

# Skunk Lake

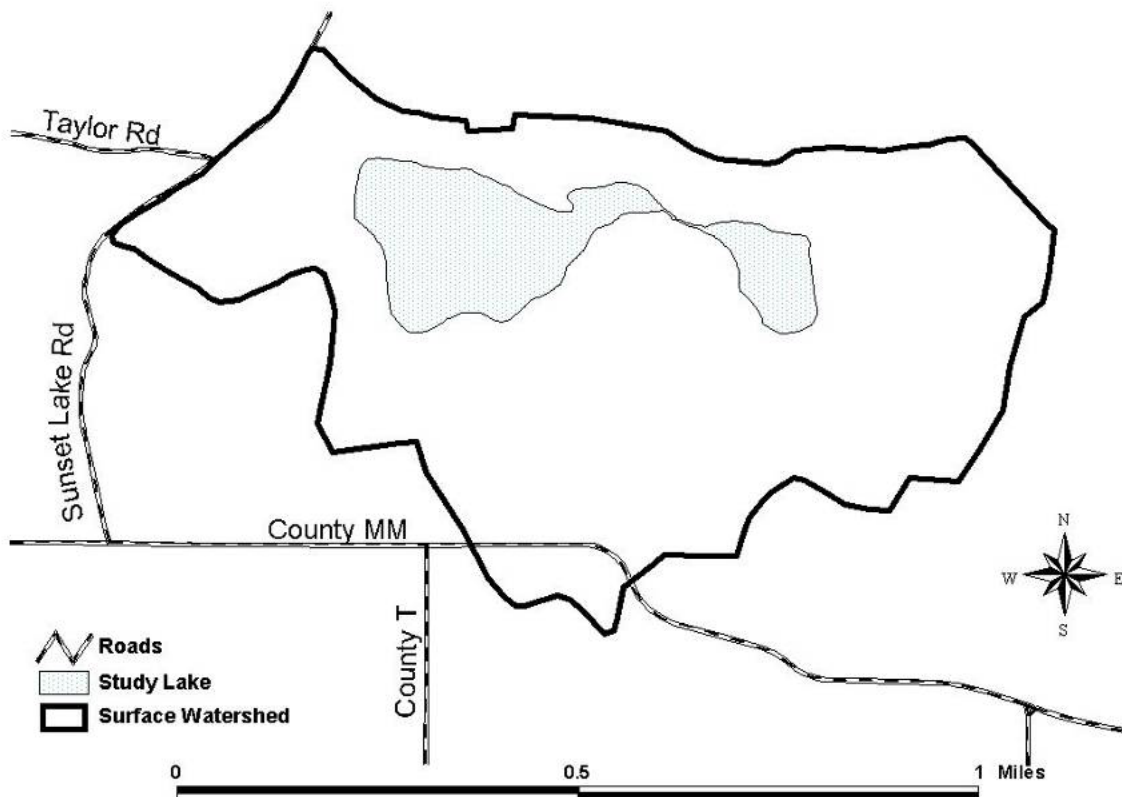
## Introduction

Skunk Lake is a beautiful 27.8 acre, **hard water seepage lake** located in the Town of New Hope. It is of moderate depth with a deep hole of approximately 20 feet. The shoreline is completely undeveloped and surrounded by a hardwood and conifer forest, providing an atmosphere of peace and serenity. It is set in a depression with steep slopes surrounding the entire lake. Deer, muskrats, songbirds, and waterfowl are all common sights in this area. Largemouth bass are the most common fish species with northern pike and panfish present. Skunk Lake is surrounded by private land and does not have public access.

