Onland Lake

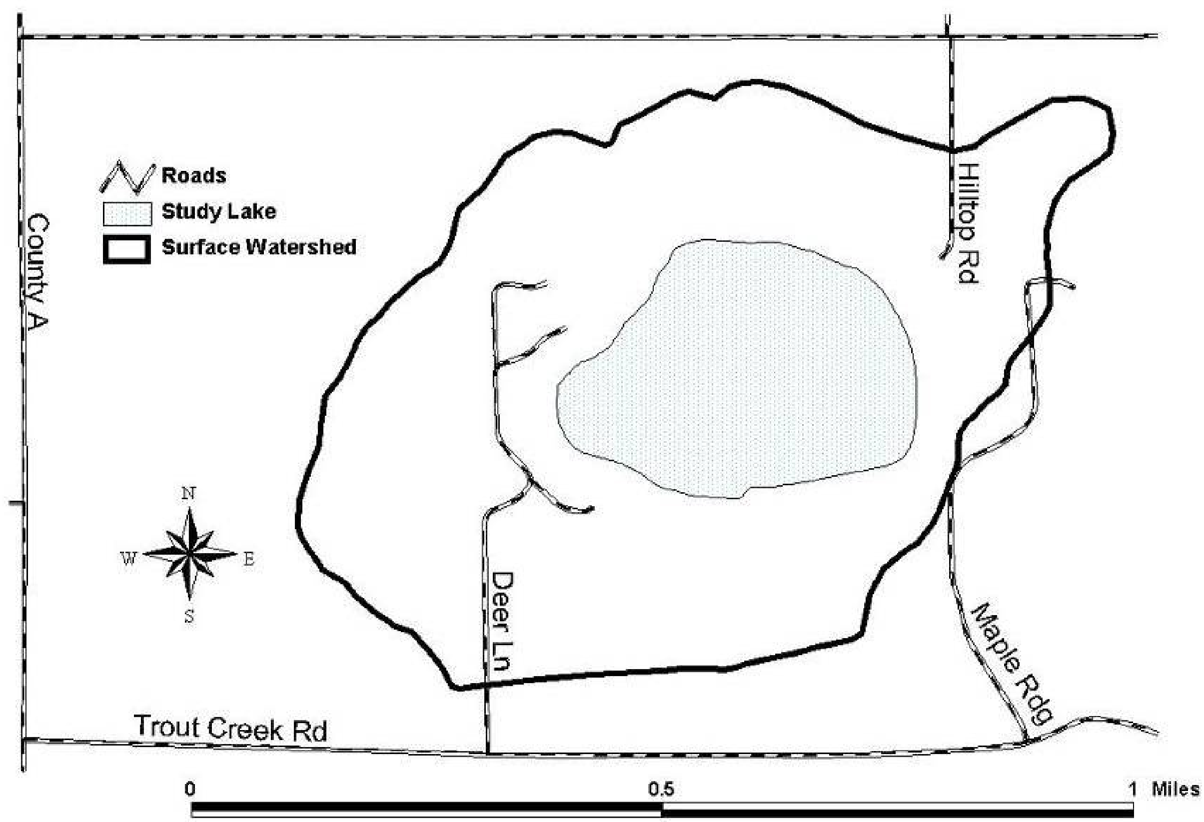
Introduction

Onland Lake is a 47 acre **seepage lake** with an estimated volume of 669 acre-feet, located in the Township of New Hope. The lake has a maximum depth of 25 feet with a sand and gravel bed, though silt **sedimentation** has been a problem. The estimated **retention time** is 3.1 years. A total of 13 species of fish have been reported in Onland Lake since 1949. Northern pike, largemouth bass, and panfish are present. There is small public boat launch on the southwest side that is somewhat difficult to access due to the narrow, steep, gravel road. The shoreline has residential development primarily on the south and west sides.

Land Use and Watershed

The surface **watershed** for Onland Lake is 239 acres (Figure 1). Land use is dominated by non-irrigated agriculture (34%) and forestland (31%), and has been since 1948. Non-irrigated cropland has declined somewhat since 1968, resulting in an increase in residential and transportation development, along with forested area. The number of acres of shrub/wetland vegetation has fluctuated during this period but remains low (Figure 2 and Figure 3).

Figure 1. Onland Lake surface watershed boundary.



