Jordan Pond

Introduction

Jordan Pond is an **impoundment** on the Plover River created by a dam near the intersection of State Highway 66 and County Road Y, northeast of Stevens Point in the Town of Hull. Jordan Pond is an 84.5 acre lake with a maximum depth of 8 feet and an estimated volume of 298 acre-feet. The shoreline length is 2.9 miles. The southern half of the lake, on both the east and west sides, is in the County Park system with shelters, bathroom facilities, a boat landing, and camp sites; the park totals 271 acres. The remaining land on the north end of the lake is largely forested with some agriculture and rural homes. The **lake** contains northern pike, smallmouth bass, largemouth bass, and panfish.

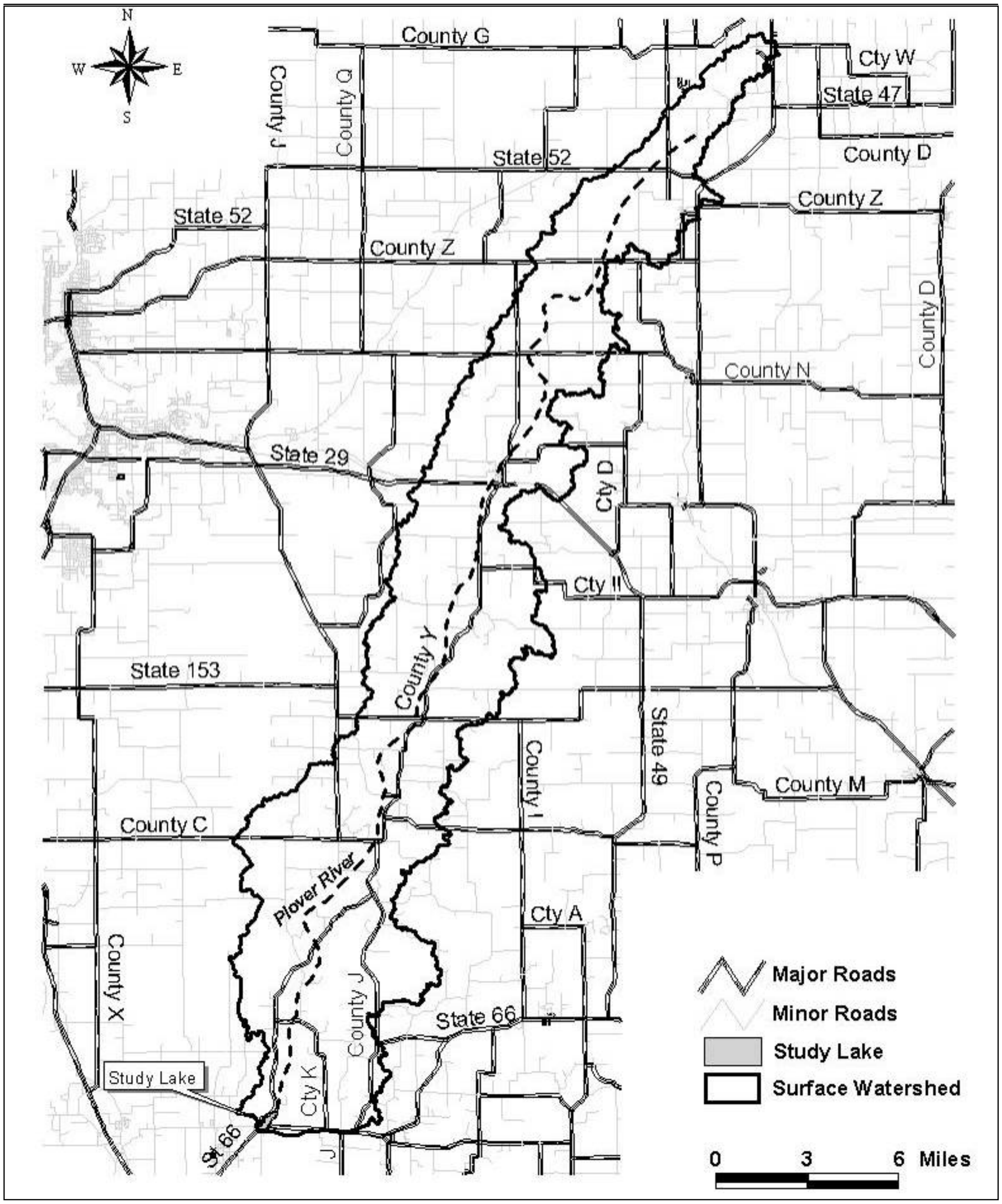
Land Use and Watershed

The surface **watershed** of Jordan Pond is the **watershed** of the Plover River north of the Jordan Pond dam. It is located north of State Highway 66 upstream into Marathon and Langlade Counties encompassing 97,281 acres (Figure 1). The 1992 WISCLAND land use coverage for the surface **watershed** shows that forest dominates the land use with 36,066 acres (37%). There were 20,530 acres (21%) are in agriculture, and 13,452 acres (14%) are forested wetlands (Figure 3). Urban