



Tamarack Lake is located 4 miles south of Duxbury, MN, in Pine County. It is a small lake covering approximately 71 acres with a shoreline length of 1.84 miles (Table 1). Tamarack Lake has no major inlets or outlets.

Water quality data have been collected on Tamarack Lake from 1982-2017 (Tables 2 & 3). These data show that the lake is oligotrophic/mesotrophic with fairly clear water conditions most of the summer and excellent recreational opportunities.

Table 1. Tamarack Lake location and key physical characteristics

Location Data

MN Lake ID: 58-0024-00

County: Pine

Ecoregion: Northern Lakes & Forests

Major Watershed: Upper St. Croix River

Latitude/Longitude: 46.072468/-92.504683

Invasive Species: None listed

Physical Characteristics

Surface area (acres): 70.6

Littoral area (acres): 38.5

% Littoral area: 55%

Max depth (ft), (m): 47, 14.3

Inlets: 0

Outlets: 0

Public Accesses: 1

Table 2. Availability of primary data types for Tamarack Lake

Data Availability

Transparency data



Good Data Available

Chemical data



Limited Data Available

Inlet/Outlet data

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No inlets or outlets

Recommendations

For recommendations refer to page 14.

Lake Map

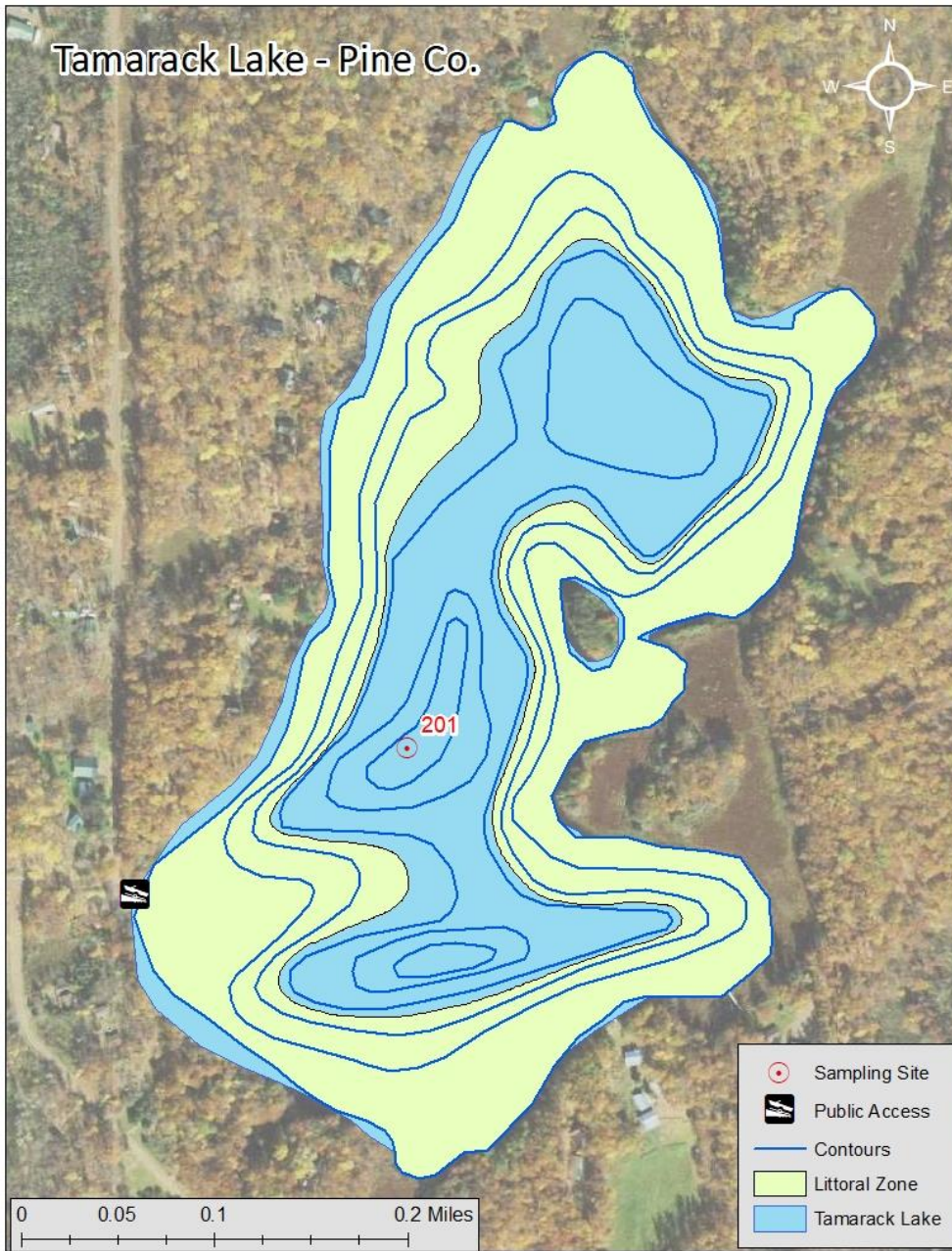


Figure 1. Map of Tamarack Lake with aerial imagery and illustrations of lake depth contour lines, sample site locations, and public access points. The light green areas in the lake illustrate the littoral zone, where the sunlight can reach the bottom of the lake.

Table 3. Monitoring programs and associated monitoring sites. Monitoring programs include the Citizen Lake Monitoring Program (CLMP), MPCA Lake Monitoring Program Project (LMPP), North Shore Lake Superior Lake and Stream Water Assessment (NRRI).

Lake Site	Depth (ft)	Monitoring Programs
58-0024-00-201	47	CLMP: 1987, 1989-2014; LMPP: 1982-1986, 1989-1996, 1998; NRRI: 2016-2017

Average Water Quality Statistics & Comparisons

The information below describes available chemical data for Tamarack Lake through 2018 (Table 4). Data for total phosphorus, chlorophyll *a*, and Secchi depth are from site 201.

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 ecoregion¹ (Table 4). Tamarack 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 List².