## Land Use and Watershed

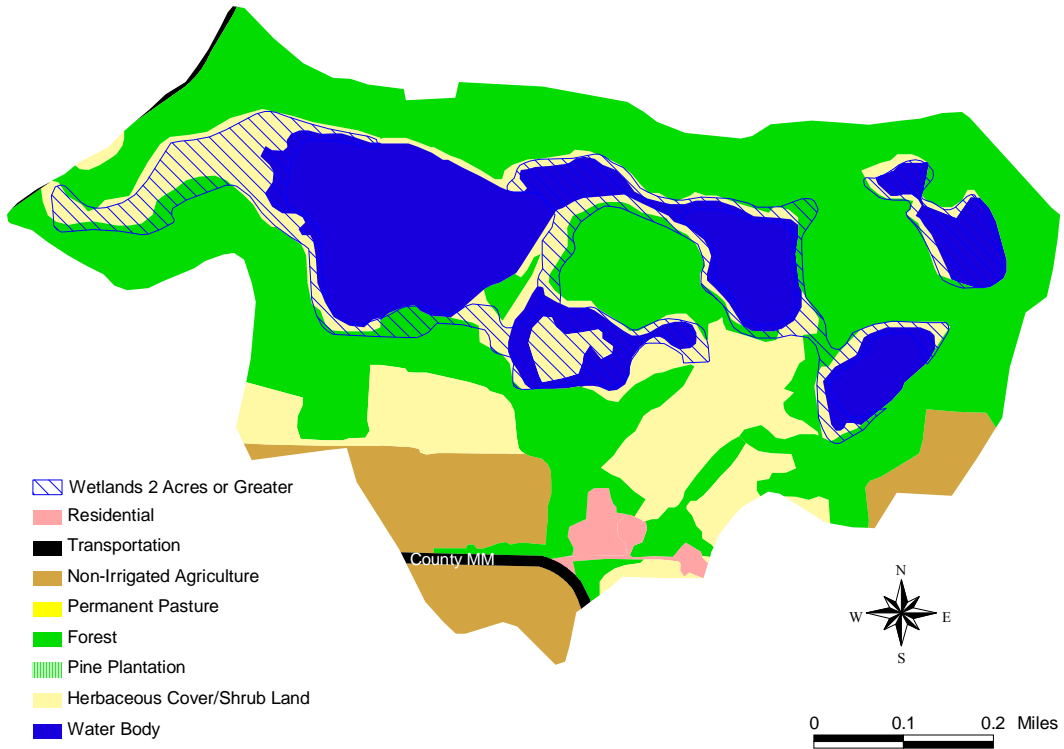
The surface **watershed** for Skunk Lake is approximately 295 acres (Figure 1). The land uses are predominantly forest, making up about half of the area, followed by shrub/wetland cover (20%) (Figure 2 and Figure 3). Since 1948 there have been slight fluctuations in shrub/wetland cover, a modest decrease of 11.5 acres of non-irrigated agricultural land, and a modest increase of 12 acres of forested land. Overall, from 1948 to 2002, there haven't been any major changes of land use in the surface **watershed** therefore, this lake makes a good reference lake in terms of water quality and habitat.

Figure 1. Skunk Lake surface watershed boundary.

