Severson Lake

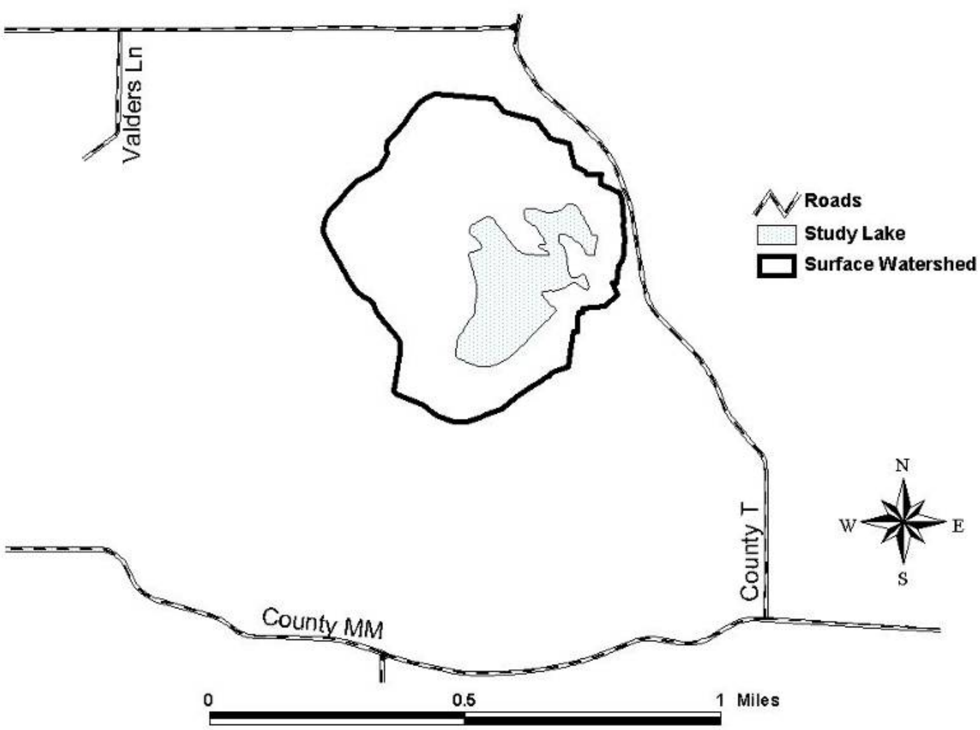
Introduction

Severson Lake is a very scenic, **hard water seepage lake** situated in a kettle seven miles southeast of Rosholt in the Town of New Hope. The lake has a surface area of 31 acres and a maximum depth of 60 feet. The estimated **retention time** is 1.4 years. The **littoral** bottom materials consist primarily of **marl** with limited areas of sand and gravel also present. The bottom drops off rapidly a short distance from shore, and an abrupt drop in temperature and dissolved oxygen develops at 15 feet. Largemouth bass and panfish are the most common fish present. A mixed pine and hardwood forest surrounds the lake. A group of people who are trying to maintain the lake in its natural state own most of the shoreline. The University of Wisconsin-Stevens Point also owns a part of the shoreline and is using the land as a conservation study area. Two dwellings are present but they are built back from the water and are not visible from the lake. A small, private beach is the only part of the shoreline that has been altered. Recreational use is light and mostly local.

Land Use and Watershed

Severson Lake has a relatively small 157 acre surface **watershed** (Figure 1). Approximately 110 of those acres are forested and have been since 1948. Land use in this **watershed** has undergone very little change since 1948 (Figure 2 and Figure 3) The northern edge of the **watershed** includes a small amount of non-irrigated agriculture (6 acres). Non-irrigated cropland doubled between 1948 and 1968.

Figure 1. Severson Lake surface watershed boundary.



*Terms in bold, see glossary pp 16-21

Figure 2. Land use in the Severson Lake surface watershed (2002).