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 (µg/L)	19.8	14 – 27	> 30	Results are within the expected range for the Northern Lakes and Forests Ecoregion
³ Chlorophyll <i>a</i> (µg/L)	4.3	4 – 10	> 9	
Chlorophyll <i>a</i> max (µg/L)	19.1	< 15		
Secchi depth (ft)	14.7	8 – 15	< 6.5	
Dissolved oxygen	<i>See page 8</i>			Dissolved oxygen depth profiles show that the lake stratifies during summer months
Total Kjeldahl Nitrogen (mg/L)	0.63	<0.4 – 0.75		Indicates sufficient nitrogen to support summer nitrogen-induced algae blooms
Alkalinity (mg/L)	6.7	40 – 140		Indicates a high sensitivity to acid rain and a low buffering capacity
Color (Pt-Co Units)	NA	10 – 35		NA
pH	6.4	7.2 – 8.3		Below 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)	0.47	0.6 – 1.2		Below the expected range for the ecoregion, indicating a low amount of dissolved salts in lake
Total Suspended Solids (mg/L)	2.2	<1 – 2		Slightly above the expected range, indicating turbid water
Specific Conductance (µmhos/cm)	24.6	50 – 250		Below the expected range for the ecoregion
TN:TP Ratio	32:1	25:1 - 35:1		Within the expected range for the ecoregion, and shows the lake is phosphorus limited.

¹The ecoregion range is the 25th-75th percentile of summer means from ecoregion reference lakes: <https://www.pca.state.mn.us/quick-links/eda-guide-typical-minnesota-water-quality-conditions>

²For further information regarding the Impaired Waters Assessment program, refer to <http://www.pca.state.mn.us/water/tmdl/index.html>

³Chlorophyll *a* measurements have been corrected for pheophytin

Units: 1 mg/L (ppm) = 1,000 µg/L (ppb)

Water Quality Characteristics - Historical Means and Ranges

Table 5. Water quality means and ranges for site 201

Parameters	Site 201
Total Phosphorus Mean (µg/L):	19.8
Total Phosphorus Min:	9
Total Phosphorus Max:	58
Number of Observations:	24
Chlorophyll a Mean (ug/L):	4.3
Chlorophyll-a Min:	0.3
Chlorophyll-a Max:	19.1
Number of Observations:	61
Secchi Depth Mean (ft):	14.7
Secchi Depth Min:	6.9
Secchi Depth Max:	26
Number of Observations:	306

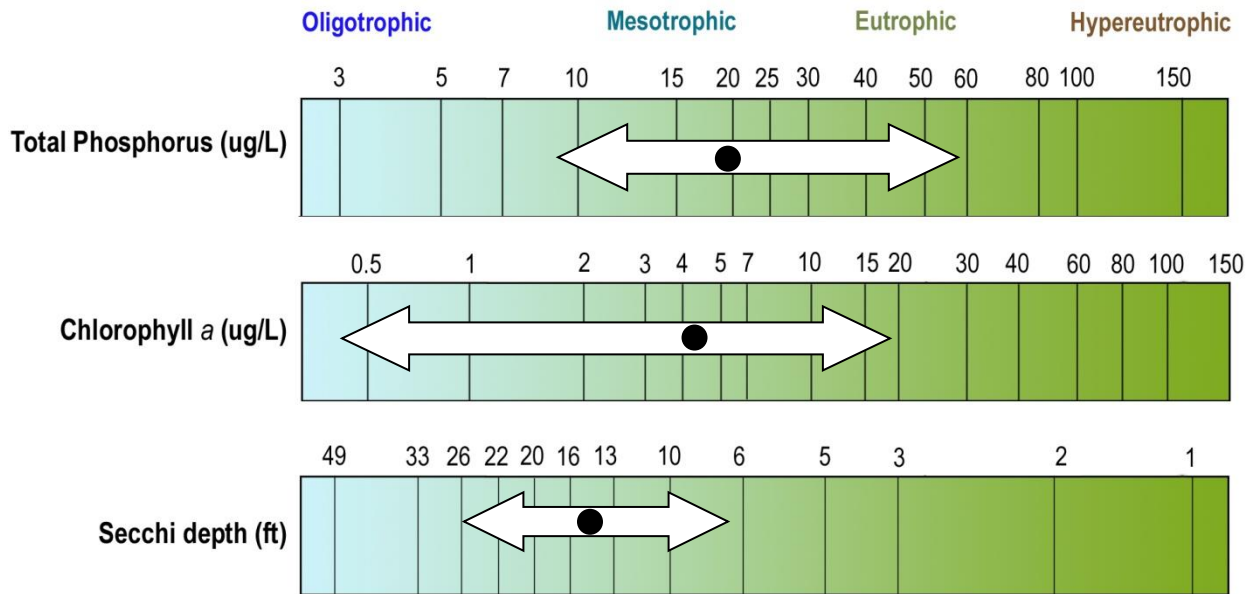


Figure 3. Tamarack Lake total phosphorus, chlorophyll a, and transparency historical ranges. The arrow represents the range and the black dot represents the historical mean (Site 201). Figure adapted after Moore and Thornton, [Ed.]. 1988.

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 Tamarack Lake ranges from 8.7 to 20.2 feet (Figure 4). The annual means hover fairly close to the long-term mean of 14.7. For trend analysis, see page 9. Transparency monitoring should be continued annually at site 201 in order to track water quality changes.

