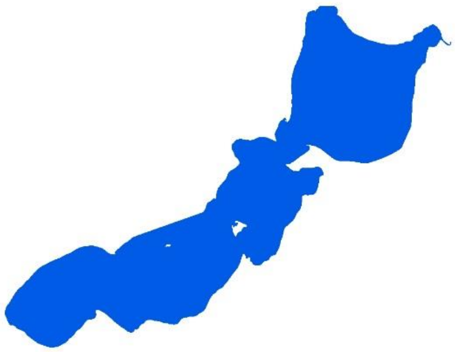
Island Lake 58-0062-00 Pine County



Island Lake is located about five miles east of Sturgeon Lake, MN in Pine County. It is adjacent to Interstate 35 and is a long lake, oriented NE to SW, covering approximately 527 acres with a shoreline length of approximately 7 miles (Table 1).

Island Lake is classified as a drainage lake because it has three inlets and one intermittent outlet. A drainage lake typically gets its water from runoff.

Water quality data have been collected on Island Lake periodically from 1978 - 2018 (Tables 2 & 3). These data show that the lake is eutrophic (TSI = 54) with moderately clear water conditions most of the summer and excellent recreational opportunities.

Table 1. Island Lake location and key physical characteristics.

Location Data	
MN Lake ID:	**58-0062-00**
County:	**Pine**
Ecoregion:	**Northern Lakes & Forests**
Major Watershed:	**Kettle River**
Latitude/Longitude:	**46.155832/-93.051352**
Invasive Species:	**None as of 2019**

Physical Characteristics	
Surface area (acres):	**526.7**
Littoral area (acres):	**267**
% Littoral area:	**51%**
Max depth (ft), (m):	**42**
Inlets:	**3**
Outlets:	**1**
Public Accesses:	**1**

Table 2. Availability of primary data types for Island Lake.

Data Availability	
Transparency data	**Good**
Chemical data	**Fair**
Inlet/Outlet data	**N/A**
Recommendations	**For recommendations refer to page 14.**

Lake Map

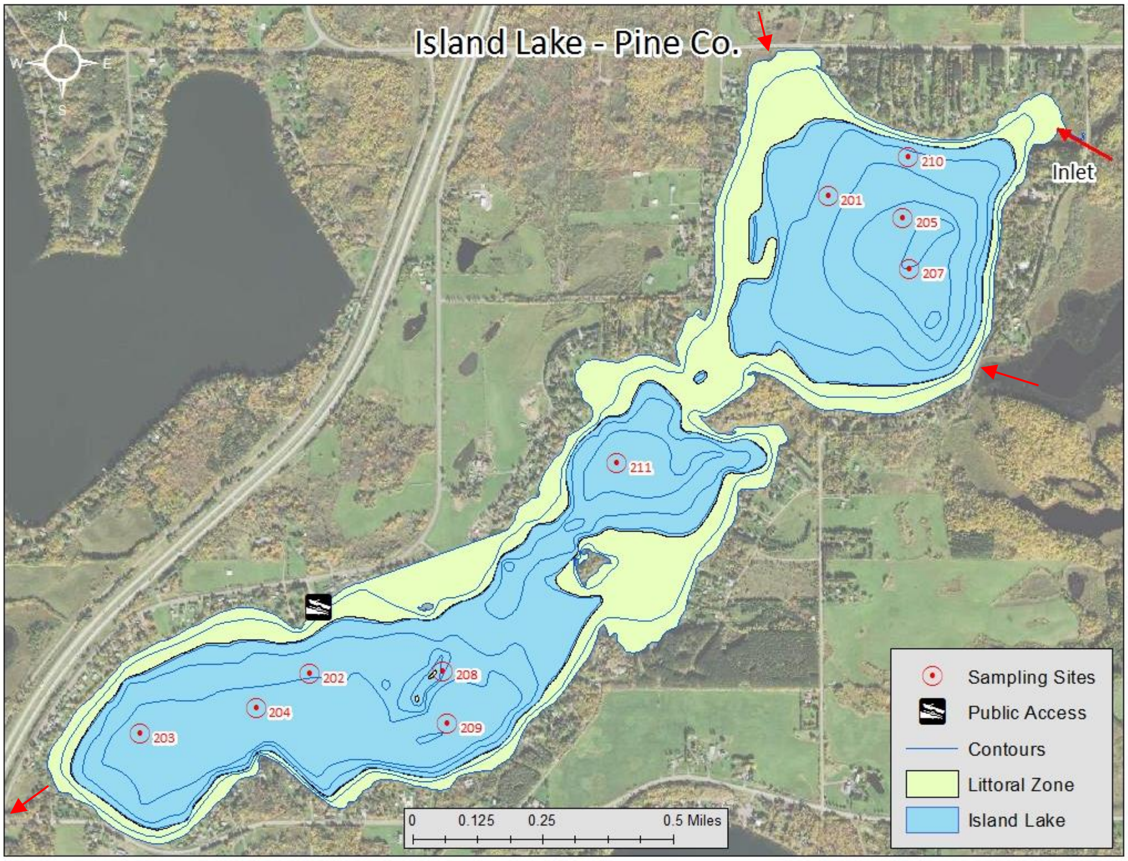


Figure 1. Map of Island Lake with 2018 aerial imagery and illustrations of lake depth contour lines, sample site locations, inlets and outlets, and public access points. The light green areas in the lake illustrate the littoral zone, where the sunlight can reach the bottom of the lake.

Table 3. Monitoring programs and associated monitoring sites. Monitoring programs include the Citizen Lake Monitoring Program (CLMP), MPCA Lake Monitoring Program Project (MLMPP), Lake Assessment Projects (LAP), Pine County SWAG (SWAG), RMB Environmental Lab (RMBEL), Clean Water Legacy Surface Water Monitoring (CWLSWM)

Lake Site	Depth (ft)	Monitoring Programs
58-0062-00-201	15	CLMP: 1978-1985, 1990-1996
58-0062-00-202	20	CLMP: 1986; LAP: 2003; MLMPP: 1988,1992; RMBEL: 2018
58-0062-00-203	22	CLMP:1990-2004, 2006-2007
58-0062-00-204	23	CLMP: 1990-2004, 2006-2007
58-0062-00-205	38	CLMP: 1997-2001
58-0062-00-207	40	CLMP: 2006-2018; LAP: 2003; MLMPP: 1988,1992; SWAG: 2008
58-0062-00-208	8	CLMP: 2010-2011
58-0062-00-209	29	CLMP: 2012-2018; CWLSWM: 2016-2017
58-0062-00-210	10	CLMP:2011-2018
58-0062-00-211	27	CLMP: 2016

Average Water Quality Statistics & Comparisons

The information below describes available chemical data for Island Lake through 2018 (Table 4). Data for total phosphorus, chlorophyll *a*, and Secchi depth are from various sites.

Minnesota is divided into 7 ecoregions based on land use, vegetation, precipitation and geology. The Minnesota Pollution Control Agency (MPCA) has developed a way to determine the "average range" of water quality expected for lakes in each ecoregion[1] (Table 4). Island Lake is in the Northern Lakes and Forests Ecoregion (Figure 2).

The MPCA has developed Impaired Waters Standards for lakes in each ecoregion to determine if a lake is impaired for excess phosphorus/eutrophication (Table 4). Lakes that are over the impaired waters standards are placed on the state's Impaired Waters List[2].