*Terms in bold, see glossary pp 17-22

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

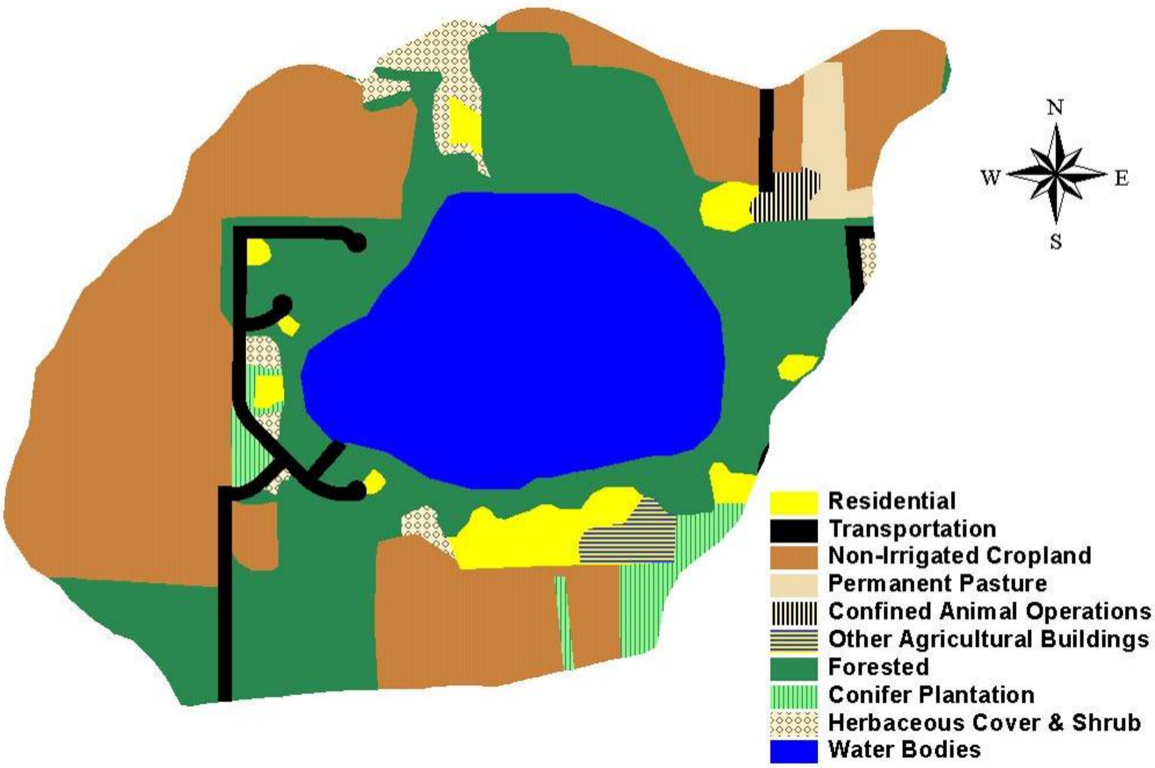
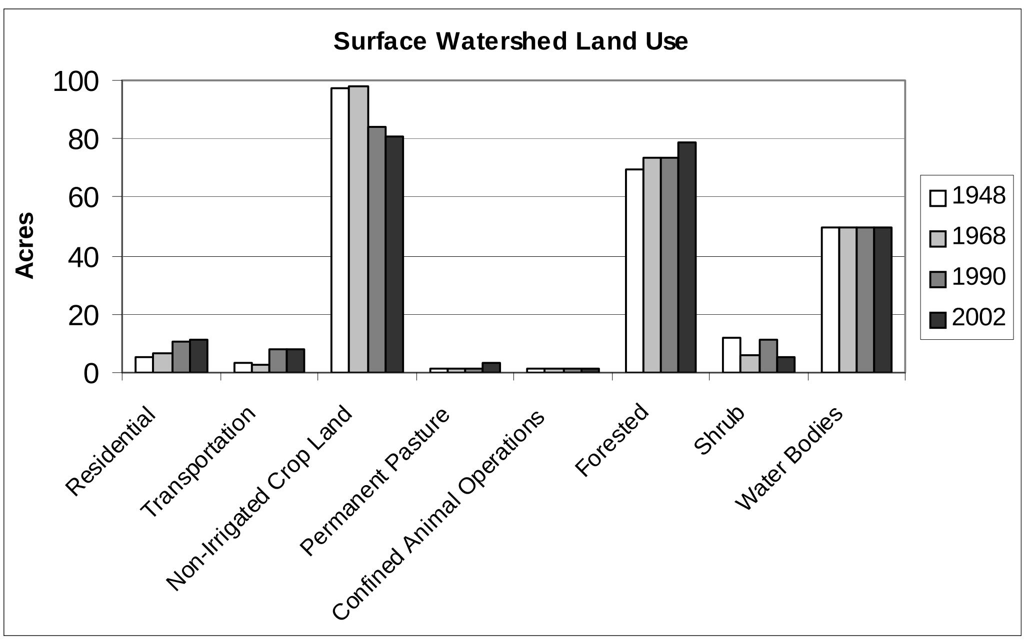


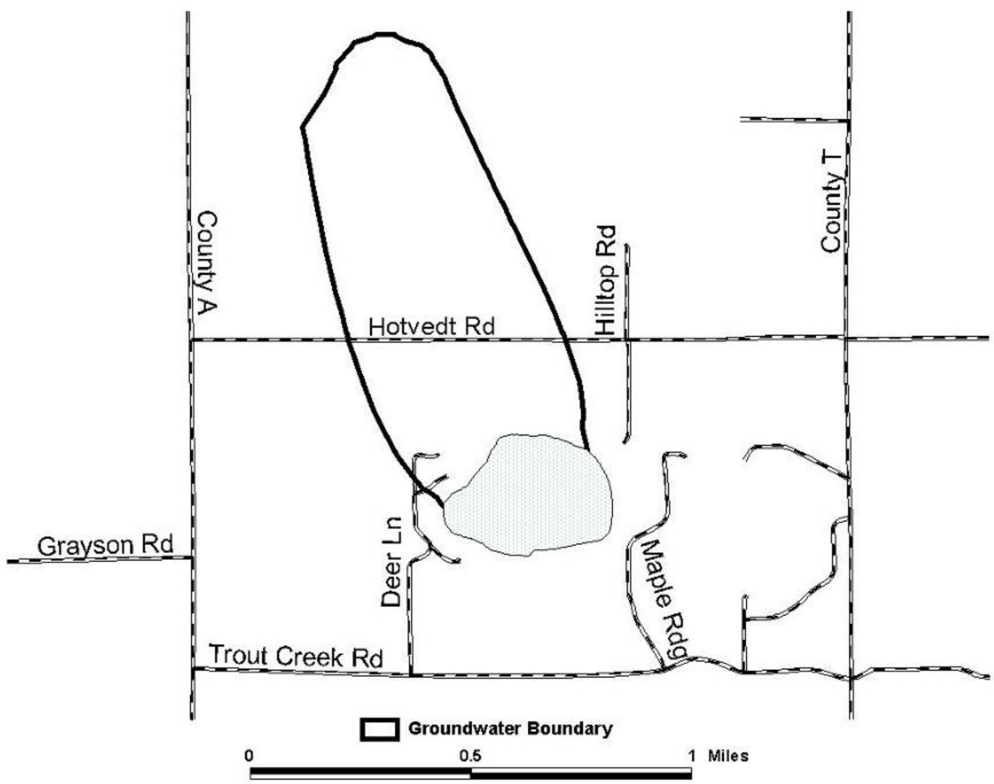
Figure 3. Land use in the Onland Lake surface watershed 1948-2002.



*Terms in bold, see glossary pp 17-22

The **groundwater watershed** for Onland Lake is an area of approximately 293 acres to the northwest of the lake (Figure 4). Land use in this area has not changed much since 1948. Forestland is the most prevalent land use (54%), followed by non-irrigated cropland (26%). Since 1948 shrub/wetland vegetation has decreased slightly, corresponding to a very small increase in forested areas, residential and transportation development (Figure 5 and Figure 6). According to County records the Onland Lake **watershed** does not contain any potentially failing septic systems based on age or former landfill sites within either the surface or **groundwater watersheds**.

Figure 4. Onland Lake groundwater watershed boundary.