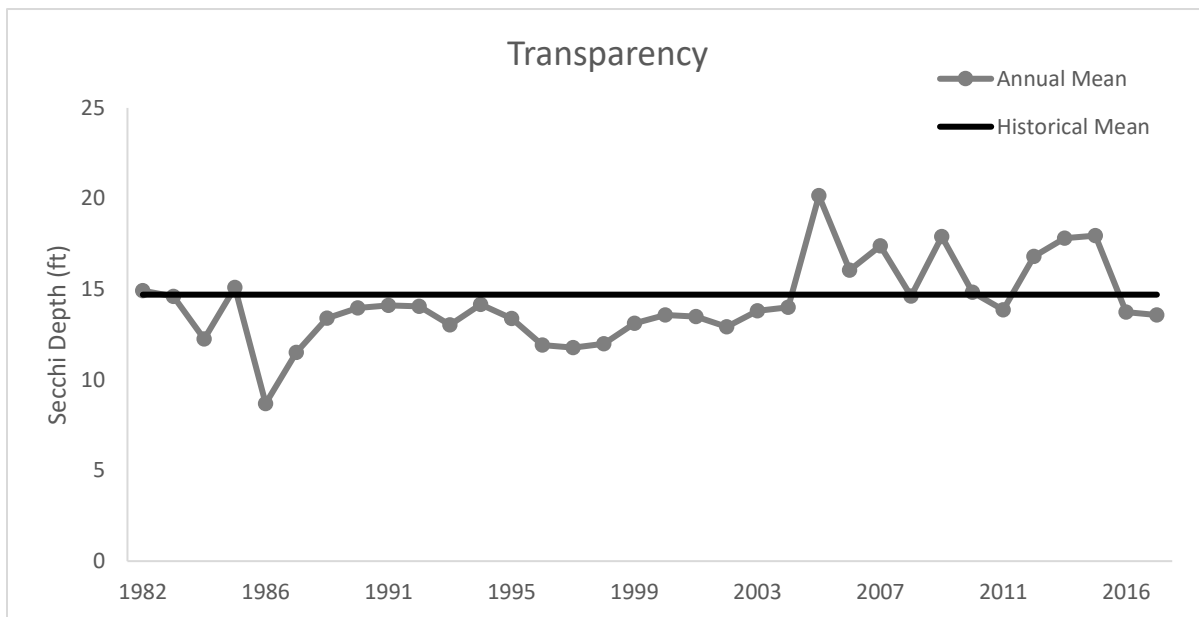


Figure 4. Annual mean transparency compared to long-term mean transparency

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. Tamarack 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.

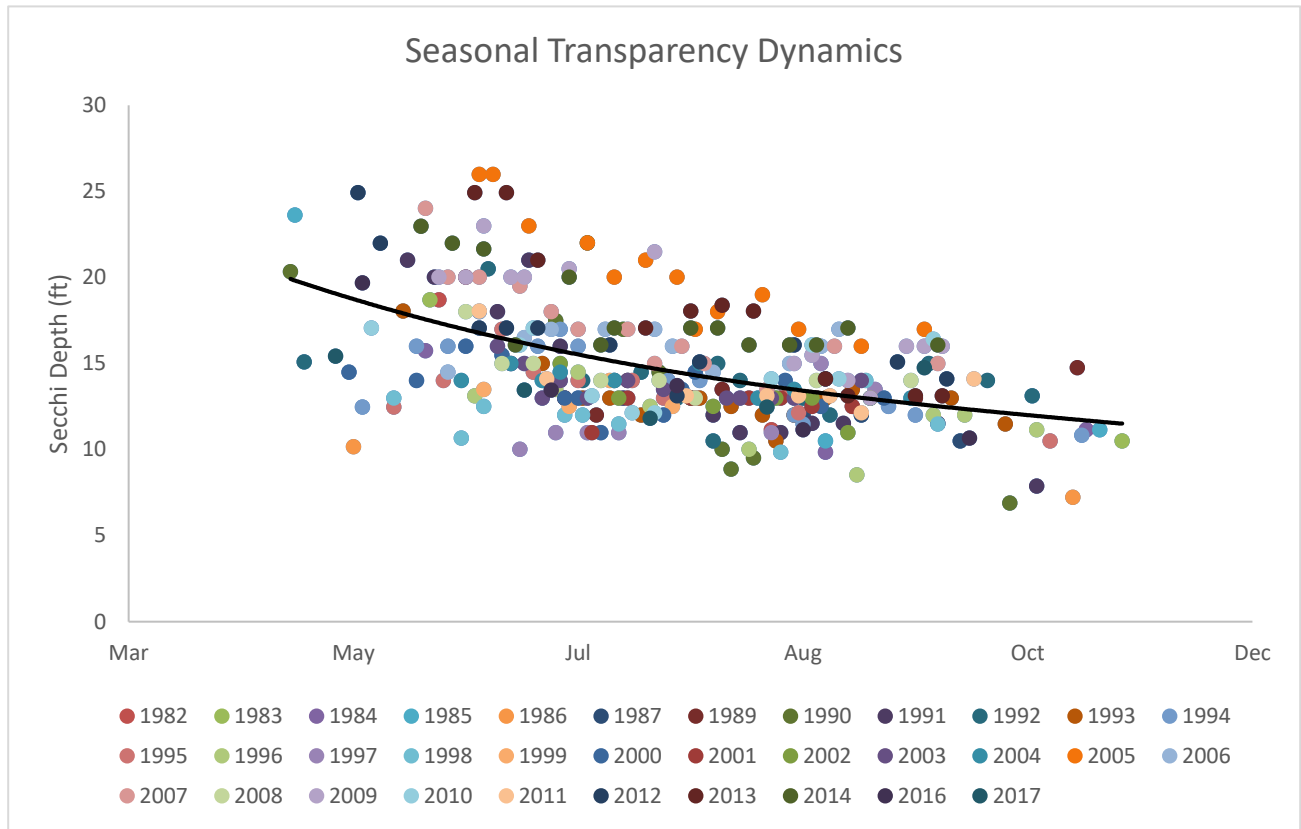


Figure 5. Seasonal transparency dynamics and year to year comparison (Site 201). The black line represents the pattern in the data.

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).

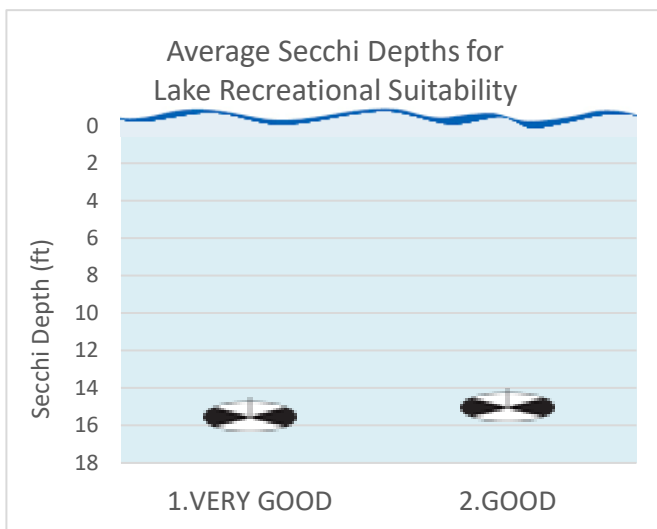


Figure 6. Average Secchi depth (ft) for each lake recreational suitability rating

