Springville Pond

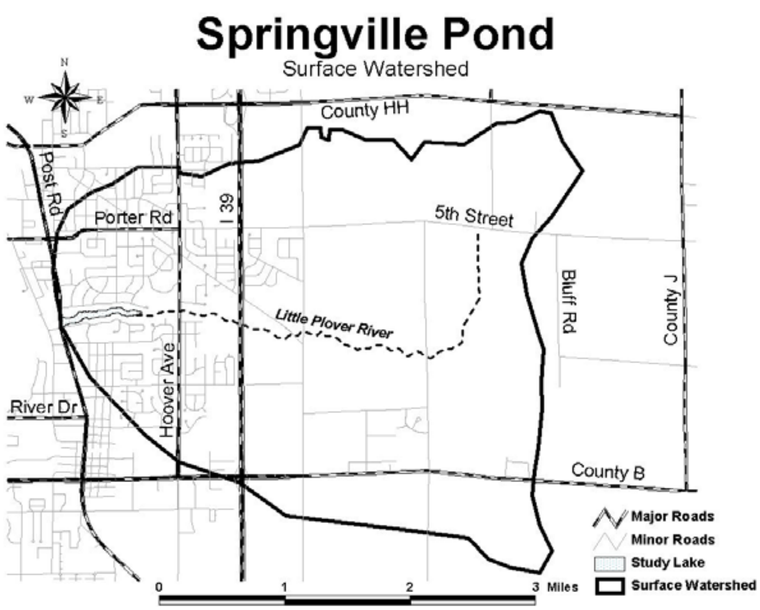
Introduction

Springville Pond is an 18 acre **impoundment** of the Little Plover River formed by a dam located in the Village of Plover. The pond has an estimated volume of 107.3 acre-feet, a maximum depth of 12 feet, and bottom materials of sand with some silt. The lower part of the pond has been dredged, but the upper end has not. This part of the pond has muck overlying the sandy **substrate**. The shoreline has seen extensive urban development in the recent past. The Little Plover River is navigable both above and below the dam. In recent years the Little Plover River has experienced historic low flows of water that has even resulted in some sections being completely dewatered. The fishery in Springville Pond consists of largemouth bass, panfish, and trout. There is a small park on the south side of the pond with public carry-in boating access. Motors are not allowed on the Pond. Eurasian water-milfoil is an invasive aquatic plant that recently began having a significant impact on the aquatic plant community and ecosystem along with curlyleaf pondweed.

Land Use and Watershed

The surface **watershed** for Springville Pond is 6,165 acres (Figure 1). In 1992 irrigated and non-irrigated agriculture together made up 45% of the land use in the area. Forest (26%) and residential areas (18%) comprised the majority of other land uses (Figure 2). Residential and road development has increased considerably since 1992, the most recent year for which electronic urban land use data is available from Portage County. A search of the records in 2002 indicate that based on age there were fourteen potentially failing septic systems within Springville Pond's surface **watershed** and one landfill site. The **groundwater watershed** boundary for Springville Pond is substantially different from the surface **watershed** boundary. Both are shown in Figure 3.

Figure 1. Springville Pond surface watershed boundary.



*Terms in bold, see glossary pp 13-17

Figure 2. Land Use in the Springville Pond surface watershed (1992).