*Terms in bold, see glossary pp 17-22

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

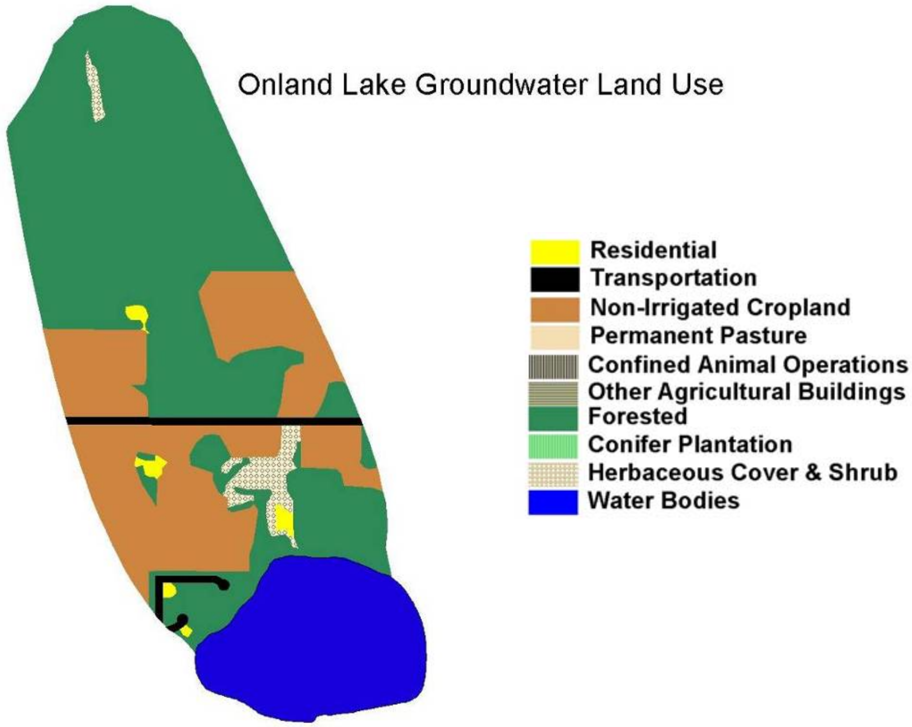
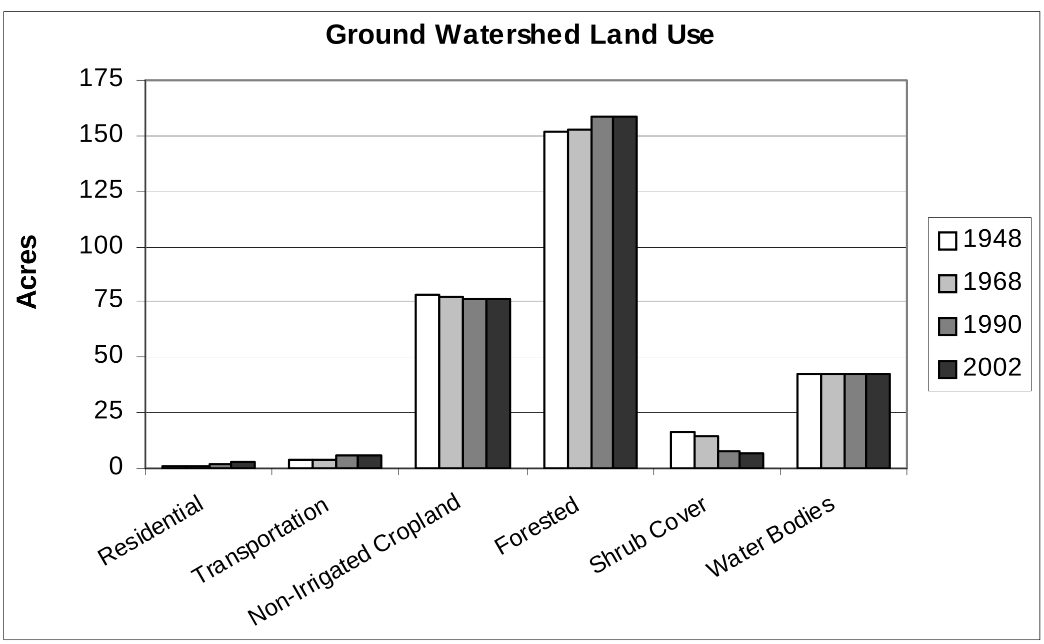


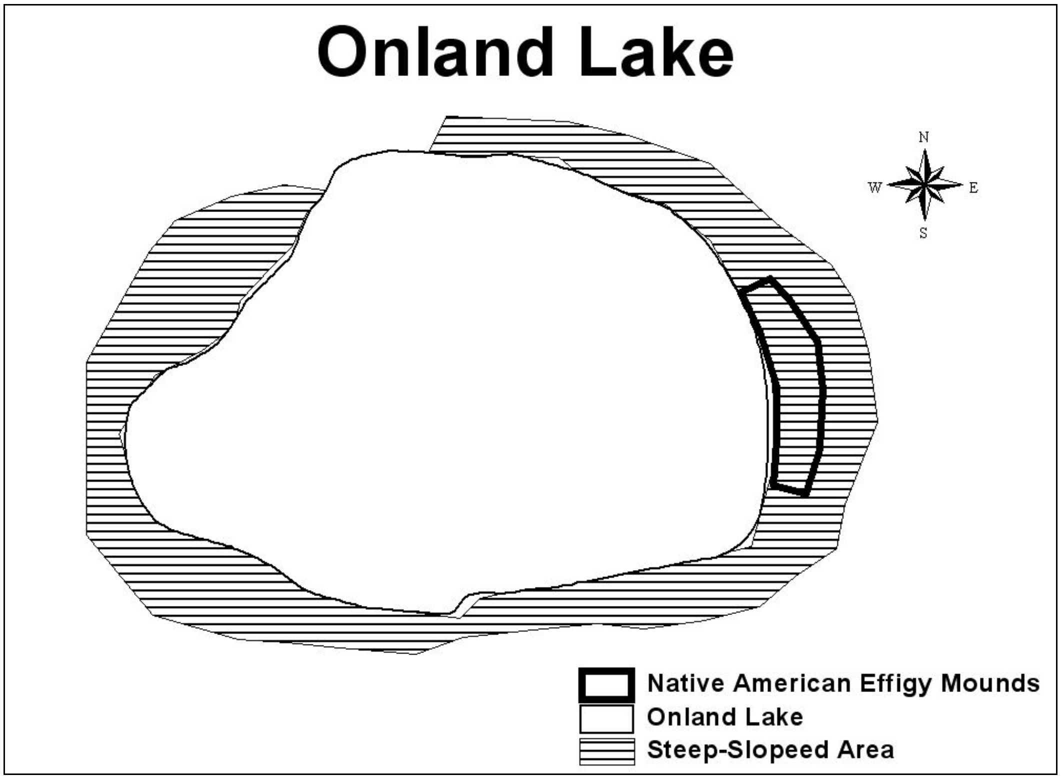
Figure 6. Land use in the Onland Lake groundwater watershed 1948-2002.