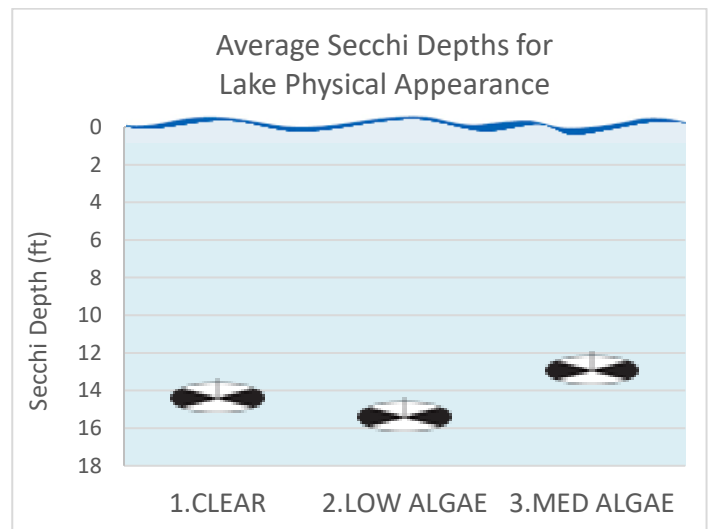


Figure 7. Average Secchi depth for each lake physical appearance rating

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.

Chlorophyll *a* concentrations greater than 10 $\mu\text{g/L}$ are perceived as a mild algae bloom, while concentrations greater than 20 $\mu\text{g/L}$ are perceived as a nuisance.

Chlorophyll *a* was evaluated in Tamarack Lake at site 201 from 1982-1998, and in 2016-2017 (Figure 8). Chlorophyll *a* concentrations mostly remained below 10 $\mu\text{g/L}$ in all the sample years, with only three samples indicating algae blooms. There was not much variation over the years monitored and chlorophyll-*a* concentrations remained relatively steady over the summer.

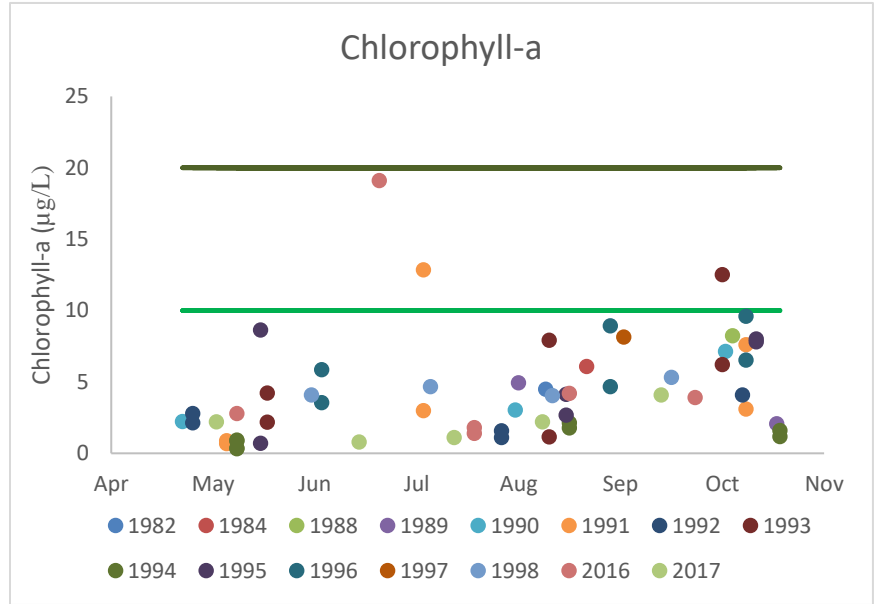


Figure 8. Chlorophyll *a* concentrations ($\mu\text{g/L}$) for Tamarack Lake at site 201

Phosphorus

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

Total phosphorus was evaluated in Tamarack Lake in 1982-1983, 1998, and 2016-2017 at site 201. The data do not indicate much seasonal variability. Majority of the data points fall into the mesotrophic/eutrophic classification (Figure 9).

Phosphorus should continue to be monitored to track any future changes in water quality.

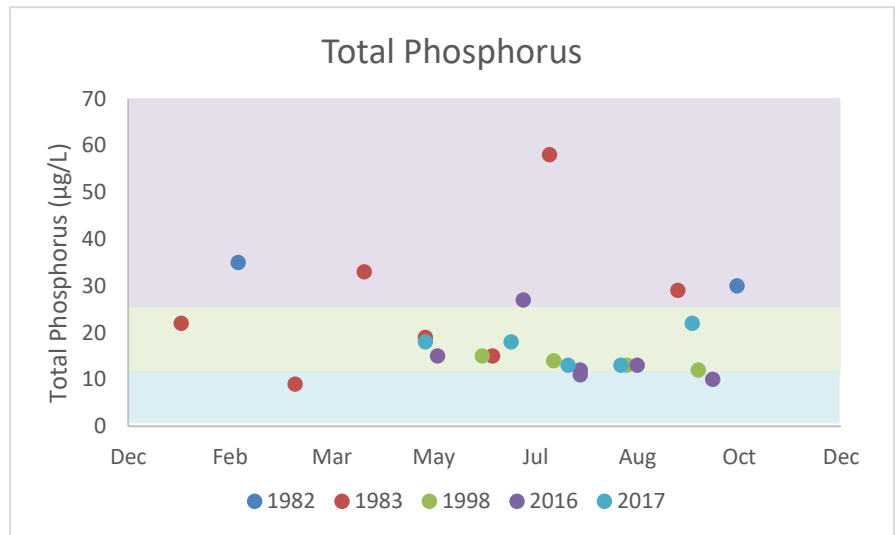


Figure 9. Historical total phosphorus concentrations ($\mu\text{g/L}$) for Tamarack Lake at site 201