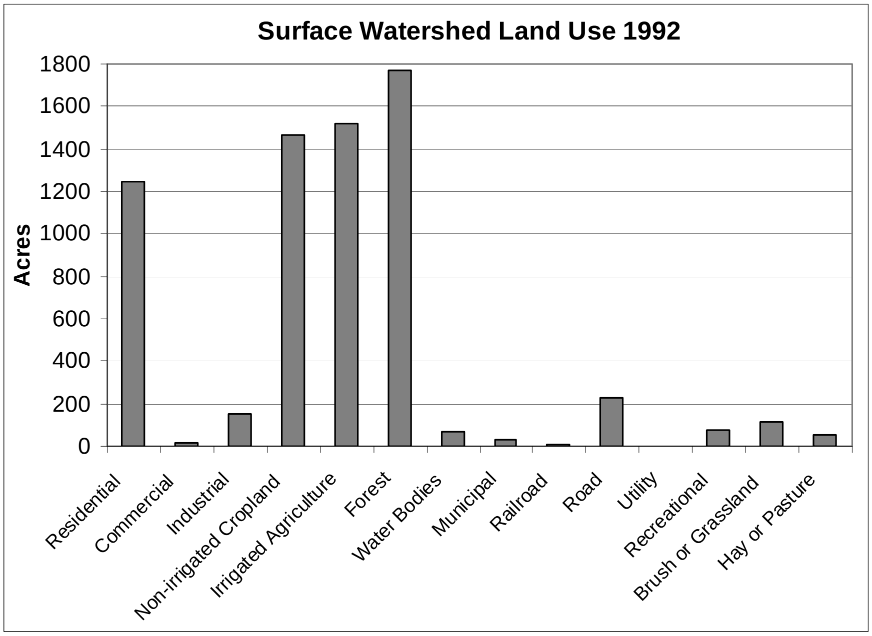
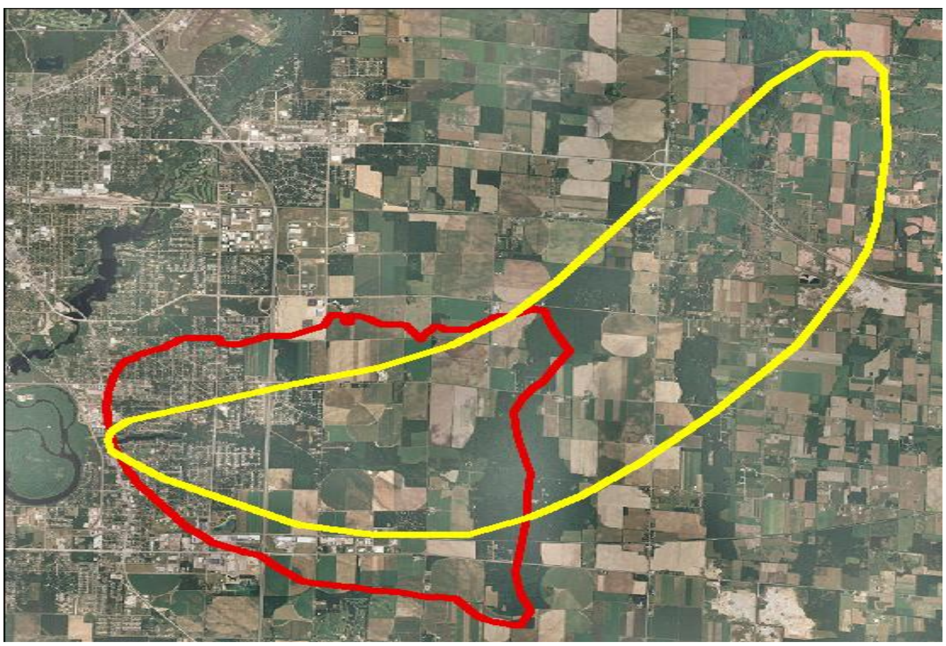


Figure 3. Orthophoto showing the surface and groundwater watershed boundaries for Springville Pond.



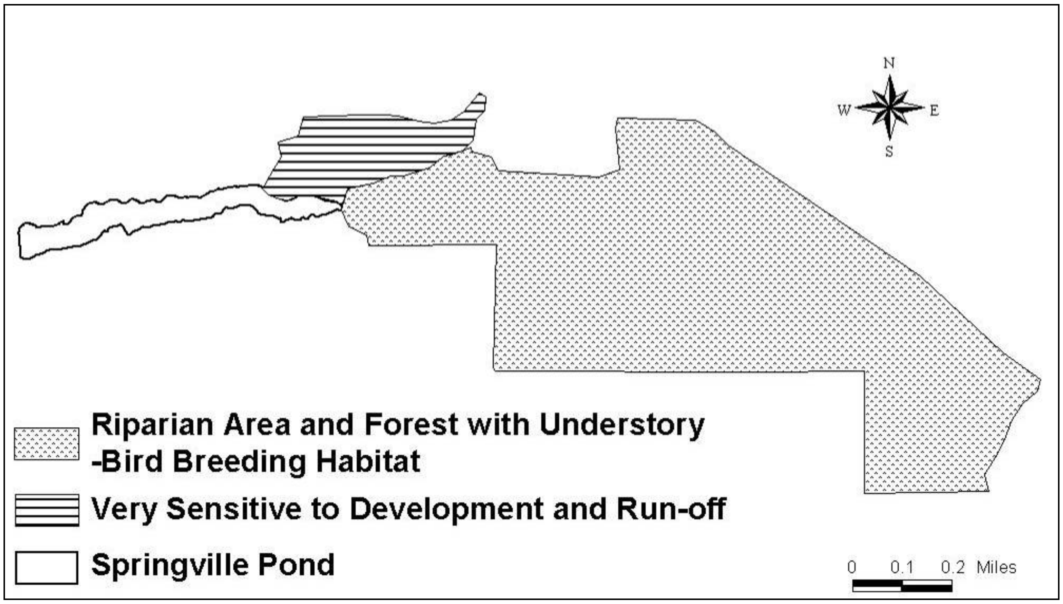
Upland Sensitive Areas

The survey of upland sensitive areas was conducted to note areas immediately around the pond that are particularly valuable, or sensitive to disruption. Springville Pond has a good deal of land around it that is particularly susceptible to disturbance and contamination. These areas should be

