSOLVED OXYGEN	N/A		Dissolved oxygen depth profiles show that the deep areas of the lake are anoxic in late summer.
CHLORIDE (MG/L)	17.9	4 – 10	Higher than the expected range, which is most likely caused by winter road salt.
TOTAL KJELDAHL NITROGEN (MG/L)	0.49	0.62 – 1.2	Indicates insufficient nitrogen to support summer nitrogen induced algae blooms.
ORTHO PHOSPHORUS (SURFACE, UG/L)	6.1	N/A	Indicates that all available ortho phosphorus is taken up by plants and algae living in the lake.
ALKALINITY (MG/L)	180	75 – 150	Indicates a low sensitivity to acid rain and a good buffering capacity.
COLOR (PT-CO UNITS)	6.5	10 – 20	Indicates very clear water with little to no tannins.
TOTAL SUSPENDED SOLIDS (MG/L)	1.6	2 - 6	Below the ecoregion expected range, indicating clear water.
SPECIFIC CONDUCTANCE	405	300 – 400	Slightly higher than ecoregion range, which could be due to increased salinity or temperature.
TOTAL NITROGEN : TOTAL PHOSPHORUS	34:1	25:1 – 35:1	The lake is phosphorus limited, which means that algae growth is limited by the amount of phosphorus within the lake.

WATER QUALITY CHARACTERISTICS HISTORICAL MEANS & RANGES

TOTAL PHOSPHORUS (UG/L)	SITE 201	SITE 205	SITE 206*
RANGE (MIN – MAX)	6 - 35	6 - 39	5 - 37
NUMBER OF OBSERVATIONS	91	93	93
MEAN	13.6	15.9	14

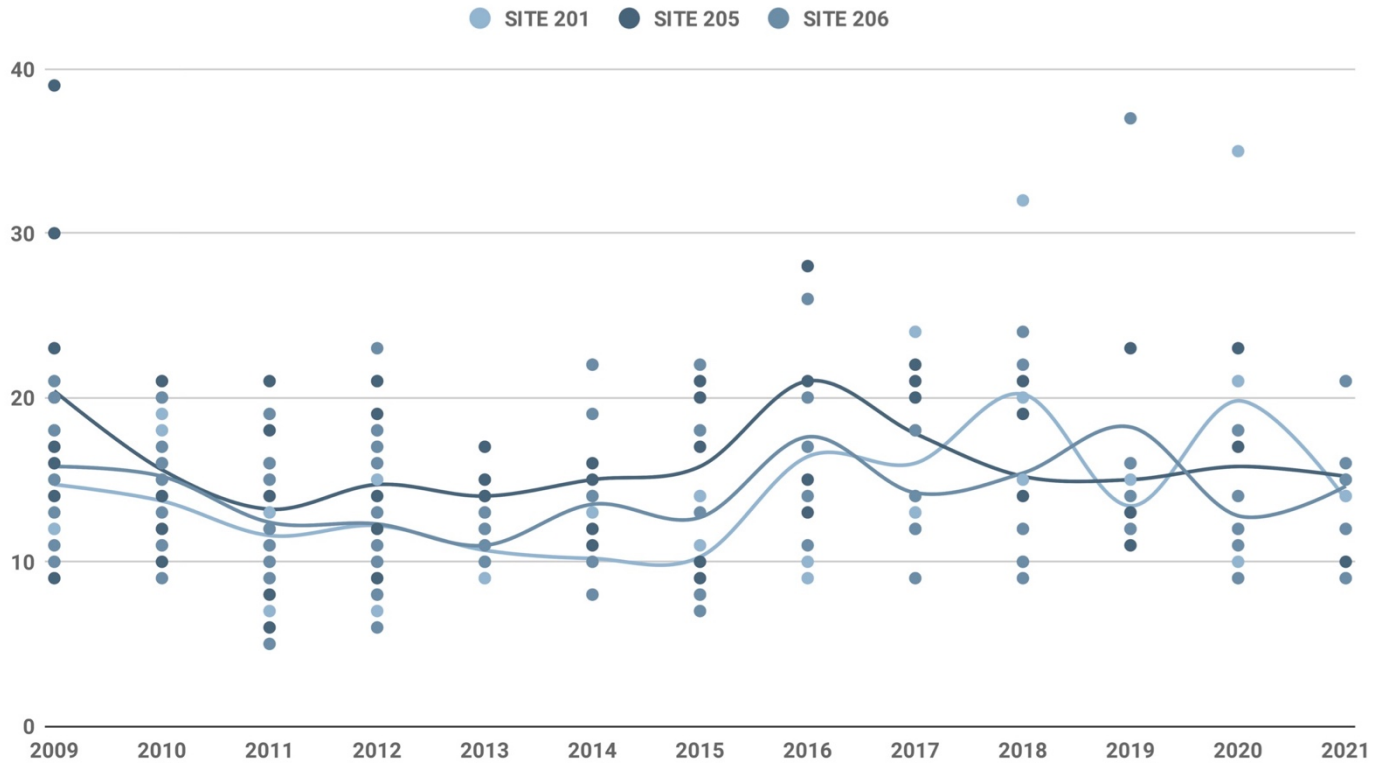
CHLOROPHYLL-A (UG/L)	SITE 201	SITE 205	SITE 206*
RANGE (MIN – MAX)	< 1 - 11	< 1 - 13	< 1 - 10
NUMBER OF OBSERVATIONS	91	93	92
MEAN	3.1	4.1	3.4

SECCHI DEPTH (FT)	SITE 201	SITE 205	SITE 206*
RANGE (MIN – MAX)	3.9 – 32.2	5.5 – 29.5	6.5 – 36.1
NUMBER OF OBSERVATIONS	159	285	232
MEAN	14.1	12.8	13.8

** Figures are based on primary site 206.*

TOTAL PHOSPHORUS (UG/L)

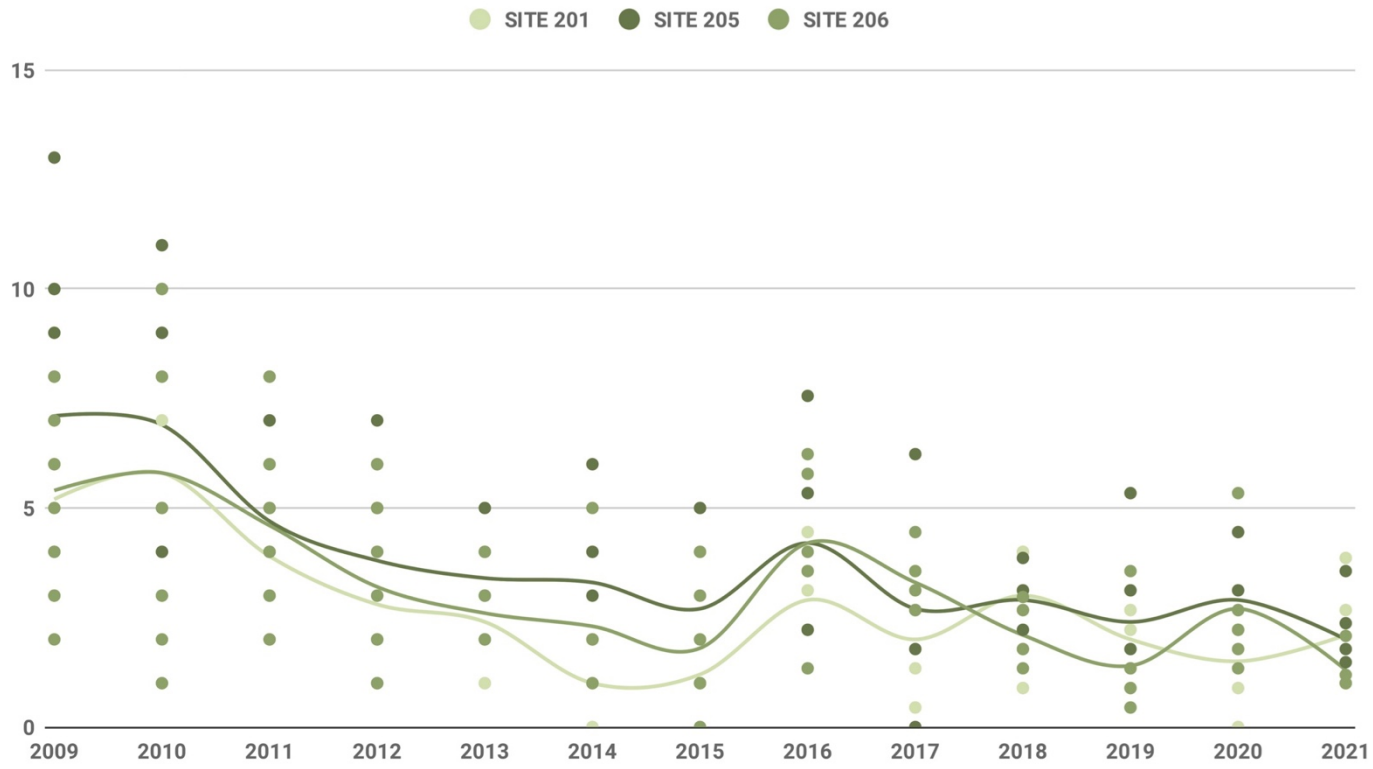
Phosphorus is a nutrient that plays an important role in plant growth. Total phosphorous is a "cause" parameter: when phosphorus increases, algae concentration increases and transparency decreases. Pelican Lake is phosphorus limited, which means that the growth of algae and aquatic plants is dependent upon available phosphorus. Lower phosphorus levels are generally associated with better water quality.



Total phosphorus has been evaluated in Pelican Lake since 2003. The graph contains data for sites 201, 205, and 206 from 2009 – 2021. The moving trend line represents the annual summer means for each site. Total phosphorus levels are highest at site 205 and lowest at site 201. This trend aligns with the chlorophyll-a results, as phosphorus fuels the growth of algae. Bob Creek and Spring Creek are responsible for most of the phosphorus loading into Pelican Lake.

CHLOROPHYLL-A (UG/L)

Chlorophyll-a is the pigment that makes plants and algae green. Chlorophyll-a is tested in lakes to determine the algae concentration or how "green" the water is. Concentrations greater than 10 ug/L are perceived as a mild algae bloom, while concentrations greater than 20 ug/L are perceived as a nuisance.



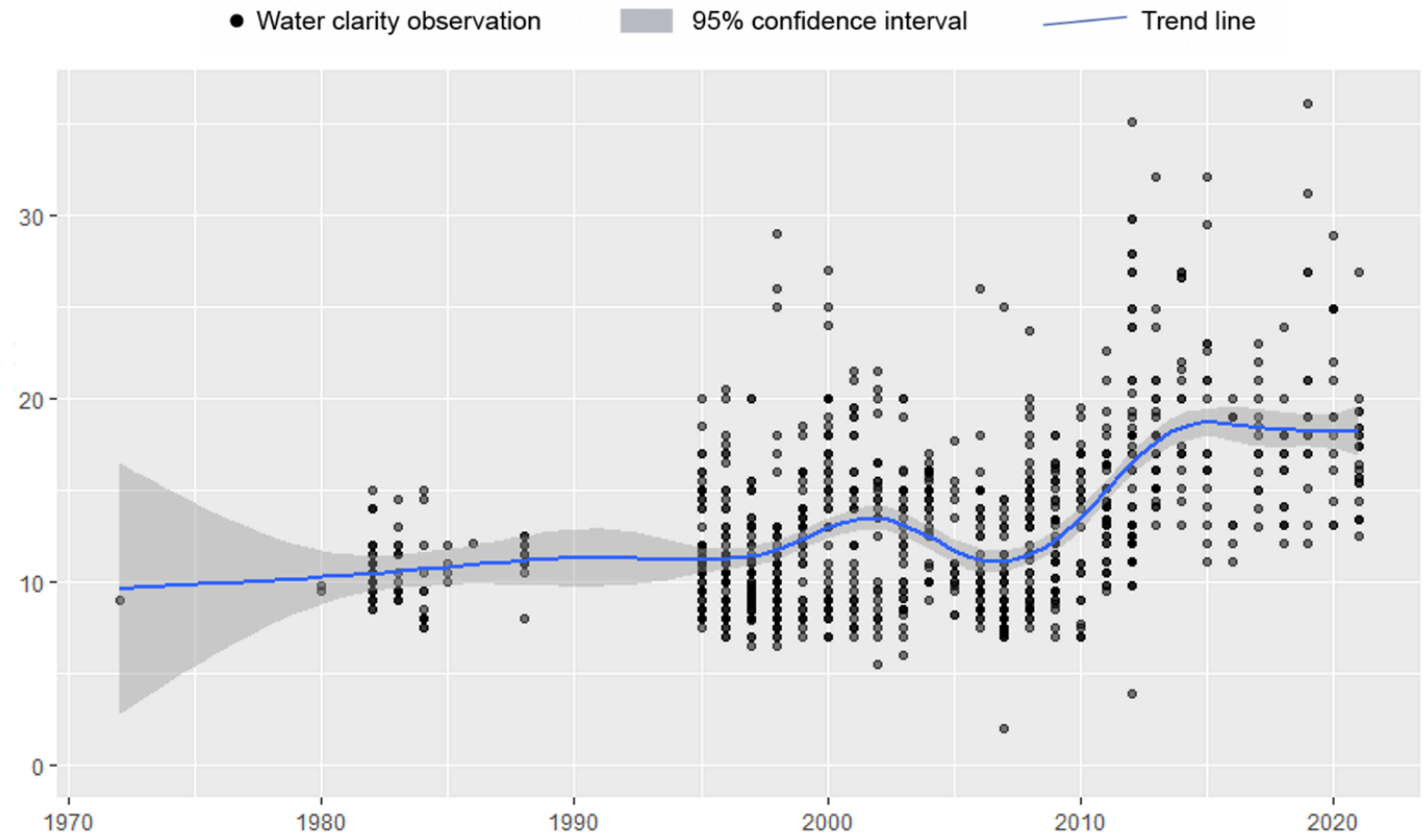
Chlorophyll-a has been evaluated in Pelican Lake since 2003. The graph contains data for sites 201, 205, and 206 from 2009 – 2021. The moving trend line represents the annual summer means for each site. Chlorophyll-a concentrations are highest at site 205 and lowest at site 201. This trend aligns with the total phosphorus results, as phosphorus fuels the growth of algae. Algae presence tends to increase throughout the summer, peaking in mid to late August. Chlorophyll-a concentrations have not exceeded the mild algae bloom threshold of 10 ug/L since 2010.

SECCHI DEPTH (FT)

Transparency is how easily light can pass through a substance. In lakes, it is how deep sunlight penetrates through the water. Plants and algae need sunlight to grow, so they are only able to grow in areas of the lake with adequate transparency. Water transparency depends on the amount of particles in the water. An increase in particulates results in a decrease in transparency. In lakes, transparency is measured using a Secchi disk.

Transparency varies from year to year due to changes in weather, precipitation, lake use, flooding, temperature, lake levels, etc. Secchi depth has been monitored consistently in Pelican Lake since 1996. The historical mean from 2009 – 2021 is 13.8 feet.

Pelican Lake transparency ranges from 6 to 36 feet throughout the summer. Transparency is highest in May and declines throughout the summer. After the lake turns over in September, the transparency improves in October. This pattern is typical for a lake of this depth in Minnesota. The transparency dynamics are related to lake turnover and seasonal variation of algae concentrations.



This figure show water clarity over time on this lake. The trend analysis was performed with a Seasonal Mann Kendall test. This statistical test detects changes in water clarity over time by comparing months across years (example - Mays are compared to Mays, Junes to Junes, etc.). For lakes with enough data, the figures include a trend line, which shows the direction of detected changes in water clarity. The gray area around the trend line represents the range where the actual clarity measure will fall with 95% certainty.

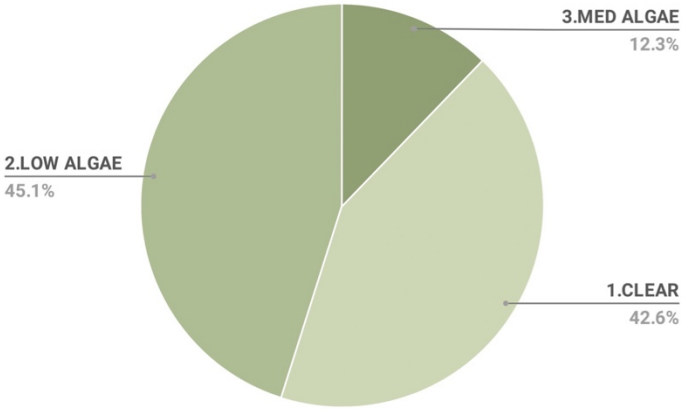
For years 1972 to 2021 there is evidence of improving water clarity at this lake, of approximately 1.9 feet per decade. For the most recent year of the analysis, median water clarity was 3.12 feet higher than the watershed median.

GRAPH SOURCE: *MINNESOTA POLLUTION CONTROL AGENCY*
https://webapp.pca.state.mn.us/surface-water/impairment/56-0786-00

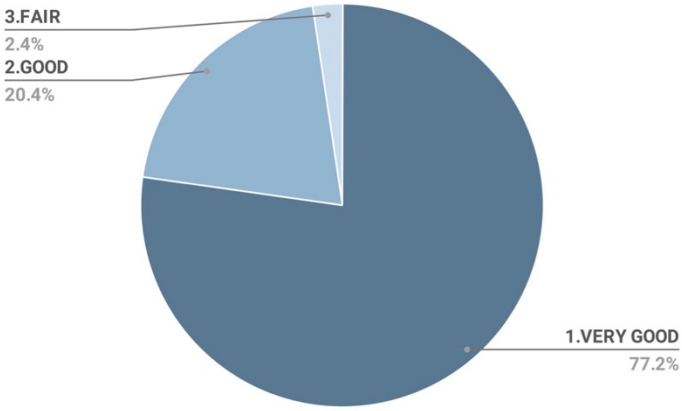
USER PERCEPTION RATINGS

When Secchi depth readings are collected, perceptions of the water based on the physical appearance and recreational suitability are recorded. These perceptions can be compared to water quality parameters to see how the lake "user" would experience the lake at that time.

PHYSICAL CONDITION



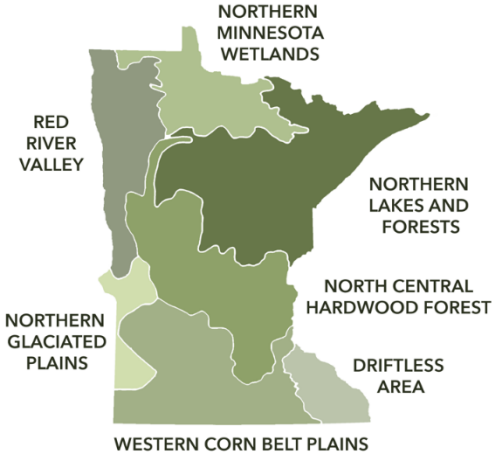
RECREATIONAL SUITABILITY



As the Secchi depth decreases, the perception of the lake's physical appearance decreases. Pelican Lake was rated as "clear" 42.6% of the time from 1995 – 2021.

As the Secchi depth decreases, the perception of the lake's recreational suitability also decreases. Pelican Lake was rated as "very good" 77.2% of the time from 1995 – 2021.

ECOREGION COMPARISONS NORTH CENTRAL HARDWOOD FOREST



Minnesota is divided into seven ecoregions. An ecoregion is a geographical area where the land use, underlying geology, native plant community, and soils are relatively similar. Pelican Lake is located in the North Central Hardwood Forest ecoregion, which is an area of transition between the forested areas to the north and east and the agricultural areas to the south and west. Lakes in the North Central Hardwood Forest ecoregion tend to have moderate nutrient levels and water clarity. Pelican Lake is better than the ecoregion expected ranges for all three parameters.

TOTAL PHOSPHORUS (UG/L)	23 – 50 ug/L	Better Than Expected Range
CHLOROPHYLL-A (UG/L)	5 – 22 ug/L	Better Than Expected Range
SECCHI DEPTH (FT)	5 – 10.5 ft	Better Than Expected Range

TROPHIC STATE INDEX (TSI)

Total phosphorus, chlorophyll-a, and Secchi depth are related parameters. As phosphorus increases, there are more nutrients available to fuel algae growth, resulting in increased chlorophyll-a concentrations. When chlorophyll-a concentrations increase, the water becomes less transparent, so the Secchi depth decreases.

The results from these three parameters cover different units and ranges, and thus cannot be directly compared to each other. In order to standardize these measurements to make them comparable, they are converted to a trophic state index (TSI). Trophic state index is a standard measure for calculating the trophic status or productivity of a lake.

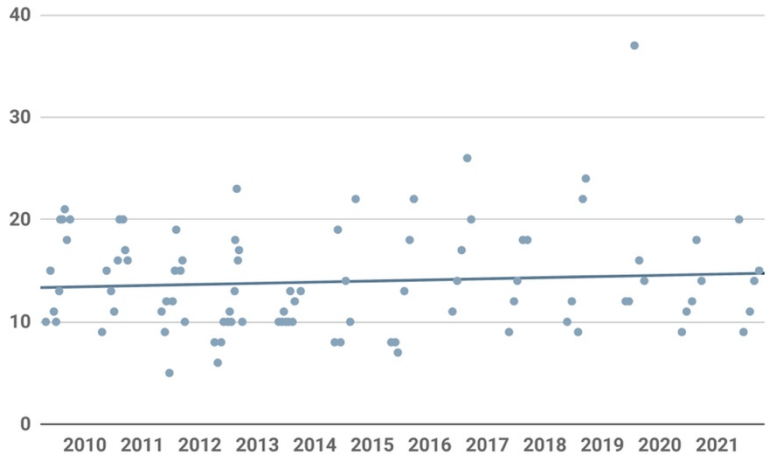
EUTROPHICATION

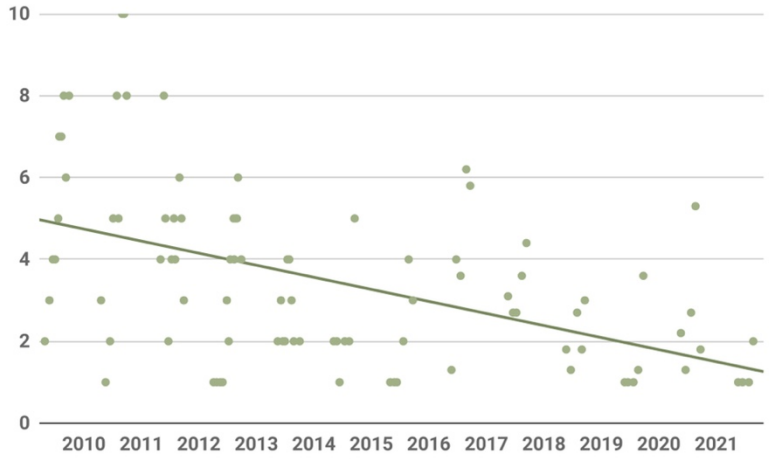
TSI	ATTRIBUTES	FISHERIES & RECREATION
< 30	**OLIGOTROPHIC:** Clear water, oxygen throughout the year at the bottom of the lake, very deep cold water.	Trout fisheries dominate.
30 - 40	Bottom of shallower lakes may become anoxic (no oxygen).	Trout fisheries in deep lakes only. Walleye, Tullibee present.
40 - 50	**MESOTROPHIC:** Water moderately clear most of the summer. May be "greener" in late summer.	No oxygen at the bottom of the lake results in loss of trout. Walleye may predominate.
50 - 60	**EUTROPHIC:** Algae and aquatic plant problems possible. "Green" water most of the year.	Warm-water fisheries only. Bass may dominate.
60 - 70	Blue-green algae dominate, algal scums and aquatic plant problems.	Dense algae and aquatic plants. Low water clarity may discourage swimming and boating.
70 - 80	**HYPEREUTROPHIC:** Dense algae and aquatic plants.	Water is not suitable for recreation.
> 80	Algal scums, few aquatic plants.	Rough fish (carp) dominate; summer fish kills possible.