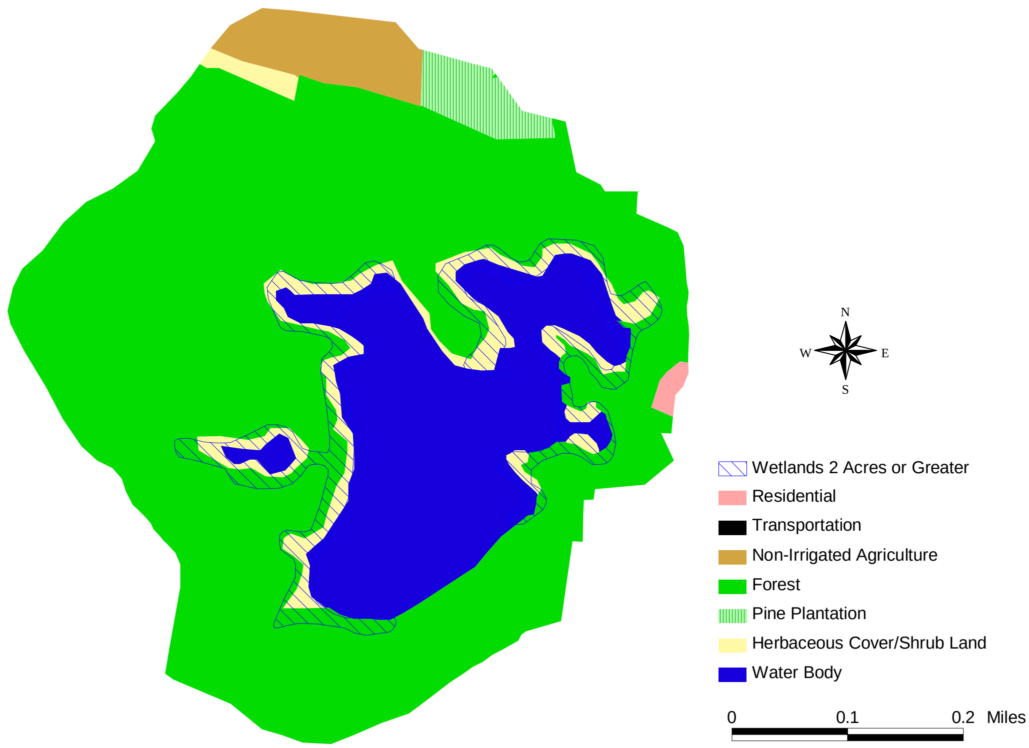
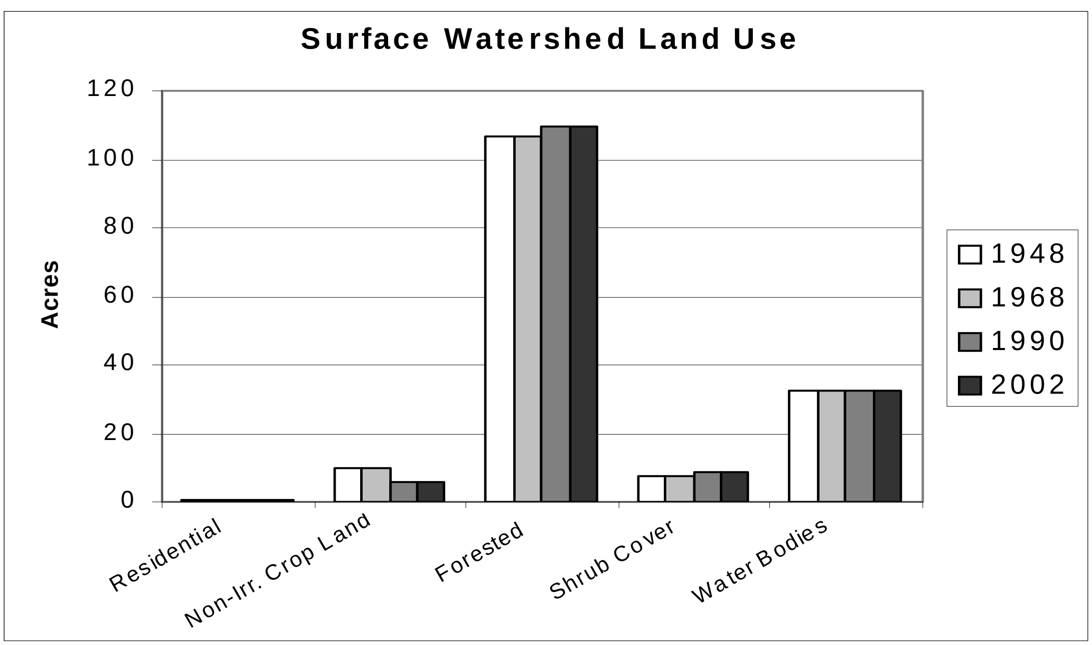


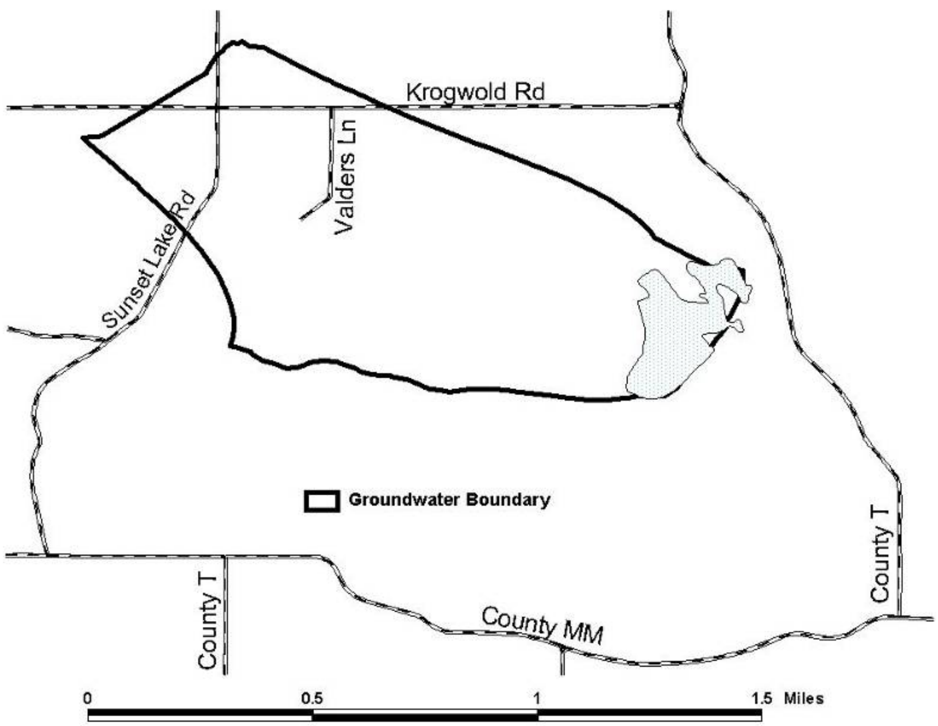
Figure 3. Land use in the Severson Lake surface watershed 1948-2002.



*Terms in bold, see glossary pp 16-21

The **groundwater watershed** for Severson Lake encompasses 418 acres to the northwest of the lake extending beyond the intersection of Krogwald and Sunset Lake Roads (Figure 4). Land use in the **groundwater watershed** is dominated by 239 acres of forest (57%) followed by 115 acres of non-irrigated cropland (28%) (Figure 5 and Figure 6). Similar to the surface **watershed**, land use in the **groundwater watershed** has undergone very little change since 1948. A search of the records in 2002 indicate that based on age there are no potentially failing septic systems or former landfill sites present in either the Severson Lake surface or **groundwater watersheds**.

Figure 4. Severson Lake groundwater watershed boundary.



*Terms in bold, see glossary pp 16-21

Figure 5. Land use in the Severson Lake groundwater watershed (2002).