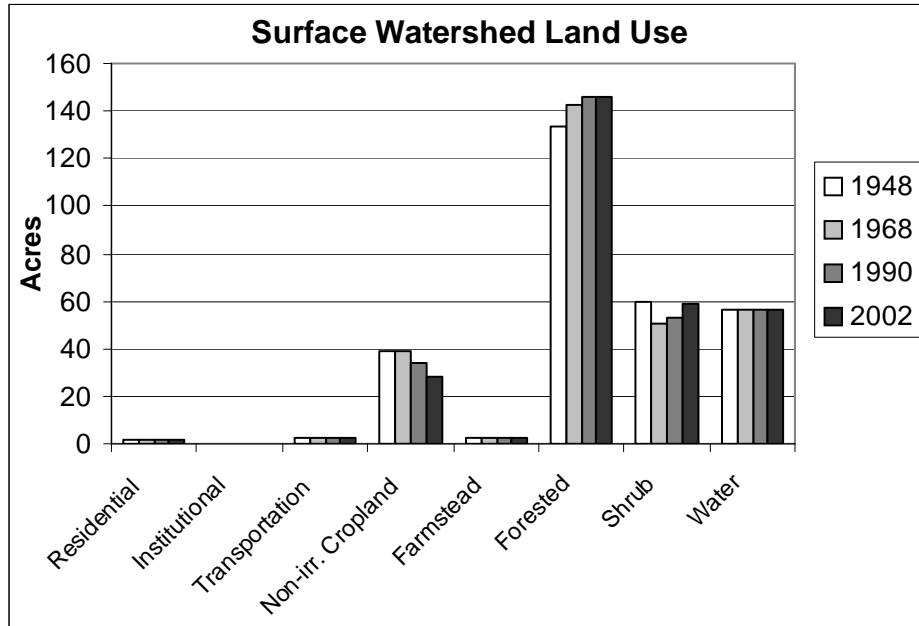


\*Terms in bold, see glossary pp 15-20

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



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

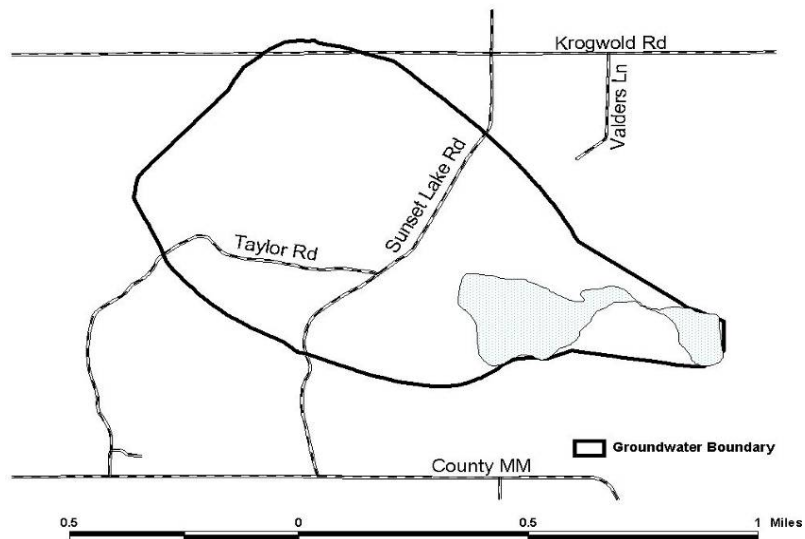


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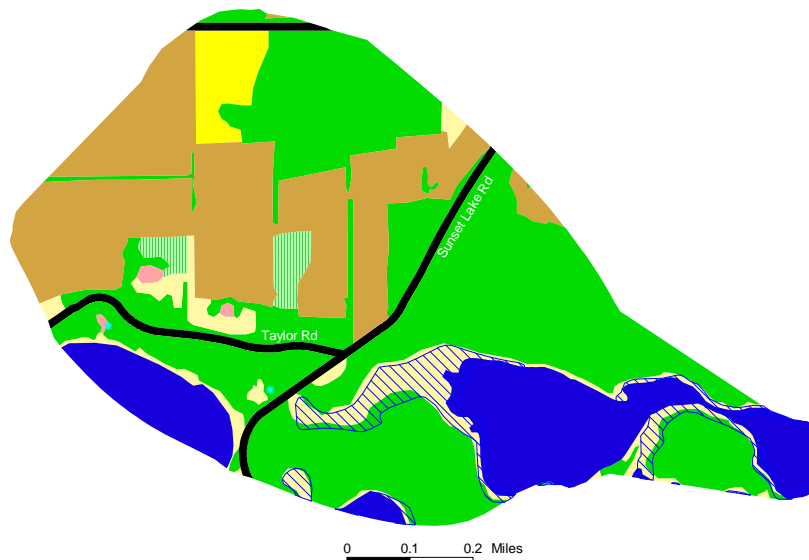
The **groundwater watershed** for Skunk Lake is approximately 383 acres (Figure 4). The dominant land use is forested area (46%), followed by non-irrigated agriculture (25%) (Figure 5 and Figure 6). Ten acres of pasture land was introduced between 1990 and 2002. Shrub/wetland cover and non-irrigated cropland has decreased slightly. However, as is the case with the surface **watershed**, the land use in Skunk Lake's **groundwater watershed** has seen little change since 1948.

An analysis of records indicate that there are no potentially failing septic systems or former landfill sites in existence in either the surface or **groundwater watershed**.