Figure 2. Minnesota ecoregions.

Table 4. Water quality means compared to ecoregion ranges and impaired waters standard.

Parameter	Mean	Ecoregion Range[1]	Impaired Waters Standard[2]	Interpretation
Total phosphorus (ug/L)	34.3	14 – 27	> 30	Results are higher the expected range for the Northern Lakes and Forests Ecoregion; however, there is limited data to draw from. Continued monitoring will help to determine any statistically significant trends that may exist.
[3]Chlorophyll *a* (ug/L)	13.8	4 – 10	> 9	
Chlorophyll *a* max (µg/L)	31.9	< 15		
Secchi depth (ft)	6.9	8 – 15	< 6.5	
Dissolved oxygen	*See page 8*			Dissolved oxygen depth profiles show that the lake stratifies during summer months
Total Kjeldahl Nitrogen (mg/L)	1.2	<0.4 – 0.75		Indicates nitrogen to support summer nitrogen-induced algae blooms.
Alkalinity (mg/L)	33.9	40 – 140		Indicates a high sensitivity to acid rain and a bad buffering capacity.
Color (Pt-Co Units)	22.5	10 – 35		NA
pH	7.3	7.2 – 8.3		Within the expected range for the ecoregion. Lake water pH less than 6.5 can affect fish spawning and the solubility of metals in the water.
Chloride (mg/L)	6.4	0.6 – 1.2		Outside the expected range for the ecoregion. Indicates high amount of dissolved salts in lake.
Total Suspended Solids (mg/L)	3.5	<1 – 2		Indicates turbid water.
Specific Conductance (umhos/cm)	82.0	50 – 250		Within the expected range for the ecoregion.
TN:TP Ratio	8:1	25:1 - 35:1		Within the expected range for the ecoregion, and shows the lake is phosphorus limited.

[1]The ecoregion range is the 25^{th}-75^{th} percentile of summer means from ecoregion reference lakes: https://www.pca.state.mn.us/quick-links/eda-guide-typical-minnesota-water-quality-conditions
[2]For further information regarding the Impaired Waters Assessment program, refer to http://www.pca.state.mn.us/water/tmdl/index.html
[3]Chlorophyll *a* measurements have been corrected for pheophytin
Units: 1 mg/L (ppm) = 1,000 ug/L (ppb)

Water Quality Characteristics - Historical Means and Ranges

Table 5. Water quality means and ranges for sites monitored on Island Lake.

Parameters	Site 207 (Primary)	Site 209	Site 210	Site 202
Total Phosphorus Mean (µg/L):	34.3	45.9	-	33.6
Total Phosphorus Min:	23	15	-	22
Total Phosphorus Max:	58	323	-	54
Number of Observations:	19	11	-	17
Chlorophyll *a* Mean (ug/L):	13.8	14.9	-	14.0
Chlorophyll-a Min:	1.0	2.3	-	3.2
Chlorophyll-a Max:	31.9	30	-	42.7
Number of Observations:	20	12	-	16
Secchi Depth Mean (ft):	6.9	6.9	8.4	7.0
Secchi Depth Min:	2.9	3.2	4.9	4.5
Secchi Depth Max:	13.1	14.4	9.9	14.4
Number of Observations:	147	86	80	20

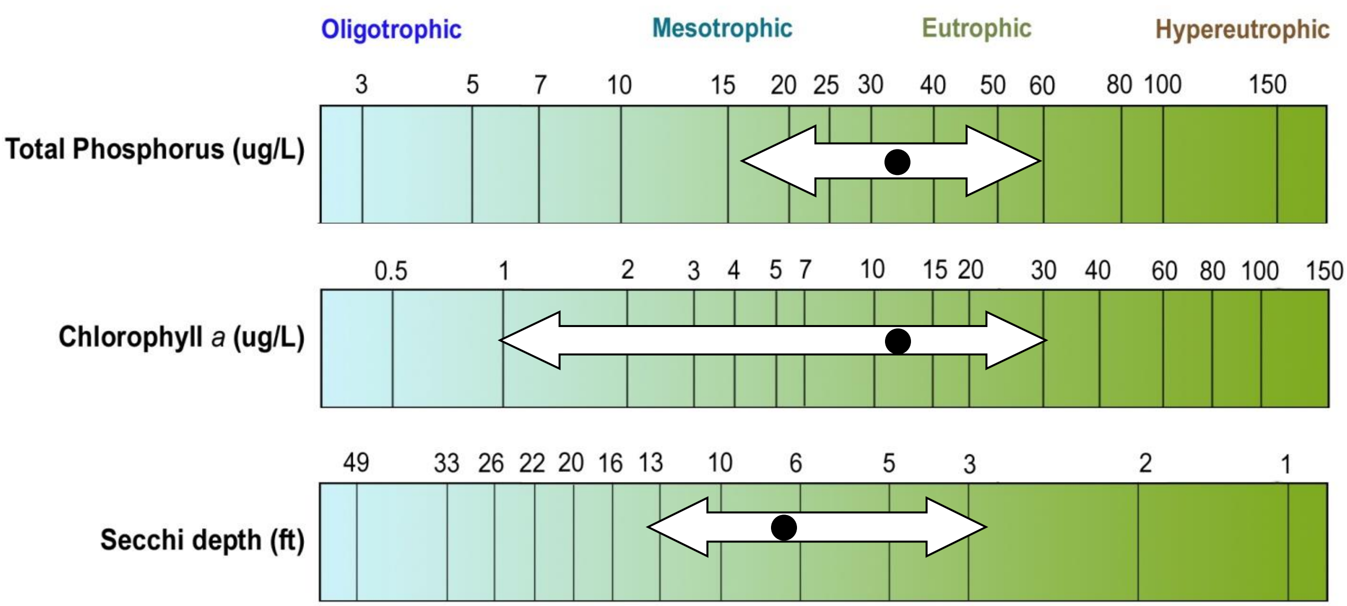


Figure 3. Island Lake total phosphorus, chlorophyll a and transparency historical ranges. The arrow represents the range and the black dot represents the historical mean (Site 207). Figure adapted after Moore and Thornton, [Ed.]. 1988.

Transparency (Secchi Depth)

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 lakes where the sun penetrates. Water transparency depends on the number of particles in the water. An increase in particulates results in a decrease in transparency. The transparency varies year to year due to changes in weather, precipitation, lake use, flooding, temperature, lake levels, etc.

The annual mean transparency in Island Lake ranges from 4.9 to 8.3 feet (Figure 4). The annual means hover fairly close to the long-term mean of 6.9. For trend analysis, see page 10. Transparency monitoring should be continued annually at site 207 in order to track water quality changes.