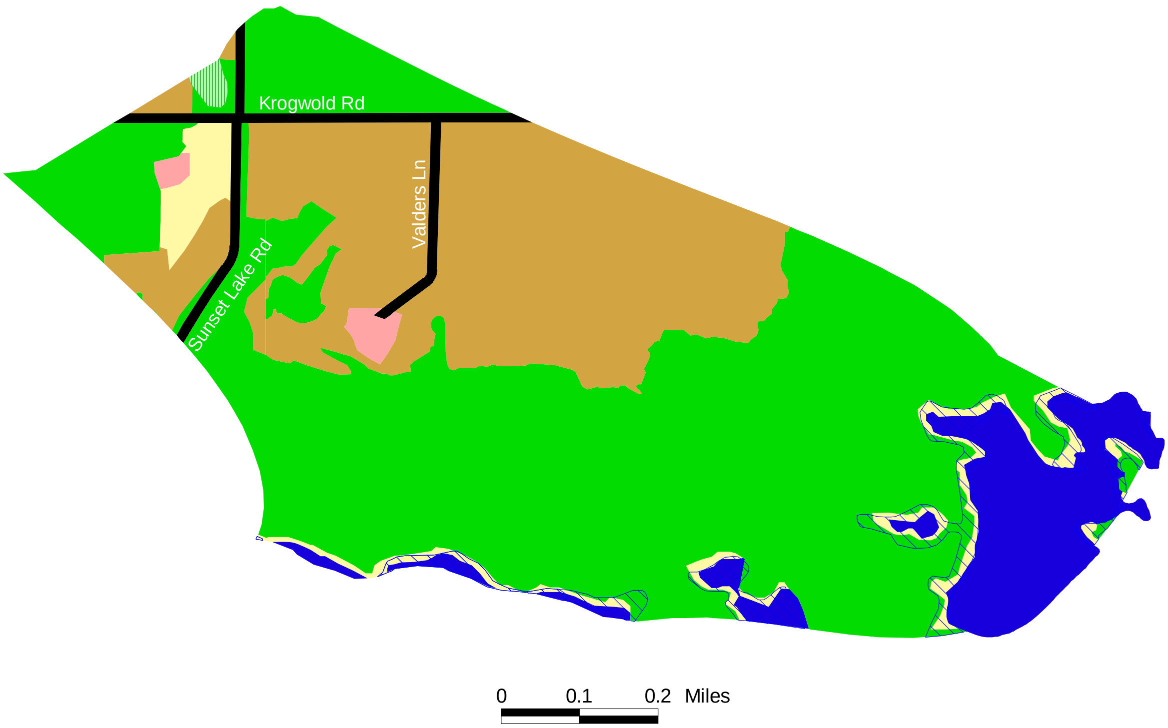
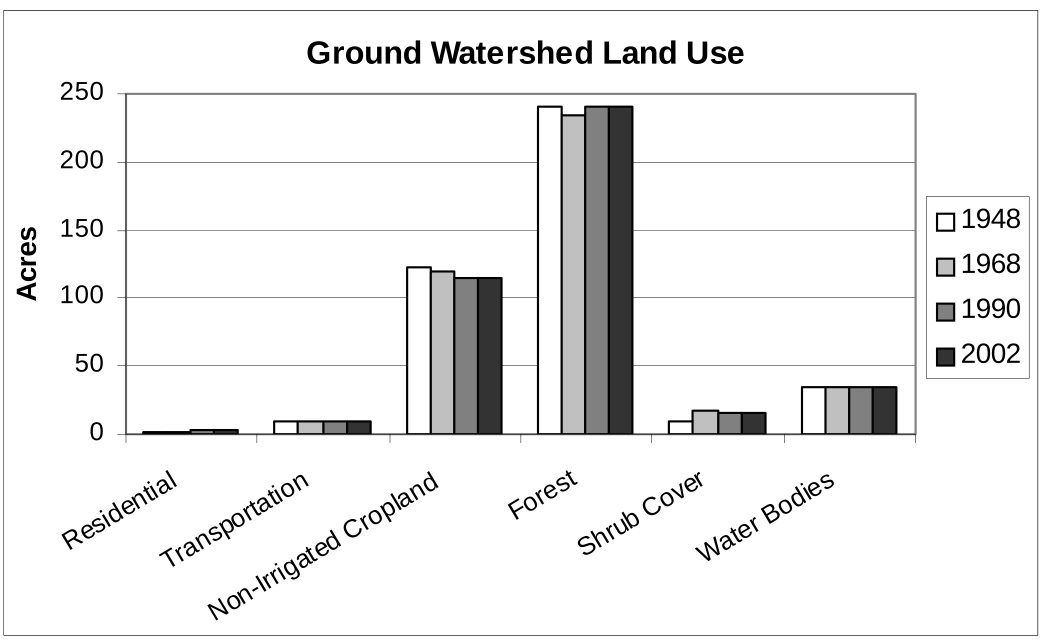


Figure 6. Land Use in the Severson Lake groundwater watershed 1948-2002.

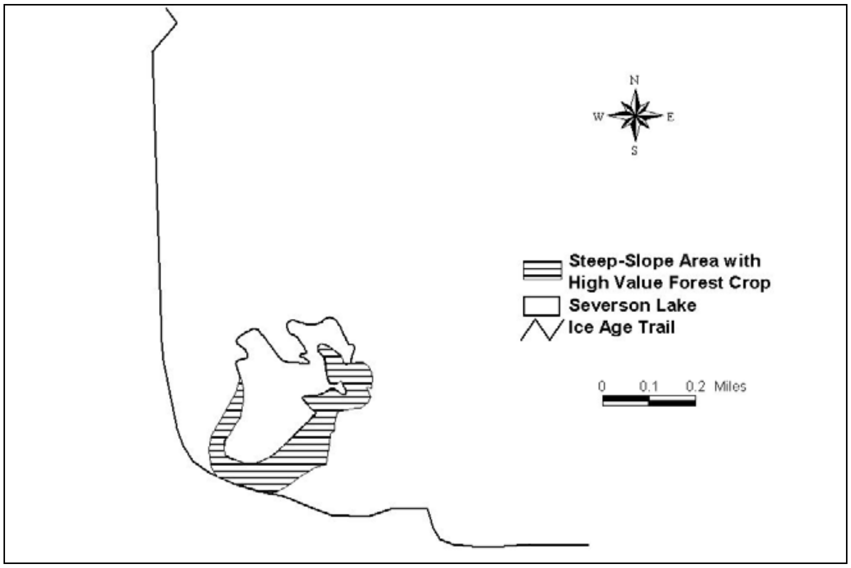


*Terms in bold, see glossary pp 16-21

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. The natural state of the shoreline along with the modest amount of development in the Severson Lake **watersheds** make it unique. The Ice Age Trail passes to the west of the lake and south of the lake. The survey of sensitive areas notes that there are steep slopes on the east, south, and southwest sides of the lake that should be protected from **erosion** (Figure 7).