**Figure 4. Skunk Lake groundwater watershed boundary.**

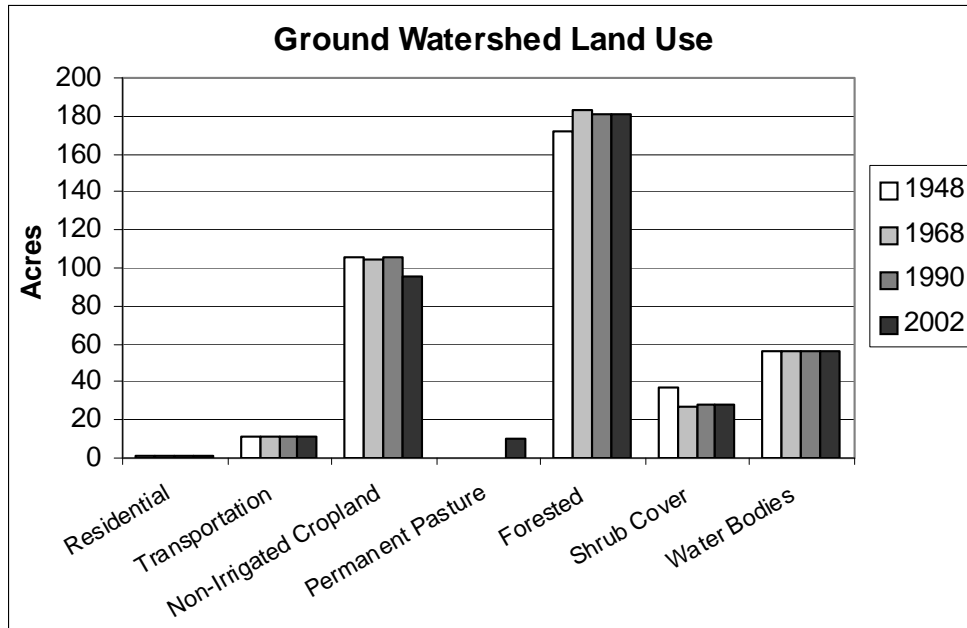


**Figure 5. Land use in the Skunk Lake groundwater watershed (2002).**



\*Terms in bold, see glossary pp 15-20

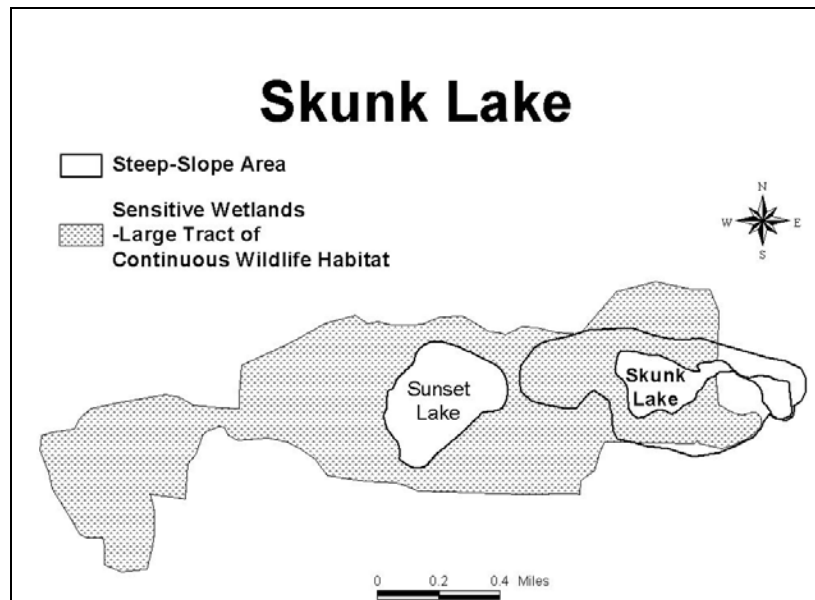
**Figure 6. Land use in the Skunk Lake groundwater watershed 1948-2002.**



### 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. From our survey of sensitive areas, the most obvious characteristic of Skunk Lake is the large tract of wetland that surrounds most of Skunk Lake and continues west past Sunset Lake towards County Highway A. Steep slopes that are sensitive to **erosion** also surround Skunk Lake (Figure 7).

**Figure 7. Upland sensitive areas near Skunk Lake.**



\*Terms in bold, see glossary pp 15-20

## Birds

Lakeshore development can negatively or positively affect habitat quality of birds depending on the ecological requirements of each species. Development can play an 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 (*Sayornis 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 (*Cyanocitta cristata*), red-bellied woodpecker (*Melanerpes carolinus*), Eastern wood-pewee (*Contopus virens*), indigo bunting (*Passerina cyanea*), and common yellowthroat (*Geothlypis 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 Skunk Lake.**

Common Name	Number Observed	Food	Foraging	Nest Type	Nest Location
American Goldfinch	3	seeds	foliage gleaner	cup	shrub
American Robin	1	insects	ground gleaner	cup	deciduous
Baltimore Oriole	1	insects	ground gleaner	oven	ground
Black-capped Chickadee	2	insects	foliage gleaner	cavity	deciduous
Blue Jay	4	omnivore	ground gleaner	cup	coniferous
Brown-headed Cowbird	1	insects	ground gleaner	parasite	deciduous
Chipping Sparrow	2	insects	ground gleaner	cup	coniferous
Common Yellowthroat	2	insects	foliage gleaner	cup	shrub
Eastern Wood-Pewee	3	insects	hawker	cup	deciduous
Great Crested Flycatcher	1	insects	hawker	cavity	deciduous
Least Flycatcher	4	insects	hover gleaner	cup	deciduous
Ovenbird	3	insects	hawker	cup	bridge
Red-eyed Vireo	5	insects	hover gleaner	cup	shrub
Red-winged Blackbird	4	insects	ground gleaner	cup	reed
Rose-breasted Grosbeak	1	insects	foliage gleaner	cup	deciduous
Ruby-throated Hummingbird	1	nectar	hover gleaner	cup	deciduous
Scarlet Tanager	1	insects	hover gleaner	saucer	deciduous
Song Sparrow	4	insects	ground gleaner	cup	ground
<b>Total</b>	<b>43</b>				

\*Terms in bold, see glossary pp 15-20

## **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 near Skunk Lake. The survey of amphibians near Skunk Lake revealed four frog species (spring peeper [*Pseudacris crucifer*], gray treefrog [*Hyla versicolor*], Cope's gray treefrog [*Hyla chrysoscelis*], and green frog [*Rana clamitans*]). The primary amphibian habitat can be found on much of the shoreline (the most sensitive areas are identified in red in 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 is plenty of ideal, natural habitat for many amphibian and reptile species due to minimal levels of development. Because of this there are no major threats towards amphibians or reptile habitat at this time.

\*Terms in bold, see glossary pp 15-20

**Figure 8. Regions of primary amphibian habitat around Skunk Lake.**



### **Aquatic Plants**

There are **53** species of aquatic and wetland plants (**52** species of **vascular plants** plus a **macrophytic alga**) that have been found at Skunk Lake; most of these occur in the extensive wetlands surrounding the lake. This is above average for Portage County lakes. The average **coefficient of conservatism (c-value)** is **5.3**, which is above average. The **floristic quality index** is **37.6**, which is also above average for Portage County lakes.

