Tree Lake

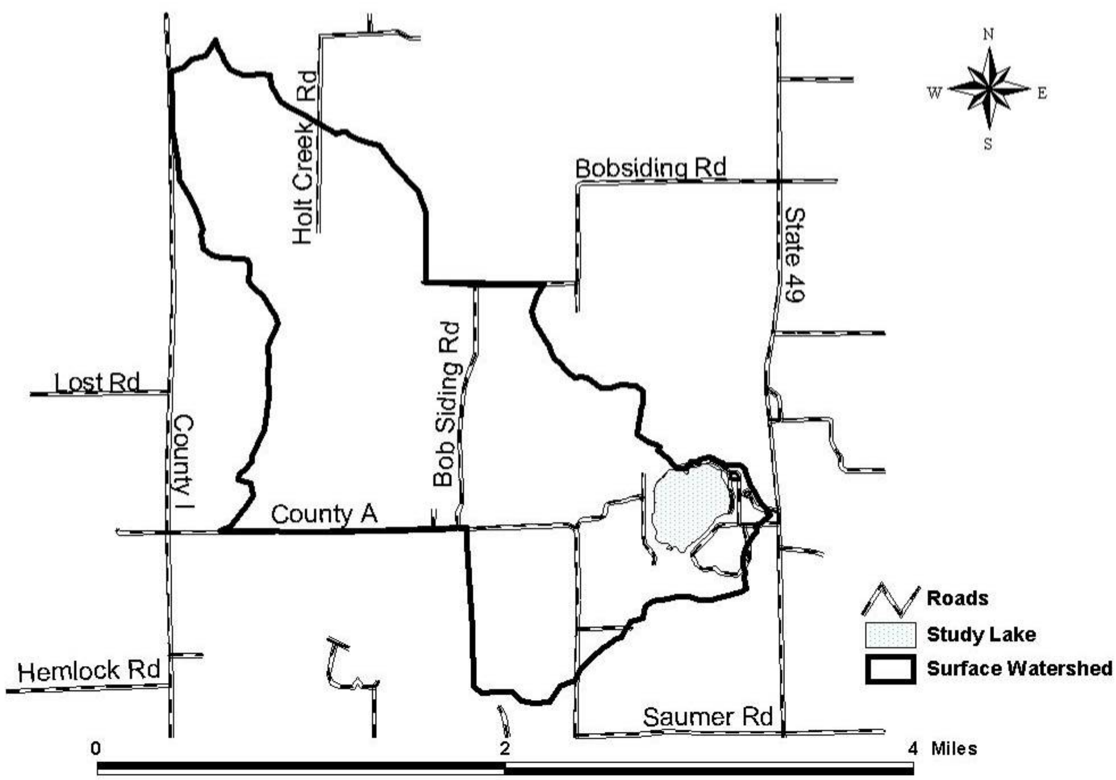
Introduction

Tree Lake is a 71.3 acre **hard water drainage lake** with an estimated volume of 1,051 acre feet, located in the Township of Alban, four miles north of Rosholt. It has a maximum depth of 34 feet and a bottom consisting of sand, gravel, and silt. Tree Lake has two inlets. The smaller of the two enters on the northwest side and flows from Mud Lake. The other, Klondike Creek, is a cold water stream that provides good habitat for brook trout. There is one outlet present which feeds into the North Branch of the Little Wolf River (WDNR 1972). The estimated water **retention time** is 2.3 years. The fishery here is made up of largemouth bass, panfish, and northern pike (WDNR 2001). On the southeast shore of the lake Peterson Park offers a beach, facilities, boat launch ramp, and plenty of parking, all of which is open to the public. The shoreline is heavily developed.

Land Use and Watershed

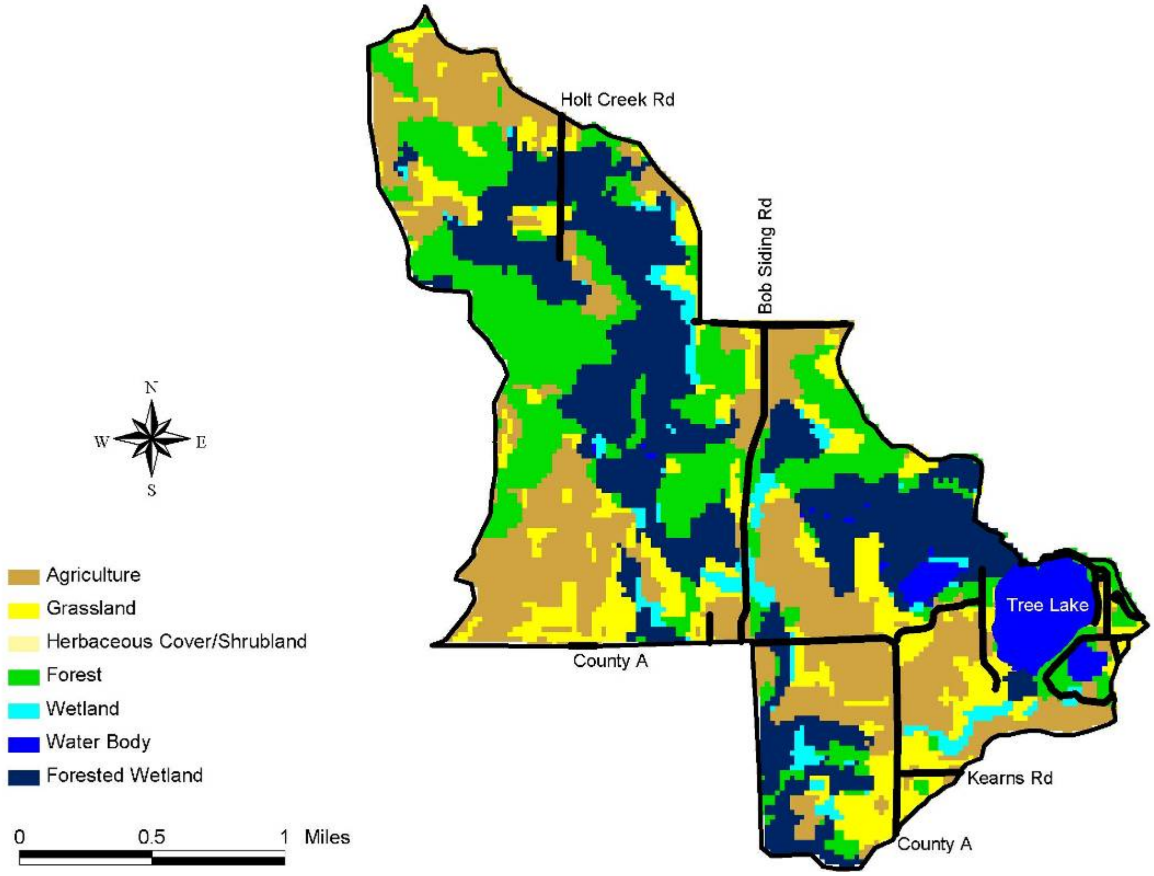
Compared to most of the other lakes in this study Tree Lake has an enormous surface **watershed** of approximately 2,524 acres (Figure 1). The **watershed** extends north into the forested wetlands of Marathon County, with little topography to define its boundaries. Because the **watershed** enters Marathon County, historic land use data was not readily available. The 1992 WISCLAND data show that the dominant land use was fairly evenly split between 706.5 acres of agriculture and 681.6 acres of forested wetland. In addition, there were 557.3 acres of forest, 388.3 acres of grassland, and 90.5 acres of wetland (Figure 2).