*Terms in bold, see glossary pp 13-17

of concern due to the increasing development within the **watershed**. One such area is located near the northeast shore of the pond, which would be affected adversely by any kind of development and increased run-off. Another area, east of the pond, is a particularly important riparian area with adjacent forest and under story that provides birds with excellent bird breeding habitat (Figure 4).

Figure 4. Upland sensitive areas near Springville Pond.



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*), 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.

*Terms in bold, see glossary pp 13-17

Table 1. Bird species identified near Springville Pond.

Common Name	Number Observed	Food	Foraging	Nest Type	Nest Location
American Goldfinch	5	seeds	foliage gleaner	cup	shrub
American Robin	2	insects	ground gleaner	cup	deciduous
Blue Jay	3	omnivore	ground gleaner	cup	coniferous
Brown Thrasher	2	omnivore	ground gleaner	cup	shrub
Downy Woodpecker	1	insects	bark gleaner	cavity	snag
House Finch	1	seeds	ground gleaner	cup	deciduous
House Wren	1	insects	ground gleaner	cavity	deciduous
Northern Cardinal	3	insects	ground gleaner	cup	shrub
Purple finch	2	seeds	ground gleaner	cup	coniferous
Red-breasted Nuthatch	2	insects	aerial foliager	cavity	snag
White-breasted Nuthatch	1	insects	bark gleaner	cavity	deciduous
Total	**23**				

Shoreline Vegetation, Reptiles, and Amphibians

Two frog species were identified during the survey of Springville Pond (american toad [*Bufo americanus*] and spring peeper [*Pseudacris crucifer*]). The primary amphibian habitat is located on the east side of the pond (sensitive area is identified in red on Figure 5). Some of the key features of this habitat include undisturbed natural shoreline with large amounts of submergent, emergent, and floating-leaf vegetation.

The good news is that several areas on the eastern end of the pond support some amphibian species. The bad news is that few amphibian species have been found at Springville Pond; the high levels of altered shoreline may be preventing the establishment of amphibian populations , or agricultural chemicals may be affecting the reproduction and/or survival. Reptile surveys were not conducted on Springville Pond.

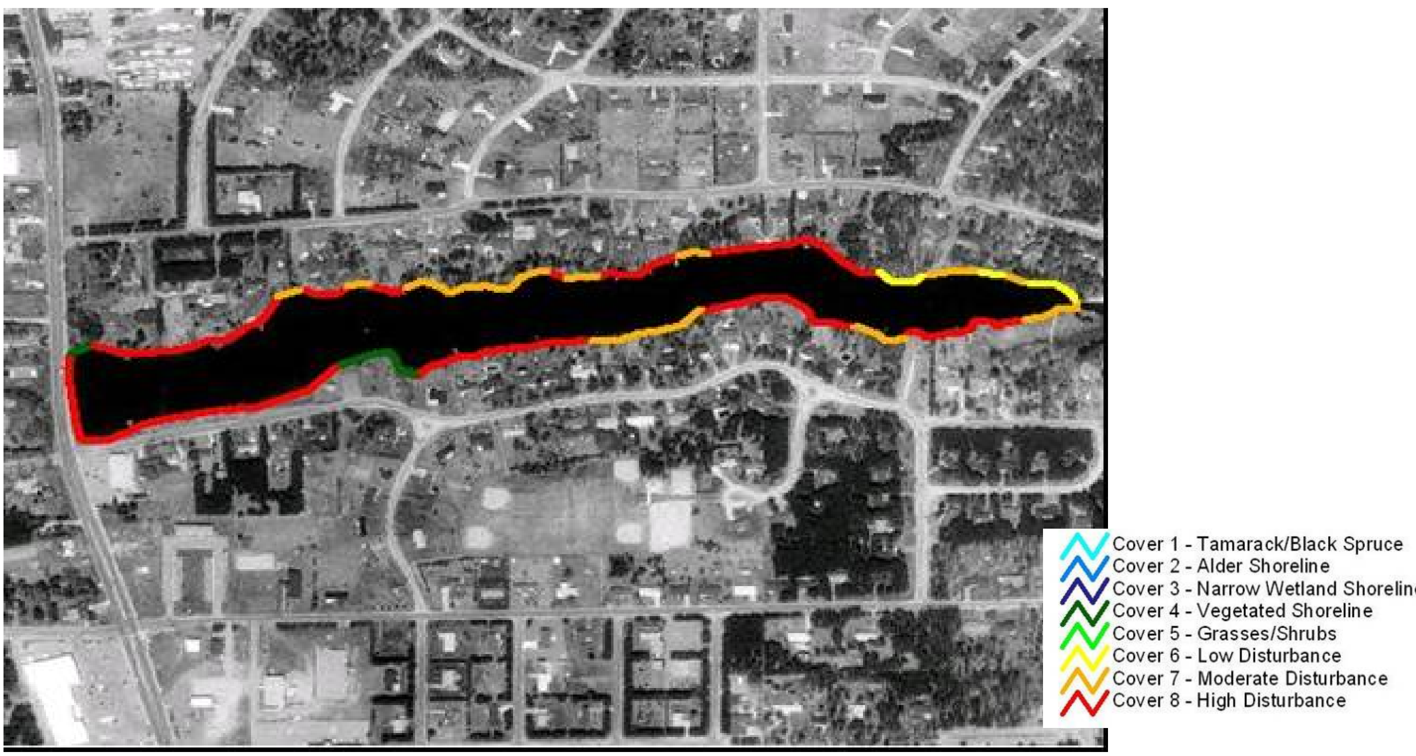
Figure 5. Regions of primary amphibian habitat around Springville Pond.