development barely registers at 61 acres, however the 'urban' classification does not account for rural homes. Depending upon the land use management, these developments may have minimal or significant impact on the water quality. Since the **watershed** is in three counties, historical land use records are not available for Jordan Pond as they are for most of the other lakes in this study. Similarly, land use information for the **groundwater watershed** of Jordan Pond is not addressed in this study. However, based on the hydrology of the Plover River, the **groundwater watershed** is likely quite similar to its surface **watershed**.

Records indicate that there are 61 potentially failing septic systems in the **watershed** of Jordan Pond in Portage County alone. There are also 3 landfill sites in Portage County that are in the **watershed**. Records for Marathon and Langlade Counties were not available.

*Terms in bold, see glossary pp 14-19

Figure 1. Jordan Pond surface watershed boundary.



*Terms in bold, see glossary pp 14-19

Figure 2. Land use in the Jordan Pond Watershed (WISCLAND 1992)

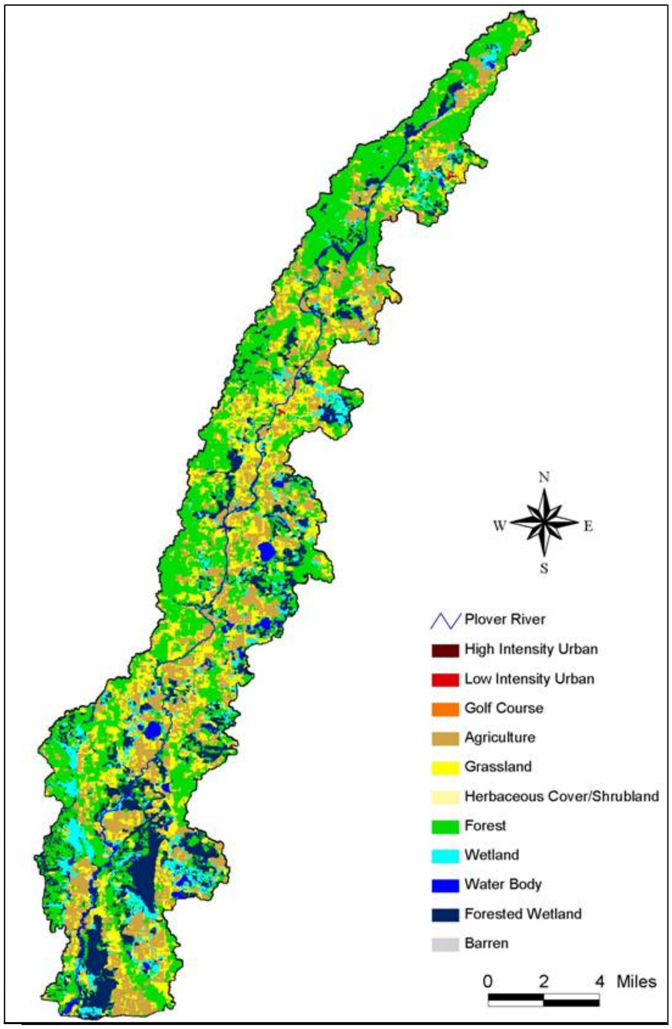
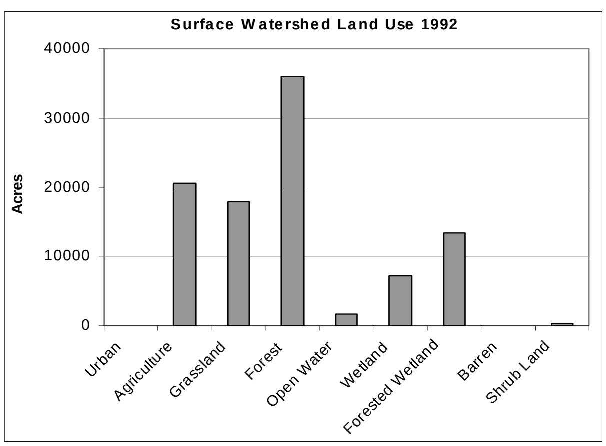


Figure 3. Land use in the Jordan Pond surface watershed (1992).