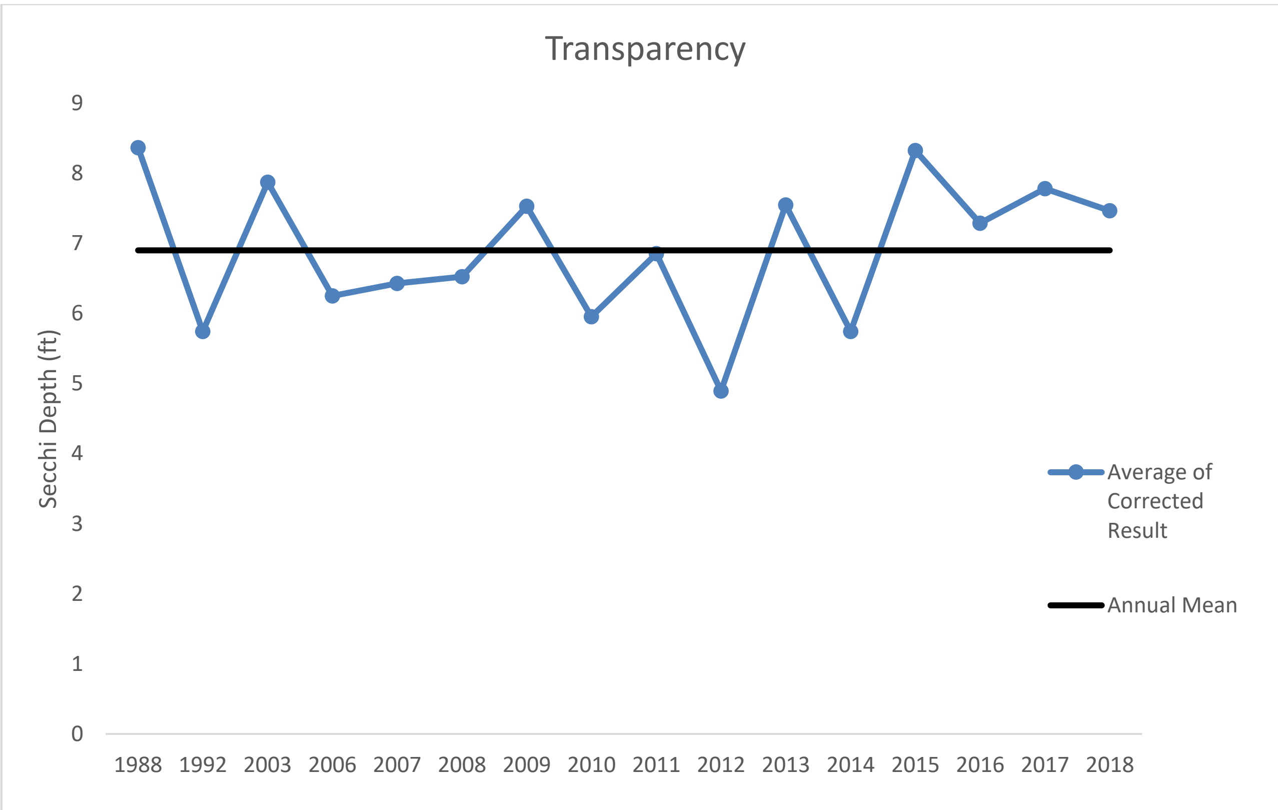


Figure 4. Annual mean transparency compared to long-term mean transparency

It is important for lake residents to understand the seasonal transparency dynamics in their lake so that they are not worried about why their transparency is lower in August than it is in June. It is typical for a lake to vary in transparency throughout the summer (Figure 5).

The maximum Secchi reading is usually obtained in early summer. Island Lake transparency is high in May and June, and then declines through August. The transparency then rebounds in October after fall turnover. This transparency dynamic is typical of a Minnesota lake. The dynamics have to do with algae and zooplankton population dynamics, and lake turnover.

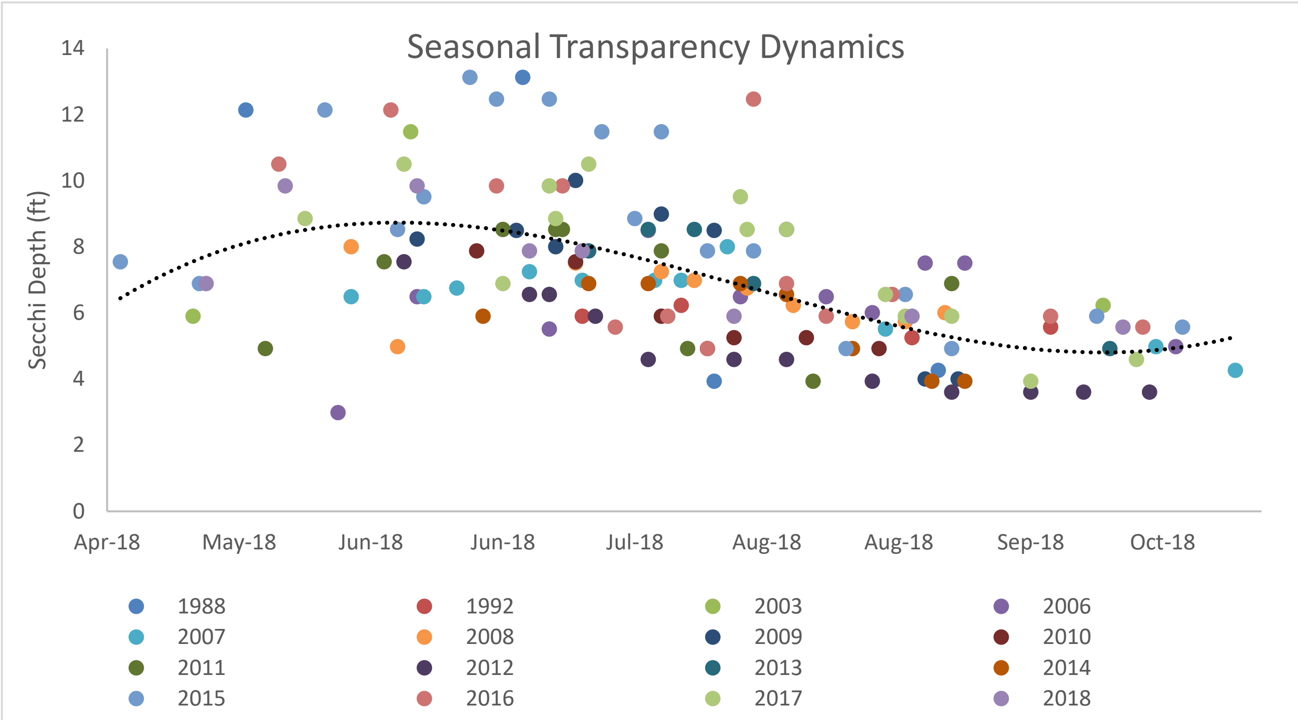


Figure 5. Seasonal transparency dynamics and year to year comparison (Site 207). The black line represents the pattern in the data.

User Perceptions

When volunteers collect Secchi depth readings, they record their perceptions of the water based on the physical appearance and the recreational suitability. These perceptions can be compared to water quality parameters to see how the lake "user" would experience the lake at that time. Looking at transparency data, as the Secchi depth decreases the perception of the lake's physical appearance and recreational suitability decreases (Figures 6-7).