*Terms in bold, see glossary pp 17-22

Upland Sensitive Areas
The survey of upland sensitive areas was conducted to note areas immediately around the lakeshore that are particularly valuable, or sensitive to disruption. The vast majority of the shoreline of Onland Lake is lined with steep slopes that may be susceptible to **erosion** (Figure 7). There are also Native American effigy mounds at the east end of the lake.

Figure 7. Upland sensitive areas near Onland Lake.



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

Large sections of continuous natural shoreline on lakes are ideal habitats for many frog species. Natural areas with large amounts of submergent, emergent, and floating-leaf vegetation provide protection and a place for attachment of eggs during the breeding season. The upland areas surrounding these lakes also provide important habitat as many frog species migrate to lakes and other bodies of water in the spring or fall to breed and spend the summer months foraging in the uplands. Several species also use the surrounding uplands for overwintering. The turtle species found associated with lakes are predominantly aquatic, usually departing from the water only to deposit eggs in a nest.

*Terms in bold, see glossary pp 17-22

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 for Onland Lake. Three frog species were identified (spring peeper [*Pseudacris crucifer*], American toad [*Bufo americanus*],and gray treefrog [*Hyla versicolor*]) in the amphibian survey for Onland Lake. The primary amphibian habitat is located on several small sections of shoreline (sensitive area is identified in red in Figure 8). The key feature of this habitat is undisturbed natural shoreline.

The good news is that there has been minimal shoreline alteration from development. The bad news, however, is that there are few areas containing large amounts of submergent, emergent, and floating-leaf vegetation, the ideal habitat for amphibians.

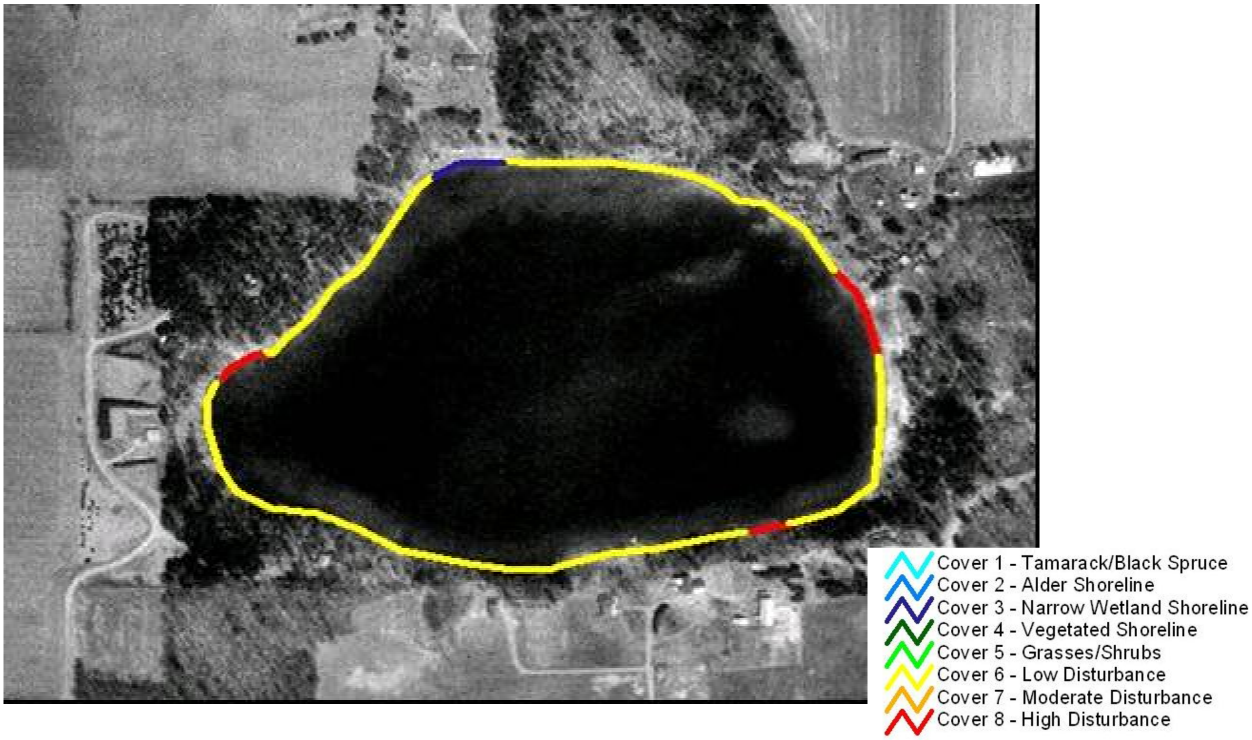
Figure 8. Regions of primary amphibian habitat around Onland Lake.

Around Onland Lake, 96% of the shoreline is considered to be in an area of disturbance. Of that, 85.1% of the lake's shoreline vegetation is considered to be low disturbance developed and 10.9% is considered to be a highly disturbed developed area. 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 exhibits high vegetation disturbance is defined as a beach, **rip rap**, sea wall or where the shore is mowed to the water line.

*Terms in bold, see glossary pp 17-22

Four percent of the Onland Lake shoreline is considered narrow wetland, which is represented by dark blue in Figure 9. Narrow wetlands are characterized as being wetland areas that extend less than 5 meters onto the shore and have an adjacent undeveloped upland area.

Figure 9. Categories of shorline vegetation around Onland Lake.



Aquatic Plants

There are **41** species of **vascular plants** that have been found in Onland Lake or on the wet shores. This value is slightly below average for Portage County lakes. The average **coefficient of conservatism (c value)** is **4.6**, which is about average. The **floristic quality index** is **29.5**, which is slightly below the average for Portage County lakes.