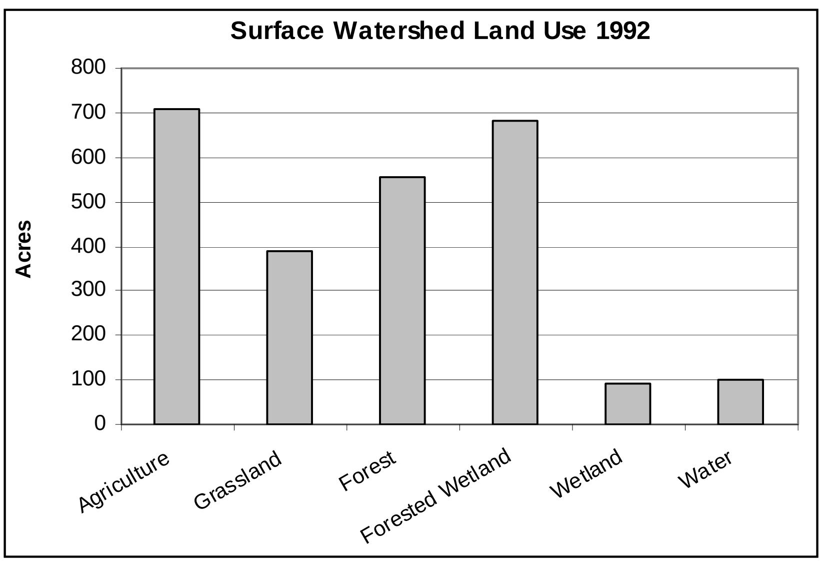
Figure 1. Tree Lake surface watershed boundary



*For terms in bold, see glossary pp 14-19

Figure 2. Land use in the Tree Lake surface watershed from WISCLAND (1992).



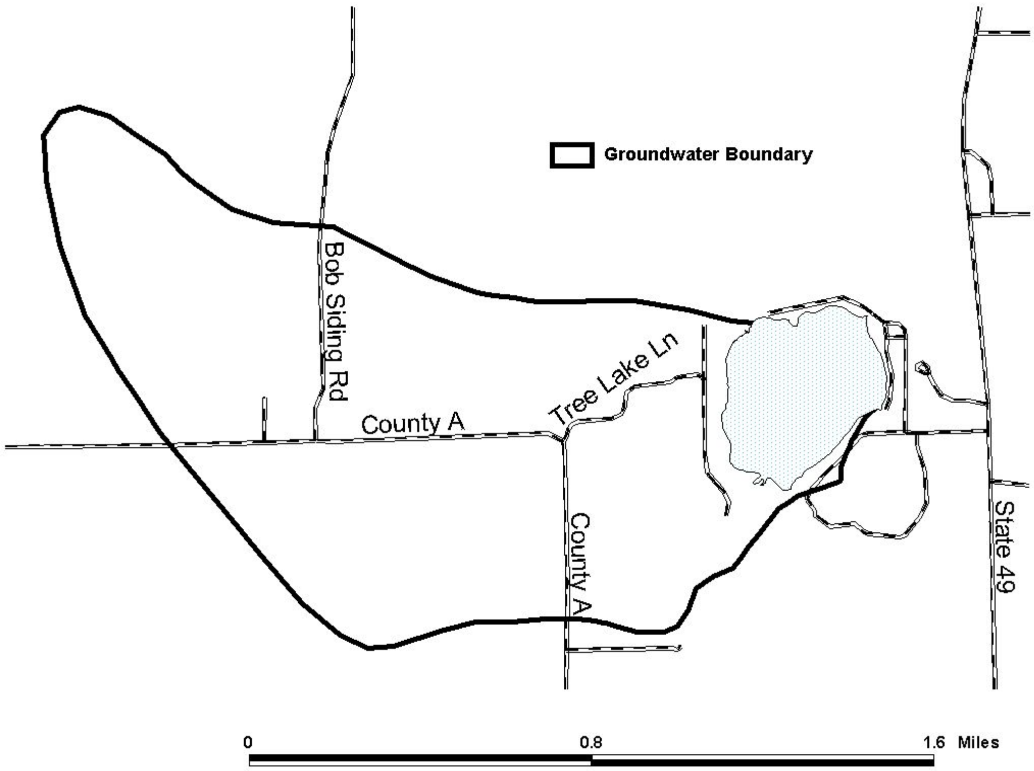


The **groundwater watershed** of Tree Lake is 825 acres, all within Portage County (Figure 3). Land use is dominated by forest (35%) and non-irrigated agriculture (30%). Non-irrigated cropland decreased between 1968 and 1990, and was apparently converted to irrigated cropland. Forestland has fluctuated since 1948 but has increased overall. Shrub vegetation has declined significantly,

*For terms in bold, see glossary pp 14-19

giving rise to residential and transportation development, particularly between 1948 and 1990 (Figure 4).

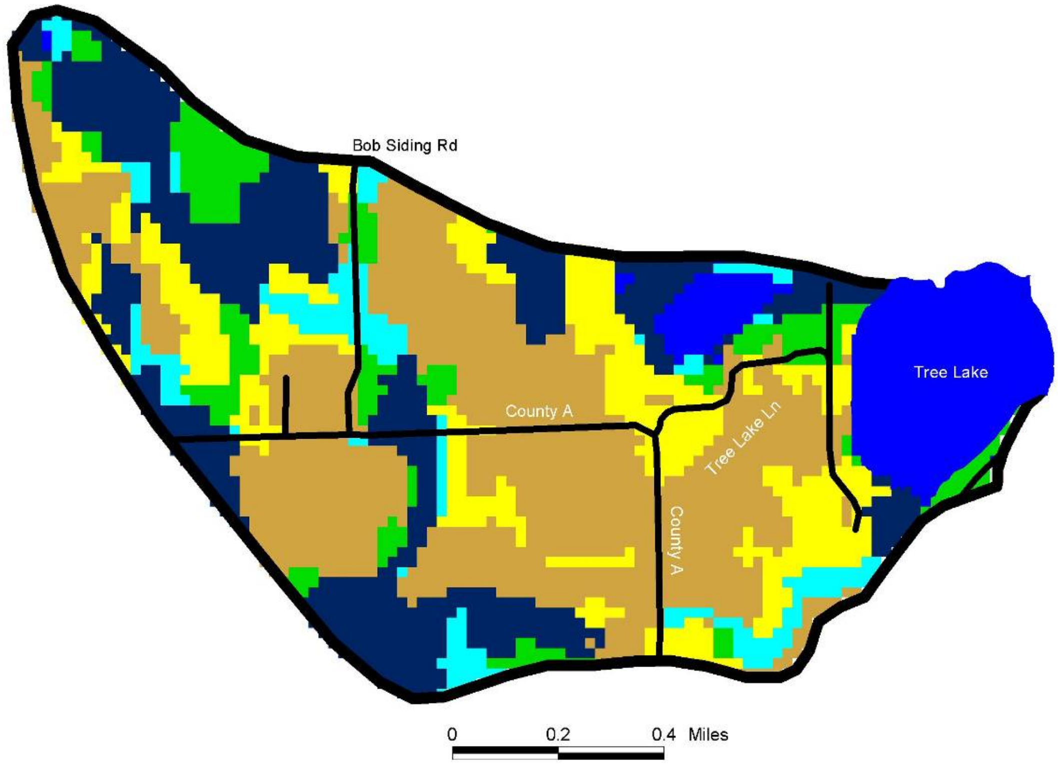
Figure 3. Tree Lake groundwater watershed boundary.