Oxygen

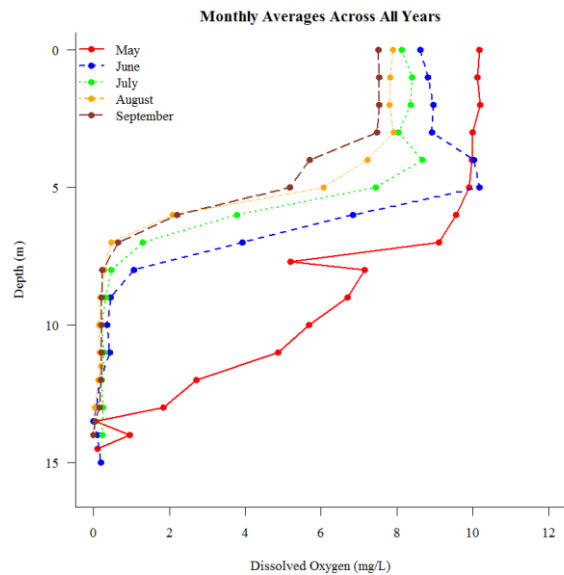


Figure 10. Representative dissolved oxygen profiles from site 201 year in Tamarack Lake

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.

Tamarack Lake is a moderately deep lake, with a maximum depth of 47 feet. Dissolved oxygen data was collected in 1982-1986, 1989-1998, and 2016-2017 at site 201. The dissolved oxygen profiles from this data show a stratified lake throughout the summer where the DO crashes around 7 meters (23 ft) down. Tamarack Lake is deep enough that spring and fall turnover only mix the upper portion of the water, leaving the lake bottom without a saturated oxygen supply (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. Tamarack Lake falls into the oligotrophic/mesotrophic range (Tables 6, 7). The average secchi depth TSI is much lower than the other parameters, but this may be due to the lack of long-term chemistry monitoring.

Table 6. Trophic State Index for Tamarack Lake

Trophic State Index	
TSI Phosphorus:	47
TSI Chlorophyll-a	45
TSI Secchi	38
TSI Mean	Not reported
Trophic State:	Oligotrophic/Mesotrophic

Numbers represent the mean TSI for each parameter.

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

Tamarack Lake	Eutrophication	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. Upper Pine 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.

Tamarack Lake had enough data to perform a trend analysis on transparency, but insufficient data for trend analysis on water chemistry (Table 8). The data was analyzed using the Mann Kendall Trend Analysis, which shows very strong evidence (99.9%) for an increasing transparency trend (Figure 11). It appears that since around 2002 the transparency has been higher than in the 1980s and 1990s. Transparency monitoring should continue at site 201 so that this trend can be tracked in future years.

Table 8: Trend analysis for Tamarack Lake

Lake Site	Parameter	Date Range	Trend	Probability
201	Total Phosphorus	1982 – 2017	Insufficient Data	-
201	Chlorophyll <i>a</i>	1982 – 2017	Insufficient Data	-
201	Transparency	1982 – 2017	Increasing Trend	99.9%

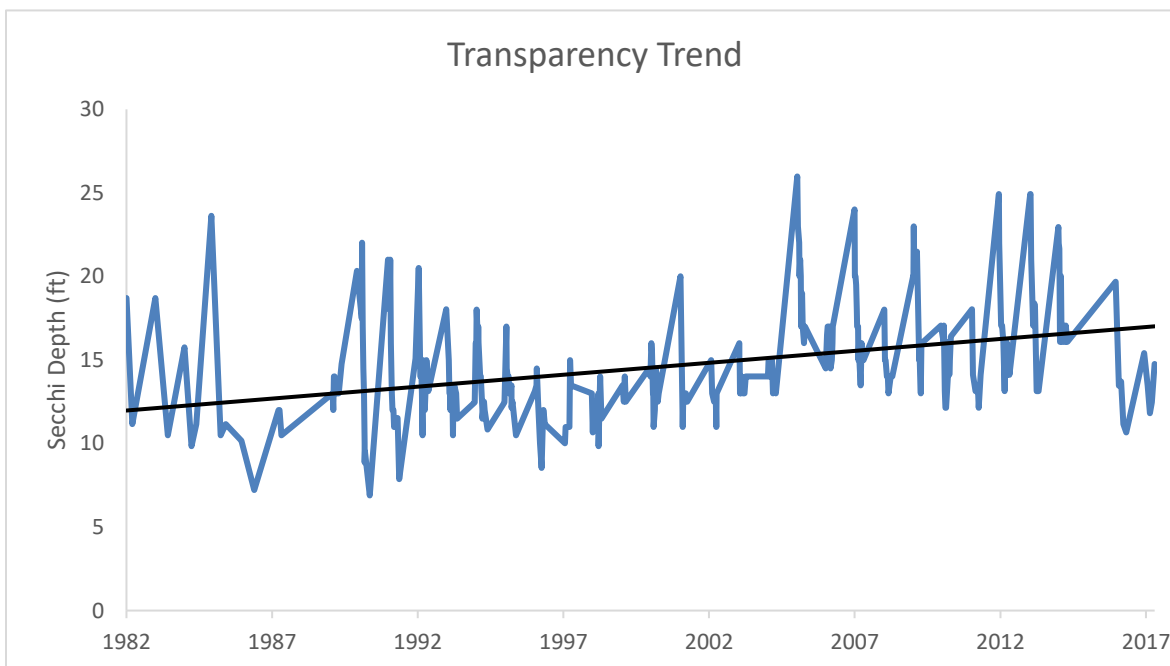


Figure 11: Transparency (ft) trend for site 201 from 1982 - 2017

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 Department of Natural Resources (DNR) has delineated three basic scales of watersheds (from large to small): 1) basins, 2) major watersheds, and 3) minor watersheds.

The Upper St. Croix River Watershed is one of the watersheds that make up the St. Croix River Basin, which drains south to the Gulf of Mexico (Figure 12).

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. Tamarack Lake falls within lakeshed 3402700 (Figure 12). 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 9). Watershed disturbance is 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. Ciscos (*Coregonus artedii*) 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.

Tamarack Lake's lakedshed is classified with having 50% of the watershed protected and 3% of the watershed disturbed (Figure 13). This shows that half of the lakedshed is protected, and the goal should be to limit any increase in disturbed land use. Tamarack Lake's lakedshed has no other lakedsheds flow into it, so activities around the lake have the highest impact on the water quality (Figure 12).