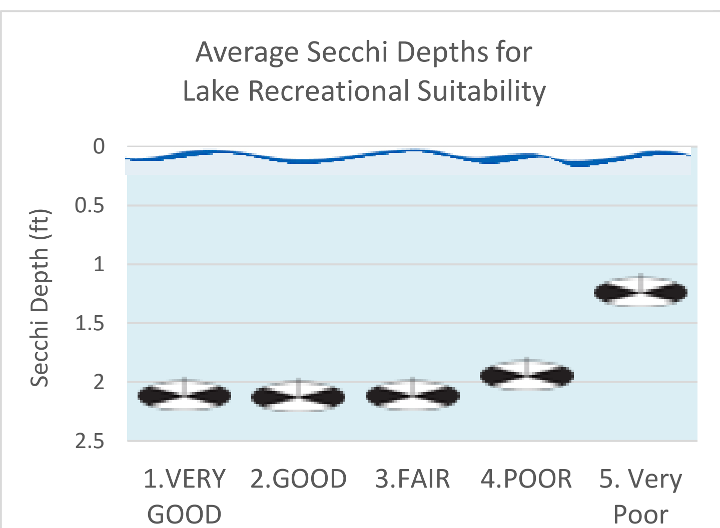


Figure 6. Average Secchi depth (ft) for each lake recreational suitability rating.

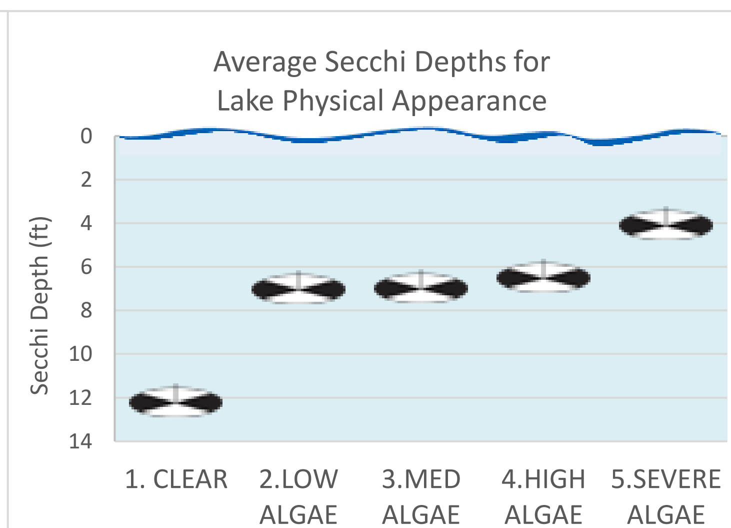


Figure 7. Average Secchi depth for each lake physical appearance rating.

Algae

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.

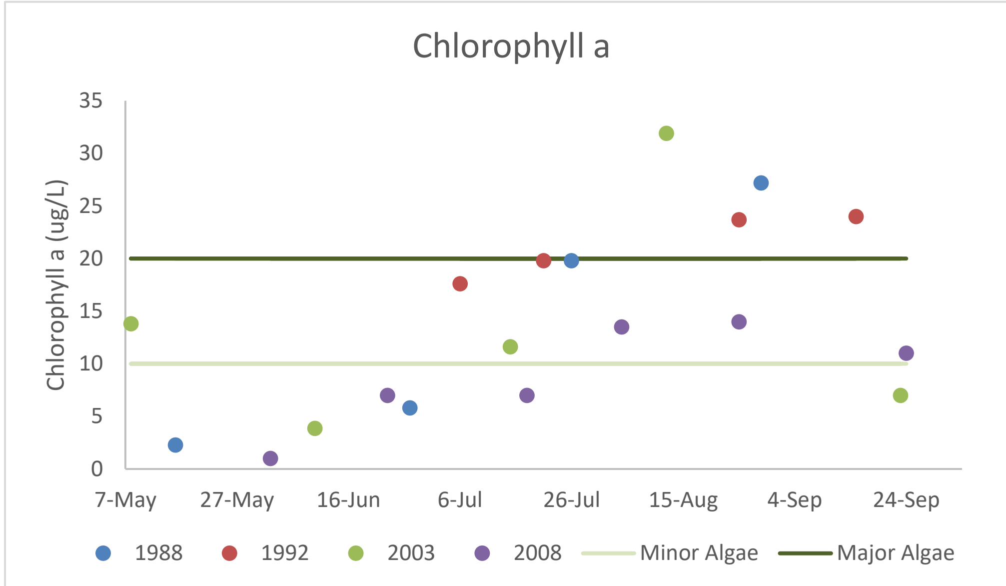


Figure 6. Chlorophyll a concentrations (ug/L) for Island Lake at site 202.

Chlorophyll *a* 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* was evaluated in Island Lake at site 207 in 1988, 1992, 2003, and 2008 (Figure 8). Chlorophyll *a* concentration did go above 10 ug/L in all four years, indicating some minor algae blooms. There is not a large variation in Chlorophyll a concentration over the four years that were monitored; and chlorophyll-*a* concentrations were constantly lower in early summer, typically peaking around mid-August.

Phosphorus

Island Lake is phosphorus limited, which means that algae and aquatic plant growth is dependent upon available phosphorus.

Total phosphorus was evaluated in Island Lake in 1988, 1992, 2003, and 2018 at site 202. The data do not indicate much seasonal variability. Majority of the data points fall into the mesotrophic/eutrophic classification (Figure 9).

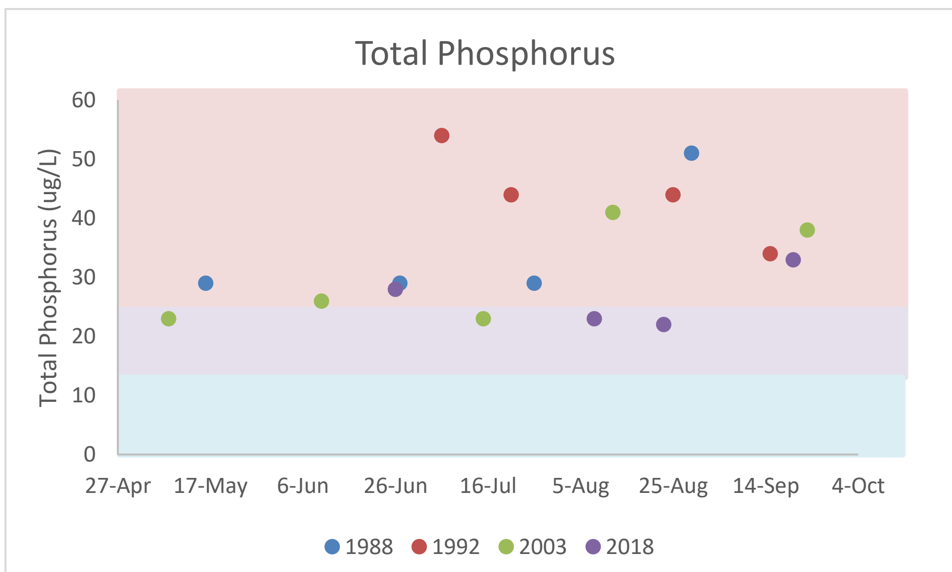


Figure 7. Historical total phosphorus concentrations (ug/L) for Island Lake site 202.

Total Phosphorus concentrations were also analyzed at sites 207 and 209 for a couple of years. Right now, it is difficult to draw conclusions from this data since they were collected at different points on the lake and there are quite a few years between data sets.

The phosphorus readings appear to be higher than what is expected for a lake in this eco region; however, many of the high readings were analyzed 10-15 years ago. Since then we have new instruments that can give a more accurate result for Total Phosphorus.