Figure 7. Upland sensitive areas near Severson Lake.



Birds

Lakeshore development can negatively or positively affect habitat quality of birds depending on the ecological requirements of each species. Development can play a important role in providing resources unavailable to certain species in a more natural environment, yet eliminate other species' needs altogether, especially at the most extreme levels of development.

Of the 28 most common species, Eastern phoebe (*Sayornus phoebe*), American goldfinch (*Carduelis tristis*), American robin (*Turdus migratorius*), mourning dove (*Zenaida macroura*), and downy woodpecker (*Picoides pubescens*) showed the greatest tendency to be found in developed areas. These species may be taking advantage of different resources available in the urban environment, such as birdfeeders (as in the case of the American goldfinch and downy woodpecker), open foraging areas (American robin and mourning dove), or nest sites (Eastern phoebe).

At undeveloped sites, least flycatcher (*Empidonax minimus*), great crested flycatcher (*Myiarchus crinitus*), red-eyed vireo (*Vireo olivaceus*), black-capped chickadee (*Poecile atricapillus*), blue jay (*Cyaanocitta cristata*), red-bellied woodpecker (*Melanerpes carolinus*), Eastern wood-pewee (*Contopus virens*), indigo bunting (*Passerina cyanea*),

*Terms in bold, see glossary pp 16-21

and common yellowthroat (*Geothylypis trichas*) were the most common. A majority of these species are insectivores and are likely to feed in more forested environments.

Table 1. Bird species identified near Severson Lake.

Common Name	Number Observed	Food	Foraging	Nest Type	Nest Location
American Goldfinch	2	seeds	foliage gleaner	cup	shrub
American Robin	2	insects	ground gleaner	cup	deciduous
Black-capped Chickadee	6	insects	foliage gleaner	cavity	deciduous
Blue Jay	4	omnivore	ground gleaner	cup	coniferous
Brown-headed Cowbird	1	insects	ground gleaner	parasite	deciduous
Catbird	3	insects	ground gleaner	cup	shrub
Common Yellowthroat	1	insects	foliage gleaner	cup	shrub
Least Flycatcher	2	insects	hover gleaner	cup	deciduous
Ovenbird	2	insects	hawker	cup	bridge
Purple Martin	1	insects	bark gleaner	cavity	snag
Red-winged Blackbird	1	insects	ground gleaner	cup	reed
Rose-breased Grosbeak	3	insects	foliage gleaner	cup	deciduous
Song Sparrow	2	insects	ground gleaner	cup	ground
Total	**30**				

Shoreline Vegetation, Reptiles, and Amphibians

Amphibians (frogs and toads) 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.

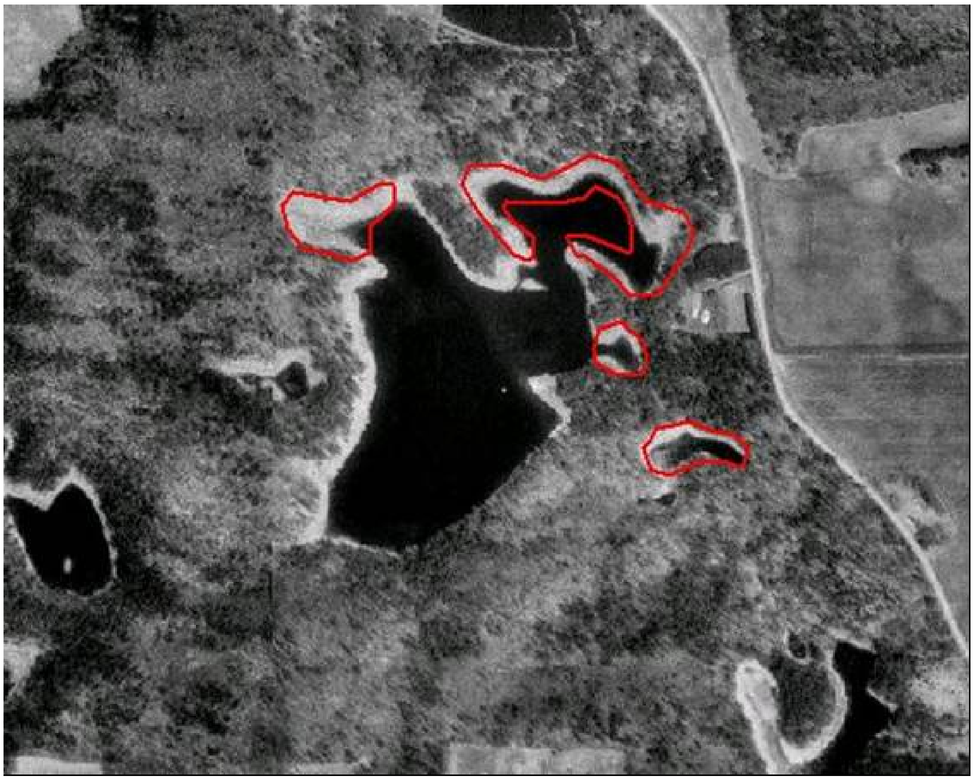
Large sections of continuous natural shoreline on lakes are ideal habitats for many frog species. Natural areas with large amounts of submergent, emergent, and floating-leaf vegetation provide protection and a place for attachment of eggs during the breeding season. The upland areas surrounding these 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 amphibian are intimately associated with lakes and the associated habitats of a **watershed**.