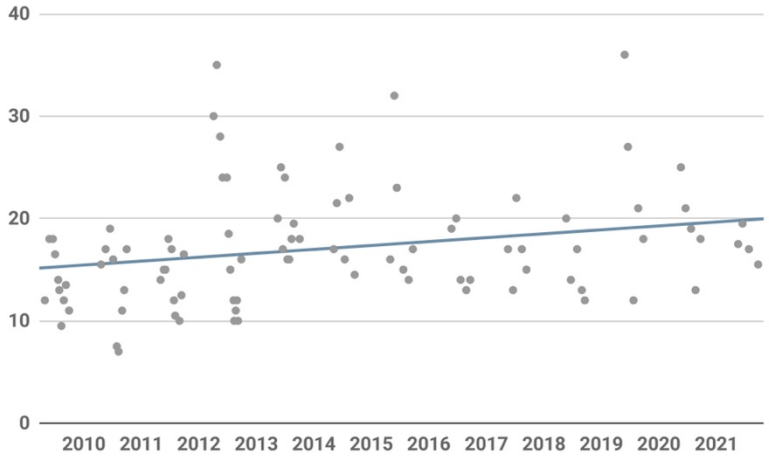
Pelican Lake is a mesotrophic lake with a mean TSI of 42. Mesotrophic lakes have moderate nutrient levels (phosphorus and nitrogen) and good clarity (Secchi depth), with some algal blooms in late summer.

TREND ANALYSIS

For detecting trends, a minimum of 8-10 years of data with four or more readings per season are recommended by the MPCA. Where data does not cover at least eight years or where there are only few samples within a year, trends can be misidentified because there can be different wet years and dry years, water levels, weather, etc., that affect the water quality naturally. The data was analyzed using the Mann Kendall Trend Analysis.







TOTAL PHOSPHORUS (UG/L)

Phosphorus is a nutrient that plays an important role in plant growth. Higher phosphorus concentrations are associated with increased growth of aquatic plants and algae. Total phosphorous is a "cause" parameter: when phosphorus increases, algae concentration increases and transparency decreases. An improving trend for total phosphorus means that the phosphorus levels are decreasing.

From 2009 – 2021, no significant trend exists for total phosphorus in Pelican Lake.

CHLOROPHYLL-A (UG/L)

Chlorophyll-a is the pigment that makes plants and algae green. Chlorophyll-a is tested in lakes to determine the algae concentration, or how "green" the water is. Concentrations greater than 10 ug/L are perceived as a mild algae bloom, while concentrations greater than 20 ug/L are perceived as a nuisance. An improving trend for chlorophyll-a means that the chlorophyll-a concentration is decreasing.

From 2009 – 2021, there is evidence of an improving trend with 99.9% confidence for chlorophyll-a in Pelican Lake.

SECCHI DEPTH (FT)

Transparency is how easily light can pass through a substance. Lake transparency is measured using a Secchi disk. An increase in particles in the water results in a decrease in transparency. An improving trend for Secchi depth means that the Secchi depth is increasing. However, increased transparency is not necessarily positive if it is caused by zebra mussels filtering the water column and redepositing nutrients on the lake bottom.

From 2009 – 2021, there is evidence of an improving trend with 95% confidence for Secchi depth in Pelican Lake.

STATE ASSESSMENTS

MPCA WATER QUALITY ASSESSMENTS

BENEFICIAL USE	ASSESSMENT YEAR	ASSESSED CONDITION	IMPAIRMENT CAUSE
Aquatic Consumption	1998	Impaired and one or more TMDLs approved	Mercury in fish tissue
Aquatic Life	2018	Standards Met for All Assessed Parameters	
Aquatic Recreation	2018	Standards Met for All Assessed Parameters	

MPCA WATER QUALITY STANDARDS

Water quality standards:

- Protect water resources for uses such as fishing, swimming and other recreation, and sustaining fish, bugs, plants, and other aquatic life
- Are a measure to identify polluted waters or healthy waters in need of protection
- Guide the limits set on what regulated facilities can discharge to surface water

The federal Clean Water Act requires states to designate beneficial uses for all waters and develop water quality standards to protect each use. Water quality standards consist of several parts:

- Beneficial uses – Identify how people, aquatic communities, and wildlife use our waters
- Numeric standards – Amounts of specific pollutants allowed in a body of water and still protects it for the beneficial uses
- Narrative standards – Statements of unacceptable conditions in and on the water
- Antidegradation protections – Extra protection for high-quality or unique waters and existing uses

Together, the beneficial uses, numeric and narrative standards, and antidegradation protections provide the framework for achieving Clean Water Act goals. The Clean Water Act specifies healthy aquatic life and recreation as beneficial uses. Others that are protected in Minnesota's rules are:

- Drinking water
- Industrial and agricultural uses
- Wildlife
- Navigation
- Aesthetic enjoyment

More information on water quality standards:
https://www.pca.state.mn.us/water/water-quality-standards

More information on monitoring and assessment:
https://www.pca.state.mn.us/water/water-monitoring-and-assessment

LITTLE PELICAN LAKE 56-0761-00

Little Pelican Lake is the first lake when it comes to water flow in the Pelican Group of Lakes. The Pelican River flows into Little Pelican on the east side and exits on the south central side.

Little Pelican Lake is considered a shallow lake, meaning the majority of its area is less than 15 feet deep. Shallow lakes provide some of the most important wildlife habitat. Aquatic plants in and around the lake are home to nearly all aquatic animals such as waterfowl, muskrats, otters, fish, insects, frogs, and turtles. These lakes are also important resting areas for migrating waterfowl. A healthy shallow lake has clear water and dense aquatic plant growth. Many shallow lakes, such as Little Pelican, have large stands of bulrush and/or wild rice. The plants in these shallow lakes hold a lot of the nutrients in their tissues so less algae growth occurs, and they produce oxygen throughout the water as a byproduct of photosynthesis. These plants also keep the sediments stable at the bottom of the lake.

Current threats to Little Pelican Lake include the removal of aquatic plants, unnatural shorelines and manicured lawns, new development that involves clearing vegetation, and large boat wakes in shallow areas.

Water quality data has been collected in Little Pelican Lake since 1997. Data shows that the lake is meso-eutrophic, with a mean TSI of 50.

LOCATION DATA

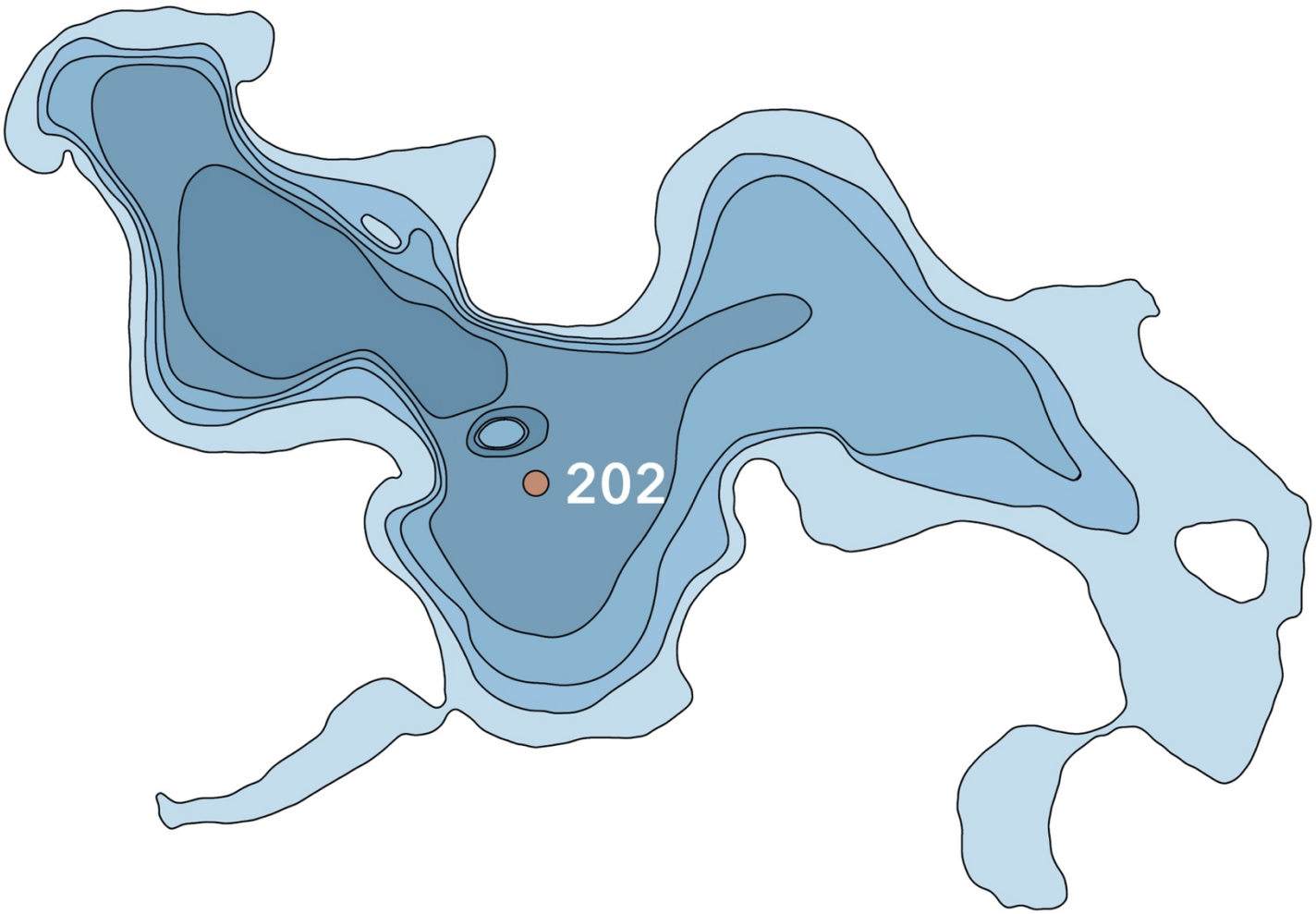
MN LAKE ID	56-0761-00
COUNTY	Otter Tail
ECOREGION	NCHF
MAJOR DRAINAGE BASIN	Red River
LATITUDE / LONGITUDE	46.7084 / -96.9495
WATER BODY TYPE	Public
PUBLIC ACCESSES	1
MONITORED SITES	202

PHYSICAL CHARACTERISTICS

SURFACE AREA	366 acres
% LITTORAL AREA	70%
MAX DEPTH	25 ft
MEAN DEPTH	10 ft
LAKESHED SIZE	1,899 acres
LAKESHED : LAKE AREA	5.5 : 1
INLETS	1
OUTLETS	1

DATA AVAILABILITY

TRANSPARENCY DATA	Data exists from the MPCA CLMP program from 1997 - 2002, and RMB Environmental Laboratories from 2003 - 2021.
CHEMICAL DATA	Data exists from RMB Environmental Laboratories from 2003 - 2021.
INLET / OUTLET DATA	The inlets and outlets have been monitored by RMB Environmental Laboratories from 2002 – 2021.

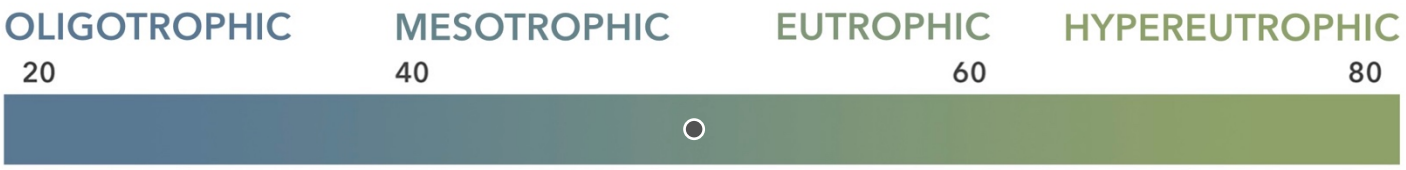

202

WATER QUALITY CHARACTERISTICS CHEMICAL DATA

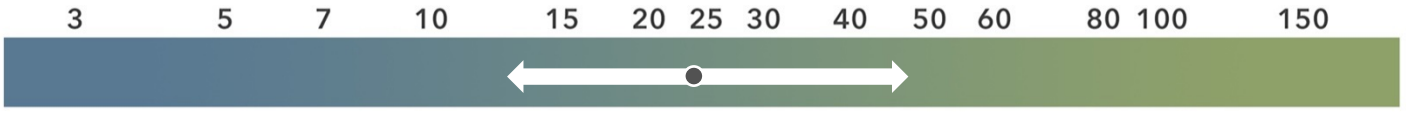
The information below describes available chemical data for Little Pelican Lake from 2009 – 2021. Minnesota is divided into seven ecoregions based on land use, vegetation, precipitation, and geology. The MPCA has developed "average ranges" of water quality expected for lakes in each ecoregion. Little Pelican Lake is located in the North Central Hardwood Forest ecoregion.

PARAMETERS	MEAN	ECOREGION RANGE	INTERPRETATION
TOTAL PHOSPHORUS (UG/L)	24	23 – 50	Within Expected Range
CHLOROPHYLL-A (UG/L)	8.1	5 – 22	Within Expected Range
CHLOROPHYLL-A MAX (UG/L)	31	7 – 37	Within Expected Range
SECCHI DEPTH (FT)	9	4.9 – 10.5	Within Expected Range
DISSOLVED OXYGEN	N/A		Dissolved oxygen depth profiles show that the lake mixes throughout most of the summer.
CHLORIDE (MG/L)	23.1	4 – 10	Higher than the expected range, which is most likely caused by winter road salt.
TOTAL KJELDAHL NITROGEN (MG/L)	0.64	0.62 – 1.2	Indicates insufficient nitrogen to support summer nitrogen induced algae blooms.
ORTHO PHOSPHORUS (SURFACE, UG/L)	5.6	N/A	Indicates that all available ortho phosphorus is taken up by plants and algae living in the lake.
ALKALINITY (MG/L)	182	75 – 150	Indicates a low sensitivity to acid rain and a good buffering capacity.
COLOR (PT-CO UNITS)	12.7	10 – 20	Indicates moderately clear water with little to no tannins.
TOTAL SUSPENDED SOLIDS (MG/L)	2.8	2 - 6	Within the ecoregion expected range, indicating mostly clear water.
SPECIFIC CONDUCTANCE	413	300 – 400	Slightly higher than ecoregion range, which could be due to increased salinity or temperature.
TOTAL NITROGEN : TOTAL PHOSPHORUS	26:1	25:1 – 35:1	The lake is phosphorus limited, which means that algae growth is limited by the amount of phosphorus within the lake.

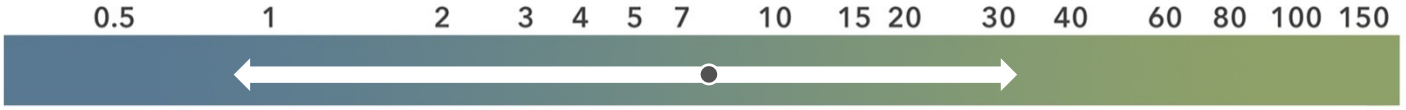
WATER QUALITY CHARACTERISTICS HISTORICAL MEANS & RANGES



TOTAL PHOSPHORUS (UG/L)	SITE 202
RANGE (MIN – MAX)	14 - 48
NUMBER OF OBSERVATIONS	93
MEAN	24



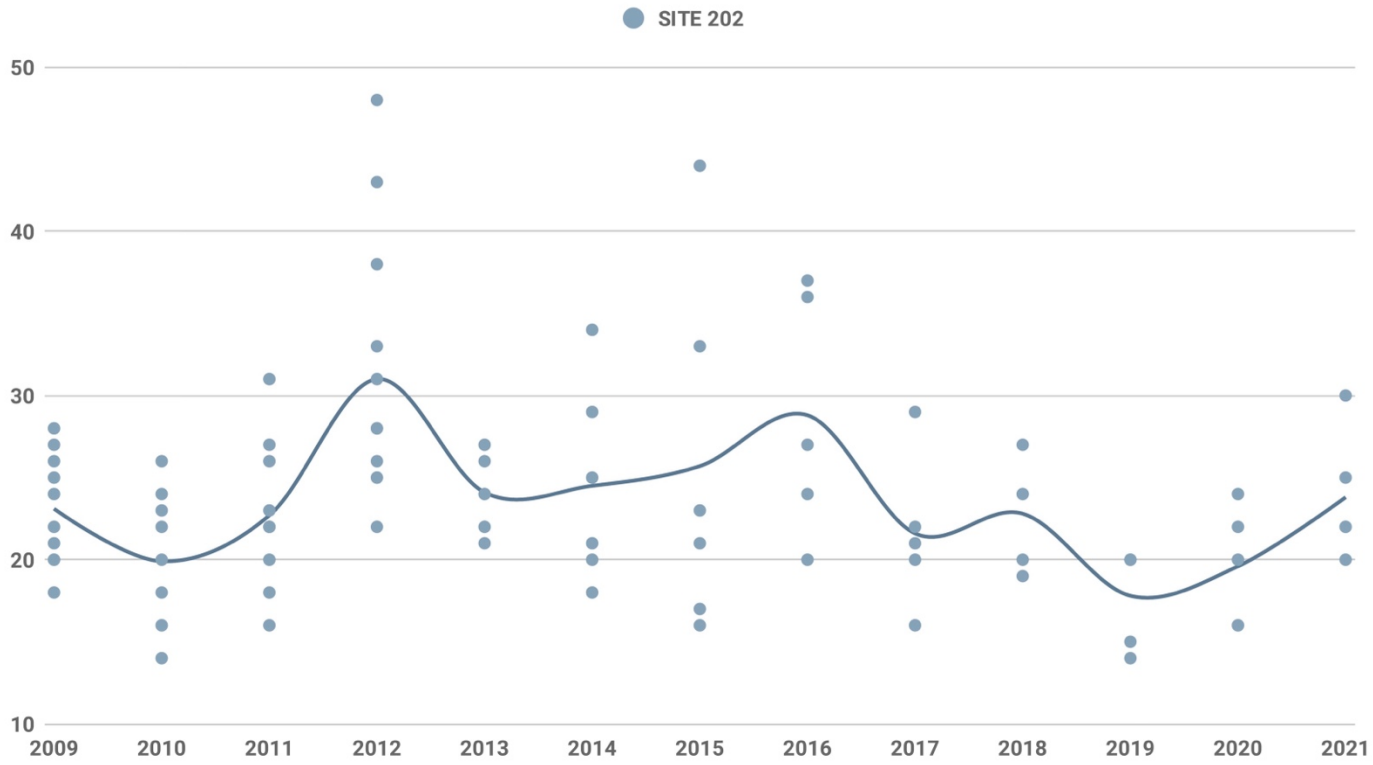
CHLOROPHYLL-A (UG/L)	SITE 202
RANGE (MIN – MAX)	< 1 - 31
NUMBER OF OBSERVATIONS	93
MEAN	8.1



SECCHI DEPTH (FT)	SITE 202
RANGE (MIN – MAX)	3.9 – 19
NUMBER OF OBSERVATIONS	127
MEAN	9

TOTAL PHOSPHORUS (UG/L)

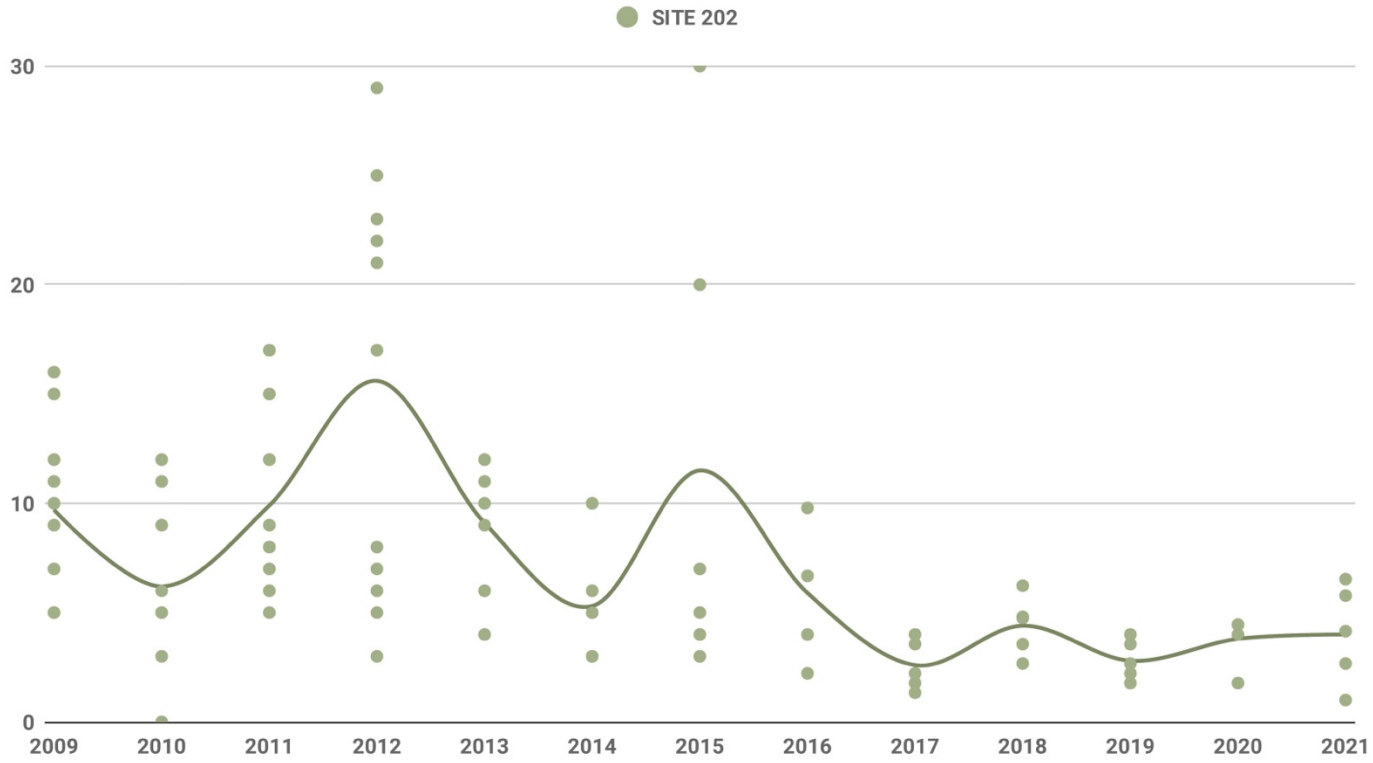
Phosphorus is a nutrient that plays an important role in plant growth. Total phosphorous is a "cause" parameter: when phosphorus increases, algae concentration increases and transparency decreases. Little Pelican Lake is phosphorus limited, which means that the growth of algae and aquatic plants is dependent upon available phosphorus. Lower phosphorus levels are generally associated with better water quality.



Total phosphorus has been evaluated in Little Pelican Lake since 2003. The graph contains data for site 202 from 2009 – 2021. The moving trend line represents the annual summer means. The Pelican River inlet is responsible for most of the phosphorus loading into Little Pelican Lake.

CHLOROPHYLL-A (UG/L)

Chlorophyll-a is the pigment that makes plants and algae green. Chlorophyll-a is tested in lakes to determine the algae concentration or how "green" the water is. Concentrations greater than 10 ug/L are perceived as a mild algae bloom, while concentrations greater than 20 ug/L are perceived as a nuisance.