The number of species of plants submersed or floating in the lake is relatively small, although only one brief survey of the lake was made prior (1972) to 2003, and some species may have been overlooked. The extensive peaty sedge meadow to the west and surrounding the lake, however, has a large rich flora. Most of the plants listed as "shore" plants occur primarily in this sedge meadow. Most abundant are tussock sedge (*Carex stricta*), bottle-shaped sedge (*Carex utriculata*), dark-green woolgrass (*Scirpus atrovirens*), bulrushes (*Schoenoplectus* spp.), broad-leaf cattail (*Typha latifolia*), and amphibious smartweed (*Polygonum amphibium*). The sedge meadow is relatively free of alien species, except for some moderate-size patches of reed canary-grass (*Phalaris arundinacea*). But a few plants of European swamp thistle (*Cirsium palustre*) were found

\*Terms in bold, see glossary pp 15-20

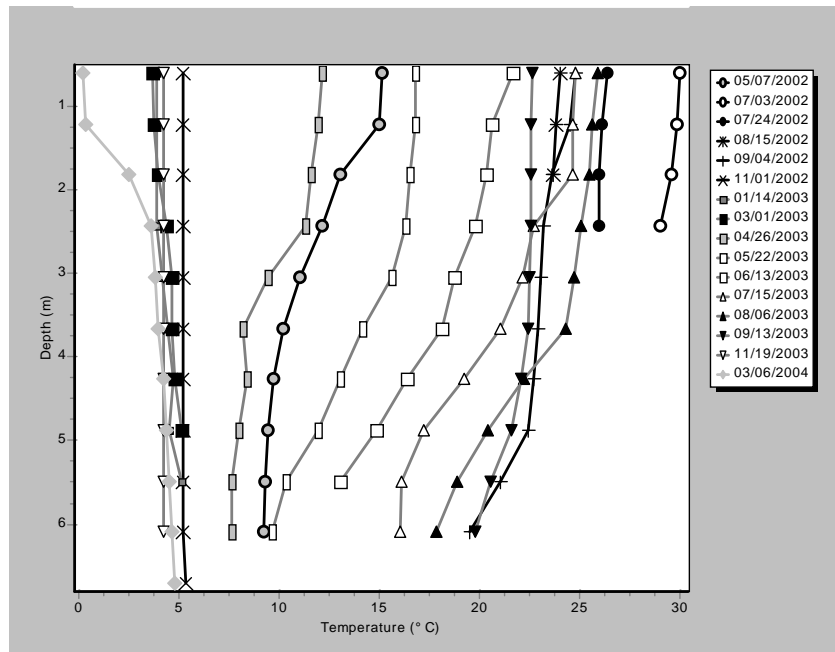
here, the first known occurrence of this species in Portage County; it is likely to become more common.

### 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.

Temperature and dissolved oxygen were measured from the water surface to the bottom of the lake. On all occasions the temperature was nearly uniform from top to bottom in Skunk Lake, indicating that the lake is fully mixed throughout the year (Figure 9). However, oxygen in the bottom water was below 5 **mg/L** on a number of dates. On several sampling dates in July 2002 and March 2003 only the upper 9 feet of water had oxygen concentrations above 5 **mg/L** (Figure 10). This should be monitored, particularly in years with long winters and heavy snow cover when fish kills are more likely to occur.

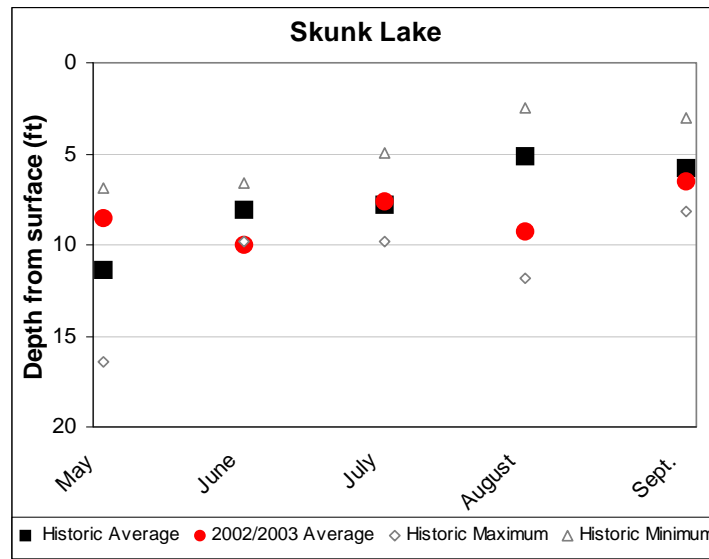
Figure 9. Profile of temperature in Skunk Lake 2002-2004.



\*Terms in bold, see glossary pp 15-20



**Figure 11. Monthly average water clarity measurements in Skunk 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 aquatic plants (similar to houseplants and crops). Throughout the year **phosphorus** and **nitrogen** concentrations were well below levels that would be considered problematic (Table 2). Skunk Lake is a hard-water lake that can support a good amount of fish and aquatic plants. **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 (0.22 and 0.14 µg/L), 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 Skunk Lake (Table 3).