Reptile surveys were not conducted on Severson Lake. During the Severson Lake amphibian survey five frog species were identified (spring peeper [*Pseudacris crucifer*], American toad [*Bufo americanus*], gray treefrog [*Hyla versicolor*], Cope's gray treefrog [*Hyla chrysoscelis*], and green frog [*Rana clamitans*]). The primary amphibian habitat can be found on numerous sections of shoreline (sensitive areas are identified in red in

*Terms in bold, see glossary pp 16-21

Figure 8). 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 there are minimal levels of development and many wetland areas surrounding the lake which provide ideal habitat for amphibians. Because of this there are no major threats to amphibian and reptile habitat at this time.

Figure 8. Regions of primary amphibian habitat around Severson Lake.



Eighty-eight percent of the shoreline around Severson Lake is comprised of vegetated shoreline. Vegetated shoreline is characterized as being upland areas with dense vegetation comprised of tall grasses or shrubs that lacks a rocky component. It is represented in dark green in Figure 9. About 6.7 % of the lakeshore is defined as alder shoreline which is represented in sky blue in Figure 9. Alder shoreline is characterized as being areas where alder shrubs dominate the shore zone.

Around Severson Lake, 5 % of the shoreline is considered to be disturbed. Of that, 3.2 % of the shoreline vegetation is considered to be a moderately disturbed developed area. Two percent of the shoreline's vegetation is considered to be in a highly disturbed developed state. 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 where the shore is mowed to the water line. These areas provide the least amount of habitat for birds, frogs, fish, and other forms of wildlife and may negatively impact water quality.

*Terms in bold, see glossary pp 16-21

Figure 9. Shoreline vegetation around Severson Lake.

Aquatic Plants

There are **43** species of **vascular plants** that were found in the water or on wet shores of Severson Lake. This is slightly below average for Portage County lakes. The average **coefficient of conservatism (c-value)** is **5.9**, which is above average. The **floristic quality index** is **38.7**, which is also above average for Portage County lakes.

Severson Lake (Budsberg Lake on older maps) is notable for being undeveloped, except for two cabins on the east side. The shoreline includes a large boggy sedge meadow on the north. Although no rare or special concern species have been found in the lake or adjacent wetland, the flora is composed mostly of native species characteristic of intact plant communities, as indicated by the relatively high average **coefficient of conservatism**. The upland is heavily wooded with large white pines (*Pinus strobus*), red oaks (*Quercus rubra*), maples (*Acer* spp.), etc. and also indicates an intact native plant community.

Current Water Quality Conditions

Water quality in lakes is assessed by measuring different characteristics including temperature, dissolved oxygen, water **clarity**, **chlorophyll *a***, water chemistry, and the algal community. Each of the water constituents discussed play a complex role in water quality.

*Terms in bold, see glossary pp 16-21

Temperature was measured from top to bottom at the time of sample collection. Severson Lake exihibited normal lake mixing and **stratification** cycles during the recent study period, with the lake showing similar temperatures from top to bottom in the spring and fall (Figure 10). Historically Severson Lake has not always mixed; its steep slopes and high treed sides can prevent winds from initiating the mixing process. This can also result in a lack of oxygen in the water. During periods of **stratification** dissolved oxygen concentrations are above 5 **mg/L** in the upper 16 feet of water. However, in March 2004 dissolved oxygen concentrations were only sufficient to support most aquatic biota in the upper 4 feet of water (Figure 11).

Figure 10. Profile of temperature in Severson Lake 2002-2004.

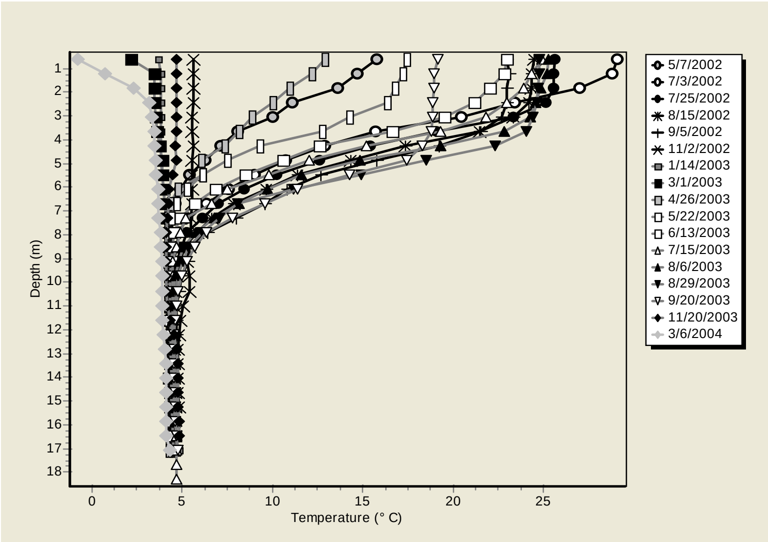
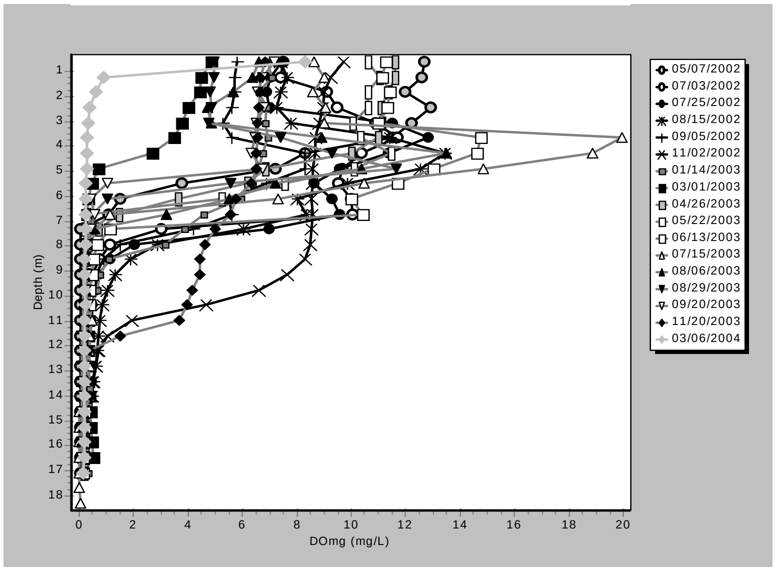