*Terms in bold, see glossary pp 13-17

The shoreline around Springville Pond includes 5.1% 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 by dark green in the Figure 6.

Ninety-five percent of the shoreline is considered to be disturbed. Of that, 5.8% is considered to be classified as low disturbance. Moderately disturbed developed areas of vegetation encompass 26.2% of the disturbed shoreline and 62.9% of the disturbed shoreline is classified as a 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 and 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.

Figure 6. Shoreline vegetation around Springville Pond.



Aquatic Plants

There are **22** species of aquatic and wetland **macrophytes** (**21** species of **vascular plants** plus a **macrophytic** alga) that have been found in Springville Pond or on the adjacent areas of wet shore. This is below average for Portage County lakes. The average **coefficient of conservatism (c-value)** is **3.5**, which is below average. The **floristic quality index** is **16.0**, which is also below average for Portage County lakes.

Springville Pond is heavily infested by two aggressive alien submersed aquatic plants: curlyleaf pondweed (*Potamogeton crispus*) and Eurasian water-milfoil (*Myriophyllum spicatum*). In

*Terms in bold, see glossary pp 13-17

addition, the native, but potentially prolific, horned-pondweed (*Zannichellia palustris*) is abundant at the east end of the pond and may become more abundant in the future.

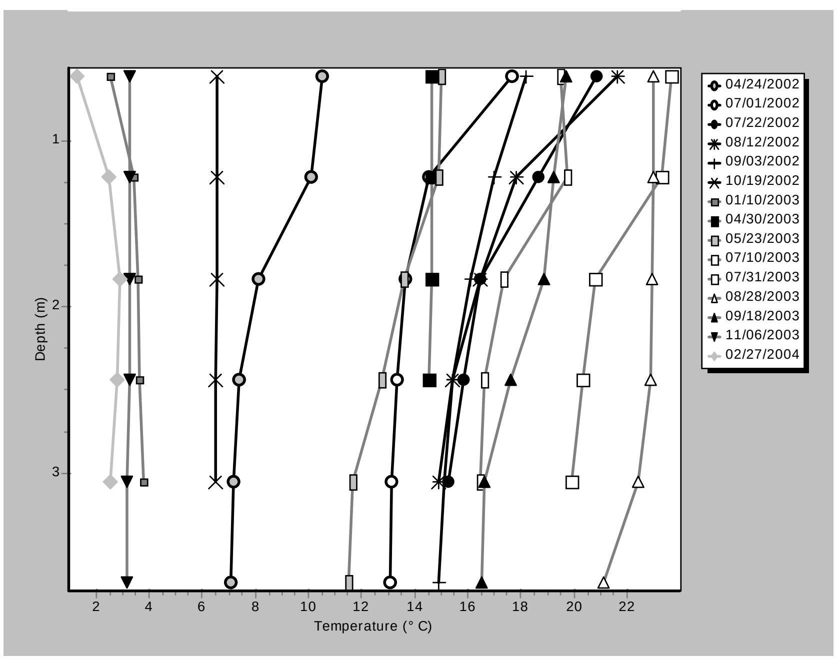
Most of the wet shore habitat is at the east end of the pond where the Little Plover River flows through mucky areas into the pond. Wet shore habitats are scarce along most of the north and south shoreline. Most of this shoreline has residential developments or mowed parkland, and the banks arise rather abruptly from the edge of the water.