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

<b>Skunk Lake</b>	<b>TP</b> (ug/L)	<b>RP</b> (ug/L)	<b>TN</b> (mg/L)	<b>NO2+NO3</b> (mg/L)	<b>NH4</b> (mg/L)	<b>Alkalinity</b> (mg/L)	<b>Total Hardness</b> (mg/L)	<b>Calcium Hardness</b> (mg/L)	<b>Color</b> (CU)	<b>Turbidity</b> (NTU)	<b>Chlorophyll a</b> (ppm)
Spring Averages	20.0	2.8	1.03	0.06	0.08	140.5	149.0	81.0	15	1.6	5.6
Summer Averages	17.8	5.5	1.05	0.04	0.01	113.5	118.0	54.4	19	1.2	5.3
Fall Averages	16.5	3.0		0.02	0.07	139.0	142.0	80.0	18	1.2	
Winter Averages	16.5	1.5		0.06	0.16						
2002-2004 Averages	17.9	3.4	1.04	0.04	0.07	131.0	136.3	71.8	17	1.3	5.3

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

\*Terms in bold, see glossary pp 15-20

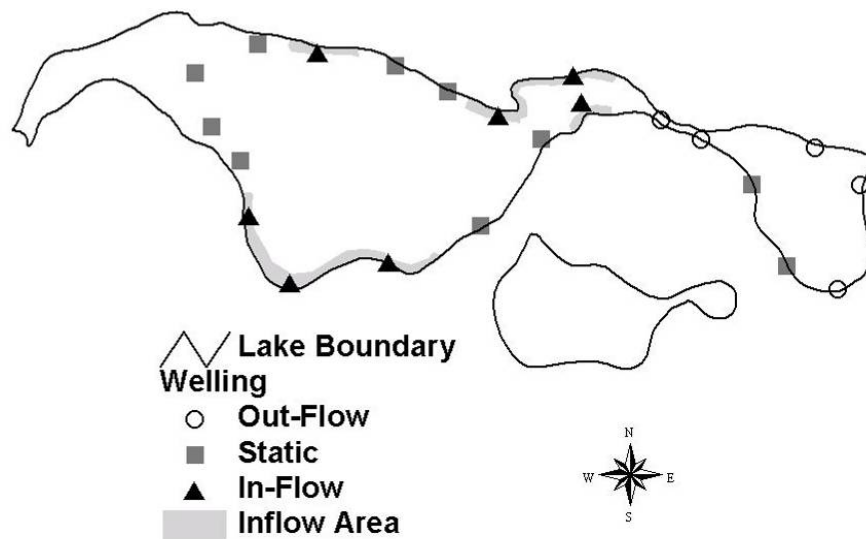
**Table 3. 2002-2003 water chemistry averages in Skunk Lake and reference values.**

<b>Skunk Lake</b>	<i>Low</i>	<i>Medium</i>	<i>High</i>	<b>Reference Values</b>	<i>Low</i>	<i>Medium</i>	<i>High</i>
<i>Sulfate</i>	6.22			<i>Sulfate</i>	<10	10-20	>20
<i>Chloride</i>	1.19			<i>Chloride</i>	<3	3-10	>10
<i>Potassium</i>	0.63			<i>Potassium*</i>	<2.16	2.16-4.30	>4.30
<i>Sodium</i>	1.48			<i>Sodium*</i>	<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 Skunk Lake to determine areas of **groundwater** inflow and outflow. **Groundwater** flows into Skunk Lake in several areas around the lake (Figure 12). **Groundwater** was sampled for water quality analysis from one site each on the north and south sides of the lake. Water quality was good; however, on the north side slightly elevated **ammonium** and **chloride** indicate some inputs from **groundwater** to the lake.

**Figure 12. Locations in Skunk Lake showing groundwater inflow/no flow/outflow from mini-piezometer measurements and winter observations.**



### **Algal Community**

The algal community in Skunk Lake (Table 4) was moderately diverse. The dominant groups were the green **algae** (Chlorophyta), **blue-green algae** (Cyanobacteria), and yellow-green **algae** and **diatoms** (Ochrophyta). These three algal phyla were nearly equal sub-dominants (21-28%). Each phylum had a brief rise to dominance over the sampling period, but no group represented more than 35% of any individual sampling period. The three dominant phyla represented 74% of all cells counted during the 2003 sampling season. In the 2,030 cells counted during this period there were 6 genera of