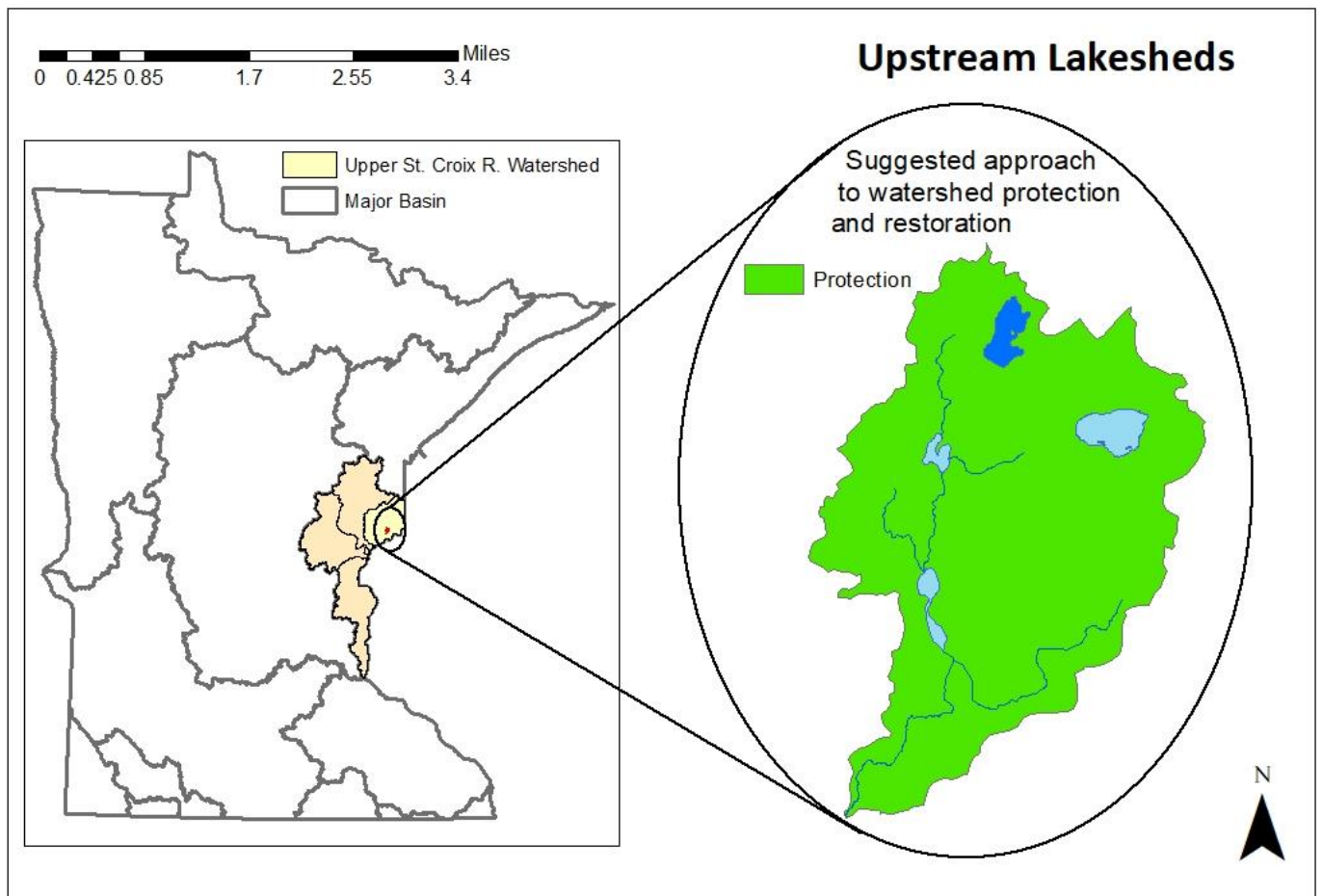


Figure 12. St. Croix major watershed and MN basins (left), and Tamarack Lake lakedshed and upstream catchments with protection suggestions (right)

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.

50% of the Tamarack Lake lakeshed is protected. This total includes water, wetlands, and publicly owned land. Five parcels along the lakeshore were selected for conservation potential, representing approximately 105 acres of the lakeshed.