Almost no botanical studies were carried out on the lake prior to 2003, resulting in a relatively small number of species listed. No alien species have been seen in the lake, but two of the most aggressive alien shoreline plants, purple loosestrife (*Lythrum salicaria*) and reed canary-grass (*Phalaris arundinacea*), are present in small numbers on the shore. A relatively good quality marsh occurs in the southwestern part of the lake and adjacent shore area.

The Fishery

Onland Lake supports a warm water fish population. A total of 15 species of fish have been reported from Onland Lake since 1949 (Table 1). Ten species of fish were collected from Onland Lake in 2002-2003 compared to 9 from historical records. Six newly documented fish were found here in 2002, more than any other Portage County lake sampled (warmouth [*Lepomis gulosus*], Iowa darter [*Etheostoma exile*], bluntnose

*Terms in bold, see glossary pp 17-22

minnow [*Pimephales notatus*], blackchin shiner [*Notropis heterodon*], blacknose shiner [*Notropis heterolepis*], and banded killifish [*Fundulus diaphanus*]). The warmouth is generally uncommon throughout Wisconsin and the latter five species are small and may have been overlooked in the two previous surveys dating back to 1949 and 1962. The sport fish population was dominated by bluegill (*Lepomis macrochirus*) and yellow perch (*Perca flavescens*). Because public access is somewhat limited by a steep trail, this lake probably has not been subjected to the same intensity of management and fishing pressure as other area lakes with public access. There are no official records of stocking or intentional management-directed lake poisoning and the fish assemblage appears to be more similar to what would be expected in an unimpacted lake setting. The lake supports blackchin and blacknose shiners, both glacial relics. Because this is a **seepage lake** without inlets or outlets, these populations may be somewhat unique because they have had the potential to have been reproductively isolated for a long period of time.

Species lost include northern pike (*Esox lucius*) and rock bass (*Ambloplites rupestris*). Only shallow water was sampled and it is possible these species had already moved to deeper water because of the mid October sampling date.

Table 1. Species occurrence in Onland Lake from the 2002/2003 study and WDNR records.

Bluegill	2002, 1962, 1949
Pumpkinseed	1962
Warmouth	2002
Rock Bass	1962
Largemouth Bass	2002, 1962
Black Crappie	2002, 1949
Crappie sp.	1962
Yellow Perch	2002, 1962, 1949
Iowa Darter	2002
Northern Pike	1962
Bullhead sp.	1962
Bluntnose Minnow	2002
Blackchin Shiner	2002
Blacknose Shiner	2002
Banded Killifish	2002

Bottom Substrate, Vegetative Structure, and Critical Habitat

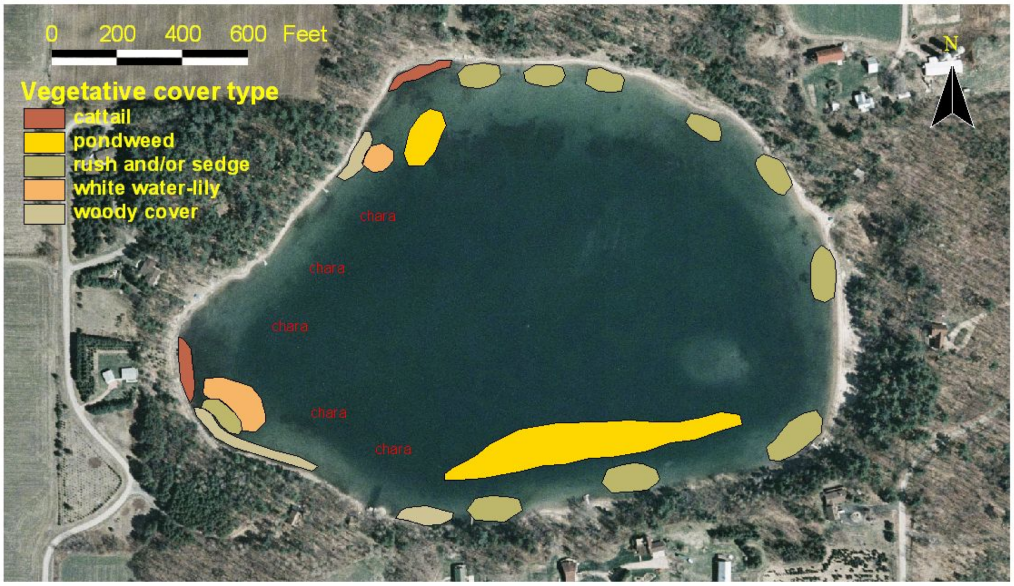
Bottom **substrate** in **littoral** areas is mostly sand with two small areas of sand and gravel on the western shore (Figure 10). The clean sandy and gravel **substrate** may be essential for maintaining populations of the blackchin shiner and blacknose shiner as well as providing spawning habitat for largemouth bass (*Micropterus salmoides*). These sand and gravel areas should be maintained and protected from disturbance or **sedimentation**. **Marl** is common in deeper water beyond the **littoral** zone. Although a portion of the lake is developed, the banks behind the beach are steep and mostly wooded. There are some downed trees in the lake that provide permanent cover for fish.

*Terms in bold, see glossary pp 17-22

Onland Lake has moderate vegetative coverage. There are a number of beds of emergent vegetation located around the lake that would provide limited spawning habitat for northern pike, although no adults or young of year were collected. A small area of water lilies along the western shore and a larger area of pondweeds near the southern shore provide excellent cover adjacent to deep water for a variety of species. *Chara* is widely distributed, but not dominant as in other **marl** lakes (Figure 11).

Figure 10. Littoral bottom map Onland Lake 6/22/03.

Figure 11. Vegetative cover map in Onland Lake 6/23/03.