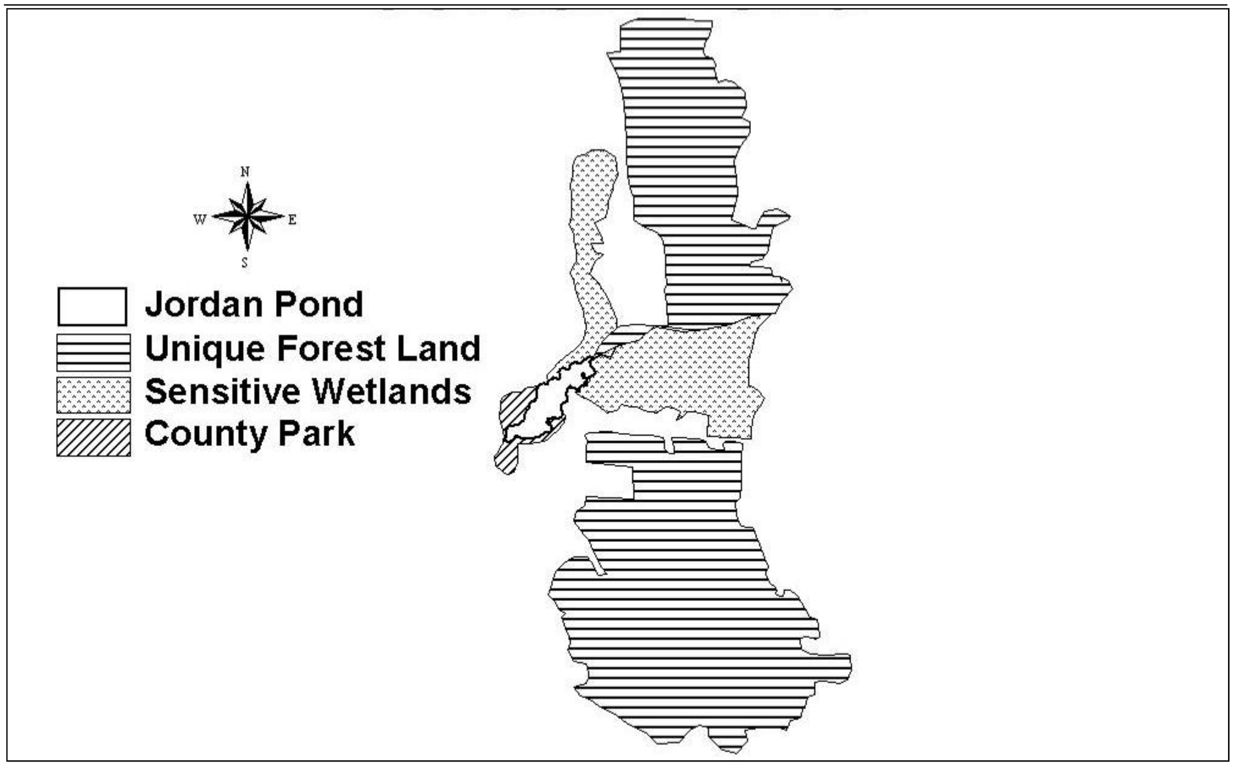


*Terms in bold, see glossary pp 14-19

Upland Sensitive Areas

The survey of upland sensitive areas was conducted to identify areas immediately around the pond that are particularly valuable, or sensitive to disruption. The river corridor north of Jordan Pond is an extremely valuable wetland complex that provides excellent riparian zone habitat. In addition, the wetland forest that parallels the river and pond along the east bank is a valuable tract that provides an almost northern forest type habitat due to the shallow water table and cool temperatures. This is a large tract of land that has many unique tree species. The section of this wetland forest tract that is due east of Jordan Pond provides a breeding ground for wetland forest species the likes of which is known in very few other places in the county (Figure 4).

Figure 4. Upland sensitive areas near Jordan 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 found in the survey of Portage County lakes, 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

*Terms in bold, see glossary pp 14-19

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.

Table 1. Bird species identified near Jordan Pond.