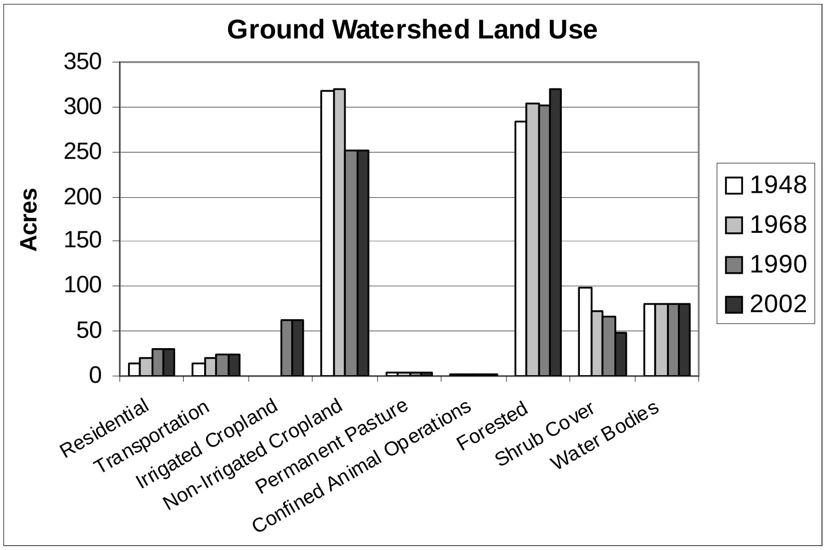


Looking at the Portage County records there are three potentially failing septic systems present on the southeast side of the lake, within the Portage County portion of the surface **watershed**. There do not appear to be any in the **groundwater watershed**. There is no indication of former landfill sites within either the **groundwater watershed** or the Portage County portion of the surface **watershed**. The presence of potentially failing septic systems or landfill sites in the Marathon County areas of the surface **watershed** is not known.

*For terms in bold, see glossary pp 14-19

Figure 4. Land use in the Tree Lake groundwater watershed 1948-2002.



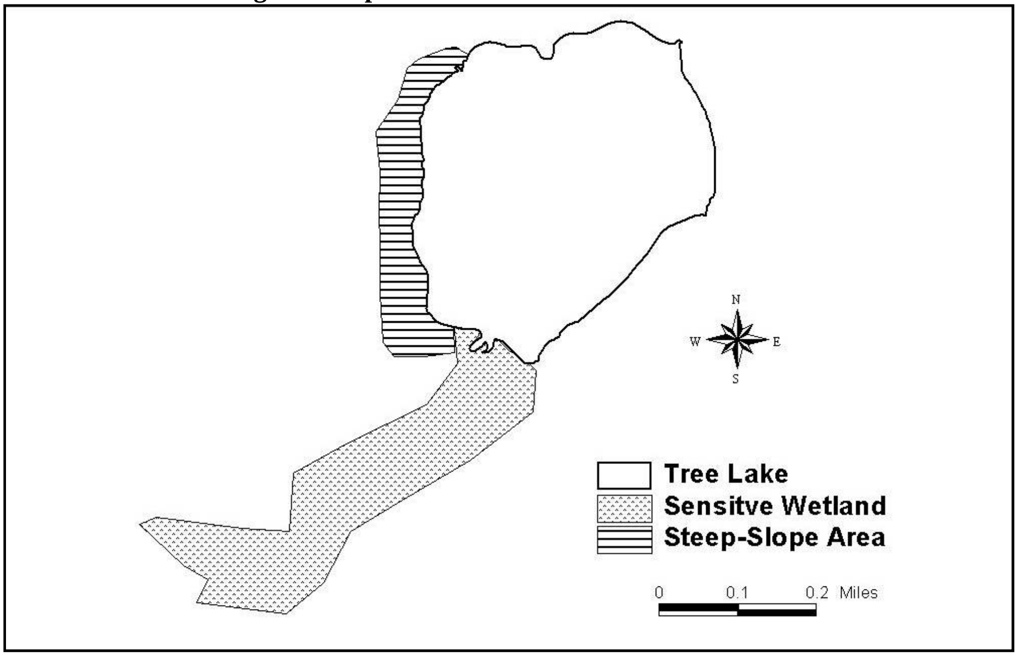


Upland Sensitive Areas

The survey of upland sensitive areas was conducted to note areas immediately around the lakeshore that are particularly valuable, or sensitive to disruption. Tree Lake has a long, finger-like wetland extending from its southern shore, heading southwest, and a steep slope lining the western banks (Figure 5).

*For terms in bold, see glossary pp 14-19

Figure 5. Upland sensitive areas near Tree Lake.



Shoreline Vegetation, Reptiles, and Amphibians

Amphibians (frogs, toads, and salamanders) were included in this survey because with their permeable skin and biphasic lifecycle (meaning that the young live in water while adults can survive on land) they are considered excellent indicators of overall ecosystem health. Furthermore, both turtles and amphibians utilize both aquatic and terrestrial habitats and especially the shoreline interface between these two habitats, and thus are of particular relevance.

Large sections of continuous natural shoreline on lakes are ideal habitats for many frog species. Natural areas with large amounts of submergent, emergent, and floating-leaf vegetation provide protection and a place for attachment of eggs during the breeding season. The upland areas surrounding these lakes also provide important habitat as many frog species migrate to lakes and other bodies of water in the spring or fall to breed and spend the summer months foraging in the uplands. Several species also use the surrounding uplands for overwintering. The turtle species found associated with lakes are predominantly aquatic, usually departing from the water only to deposit eggs in a nest. Nests are usually on south facing slopes above the shoreline where there is open vegetation and sandy soil. The newly hatched young then find their way to the water. Thus, both turtles and frogs are intimately associated with lakes and the associated habitats of a **watershed**.

Three frog species were identified near Tree Lake during the amphibian survey [spring peeper (*Pseudacris crucifer*), American toad (*Bufo americanus*), and green frog (*Rana clamitans*)]. The primary amphibian habitat is located on the west side of the lake (sensitive areas are identified in red in Figure 6). Some of the key features of this habitat include protected areas of marsh with large amounts of submergent, emergent, and floating-leaf vegetation. The good news is that some large

*For terms in bold, see glossary pp 14-19

sections of undisturbed, natural shoreline are present. However, there is also a high level of shoreline development. During the reptile survey Tree Lake was home to one turtle species, the snapping turtle (*Chelydra serpentina*).

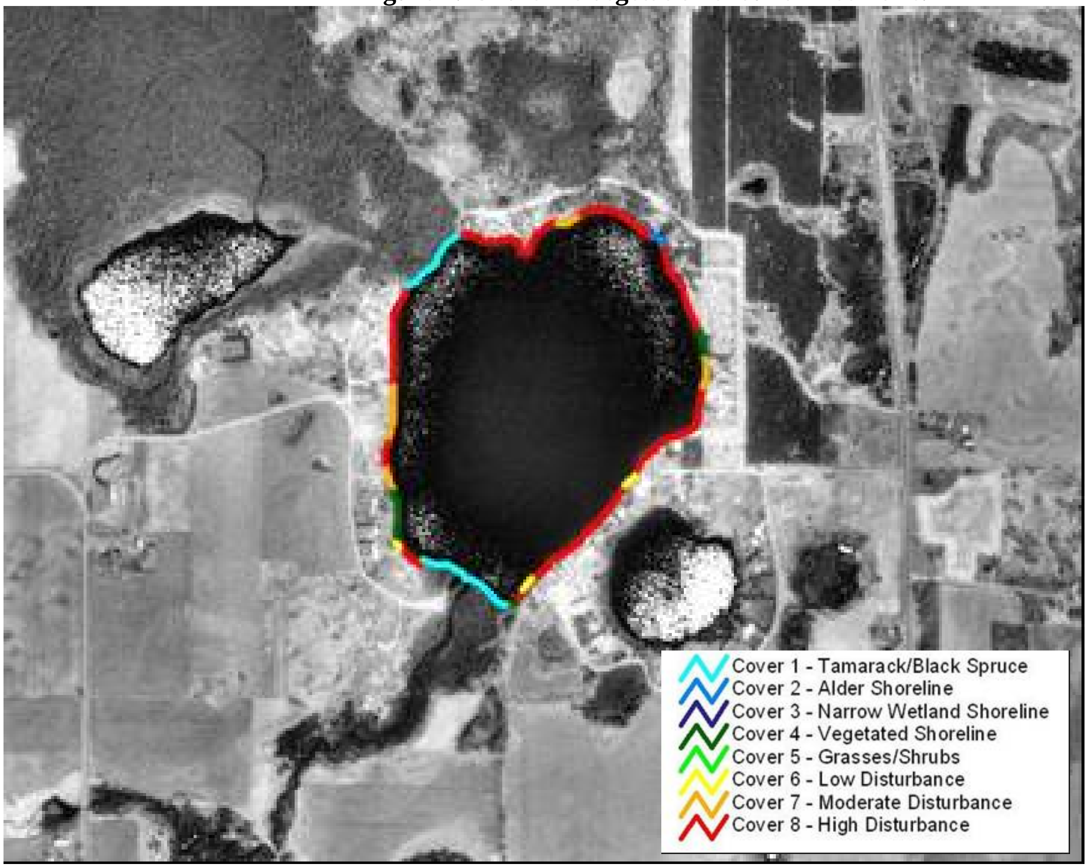
Figure 6. Regions of primary amphibian habitat around Tree Lake.