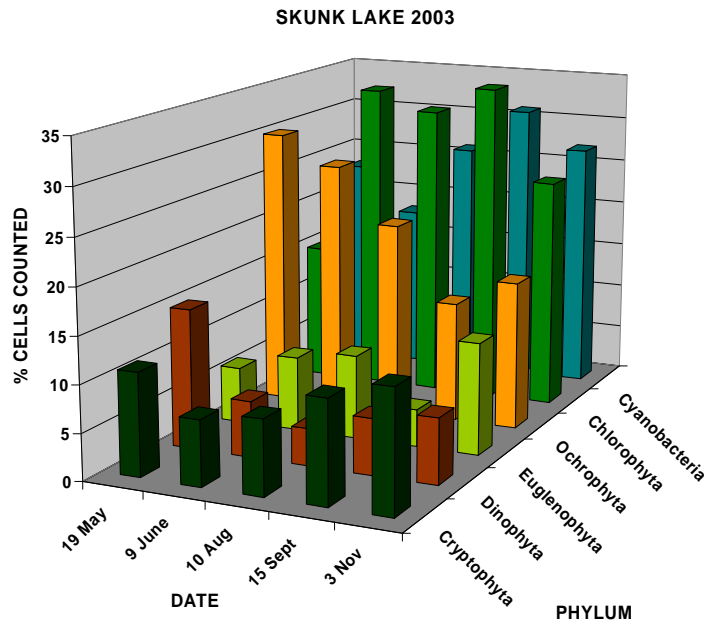
\*Terms in bold, see glossary pp 15-20

Cyanobacteria, 10 genera of Chlorophyta, 13 genera of Ochrophyta (including 10 diatom genera), 3 genera of Euglenophyta, 2 genera of Dinophyta, and 1 genus of Cryptophyta identified. The Ochrophyta (mostly **diatoms**) dominated the early sample periods (May, June) before dropping to second sub-dominant the rest of the sampling season. The green **algae** (Chlorophyta) were insignificant in the May sample but rose quickly to the dominant phylum in the remaining sample periods, especially June, August, and September sampling periods. The **blue-green algae** (Cyanobacteria) followed a similar trajectory as the green **algae** but a bit slower and never reached quite the dominance levels of the green **algae** until the November samples. The other phyla (Euglenophyta, Dinophyta, Cryptophyta) totaled about 25% of all cells counted, with no phylum ever represented by more than 15% of cell counted in a sample period (Figure 13).

**Table 4. Algal phyla and mean seasonal composition in Skunk Lake from May to November 2003.**  
SKUNK LAKE

PHYLUM	% CELLS COUNTED BY PHYLUM AND DATE					
	19 May	9 June	10 Aug	15 Sept	3 Nov	MEAN
Cyanobacteria	23	18	26	31	27	25
Chlorophyta	15	34	32	35	25	28
Ochrophyta	30	27	21	13	16	21
Euglenophyta	6	8	9	4	12	8
Dinophyta	15	6	4	6	7	8
Cryptophyta	11	7	8	11	13	10

**Figure 13. Algal community composition by date in Skunk Lake from May to November 2003 (total phylum cells counted divided by total cells counted).**

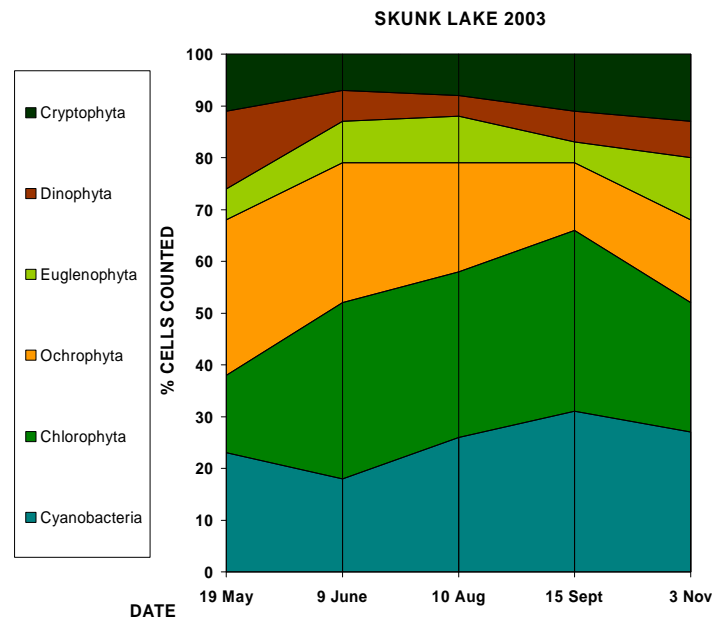


\*Terms in bold, see glossary pp 15-20

Small, nonmotile, unicellular and colonial green **algae** dominated the lake algal flora with the genera *Ankistrodesmus*, *Selenastrum*, and *Oocystis* dominant in four of five samples (Figure 14). The diatom (Ochrophyta) genus *Navicula*, a common epiphytic and planktonic taxon, was the early season dominant (May sample) and remained one of the top three in the two following samples (June, August). The colonial blue-green genus *Coelosphaerium* was a subdominant genus in three of five sample periods, all mid to late season. *Cryptomonas*, a very small, motile unicellular cryptophyte was a subdominant in three sample periods, all early or late, never midseason (Table 5).

The algal community when considered relative to the **chlorophyll**, **phosphorus**, and **nitrogen** values for Skunk Lake presents a picture of a moderately **oligotrophic** lake. The 35 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 of the algal community (**diatoms** early, greens in the middle, and cyanobacteria late) combined with the generally good water quality throughout the sampling period are all characteristics of moderately **oligotrophic** bodies of water.