Common Name	Number Observed	Food	Foraging	Nest Type	Nest Location
American Robin	3	insects	ground gleaner	cup	deciduous
Cedar Waxwing	3	fruit	foliage gleaner	cup	deciduous
Chipping Sparrow	3	insects	ground gleaner	cup	coniferous
Baltimore Oriole	3	insects	ground gleaner	oven	ground
Red-winged Blackbird	3	insects	ground gleaner	cup	reed
American Goldfinch	2	seeds	foliage gleaner	cup	shrub
Bald Eagle	2	fish	high patrol	platform	coniferous
House Wren	2	insects	ground gleaner	cavity	deciduous
Indigo Bunting	2	insects	foliage gleaner	cup	shrub
Northern Cardinal	2	insects	ground gleaner	cup	shrub
Blue Jay	1	omnivore	ground gleaner	cup	coniferous
Common Yellowthroat	1	insects	foliage gleaner	cup	shrub
Eastern Bluebird	1	insects	hawker	cavity	snag
Eastern Wood-Pewee	1	insects	hawker	cup	deciduous
Great Crested Flycatcher	1	insects	hawker	cavity	deciduous
Eastern Phoebe	1	insects	bark gleaner	cavity	snag
Red-bellied Woodpecker	1	insects	bark gleaner	cavity	coniferous
Purple Martin	1	insects	bark gleaner	cavity	snag
Song Sparrow	1	insects	ground gleaner	cup	ground
Tree Swallow	1	insects	aerial foliager	cavity	snag
White-breasted Nuthatch	1	insects	bark gleaner	cavity	deciduous
Total	**36**				

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**.

Three frog species were identified during the survey on Jordan Pond (spring peeper [*Pseudacris crucifer*], chorus frog [*Pseudacris triseriata*], and green frog [*Rana clamitans*]). The primary amphibian habitat is located on sections of the east and west sides of the pond (sensitive areas are identified in red on Figure 5). Some of the key features of this habitat include natural areas with large amounts of submergent, emergent, and floating leaf vegetation as well as downed trees. The good news is that there is a minimal level of shoreline development. The bad news is that there is some recreational use on portions of the lake which may affect amphibian populations.

During the survey of reptiles Jordan Pond was found to contain two species of turtles (painted turtle [*Chrysemys picta*] and snapping turtle [*Chelydra serpentina*]). There have also been historical records of the wood turtle (*Clemmys insculpta*) (a threatened species) observed.

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

*Terms in bold, see glossary pp 14-19

Aquatic Plants

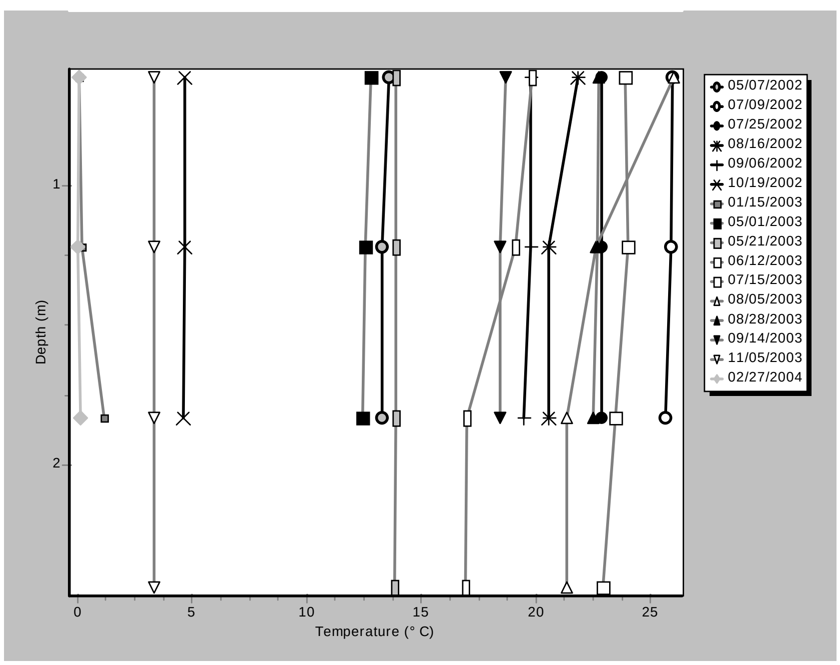
There are **73** species of **vascular plants** that have been found in Jordan Pond; it ranks fourth among the Portage County lakes in this study for species richness. The average **coefficient of conservatism (c-value)** is **4.8**, which is about average for Portage County lakes. The **floristic quality index** is **40.8**, which is above average.