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. On each sampling date the temperature in Springville Pond was nearly uniform from top to bottom (Figure 7). This would be expected because of the constant influx of water from the Little Plover River and the relatively shallow depth of the **impoundment**, however if the Little Plover River continues to have historic low flows in the late summer, the reduced water volumes entering Springville Pond would result in the water remaining in the Pond for longer time. This longer **retention time** would allow the upper layer of water to warm with the summer sun and would allow more contact time for the **algae** with **phosphorus** and **nitrogen**.

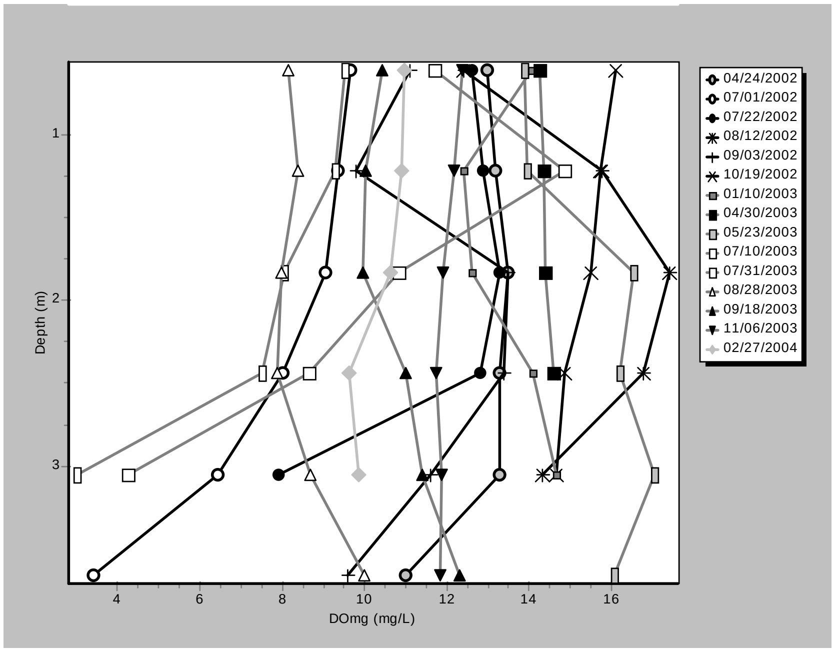
Dissolved oxygen is essential for many aquatic organisms. Oxygen concentrations were plentiful in the upper 8 feet of the Pond water. However, in July below the upper 8 feet of water, oxygen concentrations fell below the 5 **mg/L** needed to support many aquatic organisms. Cooler water contains higher concentrations of dissolved oxygen so continued low volumes of water coming in from the Little Plover River in late summer will exacerbate this occurrence.

Figure 7. Profile of temperature in Springville Pond 2002-2004.



*Terms in bold, see glossary pp 13-17

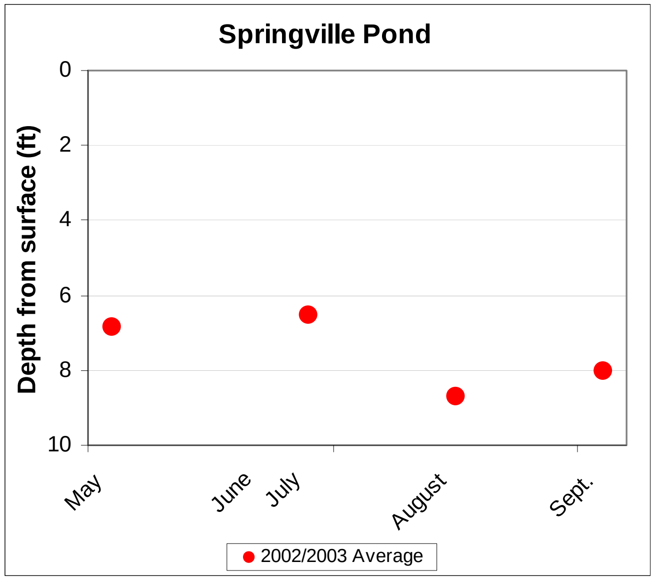
Figure 8. Profile of dissolved oxygen in Springville Pond 2002-2004.