Black spruce (*Picea mariana*) and tamarack (*Larix laricina*) wetland comprises 15.1% of the shoreline of Tree Lake (shown in blue in Figure 7). Tamarack/black spruce wetlands are characterized as wetland shoreline with a sweet gale (*Myrica gale* L.) or leatherleaf (*Chamaedaphne calyculata*) understory and a black spruce or tamarack canopy. In addition, 6.1% of the shoreline was classified as vegetated shoreline. Vegetated shoreline is characterized as being upland areas with dense vegetation comprised of tall grasses or shrubs that lacks a rocky component (shown in dark green in Figure 7). Another 1.2 percent of the shoreline consists of alder (*Alnus incana*). Alder shoreline is characterized as being areas alder dominates the shore zone.

Seventy-eight percent of the shoreline around Tree Lake is considered to be disturbed. Of that, 3.2% of the lake's shoreline vegetation is considered to be low disturbance developed, 11% is moderately disturbed, and 63.5% is considered to be highly disturbed. An area that exhibits low vegetation disturbance is defined as a location where there is an unaltered shore zone except for pier access. An area that has moderate vegetation disturbance is an area of shore that may contain a mowed lawn but has an intact overstory. An area that exhibits high vegetation disturbance is defined as a beach, **rip rap**, sea wall, or area where the shore is mowed to the water line.

*For terms in bold, see glossary pp 14-19

Figure 7. **Shoreline vegetation around Tree Lake.**



Aquatic Plants

There are **38** species of aquatic **macrophytes** (**37** species of **vascular plants** plus one species of **macrophytic algae**) that have been found in Tree Lake or on the adjacent wet shore and wetland. This is below average for Portage County lakes. The average **coefficient of conservatism** (**c-value**) is 4.7, which is average for Portage County lakes. The **floristic quality index** is 28.5, which is below average.

Tree Lake has a relatively small number of aquatic flora, composed of species typical of fairly **hard water** lakes. No major invasive species have been found to date in the lake. Although much of the shoreline is developed or in park land, reed canary-grass (*Phalaris arundinacea*) is the only invasive alien species noted. Wetland complexes including swampy or boggy woods extend northwest from the northwestern shore and also along Klondike Creek to the southwest from the south shore of Tree Lake. If botanical inventories of these wetlands were added to the data for Tree Lake, the **floristic quality index** would probably increase substantially.

*For terms in bold, see glossary pp 14-19

Current Water Quality Conditions

Water quality in lakes is assessed by measuring characteristics including temperature, dissolved oxygen, water **clarity**, **chlorophyll *a***, water chemistry, and the algal community. Based on temperature profiles, Tree Lake shows the mixed and **stratified** cycles typical of many Wisconsin lakes (Figure 8). During the summer, the upper 11 feet of water have sufficient dissolved oxygen concentrations to support a variety of fish and aquatic biota (Figure 9). Most aquatic biota require at least 5 **mg/L** dissolved oxygen for survival.

Figure 8. Profile of temperature in Tree Lake 2002-2004.

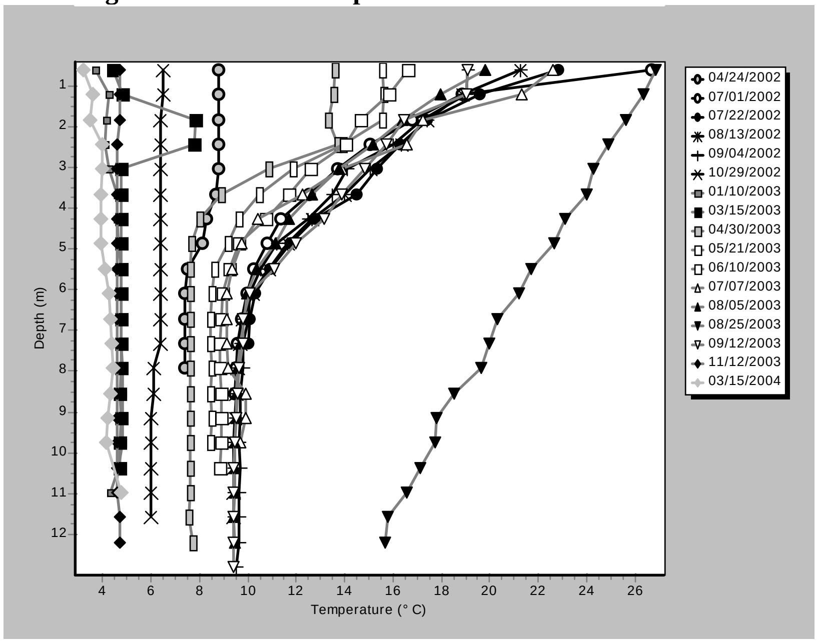
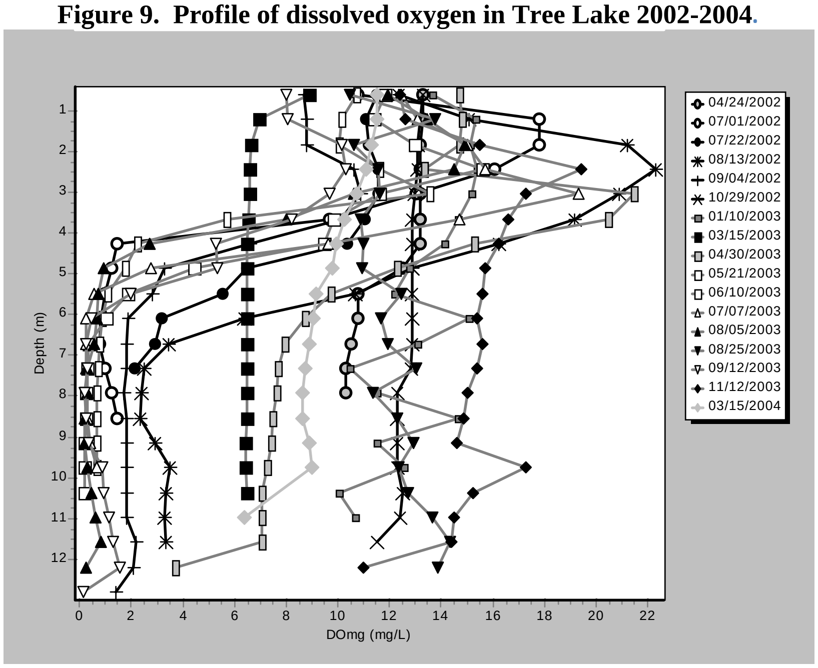


Figure 9. Profile of dissolved oxygen in Tree Lake 2002-2004.