Jordan Pond and surrounding wetlands hold a large flora, but no rare species. Much of the richness is found in the pockets of wetland, such as on the northwest shore at the north end of Jordan Park. There is some indication of deterioration in the **floristic quality** over the 40 years of herbarium records and observations. The main problem may be the arrival of some of the most aggressive aliens: reed canary-grass (*Phalaris arundinacea*) and narrow-leaf cattail (*Typha angustifolia*) on land; plus Eurasian water-milfoil (*Myriophyllum spicatum*) and curlyleaf pondweed (*Potamogeton crispus*) in the water. As of 2003, these species were not abundant, but all are likely to increase in the future.

Current Water Quality Conditions

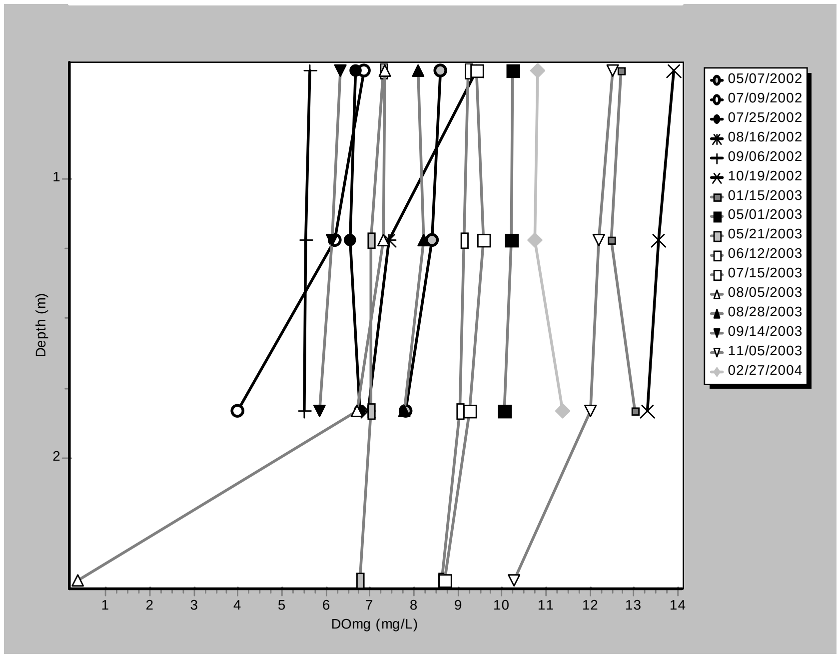
Water quality in lakes is assessed by measuring different characteristics including temperature, dissolved oxygen, water **clarity**, **chlorophyll *a***, water chemistry, and the algal community. Temperature and dissolved oxygen were measured with depth during all sampling periods on Jordan Pond. Similar to Bentley Pond, the water is mixed from top to bottom throughout the year (Figure 6 and Figure 7). This is due to the extremely short **retention time**.

Figure 6. Profile of temperature in Jordan Pond 2002-2004.



*Terms in bold, see glossary pp 14-19

Figure 7. Profile of dissolved oxygen in Jordan Pond 2002-2004.