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***). **Turbidity** levels were low and **color** was slightly elevated, likely due to natural tannins in the water. **Chlorophyll** a measures were variable but generally high with a median of 13.4 **mg/L** and a high of 24.3 **mg/L**. The water **clarity** in Springville Pond is considered good when compared with other **impoundments** in the area. The average **Secchi disc** depth for similar ponds in Portage County is 5 feet. Springville Pond has much better **clarity** than this. During 2002-03, the water **clarity** of Springville Pond was the best during the month of August and the worst during July. Fluctuations throughout the summer are normal as **algae** populations and **sedimentation** increase and decrease.

*Terms in bold, see glossary pp 13-17

Figure 9. Monthly average water clarity measurements in Springville Pond 2002-2003.



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). Although **phosphorus** concentrations were quite low during spring and fall, they increased significantly during the summer when aquatic plants and **algae** are growing. These concentrations are enough to fuel nuisance **algae** blooms and abundant aquatic plant growth. **Nitrogen** concentrations are extremely elevated for surface water (particularly **nitrate**), however these concentrations are similar to those measured in the Little Plover River and local **groundwater** (Table 2). Efforts should be made to substantially reduce **phosphorus** and **nitrogen** in Springville Pond. Common sources of **nitrogen** and **phosphorus** include fertilizers, animal waste, and septic systems/waste treatment plants. These nutrients can also move into a lake attached to soil.

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** concentrations were low, but the rest of the concentrations were elevated (Table 3). 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** was found in low concentrations (0.1 and <0.05 µg/L) in the lake water, 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 Springville Pond.

*Terms in bold, see glossary pp 13-17

Table 2. 2002-2003 water quality seasonal averages in Springville Pond.

Springville Pond	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	24.0	6.0	8.02	6.59	0.02	150.0	203.0	112.5	17	1.4	18.9
Summer Averages	37.0	15.3	7.90	6.57	0.15	148.5	202.0	106.7	14	2.0	12.7
Fall Averages	19.5	6.8		6.79	0.03	142.5	206.5	115.0	21	1.1	
Winter Averages	36.0	12.0		5.07	0.11						
2002-2004 Averages	32.5	10.6	7.96	6.29	0.09	147.0	203.8	111.4	17	1.5	13.4

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

Table 3. 2002-2003 Springville Pond average water chemistry and reference value.

Springville Pond	Low	Medium	High	Reference Values	Low	Medium	High
Sulfate		19.12		Sulfate	<10	10-20	>20
Chloride			17.79	Chloride	<3	3-10	>10
Potassium	1.58			Potassium*	<2.16	2.16-4.30	>4.30
Sodium			5.75	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.*

Algal Community

The algal community in Springville Pond was fairly diverse. The dominant groups were the green **algae** (Chlorophyta, 33% of all cells counted) and the **blue-green algae** (Cyanobacteria, 30% of all cells counted) with yellow-green **algae** and **diatoms** (Ochrophyta, 15% of all cells counted), and euglenoids (Euglenophyta, 12% of all cells counted) as subdominant phyla (Table 4). These four phyla represented 90% of all cells counted over the 2003 sampling season. In the 3671 cells counted during this period there were 7 genera of Cyanobacteria, 13 genera of Chlorophyta, 9 genera of Ochrophyta (including 7 diatom genera), 4 genera of Euglenophyta, 2 genera of Dinophyta, and 1 genus of Cryptophyta identified. In May the blue-greens, greens, and ochrophytes were nearly equal dominants (22-25% cells counted/phylum). In June the greens and blue-greens were dominant (30% and 26% respectively). In August the greens far exceeded all other groups (51% of all cells counted). In September, as in June, the greens (40% of all cells counted) and the blue-greens (31% of all cells counted) were the dominants. In November it was the blue-greens that dominated (39% of all cells counted) with the greens subdominant (21% of all cells counted). The other two phyla (Dinophyta, Cryptophyta) represented only 11% of all cells counted over the 2003 sampling period (Figure 10).