Phosphorus should continue to be monitored at the same site to track any future changes in water quality.

Oxygen

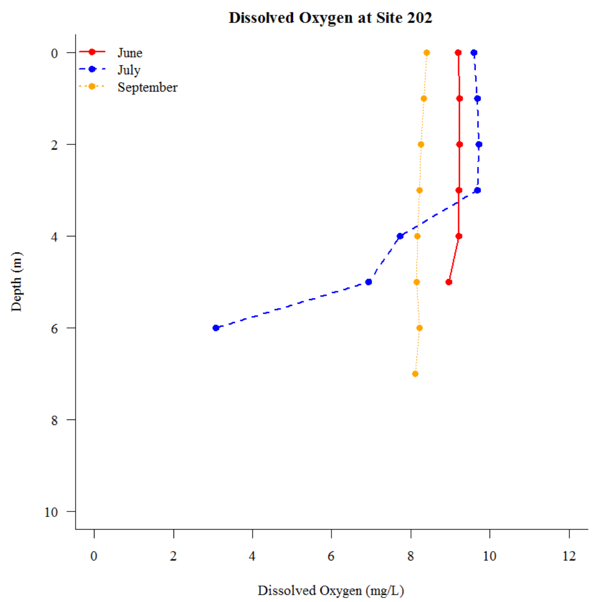


Figure 8. Representative dissolved oxygen profiles from site 202 year in Island Lake.

Dissolved Oxygen (DO) is the amount of oxygen dissolved in lake water. Oxygen is necessary for all living organisms to survive except for some bacteria. Living organisms breathe in oxygen that is dissolved in the water. Dissolved oxygen levels of <5 mg/L are typically avoided by game fisheries.

Island Lake is a relatively deep lake, with a maximum depth of 42 feet. Dissolved oxygen profiles from data collected in 1988, 1992, 2003, and 2016 at site 202 show a stratified lake in July where the DO crashes around 3 meters (12 ft) down, and a mixed lake during spring and fall (Figure 10).

Trophic State Index (TSI)

TSI is a standard measure or means for calculating the trophic status or productivity of a lake. More specifically, it is the total weight of living algae (algae biomass) in a waterbody at a specific location and time. Three variables, chlorophyll a, Secchi depth, and total phosphorus, independently estimate algal biomass.

If all three TSI numbers are within a few points of each other, they are strongly related. If they are different, there are other dynamics influencing the lake's productivity, and TSI mean should not be reported for the lake. Island Lake falls into the Eutrophic range (Tables 6, 7).

Table 6. Trophic State Index for Island Lake

Trophic State Index	
TSI Phosphorus:	**49**
TSI Chlorophyll-a	**56**
TSI Secchi	**55**
TSI Mean	**54**
Trophic State:	**Eutrophic**

Numbers represent the mean TSI for each parameter.

Table 7. Trophic state index attributes and their corresponding fisheries and recreation characteristics.

Island Lake

TSI	Attributes	Fisheries & Recreation
<30	**Oligotrophy:** Clear water, oxygen throughout the year at the bottom of the lake, deep cold water.	Trout fisheries dominate.
30-40	Bottom may become anoxic (no oxygen).	Trout fisheries in deep lakes only. Walleye, Cisco present.
40-50	**Mesotrophy:** 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	**Eutrophy:** Algae and aquatic plant problems possible. "Green" water most of the year.	Warm-water fisheries only. Island 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	**Hypereutrophy:** 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.

Source: Carlson, R.E. 1997. A trophic state index for lakes. *Limnology and Oceanography*. 22:361-369.

Trend Analysis

For detecting trends, a minimum of 8-10 years of data with 4 or more readings per season are recommended. Minimum confidence accepted by the MPCA is 90%. This means that there is a 90% chance that the data are showing a true trend and a 10% chance that the trend is a random result of the data. Only short-term trends can be determined with just a few years of data, because there can be different wet years and dry years, water levels, weather, etc, that affect the water quality naturally.

Island Lake had enough data to perform a trend analysis on transparency (Table 8). The data was analyzed using the Mann Kendall Trend Analysis.

Table 8. Trend analysis for Oak Lake.

Lake Site	Parameter	Date Range	Trend
202	Total Phosphorus	1988, 1992, 2003, 2018	Insufficient Data
202	Chlorophyll *a*	1988, 1992, 2003, 2018	Insufficient Data
207*	Transparency	2003; 2006-2018	Improving, 90%

*Site 207 was selected for analysis because site 202 did not have enough Secchi depth data to run a trend.

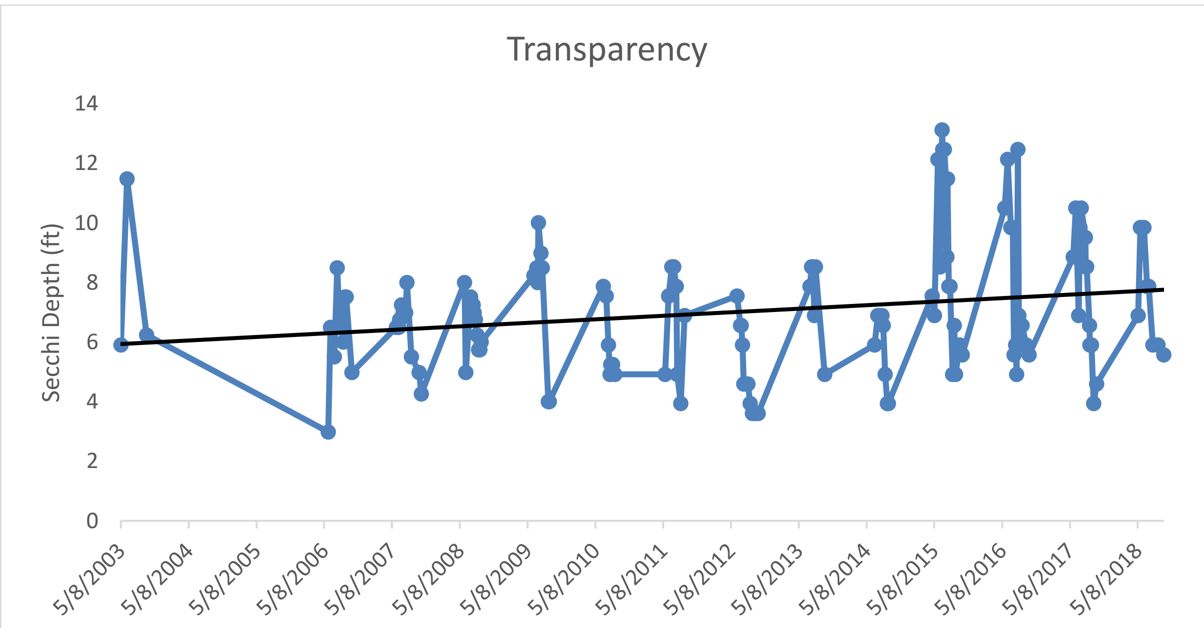


Figure 9. Transparency (feet) trend for site 207 from 2003-2010, 2012, 2016-2018.

Island Lake shows evidence of an improving transparency trend at site 207 with 90% confidence (Figure 11). There was a large gap in data between 2003 and 2006. See the recommendations section for more explanation (page 15).

Transparency monitoring should continue so that this trend can be tracked in future years.