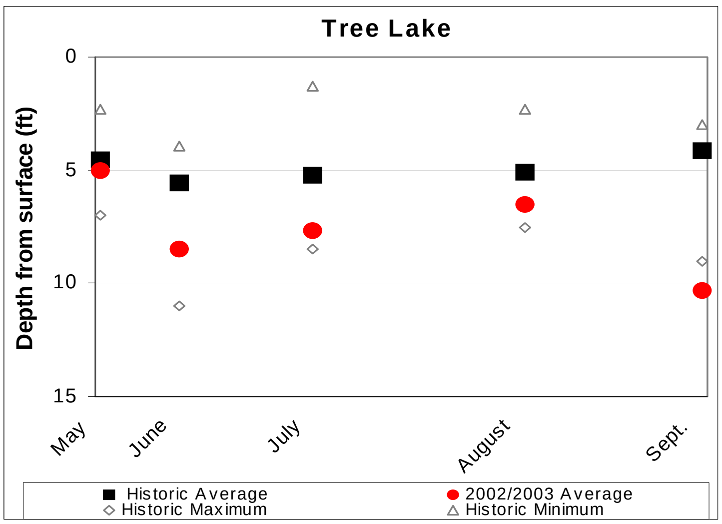


*For terms in bold, see glossary pp 14-19

Water **clarity** is a measure of how deep light can penetrate. It is an aesthetic measure and is related to how deep **rooted aquatic plants** can grow. Water **clarity** is affected by water **color**, **turbidity** (suspended sediment), and **algae** (**chlorophyll *a***). Tree Lake has relatively high **color** due to brown staining from associated wetlands. **Turbidity** in Tree Lake was quite low, but **chlorophyll *a*** was elevated during much of the summer (Table 1).

The water **clarity** in Tree Lake is considered fair. The average **Secchi disk** depth reading for similar lakes in the region is 10 feet; Tree Lake appears to have worse **clarity** than this. The water **clarity** of Tree Lake during the 2002-03 growing seasons was better than the historical growing season average. The month of September shows the best water **clarity** and the month of May the poorest. These fluctuations throughout the summer are normal as **algae** populations and **sedimentation** increase and decrease.

Figure 10. Monthly average water clarity measurements in Tree Lake 2002-2003 and historic average, maximum and minimums.



Nutrients (**phosphorus** and **nitrogen**) are important measures of water quality in lakes because they are used for growth by **algae** and **rooted aquatic plants** (similar to houseplants and crops). Total **phosphorus** (TP) concentrations ranged from 13 to 43 **mg/L** and were quite variable throughout the year, however when averaged by season they are relatively low. TP measured in the water near the lake bottom was very high; when the water mixes from top to bottom this **phosphorus** is also mixed throughout the water column. **Nitrogen** concentrations are quite high in Tree Lake; a concentration of **nitrate-nitrogen** (**NO_3-N**) plus **ammonium-nitrogen** (NH_4-N) of 0.3 **mg/L** in spring will support summer **algae** blooms if enough **phosphorus** is present (Table 1).

Chloride levels, and to a lesser degree **sodium** and **potassium** levels, are commonly used as an indicator of how strongly a lake is being impacted by human activity. **Potassium** was low but **chloride** and **sodium** were somewhat elevated (Table 2). Although these constituents are not detrimental to the aquatic ecosystem, they indicate that sources of contaminants (road salt, fertilizer, animal waste and/or septic system effluent) are entering the lake from either surface runoff or via **groundwater**. **Atrazine**, a weedkiller (herbicide) used on corn, was found in low concentrations in the lake water (0.11 and <0.05 ppb). Some toxicity studies have indicated that reproductive system

*For terms in bold, see glossary pp 14-19

abnormalities can occur in frogs at these levels. The presence of **atrazine** indicates that other agrichemicals may also be entering Tree Lake.

Table 1. 2002-2003 water quality seasonal averages in Tree Lake.

Tree Lake	*TP (ug/L)*	*RP (ug/L)*	*TN (mg/L)*	*NO2+NO3 (mg/L)*	*NH4 (mg/L)*	*Alkalinity (mg/L)*	*Total Hardness (mg/L)*	*Calcium Hardness (mg/L)*	*Color (CU)*	*Turbidity (NTU)*	*Chlorophyll a (ppm)*
Spring Averages	26.3	3.5	1.8	0.95	0.08	170	193	107	59	1.6	10.7
Summer Averages	22.1	8.6	1.3	0.34	0.18	167	181	96	58	2.6	8.5
Fall Averages	30.0	4.5	1.8	0.44	0.27	172	190	106	66	1.6	
Winter Averages	20.7	6.0	1.8	1.06	0.31						
2002-2004 Averages	23.4	4.8	1.6	0.66	0.22	169	188	103	61	1.9	8.7

TP=total phosphorus; RP=reactive or soluble phosphorus; TN=total nitrogen; NO2+NO3=nitrite and nitrate nitrogen; NH4=ammonia nitrogen

Table 2. 2002-2003 Tree Lake average water chemistry and reference values from Shaw (2000) and Portage Count Lakes study averages.

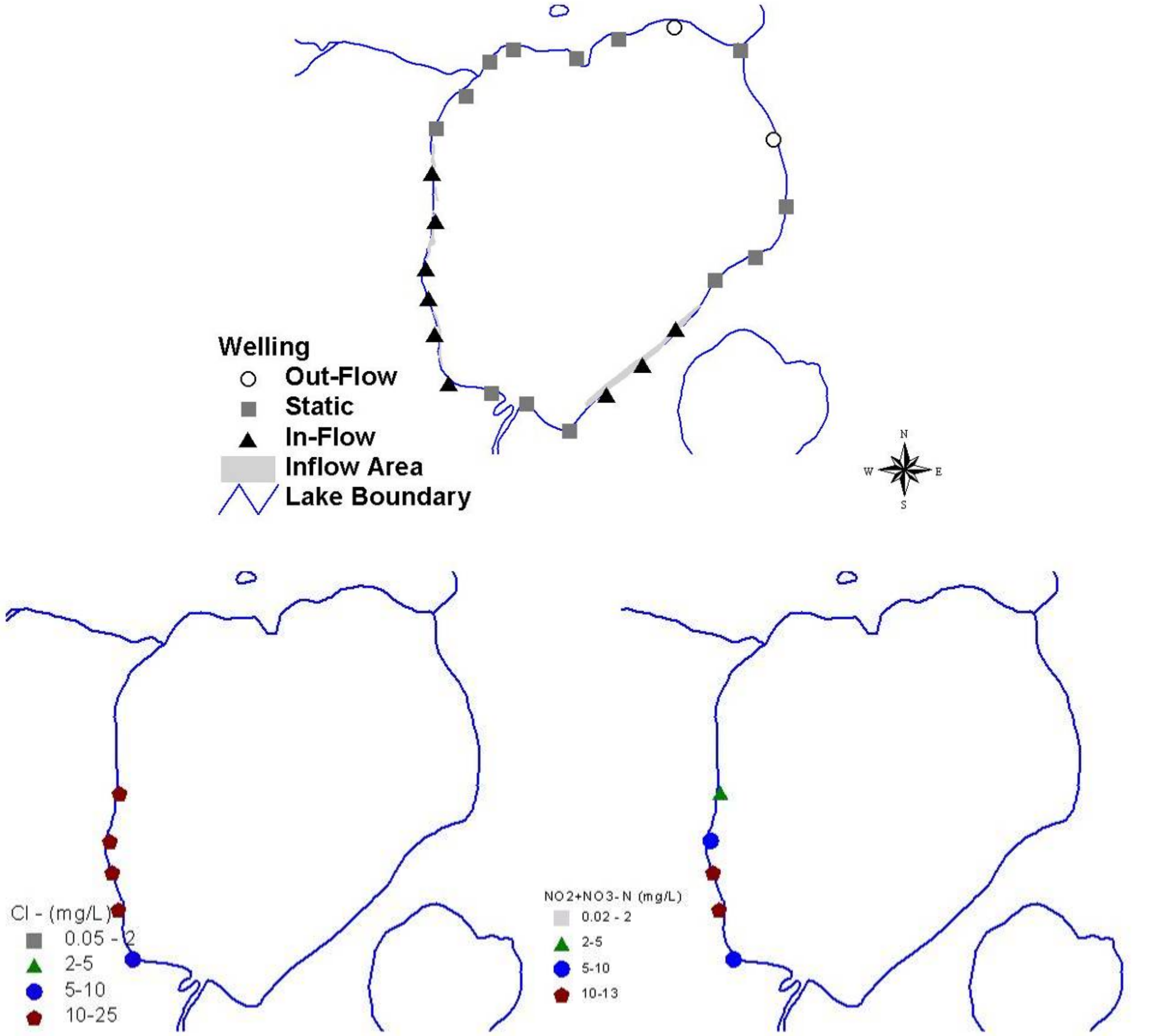
Tree Lake	*Low*	*Medium*	*High*	**Reference Values**	*Low*	*Medium*	*High*
Sulfate	8.47			*Sulfate*	<10	10-20	>20
Chloride		8.22		*Chloride*	<3	3-10	>10
Potassium	1.43			*Potassium**	<2.16	2.16-4.30	>4.30
Sodium		3.33		*Sodium**	<2.28	2.28-5.09	>5.09