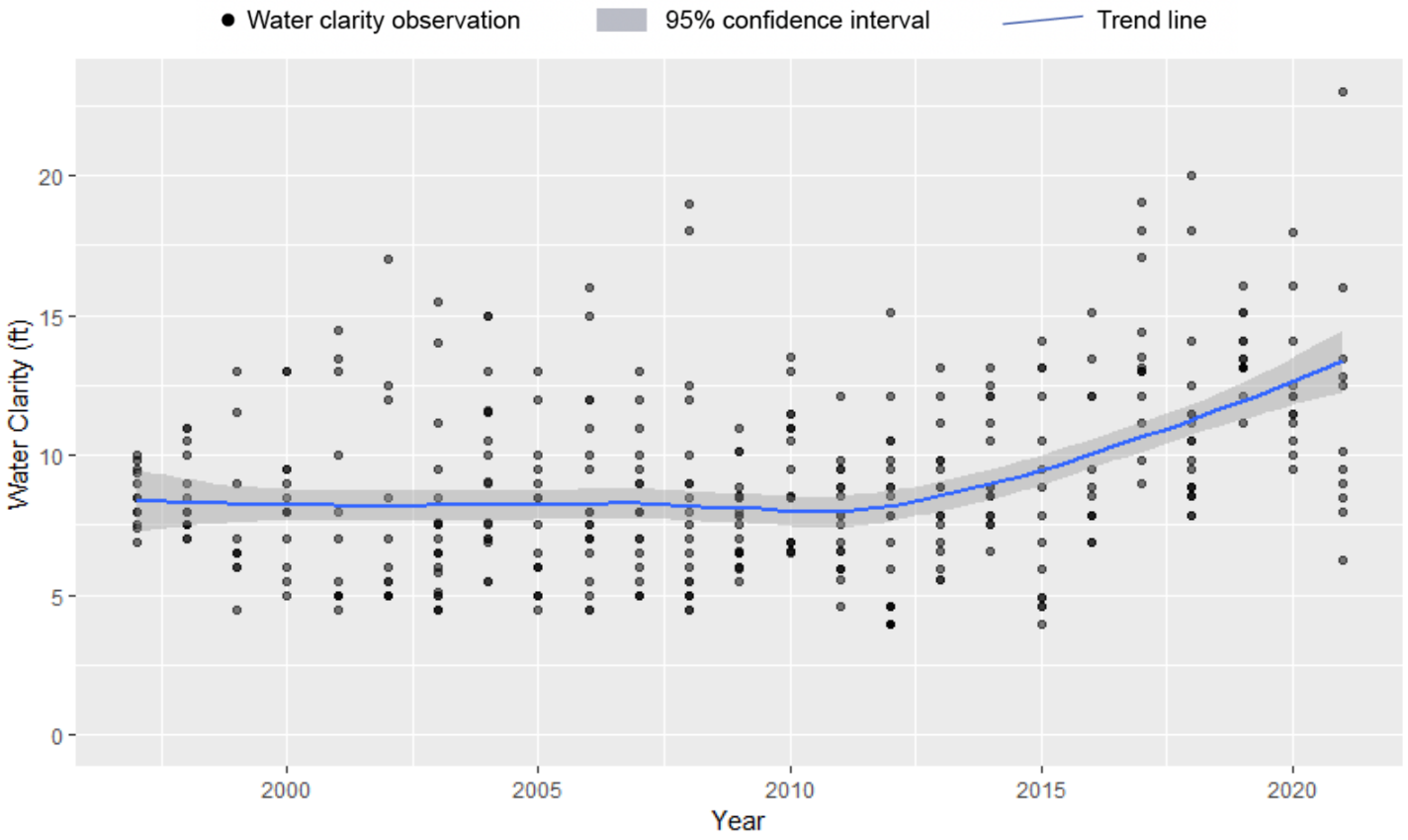
Chlorophyll-a has been evaluated in Little Pelican Lake since 2003. The graph contains data for site 202 from 2009 – 2021. The moving trend line represents the annual summer means. Chlorophyll-a concentrations start out low in June and then increase throughout the summer, peaking in mid to late August. This trend aligns with the total phosphorus results, as phosphorus fuels the growth of algae. Chlorophyll-a concentrations have not exceeded the mild algae bloom threshold of 10 ug/L since 2016. In recent years, nuisance algae blooms have become less frequent in Little Pelican Lake. The most recent nuisance algae bloom was in August 2015. These chlorophyll-a levels are typical for a shallow lake in northern Minnesota.

SECCHI DEPTH (FT)

Transparency is how easily light can pass through a substance. In lakes, it is how deep sunlight penetrates through the water. Plants and algae need sunlight to grow, so they are only able to grow in areas of the lake with adequate transparency. Water transparency depends on the amount of particles in the water. An increase in particulates results in a decrease in transparency. In lakes, transparency is measured using a Secchi disk.

Transparency varies from year to year due to changes in weather, precipitation, lake use, flooding, temperature, lake levels, etc. Secchi depth has been monitored consistently in Little Pelican Lake since 1997. The historical mean from 2009 – 2021 is 9 feet.

Little Pelican Lake transparency ranges from 4 to 19 feet throughout the summer. Transparency is highest in May and declines throughout the summer. After the lake turns over in September, the transparency improves in October. This pattern is typical for a lake of this depth in Minnesota. The transparency dynamics are related to lake turnover and seasonal variation of algae concentrations.



This figure show water clarity over time on this lake. The trend analysis was performed with a Seasonal Mann Kendall test. This statistical test detects changes in water clarity over time by comparing months across years (example - Mays are compared to Mays, Junes to Junes, etc.). For lakes with enough data, the figures include a trend line, which shows the direction of detected changes in water clarity. The gray area around the trend line represents the range where the actual clarity measure will fall with 95% certainty.

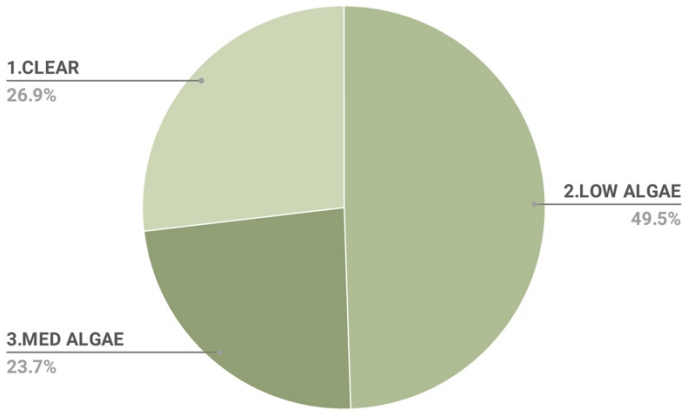
For years 1997 to 2021 there is evidence of improving water clarity at this lake, of approximately 1.0 feet per decade. For the most recent year of the analysis, median water clarity was 3.61 feet lower than the watershed median.

GRAPH SOURCE: *MINNESOTA POLLUTION CONTROL AGENCY*
https://webapp.pca.state.mn.us/surface-water/impairment/56-0761-00

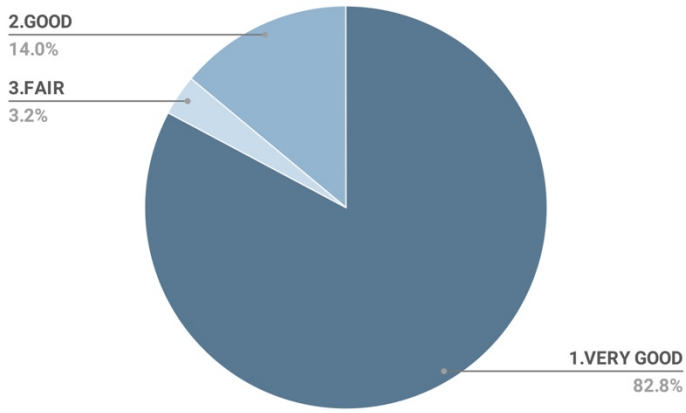
USER PERCEPTION RATINGS

When Secchi depth readings are collected, perceptions of the water based on the physical appearance and recreational suitability are recorded. These perceptions can be compared to water quality parameters to see how the lake "user" would experience the lake at that time.

PHYSICAL CONDITION



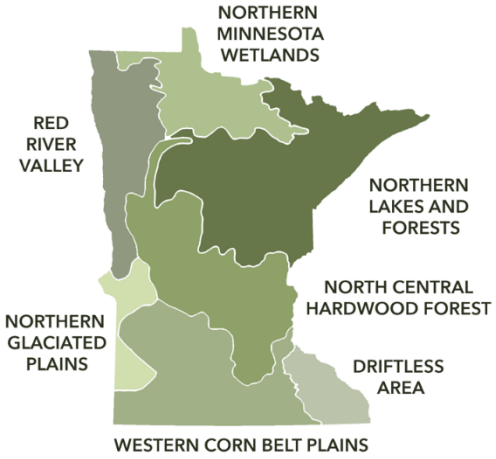
RECREATIONAL SUITABILITY



As the Secchi depth decreases, the perception of the lake's physical appearance decreases. Little Pelican Lake was rated as "clear" 26.9% of the time from 2008 – 2021.

As the Secchi depth decreases, the perception of the lake's recreational suitability also decreases. Little Pelican Lake was rated as "very good" 82.8% of the time from 2008 – 2021.

ECOREGION COMPARISONS NORTH CENTRAL HARDWOOD FOREST



Minnesota is divided into seven ecoregions. An ecoregion is a geographical area where the land use, underlying geology, native plant community, and soils are relatively similar. Little Pelican Lake is located in the North Central Hardwood Forest ecoregion, which is an area of transition between the forested areas to the north and east and the agricultural areas to the south and west. Lakes in the North Central Hardwood Forest ecoregion tend to have moderate nutrient levels and water clarity. Little Pelican Lake is within the ecoregion expected ranges for all three parameters.

TOTAL PHOSPHORUS (UG/L)	23 – 50 ug/L	Within Expected Range
CHLOROPHYLL-A (UG/L)	5 – 22 ug/L	Within Expected Range
SECCHI DEPTH (FT)	5 – 10.5 ft	Within Expected Range

TROPHIC STATE INDEX (TSI)

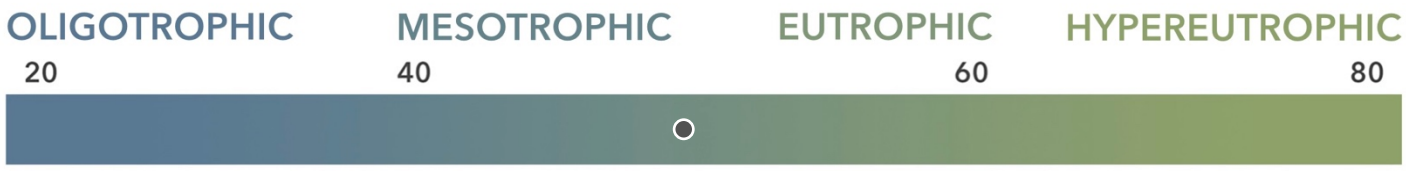
Total phosphorus, chlorophyll-a, and Secchi depth are related parameters. As phosphorus increases, there are more nutrients available to fuel algae growth, resulting in increased chlorophyll-a concentrations. When chlorophyll-a concentrations increase, the water becomes less transparent, so the Secchi depth decreases.

The results from these three parameters cover different units and ranges, and thus cannot be directly compared to each other. In order to standardize these measurements to make them comparable, they are converted to a trophic state index (TSI). Trophic state index is a standard measure for calculating the trophic status or productivity of a lake.

EUTROPHICATION

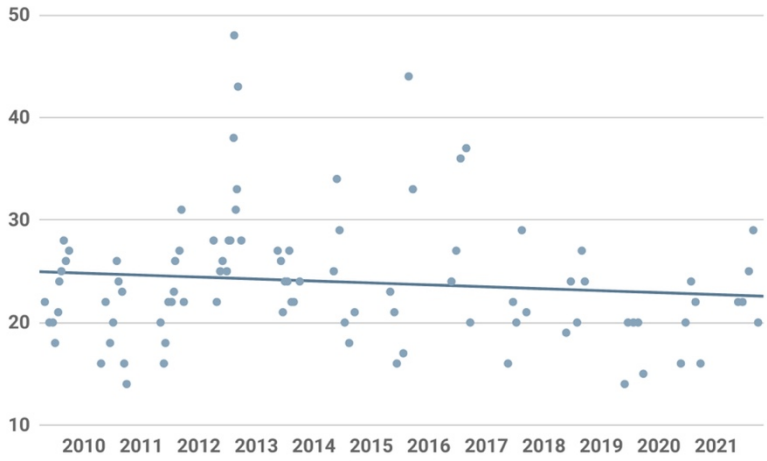
TSI	ATTRIBUTES	FISHERIES & RECREATION
< 30	**OLIGOTROPHIC:** Clear water, oxygen throughout the year at the bottom of the lake, very deep cold water.	Trout fisheries dominate.
30 - 40	Bottom of shallower lakes may become anoxic (no oxygen).	Trout fisheries in deep lakes only. Walleye, Tullibee present.
40 - 50	**MESOTROPHIC:** Water moderately clear most of the summer. May be "greener" in late summer.	No oxygen at the bottom of the lake results in loss of trout. Walleye may predominate.
50 - 60	**EUTROPHIC:** Algae and aquatic plant problems possible. "Green" water most of the year.	Warm-water fisheries only. Bass may dominate.
60 - 70	Blue-green algae dominate, algal scums and aquatic plant problems.	Dense algae and aquatic plants. Low water clarity may discourage swimming and boating.
70 - 80	**HYPEREUTROPHIC:** Dense algae and aquatic plants.	Water is not suitable for recreation.
> 80	Algal scums, few aquatic plants.	Rough fish (carp) dominate; summer fish kills possible.

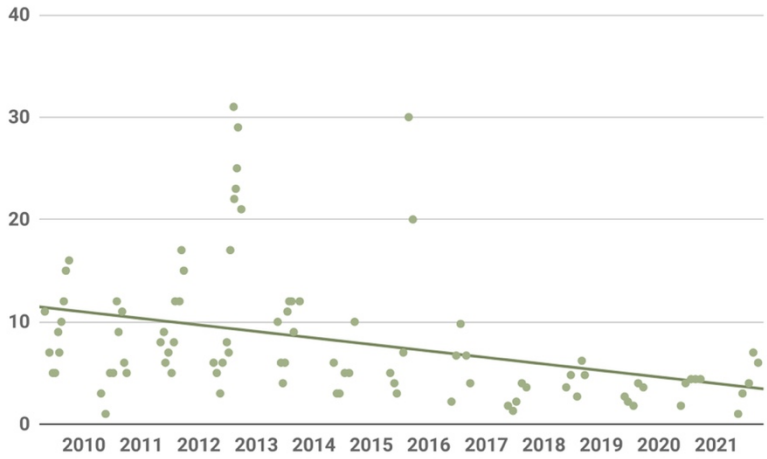
Little Pelican Lake is a meso-eutrophic lake with a mean TSI of 50. Meso-eutrophic lakes have moderate nutrient levels (phosphorus and nitrogen) and good clarity (Secchi depth), with a moderate density of aquatic plants and algae.

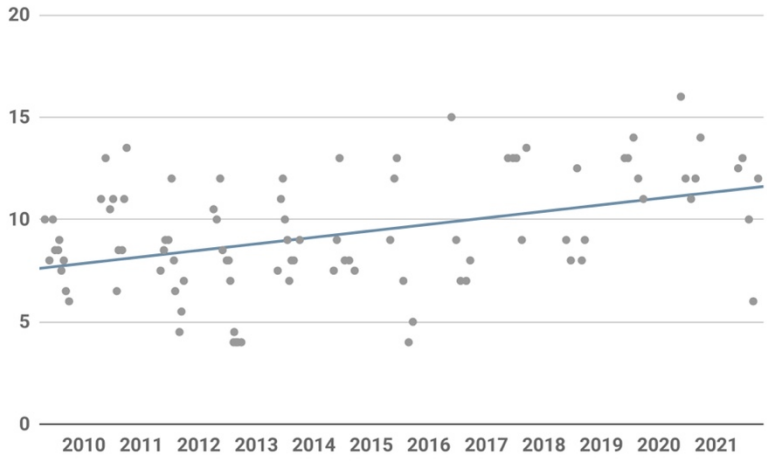


TREND ANALYSIS

For detecting trends, a minimum of 8-10 years of data with four or more readings per season are recommended by the MPCA. Where data does not cover at least eight years or where there are only few samples within a year, trends can be misidentified because there can be different wet years and dry years, water levels, weather, etc., that affect the water quality naturally. The data was analyzed using the Mann Kendall Trend Analysis.







TOTAL PHOSPHORUS (UG/L)

Phosphorus is a nutrient that plays an important role in plant growth. Higher phosphorus concentrations are associated with increased growth of aquatic plants and algae. Total phosphorous is a "cause" parameter: when phosphorus increases, algae concentration increases and transparency decreases. An improving trend for total phosphorus means that the phosphorus levels are decreasing.

From 2009 – 2021, there is evidence of an improving trend with 90% confidence for total phosphorus in Little Pelican Lake.

CHLOROPHYLL-A (UG/L)

Chlorophyll-a is the pigment that makes plants and algae green. Chlorophyll-a is tested in lakes to determine the algae concentration, or how "green" the water is. Concentrations greater than 10 ug/L are perceived as a mild algae bloom, while concentrations greater than 20 ug/L are perceived as a nuisance. An improving trend for chlorophyll-a means that the chlorophyll-a concentration is decreasing.

From 2009 – 2021, there is evidence of an improving trend with 99.9% confidence for chlorophyll-a in Little Pelican Lake.

SECCHI DEPTH (FT)

Transparency is how easily light can pass through a substance. Lake transparency is measured using a Secchi disk. An increase in particles in the water results in a decrease in transparency. An improving trend for Secchi depth means that the Secchi depth is increasing. However, increased transparency is not necessarily positive if it is caused by zebra mussels filtering the water column and redepositing nutrients on the lake bottom.

From 2009 – 2021, there is evidence of an improving trend with 99.9% confidence for Secchi depth in Little Pelican Lake.

STATE ASSESSMENTS

MPCA WATER QUALITY ASSESSMENTS

BENEFICIAL USE	ASSESSMENT YEAR	ASSESSED CONDITION	IMPAIRMENT CAUSE
Aquatic Consumption		Use Not Assessed	
Aquatic Life	2018	Insufficient Data for Use Assessment	
Aquatic Recreation	2018	Standards Met for All Assessed Parameters	

MPCA WATER QUALITY STANDARDS

Water quality standards:

- Protect water resources for uses such as fishing, swimming and other recreation, and sustaining fish, bugs, plants, and other aquatic life
- Are a measure to identify polluted waters or healthy waters in need of protection
- Guide the limits set on what regulated facilities can discharge to surface water

The federal Clean Water Act requires states to designate beneficial uses for all waters and develop water quality standards to protect each use. Water quality standards consist of several parts:

- Beneficial uses – Identify how people, aquatic communities, and wildlife use our waters
- Numeric standards – Amounts of specific pollutants allowed in a body of water and still protects it for the beneficial uses
- Narrative standards – Statements of unacceptable conditions in and on the water
- Antidegradation protections – Extra protection for high-quality or unique waters and existing uses

Together, the beneficial uses, numeric and narrative standards, and antidegradation protections provide the framework for achieving Clean Water Act goals. The Clean Water Act specifies healthy aquatic life and recreation as beneficial uses. Others that are protected in Minnesota's rules are:

- Drinking water
- Industrial and agricultural uses
- Wildlife
- Navigation
- Aesthetic enjoyment

More information on water quality standards:
https://www.pca.state.mn.us/water/water-quality-standards

More information on monitoring and assessment:
https://www.pca.state.mn.us/water/water-monitoring-and-assessment

BASS LAKE 56-0770-00

Bass Lake is a very small basin (51 acres) with no direct inlets or outlets. It is connected to Fish Lake and Pelican Lake. However, there is minimal water flow between the lakes in either direction. Because of its isolation and small surface area, Bass Lake is much more susceptible to impacts from shoreline activity such as additional impervious surface, artificial sand beaches, and removal of aquatic plants.

Currently, the main threat to Bass Lake is the removal of aquatic plants. Bass Lake has a very dense native plant population along with emergent plants such as bulrush and cattails. This vegetation has been increasingly removed over the past decade, which could be contributing to the elevated algae levels. Aquatic plants store a lot of the phosphorus and nutrients in the water. They also stabilize lake sediments. When aquatic plants are removed, the phosphorus is available to fuel algae growth. In order to maintain water quality in Bass Lake, aquatic plants should be protected and not removed by lake residents.

Water quality data has been collected in Bass Lake since 1997. Data shows that the lake is mesotrophic, with a mean TSI of 43.

LOCATION DATA

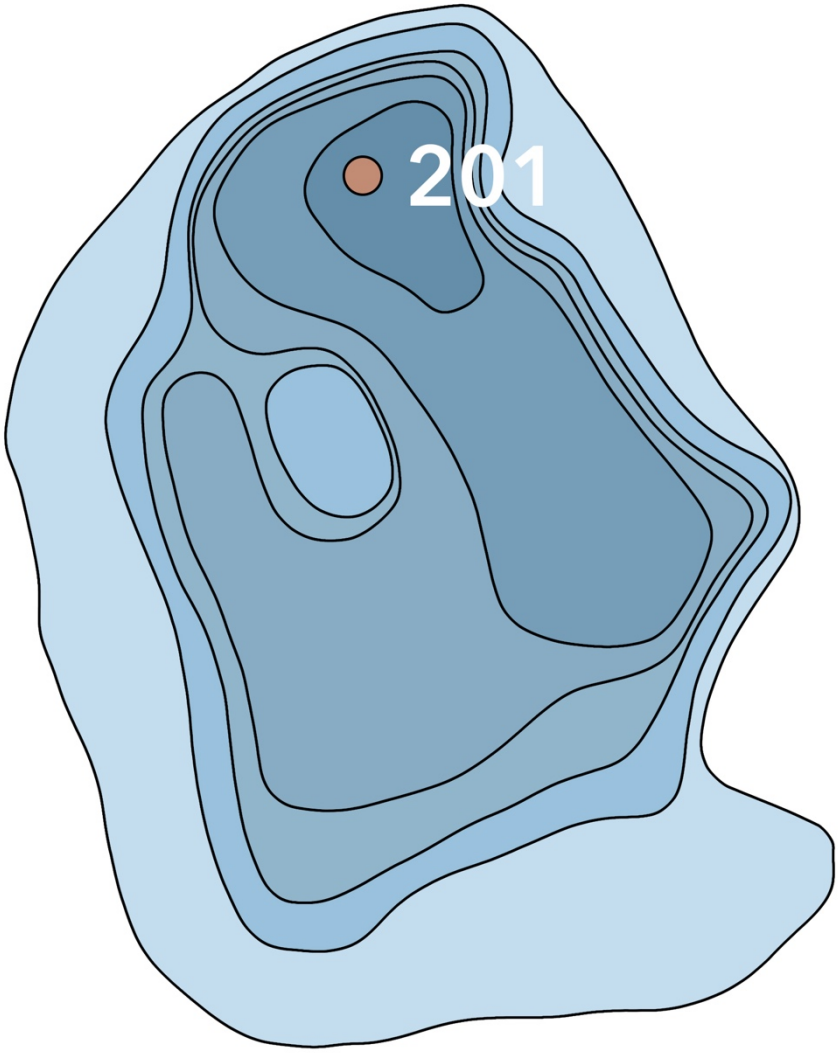
MN LAKE ID	56-0770-00
COUNTY	Otter Tail
ECOREGION	NCHF
MAJOR DRAINAGE BASIN	Red River
LATITUDE / LONGITUDE	46.6844 / -96.0106
WATER BODY TYPE	Public
PUBLIC ACCESSES	0
MONITORED SITES	201

PHYSICAL CHARACTERISTICS

SURFACE AREA	51 acres
% LITTORAL AREA	47%
MAX DEPTH	33 ft
MEAN DEPTH	18 ft
LAKESHED SIZE	N/A
LAKESHED : LAKE AREA	N/A
INLETS	Connected to Fish Lake
OUTLETS	Connected to Fish Lake

DATA AVAILABILITY

TRANSPARENCY DATA	Data exists from the MPCA CLMP program from 1997 - 2002, and RMB Environmental Laboratories from 2003 - 2021.
CHEMICAL DATA	Data exists from RMB Environmental Laboratories from 2003 - 2021.
INLET / OUTLET DATA	Bass Lake has no inlet or outlet.


201

WATER QUALITY CHARACTERISTICS CHEMICAL DATA

The information below describes available chemical data for Bass Lake from 2009 – 2021. Minnesota is divided into seven ecoregions based on land use, vegetation, precipitation, and geology. The MPCA has developed "average ranges" of water quality expected for lakes in each ecoregion. Bass Lake is located in the North Central Hardwood Forest ecoregion.