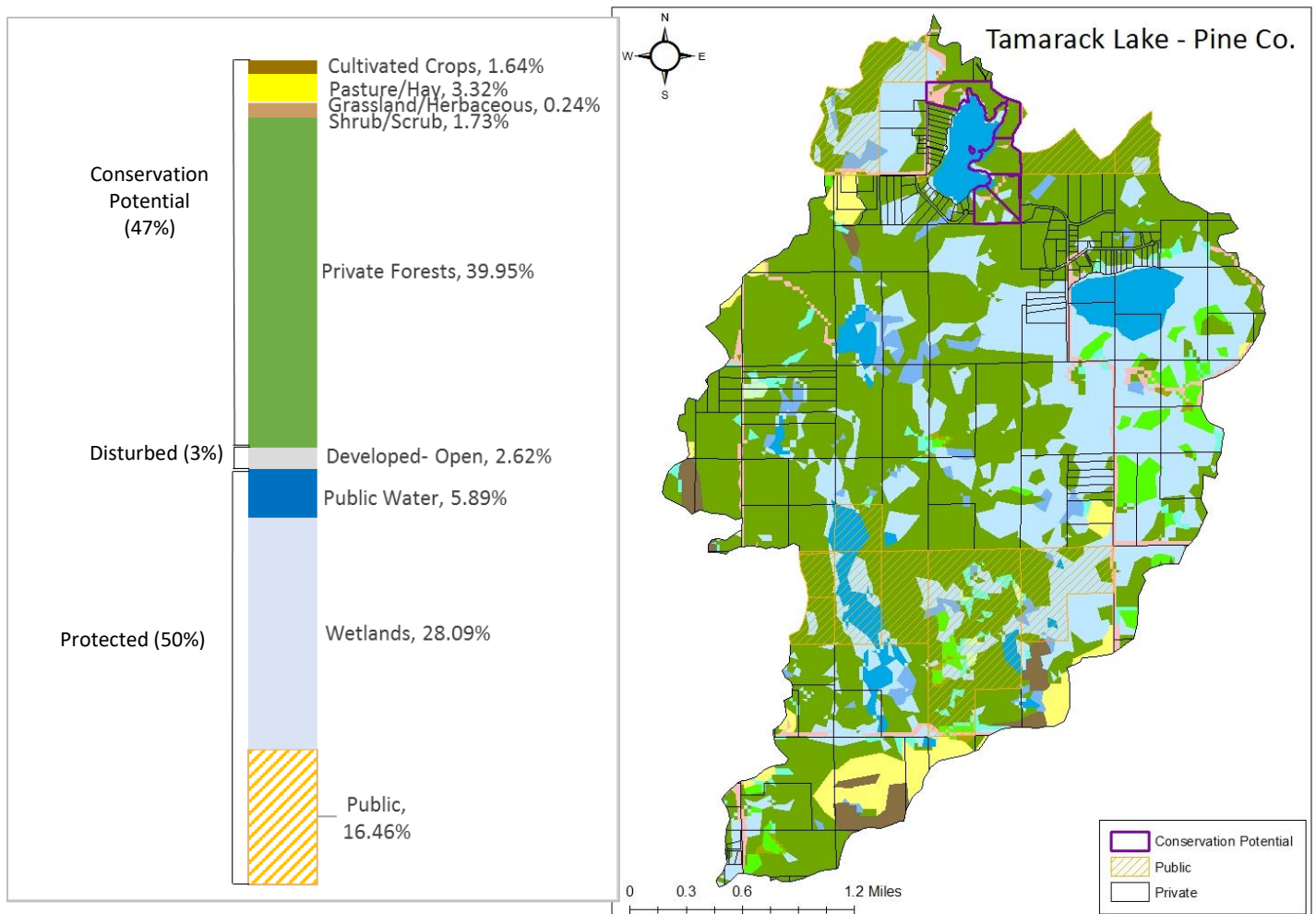


Figure 136. Land use and ownership in the Tamarack Lake lakeshed

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. Tamarack Lake lakeshed vitals table

Lakeshed Vitals		Rating
Lake Area	70.6 acres	descriptive
Littoral Zone Area	38.5 acres	descriptive
Lake Max Depth	47 ft.	descriptive
Lake Mean Depth	15 ft.	
Miles of Stream	8.3	descriptive
Inlets	0	
Outlets	0	
Major Watershed	34 – Upper St. Croix River	descriptive
Minor Watershed	34027	descriptive
Lakeshed	3402700	descriptive
Ecoregion	Northern Lakes and Forest	descriptive
Total Lakeshed to Lake Area Ratio (total lakeshed includes lake area)	76:1	
Standard Watershed to Lake Basin Ratio (standard watershed includes lake areas)	76:1	
Wetland Coverage	28%	
Aquatic Invasive Species	None	
Public Drainage Ditches	None	
Public Lake Accesses	1	
Miles of Shoreline	1.84	descriptive
Shoreline Development Index	1.52	
Public Land to Private Land Ratio	<1:1	
Development Classification	Recreational Development	
Miles of Road	11.1	descriptive
Municipalities in lakeshed	None	
Forestry Practices	NA	
Feedlots	None	
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	

Tamarack Lake, Status of the Fishery (DNR, 6/20/2016)

Big Tamarack is a small, clear lake with low fertility located in eastern Pine County. The lake is managed for Northern Pike and Bluegill. A voluntary catch and release program has been initiated by the lake association. A public access is located on the southwest end of the lake. Fishing pressure is usually light.

Although this survey found the fewest Northern Pike in the lake's survey history (4.5 fish per gill net), they are still at a level typical for this type of lake. Average size increased somewhat from the previous survey, 1.7 to 2.2 pounds, also typical for this type of lake. Growth is fairly slow though and the largest fish sampled was just under 29 inches.

Bluegill catch rates have historically been high in this lake and that held true for this survey. As is typical for lakes with very abundant Bluegill, the size of fish is not especially large. Fish averaged 5.4 inches in length and the largest fish sampled measured 8.1 inches.

Black Crappie numbers increased from the last survey to 2.9 per trap net, which is average for this type of lake and the highest since 1991. The size distribution of fish was typical of decent crappie lakes with fish averaging 8 inches and fish up to 10 inches present. As long as the population holds steady or continues to grow, it may provide an angling opportunity that was not available in the recent past.

Largemouth Bass were sampled via electrofishing at the highest rate since electrofishing began on the lake. Eighty-three fish were sampled per hour of shocking. Average length was 12.3 inches with the largest fish measuring just over 19.5 inches. The vast majority of bass are near the average with all but 6 fish sampled measuring between 9 and 16 inches.

Yellow Perch, while sampled in all previous surveys and occasionally at fishable levels, were not found during this assessment.

For more information, contact the nearest Area Fisheries office or go to the following website:
<https://www.dnr.state.mn.us/lakefind/showreport.html?downum=58002400>

Key Findings and Recommendations

Monitoring Recommendations

Transparency monitoring at site 201 should be continued annually. It is important to continue transparency monitoring weekly or at least bimonthly every year to enable year-to-year comparisons and trend analyses. Phosphorus and chlorophyll *a* monitoring should continue at site 201, as the budget allows, to track future water quality trends. The alkalinity and pH levels show acidic water with a low ability to buffer acidic inputs to the lake, so these parameters should also be monitored in a depth profile at site 201 as the budget allows.

Overall Conclusions

Tamarack Lake is an oligotrophic/mesotrophic lake with evidence of an increasing long-term trend in water clarity. The total phosphorus and chlorophyll *a* ranges are within the ecoregion ranges, but there is limited data available for these water chemistry parameters (Table 4). Additional continuous monitoring of phosphorus and chlorophyll *a* can clarify if the lake's trophic status is changing or if there are other impacts affecting the transparency.

Over half of the lakeshed (56%) is forested, with most of that area in private ownership. Half of the lakeshed is protected (50%), which includes public ownership, wetlands, and open water. Over a quarter (28%) of the lakeshed is wetland coverage, which is good for water quality and stormwater retention for areas downstream. About 16% of the lakeshed is in public ownership, while only 3% of the lakeshed is disturbed and consists of only low levels of development.