Lakeshed

Understanding a lakeshed requires an understanding of basic hydrology. A watershed is defined as all land and water surface area that contribute excess water to a defined point. The MN DNR has delineated three basic scales of watersheds (from large to small): 1) basins, 2) major watersheds, and 3) minor watersheds.

The Kettle River Watershed is one of the watersheds that make up the St. Croix River Basin, which drains south to the Gulf of Mexico (Figure 11).

The MN DNR also has evaluated catchments for each individual lake with greater than 100 acres surface area. These lakesheds (catchments) are the "building blocks" for the larger scale watersheds. Island Lake falls within lakeshed 3502204 (Figure 11). Though very useful for displaying the land and water that contribute directly to a lake, lakesheds are not always true watersheds because they may not show the water flowing into a lake from upstream streams or rivers. While some lakes may have only one or two upstream lakesheds draining into them, others may be connected to a large number of lakesheds, reflecting a larger drainage area via stream or river networks.

In an effort to prioritize protection and restoration efforts of fishery lakes, the MN DNR has developed a ranking system by separating lakes into two categories based on their lakeshed, those needing protection and those needing restoration. Modeling by the DNR Fisheries Research Unit suggests that total phosphorus concentrations increase significantly over natural concentrations in lakes that have watershed with disturbance greater than 25%. Therefore, lakes with watersheds that have less than 25% disturbance need protection and lakes with more than 25% disturbance need restoration (Table 8). Watershed disturbance was defined as having urban, agricultural and mining land uses. Watershed protection is defined as publicly owned land or conservation easement.

Table 9. Suggested approaches for watershed protection and restoration of DNR-managed fish lakes in Minnesota.

Watershed Disturbance (%)	Watershed Protected (%)	Management Type	Comments
< 25%	> 75%	Vigilance	Sufficiently protected -- Water quality supports healthy and diverse native fish communities. Keep public lands protected.
	< 75%	Protection	Excellent candidates for protection -- Water quality can be maintained in a range that supports healthy and diverse native fish communities. Disturbed lands should be limited to less than 25%.
25-60%	n/a	Full Restoration	Realistic chance for full restoration of water quality and improve quality of fish communities. Disturbed land percentage should be reduced and BMPs implemented.
> 60%	n/a	Partial Restoration	Restoration will be very expensive and probably will not achieve water quality conditions necessary to sustain healthy fish communities. Restoration opportunities must be critically evaluated to assure feasible positive outcomes.

The next step was to prioritize lakes within each of these management categories. DNR Fisheries identified high value fishery lakes, such as cisco refuge lakes. Cisco (*Coregonus artedi)* can be an early indicator of eutrophication in a lake because they require cold hypolimnetic temperatures and high dissolved oxygen levels. These watersheds with low disturbance and high value fishery lakes are excellent candidates for priority protection measures, especially those that are related to forestry and minimizing the effects of landscape disturbance. Forest stewardship planning, harvest coordination to reduce hydrology impacts and forest conservation easements are some potential tools that can protect these high value resources for the long term.

Island Lake's lakeshed is classified with having 47% of the watershed protected and 8% of the watershed disturbed (Figure 12). This shows a large portion of the lakeshed is protected, and the goal should be to limit any increase in disturbed land use. Island Lake's lakeshed, has 5 other lakes that flow into it (Figure 12).

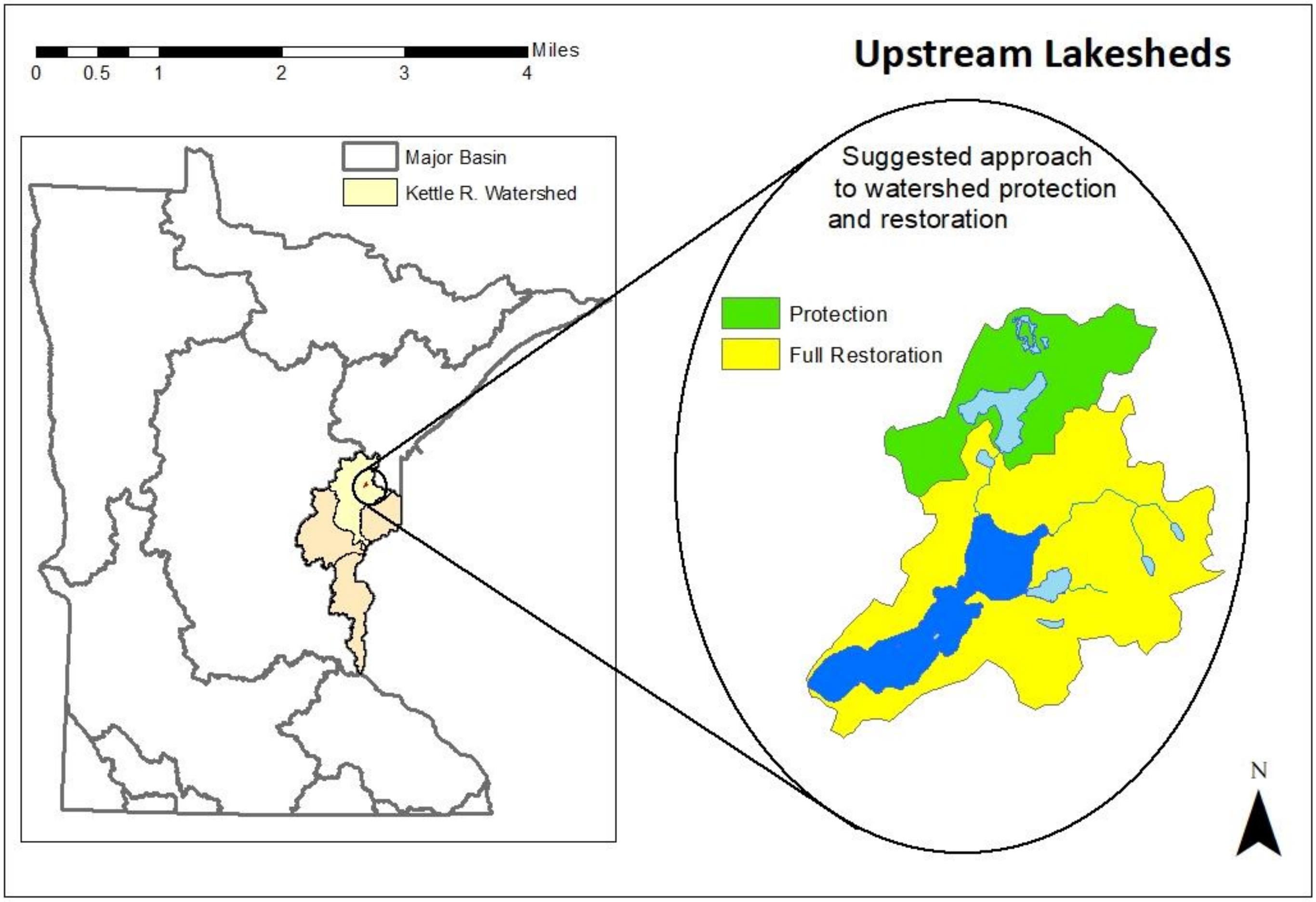
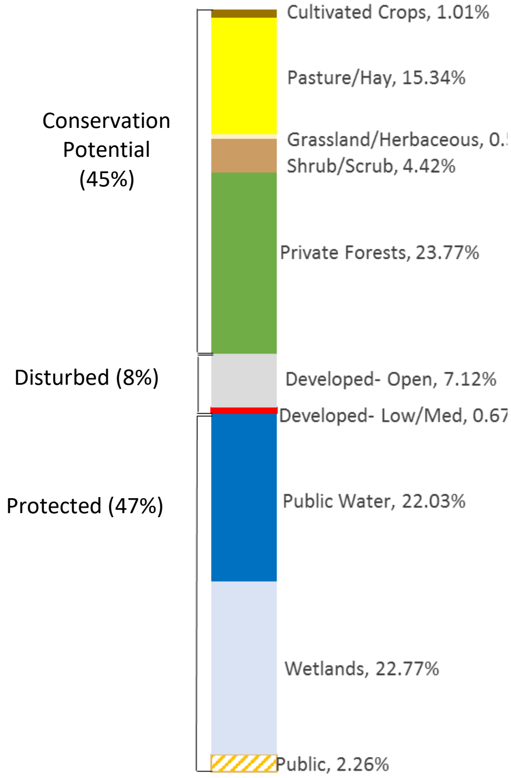