PARAMETERS	MEAN	ECOREGION RANGE	INTERPRETATION
TOTAL PHOSPHORUS (UG/L)	17.2	23 – 50	Better Than Expected Range
CHLOROPHYLL-A (UG/L)	4.1	5 – 22	Better Than Expected Range
CHLOROPHYLL-A MAX (UG/L)	17	7 – 37	Within Expected Range
SECCHI DEPTH (FT)	12.6	4.9 – 10.5	Better Than Expected Range
DISSOLVED OXYGEN	N/A		Dissolved oxygen depth profiles show that the deep areas of the lake are anoxic in late summer.
CHLORIDE (MG/L)	17.6	4 – 10	Higher than the expected range, which is most likely caused by winter road salt.
TOTAL KJELDAHL NITROGEN (MG/L)	0.61	0.62 – 1.2	Indicates insufficient nitrogen to support summer nitrogen induced algae blooms.
ORTHO PHOSPHORUS (SURFACE, UG/L)	5.6	N/A	Indicates that all available ortho phosphorus is taken up by plants and algae living in the lake.
ALKALINITY (MG/L)	182	75 – 150	Indicates a low sensitivity to acid rain and a good buffering capacity.
COLOR (PT-CO UNITS)	8.2	10 – 20	Indicates very clear water with little to no tannins.
TOTAL SUSPENDED SOLIDS (MG/L)	1.3	2 - 6	Below the ecoregion expected range, indicating clear water.
SPECIFIC CONDUCTANCE	404	300 – 400	Slightly higher than ecoregion range, which could be due to increased salinity or temperature.
TOTAL NITROGEN : TOTAL PHOSPHORUS	33:1	25:1 – 35:1	The lake is phosphorus limited, which means that algae growth is limited by the amount of phosphorus within the lake.

WATER QUALITY CHARACTERISTICS HISTORICAL MEANS & RANGES

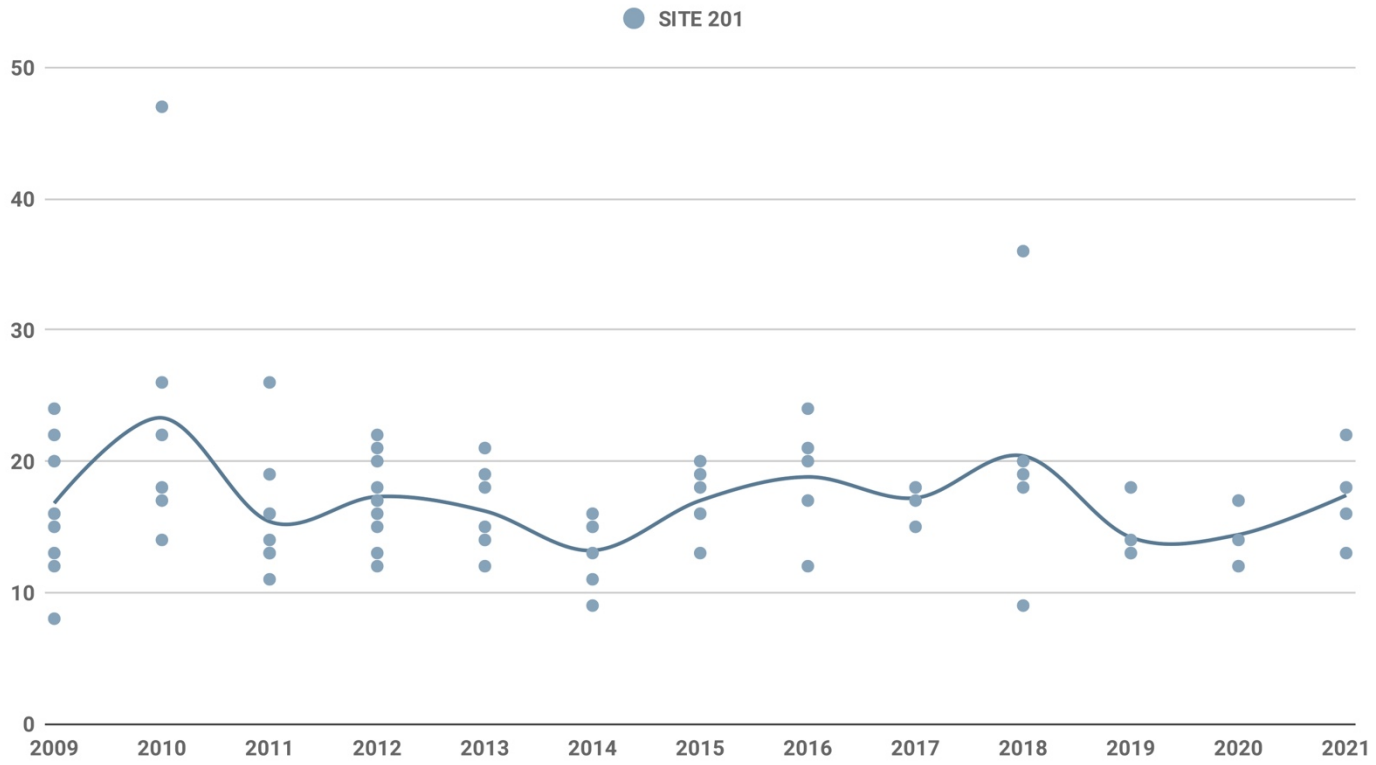
TOTAL PHOSPHORUS (UG/L)	SITE 201
RANGE (MIN – MAX)	8 - 47
NUMBER OF OBSERVATIONS	93
MEAN	17.2

CHLOROPHYLL-A (UG/L)	SITE 201
RANGE (MIN – MAX)	< 1 - 17
NUMBER OF OBSERVATIONS	93
MEAN	4.1

SECCHI DEPTH (FT)	SITE 201
RANGE (MIN – MAX)	7.5 – 21.7
NUMBER OF OBSERVATIONS	223
MEAN	12.6

TOTAL PHOSPHORUS (UG/L)

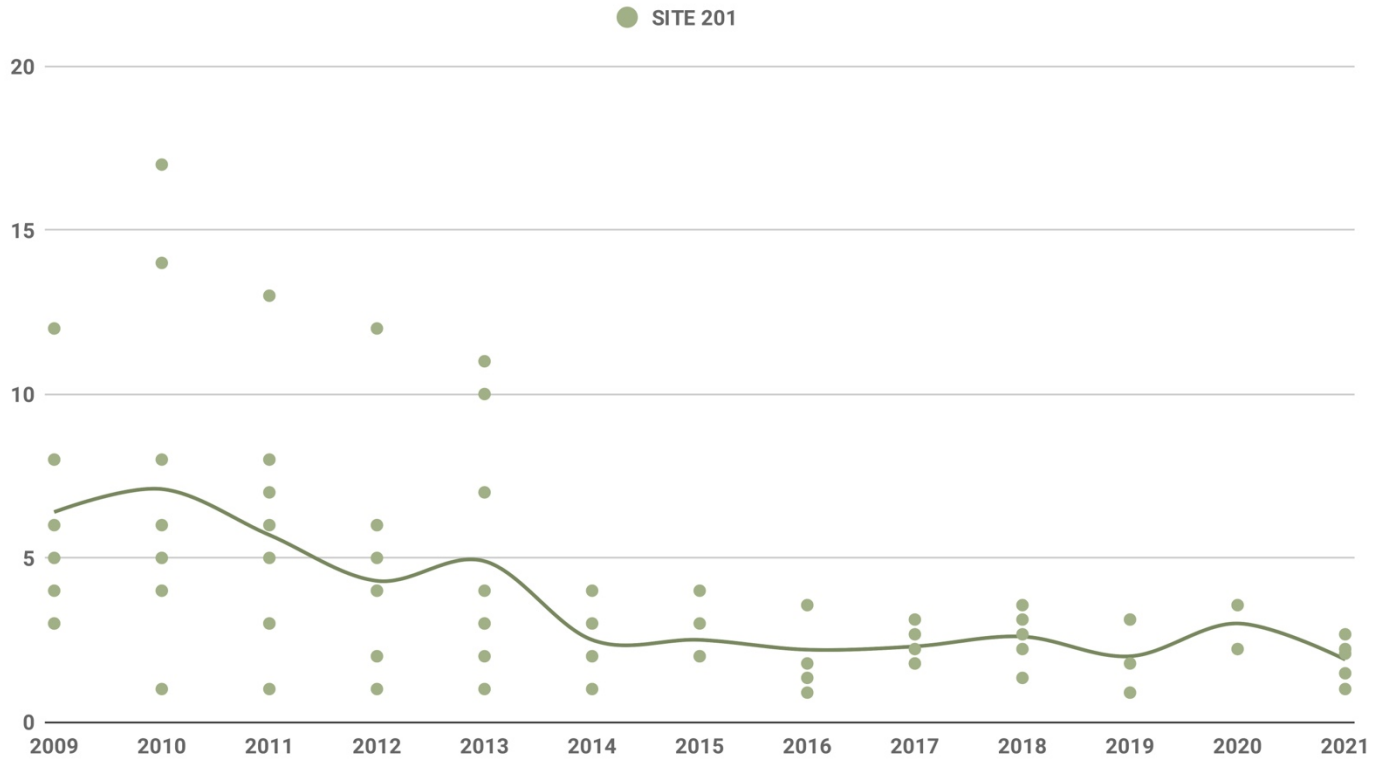
Phosphorus is a nutrient that plays an important role in plant growth. Total phosphorous is a "cause" parameter: when phosphorus increases, algae concentration increases and transparency decreases. Bass Lake is phosphorus limited, which means that the growth of algae and aquatic plants is dependent upon available phosphorus. Lower phosphorus levels are generally associated with better water quality.



Total phosphorus has been evaluated in Bass Lake since 2003. The graph contains data for site 201 from 2009 – 2021. The moving trend line represents the annual summer means. Bass Lake is connected to Fish Lake, but it has no direct inlet or outlet. Seasonal variations in phosphorus levels are due to internal loading.

CHLOROPHYLL-A (UG/L)

Chlorophyll-a is the pigment that makes plants and algae green. Chlorophyll-a is tested in lakes to determine the algae concentration or how "green" the water is. Concentrations greater than 10 ug/L are perceived as a mild algae bloom, while concentrations greater than 20 ug/L are perceived as a nuisance.



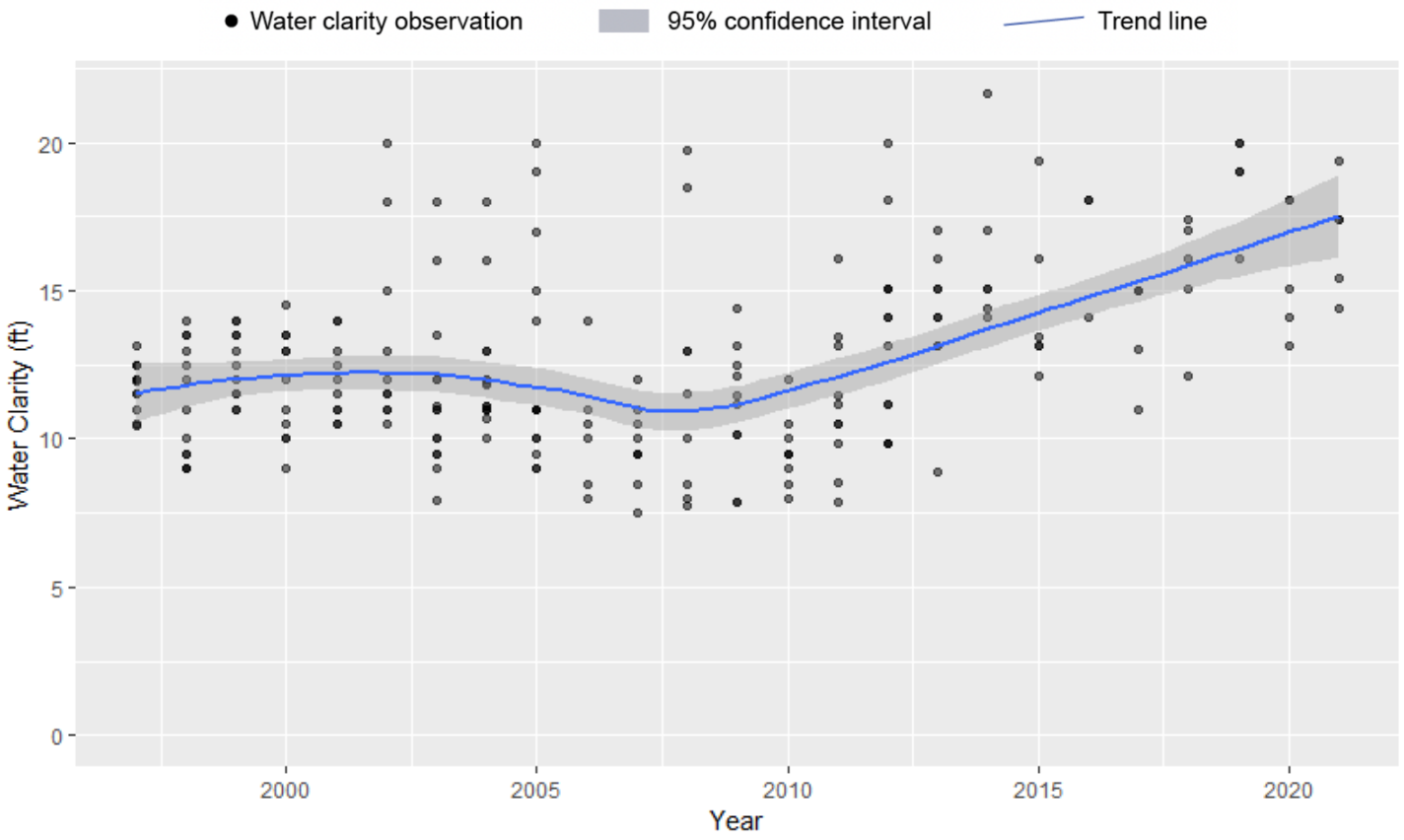
Chlorophyll-a has been evaluated in Bass Lake since 2003. The graph contains data for site 201 from 2009 – 2021. The moving trend line represents the annual summer means. Chlorophyll-a concentrations start out low in June and then increase throughout the summer, peaking in mid to late August. This trend aligns with the total phosphorus results, as phosphorus fuels the growth of algae. Chlorophyll-a concentrations have not exceeded the mild algae bloom threshold of 10 ug/L since 2013.

SECCHI DEPTH (FT)

Transparency is how easily light can pass through a substance. In lakes, it is how deep sunlight penetrates through the water. Plants and algae need sunlight to grow, so they are only able to grow in areas of the lake with adequate transparency. Water transparency depends on the amount of particles in the water. An increase in particulates results in a decrease in transparency. In lakes, transparency is measured using a Secchi disk.

Transparency varies from year to year due to changes in weather, precipitation, lake use, flooding, temperature, lake levels, etc. Secchi depth has been monitored consistently in Bass Lake since 1997. The historical mean from 2009 – 2021 is 12.6 feet.

Bass Lake transparency ranges from 7.5 to 22 feet throughout the summer. Transparency varies in May and June, and declines throughout the summer. This pattern is typical for a lake of this depth in Minnesota. The transparency dynamics are related to lake turnover and seasonal variation of algae concentrations.



This figure show water clarity over time on this lake. The trend analysis was performed with a Seasonal Mann Kendall test. This statistical test detects changes in water clarity over time by comparing months across years (example - Mays are compared to Mays, Junes to Junes, etc.). For lakes with enough data, the figures include a trend line, which shows the direction of detected changes in water clarity. The gray area around the trend line represents the range where the actual clarity measure will fall with 95% certainty.

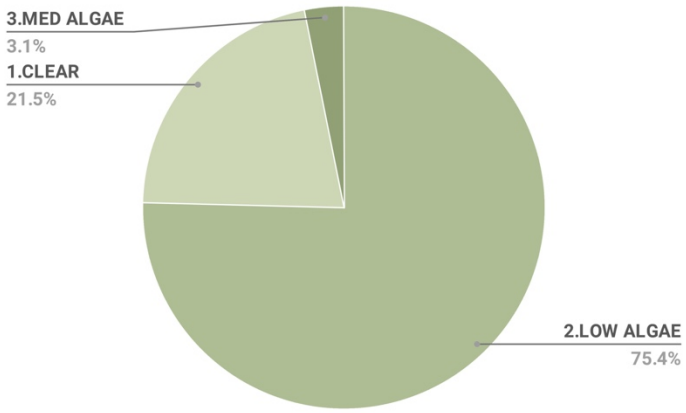
For years 1997 to 2021 there is evidence of improving water clarity at this lake, of approximately 2.3 feet per decade. For the most recent year of the analysis, median water clarity was 3.61 feet higher than the watershed median.

GRAPH SOURCE: *MINNESOTA POLLUTION CONTROL AGENCY*
https://webapp.pca.state.mn.us/surface-water/impairment/56-0770-00

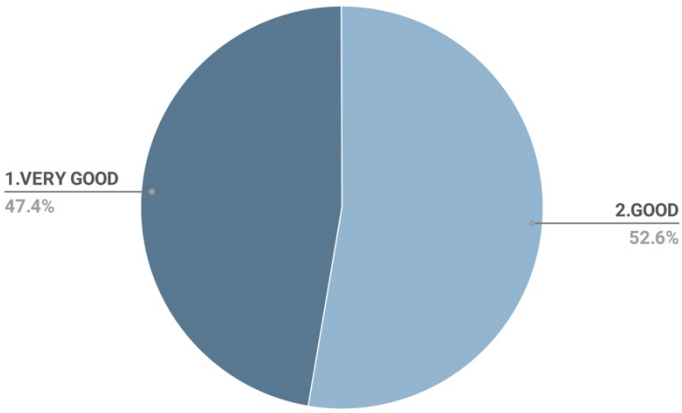
USER PERCEPTION RATINGS

When Secchi depth readings are collected, perceptions of the water based on the physical appearance and recreational suitability are recorded. These perceptions can be compared to water quality parameters to see how the lake "user" would experience the lake at that time.

PHYSICAL CONDITION



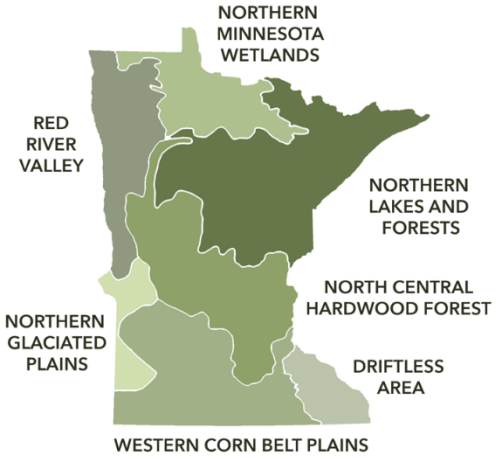
RECREATIONAL SUITABILITY



As the Secchi depth decreases, the perception of the lake's physical appearance decreases. Bass Lake was rated as "clear" 21.5% of the time from 1997 – 2021.

As the Secchi depth decreases, the perception of the lake's recreational suitability also decreases. Bass Lake was rated as "very good" 47.4% of the time from 1997 – 2021.

ECOREGION COMPARISONS NORTH CENTRAL HARDWOOD FOREST



Minnesota is divided into seven ecoregions. An ecoregion is a geographical area where the land use, underlying geology, native plant community, and soils are relatively similar. Bass Lake is located in the North Central Hardwood Forest ecoregion, which is an area of transition between the forested areas to the north and east and the agricultural areas to the south and west. Lakes in the North Central Hardwood Forest ecoregion tend to have moderate nutrient levels and water clarity. Bass Lake is better than the ecoregion expected ranges for all three parameters.

TOTAL PHOSPHORUS (UG/L)	23 – 50 ug/L	Better Than Expected Range
CHLOROPHYLL-A (UG/L)	5 – 22 ug/L	Better Than Expected Range
SECCHI DEPTH (FT)	5 – 10.5 ft	Better Than Expected Range

TROPHIC STATE INDEX (TSI)

Total phosphorus, chlorophyll-a, and Secchi depth are related parameters. As phosphorus increases, there are more nutrients available to fuel algae growth, resulting in increased chlorophyll-a concentrations. When chlorophyll-a concentrations increase, the water becomes less transparent, so the Secchi depth decreases.

The results from these three parameters cover different units and ranges, and thus cannot be directly compared to each other. In order to standardize these measurements to make them comparable, they are converted to a trophic state index (TSI). Trophic state index is a standard measure for calculating the trophic status or productivity of a lake.

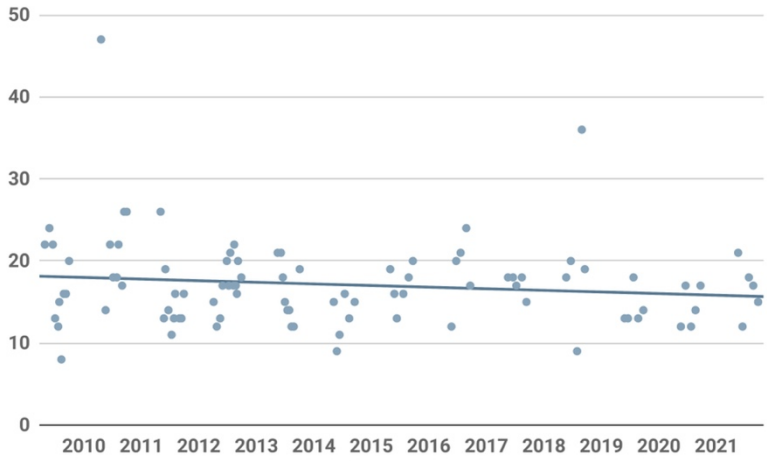
EUTROPHICATION

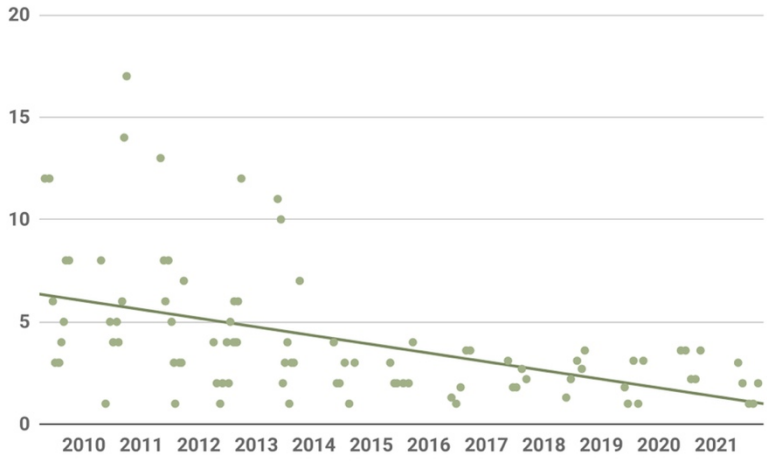
TSI	ATTRIBUTES	FISHERIES & RECREATION
< 30	**OLIGOTROPHIC:** Clear water, oxygen throughout the year at the bottom of the lake, very deep cold water.	Trout fisheries dominate.
30 - 40	Bottom of shallower lakes may become anoxic (no oxygen).	Trout fisheries in deep lakes only. Walleye, Tullibee present.
40 - 50	**MESOTROPHIC:** Water moderately clear most of the summer. May be "greener" in late summer.	No oxygen at the bottom of the lake results in loss of trout. Walleye may predominate.
50 - 60	**EUTROPHIC:** Algae and aquatic plant problems possible. "Green" water most of the year.	Warm-water fisheries only. Bass may dominate.
60 - 70	Blue-green algae dominate, algal scums and aquatic plant problems.	Dense algae and aquatic plants. Low water clarity may discourage swimming and boating.
70 - 80	**HYPEREUTROPHIC:** Dense algae and aquatic plants.	Water is not suitable for recreation.
> 80	Algal scums, few aquatic plants.	Rough fish (carp) dominate; summer fish kills possible.

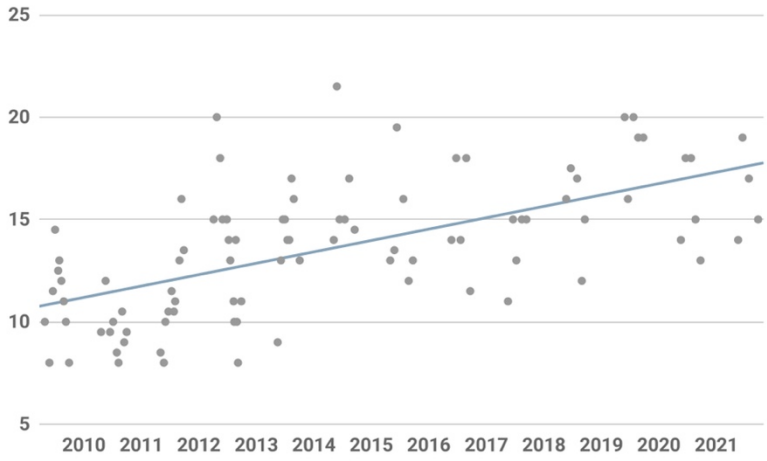
Bass Lake is a mesotrophic lake with a mean TSI of 43. Mesotrophic lakes have moderate nutrient levels (phosphorus and nitrogen) and good clarity (Secchi depth), with some algal blooms in late summer.