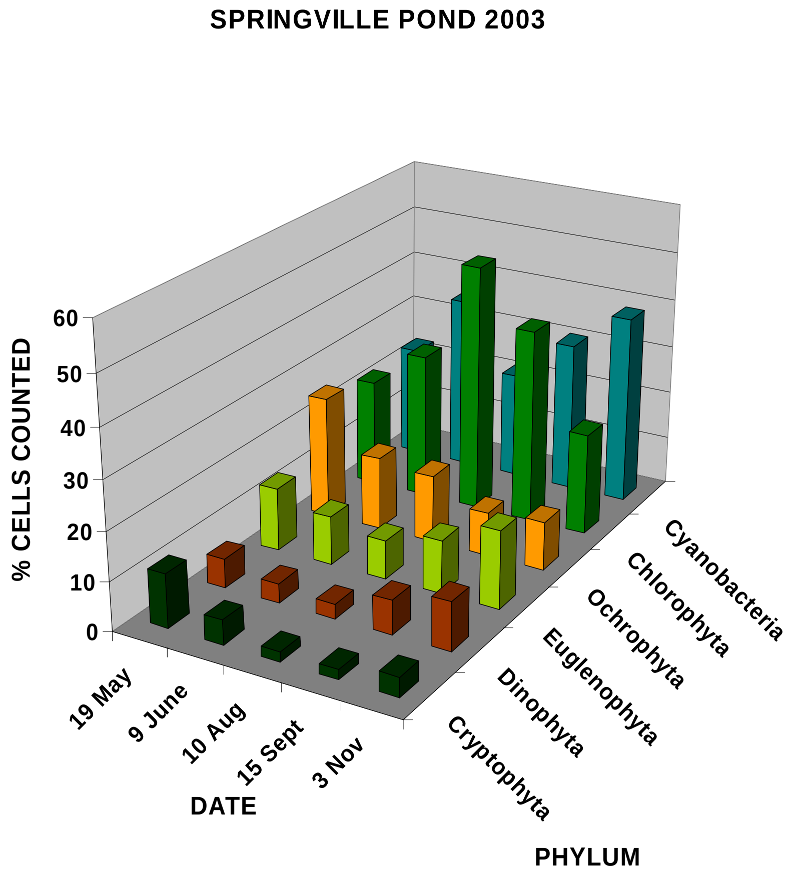
*Terms in bold, see glossary pp 13-17

Table 4. Algal phyla and mean seasonal composition in Springville Pond from May to November 2003.

SPRINGVILLE POND

PHYLUM	% CELLS COUNTED BY PHYLUM AND DATE					**MEAN**
	19 May	9 June	10 Aug	15 Sept	3 Nov	
Cyanobacteria	23	36	22	31	39	30
Chlorophyta	22	30	51	40	21	33
Ochrophyta	25	15	14	9	10	15
Euglenophyta	13	10	8	11	16	12
Dinophyta	6	4	3	7	10	6
Cryptophyta	11	5	2	2	4	5

Figure 10. Algal community composition by date in Springville Pond from May to November 2003 (total phylum cells counted divided by total cells counted).



As in the phylum analysis the cyanobacteria and green **algae** dominated the genus analysis (Figure 11). The nonheterocystous, filamentous, blue-green genus *Spirulina* was dominant in June and the small colonial blue-green genus *Gomphosphaeria* was dominant in November and subdominant in September. The heterocystous filamentous blue-green genus *Anabaena* was subdominant twice and third most common once (Table 5). The large, coenobic, nonmotile colonial green algal genus *Scenedesmus* was twice the most abundant taxon (August, September

*Terms in bold, see glossary pp 13-17

and twice the third most common genus (June, November). The small planktonic unicellular green alga *Ankistrodesmus* was third most abundant in August. The filamentous diatom genus *Melosira* was most abundant in the May sample and also subdominant in the August sample. A cryptophyte (*Cryptomonas*) and a euglenoid (*Trachelomonas*) were subdominant and third most abundant in the May sample, respectively.

The algal community when considered relative to the **chlorophyll**, **phosphorus**, and **nitrogen** values for Springville Pond presents a picture of a **eutrophic** lake. The 36 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 with the exception of the above - mentioned *Anabaena*. The dominance of blue-greens and mat-forming **diatoms** could be the result of increasing cultural **eutrophication** in the **watershed** and should be considered a warning sign. Mats of blue-greens and **diatoms** can carpet the shallow reaches, and as they trap photosynthetically-produced oxygen in the interwoven mat material, they will lift off the bottom and float to the surface. At the surface they get too much sunlight, bleach to yellow/white, and then decay. The decay can be aesthetically displeasing, and in some cases the bacterial decomposition of this material leads to oxygen depletion and perhaps to fish kills.

Figure 11. Algal community composition by phylum in Springville Pond from May to November 2003.