**Ranges of low, medium, high defined by taking the median values from all Portage County lakes and dividing into thirds.*

Twenty-four mini wells were inserted into the sediment near shore in Tree Lake to determine where **groundwater** was entering and exiting Tree Lake. **Groundwater** inflow occurred at 37% of the sites in the south part of the lake; several sites showed **groundwater** outflow from the north part of the lake (Figure 11). **Groundwater** samples were collected from five of the wells on the west side of the lake and analyzed for **nitrate**, **chloride**, **phosphorus**, and two for triazine (**atrazine**). All of the sites had elevated **chloride** (10 – 20.5 **mg/L**) and **nitrate-nitrogen** (3.2 – 12.6 **mg/L**), and all of the samples had low **phosphorus** concentrations. Both samples that were analyzed for triazine (**atrazine**) had detectable levels.

*For terms in bold, see glossary pp 14-19

Figure 11. Locations in Tree Lake showing groundwater inflow/no flow/outflow from mini-piezometer (mini-well) measurements and winter observations, nitrate, and chloride concentrations.



Algal Community

The algal community in Tree Lake was mildly diverse. The dominant groups were the green **algae** (Chlorophyta, 23% of all cells counted), **blue-green algae** (Cyanobacteria, 27% of all cells counted), and the yellow-green **algae** and **diatoms** (Ochrophyta, 21% of all cells counted) (Table 3). These three phyla (groups) represented 71% of all cells counted during the 2003 sampling season. In the 2398 cells counted during this period, there were 5 genera of Cyanobacteria, 9 genera of Chlorophyta, 11 genera of Ochrophyta (including 8 **diatom** genera), 4 genera of Euglenophyta, 2 genera of Dinophyta (3 species), and 1 genus of Cryptophyta identified (Appendix). The cyanobacteria and ochrophytes were codominants during May with the other four phyla as nearly equal subdominants. In June and August the dominants were the greens and blue-greens and the dinoflagellates began to drop out. September and November saw the cyanobacteria as the dominants with the ochrophytes codominant in September and the chlorophytes codominant in November. The

*For terms in bold, see glossary pp 14-19

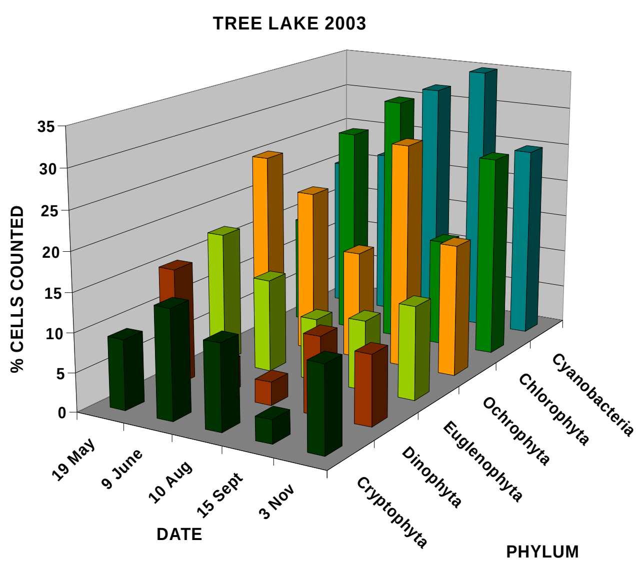
other three phyla (Dinophyta, Euglenophyta, Cryptophyta) waxed and waned from 3-17% of all cells counted over the five sampling periods in the 2003 season (figure 12)

Table 3. Algal phyla and mean seasonal composition in Tree Lake from May to November 2003.

TREE LAKE

PHYLUM	% CELLS COUNTED BY PHYLUM AND DATE					**MEAN**
	19 May	9 June	10 Aug	15 Sept	3 Nov	
Cyanobacteria	20	22	32	35	25	27
Chlorophyta	14	27	32	14	26	23
Ochrophyta	25	21	14	29	17	21
Euglenophyta	17	12	8	9	12	12
Dinophyta	15	4	3	10	9	8
Cryptophyta	9	14	11	3	11	10

Figure 12. Algal community composition by date in Tree Lake from May to November 2003 (total phylum cells counted divided by total cells counted).



The nuisance, colonial cyanobacterial genus *Microcystis* was dominant in the September sample and was subdominant in all four other periods (Figure 13). *Oocystis*, a large, nonmotile, unicellular green alga, was the most abundant organism counted in the June, August, and November samples and was a subdominant during the September counting period. A non-**diatom** ochrophyte genus (*Synura*) was the May dominant and a subdominant in September. This organism is a scaled, irregularly aggregated colonial swimmer. The motile unicellular cryptophyte genus *Chroomonas* was a subdominant during three sampling periods (June, August, and November). The colorless euglenoids genus *Astasia* was a subdominant in May (Table 4).

*For terms in bold, see glossary pp 14-19

The algal community, when considered relative to the chlorophyll, **phosphorus**, and **nitrogen** values for Tree Lake, presents a picture of a very **mesotrophic** lake. The 33 genera identified during the sample periods were relatively common, and none of those that reached numerical dominance in the sample counts are associated with toxins or health issues. The water **clarity** in Tree Lake was generally good during all algal sampling period and this seems to conflict with the high chlorophyll values, heavy algal densities, and water chemistry data. This is not an uncommon situation in **stratified** lakes like Tree Lake.

Figure 13. Algal community composition by phylum in Tree Lake from May to November 2003.

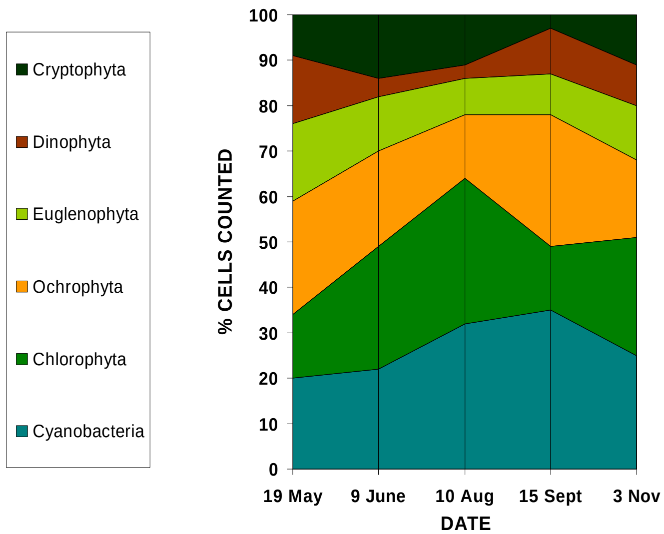


Table 4. Most common algal genera by date in Tree Lake from May to November 2003.

DATE	TOP THREE TAXA (MOST ABUNDANT, LEFT TO RIGHT)		
19 May	*Synura*	*Astasia*	*Microcystis*
9 June	*Oocystis*	*Chroomonas*	*Microcystis*
10 August	*Oocystis*	*Microcystis*	*Chroomonas*
15 September	*Microcystis*	*Synura*	*Oocystis*
3 November	*Oocystis*	*Microcystis*	*Chroomonas*

*For terms in bold, see glossary pp 14-19

Tree Lake Study Highlights

- Tree Lake has a long, finger-like wetland extending from its southern shore, heading southwest, and a steep slope lining the western banks that provides excellent habitat.