TREND ANALYSIS

For detecting trends, a minimum of 8-10 years of data with four or more readings per season are recommended by the MPCA. Where data does not cover at least eight years or where there are only few samples within a year, trends can be misidentified because there can be different wet years and dry years, water levels, weather, etc., that affect the water quality naturally. The data was analyzed using the Mann Kendall Trend Analysis.







TOTAL PHOSPHORUS (UG/L)

Phosphorus is a nutrient that plays an important role in plant growth. Higher phosphorus concentrations are associated with increased growth of aquatic plants and algae. Total phosphorous is a "cause" parameter: when phosphorus increases, algae concentration increases and transparency decreases. An improving trend for total phosphorus means that the phosphorus levels are decreasing.

From 2009 – 2021, no significant trend exists for total phosphorus in Bass Lake.

CHLOROPHYLL-A (UG/L)

Chlorophyll-a is the pigment that makes plants and algae green. Chlorophyll-a is tested in lakes to determine the algae concentration, or how "green" the water is. Concentrations greater than 10 ug/L are perceived as a mild algae bloom, while concentrations greater than 20 ug/L are perceived as a nuisance. An improving trend for chlorophyll-a means that the chlorophyll-a concentration is decreasing.

From 2009 – 2021, there is evidence of an improving trend with 99.9% confidence for chlorophyll-a in Bass Lake.

SECCHI DEPTH (FT)

Transparency is how easily light can pass through a substance. Lake transparency is measured using a Secchi disk. An increase in particles in the water results in a decrease in transparency. An improving trend for Secchi depth means that the Secchi depth is increasing. However, increased transparency is not necessarily positive if it is caused by zebra mussels filtering the water column and redepositing nutrients on the lake bottom.

From 2009 – 2021, there is evidence of an improving trend with 99.9% confidence for Secchi depth in Bass Lake.

STATE ASSESSMENTS

MPCA WATER QUALITY ASSESSMENTS

BENEFICIAL USE	ASSESSMENT YEAR	ASSESSED CONDITION	IMPAIRMENT CAUSE
Aquatic Consumption		Use Not Assessed	
Aquatic Life	2018	Insufficient Data for Use Assessment	
Aquatic Recreation	2018	Standards Met for All Assessed Parameters	

MPCA WATER QUALITY STANDARDS

Water quality standards:

- Protect water resources for uses such as fishing, swimming and other recreation, and sustaining fish, bugs, plants, and other aquatic life
- Are a measure to identify polluted waters or healthy waters in need of protection
- Guide the limits set on what regulated facilities can discharge to surface water

The federal Clean Water Act requires states to designate beneficial uses for all waters and develop water quality standards to protect each use. Water quality standards consist of several parts:

- Beneficial uses – Identify how people, aquatic communities, and wildlife use our waters
- Numeric standards – Amounts of specific pollutants allowed in a body of water and still protects it for the beneficial uses
- Narrative standards – Statements of unacceptable conditions in and on the water
- Antidegradation protections – Extra protection for high-quality or unique waters and existing uses

Together, the beneficial uses, numeric and narrative standards, and antidegradation protections provide the framework for achieving Clean Water Act goals. The Clean Water Act specifies healthy aquatic life and recreation as beneficial uses. Others that are protected in Minnesota's rules are:

- Drinking water
- Industrial and agricultural uses
- Wildlife
- Navigation
- Aesthetic enjoyment

More information on water quality standards:
https://www.pca.state.mn.us/water/water-quality-standards

More information on monitoring and assessment:
https://www.pca.state.mn.us/water/water-monitoring-and-assessment

FISH LAKE 56-0768-00

Fish Lake is attached to Pelican Lake at its north end. Water flows from Pelican Lake through Fish Lake, and the Pelican River exits at the southwest end of the lake. Fish Lake has the best water quality of the Pelican Group of Lakes. This is most likely due to the fact that it doesn't have any stream inlets, it is fairly deep, and it has a good population of emergent vegetation around its shoreline.

Currently, the main threat to Fish Lake is the removal of emergent vegetation around the shoreline. Historically, the lake was ringed entirely with bulrush. Since human development on the lake, bulrush has been removed to create swimming areas. Aquatic plants such as bulrush filter pollutants and take up nutrients such as phosphorus. They also stabilize lake sediments. In order to maintain the excellent water quality in Fish Lake, aquatic plants should be protected and not removed by lake residents.

Water quality data has been collected in Fish Lake since 1995. Data shows that the lake is oligo-mesotrophic, with a mean TSI of 40.

LOCATION DATA

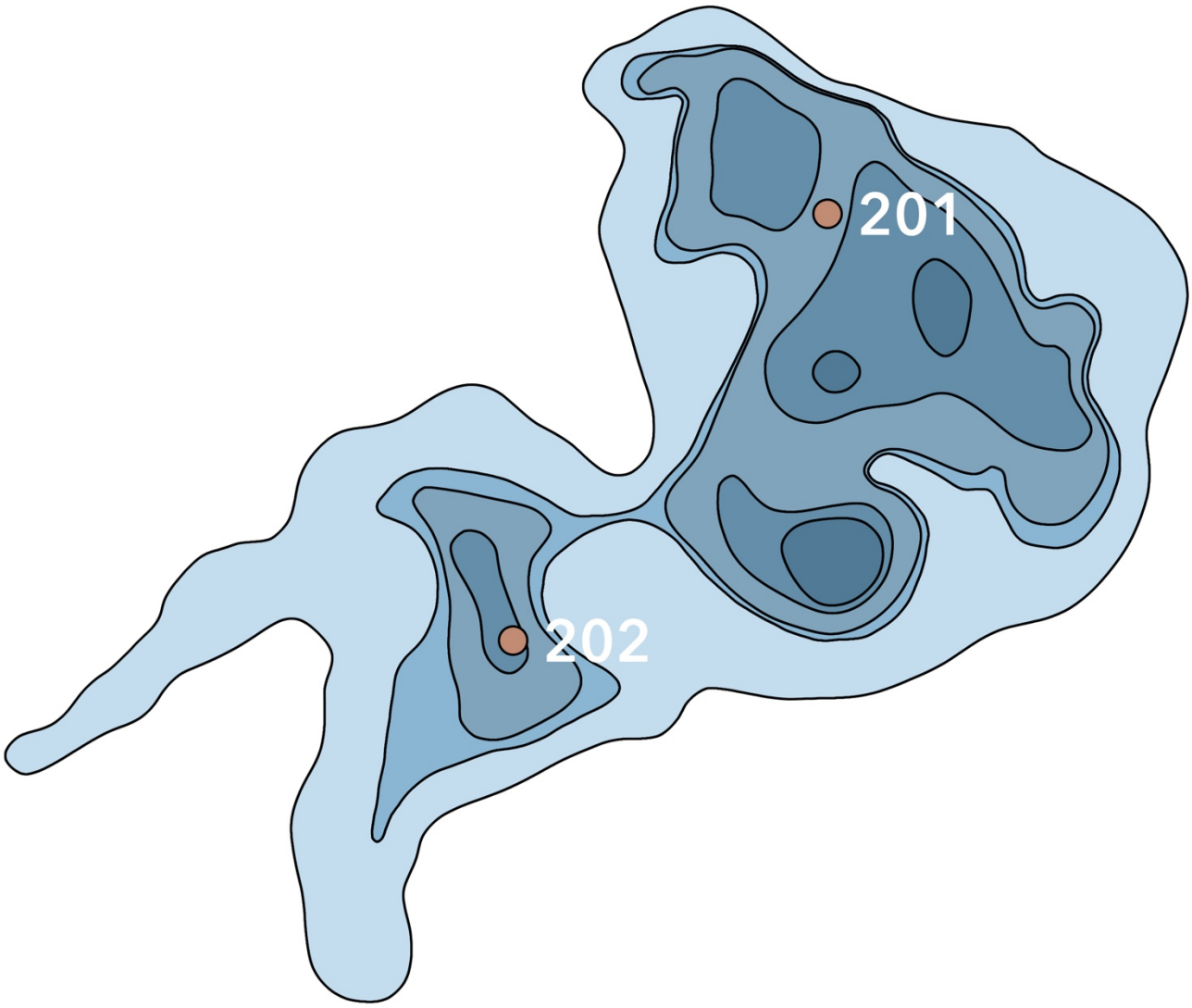
MN LAKE ID	56-0768-00
COUNTY	Otter Tail
ECOREGION	NCHF
MAJOR DRAINAGE BASIN	Red River
LATITUDE / LONGITUDE	46.6781 / -96.0006
WATER BODY TYPE	Public
PUBLIC ACCESSES	0
MONITORED SITES	201, 202

PHYSICAL CHARACTERISTICS

SURFACE AREA	293 acres
% LITTORAL AREA	69%
MAX DEPTH	43 ft
MEAN DEPTH	27 ft
LAKESHED SIZE	15,783 acres
LAKESHED : LAKE AREA	60 : 1
INLETS	Connected to Pelican Lake
OUTLETS	1

DATA AVAILABILITY

TRANSPARENCY DATA	Data exists from the MPCA CLMP program from 1995 - 2002, and RMB Environmental Laboratories from 2003 - 2021.
CHEMICAL DATA	Data exists from RMB Environmental Laboratories from 2003 - 2021.
INLET / OUTLET DATA	The Fish Lake outlet has been monitored by RMB Environmental Laboratories from 2003 – 2021.


201
202

WATER QUALITY CHARACTERISTICS CHEMICAL DATA

The information below describes available chemical data for Fish Lake from 2009 – 2021. Minnesota is divided into seven ecoregions based on land use, vegetation, precipitation, and geology. The MPCA has developed "average ranges" of water quality expected for lakes in each ecoregion. Fish Lake is located in the North Central Hardwood Forest ecoregion.

PARAMETERS	MEAN	ECOREGION RANGE	INTERPRETATION
TOTAL PHOSPHORUS (UG/L)	12.2	23 – 50	Better Than Expected Range
CHLOROPHYLL-A (UG/L)	2.6	5 – 22	Better Than Expected Range
CHLOROPHYLL-A MAX (UG/L)	8	7 – 37	Within Expected Range
SECCHI DEPTH (FT)	15.1	4.9 – 10.5	Better Than Expected Range
DISSOLVED OXYGEN	N/A		Dissolved oxygen depth profiles show that the deep areas of the lake are anoxic in late summer.
CHLORIDE (MG/L)	18.1	4 – 10	Higher than the expected range, which is most likely caused by winter road salt.
TOTAL KJELDAHL NITROGEN (MG/L)	0.52	0.62 – 1.2	Indicates insufficient nitrogen to support summer nitrogen induced algae blooms.
ORTHO PHOSPHORUS (SURFACE, UG/L)	4.5	N/A	Indicates that all available ortho phosphorus is taken up by plants and algae living in the lake.
ALKALINITY (MG/L)	177	75 – 150	Indicates a low sensitivity to acid rain and a good buffering capacity.
COLOR (PT-CO UNITS)	7.1	10 – 20	Indicates very clear water with little to no tannins.
TOTAL SUSPENDED SOLIDS (MG/L)	1.7	2 - 6	Below the ecoregion expected range, indicating clear water.
SPECIFIC CONDUCTANCE	400	300 – 400	At the higher end of the ecoregion range, which could be due to increased salinity or temperature.
TOTAL NITROGEN : TOTAL PHOSPHORUS	42:1	25:1 – 35:1	The lake is phosphorus limited, which means that algae growth is limited by the amount of phosphorus within the lake.

WATER QUALITY CHARACTERISTICS HISTORICAL MEANS & RANGES

TOTAL PHOSPHORUS (UG/L)	SITE 201*	SITE 202
RANGE (MIN – MAX)	6 – 32	10 – 20
NUMBER OF OBSERVATIONS	93	11
MEAN	12.2	11.7

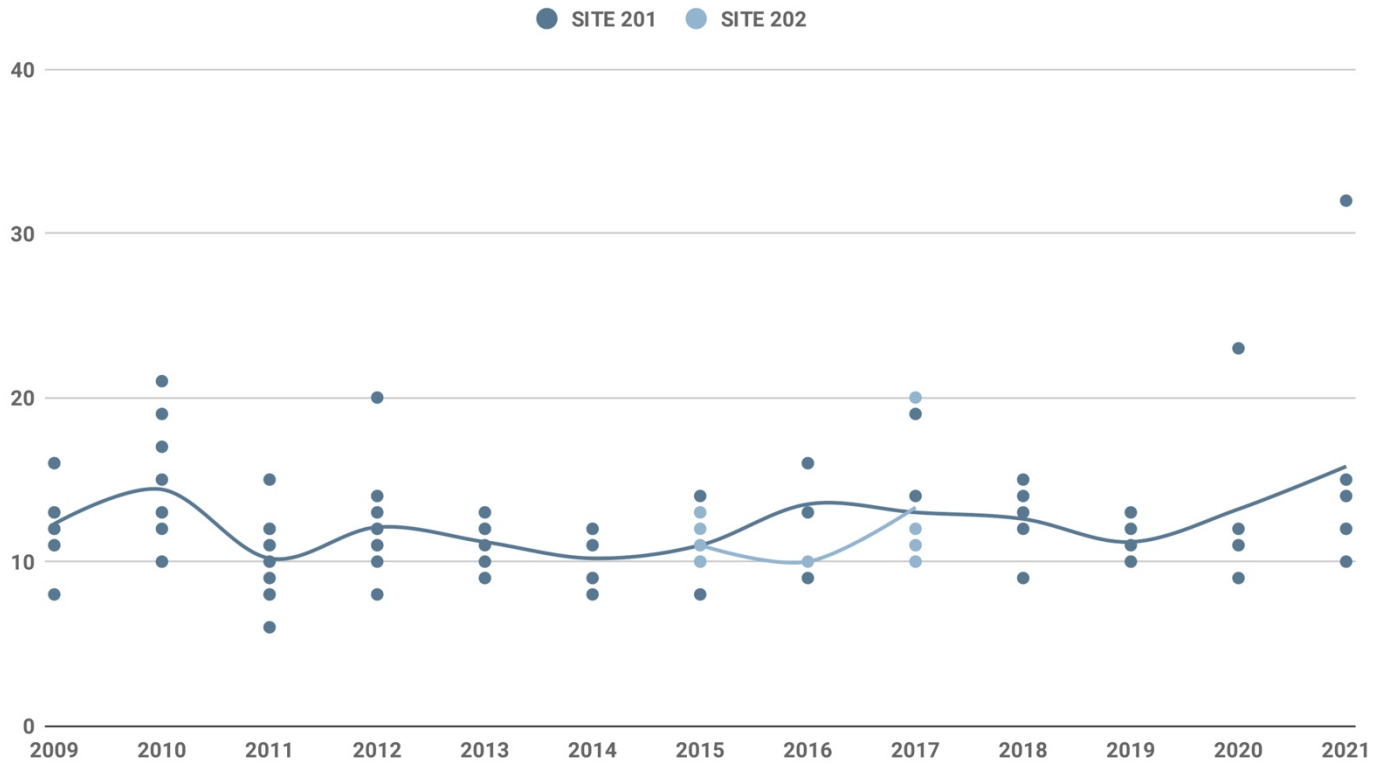
CHLOROPHYLL-A (UG/L)	SITE 201*	SITE 202
RANGE (MIN – MAX)	< 1 – 8	< 1 – 3.12
NUMBER OF OBSERVATIONS	93	11
MEAN	2.8	1.6

SECCHI DEPTH (FT)	SITE 201*	SITE 202
RANGE (MIN – MAX)	6 – 33.1	8.9 – 23.6
NUMBER OF OBSERVATIONS	314	28
MEAN	13.3	14.6

** Figures are based on primary site 201.*

TOTAL PHOSPHORUS (UG/L)

Phosphorus is a nutrient that plays an important role in plant growth. Total phosphorous is a "cause" parameter: when phosphorus increases, algae concentration increases and transparency decreases. Fish Lake is phosphorus limited, which means that the growth of algae and aquatic plants is dependent upon available phosphorus. Lower phosphorus levels are generally associated with better water quality



Total phosphorus has been evaluated in Fish Lake since 2003. The graph contains data for sites 201 and 202 from 2009 – 2021. The moving trend line represents the annual summer means for each site. Fish Lake experiences minimal seasonal variations in total phosphorus levels. This is likely because there is no direct stream inlet.

CHLOROPHYLL-A (UG/L)

Chlorophyll-a is the pigment that makes plants and algae green. Chlorophyll-a is tested in lakes to determine the algae concentration or how "green" the water is. Concentrations greater than 10 ug/L are perceived as a mild algae bloom, while concentrations greater than 20 ug/L are perceived as a nuisance.

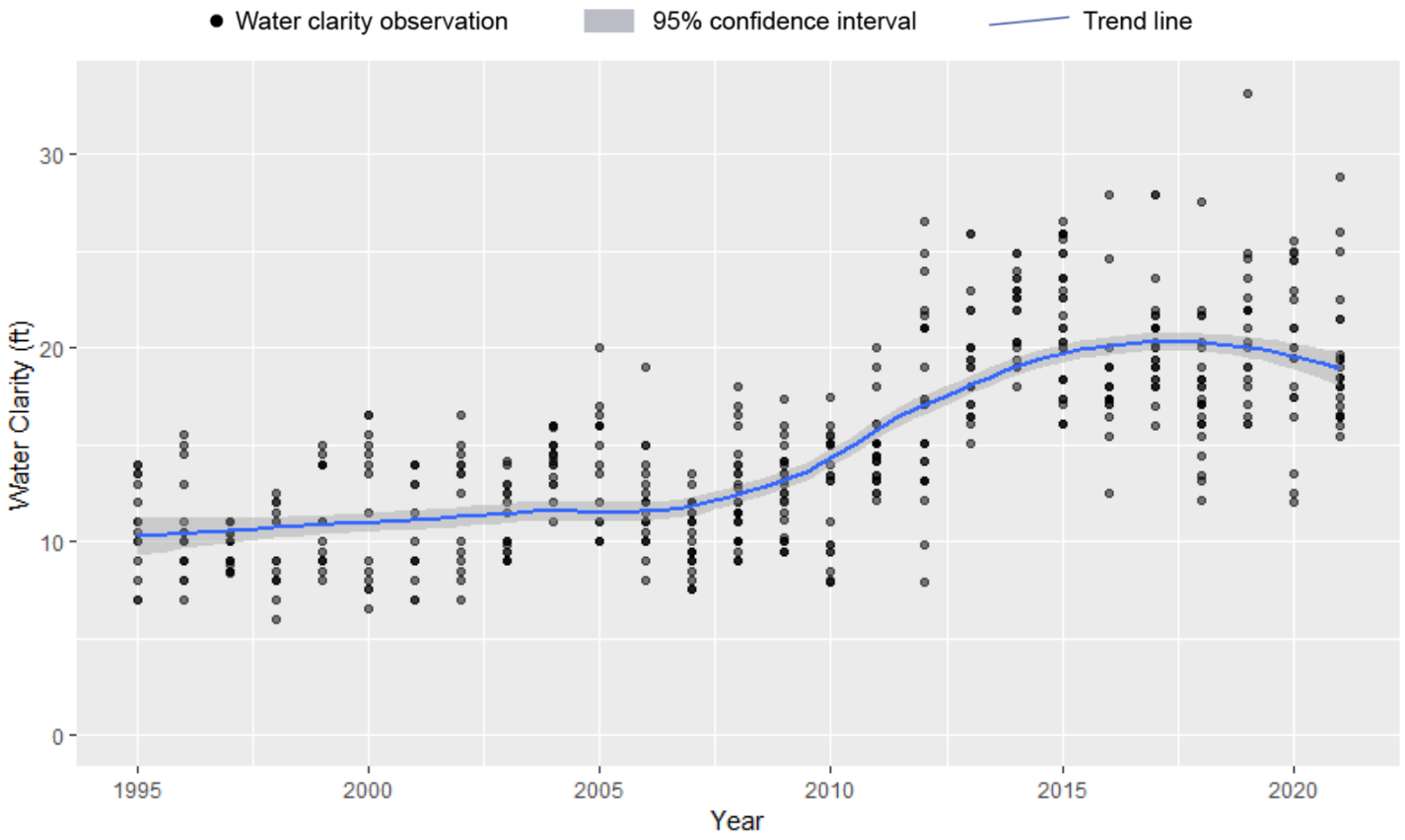
Chlorophyll-a has been evaluated in Fish Lake since 2003. The graph contains data for sites 201 and 202 from 2009 – 2021. The moving trend line represents the annual summer means for each site. Chlorophyll-a concentrations have never exceeded the mild algae bloom threshold of 10 ug/L in Fish Lake.

SECCHI DEPTH (FT)

Transparency is how easily light can pass through a substance. In lakes, it is how deep sunlight penetrates through the water. Plants and algae need sunlight to grow, so they are only able to grow in areas of the lake with adequate transparency. Water transparency depends on the amount of particles in the water. An increase in particulates results in a decrease in transparency. In lakes, transparency is measured using a Secchi disk.

Transparency varies from year to year due to changes in weather, precipitation, lake use, flooding, temperature, lake levels, etc. Secchi depth has been monitored consistently in Fish Lake since 1995. The historical mean from 2009 – 2021 is 15.1 feet.

Fish Lake transparency ranges from 6 to 33 feet throughout the summer. Transparency is highest in May and declines slightly throughout the summer. This pattern is typical for a lake of this depth in Minnesota. The transparency dynamics are related to lake turnover and seasonal variation of algae concentrations.



This figure show water clarity over time on this lake. The trend analysis was performed with a Seasonal Mann Kendall test. This statistical test detects changes in water clarity over time by comparing months across years (example - Mays are compared to Mays, Junes to Junes, etc.). For lakes with enough data, the figures include a trend line, which shows the direction of detected changes in water clarity. The gray area around the trend line represents the range where the actual clarity measure will fall with 95% certainty.

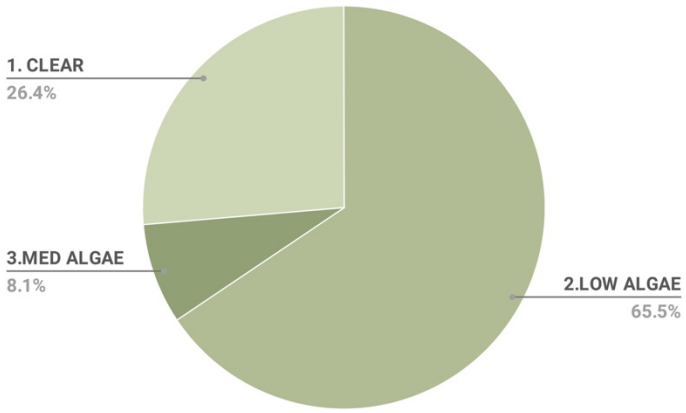
For years 1995 to 2021 there is evidence of improving water clarity at this lake, of approximately 4.2 feet per decade. For the most recent year of the analysis, median water clarity was 4.72 feet higher than the watershed median.

GRAPH SOURCE: *MINNESOTA POLLUTION CONTROL AGENCY*
https://webapp.pca.state.mn.us/surface-water/impairment/56-0768-00

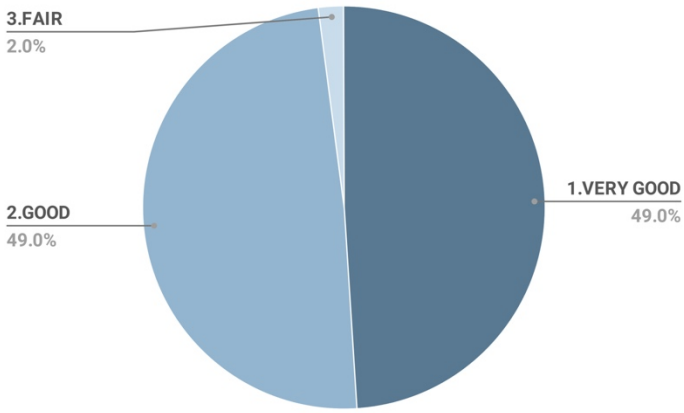
USER PERCEPTION RATINGS

When Secchi depth readings are collected, perceptions of the water based on the physical appearance and recreational suitability are recorded. These perceptions can be compared to water quality parameters to see how the lake "user" would experience the lake at that time.