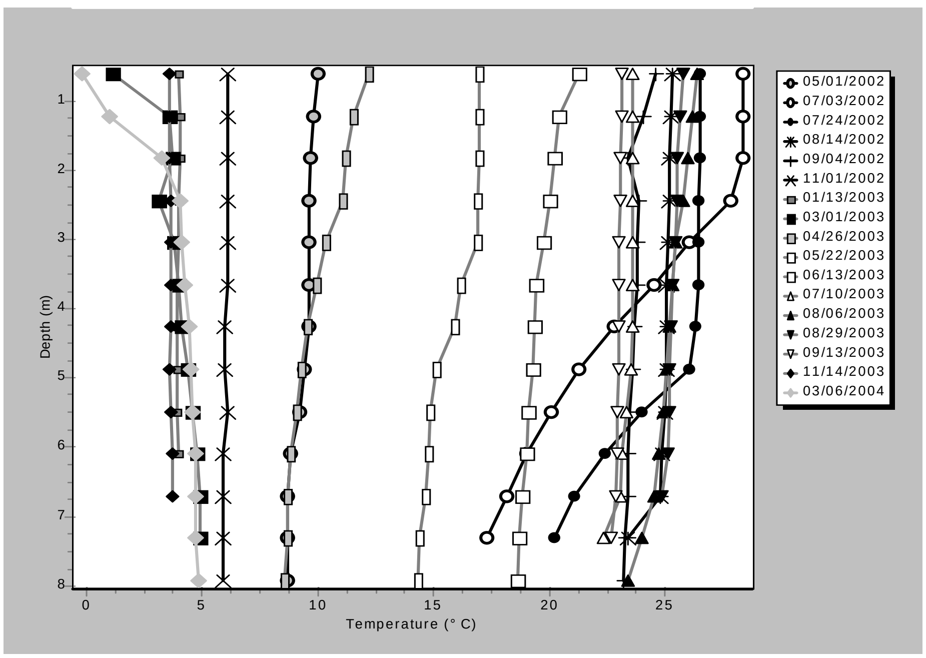
*Terms in bold, see glossary pp 17-22

Current Water Quality Conditions

Water quality in lakes is assessed by measuring different characteristics including temperature, dissolved oxygen, water **clarity**, **chlorophyll *a***, water chemistry, and the algal community. Each of the water chemistry constituents discussed play a complex role in water quality. A more detailed interpretation can be found at the beginning of this report and should be consulted for a more complete understanding of each lake.

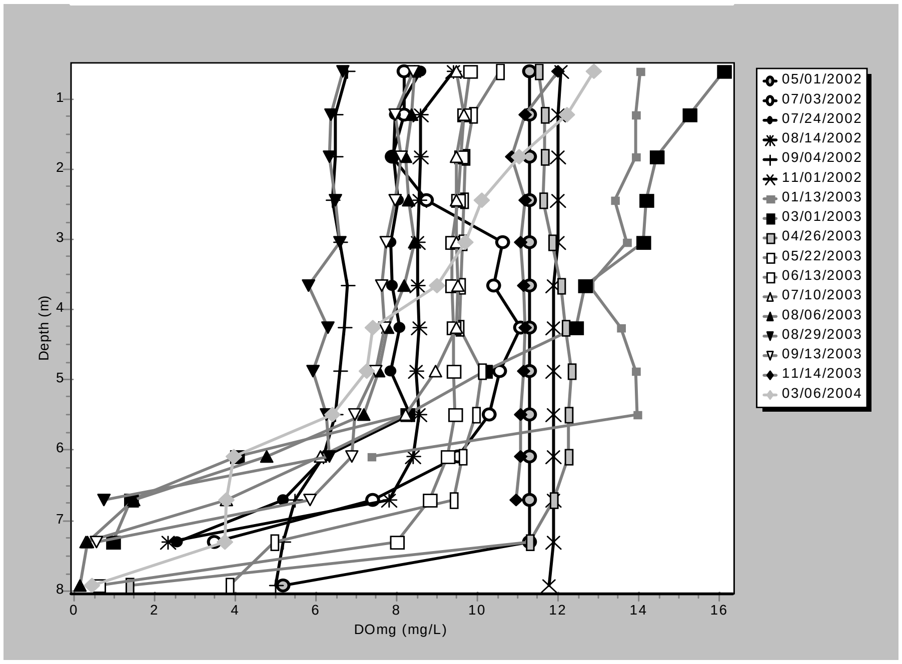
Temperature and oxygen was measured from top to bottom at the time of sample collection. Based on temperature, Onland Lake is mixed throughout most of the year. There was a slight **stratification** observed on several occasions in summer and several times in winter (Figure 12). Oxygen was always plentiful in the upper 18 feet of lake water (Figure 13). During much of the year water in the bottom 6 feet lacks enough oxygen for many biota; however, this is considered normal and is likely due to decomposition of organic bottom materials.

Figure 12. Profile of temperature in Onland Lake 2002-2004.



*Terms in bold, see glossary pp 17-22

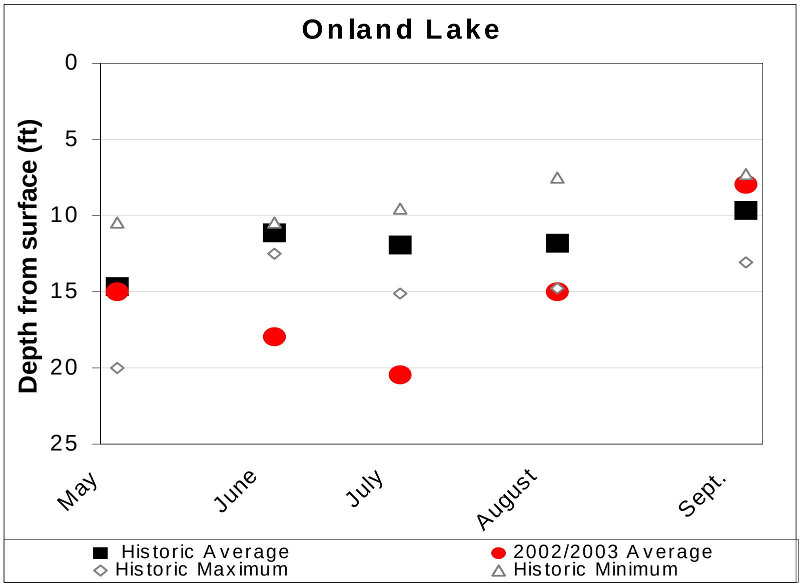
Figure 13. Profile of dissolved oxygen in Onland Lake 2002-2004.



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***). In Onland Lake **color**, **turbidity**, and **chlorophyll *a*** were all low (Table 2). **Chlorophyll *a*** ranged from 0.7 to 7.22 **mg/L**. The water **clarity** in Onland Lake is considered good. The average **Secchi disc** depth reading for similar lakes in the region is 9 feet; Onland Lake consistently has better **clarity** than this (Figure 14). **Secchi disc** depth measurements ranged from 8 to 24 feet. The water **clarity** in Onland Lake during the 2002-03 growing seasons was better than the historical growing season average, except during the month of September. The month of July shows the best water **clarity** and the month of September the poorest. These fluctuations throughout the summer are normal as **algae** populations and **sedimentation** increase and decrease (Figure 14).