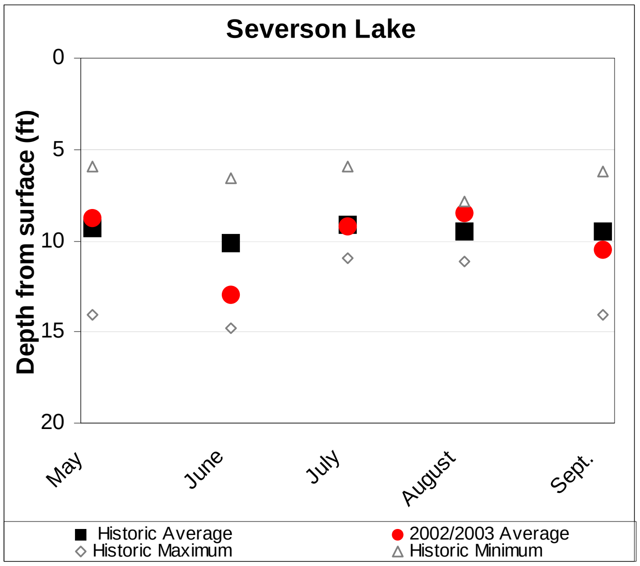
Figure 11. Profile of dissolved oxygen in Severson Lake 2002-2004.



*Terms in bold, see glossary pp 16-21

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** and suspended materials in the water (**turbidity**). **Turbidity** consists of **suspended solids**, such as suspended sediments and **algae** (**chlorophyll *a***). In Severson Lake measures of **color**, **turbidity**, and **chlorophyll *a*** were all low and correspondingly the water **clarity** is considered good. The average **Secchi disc** depth reading for similar lakes in the region is about 9 feet; Severson Lake appears to have similar/ better water **clarity** than these lakes (Figure 12). The water **clarity** in Severson Lake during the 2002-03 growing seasons was slightly better than the historical growing season average. The month of June shows the best water **clarity**, the month of August shows the worst. These fluctuations throughout the summer are normal as **algae** populations and **sedimentation** increase and decrease.

Figure 12. Monthly average water clarity measurements in Severson Lake 2002-2003 and historic average, maximum and minimums.



A variety of water chemistry measurements were used to characterize the water quality in Severson Lake (Table 2 and Table 3). Nutrients (**phosphorus** and **nitrogen**) are important measures of water quality in lakes because they are used for growth by **algae** and aquatic plants (similar to houseplants and crops). During the summer and fall **phosphorus** concentrations were elevated to levels that can enhance **algae** and aquatic plant growth. **Nitrogen** was high, but in a particulate form which is not readily used by aquatic plants. Total hardness concentrations make this a **hard water** lake. **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. These concentrations were all low. **Atrazine** was found in low concentrations in the lake water (0.11 and 0.06 ppb), however some toxicity studies have indicated that reproductive system abnormalities can occur in frogs at these levels. The presence of **atrazine** indicates that other agri-chemicals may also be entering Severson Lake.

*Terms in bold, see glossary pp 16-21

Table 2. 2002-2003 water quality seasonal averages in Severson Lake.

Severson 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	20.3	5.3	1.48	0.04	0.23	151.0	172.0	88.0	20	1.7	0.01
Summer Averages	31.0	31.8	3.14	0.03	0.65	152.5	155.0	80.4	20	2.0	4.3
Fall Averages	30.0	5.5		0.04	0.43	159.5	164.0	95.0	16	1.4	
Winter Averages	19.0	11.0		0.04	0.60						
2002-2004 Averages	27.6	15.4	2.31	0.03	0.50	154.3	163.7	87.8	18	1.7	3.9

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

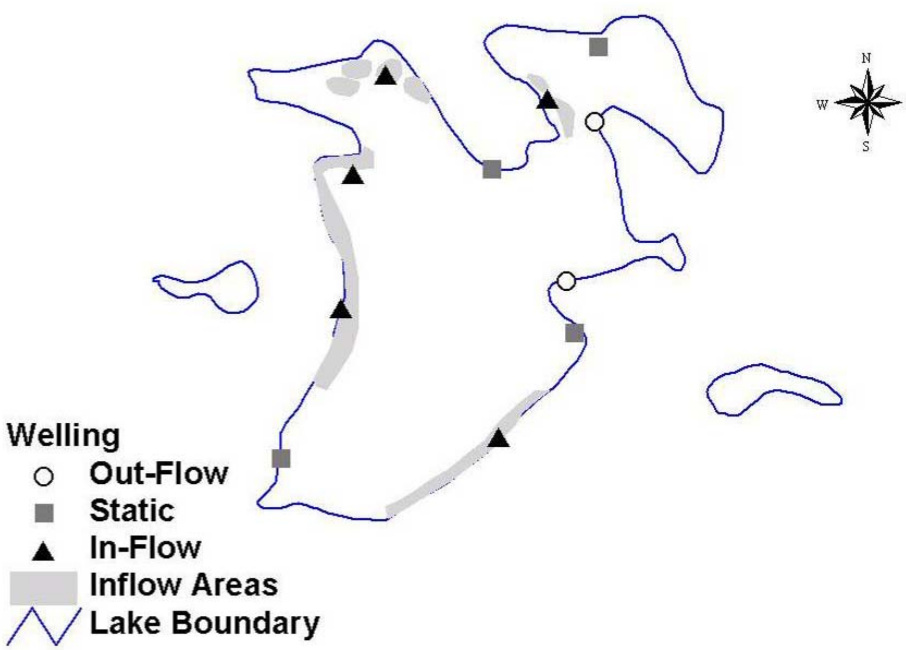
Table 3. 2002-2003 Severson Lake average water chemistry and reference value.