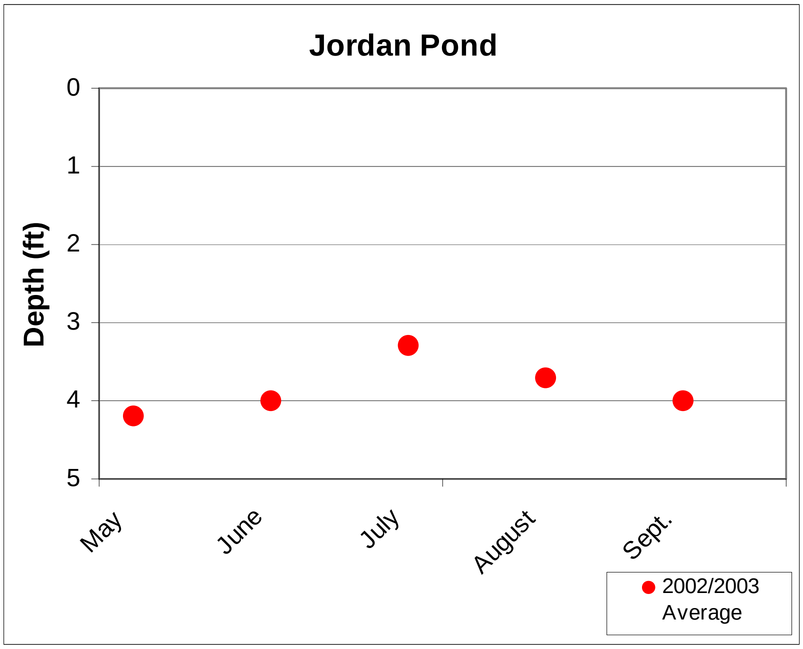


Water **clarity** is a measure of how deep light can penetrate. It is an aesthetic measure and is related to how deep **rooted aquatic plants** can grow. Water **clarity** is affected by water **color** and suspended materials in the water (**turbidity**). **Turbidity** consists of **suspended solids**, which include suspended sediments and **algae** (**chlorophyll *a***). In Jordan Pond, **chlorophyll *a*** ranged from 1 to 14.6 **mg/L** and had spring and summer averages that were elevated. **Color** in Jordan Pond is often high due to tannins. On occasion, **color** is reduced from dilution following a storm or significant snow melt. **Turbidity** was low on the dates measured, but likely increases with storm events.

The water **clarity** in Jordan Pond is considered fair for an **impoundment**. The average **Secchi disc** depth for **impoundments** in the county is 5 feet. Jordan Pond has slightly worse **clarity** than this. During the 2002-03 growing season the water **clarity** of Jordan Pond was the best in the month of May and poorest in July. Fluctuations throughout the summer are normal as **algae** populations and **sedimentation** increase and decrease.

*Terms in bold, see glossary pp 14-19

Figure 8. Monthly average water clarity measurements in Jordan 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). Most of the **nitrogen** in the pond is in the form of **nitrate**, which is readily available for uptake by **algae** and aquatic plants. These concentrations are very high for a lake. **Phosphorus** concentrations are quite variable, ranging from 12 to 66 ug/L. In a lake, concentrations above 30 ug/L are considered high, but due to the short **retention time** of water in Jordan Pond it would take considerably more **phosphorus** to have detrimental effects. In general, the **phosphorus** concentrations are quite low compared with other **impoundments** (Table 2).

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 **chloride** and **sodium** were elevated (Table 2). Although these constituents are not detrimental to the aquatic ecosystem, they indicate that sources of contaminants (road salt, fertilizer, animal waste and/or septic system effluent) are entering the lake from either surface runoff or via **groundwater**. **Atrazine** was found in low concentrations in the water (0.08 and 0.16 µg/L); 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 Jordan Pond.

*Terms in bold, see glossary pp 14-19

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

Jordan 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	48.0	10.0	1.87	1.18	0.11	140.0	170.5	88.0	58	3.3	5.3
Summer Averages	17.5	17.5	1.04	0.86	0.05	205.0	214.0	113.5	28	3.2	5.3
Fall Averages	14.5	12.5		1.72	0.05	178.0	204.5	112.0	37	2.6	9.5
Winter Averages	13.5	11.0		2.53	0.08						
2002-2004 Averages	35.6	13.7	1.46	1.49	0.07	174.3	196.3	104.5	41	3.0	5.7

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

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

Jordan Pond	Low	Medium	High	Reference Values	Low	Medium	High
Sulfate	9.55			Sulfate	<10	10-20	>20
Chloride		9.00		Chloride	<3	3-10	>10
Potassium	1.65			Potassium*	<2.16	2.16-4.30	>4.30
Sodium		4.48		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