*Terms in bold, see glossary pp 17-22

Figure 14. Monthly average water clarity measurements in Onland 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). Both **nitrogen** and **phosphorus** were at low levels throughout the year which also resulted in low **chlorophyll *a*** (**algae**). This is consistent with the results of the water **clarity** measurements. Onland Lake is a moderately hard lake based on total **hardness** (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. These concentrations were all low (Table 3). **Atrazine** was found in low concentrations in the lake water (0.1 ug/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 Onland Lake.

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

Onland 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	9.5	1.5		0.10	0.14	94.0	104.0	50.0	7	7.0	0.005
Summer Averages	11.9	3.0	0.77	0.10	0.02	92.5	95.0	41.0	5	1.4	2.7
Fall Averages	21.0	5.0		0.04	0.09	87.5	70.0	45.0	9	1.8	
Winter Averages	17.0	1.5		0.06	0.16						
2002-2004 Averages	12.3	2.9	0.74	0.07	0.08	91.3	89.7	44.8	6	1.4	2.3

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 17-22

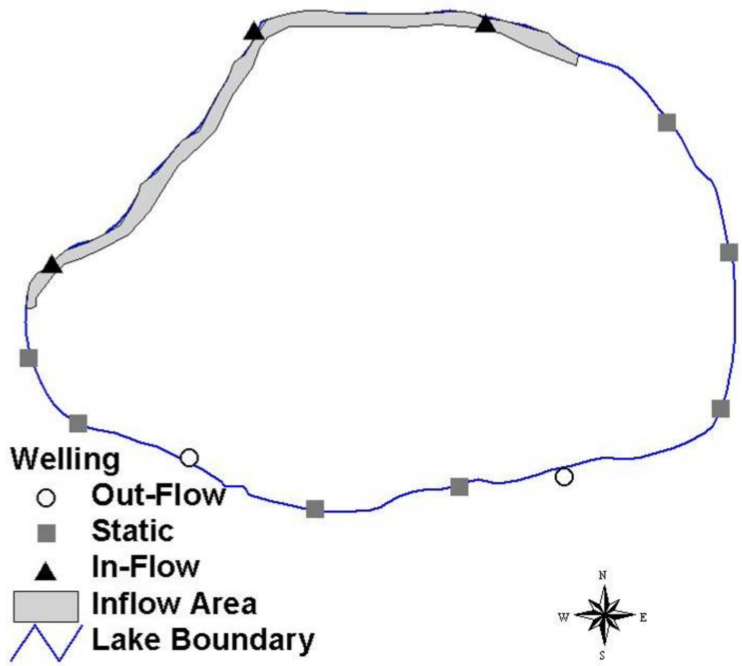
Table 3. 2002-2003 Onland Lake average water chemistry and reference values.

Onland Lake	Low	Medium	High	Reference Values	Low	Medium	High
Sulfate	4.25			Sulfate	<10	10-20	>20
Chloride	2.94			Chloride	<3	3-10	>10
Potassium	0.72			Potassium*	<2.16	2.16-4.30	>4.30
Sodium	1.48			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.*

Mini-piezometers were placed in the sediment around Onland Lake to determine areas of **groundwater** inflow and outflow (Figure 15). In addition, observations of open water around the lake were conducted in early spring to identify potential areas of **groundwater** inflow. Both measures of **groundwater** inflow were consistent, indicating that much of the **groundwater** entering Onland Lake is from the northwest. No samples were acquired for water analysis.

Figure 15. Locations in Onland Lake showing groundwater inflow/no flow/outflow from mini-piezometer measurements and winter observations.



Algal Community

The algal community in Onland Lake was very diverse and dominated by green **algae** and to a lesser extent the Ochrophyta (yellow-green **algae** and **diatoms**). These two phyla accounted for 78% of all cells counted. In the 2138 cells counted during this period there were 6 genera of Cyanobacteria, 16 genera of Chlorophyta, 14 genera of Ochrophyta (including 12 diatom genera), 3 genera of Euglenophyta, and 1 genus of Dinophyta identified. No cryptophytes were counted during the 2003 sampling period. The green

*Terms in bold, see glossary pp 17-22

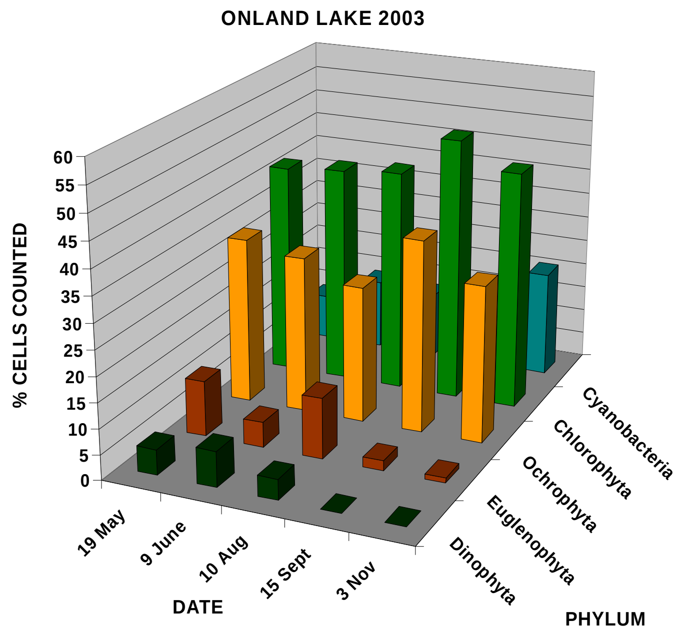
algae represented between 42-52% of all cells counted, the ochrophytes (mostly **diatoms**) represented between 27-38% of all cells counted, and the cyanophytes represented between 9-32% (Table 4). The other two phyla (Dinophyta and Euglenophyta) averaged 9% of all cells counted (Figure 16). The three dominant groups maintained nearly level percent compositions across all the sampling periods. The cycling of the major groups (greens, **diatoms**, and cyanobacteria) was fairly subtle with no group showing rapid bloom potential during the sampling period.