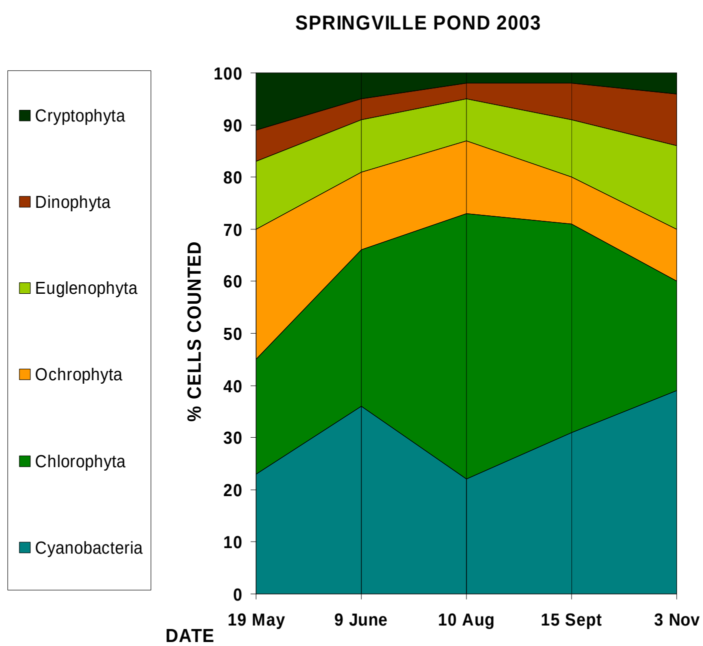


Table 5. Most common algal genera by date in Springville Pond from May to November 2003.

DATE	TOP THREE TAXA (MOST ABUNDANT, LEFT TO RIGHT)		
19 May	*Melosira*	*Cryptomonas*	*Trachelomonas 2*
9 June	*Spirulina*	*Anabaena*	*Scenedesmus*
10 August	*Scenedesmus*	*Melosira*	*Ankistrodesmus*
15 September	*Scenedesmus*	*Gomphosphaeria*	*Anabaena*
3 November	*Gomphosphaeria*	*Anabaena*	*Scenedesmus*

*Terms in bold, see glossary pp 13-17

Springville Pond Study Highlights

- Springville Pond has a good deal of land around it that is particularly susceptible to disturbance and contamination. These areas should be of concern due to the increasing development within the **watershed**.
- Only 5.1% of the shoreline is classified as vegetated shoreline. Ninety-five percent of the shoreline is considered to be disturbed. Of that, 5.8% is low disturbance, 26.2% moderately disturbed, and 62.9% is highly disturbed.
- Several areas on the eastern end of the pond support some amphibian species. However, few amphibian species have been found at Springville Pond; the high levels of altered shoreline may be preventing the establishment of amphibian populations, or agricultural chemicals may be affecting their reproduction and/or survival.
- Measures of the aquatic plant community are all below average for Portage County Lakes. Springville Pond is heavily infested by two aggressive alien submersed aquatic plants: curlyleaf pondweed and Eurasian water-milfoil. In addition, the native, but potentially prolific, horned-pondweed is abundant at the east end of the pond and may become more abundant in the future.
- Most of the wet shore habitat is at the east end of the pond where the Little Plover River flows through mucky areas into the pond. Wet shore habitats are scarce along most of the north and south shoreline. Most of this shoreline has residential developments or mowed parkland, and the banks arise rather abruptly from the edge of the water.
- Oxygen concentrations were plentiful in the upper 8 feet of the Pond water. However, in July, below the upper 8 feet of water, oxygen concentrations fell below the 5 **mg/L** needed to support many aquatic organisms. Cooler water contains higher concentrations of dissolved oxygen, so continued low volumes of water coming in from the Little Plover River in late summer will exacerbate this occurrence.
- Although **phosphorus** concentrations were quite low during spring and fall, they increased significantly during the summer when aquatic plants and **algae** are growing. These concentrations are enough to fuel nuisance **algae** blooms and abundant aquatic plant growth. **Nitrogen** concentrations are extremely elevated for surface water (particularly **nitrate**), however these concentrations are similar to those measured in the Little Plover River and local **groundwater**. Efforts should be made to substantially reduce **phosphorus** and **nitrogen** in Springville Pond.
- **Chloride** and **sodium** concentrations were elevated. **Atrazine** was found in low concentrations (0.1 and <0.05 μg/L) in the lake water, 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 Springville Pond.

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- The algal community when considered relative to the **chlorophyll**, **phosphorus**, and **nitrogen** values for Springville Pond presents a picture of a **eutrophic** 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, with the exception of the above-mentioned *Anabaena*. The dominance of blue-greens and mat-forming **diatoms** could be the result of increasing cultural **eutrophication** in the **watershed** and should be considered a warning sign.

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.

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.

*Terms in bold, see glossary pp 13-17

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.

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 13-17

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."

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.

*Terms in bold, see glossary pp 13-17

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.

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.

*Terms in bold, see glossary pp 13-17

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.

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 13-17