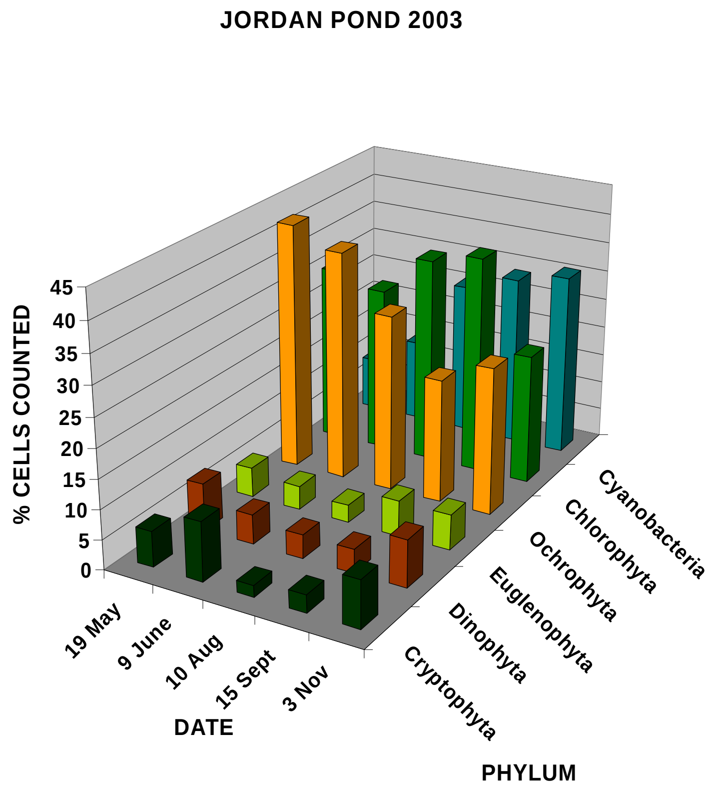
The algal community in Jordan Pond was very diverse. The dominant groups were the yellow-green **algae** and **diatoms** (Ochrophyta, 31% of all cells counted), green **algae** (Chlorophyta, 30% of all cells counted), and the **blue-green algae** (Cyanobacteria, 22% of all cells counted) (Table 4). These three phyla represented 83% of all cells counted over the 2003 sampling season. In the 3,469 cells counted during this period there were 8 genera of Cyanobacteria, 11 genera of Chlorophyta, 11 genera of Ochrophyta (including 9 **diatom** genera), 2 genera of Euglenophyta, 3 genera of Dinophyta, and 1 genus of Cryptophyta identified (Table 4).

There was very little cycling of the algal community during the 2003 sampling period. In May and June the ochrophytes dominated the greens and cyanobacteria in that order with these three groups accounting for more than 80% of all cells counted. The green **algae** dominated the ochrophytes and cyanobacteria in August and September with these groups accounting for 90% of all cell counted. The cyanobacteria dominated the ochrophytes and greens in November when these three groups again accounted for 80% of all cells counted. The other three phyla present (Dionophyta, Euglenophyta, Cryptophyta) combined to account for 17% of all cells counted, ranging from 2-10%/phylum but never more than that in any one sample (Figure 9).

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

JORDAN POND						
PHYLUM	% CELLS COUNTED BY PHYLUM AND DATE					**MEAN**
	19 May	9 June	10 Aug	15 Sept	3 Nov	
Cyanobacteria	9	14	26	29	31	22
Chlorophyta	30	28	35	37	22	30
Ochrophyta	42	39	30	21	25	31
Euglenophyta	5	4	3	6	6	5
Dinophyta	8	5	4	4	8	6
Cryptophyta	6	10	2	3	8	6

Figure 9. Algal community composition by date in Jordan Pond from May to November 2003 (total phylum cells counted divided by total cells counted).



The ring-forming colonial **diatom** genus *Asterionella* dominated the May sample as did the filamentous **diatom** genus *Melosira* during November (Figure 10). These two taxa along with another **diatom** genus (*Cocconeis*) were also found in subdominant slots four other times. The small, nonmotile unicellular green algal genus *Golenkinia* was twice the most abundant organism and four times in the top 15 abundance slots. The unbranched filamentous blue-green genera

*Terms in bold, see glossary pp 14-19

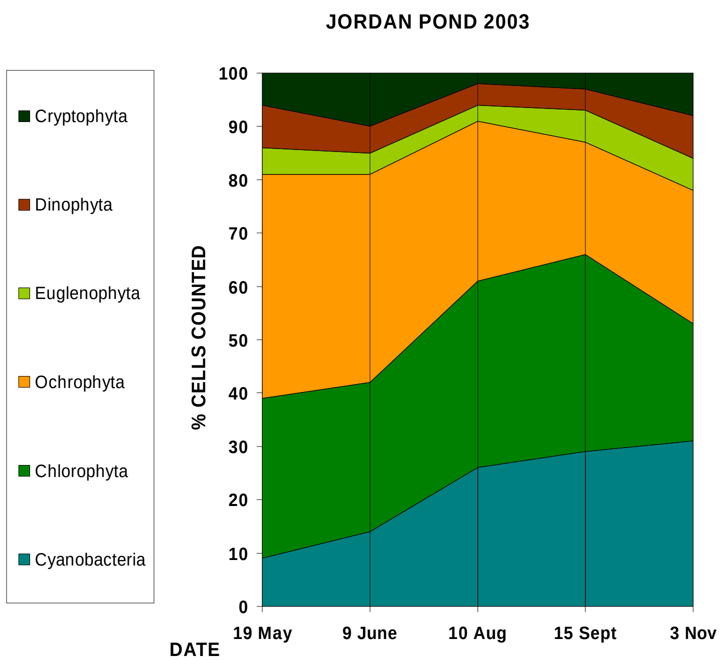
Spirulina and *Anabaena* were each present twice in the top 15 but always as a subdominant. The large motile unicellular dinoflagellate genus *Peridinium* was the dominant genus in June (Table 5).