Figure 101. Kettle River major watershed and MN basins (left), and Island Lake lakeshed and upstream catchments with protection suggestions (right).

Land use and Ownership

Activities that occur on the land within the lakeshed can greatly impact a lake. 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.

47% of the Island Lake lakeshed is protected. This total includes water, wetlands, and publicly owned land. Two parcels along the lakeshore were selected for conservation potential.



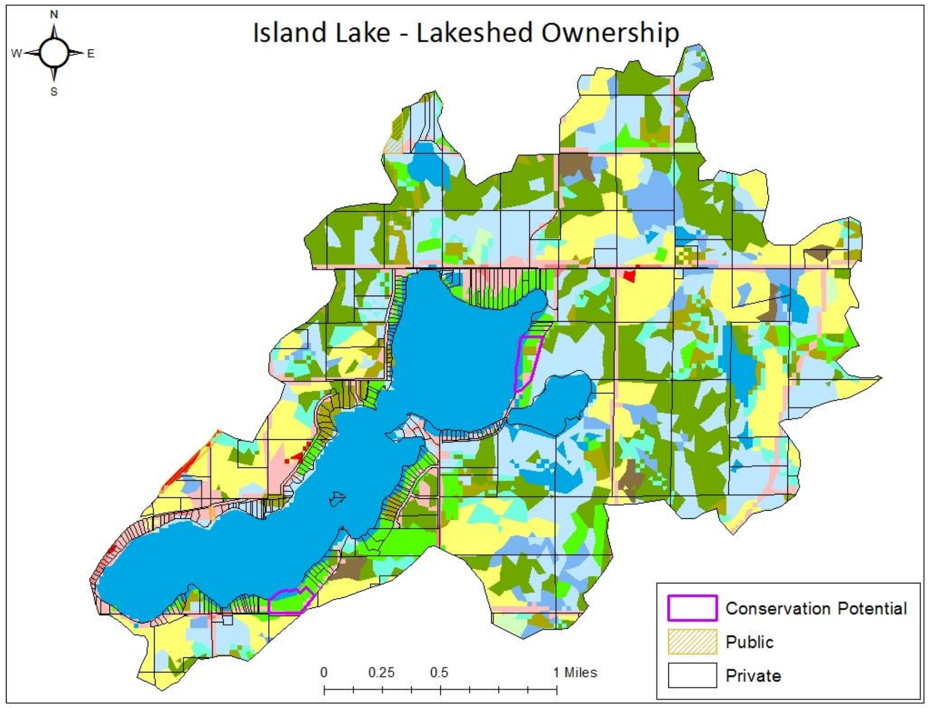


Figure 112. Land use and ownership in the Island Lake lakeshed.

The lakeshed vitals table identifies where to focus organizational and management efforts for each lake (Table 10). Criteria were developed using limnological concepts to determine the effect to lake water quality.

KEY

● Possibly detrimental to the lake
◉ Warrants attention
○ Beneficial to the lake

Table 10. Island Lake lakeshed vitals table.

Lakeshed Vitals		Rating
Lake Area	536.19 acres	descriptive
Littoral Zone Area	267 acres	descriptive
Lake Max Depth	42 ft	descriptive
Lake Mean Depth	N/A	
Miles of Stream	6.4	descriptive
Inlets	3	◉
Outlets	1	◉
Major Watershed	35 – Kettle River	descriptive
Minor Watershed	35022	descriptive
Lakeshed	3502204	descriptive
Ecoregion	Northern Lakes and Forest	descriptive
Total Lakeshed to Lake Area Ratio (total lakeshed includes lake area)	6:1	◉
Standard Watershed to Lake Basin Ratio (standard watershed includes lake areas)	1:1	○
Wetland Coverage	22.77%	○
Aquatic Invasive Species	None	○
Public Drainage Ditches	None	○
Public Lake Accesses	1	◉
Miles of Shoreline	7.09	descriptive
Shoreline Development Index	2.19	●
Public Land to Private Land Ratio	<1:1	◉
Development Classification	Recreational Development	◉
Miles of Road	12.40	descriptive
Municipalities in lakeshed	None	○
Forestry Practices	NA	○
Feedlots	1	●
Sewage Management	Individual Sewage Treatment Systems, county inspections required upon building permits and property transfers	◉
Lake Management Plan	NA	○
Lake Vegetation Survey/Plan	DNR, 1998	◉

Island Lake, Status of the Fishery (DNR, 4/18/2016)

Island Lake is a 526-acre lake in northern Pine County with a maximum depth of 42 feet. The shoreline is highly developed with homes. Water clarity is moderate. The lake is managed for Walleye and Muskellunge; both are stocked annually as fingerlings. Fishing pressure is usually moderate.

Island lake anglers can again expect moderate populations of Northern Pike and Largemouth Bass. Abundance and average size for both species were similar what was seen in the 2009 assessment. Captured pike ranged from 10 to 34.5 inches and averaged 3.3 pounds. Over one third of measured bass topped 12 inches.

Walleye abundance was comparable to other similar lakes. Both abundance and average size mirrored the previous two assessments. Netted Walleye ranged from 13 to 25.7 inches in length and averaged 2.5 pounds.

Bluegill and Black Crappie numbers, based on the trap net catch, both exceeded the norm for the lake type and their historic averages for Island Lake. Both species should provide more harvest opportunity than in 2009. While only 14% of Crappie exceeded 9 inches and 19% of Bluegill bested 7, their abundance is much higher overall. Yellow Perch remain very abundant and acceptable in size. More than a third of measured Perch were 8 inches or longer.

Muskellunge are sampled in separate assessments. Based on catch rates, muskies are not as abundant as they were in the 1990's. However, quality sized fish are available with three fourths of the sample exceeding 40 inches in length. Muskellunge greater than 50 inches are present.

For more information on how to accomplish this, contact the nearest Area Fisheries office or go to the following website: www.dnr.state.mn.us/shorelandmgmt

https://www.dnr.state.mn.us/lakefind/showreport.html?downum=58006200

Key Findings and Recommendations

Monitoring Recommendations

Transparency monitoring at sites 207 should be continued annually. It is important to continue transparency monitoring weekly or at least monthly every year to enable year-to-year comparisons and trend analyses. Phosphorus and chlorophyll a monitoring should continue at site 207, as the budget allows, to track future water quality trends.