PHYSICAL CONDITION



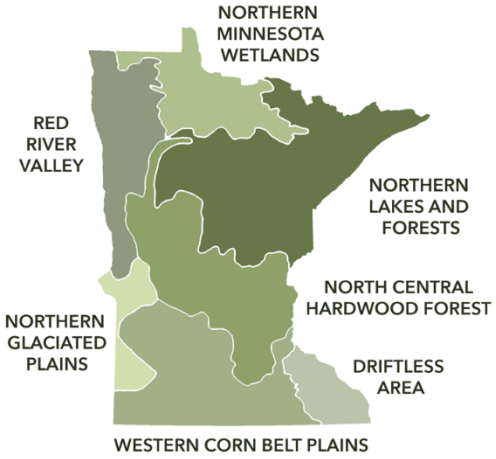
RECREATIONAL SUITABILITY



As the Secchi depth decreases, the perception of the lake's physical appearance decreases. Fish Lake was rated as "clear" 26.4% of the time from 1995 – 2021.

As the Secchi depth decreases, the perception of the lake's recreational suitability also decreases. Fish Lake was rated as "very good" 49% of the time from 1995 – 2021.

ECOREGION COMPARISONS NORTH CENTRAL HARDWOOD FOREST



Minnesota is divided into seven ecoregions. An ecoregion is a geographical area where the land use, underlying geology, native plant community, and soils are relatively similar. Fish Lake is located in the North Central Hardwood Forest ecoregion, which is an area of transition between the forested areas to the north and east and the agricultural areas to the south and west. Lakes in the North Central Hardwood Forest ecoregion tend to have moderate nutrient levels and water clarity. Fish Lake is better than the ecoregion expected ranges for all three parameters.

TOTAL PHOSPHORUS (UG/L)	23 – 50 ug/L	Better Than Expected Range
CHLOROPHYLL-A (UG/L)	5 – 22 ug/L	Better Than Expected Range
SECCHI DEPTH (FT)	5 – 10.5 ft	Better Than Expected Range

TROPHIC STATE INDEX (TSI)

Total phosphorus, chlorophyll-a, and Secchi depth are related parameters. As phosphorus increases, there are more nutrients available to fuel algae growth, resulting in increased chlorophyll-a concentrations. When chlorophyll-a concentrations increase, the water becomes less transparent, so the Secchi depth decreases.

The results from these three parameters cover different units and ranges, and thus cannot be directly compared to each other. In order to standardize these measurements to make them comparable, they are converted to a trophic state index (TSI). Trophic state index is a standard measure for calculating the trophic status or productivity of a lake.

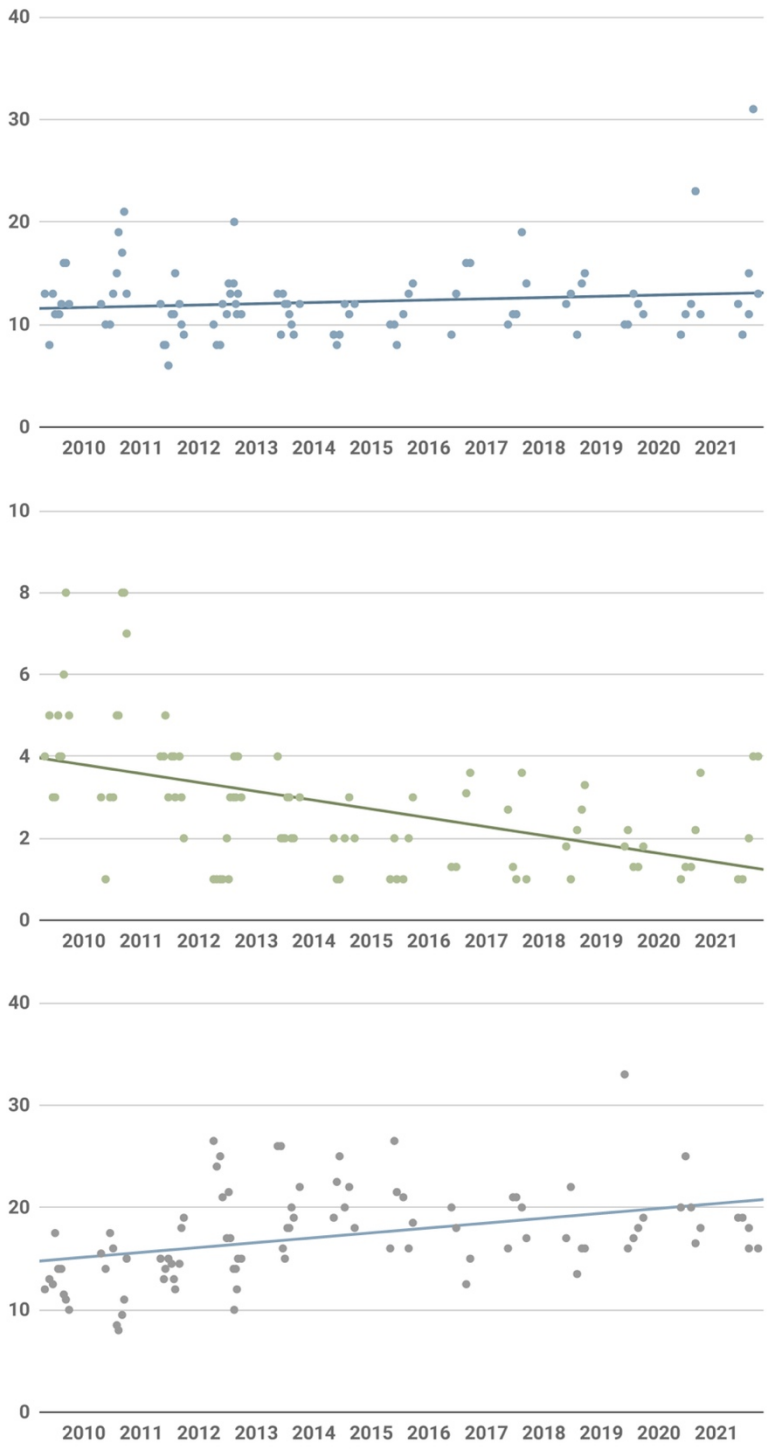
EUTROPHICATION

TSI	ATTRIBUTES	FISHERIES & RECREATION
< 30	**OLIGOTROPHIC:** Clear water, oxygen throughout the year at the bottom of the lake, very deep cold water.	Trout fisheries dominate.
30 - 40	Bottom of shallower lakes may become anoxic (no oxygen).	Trout fisheries in deep lakes only. Walleye, Tullibee present.
40 - 50	**MESOTROPHIC:** Water moderately clear most of the summer. May be "greener" in late summer.	No oxygen at the bottom of the lake results in loss of trout. Walleye may predominate.
50 - 60	**EUTROPHIC:** Algae and aquatic plant problems possible. "Green" water most of the year.	Warm-water fisheries only. Bass may dominate.
60 - 70	Blue-green algae dominate, algal scums and aquatic plant problems.	Dense algae and aquatic plants. Low water clarity may discourage swimming and boating.
70 - 80	**HYPEREUTROPHIC:** Dense algae and aquatic plants.	Water is not suitable for recreation.
> 80	Algal scums, few aquatic plants.	Rough fish (carp) dominate; summer fish kills possible.

Fish Lake is an oligo-mesotrophic lake with a mean TSI of 40. Oligo-mesotrophic lakes have low to moderate nutrient levels (phosphorus and nitrogen) and good clarity (Secchi depth).

TREND ANALYSIS

For detecting trends, a minimum of 8-10 years of data with four or more readings per season are recommended by the MPCA. Where data does not cover at least eight years or where there are only few samples within a year, trends can be misidentified because there can be different wet years and dry years, water levels, weather, etc., that affect the water quality naturally. The data was analyzed using the Mann Kendall Trend Analysis.



TOTAL PHOSPHORUS (UG/L)

Phosphorus is a nutrient that plays an important role in plant growth. Higher phosphorus concentrations are associated with increased growth of aquatic plants and algae. Total phosphorous is a "cause" parameter: when phosphorus increases, algae concentration increases and transparency decreases. An improving trend for total phosphorus means that the phosphorus levels are decreasing.

From 2009 – 2021, no significant trend exists for total phosphorus in Fish Lake.

CHLOROPHYLL-A (UG/L)

Chlorophyll-a is the pigment that makes plants and algae green. Chlorophyll-a is tested in lakes to determine the algae concentration, or how "green" the water is. Concentrations greater than 10 ug/L are perceived as a mild algae bloom, while concentrations greater than 20 ug/L are perceived as a nuisance. An improving trend for chlorophyll-a means that the chlorophyll-a concentration is decreasing.

From 2009 – 2021, there is evidence of an improving trend with 99.9% confidence for chlorophyll-a in Fish Lake.

SECCHI DEPTH (FT)

Transparency is how easily light can pass through a substance. Lake transparency is measured using a Secchi disk. An increase in particles in the water results in a decrease in transparency. An improving trend for Secchi depth means that the Secchi depth is increasing. However, increased transparency is not necessarily positive if it is caused by zebra mussels filtering the water column and redepositing nutrients on the lake bottom.

From 2009 – 2021, there is evidence of an improving trend with 99.9% confidence for Secchi depth in Fish Lake.

STATE ASSESSMENTS

MPCA WATER QUALITY ASSESSMENTS

BENEFICIAL USE	ASSESSMENT YEAR	ASSESSED CONDITION	IMPAIRMENT CAUSE
Aquatic Consumption		Use Not Assessed	
Aquatic Life	2018	Insufficient Data for Use Assessment	
Aquatic Recreation	2018	Standards Met for All Assessed Parameters	

MPCA WATER QUALITY STANDARDS

Water quality standards:

- Protect water resources for uses such as fishing, swimming and other recreation, and sustaining fish, bugs, plants, and other aquatic life
- Are a measure to identify polluted waters or healthy waters in need of protection
- Guide the limits set on what regulated facilities can discharge to surface water

The federal Clean Water Act requires states to designate beneficial uses for all waters and develop water quality standards to protect each use. Water quality standards consist of several parts:

- Beneficial uses – Identify how people, aquatic communities, and wildlife use our waters
- Numeric standards – Amounts of specific pollutants allowed in a body of water and still protects it for the beneficial uses
- Narrative standards – Statements of unacceptable conditions in and on the water
- Antidegradation protections – Extra protection for high-quality or unique waters and existing uses

Together, the beneficial uses, numeric and narrative standards, and antidegradation protections provide the framework for achieving Clean Water Act goals. The Clean Water Act specifies healthy aquatic life and recreation as beneficial uses. Others that are protected in Minnesota's rules are:

- Drinking water
- Industrial and agricultural uses
- Wildlife
- Navigation
- Aesthetic enjoyment

More information on water quality standards:
https://www.pca.state.mn.us/water/water-quality-standards

More information on monitoring and assessment:
https://www.pca.state.mn.us/water/water-monitoring-and-assessment

CHAPTER 5. FISHERIES STATUS

PELICAN LAKE

(DNR Report, as of 06/22/2022)

Pelican Lake is a 3,986-acre mesotrophic (moderately fertile) lake located in northwestern Otter Tail County approximately seven miles north of Pelican Rapids, MN. Pelican Lake is within the Otter Tail River Watershed. The southern portion of the lake (309 acres) is referred to as Fish Lake. Pelican Lake is connected to Little Pelican Lake and Lake Lizzie via the Pelican River. The Pelican River inlet is located along the east shoreline of the lake while the outlet is located along the south shoreline of Fish Lake. The Pelican River is navigable by boat upstream to Little Pelican Lake. The dam at the outlet was modified in the spring of 2018 to allow for fish passage. The maximum depth of Pelican Lake is 55 feet; however, 41% of the lake is less than 15 feet in depth. The secchi disk reading during the 2021 survey was 11.2 feet. Previous secchi disk readings have ranged from 5.4 to 14.7 feet.

The shoreline of Pelican Lake has been extensively developed. Homes, cottages, and resorts compose the majority of the development. DNR owned concrete public water accesses are located along the east and southwest shorelines of the lake. The shoal water substrates consist primarily of sand and gravel. Remnant stands of hardstem bulrush and wild rice are scattered along various shorelines of the lake. A large stand of hardstem bulrush is located along the north shoreline of the entrance into Fish Lake. Emergent aquatic plants such as bulrush and wild rice provide valuable fish and wildlife habitat, and are critical for maintaining good water quality. Emergent plants provide spawning areas for fish such as Northern Pike, Largemouth Bass, and panfish. They also serve as important nursery areas for all species of fish. Because of their ecological value, emergent plants may not be removed without a DNR permit. To maintain the excellent water quality and angling that this lake has to offer, it is imperative to preserve the quality of the aquatic habitat.

Pelican Lake is a popular angling lake. It is best known for its excellent Walleye, Northern Pike, Black Crappie, and Bluegill fishing. Pelican Lake is also renowned as a trophy Muskellunge fishery.

The Walleye population continues to be very abundant. The 2018 year class is very strong and should provide consistently good Walleye angling for several years. Walleyes ranged in length from 8.2 to 25.1 inches with an average length and weight of 14.8 inches and 1.2 pounds. Walleyes attain an average length of 16.5 inches at four years of age.

The Northern Pike population has demonstrated stability over the recent series of surveys. Northern Pike abundance has remained at a moderate density and natural reproduction has continued to be consistently good. Northern Pike ranged in length from 16.2 to 34.7 inches with an average length and weight of 25.1 inches and 3.5 pounds. Pike attain an average length of 24.9 inches at four years of age.

The Muskellunge population in the Pelican Chain of Lakes is managed as a low density, high quality fishery. Muskellunge ranged in length from 28.5 to 53.0 inches with a mean length of 42.5 inches. A 2021 recapture effort is planned to develop a population estimate for Muskellunge in the Pelican Chain of Lakes.

The Black Crappie population has an excellent size structure and age data indicate that crappie reproduction is consistently good. Sixty-eight percent of the crappies were 10.0 inches or greater in length. Black Crappie attain an average length of 10.7 inches at five years of age.

Bluegill abundance is moderate and Bluegill reproduction is consistently good. Forty percent of the Bluegills were 7.0 inches or greater in length, while 15% were 8.0 inches or greater in length. Bluegills attain an average length of 7.3 inches at six years of age.

Anglers can maintain the quality of fishing by practicing selective harvest. Selective harvest encourages the release of medium to large-size fish while allowing the harvest of the more abundant smaller fish for table fare. Releasing the medium to large fish will ensure that the lake will have enough spawning age fish on an annual basis and will provide anglers with more opportunities to catch large fish in the future.

Pelican Lake was listed as infested with zebra mussels in 2009. Aquatic invasive species are threatening Minnesota waters. Aquatic invasive species can potentially harm water quality, water recreation, aquatic habitat, native species, and fish populations. Anglers can help prevent the introduction and spread of invasive species by following watercraft transportation laws.

https://www.dnr.state.mn.us/lakefind/showreport.html?downum=56078600

LITTLE PELICAN LAKE

(DNR Report, as of 06/22/2022)

Little Pelican Lake is a 345 acre mesotrophic (moderately fertile) lake located in northwest Otter Tail County, approximately ten miles northeast of the city of Pelican Rapids. It has a maximum depth of 25 feet and 74% of the lake is 15 feet or less in depth. Shoreline substrates consist primarily of sand and muck. Secchi disk readings, a measure of water clarity, have been taken during fish assessments since 1967. The reading in 1999 was 11.0 feet. Past readings have ranged from 3.0 to 9.2 feet. Access is gained through a navigable channel from Big Pelican Lake. Development is located on the north and south shorelines. The east end of the lake contains marshy areas. Emergent vegetation (bulrush, cattail, wild rice) is located in areas throughout the basin. Emergent plants are important because they provide valuable fish and wildlife habitat and are critical for maintaining good water quality. They protect shorelines from erosion and can even absorb and break down pollutants from the water. Emergent plants provide spawning areas for fish species such as northern pike, largemouth bass and panfish. They also are important nursery areas all species of fish. Because of their ecological importance, emergent plants may not be removed without a DNR permit. Little Pelican Lake contains good populations of bluegill, largemouth bass, northern pike and black crappie. The bluegill size structure is good with 42% of the bluegill sampled in 1999 over 7.0 inches in length. Largemouth bass and black crappie are likely present in good numbers. Spring assessments in the future will provide better information on these species. Spawning habitat exists throughout the basin for these species to thrive on their own. Walleye are not stocked in Little Pelican Lake. The walleye population is likely maintained by immigrants entering from Big Pelican Lake. The population is currently good and well balanced with fish ranging in length from 10.0 to 24.5 inches.

https://www.dnr.state.mn.us/lakefind/showreport.html?downum=56076100

BASS & FISH LAKES

(DNR Report, as of 06/22/2022)

Fish Lake is a 267-acre mesotrophic (moderately fertile) lake located in northwest Otter Tail County nine miles northeast of Pelican Rapids, MN. A portion of Fish Lake is also referred to as Bass Lake. Fish Lake is connected to Pelican Lake by a navigable channel. The immediate watershed is composed of mixed hardwood forest. The maximum depth is 69 feet; however, 30% of the lake is 15 feet or less in depth. The secchi disk reading was 13.5 feet, indicating good water clarity. Previous secchi disk readings ranged from 8.9 to 11.3 feet.

Shoalwater substrates consist primarily of sand and gravel. Hardstem bulrush and common cattail are prevalent along the shorelines of the lake. These emergent plants provide valuable fish and wildlife habitat and are critical in maintaining good water quality. Emergent plants also provide critical spawning habitat for several species of fish including northern pike, largemouth bass, and panfish. They also serve as important nursery areas for many species of fish. Because of their ecological value, emergent plants cannot be removed without a DNR permit.

Since Fish Lake is connected to Pelican Lake, population dynamics of the fish community tend to reflect those in Pelican Lake.

The northern pike test-net catch rate exceeded the normal range for this class of lake. Age data indicate that pike reproduction is consistently good. Pike ranged in length from 10.9 to 33.7 inches with an average length and weight of 19.6 inches and 1.8 pounds. Seventeen percent of the northern pike were 24.0 inches or greater in length. Pike attain an average length of 21.9 inches at five years of age.

The walleye test-net catch rate was within the normal range for this class of lake. The 2002 and 2006 year classes are strong. These year classes are also strong in Pelican Lake. Walleyes ranged in length from 10.0 to 22.6 inches with an average length and weight of 15.3 inches and 1.3 pounds. Walleye attain an average length of 14.1 inches at four years of age.

The bluegill test-net catch rate was within the normal range for this class of lake. Bluegill size structure is very good. The average length of bluegill was 6.9 inches. Sixty-five percent of the bluegills were 7.0 inches or greater in length. Bluegills attain an average length of 7.5 inches at five years of age.

Anglers can maintain the quality of angling by practicing selective harvest. Selective harvest encourages the release of medium to large size fish while allowing the harvest of more abundant smaller fish for table fare. Releasing the medium to large fish will ensure that the lake will have enough spawning age fish on an annual basis and will provide anglers with more opportunities to catch large fish in the future.

https://www.dnr.state.mn.us/lakefind/showreport.html?downum=56076800

CHAPTER 6. AQUATIC PLANT SURVEYS

Aquatic plants play an important role in water quality and ecosystem health. Unfortunately, most people see aquatic plants as problems. They perceive lakes or lakeshores with lots of so-called "weeds" as messy and in need of cleaning. But what a cabin owner sees as a weedy mess is an essential part of the aquatic ecosystem. Without aquatic plants, lakes would have fewer aquatic insects, minnows, and other wildlife. If too many aquatic plants are removed from a lake, fish and wildlife populations and water clarity may suffer. Aquatic plants are an essential part of the natural community in most lakes.

Aquatic plants serve many important functions:

- Provide food and shelter for wildlife such as waterfowl, fish, otters, etc.
- Improve water quality and clarity
- Protect shorelines and stabilize lake bottom sediments

In 2003, Blue Water Science was hired by PGOLID to conduct a plant survey. They completed a transect survey that concluded that the Pelican Lakes have a moderate diversity of aquatic plants. In addition, this survey identified the presence of Curly-leaf pondweed, an invasive aquatic plant. Unfortunately, transect surveys aren't recognized by the Minnesota Department of Natural Resources (DNR).

In 2010-2011, PGOLID conducted another plant survey in Little Pelican, Bass, Fish and Pelican Lake. These surveys used the point intercept method, which is recognized by the DNR. The goals of this survey were to update plant data on the lake and compare it to the 2003 results and identify any new areas of invasive aquatic plants.

In 2015, PGOLID conducted a plant survey of Echo Bay to document the native plants present there. Echo Bay was found to have a very diverse and healthy plant community.

Starting in 2017, the Lake Coordinator started public access checks for Starry stonewort and Eurasian watermilfoil.

The Pelican Group of Lakes is surveyed annually for invasive curly-leaf pondweed. In recent years, the Lake Coordinator has documented all plant species present in the lakes at these survey points. This data is used to detect changes in biodiversity over time, which could indicate a shift in lake trophic status.

PLANT SPECIES SURVEY

(DNR Report, surveyed 06/23/2005)

SUBMERGED PLANTS

Coontail	*Ceratophyllum demersum*
Canadian waterweed	*Elodea canadensis*
Water Stargrass, Mud Plantain	*Heteranthera dubia*
Northern Watermilfoil	*Myriophyllum sibiricum*
Whorled Watermilfoil	*Myriophyllum verticillatum*
Bushy Pondweed, Common Naiad	*Najas flexilis*
Curly-leaf Pondweed	*Potamogeton crispus*
Fries' Pondweed	*Potamogeton friesii*
Illinois Pondweed	*Potamogeton illinoensis*
White-stemmed Pondweed	*Potamogeton praelongus*
Very Small Pondweed	*Potamogeton pusillus*
Flatstem Pondweed	*Potamogeton zosteriformis*
White water-crowfoot	*Ranunculus aquatilis var. diffusus*
Common Sago Pondweed	*Stuckenia pectinata*
Greater bladderwort	*Utricularia vulgaris*
Wild Celery, Eel-grass	*Vallisneria americana*

FREE-FLOATING PLANTS

Ivy-leaved duckweed	*Lemna trisulca*
Turion-forming Duckweed	*Lemna turionifera*
Greater duckweed	*Spirodela polyrhiza*

FLOATING-LEAF PLANTS

Yellow Water Lily	*Nuphar variegata*
White Water Lily	*Nymphaea odorata ssp. tuberosa*
Variable Pondweed	*Potamogeton gramineus*
Floating Leaf Pondweed	*Potamogeton natans*

EMERGENT PLANTS

Small's Spikerush	*Eleocharis palustris*
Common reed grass, Cane	*Phragmites australis*
Hard-stem bulrush	*Schoenoplectus acutus var. acutus*
Narrow-leaved cat-tail	*Typha angustifolia*
Broad-leaved cattail	*Typha latifolia*
Wild rice	*Zizania palustris*

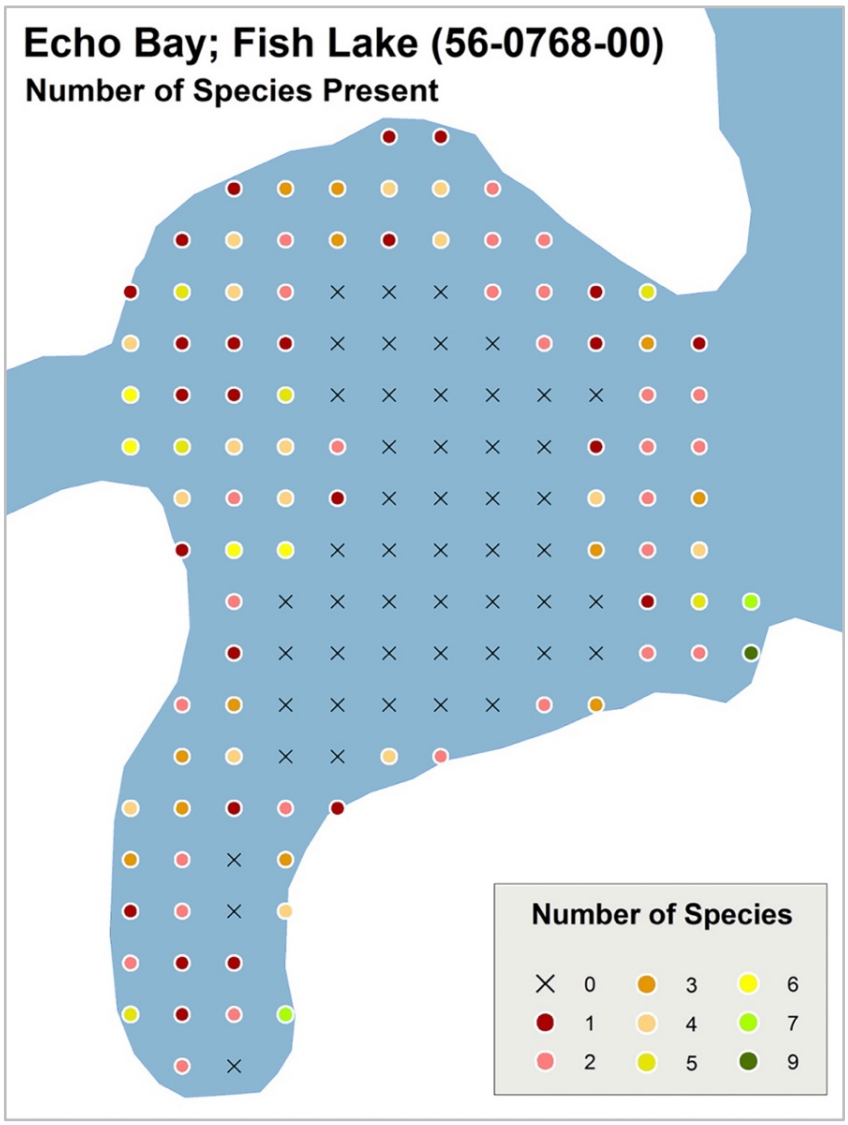
SHORELINE PLANTS

Needle Spike-rush	*Eleocharis acicularis*
Jewelweed, Spotted touch-me-not	*Impatiens capensis*
Reed canary grass	*Phalaris arundinacea*
Sand-bar willow	*Salix interior*

ECHO BAY 2015

In August 2015, RMB Environmental Laboratories conducted a plant survey in Echo Bay of Fish Lake. This is the last undeveloped shoreline in PGOLID, and has been considered by developers as a potential site for development. The survey was conducted to document the current pristine conditions of the bay, the vegetation, and fish and wildlife habitat. Echo Bay is biologically significant for Pelican and Fish Lakes. It is where much of the fish spawning in the group of lakes occurs, and it provides important wildlife habitat such as nesting sites for loons.