Severson Lake	Low	Medium	High	Reference Values	Low	Medium	High
Sulfate	6.50			Sulfate	<10	10-20	>20
Chloride	1.67			Chloride	<3	3-10	>10
Potassium	0.78			Potassium*	<2.16	2.16-4.30	>4.30
Sodium	2.15			Sodium*	<2.28	2.28-5.09	>5.09

**Ranges of low, medium, high defined by taking the median values from the lake study and dividing into thirds.*

Mini-piezometer wells were installed around Severson Lake to determine areas of **groundwater** inflow and outflow. **Groundwater** flows into Severson Lake in several areas around the lake (Figure 13). Water quality was analyzed for water collected from one mini-well; concentrations of **nitrate**, **ammonium**, **phosphorus**, and **chloride** were all low.

Figure 13. Locations in Severson Lake showing groundwater inflow/no flow/outflow from mini-piezometer measurements and winter observations.



*Terms in bold, see glossary pp 16-21

Algal Community
The algal community in Severson Lake was very diverse. The dominant groups were the green **algae** (Chlorophyta), **blue-green algae** (Cyanobacteria), yellow-green **algae** and **diatoms** (Ochrophyta), and dinoflagellates (Dinophyta). These four algal phyla were nearly equal sub-dominants (20-25%). Each phylum had a brief rise to dominance over the sampling period (except the cyanobacteria that were never a sampling period dominant) but no group represented more than 33% of any individual sampling period. The four dominant phyla represented 91% of all cells counted during the 2003 sampling season. In the 3278 cells counted during this period there were 8 genera of Cyanobacteria, 15 genera of Chlorophyta, 13 genera of Ochrophyta (including 10 **diatom** genera), 4 genera of Euglenophyta, 4 genera (and 5 species) of Dinophyta, and 2 genera of Cryptophyta identified. The green **algae** and **diatoms** dominated the early season collections with the dinoflagellates and cyanobacteria as subdominants in that order (Table 4). In August the greens again dominated with the other three phyla of nearly equal representation in the cell counts. The blue-green and cryptophyte **algae** dominated the September sample with the greens and **diatoms** as nearly equal subdominants. All four groups were of nearly equal distribution during the final sampling period in November (Figure 14).

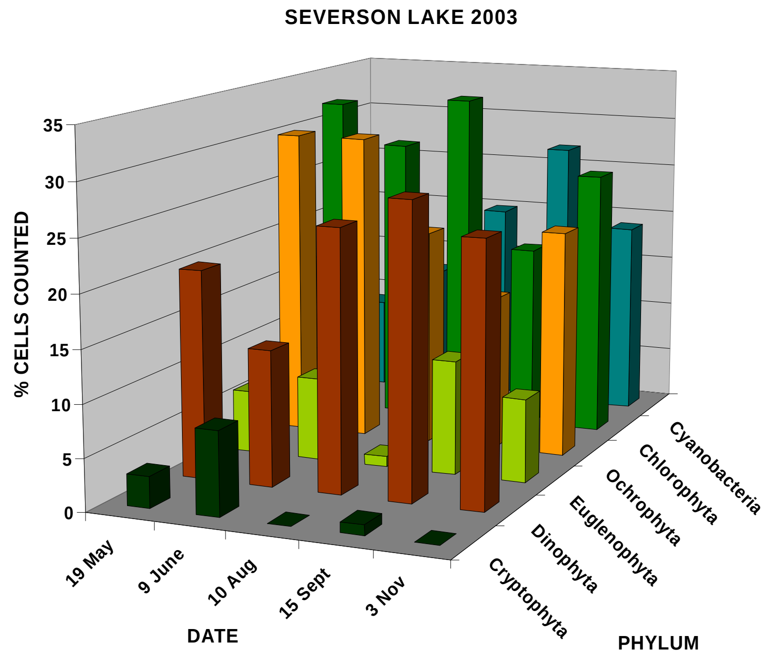
Table 4. Algal phyla and mean seasonal composition in Severson Lake from May to November 2003.

SEVERSON LAKE

PHYLUM	% CELLS COUNTED BY PHYLUM AND DATE					**MEAN**
	19 May	9 June	10 Aug	15 Sept	3 Nov	
Cyanobacteria	9	13	20	27	19	18
Chlorophyta	32	28	33	18	26	27
Ochrophyta	30	30	21	15	22	24
Euglenophyta	6	8	1	11	8	7
Dinophyta	20	13	25	28	25	22
Cryptophyta	3	8	0	1	0	2

*Terms in bold, see glossary pp 16-21

Figure 14. Algal community composition by date in Severson Lake from May to November 2003 (total phylum cells counted divided by total cells counted).



The green **algae** (Chlorophyta) occupied only 4 of the top 15 abundance slots but they were the most abundant taxa in 3 of 5 sampling periods (Figure 15). The small, nonmotile, colonial green alga, *Scenedesmus*, was twice the dominant genus (May, August) and once the second most abundant genus; another small, nonmotile, unicellular green alga, *Oocystis*, was the dominant in the November samples. The **diatom**, *Synedra* (Ochrophyta) was the dominant taxon in the June samples and a subdominant in May and September samples. A dinoflagellate (Dinophyta) genus, *Amphidinium*, was dominant in the September samples and a subdominant in all other sampling periods making it the most common taxon overall. This genus is a small, unarmored, facultative heterotroph that generally is seen early and late but in Severson Lake the genus was abundant all sampling season. *Coelosphaerium*, a moderately-sized, nonmotile, colonial cyanobacterium was present in 3 of the top 15 abundance slots but always as a subdominant, never as the dominant genus (Table 5).