**Figure 14. Algal community composition by phylum in Skunk Lake from May to November 2003.**



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

DATE	TOP THREE TAXA (MOST ABUNDANT, LEFT TO RIGHT)		
19 May	<i>Navicula</i> 2	<i>Ceratium</i> 1	<i>Cryptomonas</i>
9 June	<i>Oocystis</i>	<i>Navicula</i> 2	<i>Asterionella</i>
10 August	<i>Selenastrum</i>	<i>Coelosphaerium</i>	<i>Navicula</i> 2
15 September	<i>Ankistrodesmus</i>	<i>Coelosphaerium</i>	<i>Cryptomonas</i>
3 November	<i>Ankistrodesmus</i>	<i>Coelosphaerium</i>	<i>Cryptomonas</i>

\*Terms in bold, see glossary pp 15-20

## Skunk Lake Study Highlights

- Skunk Lake is surrounded by private land and does not have overland public access.
- Overall, from 1948 to 2002, there haven't been any major changes of land use in the surface **watershed**; therefore, this lake makes a good reference lake in terms of water quality and habitat.
- From our survey of sensitive areas, the most obvious characteristic of Skunk Lake is the large tract of wetland that surrounds most of Skunk Lake and continues west past Sunset Lake towards County Highway A. Steep slopes that are sensitive to **erosion** also surround Skunk Lake.
- There are **53** species of aquatic and wetland plants that have been found at Skunk Lake; most of these occur in the extensive wetlands surrounding the lake. This is above average for Portage County lakes. The average **coefficient of conservatism** and the **floristic quality index** are also above average for Portage County lakes.
- The number of species of plants submersed or floating in the lake is relatively small, although only one brief survey of the lake was made prior (1972) to 2003, and some species may have been overlooked. The extensive peaty sedge meadow to the west and surrounding the lake, however, has a large rich flora. Most of the plants listed as "shore" plants occur primarily in this sedge meadow. Most abundant are tussock sedge, bottle-shaped sedge, dark-green woolgrass, bulrushes, broad-leaf cattail, and amphibious smartweed. The sedge meadow is relatively free of alien species, except for some moderate-size patches of reed canary-grass. But a few plants of European swamp thistle were found here, the first known occurrence of this species in Portage County; it is likely to become more common.
- On several sampling dates in July 2002 and March 2003 only the upper 9 feet of water had oxygen concentrations above 5 **mg/L**. This should be monitored, particularly in years with long winters and heavy snow cover when fish kills are more likely to occur.
- The algal community when considered relative to the **chlorophyll**, **phosphorus**, and **nitrogen** values for Skunk Lake presents a picture of a moderately **oligotrophic** lake. The 35 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 of the algal community (**diatoms** early, greens in the middle, and cyanobacteria late) combined with the generally good water quality throughout the sampling period are all characteristics of moderately **oligotrophic** bodies of water.

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## **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 (CaCO<sub>3</sub>), or as microequivalents per liter (ueq/l). 20 ueq/l = 1 mg/L of CaCO<sub>3</sub>.

### **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<sub>3</sub>) 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<sub>4</sub><sup>+</sup>) form, but at high pH values the toxic ammonium hydroxide (NH<sub>4</sub>OH) occurs. The water quality standard for fish and aquatic life is 0.02 mg/L of NH<sub>4</sub>OH. At a pH of 7 and a temperature of 68° F (20° 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<sub>2</sub>) from the air to provide their own nutrient.

### **Chloride (Cl<sup>-</sup>):**

Chlorine in the chloride ion (Cl<sup>-</sup>) form has very different properties from chlorine gas (Cl<sub>2</sub>), which is used for disinfecting. The chloride ion (Cl<sup>-</sup>) 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."

\*Terms in bold, see glossary pp 15-20

**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.

**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).

\*Terms in bold, see glossary pp 15-20

**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<sup>++</sup>) and magnesium (Mg<sup>++</sup>) in the water expressed as milligrams per liter of CaCO<sub>3</sub>. Amount of hardness relates to the presence of soluble minerals, especially limestone, in the lake watershed. Soft water has 60 mg/L CaCO<sub>3</sub> or less, moderately hard water has 61-120 mg/L CaCO<sub>3</sub>, hard water has 121-180 mg/L CaCO<sub>3</sub>, and very hard water has more than 180 mg/L CaCO<sub>3</sub>.

**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<sub>3</sub>) 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.

\*Terms in bold, see glossary pp 15-20

**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<sub>3</sub><sup>-</sup>):**

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<sub>3</sub>-N) plus ammonium-nitrogen (NH<sub>4</sub>-N) of 0.3 mg/L in spring will support summer algae blooms if enough phosphorus is present.

**Nitrite (NO<sub>2</sub><sup>-</sup>):**

A form of nitrogen that rapidly converts to nitrate (NO<sub>3</sub><sup>-</sup>) and is usually included in the NO<sub>3</sub><sup>-</sup> 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<sub>2</sub>) 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.

\*Terms in bold, see glossary pp 15-20

**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°F (4°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.

**Sulfate (SO<sub>4</sub><sup>2-</sup>):**

The most common form of sulfur in natural waters. The amounts relate primarily to soil minerals in the watershed. Sulfate (SO<sub>4</sub><sup>2-</sup>) can be reduced to sulfide (S<sup>2-</sup>) and hydrogen sulfide (H<sub>2</sub>S) 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<sub>2</sub>) 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.

\*Terms in bold, see glossary pp 15-20

**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 15-20