Three submerged species and one emergent species made up the majority of plants sampled in Echo Bay. Chara (*Chara sp.*) was sampled at 29.66% of all sites and 42.16% of sites less than 25 feet. Bulrush (*Sirpus acutus*) was sampled at 26.9% of all sites and 38.24% of sites less than 25 feet. Coontail (*Ceratophyllum demersum*) and White Waterlily (*Nymphaea odorata*) were both sampled at 19.31% of all sites and 27.45% of sites less than 25 feet.



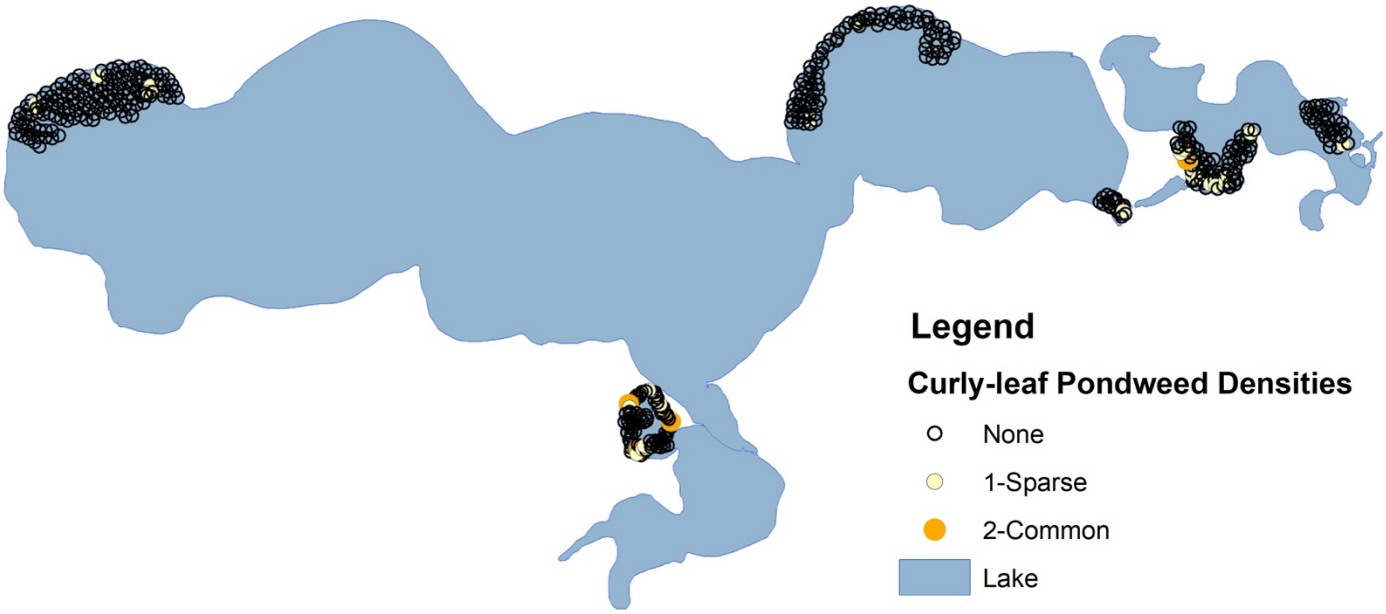
Other native plants sampled in Echo Bay include Cattail (*Typha sp.*), Claspingleaf Pondweed (*Potamogeton richardsonii*), Canada Waterweed (*Elodea canadensis*), Northern water milfoil (*Myriophyllum sibiricum*), Bushy Pondweed (*Najas flexilis*), Flatstem Pondweed (*Potamogeton zosteriformis*), Greater Bladderwort (*Utricularia vulgaris*), Illinois Pondweed (*Potamogeton ilinoensis*), Floatingleaf Pondweed (*Potamogeton natans*), Sago Pondweed (*Potamogeton pectinatus*), White Water Buttercup (*Ranunculus longirostris*), Yellow Waterlily (N*uphar variegata*), Star Duckweed (*Lemna triscula*), and Water Marigold (*Bidens Beckii*).

Sampling occurred to a maximum depth of 30 feet; however, no plants were found to be growing beyond 24 feet of water. Plant abundance was greatest between one and eight feet of water. As depths increased beyond that range, the presences of vegetation decreased and became less dense.

CURLY-LEAF PONDWEED 2021

In May 2021, the PGOLID Lake Coordinator and field staff performed a delineation of curly-leaf pondweed on Pelican, Bass, and Little Pelican Lakes. During the survey, curly-leaf pondweed was observed at 36 out of 479 (7.5%) targeted sample points. Curly-leaf pondweed was found growing most commonly at about 10 feet deep. On a 0-3 point density rating scale, it was found most commonly with a density of 1, which is generally characterized as sparse / scattered.

DENSITY RATING	# OF OBSERVATIONS	PERCENT
1 - SPARSE/SCATTERED	31	86%
2 - COMMON	5	14%
3 - ABUNDANT	0	0%



Curly-leaf pondweed was most abundant in Little Pelican and Bass Lakes. One potential treatment area was identified totaling 1 acre on Pelican Lake. Two potential treatment areas were identified totaling 3 acres on Little Pelican Lake. Three potential treatment areas were identified totaling approximately 2 acres on Bass Lake.

CHAPTER 7. INVASIVE SPECIES

Since 2004, PGOLID has been very vigilant in working to prevent invasive species in the Pelican Group of Lakes. These activities have included chemical treatment of invasive plants, the DNR Watercraft Inspection Program, and Educational Seminars conducted by the PGOLID Water Resource Coordinator.

CURRENT STATUS

Currently, there are three invasive species present in the Pelican Group of Lakes: zebra mussels, curly-leaf pondweed, and flowering rush. Unfortunately there is no treatment for zebra mussels. Curly-leaf pondweed is surveyed annually and controlled by chemical treatment. Flowering rush is established upstream through the Pelican River in Detroit, Sallie, Melissa, and Mill Lakes. In recent years, it has been found in Buck Lake, which is directly upstream from Little Pelican Lake. The Water Resource Coordinator surveys sections of the Pelican River annually to monitor the spread and remove the flowering rush by hand. PGOLID has a Flowering Rush Contingency Plan to deal with the threat of this invasive plant in the future.

HISTORY

In 2003, Curly-leaf pondweed was found in Pelican, Little Pelican and Bass Lakes during the lakewide plant survey (Blue Water Science). In 2005, PGOLID started a curly-leaf pondweed chemical treatment program and the results have been successful. From 2005 to 2009, there was a 95% reduction in curly-leaf pondweed in the PGOLID lakes. Eradication of this exotic species is not likely within any body of water the size of Pelican Lake, but continued management practices can keep detrimental effects of this plant to a minimum.

In 2006, PGOLID started the DNR Invasive Species Watercraft Inspection Program. In this program, PGOLID applies for DNR grant funding to have a DNR summer intern posted at their public accesses. This intern interviews boaters and inspects all boats entering and leaving Pelican Lake about invasive species. In 2008-2012, the DNR intern was present at public accesses from Thursday to Sunday every weekend from Opening Fishing to Labor Day. This program both protects Pelican Lake from invasive species and educates boaters about invasive species in Minnesota lakes. PGOLID plans to continue this program every summer in the future.

Zebra mussels were found in Pelican Lake in September of 2009 by a lake resident. The resident called the PGOLID Water Resource Coordinator, and the sample was confirmed as a zebra mussel. That same afternoon, the PGOLID Water Resource Coordinator and the DNR searched for zebra mussels and confirmed that they were established in Pelican Lake. Some mussels were over an inch long, indicating that they have been established for over a year. Later in the fall of 2009, zebra mussels were also found in Fish Lake.

Flowering rush was first identified in Deadshot Bay of Big Detroit Lake in the mid-1970s, and it spread into Big Detroit by the end of the decade. By the early 1980s, it was found in many places around Big and Little Detroit. Flowering rush soon had established populations down the Pelican River including Muskrat, Sallie, and Melissa Lakes. It was found in Mill Pond in 2007, and Buck Lake in 2008. The next lake down the chain is Little Pelican.

ZEBRA MUSSELS

Zebra mussels are small animals with a striped, D-shaped shell composed of two hinged valves joined by a ligament. The shells are typically one-quarter inch to one and one-half inches long, depending on age, with alternating yellow and brownish colored stripes. Adults are typically fingernail-sized. Zebra mussels attach to hard surfaces underwater.

ORIGIN AND SPREAD

The zebra mussel is native to Eastern Europe and Western Russia. The species was unintentionally introduced into the United States' Great Lakes through the discharge of contaminated cargo ship ballast water. They were first discovered in the Great Lakes in 1988 and were first confirmed in the Duluth/Superior Harbor in 1989.

People spread zebra mussels primarily through the movement of water-related equipment. Mussels attach to boats, docks, swim rafts and boat lifts. They can also attach to aquatic plants. Adult mussels can survive out of water – less than five days in dry conditions, but up to 21 days in very wet conditions (such as inside dock/lift pipes). Microscopic larvae (veligers) can survive in water contained in bait buckets, live wells, bilge areas, ballast tanks, motors and other water-containing devices.

BIOLOGY

A single zebra mussel can filter one quart of water per day while feeding primarily on algae. They live underwater, attached to natural and manmade substrates such as rocks, wood, plants, native mussels, pipes, docks, boat lifts, swim rafts, moored watercraft, and other debris. A female can produce 100,000 to 500,000 eggs per year. Fertilized eggs develop into microscopic, free-living larvae, called "veligers," that form shells. After two to three weeks, the veligers settle and attach to a firm surface using tiny fibers called byssal threads. Beds of zebra mussels can reach tens-of-thousands within a single square yard.

THREAT TO MINNESOTA WATERS

Invasive species cause recreational, economic, and ecological damage—changing how residents and visitors use and enjoy Minnesota waters.

Zebra mussel impacts:

- Encrust equipment, such as boat motors and hulls, which reduces performance and efficiency and is costly to clean and repair.
- Swimmers and pets can cut their feet on zebra mussels attached to rocks, docks, swim rafts and ladders.
- Create a costly problem for power plants, cities and residents when they clog water intakes.
- Filter tiny food particles out of the water, which can reduce available food for larval fish and other animals, and can increase aquatic plant growth as a result of increased water clarity.
- Attach to and kill native mussels.

https://www.dnr.state.mn.us/invasives/aquaticanimals/zebramussel/index.html

CURLY-LEAF PONDWEED

Curly-leaf pondweed is a rooted, submersed aquatic plant. Its coloration varies from olive-green to reddish-brown. Wavy, lasagna-like leaves grow approximately a half-inch wide and two to three inches long. Leaves have an obvious mid-vein, "toothed" or serrated edges and blunt tips. Leaves are arranged alternately, are directly attached to the stem, and become denser toward the end of the stem. The main stem can be various colors including white, green, brown, and red, and tends to branch multiple times near the top of the plant. The plant may mat at the surface, but does not have true floating leaves.

Curly-leaf pondweed looks similar to many native beneficial pondweeds found in Minnesota lakes and rivers, but can be distinguished based on its serrated leaf edges.

ORIGIN AND SPREAD

Curly-leaf pondweed is native to Eurasia, Africa, and Australia. It was likely introduced when common carp were intentionally introduced into Midwest waters as a game fish in the 1880s. The species was likely spread through the movement of watercraft and water-related equipment. It was first noted in Minnesota around 1910.

People spread curly-leaf pondweed primarily through the movement of water-related equipment. Plant fragments and turions can get stuck on trailers, motors, docks, boat lifts, swim rafts and inside watercraft (boats, canoes and kayaks). Turions, which may be hidden in mud and debris, can stick to anchors as well as scuba, fishing, and hunting gear.

BIOLOGY

Curly-leaf pondweed generally grows from the shore to water depths of 15 feet, and can grow up to 15 feet tall. It tolerates low water clarity and will readily invade disturbed areas. Curly-leaf can be distinguished from native pondweeds by its unique life cycle. Turions sprout in the fall, and it is generally the first pondweed to come up in the spring. It typically flowers, fruits, and produces turions in June before dying back in mid-summer.

THREAT TO MINNESOTA WATERS

Invasive species cause recreational, economic, and ecological damage—changing how residents and visitors use and enjoy Minnesota waters.

Curly-leaf pondweed impacts:

- Dense mats at the water's surface inhibit water recreationists.
- Overtakes habitat and outcompetes native aquatic plants, potentially lowering diversity.
- Provides unsuitable shelter, food, and nesting habitat for native animals.
- Midsummer die-offs can litter the shoreline with dead plants.

https://www.dnr.state.mn.us/invasives/aquaticplants/curlyleaf_pondweed.html

TREATMENT

A curly-leaf pondweed survey was performed within Pelican and Little Pelican Lakes during June 2005 for the identification and mapping of curly-leaf pondweed area perimeters. The areas that were mapped as containing curly-leaf pondweed during 2005 received herbicidal treatment during May 2006. The herbicidal treatment program was very successful. The curly-leaf pondweed program was continued during 2007 and 2008 adding Fish and Bass Lakes, and a total of approximately 31 acres were treated each year.

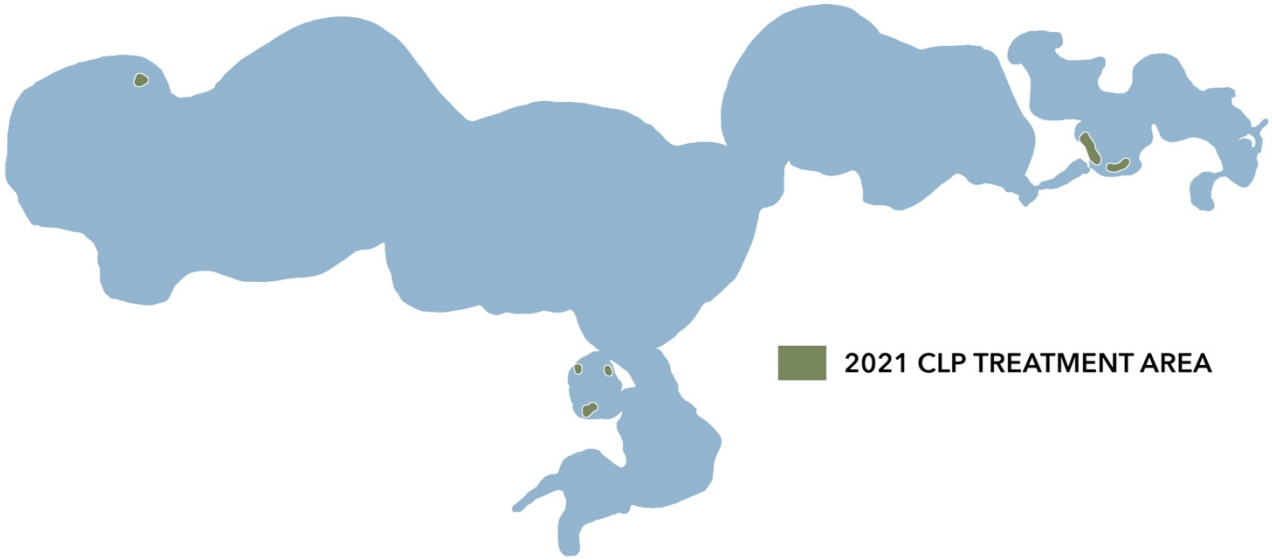
Goals of the curly-leaf pondweed herbicide control efforts include:

- Minimization of floating and drifting cut and fragmented curly-leaf pondweed plants which will inevitably be spread throughout the lakes and transported to non-infested lakes
- Prevention of the development and maturity of turions (nodules that propagate the plant)
- Prevention of matting curly-leaf pondweed on the water's surface. This prevention will improve recreational activities and increase lake-user safety
- Allowance of the native plant community to become reestablished in places where they are currently being displaced by curly-leaf pondweed to improve fish habitat

A Minnesota Department of Natural Resources (MN DNR) permit to destroy aquatic vegetation must be obtained yearly before the application of herbicide is allowed. All property owners that are adjacent to the treatment areas must provide written herbicide application authorization before the MN DNR will issue a permit.

Curly-leaf pondweed is now surveyed every spring, and dense areas are treated with herbicide. The largest areas of curly-leaf pondweed are now sufficiently thinned-out, and PGOLID is in maintenance-mode with annual treatments in small areas.

Participation by property owners, Lake Improvement District supporters, Lake Improvement District Board Persons, Minnesota Department of Natural Resources personnel and others have all contributed successfully to this program. Continued surveying and herbicidal treatments are recommended in order to keep this exotic aquatic plant managed within Bass, Little Pelican, and Pelican Lakes. Eradication of this exotic species is not likely within any body of water, but continued management practices can keep detrimental effects of this plant to a minimum.



FLOWERING RUSH

Flowering rush is a perennial plant that grows one to four feet high along shores in shallow, slow-moving water. In deeper water, it can grow in a submerged form that does not produce flowers. It flowers in early summer through mid-fall.

Flowering rush is difficult to identify when not in flower, as it closely resembles many native, beneficial shoreland plants in Minnesota, such as the common bulrush.

ORIGIN AND SPREAD

Flowering rush is native to Europe and Western Asia. The first discovery in North America was in the St. Lawrence River in 1897. The species was unintentionally introduced into the United States' Great Lakes through the discharge of contaminated cargo ship ballast water. The species was commonly imported and sold by the water garden trade, leading to the potential for illegal release into the wild. Flowering rush was first confirmed in Minnesota in 1968.

People spread flowering rush primarily through movement of water-related equipment and illegal release of water garden plants into public waters. The small rhizome buds, or bulbils, can be hidden in mud and debris, and can stick to boots, waders, and other fishing and hunting gear.

BIOLOGY

Flowering rush is a reed-like wetland plant with pink flowers. Leaves are tall, extend from the roots, and are dark green in color. Leaves have a triangular cross-section and tend to twist near the tip. Flowers comprise of three pink petals and three sepals arranged in clusters or umbels (umbrella shaped) on a flower stalk. Flowers typically bloom in June through early fall. Small buds that form in the clusters of flowers can disperse and grow into new plants. Populations in the eastern United States produce seeds. Only one Minnesota population in Forest Lake (Washington County) is known to produce viable seeds. All other flowering rush populations in Minnesota are sterile and reproduce by vegetative spread, not seeds.

THREAT TO MINNESOTA WATERS

Invasive species cause recreational, economic, and ecological damage—changing how residents and visitors use and enjoy Minnesota waters.

Flowering rush impacts:

- Dense growth along shoreland areas makes it difficult to access open water.
- Overtakes habitat and outcompetes native aquatic plants, potentially lowering diversity.
- Provides unsuitable shelter, food, and nesting habitat for native animals.

https://www.dnr.state.mn.us/invasives/terrestrialplants/herbaceous/floweringrush.html

PGOLID CONTINGENCY CONTROL PLAN

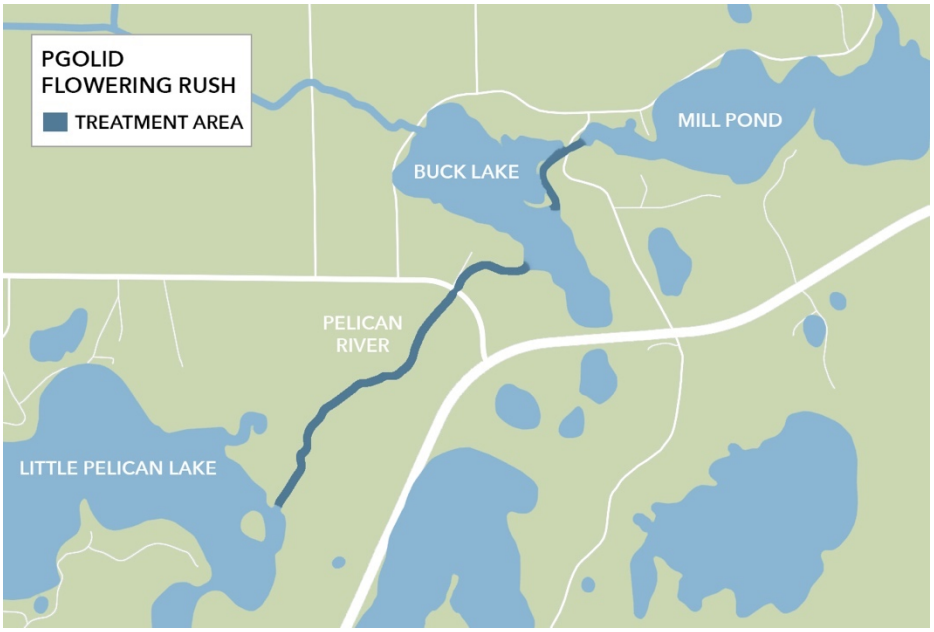
The Water Resource Coordinator shall monitor the district and upstream of the district for the introduction of flowering rush, as well as the success of the treatment and methods of control used by the Pelican River Watershed District and DNR. The Flowering Rush Contingency Control Plan will be updated accordingly.

Annually, numerous surveys will be conducted by the Water Resource Coordinator. Canoeing down the Pelican River is the best method, since many survey areas are too shallow and too dense with aquatic vegetation for a motorized boat. The survey focus will be just north of the Bucks Mill Dam in Mill Lake, the Pelican River south to Buck Lake, and the Pelican River into Little Pelican Lake. PGOLID has requested DNR surveys in Little Pelican Lake as well.

If small stands of flowering rush are discovered south of Bucks Mill, the Water Resource Coordinator will acquire a DNR permit for hand removal. The Water Resource Coordinator with an accompanying PGOLID board member will remove the plant(s) with a shovel. All discovered stands of flowering rush will be documented by a GPS location so the sites can be monitored in following years.