- Seventy-eight percent of the shoreline around Tree Lake is considered to be disturbed. Of that, 3.2% of the lake's shoreline vegetation is considered to be low disturbance developed, 11% is moderately disturbed, and 63.5% is considered to be highly disturbed.

- No major aquatic invasive species have been found to date in the lake. Although much of the shoreline is developed or in park land, reed canary-grass is the only invasive alien species noted. Wetland complexes including swampy or boggy woods extend northwest from the northwestern shore and also along Klondike Creek to the southwest from the south shore of Tree Lake.

- The water **clarity** in Tree Lake is considered fair. Total **phosphorus** (TP) concentrations ranged from 13 to 43 **mg/L** and were quite variable throughout the year, however when averaged by season they are relatively low. **Nitrogen** concentrations are quite high and are consistently above concentrations needed for excessive **algae** blooms. **Potassium** was low but **chloride** and **sodium** were somewhat elevated.

- **Atrazine** was found in low concentrations in the lake water. Some toxicity studies have indicated that reproductive system abnormalities can occur in frogs at these levels. The presence of **atrazine** indicates that other agrichemicals may also be entering Tree Lake.

- **Groundwater** inflow occurred at 37% of the wells; inflow was located in the south part of the lake and several sites showed **groundwater** outflow from the north part of the lake. All five of the **groundwater** sample sites had elevated **chloride**, four of the sites had elevated **nitrate**, and all of the samples had low **phosphorus** concentrations. Both samples that were analyzed for triazine (**atrazine**) had detectable levels.

- The algal community, when considered relative to the chlorophyll, **phosphorus**, and **nitrogen** values for Tree Lake presents a picture of a very **mesotrophic** lake. The **algae** species were relatively common and none of those that reached numerical dominance in the sample counts are associated with toxins or health issues. The water **clarity** in Tree Lake was generally good during all algal sampling period and this seems to conflict with the high chlorophyll values, heavy algal densities, and water chemistry data. This is not an uncommon situation in **stratified** lakes like Tree Lake.

Glossary

Algae:

One-celled (phytoplankton) or multicellular plants either suspended in water (plankton) or attached to rocks and other substrates (periphyton). Their abundance, as measured by the amount of chlorophyll a (green pigment) in an open water sample, is commonly used to classify the trophic status of a lake. Numerous species

*For terms in bold, see glossary pp 14-19

occur. Algae are an essential part of the lake ecosystem and provides the food base for most lake organisms, including fish. Phytoplankton populations vary widely from day to day, as life cycles are short.

Alkalinity:

A measure of the amount of carbonates, bicarbonates, and hydroxide present in water. Low alkalinity is the main indicator of susceptibility to acid rain. Increasing alkalinity is often related to increased algae productivity. Expressed as milligrams per liter (mg/L) of calcium carbonate (CaCO3), or as microequivalents per liter (ueq/l). 20 ueq/l = 1 mg/L of $CaCO_3$.

Ammonia, Ammonium:

A form of nitrogen found in organic materials and many fertilizers. It is the first form of nitrogen released when organic matter decays. It can be used by most aquatic plants and is therefore an important nutrient. It converts rapidly to nitrate (NO_3) if oxygen is present. The conversion rate is related to water temperature. Ammonia is toxic to fish at relatively low concentrations in pH-neutral or alkaline water. Under acid conditions, non-toxic ammonium ions (NH_4^+) form, but at high pH values the toxic ammonium hydroxide (NH_4OH) occurs. The water quality standard for fish and aquatic life is 0.02 mg/L of NH_4OH. At a pH of 7 and a temperature of 68^o F (20^o C), the ratio of ammonium ions to ammonium hydroxide is 250:1; at pH 8, the ratio is 26:1.

Atrazine:

The nation’s most widely used weedkiller for both grassy and broadleaf weeds.

Blue-Green Algae:

Algae that are often associated with problem blooms in lakes. Some produce chemicals toxic to other organisms, including humans. They often form floating scum as they die. Many can fix nitrogen (N_2) from the air to provide their own nutrient.

Chloride (Cl-):

Chlorine in the chloride ion (Cl^-) form has very different properties from chlorine gas (Cl_2), which is used for disinfecting. The chloride ion (Cl^-) in lake water is commonly considered an indicator of human activity. Agricultural chemicals, human and animal wastes, and road salt are the major sources of chloride in lake water.

Chlorophyll a:

Green pigment present in all plant life and necessary for photosynthesis. The amount present in lake water depends on the amount of algae and is therefore used as a common indicator of water quality.

Clarity:

see "Secchi disc."

Coefficient of Conservatism (c-value):

Indicates on a scale of 0 to 10 the degree to which a species can tolerate disturbance to a native plant community; a species with a c value of 10 is found only in relatively undisturbed areas of native plant community, whereas a species with a c value of 0 never grows in undisturbed areas of native plant communities. Plants with low numbers tend to occur in a wide range of more-or-less disturbed plant communities. Alien species are also assigned a c value of 0. The c values are used in this report in calculating the Floristic Quality Index for each lake.

Color:

Measured in color units that relate to a standard. A yellow-brown natural color is associated with lakes or rivers receiving wetland drainage. The average color value for Wisconsin lakes is 39 units, with the color of state lakes ranging from zero to 320 units. Color also affects light penetration and therefore the depth at which plants can grow.

Concentration Units:

Express the amount of a chemical dissolved in water. The most common ways chemical data is expressed is in milligrams per liter (mg/L) and micrograms per liter (ug/L). One milligram per liter is equal to one part per million (ppm). To convert micrograms per liter (ug/L) to milligrams per liter (mg/L), divide by 1000 (e.g. 30 ug/l = 0.03 mg/L). To convert milligrams per liter (mg/L) to micrograms per liter (ug/L), multiply by 1000 (e.g. 0.5 mg/L = 500 ug/L). Microequivalents per liter (ueq/L) is also sometimes used, especially for alkalinity; it is calculated by dividing the weight of the compound by 1000 and then dividing that number into the mg/L.

Diatoms:

A major group of eukaryotic algae, which are one of the most common types of phytoplankton. Diatom communities are a popular tool for monitoring environmental conditions, past and present, and are commonly

Drainage Basin:

The total land area that drains toward the lake.

Drainage Lakes:

Lakes fed primarily by streams and with outlets into streams or rivers. They are more subject to surface runoff problems but generally have shorter retention times than seepage lakes. Watershed protection is usually needed to manage lake water quality.

Endocrine:

An integrated system of small organs that involve the release of extracellular signaling molecules known as hormones. The endocrine system is instrumental in regulating metabolism, growth, development and puberty, tissue function, and also plays a part in determining mood.

Erosion:

The lowering of the land surface by weathering, corrosion, and transportation, under the influence of gravity, wind, and running water.

Eutrophic:

Eutrophic lakes are high in nutrients and support a large biomass (all the plants and animals living in a lake). They are usually either weedy or subject to frequent algae blooms, or both. Eutrophic lakes often support large fish populations, but are also susceptible to oxygen depletion. Small, shallow, eutrophic lakes are especially vulnerable to winterkill which can reduce the number and variety of fish. Rough fish are commonly found in eutrophic lakes.

Eutrophication:

The process by which lakes and streams are enriched by nutrients, and the resulting increase in plants and algae. The extent to which this process has occurred is reflected in a lake's trophic classification: oligotrophic (nutrient poor), mesotrophic (moderately productive), and eutrophic (very productive and fertile).

Fen:

A fen is a type of wetland fed by surface and/or groundwater. Fens are characterized by their water chemistry, which is neutral or alkaline, unlike bogs, which are generally acid.