The algal community when considered relative to the **chlorophyll**, **phosphorus**, and **nitrogen** values for Jordan Pond presents a picture of a fairly **mesotrophic** 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. The late season surge of blue-greens could be the result of increasing cultural **eutrophication** in the **watershed** and should be considered a warning sign. Mats of blue-greens 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.

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

DATE	TOP THREE TAXA (MOST ABUNDANT, LEFT TO RIGHT)		
19 May	*Asterionella*	*Cocconeis*	*Golenkinia*
9 June	*Peridinium*	*Golenkinia*	*Cocconeis*
10 August	*Golenkinia*	*Asterionella*	*Anabaena*
15 September	*Golenkinia*	*Melosira*	*Spirulina*
3 November	*Melosira*	*Spirulina*	*Anabaena*

Figure 10. Algal community composition by phylum in Jordan Pond from May to November 2003.



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Jordan Pond Study Highlights

- The river corridor north of Jordan Pond is an extremely valuable wetland complex that provides excellent riparian zone habitat. In addition, the wetland forest that parallels the river and pond along the east bank is a valuable tract that provides an almost northern forest type habitat due to the shallow water table and cool temperatures. This is a large tract of land that has many unique tree species. The section of this wetland forest tract that is due east of Jordan Pond provides a breeding ground for wetland forest species the likes of which is known in very few other places in the county
- Jordan Pond ranks fourth among the Portage County lakes in this study for species richness. The average **coefficient of conservatism** is about average for Portage County lakes. The **floristic quality index** is above average.
- Jordan Pond and surrounding wetlands hold a large flora, but no rare species. Much of the richness is found in the pockets of wetland, such as on the northwest shore at the north end of Jordan Park. There is some indication of deterioration in the **floristic quality** over the 40 years of herbarium records and observations. The main problem may be the arrival of some of the most aggressive aliens: reed canary-grass and narrow-leaf cattail on land, plus Eurasian water-milfoil and curlyleaf pondweed in the water. As of 2003, these species were not abundant, but all are likely to increase in the future.
- Most of the **nitrogen** in the pond is in the form of **nitrate**, which is readily available for uptake by **algae** and aquatic plants. Nitrate concentrations are very high for a lake. In general, the **phosphorus** concentrations are quite low compared with other **impoundments,** but at times are high enough to result in significant **algae** blooms.
- **Potassium** concentrations were low, but **chloride** and **sodium** were elevated. **Atrazine** was found in low concentrations in the water; 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 Jordan Pond.
- The algal community when considered relative to the **chlorophyll**, **phosphorus**, and **nitrogen** values for Jordan Pond presents a picture of a fairly **mesotrophic** lake. The **algae** identified were relatively common, and none of those that reached numerical dominance in the sample counts are associated with toxins or health issues. The late season surge of blue-greens could be the result of increasing cultural **eutrophication** in the **watershed** and should be considered a warning sign. 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.

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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 (CaCO3), or as microequivalents per liter (ueq/l). 20 ueq/l = 1 mg/L of $CaCO_3$.

Ammonia, Ammonium:

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

Atrazine:

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

Blue-Green Algae:

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

Chloride (Cl-):

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

Chlorophyll *a*:

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

Clarity:

see "Secchi disc."

*Terms in bold, see glossary pp 14-19

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 Basin:

The total land area that drains toward the lake.

Drainage Lakes:

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

Endocrine:

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

Erosion:

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

Eutrophic:

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

*Terms in bold, see glossary pp 14-19

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."

Macrophytic Algae:

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

*Terms in bold, see glossary pp 14-19

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.

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 14-19

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

Sulfate (SO_4^{--}):

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

Substrate:

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

Suspended Solids:

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

Turbidity:

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

*Terms in bold, see glossary pp 14-19

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 14-19