Overall Conclusions

Island Lake is a eutrophic lake (TSI = 54) with the start of a baseline dataset to track long-term trends in water clarity. The total phosphorus, chlorophyll *a* and transparency ranges are slightly higher than what is expected for the ecoregion (Table 4). However, more consistent data from year to year is needed in order to run any statistical analysis.

Island Lake's lakeshed is 47% protected, open water and wetlands are the main types of land cover. Approximately two percent (2%) of the lakeshed is in public ownership, and 45% of the lakeshed can be considered potential land for conservation, while only 8% of the lakeshed is disturbed (Figure 11).

Island Lake is downstream to 5 lakes, each of which are connected by unnamed streams running into Island Lake. Therefore, disturbances beyond the immediate lakeshed can adversely impact Island's water quality.

Interstate 35 is adjacent to Island Lake. Chloride concentration in the lake was monitored in 1988, 1992, and 2003, it is higher than expected for the region (Table 4). The chloride is still under the state standard though; the state standard is 207 mg/L and Island Lake's average chloride concentration is 6.4 mg/L. This higher chloride could be due to road salt use on I35. More information about chloride monitoring and guidelines can be found at the Minnesota Pollution Control Agency's website here https://www.pca.state.mn.us/water/chloride-salts. Stormwater from Interstate 35 could be diverted to a sediment basin before running into Island Lake to protect the lake from chloride runoff.

Phosphorus Loading and Priority Impacts

Island Lake is at a disadvantage because it has a large watershed and sits downstream of five lakes (Table 11). Upstream land use in the watershed is likely the main impact to the lake's water quality. However, there are many wetlands that surround Island lake, which could be helping to filter the nutrients coming from upstream run off, before they run into Island lake.

Table 11. Watershed characteristics.

Lakeshed to Lake Area Ratio (lakeshed includes lake area)	5.6:1
Watershed to Lake Area Ratio (watershed includes lake areas)	223.1:1
Number of Upstream Lakes	5
Headwaters Lake?	Yes
Inlets / Outlets	3 / 0
Water Residence Time	NA

In addition to a larger watershed, Island lake is adjacent to Interstate 35. Heavy development and impervious surfaces can change the drainage around the lake to allow more direct runoff. Although the impervious surface area can't be removed in most cases, the storm water can be captured and mitigated. See Table 12 on the next page for specific project ideas.

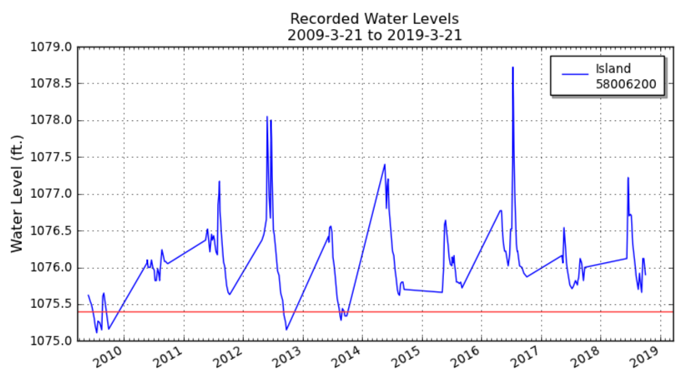


Figure 123. Monitored water levels in Island Lake, Source: MN DNR Lakefinder

Island Lake has evidence for an improving in transparency from 2003, 2006-2018 (Table 8, Figure 11), but the graph shows much lower than average transparency in 2012. Water level monitoring for island lake is shown in Figure 13. High water can cause shoreline erosion and cause decreased water transparency. Maintaining wetlands in the lakeshed helps with water storage and can decrease the impact from high water events.

Best Management Practices Recommendations

The management focus for Island Lake should be to protect the current water quality and the lakeshed. Efforts should be focused on managing and/or decreasing the impact caused by current and additional development, including second tier development, and impervious surface area. Project ideas include protecting land with conservation easements, enforcing county shoreline ordinances, shoreline restoration, rain gardens, and septic system maintenance.

Island Lake Goals

1. Protection Focus: minimize disturbed land uses and maintain protected lands
2. Manage phosphorus loading from nearshore, Table 12
3. Focused BMPs per land type: Table 12

Table 12. Best Management Practices Table specific to Island Lake (refer to Figure 12)

Category	Land use type	Conservation project ideas	Results	Who	Contact for help
Conservation Potential Land	private forests (23.77%, 668.9 acres)	Forest stewardship planning, 3rd party certification, SFIA, local woodland cooperatives	Conserve and protect current forest cover	• Individual Property Owners	Pine SWCD 320-216-4240
	cultivated crops (1.01%, 30.4 acres)	Restore wetlands; CRP; Cover Crops,	Reduce water runoff and soil erosion, better water storage	• Individual Property Owners	Natural Resources Conservation Service 123-4567-8910, info@swcd.org
	pasture/hay (15.34%, 462.6 acres)	Maintain vegetative cover, plant trees, Conservation Easements	Reduce water runoff and soil erosion, better water storage	• Individual Property Owners	Pine SWCD 320-216-4240
Disturbed Land	developed, Open Space (7.12%, 214.8 acres)	Shoreline buffers, rain gardens		• Individual Property Owners	Pine SWCD 320-216-4240
	Developed, high intensity (0.67%, 20.3 acres)	Sediment basins, rain gardens, shoreline buffers, stormwater retention		• Individual Property Owners • Cities • Lake Associations	Pine SWCD 320-216-4240

The current lakeshore homeowners can lessen their negative impact on water quality by installing or maintaining the existing trees on their properties. Forested uplands contribute significantly less phosphorus (lbs/acre/year) than developed land cover (Table 11).

Approximately a quarter of the lakeshed is privately owned forested uplands (Table 11). Forested uplands can be managed with Forest Stewardship Planning, 3rd party certification, SFIA, and local woodland cooperatives. Contact the Pine Soil and Watershed Conservation District for options for managing private forests.

Native aquatic plants stabilize the lake's sediments and tie up phosphorus in their tissues. When aquatic plants are uprooted from a shallow lake, the lake bottom is disturbed, and the phosphorus in the water column gets used by algae instead of plants. This contributes to "greener" water and more algae blooms. Protecting native aquatic plant beds will ensure a healthy lake and healthy fishery. If a swimming area is necessary in front of people's docks, clear only a small area of plants. Clearing a whole 100 foot frontage is not necessary and can contribute to additional algae blooms.

Table 13. Organizational contacts and reference sites

Organizational contacts and reference sites	
DNR Fisheries Office	5351 North Shore Drive, Duluth, MN 55804 218-302-3264, duluth.fisheries@state.mn.us
Regional Minnesota Pollution Control Agency Office	525 Lake Avenue South, Suite 400, Duluth, MN 55802 218-723-4660 https://www.pca.state.mn.us/about-mpca/duluth-office
Pine County Soil and Water Conservation District	130 Oriole Street East, Sandstone, MN 55072 320-216-4240
Pine County	635 Northridge DR NW Pine City, MN 55063 320-591-1400