Floristic Quality Index (FQI):

The FQI is a standardized method for evaluating natural plant communities by multiplying the average coefficient of conservatism (c-value) for all species by the square root of the total number of species found at that lake; an additional point is added to the index for each state-listed special concern species, two points added for a threatened species, and three points added for an endangered species. A higher floristic quality index, such as FQI=60, indicates a higher floristic quality and biological integrity and a lower level of disturbance impacts. A lower floristic quality index, such as FQI=20, indicates a lower floristic quality and biological integrity and a higher level of disturbance impacts.

*For terms in bold, see glossary pp 14-19

Groundwater:

Water found below the land surface in pore spaces between soil particles or in cracks in rock. It moves slowly from higher to lower areas on the landscape and may provide water to a lake.

Groundwater Drainage Lake:

Often referred to a spring-fed lake, has large amounts of groundwater as its source, and a surface outlet. Areas of high groundwater inflow may be visible as springs or sand boils. Groundwater drainage lakes often have intermediate retention times with water quality dependent on groundwater quality.

Hardness, Hard Water:

The quantity of multivalent cations (cations with more than one +), primarily calcium (Ca++) and magnesium (Mg++) in the water expressed as milligrams per liter of $CaCO_3$. Amount of hardness relates to the presence of soluble minerals, especially limestone, in the lake watershed. Moderately hard water has 61-120 mg/L $CaCO_3$, hard water has 121-180 mg/L $CaCO_3$, and very hard water has more than180 mg/L $CaCO_3$.

Impoundment:

Manmade lake or reservoir usually characterized by stream inflow and always by a stream outlet. Because of nutrient and soil loss from upstream land use practices, impoundments ordinarily have higher nutrient concentrations and faster sedimentation rates than natural lakes. Their retention times are relatively short.

Littoral:

The shallow water zone near the shoreline that is home to most aquatic plants.

Macrophytes:

see "Rooted aquatic plants."

Macrophytic Algae:

Algae that resemble true plants in that they appear to have stems and leaves, and are attached to the bottom.

Marl:

White to gray accumulation on lake bottoms caused by precipitation of calcium carbonate ($CaCO_3$) in hard water lakes. Marl may contain many snail and clam shells, which are also calcium carbonate. While it gradually fills in lakes, marl also precipitates phosphorus, resulting in low algae populations and good water clarity. In the past, marl was recovered and used to lime agricultural fields.

Mesotrophic:

Mesotrophic lakes lie between the oligotrophic and eutrophic trophic stages. In late summer, they lose oxygen at depth, limiting cold water fish and causing phosphorus release from sediments.

mg/L:

see “Concentration units”

Nitrate (NO_3^-):

An inorganic form of nitrogen important for plant growth. Nitrogen is in this stable form when oxygen is present. Nitrate often contaminates groundwater when water originates from manure pits, fertilized fields, lawns or septic systems. High levels of nitrate-nitrogen (over 10 mg/L) are dangerous to infants and expectant mothers. A concentration of nitrate-nitrogen (NO_3-N) plus ammonium-nitrogen (NH_4-N) of 0.3 mg/L in spring will support summer algae blooms if enough phosphorus is present.

Nitrite (NO_2^-):

A form of nitrogen that rapidly converts to nitrate (NO_3^-) and is usually included in the NO_3^- analysis.

*For terms in bold, see glossary pp 14-19

Nitrogen:

A chemical element that is an essential plant nutrient and may occur in the form of nitrate, nitrite, ammonium, or organic nitrogen in lakes.

Oligotrophic:

A trophic state in which lakes are generally clear, deep and free of weeds or large algae blooms. Though beautiful, they are low in nutrients and do not support large fish populations. However, oligotrophic lakes often develop a food chain capable of sustaining a very desirable fishery of large game fish.

Phosphorus:

Key nutrient influencing plant growth in more than 80% of Wisconsin lakes. Soluble reactive phosphorus is the amount of phosphorus in solution that is available to plants. Total phosphorus includes the amount of phosphorus in solution (reactive) and in particulate form.

Photosynthesis:

The process by which green plants convert carbon dioxide (CO_2) dissolved in water to sugar and oxygen using sunlight for energy. Photosynthesis is essential in producing a lake's food base, and is an important source of oxygen for many lakes.

Potassium:

A chemical element that is an essential plant nutrient and may enter lakes from runoff of agricultural fertilizers and animal wastes.

Retention Time:(turnover rate or flushing rate)

The average length of time water resides in a lake, ranging from several days in small impoundments to many years in large seepage lakes. Retention time is important in determining the impact of nutrient inputs. Long retention times result in recycling and greater nutrient retention in most lakes. Calculate retention time by dividing the volume of water passing through the lake per year by the lake volume.

Rip Rap (Rip-Rap):

Hard rock, commonly granite or concrete rubble recycled from construction sites, used inland on lakes, rivers, coastlines, and other waterways to prevent bank erosion. Generally rip rap is not considered good management in lakes, due to its inability to provide adequate habitat, and is no longer commonly used.

Rooted Aquatic Plants:(macrophytes)

Refers to higher (multi-celled) plants growing in or near water. Macrophytes are beneficial to lakes because they produce oxygen and provide substrate for fish habitat and aquatic insects. Overabundance of such plants, especially problem species, is related to shallow water depth and high nutrient levels.

Secchi Disc (Secchi Disk):

An 8-inch diameter plate with alternating quadrants painted black and white that is used to measure water clarity (light penetration). The disc is lowered into water until it disappears from view. It is then raised until just visible. An average of the two depths, taken from the shaded side of the boat, is recorded as the Secchi disc reading. For best results, the readings should be taken on sunny, calm days.

Sedimentation:

Accumulated organic and inorganic matter on the lake bottom. Sediment includes decaying algae and weeds, marl, and soil and organic matter eroded from the lake's watershed.

Seepage lakes:

Lakes without a significant inlet or outlet, fed by rainfall and groundwater. Seepage lakes lose water through evaporation and groundwater moving on a down gradient. Lakes with little groundwater inflow tend to be

*For terms in bold, see glossary pp 14-19

naturally acidic and most susceptible to the effects of acid rain. Seepage lakes often have long retention times, and lake levels fluctuate with local groundwater levels. Water quality is affected by groundwater quality and the use of land on the shoreline.

Sodium:

A chemical element that may enter lakes from runoff of road salt, fertilizers, and human and animal wastes.

Soft water:

Water with less than 60 mg/L CaCO3 (see Hard water).

Stratification, Stratified:

The layering of water due to differences in density. Water's greatest density occurs at 39^oF (4^oC). As water warms during the summer, it remains near the surface while colder water remains near the bottom. Wind mixing determines the thickness of the warm surface water layer (epilimnion), which usually extends to a depth of about 20 ft. The narrow transition zone between the epilimnion and cold bottom water (hypolimnion) is called the metalimnion or thermocline.

Sulfate (SO_4^{--}):

The most common form of sulfur in natural waters. The amounts relate primarily to soil minerals in the watershed. Sulfate (SO_4^{--}) can be reduced to sulfide (S^{--}) and hydrogen sulfide (H_2S) under low or zero oxygen conditions. Hydrogen sulfide smells like rotten eggs and harms fish. Sulfate input from acid rain is a major indicator of sulfur dioxide (SO_2) air pollution. Sulfate concentration is used as a chemical fingerprint to distinguish acid lakes acidified by acid rain from those acidified by organic acids from bogs.

Substrate;

The material found at the bottom of a lake, such as silt, mud, sand, clay, marl, gravel, etc.

Suspended Solids:

A measure of the particulate matter in a water sample, expressed in milligrams per liter. When measured on inflowing streams, it can be used to estimate the sedimentation rate of lakes or impoundments.

Turbidity:

The “cloudiness” or “murkiness” of water, caused by total suspended solids.

Vascular Plants:

Vascular plants are those plants that have tissues for conducting water, minerals, and food through the plant. Vascular plants include the ferns, clubmosses, flowering plants, and conifers.

Watershed:

The total land area that drains either surface water or groundwater toward a lake.

*For terms in bold, see glossary pp 14-19