Tamarack Lake is land locked, meaning no significant inlets or outlets connect to the lake. Water levels in this system are mainly affected by precipitation (i.e. rain, snowmelt), which can cause strong fluctuations in the water level with major storm events. The total watershed area for Tamarack Lake is fairly large, but it is within a headwaters lakeshed, meaning that no other lakesheds flow into it.

Phosphorus Loading and Priority Impacts

Tamarack Lake is at an advantage because the lakeshed is a headwaters catchment, which means no additional water flows into this lakeshed from upstream areas. This means that the land practices around the lake are the main impact to the lake's water quality.

The transparency trend in Tamarack Lake is improving over time, meaning the water is becoming clearer. However, the data available for chlorophyll *a* and total phosphorus show relatively high values, so they may not be driving factors in the changing transparency. The secchi readings in 2016 and 2017 were lower than average. Water level monitoring shows an increase from 2015 to 2017, which could have caused the lower transparency (Figure 14). High water can cause shoreline erosion and decreased water transparency. Wetlands in the lakeshed help with water storage and filtration, and they can decrease the impact from high water events. Protecting these wetland areas will help maintain water levels, reduce flooding, and filter runoff during large storm events.

Table 11. Watershed characteristics

Lakeshed to Lake Area Ratio (lakeshed includes lake area)	76:1
Watershed to Lake Area Ratio (watershed includes lake areas)	76:1
Number of Upstream Lakes	0
Headwaters Lake?	Yes
Inlets / Outlets	0 / 0
Water Residence Time	NA

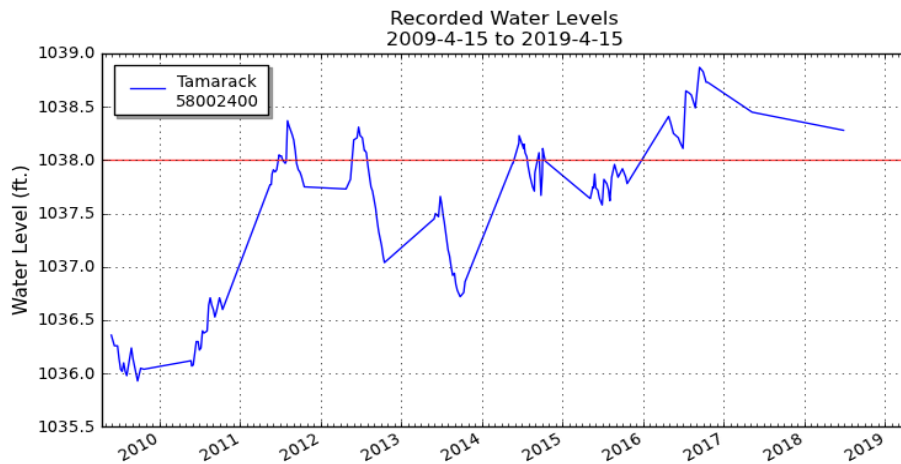


Figure 14: Monitored water levels in Tamarack Lake, Source: MN DNR Lakefinder

The watershed of Tamarack Lake is fairly large and contains a large proportion of wetlands and deciduous forest. Wetland areas that are dominated by tamaracks (*Larix laricina*) and black spruce trees (*Picea mariana*) tend to have more acidic soils and little groundwater input. The large amount of wetland areas in the lakeshed and shoreline bogs may be indicative of naturally acidic soils that are contributing to the low pH and alkalinity levels of Tamarack Lake (Table 4). Alkalinity is the ability of a water body to neutralize acidic inputs and is also known as the buffering capacity. Low alkalinity is a cause for concern because the lack of buffering capacity can result in drastic changes in pH with any acidic inputs from precipitation and snowmelt runoff. Lakes with pH values below 6.5 can affect the ecological community and fish spawning ability. It can also cause harmful metals like aluminum, copper, and mercury to become more soluble in the water, which can affect aquatic ecosystems and recreational use of a lake. The most recent fishery survey was in 2019, and there does not seem to be major effects on the fish found in the lake at this time. Additional monitoring of the alkalinity and pH in Tamarack Lake would give better understanding of whether these parameters are changing over time or remaining stable.

Best Management Practices Recommendations

The management focus for Tamarack 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.

Tamarack 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 Tamarack Lake (refer to Figure 13)

Category	Land use type	Conservation project ideas	Results	Who	Contact for help
Conservation Potential Land	private forests (40%, 2147 acres)	Forest stewardship planning, 3 rd party certification, SFIA, local woodland cooperatives	Conserve and protect current forest cover	<ul style="list-style-type: none"> • Individual Property Owners 	Pine County SWCD 320-216-4240 Jill.carlier@co.pine.mn.us
	cultivated crops (1.6%, 86 acres)	Restore wetlands; CRP; Cover Crops,	Reduce water runoff and soil erosion, better water storage	<ul style="list-style-type: none"> • Individual Property Owners 	Natural Resources Conservation Service 320-384-7432, http://www.nrcs.usda.gov .
	pasture/hay (3.3%, 177 acres)	Maintain vegetative cover, plant trees, Conservation Easements	Reduce water runoff and soil erosion, better water storage	<ul style="list-style-type: none"> • Individual Property Owners 	Natural Resources Conservation Service 320-384-7432, http://www.nrcs.usda.gov .
Disturbed Land	developed, Open Space (2.6%, 140 acres)	Shoreline buffers, rain gardens		<ul style="list-style-type: none"> • Individual Property Owners 	Pine County SWCD 320-216-4240 Jill.carlier@co.pine.mn.us
	Developed, high intensity (0%, 0 acres)	Sediment basins, rain gardens, shoreline buffers, stormwater retention		<ul style="list-style-type: none"> • Individual Property Owners • Cities • Lake Associations 	Pine County SWCD 320-216-4240 Jill.carlier@co.pine.mn.us

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 12).

Approximately 40% of the lakeshed is privately owned forested uplands (Table 12). 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	PO Box 389, 306 Power Ave N, Hinkley, MN 55037 320-384-7721, hinkley.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 St. E Sandstone, MN 55072 (320) 216-4240, https://pineswcd.com/
Pine County	635 Northridge Dr NW Pine City, MN 55063 https://www.co.pine.mn.us