In the future, if larger areas of flowering rush are discovered that are unable to be removed by hand, chemical treatment will need to be implemented. The Water Resource Coordinator will seek permission from all landowners within 150 feet of the proposed treatment area, and the PGOLID board will acquire a DNR permit and hire a chemical applicator to treat the infested areas. The chemical imazapyr under the label Habitat would be applied annually over several years for control. Residents near the infected area would be educated on the spread and treatment of flowering rush to encouraging best management practices of this exotic plant.

The PGOLID board has set aside funding for chemical treatment of flowering rush if the need arises. This flexibility in the budget allows for swift mitigation of any new problem areas. In addition, the DNR has a new grant program for Early Detection/Rapid Response to invasive species. Under this grant, PGOLID could apply for funding to chemically treat flowering rush if it is ever found in a large area south of Mill Pond.



CHAPTER 8. SHORELINE MANAGEMENT

The shoreland area is valuable for promoting a natural environment and a natural lake experience for lake users. Shoreline buffers of native plants not only filter and absorb overland runoff; they also prevent shoreline erosion, attract songbirds and butterflies, and deter nuisance geese. The shoreland is defined as the upland area about 300 to 1,000 feet back from the shoreline, and out into the lake to the end of the dock.

The PGOLID Lakes encompass approximately 1,117 parcels in total. In 2004, Blue Water Science conducted a shoreline inventory survey for PGOLID. In this survey, a photograph was taken of each parcel and the parcel was rated as to its vegetative cover. In all, approximately 40% of the parcels in PGOLID meet the natural ranking criteria for shorelines and upland areas. This is about average compared to other lakes found in northern Minnesota; however, these results show a great potential for improvement.

PGOLID took this shoreline inventory information and applied for a DNR Shoreline Habitat Restoration Grant to restore natural conditions to participating properties. PGOLID has now received three consecutive DNR grants and completed 15 restoration projects since 2009. These projects will act as demonstration sites for other property owners to see the benefits of a natural shoreline.

The DNR Shoreline Habitat Restoration Grants were discontinued in 2016. However, PGOLID has continued to encourage shoreline best management practices through projects such as the tree planting program. Lake residents may also work with the Otter Tail County Shoreline Specialist on shoreline restoration projects such as rain gardens and native plant buffers.

In the next few years, it is recommended to repeat the 2004 shoreline inventory project and see if there is improvement in the percentage of parcels that have over 50% natural vegetation. Future PGOLID shoreline management projects may include conservation easements and forest stewardship planning, as well as ongoing educational programs related to shoreline restoration and stewardship for lake residents.

SOURCE: *Michigan Natural Shoreline Partnership*

SHORELINE INVENTORY 2004

The shoreland area encompasses three components: the upland fringe, the shoreline, and shallow water area by the shore. A photographic inventory of Pelican Lake shoreline was conducted on July 17, August 21, and September 16, 2004 by Blue Water Science. The objectives of the survey were to characterize existing shoreland conditions which will serve as a benchmark for future comparisons.

For each photograph the shoreline and the upland condition were looked at and evaluated. The criteria for natural conditions were the presence of 50% native vegetation in the understory and at least 50% natural vegetation along the shoreline in a strip at least 15 feet deep. Shorelines and uplands at the 75% natural level were evaluated as well.

A summary of the inventory results is shown below. Based on the subjective criteria over 40% of the parcels in Pelican Lake shoreland area meet the natural ranking criteria for shorelines and upland areas. This is about average compared to other lakes found in the Northern Minnesota data set. In comparing the lakes, Pelican had the least amount of natural shoreline condition and Little Pelican Lake had the most.

In the next five to ten years, proactive volunteer native landscaping could improve the natural aspects of some of parcels. Improving the percentage of naturally landscaped parcels will improve water quality and fish and wildlife habitat in the Pelican Group of Lakes.

	Natural Shoreline Condition		Natural Upland Condition		Undevel. Parcels	Shoreline Structure Present	
	>50%	>75%	>50%	>75%		Riprap	Wall
PELICAN LAKE TOTALS (no. of parcels = 881)	21% (181)	16% (142)	21% (183)	14% (123)	14% (2)	68% (596)	18% (158)
LITTLE PELICAN LAKE TOTALS (no. of parcels = 119)	66% (79)	61% (73)	55% (65)	61% (51)	33% (39)	23% (27)	0% (0)
BASS LAKE TOTALS (no. of parcels = 22)	41% (9)	41% (9)	6% (27)	3% (14)	0% (0)	27% (6)	5% (1)
FISH LAKE TOTALS (no. of parcels = 95)	43% (41)	36% (38)	38% (36)	36% (34)	21% (20)	48% (46)	2% (2)
PGOLID TOTAL (no. of parcels = 1,117)	28% (310)	23% (262)	28% (311)	20% (222)	5% (61)	60% (675)	14% (161)

Example of a parcel with a shoreline buffer greater than 50% of the lot width and an understory with greater than 50% natural cover (left) and a parcel that does not qualify as having a natural shoreline buffer greater than 50% of the lot width, with an upland area with less than 50% natural cover (right).

DNR SHORELINE HABITAT RESTORATION GRANTS 2009 – 2015

In 2009, the PGOLID Water Resource Coordinator applied for a Shoreline Habitat Restoration Grant. This grant program is funded by the Minnesota Department of Natural Resources (DNR) and being implemented to protect the Pelican Group of Lakes water quality through shoreline buffers.

The purpose of this project was to educate PGOLID property owners about shoreline restoration. In order to improve the shoreline conditions in the Pelican Group of Lakes, attitudes need to shift about what is beautiful near the lake. The goal is to have property owners appreciate natural conditions over manicured lawns.

The restoration requirements to qualify for this grant funding are as follows. Projects require that at least 75% of the frontage is restored with an adjacent native plant buffer zone that is at least 25 ft deep/wide. The focus of these restoration projects must be on reestablishing native vegetation. Funds cannot be used for rock riprap stabilization or permanent wave breaks. In addition, funds cannot be used for new structures such as stairs.

Funds can be used for materials needed to reestablish native vegetation along shorelines. This may include: native trees, shrubs, plants and seeds; temporary biodegradable toe protection and erosion control fabric, mulch; herbicide to treat invasive species; controlled burns to prep or maintain the restoration site, labor to design, install and maintain the restoration project, temporary biodegradable wave breaks and fencing to keep out foot traffic or herbivores (geese/muskrats) from the site.

Projects should not destroy existing, desirable habitat or native vegetation. Only local, native species may be included within the project area. No exotic species or nursery-derived cultivars of natives may be used. Plants included in the project should be native to the county and grow in natural, reference sites along the lake or similar nearby ecosystems.

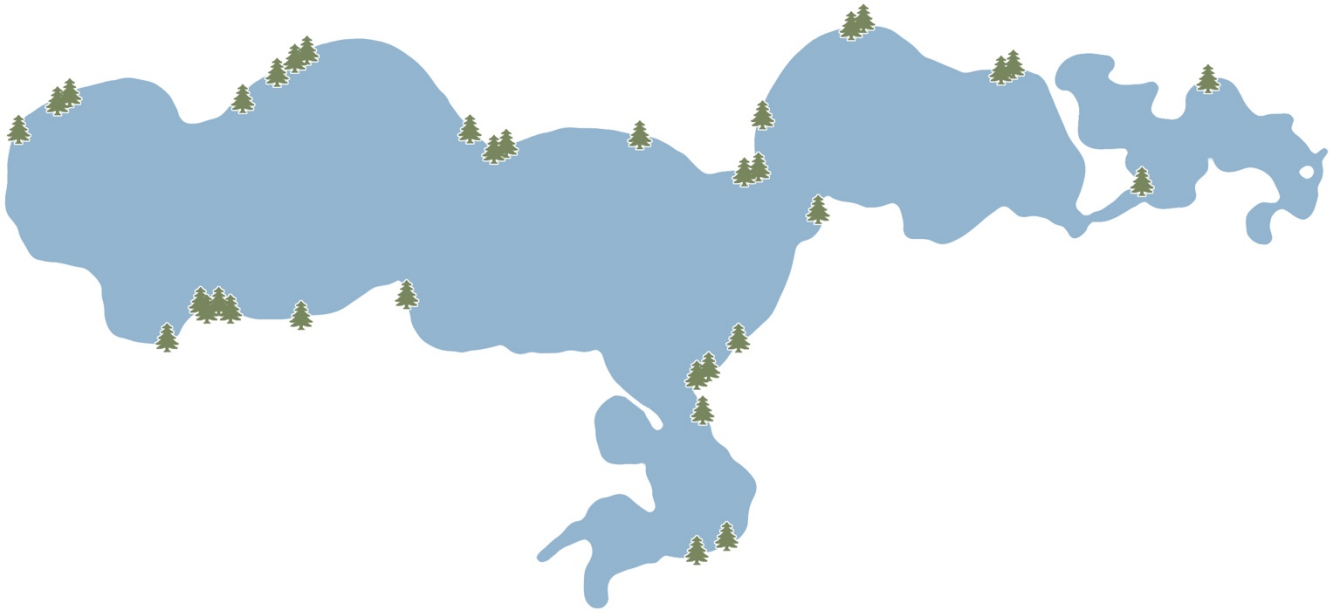
Since 2009, 15 properties have participated in this program.

- In 2009, PGOLID was awarded a $25,000 grant for restoring shoreline properties back to their natural conditions. 6 properties were planted.
- In 2011, PGOLID was awarded a $21,500 grant for restoring shoreline properties. 7 projects were completed with this funding.
- In 2013, PGOLID was awarded a $20,000 grant for restoring shoreline properties. 2 projects were completed with this funding.

This grant program was discontinued in 2016 due to a shift in funding and priorities for the DNR. Now, if residents would like to do a shoreline project, they are referred to the Otter Tail County Shoreline Specialist.

TREE PROGRAM 2016 – 2022

With the discontinuation of the DNR's shoreline restoration grants, PGOLID decided to switch gears and start a tree planting program. Most of the trees along the shoreline of the Pelican Group of Lakes are mature, and young trees don't always get a chance to get started growing due to saplings being mowed over. PGOLID wanted to help residents plant young trees so that when the mature trees die there will be new ones to take their place. Every summer, residents are able to order trees, and the Lake Coordinator and staff will come plant them.



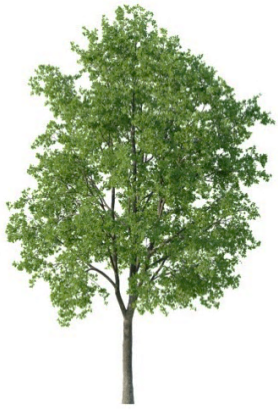
The map above shows the locations of trees planted in 2016 and 2017. In 2016, 70 trees were planted at 26 properties. In 2017, 50 trees were planted at 18 properties.

Four tree species are available for PGOLID residents who participate in the tree planting program: paper birch, white pine, sugar maple, and red oak. There is no limitation on where the trees can be planted, although preference is given to near the shoreline or around the buildings.

PAPER BIRCH

WHITE PINE

SUGAR MAPLE



RED OAK

FOREST PRESERVATION

Forest soils are loose and deep, catching water like a natural sponge. When land is developed, the soils become compacted, reducing the capacity of the sponge to absorb water. Roofs, driveways, and other structures are impervious and cannot absorb any water, increasing the volume of runoff. This increase in runoff carries sediment, nutrients, and chemicals into nearby waters. Agricultural practices removes the trees and disturbs the soils, increasing erosion and sediment runoff. When forest cover is removed from more than 25% of a lake's watershed, the impact on water quality is measurable.

The extensive root systems of forest trees penetrate deeply and create open pore spaces, which allows runoff to filter rapidly into the ground. Preserving forest cover limits changes in runoff volume, even as rainfall increases. Forest preservation also maintains habitat for wildlife, protects scenic views, and provides wood for local use.

Conversion of forests into residential or agricultural areas removes existing trees and changes the soil conditions. Traffic from construction equipment, vehicles, and lawn mowers compacts the soils and greatly reduces their ability to absorb rainfall, increasing the volume of runoff. It takes several decades for compacted soils to regain their ability to absorb water. Research by the National Park Service at wilderness campsites has found that as little as 10 days of foot traffic per year can cause significant changes to the soil conditions. Efforts to relieve compaction through tilling or soil aeration help by loosening the top layers, but these efforts do not address the significant compaction that is present 8 to 12 inches below the ground surface, which can only be repaired by natural processes over decades.

Research by the Minnesota DNR has found that removing forest cover from 25% of a lakeshed causes a noticeable decline in water quality. Using millions of dollars in Clean Water Legacy funds, conservation groups have protected thousands of acres of forests across Minnesota. Maintaining and expanding forest coverage in the PGOLID watershed is critical to preserving these resources for future generations. PGOLID hopes to partner with groups such as Minnesota Land Trust and The Nature Conservancy to develop forest protection programs around the Pelican Group of Lakes.

RECOMMENDATIONS

- Maintain existing forest cover by limiting new development
- Permanently protect forest lands with Legacy Amendment funded conservation easements
- Manage private forest acres with a forest stewardship plan, which can also provide a property tax reduction
- Restore forest coverage by planting individual trees or entire woodlands

CHAPTER 9. WASTE TREATMENT HISTORY & STATUS

PGOLID has been vigilant in monitoring septic system records for the lakes and implementing waste treatment education. The status of PGOLID waste treatment systems has improved overall since the 2003 records survey. Many of the systems from the 1970s have been updated in the last few years. The following projects have been completed:

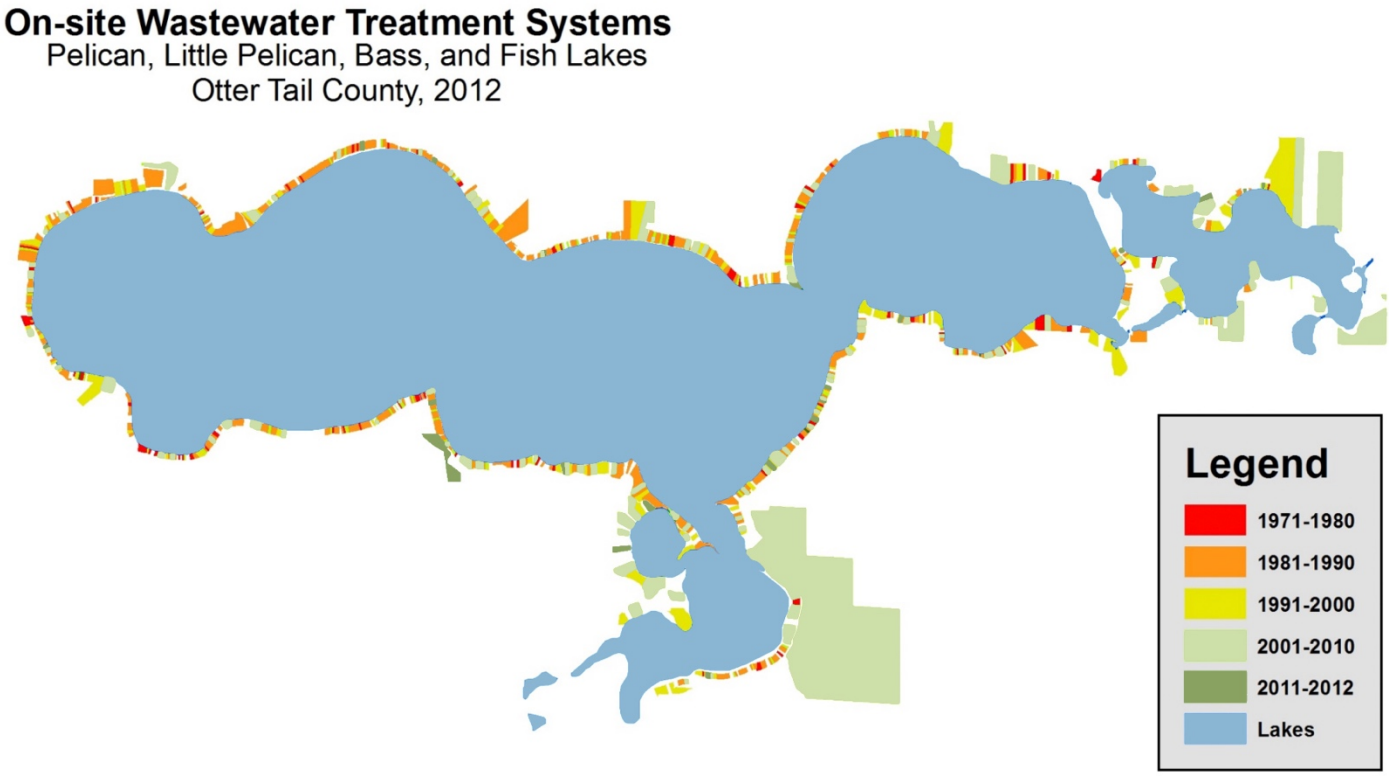
2004: COUNTY RECORDS SURVEY
Obtained county records for on-site waste treatment systems and evaluated the status and age of systems.

2006: WASTE TREATMENT SYSTEM SCREENING VOLUNTEER SURVEY
Invited lake residents to volunteer for a screening of their on-site waste treatment system.

2007 - 2009: OTTER TAIL COUNTY INSPECTIONS
In 2007-2009, Otter Tail County inspected on-site waste treatment systems that were 20 years old or older. They abated the properties that did not meet requirements.

2012: COUNTY RECORDS SURVEY
Obtained county records for on-site waste treatment systems and evaluated the status and age of systems. Findings were compared to the 2004 survey.

The status of PGOLID waste treatment systems showed improvement between 2003 and 2012. Many of the systems from the 1970s were updated. In 2003, there were 209 systems in the PGOLID lakes that were installed in the 1970s. In 2012, there were 90 systems that were installed in the 1970s, and 290 systems that were installed since 2000.



SOIL SUITABILITY FOR ON-SITE SYSTEMS

Soils around the Pelican Lakes area were evaluated for their suitability for septic systems. Each of the soils and their soil sub-types were examined for slope, permeability (excess or insufficient), and depth of the water table. These factors determine septic system drain field suitability. The five categories of soil limitations on septic systems created by these parameters are: 1) severe soil limitations with a poor filter, 2) severe soil limitations because of slope or depth of groundwater, 3) moderate soil limitations, 4) slight soil limitations, and 5) sand or gravel pits with little to no soil present.

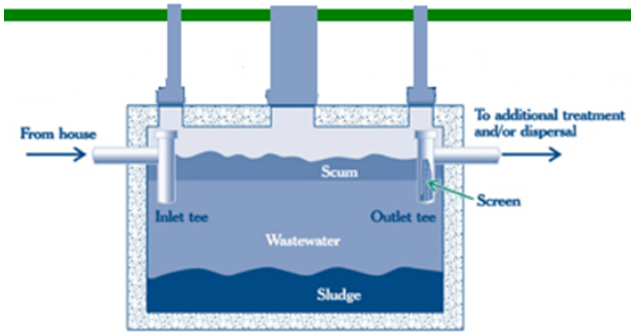
Moderately limited soils able to properly treat septic tank effluent represent about 20% of the soils around the Pelican Group of Lakes. Severely limited soils with a poor filter include those soils which are very permeable and filter water too quickly with the potential for inadequate nutrient removal. Around 25% of the soils around the Pelican Group of Lakes are severely limited by poor filtration. The majority of soils in the Pelican Group of Lakes area are considered severely limited with the following constraints which prevent them from being suitable for septic systems: slope, wetness, slow percolation, subsiding, or ponding. These severely limited soils are shown in red areas on the map and cover about 55% of the area.

BEST MANAGEMENT PRACTICES

More than 30 percent of Minnesota's households use septic systems (onsite sewage treatment systems) to treat their wastewater. Septic systems protect human health and the environment by safely recycling wastewater back into the environment. Government regulation ensures proper design and installation of permitted septic systems. However, property owners are responsible for properly operating and maintaining septic systems to protect human health and the environment. Improperly maintained septic systems are a threat to water quality. They contribute to high levels of nitrates or coliform bacteria in well water, and nutrient pollution fuels algae blooms and excessive plant growth in nearby water bodies.

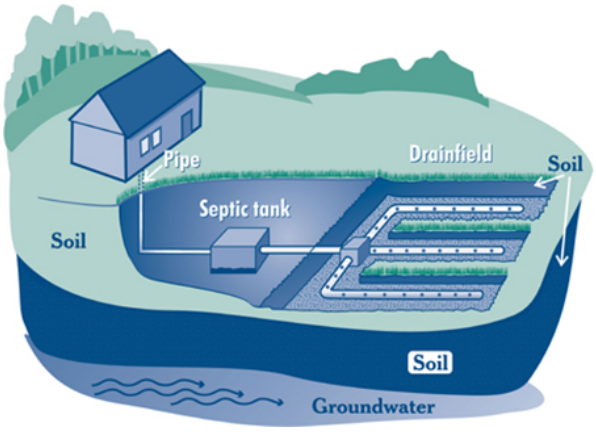
SEPTIC AND HOLDING TANK

- Make sure the riser is exposed so the tank can be inspected and pumped properly through the manhole
- Make sure your tank has an alarm to warn you when it is so full that it could cause backup
- Pump your holding tank every few weeks and your septic tank every few years
- Be conservative with your water usage



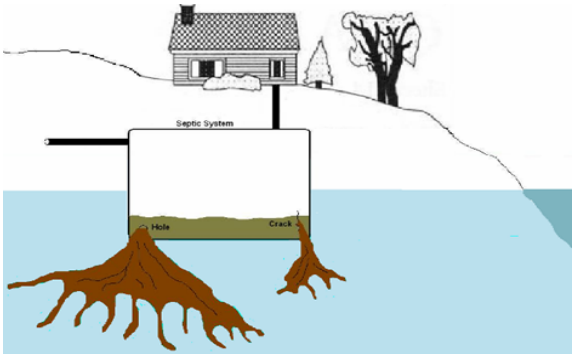
SEPTIC SYSTEM DRAINFIELD

- Make sure you have a drainfield that is not clogged and filtering correctly
- Do not irrigate your drainfield
- Do not drive on your drainfield or compact the soil, decreasing its filtering ability
- Make sure your drainfield is set back from the lake at least 50 feet
- Make sure no chemicals are killing the bacteria that recycle your waste in the drainfield (pesticides, bleaches, ammonias, paint, fuels and herbicides)



LAKE PROXIMITY

- Make sure your septic or holding tank is set back at least 50 feet from the lake
- Regularly have your tank inspected for cracks or leaks that could be leaching sewage into the lake
- Make sure your tank is properly sized for your house



CHAPTER 10. ONGOING EDUCATIONAL PROGRAMS

As a recommendation from the 2004 PGOLID Lake Management Plan, prepared by Blue Water Science, PGOLID hired a Water Resource Coordinator in 2005. This position started out as a full-time seasonal position covering just the summer months. Jordan Ornquist served as the PGOLID Water Resource Coordinator for the summers of 2005-2006. In 2006, the position changed to a part-time, year-round position. In December of 2006, Moriya Rufer was hired and served as the PGOLID Water Resource Coordinator from December 2006 to December 2018. Steve Henry has taken on the position of PGOLID Water Resource Coordinator from May 2019 to present.

The PGOLID Water Resource Coordinator's responsibilities include water quality monitoring and planning, data assessment and interpretation, problem identification and mitigation, grant writing for new lake projects, and educational programs.

These educational programs have included:

- Educational seminars for lake residents in the summer.
- Articles in the Pelican Lake Property Owners Association (PLPOA) Newsletter.
- Educational presentations at PGOLID and PLPOA meetings.
- Maintenance of the PGOLID website.
- Act as a contact and resource for community education and outreach and availability to PGOLID residents for any questions (calls, emails, visits).
- Keep abreast of new state/county/local government lake regulations and disseminate the information in an understandable way to PGOLID residents.
- Work with upstream landowners, farmers, ranchers, and other lake associations to act in a proactive manner in the protection of the water quality that flows into the PGOLID.

Education has focused on the following topics:

- Water quality
- Invasive species
- Shoreline restoration
- Septic system and holding tank maintenance
- Aquatic plants and algae
- The importance of maintaining native aquatic plants such as bulrush
- Boater stewardship
- DNR regulations

These educational programs have been deemed successful, and it is important to continue them into the future.