The algal community when considered relative to the **chlorophyll**, **phosphorus**, and **nitrogen** values for Severson Lake presents a picture of a moderately **oligotrophic** lake. The 47 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 diversity of the lake algal community and the fairly typical seasonal succession (**diatoms** early, greens in the middle, dinoflagellates and cyanobacteria late) of the algal community combined with the generally high water quality throughout the sampling period are all characteristics of moderately **oligotrophic** bodies of water.

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Figure 15. Algal community composition by phylum in Severson Lake from May to November 2003.

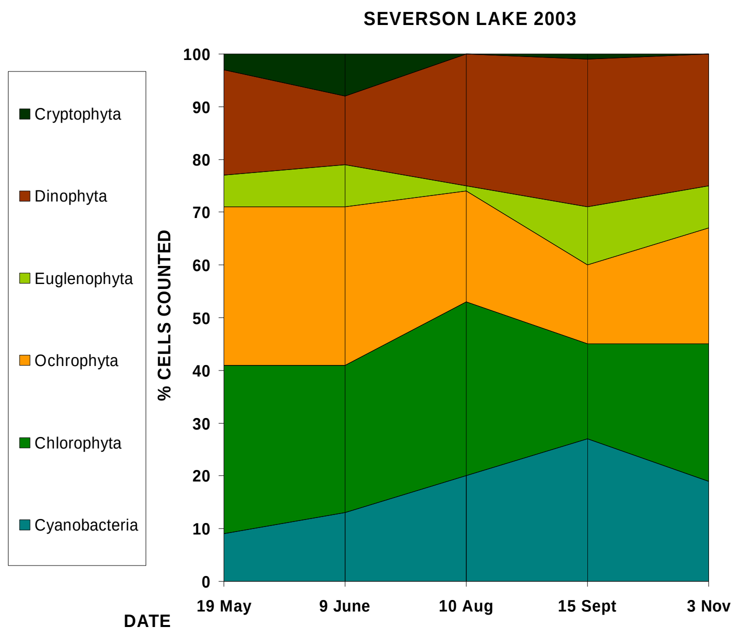

Table 5. Most common algal genera by date in Severson Lake from May to November 2003.

DATE	TOP THREE TAXA (MOST ABUNDANT, LEFT TO RIGHT)		
19 May	*Scenedesmus*	*Synedra 1*	*Amphidinium*
9 June	*Synedra 1*	*Scenedesmus*	*Amphidinium*
10 August	*Scenedesmus*	*Amphidinium*	*Coelosphaerium*
15 September	*Amphidinium*	*Coelosphaerium*	*Synedra 1*
3 November	*Oocystis*	*Amphidinium*	*Coelosphaerium*

Severson Lake Study Highlights

- The natural state of the shoreline along with the modest amount of development in the Severson Lake **watersheds** make it unique. The Ice Age Trail passes to the west of the lake and south of the lake. The survey of sensitive areas notes that there are steep slopes on the east, south, and southwest sides of the lake that should be protected from **erosion**.
- Reptile surveys were not conducted on Severson Lake. During the Severson Lake amphibian survey five frog species were identified (spring peeper, American toad, gray treefrog, Cope's gray treefrog, and green frog). The primary amphibian habitat can be found on numerous sections of shoreline.
- Eighty-eight percent of the shoreline around Severson Lake is comprised of vegetated shoreline and about 6.7 % of the lakeshore is defined as alder shoreline. Five percent of the shoreline is considered to be disturbed. Of that, 3.2 % of the shoreline vegetation is considered to be a moderately disturbed developed area.
- The number of **vascular plants** that were found in the water or on wet shores of Severson Lake was slightly below average for Portage County lakes. The average **coefficient of conservatism** and the **floristic quality index** are above average for Portage County lakes.
- Severson Lake (Budsberg Lake on older maps) is notable for being undeveloped, except for two cabins on the east side. The shoreline includes a large boggy sedge meadow on the north. Although no rare or special concern species have been found in the lake or adjacent wetland, the flora is composed mostly of native species characteristic of intact plant communities, as indicated by the relatively high average **coefficient of conservatism**. The upland is heavily wooded with large white pines, red oaks, maples, etc. and also indicates an intact native plant community.
- In the spring and fall Severson Lake does not always mix from top to bottom which can result in long periods where the water column is not replenished with oxygen. During periods of **stratification** dissolved oxygen concentrations are above 5 **mg/L** in the upper 16 feet of water. However, in March 2004 dissolved oxygen concentrations were only sufficient to support most aquatic biota in the upper 4 feet of water.
- Nutrient concentrations were variable in Severson Lake. Most measures of human activity were low, but **atrazine** was found in low concentrations in the lake water (0.11 and 0.06 ppb). Some toxicity studies have indicated that reproductive system abnormalities can occur in frogs at these levels. The presence of **atrazine** indicates that other agri-chemicals may also be entering Severson Lake.

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- The algal community when considered relative to the **chlorophyll**, **phosphorus**, and **nitrogen** values for Severson Lake presents a picture of a moderately **oligotrophic** lake. The 47 genera identified were relatively common and none of those that reached numerical dominance in the sample counts are associated with toxins or health issues. The diversity of the lake algal community and the fairly typical seasonal succession (**diatoms** early, greens in the middle, dinoflagellates and cyanobacteria late) of the algal community combined with the generally high water quality throughout the sampling period are all characteristics of moderately **oligotrophic** bodies of water.

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 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.

*Terms in bold, see glossary pp 16-21

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 used in studies of water quality; often the brown stuff attached to rock surfaces.

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.

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.

*Terms in bold, see glossary pp 16-21

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.

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. Soft water has 60 mg/L $CaCO_3$ or less, 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."

*Terms in bold, see glossary pp 16-21

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.

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.

*Terms in bold, see glossary pp 16-21

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 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.

Stratification, Stratified:

The layering of water due to differences in density. Water's greatest density occurs at 39^{o}F (4^{o}C). 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.

*Terms in bold, see glossary pp 16-21

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.

*Terms in bold, see glossary pp 16-21