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

ONLAND LAKE

PHYLUM	% CELLS COUNTED BY PHYLUM AND DATE					**MEAN**
	19 May	9 June	10 Aug	15 Sept	3 Nov	
Cyanobacteria	9	14	13	8	21	13
Chlorophyta	42	43	44	52	47	46
Ochrophyta	33	31	27	38	31	32
Euglenophyta	11	5	12	2	1	6
Dinophyta	5	7	4	0	0	3

Figure 16. Algal community composition by date in Onland Lake from May to November 2003 (total phylum cells counted divided by total cells counted).



The green alga, *Planktosphaeria*, was the dominant Onland Lake taxon in four of five sample periods. Green **algae** (*Plankosphaeria*, *Ankistrodesmus*, *Scenedesmus*) occupied the top three abundance spots in seven of 15 samples (Table 5). The **diatoms** *Achnanthes, Asterionella*, and *Synedra* filled four of 15 top spots (Figure 17). The remaining four

*Terms in bold, see glossary pp 17-22

most common taxa slots were taken by the cyanophytes *Coelosphaerium* and the euglenophyte *Euglena*. The most common taxa echoed the relative abundance of the dominant phyla – the greens were the most abundant, the **diatoms** were basically next most abundant, and the cyanobacteria and euglenoids were next most abundant.

The algal community when considered relative to the **chlorophyll**, **phosphorus**, and **nitrogen** values for Onland Lake indicates an **oligotrophic** lake. The 40 genera identified during the sample periods were relatively common and none of the most common taxa are associated with toxins. The water **clarity** during the sampling periods seemed good in this moderately **hard water** lake and the algal densities were generally low. The lack of cyptophytes and the low abundance of euglenoids and dinoflagellates indicate a lack of substantial organic matter input or decay; this is typical of **oligotrophic** lakes. Also common in such lakes is a depressed cycling of the dominant phyla and the lack of a substantial summer or fall bloom. These patterns were all seen in Onland Lake adding support to the conclusion that it is an **oligotrophic** lake.

Figure 17. Algal community composition by phylum in Onland Lake from May to November 2003.

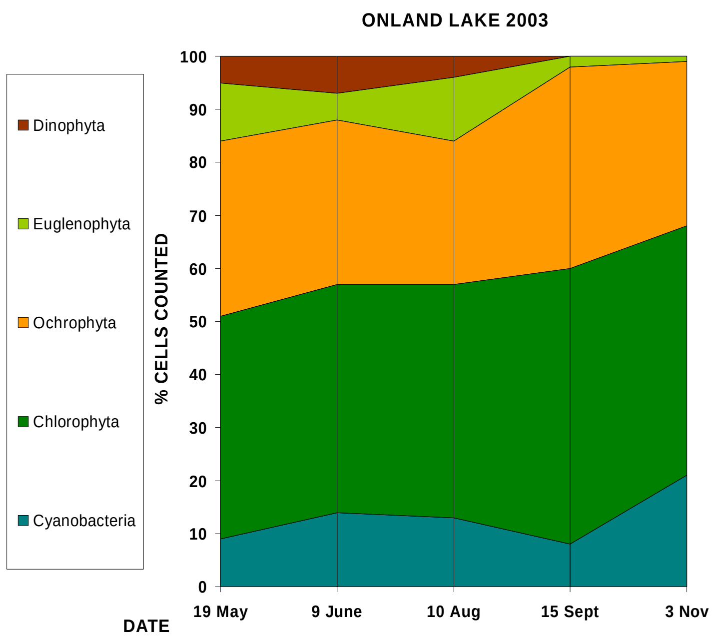


Table 5. Most common algal genera by date in Onland Lake from May to November 2003.

DATE	TOP THREE TAXA (MOST ABUNDANT, LEFT TO RIGHT)		
19 May	*Planktosphaeria*	*Achnanthes*	*Euglena 1*
9 June	*Planktosphaeria*	*Achnanthes*	*Coelosphaerium*
10 August	*Planktosphaeria*	*Euglena 1*	*Scenedesmus*
15 September	*Ankistrodesmus*	*Planktosphaeria*	*Synedra 2*
3 November	*Planktosphaeria*	*Asterionella*	*Coelosphaerium*

*Terms in bold, see glossary pp 17-22

Onland Lake Study Highlights

- The vast majority of the shoreline of Onland Lake is lined with steep slopes that may be susceptible to **erosion**. There are Native American effigy mounds at the east end of the lake.
- Consider re-designing the access at the public landing to reduce sediment **erosion** to Onland Lake.
- Around Onland Lake, 96% of the shoreline is considered to be in an area of disturbance. Of that, 85.1% of the lake's shoreline vegetation is considered to be low disturbance developed and 10.9% is considered to be a highly disturbed developed area.
- The number of aquatic plant species is slightly below average for Portage County lakes. The average **coefficient of conservatism** is about average and the **floristic quality index** is slightly below the average for Portage County lakes. No aquatic plant species have been seen in the lake, but two of the most aggressive alien shoreline plants, purple loosestrife and reed canary-grass, are present in small numbers on the shore.
- There are no official records of fish stocking or intentional management-directed lake poisoning and the fish assemblage appears to be more similar to what would be expected in an unimpacted lake setting. The lake supports blackchin and blacknose shiners, both glacial relics. Because this is a **seepage lake** without inlets or outlets, these populations may be somewhat unique because they have had the potential to have been reproductively isolated for a long period of time.
- Water **clarity** was good. Nutrient concentrations were low as were most other indicators of pollution. **Atrazine** was found in low concentrations in the lake water (0.1 ug/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 Onland Lake.
- The algal community when considered relative to the **chlorophyll**, **phosphorus**, and **nitrogen** values for Onland Lake indicates an **oligotrophic** lake. The 40 genera identified were relatively common, and none of the most common taxa are associated with toxins. The water **clarity** during the sampling periods seemed good in this moderately **hard water** lake and the algal densities were generally low. The lack of cyptophytes and the low abundance of euglenoids and dinoflagellates indicates a lack of substantial organic matter input or decay; this is typical of **oligotrophic** lakes. Also common in such lakes is a depressed cycling of the dominant phyla and the lack of a substantial summer or fall bloom. These patterns were all seen in Onland Lake, adding support to the conclusion that it is an **oligotrophic** lake.

*Terms in bold, see glossary pp 17-22

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 17-22

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 17-22

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.

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.

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 17-22